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Model Chart of Quality Control Process for Ready Mixed Concrete Plants

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ABSTRACT: *In order to ensure that concrete produced is of desired quality, it is necessary that quality control is exercised at all the stages right from receipt of raw material to delivery of concrete at site. Thus, while planning to use Ready Mixed Concrete (RMC), it should be ensured that producer of RMC has adopted quality assurance programme. Quality control is a process by which entities review the quality of all factors involved in production.*

Quality control system should be developed at RMC plant. Quality Assurance Programme for RMC can be broadly divided into three components i.e. Forward control, immediate control and retrospective control. RMC manufacturer should have laboratory facilities to carry out necessary tests to ensure quality control at all stages during production of concrete. This paper includes a typical model for RMC plant which needs to be implemented for quality control. Authors have taken efforts to suggest some QC aspects for RMC manufacturers.

Keyword *– QC, QA, RMC*

I. INTRODUCTION

Concrete is one of the major components of a structure, particularly a multi-storied structure, where in it accounts for 30% - 50% of the total cost. Concrete is the most universal of all the construction material and is frequently considered as the most economical one and is strong and durable material. The quality of concrete has also a very direct effect on the strength & durability of the structure as a whole. There are things which found fewer advantages to produce concrete on a worksite than RMC. Bags of cement, sand, aggregate (gravel) & possibly other additives must be delivered to the construction area. A supply of clean water is also necessary, along with a rented concrete mixing hopper. Even after all the dusty & heavy ingredients have been loaded into the hopper, one small error in the wet/dry ratio of ingredients can render an entire batch of concrete unusable. Quality of concrete is under threat for various reasons resulting in deficient product. There are several codes of practice, which give detailed procedure for carrying out tests and criteria for acceptance. Sampling and testing are most components of quality control. Sampling and testing of raw material is also important.

As per Indian Standard code of practice (IS 4926 - 2003) Ready Mixed Concrete (RMC) is defined as the concrete delivered in plastic condition and requiring no further treatment before being placed in position in which it is to set and harden. RMC is a specialized material in which the cement, aggregates and other ingredients are weigh-batched at a plant& mixed in a central mixer or truck mixer, before delivery to the construction site in a condition ready for placing. Thus, `fresh' concrete is manufactured in a plant away from the construction site and transported within the estimated journey time. The RMC supplier provides two services, firstly one of processing the materials for making fresh concrete and secondly, of transporting a concrete within a short time. This enables the places of manufacture and use of concrete being separated and linked by suitable transport operation. This technique is useful in congested sites or at typical work places and saves the consumer from the botheration of procurement, storage and handling of concrete raw materials. Ready mix concrete is produced under factory conditions and permits a close control of all operations of manufacture and transportation of fresh concrete. Due to its durability, low cost and its ability to be customized for different applications, RMC is now one of the most popular building materials.

Today RMC is ordered in units of cubic meters. The use of the RMC is also facilitated through a truck mounted boom placer, which can pump the fresh concrete at multi-storied construction sites. A boom placer can pump the concrete up to 80meters. The RMC concrete is generally released from the hopper in a relatively steady stream through a tough system. Workers use shovels and hoes to push the concrete into place.

Technologically speaking, ready mixed concrete is certainly advancement over the age-old site mixed concrete. The benefits of RMC in terms of quality, speed, life-cycle cost and environmental friendliness are superior to those of site mixed concrete.

II. QUALITY CONTROL OF RMC

Quality Control of Ready Mixed Concrete can be divided into three convenient areas like forward control, immediate control and retrospective control. SQC application proves to be a important tool which can be used

effectively for quality and productivity improvement for infrastructure projects. Statistical Quality Control can be effectively applied to RMC industry for online (during production) and also offline (before and after production) quality monitoring and control.

Forward control basically deals with procedures of quality control to be followed before the production process. This covers (i) materials storage, (ii) monitoring of quality of materials, (iii) modification of mix design, (iv) Plant maintenance, (v) calibration of equipment and (vi) plant and transit mixer condition.

Immediate control is concerned with instant action to control the quality of concrete during production or that of deliveries closely following production. This covers (i) weighing – correct reading of batch data and accurate weighing, (ii) visual observation and testing of concrete during production and delivery (assessment of uniformity, cohesion, workability, adjustment of water content) and (iii) making corresponding adjustments at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.

