16th

NCB International Seminar on Cement, Concrete and Building Materials

03-06 DECEMBER 2019
NEW DELHI, India

Clean & Green is Sustainable

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ABSTRACTS

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03-06 DECEMBER 2019, NEW DELHI, INDIA

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National Council for Cement and Building Materials (NCB), set up in 1962, then known as Cement Research Institute of India, is the apex body in India under the administrative control of Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India, devoted to research, technology development and transfer, education and industrial services for cement, building materials and construction industries. Its multi-disciplinary activities are performed in an integrated and coordinated manner through its units that are located at Ballabgarh (Near Delhi) and Hyderabad. The six corporate centres of the council guide the activities at different units. The centre and their main areas of activity are :

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Emerging Technological Options for Improving the Application Potential of Blended Cements

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The family of Portland cements has given rise to an industry that has achieved an annual production level of more than four billion tonnes in just about two hundred years. While this development has been a boon to the human society at large for the extensive construction of the built environment in which we live, work, travel, and rest, it has, at the same time, accounted for about eight per cent of global CO_2 emissions. Because of this environmental concern, the Portland cement industry deployed different methods to reduce CO_2 emissions, in which the most effective and important strategy has turned out to be the production of blended cements with large quantities of supplementary cementitious materials (SCMs). It has been tentatively estimated that a substitution of 60-80 per cent clinker can reduce the carbon and energy footprints of Ordinary Portland Cement (OPC) by more than 50 per cent. Compared to this potential, at present the clinker substitution has contributed, on average, to a 20-30 per cent decrease in CO_2 emissions per tonne of cement produced with reference to the levels prevailing in 1980s. The average clinker factor for cement decreased to around 0.65 in 2014, but thereafter it has been displaying a trend of levelling off. The main constraints in clinker substitution are the availability and cost of SCMs, which are highly variable in different regions, their reactivity, and some of their performance limitations. The practical approach to overcome the limitations of reactivity and performance shortcomings has so far been to process the SCMs as homogeneous powders with high specific surface area but the results have not shown the possibilities of achieving the clinker factor targeted in the roadmap laid towards containing the global temperature rise below two degrees. Research and development for achieving significantly low clinker factor in blended Portland cements continue unabated. In this context, the real focus has been on improving the early age properties of blended cements. The primary objective of investigations is to develop a technique for enhancing the relative volume of hydrates and the secondary objective is to find out the ways of manipulating the meso-scale structure to influence the final properties. Although the hydration behaviour of granulated blast furnace slag is not the same as that of the pozzolanic SCMs, such as fly ash, silica fume, metakaolin or calcined clay, or the nucleating fillers like fine limestone powder, the developmental attempts are aimed for all types of SCMs towards achieving more hydrates than in unblended or high-clinker blended cements.

In order to achieve the above objectives, it is becoming increasingly important to revisit the concept of gel space ratio for different SCMs, and also to consider the binder intensity index for them. Further, the use of SCMs in blended cements has an impact on the fresh concrete properties in terms of filling and rheological behaviour, which obviously need simultaneous attention in expanding the application potential of blended cements. Quite in keeping with the above basics, some of the developments in the field of chemical admixtures have opened up greater opportunities of enhancing the clinker substitution with different SCMs. Two important additive technologies designed to influence the reaction and hydration kinetics in cement are worth mentioning: tri-isopropanolamine (TIPA) and diethanol-isopropanolamine (DEIPA). While TIPA accelerates the hydration of carbo-aluminates in cements containing limestone powder, DEIPA catalyses the hydration of cement with SCMs containing calcium aluminates. The application of customised chemical additives or quality improvers, as they are often called, based on the above synergy with the cement- SCM systems has progressed significantly.

Use of minor additional constituents, such as micro-silica, white-lime hydrates, calcium sulfo-aluminate, calcium langbeinite, etc. has been another positive direction of improving the early-age performance of blended cements. But this approach has been overtaken by the plethora of studies on nano-additives in cement systems. Encouraged by effective results in the application of nano-science, the latest approach has been to synthesize nucleating agents for enhanced hydration with C-S-H precipitates. Highly promising results have been obtained by applying such nucleating agents coupled with PCE based chemical admixtures.

It may be borne in mind that the multicomponent system of Portland cement-SCM-filler-aggregates-chemical admixture-water has enormous space and provides unending opportunities of manipulating its hydration and performance characteristics. The available results are often sporadic but strongly indicative of the possibilities of overcoming the performance shortcomings of blended cements. The present paper is an endeavour to highlight some of the promising directions towards enhancing the potential of blended cements applications.

SUSTAINABILITY ASSESSMENT OF CONCRETE SYSTEMS WITH ALTERNATE BINDERS

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Indian Institute of Technology Madras, India

Cement for concrete, one of the widely used materials in construction, accounts for about 5-8% of the man-made CO_2 emissions, and consequently any reduction in the emissions would make a significant impact on global warming. It is evident that the use of blended binders with low portland cement clinker content can reduce the carbon footprint of concrete drastically, with viable options including the now-common secondary cementitious materials (SCMs) such as slag and fly ash. Also, recent studies have shown that limestone calcined clay is a promising clinker substitute, and considerable research and development effort has been dedicated to demonstrating its technical feasibility and advantages. The refined pore structure, lower diffusion coefficient and other improvements that a concrete with SCMs exhibits makes their usage significant. The combination of environmental impact of the binders with SCMs, with the mechanical and durability performance is needed for rational sustainability assessment of concrete. A proposal has been made to include durability and environmental impacts, along with mechanical properties in a decision framework to choose a sustainable mix.

The present work considers the Indian scenario, with primary data for the life cycle assessment (LCA), required for determining the carbon footprint and embodied energy, being collected at a typical cement plant, and presents the impact assessment for concrete with LC^3, as well as that of more conventional ordinary portland cement (OPC), fly-ash based portland pozzolana cement (PPC) and portland slag cement (PSC). A new set of indicators called A-indices have been proposed for combining the influence of carbon dioxide emissions and durability factors that relate to the service life of a structure. Here, this concept is illustrated by using factors based on the chloride migration coefficient (Dnssm) and carbonation rate coefficient (KCO_2) of the concretes to represent the service life. It is proposed that the decision-making for sustainable concrete be based on the minimization of both the A-index and the energy intensity, defined as the energy demand for a unit volume of concrete and unit performance parameter such as strength. The best concretes considered here come out as those with higher replacement levels of SCMs, i.e. with ternary binders having 40% of OPC replaced by a combination of slag and fly ash, 50% slag and LC^3 systems.

SMART CEMENT-BASED COMPOSITES – A REVIEW

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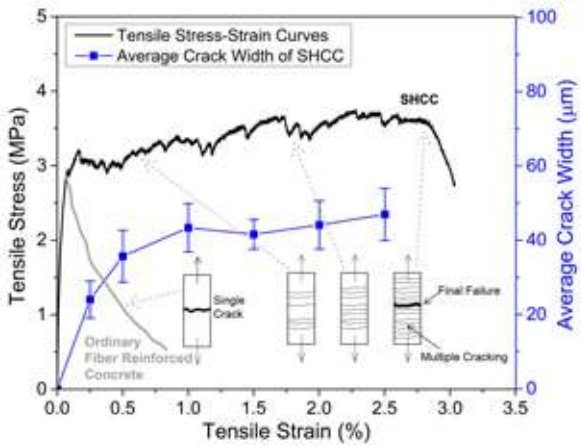
Use of smart cement-based composites is becoming increasingly critical for enhanced durability and serviceability of structures. In addition, self-sensing and self-healing cement-based materials have been subject of increasing research interest. Addition of carbon fibres, carbon nano-tubes and various nano-powders such as nano-silica, carbon black and graphite giving cement-based matrix electrical properties that can be used for self-sensing has been known for over decade and a half. In addition, more recently, the strong capacity of Fiber Reinforced Cement-based Composites (FRCCs) for autogenous healing in addition to crack-width control (especially in the case of Strain-Hardening Cement-based Composites or SHCCs) has been reported by many researchers. Similarly, the application of different mineral and bio-additive based materials to accelerate autonomic self-healing of cracks has been noted with great interest. Designing for serviceability based on durability performance of the materials used in concrete structures is often neglected. Compliance with provisions prescribed by codes and standards for different exposure conditions mainly related to cover thickness, water/binder ratio and minimum binder content are often the only design approach employed. With durability performance testing becoming more sophisticated, detailed service life design is being demanded in most important infrastructure projects. The present review is focused on identifying field applications and highlighting the Performance Driven Design Approach (PDDA) for tailoring material solutions for the problems likely to be faced by the civil engineering infrastructure of the future. One of the real-life case studies presented in this paper illustrates the minimal cost implications of adopting latest smart material for a much more eco-friendly, durable, reliable and safe infrastructure. Identifying critical challenges faced by the industry and developing solutions for the same is going to help bridge the gap between research and adoption. The paper discusses the implication of these technologies for the Indian scenario.

Keywords

Smart Concrete, High Performance Concrete, Faber-Reinforced Concrete, SHCC, Durability, Self-sensing, Self-healing, Service Life



TECHNICAL SESSION – I A

RAW MATERIAL RESOURCE MANAGEMENT

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USE OF HIGH MGO LIMESTONE IN PORTLAND CEMENT MANUFACTURE : AN INDIAN PERSPECTIVE

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Indian Cement Industry is presently facing an acute problem for the manufacture of quality cement from the existing marginal and sub marginal grade limestone. These limestone are either siliceous (high silica) or dolomitic containing high MgO. The higher content of MgO in raw materials not only causes serious problem in pyro-processing during the clinker manufacture but also makes the cement unsound. In this article the authors not only discuss the causes and problems encountered due to high MgO in raw materials during production of the Portland Cement Clinker but also suggests remedial measures to overcome such problems.

It has been observed that when the MgO content is <2.0% in the raw meal, most of it is incorporated into the crystal structure of clinker minerals and works like a mineralizer by improving the burnability during burning promoting the absorption of free lime and improving the formation of C_3S and C_4AF.

This increases the early strength of Portland cements and shorten the setting time. Use of 04.0-0.8 % Calcium Fluoride (CaF_2) as a mineralizer can also control the detrimental effects of higher content of periclase (MgO) particles during pyro-processing. Increasing the fineness of the cement can reduce late expansion of the MgO. Impact of the clinker cooling and particle size distribution in cement have been discussed which reduces unsoundness. Alternately, the production of blended cements, composite cements and sulpho-aluminate belite cement provide elegant solutions to this burning issue.

USE OF HIGH PHOSPHATE LIMESTONE IN CEMENT MANUFACTURE - A CASE STUDY

M V Karandikar and Ashish Prasad

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The Raw Mix & Product Development Division of ACC Ltd Thane, India , has carried out a number raw mix optimization studies for quality up-gradation and productivity enhancement. These studies comprise of assessment of the existing quality status of the cement plant under study, through evaluation of chemico – mineralogical and thermal characteristics of raw materials and process circuit samples. The interrelationship of the data throw enormous information leading to optimal raw mix design for overcoming the problems related to quality and productivity enhancement.

The influence of phosphatic raw materials on clinker phase formation and on cement hydraulicity has been widely studied by researchers viz: Gutt, Welch, Nurse, Schlaudt, V'Ikov et al. It has been experimentally demonstrated that at lower levels of phosphates (0.5-1.0%), solid solutions of C_2S-calcium-phosphate is in equilibrium with C_3S,these phosphatic compounds are as solid phase at clinkering temperatures due to which even with an increase in liquid content of clinker (because of phosphates), process problems like ball formation /ring formation are not encountered.

It has also been observed that in presence of phosphates, clinkers with lower alumina modulus (with low C_3A) show a shift in the phase equilibria towards decreased C_3S formation, as compared to clinkers at same levels of phosphates but with higher alumina modulus, i.e with higher C_3A. During clinkering reactions the phosphates present in raw materials get converted to soluble phosphate compounds. In the hydration of the cement, the hydrating cement particles interact with the water soluble acidic phosphate ions released from the phosphatic compounds, leading to deposition of insoluble tricalcium phosphate on the surface of the hydrating grain forming an impervious layer which retards further reactions with water, thereby affecting the rate of hydration.

The case study in this paper discusses the investigations on one of such raw mix studies having higher phosphate in limestone, where the cement quality trends indicated unusually high setting time and poor development of compressive strengths. Raw Materials, in process materials and cement characterisation revealed presence of phosphate minerals in raw materials and its derivatives in processed material as responsible for the quality related problems. The paper discusses the laboratory studies and raw mix designs carried out for modifying the clinker properties due to formation of hydroxyapetite phase during clinker formation to overcome the slow setting and poor compressive strengths in cements.

VALUE ENGINEERED RAW MATERIAL AND CEMENT GRINDING PLANTS

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In case of plant upgradations or new integrated cement plants, the total Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) are a main focus of cement producers and shareholders. Against this background and based on the experience of Thyssenkrupp Industrial Solutions (TkIS) the value engineering called approach is to design integrated cement plants showing measureable advantages for cement producers and becoming extraordinary attractive. The value engineering follows organized, systematic and measurable steps to achieve overall optimization of operating functions and costs and comprises the working packages process design, mechanical and electrical equipment, plant design, civil engineering, logistics, construction, erection and maintenance.

The first phase is a concept engineering, which starts with the technical and commercial optimization of the proprietary equipment (e.g. the quadropol® vertical roller mill, polycom® high pressure grinding roll or sepol® separator). Main focus of the process optimization is on the increase of efficiency and savings of valuable resources.

The optimized proprietary and auxiliary equipment will be combined afterwards in standardized grinding plant modules. During this phase the process design, the arrangement of the equipment, the erection and maintenance concept as well as the building concept (distribution of civil and steel structure) will be discussed, evaluated and optimized.

Figure 1 shows the standardized grinding plant module for a quadropol® vertical roller mill (Transfer Tower, quadropol® section, Cyclone Tower and Gas Compound Tower are highlighted).

Fig-1: Standardized grinding plant module: quadropol® vertical roller mill

Also the electrical equipment like transformers or MCCs can be integrated in the grinding plant modules and also cable length can be minimized. For this purpose, modern IT tools are used. During this phase flexibility is designed into the concepts to match special raw material or product properties as well as customer requirements or design criteria.

SYNOPSIS: "INDIAN CEMENT INDUSTRY – A PERSPECTIVE"

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Holtec Consulting Pvt Ltd, India

This article intends to provide an objective perspective into the Indian Cement Industry and delves into the associated fallacies and entails exploring the truth/facts behind these myths.

Indian cement industry is on a path of recovery, after growing at a lower growth rate of 6% p.a. in past, the cement demand is expected to grow between 7-8% p.a. in future. Demand is envisaged to reach 500 mio t in FY24 from around 350 mio t in FY19. Effective Cement Capacity (assuming cement plants on an all India basis can operate at maximum 90% capacity utilization) was about 445 mio tpa in FY19 and is projected to exceed 530 mio tpa in FY24, indicating that new capacities will need to come up to meet the demand of FY24 and beyond.

This article examines the following fallacies in the Indian Cement Industry:

- The cement industry is moving towards consolidation
- Plants need to work at 75 - 80 % capacity utilization to operationally cash break-even
- Indian plants have competitive advantage to export to deficit countries
- Limestone availability is abundant
- Imported clinker based grinding units are a viable long-term business model

The paper concludes that the Indian cement industry is likely to witness higher capacity utilization in coming years. India is a fragmented market and is envisaged to remain so in future with no particular cement company/ small group of cement companies being in a dominating position to influence market policies. In Indian cement industry, barriers for new entrants are high due to limestone being now available only through the auction process. However, once a plant is setup, the new entrants can work at 50-55% capacity utilization to achieve operational cash break even in their initial years and thus sustain themselves.

Looking at the demand-effective capacity balance and gestation period for setting up a greenfield plant, we can expect work commencing on some greenfield projects within the next year or so. However, in the short-medium term, brownfield capacity expansions will dominate new capacity additions.

REDUCTION IN LSF OF LIMESTONE PILE AT CHANDERIA CEMENT WORKS PLANT

Dinesh Kumar, D Banerjee and K K Singh

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Limestone is the main raw material for cement production and Lime Saturation Factor is a ratio of CaO to the other three main oxides. Applied to clinker, it is calculated as:

$LSF=CaO/(2.8\ SiO_2 + 1.2\ Al_2O_3 + 0.65\ Fe_2O_3)$

Often, this is referred to as a percentage and therefore multiplied by 100.

The LSF controls the ratio of alite to belite in the clinker. A clinker with a higher LSF will have a higher proportion of alite to belite than will a clinker with a low LSF. Typical LSF values in modern clinkers are 0.92-0.98, or 92%-98%.

With depletion of high cement grade limestone, presently Indian cement industry is facing an acute cement raw material problem for smooth plant operation and manufacture of higher grades of cement. Although India is bestowed with huge limestone deposits but most of the deposits in India presently available for cement manufacture are either marginal grade or low grade.

LIMESTONE PILE LSF	
2017-18	2018-19
112.5	107
OUTSOURCES LIMESTONE CONSUMPTION %	
2017-18	2018-19
38.08%	21.8%

CONSERVATION AND MAXIMIZATION OF LIMESTONE RESERVES BY ADOPTING SUITABLE MINING PROCESS (CASE STUDIES)

Richa Mazumder, Subrat Sahoo, A K Dubey and D K Panda

National Council for Cement and Building Materials, India

Limestone is the main raw material for cement manufacture, accounts for about 92% consumption in cement industry. In 2016-17, the total consumption of limestone, as reported by different industries was 242.45 million tonnes. As per Indian Bureau of Mines (IBM) only 10% of cement (Portland) grade limestone comes under reserves category and rest i.e. 90% are under remaining resources. So, for sustainability we have to maximize limestone reserve use efficiency (since they are finite) through extracting maximum value from mined products. Extraction and management of limestone reserves has to be guided by long-term national goals and perspectives and integrated into the overall strategy of the country's economic development.

Conservation is a positive concept leading to augmentation of reserve base through improvement in mining methods, beneficiation and utilization of low-grade ore and rejects and recovery of associated minerals. Given limitation on degrading quality of limestone reserves and in order to achieve resource efficiency, the Indian mining sector is already looking forward to adopt advanced mine surveying and exploration along with the usage of software solutions by utilizing 3D software packages in the mine planning and design stage. Still there are cases where cement grade limestone reserves are blocked due to several reasons.

In this paper, three cases have been taken where limestone reserves are blocked either by magazine area present within the mining lease boundary or by the road present in between the two limestone blocks which can be avoided by adopting suitable mining process. In case I, limestone reserves of 15.90 million tonnes are blocked due to the explosive magazine having an area of about 45.00 hectare is inside the mine lease area. Similarly, in case II, there will be an availability of additional 29.27 million tonnes of cement grade limestone reserves if the magazine safety area is shifted outside the mining lease area. In case III, there will be availability of additional 60.17 million tonnes of cement grade limestone reserves if the road passing between two limestone blocks is shifted outside the mining lease boundary.

From the above three case studies, it is observed that by shifting the safety zone for explosive magazine area outside the mining lease boundary in the first two cases and shifting the road passing between two limestone blocks outside the mining lease boundary in the third case would not only result in maximum utilization and conservation of the available limestone reserve within the mining lease area but also ensures the enhancement in life of concerned clinkerization unit by 7 years, 13 years and 27 years respectively.

TECHNICAL SESSION – I B

PORTLAND, BLENDED AND SPECIAL CEMENTS – I

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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HIGH MAGNESIA (MgO) CLINKER FOR THE MANUFACTURE OF PPC AND PSC

B N Mohapatra, G Ahamed, G J Naidu, Suresh Palla, G Bhatnagar and S K Chaturvedi

National Council for Cement and Building Materials, India

The objective of this study is to investigate the performance of high magnesia clinker containing up-to 8% MgO for the manufacturing of blended cements, such as PPC and PSC to utilize high MgO content low grade limestone for clinker manufacturing. In the present study two different types of high MgO clinker samples named as clinker-1 (MgO~6.8%), and clinker-2 (MgO~7.5%) were used for the preparation of Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC) and Portland Slag Cement (PSC) samples. Mineralogical characterisation of the above high magnesia clinker samples were studied by using Optical Microscopy and XRD. OPC, PPC and PSC cement samples were prepared by intergrinding the constituents in a laboratory ball mill utilising clinker-1 (CL-1) and clinker-2 (CL-2) respectively keeping the fineness level 350±10 m2/kg. PPC batches were prepared using 15, 20 and 35 weight percentage of fly ash in the cement. Whereas 25, 35 and 60 weight percentage of slag were used for the manufacturing of the PSC batches.

The results of the physical performance characteristics carried out as per IS:4031 indicated that in case of OPC samples, all were meeting the requirement of IS:269 except autoclave expansion. In case of PPC, it was observed that the samples prepared using clinker-1 were conforming all the requirements of IS 1489 (part-1). However, in case of clinker-2, PPC samples containing 15% fly ash also found to conform all the requirement as per IS 1489:2015 (part-1) except autoclave expansion. Similarly, in case of PSC, it was evident that samples prepared using clinker-1 were conforming all the requirement of IS:455. However, in case of clinker-2, it was found that PSC sample containing 25% GBFS conformed to all the requirement as per IS:455 except autoclave expansion. Hydration mechanism of these blended cement samples were also studied by DTA/TG and XRD and SEM. With the increase of the MgO content in the clinker as well as in the resultant cement samples, marginal reduction in the compressive strength were observed. Further studies on clinker with MgO content more than 8% are underway.

PROPERTIES OF CALCINED CLAY BASED GEOPOLYMER MORTARS IN PRESENCE OF ALCCOFINE POWDER AND POLYMER FIBER AT ROOM TEMPERATURE

S K Saxena, Mukesh Kumar, SK Wali and N B Singh

JK Lakshmi Cement Ltd, India

Geopolymer cement is produced from materials rich in aluminosilicate such as kaolinitic clay, meta kaolin, fly ash, etc., when mixed with alkali hydroxide and alkali silicate solutions at room temperature (27±2°C). Geopolymer cement mortars were prepared by using calcined clay (CC) in the presence of Alccofine powder (AF) and Recron Fiber (RF). Sodium hydroxide and sodium silicate solutions were used as alkali activators. Curing was done at room temperature and compressive strengths were determined. Calcined clay was characterized by using X-ray diffraction and TG techniques. Alccofine powder increased the compressive strength. This was due to increased geopolymerization and filling of the pores by alccofine powder. Recron fiber on the other hand decreased the strength. This was due to absorption of water by the fiber. SEM was used to study the morphology. EDX of the mortars were also recorded. FTIR spectroscopy was used to have an idea about the interaction in the geopolymer mortars. Durability of mortars in sulphuric acid was also investigated.

INCREASE UTILISATION OF FLY ASH IN PPC AT CHANDERIA CEMENT WORKS PLANT

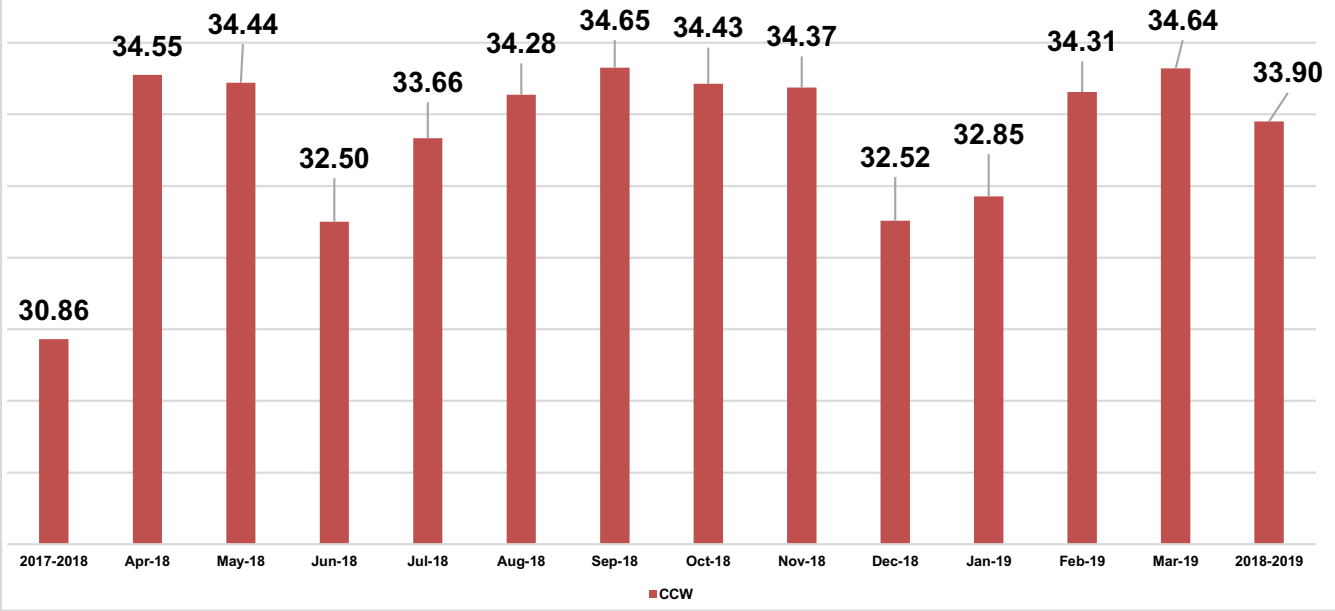
Dinesh Kumar, D Banerjee, D C Jagetiya and Narpat Anjana

Birla Corporation Ltd, India

In the past, fly ash produced from coal combustion was simply entrained in flue gases and dispersed into the atmosphere. This created environmental and health concerns that prompted laws which have reduced fly ash emissions to less than 1% of ash produced. Worldwide, more than 65% of fly ash produced from coal power stations is disposed of in landfills and ash ponds. In India alone, fly ash landfill covers an area of 40,000 acres (160 km^2). The recycling of fly ash has become an increasing concern in recent years due to increasing landfill costs and current interest in sustainable development.

Up to 35% of suitable fly ash can directly be substituted for cement as blending material. Addition of fly ash significantly improves the quality & durability characteristics.

By doing all the trials as above and various in house modification, Increased Fly ash absorption from 30.8 % to 33.9 % as annual average. Month wise and annual fly ash absorption has been given below: -



INVESTIGATION ON UTILIZATION OF WOLLASTONITE IN MANUFACTURE OF OPC CLINKER

Varsha Liju[1], S Sridhar[2], Mukesh Kumar[3], S K Saxena[3], S K Chaturvedi[1] and B N Mohapatra[1]

[1]National Council for Cement and Building Materials, India
[2]Wolkem India Ltd, India
[3]J K Lakshmi Cement Ltd, India

Global warming caused due to CO_2 emissions is increasing at an alarming rate. Cement production is known to contribute ~7% of global CO_2 emissions. Efforts are being made to minimize the emission of CO_2 per tonne of clinker from the present rate of 0.86 t/kg clinker to 0.35 t/kg by 2050. Many steps are being taken to achieve the above mentioned target. Around 60% of the total CO_2 emitted during cement manufacture is due to calcination process. Thus it is evident that use of a non carbonate lime bearing raw material for cement manufacture can drastically reduce the CO_2 emission.

The present work is carried on with the utilization of a wollastonite mineral which is a non carbonate lime bearing material by replacing equal quantity of conventional carbonate raw material i.e limestone in cement manufacture. Wollastonite is a naturally occurring calcium silicate mineral with the molecular formula $CaSiO_3$. It is a white color, needle shaped crystal. Wollastonite is found associated with other accessory minerals like quartz, calcite, diopside (calcium magnesium silicate), feldspar (calcium, sodium or potassium alumino silicate materials) garnet (calcium iron silicate, calcium aluminum silicate) etc.

These accessory minerals in wollastonite act as mineralizers and thus reduce the energy consumption for clinkerisation. For the present study, wollastonite was used for manufacture of OPC clinker along with the other conventional raw materials like high grade limestone, feedable grade limestone, low grade limestone and red ochre. Mix designs were prepared using 1 to 5% wollastonite by replacing limestone content in the raw mix. A control sample was also designed without using wollastonite mineral. The results of the mineralogical analysis showed that the clinker phases with wollastonite at 1400°C were comparable to the control clinker at 1450°C.

Thus wollastonite is a potential material for cement manufacture. Its unique characteristic of being a lime bearing non-carbonate material proves its usefulness in the much needed CO_2 reduction during cement manufacture and its mineralizing effect leads to reduction in energy consumption and fuel saving.

DETERMINATION OF SLAG & FLY ASH CONTENT IN COMPOSITE CEMENT BY X-RAY DIFFRACTION METHOD

Vaibhav Dixit, Hemant Sahu, Asit Parui, S V Kadam and K Rajesh

ACC Ltd, India

Now a days most of the cement plants are manufacturing composite cement; as per specification Portland Cement Clinker/Ordinary Portland Cement should be 35-65%, Fly ash should be 15-35%, Granulated Slag should be 20-50% with addition of gypsum so as to produce cement capable of complying standards of composite cement specification (IS 16415-2015)

During composite cement production; raw material input control by monitoring of Lime content, Insoluble Residue, Loss on Ignition in cement etc. In case of composite cement lime content is mainly govern by clinker, slag, gypsum addition in cement. Traditionally slag content & fly ash content were separately analyzed either by microscopy method or convectional wet chemical method respectively. Both the method are require long analysis time.

In this regards, composite cement samples with variation in slag & fly ash contents were evaluated with conventional methods. While conducting these studies, a correlation method was developed between XRD method & conventional method. It measures slag and fly ash phases in composite cement using XRD techniques.

Our laboratory is having integrated XRF-XRD system with 'Siroquant' software for phase quantification. XRD methods are developed for each raw material & cement types. For composite cement phase quantification are done for various phases of Clinker, Fly ash, Slag, Gypsum. With the study of these component it is been observed that it is possible to determine fly ash & slag content by correlating slag phases & fly ash phases with conventional method. With this background, a correlation was established to determine fly ash & slag content which is fast & accurate.

This paper discusses a method developed on X-ray diffraction system to analyze & to monitor slag and fly ash content in the composite cement. The method is based on accurate profile fitting using XRD quantification software and refining it at regular interval. Data obtain by these method is correlated & verified with conventional method shows that this method can be use as alternative tool to keep close monitor and control of slag & fly ash in process material and could relate effectively to performance of composite cement.

As method is plant specific & applicable for material from the same source. Periodic checks & refinement of XRD templates are necessary to improve the accuracy of the method.

INVESTIGATIONS ON IMPROVING THE PERFORMANCE OF COMPOSITE CEMENT BY SEPARATE GRINDING OF CONSTITUENTS

Varsha Liju, G Ahamed, P Pandey, M Sharma, M Pawar, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Composite cements can be produced by either intergrinding of clinker, flyash, GBFS and gypsum or by blending of the separately grinded clinker, flyash and GBFS. There are a number of factors governing the selection of appropriate grinding technique for manufacture of composite cements. The types of SCM used, energy consumption, replacement levels, the required fineness, strength and durability properties all play a vital role in deciding the suitable communition and mixing technique in cement manufacture. Although, the present standard for composite cement permits its manufacture through both the routes of inter grinding and intermixing, but mostly it is manufactured in plants through the route of inter grinding. In the present work a comparative study is carried out in the performance of composite cement prepared through both the route of intergrinding as well as separate grinding and blending

In the present work composite cements were prepared with varying concentration of constituents through both intergrinding as well as separate grinding and blending. Another set was prepared by intermixing slag with PPC and fly ash with PSC.

Results obtained from one of the set is presented in this paper. Clinker, fly ash and gypsum samples were collected from a cement plant situated in northern part of the country. Granulated blast furnace slag was collected from a steel plant. 20 nos of composite cement blends were prepared with by intergrinding as well as separate grinding and blending of constituents at two fineness levels of 350 ±10 m^2/kg and 400±10 m^2/kg. The prepared composite cement samples were studied for its chemical constituents and physical performance as per relevant Indian standard methods.

The performance evaluation of composite cement samples indicated that the composite cement samples prepared by separate grinding and blending showed better strength properties. This improvement in properties is due to the fact that particle size distribution is better in cements prepared with separate grinding. Also in intergrinding the harder constituents are lesser ground and have less contribution in strength giving phases. Therefore, the cements prepared by separate grinding of constituents gave better strength properties.

TECHNICAL SESSION – II A

ALTERNATE / WASTE FUELS AND RAW MATERIALS

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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LD SLAG UTILIZATION FOR CLINKER PRODUCTION

Lokesh Bahety and Chandan Sengupta

Dalmia Cement (Bharat) Ltd, India

The aim of this project work is to investigate the possibility of utilizing LD slag in cement manufacturing process. LD slag is a byproduct of the Linz-Donawitz process and is constantly produced as pig iron is processed into crude steel.

There were two proposals for the utilization of LD Slag

Addition of LD slag in Portland Slag Cement (PSC) as a partial replacement of Blast furnace slag.

Using as one of the raw meal component for the production of Portland cement clinker

As the result of the Laboratory scale trial for the first proposal shows a deterioration in strength this proposal for utilization of LD slag directly in manufacturing cement was rejected by the team and the 2nd proposal for using LD slag as a raw meal component for manufacturing Clinker was chosen for conducting trial.

A rawmix design was prepared and a burnability test was conducted.The result as obtained has shown a good burnability.

Clinkerisation (Temp 1420 degc)- 100gms Lab scale sample compared with respect to Free lime (burnability)

Based on the Lab scale trial a plant scale trial was planned and conducted.Based on the satisfactory trial result the same rawmix was permanently implemented.

- ***Set up of Feeding System-***

  A) Initial set up done which is still in operation with in-house tailored equipment & manual feeding arrangement and use of LD Slag for Clinker production is monitored using number of feed by Pay loader per day.

Permanent feeding system is under CAPEX approval stage and may contain full automated system with Accurate Weighing system

Utilization of LD Slag for Clinker production			
Date	Wet LD Slag	Dry LD Slag	Clinker (From LD Slag)
Feb-19	911	829.78	788.29

Benefits: (1)Conservation of natural resources : - 2% substitution of naturally occurring Limestone; Reduction of Specific Heat consumption by 10 kcal/kg clinker and hence reduce non renewable fuel consumption (2)Environment friendly - Reduces NOx emission by 50-70 mg/nm^3; - Utilization of waste material such as Slag and avoid land pollution (3)Cost effective - Return on Investment 4.67 months of Kiln running (4)Variable cost reduction - **Rs. 11/T of Clinker for Line-2. Rest is discussed elaborately in Full Technical Paper.**

AFR HANDLING SYSTEM

Michal Hrala

BEUMER Group, Czech Republic

A new AFR handling and feeding system, designed and delivered by BEUMER Group, was commissioned in Lafarge Retznei, Austria. The system was designed for handling of RDF of max 120 mm lump size (3D) at capacity of 15 t/h and is composed from the following equipment:

- Truck unloading station (BG OptiBulk)
- 20 m^3 screw weigh feeder (BG OptiFeed) filled by BG OptiBulk
- 50 m^3 screw weigh feeder (BG OptiFeed) filled by a conveyor from the existing storage hall
- U-belt conveyor (U250, length 250 m) Screw air-lock (BG OptiLock)
- Connecting screw conveyor

The system can handle material from 2 different sources – either the existing storage hall (main RDF source) or new truck unloading station (back-up source). Such concept secures 100% guarantee of AF feeding into the system because in case of malfunction of AFR storage hall, the material can be fed through the truck unloading station. Moreover, there is a possibility that some difficult or course AF materials can be added into the main RDF material stream in an exactly defined ratio so that materials are fed from both source at the same time. Material reception zone of the truck unloading station is covered by a hall, which protects the material during the walking floor trailer unloading from escape. The truck unloading station can be in case of need also fed by a front-end loader. The station serves as a material storage as well, when at least 30 m^3 can be accommodated inside.

Material is fed into the system by 2 BG OptiFeeds, which are fully closed screw feeders with feeding accuracy of +/-1%. BG OptiFeeds are regularly self-calibrated, and it allows reach such exact feeding rates.

Part of the system is also U-belt conveyor. This type of conveyor has the upper strand partly open in the U-shape, the lower strand is fully folded in the tube shape. Such arrangement allows convey larger pieces of material than a conventional pipe conveyor but still the conveyor is as flexible in routing as a pipe conveyor. At the discharge point of U-belt conveyor, there is a BG OptiLock what is an air-lock sealing the calciner from a leakage air. A certain material level is constantly maintained in a small hopper, resting on the load cells, above the screws and the system is so-called material sealed.

Entire system is in ATEX design.

This new AFR system is a further step in the AFR handling technology development, which secures the customer a high reliability and accuracy of AF feeding into his pyro process.

HANDLING OF MULTI TYPE ALTERNATIVE FUELS: A CHALLENGE AND OPPORTUNITY FOR CEMENT PLANT

Kapil Kukreja, Anupam, Prateek Sharma and Saurabh Bhatnagar

National Council for Cement and Building Materials, India

Coal is a primary fuel for Indian cement industry which provides heat for clinker production process (~ 25 to 30% of production cost is from fuel cost). Usage of Alternative Fuel (AF) becomes more popular in Indian cement industry due to higher fossil fuel prices, Ltd fossil fuel resources and stringent environmental norms. Substantial volume of the industrial, commercial, domestic and other wastes has the potential for use as an alternative fuel for energy recovery. Environmentally sustainable utilization of wastes for energy recovery can be practiced in various industrial processes. However, cement kiln is being considered as an effective and sustainable option for alternative fuel utilization. Indian cement plants are adopting the Alternate Fuel (AF) for sustainable development and achieving adequate Thermal Substitution Rate (TSR).

To achieve the targeted TSR, the cement manufacturers are adopting all possible alternate fuels according to their geographical availability and economic viability. For the AF systems, it is basic requirement to handle all type of AF utilized by the cement plant like Refuse-Derived Fuel (RDF), Industrial Plastic, Biomass, Tire chips, Hazardous waste etc. to run the plant economically. Available AFs in India have different characteristics & Physical Properties and handle these fuel with a single system is always a challenge. This paper will highlight the challenges to select a single system which may handle maximum possible AFs without any trouble for optimizing the Capital Investment and Operation Cost.

INCREASE USAGE OF AFR

Dinesh Kumar, K S Gour, R K Sharma, Narpat Anjana and R P Badoni

Birla Corporation Ltd, India

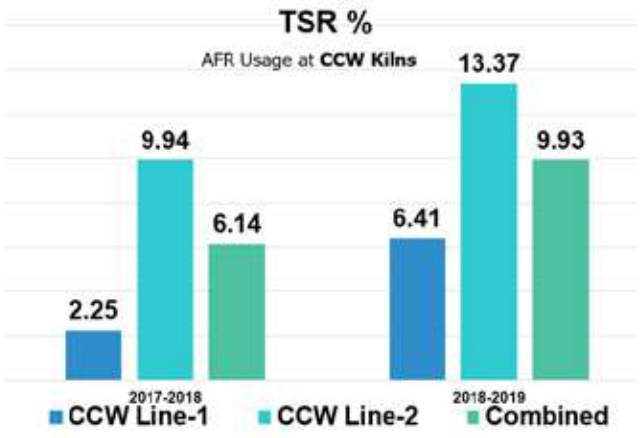
Co-processing is the process of adapting an existing industrial process whereby certain so-called waste' materials may be put to use to serve as alternatives resources as fuels in cement kilns. These materials generally termed "alternative fuels and raw materials" (AFR). Energy costs and environmental oncerns have encouraged cement companies worldwide to evaluate to what extent conventional fuels can be replaced by waste materials, such as waste oils, mixtures of non-recycled plastics and paper, used tires, biomass wastes, and even waste water sludge.

India is the second largest cement producer in the world after China, having installed capacity of more than 415 MTPA. However, the thermal substitution rate (TSR) for alternative fuels range between 4 to 5%, being much below than 30 to 80% achieved in European countries.

Indian Cement Industry has been making concerted efforts to increase the thermal substitution rate (TSR) 20 to 30% by use of alternative (AFR) fuels by 2030.

Birla Corporation Ltd has taken initiative to promote the use of alternate fuels.

By team efforts and variuos in house small modification, we have achieved 13.37% as annual thermal substitution rate (TSR) for CCW Line-2. We have consumed 48773 MT AFR during FY 2018-19 which is much more than previous year (it was only 23886 MT for FY 2017-18). We have started collecting colony wastage as dry and wet basis and started using as AFR.



UTILIZATION OF LEATHER SLUDGE IN CEMENT MANUFACTURE

D Yadav, S Palla, S Vanguri, G J Naidu, M Verma, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Investigations were carried out for utilization of leather waste sludge obtained from a leather manufacturing industry, as a raw material for clinker manufacture. The chemical characteristics along with ash percentage and GCV of the waste material were studied. In addition thermo gravimetric analysis of the leather sludge was examined in order to investigate the combustion characteristics and estimate ash percentage below 900°C. Raw mixes containing 0, 1, 2 and 3% of the leather waste sludge were prepared and basic characteristics, such as chemical contents, free lime, percentage of C_3S, C_2S, C_3A and C_4AF were determined and compared with a control mix. The obtained results revealed that leather sludge of 1 wt% content shows good burnability characteristics and comparable clinker mineral phases compared to control mix. Leather sludge shows mineralizer characteristics by reducing the free lime due to the presence of chromium and other heavy metals. The results showed that 1 wt% of leather sludge added designed raw mix chemical composition of clinker is within the limits of IS 16353-2015. The free lime results of designed clinkers with leather sludge are marginally lower/comparable at 1350, 1400 and 1450°C compare to control mix

The results showed that 1 wt% of leather sludge added designed raw mix chemical composition of clinker is within the limits of IS 16353-2015. The free lime results of designed clinkers with leather sludge are marginally lower/comparable at 1350, 1400 and 1450°C compare to control mix.

Mineralogical compositions of designed clinker with leather sludge show fine particle size of C_3S crystals than the control sample. Physical performance evaluation of cements obtained from above designed clinkers were studied by the preparation of OPC and the results shows that designed clinker with leather sludge sample shows marginal improvement in the initial days (3 and 7) performance than control sample. Later age performance of designed clinker with leather sludge sample is comparable with the control sample. Use of leather sludge in cement manufacture should strictly comply CPCB guidelines for preprocessing and co-processing of hazardous and other wastes in cement plant as per H&OW (M&TBM) rules 2016 and leather sludge can be utilized up to 1 wt% in cement manufacturing by complying CPCB guidelines.

FLY ASH AND EGGSHELL UTILIZATION IN PORTLAND CEMENT

Mukesh Kumar, S K Saxena, S K Wali and N B Singh

JK Lakshmi Cement Ltd, India

An innovative way could be related to use of Egg shell waste as secondary raw material for obtaining construction products. Traditionally materials like clay, sand, stone, gravels, Cement, brick, block, tiles and steel are used as major building component in construction sectors. All these materials have been product from the existing natural resources and will have intrinsic distinctive for damaging the environment due to their continuous exploration. Particularly, during the manufacturing process of various building materials, especially decomposition of calcium carbonate, lime and cement manufacturing. Egg shell are composed of around 95% calcium carbonate, minerals that is very important for industry, nutrition and agriculture.

In this paper we have systematically studied the effect of fly ash and eggshell (both industrial and Bio waste) on the hydration of Portland cement. Egg powders are added to Portland – fly ash blended with 20% wt of Fly Ash in presence of 5% crushed Egg Powder was studied. Water consistency, setting time, water percolation and compressive strength were measured. SEM and DTG studies were also made to have an idea about hydration products. Results have shown that Eggshell compensates the deficiencies of fly ash in Portland cement.

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

USE OF DE-CARBONATED MATERIAL 'LD SLAG' IN THE MANUFACTURE OF PORTLAND CLINKER

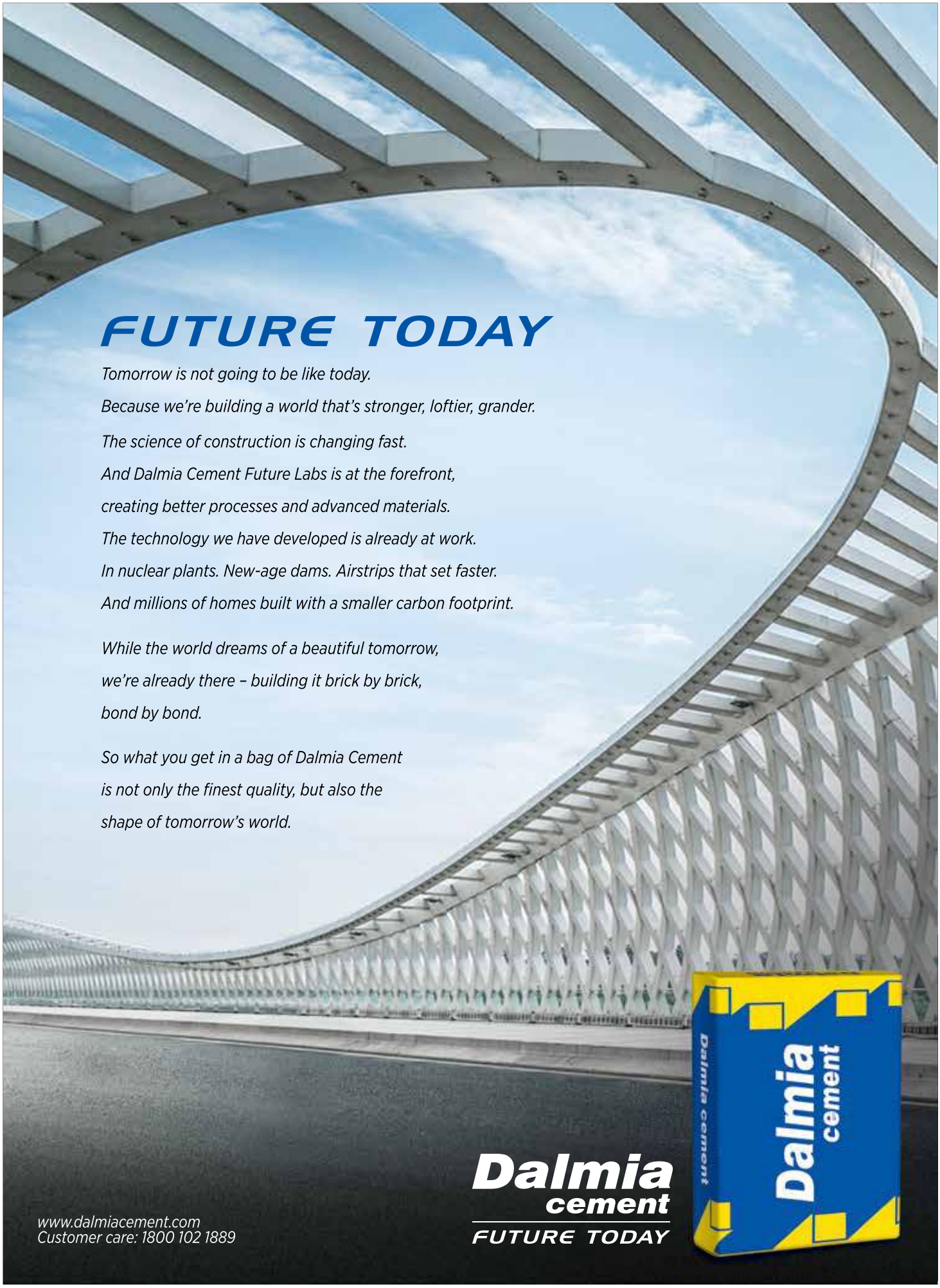
S K Agarwal, Varsha Liju, S K Chaturvedi, B N Mohapatra

National Council for Cement and Building Materials, India

Subhdra Sen, A K Gupta, Nabonita Das, R V Ramna

Tata Steel Ltd, India

The utilization of alternative raw materials containing calcium, which are either de-carbonated or contain calcium as non-carbonate minerals, provides a technically sound alternative for reducing Green House Gas (GHG) emissions The use of these lime bearing raw materials on one hand leads to mitigate GHG emissions in atmosphere, and on the other hand reduces the energy required for de-carbonation of such materials during clinkerization process. LD-slag, a by-product of steel making and could be a potential de-carbonated material, is produced during the separation of the molten steel from impurities in steel-making furnaces through Linz-Donawitz process, and compatible to cement system with major oxide constituents: 5.90% LOI, 45.86% CaO, 12.08% SiO_2, 5.86% Al_2O_3, 21.39% Fe_2O_3, 5.29% MgO. In present paper, different cement raw mixes were designed using 7.5 to 9.0 wt.% LD slag along with other conventional raw materials maintaining clinker parameters; LSF, SM and AM in the range of 0.91-0.92, 2.11-2.23, and 1.09-1.18 respectively; potential phases determined as per Bogue's calculations: C_3S, C_2S, C_3A, C_4AF in the range of 56.18-57.89%, 16.90-18.34%, 5.75-6.34%, 13.35-14.61% respectively. Burnability studies of these cement raw mixes conducted at the temperatures of 1300, 1350, 1400 and 1450°C with retention time of 20 minutes showed adequate lime assimilation, clinker phase formation and morphology of Portland clinker samples obtained at the temperature of 1450°C.


