Two Day International Seminar on

MODERN MATERIALS & METHODOLOGY FOR CONCRETE CONSTRUCTION

Date: 23 - 24, September 2016 | Venue: The Lalit Ashok Hotel, Bengaluru

SEMINAR DOCUMENT

Organised by:

INDIAN CONCRETE INSTITUTE (ICI)
Bangalore Centre - Karnataka

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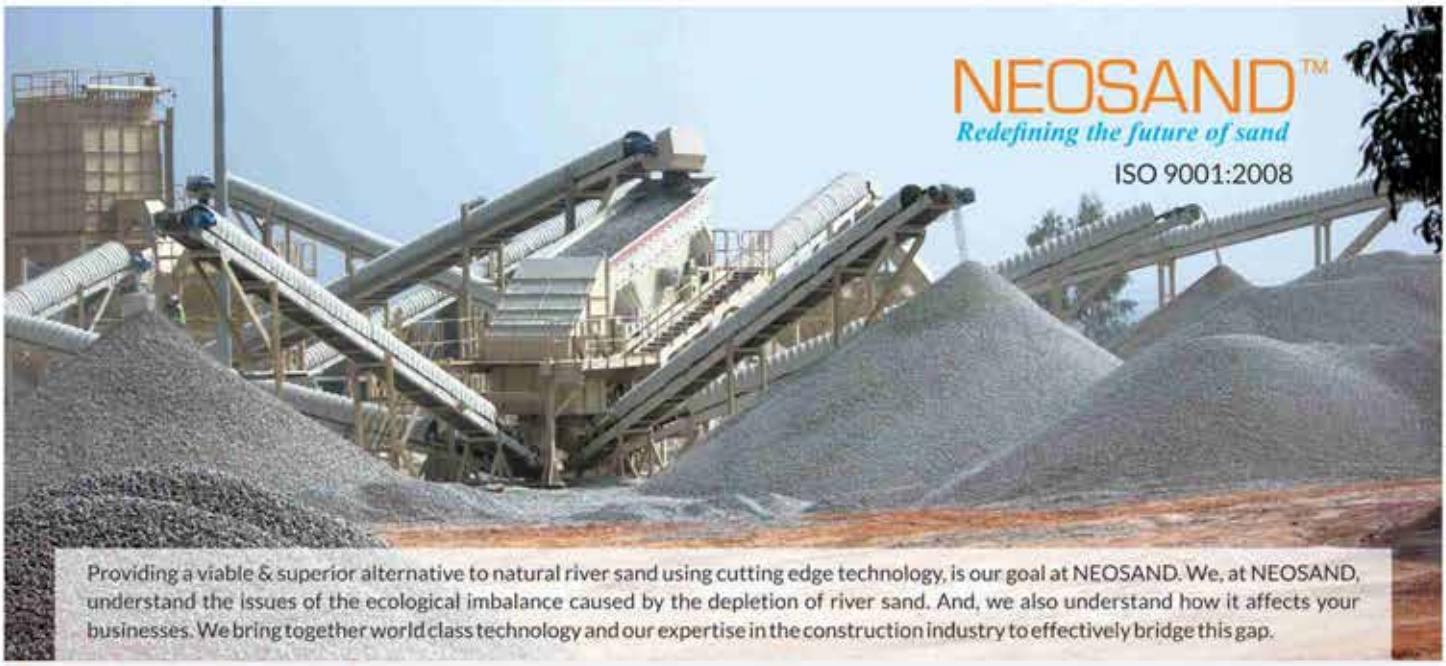

Providing a viable & superior alternative to natural river sand using cutting edge technology, is our goal at NEOSAND. We, at NEOSAND, understand the issues of the ecological imbalance caused by the depletion of river sand. And, we also understand how it affects your businesses. We bring together world class technology and our expertise in the construction industry to effectively bridge this gap.

Manufacturing Process

The solution used to manufacture NEOSAND has been provided by **METSO - Finland**, who are world leaders in providing crushing & screening solutions.

The solution involves a 250 Metric Tons Per Hour **4-stage** crushing & screening process, using imported machinery in the order of:

Jaw Crusher -> Cone Crusher -> Vertical Shaft Impact (VSI) Crusher -> Dry Air Classifier

The raw material, granite grade boulders of high quality are sourced from our quarries and fed to the primary Jaw Crusher. The material is down sized and shaped as it progresses through the first three stages.

The VSI with its rock-on-rock crushing action improves the soundness and shape of products. Aggregate particles that are cubicle in shape are ideal for maximizing the strength of mortar and concrete.

NEOSAND is further passed through a fourth stage consisting of Dry Air Classifier to remove excess ultra-fines (150 micron) to keep its percentage within grading envelopes defined by IS:383. Contrary to the previously used washing technique which uses lots of water, our new imported technology does not require water and uses air flow, gravity and directional changes to produce NEOSAND of superior quality.

Main Products

NEOSAND

Particle sizes are in the range of 150 micron - 4.75 mm. NEOSAND is the ideal substitute for natural river sand in concrete. Due to being well graded, usage of NEOSAND can overcome the defects in concrete such as honey combs, segregation, voids, capillary etc.

NEOAGGREGATES

NEOAGGREGATES are readily available in 6 mm, 10 mm, 20 mm & 40 mm varieties. They are used in many areas of construction but primarily in concrete, asphalt and as a filler medium. NEOSAND supplies aggregates of varying sizes to suit the requirements of the customer.

NEOPLAST

Particle sizes are in the range of 150 micron – 2.36 mm. NEOPLAST is NEOSAND's solution specifically tailored for the plastering industry. The specially graded product is perfectly suited for brick laying and plastering.

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A very fine product with particle sizes in the range of 150 micron – 600 micron has a wide range of uses. It is used in the manufacture of tiles, cement blocks and for compacting.

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PREFACE

Construction Industry plays a vital role in the economic development of the country. India's construction industry hasa market size worth about Rs.25 Billion. It is the second largest contributor to the GDP after the agricultural sector. A vital constituent of the construction industry is attributed to concrete. In the present day scenario concrete is rarely being used in its original form.Use of admixtures in the modern concrete is inevitable.

Indian construction chemicals industry stands at over Rs.6000cr and shows growth of approximately 17% over the last 5 years. Concrete admixtures constitute a major portion of this construction chemicals industry with 42% of the share and waterproofingcontributing to about 18% of total construction chemicals volume.

Therefore Indian Concrete Institute has precisely chosen concrete admixtures and waterproofing as prime theme of Concrete Panorama & Deminar – 2016.This is not only because of the size of the market of the above segments but also because of the importance of concrete being the largest consumed material in construction, and in modern day concrete cannot be thought without admixtures and waterproofing is also as an important part of the industry as the construction itself.

Concrete Panorama & Deminar 2016 has attracted very good response from the industry. As of now, four key note addresses, four Technical Presentations, ten Demonstrations are scheduled to take place during the event.

This souvenir consists of all the lead lectures and a few of important topics of relevance are compiled herein.

The organizations supporting the event are to be duly recognized. Keeping this in view, the advertorials of these organizations are also included in this compendium.

We hope that this Deminar document will be a good takeaway to all the participants.

Happy reading

Mr. M N Ramesh

Editor-in-Chief.

Message by Chairman, ICI - Bangalore Centre

The Civil Engineers for the present and future should have special skills and specific competencies. The engineering colleges are trying to reduce the gap existing between industry and academia by offering trainings and special courses. In spite of all these efforts the employability of the graduates coming out of the institutions is not up to the expectations of the industry. The reasons quality faculty, lack of Infrastructure and there are many such. With systematic training of faculty and students from the beginning of the professional course and regular interactions with the industry and professional associations, the problem of employability may be addressed. Motivation, practical oriented teaching -learning methodologies, original project works, proper mentoring and good salaries will make some difference in the present status of employability.

Indian Concrete Institute, Bangalore Centre will strive to reduce the gap between industry and academia by interactions with the industry experts. FOCUS ON QUALITY IN ALL THE ARES IS THE NEED OF THE DAY. To facilitate this, we have formed focused KBC working groups. These working groups will be functioning as per the guidelines of the advisory Board.

As a team, keeping the objectives of the ICI in focus, we will be able to make a difference and contribute for the betterment of the profession.

Dr. Aswath M U
Chairman, ICI-BC
Bengaluru

Message by Secretary, ICI - Bangalore Centre

Welcome to all the Civil Engineering Professionals!!!

I am sure all the delegates will have a lot of value addition by the end of the program.

I personally wish to thank the Chief Patron, Patron, Sponsors, Exhibitors, Supporting Organisations and all the Advisors and the Members of the Organizing Committeefor their support and guidance in making this event.

"There is no wealth like knowledge, and no poverty like ignorance – Buddha"

Looking forward to meet you.

Kaushik Hajra

Secretary,

ICI-BC
Bengaluru

ABOUT ICI and ICI - Bangalore Centre

Indian Concrete Institute - Bangalore Centre
www.icikbc.org Email: icikbc@gmail.com

ICI was born on 7th September 1982, with Head Quarter in Chennai.

It has 38 centers with more than 12,000 members spread across the country.

ICI is having more than 154 ICI-Student chapters across the country.

ICI- Bangalore center was started in the year 1984 and it is successfully being run by an able adoptive and progressive managing committees since then.

ICI - Bangalore Centre is one of the active centres, which conducts several programs every year.

ICI- Bangalore Centre has a membership of over 800 with over members in Bangalore city and membership is growing progressively day by day.

ICI –Bangalore Centre, Karnataka
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Objectives:

Promote growth of concrete construction and its sub-specialization.

To disseminate information and train personnel by organizing seminars/Conferences/workshops.

Training programs for fellow members/students and corporate.

Collaborate with national / international agencies.

Identify R & D problems of practical relevance.

Arrange National and International Workshops, Conferences, Seminars, Deminar and Exhibitions.

Arrange annual lecture series on selected topics of relevance to Concrete Constructions.

To identify and recognize outstanding construction and outstanding performers in the field of

concrete technology / construction.

Important Events and Programs from ICI - Bangalore Centre.

Monthly technical lectures, Endowment Lectures, National Workshops and Conferences.

ICI- BC was the first to organize ICI-IWC (Innovative World of Concrete) in 1993,

ICI ACECON in2000.

ICI- BC is the first centre among all the centres of ICI in India to start Concrete Panorama and Deminar at Bangalore in the year 2009.

Training Modules on Concrete and Concrete Technology for various organizations and Institutions,

These programs are conducted throughout the year to cater for the specific needs of the organizations concerned.

Concrete Days Celebrations:

- Indian Concrete Institute- Bangalore centre celebrates concrete Day on 7th September everyyear. This event is celebrated in a grand and befitting manner.
- Every year during the Concrete Day Celebrations ICI- BC in association with Ultratech Cements Ltd recognizes outstanding and innovative structures built using concrete as main construction material and also identify and honour an individual who has worked for the cause of Concreteand rendered significant contributions to the research, development and application of concrete.
- The prestigious awards instituted and given away during the Concrete Day Celebrations are:
- ICI-BC - Ultratech Endowment Award for outstanding Concrete Engineer of Karnataka.
- ICI-BC - Birla Super Endowment Award for Outstanding Concrete Structure of Karnataka.
- ICI-BC – Ultratech Endowment Award for "Well Built Residential Structures of Rural District
- ICI-BC – Ultratech Award for Outstanding Thesis for Masters / Doctoral
- ICI-BC – Ultratech Award for Outstanding ICI Student Chapter

The following Managing Committees are instrumental
in keeping the flag of ICI-BC fly very high since its inception in 1984

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RETROFITTING OF BRIDGES AFFECTED DURING SEISMIC ACTIVITY

Er. Vinay Gupta

GENERAL

Occurrence of earthquake is no more a rare eventuality. India has witnessed several major earthquakes, involving substantial loss of lives. To name a few, a major earthquake (Richter scale 8.5) occurred in Assam in 1897 wherein the reported death toll was 1500. It was repeated at the same place in 1950 with similar number of reported deaths. Similarly in 1934 major earthquake (Richter scale 8.4) occurred in Bihar-Nepal area claiming 14000 lives. It was repeated in 1988 claming about 1000 lives. The most recent major earthquake (Richter scale 8.0) in Bhuj claimed over 20,000 lives. By and far, major earthquakes have been observed to repeat in about 50 years in high earthquake prone areas. Comparatively, a larger number of bridges have been affected by seismic activities in America and Japan than those in India. Latur earthquake in 1993 did wake up the authorities to survey the bridges in Maharashtra area, retrofit and rehabilitate those bridges. Golden Gate Suspension Bridge, San Fransisco has been another example of Earthquake Retrofitting. Technique of retrofitting is not unique or predefined. It has to be decided on case to case basis, depending upon the prevailing circumstances.

OBSERVED DAMAGES

Quite often, damage is noticed in and around the bearings due to stress concentration at these locations. Fig.1 shows an example of such damages even in a newly constructed bridge. Bearing has always been said to be a week link between massive superstructure and the substructure. Similarly fig. 2 shows that the superstructure of another bridge pounded the dirt wall, due to excessive longitudinal movement.

FIG. 1 DAMAGE AT BEARING LEVEL IN NEW SURAJBARI BRIDGE

FIG. 2 MACCHU BRIDGE SUPERSTRUCTURE POUNDED THE DIRT WALL

Fig. 3 shows damage of short vertical cantilever attached to the pier cap provided to negotiate difference of depths of the two adjoining superstructures. This happens due to formation of plastic hinges and lack of dissipation of earthquake energy at these locations. Similarly, fig. 4 shows damages of L-shaped superstructure at the half joints provided to house the hinge bearing.

FIG. 3 BRIDGE BETWEEN SURAJBARI AND BHACHAU

FIG. 4 SURAJBARI OLD BRIDGE HALF JOINT IN DISTRESS DUE TO VERTICAL AND HORIZONTAL SHAKING

SEISMIC STRENGTHENING

Possible causes of deficiency in a bridge can be broadly the following:-

- Inadequate Design.
- Lack of Understanding by the Designer
- Inadequate Construction
- Deterioration of Material with Time
- Upgradation of Seismic Design Requirements
- Upgradation of Seismic Zones

Therefore, main requirements of the proposed strengthening are as follows:-

- Should be Economically Feasible
- Should be Technically Viable
- Should Surmount Functional Constraints
- Should Reduce Seismic Demand
  - Reduce SILD and LL
  - Reduce Stiffness – Saw Cutting of Parapet
- Increase Dissipation of Seismic Energy
- Dampers
- Increase the Supply Strength
- Structural Strengthening

Seismic forces cause plastic hinge formation and overstressing at specified locations, such as pier-foundation junction, pier-superstructure junction in case of integral bridge, etc. For all such conditions, the pier cap can be confined to substantially enhance the performance during ultimate load conditions, see figs. 5 and 6.

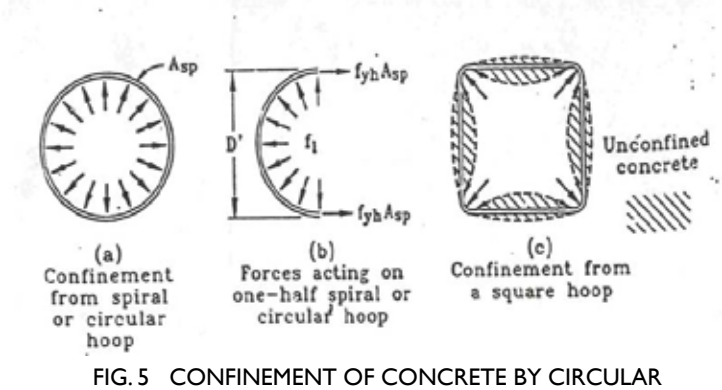

FIG. 5 CONFINEMENT OF CONCRETE BY CIRCULAR AND SQUARE HOOPS

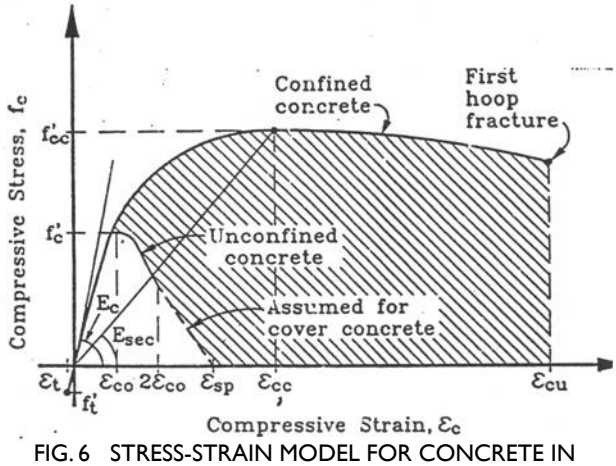

FIG. 6 STRESS-STRAIN MODEL FOR CONCRETE IN COMPRESSION

The figs. 7 and 8 below depict detailing for strength enhancement through addition of steel and concrete respectively. The additional concrete of the pier needs to be adequately anchored to the corresponding foundation.

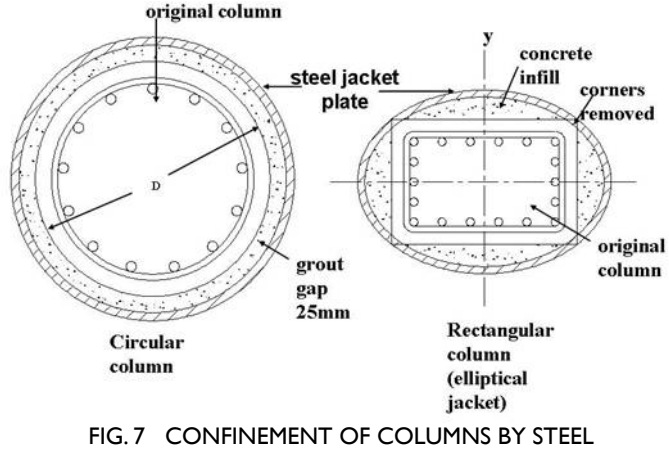

FIG. 7 CONFINEMENT OF COLUMNS BY STEEL JACKETING

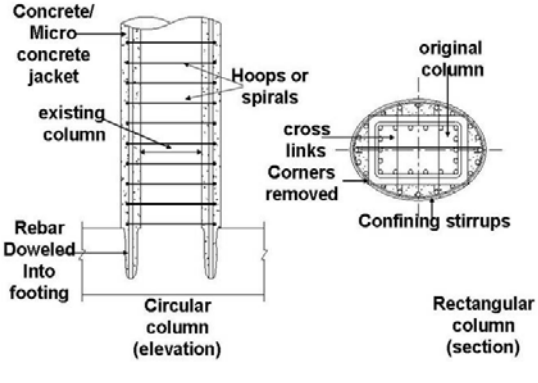

FIG. 8 CONFINEMENT OF COLUMNS BY CONCRETE JACKETING

Concrete portals are commonly connected to the superstructure either through bearings or integrally. In such cases, the seismic force carrying capacity of a portal can be enhanced as depicted in figs. 9 and 10.

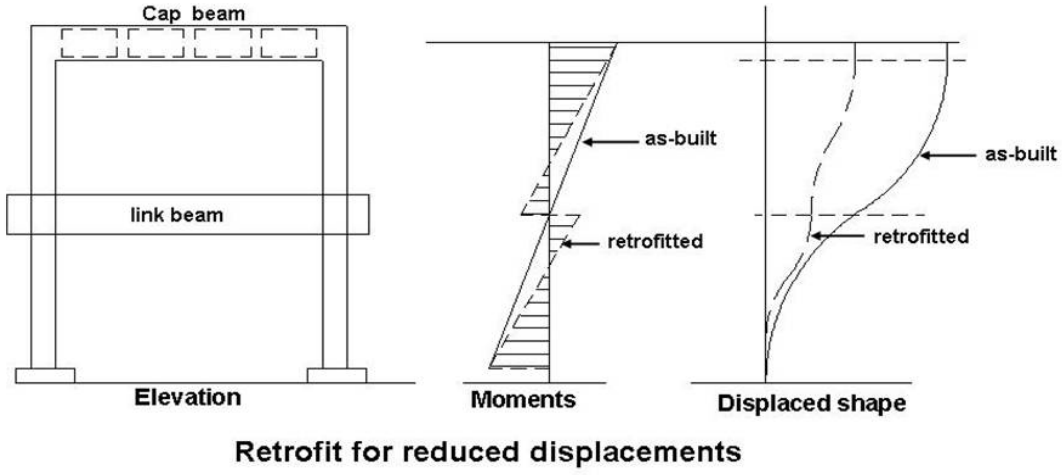

FIG. 9 USE OF LINK BEAM TO IMPROVE TRANSVERSE SEISMIC RESPONSE OF MULTI-COLUMN BENTS

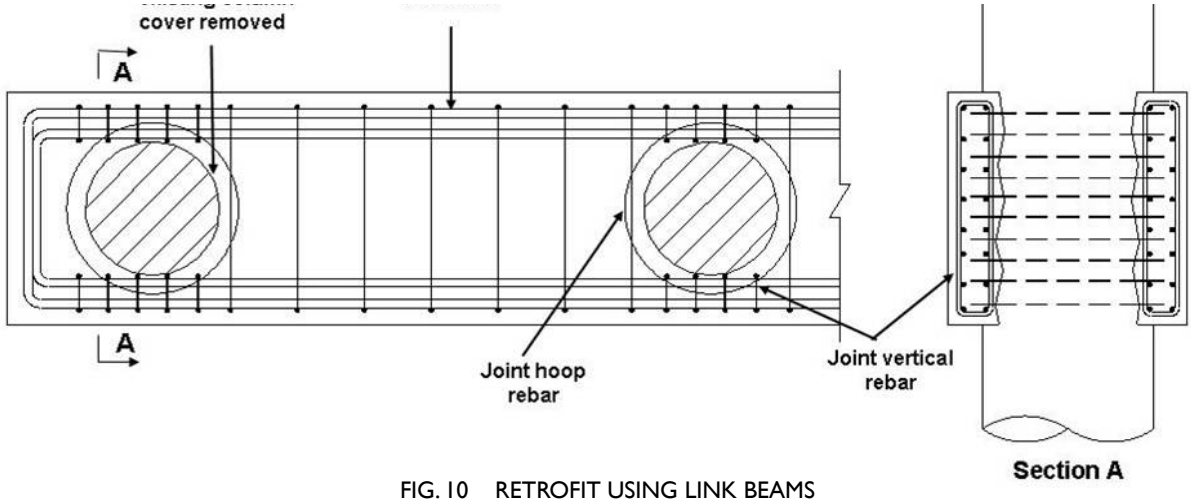

FIG. 10 RETROFIT USING LINK BEAMS

In the seismic conditions, foundations need to be strengthened both for downward load and uplift. Fig. 11 depicts the use of additional piles to increase downward load capacity of pile foundation and the use of Passive Ground Anchors for prevention against uplift. Fig. 12 depicts increase of structural strength of foundation by additional concrete and addition of prestressing after drilling hole into the foundation and grouting it after the application of prestress.

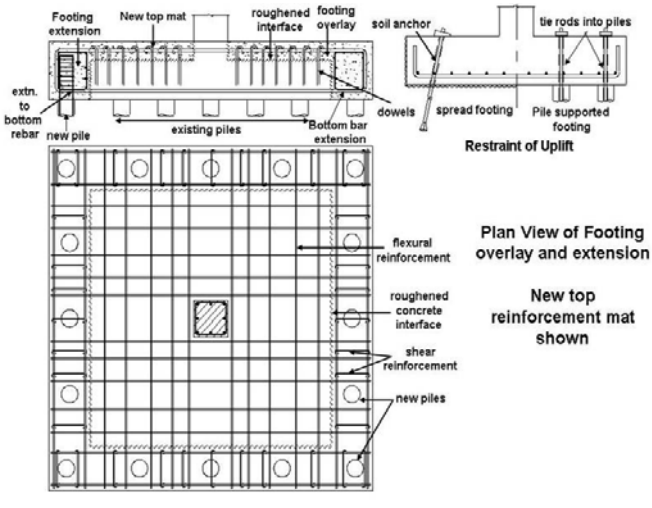

FIG. 11

FOOTING RETROFIT MEASURES

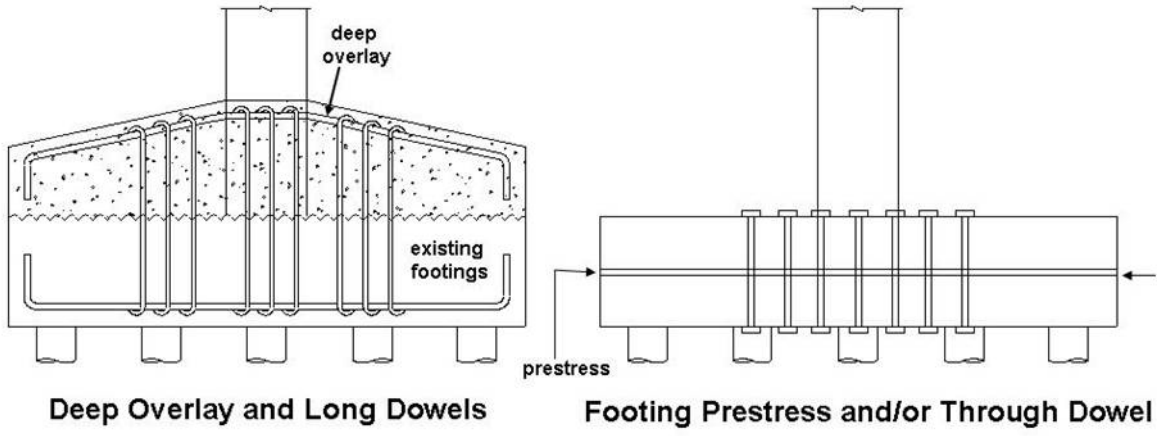

FIG. 12 RETROFIT MEASURES FOR JOINT SHEAR STRESS DEFICIENCIES

Reinforcement couplers and rebar fasteners are very useful components for enhancing the strength of an existing structures. Existing reinforcement can be suitably extended by providing reinforcement couplers, see fig 13. In case, new reinforcing bars have to be added, rebar fasteners can be provided by drilling a hole of specified diameter and depth in concrete and filling high strength resin before inserting reinforcing bar, see fig. 14. This way full strength of the bar can be achieved.

FIG. 13 REINFORCEMENT COUPLERS

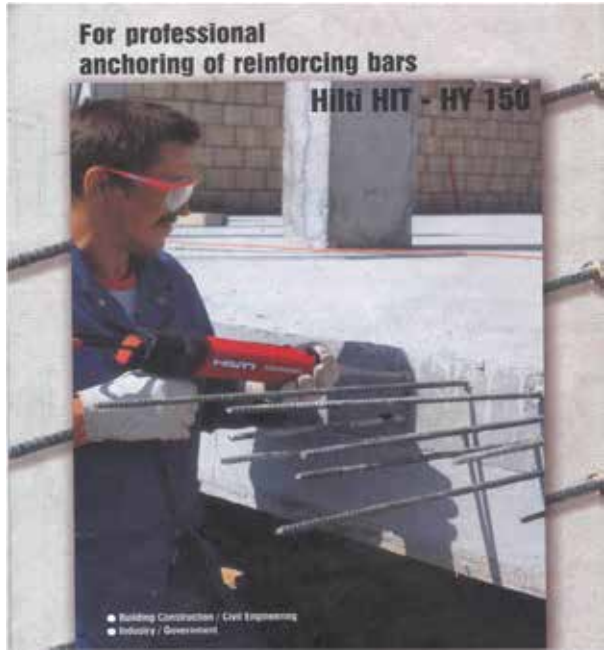

FIG. 14 REBAR FASTENERS

In case a well foundation has to be strengthened, it can be done in the manner depicted in fig. 15. In case a masonry pier/ abutment has to be increased in dimension, it can done in the manner depicted in fig. 16.

In many cases, wing walls are found to be bulged out due to seismic movement of the earthfill behind the wing wall. In such cases, solution lies in providing prestessing force to restore the wing wall as shown in figs. 17 & 18. In these cases, the operation is performed in two parts, (one half road width at a time). After removing the road crust, a 300mm dia CI pipe with coupling flanges is placed. Thereafter, RCC is added (along with necessary shear connectors) to increase the section of the wing wall and the size of its footing. Now, prestressing wire/strands encased in HDPE tube are inserted into the CI pipe and prestessed and subsequently grouted.

