Green Cement & Concrete – A Step Towards Reducing Carbon

The answer lies in Sustainability and Durability in Concrete Structures

Anil Kumar Pillai

The Ramco Cements Limited

Email akp@ramcocements.co.in

Acknowledgments – Tests and Reports of RRDC (Ramco Research Development Centre)

NBC 2016 – BIS PUBLICATION

EMBODIED ENERGY

Sum total of energy required to

EXTRACT

+

PROCESS

+

TRANSPORT

+

INSTALL

OUTLINE OF THE PRESENTATION

- Durability – What , Why & How
- Sustainability – What , Why & How
- Influence of Materials & Practices on Sustainability
- A brief overview on Ramco Cements with respect to sustainability
- Few discussion points on Durability and sustainability

Common Durability problems at small/Project sites

- Corroded Reinforcement in columns or slabs or beams
- Cracks

DURABILITY CHALLENGES IN CONCRETE

Physical Mechanisms

Freeze-thaw Deterioration of Hardened Cement Paste

Chemical Mechanisms

Alkali-Aggregate Reactivity

Alkali-Silica and Alkali-Carbonate Reactivity

Sulfate Attack External and Internal Sulfate Attack

Corrosion of Embedded Steel

Permeability & Porosity – How are they different from each other

- **Permeability** is the ease with which fluids can penetrate concrete – Interconnected pores
- **Porosity** is a measure of number of voids in concrete

❖If the porosity is high and the pores are interconnected, they contribute to the transport of fluids through concrete, so that its permeability is also high.

❖Permeability of concrete can be low even if porosity is high if the pores are discontinuous

- Avoiding permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other potentially deleterious substances.

- A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service.

- Avoiding the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other potentially deleterious substances.

Maintaining Impermeability of Concrete

- Impermeability is governed by the constituents and workmanship used in making concrete.

- With normal-weight aggregates a suitable permeability is achieved by having

a) an adequate cement content
b) sufficiently low free water/ cement ratio
c) by ensuring complete compaction of the concrete
d) by adequate curing.

What happens if water cement ratio is high and there is no curing done

Tests for evaluating Durability

- **RCPT – As per ASTM C 1202**
- **Water Permeability Test – As per IS 516 (Part 2) – 2018**
- **Carbonation Test**