FUTURE TODAY
Tomorrow is not going to be like today.
Because we're building a world that's stronger, loftier, grander.
The science of construction is changing fast.
And Dalmia Cement Future Labs is at the forefront,
creating better processes and advanced materials.
The technology we have developed is already at work.
In nuclear plants. New-age dams. Airstrips that set faster.
And millions of homes built with a smaller carbon footprint.
While the world dreams of a beautiful tomorrow,
we're already there – building it brick by brick,
bond by bond.
So what you get in a bag of Dalmia Cement
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TECHNICAL SESSION – II B

PORTLAND, BLENDED AND SPECIAL CEMENTS – II

SEMINAR PROCEEDINGS

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COST SAVING BY OPTIMIZATION/USES OF OVERBURDEN LIMESTONE OF MINES IN CLINKERIZATION WITHOUT AFFECTING THE CLINKER QUALITY

Pankaj Kejriwal, S P Shrimali, Y K Singh, S K Pandey and Sanjay Chourasia

Star Cement Ltd, India

Cement production Input costs are rising day by day and it is a big challenge for every cement plant for its survival. In current scenario of less demand and increasing competition among cement plants, lowering the product cost has become the need of the time. Raw material cost is one of the major components of the input costs for cement manufacturing. The cement industry is therefore forced to explore all options of raw material conservation and cost reduction.

Star Cement Ltd has acquired new 70 Hectare Limestone mines and during its development borehole samples have been tested and found that the upper most 03 meter layer contains non cement grade Limestone (Appox. 3.67 Milion ton) with more concentration of Iron oxide and Silica. So, the systematic plan requires to be developed to make use of the overburden material without affecting the operation and quality of Clinker.

The management of overburden is an important task in open pit exploration. Site topography and morphology as well as geological and geotechnical properties of natural and remolded materials are the most important factors affecting the disposal phase. Economic and environmental requirements are to be followed in order to achieve the best reclamation results, keeping into account site constraints such as slope stability, hauling and dumping issues and interaction of overburden with groundwater. Overburden disposal is one of the principal environmental concern for mining industry, both in case of surface stockpiles as well as in case of in-pit disposal.

This paper deals with the above mentioned issues, illustrating a rational approach applied on the case of a large limestone quarry where the thickness of the overburden is relevant and the spoil material has to be use in limestone stock for production of cement clinker.

This project has been taken for the purpose of cost saving as well as overburden management of this poor cement grade material to enhance the mines life and to avoid the re-handling. The proposed multidisciplinary approach led to the selection of most suitable methods for excavation, transportation and disposal. The selection was based on a detailed laboratory and site characterization that defined favorable and adverse factors to be considered during the preliminary study of a large quarrying project.

Broad study & number of permutation & combination have been carried out in several steps and finally with different raw mix design and its Laboratory trial, decision has been taken to use this overburden material replacing external sourced Iron additive with a targeted reduction in consumption from 1.20% to 0%. Presently Iron additive consumption is being achieved from 0.10 to 0.20 % with systematic use of this overburden during raw mix grinding without affecting clinker quality.

Benefits:

1. **Enhancement of Mines life and conservation of Natural resources:** By using this overburden in raw mix grinding the feed-able grade limestone saved up to 6.0 % which enhanced the mines life and saving of natural resources as per the present scenario.
2. **Quality of Clinker:** The quality of clinker was kept at its level best by doing several permutation and combination of input material during raw mix designing/ grinding.
3. **Cost saving:** Saving of approx. Rs. 1.0 crore per month by rational use of overburden during Raw Mix Grinding, raw mix cost reduced by Rs. 47.0/mt
4. **Environmental Impact:** Adverse impact on environment was saved by minimizing dust generation and fuel consumption which was generated and consumed during its handling and transportation during its disposal.

INVESTIGATION ON MECHANICAL PROPERTIES OF PORTLAND LIMESTONE CEMENTS PREPARED USING DIFFERENT GRADE LIMESTONE

J P Vrati, K V Singh, A K Raykundalia and B C Pandey

Ambuja Cements Ltd, India

S K Agarwal, R Singh, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Production and use of Portland Limestone Cement (PLC) have a long tradition in Europe, where high quality limestone ($CaCO_3 \geq 75\%$) substitutes up to 35% of Portland clinker, according to type CEM II, Portland Limestone Cement (EN-197-1), whereas in India, such types of cement is not standardized. In India, low grade limestone is abundantly available in many quarries within cement industry and often discarded from clinker production, or as main constituent in cement, because of limitations in the CaO, SiO_2 and MgO contents. This material is a resource which is quite similar to limestone and therefore, it can contribute to higher added value for cement industry.

In present study, different Portland Limestone Cement blends were prepared using different grades limestone; cement grade, low grade and dolomitic limestone by replacing 20, 25 and 30 wt.% of Portland clinker, by interblending technique, at the Blaine's fineness of 380±10 m^2/kg, yielding substantial economic and ecological advantages and these cement blends were evaluated for compressive strength development, attained at 1-, 3-, 7- and 28-days curing, as per the test procedure specified in Indian standard IS:4031.

INCREASE UTILISATION OF FLY ASH IN PPC AT BIRLA CEMENT WORKS PLANT

Dinesh Kumar, D Banerjee, Narpat Anjana and G Palod

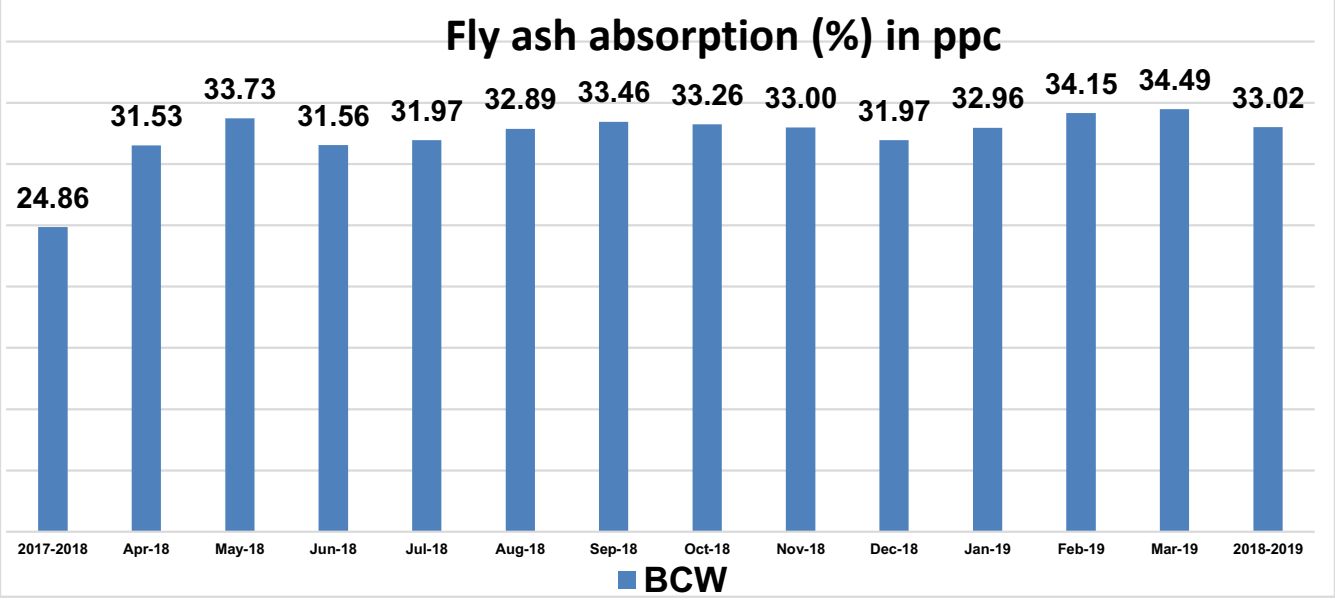
Birla Corporation Ltd, India

In the past, fly ash produced from coal combustion was simply entrained in flue gases and dispersed into the atmosphere. This created environmental and health concerns that prompted laws which have reduced fly ash emissions to less than 1% of ash produced. Worldwide, more than 65% of fly ash produced from coal power stations is disposed of in landfills and ash ponds. In India alone, fly ash landfill covers an area of 40,000 acres (160 km^2). The recycling of fly ash increasingly has become an concern in recent years due to increasing landfill costs and current interest in sustainable development.

Up to 35% of suitable fly ash can directly be substituted for cement as blending material. Addition of fly ash significantly improves the quality & durability characteristics.

If the current trends in utilization of fly ash were to continue, overall the utilization will reach to 310 MT by 2030, with cement's share in utilization, as a percentage of total fly ash generated, increasing from 25% to 35% by 2030. While cement's fly ash requirement will grow fourfold, to 151 MT in 2030, approximately 128 MT of fly ash will still remain unutilized. This will require an additional 2,300 hectares of land and 1.3 billion cubic meters of water for ash ponds, exacerbating the existing problems concerning fly ash disposal.

By doing all the above trials in house, we have increased Fly ash absorption from 24.86 % to 33.02 % as annual average in PPC. Monthly/annual fly ash absorption figures have been given below which shows results.



EFFECT OF LD SLAG ON THE PHYSICAL PERFORMANCE OF COMPOSITE CEMENT

G Ahamed, V Liju, P Sharma, Ashish Goyal, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Bureau of Indian Standard (BIS) has recently introduced standard specification for composite cement IS 16415:2015, which permit use of 35-65% Portland cement clinker/ ordinary Portland cement along with 15-35% fly ash and 20-50% granulated blast furnace slag (GBFS) together as the blending component. Apart from GBFS another important waste material, a very high amount of LD slag is also generated during steel making in basic oxygen converter (LD-Converter) in an integrated steel plant. The use of GBFS is almost 100% in India but utilization of LD slag is just about 15 to 20 percent of its production.

In the present study, investigations were carried out on the utilization of LD slag as a replacement of GBF slag in the composite cement. Control composite cement samples were prepared using fixed 20 percentage GBFS and varying fly ash from 25 to 35 percentage keeping the clinker factor in the batch 0.55, 0.50 and 0.45 respectively. Composite cement samples were also prepared using 10 to 15 percentage of LD slag replacing equal proportion of GBFS and keeping the other materials of the batch in the same proportion as per the control batch. Another batch of composite cement samples were also investigated in this study using only one type of slag that is 20 percentage LD slag and 35 percentage of fly ash keeping the clinker factor 0.45. The SO_3 content of all these composite cement samples were kept constant 3 percentage and total slag content were fixed 20 percentage in these cement batches. Composite cement samples were prepared using a laboratory ball mill by inter-grinding the constituents keeping the fineness in every case 350±10 m^2/kg. The physical properties of these cement samples were evaluated as per IS 4031. It was observed that at a fixed clinker factor of about 0.55, composite cement sample prepared using 10% LD slag shown similar 28 days compressive strength as like as control composite cement sample prepared with GBFS only. When 15 percentage LD slag were used in the composite cement batch at a clinker factor of 0.50, the 28 days compressive strength were found to be 43 Mpa. Composite cement samples prepared with 20% LD slag and 35% fly ash shown comprehensive reduction in early as well as later strength. The current investigations were carried out on cement mortar, however, durability of concrete need to be studied further.

COMPOSITE CEMENT & ITS ADVANTAGE

M K Kapoor and Vivek Agnihotri

Prism Johnson Cement Ltd, India

Across the world, and particularly in the fast moving economies of the America, Europe, India & the middle East, there are demands for reducing the Environmental impact of society and constructions certainly has its role to play. There is a particular demand for improved infrastructure to support economic growth and Portland cement concrete will fulfill much of this. Contributing around 8% of world CO_2, Portland cement manufacture is a significant contributor to anthropogenic greenhouse gas production. However, there are solutions to this issue such as the use of composite cement. The use of fly ash and blast furnace slag will, therefore, be an ever more important contributor to this requirement. This paper summarises the guideline, duly usages of fly ash and BFS, to achieve low embodied CO_2 in concrete susceptible to corrosion induced by chloride ingression and carbonation.

In this study composite cement were produced by blending OPC with fly ash and GBFS where the fly ash was kept constant at 30% and two different percentages of GBFslag (20 and 25%) was used in the study. It was observed that reduction of slag from 25% to 20% results in increase of strength specially the early strength (1 and 3 days).

Another set of composite cement was also prepared by intergrinding the clinker, fly ash, GBF slag and gypsum in Lab Ball Mill. The study concluded that Bogue potential phase of 54% C_3S and 9.3% C_3A is an optimized values and further increase in C_3S does not contribute to any strength development. The use of Portland composite cement enhances the ecological efficiency of concrete construction. The 5% decline in the average clinker production would allow reducing annual CO_2 by more than 1 million ton.

INFLUENCE OF FLY ASH FINENESS ON ITS MECHANICAL PROPERTIES

Suresh Vanguri, T Mohan Rao, Suresh Palla, V Ramaswamy, K V Kalyani, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Fly ash has been established as the most sought after material in cement, construction and related building materials Industry. Enhancing the fly ash utilization in the manufacture of cement is identified as one of the key areas to mitigate the Green House Gas emissions from cement industry. Owing to the poor reactivity of Indian fly ash, cement industry is generally using activation methods to improve the properties of fly ash for enhanced use as a blending component in cement manufacturing. Among different methods of activation, mechanical activation is the most economic and effective way for improving the fly ash properties. Grinding of fly ash alone or along with clinker to the required fineness is a common practice in cement industry. Though increasing the fly ash content in cement has economic and environmental benefits, it results in decrease in the compressive strength values particularly at early ages. Investigations were carried out on the mechanical activation of fly ash to the very high fineness values to see the effect of use of high fine fly ash on the properties of resultant cement. Fly ash samples were systematically studied for changes in the chemical, mineralogical, microstructure and physical properties with respect to increase in the fineness to higher values. Fly ash mineralogy and microstructure were studied using X-ray Diffraction and electron microscope respectively. Though the physical properties and glass content values of the fly ash were found to be improving with the fineness, after a certain fineness some properties of fly ash such as lime reactivity (L.R.) and comparative compressive strength (C.R.) were found to be decreasing. Change in the microstructure of fly ash with increasing the fineness of fly ash was identified as the primary reason that is affecting the L.R. and C.R. values. Lime reactivity and comparative compressive strength values were found to be increasing with fineness of fly ash to as high as 14.0 MPa and 98 percent respectively. Further increase in the fineness resulted in decrease in the L.R. and C.R. values to 13.0 MPa and 95 percent respectively. Increasing the fineness of fly ash beyond certain value also resulted in only marginal improvement in its properties. Besides, increasing the fineness of clinker was found to be more beneficial than increasing the fineness of fly ash to absorb more fly ash in the cement manufacturing.

INVESTIGATIONS ON DEVELOPMENT OF PORTLAND COMPOSITE CEMENTS BASED ON FLYASH AND LIMESTONE

B N Mohapatra, Varsha Liju, S Palla, S Vanguri, R Gupta, O P Sharma and S K Chaturvedi

National Council for Cement and Building Materials, India

The blended cements, which are produced using more than one mineral addition, are known as composite cements. Flyash conforming to IS 3812 (Part 1): 2003 and granulated blast furnace slag conforming to IS 12089: 1987 are used in the manufacture of composite cements(16415-2015) with 15-35% and 20-50% respectively. Presently there is almost complete utilization of granulated blast furnace slag in India. However utilization of fly ash in manufacture of PPC is still only 40% out of around 200 million tonnes generated annually. Additionally India has large reserves of low grade, dolomitic and silicious limestones.

Flyash and limestone in combination with OPC can also be used for preparing composite cement. European Standards have specifications on the portland composite cement type Cem II A-M and Cem II B-M permitting the simultaneous use of various mineral admixtures with total additions in the range of 6-20 and 21-35% respectively.

ASTM also has introduced performance-based specifications for hydraulic cements (C 1157-00) with no restrictions on composition of the cement. However, use of limestone and fly ash simultaneously in manufacture of cement is not employed presently in Indian senario. BIS, presently, has no standard for limestone and fly ash based Portland composite cement.

Manufacture of limestone and fly ash based composite cements will reduce the impact of CO_2 on environment, utilization of industrial wastes and enable production of cements with lower clinker factor leading to resource conservation, enhanced waste utilization and greater sustainability in cement manufacture.

In the present study Portland composite cements were prepared by simultaneous use of fly ash and limestone. The raw materials were collected from the eastern part of the country. Cement Blends were prepared using 15, 20, 25 and 30% of fly ash and 5,7 and 10% of limestone by intergrinding with clinker and gypsum. PPC blends were also prepared using 15, 20, 25 and 30% of fly ash. The SO_3 content maintained in these blends were 3%.

The performance evaluation of the prepared fly ash limestone based composite cement samples depicted that the results were conforming to the limits provided in the present standards of fly ash slag based composite cement. The compressive strength data revealed that even with 35-40% replacement of clinker with fly ash and limestone the 28 day compressive strength was around 40 MPa. The 28 day compressive strength of the prepared PPC samples were around 55 Mpa.

TECHNICAL SESSION – III A

ADVANCES IN GRINDING SYSTEMS-I

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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GRINDING PROCESS OPTIMIZATION LEVERS TO PULL

Caroline Woywadt and Bernd Henrich

Gebr. Pfeiffer SE, Kaiserslautern, Germany

The cement industry shall meet manifold factors and requirements to be a sustainable industry. This means achieving a balance between the fulfilment of ecological, social and economic needs now and in future. Industry's investment power and capacity for innovation is a key factor in this respect.

The proportion of energy consumption for grinding in the cement manufacturing process is quite high, with nearly 50 % of total energy consumption. Cement grinding itself is rated with approximately 34 % in the complete process. This huge number shows the potential to save energy in regard of optimization of the process. Gebr. Pfeiffer SE offers support in dealing with these issues by addressing topics and tackling tasks relating to mill operation and optimized product properties.

Levers to Pull - Cement Quality and VRM

Performance:

In the past decades the VRM has been replacing many Ball Mill (BM) grinding systems. Achieving the same quality of cement produced in BM, was essential for the success of the VRM. This was traced back by achieving the same or similar Particle Size Distribution (PSD). But nowadays it is clear that the PSD is not the only factor to impact the properties of the finish product.

Levers to pull for getting the required product quality are mainly coming from the feed material and the physical properties. The feed material describes the clinker with its chemistry, especially the C_3A-content, the sourcing of the clinker implicating a possible moisture and subsequently pre-hydration. This is very important due to the number of grinding terminals installed in the past. The sulfate agent needs a proportion of dihydrate, hemihydrate and anhydrite – balanced on the clinker properties. Additional factor are the SCMs (Supplementary Cementitious Materials) which influence the grindability and operational behavior plus the need for adequate reactivity.

To achieve the best optimized VRM mill performance some areas need special attention: Feed uniformity, metal detection and extraction, preventive maintenance are only some areas to be highlighted. Levers to pull for a well performing mill are operational parameters such as table speed, gas flow, working pressure and mechanical adjustments as dam ring height and covering the nozzle ring.

A smooth and stable mill operation with reduced or nil water spray is possible, hence grinding without external heat is depending on feed moisture of the material possible.

In this paper, the interaction between the relevant parameters for cement quality and VMR performance will be discussed in case studies.

OPERATIONS AND MAINTENANCE OF HPGR ROLLS

Rahul Deshmukh[1] and Prashant Garg[2]

[1]Thyssenkrupp Industries India Pvt Ltd, India

[2]Diffusion Engineers Ltd, India

The focus of Indian Cement Industry has always been to adopt the most reliable, energy efficient and reliable technology for grinding process. For cement grinding application combi-grinding system (High Pressure Grinding Roll + Ball Mill) are proven systems available. This system provide good control over percentage residue on 45 microns and better particle size distribution.

Thyssenkrupp has successfully installed HGPR, i.e. Polycom for raw material grinding and clinker grinding application in many locations in India and abroad. This article discusses about HPGR Rolls for various application in Cement Industry with each individual performance.

Thyssenkrupp supplied Polycom are equipped with following Roll bodies;

1. Forged
2. Stud Roll
3. Compound cast

Selection of Roll bodies wear protection depend upon following points;

- Grinding applications: OPC/PPC/PSC/Composite cement
- Abrasiveness/ specific wear rate of the feed material
- Expected life
- Maintenance procedures and return on LOI
- Risk of damage by oversize feed material, feed material distribution, Tramp metals, such as grinding media, shovel teeth etc.

This article compares the actual wear life with reference to above selection criteria. This will give a good insight to the industry users for their future operation and maintenance benefit.

M/s Thyssenkrupp Industries Pvt Ltd and M/s Diffusion engineers Ltd have signed agreement to service the HPGR Rolls for the Indian market. Based on this agreement we have received good response from various clients operating the HPGR in maintaining the Roll body in good condition. This cooperation has helped clients in terms of better roller life and overall improvement in the operation. Agreement has also help client in solving their problems on top priority and timely delivery of job. Thyssenkrupp Industries Pvt Ltd and Diffusion engineers Ltd are also able to collect the operating details of different roll bodies from time to time, so as to monitor the performance of roll and act accordingly in carrying the profiling, welding etc. timely. This article discusses about the cooperation and joint offerings.

ROLLER PRESS IN FINISH MODE FOR COMPOSITE CEMENTS: UNIQUE CEMENT EXPERIENCES IN BANGLADESH

A K Singh[2], Balesh Singh[2], Saida Shaik[1] and Akshay Singh[2]

[1]Unique Cement, Bangladesh

[2]KHD Humboldt Wedag India Pvt Ltd, India

Cost and energy reduction are essential aspects for cement producers. Grinding consumes more than 65% of the energy in the cement manufacturing process and is, therefore, an ecologically and economically important process.

For over 80 years additive materials as Granulated Blast Furnace Slag (GBFS), Fly Ash, Limestone, has been used as a replacement for clinker in the cement manufacturing process. Most popular cements in South Asian countries are PCC [Portland Composite Cement], PLC [Portland Limestone Cement] PPC [Portland Pozzolana Cement] and PSC [Portland Slag Cement].

To cater to the high quality cement demand in Bangladesh, Unique cement (Meghna Group) decided to set up Roller Press technology for its existing ball mill and one new cement grinding circuit.

The system consists of a High Pressure Grinding Roller Press with Tungsten Carbide Stud Rolls, V-Separator and Dynamic Separator in COMFLEX orientation (similar to a Ball Mill) with its dedicated Dynamic Separator connected in such a manner that at any time any circuit can be operated individually, as per requirement.

Ball Mill is with two Chamber and it can be operated either in combination with Roller Press or stand-alone mode. Similarly, Roller Press is capable to operate both in stand-alone mode as well as in combination with Ball mill.

Though the system is just commissioned few months back and is still under optimization phase, the results achieved so far are quite impressive and given under Table-1

Table-1

Parameters	Designed	Results
Composite Cement production t/h in RP Finish Mode	160	155-165
Product Residue on 45 microns	< 5%	4.5-5%
Specific energy cons. kWh/t	21.8*	22*-23*

* for the main motors - Roller Press, Separator, separator fan, bucket elevator, bag filter fan

In summary, the KHD COMFLEX circuit at Unique Cement represents the benchmark of modern Roller Press grinding technology. With the latest installation of Roller Press at Unique Cement in Bangladesh, impressive results are achieved in order to save energy and resources, reflecting good cooperation between operator and supplier.

With its focus on efficiency, innovation, and high quality design, COMFLEX® not only helps as Product but it also helps the end user to get right quality and increase productivity, low maintenance and energy consumption.

GUINNESS WORLD RECORD - LARGEST CEMENT GRINDING VRM: OK™ 81-6 MILL

A Janardhanan and John Terembula

FLSmidth Pvt Ltd, India

The end user strategies change over time, and accordingly FLSmidth® has taken up the challenge to expand our product portfolio. But still maintaining all the favourable features of our versatile grinding machine with regards to: grinding, mixing, drying and separation in one operation.

For years, it was a good practice to use multiple and smaller Vertical Roller Mills (VRM) in a production line if the line output was higher than one VRM could deliver. But, due to the cost vs. output, it has become more common to invest in big VRM's for finish grinding.

The advantage of having one big mill is mostly related to purchase and installation cost. Also, a marginally lower maintenance cost speaks in favour of one big VRM. The disadvantage is that operating only one big vertical mill may require a different spare parts strategy from running smaller mills as they are normally easier to keep running in case of a sudden breakdown.

The market trend for large-capacity plants demands bigger and bigger mills. There are number of contributing factors to the demand for larger grinding mills.

- First, there is greater general acceptance of the economic benefits of larger single mill installations.
- Second, VRM development over several decades has shown that VRMs are mechanically reliable.
- Third, there are now many large VRM references being used within all grinding applications,

The OK™ 81-6 Mill installed at Shah Cement's Muktarpur Plant features an 8.1-meter grinding table and six 2.7-meter grinding rollers. It is powered by a compact and reliable 11.6-megawatt MAAG® MAX Drive. The mill was designed to produce a full range of cement types, including OPC, PPC, PSC and slag. Feed mix and capacity are shown below:

Cement type	OPC	PPC	PSC	Slag
Feed mix	95% Clinker + 5% Gypsum	65% Clinker + 5% Gypsum + 30% fly ash	65% Clinker + 5% Gypsum + 30% Slag	100% Slag
Capacity	540 TPH @ 3600 Blaine	640 TPH @ 3800 Blaine	450 TPH @ 3800 Blaine	380 TPH @ 4000 Blaine

Cement mix types delivered by the OK™ 81-6 Cement Mill at Muktarpur Plant.

This paper will elaborate on the following aspects:

1. OK mill design & efficiency
2. MAAG MAX Drive design & efficiency
3. Selection of single large VRM over two small mills
4. Operating experiences at the Shah Cement Muktarpur Plant.

SYSTEM DESIGN-OPTIMIZATION IN GRINDING AND PYRO PROCESSING SYSTEM

Sivakumar Natesan and Murali Krishnan Kanagaraj

FLSmidth Pvt Ltd, India

Cement producers have faced a significant rise in the power consumption costs with the introduction of dry process kilns. This complex challenge, coupled with the rising fuel and energy costs along with the stringent emission norms has promoted cement producers to implement energy management programs to reduce the operating costs.

As a leading supplier of equipment and services to the global cement industry, FLSmidth is in a unique position to have an active part in understanding and solving the current and future challenges in the cement industry with respect to the optimization of fuel and power costs in the grinding and pyro processing system.

To meet these needs, FLSmidth has a legacy of successfully pioneering the adoption of innovative technologies and providing energy efficient solutions in the system design of grinding and pyro processing in the cement manufacturing process. These challenges are only getting more difficult with the ongoing demand of better burning and cooling technologies along with the lowest possible gaseous emissions.

FLSmidth has concentrated to modify process design and equipment design in the grinding and pyro processing system for attaining maximum possible energy efficiency in the system. Innovative and proprietary technology changes done in process design will be described, along with case studies reviewed.

Optimum combination of grinding circuits in a modern plant will be reviewed with examples. Best integration of grinding technologies to get minimum operating costs will be discussed with case studies. Evaluation of vertical roller mill grinding system efficiency from design stage to actual operation shall be discussed with case study.

Clinker cooler evaluation is critical for improving the plant performance in terms of energy efficiency. This become more complicated with waste heat recovery system being a part of the pyro processing system. Optimum method of cooler evaluation will be reviewed with case studies.

OPERATION OF CLINKER GRINDING AT PENNA CEMENT, KRISHNAPATNAM

M S Marathe and Vinod Wadile

Thyssenkrupp Industries India Pvt Ltd, India

Splitting the grinding units from clinkerisation units allows cement companies to minimise logistics costs significantly, provided other raw material sources (such as fly ash and gypsum) are nearby. Grinding units are closer to end-use markets and employ economic modes of transport such as seaways, allowing cement companies to manage logistics costs effectively. The profitability of a split location clinker grinding unit mainly depends on the material cost, power cost, fuel cost and freight cost.

For their grinding unit at Krishnapatnam, Penna Cement entrusted thyssenkrupp as the grinding technology provider. In March 2018, Penna cement commissioned one of the largest port based grinding units in Asia at the Krishnapatnam port with an automated ship-loading facility and a cement production capacity of 2 MTPA which will be expanded to 4 MTPA soon.

Polycom® is a well proven and reliable machine with specific features such as use of high specific grinding pressure ~6000 kN/m^2 for clinker grinding ensuring efficient grinding resulting in lower energy consumption, large shaft diameters for the absorption of bending and torsional stresses, optimum distances between bearings minimising the bending moments, high tyre thickness for safe shrink fits and high wear layer thickness for long operating times and minimum wear costs.

Combi-grinding system reduces material cost by facilitating grinding of PPC (blended cement) using 30-35% fly ash. Polycom® (high pressure grinding roll) being energy efficient machine grinding reduces the power requirement significantly and ensures grinding without water spray. In split grinding unit, despite of using cold clinker, there is no requirement of hot gases which reduces fuel requirement to zero.

At Krishnapatnam, Polycom® size 20/15-9 is working in combi-mode with ball mill Dia. 4.6 m x 15.15 m EGL and Sepol PC 32/27-440. The circuit produces PPC at ~ 340 tph at 3300 Blaine which is one of the highest capacities for combi-grinding systems. The specific power consumption for core equipment is ~ 23 kWh/t which is also one of the lowest. The system requires no hot gases.

GRINDING COMPONENTS – THE NEW WEAR MANAGEMENT

Dorival G Tecco

Pronamic, India

Grinding components i.e. roller tires and grinding plates wear during grinding. Wear is associated with loss of efficiency, which has important operational and financial implications. Available models assist in understanding the reduction in throughput and increase in specific power consumption associated with wear.

This paper initially revisits some concepts applicable to different technologies for grinding parts. It then summarizes the general efficiency model, with specific mention to the three stages of operation associated to the state of wear.

Subsequently it presents the specific case of a top mill design such as the Loesche mill, and specifically the benefits of regular maintenance as opposed to allowing tires and plates to wear continuously, degrading the mill efficiency. Finally, it highlights the relative importance of process audits, mechanical audits and the essential dimensional specifications.

The biggest efficiency benefits are achieved though process audits and then mechanical audits to ensure the strict original equipment manufacturer specifications at all times. The dimensional and quality standards obviously apply to both new products as well as for periodic maintenance.

In case of Loesche mills, the geometry of the gap between tires and plates, as well as dam and support rings are essential to achieving high performance. This implies in the need to accurately execute the original equipment manufacturer's requirements and instructions.

The extensive experience gained over the past two years shows that, when adequately engineered and controlled, the tires and plates made using a tough base and multilayered weld construction (e.g. Pronamic®) have overwhelming advantages over the traditional high chromium white irons by offering simultaneously:

- Cost efficiency
- Higher abrasion resistance
- Tolerance to impact, or metal-to-metal contact, without brittle fracture,
- Ability to be refurbished regularly
- Shorter delivery times
- Up scalability (it is simpler to cast the tough base material than to cast the sensitive high chromium white irons).

The benefits of up scalability are particularly important in case of one piece tires such as the Loesche design, bearing in mind the foreseen increase in mill dimensions and capacity by (Reichert, 2017).

Additionally, though the development and use of different hard-face materials, a high level of customization is possible to achieve target maintenance intervals. Further newer tools may be available to optimize the managerial processes, including the radically new concept of fast and small interventions (to replace the large and complex complete refurbishment operations).

OPTIMIZATION OF RAW GRINDING VRM AT CHANDERIA CEMENT WORKS PLANT

Narpat Anjana and R C Jain

Birla Corporation Ltd, India

Limestone grinding technology has been continuously improving with numerous innovations in view of improving productivity and to reduce specific power consumption. In order to reduce the manufacturing costs for cement, it is very important to optimize the existing mill installations as far as the grinding process is concerned and also to use high quality spare parts and consumables.

Many types of grinding systems presently being used for raw meal grinding in cement plants are:

- Open and close circuit Ball mills
- Roller press in combi circuit/finished mode
- Vertical roller mill (VRM)
- Tube mill with pre-grinder/crusher

We at Birla Corporation Ltd at Chanderia plant, For Line-1 in the raw grinding circuit having one Vertical Roller Mill(VRM) supplied by **Shenyang Heavy Machinery Company Ltd, China** having design capacity of 155 TPH (@16 %+R on 90 µ, < 2 % R on 212 µ).

Mill was running @170 TPH @18.0 kWh/T Raw meal with product residue of-16% @+90 R but as observed, frequent stoppages observed due to vibration high **(Up to 98.0 Nos. /Month)** causing high power consumption and loss of production.

We have done many small in house modifications, logic changes and process optimization in steps to reduce breakdowns and to improve its performance.

After all the steps/trials, stoppages (due to vibration high) has been reduced to **only 8-10 Nos./Per Month** and mill throughput also improved which is > 175 TPH @ 16.0 kWh/T of raw meal.

Mill Throughput(TPH)	
Before Optimization	**After Optimization**
165-170 TPH	175-180 TPH

Mill Stoppages due to vibration high (Nos./Month)	
Before Optimization	**After Optimization**
Up to 98.0 Nos.	8-10 Nos.

ROLLER PRESS CIRCUITS: LATEST DEVELOPMENTS AND STEPPING INTO LARGE CAPACITY PLANTS

York Reichardt[1], A K Dembla[2] and Vanam Venkatesh[2]

[1]KHD Humboldt Wedag, Germany

[2]Humboldt Wedag India Pvt Ltd, India

The operating costs of any Grinding plant technical wise are mainly resulting from electrical consumption, heat demand and maintenance efforts. In all three categories modern KHD Roller Press circuits are superior or equal to any VRM or Ball Mill solution:

- KHD Roller Press circuits are operated at lower spec. electric energy consumption than Vertical Mills and Ball Mills.
- Heat demand often is lower than in Vertical Roller Mills as water spray typically is not used in KHD Roller Press. This also results in higher potential in creating electrical power in a WHRS.
- With stud lining the lifetime of the roller surface of KHD Roller Presses is much higher than any solution of Vertical Roller Mills and in the same range than Ball Mill internals. This results in lower maintenance costs than from VRM.

In total this leads to lowest OPEX costs for Roller Press finish grinding.

However, the biggest running Roller Press RP20-220/180 can absorb about 4000 kW what is equal to a VRM with a table diameter of about 5.3 m table diameter.

For bigger capacities two Roller Press plants are in competition with one big VRM plant what in these cases lead to higher Capex costs due to more equipment and higher civil efforts needed for the two plants. To overcome this issue KHD developed and now is ready to deliver bigger Roller Presses such as RP32-320/180 which may absorb up to 6800 kW. This is in a capacity range of a VRM with a table diameter of about 6.5 m.

By this development KHD now is able to provide with the same RP32-320/180 in a single finish grinding circuit more than 1000 t/h raw material with up to 20 % feed moisture as well as 380 t/h OPC at 3200 Blaine or equivalent, in detail depending on grindability.

To overcome variety of circuits with Roller Press, KHD came up with standard COMFLEX arrangement which is proven and successful for all the grinding applications i.e., Raw Material, Clinker and Slag Grinding. This arrangement is further optimized which is now compact COMFLEX with Dynamic Separator at lower level like Roller Press to reduce the CAPEX with low civil costs.

Significant steps are being taken in the Separators area like: low pressure Separators to reduce the specific power, compact Static Separators to reduce the civil heights and introduction of bigger Separators for single large capacity plants with RP size bigger than RP20-220/180.


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A Rajendran, K Suresh and Raju Goyal

UltraTech Cement Ltd, India

In present scenario in construction industry, automation has really picked far, patronising the usage of 3D printable concrete. With more than 12 universities working globally in developing this concrete. Considering its viability over predominantly three factors of time, cost and value added, this construction technique has the added advantage of removing all types of geometrical restraints in the design of a structure. 3D printable concrete is one such concrete where numerous characterisations is to be done owing to its requirements of free form and being thixotropic in a way to support the process of 3D printing. In this paper, the influence of various special materials, comprising mainly of various chemical and mineral additives, on the rheology of 3D concrete is discussed.

The testing is carried out using Rheometer MCR 102 with ball measuring systems with the aim of simulating the 3D extrusion to generate reliable results. Materials whose effect on rheology has been studied include a polymer based chemical additive to enhance the weak interfacial zone between the layers. Chemical agent was added to obtain the required rheology for easy extrusion with shape retention and one chemical was added to achieve right setting time compatible with the printer. The results are also compared with a normal concrete where such special materials are not added. The study is expected to provide information on how the addition of such materials modify rheological properties to the required range settings making it suitable for extrusion.

VEGETAL CONCRETE: A FOUNDATION FOR CARBON NEUTRAL BUILT ENVIRONMENT

Tarun Jami, L P Singh and S R Karade

CSIR – Central Building Research Institute (CSIR-CBRI), Roorkee, India

Buildings around the world consume over 40% of the world's energy. They are one of the largest contributors to the global GHG emissions and the associated climate change. Emissions from built environment originate from three sub-sources: construction, operation and demolition. The collective emissions from built environment are studied using life cycle analyses. Researchers around the world have developed various solutions to tackle these emissions, with majority of them focusing on reducing the emissions from operations. An upcoming trend in life cycle analyses takes into account emissions from construction and demolition as well. Therefore, to satisfy this holistic approach, scientists have started researching on building materials made from crop residues and agro-forestry wastes. This resulted in the emergence of a new class of building materials called vegetal concretes, wherein, crop residues from hemp, jute, sisal, flax, nettle, pigeon pea, and so on are used as aggregates. These aggregates are contained in a mineral matrix (mostly lime based) not unlike conventional cement concretes. Some examples of emerging vegetal concrete materials are lime hemp concrete, lime stabilized straw bale, flax-lime concrete, and cement straw boards/panels.

Due to their origins, these biomass based building materials are considered to be carbon negative, due to the carbon sequestration undertaken during various stages of their lifespan. Additionally, vegetal concretes display thermal insulation and a favorable hygrothermal behavior, which affect thermal comfort and thereby, energy consumption. This paper examines the carbon footprint of vegetal concrete materials and their impact on buildings throughout the three phases – construction, operation and demolition. The examined aspects include carbon footprint of the individual building materials, and carbon savings from the improved energy efficiency of the buildings. Hemp concrete sequesters more than 250 kg of carbon dioxide per m^3. It also has a low thermal conductivity of less than 0.10 W/m.K, and high specific thermal capacity of more than 1700 J/kg.K at 60% relative humidity.

This paper forms a part of ongoing research on lime hemp concrete at CSIR-CBRI, Roorkee. Several compositions of hemp concrete and sustainable lime based binders have been developed. Some of the properties of hemp concretes developed include dry density of 600-800 kg/m^3 and compressive strength of 3 MPa. The results of these studies will be presented at the conference.

WHITE TOPPING: CEMENT CONCRETE OVERLAY ON BITUMINOUS ROADS

Binod Kumar

CSIR-Central Road Research Institute, New Delhi, India

Concrete overlays have been used to rehabilitate both the existing bituminous (flexible) pavement since 1918 and existing concrete pavement since 1913. Whitetopping in its various forms have been used in the USA and Europe on Airports, Inter-state roads, Primary & Secondary Highways, Local Roads, Streets and Parking lots to improve the performance, durability and riding quality of deteriorated bituminous pavement surfaces. There has been a renewed interest in whitetopping, particularly, in Thin & Ultra Thin Whitetopping during the last decade. This has been possible due to several successful high profile projects executed in USA and Europe. Their effectiveness has further renewed interest in them because they satisfy the demand caused by rapidly deteriorating highways confronted with Ltd fund availability. Whitetopping of all types, viz; Conventional Whitetopping, Thin Whitetopping (TWT) and Ultra Thin Whitetopping (UTWT) offer immense potential as a rehabilitation strategy for Indian roads.

Several successful projects have been executed at Pune, Mumbai, Delhi, Nagpur, Jaipur and Bangalore in the last few years. The performance of these sections has been found to be satisfactory. The paper discusses the design and construction aspects of TWT.

Thin Whitetopping at Pune
Thin Whitetopping at Bangalore

PARTIALLY CALCINED LIME SLUDGE IN CEMENT MORTAR: AN ENVIRONMENTAL FRIENDLY APPROACH

Prabhat Vashistha and S K Singh

CSIR-Central Building Research Institute, Roorkee, India

The solid waste accumulation from industries is becoming alarming environmental concerns. The pulp & paper and other industries all over the world generate millions of tons of lime sludge. Reduction of solid waste, which poses the threat to environment is utmost important. Its application as a raw material in other industries could be the suitable option. In this study, lime sludge from recovery section of the paper mill is used in mortar as-received condition and in calcined condition to partially replace cement. Calcination of lime sludge is performed at the relatively lower temperature of 650 °C - 750 °C, which takes less energy input than the industrial process of calcination. The mortar is prepared, with the substitution of cement by as received lime sludge in the range of 10%, 20%, 30% and 40% by weight. These blends of mortars are also prepared with calcined lime sludge. Produced mixtures are evaluated for compressive strength and results are also compared with standard mortar. Compressive strength is evaluated at 7 and 28 days of curing. The compressive strength of mortars with as received lime sludge matches with standard mortar grade up to 10% addition of lime sludge, after that compressive strength decreased with the further addition of lime sludge. Mortar blends with calcined lime sludge achieved the compressive strength till 30% replacement of cement in mortar.

Lime sludge after calcination produced more compressive strength than as received lime sludge due to the presence of reactive lime and pozzolanic materials. This study helps in developing the sustainable utilization of large amount of lime sludge, produced from paper industries ended up in landfills.

Based on results, lime sludge has a significant potential for replacing cement mortar. This work has concluded that compressive strength of mortars remains intact until 10% replacement of cement by raw lime sludge. While use of calcined lime sludge allow replacement of cement, up to 30% with compressive strength remain intact as reference. Therefore, lime sludge is suitable as utilization in the formation of reactive pozzolanic material. The Metakaolin that is produced after calcination shows high lime reactivity and due to this increase in strength of mortar cubes of OPC-lime sludge is obtained. The increase in strength is caused due to accumulation of increase amount hydrates of calcium silicate (CSH) and hydrates of tetra calcium aluminates (TAH). The utilization of lime sludge of paper industry is recommended as replacement material for cement in mortars and this will also beneficial for reducing environmental wallop.

EXPERIMENTAL INVESTIGATION OF FERROCHROME SLAG AS AGGREGATE IN CONCRETE

P N Ojha, Amit Trivedi, Nikhil Kaushik and Vaibhav Chawla

National Council for Cement and Building Materials, India

Ferrochrome slag is waste material obtained from the manufacturing of high carbon ferrochromium alloy. The raw material in the production of ferrochrome is chromite, which is chrome and iron oxides containing mineral. Depending upon the cooling process, two types of ferrochrome slag are produced i.e. Air cooled by letting the molten slag cooled down under normal temperature and water cooled ferrochrome slag by quenching the molten slag. Both the type of slag can be used as replacement of aggregate in concrete, however presence of chromium in Cr^{+3} which is not soluble in water and Cr^{+6} which is soluble in water, makes ferrochrome slag to check the feasibility while using in concrete. Many researchers addressed the oxidation of Cr^{+3} to Cr^{+6} in the presence of strong oxidants which results the possibility of slowly releasing Cr^{+6} to environment in the long run. Leachability of heavy metals is the main environmental concern due to possible impacts on human health and environmental impacts.

In this study characterization of both types of slag (air cooled and water cooled) has been carried out to check the feasibility of replacing natural aggregates with that of ferrochrome slag. Characterization includes physical, chemical, mineralogical, microstructural, elemental and leaching studies. Results on characterization show that specific gravity of ferrochrome slag (both air cooled and water cooled) is on the higher side as compared to natural aggregates. Elemental and leaching studies shows that percentage of Cr^{+6} is negligible in air cooled and water cooled slag, almost all of chromium is in Cr^{+3} state which is insoluble in water.

In concrete mix designs, natural coarse aggregate has been replaced with air cooled ferrochrome slag at percentage of 30%, 60% and 100%. Mixes were prepared at w/c ratio of 0.65 and detailed study on concrete properties has been carried out. It was observed that when replacement of natural coarse aggregate with air cooled ferrochrome slag goes beyond 60% segregation and bleeding was observed due to high specific gravity of ferrochrome slag. It was found that as the percentage replacement increases the compressive strength of experimental mix increases, however, flexural strength and durability properties remain comparable. It was concluded that 60% replacement of coarse aggregate with air cooled ferrochrome slag as in concrete is feasible.

Further, in this study natural fine aggregate has been replaced with water cooled ferrochrome slag at percentage of 30%, 60% and 100%. Mixes were prepared at w/c ratio of 0.65 and detailed study on concrete properties has been carried out. It was observed that when replacement of natural fine aggregate with water cooled ferrochrome slag goes beyond 60% segregation and bleeding was observed due to high specific gravity of ferrochrome slag. It was found that as the percentage replacement increases the compressive strength of experimental mix increases, however, flexural strength and durability properties remain comparable. It was concluded that 60% replacement of fine aggregate with water cooled ferrochrome slag as in concrete is feasible.

The experimentation was also carried out to study simultaneous replacement of natural aggregates with respective ferrochrome slag aggregates. However, poor workability was observed. thus, it was concluded that simultaneous replacement is not feasible.

Leaching studies on air cooled and water cooled ferrochrome slag as aggregates and as samples from replacement in concrete was performed as per TCLP procedure. The results showed that leached out chromium is well within the limits as per Ministry of Environment and Forest guidelines.

UTILIZATION & IMPACT OF WET FLY ASH

V J Mitra, Naresh Singh, A Chandilyan and Anil Bajaj

Dalmia Cement (Bharat) Ltd, India

Current annual production of Fly ash, a by-product from coal based thermal power plant (TPPs), is large. Some of the problems associated with Fly ash are large area of land required for disposal and toxicity associated with heavy metal leached to groundwater. Till recent Fly ash, being treated as waste and a source of air and water pollution, is in fact a resource material and has also proven its worth over a period of time. It is the action of human beings that determines the worth of any material. Materials having potential for gainful utilization remain in the category of waste till its potential is understood and is put to right use. Fly ash is one such example, which has been treated as waste materials, in India, till a decade back, and has now emerged not only as a resource material but also as an environment saviour. This paper presents different ways of using Wet Fly ash in our Dalmia Cement industry in India.

Fly ash composition is useful in predicting slagging and fouling characteristics of combusted materials as well as the potential utilization of ash by-products. The ash composition analysis can also be helpful in developing a pollution abatement approach for various applications of fly ash such as cement and ceramics manufacturing. The current study deals with the characterisation of fly ash samples collected from different TPP units in India for eleven major oxides (Na_2O, MnO, SO_3, P_2O_5, MgO, K_2O, TiO_2, CaO, Fe_2O_3, Al_2O_3 and SiO_2) and eleven trace elements (As, Co, Pb, Ni, La, Cu, Zn, Cr, V, Sr and Ba) by non-destructive technique, Among the major elements, the concentration of SiO_2 is found to be the highest in the range of 51.36- 58.5% and that of Na_2O is found to be the lowest in the range of 0.02-0.17%. Among the trace analytes, Ba content is found to be the highest in the range of 126.6-1393.5 ppm and As is found to be the lowest concentration in the range of 24.8-37.4 ppm, respectively. The study reveals that all the fly ash samples were of siliceous type as per IS: 3812.

SEPERATION OF DIFFERENT TYPE OF SLAG BY MAGNETIC PULLEY

A Chandilyan, V J Mitra and Anil Bajaj

Dalmia Cement (Bharat) Ltd, India

The popularly known magnetic head pulley is used widely in industries for separation of magnetic material from non-magnetic substances. They are used in almost every other industry where this necessity of separation arises. Raw materials are subjected to the magnetic head pulley which have chances of contamination of ferrous material which would lower the quality as well as damage other parts of the VRM circuit , it passes through. Introducing a magnetic head pulley into the process stream is sure to have a positive impact on grinding.