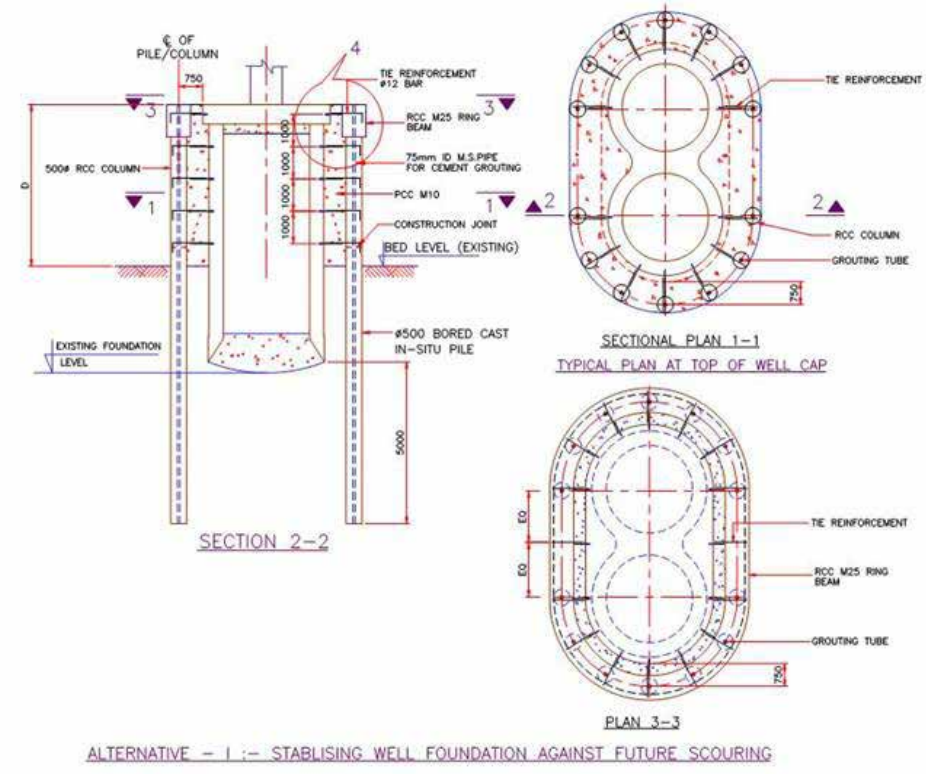

FIG. 15 STRENGTHENING OF WELL FOUNDATION

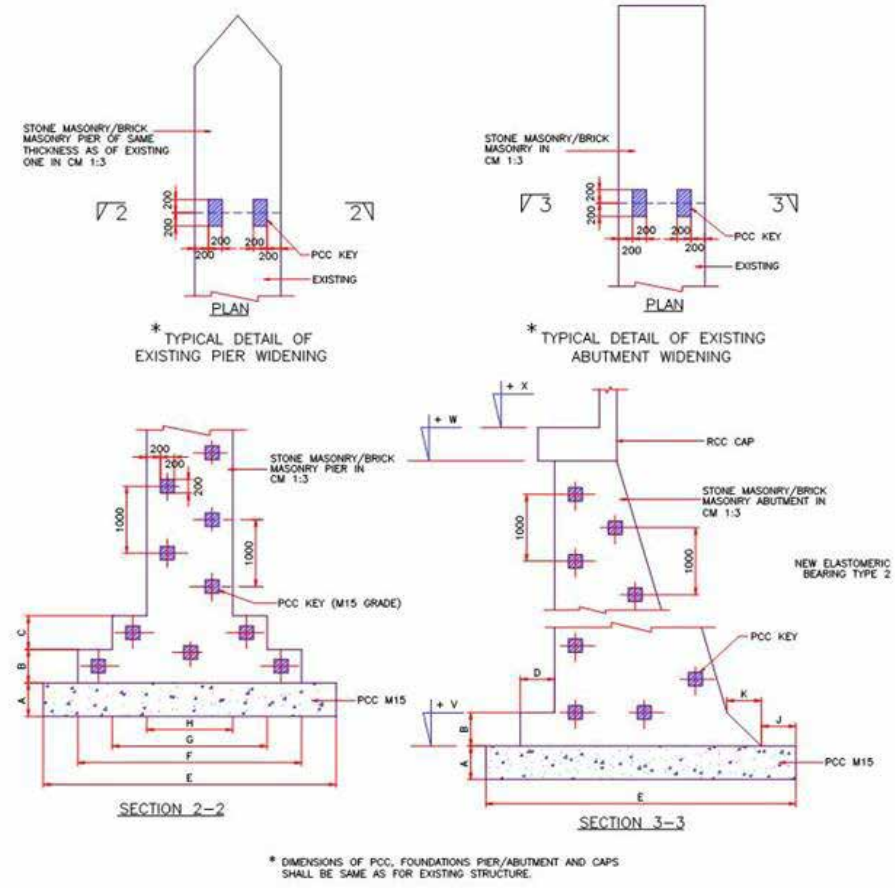

FIG. 16 WIDENING OF MASONARY PIER & ABUTMENT USING SHEAR KEYS

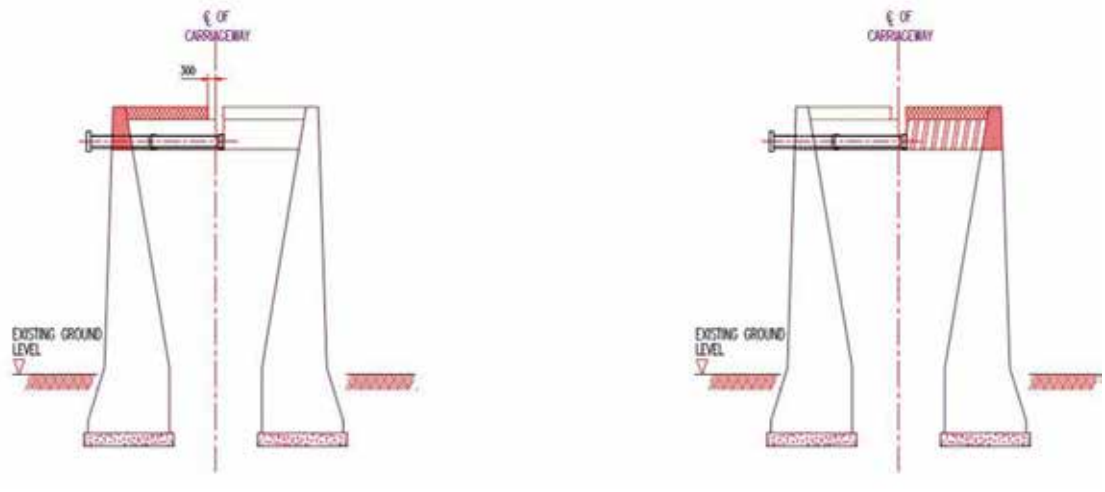

FIG. 17 SCHEME FOR STRENGTHENING OF MOVED WING WALL

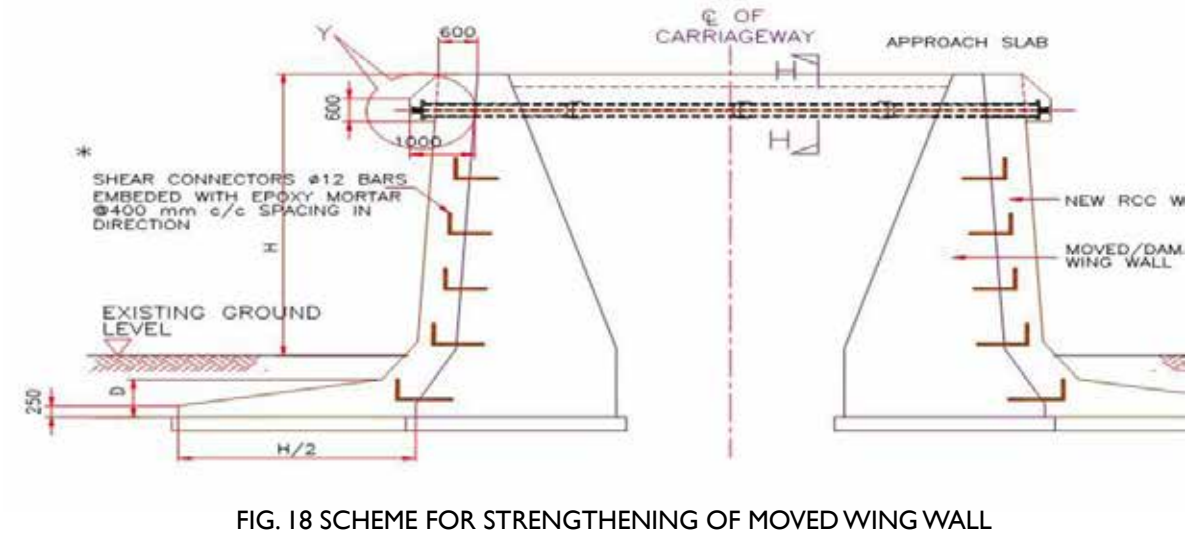

FIG. 18 SCHEME FOR STRENGTHENING OF MOVED WING WALL

Seismic forces experienced by the bridge can be substantially reduced by addition of vertical concrete upstands from the pier/abutment cap and sandwitching flexible material, such as elastomer. Figs. 19 and 20 depict the system of such an arrangement. In this arrangement.

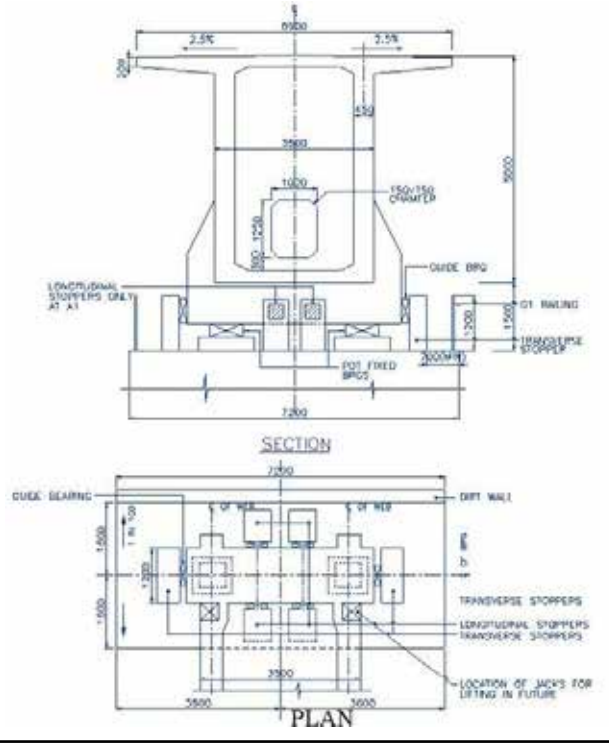

FIG. 19 SEISMIC RESTRAINT DEVICES OVER ABUTMENT

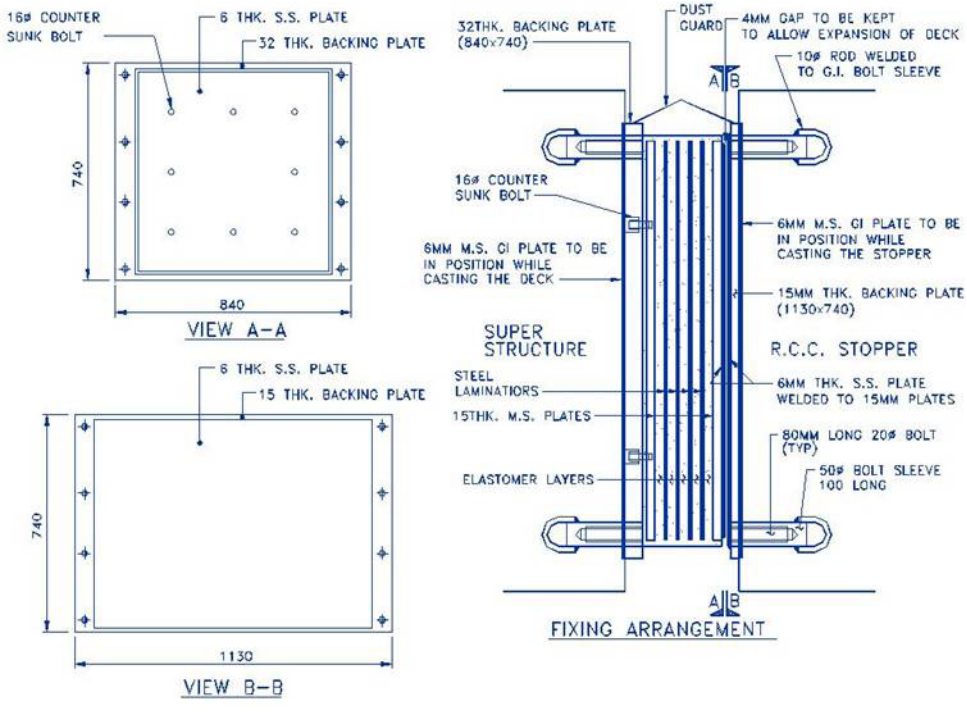

FIG. 20 VERTICALLY POSITIONED ELASTOMERIC BEARINGS

the vertical elastomeric bearings need to be detailed in a specialized way, wherein, the mating surface between the fixed side and the moveable side is made into stainless steel, in order to reduce sliding friction. For anchoring purpose a mild steel plate vulcanized on the surface of the bearing, as shown in fig. 20 is provided. Figs. 21 and 22 depict an isometric view and photograph of such concrete upstands that receive the vertical elastomeric bearings. The elastomer acts as isolator by substrantially increasing time period of the structure, thereby reducing the seismic forces experienced by the structure.

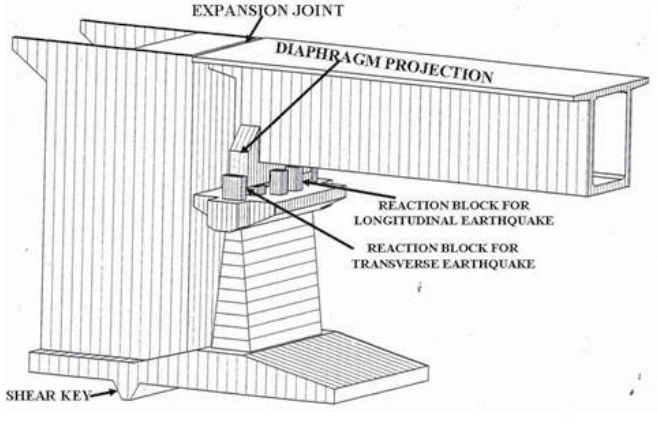

FIG. 21 DETAILS AT RESTRAINED BEARING OVER ABUTMENT

FIG. 22 PHOTO OF SEISMIC RESTRAINERS

The other method of strength enhancement is to provide fiber wraps. Mainly there are Carbon Fiber Wraps and Glass Fiber Wraps. These fiber wraps exhibit low creep and elongation and compared to steel, they are thinner, lighter and have up to 10 times and tensile strength capacity. Since, these wraps have unidirectional tensile capacity, they have to be carefully provided in the direction, strength enhancement is desired. Incase both shear and flexural strengths are required, two layers of the wrap perpendicular to each other are provided, refer figs. 23 and 24 for examples of fiber wrap application.

High tensile carbon sheets can also be used as laminates These laminates exhibits higher tensile strength compared to fiber wrap. The laminates are provided as discrete strips in the orientation of desired strength viz. shear or flexure, see fig. 25 for illustration. These laminates can also be prestessed as shown in fig. 26.

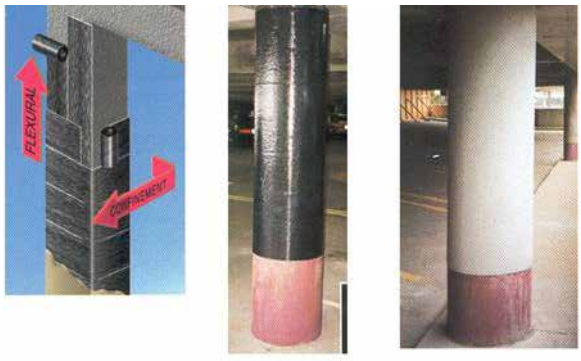

FIG. 23 EXAMPLES OF FIBER WRAP SYSTEM

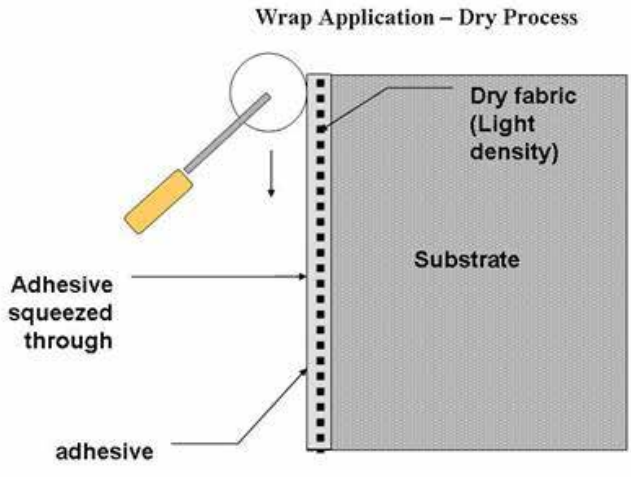

FIG. 24 APPLICATION OF FIBER WRAP

FIG. 25 CARBON LAMINATE

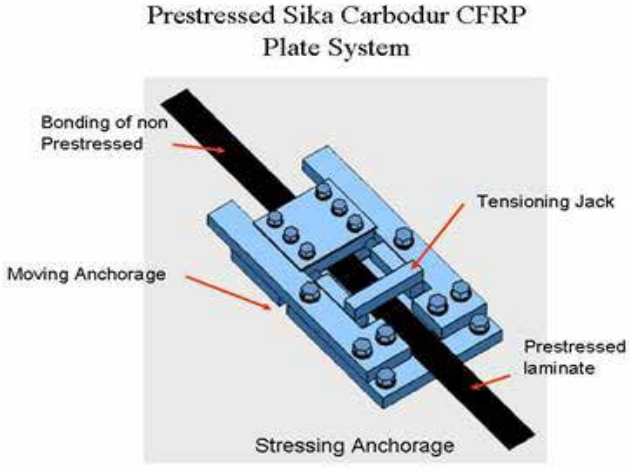

FIG. 26 PRESTRESSED LAMINATE

CONCLUSION

Method of seismic strengthening of bridges is a case specific matter. Depending upon the requirements of a particular location, the system of strengthening of superstructure, substructure and/or foundations has to be decided. An attempt should be made to reduce seismic demand by providing seismic isolators/dampers or increasing flexibility of the structure, provided they do not impare efficiency and functionality of the bridge. Confinement of core of piers using concrete jacket or steel jacket is an effective method of strength enhancement. When reinforcement has to be added, reinforcement couplers and rebar fasteners turn out to be useful items of structure. All the bridge components need to be investigated for strength enhancement.

Er Vinay Gupta
Chief Executive Officer
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New Delhi – 110014

ULTRA HIGH PERFORMANCE CONCRETE - A WONDER MATERIAL

Dr. Manamohan Kalgal

Concrete

- One of the most versatile Construction material
- Panacea for all problems
- Called ³flowing stone´
- +R732/'´LV&ROFUHWH"

- The Romans are generally credited as being the first concrete engineers,
- but archaeological evidence says otherwise
  - Known to Syrians during 6500BC
  - Yugoslavians in 5600BC and
  - Chinese around 3500 BC

Concrete

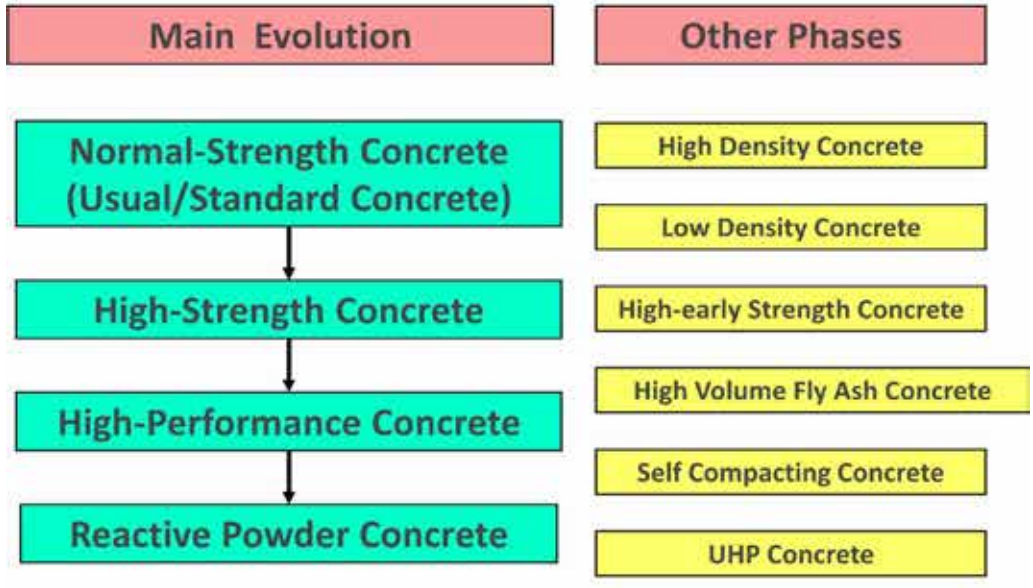
- Evolution
- Modern (newer) concretes
- All previous versions will remain in use

Why Newer concretes ?

- Structural challenges
- Architectural challenges
- Fascination with steel
- Need for fracture toughness
- Strain hardening desirable
- From stone like material to steel like performance

- Concerns of longevity
- Concerns of Sustainable development
- Commercial needs
- Repair/Rehabilitation/Retrofitting
- Above all, dynamics of evolution

Evolution in Concrete Technology



Special Concretes

- Special concrete is a concrete that has been specially designed to achieve one or more **properties, behavior, composition** or **performance** to be different, usually superior, compared to conventional concrete.
- With special concretes, possibilities are **ENDLESS«**
- Special concretes can even be designed and specified, specifically for a project or an application.
- Special concretes need special care and control to achieve the desired properties

SOME IMPORTANT ANIFE TATION OF CON RETE

- High Strength concrete,
- High performance Concrete,
- Fiber reinforced concrete,
- High Volume Flyash Concrete,
- Foam concrete,
- Self-compacted concrete,
- Self-curing concrete,
- Self-healing concrete
- Smart concrete,
- Controlled low strength concrete,
- Pervious concrete,
- Roller compacted concrete,
- Reflective concrete,
- Translucent concrete,
- Coloured and decorative concretes

High Performance Concrete (HPC)

HPC - something more than what is achieved on a routine basis and involves a specification that often requires the concrete to meet ***several criteria***.

The ACI definition - A concrete meeting ***special combinations of performance and uniformity requirements*** that cannot always be achieved routinely when using conventional constituents, mixing, placing and curing practices.

A high-performance concrete usually has certain characteristics that are ***developed for a particular application and environment***.

Properties of HPC

HPC may have performance that is superior with respect to one or more of the following properties,

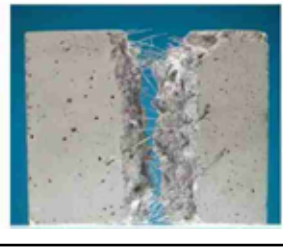
Ease of placement
Placing without Compaction
Early age strength
Long-term mechanical properties - durability
Lesser Heat of hydration
High/Low Density
Crack resistance
Toughness
Heat Resistance
/RQJOLIHLQVHYHUHHQYLURQPHQWVHWF«

Fibre Reinforced Concrete (FRC)

FRC - conventional concrete to which discontinuous discrete fibres are added during mixing, so as to enhance the properties of the concrete, such as tensile and flexural strength, ductility, toughness and crack resistance

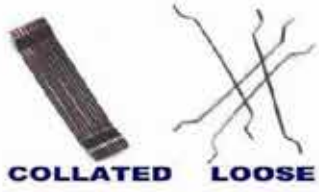
Improvement of properties of concrete by addition of fibres, governed by three main factors:

- Physical properties of concrete matrix and fibres.
- Uniform distribution of fibre throughout the matrix &
- Bond strength between concrete and fibre.

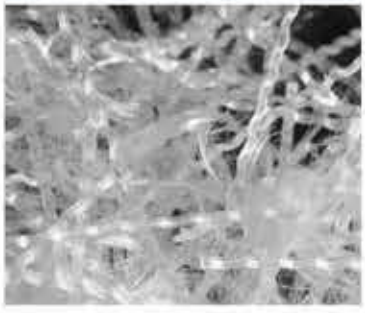


Fibre Reinforced Concrete (FRC)

Different fibres available



Steel fibres

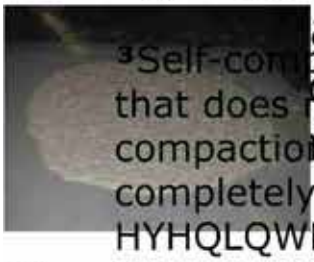


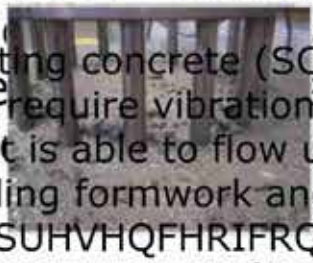
Synthetic fibres

Glass fibres

Self Compacting Concrete (SCC)

SCC - a category of High Performance Concrete that has excellent deformability in the fresh state, high resistance to





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³Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, HYHQLQWKHSUHVHQFHRIFRQJHVWHGUHLQIRUFHPHQW´ [European Concrete Platform ASBL]

Flowability

Passing Ability

Segregation Resistance

Steel Fiber Reinforced Self Compacting Concrete (SFRSCC)

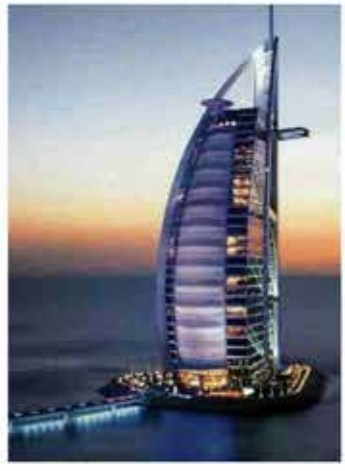
- **SFRSCC**, when compared to conventional concretes, presents clear technical advantages in terms of cost/benefits ratio.
- Concern Issues:
  - ± strong perturbation effect produced by steel fibers on the flowing ability of fresh concrete.
  - ± tendency of fibers to orient in the direction of the flow
  - ± the type, diameter, aspect ratio, and volume fraction of fibers come (in addition to the maximum aggregate size, coarse aggregate content, fine aggregate content) to play an important role in flowability of SCC with fibers.
  - ± the design procedure and the optimization technique followed to achieve self-compacting requirements must be sensible to the fiber content, as well as to the geometrical and material properties of the fibers and their orientation

Growing use of SCC

It can

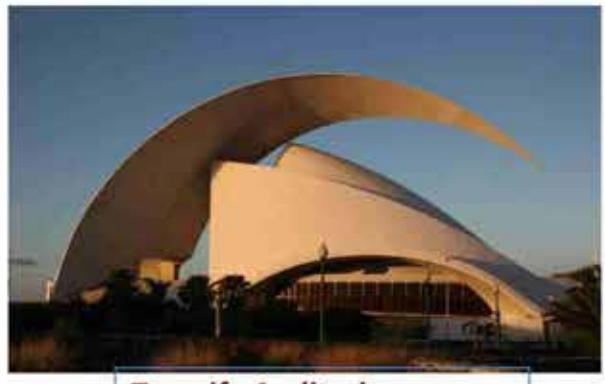
- Be placed from bottom to top
- Minimize manpower and equipment outlay for placing
- Make pumping easier and faster
- Flow into complex structures
- 2FFXS\LW¶VSODFHZLWKRXWDQ\FRPSDFWLRQ
- Reach inaccessible points
- Be placed in congested reinforcement situations
- Give a superior surface finish
- Give a safer and less noisier site condition
- Improve early strength, hence reduce form stripping time.

Aesthetic Structures in Concrete



Aesthetic Structures in Concrete

Aesthetic Structures in Concrete



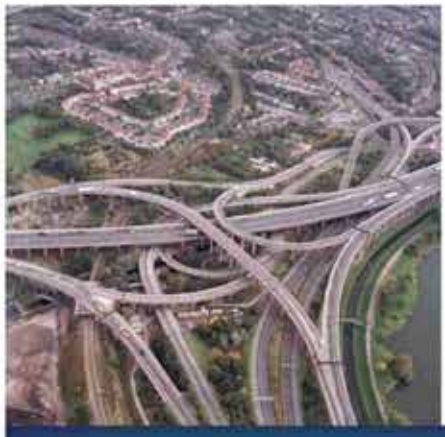
Tenerife Auditorium

TGV Railway Stn. France

tŽŽĚLJůůĞŶƐ^ůĞĞĐĐĞĞ-Colarado

Aesthetic Structures in Concrete

Creations in Concrete



Ultra High Performance Concrete (UHPC)

- It is also known as Reactive Powder Concrete (RPC)
- It is a high strength, ductile material formulated by combining portland cement, silica fume, quartz flour, fine silica sand, high-range water reducer, water, and steel or organic fibers

Material	lb/yd^3	kg/m^3	Percentage by Weight
Portland Cement	1,200	712	28.5
Fine Sand	1,720	1,020	40.8
Silica Fume	390	231	9.3
Ground Quartz	355	211	8.4
HRWR	51.8	30.7	1.2
Accelerator	50.5	30.0	1.2
Steel Fibers	263	156	6.2
Water	184	109	4.4

Ultra High Performance Concrete (UHPC)

- As a class, UHPCs have high cementitious materials contents and very low water-cementitious materials ratios.
- UHPC can be mixed in conventional mixers but the UHPC mixing time is longer than for conventional concrete.
- The method of placing UHPC has an influence on the orientation and dispersion of the fibers, which influences the tensile properties of the UHPC.
- The properties of UHPC are affected by the method, duration, and type of curing. As with conventional concrete, heat curing accelerates the development of strength and related properties.
- Delaying the application of heat for several days can enhance the measured properties, although it may not be compatible with the rapid production in precasting operations.
- Smaller size cylinders have been used in quality control for measurement of compressive strengths

UHPC

- High Compressive Strength
- Ductility in the Post-cracking Stage
- Internal crack bridging capability
- Dimensionally compatible
- Essentially zero permeability
- Excellent bonding capabilities
- Abrasion Resistance similar to rocks

Ultra High Performance Concrete (UHPC)

Range of UHPC Material Properties

Property	Range	
Compressive strength	20 to 30 ksi	140 to 200 MPa
Tensile cracking strength	0.9 to 1.5 ksi	6 to 10 MPa
Modulus of elasticity	6,000 to 10,000 ksi	40 to 70 GPa
Poisson's ratio	0.2	0.2
Coefficient of thermal expansion	5.5 to 8.5 millionths/°F	10 to 15 millionths/°C
Creep coefficient[1]	0.2 to 0.8	0.2 to 0.8
Specific creep[1]	0.04 to 0.30 millionths/psi	6 to 45 millionths/MPa
Total shrinkage[2]	Up to 900 millionths	Up to 900 millionths

[1] Depends on curing method and age of loading.
[2] Combination of drying shrinkage and autogenous shrinkage and depends on curing method.

- Creep of is much less than conventional concrete. This results in reduced prestress losses
- total shrinkage reported in table includes both drying and autogenous shrinkage. Most of the shrinkage is autogenous shrinkage.
- Has sufficient fatigue resistance in both tension and compression to resist several million cycles of loading.
- Its impact strength is 2-3 times higher than its static strength.

