RMC TECH BEAT

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Concrete Innovations & Trends

Two Significant Trends

In this issue of *RMC TechBeat* we highlight two significantly discernible trends in the use of ready-mixed concrete in India. The first trend pertains to the growing use of what is usually termed as low-fines self-compacting concrete (SCC) and the second one describes the small beginning made in specifying durability parameters for concrete.

Low-fines SCC

Self-compacting concrete was developed in Japan in the late 1980s and its use spread to other countries during the 1990s. The most important attribute of SCC is that it does not need external vibration. It is a highly workable mix, which flows around obstructions, encapsulates congested reinforcement, and fills up the forms completely under self weight without segregation or excessive bleeding. SCC reduces noise, provides excellent surface finish, requires less manpower and speeds up construction. In view of these advantages, one would have expected steady replacement of conventional concrete needing vibrations with classical SCC. Unfortunately, this has not happened. According to the latest statistics of the European Ready Mixed Concrete Organization (ERMCO), the percentage of SCC is only 2% of the total concrete produced in Europe! Similar trend is reported from other countries.

Three main factors seem to be responsible for the poor penetration of classical SCC. Firstly, to achieve the desired rheological properties as per the well-known EFNARC guidelines, classical SCC needs to have higher fines content, usually in the range of 500 to 600 kg/m^3. The share of cementitious materials in these fines generally varies from 400 to 450 kg/m^3 or even more. Such concrete mix invariably results in providing compressive strengths higher than 60 MPa, while the dominant grades produced by RMC plants generally vary from 20-40 MPa. Secondly, SCC is very sensitive to even minor changes in aggregate gradation and moisture contents, which require special efforts to control the same. Thirdly, the construction industry is yet to fully recognize the other intangible benefits of classical SCC, namely noise reduction, improved safety, saving in labour cost and acceleration of project schedule.

However, it is interesting to note that although the use of classical SCC has not witnessed the expected growth, its unorthodox variant, namely, the low-fines SCC has registered an upward swing in its use in recent years, mainly in the Asia-Pacific region, including India. This was

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Company News

Imposing Driveway and Walkway with Stamped *Dyecrete*®

The fact that *Dyecrete*® with stamping creates aesthetically pleasing pathways and driveways has been demonstrated by RMC Readymix (India) on a number of occasions. Reports published in the past issues of *RMC TechBeat* bear testimony to this, e.g. driveways in a housing complex, Chennai (*RMC TechBeat* Vol. 2, No. 1), courtyard in Manipal (*RMC TechBeat* Vol. 3, No. 1), corridors in a housing society, Mumbai (*RMC TechBeat* Vol. 3, No. 2).

The ability of *Dyecrete*® to create visually elegant appearance is once again established by the Company.

Fig 1 *Dyecrete*® with stamping for a housing complex driveway in Mumbai

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Around the World

Concrete Flooring : Health and Happiness Galore!

Food, clothing and housing (*Roti, Kapda aur Makan* in Indian parlance) are the basic needs of human beings. While the first two needs, namely food and clothing, have more or less been satisfied for the vast majority of population, the third need is far from being fulfilled. The twin problem of population growth and rapid urbanization are responsible for this. According to the latest report of the United Nations on World Urbanization, continuing population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90% of the increase concentrated in Asia and Africa[1]. In this projected growth, India's share will be highest with 404 million urban dwellers, followed by China with 292 million and Nigeria with 212 million.

In most of the developing countries the urbanization scenario presents a dismal picture. Here, the acute shortage of housing in the metropolitan and other big cities has lead to the steep rise in slums and squatter settlements. In some of these cities, the percentage of people staying in slums and squatter settlements is close to 50 percent and it continues to rise. The unprecedented growth of urban population has also placed tremendous burden on local services involving water supply, sanitation, roads, hygiene, etc.

It is beyond doubt that Herculean efforts would be needed to solve the gigantic problem of urban housing, especially in developing countries. However, even a small step can sometimes bring huge benefits. This is recently demonstrated in a Mexican government project, which simply involved replacement of dirt floors of poor households by concrete floors at an average one-time cost of $150 per household. The program, called *Piso Ferme,* offered households with dirt floors up to 50 m^2 of cement concrete flooring.