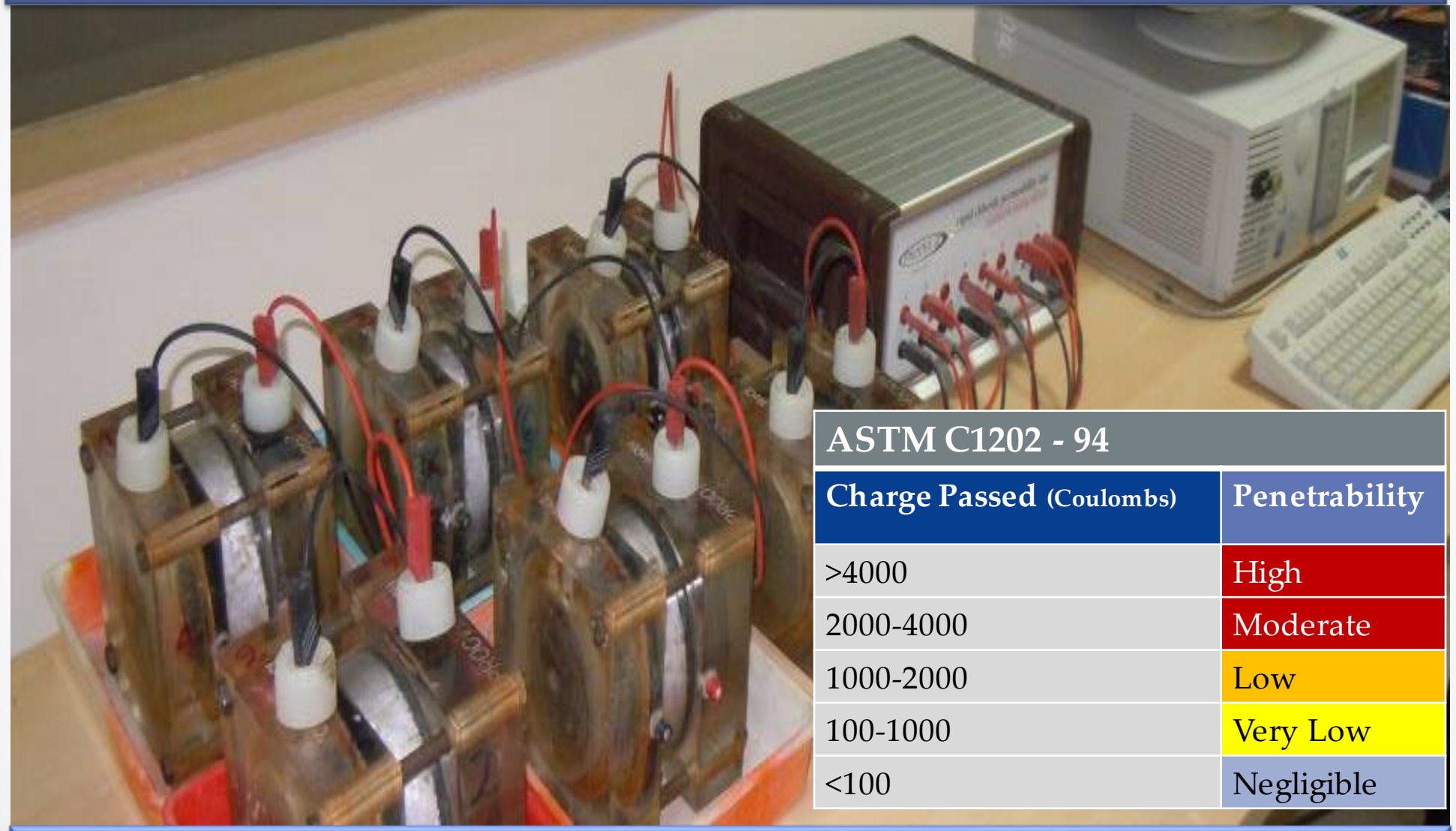

RAMCO
RESEARCH & DEVELOPMENT CENTRE
Welcome
Ramco Research & Development Centre
Right Product for Right Application
You will always find it.
RAMCO R&D
NABL ACCREDITED LAB

RRDC – An NABL Accredited Centre carries out exhaustive works on Cement & Concrete . We have state of the art facilities for evaluating cement and concrete . Apart from BIS we also take guidance from the international codes.

We invite you to our Research Centre at Chennai to interact with our Cement & Concrete Technologists for a detailed discussion on various application oriented challenges at site

Concrete Mix Design Trials done at RRDC were made use of by various prestigious projects across the country for various kinds of structures and applications

MEASURING DURABILITY



ASTM C1202 - 94	
Charge Passed (Coulombs)	**Penetrability**
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very Low
<100	Negligible

DIN Standard Water Permeability Test Equipment

Concrete Sample after Water Permeability Test

CARBONATION TEST ON CONCRETE

ASTM C 1581-04
"Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage"

This test useful to determine the effects of variations in the Mix Proportions and Materials Properties of Mortar or Concrete on cracking due to both Drying Shrinkage and Deformations caused by Autogenous Shrinkage and Heat of Hydration.

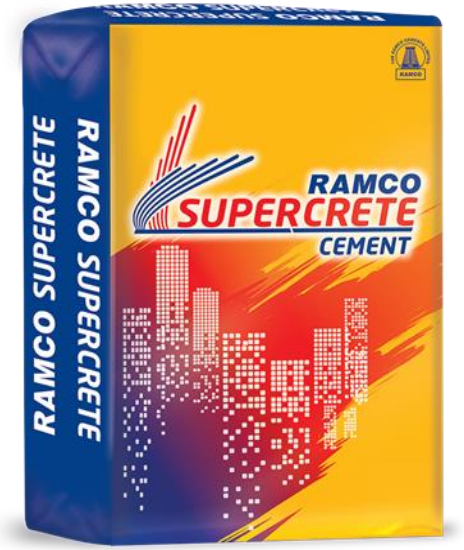
Any test to check the probability of crack occurring in concrete