Ultra High Performance Concrete (UHPC)

- Three countries have developed design guidelines for use with UHPC.
  - Design Guidelines for Ductal Prestressed Concrete Beams (Australia)
  - Recommendations for Design and Construction of Ultra High Strength Fiber Reinforced Concrete Structures by the Japan Society of Civil Engineers
  - Ultra High Performance Fibre-Reinforced Concretes, Interim Recommendations prepared by AFGC (French Association of Civil Engineers) and SETRA (French Road and Traffic Government Agency (SETRA-AFGC 2002)
- Although these documents are not as complete as the AASHTO LRFD Bridge Design Specifications, they do address the major design requirements

Ultra High Performance Concrete (UHPC)

Durability

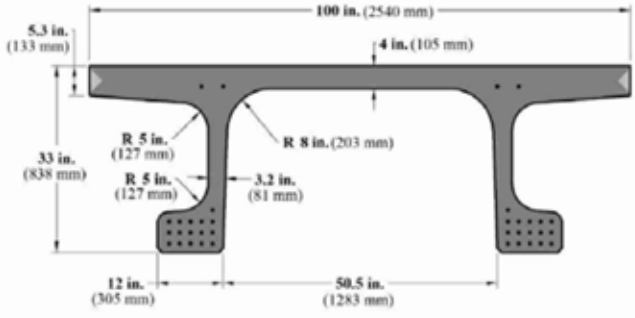
- The dense matrix of UHPC prevents deleterious solutions from penetrating into the matrix, and so the mechanisms that can cause conventional concrete to deteriorate are not present.
- Consequently, durability properties, as measured by permeability tests, freeze-thaw tests, scaling tests, abrasion tests, resistance to ASR, and carbonation, are significantly better than those of conventional concrete.
- For fire resistance, it appears that a special formulation may be necessary.

COSTS

- The initial unit quantity cost of UHPC far exceeds that of conventional concrete. Consequently, applications have focused on
  - optimizing its use by reducing concrete member thickness,
  - changing concrete structural shapes, or
  - developing solutions that address shortcomings with existing non-concrete structural materials.
- UHPC is a very durable product, and structures that use it are expected to have a longer service life and require less maintenance than structures built with conventional concrete.

Ultra High Performance Concrete (UHPC)

Applications in North America (United States and Canada)



Jakway Park Bridge, Buchanan County, IA

Ultra High Performance Concrete (UHPC)

Applications in North America (United States and Canada)

Pedestrian bridge, Sherbrooke, Quebec, Canada

Glenmore/Legsby pedestrian bridge, Calgary, Alberta, Canada

Ultra High Performance Concrete (UHPC)

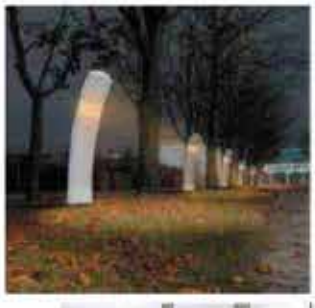
UHPC has been used in bridges in Austria, Croatia, France, Germany, Italy, the Netherlands, Slovenia, and Switzerland

Sakata-Mirai bridge, Sakata, Japan

Footbridge of Peace, Seoul, South Korea

Source: Rualt Philippe

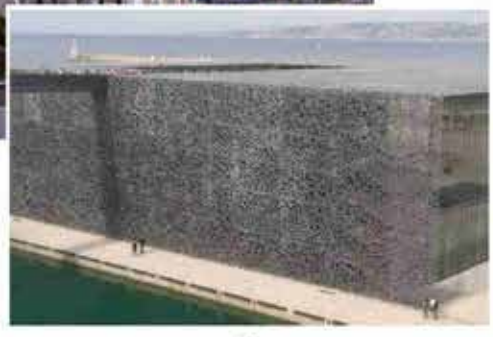
Ultra High Performance Concrete (UHPC)



'ΘtĂLJƐϬ†† -m (400-ft) long ultra-high-performance concrete (UHPC) canopy. This material offered myriad form and functional benefits.

Lightweight Ductal® Ultra-High Performance Concrete roof panels were manufactured offsite at 'ĂłĞWƌĞĞĐĂƐłƐƐŚůĂŶĚšłĻdE

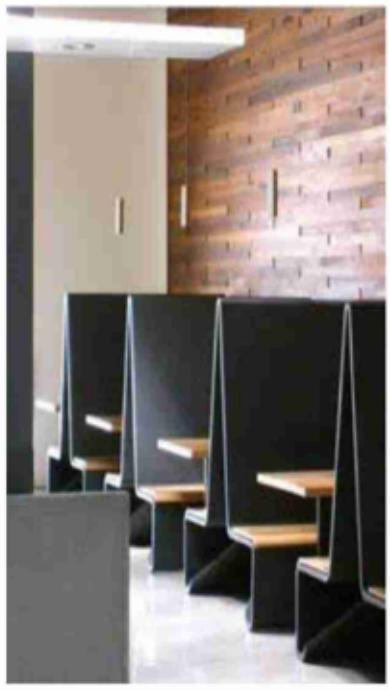
Designed by Stantec Architecture Ltd., the Shawnessy light-rail transit (LRT) station has a double-curvature roof system comprising 24 ultra-thin UHPC canopies supported on singular UHPC columns. The 5.1 by 6 m (16 2/3 by 19 2/3-ft) canopies are just 20-mm (25/32-in.) thick. Extensive tests on a full-scale prototype concluded the system carried full-factored live and dead loads without cracking and surpassed rigid test criteria.



(a) (b)

Figure 2. (a) Museum of European and Mediterranean Civilisations - Marseille, France; (b) UHPFRC façade:

Architects: La Ville Rayée
Location: **La Défense, Paris, France**
Year: **2012**
Client: **Defacto, for « Forme Publique », La Défense Urban Furniture Biennial**
Material: **Escofet fibered ultra-high performance concrete**
Photographer: **JC Decaux**



Super thin structural concrete - Ductal - is used in the Bar Agricole in San Francisco

COR - TUF

- COR-TUF is a specialized reactive powder concrete and includes formulations with and without steel fiber reinforcement.
- A family of UHPC formulations, developed tested, and patented by The US Army Corps of Engineers Engineer Research and Development Center (ERDC)
- These formulations have high strength and superior energy-absorbing capacity against natural and man-made blast forces and ballistic penetration.
- Potential uses
  - structural elements and panels (e.g. highways and bridges) with excellent strength,
  - elements resistant to natural forces such as debris impact from tornados and hurricanes, and
  - security applications such as bank vaults, anti-ballistic structures, and blast protective enclosures.

COR - TUF

Benefits:

- **Excellent Strength:** Compressive strength in excess of 240 Mpa
- **Economical:** COR-TUF® formulations are workable in production environments and provide a production economy that is market competitive
- **Proven Performance:** When tested against .50 caliber M33 ball cartridges, samples of COR-TUF® dissipated 85.6% of the rounds' kinetic energy compared to a 75.8% dissipation rate by a comparable sample of Ductal

This was UHPC the Wonder Material

Concrete Pod

Relax !

Your future is bright

Concrete Chair

Thank you

Dr. Manamohan Kalgal
President, Indian Concrete Institute
Technical Advisor, UltraTech Cement Ltd.

Master Ease

Rheology of Concrete Made Easy

MASTER® BUILDERS SOLUTIONS

Er. Anil Anjanappa

Agenda

- Introduction
- Why MasterEase?
- Rheology
- Applications and Benefits
- Project References
- Conclusions and Summary

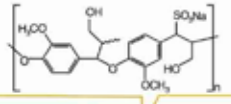
Our admixtures pushed the border of "impossible"

508m Taipei 101	541m One World Trade Center	601m Makkah Royal Clock Tower	632m Shanghai Tower	828m Burj Khalifa	1000m Kingdom Tower (under construct.)
					
Self Consolidating Concrete	**Green Sense Concrete**	**MasterGlenium** Applied by Saudi Bin Laden construction group.	**Smart Dynamic Concrete**	**MasterGlenium** Applied in a Skidmore, Owens & Merrill project.	**MasterGlenium** Applied by Saudi Bin Laden construction group. Skidmore, Owens & Merrill project.

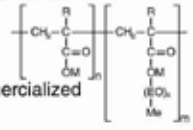
Challenges are.....

We pioneered all state of the art admixture technologies

MasterPozzolith®
Lignin as air entraining plasticizer



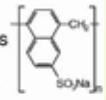
MasterGlenium®
Poly-carboxy-lates invented and commercialized by BASF



1950 1960 1970 1980 1990 2000

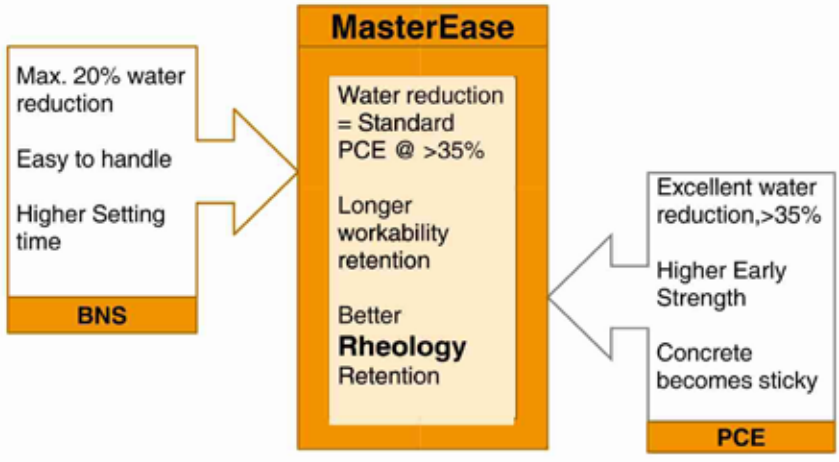
MasterAir®
Hoover Dam was utilizing air entrainers provided by Master Builders Technology in 1935

MasterRheobuild®
Naphthalene formaldehyde polycondensates invented and commercialized



What Next……

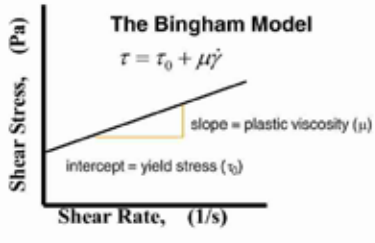
Why MasterEase ?



Rheology of concrète

- Rheology defines the flow and inherent behavior of fluids
- Concrete rheology measurements are typically expressed in terms of the Bingham model, which is a function of:
  - Yield stress: the minimum stress to initiate or maintain flow (related to workability)
  - Plastic viscosity: the resistance to flow once yield stress is exceeded (related to stickiness)

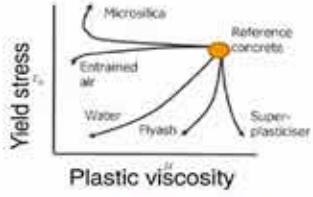
ICAR rheometer



MasterEase Attribute –
Improved Rheology – Initial Workability - L-Box

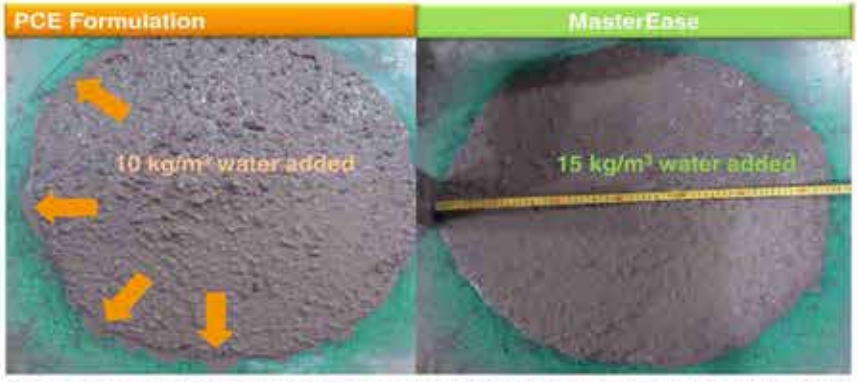
The effect of water on rheology of concrete

- Water helps the workability and finishability of concrete
- Water is the only component acting on both, the plastic viscosity & yield stress of concrete
- Theoretically ~25 liters of water is sufficient to hydrate 100 kg of cement, however workability of such a mix is very low
- Any surplus water is only required for rheological reasons



But this does not come without consequences…

Robustness to Water



Segregated mix with paste flowing out Cohesive mix even at a higher slump flow

Robustness to Water - Initial Performance of SDC Concrete

Flow: 620 mm

V-funnel: **22 sec**

Flow: 620 mm

V-funnel: **11 sec**

Rheology Retention Demo

Rheology at initial state

Rheology Retention Demo

Rheology at 1 hour

What does MasterEase do ?

MasterEase

Rheology made easy

MasterEasereduces the **V** iscosity of concrete hence improves **R**heology making it less **S**ticky, which means that.....

MasterEasemakes it easier to **P**roduce, **P**ump, **P**lace, **V**ibrate, Trowel & **F**inish

Batching

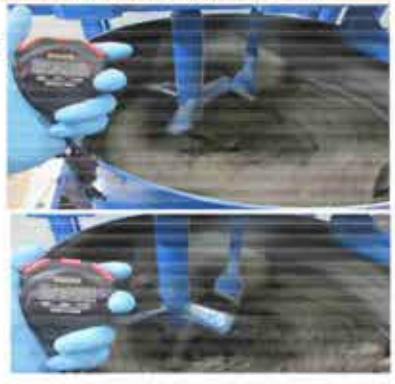
Challenge	Solution
Longer mixing time	Quick dispersion and homogeneity

Standard PCE 145 Sec

Faster Wet out –

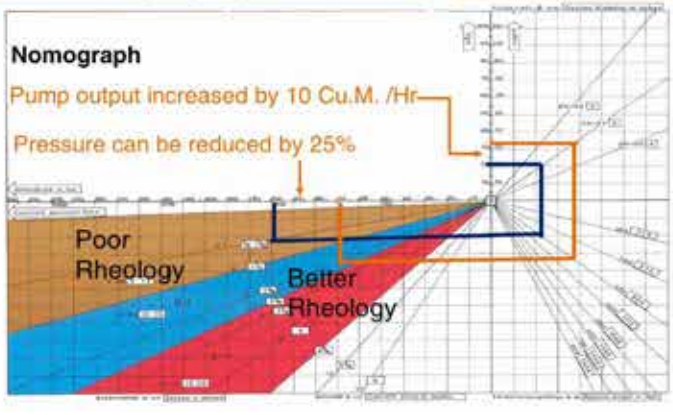
- Increased Productivity by 20%
- Lesser wear & tear
- Reduced maintenance cost by 25%

MasterEase – 92 Sec



Pumping

Challenge	Solution
To achieve concrete output equal to pump output	Reduce pressure & friction factor requires to pump concrete



- Lower yield stress –
  - Lower capital cost
  - Increased productivity.
  - Lesser Wear and tear cost.

Piping

Challenge	Solution
Pipe line choking & bursting	Reduced stickiness & concrete pressure

» Reduced Plastic Viscosity-

Maintain Safety

Saving in piping and man hour cost

Reduced concrete wastage

Placement & Finishing

Challenge	Solution
Longer man hours & quality finishes	Better response to vibration

» Better Rheology retention

Easy to spread and level

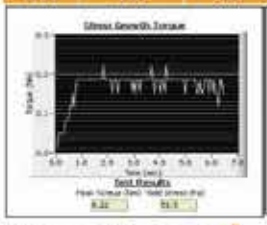
Better compaction ratio at same vibration intensity.

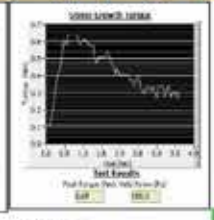
Avoid costly repairs

Faster handover

Experiment : M80 Grade concrete

Grade	Cement (OPC 53)	Fly Ash	GGBS	M. Silica	w/b	Free water	20 mm	10 mm	Crushed sand
M80	480	130	45	50	0.21	148	550	430	745





Pumping Pressure	⇩	60 Bar
Nos of Strokes	⇧	5 Strokes/Min
Cylinder Filling %	⇧	12%
Pump Out put	⇧	3.5 Cu.M./ Hr
Batching Plant Output	⇧	5.0 Cu.M./ Hr.

MasterEase- 160 Bar

Standard PCE- 220 Bar

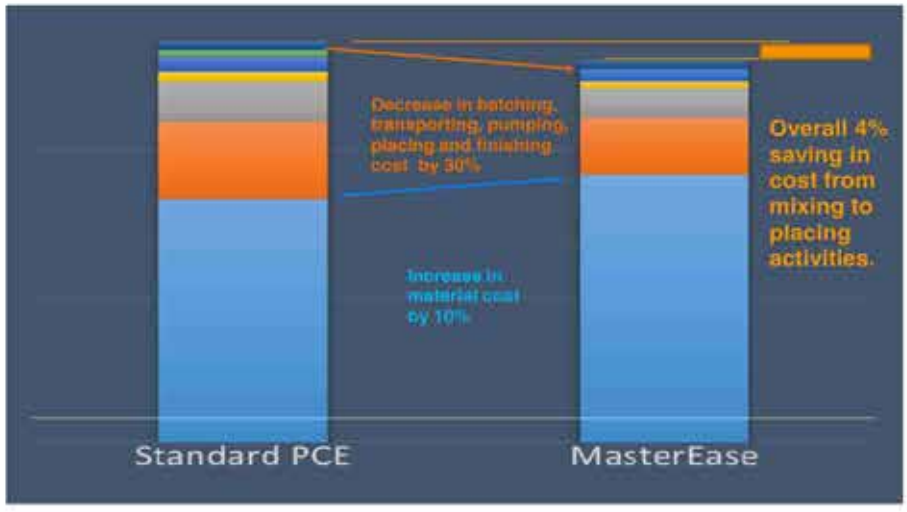
References – Landmark Project, Thailand

References – High Rise , Mumbai

References – Modular Form Work , Thane

References – Precast , Pune

Value Propositioning - Cost Benefit Analysis



Summary

Advantages of MasterEase:

- Ease of mixing and producing
- Ease of delivering and pumping
- Ease of maintaining desired workability and rheology levels
- Ease of placing and levelling
- Ease of smoothing, finishing and troweling
- Ease of improving durability

ADVANCE CONSTRUCTION TREND BY USING ALUMINIUM FORM WORK - HIGH RISE RESIDENTIAL BUILDINGS

B C SURESH

HOW MATERIAL COME TO SITE

First material will arrive to nearest port by ship.

After reaching to port, the material will be transport to project site.

Before material reaching to site, the packing list will be provide to the concern person .

With the reference of the packing list, concern person will check the container number and code.

UNLODING PROCEDURE

MACHINARIES REQUIRED TO ULOAD -HYDRAULIC CRANE, HYDRAULIC FORKLIFT

Materials will be pulled by crane from container.

Forklift helps to shift the material from the container .

CHECKING THE SEAL NUMBER AND CONFIRMING

Checking and verifying the Seal number which has been mentioned in the packing list, will be done.

After confirming from concern person, the seal will be pierced .

UNLOADING THE MATERIAL AND CHECKING WITH PAKING LIST

During the unloading time, the materials will be inspected and verified with packing list .

ARRANGING THE MAERIAL IN OPEN PLACE

The material will be shifted from the container to the ground.

Arrangement of the materials will be implemented by client in an appropriate way.

SEGREGATION OF MATERIALS IN ZONE WISE OR FLAT WISE OR UNIT WISE

Segregation of materials will be done in unit / flat wise .

Segregation will be helpful to work in faster way.

Segregation of material will helps to work for semi/unskilled labours.

Once the materials have been segregated, it will be easy to shift directly to the respective units.

FORM-WORK SETTING SCHEME

CHECKING THE LEVEL OF SLAB BY USING TOTAL STATION

Levelling will be done before fixing the structural lines.

Leveling must be checked prior to commencement of formwork installation to ensure accurate positioning.

MARKING THE STRUCTURAL LINE

After checking and verifying the level, the structural line marking will be done as per the structural and architectural drawings.

Along with structural lines 300mm offset lines will be drawn

This offset lines will be helpful to check the alignment after fixing all the panels.

SETTING OF REBARS

After marking the structural lines rebar setting will be started.

Setting of rebar will be done as per the Structural drawings

SHIFTING THE ALUMINIUM MATERIAL TO WORKING AREA

Materials will be shifted from storage yard to the working area by tower crane.

Materials will be shifted unit wise .

Materials will be placed room-wise, to work conveniently and rapidly.

APPLYING THE FORM OIL

Appling form oil on the panels evenly .

First setting will be delayed So apply thick layer of form oil to get good quality of finishing.

Form oil must be applied to form work to maintain the panel coating .

Applying grease to the other accessories like wall ties as well as PVC sleeves.

Grease must be applied to eject accessories easily after concreting.

SETTING THE PANELS

Setting process will be started with wall panels.

Wall panels and I/C will be fixed by pin and wedges.

Pin and wedges should be fixed with wall tie .

Wall tie which will be used to maintain the wall thickness and assemble the panels by pin and wedges.

BSL AND BEAM PANEL FIXING

As per given drawing, BSL panels will be fixed.

Along with BSL panels, beam panels will be fixed.

SLAB ,MB PANEL FIXING

SLAB ,MB PANEL FIXING

Staircase setting will be done in core part.

In this case, rebar should be placed before setting the stair top panels.

TIE-ROD FIXING

Tie-rod will be fixed in the top-panel before pouring concrete

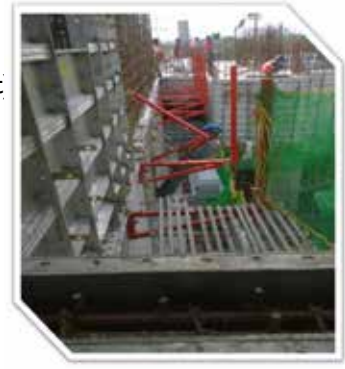
Tie-rod with square pipe will be used to maintain the horizontal alignment .

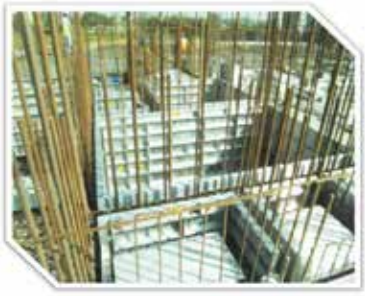
Tie-rod will be used to fix the wall brackets .

WALL AND SLAB BRACKETS

Wall brackets will be located as per given drawing , usually placed spacing of 1.2m .

Wall brackets will be used as working platform for outside work as well as slab cut-out (lift





KICKERS FORM-WORK

The kicker size is fixed of 125mm, in that 75mm will go inside the concrete and 50mm will be projected outside, which will be reference level for the next floor.

Kickers shall be placed at outer part as well as slab cut-out (lift and staircase).

MARKING OF PLUMBING GROVE AND CUT-OUT BOX

FIXING THE PLUMBING GROOVE

Plumbing grooves will be attached with the panels as per the given drawing, wherever required.

PLUMBING GROOVE after fixing

CORRECTING THE ALIGNMENT BY GIVING JACK SUPPORT

Jack support, turn buckle ,square pipe will be used to correct the vertical and horizontal alignment of the panel.

Door spacers will be provided to maintain the door width as well as to prevent sliding and bulging by the concrete pressure.

REBAR SETTING FOR SLAB WITH ELECTRICAL CONDUITS / service duct FIXING

DOWN/sunken FRAME SETTING

Wherever the slab is sunk the down frame material will be Set for concreting.

To maintain the cover(slab thickness of sunken) at bottom, we use the concrete blocks or aluminium angles will be provided.

Aluminium angles should be removed immediately after pouring concrete .

Panels should be covered with the cement bags to prevent the entry of concrete inside the panel .

READY FOR CONCRETING

During CONCRETING

Normally for form-work SCC or SDC concrete will be used.

Concreting will be done by pumping method.

DE-SHUTTERING PROCEDURE

De-shuttering procedure will start after 24 hours for walls and 48 hours for slabs after concrete.

First de-shuttering will be done where the plumbing groove and cut-out box has been fixed ,and keep all panels in good safe place .

DE-SHUTTERING OF DECK PANELS

De-shuttering of deck panels will be started after dismantling all the wall panels and window sill panels.

After de-shuttering of slab panels, the props and prop heads will remain at respective location till the completion of next floor level concrete.

REMOVING OF WALL TIES

After de-shuttering the panels, wall ties must be removed immediately, because after setting of concrete wall tie may not be able to remove.

After removing the wall tie, store in the safe place for further use.

WALL SLEEVES REMOVING

Wall sleeves will be removed after removing the wall ties.

Wall sleeves will be removed by using sleeve ejector .

After removing the wall sleeves, store in safe place for using in next floors .

SHIFTING OF MATERIAL TO NEXT FLOOR

In every flat, some place (generally in living room) will be provided in slab concrete for shifting the panels.

Slab cut-out will be provided by S-FORM of size 850mmx350mm top and 750mmx250mm bottom.

Shifting should be done from where the slab cut-out is provided .

It will be easy to shift the panels from lower floor to higher floor level.

EXTERNAL FINISH

ELECTRICAL BOXES FINISH AFTER CONCRETE

PAINTING FINISH

FORMWORK ACTIVITY CYCLE (8 DAYS)

8 Days Cycle Activities Detail

Activity	D1	D2	D3	D4	D5	D6	D7	D8
Floor Marking & Checking								
Wall Rebar works								
De-shuttering of wall panels from previous floor								
MEP wall conduits, lines and checking								
Shifting, setting out of wall panels & Checking								
De-shuttering of slab panels from previous floor								
Shifting and setting out of slab panels								
Slab/beam reinforcement								
MEP wall conduits & lines								
Inspection								
Concreting								

Measures taken to achieve slab cycles by 8 days

Increase in skilled manpower

Dedicated carpenter and rebar workmen

Toolbox being conducted along with rebar and carpenter workmen for effective coordination of works

Dedicated supplier form work supervisor for each tower along with main contractor supervisor

Continuous monitoring by engineer's QA/QC & respective block in-charge

Time line for normal conventional method of construction

Normal conventional slab cycle (column, beam & Slabs)	15 days
Construction & curing of Block work masonry	14 days
Plastering button marks & checking	02days
Chasing for electrical conduits, conduits / box fixing, packing and GI wire pulling works	07 days
Plastering	14 days
-	----------
Total	52 days

REASONS FOR CHOOSING ALUMINUM FORM WORK

REDUCTION IN PROJECT TIME LINE

FAST TRACK CONSTRUCTION

REDUCES NO OF FINISHING ACTIVITES LIKE BLOCK WORK, INTERNAL / EXTERNAL PLASTERING, CHASING/ PACKING FOR ELECTRICAL CONDUITS,PLUMBING LINE IN KITCHEN /TOILETS,

DESIGNED FOR 100 TO 140 REPETATIONS

COST EFFECTIVE BY ADOPTING ALUMINIUM FORM WORK

EASY TO HANDLE

Because of lesser wall thickness, increase in carpet area in individual area like living/dining, rooms etc

B. C. SURESH
Sr.Vice President –Projects
Brigade Enterprises limited

ABC of PRECAST CONSTRUCTION @ Brigade Orchards.

Er. Ganapati M.G.

WELCOME TO
BANGALORE'S FIRST SMART TOWNSHIP.
THE FUTURE OF HOW CITIES WILL BE DESIGNED.

A 130-acre township, designed to global best practices, Brigade Orchards includes carefully planned features and amenities, designed to create an efficient and planned smarter life for now and the future.

WHAT IS SMART ?

According to global growth consulting firm Frost & Sullivan, "Smart cities are an evolved state of urbanization where application of technology integrates diverse individual entities such as buildings, utilities, authorities, infrastructure and industries."

In a June speech Indian Prime Minister Narendra Modi said: "Cities in the past were built on riverbanks. They are now built along highways.
"But in the future, they will be built based on availability of optical fibre networks and next-generation infrastructure."

Smart features at brigade orchards
Features involving ICT (Information & Communication Technology):

- **Smart Homes**
  - Fiber to Home (FTTH) – Triple Play (Data, Voice, Video)
  - Provision (conduiting only) for Home Automation in villas
- **Security Management**
  - Visitor management using IP based CCTV cameras at entry/exits of the township and parcels
- **Wi-Fi Hotspots**
  - At designated areas like Stadium, Signature Club, Offices & Retail on a chargeable basis




- **Orchards Community App**
  - Phase-1 will be used to push marketing promotions
  - Phase-2 will be used by Orchards residents to coordinate events, accessing amenities, report civic issues, carpooling etc.

Non – ICT Based Smart Features:

- Smart Water Management
  - Water Harvesting solutions at both township & individual parcel level to recharge ground water and maximize re-use & re-cycling of water
  - Community Drinking Water Stations (at stadium, bus bays & retail)



Smart features at brigade orchards

- **Smart Waste Management**
  - Waste segregation and conversion of garbage into manure & gas
- **Smart Energy Management**
  - Solar powered LED street lights
  - Solar panels over stadium roof
  - Charging points for electric vehicles
- **Smart Transportation**
  - Community bicycles to commute within the campus
  - Eco-friendly shuttle service (CNG) connecting the township with neighbouring landmarks (SEZs, trumpet flyover, Devanahalli town etc.)
  - Golf carts for movement within the township





FLOW OF PRESENTATION

- *Precast ---production methodology*
- *Precast --- Development @ Brigade Orchards.*
  2013/2014- Aspen
  2014/2015- Banyan
  2015/2016- Cedar
- *Precast---- Summary*
- *Precast------ Realistic advantages & disadvantages*

Precast --- Production Methodology

OPEN YARD CASTING of PRECAST

- Fixed /tilting tables using mobile cranes or gantry cranes.

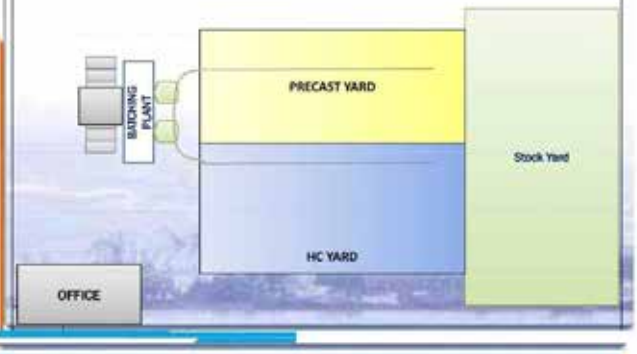
FACTORY CASTING of PRECAST -

- Fixed / tilting tables, Rotating tables, Central shifter. Battery moulds using EOT cranes

HOLLOWCORE SLABS PRODUCTION

- open yard or factory based, extruder / slip form technology

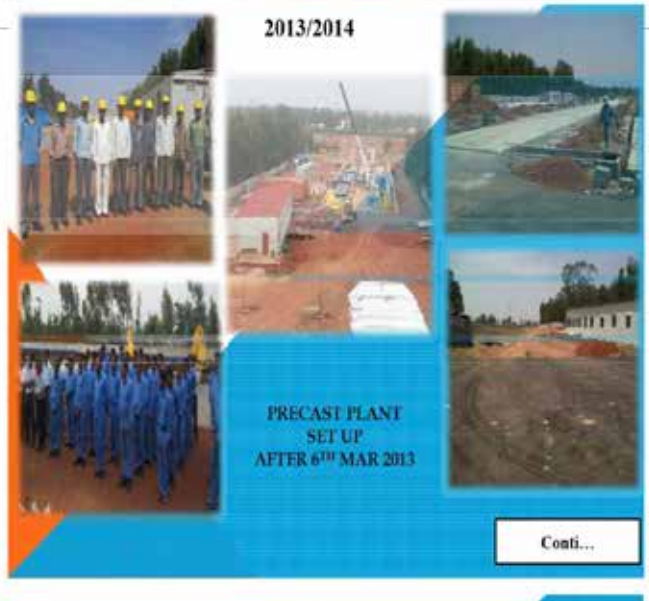
PRECAST FACTORY LAYOUT



BATTERY MOULDS

CARROUSEL SYSTEM

Precast Development @ Brigade Orchards 2013/2014 Aspen Block



ASPEN BLOCK- PERSPECTIVE VIEW

Architect:
SURBANA International Consultants Pte. Ltd.