Recently, a team of economists investigating the impact of the Mexican government program found that replacing dirt floors with concrete floors significantly improved the health of young children and their cognitive development, mainly by reducing the incidence of parasitic infections, diarrhea, and the prevalence of anemia[2]. Additionally, the economists also observed significant improvements in adult welfare measured by increased satisfaction with their housing and quality of life as well as by lower scores of depression and perceived stress scales.

It is indeed creditable to observe that concrete flooring has such a huge impact in improving the health and happiness of low-income groups. However, the economist who evaluated the Mexican program have cautioned that replacing dirt floors by concrete floors may not be so very effective in other locations, especially in rural areas, where the low-income groups may not have access to safe drinking water.

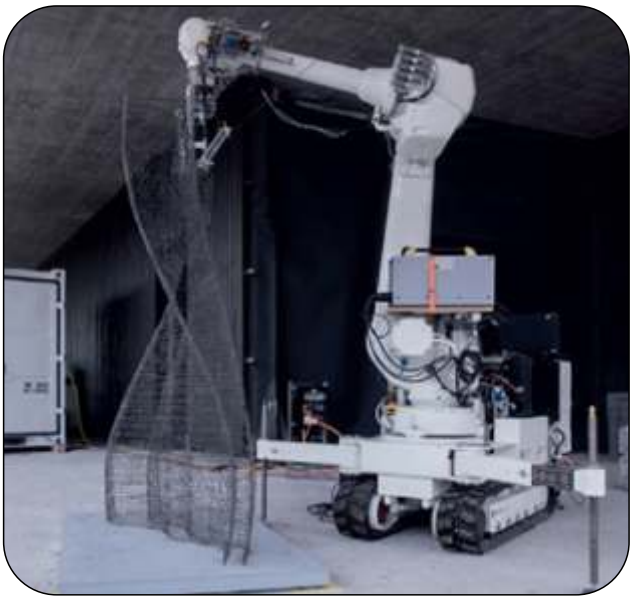
Yet, based on the Mexican experience, Indian government can certainly initiate similar program on experimental basis.

References

1. *World Urbanization Prospects: The 2014 Revision Highlights,* Published by United Nations, New York, 2014.
2. Cattaneo, M D, Galiani, S, Gertler, P J, Martinez, S and Titiunik, R, Housing Health and Happiness, *American Economic Journal,* Economic Policy 2009, 1:1, 75-105.

Concrete without formwork!

The "Mesh Mould" construction technology received the Swiss Technology Award 2016 in the "Inventors" category in November 2016 during the 11th Swiss Innovation Forum in Basel, Switzerland. This technology, developed by researchers at the Swiss Federal Institute of Technology (ETH) in Zurich, enables load-bearing concrete components to be manufactured in any shape but without formwork.



A mechatronic end-effector mounted on a robot first produces dense steel wire mesh based on a computer model. This mesh is then filled with concrete in the next stage. The concrete does not spill out of the sides due to the dense mesh and the concrete's specific mixture. Steel mesh manufactured with Mesh Mould is capable of assuming the functions of both the formwork and the reinforcement, whereas other digital construction technologies, such as printing concrete in 3D, are still struggling to integrate the reinforcement.

Mesh Mould reportedly possesses great advantages for both tailor-made and standardised concrete. The greatest advantage is found in the case of individual structures since no disposable formwork, with its high costs in time and materials, has to be produced. Mesh Mould offers unrestricted freedom to designers. Further, the use of Mesh Mould would be environmentally-friendly as one may be able to construct less expensively and the construction time will greatly be reduced.

Source: www.dfab.ch

Forum

Interview with Mr. Vaibhav Samarth

Q. We had supplied ready-mixed concrete to a number of projects of your Company such as In-Orbit Mall, Malad; Mind Space, Navi Mumbai; JW Marriot Hotel, Saki Naka; Mahalaxmi residential project, etc. and are now supplying concrete to high-rise buildings - Artesia Tower in Worli, where you are the DGM of the Project. How do you rate the quality of the concrete from RMC Readymix (I)?