2.0 Statement of the Problem:

Whenever slag is running in cement mill as a additive its impacting to mill output low also found that the mill return coming always in lower side. Difficult to maintain product residues and fineness

3.0 Studies conducted:

- Iron particles from source wise
- Strength comparison of different types of slag
- Optimization of cement mill reject
- Process Optimization
- Slag Granulometry

4.0 Results and Discussion:

The Magnetic Pulley's Permanent magnet with strong magnetic field ensure hundred percent success rate. Iron particles in slag easily comes out through magnetic pulley and grinding efficiency of mill has increased

5.0 Conclusion:

After installation of above arrangement, separation efficiency of iron particles from slag improved, resulting in Improved mill performance.

PYRO PROCESS: APPROACH FOR LOW CARBON ROAD MAP

Jens Breidenbach[1], Andreas Hand[1] and Anurag Johari[2]

[1]KHD Humboldt Wedag, Cologne, Germany

[2]Humboldt Wedag India Pvt Ltd, India

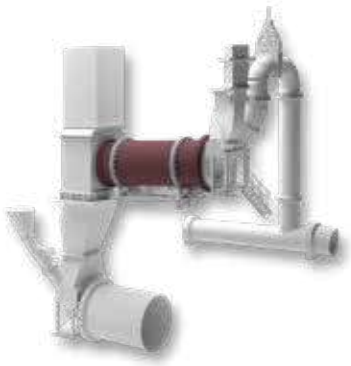
Cement industry being responsilble for approx.7% of CO_2 emission globally and stands third largest industrial energy consumer, there is huge potential available in each and every corner of the plant to work out the potential energy savings by means of lower thermal & electrical energy consumption and maximization of alternate raw materials & fuels. It is the prime responsibility of all the stake holders of the industry to integrate emerging & innovative technologies for clean footprints on CO_2 road map by lowering the CO_2 emissions.

To support various initiatives for low carbon road map, KHD has further extended its best available technology (BAT) portfolio keeping in view for lower energy consumption and maximum alternate fuels and raw materials utilization. Latest generation low pressure drop high efficiency Preheater cyclone "HE Series" is a further step forward to bring down the overall CAPEX and OPEX cost by means of low energy consumption and small preheater sizes to accommodate big capacities.

For environment security and sustainability to achieve lowest NOx emissions the design and flexibility of the calciner system is of utmost importance. To acknowledge the lowest emission guidelines across the globe, KHD has developed their PYROREDOX© reactor system (Pic-1) to operate the plants without any secondary measure to achieve NOx emission limits in India and has been proven as a very much promising solution in other countries to reduce the cost of secondary measures like SNCR technology (Ammonia injection) to a substantial level to achieve the desired emission limits.

To facilitate the utilization of various alternative fuels without much processing on account of size reduction and drying requirement, KHD has innovated rotary combustion reactor called PYROROTOR© (Pic-2) which is suitable for almost all kind of alternative fuels known so far. Key highlight for this system is the flexibility for burning coarse alternate fuels, low processed RDF, whole tyre etc., which shall lead to significant cost reduction in fuel preparation and utilization. This system is also suitable for installation in retrofit projects without having much impact of present plant layout.

Pic 1 - PYROREDOX©



Pic 2 - PYROROTOR©

PETCOKE ADDITIVE CHEMICAL FOR IMPROVED PETCOKE BURNING IN CEMENT INDUSTRY

Halim Tekkesin[1] and V Govinda Rao[2]

[1]Nuh Cemento San.A.S., Turkey

[2]Triple I Engineers, India

Nuh cement has been operating an Integrated Cement plant located at Sanyi AS, 80 km away from Istanbul, Turkey. The Plant has installed clinkerisation capacity of 4.5 million tons per year with 3 kiln lines. The 1st and 2nd kiln lines are identical with clinkerisation capacity of 3,200 TPD and Line 3 with capacity of 7,100 TPD. The Line 3 technology is of PASEC system separate line calciner modified in the year 2017 to produce 7100 TPD of clinker.

Nuh Cement decided to use Petcoke and increase Petcoke mix drastically to improve the economic and system performance. But this has affected the Pyro Process conditions badly as the increasing excess Sulphur increased in the process. In fact, adding alkali Sources to the raw mix could help the ASR of the hot meal and clinker. But the alkali addition was Ltd by the customer's demand of low alkali clinker.

High coal prices, availability of high Sulphur petcoke from local refinery, potential of early strength increase and sustainable increase of petcoke ratio in existing fuel mix without losing capacity were the main driving forces for Nuh Cement to adapt Petcoke Combustion Improvement Chemical (PCIC) to improve the petcoke burning conditions in Kiln as well Calciner.

Nuh cement decided to make trials in their Kiln 3 by adopting PCIC additive to improve the petcoke burning conditions in Kiln and Calciner and keeping the process stable with high petcoke ratio in the fuel mix. This paper covers the findings of the successful trial made using PCIC at Nuh Cement.

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श्री सीमेंट भारत की सर्वश्रेष्ठ सीमेंट कंपनियों में से एक हैं। भारत और दुबई के हमारे वैज्ञानिकों ने कई सालों के प्रयास के बाद एक बेहतरीन सीमेंट बनाया हैं, जिसे हम "**ROOFON CONCRETE MASTER**" के रूप में मार्केट में प्रस्तुत कर रहे हैं। यह सीमेंट बाज़ार में उपलब्ध किसी भी नामी सीमेंट की तुलना में कहीं बेहतर प्रदर्शन करने में सक्षम है।

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TECHNICAL SESSION – IV A

CEMENT PLANT MACHINERY AND PROJECT ENGINEERING

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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TECHNOLOGICAL UPGRADATION & MODERNIZATION FOR INBOUND & OUTBOUND VEHICLES

Manoranjan Sahoo and Santanu Giri

Dalmia Cement (Bharat) Ltd, India

Bengal Cement Works, a unit of Dalmia Cement (Bharat) Ltd, has been operating a Cement Grinding Unit having Installed capacity of 1.75 MTPA, situated in Paschim Medinipur District of West Bengal.

BACKGROUNDS & HIGHLIGHTS OF THE PROJECT

- Initially the road dispatches were managed by SAP SD module, which was a complete manual operation and was having lot of bottlenecks.
- Implemented & upgraded RFID – (Radio frequency identification device) based Integrated Plant Logistic Management System for Inbound & Outbound vehicle movement inside plant, which eliminated manual intervention.
- Technological Upgradation & modernization initiatives executed in year 2016-17 to 2018-19.
- 80% GIGO (Gate In to Gate Out) reduced i.e from 4.5 Hrs. to 2.5 Hrs. with same quantity of cement dispatch. (achieved monthly best : 2.3Hrs)
- Reduction of TAT (Turn Around Time) by 33% i.e from 8.0 Hrs. to 6.0 Hrs. with same quantity of cement dispatch.
- Reduction in manpower through Unmanned weigh bridge operation & Auto MRP solution; Saving of Rs. 10 Lacs / Year.
- Reduction in Busted Bags from 0.21% to 0.07% through Auto bag counting solution; Saving 7.8 Lacs / Year
- Tracking the KPIs with regard to Inbound / Outbound process management to improve productivity / plant process efficiency
- Minimizing paperwork and dependency on people through RFID application.
- Empowering major stakeholders i.e. Transporters by giving them access to do the transaction on their own in PLMS software.

TO ACHIEVE THE MILESTONES, FOLLOWING MAJOR INITIATIVES ARE TAKEN:

- Automation done in weigh bridge operation from manual to unmanned operation through RFID application to enhance the speed, eliminates Pilferage & save manpower.
- Auto MRP eliminates human mistakes for wrong MRP printing, reducing the time consumed.
- Auto bag counting system eliminates the manual counting process & saves time.
- In each loading bay, RFID reader is installed; Minimized busted bag percentage from 0.21% to 0.07%
- Eliminates pilferage of cement bags during loading
- RFID reader sensed when vehicle enter the yard. Now transporter can see their vehicle for order placement. As a result, order execution time is less as compared to manual intervention.
- Previously transporter issued hard copy to logistic office to place the order; Empowering transporter to create cement delivery order through RFID application; This process eliminates time and manual intervention. Minimize paperwork and dependency on people avoided through RFID application.
- Real time SAP SD module integration for data updation to avoid manual intervention.

INCREASING EFFICIENCY IN INDIA'S PACKING AND DISPATCH OPERATIONS

Stephan Oehme

FLSmidth Pvt Ltd, India

On demand from Indian customers since long, innovative solution has been successfully introduced in the field of cement packing & loading section to feed and load variety of cement bags including most demanding Indian choice of HDPE bags.

While keeping the traditional loading from the top of the trucks, with improvised automatic truck loader the bags are loaded with a mechanical system suitable to handle Indian standard non –laminated HDPE bags and different sizes of trucks. Similarly, newly developed solution of "shooting type bag applicator" will certainly deliver the performance level on typical HPDE non-laminated bags up to cement plant customer satisfaction level.

The advanced & user-friendly technology and its suitability for HDPE bags, will enhance the empty bag feeding on packing machine, logistic / dispatch capacity and utilization of packing & loading plant to ensure long term sustainability.

SAMPLING AND SAFE UNLOADING PROCEDURE OF CARBON BLACK/FLY ASH

A V Nagaraja and Naresh Singh

Dalmia Cement (Bharat) Ltd, India

Cement is the key construction material for global housing and infrastructure needs. The cement industry worldwide is facing growing challenges in conserving material and energy resources, as well as reducing its CO_2 emissions. Cement producers are striving to increase energy efficiency and also the use of alternative raw materials and fuels. Therefore the use of alternative fuels has already increased significantly with safely and accurate of sample collection

Statement of the Problem:

Sampling collection from the tanker of fly ash and carbon black from the top difficult, it self in safety hazard. The top sample is also not a representative sample if collected.

Studies conducted:

- Quality of fly ash checked as physical & chemical
- Process optimization
- Composition and content of ash,
- Volatile content ,
- Calorific value
- Physical properties (scrap size, density, homogeneity),
- Grinding properties,
- Humidity content,

Conclusion:

Installed one auto sampler to the unloading points of Cabon Black tanker therefore accurate samples collected for the CV determination of carbon black and also checked the adulteration of carbon black

CEMENT MILL PRODUCTIVITY IMPROVEMENTS BY PROCESS OPTIMISATION

R B M Tripathi, Umashankar Choudhary and Rajakumaran Kandasamy

JK Cement Works, India

The most advanced cement manufacturing technology does not, on its specific, assure profitable operations. The cement manufacturing operation for maximum cost efficiency not only requires the advanced technological design but also sound operational practices. Plant process audit is an important tool to optimize any system to reach its desirable performance level in terms of low specific power consumption and more productivity.

Cement Industry is an energy intensive industry in which cement grinding section is consuming more power while compared to all other sections in the cement plant. Everyone should adopt energy saving measures by process optimization and technology up gradation to ensure profitability in the business. In particular, cement ball mill is consuming 30 % more power than vertical roller mills to produce the same amount of cement.

Ball mill optimization areas includes mill loading, grinding media distribution, shell liners replacement, separator loading and process fan flow optimization. Vertical roller mill optimization includes grinding bed stability, air balance across the system, pressure drop reduction, nozzle ring velocity, power reduction through process fan curve optimization and false air reduction.

Specific power consumption before Process audit for OPC was 40 and 32 kWh /t cement in ball mill and VRM respectively. For PPC product, specific power consumption was 36 and 26 kWh /t cement in ball mill and VRM respectively. Where as for PSC product, specific power consumption was 52 and 41 kWh /t cement in ball mill and VRM respectively.

This paper elaborates the process audit of cement mills (Ball Mill & Vertical Roller Mill) and also shares the best optimization techniques adopted in our plant to achieve the performance equivalent to national benchmark figures in the industry.

The achieved performance with respect to specific power consumption of OPC product is 35 and 29 kWh/t cement in ball mill and VRM respectively. In PPC product, specific power consumption is 26 and 23 kWh/t cement in ball mill and VRM respectively. Where as in PSC, specific power consumption is 48 and 37 kWh/t cement in ball mill and VRM respectively.

After the process audit, the specific power consumption has reduced tremendously and increased the productivity which supports enormously in reducing the cement production cost.

MITIGATING EFFECTS OF HARMONICS ON POWER SYSTEM IN CEMENT INDUSTRY

S Peddanna and R P Singh

ERCOM Engineers Pvt Ltd, India

Various studies indicate that industries can save electrical energy cost from 10 to 20% just by reducing harmonics in their electrical network and also improving the power factor. With high incidence of harmonics with power quality problems in modern cement plants, companies are paying higher electrical energy bills and also losing productivity due to limitations posed by harmonics.

In modern cement plants, non-linear loads producing harmonics are predominant adding up to about 50 to 60% of the total loads. These non-linear loads are required to save electrical energy and to control process within limits by speed controls apart from other applications in UPS, battery charger etc. This resulted in severe problems, such as untimely burn out / breakdown of the equipment in the cement plants apart from higher energy consumption and reduced productivity.

In an electric power system, a harmonic is a current or voltage at a multiple of the fundamental frequency of the system, produced by non-linear loads such as rectifiers in variable speed drives, UPS, battery charges or saturated magnetic fields in non-ideal transformers. These harmonics pollute the power system and create power quality problems. Harmonics at higher frequencies result in increased heating due to higher copper and iron losses in the transformers, motors, capacitors, cables / wires, leading to untimely burn out and break downs of this equipment and also higher energy consumption and lower production due to harmonic currents

In case of dominant higher amplitude 3rd harmonics, the currents being in phase, add to 3 times current and flows in to the neutral conductor, which is not designed for this current. To avoid 3rd harmonics adding together, delta connections are used, and this current is cycled around the delta connection instead of combining into the neutral conductor and also thereby mitigating the effects of 3rd harmonics on the power system. All transformers should therefore preferably have one delta connection for this purpose and these third harmonics in transformers also help in producing perfect sinusoidal wave form.

Several methods to mitigate the effects of harmonics, available today such as the following, as implemented by ERCOM in various cement / power projects will be discussed in more details in the main paper.

i. Use of multi pulse (36 pulse) VVVF drives for MV motor applications

ii. Use of 12 pulse drives in case of higher rating LV drives / use of higher pulse drives similar to MV drives, cost permitting

iii. Use of input and output filters in case of LV drives

iv. Use of filter circuits on the bus to bypass harmonics in to these filters

v. Use of delta / star or star / star with delta tertiary transformers etc.

PAPER ON OPTIMIZING THE FAN POWER OF VERTICAL ROLLER MILL (RAW MILL) THROUGH MODIFICATION IN LOUVER RING

Rajpal Singh Shekhawat, Pankaj Tiwari and Manish Vijay

JK Lakshmi Cement Ltd, India

Productivity improvement and innovative works run together at JK Lakshmi Cement Ltd, Sirohi. And to continue this momentum our team does internal audits on regular interval. During the internal audit only it was found that the pressure drop across the Vertical Roller mill (Raw mill) was high with respect to industry norms. So our team did a thorough study of the profile of the mill to optimize the process and after a series of brain storming session our team came up with an unique idea of Process optimization.

In this journey of Process optimization, our team came up with an innovative idea of Power reduction in the Vertical roller mill (Raw mill) through optimizing the pressure drop across the louver ring of the mill. This paper contains the details of the work carried out in optimizing the power consumption of the Mill fan and the modification done in the louver ring of the mill. This modification helped us to reduce the Power of the Raw mill fan by 159 units/hr.

TECHNOLOGIES FOR UPGRADATION & MODERNISATION OF POLLUTION CONTROL EQUIPMENT IN CEMENT PLANT

Henrik Vittrup Pedersen, Flemming Jensen and Unmesh Chandran

FLSmidth Automation, India

FLSmidth leads the way in environmental protection, in part through a dedicated commitment to R&D that ensures cutting-edge technology and an exceptional product portfolio.

Solutions include: Particulate removal technologies, such as ESP and Fabric filter; High resistivity & fine dust collection using patented Coromax® Technology; SOx and HCl reduction technology using Proprietary Semi- Dry FGD -GSA®; Catalytic technology for Multi-Pollution control viz., Particulate and Gaseous pollutants, THC/VOC reduction, Heavy metal adsorption including mercury & Dioxin/Furan & De-NOx technology.

For new APC equipment, the utilization of Computational Fluid Dynamics-based (CFD) predictive modelling software to estimate the actual emission levels that will be achieved once the plant is operating at full capacity.

Our fabric filter solutions have more than 8,500 installed units to date & focus on the future by offering longer bag life, minimal maintenance and reliable, cost-effective operation that can deliver emissions below 2.5 mg/Nm^3.

Unique features of our fabric filters include - Unique gas distribution screens; Advanced control system (SPC with EVO-II); Long filter bag technology; Proprietary cage design as well Octagonal filter etc. agnostics

Unique features of our Electrostatic Precipitator include: FLSmidth® Electrostatic precipitators (ESP's) can match fabric filters in efficiency, delivering reliable dust emission control down to 5.0 mg/Nm^3 and has a wide range of industries and applications, and tailored solutions to meet specific plant requirements.

Features that distinguish our ESPs from the competition include - Proprietary power supply system (Coromax®); Computational Fluid Dynamics (CFD); Proprietary microprocessor controls (PIACS-DC4®) ; Unique electrode design for specific process and operating conditions.

Unique features of our Hybrid filters include: Hybrid filters combine the best of Fabric filter and Electrostatic precipitator (ESP) technology for maximum fine particulate matter emission capture. Our hybrid filters are an ideal, cost-effective solution when you need to upgrade your ESP to meet stricter particulate matter emission standards. We develop air pollution control solutions tailored to your operations and to help meet the most stringent particulate matter emission standards.

Hybrid filters offer many advantages, including efficient particulate removal and low installation and operating costs. In a hybrid filter, one part of your ESP continues to function as an ESP while the remaining part of the filter is modified to function as a fabric filter.

With more than 70 years of experience in APC customer services, no one is better equipped than FLSmidth to help you maintain and improve your APC equipment. We can help you maximise uptime, improve efficiency, save energy and meet emissions requirements by ensuring that each component functions efficiently as part of the total system. The Features, technologies and approach are discussed in technical paper.

KHD COOLING LINES: PFC2® & PSC2® COOLER

Andreas Hand[1], Ravi Saksena[2], Anurag Johari[2]

[1]KHD Humboldt Wedag, Germany

[2]Humboldt Wedag India Pvt Ltd, India

A proven and reliable clinker cooler technology influences the performance of the entire cement plant and is essential for smooth operation of the kiln line. As modern day cement production requires clean technology that can ensure sustained development and continued improvement in bottom line results.

Over the last decades, KHD has innovated and developed important technological solutions for clinker cooling, to deliver coolers that not only offer improvements over the conventional functions of clinker cooling and transport, as well as provides best available solutions for sustainable and continued advantages in terms of CAPEX and operating costs. KHD offers two clinker cooler technologies, namely PYROFLOOR²® cooler and PYROSTEP²® cooler.

PYROFLOOR²® cooler, which belongs to the latest generation of coolers, relies on the walking floor principle for the clinker transport. The walking floor moves the clinker towards the discharge end of the cooler by alternating movement patterns of the lanes. The shear friction between the clinker bed of the opposed moving lanes disable the movement of the clinker bed while retracting each of the lanes. The key features of the PYROFLOOR²® cooler are to maintain high heat recuperation while decreasing the maintenance cost. With no conveying elements within the clinker bed because of the autogenous protection of the dead clinker layer and the new cassettes design the lowest possible wear is achieved. Additionally, the improved cassettes design and new metal-to-metal-contact type lateral sealing of the lanes prevent clinker fall through, thus there is no need of any clinker transport underneath the cooler. This aspect saves building height of the cooler and also building height of the whole clinker production line.

However, amidst the present scenario where former generation of 'reciprocating grate' coolers and modern 'walking floor' coolers are in active service, there is a market specific, yet substantial, requirement of improvements in grate cooler technology. This requirement is fueled by demand of retrofits with low investment and maximum benefits that result in lowest possible ROI. Also, in green field projects, cement producers in some specific markets incline towards 'reciprocating-grate coolers'. It was only logical for KHD to combine these demands with the operational experience gained from installations of its own 'reciprocating grate' cooler PYROSTEP®, which are in active service since the 1990s.

The entire development cycle of upgrading the PYROSTEP® was marked by efforts to deliver design features that not only offer improvements in the conventional functions of clinker cooling and transport, but provide best available solutions for higher operating life time of parts, especially the grate plates. With a focus on efficient cooler, the key objectives for design improvements were identified as reducing the pressure losses for improved specific electrical power consumption, Increasing the operating life time of grate plates, state-of-the-art, reliable drive mechanism and additionally easy retrofit for existing PYROSTEP® coolers. The result is PYROSTEP²® for sustainable and continued advantages to clients in terms of Capex & Opex costs.

STATE OF THE ART COOLER REPLACEMENT - FLEXIBLE, QUICK, EFFICIENT

Ingmar Holst

Claudius Peters, Germany

To increase the overall performance of a pyro line in a cement plant a cooler replacement can be essential to reach the targets envisioned. Never the less integrating a new cooler into an existing environment can be very challenging considering all existing boundary limits between the cooler and the kiln, calciner, WHR, coal mill, etc. as well as space restraints existing in some facilities. With the precise understanding of the existing situation and the knowledge of the clients targets CLAUDIUS PETERS is able to integrate the ETA cooler into all existing pyro lines while following our philosophy to "Keep what is good; replace what is bad!"

An intelligent modular design defining quality, flexibility and efficiency as its standard give each existing pyro line access to a CLAUDIUS PETERS ETA cooler to achieve the highest efficiency, maximum availability and minimum maintenance requirements while serving the individual needs of each plant. Mastering state of the art technologies also enabled by the digitalization allows the down time required for the cooler replacement to be minimized. With the help of 3D laser scans, BIM 360 and innovative engineering tools the ETA cooler can be placed in any existing environment as a digital twin reducing the conflicts during realization to a minimum to guarantee a smooth transition. Allowing our clients to grow their business is what drives us. We know how!"

Key Words: Eta Cooler, modular design.

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UNCOALER/ACTIVATER FEEDER FOR COAL EXTRACTION

K S Nalwaya[1], Jogesh Narula[1] and Yong Wei[2]

[1]KSN Tech Ventures Pvt Ltd, India

[2]General Kinematics, USA

Bulk Materials enter a plant through a Wagon Tippler System or Track Hopper System

A typical system with a Wagon Tippler Hopper would as an extracting mechanism would have an apron feeder(s) installed beneath it along with the dribble chain conveyor. In some rare cases vibrating feeders or belt feeders or drag chain feeders may be installed.

Wagon Tippler system based on the above equipment suffers from the following dis-advantages:

1. Apron feeders, vibrating feeders, belt feeders require more height for fitment, thus further depth added to excavation.
2. Apron feeders are expensive, have high wear-out rates of spares (sprocket segments, chains and pans). The belting in belt feeders is prone to ripping and the vibrating feeders in addition to large height requirements have high maintenance requirement in the drive systems.
3. With all these factors the depth of wagon tippler underground portion vary from 15 to 18 meter,

Similarly a Track hopper fitted with a plough feeder suffers from the following disadvantages

1. Long length- 230 meters and beyond. Depth around 11 to 12 meters
2. High construction cost and time.
3. Large space requirement.
4. Complex civil construction for the plough feeder rail platform.
5. Ltd extraction capacity.

To overcome the above disadvantages, Vibrating Un-coalers were developed by M/s General Kinematics and these have the following design features:

1. These can be fitted under hoppers having wide openings and shallow internal angles. The Hoppers are thus 4-5 m less deep as compared to conventional hoppers for wagon tipplers. Resultantly the penthouse length is also reduced by 20-25m, thus saving in Civil cost and construction time. Similarly out going conveyor angle reduces, length reduces, motor power also reduces, which result in a great saving
2. Compact equipment- equipment height varies from 0.5 m to 0.9 m for the most commonly used models.
3. Simple vibrating equipment based on the 2 –mass theory, having no complex mechanical linkages or wear-parts.
4. The Un-coaler installation, comparable to Track hoppers is about 65 m long as against 230 m for Track hopper. Depth of Un-coaler hopper is 4-5m less than Track hopper with Plow Feeder. This results in Tremendous saving in space, construction cost and time and conveyor lengths.

Uncoalers when installed under Silos, lead to reduced Silo heights, smooth Material Discharge Power Saving and Compact Layout.

3D PRINTABLE CONCRETE: DESIGNED BY LOCAL MATERIALS

Shrivats Singhania, S K Wali, S K Saxena and Mukesh Kumar

JK Lakshmi Cement Ltd, India

3D Concrete Printing technology has a potential for the rapid industrialization of the housing sector, with benefits of reduced construction time due to no formwork requirement, ease of construction of complex geometries, potential high construction quality and reduced waste. The Mix design consist of 80% OPC 43 grade cement and 20 % Dry Fly ash with Polypropylene fibers of 12 mm length and 40microns lateral dimensions were used at dosages of 0.2% by volume of mortar. VMA and superplasticizer dosages were adjusted until a flow value of 80% was obtained.

Extrudability test, Yield stress test, Buildability test, Robustness test and Flow table test were studied. These were conducted to give an idea about the printing of concrete with 8 mm local aggregate, crushed sand and OPC 43 GRADE Cement.

Results have shown that it is important to understand the local materials properties for layer –wise extrudability test and print the 3D Concrete structure.

NEW TECHNOLOGIES BY ATS-GROUP FOR ALTERNATIVE SOLID FUELS HANDLING

Luc Rieffel

ATS Conveyors India Pvt Ltd, India

This paper presents a recent case of executed project supplied with new designed equipment handling coarse alternative fuels. The renowned cement factory in middle-east supplying cement within country as well as exporting cement is the key decision maker in replacing facile fuels with wood chips, tyre chips & RDF.

The plant was commissioned in 1977 in middle-east & has been the market leader in the production of its Portland cement and GGBS products since the company commenced production in 1977.

In 2017, Management decided to use alternative solid fuels (ASF) as construction wood waste is increased in middle-east. Construction Wood waste is available in nearby region & is used now at plant for replacing coal. Management was also clear that in future alternative solid fuels will also extend to RDF (Refuse derived fuel) & TDF (Tyre derived fuels) and was looking for a turnkey solution to use all ASF in its cement kiln.

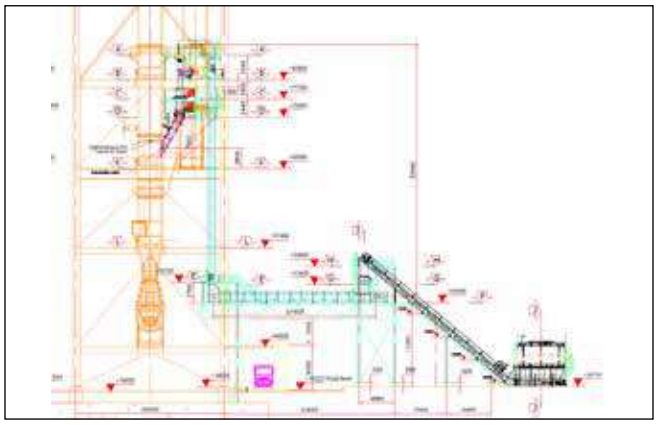
User made a market survey on various system and visited several plants during 2017. User as well visited WALTER installation in India found WALTER equipment as the most flexible in handling all range of alternative fuels.

After detailed analysis user decided to work with WALTER Material Handling solution a division of ATS-Group for its ASF solution. Below are the technical specifications of the project under case study.

PRODUCT	Wood chips, tyre chips, refuse derived fuel
GRAIN SIZE	0.5 to 30mm
PRODUCT BULK DENSITY	0.2 to 0.6 T/m^3
MOISTURE CONTECT	< 5%
FEEDING CAPACITY	5 ton/hour

For a low investment, Walter came with innovative solution for cement industry with top loader. After a comprehensive evaluation and discussion with User, WALTER proposed a turnkey handling solution suitable for the user layout as below...

- Toploader scrapper with bunker storage capacity
- Chain belt conveyor with hopper & calibrator
- Dosing belt
- Side wall conveyor for conveying & lifting
- Small Vibrating conveyor for isolation of the belt
- Double valve airlock with safety shut off gate



1. Project General Arrangement drawing

2. Project arrangement site picture

DEVELOPMENT OF BELITE CALCIUM SULPHO-ALUMINATE CEMENT USING LOW GRADE LIMESTONE AND INDUSTRIAL WASTE

B N Mohapatra, G J Naidu, S Palla, S Vanguri, V Liju, M Kumar and S K Chaturvedi

National Council for Cement and Building Materials, India

Cement industry contributes for about 5-7% of the total man made CO_2 emissions. One of the possible ways for decreasing these CO_2 emissions is the development of alternative clinkers with lower proportion of limestone in the raw materials. Belite Calcium sulfoaluminate Cements (BSAC) are regarded as a promising low CO_2 alternative to Portland cements. The production of Belite Calcium sulfoaluminate cements requires sulphate (gypsum or anhydrite) as a major raw material. But, availability of gypsum is not uniform throughout the India. In order to address these concerns, the present study highlights the effect of the addition of typical industrial waste as a substitute for sulphate and Iron source (generally gypsum and Iron Ore) in production of BSAC clinker. BSAC raw mixes were prepared with jarosite and other conventional raw materials. Jarosite, a residual by-product generated by the zinc industry during the hydrometallurgical process, contains predominantly Fe_2O_3, SO_3 and alkalis with a small amount of ZnO. The chemical constitutes of jarosite were known to contribute significantly in the formation of clinker mineral phases and, therefore, the jarosite could be an effective raw material in the manufacture of BSAC. Different computational raw mixes with LSF around 70 % were designed with jarosite and other conventional materials. Burnability studies of the designed raw mixes were carried out at temperatures of 1150, 1200 and 1250°C with a retention time of 20 min showed rapid formation of BSAC clinker mineral phases with low LSF (~70) of raw mix. The mineral phase developments such as dicalcium silicate (C_2S) and ye'elimite ($C_4A_3\overline{S}$) and microstructures of laboratory clinkers fired at 1250°C were found to be adequate in the presence of jarosite. XRD, and Scanning Electron Microscope confirmed the formation of ye'elimite ($C_4A_3\overline{S}$) and C_2S through microstructural and morphological characterization. Isothermal conduction calorimetry measurements showed that the heat liberation of BSAC were higher at early age compare to conventional OPC. The performance evaluation of resultant cements obtained from belite calcium sulfo aluminate clinkers indicated high early compressive strength at the age of 3 days was obtained highest around 42.5 Mpa and fast setting time around 30 mins of initial and below 60 mins in final setting time. The results obtained indicated the developed jarosite based calcium sulfo aluminate clinkers has potential to be commercialized in future. Further studies are under process to optimize setting behavior of calcium sulfo aluminate cements.

INDIA ADVANCES IN CONCRETE PAVING TWO-LAYER TECHNOLOGY

R K JAIN

DCRUST, India

2LCP is composite pavement, by wet-on-wet process of laying with time gap of not more than 45 minutes. The 2LCP is known as Two layers' construction or two lift construction or dual layer construction. The lower layer is also known as base course. It has strength of 3-4 MPa. The top layer has strength of 4.5 MPa or above and utilises hard non-polishing aggregates, higher cement content with almost cubical coarse aggregates.

The concrete in bottom layer includes replacement of cement with 20-25% flyash. It also permits use of RAP to upto 10%. This also allows use of RAC to a great extent. These provisions lead to environmental advantages by utilising the materials on the waste heaps. Due to reduction in use of virgin aggregates, the crushing energy in producing the same is saved affording carbon credits.

The 2LCP is a tried technology in developed countries where the recycled aggregates marginal aggregates and supplementary cementitious materials are economically utilised. In our country, the availability of hard and non polishing aggregates is getting scarce and costly. It is high time India should take up the construction of 2LCP and some experiments are urgently needed. At least a few kms need to be sanctioned by the MORTH / NHAI as experimental stretches or try the technology.

Keywords

RAP = recycled asphalt pavement material

RCA = recycled concrete aggregates

EAC = exposed aggregate concrete

PHASE EQUILIBRIUM STUDIES ON THE EFFECT OF MINERALIZERS ON THE FORMATION OF HIGH TEMPERATURE IONIC LIQUID OF $CaO-SiO_2-Al_2O_3-Fe_2O_3-MgO$ SYSTEM

Tazuddin and Amit Chatterjee

Aditya Birla Science and Technology Pvt Ltd, India

Mineralizers are inorganic compounds which are used in cement raw mix to reduce clinkerization temperature by assisting high temperature reactions during clinkerization process. It involves in the clinkerization reaction by assisting formation of ionic liquid and by altering the properties of ionic liquid such as viscosity, surface tension etc. Ionic liquid plays a critical role in controlling and completing clinkerization reactions at high temperature. A detail thermodynamic study has been carried out to investigate the phase evolution during clinkerization process and to study the effect of those mineralizers on ionic liquid formations and other phases. The effect of common mineralizers like CaF_2, AlF_3, $MgSiF_6$, Na_2SiF_6, $CaCl_2$, ZnO and $CaSO_4$ on the formation of ionic liquid has been investigated here using phase equilibrium calculation. All these mineralizers are found to be very effective in enhancing weight fraction of ionic liquid at high temperature.

AlF_3 was found to be the most effective mineralizer in increasing ionic liquid compared to other mineralizers. On the other hand, ZnO has minimal effect in increasing ionic liquid. Simulation data also describes the correlation between the dosages of mineralizers and corresponding liquid formation. In addition, the combined effects of different mineralizers have also been studied. It was found that, when AlF_3 and CaF_2 both are added together, the effect is more prominent if AlF_3/CaF_2 ratio is less than 0.5. Similar study has been carried out for CaF_2 and $CaCl_2$ system where, the results showed that by replacing $CaCl_2$ with CaF_2, clinkerization temperature decreases linearly. Phase equilibria study also showed that the mineralizers also affect other important phases like C_3S and C_2S while increasing ionic liquid. CaF_2, AlF_3, $MgSiF_6$, Na_2SiF_6 significantly decreased C_3S and C_2S but, $CaCl_2$ had marginal effect in decreasing C_3S and C_2S compared to other mineralizers. ZnO and $CaSO_4$ slightly increased C_3S and decreased C_2S.

THE INFLUENCE OF CHEMICAL AND MINERALOGICAL VARIABILITY ON THE GRINDING BEHAVIOUR OF LIMESTONE

A Sadangi, M Kuchya, A K Singh, K Suresh and Raju Goyal

UltraTech Cement Ltd, India

The role of mechanical – chemical and mineralogical characteristics of limestone in their amenability to crushing and grinding has direct impact on the operational performance of crushers and milling systems, and an understanding of their interrelationship is helpful in machinery design, capacity utilization and selective mining for enhancing productivity. The grindability of limestone principally depends on the chemical composition, mineralogy, textural features like size of the grains, bulk density and mineral content.

Around thirty Indian limestone samples have been collected depth wise up to 50 meters from a quarry belonging to Vindhyan formation. Chemical and mineralogical behaviour of limestone have been compared with their grindability value. A strong correlation exhibits between quartz content, SiO_2%, Al_2O_3%, vs. grindability (R^2 = 0.87, 0.73, 0.70). Depth wise decrease in grindability have been noticed.

IMPROVISING LOGISTICS AND SUPPLY CHAIN IN CEMENT INDUSTRY

Ravindra Kumar Singh

BEUMER India Pvt Ltd, India

Worldwide, Logistic and Supply Chain play a vital role and contribute immensely to the economy of a nation. In this paper, research was conducted to investigate how logistic and supply chain are implemented in cement factories in India, identify the problem areas and proffer solution.

Since cement is a vital building material it demands a well-organized distribution and delivery system with a focus areas to optimize the overall logistics cost upto the point of consumptions.

The Cement Industry has gone many phases of technological advancement to improve the overall production cost. The technological advancement has also reached to a point of saturation where not much improvement is forecasted at the moment and then we have to think of a solution to reduce the packing, loading, distribution and logistics cost in order to keep the cement prices affordable to the end user and at the same time maintain the profitability of the cement producer.

The technological upgradation in packing and loading has already started but still lot more has to be done, specially in India, where still the automatic bag placing and automatic truck loading machine usage are minimal, at the same time the use of automatic bag placers and automatic palletizers are non-existent and this can reduce a substantial cost in packing as well as loading by reducing not only the time but also the reduction in human resource involvement. The biggest advantage will be the protection of health hazards to the human resource besides environment.

The distribution cost of cement from the manufacturer to the end user including the logistic cost are as high as 25-30% of the total cost of cement. The optimization of this cost can not only reduce the burden on the pockets of the cement user but also enhance the profitability of the cement producers, which will result in a higher growth rate of the industry.

In order to optmize this cost lot has been done like decentralied grinding units, blending plants, as well as warehousing. But still lot more has to be done such as more and more usage of rail transport which works out to be 12-15 rupees in India as against 18-25 rupees by road if we consider a 50 kg filled bag. This can be further improved if we look the possibility to transport the cement by water transport as worldwide more than 70% cement is transported by water whereas in India it is merely 3-4%. Bulk transport of cement can also reduce not only the transport cost but also drastic reduction in packing and loading cost.

For reduction in inward transport cost the strategic planning of two way logistics wherein the vehicle carrying a particular material from one location to the other location is utilized to carry other raw material from the second location to the first location as the case is in Nuvoco Cement (formerly Lafarge Blending Station, at Bhiwani, Haryana).

IMPROVEMENT OF ASH QUALITY THROUGH CHEMICAL / MINERAL DOPING IN COAL DURING ITS GENERATION

G J Naidu, S Palla, S Vanguri, G Ahamed, F Ahmad, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Fly ash is a typical industrial waste and around 167 mtpa produced from thermal power plants in India. Around 65% of generated fly ash is utilized in different sectors including cement. The utilization of fly ash largely depends on its characteristics such as amorphous /glass content, lime reactivity and carbon content percentage. Quality Indian fly ashes were relatively poor and vary from in terms of glass content (15-45%), lime reactivity (2-7 Mpa), and reactive silica.

Amorphous content is an important characteristic property for utilization of fly ash in cement sector. Fly ash is generated by combustion of coal and contains various inorganic minerals such as silicate, alumino silicate, iron silicate, minerals, etc which influence its reactivity. The present study investigates the effect of mineral matter doping in the coal before combustion on its chemico-mineralogical constituents of the resultant ash.

Different types of sintering aids were mixed with coal of different percentages. The ash prepared of the designed coal and dopants mixes in laboratory furnace at around 950^{0}C. The resultant ash with and without dopants were evaluated for their chemico-mineralogy and microstructure characterization using state of art instruments such as XRD, SEM and Optical Microscopy The mineralogical or crystalline compositions and glass content of doped ash samples shows better characteristics than the un doped sample. The addition of sintering aids may convert the crystalline content of silicate minerals into amorphous content and enhances the total amorphous content in the doped ash samples. Lime reactivity, and cement reactivity of doped ash samples shows better performance than the control sample. Tie up with the thermal power plant for industrial plant scale trials are advance stage.

JSW Cement is **India's leading producer** of **Green Cement.** JSW entered the cement market with a vision to ensure a sustainable future for the country by producing **eco-friendly cement.**

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MODIFICATION OF CEMENT MILL BAG HOUSE PURGING SEQUENCE & INCREASED THE PPC OUTPUT BY 10%

M Narsi Reddy

Dalmia Cement (Bharat) Ltd, India

Dalmia Cement Ariyalur unit, having designed capacity of 300 TPH Cement Mill in PPC grinding. Through many innovative modifications and improvements, the grinding capacity was enhanced to 330 TPH. Though there was a potential to increase the mill output but we were not able to increase beyond 330 TPH due to Silo feed elevator is getting frequent boot level & high variation in elevator current.

The issue was discussed with OEM but no solution provided. Our Cross Functional Team (CFT) has done the brain storming session & identified the root cause of the problem. Team came up with innovative idea to maintain the uniform flow of material from the Bag house to silo feed elevator by changing the purging sequence without major investment.

What was our approach/methodology towards making this initiative a success?

Cement Mill PPC output increased from 330 to 365 TPH after modification of Bag house purging sequence successfully.

As per OEM, the Bag house purging sequence starts in chamber L1 & R3, then L5 & R7 chambers and continuous for remaining chambers in the sequence of L3 & R1, L7 & R5, L2 & R4, L6 & R8, L4 & R2, L8 & R6 with existing arrangement material flow was non-uniform which leads to vary the Elevator current & frequent boot level which restricted the mill output.

Before:

It was observed that the variation in silo feed elevator current is due to purging of adjacent and more dust collection chambers at a time.

L	1	5	3	7	2	6	4	8
R	3	7	1	5	4	8	2	6

After:

Bag house purging sequence was modified as mentioned below to get the consistent & uniform flow material through-out entire chambers. BH purging sequence starts with L1 & R8, L2 & R7, L3 & R6, L4 & R5, L5 & R4, L6 & R3, L7 & R2, L8 & R1 and Optimized the elevator current <140 Amps and achieved the mill output 365 TPH.

L	1	2	3	4	5	6	7	8
R	8	7	6	5	4	3	2	1

Our learning during/at the end of the project: We need not rely only on the machine design/settings by the OEM. By applying innovative ideas and brain storming, the better results can be achieved.

RESULTS:

- Optimized the Silo feed elevator current < 145 Amps and no tripping of elevator.
- CVRM Availability increased from 94 to 97%
- Cement Mill output increased from 330 to 365 TPH
- Cement mill PPC specific power consumption got reduced from 24.2 to 22.5 kWh/MT.
- Similar modification was horizontally implemented in our group units.

CUSTOMER PARTNERING THROUGH RELIABLE & RESOURCEFUL SERVICES & PRODUCT OFFERINGS

Sitaram Sharma and K Vikram

KHD Humboldt Wedag India Pvt Ltd, India

Modernization of existing cement plants with state-of-art technological products and quality service support from OEM`s leads to OPEX savings and improves the reliability & availability of equipment. KHD Humboldt Wedag strongly believes in 'Customer Partnering' while developing and offering product & service solutions.

'SERVICE OFFERINGS' SPECTRUM OF KHD'

Process audits and feasibility studies, Kiln services & Hot Kiln Alignment (HKA), Supervision, Operation & Maintenance (O&M) Services, Training / workshop to plant team for efficient operation, Refurbishment & In-Situ Grinding Services 'PRODUCT OFFERINGS' FOR MODERNIZATION OF EXISTING CEMENT PLANTS'

Modification / Upgradation of Preheater Cyclones:

KHD`s top stage twin cyclones are best-in-class and designed with highest dust collection efficiency of >96%, low exhaust gas temperatures and low pressure drop. KHD's top stage cyclones are the ideal choice for replacing existing inefficient top stage Preheater cyclones for improving the dust collection efficiency, to improve the heat transfer rate thus reduced exhaust gas temperatures and also to reduce the pressure drop across the cyclones. Further, the same can be installed for marginal clinker production increase subject to suitability of upstream and downstream equipment.

The bottom stage Preheater cyclones are designed with 270 deg inlet spiral with optimum heat transfer and dip tube (immersion pipe) design is a combination of high dust collection efficiency and optimum pressure drop.

Other 'PRODUCT OFFERINGS' are PYROBOX® for solid fuel (coal / petcoke) firing in Calciner, High efficiency dynamic classifier for raw meal, cement & slag applications, V-Separator in HPGR circuits, Low NOx burner (Pyro-Jet® Burner), PYROROTOR® for alternative fuel firing, New Generation Clinker Cooler Static Inlet & Grate plates for 2nd & 3rd Gen Grate Cooler

CASE STUDY: Replacement of existing Cement Mill Separator with new SKS Dynamic Separator at a Plant in North India:

In existing set-up, the plant in its closed circuit cement ball mill had an old generation ZUB Separator. The cement mill system regularly had problems of low output and Blaine. The cement mill was operating at an output of 108-109 tph PPC at a Blaine of 3300 cm^2/g. KHD HWI team after conducting process audit and review of the existing system, proposed to upgrade the existing cement mill separator with a latest generation dynamic Separator.

KHD HWI proposed to replace the existing ZUB Separator with SKS- Z 2500 Separator along with other required auxiliaries like separator fan, air slides etc. KHD HWI offered performance guarantees in terms of production increase & specific power consumption for key equipment. The proposed modifications were implemented successfully.

After commissioning of the system, the performance guarantee test of the cement mill was successfully completed and the summary of the key operating data during the performance guarantee test is given below. After modification, the Cement mill production- PPC has increased by 16 %. The specialty of the product & service offerings, features and some case studies are described in the paper.

INCREASED USAGE OF ALTERNATE FUELS & RAW MATERIALS BY IN-HOUSE MODIFICATION

G Sakthivel

Dalmia Cement (Bharat) Ltd, India

At Dalmia Ariyalur unit, the AFR utilization was 1.6% on TSR basis through existing feeding arrangement having the bucket capacity of 0.8 m^3, in which tire threads, resin waste, cotton waste, municipal waste, paint sludge and various type of plastics (biscuit, chocolate wrappers) were fed maximum of 15 tonnes per day. Further we couldn't able to increase more than 15 tonnes per day due to feeding arrangement constraints.

A proposal was made to set up a new full pledged AFR feeding system with shredder arrangement, which is costing around 10 crores and project will be completed around 8-12 months. In meanwhile our Cross Functional Team (CFT) team has decided to modify the existing feeding arrangements by in-house design without any major investment to enhance the AFR utilization from 15 to 50 tonnes per day.

What was our approach/methodology towards making this initiative a success?

Our CFT team has decided to modify the AFR feeding system by in-house design through innovative approach. We found that there was a possibility to increase the bucket feeding size from 0.8 to 2.3 m^3 with existing arrangements and the following initiatives was carried out.

1. Modified the bucket feeding system with box arrangement with volume of 2.3 m^3 through which we can feed up to 50 MT per day
2. The following major modifications were carried out for easy, reliable & 100% safe operation:
   a. Higher size pulley -3 nos. were replaced for strengthening the system
   b. Proxy limit switch was provided for up & down of safe operation
   c. Proxy limit switch was provided for door opening & closing interlock
   d. For bucket movement in & out swirl plate installed at entrance of the gauge
   e. Variable speeds drive arrangement for optimized the bucket speed.
3. Three feeding points with hopper arrangements were made ready for easy unloading & consistent feeding.
4. Installed double flap at both feeding arrangement to reduce the false air entry thereby Preheater fan speed reduced by 5% and also avoided the back fire.

RESULTS:

- AFR feeding rate increased from 15 to 38 MT per day with low investment
- % of AFR utilization increased from 1.6 to 5%
- Ensuring 100% safe operation
- Same feeding arrangement was implemented in our group units.

IMPROVING THE ELECTRICAL ENERGY CONSUMPTION OF CLINKER PRODUCTION – RECENT DESIGN IMPROVEMENTS

Sebastian Frie

Thyssenkrupp Industrial Solutions AG, Germany

Driven by the incentive to reduce the emission of carbon dioxide as well as by the obligation to reduce the cost of production, clinker producers in India are steadily searching for opportunities to minimize the consumption of electrical energy during clinker production. India is already world leading regarding average kWh/t of clinker energy consumption as well as regarding the co-generation of electrical energy using process waste heat.

This article highlights some recent design improvements for the polysius preheater system and the polysius polytrack® clinker cooler of thyssenkrupp Industrial Solutions and thyssenkrupp India that are focusing on this target: reduction of electrical energy consumption in the clinker production along with remaining low in investment and operation costs.

The preheater is of special interest as the pressure drop of the cyclones is the main reason for the electrical energy consumption. Therefore, thyssenkrupp has recently further improved their preheater and de-dusting cyclones with the goal of conserving the already existing de-dusting efficiency but to further reduce the pressure drop.

This development was not only focusing on the cyclone alone but investigated the whole preheater plant design. Actions were taken to optimize the cyclone arrangement in order to retain the size of the preheater building while placing larger cyclones with lower pressure drop.

The clinker cooler is relevant as well. The design of the polysius polytrack® clinker cooler was recently optimized in order to reduce the pressure drop for the aeration. If it comes to co-generation the cooler waste air temperature is enhancing the efficiency of the waste heat recovery system. Successful applications of waste-heat-recovery systems will be demonstrated.