Structural Consultant:
BURO Engineers Pt. Ltd.

MEP Consultant:
ENTASK Consultancy Services

- Floors :G+7
- Flats :256Nos.
- saleable Area:2,88,000 sqft

Precast Development @ Brigade Orchards 2014/2015 Banyan Block

BANYAN BLOCK- PERSPECTIVE VIEW

Architect:
PLANNERS Group

Structural Consultant:
CHOPRA Consulting Engineers

MEP Consultant:
ENTASK Consultancy Services

- Floors :G+7
- Flats :272 Nos.

Saleable Area :2,98,000 Sqft

Precast Development @ Brigade Orchards 2015/2016 Cedar Block







CEDAR BLOCK- PERSPECTIVE VIEW

Architect:
RSP INDIA Pvt. Ltd.

Structural Consultant:
BASE Engineering Services Pvt. Ltd.

MEP Consultant:
ENTASK Consultancy Services

- Floors:G+7
- Flats :480 Nos.
- Salable area:*5,34,000 Sqft

FUTURE PROJECT: JUNIPER & IVORY

Architect:
RSP INDIA Pvt. Ltd.

Structural Consultant:
MELIOR Structural Solutions Pvt. Ltd.

MEP Consultant:
RSP INDIA Pvt. Ltd.

- Floors :G+14
- Flats :1200 Nos.

Summary

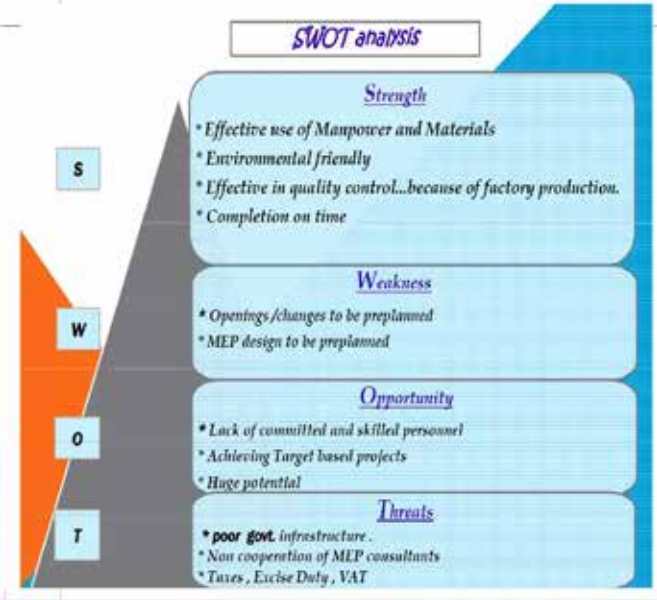
SUMMARY OF ASPEN, BANYAN & CEDAR BLOCK

SL No.	DESCRIPTION	ASPEN BLOCK	BANYAN BLOCK	CEDAR BLOCK
1	Saleable Area (Sqft)	2,88,000	2,98,000	5,34,000
2	Number of Flats (No's)	256	272	480
3	Duration	12 MONTHS	7 MONTHS	10 MONTHS
4	Achievements - Production Erection	(Peak Time) 75 m^3/Day 90 m^3/Day	(Peak Time) 100 m^3/Day 213 m^3/Day	(Peak Time) 110 m^3/Day 223 m^3/Day
5	Mode of Erection	MOBILE CRANE	TOWER CRANE & MOBILE CRANE	TOWER CRANE & MOBILE CRANE
6	Concrete Quantity (m^3)/nos	11,014/12613nos	11,720/11389nos	18,904/20318nos

PRODUCTION VS ERECTION HISTORY MONTHWISE - CEDAR BLOCK

Month	Production		Erection	
	Nos.	Cum.	Nos.	Cum.
Jun'15	306	327.9	4	4.9
July'15	586	700	22	25.34
Aug'15	1149	1058.5	803	877.97
Sept'15	1727	1601	1168	1150
Oct'15	2552	2349.1	1889	1833.92
Nov'15	926	850.7	1209	1355.37
Dec'15	1435	1506.9	1447	1413.02
Jan'16	1939	1726.3	1531	1445.48
Feb'16	2158	2102.9	2329	2260.13
Mar'16	2447	2339.2	2284	2226.21
April'16	2324	2179	2200	2100.7
May'16	1552	1452.1	2158	2094.376
June'16	1066	689.4	1623	1544.09
TOTAL	20,167.00	18,883.00	18,667.00	18,131.51

Precast
Realistic advantages & disadvantages



REALISTIC - DISADVANTAGES

1. Handling of external consultants – MEP, shortage of experts
2. Irritation to the Main contractor
3. Waterproofing a challenge – joints and roof
4. Belated changes – limitations
5. Maintaining committed employees- MAN /MACHINE COMBINATION, shortage of leaders
6. MANAGEMENT – short sight
7. Cost

REALISTIC – ADVANTAGES

1. DIGITAL CONSTRUCTION- software in design,planning etc
2. NOISE FREE CONSTRUCTION – night working in busy areas
3. TRACING BACK- quality issues , variation claims
4. Construction – converted to factory based,recovery of delay etc
5. No quality compromise
6. Young Brigadiers- better for female Engineers
7. As per dwg.- future reference
8. Shifting the structure- an option to reuse
9. Transparency – performance of staff, billing etc
10. Minimising Manpower with Automation- cost reduction
11. FUTURE.....???????

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VICE PRESIDENT
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RMC Industry Scenario and Need for Quality Scheme

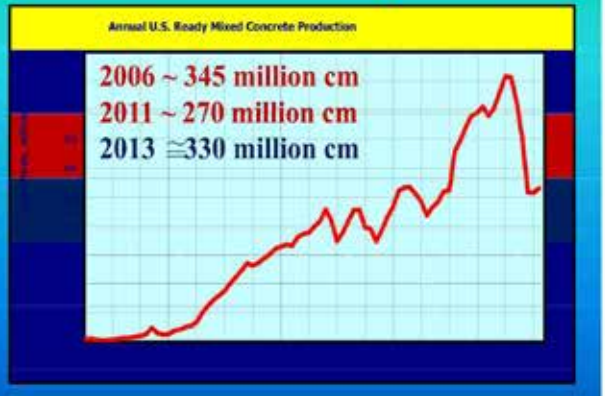
RMC Industry Scenario and Need for Quality Scheme

Ravishankar M

Beginning of RMC Production

1903	Germany	1956	Belgium
1912	Spain	1958	Finland
1913	USA	1961	Austria
1918	Holland	1961	Ireland
1926	Denmark	1962	Italy
1930	UK	1963	Israel
1930	Norway	1966	Portugal
1932	Sweden	1968	Greece
1933	France	1970s & 1980s	Developing countries like Taiwan Malaysia, Indonesia, etc.
1933	Swtizerland		
1949	Japan		

RMC Industry: USA



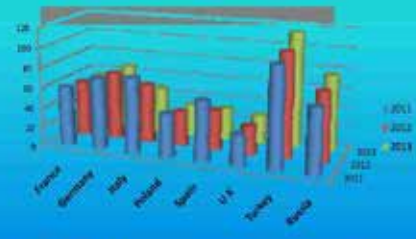
RMC Industry: USA

- m^3 sold by Average company 335,000
- Cubic meters per Plant 29,400
- Cubic meters per Truck 3,400
- Average age of fleet 8.3 years
- Production /employee 2550 m^3
- Per driver Hour m 2.7 3
- Cement Consumed 75% of total

RMC Industry: Europe

- Status -2011(20 nation)
  - No. of plants: 8211 (ERMCO)
  - Concrete Production: 387 mil. m^3
  - % of Cement to RMC: 51.4%

RMC Industry: Europe

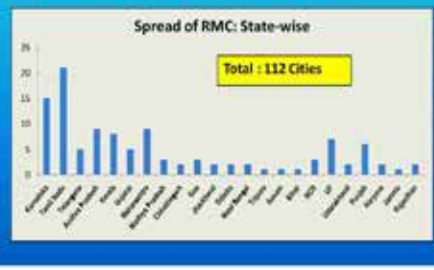


- From 2007 to 2011, in a declining economy RMC has declined more than the construction sector as a whole.
- IN recent times, some improvement is being witnessed.

Vestige of Past

Indian RMC Industry Scenario

- Growth of RMC slowed down during 2011-14
- Expansion plan shelved; profitability affected
- However, RMC industry now looking forward to improvement in its fortunes



Major Challenges

1. No Level playing field between Organized and Unorganized players
2. Land Scarcity for Setting up New Plants
3. Traffic Snarls leading to Long Haulage Time
4. Difficulties in getting Good Quality Fine Aggregates
5. High-rise Construction – Growing use of HSC/HPC
6. Lack of framework for Quality of the Product

Major Concerns of Concrete Customer

- Can we get the required quantity of concrete and delivery in time ?
- Will the concrete have the desired workability enabling proper placement ?
- Will the concrete achieve the desired compressive strength?

Major Concerns of Concrete Producer

- Can we get timely supply of all raw materials?
- Can we get consistent quality of different ingredients?
- How do we overcome traffic bottlenecks?
- Can we achieve the desired slump and compressive strength?

Main Challenges in Producing Quality Concrete

1. **Quality Variations in Properties of Ingredients**
2. **Production Control Parameters – Management of plant & equipments**
3. **Sampling and Testing**

Contribution of Different Components on Standard Deviation for Concrete Strength

Aspect	Standard Deviation, N/mm²	% Contribution
Cement	2.5	29%
Aggregates	2	21%
Sampling and Testing	2	21%
Production	2.5	29%
Overall	4.5	100%

Note: Overall standard deviation is square root of sum of squares of component value

Source: Manual of Ready Mixed Concrete by Dewar & Anderson

Can Poor Quality River/ Pit sand Provide Good Concrete?

VSI Coarse Aggregates

Manufactured sand

Effect of Sampling & Testing

Aspect	Standard Deviation, N/mm²	% Contribution
Cement	2.5	29%
Aggregates	2	21%
Sampling and Testing	2	21%
Production	2.5	29%
Overall	4.5	100%

Importance of Correct Sampling

- How to take a representative sample?

- IS 4926 Guidance
  - First 1/3rd and last one m³ portion to be ignored
  - Four incremental samples to be from middle portion
  - Through mixing of composite samples on a mixing tray

Errors in Making and Curing Cubes

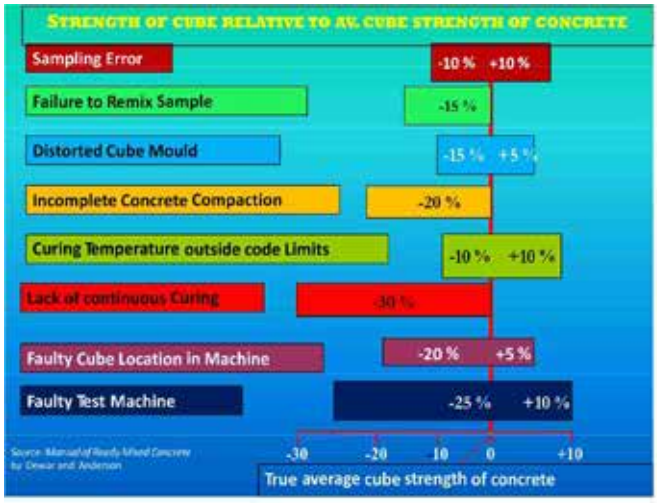
- Errors in making cubes
  - Filling in three equal layer
  - Hand tamping at least 25 strokes per layer
- Errors in handling and storing cubes in early stage
- Curing conditions

Controlled curing at 27±2 °C

Testing Errors

Eccentrically loaded (15-20mm) Sample may result in 20% reduction in strength

Can the rate of loading be accurately controlled with manual operation?



Effect of Shortcomings in Production Process

Aspect	Standard Deviation, N/mm²	% Contribution
Cement	2.5	29%
Aggregates	2	21%
Sampling and Testing	2	21%
Production	**2.5**	**29%**
Overall	4.5	100%

Intermixing of Aggregates

Intermixing of aggregate fractions

Calibration

- Accuracy and sensitivity of weighing devices
  - Tolerances specified in IS 4926
    - Cement & SCMs:
      - ± 2 percent of the quantity of constituents being measured
    - Aggregates, chemical admixture and water:
      - ± 3 percent of the quantity of constituents being measured

Mixer Blade Worn Out

Built-up on Mixer Blade/Arm

Inside cleaned mixer

RMCMA Quality Scheme

Best Practices : Advanced Countries

USA
National Ready Mixed Concrete Association, (NRMCA)

1. Plant Certification Scheme
2. Quality Management System for RMC Company

U.K.
Quality Scheme for Ready Mixed Concrete (QSRMC)

Quality & Product Conformity Regulations

Canada
RMC Association of Ontario State, (RMCAO)

1. RMCAO Seal of Concrete Quality
2. RMCAO Seal of Special Concrete Quality

Turkey
Turkish Ready Mixed Concrete Association,

Third Party Quality Scheme "KGS"

RMCMA Quality Scheme

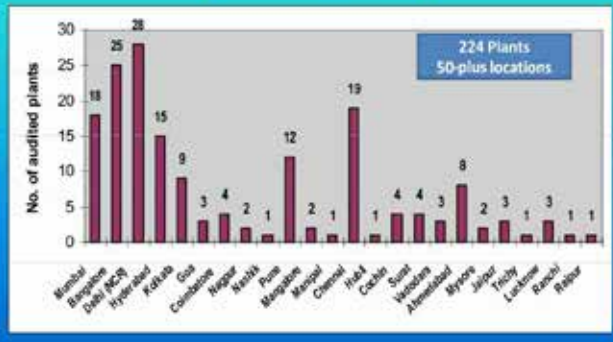
- Indigenous in character
- Based on two strong pillars
  - Best practices from advanced countries
  - Strict adherence to various BIS codes of practice

Experts Contribution to RMCMA Scheme

- Quality Committee
  - Mr.Vijay R. Kulkarni, Convener
  - Mr. Rajiv Talwar, Head QA, ACC Concrete Ltd.
  - Dr. P. Dinakar, ACC Concrete Ltd
  - Mr. Harpal Singh Sehmi, ACC Concrete Ltd
  - Mr. Anuj Maheshwari- Asst. VP, Ultratech Concrete-
  - Mr. S. G. Bhat, Manager QC, Lafarge Aggregate & Concrete (I) Pvt Ltd
  - Mr. Hiren Joshi., QA-QC In-charge, Lafarge Aggregate & Concrete(I) Pvt Ltd
  - Mr. S. D. Govilkar, Deputy General Manager(Technical), RMC Readymix (I) Pvt Ltd.
  - Mr. Girish Bonde, Head, Technical, RDC Concrete India Pvt Ltd
  - Mr. Bilal Baig, Manager, Quality, Godrej & Boyce Mfg. Co. Ltd.
  - Mr. D. Mohan, Manager Technical, UM Concrete Products Pvt. Ltd.
- Experts Committee
  - Dr. A. Ramakrishna, Advisor, L&T
  - Dr C. S. Viswanatha, Torsteel Research Foundation in India,
  - Mr. Jose Kurian- Chief Engineer, DT & TDC, New Delhi
  - Dr A K Mullick, Former D G, NCB, New Delhi
  - Mr. A. K. Jain- Technical Advisor, Grasim Industries Ltd.
  - Mr. P L Bongirwar- Former Jt. Managing Director, MSRDC,
  - Mr. C M Dordi- Customer Support Group Head Ambuja Cements

RMCMA Quality Manuals

City-wise Certified Plants (March 2012)



Why QCI Scheme?

- Need for upgradation
  - –Multi-stakeholder Ownership of the Scheme
  - –Independent character that will instill confidence in users
  - –International parity

Structure of New QCI Scheme

Multi Stake Holder Ownership

- Participations from:
  - – Central Government Ministries, e.g. Housing, MORT&H, etc.
  - – Key Specifier: Central Public Works Department (CPWD)
  - – Central PSUs e.g. NHAI, AAI, etc.
  - – User bodies, e.g. BAI, CFI, etc.
  - – Professional bodies, e.g. ICI, ICCE, CREDAI
  - – Consultants, e.g. Mahendra Raj, TCPL, etc.
  - – Manufacturers, e.g. RMCMA, CMA
  - – Certifying bodies, e.g. BVCI, ICMQ

Multi Stake Holder Committees (con'd)

- Independent Chairmen
  - – Steering Committee
    - Mr. Jose Kurian, C E, DT&TDC, & Chairman, BIS Committee on Cement and Concrete
  - – Technical Committee
    - Dr A. K. Mullick, Former Director General, NCB
  - – Certification Committee
    - Mr. Anil Jouhri, CEO, NABCB (QCI)

Quality Scheme: New Manuals

Criteria for Production Control of RMC | Certification Process for RMCPCS | Provisional Approval for CBs for RMCPCS

Download from http://qcin.org/CAS/RMCPC/

Certification Scheme Launched in Delhi

Quality Scheme launched on May 17, 2013 in Delhi

Two Schemes

- Ready-Mixed Concrete Plant Certification Scheme (RMCPCS)
  - RMC Capability Certification: A Must
  - RMC 9000+ Certification: Optional

Scope of QCI Scheme

- QCI Scheme applicable for:
  - RMC Plants supplying concrete commercially
  - RMC plants supplying concrete for specific project
  - RMC Plants supplying concrete partly on commercial basis and partly for captive consumption
- Scheme excludes operations of placing, compaction, finishing and curing of concrete

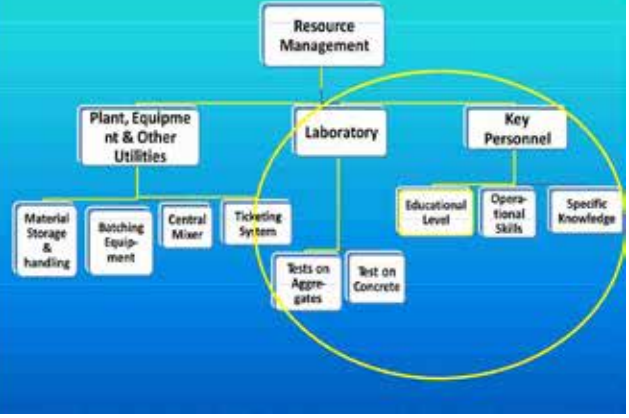
Conforming Standards

- Provisions of QCI Scheme conform to:
  - Bureau of Indian Standards
  - Indian Roads Congress
  - Indian Railway Standards

Production Control Criteria: Broad Contents

- Section A
  - Resource Management
    - Plant and equipment
    - Laboratory
    - Key personnel
  - Control on quality of incoming materials
  - Concrete design
  - Production and delivery
  - Control on process control equipments and maintenance
  - Complaints
  - Feedback
- Section B
  - Check List (182 Item)
- Tables
  - Table No 1 to 11

Resource Management



Testing Laboratory: A Must

Minimum Specified Lab Test

- Aggregates
  - Sampling (conforming to IS 2430)
  - Moisture content (conforming to IS 2386-Part III)
  - Bulk density (conforming to IS 2386-Part III)
  - Sieve analysis (conforming to IS 2386-Part-I)
- Concrete
  - Slump (conforming to IS 1199)
  - Unit weight (conforming to IS 1199)
  - Strength (conforming to IS 516)

Minimum Test Equipment & Calibration Frequency

Relevant test	*BIS Standard*	*Minimum units*
Slump test	IS 1199-1959	2 sets
Compressive strength of concrete	IS 516	One no.
Preparing concrete test specimens	IS 1199	30 nos.
Sieve analysis of fine and coarse aggregates	IS 2386- Part I	one set for C.A. and F.A.
Agg. Sampling (sieve shaker/sample divider)	IS 2430	One
Unit weight of concrete	IS 1199	one no.
Aggregates Bulk density	IS 2386- Part III	one each for C.A. and F.A.
Silt content of sand		one no.
Specific gravity of aggregates		one no.
Other accessories		
Electronic weighing balance		One
Laboratory mixer(min 50 lit)		One
Electric microwave oven	(IS 11332)	One
Table / needle vibrator, tamping rods		One
Curing tank with temperature control		One
Shovels, trowels, flexible spatulas, meter,		Sufficient nos.

Quality of Incoming Materials

Material	*IS Conformity Requirements*	*Physical and Chemical Testing*	*Testing at NABL-accredited Lab*
Cement	IS 8812 (OPC) IS 12269 (OPC) IS 1489 (PPC) IS 455 (PSC)	Manufacturers' certificate for each consignment	First consignment of each brand Once in a year for used brands or change of source
Fly ash	IS 3812 (Part 1 and 2)	Manufacturers' certificate for each consignment	BIS conformity tests once in six month or when source changed
GGBS	IS 12089 and BS 6699	Manufacturers certificate for each consignment	BIS/BS conformity tests once in six month or when source changed
Silica fume	IS 15388	Manufacturers' certificate for each consignment	BIS conformity tests once in six month or when source changed

Quality of Incoming Materials (con'd)

Material	*IS Conformity Requirements*	*Physical and Chemical Testing*	*Testing at NABL-accredited Lab*
Chemical Admixtures	IS 9103	Manufacturers' certificate for each consignment	All code-specified tests before finalization of source BIS conformity tests once in six month or when source changed
Water	IS 456 and IS 4926		Non-mains water: Initially every week for first 6 weeks and then at 3-monthly internal Mains water: Annual basis once all tests for source are satisfactory
Coarse and Fine Aggregates	IS 383		All IS-specified tests during selection of source or change of source Minimum tests in plant lab Other tests at NABL-accredited lab at IS-specified frequencies

Concrete Mix Design

- Organization should have the capability to design concrete mixes by adopting any rational method
- Organization should also have the ability to convert prescribed and designed mixes into batches of production
- Organization to keep records of trial mixes and modifications done for the scrutiny of auditors

Production & Delivery

- Company to prove evidence that materials and quantities batched are in accordance with order placed and approved mix design
- Auditors shall choose and verify any five customer orders during past three months, verifying following basic parameters

Properties	*As ordered*	*As delivered*
Grade of concrete		
Slump, mm		
Minimum/maximum cementitious content and Cement Type, if specified		
Maximum water-binder ratio, if specified		
Chemical admixture dosage, if specified		

Control of Final Product

Fresh Concrete		
a) Sampling (IS 4926 procedure)	a) Sampling: At least one sample for every 50 m³ of production or every 50 batches whichever is of greater frequency	a) IS 4926
b) Slump test	b) At least one sample for every 50 m³ of production or every 50 batches whichever is of greater frequency	b) IS 1199
c) Density of fresh concrete	c) At least once in a day	c) IS 1199
d) Placing Temperature of the concrete #	d) At least one sample for every 50 m³ of production or every 50 batches whichever is of greater frequency	d) IS 1199
Hardened concrete		
a) Compressive strength *	a) At least one sample for every 50 m³ of production or every 50 batches whichever is of greater frequency *	IS 516

optional test (if specified)
* One sample involves casting of 3 specimens of 150x150x150mm size, to be tested at 28 days.

Key Personnel

- Key personnel to be competent, adequately qualified and trained
- Basic knowledge in concrete technology essential
- QC in-charge to have degree/diploma in civil engineering with min. 3 years of experience
- Lab Technicians to have knowledge and skills in sampling and testing
- Identification of gaps in knowledge and efforts in training personnel

Certification Process

1. Application for Certification
2. Audit Program
3. Audit Mandays
4. Audit Planning
5. Certification Audit
6. Certification Decisions
7. Surveillance
8. Complaints
9. Certificate
10. Suspension
11. Change of Ownership
12. Fees

Non-Conformities

Type	Description	Classification	Time frame for closure
Critical	Non compliance with a requirement which indicates serious failure of the plant's capability to produce and deliver RMC to meet the customer requirements	Check List items: 3.2.1.1 Storage - Cement only 3.2.1.2 Batching and Mixing 3.3 Laboratory 5. Concrete Mix design 6. Production and delivery 6.1 Identification and traceability 7. Control of process control equipment and measurements	Within 15 days. Corrective actions shall be submitted to CB within 10 days. Onsite verification to be undertaken within 5 days and decision taken either to close the NCs or suspend certification
Major	Non conformity regarding a Management system requirement which does not allow the production and delivery process to meet the customer requirements (applicable to ISO 9001 requirements only as defined by CB) or as given in the Criteria in column 3	3.2.1.1 Storage –other than cement 3.2.1.3 Delivery fleet 3.4 Key personnel 4. control of incoming materials 8. Complaints	Within 1 month. Evidences of closure shall be provided to the CB; verification to be done on site
Minor	Non compliance with a requirement which does not compromise either the overall management system effectiveness or the production and delivery process	6.2 Control of non-conforming products 9. Feedback.	Within 3 months. Evidences of closure shall be provided to the CB; verification to be done in the following surveillance audit

Minimum Qualification of Auditor

- Minimum Bachelor's degree in engineering in related field(s) with at least 5 years of relevant experience in RMC/Batching plant; or Diploma in engineering in related field(s) with 7 years of relevant working experience in RMC/batching Plants
- Experience in core technical processes like QA/QC or production and process control
- Training and experience in auditing.