A. Quality of concrete supplied to our project by your Company was found consistent and the service was good. We have not faced any cube failure issue for this project. When we pointed out certain higher level of variations in the standard deviation of compressive strengths, prompt corrective action was taken by your Company.

Occasionally, there were some coordination issues in the supply of concrete, which were amicably resolved. It is my personal opinion that the coordination issues will be minimised if RMC plant is closer to the construction site.

Q. At this high-rise building project in Worli we have supplied M50 grade self-compacting concrete *(Easycrete®)* and *Foundationcrete™* for the raft foundations. Kindly briefly explain the challenges you faced in the construction of raft foundations and also inform how our Company's products helped to solve some of these challenges?

A. It was the main foundation for core walls, and the reinforcement consisting of 40-mm diameter rods lead to very heavy congestion of steel. The depth of foundation was 1.5m. Recognizing the difficulties in placing concrete in such foundation, the technical team from RMC Readymix (I) suggested us to use their Special Product named as *Foundationcrete™* and *Easycrete®*. When we used these products we found them satisfactory. In the Foundationcrete™, although we have specified the 56-day strength criteria, we observed that the desired strength was achieved at 28 days itself and the strength gain at 56-day was of the order of around 12 percent. In case of your other product *Easycrete®*, we observed that the concrete flowed easily through the congested reinforcement. After the formwork was removed, there was no honeycombing. The finish was good and the incidence of cracking and blow holes was minimal.

Q. For the core walls of the high-rise building in Worli, we understand that you have been using an innovative technique involving climbing formwork for the densely-reinforced core walls. Can you briefly explain the advantages of this technique?

A. Yes. We have used innovative technique for climbing formwork. The densely-reinforced core wall required higher grade and high-early strength concrete. It was specified that concrete should achieve a compressive strength of at least 40 MPa on the 5th day. We are happy that the concrete supplied by your Company comfortably achieved this requirement.

Q. For the core walls, we have supplied more than 8500 m^3 of *Megacrete®* of grade M70. Are you satisfied with our supply and the fresh and hardened properties of concrete achieved by *Megacrete®* ?

A. Before starting supply we had conducted laboratory trials in your Ghatkopar lab and your team developed different mixes to satisfy the specified criteria of flow and slump up to 3 hours, required early strength and the 28-day compressive strengths. The mixes were

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Mr. Vaibhav Samarth

Mr. Vaibhav Samarth is the Deputy General Manager-Engineering with K. Raheja Corp, Mumbai. He has more than 22 years of experience in civil construction works, mainly in the construction of high-rise residential and commercial buildings, institutional and educational buildings, factories, etc. He has completed a number of difficult and challenging projects. Some of the significant projects executed under him include: Artesia Tower, Worli; Saarthi Tower, Girgaon, Sumer Towers, Prabhadevi (all residential towers in South Mumbai); Midspace Gigaplex, Airoli; TCS Banyan Park, Andheri; TCS International Headquarters, Fort (all commercial construction); He was also involved in the construction of Phoenix Mall Palladium, where top-down construction was adopted first time in India. Number of industrial structures were constructed under his guidance at Asian Paints (Mazda Dye-chem), Turbhe; Lubrizol India, IPCL, etc. Some other important structures where he was involved include: DAV Schools, Navi Mumbai; Apeejay School, Shivamrut Dairy Vashi and Rambhau Mhalgi Prabodhini, Uttan, Mumbai.

Forum

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Artesia Tower - Aerial view during construction

finalised after getting satisfactory results. Some testing was done in a third-party NABL accredited lab and the results were satisfactory.

Q. We have also supplied *Megacrete*® of grade M80 (around 750 m^3) and M90 (around 250 m^3) to your project. Are you satisfied with our supply and the fresh and hardened properties of concrete supplied by us?