Retrospective control primarily deals with the quality control procedures after production. This covers (i) sampling of concrete, testing and monitoring of results, (ii) weighbridge checks of loaded and unloaded vehicle weights, (iii) Stock control of materials and (iv) diagnosis and correction of identified faults.

The design team or the construction management team, with the prime sources of such errors being seen as

- Inadequate training and management of the designers responsible for producing calculations and drawings.
- Inadequate or incorrect specifications at tender.
- Inadequate definition of responsibility within both management groups, i.e., in the office and on site.
- Poor communication between the principal parties in contract, which ultimately leads to confusion and cost related delays.
- Inadequate training and management of the technicians and labour on site.
- Inadequate verification routines to ensure that design materials and workmanship meet specified requirements.

When dealing with a complex and varied industry within which numerous professionals and artisans operate, whose background training and professional development are entirely different from each other, the most effective way to achieve good communication is to formalize it.

Another important factor to be considered is training at most of the levels within the indus RMC is a specialized material in which the cement, aggregates and other ingredients are weigh-batched at a plant& mixed in a central mixer or truck mixer, before delivery to the construction site in a condition ready for placing. Thus, `fresh' concrete is manufactured in a plant away from the construction site and transported within the estimated journey time. The RMC supplier provides two services, firstly one of processing the materials for making fresh concrete and secondly, of transporting a concrete within a short time. This enables the places of manufacture and use of concrete being separated and linked by suitable transport operation. This technique is useful in congested sites or at typical work places and saves the consumer from the botheration of procurement, storage and handling of concrete raw materials. Ready mix concrete is produced under factory conditions and permits a close control of all operations of manufacture and transportation of fresh concrete. Due to its durability, low cost and its ability to be customized for different applications, ready mix concrete is now one of the most popular building materials.

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Quality of concrete

We use sophisticated plant and equipment, which enables it to produce quality concrete. The Company exercises strict control on the quality of all ingredients through rigorous testing, applies stringent controls on process parameters, monitors key properties of concrete in the fresh and hardened state and applies the well known Cusum technique to quickly detect any changes in the properties of concrete. All these efforts result in providing uniform and assured quality of concrete to customers. In contrast, in a typical site-mixed concrete there is poor control on the quality of input materials, batching of ingredients and mixing of concrete, thus the resultant quality of concrete is poor, non-uniform and inconsistent.

With the use of RMC, customers are not required to procure and store cement, aggregates, sand, water and admixtures at site. This not only drastically reduces the space requirements at construction sites but also minimizes efforts on the part of customers to procure different materials, ensure their proper storage and check their quality parameters from time to time.

The international and competitive market place today demands not just quality from products or services but also quality in delivery and customer support. Quality assurance control is therefore being increasingly adopted by companies to remain competitive. With liberalization policies and international competition, the product life-

cycle in the global market becomes shorter and customer expectations continue growing. In such a scenario, traditional approaches to product testing or certification will not be adequate to improve the quality of products.

Today, customers all over the world are aware of the importance of product quality. To maintain customer satisfaction and attract new customers, a company has to implement quality management in addition to streamlining the work of employees. Every company will have unique processes directed towards achieving strategic goals and QA control objectives. However, the really good companies are the ones who are skilled in identifying their strengths and weaknesses and in devising methods to maintain quality.

Quality control management helps a company to

- Boost the production processes
- Decrease any possibilities of lag in carrying out product deliveries from clients
- Set up a strong foundation to encourage the improvement of internal processes of the organization and enhance its ability in achieving strategic aims
- Evaluate the quality checking system based on established industrial or international standards

The QA /QC team for the plant is headed by a QA/QC Manager. He is the key person involved in the decision making process. He is assisted by QA/QC In charge whose job is to co-ordinate and implements the QA /QC guidelines and test procedures for the entire batching plant. There are two QA/QC assistants to assist the in charge. The engineers are involved in physically conducting the tests of the incoming raw materials and the final product i.e. RMC. They are physically present to check that all the equipment are calibrated properly. Also they carry out the daily or weekly quality monitoring as per the model. The QA/QC In charge will take decisions about the assignable causes noticed during the monitoring phase. There are four lab technicians employed to carry out the sampling and testing.