The above mentioned improvements are applicable not only for new production lines but can be adapted to existing production facilities as well with positive environmental and economic impact on the whole production float.

INCREASE OF KILN-2 THROUGHPUT BY 300 TPD

Lokesh Bahety and Rakesh Nayak

Dalmia Cement (Bharat) Ltd, India

Kiln throughput enhancement and reduction of specific power consumption is the key aspect of cement plant. Optimization of kiln to achieve maximum output is the prime objective of our study.

Dalmia Cement Bharat Ltd (DCBL, Rajgangpur) is effectively utilizing kiln-2 output to maximum extent over designed output of 4000 TPD. Kiln-2 is optimized to achieve output of 4800 TPD from avg. of 4500 TPD with effect from Feb'19 with in-house modification as well as optimization in the circuit.

The optimization includes installation of higher capacity preheater fan & cooler esp fan, increase of kiln rpm from 5.0 to 5.5 rpm by replacement of main drive gear box. etc.

Details of modifications:

1. Installation of higher capacity PH fan of 7,60,000 m^3/Hr, Pressure: 1134 mmwg, from earlier PH fan of 7,00,000 m^3/Hr, Pr: 800 mmwg.
2. PH Fan motor changing from 2250 kW to 3200 kW.
3. Installation of higher capacity cooler ESP fan of 6,70,000 m^3/Hr from 5,50,000 m^3/Hr.
4. Increase of kiln rpm from 5.0 to 5.5 by replacement of Gearbox.
5. Installation of additional Grate-3 in cooler to improve cooler reliability.
6. Improving burnability of Raw meal by reduction of SM from 2.4 to 2.2.
7. Reduction of false air in the circuit from 6% to 4.5%.

In addition to the above mentioned modification and optimization, DCBL, Rajgangpur is planning for further increase of production of line – 2 to 5500 TPD in 2019.

OPTIMIZATION TO ENHANCE PRODUCTIVITY, QUALITY & OPERATION PERFORMANCE FOR COMPOSITE CEMENT

Manoranjan Sahoo[1] and Sougata Mahanti[2]

[1]Dalmia Cement (Bharat) Ltd, India

[2]Bengal Cement Works, India

OCL Bengal cement Works (here-in-after referred to as OBCW), a unit of Dalmia Cement Bharat Ltd, is operating a Cement Grinding Unit having Installed capacity of 1.75 MTPA, situated at West Medinapur district in West Bengal.

- Cement Plant commissioned on 27th March, 2014
- A Solar PV Power Plant of 5 MW capacity commissioned on 30th March 2016
- Certified for Integrated Management System of ISO 9001,14001, 45001 & 50001 (Quality, Environment, OHSAS & energy)
- Presently operating a FLS OK MILL (42.4) for PSC, PPC & Composite Cement in inter-grinding mode.
- Catering to the entire pockets of West Bengal with 100% road dispatches

This paper discuses about several optimization initiatives executed in 2017-18 & 2018-19

HIGHLIGHTS:

- 12% productivity enhancement (tph) with in one financial year i.e from 252 to 279 tph with sustained Internal quality parameters. (achieved monthly best : 295 tph)
- Reduction of 10% Specific power consumption (from 34 to 31.5 kWh/T).
- Green cement initiative: Improvement of clinker factor by 10 % (from 49.5% to 44.5 %)
- Improvement in slag addition from 22% to 26%.
- Sustaining Fly ash addition at 28-28.5%.
- Despatch volume to market is doubled (26% to 60% of total cement despatch from the unit) with in one financial year due to superior & sustained quality.

CONTENTS:

- **Detailed TPH enhancement initiatives:**
  - I) Operation parameter optimization
  - II) Damring optimization.(from 140mm to 160 mm)
  - III) Optimized reclaiming of high moistured slag(> 10 % slag moisture) for CC cement production only to facilitate uniform bed formation with least water spray.
- **Detailed Energy reduction initiatives:**
  - I) Grinding pressure (increased from 150 to 158 Bar) & separator optimization (from 835 RPM to 830 RPM)
  - II) CVRM ID fan flow (reduced from 2.3nm^3/Kg to 1.9 nm^3/kg) & cone gap reduction (23mm to 12 mm)
  - III) Other auxiliary power saving initiatives.
- **Quality parameter & cementatious optimization :**
  - I) Quality parameter at different cementatious combination
  - II) Reduction of Clinker factor from 49.5 % to 44.5%
  - III) Enhancement of slag % from 22 % to 26%.

REDUCTION OF RAW MILL - 2 SPC BY INCREASING THE FEED

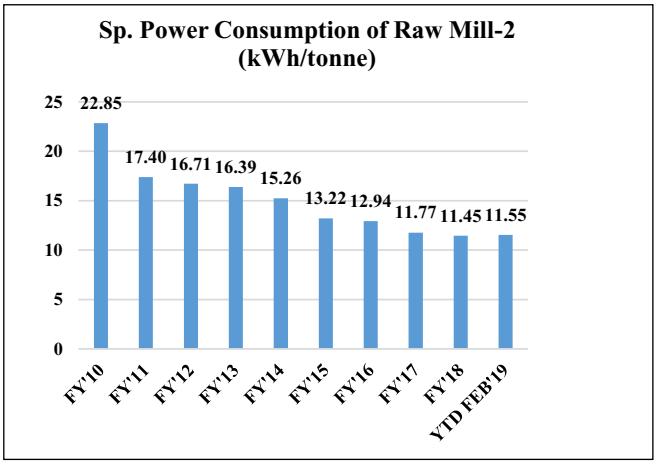
Lokesh Bahety and Debi Prasad Das

Dalmia Cement (Bharat) Ltd, India

Reduction in Specific Power Consumption in Raw Mill-2 was achieved mainly by increasing the output of the mill.

Dalmia Cement Bharat Ltd (DCBL, Rajgangpur) has effectively reduced the Specific Power Consumption (SPC) of raw mill-2 from more than 13.2 kWh/tonne in FY'15 to less than 11.5 kWh/tonne in YTD Feb'19. This was achieved with some in-house modifications in both mill and the mill circuit.

The modifications include some changes in specific areas where the equipment were running at bottleneck.



In order to decrease the SPC of Raw mill-2, the tph of mill was enhanced. To do so following modifications were made:

- Silo feeding bucket elevator motor was replaced by a higher rating motor, as there was margin in gearbox and drive coupling but motor was running at bottleneck.
- Grinding pressure was increased from 85 bar to 100 bar keeping in mind the Roller-Load curve.
- Mill feed receiving chute was designed as per 370 tph, so the cross section area of the chute was increased as the feed chute was getting jammed frequently if mill was running over 450 tph.
- Mill reject hopper capacity was increased from 3 tons to 5 tons as it will increase the material retention time of diverted mill material and elevator load will be reduced.

In addition to these changes, we are trying to decrease the SPC of Raw mill-2 even more in 2019.

REDUCING POWER CONSUMPTION OF PH FANS BY CFD APPLICATION AND IMPROVING PRODUCTION

Pritam Hukire and Akshay Shah

Mechwell Industries Ltd, India

Reduction in Energy consumption & Pollution control is the main objective of all cement industries for long term sustainability. Computational Fluid Dynamic (CFD) is a universal tool that uses numerical methods & algorithms to solve and analyze various problems that involve fluid flow. CFD technology is now widely used to analyze performance and reduce energy consumption in the pyro section of cement industry. CFD analysis is used to carry out studies pertaining to Single Phase/Multi Phase flow analysis, Heat transfer, Combustion analysis, Material/ Particle behavior, pressure drop reduction. CFD analysis is used in Cement Industry to solve problems in PH system, Cyclone, Ducts, Separator, Raw mill, Cement mill, ESP, Bag house, Gas Conditioning Tower, Fan, Kiln & Calciner etc.

CFD tool can be used in Greenfield, Brownfield cement plants for performance improvements in cement plant. It can improve retention time in calciner, Reduced erosion of castables in kiln, Improved flame propagation length, Optimum performance of Pyro Section and reduced auxiliary power consumption Problems like are Improper heat transfer, Improper material distribution, Material accumulation, High pressure drop across cyclones & downcomer duct, Erosion which causes higher power consumption are addressed using this technique By means of minor modifications in Riser duct, Spreader box & Cyclones,. Problems occurred in ESP & Baghouse like Improper flow distribution and Low collection efficiency, ash re-entrainment causes reduced performance of ESP, gas flow uniformity required for Optimum ESP performance as per ICAC EP-7 norms is achieved which reduces SPM emissions.

Cement manufacturing industries releases a lot of COx and NOx. It is estimated that 7% of global CO_2 emission originate from Cement production. Employing alternative fuels in cement plants not only reduces cost but also have important ecological benefits of conserving non-renewable energy sources. To examine the suitability of a fuel, CFD analysis is carried out to predict the final impact of that fuel on Kiln performance and greenhouse gas emission. With an accurate model & sufficient data it is possible to conduct simulations for wider range of alternative fuels. and optimise.

CFD Application in Cement Plant-

- Cyclone
- Raw Mill/ Cement Mill
- Ducting system
- Waste Heat Recovery Boilers
- Calciners
- Kiln
- Coal Mill
- Separators
- ESP`s / Baghouses

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

DETAILED CFD MODEL FOR PREDICTING COMBUSTION, CALCINATION AND POLLUTANT FORMATION IN CALCINER

Shital Mone[1], B S Gawali[1], M S Joshi[1] and Vivek Vitankar[2]

[1]*Walchand College of Engg. India*

[2]*FluiDimensions, India*

Cement clinker manufacture is an endothermic process and releases pollutants like CO, CO_2 and NOx. The energy required for this reaction is supplied by the combustion of fossil fuels like coal, petcoke. The introduction of calciner in the cement industry has reduced the fuel consumption to a considerable amount.

The major problems related to the performance of a calciner are handling the combustion of fuel, dust loading, pollutant formation. The extent of fuel combustion, calcination, and pollutants formation depend on the interaction of air, coal particles and raw meal particles ($CaCO_3$), temperature and the residence time. The flow patterns and temperature profiles inside the calciner drive the performance of calciner. Also, the pollutants reduction is possible by maintaining the right mixing, proper residence time and temperature profile in the calciner.

CFD is the best tool to analyze mixing, predict the extent of coal combustion, understand temperature profile, extent of calcination, and pollutant formation. Most importantly, CFD helps to understand the root cause of inefficiency of combustion and calcination and high pollutant formation.

In this work, the detailed physics of combustion, calcination, formation of pollutants like NO_x has been modelled for industrial calciner along with the fuel trajectories and raw meal mixing pattern.

Detailed analysis of flow patterns, thermal profiles along with the effect of radiation is also included in the model. All the important mechanisms of NOx formation, thermal, prompt and Fuel NOx have been studied.

The in-depth understanding of flow patterns and temperature profiles can help us to decide the optimal injection locations of the air, fuel and raw meal to maximize fuel combustion efficiency, calcination and reduce pollutant formation. The detailed model can be applied to address multiple issues (1) Raw meal and TA split to reduce NOx (2) Increase AFR % (3) Improve Calciner performance in terms of fuel combustion efficiency and raw meal clinkerization efficiency.

The developed CFD model of combustion is used in the industry-scale cement calciner to analyse the combustion and calcination processes in it. The results obtained by the simulations give the in-depth understanding of the calciner processes which can be used for the optimization of the calciner's geometry, to have a more efficient production of cement, to lower the pollutant emissions.

North East's 1st International Half Marathon

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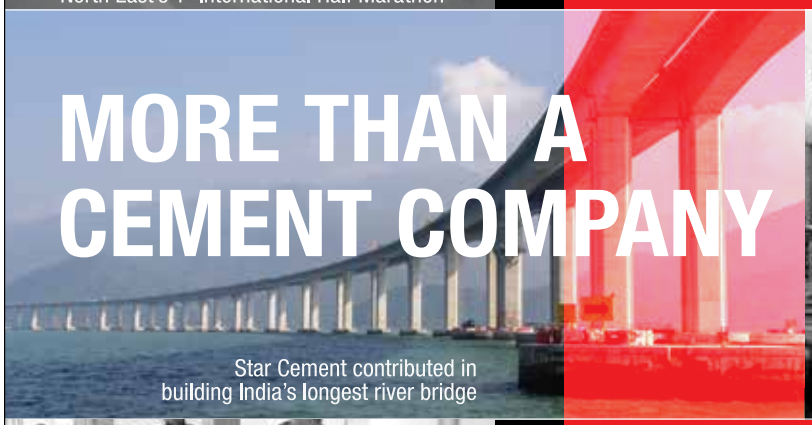
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16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
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TOTAL QUALITY MANAGEMENT (TQM) (TEI - A Key to its Implementation & Success)

O P Agrawal[1], B N Mohapatra[2], P N Ojha[2] and Abhishek Agnihotri[2]

[1]Qualman Consultancy Services, India

[2]National Council for Cement and Building Materials, India

For any business organisation, it is very imperative that it must have a profitable growth on a long term basis, which can be achieved by continuously satisfying the external customers through meeting their needs and expectations. It has been achieved by many Organisations, like Toyota, Nippon, Honda, Sony, Tata Motors, L&T, Maruti, Hero Honda, etc., by implementing various concepts included under the umbrella of Total Quality Management (TQM). It is also experienced that the above can be made feasible only by involvement of total employees of the Organisation.

Here, Total Employee Involvement (TEI) is one of the main pillars on which TQM stands. All TQM initiatives would be a house of cards, if we are unable to involve the total work force from each work area and level towardsn achieving company's Vision, Mission and Objectives. Continuous improvement is possible with TEI only.

The issue is how to have 100% TEI?

Following factors are to be considered for its effective implementation in the Organisation:

1. Top Management's Policy and Approach towards Employees should ensure:
   - Interesting work, matching to peoples' competency and liking.
   - Specific responsibility, adequate Authority with accountability.
   - Objectives to be "SMART" and attainable, but challenging
   - Periodic feedback on their progress towards achievement of Objectives
   - Working in groups/ teams.
   - Self-respect and listened to with patience by Superiors.
   - Self-development opportunities
   - Opportunities to share experience & achievements.
   - Opportunities to be creative & give suggestions.
   - Recognition of achievements / good performance.
   - Attention to personal and family related problems.
2. Creating Opportunities and Enabling Environment for motivation of Employees:
   - Shared Vision & Mission creates a unity of purpose, which becomes a common driving force.
   - Continuous Improvement &Team-Working through Kaizen, QCC, SGA, "5-S" House Keeping, TPM, Lean manufacturing, Just-in-time, Outdoor programmes, etc
   - Visible & effective leadership at all levels:

     The emphasis should be on "what is wrong" and not "who is wrong".
   - Fair and unbiased personnel Policies and Systems
   - Respect, Openness, Trust and Good human relations
   - Training & Development
   - Recognition and Rewards
   - Internal Communication - House journals, newsletters, CEO's communication, etc., play a very important role in creating involvement & belongingness.

Effective implementation of TQM with adequate focus on TEI is the Key to the Success of an Organisation.

EXCELLENCE IN QUALITY MANAGEMENT SYSTEM THRO' PDCA MODEL- AN ENABLER OF BUSINESS GROWTH

R Rajamohan, K Vinayagamurthi and R A Krishnakumar

Dalmia Cement (Bharat) Ltd, India

Our organization is the first and one of the 4 cement Plants in our country to have obtained API (American Petroleum Industry) Monogram License for Oil Well Cement (OWC) for use in the petroleum and natural gas industry. This License is not only value adding but also mandatory for sale of OWC product. To get API Monogram, an organization has to demonstrate its Quality management system (QMS) as per API Spec Q1, which is specifically geared towards the Oil and gas industry.

This specification, which, as such was stringent, had become all the more a **daunting task after advent of 9th edition with 85 new clauses. Our team took up the Challenge to develop & implement with in-house talents,** conceptualizing/evolving a One Page Model as per PDCA, capturing the complete API System requirements.

Salient features of this one Page Model is enumerated in this Full Paper.

This One Page Model with links to Key documents, developed in-house on PDCA principle#. It had enabled implementation of API Spec Q1 9th edition successfully, enabling our unit, obtaining API Monogram. This being a Mandatory requirement, has not only contributed to additional business volume, impacting the bottom line., but also gives more clarity, easy understanding, quick execution of any updates and supports in training & confident handling of Audits.

HOW TO ACHIEVE STABILITY IN QUALITY AND PROCESS USING ADVANCE PREDICTIVE LAB TECHNIQUES

Roger Meier[1] and S Sankaralingam[2]

[1]FLSmidth Automation, Denmark

[2]FLSmidth Automation, India

Worldwide we see a trend towards stable process which help to reduce the maintenance and operational cost in the cement manufacturing process. This trend has been stimulated towards automation and digitalization of the cement plant with advanced predictive control

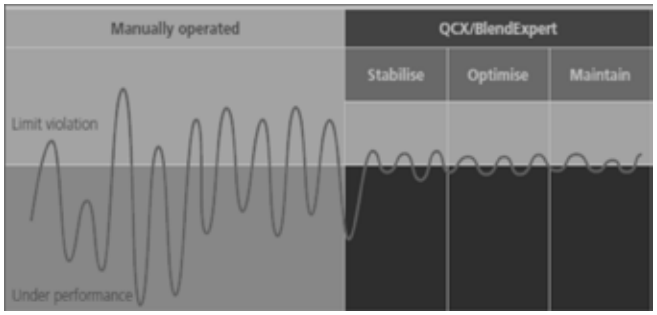
Current practice in the cement plant today is to analyse the quality and efficiency of the different processes in order to identify and improve the pain area of the process cycle using digital techniques. The analysis is typically repeated until the outcome matches the stability quality, process and efficiency potentials.

This paper discusses the most important stages in the analytical chain and how interconnected influences can impact on total performance. The discussion is partly illustrated by a customer case study.

The paper begins with the discussion first on the underestimate the first step in the process that is collecting the right sample at the right time with the consistent time and homogenization. All subsequent steps rely on the correctness of this step; it is not possible to repair mistakes made during sampling.

Next, it is important for the sample to be transported and prepared as per the international guide lines with the clear KPIs of the sample preparation and analysis procedure. Proper Sample preparation and analysis methodology helps in controling the process to obtain stability in quality and the process.

Finally, the utilization of the analytical results using digital and advance predictive control techniques will lead to stability in the quality and the process control which in turn benefit in the maintenance and operational cost of the plant.



A concluding summary of the achieved improvements, in comparison with the earlier performance and review of the expectations, illustrates the potential of this approach and proves its relevance for today's state-of-the-art cement productions.

MARKET STUDY - APPROACH AND METHODOLOGY FOR CEMENT INDUSTRY

Rahul Kumar Sadhu and Sharad Prahlad Aggarwal

ERCOM Engineers Pvt Ltd, India

A market study is necessary primarily because it gives a realistic handle on the future sales volumes and net sales realizations for any cement plant. Without a real basis, there is a risk of financial sickness or of the creation of nonperforming assets. Nowadays, the roles of regulators, bankers, promoters and advisors are being subjected to deep scrutiny.

The methodology for demand forecasting encompasses both quantitative and qualitative approaches. Quantitative techniques rely on statistical correlations between cement demand and independent macroeconomic variables, such as real GDP, population or time series. Tools include the use of curve fitting, Monte Carlo simulation, etc. The "S' Curve (Product Life Cycle Curve) and End Use methods may be used if applicable. Qualitative factors considered include market opinion, political or socioeconomic assessment, etc.

Existing capacity is assessed on the basis of both primary and secondary data. Reliance is placed on the effective capacity rather than on the nameplate capacity. Few "obvious" norms, like assuming 310 days instead of 345 days or vice versa, may alter capacity projections by over 20%. Future capacity projections are based on actual on-the-ground developments rather than on mere news announcements. Such developments would include land acquisition, machinery order placement, financial closure, etc.

Alternate scenarios are created using a contingency model for both demand and capacity projections. The resulting capacity surplus or deficit has a major impact on decisions for establishing future plants. Such projections may be done at the continental, national, regional or state levels.

Market characteristics include product mix, bag versus bulk, price and price structure, price forecasting, consumer preferences, etc. A practical approach to price forecasting is proposed. Logistics plays a very vital role in the marketing of cement because freight costs constitute a substantial proportion of the landed cost of cement. The multitude of choices of delivering to alternate markets by different modes provides scope for optimizing using linear or dynamic programming models.

The assessment of an upcoming plant's likely market share is one of the most critical tasks in any forecast. It depends on estimating the competitiveness of the plant in terms of freight costs, brand pull, service levels, capacity, etc. A possible metric for competitiveness is proposed. The sales volumes depend on the market share multiplied by the demand forecast. This seems to be a simple conclusion but it cloaks unforeseen risks, such as material or working capital shortages, transport strikes, civil war, etc. Risk mitigating mechanisms need to be in place.

This paper focuses on the following in relation to the market for the cement industry: necessity for a market study; demand forecasting; capacity projections; demand supply gaps; regional analysis; market characteristics; outbound logistics; market share assessment; sales volume projections; risk and mitigation.

A cement market study is therefore complex and better entrusted to the safe hands of a reputed and competent organization.

IMPORTANCE OF ISO: 17020 IMPLIMENTATION FOR QUALITY ASSURANCE SYSTEM IN CONSTRUCTION INDUSTRY

Vikas Patel, B Pandu Ranga Rao, Brijesh Singh and V V Arora

National Council for Cement and Building Materials, India

In the era of open economy, quality has emerged as important parameter that determines the success or failure of an organization. Quality, though an elusive attribute, has always been an important issue in construction. It is an integral concept that provides a competitive edge to one organization over the other. The construction industry being unique in nature is always expected to create a balance between cost, time and quality. This has become a critical parameter for Engineering, procurement, construction and commissioning (EPCC) contracts in particular where the agency is responsible for performance of the structure. Quality assurance is needed because of the involvement of negligence and lack of knowledge especially in smaller projects which deduces the quality of the construction. How to establish a quality assurance system and implement the quality assurance system for overall upgrading of the construction quality has become a very essential topic. In order to build customer confidence, the quality of its work should be done according to the developed quality assurance program. Now a days in order to enhance the quality implementation at construction site; laid down standards such as ISO:17020 accreditation for inspection bodies is the need of hour. The implementation of ISO:17020 is helping Inspection bodies to gain confidence of the customers on the technical competence and recognition of good management practice.

The objective of the paper is to analyze the various factors and loop holes that have a significant impact on effectiveness of quality and quality assurance system and to suggest recommendations to increase the quality performance of the construction projects. The paper also highlights the difference in Quality Assurance system of projects wherein ISO:17020 is not implemented and the project wherein it is implemented. In the current paper, NCB monitored 30 construction projects were selected with a construction cost between five to thirty Crores covering 15 project with ISO:17020 procedure and 15 project without ISO:17020 procedure. The data was collected from these projects on various quality and management related aspects. These projects cover structures such as school buildings, community hall, hostel block, convention centres etc. The study was conducted for construction projects of different government bodies. This analysis has been mainly done covering the factors playing key role in quality of a structure during construction such as client's commitment towards quality, quality of material, documentation, work practices, personnel etc.

Based on the data analysis, quality assurance system for these projects were categorized as Excellent, Good, Average and Poor in Quality Grading based on the various factors that directly or indirectly affects the quality and smooth functioning of project during and post construction. The difference in implementation of quality system with and without ISO:17020 is highlighted in the paper. The issues and way forward for improvement in quality has been suggested to meet the expected design life of structure and thereby reducing or avoiding repair and maintenance cost because of poor quality.

ROLE OF A PROJECT MANAGEMENT CONSULTANT (PMC)

S K Gupta

Holtec Consulting Pvt Ltd, India

Uptill now, Project Management Consultancy (PMC) services were being provided to only major industrial and infrastructure projects. On the face of it, to the smaller project owners, it appeared to be a superfluous work. Customer's project team used to think that they themselves can play this role. However, slowly and steadily, PMC has made in-roads in cement industry also.

Project Management Consultant is a body, which monitors activities of each and every stake-holder of a project. Typically, there could be about 4 – 5 agencies in case of EPC based projects, 10 – 15 agencies for package based EP projects and 90 – 100 agencies for shopping mode based projects. Irrespective of mode of implementation of the projects, it may run into several thousand activities, which need to be tracked and monitored for implementation of the project, in timely and cost-effective manner.

Some of the specific activities of PMC include Time & Resource planning, Monitoring of various project Activities/ Works, Budget Control, Quality Assurance, Resolving of Conflict etc. PMC keeps a track on risks involved at various stages of a project and smells delays, and resolves the same in time, to avoid any set-back to the project time-line.

PMC services can help in reducing the project implementation time by 1 to 4 months, and may cost Rs.1 crores to 5 crores to the customer depending on the roles & responsibilities assigned to him, PMC may use MS Project, Primavera, Aconex and McLaren platforms for document control and progress reporting.

Apparently, it may sound as if PMC is not doing any value addition to the project. However, the benefits are in-tangible. It is needless to mention that PMC has to be empowered by the project owners adequately. Then only, PMC services can provide positive results.

The paper also covers a Case Study of a recent project, where owners have reaped considerable benefits, by engaging PMC in implementation of the project.

PRODUCING CEMENT IN SUSTAINABLE WAY FOR BETTER TOMORROW

Santosh Kumar Sharma

Orient Cement Ltd, India

As control of sources, generation, distribution and consumption of energy is central to many current world issues, controlling the industry's energy footprint is a matter of intense interest. This is recognized in such initiatives as ISO 50001, the World Business Council for Sustainable Development's Cement Sustainability Initiative, Energy Star in the USA, PAT in India and CO_2 taxes/trading in Europe and in other countries. For the producer, these factors have a significant influence on cost competitiveness, usually accounting for over 50 per cent of total production costs, so that accurately and continuously monitoring energy usage must be a way of life for any producer's technical team.

FLSmidth a Full Life cycle partner to Cement industry, Promote Sustainable Solution through its efficient product and process technology.

Orient Cement with its key focus on reduction of carbon foot print, has taken several initiatives to reduce the energy consumption and always preferred sustainable solutions.

Orient choose FLSmidth as a sustainable partner for its new Greenfield Project at Chittapur. Now, Orient Cement Chittapur plant is one of the best class plant with least energy consumption and CO_2 emitting plant in India. The plant has state-of-the-art technology.

The Core equipments which involves intense energy consumption were selected to ensure most optimum power consumption. The Plant specific Power consumption and fuel consumption is best in class on industry standards.

This paper is intended to present the best operating parameters and key initiatives by both Orient and FLSmidth towards sustainability.

Few Sustainability measure,

- Optimization of grinding circuit for least power consumption
- Optimization of pyro system for lower fuel consumption and emission

QUALITY MANAGEMENT SYSTEM IN CONSTRUCTION PROJECTS

Raksha Rajani DSouza, Lavanya A R and Umesh R

N M A M Institute of Technology, Karkala, India

Quality is an important factor to know how well is a product. Quality is the degree to which a set of inherent characteristics fulfil requirements. A good quality product gives an essence free from defects and deficiencies by providing excellence. Successful completion of project depends on quality. Construction consists of idiosyncratic projects, that means each project differs from one another. So, maintaining a good quality is very difficult task. The need for maintaining quality in present scenario is increasing the cost of construction. India having the large construction market, to sustain in this market, construction firm need to provide a consistent quality and should value the customer/owner's requirement and it should also complete the project well within the time. The proper planning should be done to get an excellent quality product. The quality management system can be implemented in the firm level or can be implemented in the project level itself. There should be improvement in quality management continuously for which top management support is very much required. The quality management system intends to provide efficient use of resources, time and cost by maintaining the required quality. Quality management system includes quality planning, quality control, quality assurance and quality audit. This paper gives informative details as per literature study about quality management system, benefits, requirements and basic steps in implementation of quality management system, quality management principles, needs for documentation of quality management system and basic considerations while preparing document, quality manual and its requirement, various quality management tools and techniques and various quality management practices used in construction industry. By this one can get know the various commonly used quality management practices in construction industry a simple idea about how quality management system works with its benefits, the necessity of quality management system of being documented. This paper gives a basic idea of quality management system as per literature.

ROLE OF CALIBRATION IN MANAGING MEASUREMENT RISK AND DECISION RULE

P Srikanth, R P Vijayvergia and P N Ojha

National Council for Cement and Building Materials, India

It is vital for any industry to correctly measure the different parameters of a product to determine whether the product conforms to the quality requirements. Industries especially cement and construction industries take measurements during different stages of production and also after the final product is manufactured, by sending the product samples to its in house quality control laboratories. Industries also send their samples to an independent third party testing laboratories as part of regulatory requirements and also to have a rigorous check on their product quality.

But measurement involves risk as decision will be taken based upon these measurements. **Measurement risk** can be defined as the probability of making an incorrect decision based upon the measurements made.

The measurement in generally has four outcomes, which are given here as under:

i. **Correct Accept** - Means the product has been correctly identified as satisfying the quality/conforming standards.

ii. **Correct Fail** - Means the product has been correctly identified as failing to satisfy quality/conforming standards.

iii. **False Fail** - Means the product has been wrongly identified, that it has satisfied quality/conforming standards.

iv. **False Accept** - Means the product has been wrongly identified, that it has satisfied quality/conforming standards.

Clearly the scenarios mentioned in iii. & iv. are due to faulty measurement or due to incorrect interpretation of measurement results. Also, these two scenarios will result in production losses, faulty or defective products reaching to customers and losing of credibility in the origination.

To minimize the measurement risk and to avoid taking wrong decisions, one of the key but neglected aspects is calibration. Calibration of the measuring and testing equipment play a key role in minimizing the risk and also help the laboratories to reach the correct decision on whether the particular instrument is suitable for carrying out measurements or not. In this paper authors will explore and elucidate how proper and timely **calibration of equipment and proper evaluation of measurement risk and formulation of decision rule**, can lead the laboratory in making precise measurements, help the laboratory and organization in general to make the right decisions, which in turn will lead to better product quality with reduced costs.

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TECHNICAL SESSION – VI A

REFRACTORY MANAGEMENT
AND
PROCESS OPTIMIZATION

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MODERN SOLUTIONS IN REFRACTORY CASTABLES FOR CRITICAL AREAS IN CEMENT KILNS

Sumanta Mukhopadhyay and Manoranjan Nayak

Dalmia Refractories Ltd, India

Modern cement kilns in present time are bigger in size having comparatively bigger thermal loads, higher specific load, shorter increased slope, main burner able to burn RDF and other alternative fuels, longer campaigns without maintenance and shorter shut downs, increased use of low cost fuels, secondary fuels and agro-industrial wastes, pet coke. All these factors lead to refractory failures at critical areas like bull nose, tip casting,burner pipe, TAD bends, smoke chamber, kiln inlet etc. This paper highlights the advantages of castables over bricks in general & modern trends in refractory castable installation for above said critical areas to increase refractory life.

By installing proper castable as per the process conditions mentioned above, refractory life can be enhanced to large extent. We, Dalmia Seven Refractories Ltd, a joint venture between decades old Dalmia bharat group & Seven Refractories, Slovenia, are continuously doing research on these castable products to enhance the performance & bringing the most advanced monolithic solutions to India's Cement makers.

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

JETFLEX®BURNER PERFORMANCE FOR MAXIMISING COMBUSTION OF ALTERNATE FUELS AND REDUCING NO_x EMISSIONS

David Jayanth[1], Ram Kumar Sridharan[1] and Morten Pedersen[2]

[1]FLSmidth Pvt Ltd, India

[2]FLSmidth A/S, Denmark

FLSmidth Jetflex Burner represents the latest evolution in rotary kiln burner technology. The design targeted towards usage of traditional fuels as well as alternative fuels. It combines our combustion and cement production know-how with industry requirements for reliability, energy efficiency, fuel flexibility and low emissions. The burner provides efficient fuel combustion and stable flame formation ensuring stable kiln coating and high clinker quality.

Jetflex Burner - innovative features:

Axial air is introduced through rectangular air nozzles concentrically surrounding the fuel. The axial air nozzles form flat high velocity jets with a relative large surface area, which enables fast and powerful entrainment and mixing of fuel and the hot secondary air ensuring fast ignition and stable flame formation.

The swirler is the main mechanism for shaping the flame during start-up and in daily operation. Increasing the swirl leads to increased/faster mixing and thus a shorter, wider and more intense flame. Depending on the volatility and the type of the fuel, the swirl needs to be adjusted for a good flame and avoiding damages in the burner refractory

The Jetflex burner enables the use of only one solid fuel pipe as a common fuel channel for multiple solid fuels, such as coal, petcoke and solid alternative fuels. This improves heat and power consumption, minimizing the cold airflow entering from the fuel transport.

Jetflex Burner operational performances:

With the exceptional performances coming out from the good number of installations of Jetflex, this paper mainly focuses on the analysis of the actual operational data from the cements plant(s) and how the technical features resulted in tangible benefits to the plant such as

- Rectangular jets provides higher stability of the flame resulting in dense and stable kiln coating, improving the kiln refractory life
- Solid pulverized and/or alternative fuels are injected through a straight, uninterrupted pipe design, in which fuels can pass without disturbance, resulting in reduced wear, maintenance and unplanned kiln stop.
- No moving parts resulting in increased reliability due to reduced wear of parts and maintenance
- Reduced primary air consumption resulting in better heat economy.
- Common fuel channel for multiple solid fuels resulting in lower power and heat consumption
- Fuel rich flame core and flexibility in flame shaping for various operational parameters resulting in reduced NOx emission
- Optimised flame shape resulting in higher clinker quality

Jetflex Burner design incorporates several decades of our experience and setting the standard for today and tomorrow

CAUSES OF UNWANTED COATINGS/ BUILDUPS IN KILNS OF MEGHALAYA CEMENT PLANTS AND ITS REMEDIAL MEASURES

Satyendra Katiyar, Sudesh Sharma and Pramod Kumar Pandey

Gold Stone Cement Plant, India

There are large no of dry process Cement plants in Meghalaya zone making Clinker using high grade limestone (CaO>48 %) expecting very high quality Clinker. In Raw Mix design, these plants can use limestone to the tune of 86-88percent, are bound to use Aluminous Shale, Hill or River sand, Laterite/Millscale as an additive to compensate Alumina, Silica & iron in the various module values to the desired level. Due to excessive rains in the area, the plants are off and on facing problem of jamming, unnecessary coatings, buildups in preheater, cyclone, kiln inlet & pre calciner etc. These problems adversely affect the smooth running of Kiln & other Pyroprocess control parameters due to variations/jamming of Raw materials and material flow, mixing of Argillaceous/ Calcareous materials not exactly in the pre determined ratio and variation in ash content of Coal.

The improper operation of Kiln/ Cooler and insufficient air for combustion lead to the formation of not only unsound dusty Clinker but also cause unwanted Build ups/ Coatings in the cyclones making it difficult the proper flow of the feed difficult.

The excess Sulphur present in Meghalaya Coal also create reducing atmosphere causing the formation of Spurrite, sulpho-spurrite, Lang beinite, yellimite etc. The operational parameters can suitably be controlled to minimize the occurrence of buildup/coatings and can maintain the kiln operation by appropriate raw mix composition and its fineness, feed rate, air draft across each stage of cyclone, temperature profile in the preheater system and balancing ratio of primary/secondary air.

In the present paper, case studies are highlighted to minimize the Coatings / Build ups by diagnostic measures for stabilizing the Kiln operations thus making Sound clinker with minimal stoppages.

A COOLER FOR THE FUTURE

F Lichomski[1] and M Rasiraju[2]

[1]IKN GmbH, Germany

[2]IKN India Pvt Ltd, India

Installation time is always an important point during project execution, as any downtime costs money. A cement plant was experiencing frequent clinker cooler downtime and high clinker temperatures, which were causing production issues. In addition, the cooler's Ltd potential for future upgrade projects was a concern. IKN received the assignment to address these issues with a new cooler and some auxiliary and enable an increase in production capacity.

Therefore, the contract was signed with IKN for replacement of the cooler in December 2016. The scope of the project included the supply of a complete new IKN Pendulum Cooler® with a capacity of up to 8,500 stpd. The new cooler is equipped with an IKN Roll Crusher in the intermediate position and state-of-the-art grate drive – IKN Dynamic Linear Drive.

Into the scope of supply of this EPC project all related electrical, civil and mechanical installation supply and erection work was included. Sourcing and installation of the refractory was also under the responsibility of IKN.

Special emphases of the project were put on complying with safety regulations during the project implementation stage as well as minimising installation time.

Due to the modular design of the IKN cooler, which was completely preassembled and only needed to be shifted to the final position, the downtime of the production line was only 37 days flame-to-flame.

TOTAL PRODUCTIVITY ENHANCEMENT AND COST REDUCTION TECHNIQUES

Shivam Agarwal, Subham Agarwal and Avijit Dhole

JBS Associates, India

The grinding of clinker to cement is essentially a dry grinding process and 3% to 5% gypsum is added to the clinker during the process of grinding. The requirement of power per ton material is the highest in finish grinding, it may vary from 35kWh per ton of cement to 45kWh per ton. It may be higher for making blended cements. Therefore, a cement mill must be run under the best efficiency condition.

It was observed that during the grinding process a coating gets formed over the grinding media due to static charges. Very fine particles in a mill become charged. One part becomes positively charged and other negatively. These opposite charges attract each other and the particles agglomerate. Individual particles absorb a surface film of air, presumably this film tends to prevent the particles from combining. However, if this film is removed in some way, the particles may then be free to combine more readily.

Grinding Aids are materials which facilitated grinding in ball or tube mills, by eliminating ball coating or by dispersing the ground material. When grinding cement, the additive must also have shown not to be harmful to the finish cement. Grinding Aids may be added in solutions, as solids to the mill feed or directly to the mill itself. The addition of a fluid may be more readily control than the addition of a small amount of granular material.

A unique product solution in our product range, focuses on adding value to cement production from 10% - 15% considering all aspects relating to cement manufacturing process. GMAX works in number of different ways to improve the efficiency and effectiveness of grinding action during production and providing important application benefits in terms of flow, compressive strength and consistency of finished product.

HIGH PERFORMANCE PRECAST SOLUTION FOR CEMENT PLANT CRITICAL ZONES

Purushottam Bedare[1], Stephen Woodcock[2] and Parthasarathi Mukhopadhyay[1]

[1]Vesuvius India Ltd, India

[2]Vesuvius UK Ltd, UK

This paper covers the high performing precast solutions for cement plant critical zones. There are many zones in the cement plant which are vulnerable to the failures due to in situ castings, results into the stoppage of plants. There are several critical areas like Tip casting, Cooler or Cyclone bull nose, Burner Pipe, Cooler roof and Kiln drop bottom wall. Present castable or bricks solutions are not enough to improve upon the performance. Precast technology overcomes various drawbacks of castable and brick material and its applications. Simple precast design, ready to fit within short time, convenience for application and improved performance are the benefits of precast technology. The paper will further cover various uses of precast solution like blasters and dampers. The paper will cover salient features of both technologies along with a few specific case studies in cement plants.

The paper will conclude with a comparison & recommendation of selection of appropriate technology for cement plant refractory repairs. The PCPF solution is also a precision solution as it can solve specific performance requirements.

Study on PCPF superiority

- Macro-TGA study of a typical low cement & medium cement composition
- Comparison of Gun/ Shotcrete, In-Situ Casting and PCPF solutions
- Performance and ownership cost comparison from practical experience

Case Studies covered for PCPF solution implemented

1. Poland, Cementownia-warta-sa
2. Indonesia, PT Rembang

NEW LINING CONCEPT BY USING ALUMINA BRICKS INPLACE OF BASIC REFRACTORIES IN CEMENT ROTARY KILN

J P Nayak, B Ghosh, R Adhikari, R Dey, A Tripathy, S Sengupta and P B Panda

TRL Krosaki Refractories Ltd, India

In 21st century, due to big thrust upon infrastructure development; a huge demand of cement in worldwide, as result cement manufacturers are under tremendous pressure to increase production with quality at a competitive cost. It is quite obvious, longer life of the kiln with minimum down time and low specific energy consumption helps to cater the demand in time. However to produce cost effective product; cement industries are focusing to use alternative fuels like pet coke, used tyre, oil sludge, municipal waste etc. These fuels are having higher content of SO_2, NO_x, and CO emissions, and dusty in nature which are affecting refractory life of cement rotary kiln causing thermo-chemico mechanical load on the refractory lining. Thus it is important to understand the real mechanism involved in cement rotary kiln (CRK) between refractory lining and kiln feeds at the elevated temperature. To achieve desire life of refractories in CRK; it is therefore necessary to understand the characteristics, behaviour and location/zone where refractory will be lined inside the kiln. TRL Krosaki has developed new generation cost effective energy saving alumino-silicate refractory which is replacing the basic quality bricks in transition zone of the CRK. Life cycle of the rotary kiln has been increased significantly with uninterrupted operation by using alumino-silicate refractory, which is less cost than the basic quality bricks. TRL Krosaki has supplied improved quality alumino-silicate brick for this specific use which is performing very well at different customer's end in India. Special characteristics of this improved product like volume stability, thermal conductivity, thermal shock and corrosion study have been studied in this context thoroughly.

Key words: Cement; Pet Coke; Rotary Kiln; Alumino-Silicate; Infiltration

NEW DEVELOPMENT FOR TIME SAVING CALDE RDS - PRE-CAST – PRE-FIRED SOLUTION

Saumen Sinha, Alok Nagar, Rajeev Kumar Laharia, R Chokkar and Satwinder Kalsi

Calderys India Refractories Ltd, India

Calderys India is known for providing new age unique solutions to cement industry. This attempt is to provide stable and superior long performance solution for most critical areas.

All Cement manufactures always showcase efforts to achieve ideal kiln operational condition i.e. one shutdown in a year. Targeting for more refractory life in the critical areas of cement plant, enables to meet the objective. Refractory relining is time taking, hence maximising the refractory performance in any areas would provide financial benefits along with mental/operational satisfaction.

Few Critical areas of a cement plant like Tip casting (Nose Ring), Cooler Beam (Bull nose) and TAD dampers are very sensitive. At present bricks and various quality of castable are being used. Getting Consist performance is still challenge.

Calderys has refractory ready shape solutions for cement plant critical areas. These ready shapes provides are made from very high quality, special refractory material, provides consistently assured

This paper describes in details of special features of new Ready Shape Technology with various advantages on use.

INNOVATION IN OPEN GEAR LUBRICATION

Satheesh Kumar, Joseph Robert and Pramod Almore

Klüber Lubrication India Pvt Ltd, India

Large gear drives or open gear system are used to transmit rotational motion under heavy load conditions. The forces transmitted from one gear to another are such that they cause pronounced wear on the tooth surfaces in contact.

Lubrication of open gear drives is therefore essential to ensure trouble-free operation of these gear drives and extend their mechanical lifetime. The lubricant oil film reduces the friction at the gear interface and protects the mechanical components against fast premature wear.

Traditionally, graphite-containing greases are the most commonly used open gear lubricants. Graphite containing greases have replaced asphaltic (bitumen and solvent) containing lubricants to prevent environmental or health hazards.

However, in some cases the solid graphite particles in the lubricant may block the automatic spraying systems leading to serious mechanical problems and increased operational cost.

In addition, the users see the black color of the graphite containing lubricants as a disadvantage having problems like housekeeping, inspection difficulties due to lubricant dark appearance, unsatisfactory adhesion on the gear surface, separation of the solid particles leading to the hardening of the lubricant and even build-up of hardened lubricant in the roots of the gears.

Dwelling with over 80 years of experience, scientists at Klüber Lubrication have developed Klübersynth OA 98-15000, to enhance the durability of the open gears and to improve productivity at customer applications.

Klüber lubrication has used an advanced solid lubricant integrated base fluid (SLIBF) concept to develop a novel product for open gear drives. Klübersynth OA 98-15000 is significantly advantageous over the traditional graphite based black grease.

Klübersynth OA 98-15000 is free of asphaltic and volatile solvents, is off-white in color and provides better solution in comparison to the traditional open gear lubricants. The base oil used is a mixture of synthetic hydrocarbons and mineral oil with high viscosity. The formulation has solid lubricants integrated within the base fluid that assist in significantly reduced vibrations, gear tooth temperatures and wear protection of the gear teeth during operation. The light appearance of Klübersynth OA 98-15000 permits a clean gear set and friendly environment during operation and maintenance.

Klübersynth OA 98-15000 being free from separable solid lubricant like graphite eliminated issues like choking of nozzle. Enhanced pumpability and improved adhesion results in uniform spray pattern and good lubricant coverage on the tooth flanks.

The extreme wear protection properties of the lubricant enhances the durability of the open gear drives. The integrated solid particles in the lubricant structure works very well under high load conditions by forming a sacrificial layer on the surface and protects the gear teeth during shearing action. Benefits of solid lube integrated base fluid (SLIBF) concept as summarized below:

- Excellent pumpability
- Uniform spray pattern
- Better wear protection
- Enhanced durability of tooth flank


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TECHNICAL SESSION – VI B

ANALYTICAL METHODS
AND
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IMPORTANCE OF CALIBRATION STANDARD, SAMPLE PREPARATION AND EVALUATION OF ANALYSIS RESULTS IN XRF ANALYSIS IN CEMENT PRODUCTION

Hisashi Inoue, Yasushi Kusakabe, Kosuke Kawakyu, Einoshin Kamota and Yasujiro Yamada

Rigaku Corporation, Japan

X-ray fluorescence (XRF) spectrometry has been used for chemical composition analysis in cement production processes owing to its simple sample preparation, rapid analysis and high precision.

Since XRF is a relative analysis, reference materials are required for quantitative analysis as calibration standards. There are two types of reference materials for calibration; certified reference materials (CRM's) available in the market and house standards. The latter are user's own samples whose compositions are obtained by other chemical analysis method, such as the wet chemical, ICP, conducted in their own laboratory or a commercial lab. In order to conduct accurate XRF analysis, it is necessary to select proper calibration standards.

Calibration accuracy is an evaluation factor for quantitative analysis by XRF. This accuracy represents how good a fitting of a calibration plot is.

Another evaluation way is to analyse samples whose chemical compositions are known. Occasionally, analysis results of this evaluation way are not good though calibration accuracy is good.

Sample preparation is also very important to conduct accurate XRF analysis. In cement production, raw material, raw meal, clinker, cement products and alternative fuel are analysis by XRF. Most of them are powder samples, where the pressed powder method or the fusion method is applied.

In the session, selection of calibration standards and sample preparation and evaluation of analysis results to conduct accurate XRF analysis is discussed

IMPROVING THE REACTIVITY OF FLY ASH DURING ITS GENERATION & EFFECT ON CEMENT PERFORMANCE

M V Karandikar , D D Kulkarni, A Shah, A Morajkar, V Sagvekar and Kiran Patil

ACC Ltd, India

The Mineralogical make up of fly ash is of course governed by the Chemical composition of the Mineral matter of coal as well as the mineral matter Contents . The mineralogy of fly ash determines the reactivity of fly ash in its various applications, for e.g the pozzolanic reactivity of fly ash would depends on glassy/ amorphous silicate phase of fly ash and specific surface area available for reaction with lime.

Studies carried out by Joshi R.C and Rosauer E.A on synthetic fly ashes produced at laboratory scale, indicated that prolonged heat treatment promotes sintering and de-vitrification which in turn influences other properties . Iron in pure alumino-siliceous ash reduces pozzolanic strength, whereas calcium in an alumino-siliceous fly ash results in a very reactive ash. The work by Diamond et al concluded that fly ashes with CaO content upto 20% showed maximum indicative of siliceous glass whereas Haobo et al studied the influence of CaO addition on granulated cinders concluded that with increase in CaO content, the vitreous network of granulated cinders becomes disordered and is destroyed, the polymerization of network formed reduces and the hydraulic activity of granulated cinder improves.

Thus fly ash Mineralogy can be altered by Compositional as well as process parameters which alter the properties of fly ash, however this aspect necessitates better understanding of the influence of different minerals and minor constituents present in coal and processing conditions on the resultant fly ash properties, so as to Tailor make a fly ash with enhanced reactivity in its applications. Altering the Mineralogy of an available fly ash is another avenue available on hand to alter the Mineralogy of the fly ash for its desired applications and enhanced usage.