A. There was no major issue about the quality of concrete. Occasionally, owing to mis-communication between personnel from site and the RMC plant, we had faced segregation issues, which were promptly attended and rectified. As mentioned earlier, the results of compressive strengths done in your lab as well as in third-party lab were found satisfactory.

Q. Have you specified any durability parameters for pre-qualifying the concrete? Kindly inform if the specified durability parameters were satisfied

A. We were happy that the results of various durability tests such as Rapid Chloride Permeability Test (RCPT), Initial Surface Absorption Test (ISAT), Water Penetration Test (DIN 1048) were satisfactory. For M60, M70, M80 and M90 grade concretes the results of RCPT test done in your lab as well as in third-party lab showed that the values were lower than 1000 coulombs. As per ASTM C 1202, this is considered as concrete having "low permeability".

To conclude, I would like to state that the quality and service provided by your Company for this project was quite satisfactory.

Q. Will you recommend us to other developers / builders / contractors ?

A. Yes.

NSC Safety Awards

Every year RMC Readymix (India) participates in the Safety Competition organized by the National Safety Council of India (NSC). The objective of the competition is to assess and quantify the occupational health and safety performance of an industrial unit. The prestigious NSC Award is recognized by the Ministry of Labour and Employment (Government of India).

It is indeed creditable that out of the 7 plants of the Company which participated in the 2016 competition, six plants received NSC awards! The details of award-winning plants are as below:

Prashansa Patra (Certificate)

- Thirumudivakkam Plant, Chennai, Tamilnadu
- Mahape Plant, Navi Mumbai, Maharashtra.

Certificate of Appreciation

- Sakinaka Plant, Mumbai, Maharashtra.
- Mysore Plant, Mysore, Karnataka.
- Derabassi Plant, Mohali, Punjab.
- Vadodara Plant, Vadodara Gujarat.

In the span of past five years (2011-2016), a total of 38 RMC plants belonging to the Company have received the prestigious NSC Awards.

Two Significant Trends

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Typical high-rise building constructed with *Readyspread*® and Mivan formwork

possible mainly because of the availability of the state-of-the-art viscosity modifying agents (VMA) incorporated in polycarboxylate ether (PCE)-based chemical admixtures.

By incorporating such admixture, it is possible to effect reduction in the total fines content in SCC and still achieve fresh properties of concrete, which are more or less similar to those of classical SCC. With this innovation, concrete can now be designed to achieve compressive strengths in the range of 25-40 MPa, having filling and passing abilities similar to the classical SCC.

Of course, low-fines SCC cannot be termed as a totally vibration-free concrete as certain minor level of external vibration may become necessary on some occasions. Yet, the excellent flow characteristics of the low-fines SCC are welcomed by the contractors, as it is helping them in speeding up construction and also improving the concrete pumping characteristics and its finish.

In India, the use of low-fines SCC is found quite advantageous in housing construction, especially when pre-engineered formwork systems are being used. Such formwork systems are increasingly used in the country. In fact, one such pre-engineered aluminium formwork system, commonly known by trade name '*Mivan*' has found favour with a number of construction agencies. It is now realized that *Mivan* formwork system provides numerous benefits such as higher speed of construction, easy transportation in view of its lightweight nature, good surface finish eliminating the need of plastering, box-type monolithic construction providing higher earthquake resistant, large re-use potential and lower cost. A comparative study of a typical medium-rise building having conventional framed structure consisting of beams, columns and slab on the one hand and the *Mivan*-type system on the other proved that the latter is cheaper by around 12 percent*. The economics improves further with the increased re-use of the system. No wonder that *Mivan*-type system is gaining ground.

What type of concrete is suitable for the *Mivan*-type system? Here, concrete needs to be placed in 100-125-mm thick and 3-m tall walls and it needs to flow easily below and above the window and door cut-outs. Initially, attempts were made to use high-slump concrete; but these attempts failed in view the occurrence of empty pockets and honeycombing. The constructors then tried to use low-fines SCC, which proved successful.