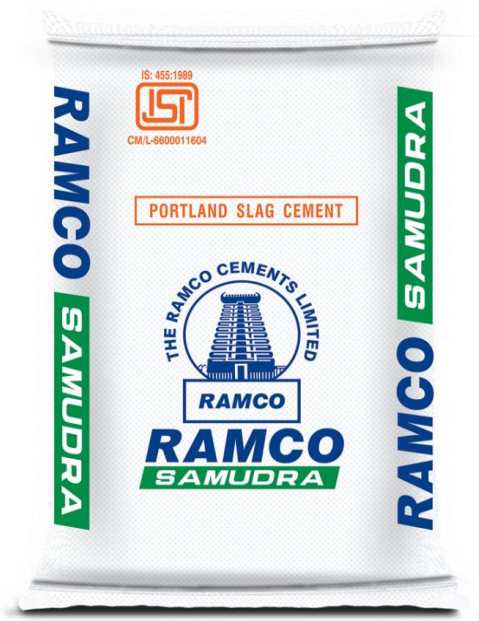
Shrinkage Crack Ring Test


CUPBOARD-2
CUPBOARD-3


SHRINKAGE CRACK-RING TEST APPARATUS
RING - 1
RING - 2
17:34:44 PD 08/09/21
RECORDING: STARTED!
08092102.CSV 007288
LP:07 [010080] LI:05
S1
S2
S3
T1
RING - 3
RING - 4
+0.000222 +0.000000
+0.000236 +0.000227
+0.000554 +0.099921
TE:25.6°C TE:25.6°C
MENU
INC
DEC
ENTER
RING - 5
RING - 6
+0.000222 +0.000206
+0.000218 +0.000205
+0.000207 +0.000231
TE:25.6°C TE:25.7°C
RING - 7
RING - 8
TE:25.6°C TE:25.6°C
5V FUSE
USB
10V FUSE
POWER ON
R 1
R 2
R 7
R 8
DAMIEN ELECTRIC MADRAS

Cement Products





Cement Products

DRY MIX RANGE OF PRODUCTS

BLOCK ADHESIVES (For AAC Blocks)

TILE ADHESIVES (T2, T3,T4,T5,T6- WHITE)

TILE GROUT

WALL PUTTY

RAMCO SUPER PLASTER – GENERAL PURPOSE PREMIXED (GPP2 1:5 , SELF CURING PLASTER , WATER REPELLANT PLASTER)


RAMCO
SUPER FINE
CEMENT-BASED PUTTY


RAMCO
TILE FIX
HIGH PERFORMANCE TILE ADHESIVE
T2
25 kg Nett


RAMCO
SUPER PLASTER
HIGH PERFORMANCE PLASTER


RAMCO
BLOCK FIX
BLOCK LAYING MORTAR


RAMCO
TILE GROUT
Cement Polymer Grout
5kg nett

Area of the project
350 acres

Location
Pandalgudi, Virudhanagar, Tamil Nadu

Afforestation of the exhausted limestone mines in Pandalgudi

This work began in 2019 on 65 acres, but over the past 3 years has extend out to 350 acres, which will eventually over the next 5 to 10 years to over 850 acres

The overall aim is to create natural self-sustaining eco system that supports local bio diversity of flora and fauna, as well as establishing an environmental education center and recreation area that caters to the needs of the school students and visitors.

Ramco Eco Park was inaugurated by Hon'ble Chief Minister of Tamilnadu on 06thMarch 2022.

Educating Construction professionals to ensure long life of concrete structures through our Technical Services Managers

KERALA

- Kozhikode – Er SREENIDH -9496077722
- Ernakulam – Er Sanulal - 9446998118
- Kottayam – Er Vishnu -9633328867
- Trivandrum –Er Kevin – 9496077704

TAMIL NADU

- Trichy – Er RAMACHANDRAN – 9445009480
- Chennai – Er RAMACHANDRAN – 07358177999