The nerve and brain of our RMC plants is the quality control lab equipped with sophisticated instruments and manned by trained and widely experienced personnel. The quality is monitored at every stage, right from receipt of raw material to dispatch (Annaxure I to VI) and placing of concrete, which ensures that consistent quality reaches the customer.The following tests are conducted for quality assurance

- Cement: Water consistency, IST/FST, Compressive strength and Chemical analysis.
- Fine Aggregates: Sieve analysis, Silt test, Specific gravity/Density, Moisture absorption test.
- Coarse aggregates: Sieve analysis, Crushing value, Abrasion value, and Specific gravity/Density.
- Water: Chemical analysis.
- Concrete: Workability, Compressive Strength.

A standard QA /QC lab with latest testing equipment is established at the plant.

Testing of Raw Materials, Fresh Concrete and Hardened Concrete: The incoming materials particularly raw materials like cement, coarse aggregate 10mm, coarse aggregate 20mm, fine aggregate, admixtures should be subjected to testing as per adopted acceptance sampling plan. A scheme for the basic tests to be conducted for raw materials, fresh concrete and hardened concrete (Annexure IV) along with their frequency of testing.

The chart 1 shows various steps of the work to be done are explained below.

1) Mix Design: This is the step done the mix design is very important step. The various quantity of material is decided at this step. The tested or received material is supplied to the laboratory where Mix design is done. This laboratory should be approved or authorized to do the mix design.

2) Approved by Authority: In this step the manager in charge or panel of directors should approve the Mix design, & then forward it to quality control dept. for next action.

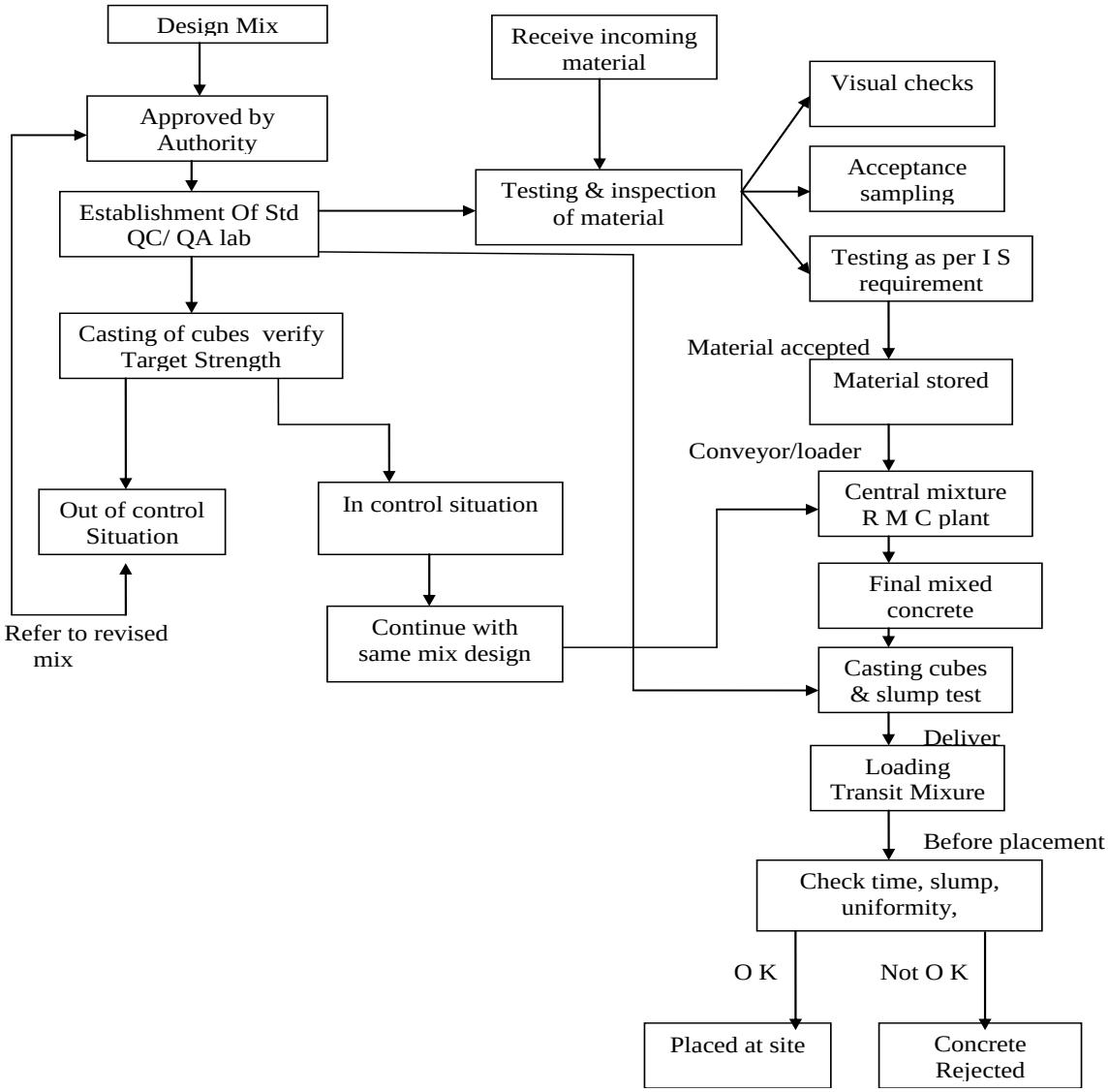
3) The Establishment of QC/ QA Laboratory: It is important step in RMC process. For this unit the service from mix design unit is supplied, and this unit casts the cubes as per given mix design & verifies the target strength, if target strength, is satisfactory, then this Mix design is confirmed & data is send to central Mixture plant as recipes. And if target strength is unsatisfactory then the data from Mix design is sand back for revision/ redesign or resolution