Audit & Surveillance

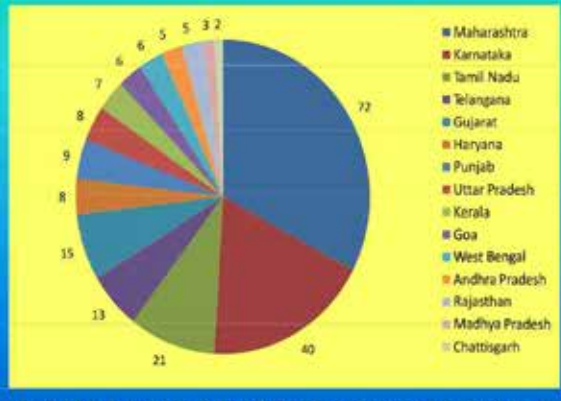
Certification	RMC Capability Certification	RMC 9001+ Certification
Certification Audit – Stage 1	-	✓
Certification Audit – Stage 2	✓	✓
Surveillance Audits		
• 6-monthly	✓	✓
• 12-monthly	✓	✓
• 18-monthly	✓	✓
• 24-monthly	✓	✓
• 30-monthly	✓	✓
Fresh Complete Audits		

Complaints

- Company to nominate Nodal Officer, responsible for:
  - Receiving complaints
  - Maintaining complaint register
  - Ensuring that complaints are investigated properly, root causes identified, recorded and resolved
  - Carrying out Systematic review on a periodic basis and corrective actions initiated
- You can complain to:
  - RMC Producer
  - Certifying Agency
  - Accreditation agency
    - nabcb@qcin.org
    - info@qcin.org

Growing Acceptance QCI Quality Scheme

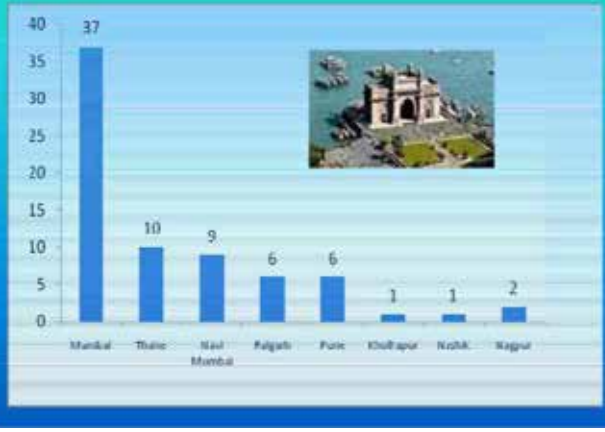
QCI RMCPCS Footprint*



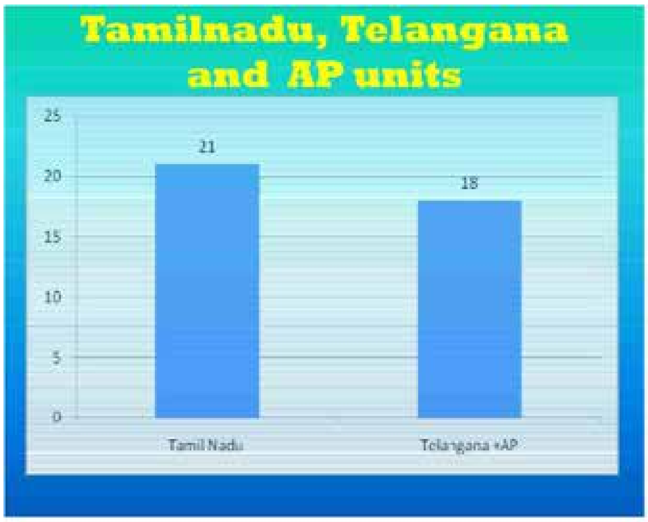
220 RMC plants of RMCMA Companies in 15 states

* as on December 2015

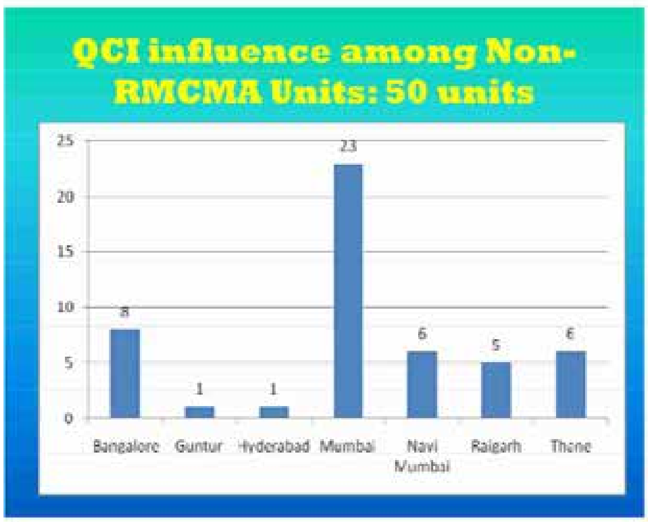
Maharashtra 72 units

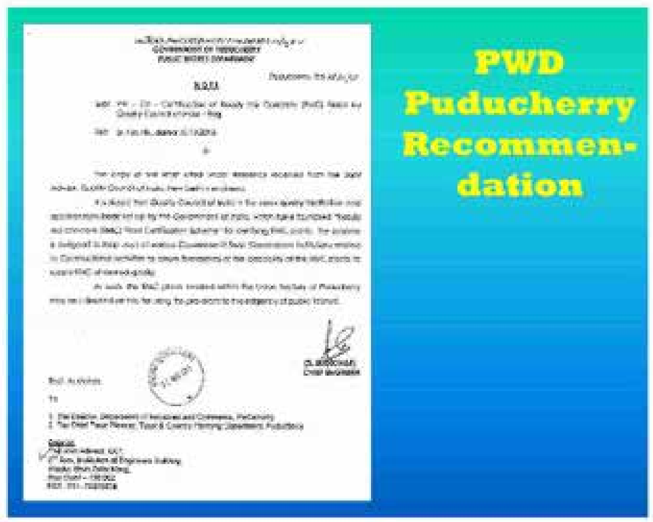


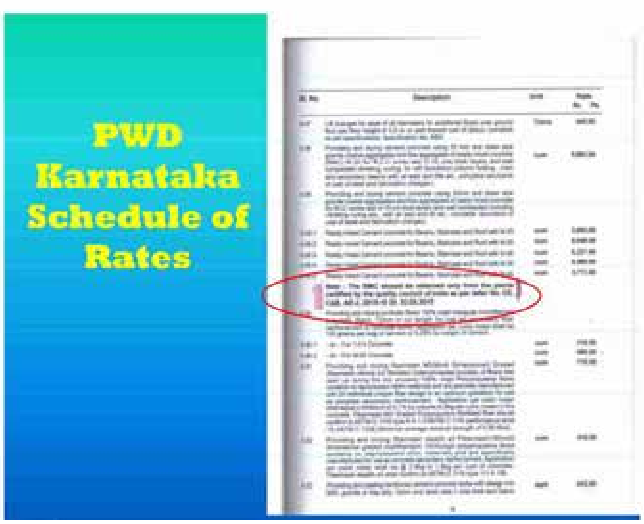
Karnataka 40 units

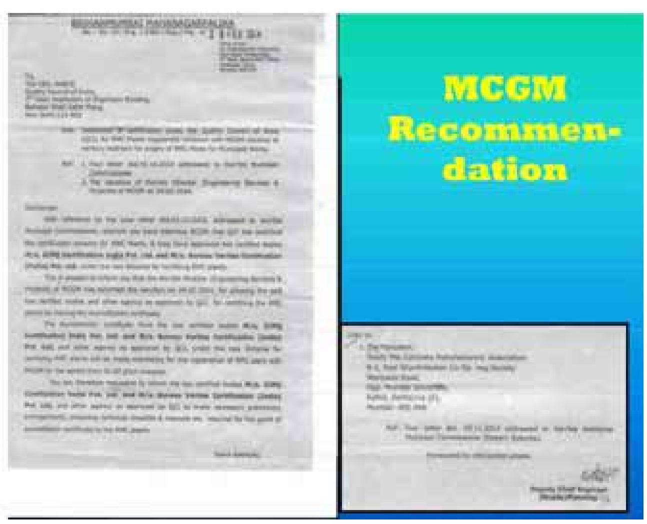

Tamilnadu, Telangana and AP units
25
20
15
10
5
0
21
18
Tamil Nadu
Telangana +AP


NCR 13 units
7
6
5
4
3
2
1
0
1
1
6
3
2
Dadri
Faridabad
Gurgaon
NOIDA
Sahibabad


QCI influence among Non-RMCMA Units: 50 units
25
20
15
10
5
0
8
1
1
23
6
5
6
Bangalore
Guntur
Hyderabad
Mumbai
Navi Mumbai
Raigarh
Thane


PWD Puducherry Recommen-dation


PWD Karnataka Schedule of Rates


MCGM Recommen-dation

CIDCO Recommendation

CIDCO

CITY AND INDUSTRIAL DEVELOPMENT CORPORATION OF MAHARASHTRA LIMITED

To,
M/s. J. M. Mhatre Infra Pvt. Ltd.,
Plot No. 402, Market Yard,
Sahakar Nagar, Panvel,
Dist. Raigad,
Maharashtra – 410206.

Sub: Requirement of Certification under the Quality Council of India (QCI) for various RMC Plants registered with CIDCO.

Dear Sir,

This is to inform you that, CIDCO has decided to implement the newly launched scheme of the Quality Council of India (QCI) for certification of various RMC Plants situated within its jurisdiction.

As per this new scheme, it is mandatory for all RMC Plants to get registered with QCI, an autonomous body set up by Govt. of India to establish & operate national accreditation structure and ensure quality in operation and processes of RMC plants.

Recommendation of RMCPCS BY CONSULTANTS

Recommendation of RMCPCS BY CONSULTANTS

CONSULTANTS CONSORTIUM
Engineers & Architects

Recommendation of RMCPCS BY CONSULTANTS

Recommendation of RMCPCS BY CONSULTANTS

STUP Consultants Pvt. Ltd.

Recommendation of RMCPCS BY CONSULTANTS

STERLING
ENGINEERING CONSULTANCY SERVICES PRIVATE LIMITED

Benefits of QCI Certification

- For Owners & Specifiers (architects, consultants)
  - Third-party quality assurance from an independent agency, based on well-defined quality norms evolved by experts
  - Reliable Tool for short-listing of concrete producers
- For RMC/Concrete Producers
  - Competitive advantage over non-certified producers
  - Top management gets audited data on their plants

Benefits of QCI Certification (con'd)

- Small Customer (e.g. individual house builder)
  - Assurance on QA&QC of concrete, without employing experts
- Concrete Industry
  - Raise the industry standard
  - Bring it on par with those from advanced countries.

Chronology of RMC Certification Schemes : A Comparison

- USA
  - 1913: Beginning of RMC production
  - 1935: ASTM C 94 adopted first time
  - 1965: Certification System commenced

  30 years
- U. K.
  - 1930: beginning of RMC production
  - 1950: BRMCA formed
  - 1968: "Authorisation Scheme"
  - 1984: QSRMC launched

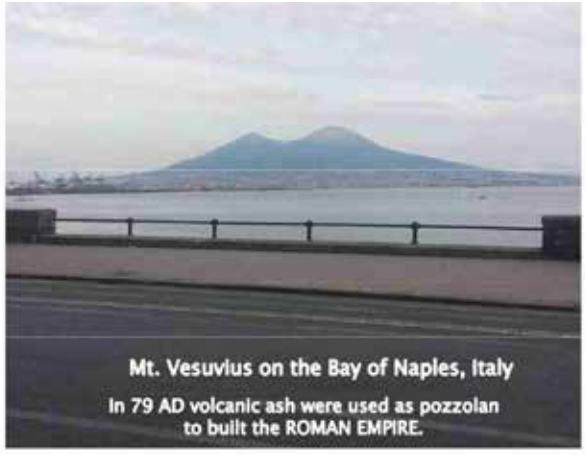
  18 years
- India
  - 1994: Beginning of commercial RMC
  - 2002: RMCMA established
  - 2008: Quality Scheme commenced
  - 2013: QCI certification launched

  6 years

  5 years

Ultrafine fly ash
- an introduction

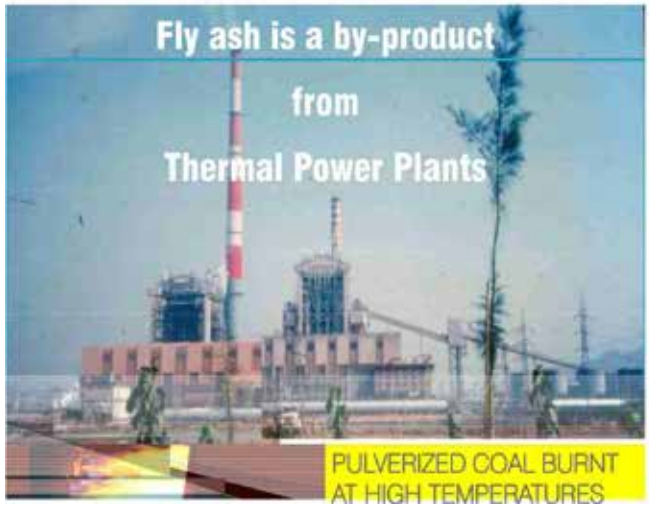
Prakash Sreenivasan



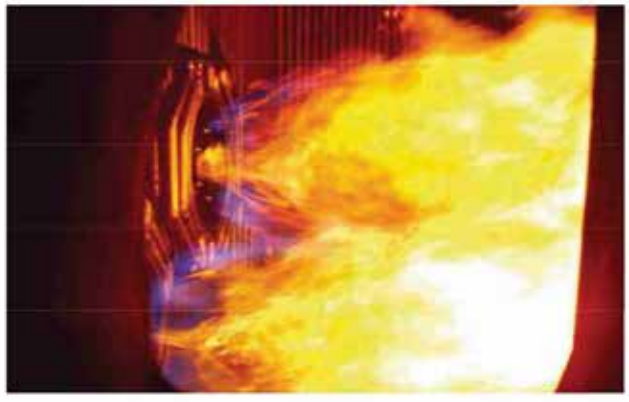
The Coliseum in Rome built with ash ….2000 years ago!

Olympic Stadium Montreal,Canada (1976)

Auditiorio de Tenerife –
Canary Island – 2003 AD

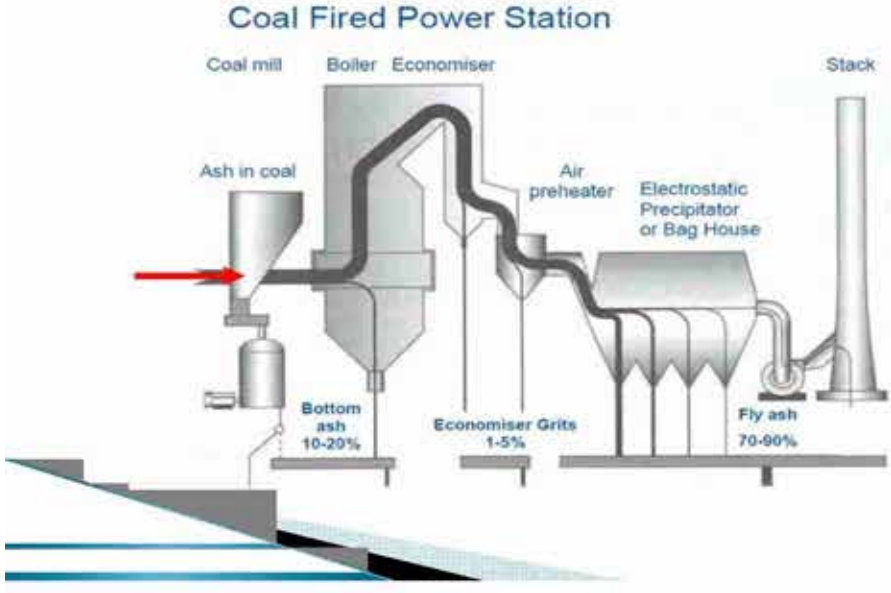


A modern-day Volcano!..... Inside a coal fired boiler



How is FlyAsh Produced...?

Well, Its no exactly produced. It's a by – product generated in thermal power plants. The process is highlighted as follows:



Where does FA come from?

PULVERIZED COAL BURNT AT HIGH TEMPERATURES 1300° **C to 1500°C**

Where does FA come from?

FA collected in different ESP Hoppers

HYDRATION MECHANISM

QUALITY OF FLY ASH AND ITS IMPACT ON CONCRETE PERFORMANCE

Non stable "by-product"

Pozzolanic Reaction …

$$2C_2S + 4H_2O \longrightarrow C_3S_2H_3 + Ca(OH)_2$$

Cement + Water → Calcium Silicate Hydrate + Calcium Hydroxide

$$Ca(OH)_2 + S + H_2O \longrightarrow CSH$$

Calcium Hydroxide + Fly Ash + Water → Calcium Silicate Hydrate

Fly ash has unique physical and chemical characteristics;

Physical

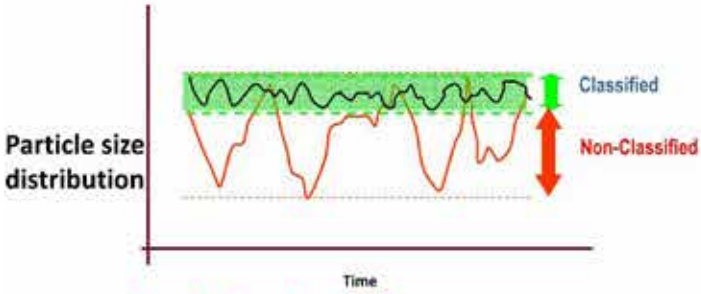
- The finer the fly ash particle size the more reactive it is = higher performance
- Beneficiation using air-classifiers (classification) separates these highly reactive smaller particles
- After classification these smaller particles are also the most spherical and are more evenly distributed

Chemical

- Fly ash contains the same oxides as Portland Cement
- However, these are in significantly different proportions and mineralogy
- Cement is rich in lime (CaO) with fly ash rich in alumino-silicates (SiO_2 & Al_2O_3) together they possibly make the 'perfect' cementitious binder for strength and durability

WHY CLASSIFY FLY ASH?

Classified vs Non Classified



Using *"raw"* or "unclassified" fly ash will certainly lead to a less consistent concrete quality!

DEFINITION

International Fly Ash Standards adhered to by Ashtech

BS EN 450

Main Features

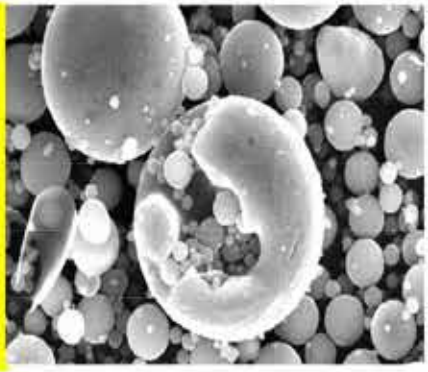
BS EN 450 has two categories,

Category N – The Fineness shall not exceed 40% by mass of FA retained on the 45 Micron Sieve.

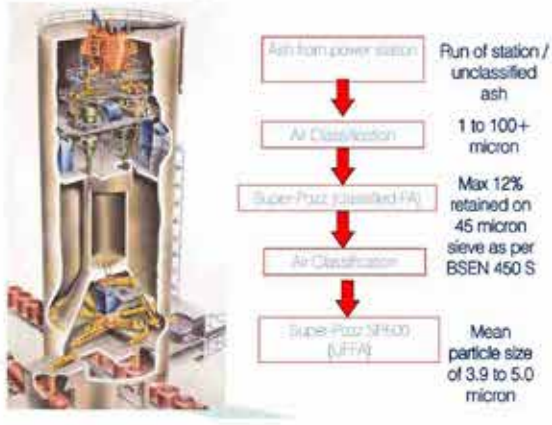
Category S – The Fineness shall not exceed 12% by mass of FA retained on the 45 Micron Sieve.

PHYSICAL CHARACTERISTICS

SMALLER PARTICLE SIZE MEANS MORE REACTIVITY & SUPERIOR PACKING!



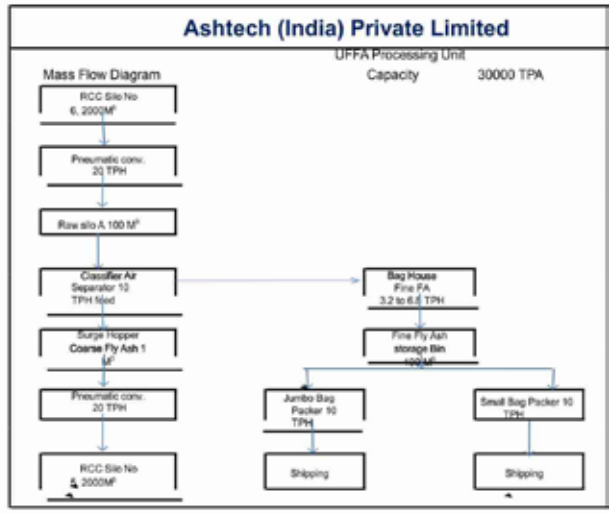
Schematic Diagram of Classification



UFFA Definition

- Unprocessed/**unclassified fly ash** (raw fly ash) from the electrostatic precipitators of the Power Station is a **GOOD** material;
  - It a good material when used in an environment that has no Chlorides or Sulphates i.e. as a cheap cement replacement
  - It has all the chemical characteristics of coal combustion fly ash however, the ~ particle size can be 45 to 50 microns with the largest 100+ microns (which is by the way the same size as cement!)
- Classified fly ash is a **BETTER** material
  - again, the chemical genesis is the same (all comes from the same coal!)
  - Classifying to recognised Int'l specifications however ensures that particles greater than 12 microns are discarded; remember the smaller the particle and more spherical the higher the performance
- Super Pozz P500® UFFA the **BEST** material
  - Super Pozz P500
  - ® 'engineering' starts with processing classified fly ash (Class F) through another set of specialised classifiers to produce a fly ash with a mean particle size of 3.9 to 5 microns with 90% of the fly ash (D90) smaller than 10 microns

GOOD; BETTER…….. BEST!



UFFA PROCESSING UNIT TIRRODA - NAGPUR

- ADANI BIGGEST THERMAL POWER PLANT MAHARASHTRA 3300 MW CAPACITY
- CONSISTENT COAL QUALITY BECAUSE OF RESTRICTED COAL SOURCE
- 100 MT CAPACITY UFFA UNIT
- MALVERN PARTICLE SIZE ANALYSER TO CHECK FOR CONSISTENCY OF PARICLE SIZE

Super Pozz P500 ® Properties	
Relative Density	2.2
Theoretical surface area	13 000-17000 cm²/g
pH in water	11-12
Moisture content %	< 0.1
Colour	Light grey
LOI % (Loss on Ignition)	< 1.0
Carbon content	< 0.2

UFFA Processing Unit

Salient Features of plant

- Ashtech UFFA Processing plant is located in Adani Power Maharashtra Ltd , Plot A-1, MIDC Tirora Growth Center, Tirora Dist Gondia.
- Plant is located at the center of India hence product can deliver at any corner of the India within 48 hrs
- Adani Power is Maharashtra's largest Thermal Power Station, producing power of 3300 MW through its 5 units each of 660 MW, Adani has specified coal mines hence quality of the coal and ash will **consistent.**
- Ultrafine ash produced in this plant is consist in quality throughout the life span of the plant unless coal is changed.
- Power plant is having 6 silos each of 2000 M^3 capacity,
- Air classification process is designed by its Technical research team, Start of art technology is used to produce goods quality and consistent product, process through **PLC SCADA** from control room

Processing

- Selected field ash is stored in to RCC silo 6 from various boilers, [Raw Ash]
- Raw ash is pneumatically conveyed to Raw Silo,
- From raw silo ash is fed to classifier through controlled valve
- Classifier separate fine and coarse by air
- Fine ash collected in the bag filter and stored in Fine silo Reject ash
- taken back to the RCC silo 5 for disposal. Automatic packing machine provides packed bags.

Quality Control

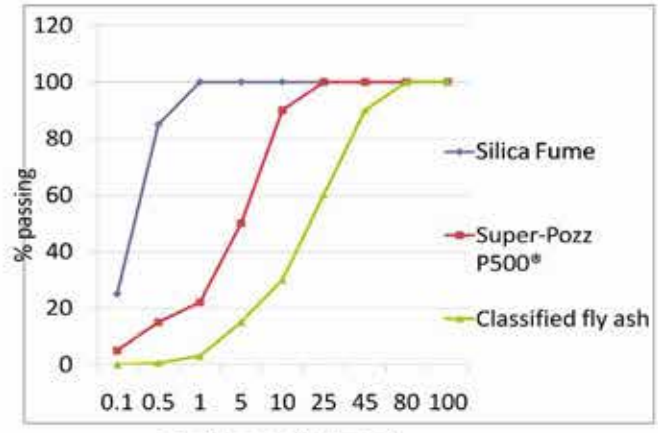
- Raw material samples are taken before processing
- In process samples are taken for fine and reject for particle sizing. Finish goods
- quality is monitored every hour by sampling
- Unit is well equipped with all in-house test facility except chemical analysis & LOI
- Over 20-25 years experienced senior staff are controlling the Production, quality Control , Operation and Maintenance.

Packing & Shipping

- Product can be packed in small bags of various sizes as per customer demand
- Standard Jumbo bag automatic packing system is available
- Regular truck loading and container stuffing facility is available

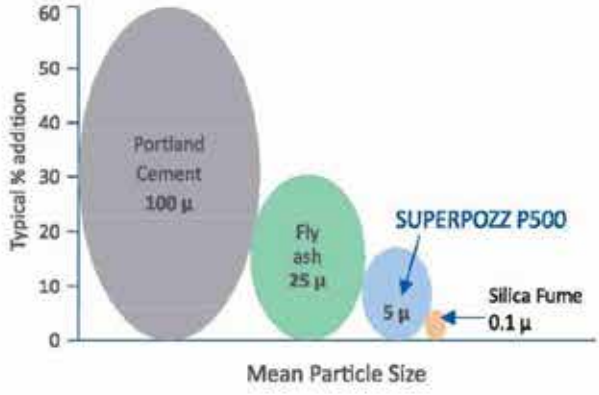
ULTRA FINE FLY ASH PARTICLE DISTRIBUTION

Typical particle size distribution of Super-Pozz P500® UFFA



BENEFITS OF CLASSIFIED FLY ASH / UFFA

Typical particle packing for high strength concrete

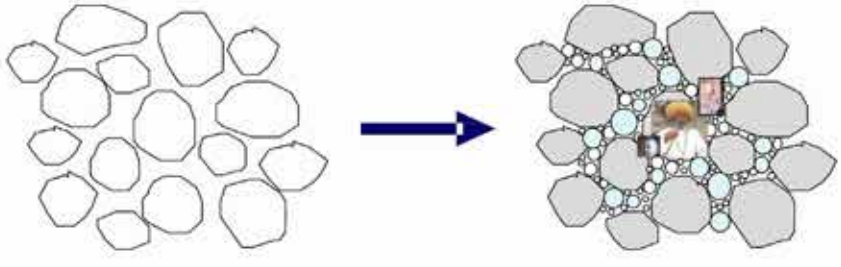


Material Combination and the role of Rheology in CEMENT CONCRETE

Particle Packing

CONVENTIONAL

OPTIMUM PACKING



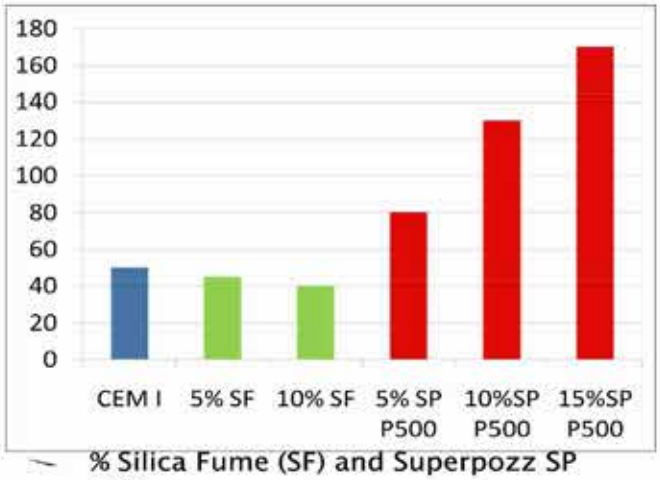
So how does Super Pozz P500 work?

- Ultra-fine ash particles being spherical (round) are able to 'roll' in the concrete mix
- This provides a lubricating effect which can either allow less water to be added to the concrete to give a required slump/workability or can lead to water reduction which improves the water: cement (binder) ratio therefore increasing strength
- Combined with this, fly ash reacts with the lime given off by the cement during hydration (pozzolanic reaction)
- This creates additional impervious hydrates (CSH gel) which fill the pore spaces in concrete making it very dense, impermeable and extremely durable
- The formation of CSH continues up to and beyond 90 days!

Super Pozz P500 (UFFA) versus Silica Fume

- Super Pozz UFFA is not as fine as condensed Silica Fume (SF)
- At a surface area of some 20 - 25 000 cm2/g silica fume is a magnitude finer than UFFA (13 - 17 000)
- With its high silicon dioxide content of ≥ 85% , SF is highly reactive and being extremely fine does act as a good pore-blocker
- It reacts very quickly in concrete giving high early and 28-day strengths
- It does however make concrete extremely cohesive and 'sticky' and this increases water requirement and/or admixture dosage i.e. the opposite of UFFA
- Unlike UFFA, the pozzolanic effect does not continue for 90+ days
- SF is costly and often requires specialised mixing and pumping equipment
- Dependent on the required plastic and/or hardened concrete properties good results have been achieved using both SF and UFFA in the same mix e.g. 5% SF + 5% UFFA and up to 10-15% UFFA

BENEFITS of CLASSIFIED ULTRA FINE FLY ASH

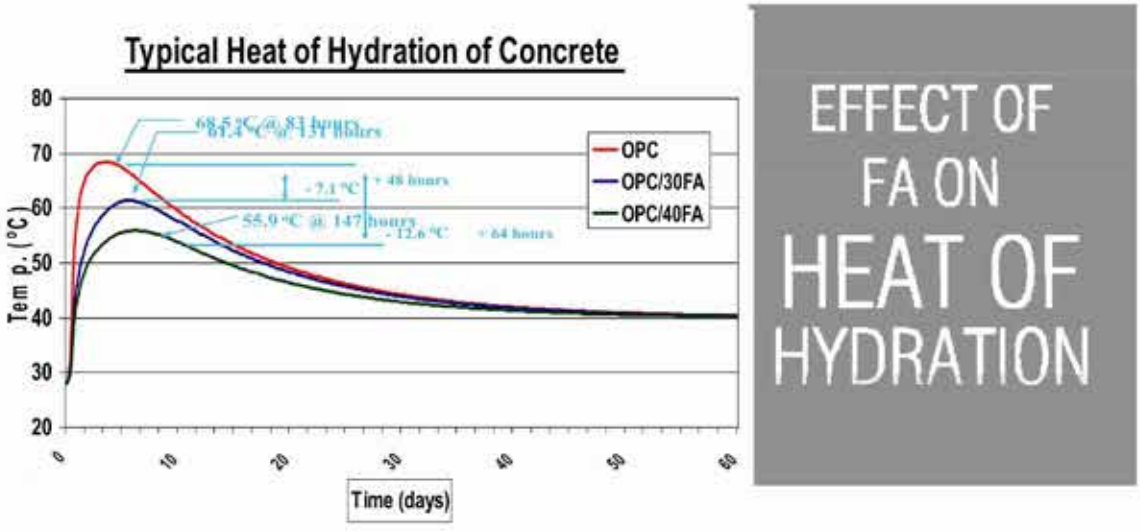


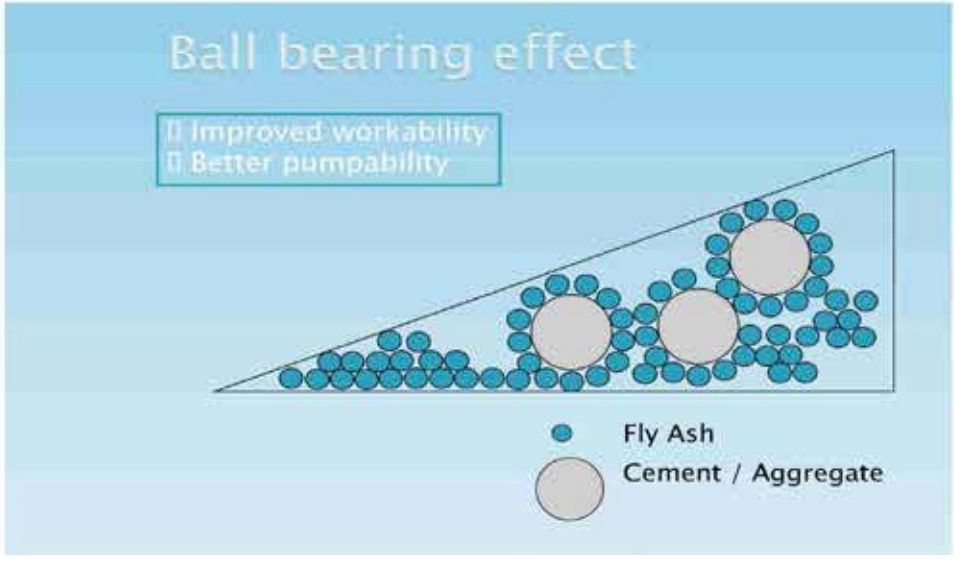
% Silica Fume (SF) and Superpozz SP 500

Super Pozz P500 (UFFA) Benefits

- Being a fly ash, UFFA is very effective at controlling **Heat of Hydration**
- At 15% addition levels HoH maximum temperature levels can be reduced by up to 15%
- **Water absorption** is reduced due to the additional CSH gel filling the pore spaces in concrete (ideal for structures which are required to be water-tight)
- As mentioned, **Durability**; less water requirement plus durable CSH gel reduces the rate of ingress of harmful chlorides and other salts
- Research has shown that alumino-silicates like Super Pozz P500® are highly effective at binding harmful chlorides. The alumina content of Super Pozz P500 is > 25%
- **Sulphate resistance** is improved as Super Pozz P500 addition decreases the available sulphate from preventing the formation of ettringite
- Last….but not least, the use of Super Pozz P500 like all fly ash materials improves the **carbon footprint** of concrete (substituting cement which during its production emits 1-ton of CO_2 for every ton of cement produced!)