KARNATAKA & GOA

- Bangalore Er SHASHANK -9900016115
- Mangalore & Goa Er SURAJ 9900016130

TELANGANA

- Hyderabad Er VIGNESH RAJENDRAN 6309058759
- Warangal Er SRINIVAS R 9849912321

ANDHRA PRADESH

- Vijayawada Er VENKATESH PULAVARTY 7893242243

- **ODISHA**

- Bhubaneswar – Er AWADESH KUMAR SINGH 9934011200

- **WEST BENGAL**

- Kolkata – Er ANIRBAN BANERJEE – 9163133122

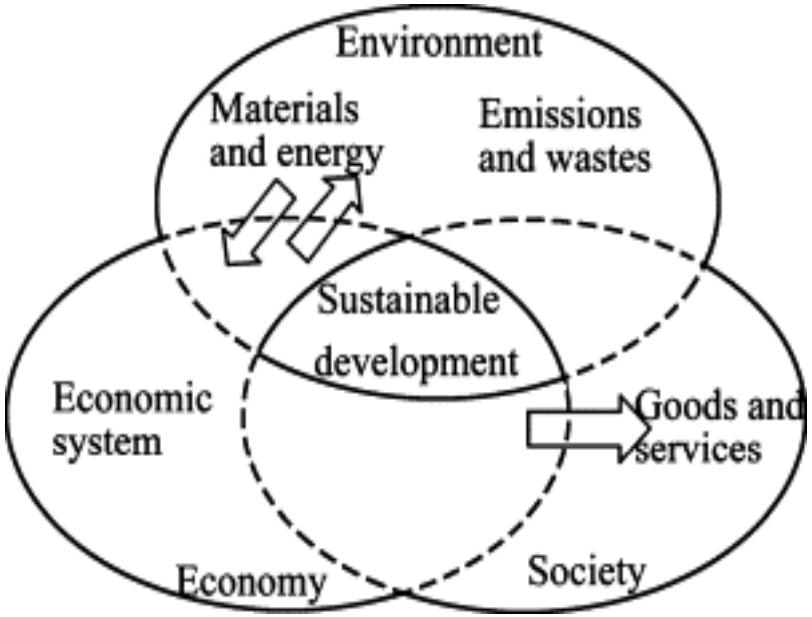
FOR ALL QUERIES

- **EMAIL ID akp@ramcocements.co.in**

SITE ENGINEER: I have to take care that work is completed as per schedule within given resources, manpower etc.

QUALITY ENGINEER : I DON'T CARE, I WANT QUALITY.

Sustainable development is a concept, which involves social, ecological and economic objectives, and requires to sustain the integrity of resources exploitation, the direction of investments, the orientation of technological development and institutional change



Progress in Natural Science: Materials International
Volume 20, November 2010, Pages 16-2

Sustainable development is production in a way in which resources and energy are used in an efficient way and only small amounts of waste and emissions are produced - use of renewable resources.

Minimizing use of resources and cutting back emissions can also decrease the costs of a given process.

Sustainability is made up of three pillars: economy, society, and the environment. These principles are also informally used as profit, people and planet.

Elements of Sustainability as per NBC 2016

1. Set the design parameters to be implemented to be equal to or higher than benchmarking standards given in the code
2. Make the basic performance requirements and set standards applicable /selectively adaptable to the climatic zones and geological conditions in which construction is proposed
3. Have deep understanding of requirements

Explanation of terms – as per NBC 2016 Volume 2

- Building Environment – The surrounding in which a building operates including air , water , land, natural resources, flora, fauna , human beings and their interrelations
- Built Environment – The built environment typically is taken to include buildings, external works (landscape areas) ,infrastructure and other construction works within the area under consideration.
- Ecological footprint- The impact of a person or community expressed as the amount of land required to sustain their use of natural resources.

Materials (As per IS 456)

- Pozzolanas

Fly ash (pulverized fuel ash) Fly ash conforming to Grade 1 of IS 3812.

Silica fume - 5 to 10 percent of the cement content .

Rice husk ash produced by burning rice husk and contain large proportion of silica. To achieve amorphous state , rice husk may be bumt at controlled temperature

Metakaoline obtained by calcination of pure or refined kaolintic clay at a temperature between 6500C and 850OC having fineness between 700 to 900 m^2/kg may be used as pozzolanic material in concrete.

Ground Granulated Blast Furnace Slag obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used

Why Concrete

Concrete is a strong , durable material and provides good thermal mass to the buildings. Alternatives to conventional concrete are

1. Use of pozzolanas and other mineral admixtures for cement replacement in cement concrete and other cement matrix products
2. Use of recycled aggregates
3. Precast concrete
4. Use of masonry concrete blocks – solid and hollow concrete blocks , AAC blocks , Lightweight concrete blocks

Framework for Construction Practices- NBC 2016

- Preconstruction and Prerequisites
- Planning for sustainable construction
- Preparation of sustainable construction management plan
- Planning , monitoring and control of environmental descriptors
- Sustainable work execution procedures
- Effective use of water
- Construction waste management
- Post construction closeout
- Alternate use , deconstruction , dismantling ,demolition

Preconstruction and prerequisites – NBC 2016

- Developing design proposal which is efficient in terms of functional performance , ensures that material resources and construction technologies are used efficiently during construction .
- Feasibility reports : Benchmarks for energy consumption , water utilization , waste generation , reuse of waste during construction and operation phase should be established
- Construction methodology to be established before physical execution of works .Evolve them on digital models so that physical developments can be simulated.
- Assignment of responsibility for sustainability practices during construction

Planning for sustainable construction- NBC 2016

- Describes approach towards construction
- Identification of sustainable issues during construction – Consideration to Environmental impact assessment (EIA) , Social Impact Assessment (relating to economic sustenance , livelihood and socio cultural aspects , privileges to the affected population and undertake actions to contribute towards deployment of social infrastructure
- Prevention and Management of construction accidents
- Identification of training needs and workforce training

Effective use of water- NBC 2016

- Reducing water used for mixing and curing
- Usage of curing compounds
- Decreasing water cement ratio through usage of good quality superplasticizer
- Treated Domestic Effluent (TDE) for concrete mixing and curing after testing water as per specifications especially for total solids , chlorides sulphates .