The paper discusses the studies carried out at author's lab on manufacturing of synthetic fly ashes from different coal sources with varying ash content at two temperature levels (1350°C & 900°C) with use of different dopants like Sodium/Potassium /Phosphates/Alumina/ CaO etc. The paper further illustrates the changes in the mineralogical and micro-structural properties of synthetic fly ashes along with changes in the pozzolanic reactivity due to addition of dopants and concludes that Alkalis and CaO shows the best results amongst the dopants selected, in terms of higher strength developments in cement due to formation of alkali & Calcium alumino silicates with higher amorphous phase in synthetic fly ash.

COMPREHENSIVE METHODOLOGY FOR GUIDING THE PROCESS DYNAMICS BASED ON MINERALOGICAL ASSESSMENT OF OPC CLINKER BY MICROSCOPY AND X-RAY DIFFRACTOMETRY

J P Vrati , K V Singh, A K Raykundaliya and B C Pandey

Ambuja Cements Ltd, India

In today's era of scarcity of natural fuels, usage of petcoke and AFR by most of the cement plants is common practices, but by all this, process dynamics has changed to a great extent and impacted the mineralogy of Portland clinker. Most of the cement Industries is now operated at higher levels of alternative fuel consumption and thermal substitution rate (TSR) has gone beyond 10% at many places. This induction has by and large made many changes in the clinker mineral phase development and its hydraulic properties. Therefore, it becomes a need to redefine the old postulates of assessment of process dynamics and clinker quality assessment procedures. Clinker microscopy and XRD assessment has not untouched with these changes and many new concepts has emerged and accepted by masses in the field of R&D.

However, R&D team at Ambuja Cements Ltd, Rabriyawas found that any assessment through this two quality control equipment analysis is not sufficient until and unless we draw some benchmark/reference bottom line for each concerning parameters with reference to specific kiln/ mineral deposits/ type of fuel and AFR used. In this study, we have developed many such criteria's and correlate various process conditions impacting clinker granulometry, porosity, homogeneity, clusters of periclase, belite and free lime, nest formations, changes in alite/belite and aluminates crystals etc. By applying this comprehensive methodology optimum process conditions are achieved and clinker quality is also improved with consistent throughput of kiln.

CHEMICAL COMPOSITION AND BOND WORK INDEX OF LIMESTONE – CORRELATION

Suresh Vanguri, G Prasad, A Sushmitha, M Balaraju, G Jayaramudu, P Janardhan, V Rama and S K Chaturvedi

National Council for Cement and Building Materials, India

Bond Work Index of limestone indicates the hardness of the material, resistance of the material towards grinding and in turn gives the power requirement for grinding the material. Determination of Bond Work Index is done by a procedure which involves several cycles of experimentation (milling). Bond Work Index (BWI) value helps in selection of the crushing and grinding equipment. It is believed that presence of quartz (free silica) in limestone increases the hardness of the material and thereby Bond Work Index value. Besides major oxides, presence of minor oxides may also influence the mechanical properties of limestone. Alkali content present in limestone is also gaining importance, particularly in the cases where pet coke is being used as fuel. However there is not much data available in the literature on the effect of complete chemical composition on Bond Work Index of limestone. Therefore studies were carried out on different limestone samples with varying Bond Work Index values and their chemical composition was determined. Correlations were drawn between chemical composition and Bond Work Index values. XRD studies were also conducted on some selected limestone samples to identify the role of mineralogy along with the chemical composition in hardness of the limestone. Study is beneficial for better understanding the correlations between various parameters and also can help in prediction of Bond Work Index values based on the chemical composition. Limestone samples with varying quality were selected for the study; SiO_2 and free silica were found to be varying from 6.90 to 14.15 percent and 6.3 to 11.4 percent respectively. CaO content in limestone was found to be varying from 45.09 to 48.01 percent. BWI values of these limestone samples were found to be varying from 7.8 to 14.1 kWh/sht. Fair correlations were observed between BWI and LSF, Free silica of limestone. Results indicated that besides major oxides, presence of minor oxides and mineralogical composition of the limestone had a significant effect on the BWI values.

MINERALOGICAL AND MICROSCOPY TECHNIQUES AS EFFECTIVE DIAGNOSTIC TOOL FOR PROCESS CONTROL AND QUALITY MONITORING IN CEMENT MANUFACTURING PROCESS

Biju Mathew and M V Karandikar

ACC Ltd, India

Conventionally, the cement manufacture process is controlled at each unit operation by monitoring the oxide composition of raw mill, kiln feed as well as clinker. The chemical composition although is effective in controlling the cement process, many a times it doesn't reveal the changes in the process which ultimately could lead to unsteady kiln operation and it also affects the extent of formation of clinker mineral phases, which would affect the cement quality.

Monitoring the mineralogical / micro-structural changes in a manufacturing process has always been an aspiration in a cement plant. Through the recent innovations and developments in the modern analytical techniques, this aspiration of monitoring the mineralogical changes is a reality, wherein along with the chemical composition, the mineralogical composition and micro-structural changes could be monitored for effective process and quality control at each stages of cement manufacturing process.

The process control depends on many process parameters such as raw material composition, mix proportion, burnability, quality and type of fuels used, burning conditions, temperature profile, cooling conditions etc. Mineralogy and microstructure of clinker and raw material have a very important role in product quality and product performance. Using microscopy, one can gather remarkable information about clinker history and predict cement performance. Clinker observation under microscope can determine the temperature profile in the kiln and provide clues to improve clinker grindability optimize raw feed fineness and increase later age strength.

Quantitative estimation of mineralogical phases through Microscopy and X-Ray Diffraction techniques is a very important in controlling and monitoring the quality of raw material as well as clinker. Monitoring and identifying Mineralogical and micro structural signatures can effectively control the process conditions. Plant quality control department should effectively use the mineralogy and microscopy techniques for quality and process control.

The paper discusses how effectively the mineralogical and microscopy techniques can be utilized for the diagnostic evaluations of the materials for process control and quality monitoring in Cement manufacturing process. The paper further discusses case studies of mineralogy & microscopy application in control of cement manufacturing process.

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

DETERMINATION OF FLY ASH PARAMETERS TO DEVELOP A SIMPLE AND EFFECTIVE BLENDING TECHNIQUE TO REDUCE THE VARIATION IN FLY ASH CONCRETES

Satya Medepalli and Shashank Bishnoi

Indian Institute of Technology Delhi, India

Fly ashes are generated from thermal power plants and substantial quantities are available due to the dependence of coal as a major fuel source in India. Studies showed that fly ash available in India has a lot of variability in their characteristics leading to variability in the concrete performance. In this study, class F fly ashes from different sources across India are studied for variation in physical and chemical characteristics. A 43 grade ordinary Portland cement was used to make cement paste and concrete mixes with different fly ashes at a fixed water to binder ratio. Isothermal calorimetry and compressive strength tests were carried out on paste and concrete mixes respectively. Significant variation was observed in the degree of hydration of cement and the compressive strength of concretes with different fly ashes. A new technique was developed to blend fly ashes based on the properties of fly ashes. Blaine fineness, reactive silica and alumina content of fly ash were identified initially based on the existing literature to design blends. These blends were used to blend fly ashes using law of mixtures. Degree of hydration of cement and the compressive strength of concretes with blended fly ashes were compared to that of original fly ashes. The results show that the Blaine fineness and alumina content of fly ash were found effective in reducing the variation. A significant reduction in the degree of hydration of cement and compressive strength of concretes was observed by blending fly ashes using these parameters.

Keywords: Fly ash, blending technique, degree of hydration, compressive strength, fly ash concrete

DEVELOPMENT OF BND – INDIAN CERTIFIED REFERENCE MATERIALS FOR CEMENT AND CEMENTITIOUS MATERIALS TO SUPPORT NATIONAL TRACEABILITY

Suresh Kumar Shaw, V Naga Kumar, Abhishek Agnihotri and P N Ojha

National Council for Cement and Building Materials, India

Certified Reference Materials (CRM's) by the National Council for Cement and Building Materials, are important mechanism being utilized to assure the accuracy and compatibility of measurements in large measurement systems. CRM's are materials whose properties (compositional and/or physical) have been well-characterized and certified by NCB. Reference Methods are analytical methods having high accuracy and precision, which have been thoroughly demonstrated. A systematic approach to establishing accurate measurement systems is presented. Reference materials and reference methods assist in the transfer of accuracy gained in the experimental realization of base measurement units to the performance of measurements in the field.

In the year 2018, Government of India had decided to develop their own standard material as Bhartiya Nirdeshak Dravyas (BNDs) i.e Indian Certified Reference Materials through National Physical Laboratory (NPL), India. CSIR-NPL and NCB have shown interest in working together for providing traceability for the reference materials in the field of cementitious product for making such CRMs in India which are traceable to SI units. CSIR-National Physical Laboratory (NPL-India) is mandated to be India's "National Measurement Institute" (NMI) by act of Parliament and is the custodian of "National Standards" with a responsibility of the dissemination of measurements to the needs of country. Hence Bhartiya Nirdeshak Dravya as a certified reference material stands top in traceability chain of SI units among all Reference material producer (RMP).

The application of the systematic approach is illustrated through the development of Portland Pozzolana Cement (BND 5001) on physical parameters such as Blaine fineness & Specific gravity. The development of certified reference material as per guideline of ISO 17034 and guide 35. The methodology for developing CRMs are as follows: Production Planning; Production Control; Material handling & Storage; Materials Processing; Measurement Procedure; Measuring Equipment; Assessment of Homogeneity; Monitoring of Stability; Assignment of property values alongwith their uncertainties and Certification.

The purpose of this paper is to provide a detailed description of the process used to development, package and certification of CRM of OPC Blaine fineness as Bhartiya Nirdeshak Dravya (BND). All measurements used for the certifications are provided along with descriptions of the statistical analyses.

ROLE OF PROFICIENCY TESTING (PT) IN THE FIELD OF CEMENT AND BUILDING MATERIALS

V Naga Kumar, Suresh Kumar Shaw, Abhishek Agnihotri and P N Ojha

National Council for Cement and Building Materials, India

Laboratory Proficiency Testing (PT) is defined in ISO/IEC17043:2010 as "the evaluation of participant performance against pre-established criteria by means of inter laboratory comparison." Proficiency testing is a key element in the laboratory accreditation process and also enabling labs to monitor the quality of their analytical results. Proficiency testing determines the performance of individual laboratories for specific tests or measurements and is used to evaluate laboratories continuing performance.

For labs that are going for accreditation for the first time, it is particularly important as an initial step in that process. Even if there are no plans for accreditation, successful participation in PT programmes assist laboratories in variety of ways by demonstrating accurate laboratory performance in sales promotion and also helps to measure individual employee performance and training.

NCB PT schemes on cement and building materials provide opportunity for laboratories to determine the chemical and physical parameters of cementitious product.

In 2013, Interlaboratory Services (ILS) programme of Centre for Quality Management, Standards and Calibration Services (CQC) of NCB received first NABL accreditation for PT provider as per ISO/IEC 17043: 2010 in the country, and successfully completed 59 PT schemes thereafter.

The benefit of the NCB Proficiency Testing is that it enables the management of participant laboratories to benchmark their own performance against other laboratories using defined sample. If performance is below standard, laboratory management can review and revised their methods to ensure that quality and safety criteria for products to be meet the objective to compete in competitive market. The paper discusses the application of PT in quality control. It presents salient features of ISO 17043:2010 such as the design plan, produce and outcome of the simultaneous proficiency testing on Ordinary Portland Cement on mechanical parameters such as 'Specific surface (Blaine fineness)', 'Normal Consistency', 'Initial setting time', 'Final setting time', '72±1 hrs. comp. strength', '168±2 hrs. comp. strength' and '672±4 hrs. comp. strength' and also highlight the highest quality of NCB Proficiency Testing activities in cement and building materials.

TECHNICAL SESSION – VII A

ENERGY
CONSERVATION SYSTEMS-I

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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03-06 DECEMBER 2019, NEW DELHI, INDIA

FALSE AIR REDUCTION- THE METHOD OF REDUCING CARBON FOOTPRINT IN CEMENT PLANTS

K K Sharma

Invotech Industrial Solutions Pvt Ltd, India

The Cement Industry is reckoned as most energy consumed industry and due to not taking adequate measures or may be not having sufficient tools to plug in the leakages, a lot of energy goes waste. Therefore, it is high time that we should pay attention on reducing energy consumption so as to reduce cost of production as well as play role in nation building through energy saving.

INTRODUCTION

Cement Industry is one of the most energy consumed industries in the world and India remained second-largest cement producer in the world in terms of cement capacity during 2018. We can find hundreds of research papers / case studies discussing the factors on energy consumption in cement manufacturing facilities and all the researchers more or less agree to the fact that 'FALSE AIR" not only but may be one of the factor of more energy consumption in Cement Industry. Further, based on the several studies in the field of operational audit, it has been observed and is proven that energy consumption can be reduced and production level improved by reduction of "FALSE AIR".

WHAT IS FALSE AIR AND ITS IMPACT IN CEMENT PLANT

False air is any unwanted air entering into the process system. Due to unwanted air, the power consumption increases and system's temperature decreases. Therefore, to maintain the same temperature, fuel consumption has to be increased. In a nutshell False Air increases power, fuel consumption and reduces production of a Cement Plant.

WHAT IS COST EFFECTIVE, ENVIRONMENT FRIENDLY SOLUTION

Usually Cement plants use conventional methods to arrest false air but these conventional methods are not reliable or permanent in nature. Therefore, Invotech Industrial Solutions Pvt Ltd, a Rajasthan based company have come up with a unique product range 'Arrest Master Series 1001 to 1004 & 2001' (Product Name) (Temp. resistant from 180^0C to 800^0C) for arresting "False Air" in Cement Plants. Their products are being used by renowned names like- JK Cement Group, Dalmia Group, Nuvoco Vistas Group, Ultratech Group and many more are in pipe line.

CONCLUSION

Substantial potential for energy efficiency improvement exists in the Cement Industry and in individual plants. Our baby step towards arresting "FALSE AIR" can contribute immensely towards cost cutting of cement manufacturing and improving energy efficiency.

IMPROVED ENERGY EFFICIENCY IN CPP

K A Mathew and Narendra Prasad Barik

Dalmia Cement (Bharat) Ltd, India

Sustainability is vital to steer operational excellence and ensure business growth. Hence, we have embedded sustainability as a strategic tool in our business model to ensure our consistent progress in the ever-changing world of business. To excel in operations upholding world-class standards of governance to achieve zero harm, zero discharge while being socially responsible. Our demonstrated & continuous efforts started with 15.1% auxiliary power consumption in 2011-12 & today we achieved 7.7% aux. power consumption

Initiatives: Our Mission is to become a global leader and create value by conducting our business in socially responsible and ethical manner by improving Health, Safety and Well-being at workplace & eliminating any potential damage to the environment and by reducing environmental footprint with adoption of sustainable practices and conservation of natural resources.

Methodology: 2014-15 to 2018-19 are as follows:

1. CT makeup pumps capacity optimized by reducing the motor size
2. Utilization of Cooling water for aux. Cooling stopped
3. Installation of 2 new energy efficient pumps with VFD
4. Installation of 3 no. VFD for boiler feed pump
5. Installation of 2 no. VFD for compressors
6. Trimming of ACW pump impeller & VFD installation
7. Installation of 4 nos. VFD for CT pumps
8. Installation of 2 no. Pumps for PA fan
9. Aluminium blade replaced with FRP blades for CT fan
10. Installation of Low RPM motor for water pumps

Above mentioned are few and our efforts will continue for energy efficiency & protecting the environment. We at DCBL Meghalaya are committed towards becoming carbon negative by 2040.

COOLER ESP EFFICIENCY ENHANCEMENT

K A Mathew and Rajesh Chandravansh

Dalmia Cement (Bharat) Ltd, India

The sustainability journey at Dalmia Cement received a major push in the last 5 - 7 years, when we started integrating climate change into our risk assessment process. We adopted new ambitions and commitments to progress in a clean energy transition. As we were mapping out the future, one thing became clear, to be a leader, we need to see climate risk as a business opportunity.

Challenge: All Industrial facilities commonly utilize Electrostatic Precipitators for collection of collection of filterable dust from process gas stream. Historically the vast majority of ESPs system have been powered by using 2 phase (415 V AC) transformers. Conventional power systems have a flaw, limiting amount of power it can transmit to the ESP before a spark occurs & hence trip the transformer & affect the overall performance of ESP. DCBL Meghalaya also has similar challenge resulting slightly higher emissions intermittently according to new norms.

Initiatives Taken: Technology is a key pillar in the cement industry's drive to reduce emissions and energy consumption. In order to address new norms and keeping parameters below the new standards, DCBL Meghalaya has taken some primary measures by exploring the possibility of enhancing the performance of ESP using new technologies. After exploring all possible methods, DCBL Meghalaya has decided to install 3 phase transformers instead of 2 Phase transformers in its all 3 fields, which is most economical & effective measure to improve ESP performance.

Methodology adopted:

1. Discussed with Technical team within the group & explore the possibility of additional field to comply the regulations.
2. Explored the similar cases within the group
3. After discussion with plant team, we took the challenge to install 3 phase transformers replacing existing transformers.
4. Initially we replaced 2 transformers & after satisfactory results we replaced third transformer as well

Conclusion & way forward: Now the emissions has come down from 47 mg/Nm^3 to 17 mg/Nm^3 & well within norms. After some work in ESP internals will further bring down the emissions to 10 mg/Nm^3. With this decision we have saved Rs. 1.2 crore, as we have already planned for extension of field (Project cost of Rs 1.5 Crore).

ENERGY CONSERVATION BY ADAPTING & INCORPORATING ENERGY EFFICIENT TECHNOLOGIES AND OPERATIONS

B Madhu, D Kumaresan and R Rajamohan

Dalmia Cement (Bharat) Ltd, India

Energy is one of the major inputs for the Economic development of our Country. To meet the increasing energy demands, end user efficiency plays an important role. This paper deals with the energy conservation achieved by adapting energy efficient technologies and incorporating energy efficient operation, encompassing various measures as below:

Compressor power optimization with up-gradation of old with energy efficient compressor (savings: 400 kWh/ day), Modification in control logics of old compressor (savings: 50 kWh /day), installation of VFDs in compressors (Savings:240 KWh/ day), optimization of pressure settings, vigilant monitoring & arresting of leakages, installation of additional receiver tanks (Savings:240 kWh/day)

VFD provision in L1 cooler fan No 4, L 2 packing plant bag filter fans, L 2 green fuel feed belt, green fuel shredding machine operation of turbo blowers instead of PD blowers. (Savings:)

In air conditioners, water cooled condenser's in place of air cooled condensers, optimisation of air conditioning space, room temp. based package AC machine operation, instead of return air

Single raw meal silo operation instead of two for the raw meal blending & extraction, installation of occupancy sensors in load centers, cogged belt in place of V Belt and FRP blade in place of aluminium / cast Iron blades, SPRS for the process mill fan, monitoring and controlling of ideal power consumption, monitoring specific power consumption on daily basis.

The savings of annual energy with the above is estimated 5% compared to the earlier consumption, which is enumerated in detail in this paper.

ECO-FRIENDLY TRANSPORTATION OF CEMENT FOR CONSTRUCTION OF AMARAVATI CAPITAL – CASE STUDY

G V K Prasad

The KCP Ltd, India

Presently, 10,000 MT of cement per day is consumed for construction of Amaravati Capital City of AP. From Amaravati City, majority of the Cement Units are located 140 KM away by road and 80 KM away by water transport through Krishna River. Among different transportation modes, water transport is recognized as a low-cost, environmentally friendly way of transportation. The use of this mode for transportation of cement from nearest cement units to Amaravati city encounters many challenges. KCP has developed and implemented an innovative method for cement transport by which CO_2 emissions per tonne of cement transported one kilometer reduced by 50% compared with Road transport. Through Krishna River water, KCP has started operation of 600 tonnes capacity vessels at a time for cement transport which is equal to 20 trucks of transport capacity. Moreover, transportation cost come down by half.

Following this, the article includes the summary of obtained results of CO_2 reduction in transportation of cement through Krishna River which has brought the waterways to other cement companies that allows its usage. However, the enormous scale of cement transport through River Krishna for AP Capital construction has significantly reduced greenhouse gas emissions and found a path to achieve economy-wide emissions reduction in cement transport.

The paper will highlight the methodology applied and mode of operation of above system which have been running satisfactorily. The paper will also demonstrate that how reduction of CO_2 emission was achieved in transportation of Cement to Amaravati Capital.

REDUCTION IN THERMAL ENERGY CONSUMPTION AT CHANDERIA CEMENT WORKS PLANT

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Birla Corporation Ltd, India

Cement clinker is manufactured primarily from limestone, clay, sand and iron oxide bearing material as raw materials. These materials are blended and finely comminuted to form the raw meal.

The process to manufacture the cement consists essentially of crushing and grinding of the raw materials, mixing them homogenously at certain proportions and burning them, usually in a rotary kiln at a temperature of approximately 1450°C.

The material sinters and partially fuses to promote the formation of the clinker phases. The principal phases in the cement clinker are tri-calcium silicate, di-calcium silicate, tri-calcium aluminate and tetra calcium alumino-ferrate. The clinker is then cooled and ground to fine powder with the addition of a few percent of gypsum. The resulting product is so called commercial Portland cement.

During the heating up and burning process, decomposition reactions, phases transformations and formation of new phases occur. These phenomena influence each other.

Regarding the energy consumption in the kiln, the important aspects are the enthalpies of the reactions, which may be endothermic or exothermic.

The share of energy consumed in a cement clinker kiln plant attains 70-78% of the overall energy consumed in the process of cement production as a whole. The residual (22-30%) is the share of electrical energy.

On the other hand, for the burning of the clinker in kiln, thermal energy represents 92-96% of the required energy and the electrical energy accounts for only 4-8%. Therefore, potentials for reducing specific heat consumption in the kiln deserves priority (6-10).

Birla Corporation Ltd is having two cement plants at Chanderia (Rajasthan) one is Birla Cement Works (BCW) and another is Chanderia Cement Works (CCW). Chanderia Cement Works is having two ILC preheater kiln.

Various initiatives were taken at Birla Corporation Ltd, Chanderia plant to reduce thermal energy consumption at both the lines of CCW. The results of these initiatives are tabulated below:

Thermal Energy consumption (kcal/kg clinker)		
Kiln Line	**2017-18**	**2018-19**
CCW Line -1	740	720
CCW Line -2	736	713

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ROLE OF CAPTIVE POWER PLANTS IN ACHIEVING PAT ENERGY TARGETS FOR INDIAN CEMENT INDUSTRY

Prateek Sharma, Ankur Mittal, M V Ramachandra Rao, V Venkatesh, Ashutosh Saxena and B N Mohapatra

National Council for Cement and Building Materials, India

Captive Power Plants (CPPs) set up by industrial and commercial consumers, play a significant role in meeting power generation requirements of such consumers and reduce dependence on grid while optimizing the energy costs. The Indian cement industry has more than 4,000 MW of installed captive power capacity, including coal-based plants, diesel generating sets and wind turbines to overcome rising power costs and uncertainty over supply.

Cement plants have to meet specific energy targets set by Bureau of Energy Efficiency (BEE) and low hanging fruits are already conceptualized.

Process optimization and operational improvement generally involve marginal financial investment and produce quick results in energy savings. Now plants have to opt for some other measures involving capital investment to achieve PAT targets this time. Cement plants have captive power plants can look upon energy savings in this area. Energy savings in captive power plants can act as blessing in disguise for such energy efficient plants. This paper is focused on energy saving opportunities in captive power plants.

STUDY OF EMPIRICAL RELATION BETWEEN PROXIMATE ANALYSIS DATA AND GROSS CALORIFIC VALUE OF COAL

Jishnu Devan Sankaran

Century Textiles & Industries Ltd (Cement Division), India

The Gross Calorific value of fuel is an important parameter which indicates its efficiency and also plays an important role in Fuel/Coal mix design in Cement factories, Power Plants and many other industries.

However, the standard method of testing requires a Bomb Calorimeter which may be impractical for some industries due to the installation & service costs and also for industries were multiple batches of coal have to be tested frequently in a short span of time.

The proximate analysis of coal can be conducted for multiple samples with minimum resources to determine moisture, ash and volatile matter and therefore a correlation between these two factors can save time and cost of testing GCV separately.

The study has been conducted as follows with the objective of developing such a correlation.

The method is briefed as follows:

Proximate analysis and GCV studies were conducted on a total of 217 samples consisting of different types of coal Bituminous Coal - Indian, Imported Pet Coke and mixture of different types either tested in-house laboratory of Maihar Cement or in an external lab like NCCBM. The obtained results were converted to moisture & ash free basis and by using mathematical regression, an empirical formula has been developed to predict the GCV/HHV from the values of volatile matter and Fixed Carbon.

The parameters were plotted against GCV and variance analysis was conducted to determine their significance and to discard any possibility for null hypothesis. The GCV values calculated from the resulting equation were plotted against the tested values and the suitability of the empirical formula was reaffirmed with the help of the calculated R2 value and Standard Error.

ENERGY AUDIT OF WASTE HEAT RECOVERY SYSTEMS OF CEMENT PLANTS IN INDIA: CASE STUDIES

Prateek Sharma, Ankur Mittal, M V Ramachandra Rao, K P K Reddy, Ashutosh Saxena and B N Mohapatra

National Council for Cement and Building Materials, India

Waste heat is generated in a process by way of fuel combustion or chemical reaction, and then "dumped" into the environment even though it could still be reused for some useful and economic purpose. Indian cement industry has come a long way in implementing Waste Heat Recovery Systems (WHRS) which resulted in numerous benefits, such as mitigating Green House Gas (GHG) emissions and achieving PAT cycle targets. WHRS capacity in India increased by 212% in 2017 compared to 2010, with total installed capacity of 344 MW in 2017. This may ultimately help contribute to long-term energy security in India.

WHRS has been identified as a key area for energy reduction potential in future and can play a significant role in reduction of gate to gate energy consumption for the cement plants. The significance of energy audit for energy and cost saving in WHRS of cement plants is highlighted in this paper through different case studies carried out by NCB in the recent past.

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TECHNICAL SESSION – VII B

SMART AND HIGH PERFORMANCE CONCRETE

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STRESS STRAIN CHARACTERISTICS OF HIGH STRENGTH CONCRETE WITH STEEL FIBRES USING BLENDED CEMENTS

Brijesh Singh, V V Arora, Vikas Patel, Amit Trivedi and Megha Kalra

National Council for Cement and Building Materials, India

High strength concrete exhibits several desirable mechanical properties, but its structural application in high seismic regions has been Ltd because of its brittleness. The use of steel fibers in concrete can mitigate early cracking and improve ductile behavior. The paper covers the study on compressive behavior of fiber-reinforced high strength concrete with trough and end-hooked steel fibers having 0.55 mm diameter and 35 mm length (aspect ratio: 63) satisfying the requirements of ASTM A-820. The concrete mix with three different w/c ratios (0.47, 0.36 and 0.27) were used in the study. Medium quality flyash meeting the criteria of IS: 3812, Cement OPC 53 grade and silica fume were used in concrete mixes. Commonly available OPC 53 grade cement in India was selected. The stress-strain behavior under uniaxial compression test has been investigated by varying concrete compressive strength and fiber volumetric ratio. In order to minimize the effect of specimen size on fibre distribution, cylinder specimens 150 mm in diameter and 300 mm in height were prepared and then subjected to uniaxial compression under strain controlled mode. The paper also covers the study on effect of gauge length (ratio of measurement length along the height to height of the specimen) on stress-strain characteristics of steel fibre reinforced high strength concrete wherein the comparison of stress strain curve obtained using compressometer with gauge length of 150 mm and Linear Variable Displacement Transducer (LVDT) with gauge length of 300 mm (platen to platen) has been compared. (shown in figure 1 given below)

From the test results, it has been seen that steel fiber-reinforced concrete (SFRC) specimens exhibited ductile behavior after reaching the peak stress in comparison to plain high strength concrete i.e. fibre reinforced concrete exhibits far better post-cracking load resisting

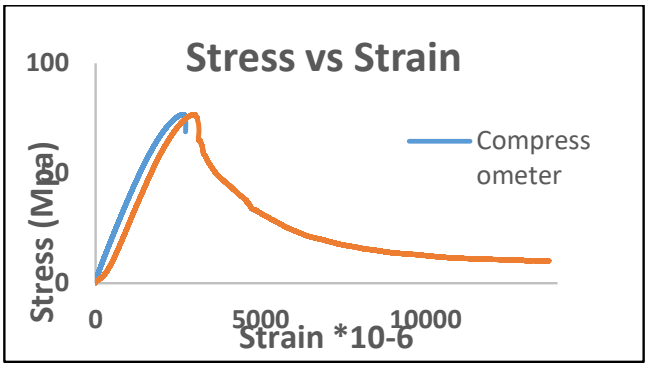

Figure-1 Typical stress Strain curve measured using Compressometer and LVDT placed between end plates

behaviour than plain high strength concrete. The addition of steel fiber to concrete mix also showed increase in ultimate strain (ultimate strain was considered as strain corresponding to 90 % peak stress) compared to plain concrete. The study indicated that specimens with smaller gauge length i.e. when tested using compressometer gave more realistic value of Modulus of Elasticity (MOE) of concrete as compared to LVDT used between end platens. The post peak portion of the stress-strain curve is not only a material property but is dependent on measuring length because a localized failure zone is the cause of snapback observed with specimens tested using compressometer. The MOE measured by the platen to platen LVDT, have the lowest values which can be attributed to the machine to specimen interaction which includes the unwanted end-zone effects and machine flexibility. The compressometer used during the tests had a gauge length of 150 mm and consistently gave erratic responses during post-peak of high strength concrete due to cracking and spalling under the attachment points of the transducer.

EXPERIMENTAL SHEAR STUDY ON REINFORCED HIGH STRENGTH CONCRETE BEAMS

V V Arora, Brijesh Singh, Vikas Patel, Amit Trivedi and Lalit Kumar

National Council for Cement and Building Materials, India

With increase in the use of High Strength Concrete (HSC) in construction and lack of proper guidelines for design in Indian standards, behavioral study of high strength concrete is an important aspect of research. Research on the behavior of HSC beams with concrete strength higher than 55 MPa has been carried out in the past and is still continuing, to understand the behavior of HSC beams. Along with the many benefits of the high strength concrete the more brittle behavior is of concern which leads to sudden failure. In case of high strength concrete reinforced beams, the combined action of higher dowel forces and highly concentrated bond stresses result in higher bond splitting stresses where the shear crack crosses the longitudinal tension bars. In various International codes of practice, the shear strength of a reinforced concrete beam is taken as the sum of the shear force that is carried by the concrete (Vc) and the web reinforcement (Vs). The term (Vc) in a diagonally cracked beam with web reinforcement represents the sum of three components: (a) dowel action resistance of the longitudinal reinforcement, (b) aggregate interlock resistance along the diagonal crack, and (c) the shear resistance carried by the uncracked concrete compressive zone. The term (Vs) represents the vertical component of the shear force carried by the shear reinforcement.

This paper presents the behavior of reinforced HSC beams in shear with considering the effects of various factors like shear reinforcement ratio, longitudinal reinforcement ratio, a/d ratio (shear span to depth ratio), etc. Results of this study can be used in the design of high strength concrete and will be more reliable in Indian continent as the regional materials and exposure conditions were considered. Ten numbers Reinforced Concrete Beams of various sizes using concrete mix with three different w/c ratios (0.47, 0.27 and 0.20) were cast for shear strength assessment. The test was done on 500 kN capacity displacement controlled machine. The beams were tested in simply supported condition (Figure-1) over two fixed steel pedestals with load rate of 0.2 mm/minute in displacement control. Strains in concrete and stirrups were measured using strain gauges placed on concrete surface and on embedded stirrups. Mid-point deflection was measured using LVDT.

Figure-1 Test Set up for High Strength Concrete Reinforced Beams in Shear

A comparative analysis of theoretical approaches of Euro code, extension of current IS code up to M90 and the experimental data was done to understand the behavior of beams. Shear capacities of beams without any factors of safety were used to assess the actual capacities and then was compared with the experimental capacity obtained.

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EVOLUTION OF CONCRETE MIXTURE DESIGN METHODS AND IGNORED ISSUES

Subrata Chowdhury

Conmat Technologies, India

Concrete mix proportioning is essentially an iterative approach involving the trials. Selection of ratio of water (w) to cementitious material (cm) has significant bearing on the number of trials. Objective of concrete mix proportioning is to determine suitable quantities of ingredients to achieve a good balance between specified properties and ingredient's quantities.

The historic trend of the development of concrete mix design process is gradual and a good quantum of similarity in approach exists amongst the current few widely used methods. The strength is considered as the most important performance parameter of concrete achieved by following systematic mix design procedure. Durability is believed to be directly proportional to the strength and workability. For realistic stand point of view, the Concrete mix design methods should take into account the quantity and quality of material. The strength characteristics of concrete primarily depend on that of mortar. The pattern of strength development of mortar and concrete is close to each other, owing to similarity in the hydration process of cementitious material in association with fine aggregates.

The central point of concrete mixture proportioning methods practiced globally is to achieve target compressive strength. This has become century old practice in use by construction industries in many part of the world. The durability is no way of lesser importance than any other performance criteria of concrete, notably strength. Nevertheless till recently advance concrete technology concentrating higher and higher strength driven by an assumption that "strong concrete is durable concrete". The both strength and durability must be considered explicitly right from the design stage.

The literature reports rational development and successful use of strength-cementitious materials- water relationship for working out w/c_m, incorporating characteristic and quantities of ingredients on hydration kinetics and involving non-dimensional parameter f_c/f_m termed as strength ratio.

The permeability, durability, robust micro-structure, thicker continuous phase, and workability of concrete are primarily governed by the paste and mortar volume. The mix design outcome does not give any hint of indicative volume of paste or mortar essential for improved workability and durability. Sufficient quantity of paste present in a concrete mix and intelligently designing the composition of a paste would further minimise the permeability level. The approach detailed here for reduction of concrete permeability is solely dependent on the quality of ingredient in use and the performance criterion of the concrete. The permeability of concrete is greatly influenced by the pore structure or system within the bulk of the hardened cement paste and transition zone. The permeability of concrete is reduced significantly by lowering w/c up to certain level and it could further be minimised through proper design of the composition and volume of the paste present in the mix.

COMPATIBILITY ISSUES OF FLYASH BASED CEMENTS WITH NANOMATERIALS LIKE NANO-SILICA

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[2]*Indian Institute of Engineering Science & Technology Howrah, India*

Though Indian cements boast of higher power & heat efficiencies their waste management in terms of fly ash utilization, carbon capture is un-sustainable going by the current rate of fly-ash utilization as against the 100% utilization prescribed by Government of India. There has been a positive wave of changes across the Indian Cement Industry, significantly on the front of Cement economics and Sustainability with a number of successful studies have been conducted on the use of Nano-Silica in cement-concrete, but the cement industry still faces a broad range of challenges from the 'nano' materials in issues of cost, mixing, dosage, compatibility etc. As existing literatures suggest, nanomaterials did exist historically but people were ignorant of such science due to the nonexistence of highly sophisticated instruments and today with nano-enabled TiO_2 cements, other countries' cements have gone from 'low carbon' to 'carbon neutral' to 'carbon positive' in the lines of 'polluter to pay' principles which we need to focus upon. Also, Fly ash, a coal combustion product, primarily generated from the thermal power plants and originally considered a hazardous waste, which was previously normally discarded into the atmosphere, now requires that it be captured prior to release, as per new pollution norms. Looking at the future projections of fly ash generation it is expected that, coal will continue to be the fuel of choice and in spite of the massive initiatives taken by the government , there will be continued dependence on high ash coal to meet the future targets of power generation to achieve the objective of 'power to all'.

As of now, there is not much literature available regarding the compatibility of these two materials i.e. nano-materials with fly ash. Our paper reports that with small addition of nano particles viz. Nano-Silica (nS) in optimized quantities (w.r.to the weight of cement & water added as per the normal standard consistency formula of the Indian standards) to Portland Pozzolona Cement (PPC) it is observed that the consistency in gain of strength at 28 has been retained in the long term of 365 days, showing a strength of more than 55% increase over that of control PPC. Thus this Paper aims to explore the fact that fly-ash based cement containing 15%-35% fly-ash (as per Test Certificate), like Portland Pozzolona cement (PPC) have arrested this long term inconsistency to a certain appreciable extent due to addition of Nano-silica by its pozzolanic activity, finely divided spherical form i.e. high surface area and higher residual carbon content measured by loss on ignition (LOI), when compared to OPC.

So Nano's blend, if it can take off then perhaps we would be leap-frogging into a 2^0 world if not 1.5^0.

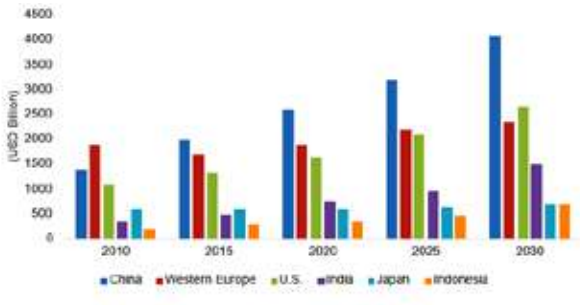

Figure: Future projections of Nano-silica market
(Source: www.grandviewresearch.com)

Keywords: Cement, Fly ash, Materials, Nano-materials, Strength, Sustainability

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ROLE OF PACKING DENSITY, MIXING EFFICIENCY AND CURING REGIME ON DEVELOPMENT OF UHPC

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National Council for Cement and Building Materials, India

Ultra-High Performance Concrete (UHPC) is a cementitious, concrete material that has a minimum specified compressive strength of 120 MPa (17,000 pounds per square inch) with specified durability, tensile ductility and toughness requirements. The microstructure of UHPC is denser and more homogeneous in comparison to normal concrete. UHPC has several advantages over conventional concrete but the use of it is Ltd due to the high cost and Ltd design codes. Methodology for production and development of UHPC is yet to be established. Therefore, it is imperative to study and further develop UHPC using the indigenous materials for production and usage in India. The paper covers the importance of packing density, mixing efficiency and curing regime on the development of UHPC. Cementitious content of all the mixes in the study were kept in the range of 1000 kg/m^3 having water to binder ratio varying between 0.15-0.25. This study focuses on the methodology to be adopted for optimising the packing density of UHPC and the challenges associated with it. The paper also highlights the effect of type of mixer, variation in mixing speed, total mixing duration which may lead to significant changes in fresh and hardened properties of concrete having same composition of materials. Paper also discusses effect of curing regime on compressive strength.

The key to the production of UHPC, which demands both a low w/c ratio to be used and a high workability to be attained, is the maximisation of the packing density of the granular skeleton of the concrete. In this study, approach of ideal curve has been adopted for the optimization of concrete mix to attain the maximum possible packing density. all the concrete mixtures are designed based on the basis of modified Andreasen and Andersen model, which is as follows:

$$P(d) = \frac{d^q - d_{min}{}^q}{d_{max}{}^q - d_{min}{}^q}$$

Where D_{min} is the minimum particle size (μm).

Based on the literature studies done and study conducted several conclusions were drawn. Optimization of mix constituents for design of UHPC mix using any methodology, requires precise particle size distribution of individual materials. Hence, method to obtain particle size distribution of ultra-fine cementitious materials needs to be optimised to yield consistent results. It is important to individually optimize the duration of external sonication required for all the ultrafine and nano materials to obtain a reasonable particle size distribution. Factors affecting production of UHPC are mixing speed, duration of mixing and sequence of mixing. Use of high energy and high speed mixer leads to the breakdown of lumps formed during the mixing process, which helps in producing a homogenous concrete mix. Dry mixing and appropriate mixing sequence ensures higher bulk density and lower moisture requirements. The study also indicated that the compressive strength in case of steam curing is higher in comparison to strength obtained in the case of normal curing at both 7 and 28 days.

SYNERGY OF MICRO SLAG IN HIGH VOLUME FLYASH CONCRETE

Praveen Kumar[1] and Zafar Ahmad Sultani[2]

[1]Rajasthan Technical University, India

[2]NHAI, Gujarat, India

An experimental study has been undertaken to valuable the effect of addition of high volume of flyash in concrete systems containing micro slag. Compressive strength at early age, i.e. at 3 days and at later ages, 28 days and 60 days have been studied. Cement content in the mixes containing micro slag or micro slag together with flyash were reduced in accordance with IS 10262. Different mixes were prepared keeping water- cementitious material ratio constant and equal to 0.42.

Mixes were made with two proportions of micro slag, 5 % and 7.5 % and flyash content used was 70 % . Test results show that in a concrete mix, containing about one third less quantity of cement than in the control mix with conjunctive use of the two supplementary cementitious materials, three days compressive strength is about 74 % higher than that of control mix. Such mix/es exhibit almost similar strengths to those of control mix, at 28 days and 60 days age.

The presence of micro slag appears to have resulted in higher rate of reaction in high volume flyash concrete, leading to substantial increase in early age strength.

The paper presents the details of mix proportions and the test results. Discussion of probable reasons for the variation in strengths noted is also presented

ULTRA-HIGH PERFORMANCE ENVIRONMENT-FRIENDLY CONCRETE

Kumar Shaswat

Bennett University, Greater Noida, India

Research in the past two decades in the concrete and its properties has lead to the development of Ultra-High Performance Concrete. Ultra-High Performance Concrete (UHPC) or Reactive Powder Concrete (RPC) can be defined as concrete with compressive strength exceeding 100 MPa and is generally fibres reinforced to improve tensile strength (exceeding 48 MPa) and to reduce micro-cracking. UHPC also exhibits remarkable workability, high flow characteristics make it self – compacting, UHPC is very dense in comparison to conventional concrete reducing the number of connected pores. UHPC has minimal pores, which leads to low permeability and inturn prevents ingress of chemical attacks. Improvement in properties and behaviour has projected the UHPC as a viable sustainable material for Buildings, Industrial Structures, Hydraulic Structures, Bridges and Highways etc. UHPC is the "future" building material which meets various requirements of large scale construction.

All types of resources used in construction such as embodied energy, cost of construction, labour required at the stage of the erection of buildings and other infrastructure including maintenance throughout the life of the structure are reduced.

This paper explores the compressive and tensile strength of UHPC in comparison with conventional concrete, improved safety and increase in life of the structure. UHPC's Ltd applications in the current construction industry, because of initial high cost is also discussed. A strong case in favour of the use of UHPC to overcome the difficulties on the basis of benefits is presented. The research findings of over 20 years in development of UHPC with its benefits should reach the industry. Increasing awareness about UHPC's properties, its design procedures, precaution in use and conventional ways of handling paste can bring a revolution in the construction industry while reducing impact on environment and resources required.

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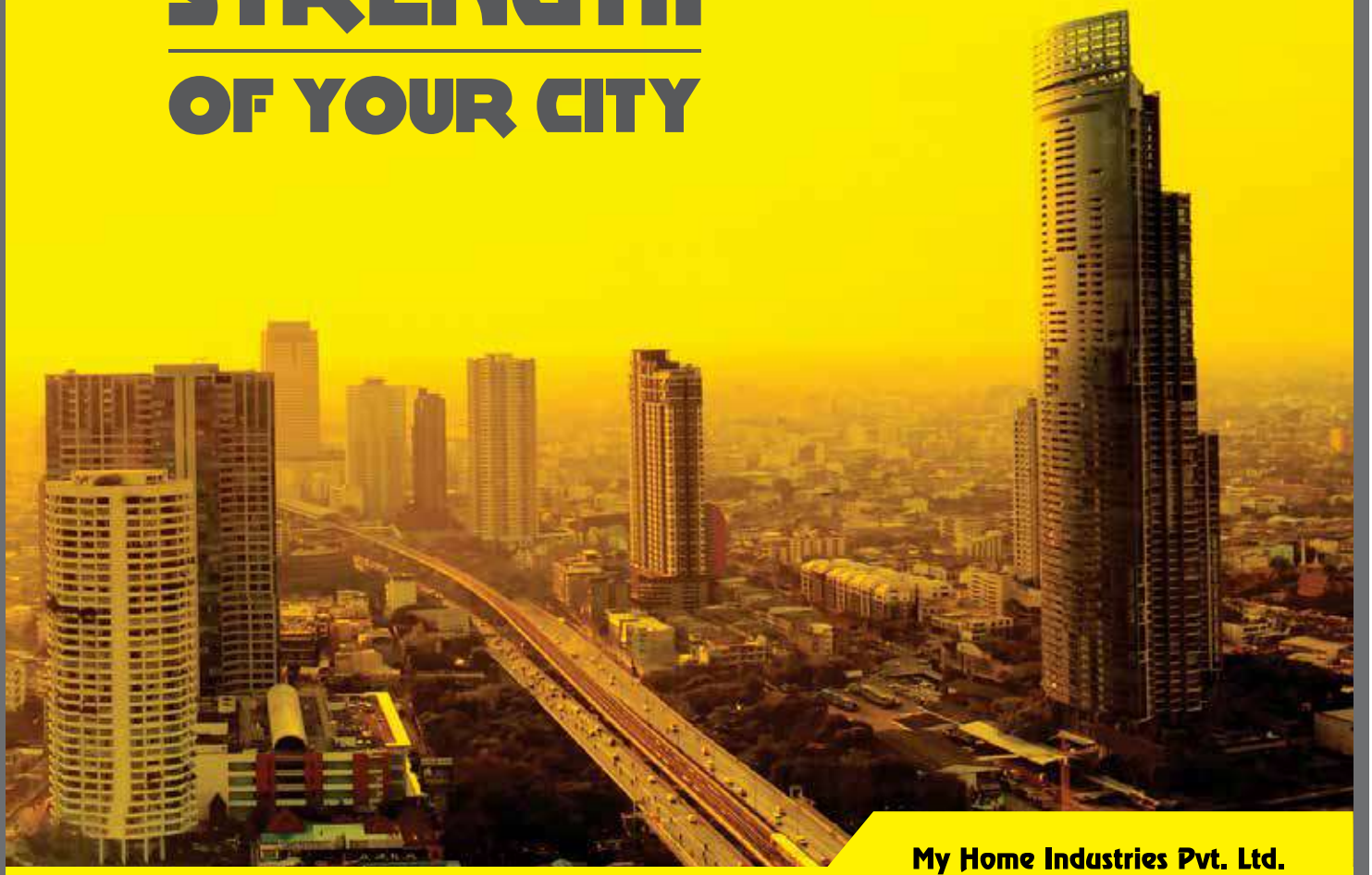

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PRODUCT OPTIMIZATION BY USING GRINDING AID AT PRISM JOHNSON Ltd, SATNA, MP

Pravesh Kumar Sharma, Ghanshyam Mishra, Raghvendra Pandey, Rajendra Kumar Jha Dinesh Agrawal, Manish Kumar Singh and Manoj Kumar Jha

Prism Johnson Ltd (Cement Division), India

Rapid technological advancement in construction industry has focused customer attention towards the product quality. In this context, continuous Product Optimization is an important element at PRISM JOHNSON Ltd mindset for Better Cost Management (BCM), Permanent Marketing Innovation (PMI) and Sustainable Ecological Performance (SEP). A key indicator for product optimization is the clinker factor in the cement. Lowering the clinker factor contributes to cost reduction, volume enhancement, permits product differentiation and is one of the best measures to minimize the specific CO_2 emissions. Apart from these, selection of a good grinding aid also decreases the energy consumption to obtain a given fineness or flow of cement as well as reducing agglomeration and providing energy savings, reduces setting times and increases the rate at which strength is developed in the course of subsequent hydration.

An important pre-requisite for product optimization is the proper definition of the product mix and requirements between marketing and manufacturing, which sets the framework for the optimization of the individual products by using appropriate grinding aid to achieve the required cement quality and productivity at lowest possible cost.

The objective of this paper is to study the effectiveness of cement grinding aid in the manufacturing of high early strength cement and improvement in Premium Product DuraTech Cement (Portland Pozzolana Cement), productivity and performance in different aspects. Plant data on mill TPH, Blaine, residue, compressive strength and fly ash consumption make the study more comprehensive. Mill operation at different grinding aid dosage also helps to optimize the application. Our main approach was to watch closely on the improvement in mill TPH and fly ash consumption without deterioration of mortar compressive strength.