Table 1: List of supply of *Readyspread*® for housing projects using *Mivan* - type formwork

Location of Project	*Plant which Supplied SCC*	*Grade of low-fines SCC*
Powai, Mumbai	Ghatkopar/SakiNaka	M35
Powai, Mumbai	Ghatkopar/SakiNaka	M40
Powai, Mumbai	Ghatkopar/SakiNaka	M50
Kandivali, Mumbai	Dahisar	M35
Kandivali, Mumbai	Dahisar	M45
Andheri, Mumbai	Saki Naka	M40
Andheri, Mumbai	Saki Naka	M50
Andheri, Mumbai	Saki Naka	M30
Andheri, Mumbai	Saki Naka	M40
Mulund, Mumbai	Mulund	M30
Mulund, Mumbai	Mulund	M30
Mulund, Mumbai	Mulund	M40
Thane	Mulund	M30
Thane	Mulund	M40
Thane	Thane	M30
Thane	Thane	M35
Ghatkopar, Mumbai	Ghatkopar	M30
Noida, NCR	Saibada	M35
Bangalore	Veerasandra	M45
Bangalore	Bharatiya City	M30
Pune	Hinjewadi	M30

RMC Readymix (I) was quick to spot this change. Based on a work of large number of laboratory trials, the Company developed two Special Products to cater to the market needs in SCC. While the product named as *Easycrete*® satisfies the requirements of classical SCC, *Readyspread*® caters to the requirements of low-fines SCC. It is interesting to note that the Company is able to secure a number of jobs in the recent past wherein *Readyspread*® was supplied for housing projects using *Mivan*-type formwork. This is evident from the list of projects included in Table 1. The trend of using *Readyspread*® commenced with Mumbai-Navi Mumbai-Thane region, but it is now spreading to other big cities too.

We believe that the use of low-fines SCC is going to get strengthened in the near future. RMC Readymix (I) with its long experience in the use of *Readyspread*® is geared up to take up the challenge.

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*Bongirwar P.L., Srinivasachar, P.H., D'Monte, S. and Shah S.D. Conventional vis-a-vis conventional formwork system: Techno-economic evaluation, The Indian Concrete Journal, July 2005, pp.35-39.

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Coastcrete™ Gaining Ground

Concrete is commonly specified in terms of its two universally-known parameters – slump as a measure of its fresh-state property and the 28-day compressive strength as a measure of its hardened-state property. Once these two properties are satisfied, concrete is considered acceptable.

Durability of concrete is an important attribute of concrete. In recent years, it has assumed importance in view of the phenomena of premature deterioration of some recently constructed concrete structures on the one hand and the global emphasis on sustainability of concrete on the other. Most of the internationally well known standards on concrete, including those from the Bureau of Indian Standards, specify durability indirectly, usually in terms of the minimum cement content, maximum water binder ratio, grade of concrete and cover to the concrete.

However, recognizing that this 'deem-to-satisfy" prescriptive criteria do not necessarily guarantee the long-term durability of concrete, the latest trend is to specify some durability tests for pre-qualifying the concrete mixes. While numerous such tests have been developed in the recent past, the most common and popular durability test which have been codified include: Rapid Chloride Ion Permeability Test (RCPT) conforming to ASTM 1202, Water Penetration Test conforming to DIN 1048, and Initial Surface Absorption Test (ISAT) conforming to BS 1881 P-208.

A beginning is now made in the country in specifying some durability-related parameters for some mega projects like metro rail, tall buildings, prominent bridges, airports etc.

Considering this need RMC Readymix (India) developed a special product named as *Coastcrete*™. The product is developed after long laboratory trials, using well-known durability tests mentioned above.

Recently, a leading construction company specified durability parameters for their raft foundations, where about 800 m^3 of M45 grade *Coastcrete*™ was supplied. Table 2 provides a comparison of the durability test parameters specified by the construction company and the actual value achieved by using *Coastcrete*™. It can be seen that *Coastcrete*™ has satisfactorily achieved the given parameters.