BENEFITS OF CLASSIFIED FLY ASH





Characteristics of high-performance concrete with UFFA

Plastic State

- Ease of placement (Workability)
- Compaction without bleed or segregation (Cohesiveness)
- Volume stability (shrinkage) ie. Less cracking

Characteristics of high-performance concrete with UFFA

Hardened Concrete

- Strength
- More durability and long life in severe environments/conditions
- Low permeability and diffusion
- High modulus of elasticity
- High abrasion resistance
- Resistance to chemical attack

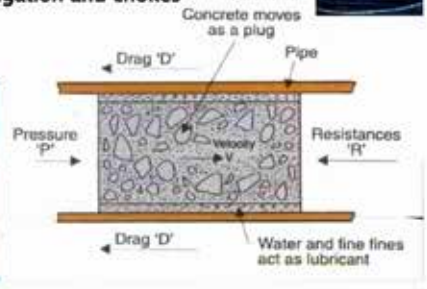
FA Has a proven track record

Classified fly ash has always been seen to
1)Reduce heat development (H o H) and risk of cracking
2)Economical
3)Reduced chloride ingress (due to dense impervious concrete matrix)

Classified Fly ash is environmentally friendly;
1) A true (green) product
2) Use of what may become a waste product
3) Fly ash when replacing cement lowers CO2 levels

Improvement in pump ability due to fine and UFFA

Forms a good lubricating layer on the internal pipe surface and assists pumping.
Reduces ware and tare of pump line.
Reduces chances of stiffening in the pipeline
Prevents mix segregation and chokes



Improved workability, flow ability and cohesiveness Self Compacting Concrete Delivered / Pumped at Site

Date	05.04.16	05.04.16
Location	Nagpur	Nagpur
Client Name	U Tech	U Tech
Trial No	1	2
Grade	M60	M60
Binder	567	567
Cement	446	446
Flyash	91	91
Alccofine	0	30
UFA	30	0
10 mm	447	447
20 mm	672	672
N'sand	855	855
C'sand	152	152
Water	190	190
Admixture	4.536	4.536
Dose	0.80%	0.80%
Brand of admixture	Fosroc Auramix 300	Fosroc Auramix 300
Mixing Time	3.05 PM	6.35 PM
Flow/Slump		
Initial	Collapse	Collapse
1 Hr.	700 mm	720 mm
2 Hr.	700 mm	705 mm
3 Hr	695 mm	
3.5 Hr		
Avg Compressive Strength (Mpa)		
1 Days	45.98	38.76
3 Days	64.48	63.62
7 Days	72.62	72.58
28 Days	84.47	83.77

PRECAST INDIA TRIAL RESULTS – PUNE

ASHTECH INDIA PVT LTD

Trial Summary with Superpozz P500

Mix Design (Corrected)

Date	29.06.16	30.06.16	30.06.16
Location	Pune	Pune	Pune
Client Name	Precast	Precast	Precast
Trial No	1	2	3
Grade	M60	M60	M60
Binder	580	540	540
Cement	475	400	400
Flyash	105	105	105
GGBS	0	0	0
MS	0	0	0
UFA	0	35	35
Water	196	182	165
Dose	1.00%	0.80%	0.90%
Admixture	CAC PC	CAC PC	CAC PC
Flow/Slump			630 mm
Initial	650 mm	620 mm	
1 Hr.			
2 Hr	630 mm	510 mm	580 mm
1 Day	24.40	24.62	28.45
2 Days	47.55	43.35	50.75
Remarks	Precast Mix	Ashtech mix	Ashtech mix

LODHA PROJECTS – MUMBAI

Mix Design (Corrected)

Date	30.05.16	30.05.16	30.05.16	30.05.16
Location	ACC R&D Thane	ACC R&D Thane	ACC R&D Thane	ACC R&D Thane
Trial No	1	2	3	4
Grade	M70	M70	M70	M70
Binder	655	645	635	620
Cement	450	450	450	450
Flyash	140	140	140	140
UFA	65	55	45	30
Water	175	175	174	175
Dose	0.72% + 0.12 % Retarder	0.55% + 0.12 % Retarder	0.59% + 0.12 % Retarder	0.60% + 0.12 % Retarder
Admixture	ACC Sigma PC	ACC Sigma PC	ACC Sigma PC	ACC Sigma PC
Initial	650 mm	670 mm	680 mm	680 mm
1 Hr.	500 mm			650 mm
2 Hr.				
2.5 Hr.		580 mm		
3 Hr.	470 mm	430 mm	350 mm	450 mm
Strength (Mpa)				
3 Days	58.08	60.45	63.2	59.26
7 Days	77.63	80.00	80.89	79.41
28 Days	93.63	93.92	97.19	87.70
UFFA %	10	9	7	5

Ashtech Fly Ash Trial Report

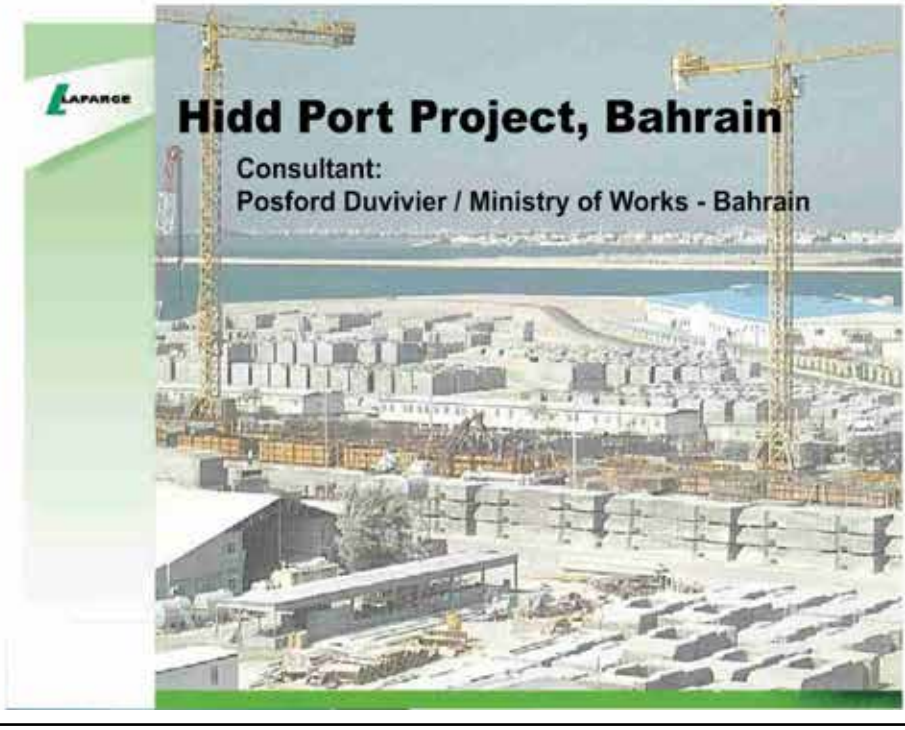
DT of Cast	14.06.2016	18.06.2016	21.06.2016	23.06.2016	25.06.2016	28.06.2016	29.06.2016	30.06.2016
Trial	TM 365	TM 367	TM 369	TM 371	TM 373	TM 375	TM 376	TM 377
Details	Total Cementatious - 400 Kgs/cum				Total Cementatious - 450 Kgs/cum			
	OPC	OPC + PFA + M Silica	OPC + PFA + UFFA	OPC + PFA + Alccofine	OPC	OPC + PFA + M Silica	OPC + PFA + UFFA	OPC + PFA + Alccofine
OPC - Ultratech	400	310	310	310	450	350	350	350
PFA	0	65	65	65	0	70	70	70
UFFA	0	0	25	0	0	0	30	0
Alccofine	0	0	0	25	0	0	0	30
M. Silica	0	25	0	0	0	30	0	0
20mm - Ambernath Quarry	695	675	676	678	672	655	655	668
10mm - Ambernath Quarry	333	283	284	286	288	281	281	270
C SAND - Turbhe	895	935	933	935	924	915	915	915
Total Water	213	232	199	207	210	223	195	198
Free Water	160	179	146	154	157	171	143	146
W/C ratio	0.40	0.45	0.37	0.39	0.35	0.38	0.32	0.32
Admixture Kg. PC 105 R	4.80	4.80	4.80	4.80	5.40	5.40	5.40	5.40
%	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Plastic Density kg/m3								
Theoretical 2536		2525	2492	2506	2544	2524	2496	2499
Wrokability (mm)								
Initial	Collapse	< 700	< 700	< 700	< 700	< 700	< 700	< 700
60 min.	550	545	555	550	555	555	555	555
120 min.	450	440	455	445	445	445	445	450
Compressive Strength, N/mm²								
1 Day	19.78	8.70	10.36	9.88	15.28	10.37	10.31	7.46
1 Day	18.87	8.38	10.44	10.09	12.77	8.04	10.27	8.98
Avg 01 day	19.33	8.54	10.40	9.99	14.03	9.66	10.29	8.22
03 day	24.98	14.57	17.95	22.39	26.67	18.81	22.79	26.71
03 day	24.56	15.07	18.08	20.97	26.63	18.19	22.97	24.24
Avg 03 days	24.77	14.82	18.02	21.68	26.65	18.50	22.88	25.48
07 day	33.16	21.96	25.82	31.58	35.35	29.47	32.90	35.73
07 day	32.51	24.86	25.01	31.06	35.81	29.42	31.64	35.52
07 day	37.31	25.10	25.82	31.04	35.50	29.76	33.29	35.80
Avg 07 days	34.33	23.97	25.55	31.23	35.55	29.55	32.61	35.68
14 day	45.35	35.27	35.05	39.82	42.55	40.37	44.92	44.51
14 day	48.26	33.45	35.23	39.88	44.16	42.57	44.27	43.37
Avg 14 days	45.81	34.36	35.14	39.85	43.36	41.47	44.60	43.94
28 day	56.15	39.85	48.17	49.71	52.47	48.72	52.49	52.28
28 day	56.19	41.21	48.45	48.73	51.02	48.36	51.59	51.48
28 day	56.44	40.32	46.59	48.39	50.11	48.09	52.53	52.24
Avg 28 days	56.26	40.46	47.74	48.94	51.20	48.39	52.20	52.00
56 day	58.69	46.37	57.18	56.95	55.28	56.87	61.89	62.00
56 day	60.06	47.22	58.47	56.52	56.21	58.09	61.91	63.00
Avg 56 days	59.38	46.80	57.83	56.74	55.75	57.48	61.90	62.50
90 day	61.07	52.12	64.90	63.35	57.30			
90 day	61.60	53.06	64.96	62.89	56.89			
Avg 90 days	61.34	52.59	64.93	63.12	57.10	0.00	0.00	0.00
Flexural Strength, N/mm²								
07 Days	3.51	3.03	3.20	3.03	3.92	3.38	3.56	3.20
28 day	4.27	4.81	4.63	4.98	5.21	4.67	5.23	4.90
28 day	4.45	4.63	4.81	4.81	5.12	4.98	5.41	5.33
Avg 28 days	4.36	4.72	4.72	4.90	5.17	4.83	5.32	5.12
Water Permeability, mm @ 28 days				11.32	17.1	12.02	11.43	11.9
RCPT, coulombs @ 28 days	3328	1558	1897	1914	3786	1884	2255	2275
Chloride Migration, m2/second @ 28 days	1.54E-11	7.88E-12	8.66E-12	8.70E-12	1.36E-11	5.15E-12	8.92E-12	7.56E-12

COMPANIES SPECIFYING UFFA

- United States Navy
- The United States Federal Highway Administration (FHWA)
- Saudi Aramco, Saudi Arabia
- Bahrain Ministry of Works
- The Concrete Institute of South African
- The British Highway Authority

Successful UFFA Projects

- **Palabora Copper Mine** in Limpopo, South Africa (one of the world's largest copper mines) used for ore-pass linings and roadways
- **Metalong Dam** in Lesotho, Southern Africa used in conjunction with classified fly ash in dam wall concrete (265 000 m^3 of concrete placed)
- **M 90** carraige-way in Scotland
- **Hidd Port Project** in Bahrain; over 28 000 tons of UFFA was used in the concrete mixtures for durability
- **Bandar Abass**in Iran, project to upgrade the port
- **New Saint Helena Airport** in the South Atlantic; product was shipped in bulk bags from Cape Town (a distance of 3100 kilometres!)
- **INDIA**
- **DMRC – IV PHASE APPROVED.**
- **HIRANANDANI MUMBAI.**
- **BHOJWANI MUMBAI.**
- **ULTRATECH RMC, SKYWAY RMC RELCON RMC – COMMERCIAL DISCUSSION.**



Green engineering with fly ash

Design Parameters:

1. Use the lowest water content for a given workability to reduce shrinkage
2. To use the lowest w/b ratio to reduce porosity, cement content, and heat development, without introducing excessive strength and brittleness.
3. Utilize cementitious materials that will lead to high mobility in the mortar fraction

Green engineering with fly ash

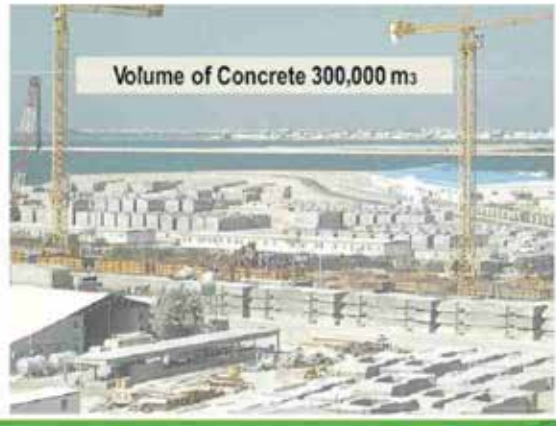
AshResources

Specificatiohn Requirement		Results
Maximum Aggregate	20mm	-
Volume Stone, minimum	50%	50%
W/b ratio, maximum	0,35	0,30
Free Water Content, max	125 ltrs	110 ltrs
28 day Compressive Strength	65 MPa	75 MPa
Slump, minimum	100mm	125 mm
Temperature rise/m3, max	30 deg C	26 deg C
Permeable Pores (ASTM C642), max	7% @7d	6,6% @ 7d
Capillary Index, max	5 g/m2/sec	3,9 g/m2/sec

Portland Cement 252 kg
Dura-Pozz® 108 kg
Super-Pozz® 18 kg

Low Water demand, low temperature, low permeability, high strength; and far less sensitive to field curing than all other mixtures tested.

Green engineering with fly ash



Green engineering with fly ash

AshResources

Green engineering with fly ash

AshResources

Green engineering with fly ash

CONCLUSIONS

- For proper particle packing, Ultrafine materials have to be used in conjunction with fine materials.
- Shape and size as well as distribution (PSD) of fine and ultrafine materials play an important role in workability , cohesiveness and pump ability.
- In HPC, fine and ultrafine materials play a very important role to strengthen the interface between the binder paste and the aggregates.
- Free water and entrapped air get reduced in binder paste when fine and ultrafine materials are used. This reduces shrinkage.
- Sustainability Durability and Strength are greatly enhanced if fine and ultrafine materials are used in concrete (HPC).

It is not the strongest species that survive, nor the most intelligent, but the ones Most responsive to change

- Charles Darwin

LET US BE RESPONSIVE TO EMERGING CHANGES

Questions?

Prakash Sreenivasan
VP – Techno Marketing UFFA

APPLICATION OF POLYMERS IN CONSTRUCTION INDUSTRIES

S.B Raghunath

Polymer

The word polymer is been used as JARGON off late and is being given undue importance.

From simple water to high end Polyuria are all

Composites and polymers

DEFINATION

Polymers are nothing but combination of molecules which have branched reaction it can be water, common salt, cement to any thing. Monomers are single line combination which becomes polymers when exposed to air or atmosphere in most of the cases. Ex : super glue or cyanoacrylates.

IMPORTANCE

Polymers have become increasingly important as engineering materials in the past decade and applications in the construction industry are expanding. In Europe, around 20% of plastic consumption is in this industry, i.e., around 5 million tonnes per year.

Fibre reinforced polymeric materials are gaining market share from traditional construction materials due to their low weight combined with high strength. Mechanical properties can be tailor-made by careful selection of fibre and direction of reinforcement.

Applications include bridge construction, pipes, column reinforcing wraps and reinforcing bars for concrete. They can also offer better fire resistance than most other materials, for example, phenolic are used in firewalls.

EPS STRUCTURES

Concrete is a versatile construction material, but could benefit from improved strength, toughness, ductility and durability. One approach is to develop cement based composites. Polymer mortars and concretes are finding increasing use in applications such as protective coatings.

Polymer concretes are structural materials capable of withstanding highly corrosive environments. Polymers also offer the chance to increase the ductility of reinforced concrete to prevent cracking under load.

Polyester (Thermosetting)FRP :Bridge Sections, Cladding Panels, Sinks, Surfaces, Coatings

Polyethylene Foam: Underlay, Damp-proof Membranes, Coatings

Polymer Type Applications

- Epoxy resins: Solid resin and Terrazzo flooring,
- Anchor fixings, Adhesives, waterproofing.
- Ethyl vinyl acetate (EVA :) Solar panel encapsulants
- Expanded polystyrene (EPS): Concrete moulds, Insulation,
- Packaging flotations.
- Polycarbonate :Lighting housings, Fittings in hot water systems, Glazing

Polyisobutylene (PIB) :Glazing Sealants,Waterproof Membranes

Polymethylmethacrylate / Acyrlic (PMMA):Surfaces, Sinks

FLOTATIONS, HARD FLOORS, BLAST RESISTANT COATINGS, EPS COATINGS,

WATER TRANSPORT VEHICLES

FLOOR AND HANGER COATINGS,

Using the Watershield as basic raw material many other products can be manufactured .

- Waterproofing
- Waterproofing & Temperature Resistant Paints
- Ready mix plaster (Dry)
- Ready Mix Concrete (Dry)
- Bore Packing compound
- Crack and UV resistant & Waterproofing Cement
- Bricks
- Slabs
- Countertops
- Solid blocks
- Pillars and beams

Waterproofing & Temperature Resistant Paints

Perfectcoat-TR: Temperature resistant paint which is also water, algae, fungus proof internal and external paint first of its kind for having UV and heat resistance upto 10°C.

Ready Mix Plaster (Dry)

Dry plaster mortar that can be used for fixing bricks, plastering surfaces internal, external and ceiling

Has waterproofing, heat and UV resistant property along with crack resistance.

Can be used in large projects and also for small repairs like fixing plumbing hole, wall cracks, etc

Also available as acid alkali resistant mortar and lining material.

Dry concrete as per designer specification for both projects and repair activities like filling of voids, fixing of poles, machineries, transformers, repairing drains, potholes, for making Hume pipes…….

Bore Packing

Toilet Bore packing material which can also be used as grout with inherent properties like crack and water resistance.

Perfect Bond has a shelf life of 6 months if kept in a dry store in sealed bags. If stored in high temperature and high humidity locations, the shelf life may be reduced.

Advantages

High ultimate strength ensure the durability of the hardened grout

Free flow ensures high level of contact with load bearing area

No metallic iron content to cause staining

Pre-packed material overcomes onsite batching variations

Develops high early strength without the use of chlorides

TILES, Counter Tops

Available in acid alkali resistance form

Can be used in laboratories, battery rooms, industries, WTP.

When REMAT is selected can be used in low cost projects and also as green project,

Available in different colors, shapes and sizes.

Mud Bricks

PERFECTBLOCK

This comes in 2 variants one is virgin material where it can be used as acid and alkali resistant block for WTP or for costal area another version is used for conventional structures as this comes with construction debris. Both the versions are pre-plastered and is ready to be painted. Interlocking version is also available against specific enquiry. Size and strength is custom designed. We also can offer other variants of structures in precast form as per designers specification.

polymer foams are extensively used for insulation, primarily polystyrene, PVC, phenol-formaldehyde and polyurethane. Structural foams have also been developed from materials such as polyolefins, polycarbonate and ABS.

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"Sustainable Materials – towards a innovative Architecture"

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Presentation Summary

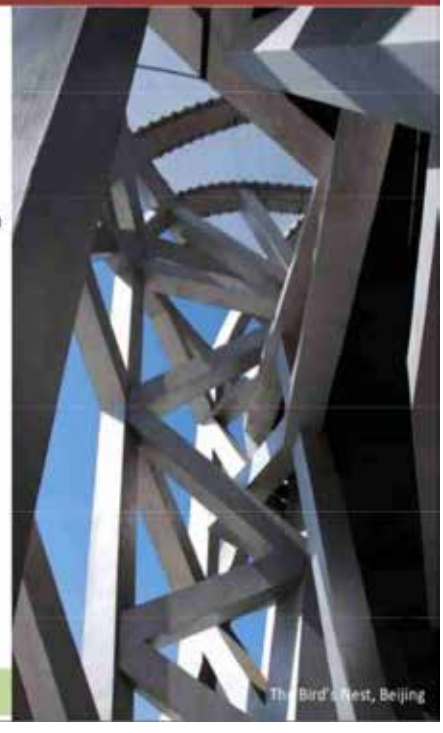
In this presentation, we will discuss;

Materials
Characteristics
Renewable vs non-renewable
Durability
Insulation
Heat storage capacity of Materials
Thermal Mass
Properties
Green Design
Sustainable materials used in Green
Green buildings projects in India

Materials First!

Materials need to be part of the very initial thoughts as a building is conceived.

A building's design is intrinsically linked to its materiality.



Material Choices

- When designing buildings we usually have a choice as to what material to specify
- Materials can be compared as being more or less harmful to the environment
- We should obviously choose less harmful materials
- We should use materials that use less energy
- We should use materials that make our buildings more efficient
- Materials should be both beautiful and enduring

Renewable vs Non-Renewable

- Materials can be classed as either renewable or non-renewable
- Non renewable materials includes metals, and stones and items that "do not grow"
- Renewable materials include wood, straw, bamboo and other "growing" substances


Caisse du Depots et Placements, Montreal

Durability

- Preference is almost always given to the use of more durable/long lasting materials
- It is expensive to have to replace windows, roofing materials and cladding
- Expense can be measured both in terms of dollars as well as energy (and associated greenhouse gas emissions)

Video on Green building concepts

Insulation


Soybean based spray

Different types perform different ways, as a function of their materiality and thickness. *More is more...*

Some are less environmentally harmful than others.


Fiberglass batt

Heat Storage Capacity of Materials

The specific heat of materials is different than their ability to store this heat. This is referred to as their "thermal mass" or "heat storage capacity". Thermal mass is the ability of a material to hold heat and *slowly* release it back into the environment giving a flywheel effect.

We often make a choice, depending on the climate, if we need to store heat to have it released later in the day, when the sun is down and things have "cooled off".

Materials with a high thermal mass are helpful in the heating of building interiors in cold climates.

We need to select materials with a high heat storage capacity but that are not conductors (like metal).

Heat Storage Capacity of Common Materials

MATERIAL	Heat Storage Capacity BTU/Cubic ft./°F
Water	62.5
Cast Iron	54.0
Concrete	31.7
Glass	27.7
Oak	26.8
Brick	24.8
Earth	20.0
Gypsum	20.3
Pine	18.1
Air	0.018

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Thermal Mass

Exposed concrete floors are becoming increasingly common in sustainable buildings.

The concrete is both structural and acts as an excellent storage material for free solar energy that comes in through the windows.

It can be made less harmful by replacing some of its cement content with "flyash" which is a waste product of the steel industry.

The concrete can be stained with different colours if desired.

Materiality and Site

Intelligent Smart bldg

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Materiality and Site

COMMSCOPE®

Green Properties

The practice of

- increasing the efficiency of buildings and their sites using energy, water and materials, and
- reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal – the complete building lifecycle.

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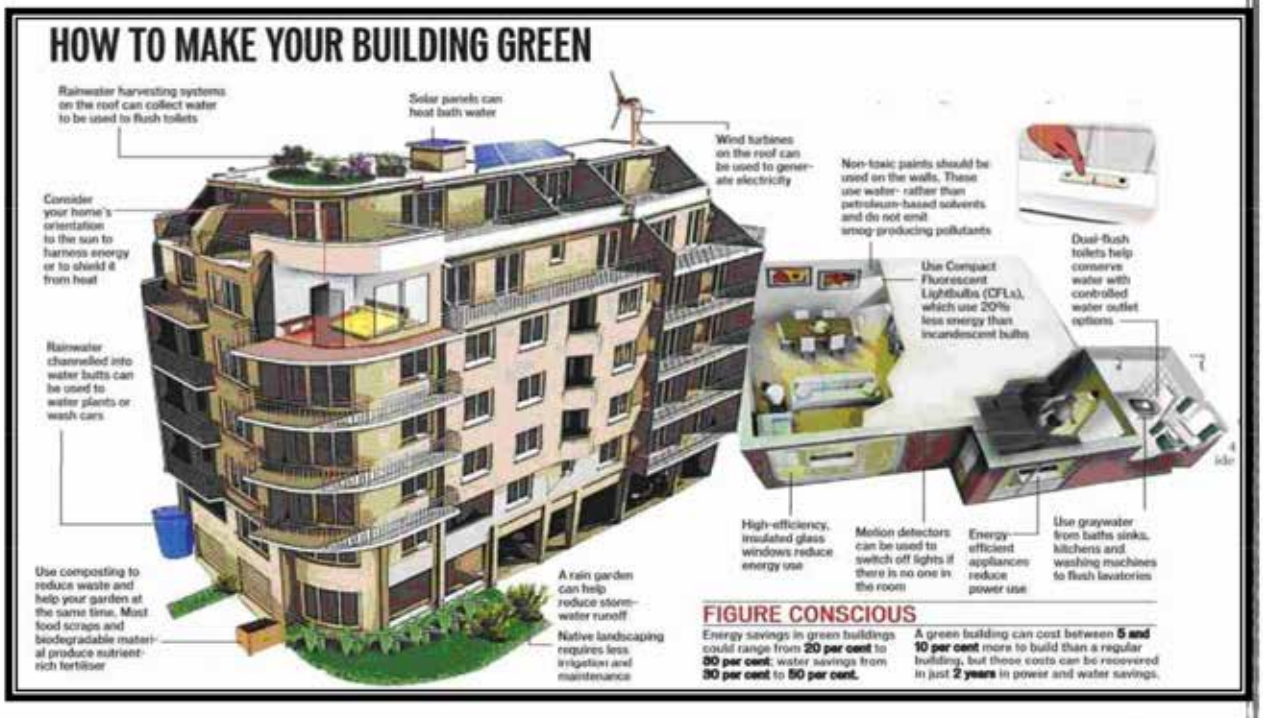
Green Design



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Sustainable Materials Used In Green

- Renewable sources: Forests
- Reuse from waste: old plumbing , doors etc.

Wool brick

- Obtained by adding wool and a natural polymer found in seaweed to the clay of the brick,
- 37% More strength than burnt bricks
- Resistant for cold and wet climate

Sustainable Concrete

- Crushed glass
- Wood chips or slag - a byproduct of steel manufacturing.
- Reduces the emission of CO2

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Sustainable Materials Used In Green

Paper Insulation

- Made from recycled newspapers and cardboard
- Then filled with chemical foam
- Insect resistant &fire retardant

Solar Tiles

- Exist to simply protect a building
- They spend a large portion of the day absorbing energy from the sun.

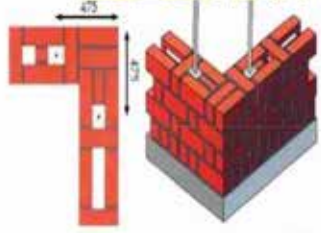
Triple-Glazed Windows

- Super-efficient windows
- Stops heat to enter the building & from direct sunlight

Eco Friendly

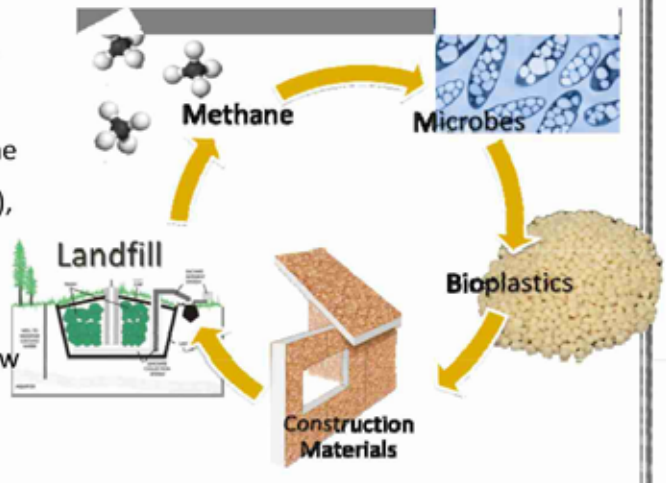
Using Bamboo

Replacing The Steel Bars



Sustainable Materials Used In Green

Due to continued concern over environmental impact and sustainability of materials, poly(hydroxyalkanoates) (PHAs), a family of bacterial polyesters, have been growing in popularity. PHAs have properties comparable to the conventional plastic polypropylene (PP), with the added benefits of biodegradability, biorenewability, and no toxicity. However, they have a narrow thermal processing window and poor mechanical properties that limit its application.



PHA foams for insulation and structural applications

Green buildings project in India

Bangalore City

1. Suzlon Energy Limited-Pune
2. Biodiversity Conservation India Ltd (BCIL) Bangalore
3. ITC Green Centre Green building-Gurgaon
4. The Druk White Lotus School-Ladakh
5. La Cuisine Solaire - Auroville
6. Doon School-Dehradun
7. Raintree Hotels-Chennai
8. Nokia-Gurgaon
9. Rajiv Gandhi International Airport-Hyderabad
10. Patni Knowledge Center - Noida
11. Hiranandini-BG House, Powai
12. ABN Amro Bank, Chennai
13. Palais Royale at Worli, Mumbai
14. Punjab Forest Complex,Mohali
15. Olympia Technology Park-Chennai

Suzlon global headquarters 'One Earth'- Pune

- Suzlon Energy Limited (SEL), the world's third-largest* and India's largest wind turbine manufacturer accepted on April 29, 2010 the Leadership in Energy and Environment Design (LEED) Platinum award for its new corporate headquarters in Pune, Maharashtra, India.
- Developed on an area of 41,000 square meters (10.13 acres) with a capacity to house 2,300 people, One Earth ranks among the largest green building projects in India.