ENERGY EFFICIENT VRM TECHNOLOGY FOR CEMENT AND SLAG GRINDING

Y Shigemoto[1], T Hinauchi[1] and R K Sharma[2]

[1]UBE Machinery Corporation Ltd, India

[2]AMCL Machinery Ltd, India

UBE Machinery Corporation Ltd (UBE) has been supplying vertical mills for the last 60 years. There has been an outstanding feedback from the customers who are using UBE Mills for grinding raw material, clinker, slag and coal etc. UBE has supplied over 500 Mills across the world including 20 Nos. in India. UBE Mills are known to be sturdy and have the high reliability factor built in.

UBE Mills are energy efficient and easy to operate and maintain. The hydraulic system is also very effective and robust. The mills are available in wide range of capacity for all the applications. UBE has been pioneers in cement and slag grinding where "2-Way System" is applied to allow highly efficient grinding while maintaining vibration at minimum level. Design of VRM rollers is done in accordance with modular design concept to meet the needs of variety of customers. UBE has done a lot of innovation to improve the separator efficiency. Continuous innovation and improvement has been the hallmark of UBE's design.

For grinding Slag and Cement, UBE has been able to achieve the lowest specific power consumption. UBE also has the experience to grind composite cement with different Blaines. The paper would cover some specific case study to elaborate the same.

In order to serve Indian Industry better, UBE has entered into a License Agreement with AMCL. AMCL has been in the business of vertical roller pre-grinding mills for the last 20 years and is fully capable of manufacturing vertical mills. AMCL-UBE combine will be able to serve the Indian Industry in a more effective manner where due importance will be given to after sales services and overall customer satisfaction.

HEXADUR® IN CEMENT INDUSTRY - 25 YEARS OF OPERATION WITH HEXADUR® PROTECTED HPGR ROLLERS

Jörg Oligmüller, Andreas Packeisen and Kaushik Ghosh

Koeppern, Germany

Since 1986 high-pressure grinding rolls (HPGRs) are operated in the cement industry for grinding of clinker, limestone and blast furnace slag. Although comminution with HPGR's keeps the contacts between feed material and roller surface to a minimum, the crushing tools wear out because of abrasion and indentation. This reduces availability, generates significant costs for regeneration or replacement of the roller, causes production losses and increases energy costs. Thus, wear surface developments target the combination of high service lifetimes and low operating costs [5]. Improvements in the intake behavior as well as the surface wear protection contribute to an overall cost reduction.

The HIP-cladded HEXADUR® wear protection comprises an applied combination of materials with different, but well defined properties with regard to process technology, structural integrity and wear resistance. The inter spacings between the hexagons are filled up with crushed feed material, building up a comb-like autogenous wear protection layer (APL) and improving intake behavior as well as throughput of the machine. A tough inter spacing material creates high resistance against expansion of local damages to neighboring hexagons. Moreover, the hexagons are very tolerant to tramp material due to the potential for smoothing partial chippings without any consequences for the tool life. The completely maintenance-free operation of Hexadur® rollers combined with maximum availability over a prolonged operation period has improved the total cost frame and clearly spoken for the Hexadur® wear protection system.

EFFICIENT GRINDING OF LIMESTONE ALONG WITH SLURRY MATERIAL IN GEBR. PFEIFFER VRM FOR UTILIZATION OF GREY SILICEOUS LIME STONE AT CHAIBASA CEMENT WORKS

Raghvendra Singh[1], Piush Mishra[1] and Sudipto Mondal[2]

[1]Gebr. Pfeiffer (India) Pvt Ltd, India

[2]Chaibasa Cement Works (A Unit of ACC Ltd), India

The effective utilization of mining material is the need for the survival of any cement plant.

Chaibasa cement works (a unit of ACC Ltd) has 1.2 MTPA clinkerisation unit. Mines of Chaibasa cement works has grey siliceous limestone material which is being used after enrichment in quality as raw meal for cement manufacturing. The carbonate % in Grey Siliceous Limestone (GSLS) material is around 66+ 1% and is being enriched to 86+ 1% by froth flotation method in Rougher (first stage flotation cell) and Cleaner (second stage flotation cell) followed by Thickener. The main advantages of using enriched GSLS material for producing raw meal are -

- Utilization of low grade lime stone in raw meal by 16-17%
- Utilization of shale material in raw meal by 6-7%
- Reduction of high grade lime stone by 24-25%

Now there was challenge to grind the raw material having 20-22% enriched GSLS material in the form of slurry with 35-36% moisture content. It was not easy to grind such kind of high moisture content material along with other material having only 1-2% feed moisture.

Pfeiffer designed vertical roller Mill MPS 4250B/ SLS 3750B was selected to grind such kind of typical raw mix material. For drying and grinding 20% slurry mix feed material, the hot gas temperature was required as high as 385 Deg C so the mill grinding bowl was insulated and other part were selected and designed suitably to handle such high temperature gas.

It was very difficult to dry and grind the slurry mix material as with slurry addition, the grinding bed formation will be very high and uneven. So Pfeiffer designed the grinding rollers arrangement and inclination in such a way that the grinded material should release from the table very fast while the fresh feed material should retain on table for grinding.

Efficient material grinding is being done with 320 TPH throughput consisting 250 TPH (dry basis) of dry feed (limestone and additive of -75 mm size) and 70 TPH of slurry (35% moisture). A stable mill operation with product quality 14%R on 90 microns is achieved while the mill absorbed power is 1500 kW and the fan absorbed power is 1600 kW.

CONSOLIDATED JOURNEY OF MORE THAN 100 ROLLER PRESSES IN INDIA

Balesh Singh, PVR Murthy, Atul Johri and Vimal Singh

KHD Humboldt Wedag India Pvt Ltd, India

All over the world, the cement industry is striving for improving energy efficiency, product quality and environment. The Indian cement industry transformed itself into a modern, energy efficient and environmental friendly industry by taking full advantage of technological developments.

In the technological development, Roller Press has emerged as the most energy efficient comminution machine till today. KHD India has installed around 117 Roller Presses for Raw Material, Clinker & Slag Grinding.

Out of 117, 25 are installed for Raw material grinding, 64 are for Clinker Grinding and 28 are for Slag Grinding in Finish mode.

On the journey of its development, Roller Press has gone through the following changes with respect to the type of circuit COMFLEX®, Stud Roll surface, large capacity Roller Press model, upgradation capacities and reduction in specific power consumption.

- Pre-Grinding: Up to 35% capacity increase & 2 - 3 kWh/t reduction in power
- Semi-finish Grinding: 2.5 - 3.0 times in capacity increase & 5 - 6 kWh/t reduction in power
- Finish Grinding: Lowest energy consumption
- Stud Roller Surface: High roller life more than 40,000 hrs with minimum maintenance
- Large capacity - KHD has developed new Roller Press models (RP27 & RP32) for large Grinding capacoty

Over the years, Roller Press has established itself as the most energy efficient comminution machine. Many KHD supplied Roller press circuits with Ball mill in semi-finish mode are operating with lowest specific energy consumption. The lowest energy consumption for raw material grinding circuit is 9-10 kWh/t for complete circuit and 23.5 kWh/t for PPC grinding.

KHD was the first to run its Roller presses in finish grinding mode for Raw Material, Clinker, Slag & Composite Cements.

Advantages of Roller Press Over other Grinding system:

- Lower specific energy consumption
- No water requirement for Raw and Clinker grinding circuits
- Less water requirement in case of Slag grinding
- Less heat requirement due to lower water requirement in case of Slag grinding and no heat requirement in case of OPC and PPC
- No heat requirement for Composite cement grinding in case of Roller Press with ball mill mode
- Compact circuit in case of Comflex arrangement

RAW MILL FINISH MODE GRINDING @ 10.5 kWh/MT

Swapnil S Kotpalliwar

Dalmia Cement (Bharat) Ltd, India

"Dalmia Cement (Bharat) Ltd - Belgaum" is situated in Gokak Taluka near Yadwad village in Belgaum district, Karnataka.

In Indian Cement industry either Ball Mill or Vertical Roller Mills were in application traditionally for grinding of raw materials, whereas at Belgaum we are using Roller Press for same. This Roller Press is used without any support from secondary crusher or Ball Mill for grinding of limestone & other additives. Grinding of raw material standalone in single Roller Press also called as "Finish mode grinding". With this scenario we are successfully achieving 11.54 kWh/MT (Month Average Feb-19) & lowest to the extent 10.5 kWh/MT (for the day) specific power consumption. Roller Press is designed to perform at rated output of 390 tph on dry basis whereas we are achieving 427 tph (Feb-19) for the month average. Also we have achieved 490 tph on day basis but at slightly higher specific power consumption. The remarkable thing is that along with achieving lower specific power & higher than rated productivity, we are achieving 0.58 % residue on 212 µm & 6.1 % residue on 90 µm (Feb-19-month average) as per quality requirements for the kiln. As far as feed material is concerned we are using 96% limestone from our own mines and 4 % we are using Aluminous laterite + additives to suffice our Alumina, Iron & Silica requirement as per process. This Crushed-limestone is having size of 90 % < 50 mm & 10 % 50 - 70 mm with moisture varying in the range of 1.2 to 1.6%.

Total circuit consist of roller press, belt conveyors, dynamic separator, 6-cyclone separators, V-separator, ID fan, bucket elevator for material re-circulation, silo feeding & Baghouse to collect dust from raw mill as well as pyro return dust.

Paper will be based on journey of achieving specific power from 13.5-14.0 kWh/MT to 10.5-11.50 kWh/MT along with improving reliability & process optimization including sections like major breakdown & troubleshooting, optimization for achieving lower residue, false air reduction, training to operators, support from OEM & other relevant topics.

As of now in Dalmia group, Belgaum Roller Press is the second in terms of specific power consumption. Our vision is to achieve single digit power consumption (i.e. < 10.0 kWh/MT) in sustainable way at same level of Productivity & Quality.

JSW GREEN FOOT PRINTS : EXPERIENCES WITH KHD ROLLER PRESSES

G Veera Babu[1], A K Dembla[2], Prakash Patil[2] and Deepti Varshney[2]

[1]JSW Cement Ltd, India

[2]Humboldt Wedag India Pvt Ltd, India

KHD's association with JSW group started in the year 2007 when JSW entered Indian cement market with a vision to manufacture eco-friendly green cements and with partnership of KHD green technologies they achieved their vision over the years.

JSW Cement started its cement journey with Greenfield plant at Nandyal, Andhra Pradesh. This is a unique plant with KHD Roller Press technology for all the grinding applications i.e., raw materials, clinker and slag. Total 8 Nos. similar Roller Presses were installed at this plant site. Needless to mention that KHD started the standard and successful COMFLEX arrangement with this plant for all applications. Especially the success story of slag grinding with KHD technology attracted the Indian cement industry attention.

Due to the success story of Nandyal plant and trust in KHD Energy Efficient technologies, JSW cement awarded another 16 Roller Presses in year 2015 for slag and clinker grinding applications. Each unit comprising of 2 machines is designed for 1.2 MTPA cement.

The main advantages considered by JSW for this big contract are:

- Lowest sp. power consumption w.r.t other technologies
- No heat requirement because of no water spray requirement with clinker grinding
- Highest availability and reliability with maintenance free roller surface i.e., STUD rollers
- Commonality of the equipment

Out of these 16 Roller Presses 12 No Roller Presses are already being commissioned or under commissioning. 6 Nos PG Tests are already completed and 4 nos. are under PG completion Test. The results as achieved are quite rational in deciding grinding requirement for any material in cement industry Roller press systems are the most Energy Efficient installations.

Further details shall follow on the selection criterias of the equipments and technology offered. Also a brief study of the operating parameters and the Roller Press behaviour in all the circuits will be elaborated.

INCREASE THROUGHPUT OF CEMENT MILLS AT CHANDERIA CEMENT WORKS PLANT

Dinesh Kumar, D C Jagetiya and Narpat Anjana

Birla Corporation Ltd, India

Clinker grinding technology has been continuously improving with numerous innovations in view of improving productivity and to reduce specific power consumption.

In order to reduce the manufacturing costs for cement, it is very important to optimize the existing mill installations as far as the grinding process is concerned and also to use high quality spare parts and consumables like grinding media, rollers for roller presses etc.

Ball mills are predominantly used machines for grinding in the cement industry. Although Ball mills have been used for more than one hundred years, the design is still being improved in order to reduce the grinding costs.

Many types of grinding systems presently being used for clinker grinding in cement plants are:

- Open and close circuit Ball mills
- Roller press in combi circuit/finished mode
- Vertical roller mill (VRM)
- Tube mill with pre-grinder/crusher

Birla Corporation Ltd is having two cement plants at Chanderia (Rajasthan) one is Birla Cement Works (BCW) and another is Chanderia Cement Works (CCW). Chanderia Cement Works is having two ILC preheater kiln and two cement grinding ball mills with Polysius Roller press as per-grinder in combi circuit mode.

The plant team has done Performance Optimization of the cement grinding circuits by doing process diagnostic studies. At CCW Plant, we have taken various action and trial in steps and increased throughput by 25-30% in both the mills. Output from the two cement mills CM-1 and CM-2 was only 225 TPH and 240TPH PCC, respectively in 2017-18.

These annual average capacities in 2018-19 has been increased to 300 TPH in Cement Mill 1 and 310 TPH in Cement Mill 2 respectively and reduced power consumption from 30.38 kWh/T Cement in 2017-18 to 27.51 kWh/T Cement in 2018-19.

OPTIMIZATION OF RAW GRIDNING ROLLER PRESS AT CHANDERIA CEMENT WORKS PLANT

Narpat Anjana , R C Jain and Dinesh Badala

Birla Corporation Ltd, India

Limestone grinding technology has been continuously improving with numerous innovations in view of improving productivity and to reduce specific power consumption. In order to reduce the manufacturing costs for cement, it is very important to optimize the existing mill installations as far as the grinding process is concerned and also to use high quality spare parts and consumables.

Many types of grinding systems presently being used for raw meal grinding in cement plants are:

- Open and close circuit Ball mills
- Roller press in combi circuit/finished mode
- Vertical roller mill (VRM)
- Tube mill with pre-grinder/crusher

We at Chanderia plant of Birla Corporation Ltd in the raw grinding circuit having two KHD supplied roller

Presses RP-1 and RP-2 with single circuit of fan/separator which produce 360 TPH raw meal as annual average and consumes 16.5 kWh/T raw meal. We have to run one standby Ball mill to makeup extra requirement of Raw meal which consumed 25.0 kWh/T raw meal which was a big loss.

We have done many small in house modifications, logic changes and process optimization in step to improve its productivity and to reduce power consumption.

After all the steps/trials, mill is running > 410 TPH with 14.5 kWh/T Raw meal and major advantage for our plant that we have almost stopped Ball mill operation to make up extra raw meal requirements.

Mill Throughput	
Before Optimization	After Optimization
360 TPH	410 TPH
Mill Power	
Before Optimization	After Optimization
16.5 kWh/T Raw Meal	14.5 kWh/T Raw Meal

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TECHNICAL SESSION – VIII B

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STUDY ON BEHAVIOR OF POLYPROPYLENE FIBER REINFORCED HIGH STRENGTH CONCRETE EXPOSED TO HIGHER TEMPERATURES

Vikas Patel, V V Arora, Brijesh Singh, Megha Kalra and Sahara Adhikari

National Council for Cement and Building Materials, India

High strength concrete has some disadvantages such as brittleness and poor resistance to fire. This paper discusses the effect of addition of polypropylene fiber on physical and mechanical properties of concrete and its exposure to elevated temperature. Literature review indicates that polypropylene fibers, when uniformly distributed within concrete, play an active role in improving spalling resistance of concrete induced to elevated temperature while have no adverse effect on its mechanical properties.

Explosive spalling has been observed by many researchers often resulting in serious deterioration of the concrete in case of High Strength Concrete (HSC). To reduce the risk of deterioration and spalling, researchers suggest the use of fiber such as polypropylene and steel can have sufficient fire protection on the concrete structures. Therefore, there is necessity to quantify the effect of addition of polypropylene fibers in terms of the fiber dosage, the strength of the concrete and most important is to know the residual mechanical properties of FRC under exposure of high temperature from fire.

The study is carried out for investigating the effects on polypropylene fiber reinforced concrete upon exposure to high temperatures up to 600°C, establishing a relationship between fire exposure and mechanical properties of concrete by studying and comparing the behavior of high strength concrete and normal strength concrete reinforced with polypropylene fiber when subjected to higher temperature.

In this study, concrete mixes with three different w/c ratio (0.47,0.36 & 0.2) using granite aggregate were studied for determining short term mechanical properties such as modulus of elasticity, Poisson's ratio, split tensile strength, flexural strength and compressive strength of Polypropylene fiber reinforced concrete in comparison to control mixes. (i.e. mixes without fibres) The experimental program described herein includes specimens 100 × 200 mm & 150 x 300 mm cylinders with fiber volume of 0.5% that were subjected to temperature exposures of 400^0C and 600^0C for duration of 1 hour.

Values of % reduction in compressive strength of mix did not decrease with incorporation of polypropylene fiber. Values of % reduction of split tensile strength was similar for both control and fiber mix at 600^0C and no notable improvements could be recorded. Values of MOE at different water cement ratio for both control and fiber mix were found to be similar. Values of flexure strength for fiber mix for HSC showed no improvement at elevated temperature. Similarly, other mechanical properties like MOE and Poisson's ratio, no trend of positive impact could be established. From the Experimental investigation carried out, it was observed that no significant enhancement in mechanical properties such as modulus of elasticity, Poisson's ratio, split tensile strength, flexural strength and compressive strength was observed on addition of polypropylene fibers for High Strength Concrete. (Dosage -0.5 %)

THE INFLUENCE OF HIGH SULPHATE CONTENT ON PERFORMANCE OF ORDINARY PORTLAND CEMENT

Arun C Emmanuel, Riya Anil Kumar, Gopala Rao Dhoopadahalli and Shashank Bishnoi

Indian Institute of Technology Delhi, India

The influence of high sulphate content over the performance of Ordinary Portland cements (OPC) was studied. Blends of OPC were prepared by replacing clinker with 5%, 10% and 15% gypsum. Mortar and paste specimens were prepared and cured at 27°C. Hydration kinetics was studied using isothermal calorimetry. Compressive strength was carried out in mortar specimens. The influence of additional gypsum on the degree of hydration of clinker was obtained by XRD-Rietveld analysis. Crystalline hydration products such as portlandite and ettringite was also quantified. The strength development of OPC with high gypsum content was observed to be relatively slow. However, at 90 days, there was no significant difference in strength development.

The better later age strength in OPC with higher gypsum could be due to the formation of additional ettringite. This additional ettringite is formed from the reaction of gypsum with aluminate contributed by C_4AF.

The additional gypsum reduces the rate of strength development at early ages but accelerates it at later ages. Also, the blends with excess gypsum show relatively similar ultimate strength even at a reduced clinker content. Apart from increasing the stability of ettringite, the excess gypsum produces more amount of ettringite makes the system compensates the reduced clinker content. The later age formation of ettringite in 15% Gypsum could be mainly due to later age hydration of the ferrite phase.

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ASSESSMENT OF MECHANICAL AND MINERALOGICAL PROPERTIES OF CONCRETE DAMS IN INDIA

Brijesh Singh[1], V V Arora[1], Shubham Jain[1], Vikas Patel[1] and Pramod Narayan[2]

[1]National Council for Cement and Building Materials, India

[2]Dam Safety Rehabilitation Directorate, Central Water Commission, India

In India many of dams are entering in to the middle age and need to deal with "ageing" of the concrete in the dam structures is of great importance. This paper highlights the importance of in-situ properties of dam construction material over a period of time. These actual properties of material play an important role in the advanced FEM modeling of dams wherein basic objective remains to get reliable model output about the realistic deformations, stresses, inclination, etc., in order to address the problem through appropriate rehabilitation. These material properties are very sensitive in evaluating various engineering parameters required for bankable dam design. In the ongoing Dam Rehabilitation and Improvement Project (DRIP), NCCBM is associated officially with CWC in some of the important modeling works of few DRIP dams to test various existing dam material properties as a model input. To deal with the affected structures, it is necessary to precisely understand the chemo-mechanical effects of each reaction. In the present paper case studies from the investigation of two large concrete dams; one arch dam and other gravity dam both more than 45 years old are presented.

The completed investigations of mechanical properties including field assessment, thermal properties and expansion issues such as Alkali Silica Reaction and Sulphate attack are presented. The overall quality of concrete is sound and the experimental test results of compressive strength, modulus of elasticity, poisson's ratio and split tensile strength are in similar range to the designed values for these parameters considered in design for both arch and gravity dams. The test results of resistivity test and humidity meter indicate that moisture content in upstream side is higher than downstream side. The impact of aggregate and other concrete constituents on deterioration of concrete which can have a significant impact on durability and safety of dam are discussed.

The expansion study indicates that though the aggregate is not under potentially reactive category and the typical pattern cracking due to ASR will not occur but length change can be caused even by small amount of ASR expansion. With the end restraints in case of arch dam, this small expansion may also add to the movement of mid-point towards upstream side. Therefore, one of the main cause of displacement and cracking in arch concrete dam were identified as Alkali Silica Reaction apart from thermal stresses and differential drying shrinkage.

The test results of petrography studies, Scanning Electron Microscopy studies, Accelerated test on concrete cores and Colour test indicates there is no Alkali Silica Reaction in concrete. The sulphate in the form of pyrite is found in the aggregates from petrographic, SEM and XRD studies and this is the reason for crystalline ettringite formation.

FAST TRACK CONSTRUCTION SYSTEMS FOR AFFORDABLE HOUSING – NEED OF THE HOUR

Shailesh Kr Agrawal

BMTPC, India

Urban India is transforming at an unprecedented rate as regards urban revival is concerned. Besides, Atal mission for rejuvenation and urban transformation (AMRUT), there are other flagship programmes run by Ministry of Housing & Urban Affairs such as Smart Cities Mission, Swachh Bharat (Urban) Mission, Heritage City Development & Augmentation (HRIDAY) Scheme, Urban Transport & Pradhan Mantri Awas Yojna - Urban (PMAY-U). The PMAY-U has been the landmark in the annals of India history where it is dreamt to provide shelter security to one and all by the 75th year of Independence. It is one of the biggest missions ever thought of around the globe with the objective of providing 11 million houses within the span of eight years starting from 2015 to 2022.

The cast-in-place brick by brick construction and RCC beam-column construction are the things of past and are slow track construction practices. The world over, building construction has been shifted from site to the factory where building components partially or fully are manufactured and then transported to the site for their erection, assembly and finishing. We can take cue from metro construction or bridge construction where long span horizontal members (girders) are cast in casting yard and then assembled over piers within no time. This is known as typically precast or prefabricated construction where building components as a whole or in parts are cast in the factory. In addition, there are other options also such as replacing the wall by sandwich panels or creating a customized formwork for the building or manufacturing the entire three-dimensional building in the factory which can be pre-finished or printing the building layer by layer manufacturing at site.

FAST TRACK CONSTRUCTION SYSTEMS

BMTPC has been engaged in identification & evaluation of such suitable technologies, which can be adapted in Indian context.

These technologies along with other potential technologies under broad classification are as follows:

Engineered Formwork Systems
Lost Formwork Systems

Insulated Form work systems

Stay-in-place Structural Form work systems

Precast Sandwich Panel Systems

EPS Core Panels

Other Panels

Light Gauge Steel Structural Systems

Steel Structural Systems

Precast Concrete Construction Systems

BMTPC through Ministry of Housing & Urban Affair has been advocating use of fast track construction technologies for housing and it is more apt now since India is committed to climate change mitigation, reduction of carbon foot print, resource-efficient & environment-responsive clean technologies.

As regards implementation and efficacy of these new construction systems in the field, it is heartening to note that with the constant effort of BMTPC and Ministry of Housing & Urban Affairs, around 13 lakhs houses are being constructed with new technologies in different States under PMAY(U) and other Schemes.

MATERIAL EFFICIENT FLOOR SYSTEM FOR HOUSING IN INDIA

Mohamed Ismail and Caitlin T Mueller

Massachusetts Institute of Technology, USA

In 2015, the government of India launched the "Housing for All by 2022" initiative to build 20 million units of affordable urban housing for lower income groups. Thus far, they have built fewer than two million units. In India, it is estimated that material costs can constitute 60 to 80% of the total cost of residential construction. Nonetheless, their construction mimics the materially inefficient practices of developed countries, practices developed to reduce labor over material costs. As a result, prismatic beams and flat slabs are frequently used despite their structural inefficiency. As it stands today, the construction industry is resource intensive and unsustainable.

The mounting use of steel-reinforced concrete structures in Indian cities has also garnered concern for the environmental costs of construction; construction accounts for 22% of India's carbon emissions. The impact of structural systems on a building's embodied energy are immediately apparent: cement and steel are responsible for nearly 90% of a multistory concrete frame building's total embodied energy, and at least 50% of that is in the horizontally-spanning elements alone. With no end to construction in sight, new practices are needed to curb the environmental and economic costs of India's construction.

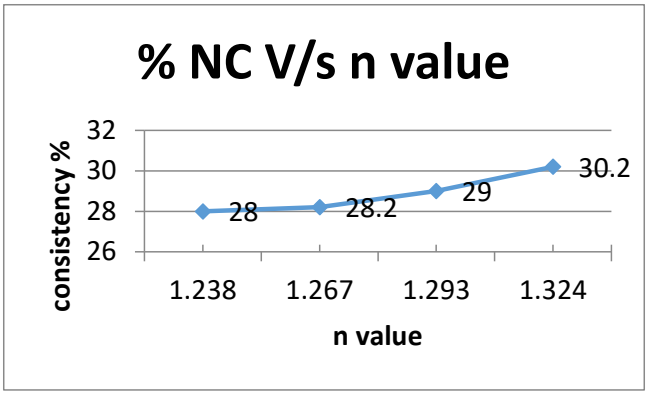
This paper explores the design of materially efficient floor systems that can reduce the economic and environmental costs of construction. Utilizing computational structural design, this thesis presents a strategy for the structural optimization of a one-way concrete floor systems. Designed for the constraints of India, the structural element is optimized to reduce the necessary volume of concrete and steel while resisting the same loads of an equivalent solid prismatic beam or slab. The result of this strategy is a material efficient ribbed slab with a potential 55-65 percent reduction in embodied energy, and a similar reduction in material and mass, when compared to a typical flat slab of 5m span. This span was chosen as representative of multi-story concrete residential construction in Indian cities, which are typically built with slabs spanning three to five meters. While structural optimization for material efficiency is not a new practice, it is technically challenging and often reserved for large-scale and exclusive architectural projects. Conversely, this research applies these principles to common residential construction.

COMPARATIVE STUDY OF CHARACTERISTICS OF OPC-53 GRADE CEMENT AND ITS INFLUENCE ON WATER DEMAND AND RHEOLOGICAL PROPERTIES OF CONCRETE

P N Ojha, G J Naidu, Suresh Palla and Piyush Mittal

National Council for Cement and Building Materials, India

With all other concrete making materials as same, water demand & rheological properties of concrete depends on cement characteristics and its compatibility with superplasticizer. In the present study, OPC-53 grade of cement obtained from four different manufacturing units have been evaluated. Concrete mix trials at w/c = 0.5 without admixture and at w/c = 0.42 with Polycarboxylate-ether (PCE) & Napthalene based superplasticizer have been carried out and results have been discussed on the basis of their relative performance in terms of their rheological properties such as water demand, initial slump and slump retention. To determine the probable cause of relative performance, the cement samples have also been evaluated for various physical & chemical properties. The cement samples were also tested for particle size distribution, XRD to determine phase distribution. Physical, chemical, mineralogical and particle size distribution characteristics of cement samples have been discussed with respect to the water demand & rheological properties observed when used in concrete. One of the cement sample having higher water demand and relatively lower rheological property have been further investigated. The clinker, limestone and gypsum etc. have been tested. Also, the effect of fineness and SO_3 content on normal consistency and mechanical properties of OPC have been studied on cements prepared in laboratory with varying fineness at fixed SO_3 and varying SO_3 content at fixed fineness.



Particle Size distribution is an important property of cement with respect to rheology of concrete. Small uniformity constant value decreases water demand and increases packing density. On the other hand, higher value of uniformity constant leads to narrower particle size distribution that gives higher hydration rates for equal specific area and increases water demand. Particle size distribution results show that Cement U has significantly higher uniformity constant value than Cement UA, UB, UC. This seems to be one of the cause of higher water demand for Cement U as shown in figure given below. Also, it was observed that water requirement for cement paste (Normal Consistency) is decreasing when SO_3 content is above 3.0 percent. Water requirement with and without performance improver doesn't shows any significant changes.

EFFECTIVENESS OF WATERPROOFING ADMIXTURES IN LOW CLINKER CEMENT MORTARS

Lav Singh, Ujjwal Kant and Shashank Bishnoi

Indian Institute of Technology Delhi, India

Durability of structures made with cementitious binders are susceptible to deterioration in long term. The main contributing factor leading to deterioration of concrete structure is ingress of water through its porous microstructure. This study is focused on the influence on carbonation resistance of low clinker cement by addition of waterproofing admixtures. Several industrial brands of waterproofing admixtures were used with 3 types of blended cements (OPC, CC and LC^3) to make mortar specimens at 0.45 water binder ratio. Investigation was done on transport properties of these specimens – capillary sorption and water boiling test. The specimens were further subjected to carbonation study to examine the effectiveness of water resistance produced by waterproofing admixtures. The study reveals that current waterproofing admixtures are not significantly effective in enhancing the durability of concrete in terms of carbonation resistance.

Keywords: Waterproofing admixture, blended cements, carbonation

PERFORMANCE ANALYSIS OF IN-SERVICE RC MEMBERS OF TURBO GENERATOR IN INDIA - A COMPARATIVE STUDY OF SERVICE LIFE ASSESSMENT

Sanjay Mundra, T V G Reddy and Naman Agarwal

National Council for Cement and Building Materials, India

As per Central Electricity Authority, Thermal power plants constitute 68% (222GW) of total Installed capacity in India. Structures supporting Turbine Generator machines form the heart of any power plant. Issues normally arises in RCC due to lack of quality control during construction or absence of performance based documentation during its service period. The condition of RC foundation which supports these critical machines is needed to be routinely assessed to avoid the power generation loss in future.

The present paper highlights the condition assessment study of RC Structures with the approach of field & Laboratory investigations. Non Destructive Evaluation Techniques are adopted to generate the test data & the further comparative analysis of these data is summarized for revealing the service life assessment of turbo generator foundations of five thermal power plants, operating in different climatic zones in India. All TG units under research studies are more than 20 years old. The remedial measures for repair & strengthening of distressed RC member of the structures are also briefly discussed in the paper. Ultrasonic pulse velocity of research studies indicate that quality of concrete is found to be good (above 3.5 Km/Sec) in all tested 5 Nos.TG units & Rebound hammer results also indicate the surface compressive strength (above 50 N/mm^2) is satisfactory for all 5 Nos. units. Depth of carbonation is not exceeding (15mm) in all TG units except Farakka unit (35mm) however these values obtained from different RCC members are found below the concrete cover values. Half-cell test values found to be uncertain in all identified TG units, except Ratnagiri power unit where it was more than 90%, which is exposed to high chloride content (above 5 kg/cum.) as observed in RCC members & this might be the reason for susceptible corrosion in members. Based on the studies using different non-destructive techniques, the testing results predict good performance of all TG units. However, the performance of Ratnagiri Power unit is affected by high intrusion of chloride content which might be the reason of corrosion of reinforcement bars as the unit is situated in coastal areas, where chloride concentration in water might have affected the RCC members. The repair & restoration measures of Ratnagiri & Farakka unit is presented briefly for corrosion treatment & restoring the further deterioration to enhance the service life of the TG unit.

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TECHNICAL SESSION – IX A

ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT-I

SEMINAR PROCEEDINGS

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03-06 DECEMBER 2019, NEW DELHI, INDIA

TECHNOLOGICAL UP-GRADATION & SUSTAINABILITY INITIATIVES AT KAPILAS CEMENT MANUFACTURING WORKS

Manoranjan Sahoo and Ahmer Ali Khan

Dalmia Cement (Bharat) Ltd, India

Kapilas Cement Manufacturing Works (here-in-after referred to as KCMW), situated at Biswali in Cuttack district of Odisha is operating a Cement Grinding Unit with an installed capacity of 1.7 MTPA. KCMW has taken several measures for technological Upgradation resulting into Productivity improvement, reduction of Power consumption and Heat consumption and various Sustainability initiatives.

HIGHLIGHTS:

- Increase in Mill TPH by 20% over a period of last three years, i.e. Fy-19 over Fy16.
- 7%, 16%, 18.6% reduction of Electrical Energy in consecutive years of FY-17 (39.9 kWh/T), FY-18 (35.5 kWh/T), FY-19 (34.88 kWh/T) respectively over FY-16 (42.88 kWh/T).
- 20.8 %, 20.9 % & 22.3% reduction of Thermal Energy in consecutive years of FY-17 (80.24 kcal/kg cement), FY-18 (80.1 kcal/kg cement) & FY-19 (78.7 kcal/kg cement) respectively over FY-16 (101.3 kcal/kg cement).
- 4 % reduction in Carbon foot print in year 2018-19 (399 kg/tonne) over 2014-15 (415.4 kg/tonne)
- Achieved 153% water positive status

INITIATIVES:

1. Mill tph was increased from 235 tph to 248 tph by optimization of various operational parameters and louvre ring, scatter ring and dam ring modification, thus saving of 0.2 kWh/tonne
2. False air reduction across the mill circuit from 8 to 4% by rocker arm sealing resulting in arrest of false air, resulting into reduction of specific power by 0.15 kWh/ tonne.
3. Cooling tower water circulation system running from two pumps of 55kW instead of 3 pumps of 165 kW resulting into specific power reduction by 0.24 kWh/tonne of Cement.
4. Zero water utilization in PSC grinding & stopping of one HAG in PSC grinding, resulting into reduction of specific power by 0.2 kWh/tonne of cement and reduction of specific thermal energy consumption by 2.4 kcal/kg of cement.
5. Reducing tippling time of wagon tippler by increasing speed of side arm charger and changing the tippling inclination from 155 to 140 degree, reducing tippling angle and arrangement of online breaking of lumps resulting into reduction of specific power by 0.18 kWh/tonne
6. 7 % & 6.7% of the total Power consumption substituted by Solar Power in FY18, FY19 respectively.
7. 82 % of the total power consumption substituted by Open Access from our own GPP (WHRS) in FY 2017-18 respectively.
8. Reduction in Clinker Factor in PSC upto 33.6% & in Composite Cement upto 43.7% upto March, 2019 by increased use of Additives over earlier periods
9. Water Positive status achieved by reduction in specific water consumption to 18 L/Tonne, reduction in fresh water consumption from 358 KLD to 340 KLD, increasing rainwater harvesting capacity from 1.03 lacs kL to 1.16 lacs kL
10. 100% utilization of harvested rain water for process and domestic consumption, except for drinking

IMPROVED LOW NO_x CALCINER

Ram Kumar Sridharan, Steven Miller and Mads Nielsen

FLSmidth Pvt Ltd, India

Increasingly stringent regulations mean it's more important than ever to be sure that a cement plant complies with the norms at any time. A preheater design is especially important in reducing the overall NOx emissions from a cement plant.

FLSmidth® In-Line Calciner (ILC) is both flexible and highly reliable and makes it easy to reduce the thermal NOx generated in the kiln and limit the formation of fuel NOx in the calciner. Introducing fuel or tertiary air and raw meal, correctly and operating the calciner / riser at the optimal temperatures is essential for NOx reduction by primary measures. In the ILC, which is also called as Low NOx calciner, the fuel is injected into the kiln riser below the area where the tertiary air enters at the base of the calciner. This so-called reduction zone, sized for a particular gas retention time, has an oxygen-deficient atmosphere that promotes NOx reduction.

The improved Low NOx calciner is built upon the proven experience of the Low NOx ILC. A larger reduction zone is introduced with appropriate meal split and appropriate diameter of calciner vessel.

The new design keeps the meal on the walls, and therefore high average temperatures are created and less meal can be used and at the same time ensuring that the wall temperatures are well cooled to average build ups. The improved ILC system has been installed in a cement plant in Turkey with exceptional performance results of NOx in the range less than 600 mg/Nm^3 @10 % O_2. The achieved results are with petcoke, and that similar results have not been seen before on an ILC with petcoke, and that an equally better operation with volatile fuels is expected. The details of the performance will be presented and analyzed in this paper.

CPP-DE-SO_x SYSTEM

Sushil Kumar Paneri, Vijaykumar Agrawal, Umashankar Srinivasan and Vinod Mishra

Ambuja Cements Ltd, India

Coal-based power plants are a significant source of emissions which is of great concern to India, due to their resultant impacts on human health and the environment. Power generation from coal emits harmful pollutants such as Suspended Particulate Matter (SPM), Sulphur Dioxides (SO_2), Nitrous Oxides (NOx) and as well as Greenhouse Gases (GHG) like Carbon Dioxide (CO_2). In order to curb emissions, new emission norms for power plants have been notified by Ministry of Environment and Forest & Climate Change (MoEF&CC). As per new norms, for CPP capacities lesser than 500 MW, the SOx emission should be less than 600 mg/Nm^3 for the plants installed before 31st Dec. 2016. SOx emission level in the power plant mainly depends on the Sulphur content in the fuel. Maratha Cements Works has total Captive Power Plants of 60MW with 5 boilers for meeting the power for the cement plant. Though there are many methods for reducing the SOX emissions which were costly for operation and maintain the price of product in marketing, Maratha Cement works has installed De-SOx system with low operating cost.

Maratha Cement works has mitigated the SO_2 emission by dosing Bag house dust / Raw meal powder from cement plant to CPP boiler. The bag house dust from the cement plant is transported to the power plant and injected in the boiler, which resulted in reduction of SO_2 emissions level less than 600 mg/Nm^3. The bag house dust is rich in lime react with the SO_2 so generated in the boiler and form $CaSO_4$, which will be trapped in ESP alongwith the flyash. This flyash is again being used in the cement grinding at high percentage than earlier. In the paper the analysis of baghouse dust and flyash dust alonwith the system details of De-SOx system were given.

Keywords: SO_2 emission <600 mg/Nm^3, Bag house dust, $CaSO_4$, De-SOx

NO_x REDUCTION THROUGH PRIMARY & SECONDARY MEASURES AT JK Lakshmi Cement Ltd, JAYKAYPURAM

Rajpal Singh Shekhawat, Pankaj Tiwari and Kanish Singh

JK Lakshmi Cement Ltd, India

The norms set by Ministry of Environment and Forest has worked as a catalyst for entire cement fraternities across India to come ahead and start working on meeting the norms of NO_x reduction as per the emissions standard.

To maintain the limit of NO_x < 800 mg/Nm³@10 % O_2 for the inline calciner Kiln and < 1000 mg/Nm³ for the separate line calciner kiln is now a day the biggest burning issues for every cement industry across India.

This NO_x reduction target was no exception for JK LAKSHMI CEMENT also. Therefore, the efforts started on finding the solution for meeting the target of NOx reduction.

The first concept identified for the NO_x reduction is Primary mitigation which is a cost effective measures with only limitation of NO_x reduction up to 20 to 30 % by this technique.

As JK Lakshmi Cement always believes in stretching its limit so we took these norms of NO_x reduction as a challenge and first we decided to go for Primary mitigations measures in our Kilns and then we decided to go for Secondary mitigation measures.

This paper contains the details of all the measures taken at JK Lakshmi Cement, Jaykaypuram for NO_x reduction.

MAXIMUM UTILISATION OF LOW GRADE LIMESTONE IN CEMENT CLINKER PRODUCTION

Anil Singh and Tushar Ghorai

KJS Cement (I) Ltd, India

Limestone reserves are depleting very fast globally and time will come when cement industry will face acute shortage of limestone for production of clinker. The situation is further aggravated due to steep increase in coal price and industry is switching towards high ash coal. Therefore, this is necessary to focus on use of marginal grade limestone without affecting clinker quality. Most of the time it has been observed that inefficiencies in operation and high variability in process has negative impacts in clinker or cement quality as well as production volume. To overcome the situation and to meet internal quality, plant follows easy path and increases LSF requirement of raw mix instead of reducing process variability. Increase in LSF demand by 1% reduces mines reserves for few years and ultimately it has detrimental effect in natural resource. This paper will focus various areas of plant optimization in brief so that clinker quality can be improved and allow for maximum use of marginal grade limestone.

Cement industry has a very important role in nation building. Our prime focus should be to produce cement consuming less natural resources as well as less possible energy which is possible with the use of state of the art technology and running the plant in optimum operational parameters as indicated in the paper. Natural resources like limestone, additive materials are now approaching to alarming zone in our country as well as globally. Government body and standards only guides for minimum requirement of quality and defines boundary lines. Meeting all those guidelines we can run our plant at optimum level.

DUST CONTROL IN CONSTRUCTION PROJECTS

Lavanya A R[1], Raksha Rajani DSouza[1] and Umesh R[2]

[1]N M A M Institute of Technology, India

[2]Rohini Project Management Consultants Pvt Ltd, India

India being fast growing developing country; construction industry is in full bloom. The Construction industry in India is expected to grow at a rate 5.6% during 2016-20, compared to 2.9% during 2011-15.

India is expected to become the third largest construction market globally by 2022. The process taking place with rapid construction of highways, bridges, single-family buildings, multi-storey dwellings, sky scrapers, demolition of old and structurally weak buildings, expansion and repair works of old roads produces a huge quantity of dust.

Working in such a dust filled environment creates mainly problems related to lungs, bronchial tubes as well as other health issues. Annually, around 3,000 workers in the construction sector suffer with "breathing and lung problems".

While this equates to just 0.14% of workers in the sector, the rate is statistically significantly higher than for workers across all industries (0.08%).

Almost 20% of workers reporting work-related respiratory problems identified "dusts from stone, cement, bricks or concrete" as contributing to their condition.

Though there are several regulations like the Factories Act-1948, Mines Act-1952, Metalliferous Mines regulation-1961, and Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act- 1996 and Rules, which specify much higher limits of particulate matter and silica dust, these limits are rarely imposed.

Hence Dust control is a vital element in meeting safety, health, environmental requirements and sustainable development of construction industries.

Dust control systems not only help reduce site emissions but also help protect employees. During construction equal importance must be given to dust control and it should also be included in project management cycle along with other processes.

This paper attempts to study the various causes and sources of dust generation at construction site, their ill effects and certain control measures.

PRACTICAL APPROACH TO CSR JOURNEY IN CEMENT MANUFACTURING

Mangleshwar Nath Verma

Knight Synergy GT LLC, Dubai, UAE

This work explores the environmental and social responsibility shouldered by the cement manufacturing sector and outlines a new approach to address the economic, environmental and social dimensions of sustainable business. Minerals are natural resources and the manufacturing of cement operation involves mining of raw materials, transportation, material handling, size reduction, homogenization, pyro-processing (blended raw materials are heated to 1450^0C in a kiln to produce clinker) and inter-grinding of clinker and gypsum to yield the final product. Cement Production is a capital intensive and high energy consuming industry. Like any mineral based industry it has environmental and social issues which need to be addressed in long term as well as on a day-to-day basis. Managing of environmental, social and economic dimensions in business translates corporate responsibility into a singular goal of doing business profitably, sustainably and ethically. The environmental responsibility refers to the continuous management of environmental impacts of the company's operation in short term and long term. The social responsibility takes care of the expectations of internal and external stakeholders – shareholders, employees, customers, suppliers, community and other groups that comprise the civil society. Sustainability/ CSR reports of world renowned cement companies have been carefully analysed to develop a common agenda for improving management practice in environmental and socially responsible management of cement manufacturing. Environmental sustainability requires efficient use of natural resources, recycling, waste elimination and environmental protection. Key environmental issues of climate change, Air pollution, reducing consumption of natural resources, use of alternative materials, recycling and energy efficiency in cement manufacturing have been dealt with in detail in this paper. Social sustainability is essential for individual and collective human wellbeing. Social issues like safety, health and wellbeing of employees, employee engagement, training and development and involvement of stakeholders have been given due consideration in this paper.

Contribution to knowledge of this paper is in development of new trends of Environmental and social indicators taking into considerations the recommendation of the Global Reporting Initiative, the Global UN Compact and draft standard of the ISO 26000:2008. Contribution to practice is the research frame work, comparative report on implementation of environmental and social performance of core members of CSI, established in 1999, to develop an action plan for managing the cement manufacturing operation in general as well as case specific.

BULK FLY ASH UTILIZATION - R&D INITIATIVES AT NETRA

Rajiv Satyakam, Pranay and N K Soni

NTPC-NETRA, India

There is a growing need for disposing of fly ash with the ever increasing demand for coal as an energy source. Fly ash generation was in tune to ~180 MT by 2017 and with the present momentum of the capacity addition is likely to increase to around 221 MT by 2018. Current levels of efforts of ash utilization have resulted in achieving just 63.28% by year ending 2017 and India is nowhere near its target of utilizing 100% of fly ash generated by the coal based power plants and the balance ash is getting dumped as solid waste in ash ponds. Presently, NTPC generates around 60 million tons of coal ash annually from its coal based thermal power plants with an ash utilization of 53.65 %.

A lot of R&D efforts have been put forward to achieve the target of mandatory 100% utilization of fly ash by power utilities over a stipulated time span, as stipulated in Ministry of Environment & Forests Gazette Notification, Government of India of 3rd November, 2009. These efforts include setting up of Sintered fly ash Light Weight Coarse Aggregates manufacturing plant for technology demonstration at NTPC Sipat of capacity 50,000 m^3/Annum, Construction of Fly ash based Geo-Polymer concrete road as per IRC specifications, Use of Bottom Ash as Replacement of Fine Aggregate in Cement Concrete, Process development for conversion of fly ash to fine aggregate (Sand) & Casting of fly ash based spun/Hume pipes.

An attempt has been made, here, in this paper to highlight these R&D technologies which can lead bulk fly ash utilization and prove to be beneficial from both financial & technological point of view not only to NTPC but to entire power sector and nation as a whole.

Key words – Light Weight Aggregate, Geo ploymer, Tetrapods, Hume pipes

Energy, Environment, Resource Conservation and Waste Utilization Practices in Ghorahi Cement, Nepal

Suraj Chauhan, Ashwani Rawal and S V P Gupta

Ghorahi Cement, Nepal

Ghorahi Cement Industry is one of the largest cement industries in Nepal, established in 2010 in the largest valley of Asia. It is a subsidiary of Triveni Group, Nepal. It has total clinker producing capacity of 1900 TPD with capacity utilization of 110-120% achieved through Six-stage preheater/ Precalcinator. Seeking the demand of the market, a new unit of 3500/4000 TPD is being installed which is likely to be under operation by April'2020.

It use to work on the philosophy of "Sustainable Industrial Growth in Cement Sector of Nepal for Import Substitution of Clinker and Cement".

This vision itself shows not only the industrialization as a profit making scheme but patriotism to the land also.

To achieve the vision GCIPL team is dedicated in following areas working tirelessly for-

a. Energy Conservation – The focus areas are energy cost & consumption, optimization, modification, use of VFD's, adaptation of new technologies etc.

b. Environmental Protection – The focus areas are the best use of pollution controlling equipment's, their maintenance , control of fugitive dust by metallic roads, water sprays, plantation, implementation of complete Environmental management system(ISO-14001)

c. Resource Conservation - To maximize use of hydro power, use of alternative & waste derived fuels, use of waste materials, recycling the solid wastes, hundred percent use of rejects and scrap materials, rain water harvesting etc.

d. Waste Utilization – The focus areas are the use of reject tyres, reject PVC bags, Concrete Cubes, Reject Unilever waste, Reject TMT, Cotton and fabric Industry waste, Chappel Industry waste, HFO Sludge, Burnable bio degradable, Reject Rubber, Plastic waste, Reject Insulation material , Reject bag house and bag filters bags, Reject burnable lubrication, Fast moving consumer Goods(FMCG), Plastic barrels, Waste plastic, Reject Belt conveyors belts, Reject saw mill dust, wooden dust , Rice Husk etc. We have contacts with almost 75% of the industries of Nepal for identification of waste items in those industries, check the usability of those and start using of those items, if found economical.

e. Waste Heat Recovery System (WHRS):- As in cement industry, energy corresponds to the major cost head of operating expenses. An appreciable amount of energy can be conserved by recovering waste heat from the preheater and cooler gases. Electricity generation from surplus waste heat is the next preferred option, where GCIPL is working on it. Waste Heat Recovery Power Plants; contribute significantly, to the electrical energy saving (to the tune of 25%). The reduction in CO_2 emission makes it environmental friendly.