Table 2: Comparison of specified durability parameters and those actually obtained with *Coastcrete*™

Durability test method	*RCPT (ASTM 1202), Coulomb*	*Water penetration (DIN 1048), mm*	*ISAT (BS 1881 -P 208), ml/m^2.s*
Parameters specified by client	3800	25 (max)	0.02 to 0.3
Actually achieved values	1347	6.22	0.002

We believe that the trend of specifying durability parameters will get strengthened in near future. RMC Readymix (I) is now confident to supply concrete suited to customers' requirements.

Welcome to RMC Family

We extend hearty welcome to the following senior persons from management cadre, who joined RMC Readymix (I) - a division of Prism Cement Ltd. since January 2017.

- **Mr. Prateek Mathur,** as Vice-President- Marketing. He has a civil engineering degree and a post-graduate diploma in business management.
- **Mr. Sreenivasan Prakash,** as Head-QCP, Bangalore. He has civil engineering degree with Masters in Structures.
- **Mr. Santoshi Prasad Mishra,** as Manager-Business Development, Delhi. He is a civil engineering graduate.
- **Mr. Bijeet Kumar,** as Manager-Marketing, Mumbai. He possesses BTech in Civil Engineering from Kalinga Institute of Industrial Technology, Bhubaneswar and has also studied International Business from Hult International Business School, Boston-USA.
- **Mr. Kalim Ullah Kabir,** as Manager-Business, Sindraul. He has a degree in civil engineering.
- **Mr. Sandeep Ganhar,** as Deputy Manager-Sales, Mumbai. He has a degree in civil engineering.
- **Mr. Male Chenchireddy,** as Deputy Manager-Operation, Hyderabad. He has a diploma in mechanical engineering.
- **Mr. Varun Dixit,** as Assistant Manager, Surjapur, UP. He possesses BTech and MTech degrees in mechanical engineering.
- **Mr. Premin Bipin Toprani,** as Assistant Manager-Sales, Hyderabad. He has a degree in MBA (Mrktg.).
- **Mr. Mahesh Ankush Patil,** as Assistant Manager-Operations, Thane. He is a degree holder in electrical engineering.
- **Mr. Swapnil Madhukar Maid,** as Assistant Manager-Operations, Ghatkopar, Mumbai. He is a degree holder in electrical engineering.

Our best wishes to all the new recruits. We are sure they would excel in fulfilling the tasks assigned to them and help the Company in achieving its vision and mission.

Company News

(Continued from page no.1)

This time, an imposing driveway was constructed using *Dyecrete*® with stamping for a housing complex in Mumbai belonging to a leading real estate developer (Fig 1). The stamping pattern was Ashlar slate with gray colour. The total area covered with stamped *Dyecrete*® was around 450m^2.

Another Stamped Dyecrete® at Udipi

RMC Readymix (India), Manipal plant executed Dyecrete® with stamping for Kirthi Constructions, Udupi for their project "Solitare" at Udupi.

The stamped concrete is intended to be used as a walkway and is placed adjacent to the car parking area. The pattern used for the stamped Dyecrete® was English brick in red colour. A total of around 160 m^2 area was covered with stamped Dyecrete®

Fig 2 Stamped Dyecrete® for a walkway in Udipi

1,000-plus m^3 *Easycrete*® pour completed in 24 hours !

Recently, NCR Haryana Region team of RMC Readymix (I) had accomplished a challenging task. Around 1000 m^3-plus volume of M50 grade self-compacting concrete was poured in one go in a massive beam-cum-slab in just 24 hours!

The customer specified that the concrete should be poured in a single pour to avoid any joint and that it should develop at least 75% of the strength in 7 days. This was essential to undertake post-tensioning operations. Further, the structural element consisted of around 200t of steel reinforcement as well as pre-stressing cables, creating massive congestion of reinforcement. As a result, the customer specified the use of self-compacting concrete.

The NCR Haryana team sensed a good opportunity in the challenge. The team prepared appropriate design of M50 grade *Easycrete*®, satisfying the three basic criteria for self-compacting concrete, namely filling ability, passing ability and segregation resistance. These three parameters were verified by conducting the slump-flow, V-funnel, U-box and L-box tests. Besides satisfying the fresh concrete tests, the *Easycrete*® also satisfied the specified compressive strength criteria.