4) Receive in Coming Material: This step gives the idea to inventory stock, As and when required the material i.e. cement, sand, aggregates admixture is purchased.

5) Testing and Inspection: This is the stage, where the quality of incoming material is checked, The three various activities are done quality checking, visual checks are the performed, and if the same material from same source is coming at the stock, and the testing as per IS code is previously done. Acceptance sampling is next step this gives the requirement of field tests e.g. fields tests on aggregates & cement if necessary are carried out. But if any material coming from new location or material with new brand, the laboratory testing becomes necessary. The aggregates are tested according to IS 383-19, and cement according to grade of cement. But the loose cement i.e. about 14 tones is purchased at a time, and then the factory testing is cheeked.

6) Material stored: The material should be stored in such a way that, it should not lose its standards. The

Chart 1 Quality control process chart: case study



aggregates should not get mixed with each other. The moisture content should not come in contact with material. Sufficient quantity of the material should be at the stock.

7) Central pan mixture: This is the heart of RMC plant. Here the mix design data supplied from QC/QC unit. As a recipe for various mixes i.e M 15, M 20, M 35 etc. as the case may be. The pan mixture is horizontal with single or double shaft. In this pan mixture the material is feed by weight. The computer controlled hydraulic jacks are used to feed each material for particular mix design. The concrete from pan mixture is directly supplied to transit mixture.

8) Final Mixed concrete: It is the output of pan mixture, Here to check the quality, the cubes are casted by QC/QA unit, while the transit mixture is leaving the RMC plant. At this stage the slump & temperature is observed, if satisfactory the transit mixture is allowed to go further; if not corrective measures are taken by QC/QA unit. At the time of delivery on site, sample from transit mixture is taken out, slump test is carried out, the temperature & uniformity is checked if the test found OK them only concrete is allowed to place at site, if not OK then concrete is rejected. Then the concrete is taken back to RMC plant, investigation is done & remedies are taken out such that no more such failure should occur.

III. CONCLUSION

RMC emerges to be an advantageous material in congested sites where setting up of a mixing plant is difficult. However, there is absence of proper and effective quality monitoring systems in most of the batching plants,

Hence there is a need to analyze the applicability of scientific quality monitoring techniques to RMC. The Quality Control model for RMC industry is simplified user friendly model, which if adopted, we think, would make RMC industry much more organized and efficient in terms of production and operation.

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