Above mentioned efforts of GCIPL are for maintaining clean & green environment on one hand & economy of operations on the other hands. We are on the path which is the demand of time for curtailing the cost of production also so as to meet out the challenges of the market competition. The ecology and the environment scenario is changing rapidly and the resources are depleting fastly. Global temperature is rising, natural disaster are threatening. In this condition, this is our duty to utilize the resources efficiently, utilize the waste to the most possible extent, create & utilize the alternative natural resources and work for the least carbon emission philosophy, plant more and more trees to absorb the carbon emission and thus ensure survival of human life on the Globe. GCIPL is contributing to this most global cause of the humanity.

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TECHNICAL SESSION – IX B

DISTRESS INVESTIGATION, REPAIR/ STRENGTHENING/ RETROFITTING OF CONCRETE STRUCTURES

SEMINAR PROCEEDINGS

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LABORATORY TEST METHOD FOR EVALUATING CORROSION INHIBITING EFFICIENCY OF ADMIX TYPE BIPOLAR CORROSION INHIBITOR

Puneet Kaura, P N Ojha, Piyush Mittal and V V Arora

National Council for Cement and Building Materials, India

Corrosion of reinforcement is one of the major durability problem and it significantly affects the serviceability and load carrying capacity of reinforced concrete structures. To mitigate the corrosion of embedded steel in concrete, various methods/techniques are being adopted to enhance service life of concrete structures such as protective coatings, sacrificial protection techniques, alternative reinforcement, corrosion inhibitors etc. Use of corrosion inhibitors is getting widely popular around the world as it offers easy operation since it is added in concrete. Thus, there is an urgent need to develop a standardized testing procedures and guidelines to evaluate the effectiveness of these corrosion inhibitors.

In present study, performance of 24 numbers of commercially available bipolar corrosion inhibitors samples have been evaluated through short term laboratory test method like modified JIS Z1535. Immersion test as per ASTM G1 were also conducted. Accelerated chloride induced corrosion test (NCB Method) were conducted as well for which corrosion rate was measured as per ASTM G3. Corrosion inhibiting efficiency have been determined based upon rate of corrosion in immersion test and NCB test method. On the basis of corrosion inhibiting efficiency of the two test, corrosion inhibiting classes have been defined.

With regard to the use of corrosion inhibitor as a preventive or supplementary measure for new reinforced concrete structures, one of the major problems is how to evaluate their effectiveness in laboratory and predict their influence in delaying the initiation of corrosion in the field, and extending the service life of reinforced concrete structures. Therefore, standard testing procedure and guidelines for proper independent assessment of the effectiveness of these proprietary corrosion inhibitors is an urgent need not only for source approval but also for quality control purpose. These test procedures should simulate as closely as possible real conditions of steel corrosion in concrete. Standard specification along with acceptance criteria based upon corrosion inhibiting efficiency is also urgently required.

Looking at the duration of each test and their effectiveness in evaluating the performance of corrosion inhibitor, single test method / techniques may not be suitable while evaluating the inhibiting efficiency of corrosion inhibitor. Combination of test as presented by the authors may be used for source approval and for quality control purpose. Such approach avoids the variability effect arising in individual test method.

OPTIMIZATION OF THERMO-MECHANICAL TREATMENT FOR RECYCLING DEMOLISHED CONCRETE

Rohit Prajapati and Ravindra Gettu

Indian Institute of Technology Madras, India

In India, more than 700 million tonnes of construction and demolition (C&D) waste is generated every year. This waste is mostly disposed off in landfills or sometimes illegally dumped in the vacant areas. On the other hand, there is significant scarcity of natural aggregates, and the annual demand is estimated to reach about 5.5 billion tonnes by the year 2020. Recycling of demolished concrete can provide a solution to manage the construction waste and provide an alternative to virgin aggregates. The aim of this work is to produce recycled coarse and fine aggregateswith acceptable characteristics for use in concrete production.

Thermo-mechanical treatment is used to recover the aggregates by separation from the hydrated cement paste. Various temperatures from 350 to 500°C were tried along with mechanical abrasion ball milling. The heating temperature and mechanical abrasion were optimized based on the improvement observed in the physical and mechanical properties of the recycled aggregates. The preliminary results indicate that water absorption, specific gravity, crushing strength, etc. of recycled aggregates can match those of conventional aggregates.

CASE STUDIES ON REPAIR OF CONCRETE DAM IN HIMALAYAN REGION USING HIGH PERFORMANCE CONCRETE

P N Ojha, Suresh Kumar, Digvijay Kumar and V V Arora

National Council for Cement and Building Materials, India

Appurtenant structures of dams in the Himalayan regions, such as spillway glacis, roller bucket, energy dissipation arrangements etc. are subjected to damages/deterioration more frequently owing to floods in the monsoon season. The maintenance and repair generally required the use of high performance concrete mixes. Available aggregates in region are either alkali silica reactive (ASR) or mechanically weak in nature or combination of both. Selection of concrete making materials, production and placement of concrete in extreme cold weather conditions and quality control is amongst the major challenges.

This paper demonstrates a systematic procedure of material evaluation and design of High Performance Concrete mixes (HPC) in Laboratory and the production and placement of concrete at site through three case studies of three existing dams in the Himalayan regions. Aggregates available in the vicinity of two dam sites were reactive in nature whereas near the dam site the aggregate was found mechanically weak. The performance evaluation of High performance Concrete mixes of M90, M75 and M60 grade using steel fibers and M90 grade without steel fibers are highlighted. The paper also covers production and placement strategy for concreting including temperature control and temperature rise study.

Based on literature done and study conducted several conclusions were drawn. Specification of the concrete shall be as per the degradation / severity of abrasion at dam site. All the Concrete making materials shall be evaluated in the laboratory, If the aggregates are found to be mechanically weak, then the maximum possible grade of concrete shall be designed with available material in the vicinity. If the aggregate are reactive then appropriate supplementary cementitious material shall be added to take care the alkali silica reactivity. For improvement of abrasion resistance properties of concrete, silica fume should be used as one of the concrete making constituent. Steel fiber shall be used for improvement of impact resistance of Concrete. Systematically automatic batching plant shall be installed at site to improve the quality control of High Performance High Strength Concrete. For production & placement of concrete all the precautions for concreting done in cold weather shall be taken as per IS 7861 Part-II.

AN IDEAL PHOSPHOSILICATE BASED BINDER FOR CONCRETE REPAIR AND REHABILITATION

N Ramkumar

Navoday Sciences Pvt Ltd, India

In this paper we present the properties of novel phosphosilicate based binder developed using the reaction between sparsely soluble metal oxides and phosphates having low solubility. Geokrete is manufactured via simple powder blending process of carefully processed naturally occurring silicate minerals with a mix of acid and alkaline phosphates. A series of laboratory experiments were carried out to study the mechanical properties and durability aspects of the phosphosilicate binder. The experimental findings show that it is having all the attributes needed to be used as concrete repair material like short set time, rapid strength gain, good durability and satisfactory flexibility. The final setting time of the binder was found to be close to 20 minutes and the 2 hour and 28 days compressive strength of the binder was found to be close to 20 Mpa and 60 Mpa. In any economy the reinforced concrete assets such as bridges, tunnels and buildings becomes very important factors.

Concrete can deteriorate due to combination of many reasons such as corrosion of steel rebars, environmental conditions like presence of excess sulfates in air and errors in design etc. The materials used for repair of concrete are ideally expected to be not affected by chlorides and sulfates and should prevent the rebars from corroding further so that the repaired structures last for long. From the aspect of durability, water penetration as per DIN 1048 part 5 and rapid chloride permeability tests as per ASTM C 1202 were performed on the binder and the results were found to be very low thus making it an ideal choice for repair of concrete pavements, roads, bridge surfaces, runways and floors of industrial plants that can harden rapidly.

PERFORMANCE EVALUATIONS OF POLYMER MODIFIED MORTAR AND BONDING AGENT FOR STRUCTURAL REPAIR

Puneet Kaura, Y N Daniel, Nitesh Kumar and T V G Reddy

National Council for Cement and Building Materials, India

Normal mortar made with Portland cement is not recommended for use in structural concrete repair because of certain disadvantages, such as low tensile strength, high drying shrinkage and low chemical resistance. Polymer-modified mortar (PMM) is an alternative to conventional mortar with enhanced mechanical properties. However, there are no proper specifications and guidelines available for specifying PMM mixes for structural repair work. The study is intended to examine the mechanical behavior of polymer modified mortar system at various levels of polymeric modifier dosage using styrene-butadiene rubber (SBR) latex. Laboratory tests for compressive strength, flexural strength, drying shrinkage, plastic shrinkage and modulus of elasticity were carried out to determine the performance of polymer modified mortar at various dosages.

Another aspect in repair of corrosion damage structures is the bond between the substrate concrete and repair mortar. The performance of these bonding agents have been evaluated using slant shear test and pull off test as per ASTM C 882-13 and EN 1542-99 respectively.

Optimization of SBR latex content in PMM study was carried out by varying SBR latex's solid content (0, 8, 10, & 15%) by weight of cement. Two types of cement (OPC & PPC), with a constant water/cement mass ratio of 0.35 and cement to fine aggregate ratio by mass of 1:3 were used for the study. The specimens were cured at Lab conditions of 27±2ºC and 65±5% RH.

Performance of structural bonding agents was carried out using locally available brand of Epoxy and SBR latex. Preparation of test specimen, mix proportioning, coverage area & procedure of application was carried out as per manufacturer's technical data sheets. Bond strength of bonding agent was carried out by slant shear test and pull-off test method.

Based on the study, it was found that the optimum degree of polymer modification is achieved in 8 to 10% dry polymer solids by mass of cement in the mixture. Optimal polymer content of the research is related to enhancing flexural strength, static modulus of elasticity & decrease in drying shrinkage of mortar while maintaining an acceptable plastic shrinkage, compressive strength, and workability remain within acceptable limits.

Slant shear & pull-off test method shows epoxy bonding agent give better bond strength as compared to SBR latex.

EXPERIMENTAL STUDY ON THE FLEXURAL BEHAVIOUR OF RETROFITTED RC-BEAMS

Aastha Singh and R R Singh

PEC University, Chandigarh, India

Most of the RCC Structures are in a phase of deterioration due to adverse environmental conditions. Some of these reinforced concrete structures has reached their lifetime. In order to extend their life, time has come to repair/ strengthen them. Various retrofitting techniques in the field of repairing is mentioned in the study. The awareness among the people regarding retrofitting techniques is quite low. This study primarily deals with the use of Basalt Fiber Reinforced Polymer bars and sheets for strengthening the RC beams. In this work the BFRP bars and sheets are used to enhance the flexural capacity of the RC beams under four-point loading conditions and retrofitted at various pre-loading conditions.

The load deflection characteristics are studied for various pre-loading conditions using BFRP bars, sheets and the combinations. The BFRP bars and sheets are introduced into the pre-cracked beam using epoxy adhesive.

The study considered the comparison of retrofitted beam under 50% & 70% preloading conditions with the control beam. The enhancement of ultimate load carrying capacity was above 25% in all the cases. The use of bi- directional BFRP sheets has also increased the capacity by more than 40% and the combinations increased the capacity by more than 50%. Slipping/de-bonding is not observed in the bars, but the sheets showed de- bonding with the concrete under ultimate loading conditions.

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

EXPERIMENTAL INVESTIGATIONS ON FIBER REINFORCED SELF LEVELING PAVEMENT QUALITY CONCRETE (PQC) FOR USE IN PARTIAL DEPTH REPAIRS OF CEMENT CONCRETE PAVEMENTS IN URBAN AREAS

D Pavan Kumar, J Narsinga Rao, P N Ojha, B Sreenivasa Rao and Adarsh Kumar NS

National Council for Cement and Building Materials, India

Rapid urbanization, increase in number of vehicles year after year, lack of drainage and other issues are the reasons reported in literature for early deterioration of Cement Concrete (CC) Pavements. Distress in CC Pavements like development of cracks, slab cracking, spalling etc is causing discomfort to the road users. Repair of distressed CC Pavements is very much required in the initial stages of identification of such distress, so as to provide good riding comfort to the users. Conventional methods of partial depth repair of CC Pavements are cumbersome and time consuming. Hence novel Pavement repair materials and methods, which are environmental friendly and requires less time and effort, is need of the hour, especially in urban areas, where the repaired stretches of pavements are demanded to be opened to the road users at the earliest time. In this study, experimental investigation is made to develop and evaluate the performance of M30A20 and M30A10 grades - Fiber Reinforced Self Leveling Pavement Quality Concrete (PQC), as a CC Pavement repair material to optimize percentage replacements: Trial-1: 40 % Ground Granulated Blast Furnace Slag (GGBFS) + 60 % of Ordinary Portland Cement (OPC) 53 Grade, Trial-2: 75 % Portland Pozzolana Cement (PPC) + 25 % GGBFS. 0.2 % of Poly Propylene Fiber (by weight of total Cementitious Materials) and 100 % Crushed Rock Sand is used in both the trial mixes. Compressive Strength test, Flexural Strength test and Split Tensile Strength test results are carried out in arriving at optimal concrete mix. Water Sorptivity tests and percentage of Permeable Voids in hardened concrete tests are conducted as per ASTM C 1585 and ASTM C 642 respectively to evaluate the performance. The above concrete mix proportions have been satisfactorily used in trial stretch as partial depth repair material of road pavements at in-situ (site) conditions. The road was opened to traffic after 8 hours. Repair is intact and observed to be of satisfactory finish.

CONDITION ASSESSMENT AND REMEDIAL MEASURES FOR REHABILITATION OF INDUCED DRAUGHT COOLING TOWERS (IDCTS) LOCATED IN DIFFERENT CLIMATIC REGIONS OF INDIA - A CASE STUDY

Rizwan Anwar, T V G Reddy and Sanjay Mundra

National Council for Cement and Building Materials, India

Induced Draft Cooling Towers (IDCT) are an important industrial structure, which removes the heat absorbed in the circulating cooling water systems of thermal power plants. Due to different exposure conditions, RCC members of these structures generally shows very contrasting states of distress i.e. varying from apparently un-distressed to highly distressed state. The important factors that affect the durability of these RCC structures are presence of Chloride in water being cooled and carbonation due to aging of concrete. The present paper highlights the findings of condition assessment studies, cause & extent of distress and recommendations for rehabilitation of four IDCTs (Site-1, Site-2, Site-3 & Site-4) located in tropical and semi-arid geographical regions of India.

During the assessment, it was observed that the external RCC members are subjected to alternate drying & wetting which is severe exposure condition and internal members were continuously in exposure to water in all IDCTs. The exposure condition at Site-1 is very severe due to sea water being used as circulating water. At Sites 2, 3 & 4 exposure condition is Severe. The UPV test results indicated the quality of concrete is medium in majority of RCC members in Site-1 and quality of concrete is varying from good to excellent in majority of RCC members of Site-2, Site-3 & Site-4. The average equivalent cube compressive strength of concrete obtained by core extraction and testing was found to be M30 grade of concrete in Site 1 & 4 and M25 grade in Site 2 & 3. The average depth carbonation in all site locations was found to be lower than the provided average nominal covers. The nominal concrete cover assessed by electromagnetic cover meter at Site-1 was 35mm which is less than the required minimum 50mm to meet durability requirements. The Half Cell Potential (HCP) values obtained from different locations indicated that there is a greater than 90 % probability that reinforcing steel corrosion is occurring in that area at the time of measurement in all members of Site-1, in 38% members of Site-2 & 57% members of Site-3. In site-4 all members there is a greater than 90 % probability that no reinforcing steel corrosion is occurring in that area at the time of measurement. The acid soluble chloride content is found to be high in Site-1 & Site-3. In Site-2 & Site-4 the chloride content is acceptable.

The distress specifically in Site-1 & Site-3 has occurred due to chloride induced corrosion of embedded steel reinforcement and also high chlorides content present in the cooling water have ingress into the concrete cover, which is clearly shown by chemical analysis results since chloride levels are found to be higher in outer layers than the inner layers of RCC members. The carbonation depth is within cover region in all the tested site locations. This indicates that presently there is less chance of carbonation induced corrosion, except at locations where cover is relatively low. Based upon the various NDE test results it was concluded that the distress has occurred in mostly external RCC members which are in severe exposure condition and not provided with any protective coating. At Site-1 & Site-3 distress has occurred due to Chloride induced corrosion. At Site-2 distress has occurred due to carbonation induced corrosion wherever concrete cover is relatively low. At Site-4 majority of members are undistressed since the protective coating is applied at this structure. The IDCT which is provided with protective coating performed better than the IDCTs which are not provided with any protective coating. Based upon the conclusions, it was recommended to carryout the sealing of cracks by epoxy grouting and patch repair by removing loose concrete, anticorrosive treatment of rebar, epoxy bond coat, Polymer modified mortar to reinstate the lost cover and application of protective coating on all RCC members of Cooling Tower structure to enhance their service life.

TECHNICAL SESSION – XA

ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT-II

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OPTIWAVE PULSE CLEANING (OWPC) TECHNOLOGY FOR LONG BAG FILTERS

T V Naresh and S B Aradhya

Clair Engineers Pvt Ltd, India

CLAIR Engineers Pvt Ltd (CEPL) has developed Optiwave Pulse Cleaning Technology (OWPC), for long bag filters which can be applied in Cement, Steel, Power and other allied industries. OWPC has been developed with an aim to meet stringent pollution norms set by the statutory bodies.

OWPC generates sonic velocity which induces wave in the filter bag and hence cleans the filter bag efficiently. The sonic velocity produced by the system can clean filter bags up to 12 m in length. The main principle of OWPC is based on creating high pressure inside the filter bag by injecting a large volume of compressed air in a very short span of time. This flow of air creates a wave in the bag which travels along the length of the filter bag dislodging the dust build up on the surface. OWPC uses medium pressure compressed air (approx. 2.0-3.5 bar), for effective cleaning.

CEPL has successfully installed several bag filters based on OWPC technology for Raw Mill and Cement mill applications in 2018, located in India and overseas. Installations include bag filters with 8 m and 10 m long filter bags.

The paper will highlight the operating parameters for the above mentioned OWPC installations which have been running satisfactorily. The paper will also demonstrate that the bag filter was able to achieve reduced energy consumption based on lower pressure drop across the bag filter and lower compressed air consumption. This reduction in energy consumption by the bag filter translates to lower operational costs for clients adopting the OWPC technology offered by CEPL. The OWPC technology based bag filters have also been able to meet the stringent emission norms, which will also be discussed.

OUR JOURNEY ON WATER POSITIVITY-WORKING TOWARDS FUTURE GENERATIONS AND GLOBAL HAPPINESS

R Rajamohan, K Vinayagamurthi and R A Krishnakumar

Dalmia Cement (Bharat) Ltd, India

Sustainability is rooted in our Corporate Vision with the philosophy that a clean and green company has a profitable & sustainable future. Accordingly, several Sustainability initiatives are on focus, out of which, this Paper deals with our journey in brief towards becoming a Water Positive Plant.

It is imperative that water conservation is every one's responsibility.

The Methodology:

We embarked on our journey towards attaining water-positivity with the two steps as below:

i. To reduce the water consumption

ii. To harvest more water than the consumption by creating structures, as needed.

Several water conservation initiatives implemented through internal brainstorming & structured water audits, which have brought down the consumption by about 500 Cum/day. Also, increasing in Water harvesting through structures created in Plant/Mines as well as through CSR interventions.

A Water audit was carried out with a systematic study for identifying optimization potential and several ideas were generated through brainstorming and the following steps were implemented:

Treated STP (Sewage Treatment Plant) water to be used for Plant processes, replacing Raw Water consumption.

- Level sensors installation.
- Leakage Management. Cooling Tower Management.
- Checking and repairing of Float Valves.
- Optimization of Domestic Water usage in Plant through awareness, Pep talk and education. Creating awareness
- Re-utilization of RO Reject from CPP after treatment
- Installation of Flow meters to receipt/supply locations in our Plant
- Provision of Flow meters in our Colony & School
- Sprinkler system for Watering in Garden, Drip irrigation for tree saplings
- Ideas involving investment were listed separately such as Filter feed pump, Sand filter Media replacement, New Pump from Slurry basin to ETP, Pipeline replacement from ETP to CVRM-2.

Results & Way Forward :

With the efforts above, as assessment carried out and as per the same, Our Plant has achieved Water Positive Status and it is 1.52 times Water Positive, without taking into account an additional harvesting initiative.

Motivated with the results achieved, our next step is to take this up & set a new target to become 5 times water positive by 2020.

PULSED RADIO WAVE TECHNOLOGY FOR MITIGATION OF AMBIENT PARTICULATE POLLUTION

Srikanth Sola

Devic Earth Pvt Ltd, India

As a rapidly developing economic super power India has several industries ranging from energy, fuel and cement industry which are on the forefront contributing to the country's growth as well as to the increasing load on atmospheric pollution. The Indian cement industry which accounts for the world's second largest producer of cement also serves as a huge anthropogenic source of air pollution. The cement industry alone is responsible for 7% of global carbon dioxide emissions alongside other primary contributors to air pollution which include – particle pollutants, nitrogen oxides (NO_x), sulphur oxides (SO_x) and carbon monoxide (CO). Similarly, coal-fired thermal power plants (TPPs) which serve as a major energy source in most developing countries, including India also release a plethora of pollutants that are harmful to human health and environment through the process of coal handling and combustion. While there are known technologies to limit pollution emissions from the stacks of such plants, there is Ltd knowledge on the air quality within and around these industries and solutions to improve it. The significant reductions observed in the levels of the particulate pollutants through our studies at several locations suggest that pulsed radio wave technology holds promise in reducing particulate pollution within and around major industries.

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03-06 DECEMBER 2019, NEW DELHI, INDIA

ASSESSMENT OF SO_2 GENERATION AND MITIGATION MEASURES AT A CEMENT PLANT IN INDIA – A CASE STUDY

Anand Bohra[1], K P K Reddy[1], K R P Nath[1], Anupam[1], A Saxena[1] and B N Mohapatra[1]

Pankaj Kejriwal[2], A K Sinha[2], S P Shrimali[2], S K Kulshrestha[2], Y K Singh[2] and B L Suthar[2]

[1]National Council for Cement and Building Materials, India

[2]Star Cement Ltd, India

In India, Ministry of Environment, Forests and Climate Change (MOEF&CC) notified emission limits for SO_2 of 100/700/1000 mg/Nm^3 depending upon the pyrite content in the limestone of <0.25%, >0.25% to <0.5% and >0.5% respectively for kiln stacks of cement plants. NCB carried out a detailed assessment study for SO_2 generation and mitigation measures from pyro-processing system at a cement plant of M/s Star Cement Ltd In this study, NCB team collected limestone samples from different benches of the captive limestone mine and tested them for pyritic sulphur content at our laboratories.

The process measurements were carried out at stage wise preheater cyclones to study the release of SO_2 from pyritic sulphur in the preheater cyclones. The SO_2 concentration was measured at various locations like preheater downcomer, raw mill circuit, coal mill circuit and kiln/raw mill stack of the cement plant.

It was observed that optimization of raw mill gases by reduction of false air and diversion of more preheater gases to raw mill, will help in SO_2 reduction by adsorption on the raw meal. Due to the Ltd SO_2 reduction from primary control measures in comparison to required reduction, use of secondary SO_2 control measures becomes imperative. Based on the SO_2 emission levels and the emission limit prescribed for the plant, the reduction required for the plant is in the range of 50-70%. Hence, a trial run was conducted with lime injection at different molar ratios and up to 40% reduction in SO_2 emission level at stack was observed. The paper showcases the joint efforts made for assessment and reduction of SO_2 emissions at the plant.

PROGRESSING ON LOW CARBON TRANSITION OPPORTUNITIES

Anupam Badola and Ashwani Pahuja

Dalmia Cement (Bharat) Ltd, India

The next decades of India are dedicated to an unprecedented growth. This growth will be unleashed by rising middle class, their reasonable expectations of improved lifestyle and commitments of democratically elected governments to provide better-quality infrastructure to its people. The country will witness an overwhelming migration from rural settings to an urban infrastructure. The rising aspirations and expenditures will fuel enormous opportunities of growth for the entire construction value chain with multiple growth dimensions attached to it. Tapping this multi-dimensional growth opportunity in the construction sector requires an approach that brings people, profit and planet closer through a business approach that maximizes the positive impacts on human, natural, financial, intellectual, manufactured and social & relationship capital.

Recognized as the most energy efficient globally, leading cement groups in India are taking this progressive approach to progress in the dynamic landscape of value creation.

Dalmia Cement (Bharat) Ltd, a leading cement producer of India, understands and takes action to maximize the total sustainable value creation. The company has been ranked No. 1 in the cement world by CDP (Carbon Disclosure Project) on the business readiness for a low carbon transition. As highlighted in the report, Dalmia Cement comes first by a distance, performing well on a number of metrics. The company makes the most use of alternative materials and has the best emissions profile against IEA 2-degrees targets out to 2030. In addition, Dalmia Cement is a water positive company and first entity globally to have committed to both RE 100 and EP 100 ambitious campaigns.

USAGE OF AMMONIUM CARBONATE IN PLACE OF AQ. AMMONIA IN SNCR OPERATION

K Subbulakshmanan, Vijay Chauhan, Keshav Katare, Ramsinh Chauhan, Reshu Chauhan, Sunil Kothari and Sukuru Ramarao

Ambuja Cements Ltd, India

Ambuja Cements Ltd, Ambujanagar is using Petcoke as main fuel along with alternate fuel for the clinkerization process. Thermal and fuel NO_x are generated in the pyro-process, resulting in NO_x levels of around 1300 - 1500 mg/Nm^3 at kiln/raw mill stack. In order to comply with the MoEF&CC NO_x emission limit of 800 mg/Nm^3 @10% O_2, plant has installed SNCR system in all three kilns and using aqueous ammonia (having 25% NH_3 by weight). Ammonia is a natural resource and majorly it is used by fertilizer industry in agricultural sector. Aq. Ammonia is also hazardous material and handle cautiously.

The SNCR process is basically the injection of ammonia in the form of ammonia water or urea in the flue-gas at a suitable temperature and its performance depends on temperature, residence time, turbulence, oxygen content, and a number of factors specific to the given gas stream. SNCR removes 30-70% of NO_x in flue gas.

$$NH_3 + OH = NH_2 + H_2O$$

$$NH_2 + NO = N_2 + H_2O$$

$$NH_2 + O_2 = NO + H_2O$$

At lower temperature formation of NH_2 radical is slow. At high temperature, oxidation of NH_2 radical is faster. NO_x reduction depends on molar ratio of NH_3 to NO. Ambujanagar worked out the scenario of using ammonium carbonate (a byproduct of pigment industry) in place of Aq. Ammonia through the installed SNCR system.

The reduction of the nitrogen monoxide (NO) is effected via the NH_2 radical. This means that all substances capable of supplying a NH_2 radical may be used for reduction of NO. Ammonium carbonate can spontaneously decompose into ammonium bicarbonate and ammonia.

$$(NH_4)_2CO_3 \rightarrow NH_4HCO_3 + NH_3$$

Theoretically we have two NH_2 radical in ammonium carbonate to react with NO, so here we can have lower stoichiometric molar ratio than aqueous ammonia. First trial was conducted under supervision of GPCB and the trial was successful. Now, ammonium bicarbonate has been used regularly in all three kilns for NOx reduction.

DEPLOYMENT OF COLD FOG SYSTEMS & OTHER TECHNOLOGIES FOR FUGITIVE DUST CONTROL IN CEMENT PLANTS: A CASE STUDY

S Chakravarti and U S Chakravorti

Ecodea Projects & Control Pvt Ltd, India

The paper introduces case studies of successful application engineering which has been established in Indian Cement plants for Fugitive Dust Control using non-conventional methods.

Single Fluid Atomization Systems (Compressor Less Fogging) has been replacing Nuisance filters in conveying, wagon & truck tippling & other application points due to substantially low energy cost, low capex & superior emission guarantee & performance.

The paper will emphasize on the technological aspect of this systems, its effectiveness in contrast to conventional methods & will also exhibit that how these technologies once deployed, reduces cost of operation & maintenance hassles, provide longer life to the equipments, reduces health hazards & creates safer work environment.

The paper shall also emphasize on Barrel-Misting Machines which is ideal for airborne dust control for large open areas like stockpiles & dust generated from blasting in quarries.

These machines which can also be truck or trolley mounted have a throw range from 30 meters to 500 meters, generating a droplet size of 60-70 microns & covers an area of up to 130,000 square meters (depending on the model). The principle of operation of this technology will be discussed along with comparison with decade old sprinklers which have been found ineffective and a resource guzzler.

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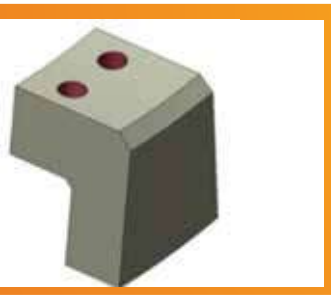

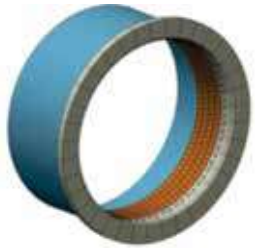

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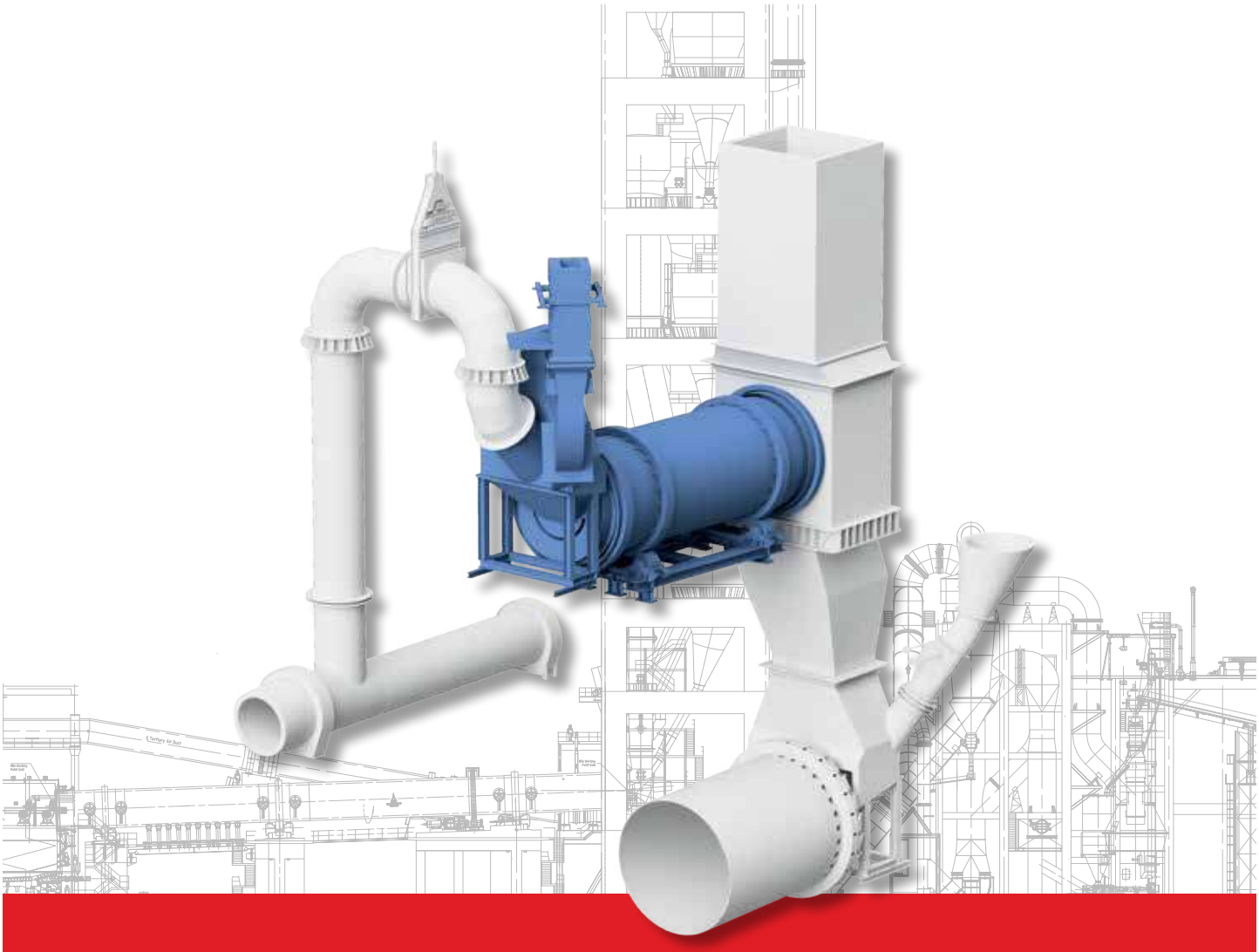

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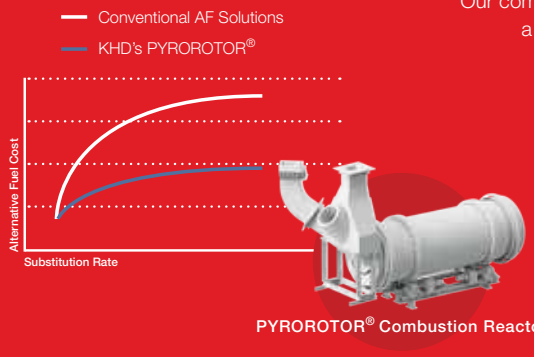

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TECHNICAL SESSION – XI A

ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT-III

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MITIGATION OF NO_x AT ULTRATECH DHAR CEMENT: A CASE STUDY

Sabastian Frie[1] and Anupkumar Das[2]

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[2]Thyssenkrupp Industries India Pvt Ltd, India

The environmental notification in gazette of India dated 25th August 2014, specifies that cement plants commissioned after 25th August 2014 should have NO_x emission ≤ 600 mg/Nm^3 at 10% O_2 at the kiln stack. Achieving these emission levels has been a challenge for the cement plants using 100% petcoke as fuel, wherein the NO_x levels are observed to be in the range of ~1000 mg/Nm^3.

Most of the cement plants are either using mixed fuel or are firing alternate fuel, containing higher percentage of volatile content, along with petcoke to facilitate burning of sluggish petcoke, so that NO_x emission levels can be complied with. Some of the cement plants have installed SNCR systems, so that the NO_x emissions can be controlled. However, continuous use of ammonia leads to higher OPEX.

UltraTech Cement is the largest manufacturer of the grey cement in India and one of the leading cement producers globally. Being a market leader, UltraTech selects plant and machinery which not only meets their capacity requirement and energy efficiency and also fulfills the environmental strategy in long run. After careful evaluation of the performance of the plants supplied by thyssenkrupp India, UltraTech Cement awarded contract for the Pyro-processing section of their Dhar Unit to thyssenkrupp India in February'17, which was commissioned in March'18 and achieved successful results not only in terms of capacity, power consumption, heat consumption but also recorded low NOx emissions with 100% petcoke as a fuel.

The 7200 tpd cement plant is designed by thyssenkrupp based on their worldwide experience with an innovative solution to mitigate NOx emission. Optimized Multi-Stage-Combustion (MSC) Calciner, creates high sub-stoichiometric zone of ~1100 Deg.C and achieve adequate residence time by providing a raw meal split as well as tertiary air split. The flexibility in adjusting the tertiary air quantity and raw meal quantity is crucial for creating, the effective de-NO_x zone. The optimized design of Polflame-MC burner for kiln contributed significantly in achieving low NO_x values.

The NO_x values measured in the main stack were found in the range of 500-600 mg/Nm^3 at 10% O_2 on consistent basis meeting the environmental guidelines with 100% petcoke as a fuel.

Optimized Multi-Stage-Combustion is the most effective and economical solution to reduce NOx emission levels without SNCR. The environmental challenges are best met with the innovative technology developed by the team of engineers at thyssenkrupp who believe in engineering tomorrow together.

IMPACT OF AMMONIA ON ENVIRONMENT DUE TO ITS USE FOR SECONDARY NOx CONTROL IN CEMENT PLANTS

Anand Bohra, Prateek Sharma, M Selvarajan, A Saxena and B N Mohapatra

National Council for Cement and Building Materials, India

In India, Ministry of Environment, Forests and Climate Change (MOEF&CC) notified NO_x emission limits of 600/800/1000 mg/Nm^3 depending upon the type of technology installed in the cement plant. As NO_x emissions in some of the cement plants may reach upto 2000 mg/Nm^3, therefore, achieving NO_x emission limits through primary measures like process optimization would be difficult. Hence, Indian cement plants are in the process of installing secondary NO_x control equipment like SNCR (Selective Non-Catalytic Reduction), which utilizes ammonia/urea for reduction of NO_x level to meet the prescribed emission limits. There was a serious concern in the Indian cement industry that usage of ammonia for NO_x reduction using SNCR will result in net increase in environment impacts, as the ammonia consumption will be having its own environmental issues like Ammonia slip/emission, additional carbon foot print in ammonia manufacture and transport of ammonia over long distances to cement plants. For higher base NO_x emission level, the ammonia consumption to reduce NO_x by secondary measures like SNCR will be huge.

Ammonia slip emissions are as problematic as NO_x emissions due to creation of blue haze, also called detached plume with a bluish color due to the scattering of light.

NCB has carried out a holistic assessment of environment impacts by comparing the uncontrolled NO_x emissions from baseline scenario and impacts from secondary NO_x control (involving ammonia production, transportation, ammonia slip, controlled NO_x emissions). The environment impacts assessed in this study were Global Warming Potential, Acidification Potential, Eutrophication Potential and Particulate Formation Potential. These impact categories were selected to capture the effect of ammonia and NO_x emissions. The impacts were assessed for base NO_x levels between 1200 mg/Nm^3 to 2000 mg/Nm^3. It was observed that the environment impact due to use of ammonia for NO_x control in cement plants will be lower than the baseline scenario. This is mainly due to higher baseline impacts, reduction in NO_x emissions and lesser quantity of ammonia requirement for NO_x reduction.

SUSTAINABLE PRODUCTIVITY IMPROVEMENT THROUGH COGNITIVE PROCESS OPTIMIZATION & REMOTE ASSET MANAGEMENT – A SYSTEMATIC APPROACH TOWARDS DIGITALIZATION

Sridhar P, Jeyamurugan Kandasamy and IssacJobGodsFeareth

FLSmidth Pvt Ltd, India

The growth of cement industries in India is phenomenal, contemporarily imposing challenges like acute shortage of high-grade limestone and the impetus to substitute coal is imperative, being driven by the government's Swachh Bharat Mission directive to use alternative fuels and raw materials (AFR). Such substitutions trigger complex process dynamics, operational inconsistency and high degree of non-linearity makes a cement plant control a non-trivial activity, resulting in extensive use of energy and resources affecting plant profitability.

One such case study is discussed here on how the cement kiln was optimized using advanced technologies to achieve higher energy efficiency and to drive sustainability. Ash Grove Cement Company, USA decided to implement FLSmidth process optimization solution to optimize their cement kiln which has 60% to 85% of the heat energy generated from alternative fuels. The implementation of Advanced process control system is challenging due to the unwarranted upsets and undesirable breakdown of the alternative fuels which causes frequent disturbance to the pyro process. The "hard & soft" process constraints are solved with generalization of cost objective functions, built-in multi fuel controllers with intelligent dynamic process algorithms & model prediction, which brings additional flexibility to address the non-linearity caused by the alternative fuel in the process. The introduction of advanced process control system has helped to stabilize the cement kiln process, reduce the upset conditions, prevent breakdowns and even greater production efficiencies and reduced fuel consumption making it a most economical plant.

The success of the Cognitive Process Optimization solution is ensured with FLSmidth Asset Management Center a state-of-art, world's superior 24x7 Remote Asset Management (RAM) Center with the combination of well-defined process, dedicated specialists with domain expertise and technically advanced support tools. Key Performance Indicators (KPI), operating equipment efficiency (OEE) data and system generated events from the cement plant are securely monitored through FLSmidth IoT platform, from where the data is retrieved, analyzed and used for various digital solutions. The Experts proactively fine tune/ optimize through RAM & process insights – the digital enabler to ensure the product availability and improve plant productivity.

SO_x EMISSION CONTROL THROUGH INSTALLATION OF FLUE GAS DESULPHURIZATION SYSTEM IN CAPTIVE THERMAL POWER PLANTS

Tanmay Maitra, D H Thanki and S K Gotecha

ERCOM Engineers Pvt Ltd, India

Total installed power from different sources is 350,000 MW out of which 197,000 MW is from thermal power plants which is 56% and on the consumption basis, Thermal Power Plants (TPP) contribute more than 66%. Recently, Ministry of Environment, Forest and Climate Change has imposed new norms for TPP with limit of 200 mg/Nm^3 SO_2 emission for plants having capacity above 500 MW established after 2004 and 600 mg/Nm^3 for plants less than 500 MW capacity. For new plants installed after 2017, the norm is even more stringent at 100 mg/Nm^3.

To reduce the Sulphur Dioxide (SO_2) load, installation of Flue Gas Desulfurization (FGD) is essential. As per the preliminary information, 161,000 MW which is 80% of the total capacity of thermal plants have planned to install FGD system, which calls for additional 8 to 10 million tonnes of limestone consumption and corresponding 15 to 17 million tonnes per annum of FGD gypsum production. The captive power plants connected with cement units may need to install FGD system depending upon type of boiler installed. Thus it is important to evaluate the right technology, raw material and finish products

There are number of technologies available to control the sulphur dioxide from the power generation process such as dry/water/seawater based FGD. Therefore, it has become necessary to review and evaluate various available FGD techniques to adopt the most suitable technology for each individual power plant.

This paper covers the review of the available FGD technologies and their merits and limitations and basic characterization.

This paper also outlines the typical Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) requirement of a FGD installation for a power plant. This paper also covers the all India scenario for Limestone and FGD gypsum quantity and quality requirement when total FGD systems for power plants are implemented as per projection.

The information presented in this paper shall be useful to cement industry as well as to other thermal power plants.

ENERGY AND OCCUPANT COMFORT EVALUATION FOR BUILDING

Kajol[1], Ankur Mittal[2], Ashutosh Saxena[2], B N Mohapatra[2] and Devinder Singh[3]

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Current projections indicate that 66 percent of the world's population will live in cities by 2050. Population equivalent to 7 (seven) "New Delhi" size cities is added per year to world's urban population. According to the data published by The Energy and Resources Institute (TERI), urban share of GDP in India will rise to 75% in 2030-31.

Buildings represent around 40% of world's primary energy consumption. They are, therefore, directly responsible for increase in greenhouse gases and can play a key role in climate change adaptation. To achieve an energy efficient building regime, governments, businesses and individuals must transform the way buildings are designed, built and operated.

Energy efficient buildings (new constructions or renovated existing buildings) can be defined as buildings that are designed to provide a significant reduction of the energy need for heating and cooling, independently of the energy and of the equipment that will be chosen to heat or cool the building.

The area of study to achieve the purpose may be as under

1. bioclimatic architecture: shape and orientation of the building, solar protections, passive solar systems
2. high performing building envelope: thorough insulation, high performing glazing and windows, air-sealed construction, avoidance of thermal bridges
3. high performance controlled ventilation: mechanical insulation, heat recovery
4. Lean-Mean-Green Strategies for Space Cooling
5. Generate market momentum towards smart cooling through awareness campaigns, access to information and technical assistance.
6. Drive adoption of energy efficient building materials and equipment into mainstream through consistent testing and rating protocols, and market transformation strategies.
7. To investigate and quantify the energy impact from the expected proliferation of important IoT solutions like Smart light bulbs, Smart street lighting systems, Smart controllers for irrigation pump sets, Smart sockets, Smart meters, Smart air conditioners/ thermostats, Smart geysers, Smart refrigerators, Smart televisions, Home and building automation systems etc.

CONTINUOUS MEASUREMENT OF PARTICULATE EMISSIONS AT STACK

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Maxtech Industries LLP, India

Globally there is a heightened concern for environmental pollution control. In India after implementation of 30 mg/Nm^3 particulate emission limits by CPCB, cement plants across the country are required to install continuous particulate emission monitor in all major stacks namely, kiln/raw mill, cement mill, coal mill, cooler baghouse/ESP and CPP stacks. Online reporting protocol has been developed to transmit real-time emission data to central and state pollution control boards.

The cement industry is continuously looking for better emission control and preventive methods to reduce the incidence of high emissions. Several types of devices have been developed for continuous monitoring of particulate emissions in these applications. The core technologies for particulate monitoring include opacity, light scattering, triboelectric, and charge sensing. In general, these devices monitor the particulate flowing through a duct or stack, and, principally, monitor the amount of particulate being emitted. The greater the concentration of particulate relative to the emissions, the greater the quantity of pollutants exhausting to the atmosphere.

FilterSense's non-optical, particle charge induction-sensing technology (Dyna CHARGE™), in combination with high-speed digital signal processing and a protected probe, offers a cost-effective means of measuring the mass concentration and mass emissions of particles from industrial stacks. FilterSense's DynaCHARGE technology takes advantage of the fact that all particles have a charge. With dust traveling through a duct or stack, where charged particles flow near and around an electrically isolated probe, the charge is induced into the probe. This creates small induced currents (pico amperage) that are analyzed. The output is linear and proportional to mass concentration. A proportional output means that if the output of the DynaCHARGE monitor increases by a factor of, for example, 3 times, the mass will have increased by a factor of 3 times.

In this article, we shall discuss how Filtersense technology can help plants in:

- Early identification of leaks
- Allow longer production time with damaged bags (delay maintenance shutdown)
- Reduce the power consumption of the cleaning system in a bag filter and
- Increase the overall performance of the bag filter system.

NO_x REDUCTION EXPERIENCES IN KILN & CPPS OF CEMENT PLANT

Prem Talreja and Geet

YARA Environmental Technologies, India

Over the last few years, significant progress has been made with the SNCR process for Captive Power Plant (CPP) & cement kiln, especially those fired with municipal waste, RDF, bio mass and coal.

Recently, the focus has shifted more and more to reducing NOx in large boilers and coal fired power plants. As a result, NOx emission levels have been lowered.

The following topics are the key focus of this paper:

- Solutions to retrofit a De-NO_x system into an existing boiler within the Ltd space
- Ensure high performance and safe operation
- Comparison of honeycomb and plate type catalysts in a long-term perspective
- Selection between Anhydrous ammonia, Ammonia water and Urea for use in SNCR

These topics are outlined in case studies of De-NO_x systems in successful long-term operation. The market penetration of the De-NO_x technology in the coal/coke dominated countries reflects the fulfillment of the strict government requirements.

These case studies specifically pay attention on the challenges of retrofitting a high performance De-NOx technology in CPPs & Kilns during operation, with minimized boiler shut down period. They also highlight important design factors and technical solutions to ensure reliable operation with low maintenance needs and cost.

Furthermore, a comparison of honeycomb and plate type catalyst is discussed to highlight the advantages and risks of each technology under long time operation. Special attention is paid to the impact on overall plant behavior and the reuse of old catalyst.

In addition, the paper includes advantages and disadvantages of anhydrous ammonia, ammonia water and urea as reagent .

MICROSTRUCTURAL DEVELOPMENT IN CLINKER PHASES WHILE USING WASTE MARBLE DUST POWDER AS A RAW MIX COMPONENT

S K Gupta[1], S K Agarwal[1], S K Chaturvedi[1], B N Mohapatra[1] and Megha Bansal[2]

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[2]Manav Rachna University, India

Marble slurry/dust is a waste generated by marble processing industries. The current estimate reveals that the generation is to the tune of 5-6 million tonnes annually, particularly in the state of Rajasthan, causing environmental and ecological problems. Chemical and mineralogical evaluation of these wastes showed their compatibility to the cement system and could be a potential material, partially substituting traditional limestone in the manufacture of Portland clinker. In the present study different cement raw mixes were designed by replacing the conventional limestone with varying doses of marble wastes, in the range of 7.5% to 84.2% collected from different marble clusters. The above raw mixes were designed by maintaining clinker parameters, such as LSF, SM, AM and potential phases; C_3S, C_2S, C_3A and C_4AF, comparable to conventional Portland clinker. Burnability study of raw mixes showed improved lime assimilation even at the temperature of 1350°C followed by well development of clinker mineral phases and morphology of clinkers. The results showed that the addition of marble dust has not only shown reduction in clinkerisation temperature but also showed development of fine grained alite and belite phases with average gain sizes of 21-22 and 24-27 µm respectively. The microstructure of the resultant clinkers has been studied by Optical microscope, Make: NIKON 100 POL using NIS elements software. Performance evaluation of ordinary Portland cement, prepared using about 84% marble waste as raw material in the manufacture of Portland clinker, showed their conformity to Indian standard IS: 269-2015, specified for ordinary Portland cement.