Biodiversity Conservation India Ltd (BCIL) - Bangalore

- As a green builder who strives for the conservation of diversity in vegetation, forests, culture and urban lifestyles, BCIL has created some of the most energy-efficient residential homes India has ever set eyes upon.

- The company's TZed homes in Whitefield, Bangalore has been certified as the first residential apartment in the world to be rated 'Platinum' under LEED.
- TZed, which means "Towards Zero Energy Development" is a 2,49,000 sq.ft. green project spread across 5.5 acres and is designed to reduce lighting and energy by nearly 70 per cent.

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ITC centre green building- gurgaon

- Renowned as one of the early adopters of the green building movement in India, the ITC Green Centre is still considered a benchmark for green buildings.
- It was the first 'Platinum' rated building in India and has endeavored to adopt green practices that go beyond recycled waste and day-lit offices.
- Within a built-in area of 180,000 sq.ft., **the building features alternative transportation facilities, storm water management system, solar thermal technology, reflective high-albedo roof paint, minimal exterior lighting, separate smoking rooms with exhaust system and zero-water discharge**

More than 10% of the building materials are refurbished from other sites and 40% are from within 500 miles of the project site

The Druk White Lotus School - Ladakh

- In this desert landscape of severe climatic conditions, 3,500 meters above sea level, was born a modest school that is adjudged as an outstanding example of sustainable, green, cost effective building development.
- This multi-award winning structure is the recipient of the **Best Asian Building, Best Education Building and Best Green Building awards.**
- **It combines the best of traditional Ladakhi architecture with 21st century engineering excellence and is built with traditional materials such as locally excavated stone, mud bricks, timber and grass.**

La Cuisine Solaire - Auroville

- One of the most innovative green buildings in the country is the **solar kitchen** at Auroville, Tamil Nadu that best demonstrates the use of solar energy to produce steam.
- **This 1700 sq. m. kitchen is named thus because of the huge 15 diameter solar bowl that has been fixed at the top of the structure to harvest solar energy.**
- **On a clear day, this green structure can generate enough steam at a temperature of 150°C that can be used to cook meals for 1000 people, three times a day.**

This building puts to use appropriate technologies and passive solar concepts to achieve energy-efficiency

Doon School - Dehradun

- Authorities can rightfully claim that this establishment is one of India's first green school campuses **that opted for recycling measures and successfully achieved cent per cent self-sufficiency in energy, water and organic fertilizer.**
- **Several old building blocks that were part of the 69 acre school were redesigned and solar thermal systems, waste management processes as well as biomass gasification systems were introduced as part of its green initiatives.**

Doon school drastically reduced the need for artificial heating/cooling air conditioning through solar thermal systems and cross-ventilation

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Raintree Hotels - Chennai

- Here is an eco-sensitive hotel for the eco-savvy traveler.
- The entire chain of Raintree business hotels across Chennai city are the first eco-sensitive hotels in South India.
- Everything about this hospitality range is green: **right from the rubber wood, bamboo and medium-density fiber used for construction down to the Portland Pozzalana cement containing 15 to 20 per cent fly ash.**
- **The George Fisher concealed cistern installed at the hotel controls the water used in toilet flushes and the sewage treatment plant recycles water for use in air conditioners.**

Setting new standards of environmental responsibility without compromising on guest experience

Rajiv Gandhi International Airport - Hyderabad

- India's first Greenfield airport is undeniably among the top 10 green buildings in India and the first airport in Asia to be awarded the LEED 'Silver' rating certification by US Green Building Council.
- **Featuring 100,005 sq. m. of glass encased terminal, this green building ensures optimal use of natural light and minimal wastage of electricity or energy consumption.**
- Yet another of its green features includes the **recycling of treated wastewater for landscaping, air conditioning and flushing requirements.**

This greenfield airport has been built at a cost of Rs 2,478 crore

Patni Knowledge Center - Noida

- Covering a built-up expanse of 4,60,000 sq ft, The Patni Campus, situated in suburban sprawl of Noida, has been conferred as the Second Largest Platinum rated LEED Certified Green Building by the IGBC for Block A & Block B is also awarded as GOLD rated LEED Certified Green Building, the highest form of honor to be bestowed by the council.
- Over 50% green area
- 75% of the area receives natural daylight
- 95% of the occupants get access to outside views
- Zero discharge building; 100% recycling of sewage
- Drip water irrigation and solar water heating
- Interior materials with low volatile organic compound (VOC) emissions
- Healthy air quality with CO2 sensors for adding fresh air on demand
- Maximum use of eco-friendly recyclable material.

Set up with an investment of Rs.. 175 crores, this Green IT-BPO centre is spread over 5 acres of land and seats over 3,500 people. 27

Nokia - Gurgaon

Among India's most sustainable buildings is the corporate office of Nokia in Gurgaon which has been granted accreditation as one of the world's leading green buildings by the U.S. Green Building Council (USGBC).

This is the first time that a commercial interior fit-out project in India is being awarded the Green Building Award and prestigious LEED 'Gold' rating.

What makes this green office stand out from the rest is its smart **lighting and ventilation systems, high-efficiency chillers, high-performance double glazing, heat recovery wheel, green guard certified furniture and online CO2 monitoring system.**

The construction cost (of the structure) was around 10 per cent more with a payback period of four years but while green projects are cost-intensive,

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Merits of Green building

1. Efficient Technologies
2. Easier Maintenance
3. Return On Investment
4. Improved Indoor Air Quality
5. Energy Efficiency
6. Water Efficiency
7. Waste Reduction
8. Temperature Moderation
9. Water Conservation
10. Economical Construction For Poor
11. Healthier Lifestyles and Recreation
12. Improved Health.

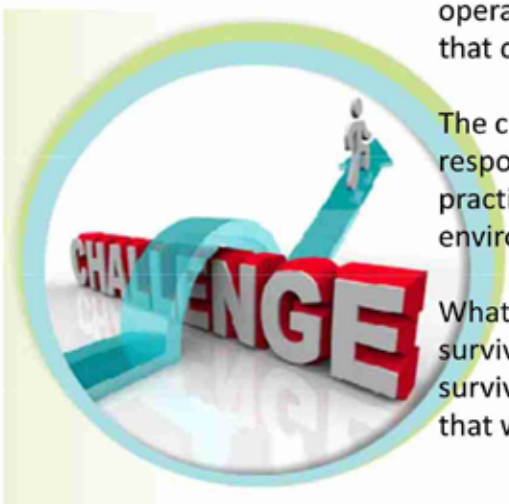
Demerits

1. Initial cost is high
2. Availability of materials
3. Need more time to construct
4. Need ~~skilled~~ worker

The Green Road to Success

The killer summer that just went by, a somewhat truant monsoon, and generally whack doodle weather are wake-up calls for us all.
Global warming has arrived – like it or not. And whether it's here to stay – or not – depends upon us. The weather will get a lot worse if we don't do something about it now.

Much of the business of our industry is derived from operations that are somewhat ecologically challenged (or, that compromise on the environment).



The challenge of industries (particularly the socially responsible ones) is to integrate into their operations practices that mitigate their negative impact on the environment.

What is the purpose of protecting the environment? Our survival. A degraded environment lowers our chances of survival as a species. It is, therefore, in our own interests that we take care of the environment that takes care of us.

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Quality Rating System for Buildings Systems – A TQM Approach

Prof Anil K Sharma

Why Quality Rating?

- Increased
  - Urbanisation & Expectations
  - Builders and
  - Variety of Quality

Why Quality Rating?

- Internationally there are quality systems' certifications for almost all activities but there is almost none on Quality Rating for buildings
- Quality of building projects on a quantitative scale would enable comparison of quality parameters of different buildings on a common benchmark
- Quality Rating System – A necessity

Benefits of Quality Rating

- Instill confidence in quality, structural safety and serviceability of a Building
- Encourage standardization
- Differentiate similar buildings with varied quality
- Encourage competition to achieve higher ratings.
- Help for corrective measures to improve the overall quality.
- Encourage optimisation of resources

Thus promote sustainable construction.

Quality Components

- Quality is recognised to have following 8 dimensions:
  1. Performance
  2. Features
  3. Reliability
  4. Conformance
  5. Durability
  6. Serviceability
  7. Aesthetics
  8. Perceived Quality
- All these are envisaged to be included in proposed 'Quality Rating of Buildings'

Quality Assessment is Intricate

- Quality of a Building is aggregation of:
  - Quality of Planning, Design & Execution
  - Quality of materials and workmanship
- Assessment becomes intricate due to:
  - Multiplicity of parameters
  - Subjectivity and Objectivity

Quality during Planning & Design

- Optimal siting and its orientation
- Architectural planning
- Selection of green materials
- Efficiency in design to optimise

  - Structural safety vis-à-vis structural materials,
  - Energy consumption,
  - Waste generation
- Harvesting Natural Resources
- Recycling of waste generation

Quality during Execution

- Achieving implied and specified quality of all materials and workmanship is highly challenging engineering task due to:
  - Almost all engineering disciplines get involved and need to be coordinated.
  - Processing and integrating a large variety of materials, which are raw, semi-processed as well as manufactured
  - Skill/ workmanship of a different kind is involved in each process.

Inadequacy in Performance

- A well planned, designed and executed building would give an optimum performance
- It is generally difficult to identify the genesis of an inadequacy in its performance
- Quality Rating should be able to
  - Identify the source of inadequacy
  - Help in taking remedial action.

Quality Rating

- Quality Rating should reflect Quality covering aspects relevant to the usage of a built facility
  - An objective and rational measure of quality of all sub-components e.g. Planning, design, execution, etc and
  - Aggregate the same to reflect as a whole
- The quality rating system could be on a scale of 1-10 with ranges of 1-3 (Low), 4-6 (Medium), 7-9 (High), and 10 (Exceptional)

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Broad Parameters

- Planning & Design
  - Parameters include architectural, accessibility, structural and MEP services (mechanical, electrical & plumbing).
- Construction:
  - Materials used
  - Construction processes
  - Structural quality
  - Workmanship (including Geometrics)
  - Functionality of services
  - Safety during construction processes
- Environment Quality & Fire Safety
  - Green building parameters;
  - Fire-Resistance Rating;

Structural quality and Fire Safety to have to have multiplier effect

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Planning & Design

- Architectural Planning
  - Conformance to Standards
- Byelaws
- Building Standards
- Code of Practices for Different Buildings – NBC
- Fire Safety Byelaws
  - Innovation
  - Design Efficiency/ Closeness to Desirables
  - Building Envelop
  - Aesthetics
  - Finishes
- Functionality
- Value for Money
  - Maintainability

Planning & Design

- Civil Planning
  - Specifications
- Innovative materials & their Relevance
- Maintainability
- Written Specifications for non-standard items
- Civil Services
  - Innovation
  - Design Efficiency
  - Conformance to Standards
  - Maintainability
  - Ease of Execution
  - External Services
- Roads & Footpaths
- Storm water Drainage
- Sewerage
  - Internal Services
- Water Supply
- Drainage
- Sewerage
- Storm water Drainage
  - Horticulture
- Structural Planning
  - Innovation/ Structural System
  - Design Efficiency
- Steel/ Concrete ratio
- Steel Consumption per unit area

- Cement Consumption per unit area
  - Conformance to Standards
  - Foundation System Efficiency
  - Ease of Execution
- Reinforcement Detailing for compactability
- Repetition of Shuttering
- Mechanical & Electrical Services
  - Innovation
  - Design Efficiency
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Construction

- Materials Used
  - Consistency of Quality
  - Quality w.r.t. specifications
- Construction Processes
  - Innovation in Construction Technology
  - Level of Mechanisation
  - Consistency & Quality w.r.t. specifications
- Structural Quality
  - Consistency
  - Technology
  - Plant & Machinery
- Workmanship
  - Geometric Controls – Slope, Lines and Levels
  - Consistency
- Functionality of Services
  - Record of Testing and functionality
  - Maintainability
- Construction Safety
  - Training of Workmen on Safety
  - Use of Safety Equipment & Tools
  - Safety Drills
  - Record of Safety Compliances
  - Accident Record

Inadequacy in Performance

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- It is generally difficult to identify the genesis of an inadequacy in its performance
- Quality Rating should be able to
  - Identify the source of inadequacy
  - Help in taking remedial action.

What is Quality Rating?

- Quality Attributes
  - Identification

  - Classification
  - Assign weightage
- Within the classification
- Of All Classifications
- Quality Rating
  - On a Scale (say 1 to 10)
- for each of the Attribute
  - Aggregate Quality of all identified attribute
- Within the class as per weightage assigned
- Of All classifications as respective weightage
- Quality Rating of a Building is weighted sum of all quality attributes in the building system
- Quality of building projects on a quantitative scale would enable comparison of quality parameters of different buildings on a common benchmark
- Increased
  - Urbanisation & Expectations
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Quality Attributes

- Planning and Design
  - Architectural Design
- Siting of building block
- Functionality based features
- Linkage of Spaces
- Efficiency
- Accessibility
  - Structural
- Safety
- Economy
- Ease of Construction
  - Services
- Maintainability
- Operation & Maintenance Manuals/ Plans
- Execution
- Materials
- Workmanship
- Sustainability
  - Materials
- Selection
- Efficient Use
  - Safety
- Fire
- Structural

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- Environment Quality & Fire Safety
  - Green building parameters;
  - Fire-Resistance Rating;

Structural quality and Fire Safety to have to have multiplier effect

Essentials for Quality Rating

- Quality Assurance System
  - Appropriately defining
- Quality Parameters
- Stages of Compliance Checking
  - For authentic and accurate data at applicable frequency
- Quality rating parameters and their weightage
  - Based on overall impact on the project.
- Consistency of quality (or its variance) at various locations
- Green parameters for environmental quality
- Safety during construction
- Development of system standards and parameters for:
  - Planning & design efficiency,
  - Geometric controls (lines, levels & slopes),
  - Quality of materials,
  - Construction processes,
  - Safety,
  - Eco-friendliness,
  - Workmanship,
  - Building finishes,
  - Functionality and
  - Performance of services, etc
- Report & Review (Formats)
  - Planning & Design
  - Construction Stage
- Institutional Setup
  - Organisation
  - Duties
- Quality Assurance System
  - Appropriately defining
- Quality Parameters
- Stages of Compliance Checking

- For authentic and accurate data at applicable frequency
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- Safety during construction

Why Quality Rating?

Why not Griha/ Lead Rating?

- Griha/ Lead Rating
  - Restricted
- Only Sustainability.
- Quality Rating of Building System is
  - Holistic Rating incorporating quality
- Sustainability
- Safety
- Economy
- Planning & Design
- Execution
  - Quality Rating can be taken together as well as can be seen separately for each of its Components
- Quality Rating of Building System has an Edge over Griha/ Leed Rating

Conclusions:

- Quality Rating of Buildings
  - Is the requirement of Society
  - Is Assurance of Structural Safety
  - Is needed to be developed and implemented
- An essential arm for Builders' Regularity Authority proposed by Government

Prof Anil K Sharma,
Former Spl. Director General, CPWD

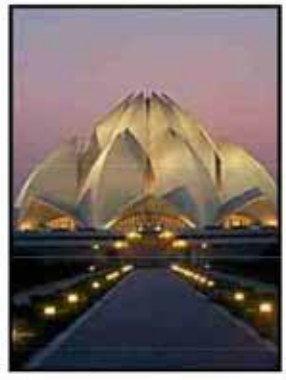
Fly Ash a Cement Alternative: Status, Challenges and opportunities

Kolluru V.L. Subramaniam

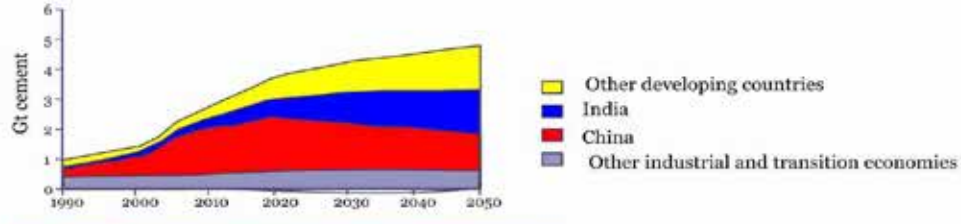
Concrete the Material for Infrastructure

Concrete is one of the most extensively used materials worldwide

— on average, more than two tons per year is produced for every man, woman and child on Earth, making its use second only to water.



Cement Production Past, Present and Future



India and China will contribute about 50% of the global cement output of 2050

Cement Production: Material Demand and Challenges

Indian Cement Scenario for 2050

- Increase Cement Production capacity to 750 million tons/PA to meet demand
- Challenges to meet demand
  - Limitation of raw materials (limestone)
  - Ensuring adequate energy for production
  - Cost of production
  - Reduction of Carbon footprint

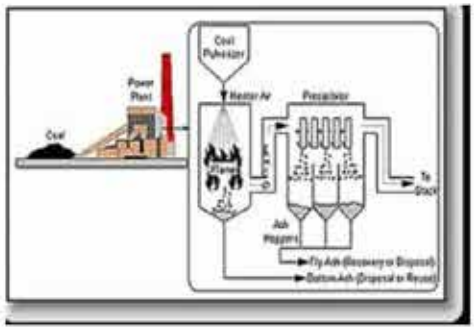
Energy | Resource Limitation | Carbon Footprint

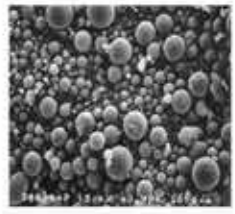
Fly Ash in Indian Context

Magnitude of the problem and potential for use

Fly Ash Generation

Fly ash is the byproduct of the burning of pulverized coal in power plants, being collected from the exhaust gases by electrostatic precipitators or bag filters.





Photomicrograph made with a Scanning Electron Microscope (SEM): Fly ash particles at 2,000x magnification

Coal Consumption and Ash generation

Major contributor

- During 2014-15 the coal consumption for thermal power = **550 million ton**
- Ash content of Indian coals : 30-50%

Fly ash Production Scenario

Indian Context

- The annual production of fly ash in 2014 15 was **185 million tons**
  - **Current utilization 56%**
  - Fly ash was moved from "**hazardous industrial waste**" to "**waste material**" in year 2000
  - November 2009, it became a saleable commodity
- Production of fly ash set to increase with increasing power demand
  - Generation of fly ash from coal based thermal power plants in India is expected to increase to **300-400 MT/year by 2017-18**

Fly ash ideal for large-scale use in low carbon binders

Fly Ash as a Cement Substitute

As **value add** – where replacement enhances performance

Replacement enhances performance
- Strength
- Durability
- Rheology

As a **replacement**

Recover performance at high volume replacement
- Utilize full potential from fly ash to recover cement properties
- Cost
- Carbon footprint

Fly Ash uses in Products and Applications

Magnitude of the problem and potential for use

Uses and Applications

- Mass Concreting
  - Control of heat
- Roller Compacted Concrete
- Pavements
- Cement Replacement in construction

Precast Concrete: zero slump concrete

Use of Fly Ash

- Cement Replacement
  - Low level of replacement
  - High level of replacement
- Alternate Binder

Control of rheology

Challenges in Use of Fly Ash

- **Large Variability in composition (Source to Source and within Source)**
  - Variation with source -- process of collection and processing
  - Variability in raw feed -- coal
- **Low reactivity**
  - Rely on secondary reaction effect
  - Low content of reactive material

Fly ash in India

Pan-India analysis of Fly ash

Oxide	Cement (% mass)	Fly ash (% mass)
Al_2O_3	3-8	20-30 ↑
SiO_2	15-25	55-65 ↑
CaO	60-70	0.5-2.5 ↓
Alkalis	0.4-1.3	0.50
Sulfates	1-3	0

IS 3812-13 Requirements

Table 1 Chemical Requirements
(*Clauses* 5.1 *and* 6.1)

Sl No.	Characteristic	Requirements		Method of Test, Ref to	
		Siliceous Fly Ash	Calcareous Fly Ash	Annex	IS No.
(1)	(2)	(3)	(4)	(5)	(6)
i)	Silicon dioxide (SiO_2) plus aluminium oxide (Al_2O_3) plus iron oxide (Fe_2O_3) in percent by mass, *Min*	70	50	—	IS 1727
ii)	Silicon dioxide (SiO_2) in percent by mass, *Min*	35	25	—	IS 1727
iii)	Reactive silica in percent by mass[1], *Min*	20	20	B	—
iv)	Magnesium oxide (MgO) in percent by mass, *Max*	5.0	5.0	—	IS 1727
v)	Total sulphur as sulphur trioxide (SO_3) in percent by mass, *Max*	3.0	3.0	—	IS 1727
vi)	Available alkalis as equivalent sodium oxide (Na_2O) in percent by mass, *Max*	1.5	1.5	C	—
vii)	Total chlorides in percent by mass, *Max*	0.05	0.05	—	IS 4032[2]
viii)	Loss on ignition in percent by mass, *Max*	5.0	5.0	—	IS 1727

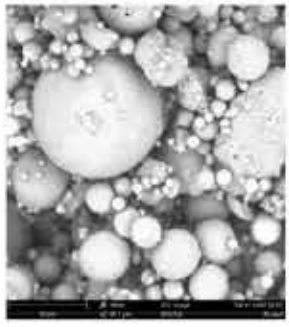
[1] The test may be carried out, if agreed to between the manufacturer/supplier and the user/purchaser with the requirement being as given herein.
[2] For the purpose of this test, wherever reference to 'cement' has been made in IS 4032, it may be read as 'pulverized fuel ash'.

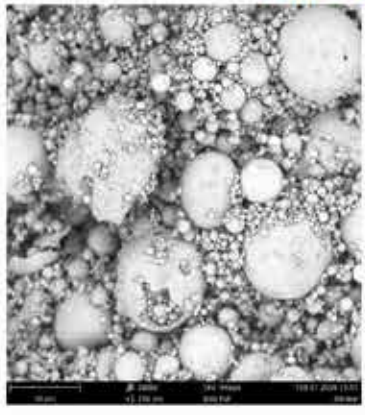
Reactive silica>20%

No requirement on reactive Alumina

Fly ash reactivity

Related to Reactive Silica, present in the **glassy Phase**

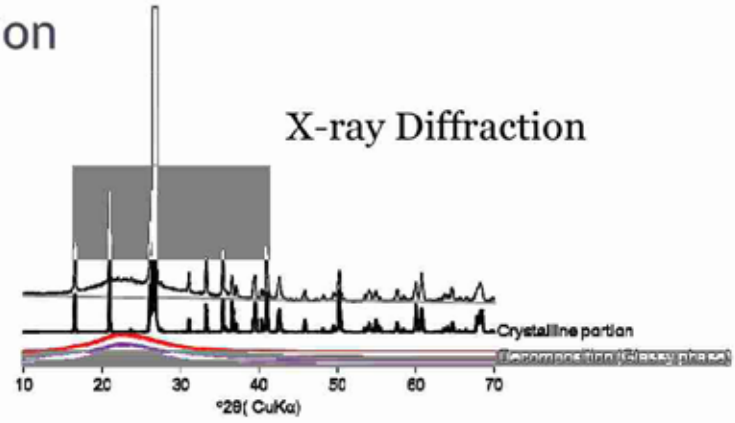




Fly Ash classification

X-ray Diffraction

Pawley intensity refinement



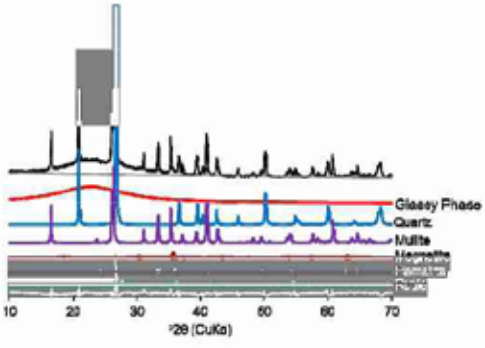
Degree of Crystallinity method

Total crystalline content, TC = □ intensity

Total glassy phase = 1 - TC

Crystalline Phase quantification

Rietvled structure refinement

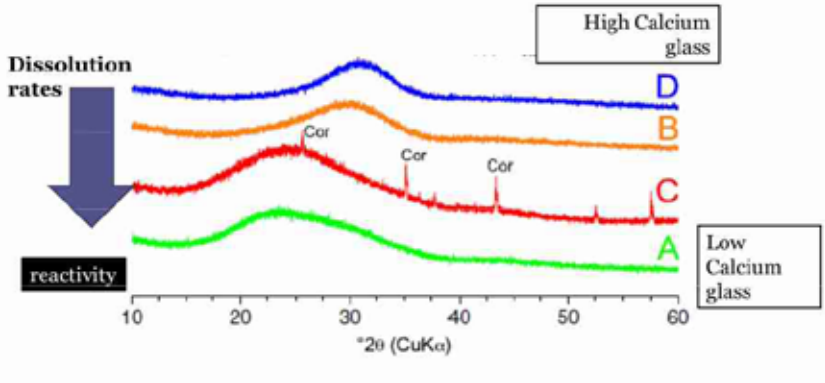


Quantification of crystalline phases using external standard (NIST SRM 676a □Al_2O_3)

$$w_\alpha = \left[\left(\frac{(ZMV)_\alpha}{(ZMV)_s}\right)\left(\frac{S_\alpha}{S_s}\right)\left(\frac{\mu_{sample}}{\mu_s}\right)\right] w_s$$

Glassy phase Characterization

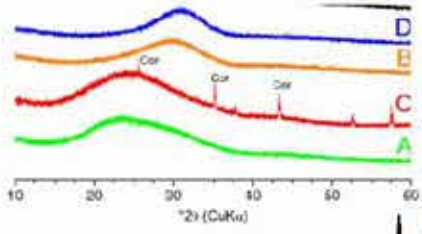
Reactive Silica (Glassy Phase) is present in different Forms



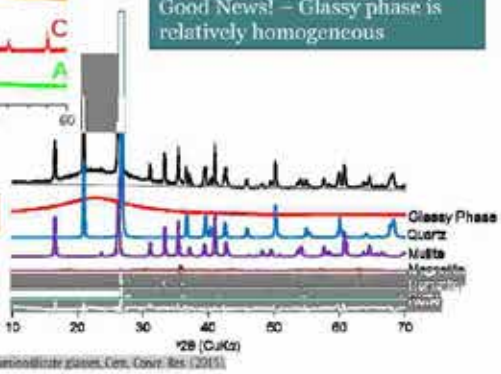
P.T. Durdziński et al. Fly ash as an assemblage of model Ca-Mg-Na-aluminosilicate glasses. Cem. Concr. Res. (2015)

Glassy phase Characterization

Typical Fly ash in India, Low Calcium Aluminosilicate glass



Good News! – Glassy phase is relatively homogeneous

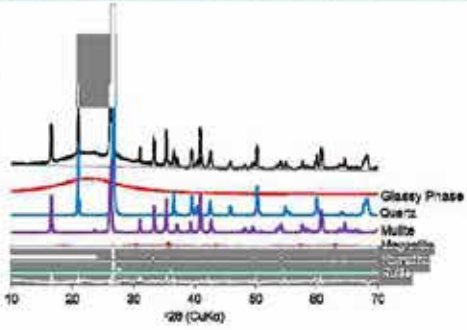


Glass type: A and C

Low reactivity

P.T. Durdziński et al. Fly ash as an assemblage of model Ca–Mg–Na aluminosilicate glasses. Cem. Concr. Res. (2015).

Fly Ash in India



- High crystalline content
  - High Mullite content
  - High Quartz content

Most of Si and Al present in crystalline (non reactive) forms

- Low Reactive Silica → **10-25% by mass**
- Very low Lime content → **No Hydraulic action**

Fly Ash as a Cement Replacement

Sustainable Alternative for Low Carbon binder in Indian Context

Fly ash as Cement Replacement

(Basics)

Requirements of IS 3812 - 2003-Pulverized Fuel Ash for use as Pozzolana in Cement, Cement Mortar and Concrete.

Fly Ash Utilization level in Concrete has reached from meagre 0.3 million tonne in 1991 - 1992 to 104 million tonne in 2014-15

Fly ash: Cementing Effect

Roman concrete, like any concrete, consisted of an aggregate and hydraulic mortar – a binder mixed with water that hardens over time

- *Pozzolana*, which were volcanic ash and sands, used as cements

- The pozzolana had a high content of **Alumina** and **Silica**

1 part (**lime**) to 3 parts (**Pozzolana**) for cements used in buildings

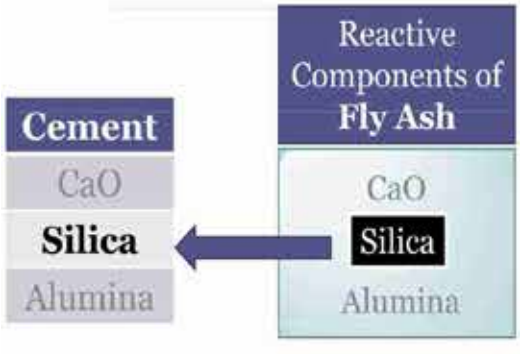
Fly ash as Cement Substitute

Pan-India analysis of Fly ash

Oxide	Cement (% mass)	Glassy phase Components of Fly ash (% mass)
Al_2O_3	3-6	7-12
SiO_2	14 -16	10-25
CaO	65 - 75	1 - 3

- **Increase in** Al
- **Increase in** Si
- **Reduction in** CaO

Fly ash as Cement Replacement (Basics)



- Used as **Silica Replacement**
- Used in Secondary Pozzolanic reaction

Fly Ash as Cement Replacement (Current Practice)

Considering source variability and low reactivity

- ASTM C311 recommends that fly ash to be used in Concrete should be monitored by a quality assurance program
- Indian Codes of practice limit the usage to **35% level of replacement**

Fly Ash as Cement Replacement
(Methodology for Systematic implementation)

To maximize the amount of **clinker substitution**, the maximum potential needs to be obtained from each of the binder ingredients

- Assess base reactivity
- Establish a metric for Efficiency of substitution
- Activation to improve efficiency
  - Understanding the basic reactions

Fly Ash (Reactive Potential)

Oxide Compositions from XRF

Oxide	Cement (% mass)	Fly ash (% mass)
Al_2O_3	3.10	**28.82**
SiO_2	15.76	**57.35**
CaO	71.33	1.92
Fe_2O_3	5.53	5.97
MgO	0.72	0.50
K_2O	0.72	1.93
SO_3	2.06	0
Cl	0.23	0.25
TiO_2	0.52	2.24

Reactive SiO_2[a] (%)	Vitreous Al_2O_3[b] (%)	Quartz[c] (%)	Mullite[c] (%)
20.19	**11.61**	**25.64**	**27.83**

[a] Value determined as specified in IS Standard.
[b c] determined by Rietveld Quantification (XRD).