Once the mix design was approved, the NCR Haryana geared up for execution through proper planning. *Easycrete*® was supplied from Dhumaspur plant with Faridabad plant being kept as a stand-by to support the operations if necessary. A total of 22 transit mixers and three pumps were brought into operations. The *Easycrete*® pour started at 6 am in the morning and was completed in just 24 hours – 10 hours ahead of the time span specified by the customer!.

Easycrete® satisfied the specified test criteria. Nearly 82% of compressive strength was achieved in 7 days. The customer was very happy at the outcome and remarked in his feedback, " They (RMC team) have done excellent job to completion within 24 hours".

Mail Box

Q. We are the lone ready-mixed concrete producer from interior location in north India, where no experienced producer like your Company has till date set up its plant. We are therefore looking for advice from you on a peculiar problem that we have faced recently. We have supplied a customer M30 grade concrete and cubes were cast at customer's site by our as well as by the customer's representatives. Our representative left the site after taking samples and could not wait till the pour was completed. While the compressive strength results of cubes cast and tested by us were satisfactory, those cast and tested by the customer achieved around 10-15% lower strengths. The customer directed to extract the cores, without conducting the usual NDT tests and without even informing us. When our representative went to witness the core testing, he observed that the density of cores varied considerably, in that the values were 2410, 2200 and 2180 kg/m^3. While the result of the core having density of 2410 kg/m^3 was satisfactory, those having lower densities had lower core strengths. As a result, the average core strength fell short of the requirement by around 10 percent. The customer now claims that the concrete has failed and is trying to put the blame squarely on us. How should we defend ourselves?

A. Thank you for referring the case to us. At the outset, we would like to suggest that when low results are reported from the cubes tested by the client, you should get alarmed and immediately take up the issue with the client. Before going to the client, you should check all your records thoroughly and ensure that all production control parameters and test results are in order. Once you are convinced that your test results are satisfactory, make the best efforts to win over the client.

Even now, if it is not too late, please take up the issue with the client, showing him the autographic records pertaining to his concrete supply. Also share the compressive strengths of the previous more than 30 results of the same mix, supplied either to him or to other parties. If you have used fly ash or ground granulated blast-furnace slag as partial replacement of OPC in the concrete, you must have the laboratory data of the 56-day and 90-day compressive strengths of this mix. We suggest that you should also share such long-term strength gain data with the client. You may even invite the clients' representatives to your plant to witness the quality control and quality assurance measures being taken by you. All these actions of yours will certainly create some level of confidence in the client about the quality of your concrete.

The difference of about 200 kg/m^3 in the densities of cores clearly indicates that the concrete from which cores are extracted is relatively porous. However this does not mean that the entire concrete in the structural element would be porous. Possibly, there could be pockets of segregation owing to poor compaction. We therefore suggest that you may conduct the ultrasonic pulse velocity (UPV) survey of the structural element to find out the extent of the pockets of relatively porous concrete. It may be pointed out that while UPV values below 3 km/s indicate poor quality, those between 3.0 to 3.75 km/s indicate medium concrete quality and values above 4.0 km/s are considered excellent quality. Once it is established that there are limited pockets of poor and medium quality, the same could be grouted with appropriate technique.

Finally, we believe that around 10-15% reduction in the concrete strength as revealed by testing of cubes and cores may not seriously affect the load-carrying capacity of the member. Usually, there are sufficient margins in the structural design. This should however be verified by the structural designer. In fact, the ACI Building Code (ACI 318) suggests that an investigation of low strength results should be done only when the likelihood of low strength is confirmed and calculations indicate that the load-carrying capacity of the structure may have significantly reduced! We therefore suggest that you may strongly insist upon the client for such verification by the structural consultant. If there is sufficient design margin, then the customer may be requested to close the case after satisfactory repairs are carried out.

Incidentally, for providing increased assurance about the quality of your concrete, it would be worthwhile for you to get your RMC facility certified by the Quality Council of India.

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