Preparation of Construction Management Plan- NBC 2016

- Establishment of Construction Project Management Processes (Time , cost , quality , scope , risk , procurement , human resources, health and safety)
- Establishment of Management systems which defines organizational commitment , organizational structure, resource allocation , procedure for monitoring and control to ensure continual improvement
- Establishing site organization structure
- Overall construction site planning – Location of infrastructure for laborers Setting up of health and hygiene infrastructures , Location of facilities for hazardous materials

Planning , monitoring and control of environmental descriptors – NBC 2016

- Soil Monitoring
- Water quality monitoring
- Ambient Air quality monitoring
- Noise Monitoring
- Tree counting
- Traffic survey

Construction waste management – NBC 2016

- Identification , segregation and storage of wastes
- Reuse and Recycling
- Handling and Disposal of waste

Post Construction close out- NBC 2016

- Disposal of structures and infrastructures for construction so that they can be used in other sites or to explored to be used as backfill
- Closure of tube wells
- Reuse of top soil – identify another location for proper storage

Alternative Use, Deconstruction , Dismantling and Demolition – NBC 2016

- Effort to reuse facilities due to change in functional use of built facilities over a period of time
- Deconstruct so as to retrieve as many building assemblies/materials/installations for reuse and recycle as possible
- If not possible to deconstruct dismantling so as to maximize retrieval of materials
- Demolition operations should be resorted to in a way considering safety of workers, avoiding damage to adjoining properties , noise, vibration , air pollution

Specifications

- IS 10262 – SCC , Mass Concreting ,High Strength Concrete , Mix design using flyash and slag as part replacement of OPC
- IS 456 , IS 1343 (Prestressed concrete)
- Cement codes
- NBC 2016
- 15792 : 2008 Guidelines for artificial recharge of water
- 15797 :2008 Guidelines for rooftop rain water harvesting
- 3792 :1978 Guide for heat insulation of non industrial buildings
- 4130 :1991 Safety code for demolition of buildings

1. **RAMCO CEMENTS** produces Ready Mix Concrete and Dry Mortar products, and operates one of the largest wind farms in the country. Generates on an average of 2400 lakh units.

2. **Latest technology** is incorporated at all stages of manufacturing process

3. **Green Pro Certification** to company's flag ship product – RSG by CII . Energy Efficiency Awards

4. **Sustainability has always been of great importance** in the operations of the company as validated with the Company winning several awards from the Government and Industry for its benchmark standards in sustainable processes and operational efficiencies in mining and manufacturing

5. CSR Activities – CSR awards

RAW MATERIAL TESTING AND TECHNOLOGY IN CEMENT MANUFACTURING

- X- Ray Fluorescence Analyzer at mines to determine the chemical parameters of limestone
- First cement manufacturer in India to use a Surface miner for its limestone mining operations in Alathiyur
- Organization has a powerful ERP to integrate data at all levels of operations for timely review and intervention

- **Technology Absorption** : Implementation of Energy Management system for monitoring electrical energy distribution , implementation of OPTIMA fuzzy logic control system for kiln operation , installation of high efficiency , low NOX burner for firing fuel in Kiln .

- **Testing equipment** – X- Ray Fluorescence for determining chemical analysis of raw materials , clinker and Cement ; Particle Size Analyzer for determining the particle size distribution of cement and ground raw materials

REFERENCES

1)NBC- 2016 VOLUME 2 Published by BIS
2) Reports from RRDC (Ramco Research & Development Centre)

SUMMARY
&
ADDITIONAL POINTS

Please visit our YOU TUBE channel for the recordings of webinars on Civil Engineering topics by typing the following in you tube

The Ramco Cements Limited MACE Team

Link

https://www.youtube.com/channel/UCwYmUZ8o9nmif0fcFgijkng

Our fb page link for viewing talks on Civil Engineering topics
https://www.facebook.com/theramcocementsltd/

Thank You for your attention

Email – akp@ramcocements.co.in

Acknowledgments – Tests and Reports of RRDC (Ramco Research Development Centre)

NBC 2016 – BIS PUBLICATION