- Only 20% Reactive of 57% Silica
- 11.6% reactive Alumina

Fly Ash as a Cement Replacement
(Metric for assessment)

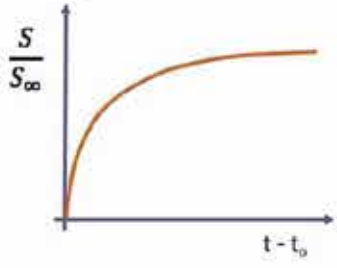
Efficiency for Cement Replacement

$$\frac{S}{S_\infty} = \frac{K_T(t - t_o)}{1 + K_T(t - t_o)}$$

For a reaction with activation

$$K_T = A.exp\left(\frac{-E_a}{RT}\right)$$

where
A = frequency constant (day^{-1});
E_a = apparent activation energy (J/mol);
R = gas constant (8.314 J/K.mol);
T = Kelvin temperature (K).



Efficiency Factor, $C_{eff} = \frac{S}{S_\infty}\left(\frac{1}{K_T} + 1\right)$

Fly Ash as a Cement Replacement

Max. Cement Substitution

Efficiency factor based on Silica replacement

$C_{eff} = 1.0$

Fly ash as Cement Substitute

Example (20% Replacement)

Oxide	Cement (% mass)	Reactive Components of Fly ash (% mass)
Al_2O_3	3.10	11.6
SiO_2	15.76	20
CaO	71.33	1.92

- Decrease in Al
- Increase in Si
- Reduction in CaO

Typical replacement levels: 30-40%

M35 mix – 180 day compressive strength 59MPa

OPC (Grade 53)	Coarse Agg	Fine Agg	Water	w/c
320	1040	840	165	0.47

180 day Comp. Str. at 20% replacement 77 MPa

Fly Ash Concrete with Cement Addition (High Volume Replacement)

From
70 (cement): 30 (fly ash)
to
30 (cement):70 (fly ash)

Ultra High Volume Fly Ash Concrete

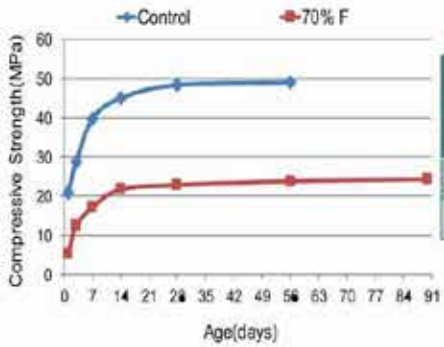
Materials(kg/m³)	Control	Baseline Fly Ash Mix
OPC (53 grade cement)	340	100
Fly ash	0	240
20 mm aggregates*	573	573
10mm aggregates*	573	573
Fine aggregates*	767	767
Water	146	146

Reactive Silica content = 20%

- Cement content 100 kg/m³
- 70% replacement of Cement with Fly Ash

Baseline Study

Total Cementitious Material: 320kg

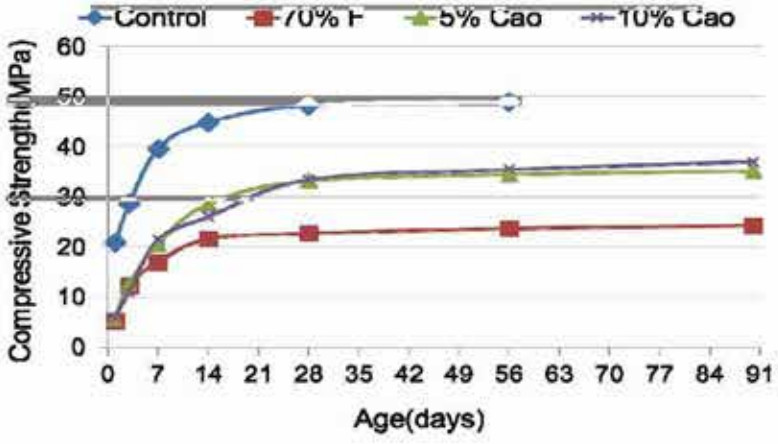


100% Cement	30% Cement 70% Fly Ash	
227 kg	72 kg	Ca
51 kg	62 kg	Si

Lime Depleted

Activation using CaO

Activation with external supply of Lime



5% CaO sufficient for supporting secondary reaction to overcome the loss of lime from cement

Total Cementitious Material: 320kg

100% Cement	30% Cement 70% Fly Ash		30% Cement 65% Fly ash 5% CaO	30% Cement 60% Fly ash 10% CaO
227 kg	72 kg	Ca	88 kg	104 kg
51 kg	62 kg	Si	59 kg	55 kg

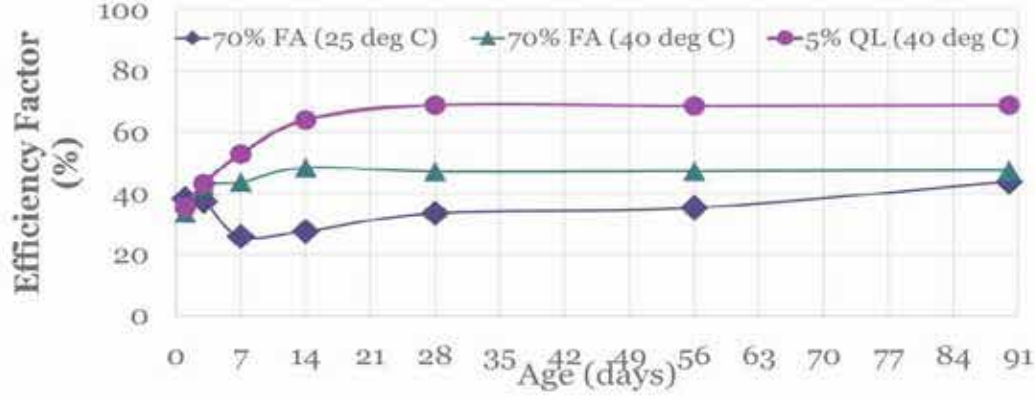
55 kg of Si consumed

Lime Depleted

Lime Depleted

Si Depleted

High Volume Fly Ash



Up to 70% efficiency achieved through pozzolanic reaction

Si substitution

Self Consolidating Concrete

SCC mix design for M45 Concrete with fly ash using the powder method

Cement (Kg)	Fine Agg (Kg)	Coarse Agg 12mm (Kg)	Fly ash (Kg)	Water (Kg)	HRWR Glenium (Kg)	VMA (Kg)	CA: FA ratio
380	808	782	180	186	4.2	1.25	49:51

32% Fly Ash

Property	Limits				
Flow in mm	650-800 mm	0	30	60	90
		760	740	710	700
T_{500} flow in sec	2-5 sec	1.63			
V-Funnel time in sec	6-12 sec	11.38			
V- Funnel T_5 in sec	6-15 sec	16			
L-Box H_2/H_1 ratio	0.8-1	0.98			
Segregation resistance	20%	18%			

SCC Application

Mix was cohesive and no bleeding and segregation were found.

- Baseline mix adjusted based on C_{eff} =1.2
- Replaced sand with unreactive Silica and used 70-80% Fly ash

Additional Activation and Increase in Efficiency

- CaO for support of pozzolanic reaction of **Silica**
- Additional activation to enhance the participation of **Alumina**

For a given fly ash, the maximum level of cement replacement to achieve Efficiency Factor of 1.0 can be established

Low Carbon Binders with very High volume fly ash substitution

- High volume fly ash – **Source classification is essential**
  - Derive Maximum Efficiency Factor based on optimal utilization of **Silica** and **Alumina**
  - Establish the maximum replacement level of cement based on fly ash composition
- Optimized Activators can be developed for maximum cement replacement based on chemistry

Low Carbon Binders with very High volume fly ash substitution

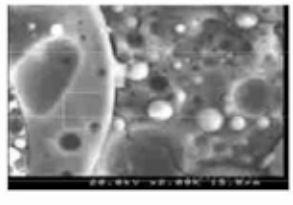
- Achieving higher levels of clinker substitution will call for more sophisticated binders
  - Requiring a higher level of quality control and precision performance.
  - Achieved if all components are independently controlled and **accurately blended**
- Binders sold according to performance specifications should be controlled at source and not in the field.
  - binder components are blended together at the cement facility.

Alternate Binders with fly Ash

Alumino-Silicate Binders

Alumino-Silicate Binder

Si and Al dissolved and react with each other under highly alkaline conditions to form a cement-like binder.



The material, also called Geopolymer results in structural strength.

Alumino-Silicate Cement with fly ash

Challenges in producing Geopolymers of consistent quality with Fly ash:

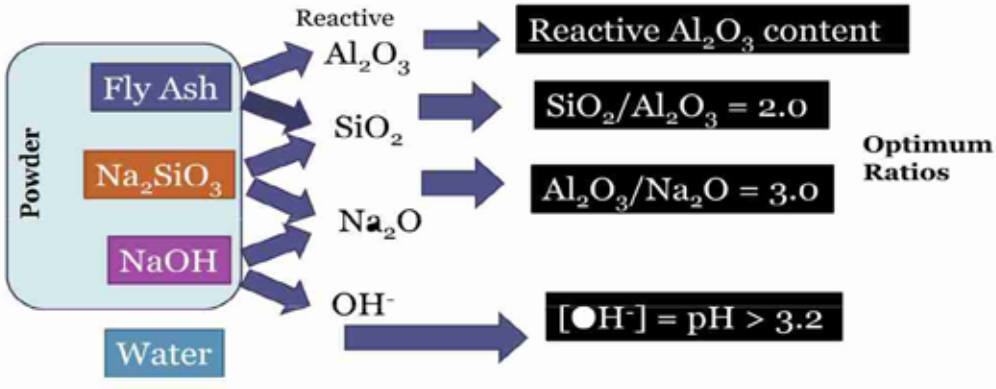
Variable feeder stock:

- Oxide and Phase composition

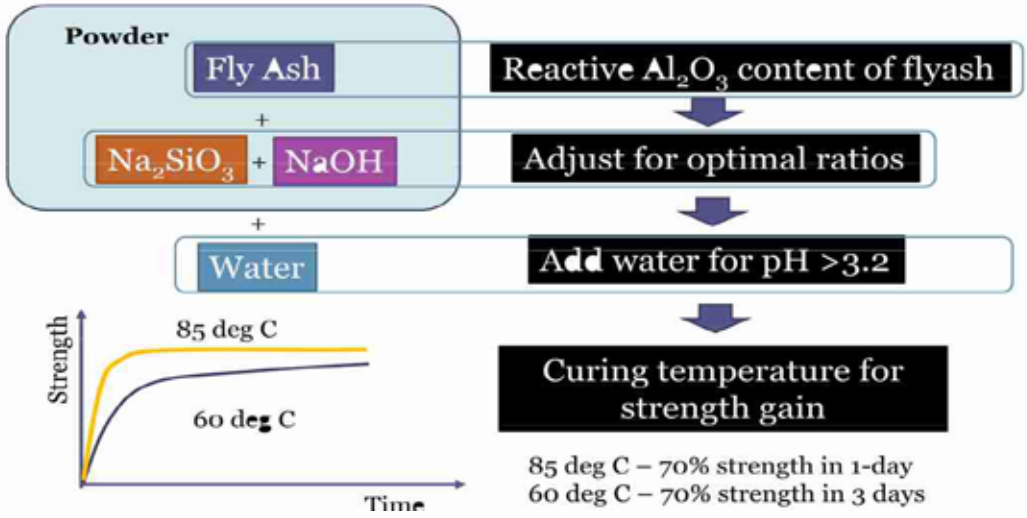
Processing requires:

- Strong Chemicals for activation (8M and higher NaOH)
- Temperature activation/curing at elevated temperatures

Alumino-Silicate Binder with Low-Calcium Fly ash

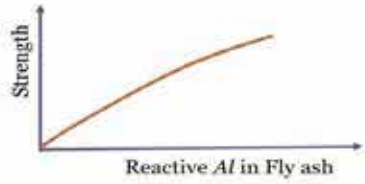


Alumino-Silicate Binder with Low-Calcium Fly ash



Alumino-Silicate Binder with Low-Calcium Fly ash

Reactive *Al* content	Fly Ash 1	Fly Ash 2
	16%	8%
	Strength: 77MPa	Strength: 35MPa



Maximum strength attained depends on the reactive Alumina content

Fly ash Geocement in a Bag

Fly ash

Optimize activator Based on oxide ratios

Grade based on Reactive Alumina Content

Reactive Al, Si content

Maximum strength attained depends on the reactive Alumina content

Challenges in commercializing Fly ash based Geocrete

- Standardized Test Procedures for Reactive Alumina Content
- Lower/room temperature curing

Cellular Concrete Blocks
85 deg C curing

Low K value, lightweight

aqueous concentrate of a surface-active **Polypeptide-Alkylene Polyol** condensate,

Foam generator

stable, voluminous micro bubbled foam

Activated Flyash Paste

Cellular Concrete

In Conclusion!

- Fly ash is ideal for precast construction, where large volumes can be used
- Bags of Fly ash Cement optimized for Efficiency Factor
- Used for Rheology Control on site and sand replacement
- GeoCement with alkaline activation

Kolluru V.L. Subramaniam
Professor, Dept. of Civil Engineering
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SK EDUCATIONAL SERIES #3

Useful Information

THERMO MECHANICALLY TREATED (TMT) BARS

Thermo mechanical treatment is an advanced heat treatment process in which hot bars coming out of last rolling mill stand are rapidly quenched through a series of water jets.

Rapid quenching provides intensive cooling of surface resulting in the bars having hardened surface with hot core. The rebars are then allowed to cool in ambient conditions.

During the course of such slow cooling, the heat released from core tempers the hardened surface while core is turned in to ferrite-pearlite aggregate composition.

TMT process thus changes the structure of material to a composite structure of ductile ferrite pearlite composition with tough surface rim of tempered martensite providing an optimum combination of high strength, ductility, bendability and other desirable properties.

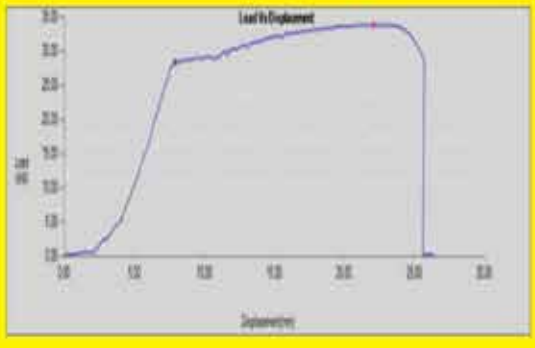
Field Test: It becomes necessary to determine if a particular reinforcing bar /wire, or lot, has undergone proper heat treatment or is only a mild steel deformed bar. Because the two cannot be distinguished visually, the following field test may be used for purposes of identification. A small piece (about 12 mm long) can be cut and the transverse face lightly ground flat on progressively finer emery papers up to '0' size. The sample can be macro etched with nital (5 percent nitric acid in alcohol) at ambient temperature for a few seconds which should then reveal a darker annular region corresponding to martensite / bainite microstructure and a lighter core region. However, this test is not to be regarded as a criterion for rejection. The material conforming to the requirements of IS 1786 standard for chemical and physical properties shall be considered acceptable.

IS 1786 covers the requirements of deformed steel bars and wires for use as reinforcement in concrete, in the following strength grades:

a) Fe 415, Fe 415D, Fe 415S;
b) Fe 500, Fe 500D, Fe 500S;
c) Fe 550, Fe 550D; and
d) Fe 600.

NOTES:

1 The figures following the symbol Fe indicate the specified minimum 0.2 percent proof stress or yield stress, in N/mm2.
2 The letters D and S following the strength grade indicates the categories with same specified minimum 0.2 percent proof stress/yield stress but with enhanced and additional requirements.



FOR BILLETS IS: 2830 CM/L NO.4710055

FOR STEEL IS: 1786 CM/L NO.3433147

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Company Profiles

Company Name	:	**UltraTech Cement Ltd**
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About company:

UltraTech Cement Limited is the largest cement company in India and among the leading producers of cement globally. UltraTech Cement is the largest manufacturer of grey cement in India, with a manufacturing capacity of 64 million tonnes per annum. It is the preferred cement supplier to the most prestigious infrastructural, commercial and residential projects in India. UltraTech is also the largest manufacturer of white cement and ready mix concrete in India.

UltraTech Cement has been selected as Superbrand and Powerbrand by the Superbrands Council and Power brand India respectively.

UltraTech Cement provides a range of products that cater to the needs of various aspects of construction, ranging from foundation to finish. This includes Ordinary Portland Cement, Portland Blast Furnace Slag Cement, Portland Pozzalana Cement, White Cement, Ready Mix Concrete, building products and a host of other building solutions. Cement is sold under the brands 'UltraTech, UltraTech Premium and Birla Super.' White cement is manufactured under the brand name of 'Birla White', ready mix concretes under the name of 'UltraTech Concrete' and new age building products under the names of 'Xtralite, Fixoblock, Seal & Dry and Readiplast'. UltraTech Building Solutions is a retail format that caters to the end consumer providing a variety of primary construction materials under one roof.

About Services:

Our Technical Services wing provides value-added services like training programmes for masons, construction engineers, and channel partners, on-site demos, concrete testing and advice on good construction practices. Its aim is to create a service differentiation to the customers and ensure quality leadership among the cement players.

Actively involved with Cement Manufacturers Association through participation in seminars, publication of handbooks & literature to promote the use of concrete in roads and mass housing

Initiatives include Mobile Concrete Testing Laboratory, training programs for masons on good construction practices, Concrete Mix design workshops, and technical programs for dissemination of advances in materials and construction technology.

UltraTech has the largest technical force and largest fleet of mobile concrete labs across the country.

Provide perceivable benefits to a large number of Individual House Builders, masons, engineers, channel partners and others

Participation in rural construction activities like engaging with decision makers and beneficiaries of rural housing and infrastructure projects.

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About company:

Master Builders Solutions from BASF offer advanced chemical solutions for new construction, maintenance, repair or renovation of structures. Our employees form a global community of construction chemicals experts that are passionate about solving our customers' specific challenges at all stages of construction as well as throughout the lifecycle of the structure.

Under the Master Builders Solutions brand BASF combines its technological know-how and comprehensive product portfolio to provide the right solutions, based on our experience gained in countless construction projects worldwide.

Master Builders Concrete admixtures, cement additives, solutions for underground

Master Builders Construction, waterproofing systems, concrete repair and protection

Solutions portfolio: Systems, performance grouts, flooring systems.

Company Name	:	**Fosroc Chemicals (India) Limited**
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Email	:	Chandrashekhar.Nagarajaiah@Fosroc.com
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Website URL	:	www.fosroc.com

About company:
Fosroc Chemicals (India) Limited is a division of worldwide JMH Group. For over 50 years, Fosroc has developed intellectual properties in specialised products and services that are acknowledge being the cutting edge of construction technology.

Fosroc product portfolio:

Cement and Concrete Technology	Finishes	Barriers	Repair and remediation
Cement Additives	Industrial Flooring	Waterproofing	Concrete Repair Mortar
Admixture – SNF and PCE based	Heavy duty flow applied flooring	Joint Sealants	Crack Injection Resins
Corrosion Inhibitors	Surface Coating	Membrane Waterproofing	Corrosion Control
Surface Treatment Curing compound and release agents.	Protective Coating	Liquid applied, food grade certified waterproofing	Micro-concrete and Under water repairs
Grouts and Anchors Epoxy and cement based	Breathable protective coating	Pre-applied and spray applied robust water proofing system	Spray applied structural grade mortars FRP laminates and wraps

Fosroc is an ISO 9001: 2000 certified company which ensures that the quality of all products and service and the level of customer satisfaction are on par with highest standards in the concrete industry.

Company Name	:	**PERMA CONSTRUCTION AIDS PVT. LTD.**
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Website URL	:	www.permaindia.com /www.permaindia.net

General Profile :

From the beginning of twentieth century cement concrete and cement mortar based on ordinary Portland cement, have been accepted as the main building materials for the construction of buildings and the infra-structures, considering the ease, speed and the strength they offer. But this new building material that is the ordinary Portland cement, suffered from some initial drawbacks such as shrinkage cracks and leakages when compared to the then existed lime concrete and lime mortar. So this product needed some modifications to get over its inherent weaknesses, which was achieved by use of some chemicals. With the increase in demand for bigger, higher and stronger structures in various environmental conditions, the ordinary concrete required further modifications to perform as per the expectations and deliver the end strengths in various climatic and critical conditions. This was again achieved through addition of chemicals to modify the behavior of cement concrete to give the desired end results. With time the performance demands on concrete increased and research and development of chemicals for modification of concrete became a regular industry which is now known as CONSTRUCTUION CHEMICALS INDUSTRY. To keep with the pace of developments, construction chemicals industry took upon itself to develop products which not only make construction of modern structures possible by imparting easy workability, better strength development characteristics and expected performance in extreme environmental conditions and also to maintain structures through various climates extending their life. Now a concrete admixture has become an essential fifth ingredient of concrete and construction and completion of a new structure can't be imagined without the use of construction chemicals at various stages of construction.

CONSTRUCTION CHEMICALS

Starting from water proofing compounds, construction chemicals have expanded range to ease the workmanship in demanding situations at various stages of construction. Today each full-fledged construction chemicals manufacturer manufactures fifty to hundred various construction chemicals. These construction Chemicals can be generally divided into the following groups:

Water Proofing Compounds, Tile Fixing Adhesives and Joint Fillers, Repair and Renovation Products

Admixtures for concrete and mortars, Coating and protection products, Construction and workmanship aids

CODES AND STANDARDS

As Portland Cement was developed in Europe so also the construction chemicals. Suitable codes and guidelines were also framed there to take the full advantage of these new developments in the advancing civil engineering industry. In India we adopted the use of Portland cement very fast and our government recognized the cement industry as the one essential in Nation building, and supported the industry by easing the norms in its classification in excise and its treatment in sales tax etc. in the beginning of the twentieth century itself. This industry grew rapidly. But after independence the construction practices and the building technology did not develop with the same speed leaving our own civil engineering codes and practices far behind when compared with the developed nations. Because of this reason Construction chemicals were very slow to enter our market, and did not get the due recognition they deserved. Now generally construction chemicals are thought of when the structure is leaking or in distress or in situations when some extraordinary requirements are expected out of structural member such as very high strength bridge girder or superior industrial floor etc. For creating safe healthy structures for mankind we need to revise our age old meaningless building codes and civil engineering practices and over haul the civil engineering syllabus in the engineering colleges to incorporate the latest technology and available materials. We not only need to create new codes for civil engineering but also for construction chemicals so that wrong materials do not enter the construction arena putting the structures to risk.

Company Name	:	**SV CONCRETE PRODUCTS PVT LTD**
Mailing Address	:	No-72 & 78/1, Koppa, Hulimangala Post, Jigani Hobli, Anekal Taluk, Bangalore-560105.
Name	:	Mr. R. Subramanya Naidu
Department	:	General Manager
Email	:	rsngm@svconcrete.co.in
Contact Details	:	+91 8494916667
Website URL	:	www.svconcrete.co.in

About company:

M/s S.V.Concrete Products Pvt. Ltd., is one among the leading Ready Mix Concrete manufacturer in Bangalore, and has started their first commercial plant with the state of the art plant of 60cum/ Hour (M1 Plant) supplied by M/s Stetter at Koppa near Jigani during May'2008. Koppa plant is catering to the need of both industrial and Residential buildings covering up to Sarjapura on the South, Kengeri, on East Bangalore, Basavanagudi – on the West and Jayanagar on the North.

With the demand surging, a Second unit of M1 Plant got commissioned during April'2009 within 1 year after the launching of its first unit. Koppa Unit has the distinction of being the only plant having produced consistently a volume of about 15000 cum among 6-8 competitors in the vicinity of 10-12 Km radius. M/s SVCPPL 2nd unit got commissioned off Mysore Road near Bidadi during March'2011 with the commissioning of first Simem 90 cum/ Hour plant in South India.

Today M/s SVCPPL, unit III is the highest volume producing plants among the various National Brands.

Dedicated Units (4 Nos) With the reputation of supplying quality concrete with Timely supply, M/s SVCPPL could able to bag very prestigious orders for setting up Dedicated batching plants to various Construction Congloromate like M/s Sattva Salarpuria, M/s Mantri Serenity, M/s Brigade Group, M/s Reddy Infrastructures etc., etc.,

Company Name	:	ASSOCIATION OF CONSULTING CIVIL ENGINEERS (INDIA)
Mailing Address	:	No.2, U V C E Alumni Association Building, K R Circle, Bangalore – 560 001.
Contact Person	:	Mr. S. D. Annegowda
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ABOUT ACCE(INDIA)

Association of Consulting Civil Engineers (India) was formed and registered in 1985 by a group of Consulting Civil Engineers in Bangalore. ACCE(I) has its head quarters at Bangalore and has since grown into a National Association with 17 Centres formed all over India including Bangalore, Ahmedabad, Bidar, Chennai, Coimbatore, Chidambaram, Davangere, Dharwad, Hyderabad, Indore, Karimnagar, Mangalore, Madurai, Mysore, Nagpur, Nashik and Vishakhapatnam.

Broadly, the objects of the Association are:

- To encourage and foster the ideals of the profession.
- To hold conferences/meetings/seminars for dissemination of knowledge amongst the Civil Engineers in particular and society in general.
- To promote friendship, establish rules for professional and ethical conduct and to develop social awareness and responsibility amongst the members.
- To bring the latest technological advancements in the world to the members and prepare them to carry out futuristic design with an eye on assurance of quality.
- To facilitate access to technical papers, books and computer software.
- To arrange lectures by distinguished Engineers/Professionals from India and abroad and conduct study tour of projects.
- To act as spokesman for the Consultant to deal with Government, Corporations and other agencies regarding policy matters.
- To identity the areas in which the Consultants can contribute to the betterment of the country like Rural Housing, Urban Development, Low Cost Housing, Infrastructure Development, Economic and Safe Design and Construction Practice, etc.,

Company Nam	:	INSTRUCT – INSTITUTE FOR RESEARCH DEVELOPMENT & TRAINING OF CONSTRUCTION TRADES & MANAGEMENT
Mailing Address	:	I Floor, UVCE Alumni Association Building, K.R. Circle, Bangalore 560001
Name	:	Mr. Renukaradhya N Shivanna
Designation	:	Director (In- charge)
Email	:	instruct1989@gmail.com
Contact Details	:	9035043501
Website URL	:	www.instructindia.org

Write up about company:

A well trained workforce is more efficient and effective team in the Construction Industry. With a view to empower India's Construction workforce the institute was conceived as " Centre of Awareness' in Construction and Engineering" (CACE) during october1989 by few likeminded , dedicated professional to provide vocational training to grass root level and middle level managers. During December 1993, it was registered as Regional Institute of Construction Management and Research (RICMAR) under Karnataka Co-operative Societies Act. In 1997, it was renamed as Institute for research Development and training of Construction trades and Management (INSTRUCT). INSTRUCT Specializes in Designing and customizing training programmes for all levels of targets group on sponsorship basis. Training programmes for artisans on plumbing, masonry, bar bending, awareness programmes, training programmes of any duration, say one day to one month duration for masonry and small contractors, with the objective of promoting education training and skill formation in the civil engg fraternity and undertake pilot projects demonstration projects in urban and rural environment among many other vision. It is proud that INSTRUCT is recognized by CIDC –Construction Industry development Council Since 2008 with collaboration adopted 3 Year Diploma Courses for candidates who were interest to pursue diploma engineering. Since the last 6 years INSTRUCT has been in the forefront of providing value added training programmes and short term courses, for the construction industry. INSTRUCT has entered into the Corporate sector like L&T, RNA Corp and such other industries and has many inroads into the training of their personnel. INSTRUCT boasts of providing training to more than 26,000 personnel and have conducted more than 1100 programmes. After considering the above facts, CIDC have assessed INSTRUCT to be awarded the "Partner in Progress" Award in 2013 at the 5th Vishwakarma Awards and for the continued efforts by INSTRUCT, CIDC have recommended for the consecutive award for the "Achievement for Construction Education in 2014", 6th Vishwakarma Award. Efforts to provide quality training and knowledge dissemination is continuing unstintingly and the Office Bearers and the Board of Governors are not leaving any stones unturned.

GRIPSINDIA is a leading services organization focused on Research & Development of new construction materials, technology & methods. Market development with focus on Special Construction Businesses is its forte. Established in 1993, the company performs assignments for construction industry countrywide and abroad.

Through decade long strong relationship with Dywidag Systems International of Germany, it provides the construction industry with world class Post Tensioning Systems, Cable Stay Systems and Geotechnical Systems to the infrastructure sector. It also provides the industry with world class materials from Sumitomo Electric Wire Corporation, Japan.

Being pioneer in development of Precast Concrete Industry in India, it provides an unparallel range of complementary services through handholding the entrepreneurs to venture into emerging markets of Asia.

Consulting & Advisory Services offered are

- Market Entry
- Market Study
- Business Selection
- Investment/Industry Partnerships
- Return-on-Investment Analysis
- Market entry Strategy
- Strategic operational plans
- Strategic operational Plans
- Operational Audits & Advisory

GRIPSINDIA plays host to annual Construction Investment Conference, the leading construction investment conference in Asia.

Ravishankar JB, the founder President is a civil engineer from National Institute of Engineering, Mysore University. He has received Best Bridge Award from IIBE for Khargar Cable Stay Bridge in Mumbai. He is in the organising committee to host FIB 2014 conference in Mumbai, a *fib* Congress event every four years.

Major Projects involved

- Kaiga Nuclear Plant
- Panvel Viaduct
- MRTS Chennai
- Bangalore Metro
- Kochi Metro

Major Technologies to India

- BARGRIP
- Cable Stays
- Precast Concrete

Widely travelled all over the world, he has the in depth knowledge of technology, marketing & finance, required for setting up a new business ventures with a vision.

He can be reached by email *jbr@gripsindia.com*