BEST ENGINEERING PRACTICES: AN IMPORTANT TOOL FOR ATTAINING HIGH AND SUSTAINABLE TSR

M V Ramachandra Rao, Anupam, Anil K Popuri, Kapil Kukreja and Rayees Ahmed

National Council for Cement and Building Materials, India

Usage of Alternative Fuel (AF) becomes more popular in any cement industry due to higher fossil fuel prices, Ltd fossil fuel resources and stringent environmental norms. Substantial volume of the industrial, commercial, domestic and other wastes have the potential for use as an alternative fuel for energy recovery.

An estimated one billion tyres worldwide (about 17 million tonnes) reach the end of their useful lives every year. In Europe, an estimated 3.3 million tonnes of End-of-Life Tyres (ELT) arise annually with an estimated stockpile of 5.7 million tonne. In Sultanate of Oman, approximately 45,000 tonnes are generated per annum of which 35,000 tonnes can be collected for ELT processing. The data suggests that the number of tyres imported in Sultanate of Oman have increased from 19,80,556 in 2010 to 42,08,056 in 2014.

Considering the contamination of minor elements in the Tyre Derived Fuel (TDF) prepared from the ELT, a TSR of about 25% can be achieved. A system is designed keeping in mind all the Best Engineering Practices, can support the plant management and the plant operation team in achieving a sustainable TSR of 25%. This paper highlights the salient features of the system designed for the utilization of End-of Life Tires in one of the cement plants in Sultanate of Oman. All important and key-points which, when missed, needs immense troubleshooting post the project implementation and operation, are covered during the system engineering.

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PERFORMANCE EVALUATION OF TERNARY BLENDED CEMENTS FOR MASONRY APPLICATION

S Divya Rani, Thangadurai Raja, Sasidharan Thillai and Manu Santhanam

Indian Institute of Technology Madras, India

Ordinary Portland cement is not a preferred binder for masonry structures as it leads to incompatibility with the masonry units especially in the case of porous brick and stone masonry because of its high strength along with poor resistance to cracking. The preferred binder in the past was lime; however, lime mortars tend to take long time to achieve the desired properties, and are also problematic because of the inconsistent quality and availability of lime. The inclusion of supplementary cementitious materials is widely reported to have reduced the carbon footprint associated with cement, and it is possible to achieve the desired characteristics by suitable combinations of these materials with cement.

In the present study, performance characteristics of three different blended cements prepared with combinations of OPC clinker, fly ash and limestone were monitored up to a period of one year. The water retention, compressive and flexural strengths, dynamic modulus, water sorptivity, and pull-off strength of the mortars were evaluated for bedding and plastering applications. A combination with 50 - 60% fly ash and 20% limestone replacements in OPC clinker was seen to perform satisfactorily in the investigations, and can be used as a potential binder for masonry applications.

A SUSTAINABLE MIX PROPORTIONING METHOD FOR COAL BOTTOM ASH CONCRETE BASED ON MINIMUM PASTE THEORY

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There are million tons of coal bottom ash (CBA) waste in piles and ponds adjoining the power stations threatening the health and safety. In many countries, CBA are identified as hazardous materials. Therefore, innovative, safe, sustainable, environmentally friendly, and economical solutions to use this industrial by-product are indispensable. Conventional mix proportioning of concrete with CBA does not improve the performance of the concrete. Therefore, an innovative method based on particle packing density and minimum paste theory has been used and mix design for concrete is developed. The efficacy of the newly developed mix proportioning for river sand (RS) and CBA concrete is compared with the conventional concrete proportioned as per IS 10262. Life cycle cost analysis (LCCA), CO_2-e emission and cost are also evaluate to substantiate the advantageous of developed mix proportioning. The increased compressive, splitting tensile, flexural strength and modulus of elasticity at 56 days were in order of 10.86%, 2.15%, 10.73% and 3.47% respectively of 30% replacement of river sand (RS) with CBA. Both RS and CBA concrete mix designed experimentally verifies to have lesser environmental impacts, CO_2-e and cost compared to theoretically developed mix for 1 m^3 concrete. The developed method is found sustainable approach for mix proportioning based minimum paste theory.

In this study, productive application of CBA based concrete is possible using newly established mix proportioning. 100% replacement can be accomplished with improved performance with addition of mineral admixtures or fibers in the concrete. This mix proportioning method proved to be more economical and sustainable as compared to conventional method of design. Future research possibilities should consider the contributions and efficiencies of other cementitious binders using this developed proportion for CBA based concrete.

MECHANICAL AND DURABILITY PROPERTIES OF CONCRETE MADE WITH TERNARY BLENDS

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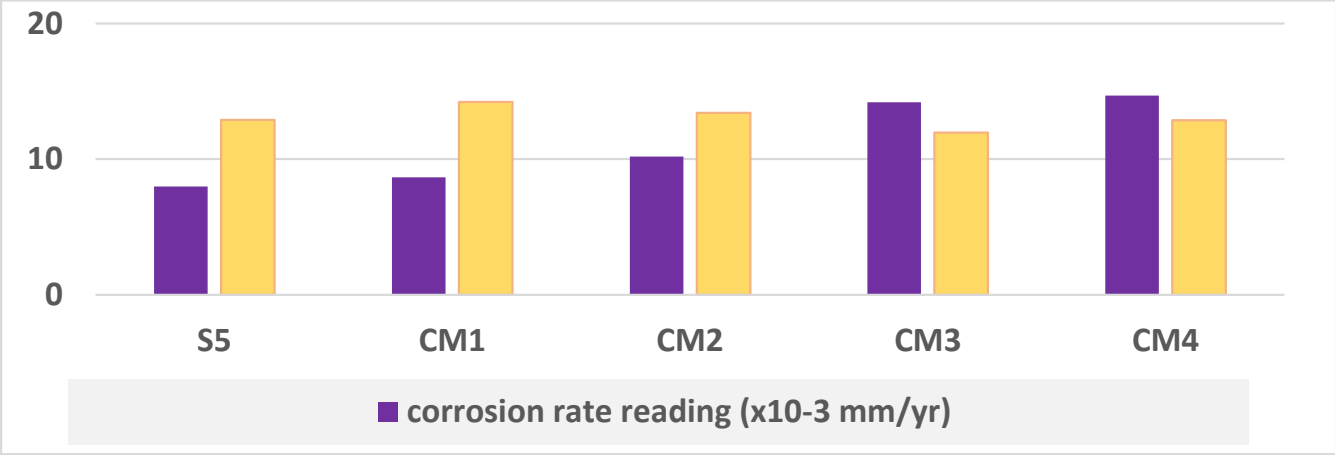
An experimental investigation was carried out to evaluate the mechanical and durability properties of concrete made with low OPC content containing high supplementary cementitious materials like fly ash and ground granulated blast furnace slag (GGBS) in both binary and ternary systems. The fly ash and GGBS has been used as partial replacement of cement in the concrete. The fly ash is obtained by the combustion of pulverized coal and collected by mechanical dust collector or electro static precipitator whereas GGBS is a by – product of iron and steel making industry, obtained by quenching of molten iron slag from a blast furnace in water or steam to produce a glassy granular product which is later dried and ground into a fine powder. By utilizing these two by -products as a partial replacement of cement in concrete, the concrete can be made more sustainable and economical. Performance of these concrete mixes has been measured with short and long-term tests, which include compressive strength, flexural strength, RCPT, NT Build 492, Electrical resistivity, Chloride diffusion and accelerated carbonation test and the results of the same in details are discussed in the paper. The results of the carbonation induced corrosion rate is shown in fig1. In general, all the ternary concrete mixes have comparable to slightly higher carbonation depth in comparison to binary blend. It was also observed that although the depth of carbonation is slightly higher in ternary blends CM1 containing 35 % fly ash in comparison to S5 but the rate of corrosion is found to be comparable.



Binary blend : S5, (65%OPC +35%FA)

Ternary blends: CM1 (40% OPC+35%FA+25%GGBS), CM2 (50% OPC+25%FA+25%GGBS), CM3 (55% OPC+20%FA+25%GGBS) and CM4 (35% OPC+15%FA+50%GGBS)

Fig1. Corrosion rate and accelerated carbonation depth

EVALUATION OF DURABILITY FEATURES OF CONCRETE COMPOSED WITH LOW CARBON CEMENTS

V H Choudary[1], P Anantham[1] and Subrata Chowdhury[2]

[1]My Home Industries Pvt Ltd, India

[2]Conmat Technologies, India

This paper investigates some of the durability features of concrete mixtures composed with Low Carbon Cements. The Portland Pozzolana Cement (PPC), Portland Slag Cement (PSC), Composite Cement (CC) is currently the members of emerging family of low carbon cements widely used in multipurpose construction. The efficacy of manufacturing of low carbon cement has predominant and multidimensional influence on improving geo-environmental sustenance. The PPC & PSC are being used in India since more than five decade whereas CC is the newest inclusion in the list of low carbon cements in the current decade. The low carbon cement were widely used in construction industry due to the potential contribution towards improving durability characteristic of concrete structure.

The improvement in the properties of concrete is directly related to the grain and pore refinement with in transition zone in the microstructure. The hydration process greatly depends on the characteristics of cementitious materials, that is, OPC plus supplementary cementitious materials(SCM) and some external factors like ambient temperature and humidity.

Inadequate durability manifests itself by the deterioration which can be due to host of both internal and external factors. Mega defects in construction of concrete structure are largely responsible for the lion's share of the early aging problem or loss of durability. Nevertheless the inadequate durability of mega defect free concrete structure is primarily due to different degree of permeability. Disruption in concrete due to the reaction between reactive silica and some carbonate in aggregate and the alkalis in hydrated cement paste is a potential durability problem. The low carbon cements reduce the risk of alkali silica or carbonate reaction and minimizing or eliminate probable attack regardless of alkali content in cement.

Two grades of concrete mixture were proportioned with each of the three types of cement; PPC, PSC & CC. The water cement ratio were 0.35 and 0.45 and same coarse and fine aggregates, chemical admixture and water were used for the preparation of concrete mixtures. The mixing protocol, curing and environmental control of specimen preparation and testing was identical throughout the tenure of the experiment. The compressive strength at 1, 3, 7 and 28 days, rapid chloride penetration test (RCPT) and potential alkali reactivity following accelerated mortar bar method were determined at hardened state of concrete. The result shows that the ratio of water to cementitious materials has a critical bearing on regulating the concrete compressive strength at all ages and quick response to initial strength. The RCPT values are influenced by both ratio of water to cementitious materials and paste volume. Alkali Silica Reaction (ASR) or Alkali Carbonate Reaction (ACR), the rate of reaction is influenced by the component of supplementary cementitious materials. Rich quantum of SCM bearing, low carbon cement offers high resistance against probable ASR or ACR reactivity and expansion.

INVESTIGATIONS ON PORTLAND LIMESTONE CEMENT COMPOSITIONS AND THEIR PERFORMANCE CHARACTERISTICS

Pinky Pandey, D Yadav, K Sharma, S K Chaturvedi and B N Mohapatra

National Council for Cement and Building Materials, India

Apart from being energy intensive and raw material oriented process, cement manufacturing is one of the primary producers of CO_2 creating up to 5-8% of man made emissions. This has resulted in increase of green house effect causing great concern to every stakeholder including environmentalists. To mitigate the problem, enormous endeavor so far has been made by responsible industries, research bodies and academia, to reduce CO_2 emission from cement production process by developing new technological solutions thus continually stepping towards reducing the environmental footprint of cement production and making it more and more sustainable.

Blended cements so far have stood the test of time and are found to offer significant performance advantages along with environmental mitigation in terms of reduced emission, natural resource conservation and waste utilization.

Globally three main types of blended cements namely Portland Slag Cement (PSC), Portland Pozzolana Cement (PPC) and Portland Limestone Cement (PLC) are being produced. As per EN-197-1, Portland Limestone Cement containing up to 35% limestone bearing $CaCO_3$ ≥75% is allowed whereas as per ASTM C595, 5-15% limestone is allowed in PLC. In India, only 5% limestone is allowed as performance improver as per IS 269: 2015.

In India, only PPC, PSC and recently composite cement are being produced commercially. However, producing Portland Limestone Cement using different grades of limestone is the need of the hour as large deposits are existing in our country and are not being adequately utilized. The present work deals with the effect of- type of limestone, its percentage and preparation method (inter-grinding & separate grinding with blending of limestone, clinker & mineral gypsum) on chemical and mechanical properties of prepared PLCs.

It has been found that Characteristics of PLCs are related to clinker and limestone quality. Control OPC characteristics were compared to those of PLC compositions. With an average quality clinker used in the study, the compositions with 10% of cement grade limestone prepared by blending exhibit slightly improved strength compared to those prepared by intergrinding at early stages. All interground compositions with low grade limestone exhibit decrease in strength at all ages while those prepared by blending show slight increase in early strength at 10%, later showing gradual decrease with increasing limestone content at all ages. More studies involving quality variation in clinker and limestone can lead to better optimization of composition and quality of PLC.

THE INFLUENCE OF TEMPERATURE ON THE HYDRATION AND STRENGTH DEVELOPMENT IN SLAG-FLY ASH COMPOSITE CEMENTS

Sreejith Krishnan, Meenakshi Sharma and Shashank Bishnoi

Indian Institute of Technology Delhi, India

The influence of curing temperature on a ternary blended cement system containing portland cement, ground granulated blast furnace slag (GGBS) and fly ash was investigated in this study. A clinker factor of 0.55 was used for the preparation the ternary cement, with the rest being replaced by a combination of GGBS and fly ash. The ratio between slag and fly ash was kept 1:1 by mass. Ground quartz was used as an inert filler to replace GGBS and fly ash individually to determine the sensitivity of the slag and fly ash to the curing temperature. Studies where carried out at two curing temperatures - 27°C and 50°C. Mortar cubes of size 70.6mm x 70.6mm x 70.6mm where used to determine the compressive strength. At 50°C, it was seen that the AFm as well as the AFt phases were unstable, indicated by the lack of sharp peaks in the x-ray diffractogram.

It was observed that the hydration of slag was sensitive to the change in curing temperature when compared to fly ash. The presence of fly ash was observed to have a beneficial effect in the portland cement – slag – fly ash systems when cured at higher temperatures

In this study, the effect of temperature on strength and phase assemblage in composite cement systems were studied. Crushed quartz was used to isolate the individual effects of slag and fly ash. From the compressive strength results, it was observed that the hydration of slag is more sensitive to temperature compared to hydration of fly ash. From the phase assemblage, it is clear that the AFm phases formed at higher temperatures are poorly crystalline. The present results highlight the necessity of additional investigations to understand the robustness of composite cements with respect to temperature.

FLY ASH BASED "BINDING (ADHESIVE) MATERIAL [B(A)M]" YEAR: 2019-20

Bhupendra Mohan Manglik and Ashish Kumar Pandey

Individual, India

This all started with the affirmation of substituting sand with waste material (here it's Fly Ash from thermal power plant). In this process after trying several combinations (of fly ash and different additives) we get success in developing a material which has the nature of binding civil constituents (such as bricks, tiles, marbles, wall plaster etc) without using sand and now cement too. As major constituent of the material is fly ash so production of the same will be economical in large scale manufacturing and at the same time pocket friendly for the customer. The nature and physical appearance of the material is very much similar to the conventional options available today with us. We named this material (cum project) as Binding (Adhesive) Material {B(A)M}. B(A)M not just looks itself as one of the substitute to the sand & cement or part of a waste utilization drive but need and necessity of tomorrow which will prove to be economical and pocket friendly. B(A)M in dry powder state is ready to use product with one only needs to add water before application. As we know R&D is time taking process, so is the case with B(A)M. We too are working hard in order to develop B(A)M(with different types of ash), and attain much more strength to substitute R.C.C. in heavy duty constructions such as bridges, dams & other mega infrastructure projects.

CHARACTERISTICS OF INDIAN BOTTOM ASH AND ITS FEASIBILITY FOR USE AS FINE AGGREGATE IN REINFORCED CONCRETE

P N Ojha, Amit Trivedi, Suresh Kumar, Nikhil Kaushik, Digvijay Kumar and V V Arora

National Council for Cement and Building Materials, India

In this study, bottom ash from 10 sources from all over the country (3 from Northern India, 2 from southern India, 3 from central eastern region & 2 from western India) were collected. Characterization of all sources of bottom ash has been carried out. Characterization includes physical, chemical, mineralogical & microstructural properties. Out of 10 bottom ash samples, two samples were selected for detailed investigation on fresh concrete properties. Mixes were prepared at two w/c ratio i.e. 0.4 and 0.65 and at different percentage replacement of bottom ash i.e. 25%, 50%, 75% and 100%. (% of Fine aggregate)

It was observed that when bottom ash percentage goes beyond 50%, it does not give workable mix even at the higher admixture dosage than the permissible limits. On the same two source of bottom ash, concrete mixes were prepared at 25% and 50% replacement of bottom ash to study results of durability related tests (water permeability, RCPT, volume of permeable voids, electrical resistivity, air permeability and accelerated carbonation), and results at both the percentage replacements of bottom ash were found to be comparable with that of control mix.

Further on the remaining 8 sources of bottom ash, composite fine aggregates were prepared by mixing bottom ash at different percentage (10%, 20%, 30%, 40% and 50%) with that of natural sand (Zone-II and III) and crushed sand (Zone-I, II and III). All the composite fine aggregates were characterized on the basis of fineness modulus and their fineness modulus were in the range of 1.33 to 3.01. Lowest possible fineness modulus of zone-IV fine aggregate as per IS:383-2016 is 1.35.

Based on literature done and study conducted several conclusions were drawn. It is observed that when fine aggregate is replaced by bottom ash beyond 50%, the concrete mix is not workable even at higher dosage. Hence replacement of fine aggregate by bottom ash has been restricted to maximum 50%. The durability properties of concrete with composite fine aggregate (maximum 50% of replacement of fine aggregate by bottom ash) and OPC are comparable with the concrete mix without bottom ash. Hence maximum 50% of fine aggregate can be replaced by bottom ash in concrete made with OPC. From this study it was observed that, it is possible to formulate specifications and guidelines of mix design by using Bottom ash as part replacement of fine aggregate in reinforced concrete using OPC.

TECHNICAL SESSION – XII A

ENERGY CONSERVATION SYSTEMS-II

SEMINAR PROCEEDINGS

NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS
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GREEN ENERGY FOR CEMENT PLANTS

Abhay Patil

Thyssenkrupp Industries India Pvt Ltd, India

Waste Heat Recovery (WHR) as a technology has gained momentum in Cement Sector in India during the last decade.

Cement production has been one of the energy-intensive processes and has been contributing to carbon foot print also. In order to implement pollution control measures and efficient energy management scheme, energy & environment audit is generally carried out in a cement plant. Reduction in emissions and production cost of cement is very important, because of which waste heat recovery is implemented in the cement industry.

The waste heat recovery reduces the green-house gas emissions and also enhances the overall energy performance. The aim is to lower the emissions and generate power by utilizing the waste exit gases from the preheater and grate cooler. This also leads to saving in fossil fuel combustion which would have been necessary for power generation. For waste heat recovery systems, the exhaust gas temperature, dust concentration and velocity are identified. A detailed analysis of grate cooler and preheater is done and the possible approaches of heat recovery are established. Integration of available heat with steam and power generation scheme is woven further. This is achieved by keeping delicate balance of existing cement manufacturing process on one side and synchronization of power with existing Captive Power Plant (CPP)/Grid on the other.

Thyssenkrupp has been one of the leading technology providers for Waste Heat Recovery based power plants in Cement Industry with successful installations in India and abroad.

LATEST ENERGY EFFICIENT CLINKER COOLING TECHNOLOGY AND OPERATION - FONS DELTA COOLER

Jayaram Sudhakar

Fons Technology International

Clinker cooler is the heart of the clinker production line. FTI understood this and have been a pioneer with our technological advancements to meet the customer requirements on technology, modernization, availability, flexibilty and downtime for upgrades.

Fons Delta cooler offers consistency to the recuperation air, which is very crucial for the clinkerization process. The high temperature of recuperation air directly impacts the specific heat consumption of complete pyro line and our Fons Delta cooler is carefully designed to minimise the specific heat consumption of pyro line.

From the cooler process point of view the temperature of the recuperation air to the kiln, low clinker outlet temperature and the stability of the cooler are the most critical items for pyro line. This is perfectly taken care by our patented Iso kinetic static inlet, Shuttle floor mechanism, STAFF regulator and unique features of Fons Delta Cooler.

Clinker cooling is optimized by our innovative patented product STAFF (Stepped Air Flow Function). Each individual grate plates (400x400mm) have a STAFF regulator to control the aeration. With this new principle, the recuperation efficiency can reach maximum 80% and the savings can reach upto 50-60 kcal/kg of clinker in retrofit project and 100-120 kcal/ kg Cl for replacement of satellite cooler.

Fons Delta Cooler is designed with shuttle floor mechanism to transport clinker by means of grate lanes. Cooler runs at very slow speed in the range of 3 to 6 SPM, to have the least wear, tear and lowest mechanical maintenance. With slower grate speed the availability increases. Maintenance cost of Delta Cooler is the lowest in Cement industry max 0.03 Euro/MT.

As the energy costs and demand for clinker are increasing continuously in Indian cement industry and to keep the competitiveness in domestic and abroad markets the best way is lowering down the energy costs in fuel, power, increasing availability and decreasing the upgrade down time.

In this presentation, we'll submit our new innovations to lower down the energy cost, technology to increase cooler availability and minimise cooler upgrade downtime in the pyro line with our 4th generation clinker cooling technology.

16th NCB INTERNATIONAL SEMINAR ON CEMENT, CONCRETE AND BUILDING MATERIALS
03-06 DECEMBER 2019, NEW DELHI, INDIA

EFFECT OF CALCINATION CHARACTERISTICS OF CHINA CLAYS ON THE PERFORMANCE OF LIMESTONE-CALCINED CLAY CEMENTS CONTAINING DIFFERENT GRADES LIMESTONE

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S K Agarwal[2], S K Chaturvedi[2] and B N Mohapatra[2]

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The use of supplementary cementitious materials (SCMs) has a huge potential to reduce carbon footprint and resource conservation in cement production. Due to the growing scarcity of widely acceptable SCMs, such as fly ash and granulated BF slag, a new ternary cementitious cement system based on calcined clay (particularly calcined kaolinite) in combination with limestone (LC^3 technology) could have tremendous potential to broaden the raw materials base as a partial replacement of Portland clinker. The new limestone calcined clay cement could increase clinker substitution to about 50 percent without significantly influencing cement performance due to the synergy between aluminates from calcined clay and carbonates from limestone.

The present paper highlights the calcination characteristics of clays containing different kaolinite contents and their reactivity.

During the calcination process, the crystalline structure of kaolinite is lost by 'dihydroxylation' of kaolinite clay. Limestone calcined clay cement (LC^3) blends were prepared using different calcined clays and different grades limestone; cement & low grade limestone and dolomitic limestone.

The compressive strength of LC^3 cement mortar and M20 grade concrete showed that in most of the cases, the strength development is very much in line with conventional OPC-43 grade cement except workability, that could be easily averted by using suitable admixture and SO_3 optimization in cement blend.

POWER OPTIMISATION & COST SAVINGS ANALYTICAL TOOL FOR CONTINUOUS IMPROVEMENT

Rajesh Kumar Gupta

Individual, India

In Cement Industry electrical energy conservation has been one of the main focus since few decades for cost reduction and now for sustainability. Several technologies, energy efficient equipment, monitoring system developed to address this issue. In India, under Ministry of Power, Bureau of Energy Efficiency launched PAT (perform, achieve, trade) scheme to reduce & conserve energy to the tune of 0.815million tons of oil equivalent by the end of PAT-cycle I as compared to baseline year 2009-10.

This paper focus on how power optimization & cost savings can be achieved through operational efficiency. The result is based on application in a plant using simple analytical tool.

Each plant for given set of equipment for crushing, raw material grinding, pyro-processing, cement grinding has fixed connected load but operating load varies and is dependent on different factors of operational efficiency. At the desired output level, for example rated TPH, optimized run load can be worked out which will give best power utilization. Section wise optimized load is sustained through intensive audit of each equipment and activities like maintaining feed size, grinding pressure, grinding media classification, VFD for process fans, product quality etc. Finally, connected load is judiciously reduced for additional savings.

Savings of 5.71 kWh/ton cement was achieved with exercise which spanned over six months.

OPPORTUNITIES FOR IMPROVING ENERGY EFFICIENCY IN BAG FILTER SYSTEMS

Dilip Sakhpara and Rushabh Sakhpara

Maxtech Industries LLP, India

Over the last 20 years, the use of advanced technology PTFE membrane filter bags has become the standard in the cement industry for the critical raw mill/kiln de-dusting application all over the world including India. Cement plant engineers have seen the opportunity for lower pressure drop in the filter system by switching from conventional (without membrane) filter bags to membrane filter bags and as a result, most plants and even bag suppliers are switching to membrane filter bags.

There is a wide range of filter drag (resistance) performance among the various commercially available PTFE membrane filter bags today. The actual power savings achieved year after year depends on the quality of the PTFE membrane.

Two most important parameters of the total cost of ownership of the bag filter are bag life and pressure drop. Many cement plants tend to ignore the pressure drop cost factor since it is a relative measure and needs to be measured and tracked periodically. It is very important to analyze the power consumption per ton of clinker/raw material processed through the bag filter over the entire bag life. This is not done easily and hence most plants miss out on this important area of power savings.

This article takes a deep dive into how one can optimize filter system performance to maximize the power savings and minimize the operating cost of the bag house and achieve the highest possible equipment productivity through the use of best quality filter bags and ensuring proper optimization of the bag filter.

New products from W.L. Gore & Associates, Inc. USA the innovators and leaders in PTFE membrane technology make it possible to further optimize the bag filter performance and achieve substantial power savings. The author will share actual plant operating data from cement plants using the new Gore Low Drag filter media developed and commercialized by Gore.

The method adopted by the author to evaluate filter system can be easily used by all cement plant engineers to evaluate the performance of the important filter systems in their plants and identify potential areas for energy savings and productivity enhancement.

INITIATIVES FOR ENERGY CONSERVATION EFFECTIVE ENERGY CONSUMPION AT JK CEMENT, MANGROL, LINE-2

Devendra Kumar Patel

J K Super Cement, India

The cement sub-sector consumes approximately 12- 15% of total industrial energy use. In this paper energy use at different sections of cement industries, specific energy consumption, types of energy use, details of cement manufacturing process, and various energy savings were reviewed and presented. A detailed analysis of kiln, grate cooler, preheater are done and the possible approaches of heat recovery from major heat loss sources are discussed and also identify technological opportunities in order to decrease energy consumption of the plant, increase the productivity and improve the production process. Amount of CO_2 reduction has been presented along with the payback period for different energy savings measures as well. This project bring out in a holistic and simple fassion the frame work and the methodology required to be followed to conduct an energy audit and conversion study in a typical cement plant.

The conservation, balance and management of energy are hot and emerging topic of today's discussion. The main aim of the energy audit is to provide an accurate account of energy consumption and energy use analysis of different components and to reveal the detailed information needed for determining the possible opportunities for energy conservation. In this regard, the attempts for energy balance in the industries of developing countries like India are having extreme significance. Cement industry is an energy intensive industry. The process of manufacturing of cement using dry process include the use of a rotary kiln, which consume large amount of energy to burn coal and the working of the blower which is used to suck the heated air to the other end of the rotary kiln. The higher specific energy consumption is due to the harder raw material and poor quality of fuel. A significant quantum of studies can be witnessed in this field. Among them, there are many attempt aiming, not only energy approach to the cement industry, but also the potential means of improvement in energy consumption of cement industry. The detailed analysis of kiln, grate cooler, preheater, Pre-calciner, raw mill, coal mill and gas conditioning tower are done, and then, the possible approaches of heat recovery from some major heat loss sources are discussed.

Optimization of Heat Consumption of Kiln by various steps: -

1. Optimization of Burner Momentum.
2. Optimization of excess Air.
3. Optimization of Raw Mix chemistry.
4. Optimization of Process Parameters.
5. Optimization of PID Controls.

The aim of this study was to determine energy situation in cement plant and the possible energy conservation measures and financial saving potentials.

The energy cost plays a major role in production cost of the cement, so thermal energy conservation study is carried out in a cement industry. The conservation is concluded depends on the payback. Thermal Energy consumption decreased from FY 2014-15 by above measures/steps and continual improvements.

	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19
Thermal Energy	723	703	682	683	682

ASSESSMENT OF COMPRESSOR ENERGY CONSUMPTION IN CEMENT PLANT - A CASE STUDY

Ankur Mittal, Saurabh Bhatnagar and Ashutosh Saxena

National Council for Cement and Building Materials, India

Air compressors account for significant amount of electricity used in Indian cement plants. Air compressors are used in a variety of applications whether to operate pneumatic tools and equipment, conveying of fine materials or to meet instrumentation needs. It is estimated that only 10 – 30% of total energy is utilized in main application while balance 70 – 90% of energy is wasted in form of unusable heat energy and to a lesser extent lost in form of friction, misuse and noise.

Source of losses in a compressed air network are generally defined as of varied nature. The losses can be quantified and classified under 1) Leakages 2) Inefficient compressor operation 3) Improper distribution of compressed air 4) Malpractices and 5) Insufficient end /intermediate storages.

The compress air audit helps in identifying various losses in compressed air networks and recommend solutions which help in reducing the compressed air costs. During energy audit studies performed by NCCBM at cement plants, assessment of compressors is fairly given weightages and detailed outcome with suitable suggestion is provided to plant.

This paper covers a case study and related findings for dedicated compressed air energy audit at one of the cement plants in Central India.

UTILIZATION AND RECOVERY METHODS OF WASTE HEAT IN CEMENT PLANT

Ankur Mittal[1], Ashutosh Saxena[1], B N Mohapatra[1] and Dibakar Rakshit[2]

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[2]Indian Institute of Technology, Delhi, India

India is the second largest cement producer in the world after China and it has evolved to become one of the best in terms of energy efficiency, quality control and environment improvement. The current installed capacity of cement industry in India in 2018 is 509 million tonnes. Indian cement industry is continuously adopting conventional as well as advanced energy saving measures. Also cement industry is giving thrust to replace fossil fuel-based energy usage by renewable energy sources like wind mill, solar PV system etc.

Apart from energy efficiency, energy optimization and renewable energy usage, there is a great scope of making utilization of energy available in waste process flue gases and radiation energy from rotary kiln shell (High surface temperature). Adoption of Waste Heat Recovery (WHR) systems in Indian cement manufacturing facilities has gained a lot of momentum during the past decade and presently several plants are using WHRS gainfully.

High temperature heat is directly dissipated into atmosphere in the form of flue gases and radiation. For heat recovery from hot flue gases, a lot of work has already been done and presently total installed capacity of WHRS installed using hot kiln flue gases is 344 MW (2017). Many case studies and optimization techniques are available for further optimization of WHRS through process flue gases.

A significant potential exists for utilization of kiln waste radiation energy (emitted from hot rotary kiln surface) which is under exploration for feasibility. A great potential (3.9 % or ~30 kcal/kg clinker) rests with radiation energy from rotary kiln surface.

Under this condition, it becomes a great area to study the feasibility of waste energy utilization. The recovered energy can be used either for electricity generation or hot water preparation.

In this paper, emphasis shall be on the study of literature, making calculation of available energy, rate of recovery and quality of heat recovered based on the cement plant data base, focusing on waste radiation energy from hot surface of cement rotary kiln.

TECHNICAL SESSION – XII B

SUSTAINABLE CONSTRUCTION PRACTICES AND OTHER BUILDING MATERIALS AND BINDERS

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CHARACTERISATION OF LADLE FURNACE SLAG FOR DEVELOPMENT OF CEMENTITIOUS BINDER

Surya M, S K Singh, Jyoti and Akhil Rana

CSIR- Central Building Research Institute, Roorkee, India

Ladle Furnace slag (LFS) is a crystalline slag. The past studies identified that the presence of di calcium silicates, aluminates, Portlandite (Free lime) and Periclase (Free MgO) contributing to its cement like properties and also making it susceptible to dimensional instability when it comes in contact with moisture or carbon dioxide. However, the use of LFs is Ltd in cements due to its non-reactive crystalline nature. A few research studies were performed exploring the feasibility and limitations in use of LFS in civil engineering applications such as fines, pavements and cements. The studies indicated that LFS has hydraulic reactivity and pozzolanic properties. However, the volumetric instability of the material in presence of moisture and carbon dioxide is a major hindrance in use of LFS. Studies show that the limits for use of LFS have been restricted to 10% for fines and 20% for cementitious replacements without affecting its mechanical properties.

However, these studies insist for further research on durability of the same on a long term for its confident use. This study therefore aims at the characterisation of LFS pertinent to the hydraulic properties and pozzolanicity.

The following conclusions can be drawn from the studies: The mineralogical and chemical properties indicate that the LFS is a crystalline slow reacting cement clinker. The LFS reacts fast with water due to flash reaction of aluminates to form various polymorphs of CAH. The LFS can be effectively used in cements provided the crystalline phases of the slag are effectively dissolute and effectively consumed by means of addition of external source of reactive silica.

STUDIES ON FLY ASH AND SLAG BASED GEOPOLYMER CONCRETE

Lalit Kumar[1], Amit Trivedi[1], V V Arora[1] and Lopamudra Sengupta[2]

[1]National Council for Cement and Building Materials, India

[2]JSW Cements Ltd, India

The advancements in material sciences have led to development of altogether alternative binding material to concrete in form of alkali activated concrete. The alternative works out to be green and sustainable but there are apprehensions regarding costs, testing methods and field performance.

The study presents development of mixes in laboratory conditions. The mixes have been developed keeping view the optimal ratios of SiO_2/Al_2O_3, SiO_2/Na_2O as per established researches and trials were conducted in the laboratory.

The study also presents major difficulties that may arise during production and measures adopted to overcome the difficulties.

The selection of activator modulus (SiO_2/Na_2O) and Na_2O content can not only help in cost optimization but can significantly influence the workability and strength of the mixes. The mixes adopted were used to cast precast plain concrete product (interlocking paver blocks). The curing was done in ambient conditions (without use of water or curing compounds). The paver blocks developed using Geopolymer concrete were used to cast a trial stretch. The laid stretch was monitored for about a year regarding its field performance under low volume traffic flow.

The study includes strength development, abrasive behavior, water absorption etc. The studies present a discussion on the comparative discussion on carbonation in conventional systems and alkali activated systems.

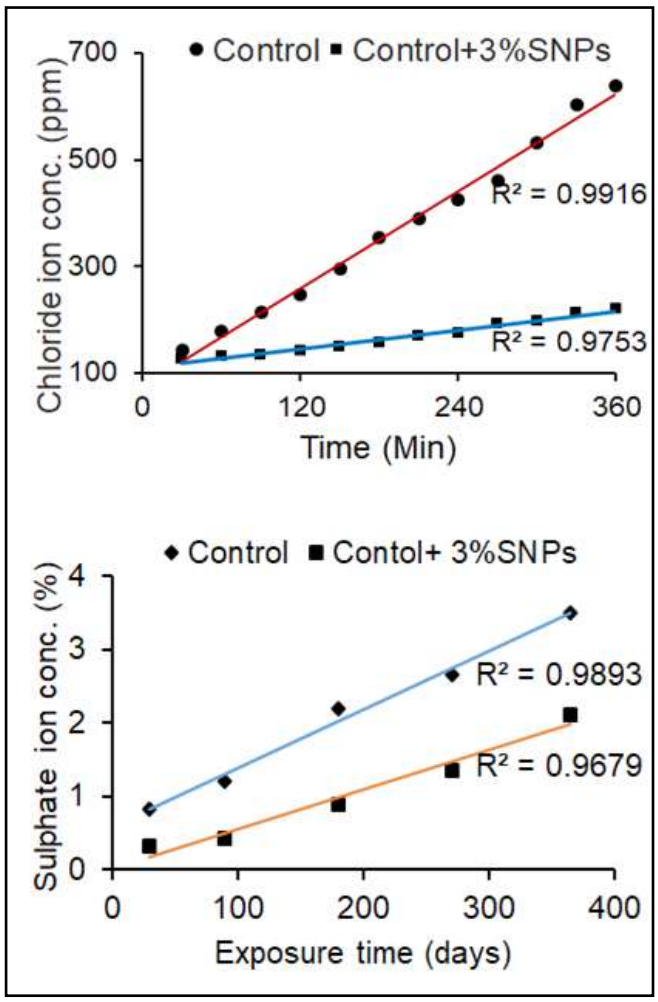
The findings of study indicate that with little modifications in testing, development and usage methodology, precast plain alkali activated products can be used as a substitute as well as supplement / compliment to conventional concrete products.

ACHIEVING CONCRETE SUSTAINABILITY THROUGH NANOTECHNOLOGY

L P Singh, U Sharma, D Ali and Srinivasarao Naik B

CSIR-Central Building Research Institute, Roorkee, India

The application of nanotechnology in cement/ concrete is expected to result in the development of materials exhibiting eco-friendly, high performance and enhanced durability characteristics. Several types of nanomaterials are used by concrete technologists to improve the performance of cementitious system, amongst them silica nanoparticles (SNPs) have gained widespread attention due to its high reactivity. A systematic study was performed on cement paste, mortar and concrete with addition of 3% silica nanoparticles (SNPs) to understand the impact from micro-structure modification on macro-level properties. The results show that in presence of SNPs, the hydration reaction reach to 76% at 28 days, whereas plain cement achieve up to 63% at 28 days. An influence of degree of hydration on the porosity was also determined observed. In plain cement paste, the capillary porosity at 1h is ~48%, whereas in SNPs added cement is its ~35% only, which revealed that silica nanoparticles refines the pore structure due to accelerated hydration mechanism leading to denser microstructure. Addition of SNPs increases the gel porosity ~55% as compare to control system showing the formation of additional C-S-H, which is responsible for 37% enhancement in compressive strength of cement mortar at 28 days of hydration. Similar trend of results were observed in concrete system, wherein, the enhancement was ~14% with 3% SNPs addition. Overall, addition of SNPs densifies the microstructure, resulting in the reduction of chloride penetration by 65% at 28 days of hydration, while the sulphate ingression is reduces by 40% at 365 days of hydration. Detailed results will be presented and discussed during the conference.



UTILIZATION OF BRINE SLUDGE IN MANUFACTURE OF BUILDING BRICKS THROUGH GEOPOLYMERIZATION PROCESS

S D Muduli and N K Dhal

CSIR- Institute of Minerals and Materials Technology, Bhubaneswar, India

Most of world's chlorine production is by caustic soda industry. It has attracted particular attention of pollution control authorities. Stoichiometrically 1.46 MT salt (100% NaCl) and 0.45 MT water is converted to produce 1 MT of caustic soda, 0.89 MT of Chlorine and 25 kg of Hydrogen. Chlorine is largely used in the synthesis of chlorinated organic compounds and 98% of the water treatment plants in the world. The brine sludge is the waste of chlor-alkali manufacturing industry, generated during the chlorine and caustic soda production through the electrolysis of brine. The major environmental problems and challenges posed by this industrial sector are related to the disposal of brine sludge which may contain hazardous or toxic materials that precipitate from the brine. Even when the sludge produced is nonhazardous, it may contain substantial levels of dissolved metals and other impurities which during the course of time get leached out, thereby affecting ecosystem. It is, therefore, required to find alternate solutions for brine sludge management to render it suitable for ecologically safe disposal or utilization. In the present research work, manufacture of building bricks using brine sludge through geopolymerization process has been focused. Geopolymerization is a process which involves a substantially fast chemical reaction under alkaline condition with Si and Al bearing minerals that result into the three dimensional polymeric chain and ring structures of Si-O-Al-O monomers. Al and Si coordinate with oxygen atoms, and therefore, the presence of cations such as Na+ is essential to maintain the electrical neutrality in geopolymer matrix and to add strength to the product. Here along with fly ash locally available sea sand has been used as raw matrix. Suitable mixture of sodium hydroxide, sodium silicate in presence of cation and anion based chemical has been used as the chemical activator for preparation of brine sludge sand geopolymer building bricks . From the experimental investigation it is observed that there is a significant variation in setting and development of crushing strength of brine sludge sand geopolymer building bricks prepared with different combination of chemical activator. After 25 days of ambient curing it is found that the geopolymer building bricks manufactured with 50% of brine sludge by weight with addition of 4-10% of alkali activator in presence of cations and anions shows highest crushing strength. All the details of the experiment will be presented in the full paper.

SUSTAINABLE SOULTION FOR JUDICIOUS USE OF FLYASH FROM DESULFURIZATION PROCESS AND POND ASH

Alka Mishra, Raja Annamalai and Swaminathan N

FLSmidth Pvt Ltd, India

One of the major challenges in the present scenario is to utilize the flyash from desulfurization process. This type of flyash is generated when limestone was employed as SO_2 sorbents in the desulfurization process. The chemistry, mineralogy and high carbon content made this flyash unsuitable for use as a cement additive or a mineral admixture in concrete. Added to this the high sulphur content resisted to be used as part of fuel in clinkerization.

The other challenge that the power plant faces today is the utilization of pondash. It is mainly obtained from the wet disposal of the fly ash, which when get mixed with bottom ash is disposed off in large pond or dykes as slurry. The pond ash is relatively coarse and has high carbon content than flyash hence unsuitable for use as supplementary cementing materials (SCMs). The generation of the pond ash is posing a lot of threat to environment and thus its sustainable management has become the thrust area in engineering research.

F.L.Smidth (FLS) has been working over the years on judicious usage of these wastes. FLS and ST Equipment & Technology (STET) have come up with a sustainable solution for separation of high carbon content from, flyash from desulfurization process and pre-processed pondash.

With the help of tribo-electrostatic belt separation, a high efficiency multi-state separation is achieved by particle-to-particle charging, results in superior separation as compared to that achieved by a conventional free-fall tribo-electrostatic separator. It is a dry technology and does not require water or environmentally sensitive chemicals, unlike in wet beneficiation.

The pre-processing of pond ash helps to remove coarse particle and makes fit for separation system to remove carbon content. The final product dried flyash can be used as SCMs. FLSmidth supplies flash driers and separator combination to dry and classify the pond ash. Coarse pond ash has high carbon content and can be directly used as a fuel. Dry pond ash is pass through the tribo- electrostatic belt separator so carbon can be removed from pond ash.

"FLSmidth and STET has an understanding under which FLSmidth will undertake all studies and supply of equipment related to separation technology and tribo-electrostatic belt separator"

A FLEXIBLE TECHNOLOGY TO PRODUCE GRAY CALCINED CLAYS

Luiz Felipe de Pinhol, Luis Felipe Von Rainer Fabiani and Natália Bernardi Ghisi Celeghini

Dynamis Engenheria e Comércio, Brasil

The use of calcined clays as a substitute for clinker in the cement manufacturing is of great interest among the industries of cement and concrete due many reasons, such as lower cost of production, lower CO_2 emission rate and great availability of clay material. However, there are different kinds of clays available, regarding chemical and mineralogical composition. Processing clays with high iron content results in reddish or pinkish pozzolan and cements with reddish and pinkish hues are misjudged as low quality material.

A color change technology to produce gray pozzolan from high iron content clays have been developed by Dynamis and proved in both laboratorial and industrial scales.

This work presents the advance of this technology, proving that it can be applied to different kinds of clays and also that it can be implemented with the use of a flash dryer and a rotary kiln or considering only the kiln, that can be a refurbished equipment.

The technology also enables the production of pozzolan without the color change issue, but also in an efficient and economically viable way.

Using a combustion technology developed for clay activation, it's possible to control the calcination temperature and to obtain a controlled atmosphere, that is the key to the color change process.

Industrial scale tests proved that the technology is viable and versatile, regarding the types of processed clays.

Keywords: Pozzolan, Clay Color, Reducing Atmosphere, Industrial Scale, Calcined Clay, Rotary Kiln, Flash Dryer.

DESIGN AND CONSTRUCTION OF LOW TRAFFIC VOLUME CONCRETE ROADS USING C&D AGGREGATES AND SUPPLEMENTARY CEMENTITIOUS MATERIALS

Vaibhav Chawla, Amit Trivedi and V V Arora

National Council of Cement and Building Materials, India

Low-traffic volume roads connects built up areas of cities, towns, and communities, and it shall have a traffic volume of less than 450 CVPD. In order to adopt sustainable construction practices, use of alternate materials and waste based aggregates is being pursued to conserve natural resources. In this paper, the author had worked on design of low traffic volume concrete roads using C&D aggregates as recycled aggregates (RA) in base/sub-base layer and recycled concrete aggregates (RCA) in pavement quality concrete (PQC) layer. Also, in-situ blends with composition (50% OPC-43G cement, 30% Ground granulated blast furnace slag (GGBS) and 20% Flyash) has been used in PQC layer. The study includes testing of C&D aggregates for their suitability in base layer (as RA) and PQC layer (as RCA). It is observed that the RA conform to the requirements laid by IRC SP-62:2014 for base layer. RCA aggregates were tested for their physical and mechanical properties and concrete mix designs were carried out with various replacement of natural aggregates with RCA (both as coarse and fine aggregate) at various percentages. The fresh and hardened concrete properties were studied and compared with similar specimens cast using natural aggregates (control sample). As per the analysis of concrete properties concrete mix at 75% and 100% replacement of natural aggregates with recycled concrete aggregates were selected for experimental stretch casting. Experimental stretches with uniform base using recycled aggregates and PQC Layer with panel size of (1.33m X 1.25m) were cast using supplementary cementitious materials (GGBS and flyash along with OPC) and C&D aggregates (recycled concrete aggregates) at replacement of 75% and 100% to that of natural coarse and fine aggregates respectively. A control stretch with similar base layer and PQC layer with 100% natural aggregates was also cast to compare the performance of the experimental stretches. The stretches were analyzed for strain and thermal stresses over a period of 28 days and the results were found to be comparable with the control stretch. On the basis of lab results and performance analysis of cast stretches it was concluded that C&D aggregates can be used as 100% replacement of natural aggregates in base layer (as RA) and PQC Layer (as RCA).

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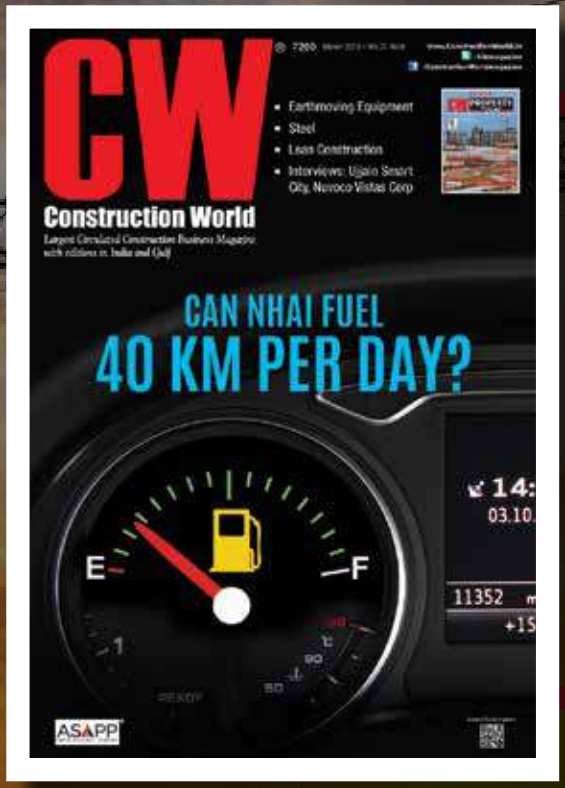

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