An Approach for Ready Mixed Concrete Selection for Construction Companies through Analytic Hierarchy Process

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ABSTRACT: ***One of the most useful method for selecting a project that is becoming more and more important is the Analytic Hierarchy Process (AHP). This method was developed by Dr. Thomas L. Saaty in 1970s as a tool to help with solving technical and managerial problems. Ready Mix Concrete (RMC) industry is continuously growing all over the world and India is not an exception to it. The pace of mechanization in the past was very slow due to the availability of cheap and abundant labor, lack of capital investment and the highly fragmented nature of the construction sector. The Ready Mixed Concrete in India on commercial basis started in 1994 and has achieved about 2% conversion from the site-mixed concrete by the year 2001. It is heartening that the acceptability of Ready mixed concrete is increasing though at a slow pace. The entry of foreign firms and major Indian cement producers in this field are likely to provide the necessary boost to this industry in the future. The growth prospect of Ready-mixed concrete is enormous, provided requisite support is given by the regulatory authorities, consumers and decision makers. At the present, the cost differential between Ready-mixed concrete and site mixed concrete is proving a major constraint in its growth. This problem will be resolved with the increasing awareness about the advantages of RMC by the end consumers.***

KEYWORDS: analytic hierarchy process (AHP); comparisons; ready mixed concrete (RMC); construction; site; growth; constraint; advantage

INTRODUCTION

Ready-Mixed Concrete (IS: 4926-2003) as “Concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser’s vehicles.”

Ready Mixed Concrete (RMC) is delivered to the worksite, often in transit mixers capable of mixing the ingredients of the concrete just before the delivery of a batch. This results in a precise mixture, allowing specialty concrete mixtures to be developed and implemented on construction sites. The second option available is to mix the concrete at the batching plant and deliver the mixed concrete to the site in an agitator truck, which keeps the mixed concrete in correct form.

In the case of the centrally mixed type, the drum carrying the concrete revolves slowly so as to prevent the mixed concrete from "segregation" and prevent its stiffening due to initial set. However, in the case of the truck-mixed concrete, the batched materials (sand, gravel and cement) are carried and water was added just at the time of mixing. In this case the cement remains in contact with the wet or moist material and this phase cannot exceed the permissible period, which is normally 90 minutes.

The use of the Ready Mixed Concrete (RMC) is facilitated through a truck-mounted 'boom placer' that can pump the product for ready use at multi-storied construction sites. A boom placer can pump the concrete up 80 meters.

Ready Mixed Concrete (RMC) is preferred to on-site concrete mixing because of the precision of the mixture and reduced work site confusion. It facilitates speedy construction through programmed delivery at the site and mechanized operation with consequent economy. It also decreases labor, site supervising cost and project time, resulting in savings. Proper control and economy in use of raw material results in saving of natural resources. It assures consistent quality through accurate computerized control of aggregates and water as per mix designs. It minimizes cement wastage due to bulk handling and there is no dust problem and therefore, pollution-free.

Ready Mixed Concrete (RMC) is usually ordered in units of cubic yards or meters. It must remain in motion until it is ready to be poured, or the cement may begin to solidify. The Ready Mixed Concrete is generally released from the hopper in a relatively steady stream through a trough system. Workers use shovels and hoes to push the concrete into place. Some projects may require more than one production run of Ready Mixed concrete, so more trucks may arrive as needed or additional batches may be produced off site and delivered.

Figure 1 - Modern Ready Mixed Concrete Plant
(Source: Concrete Technology Theory and Practice, M.S SHETTY, S.Chand- New Delhi)

LITERATURE REVIEW

The objective of Ready Mixed Concrete (RMC) selection is to identify Ready Mixed Concrete with the highest potential for meeting a customer's needs consistently.

Ready Mixed Concrete was first patented in Germany in 1903, but a means of transporting was not sufficiently developed by then to enable the concept to be utilized commercially. The first commercial delivery of Ready Mixed Concrete was made in Baltimore, USA in 1913 and first revolving-drum-type transit mixer, of a much smaller capacity than those available today, was born in 1926. In 1920s and 1930s, Ready Mixed Concrete was introduced in some European countries.

Ready Mixed Concrete plants arrived in India in the early 1950s, but their use was restricted to only major construction projects such as dams. Later Ready Mixed Concrete was also used for other projects such as construction of long-span bridges, industrial complexes, etc. There were, however, captive plants which formed an integral part of the construction project. It was during 1970s when the Indian construction industry spread its tentacles overseas, particularly in the Gulf region, that an awareness of Ready Mixed Concrete was created among Indian engineers, contractors and builders. Indian contractors in their works abroad started using Ready Mixed Concrete plants of 15 to 60 m^3/h and some of these plant were brought to India in 1980s. Currently there are approx. 30 Ready Mixed Concrete Plants operating in different parts of Gujarat.

The Ready Mixed Concrete business in India is in its infancy. For example, 70% of Cement produced in a developed country like Japan. Here in India, Ready Mixed Concrete business uses around 2% of total cement production.

Ready Mixed Concrete (RMC) is a specialized material in which cement, aggregate, and other ingredients are weight batched at a plant in a central or a truck mixer before delivery to the construction site in a condition ready for placing by the customer. RMC is manufactured at a place away from the construction site, the two locations being linked by a transport operation.

Basic requirement for growth of the industry:-
Government bodies, private builders, architects/engineers, contractors and individuals are to be made fully aware about the advantages of using Ready Mixed Concrete. Government bodies / consultants to include Ready Mixed Concrete as mandatory in their specification for execution.

NEED OF INNOVATIVE READY MIXED CONCRETE SELECTION MODEL

To understand current practice of Ready Mixed Concrete selection, a survey was carried out on selected Ready Mixed Concrete plants in Central Gujarat region of India. The purpose of the survey was to study the methodology and derive the relation between the various criteria for enhancing the utilization of Ready Mixed Concrete. Figure 2 Given below shows the present approach used by construction companies in selection of best Ready Mixed Concrete.

Figure 2 - The present approach used by construction companies in selection of best Ready Mixed Concrete

From the study of current Ready Mixed Concrete selection approach, it is felt that stakeholders require support of scientific and mathematical technique. The present approach of Ready Mixed Concrete selection has following shortcomings:

- Need huge initial investment.
- Not affordable for small projects (small quantity of concrete).
- Needs effective transportation system from R.M.C. to site.
- Traffic jam or failure of the vehicle creates a problem if the proper dose of retarder is not given.
- Labors should be ready on site to cast the concrete in position to vibrate it and compact it.
- Double handling, this results in additional cost and losses in weight, requirement of go downs for storage of cement and large area at site for storage of raw materials.
- Aggregates get mixed and impurities creep in because of wind, weather and mishandling at the site.
- Improper mixing at the site, as there is ineffective control and intangible cost associated with unorganized preparation at site are other drawbacks of RMC.
- There are always possibilities of manipulation; manual error and mischief as concreting are done at the mercy of gangs, who manipulate the concrete mixes and water cement ratio.

Ready Mixed Concrete (RMC) - MAJOR ADVANTAGES

The major advantages of RMC are recognized:

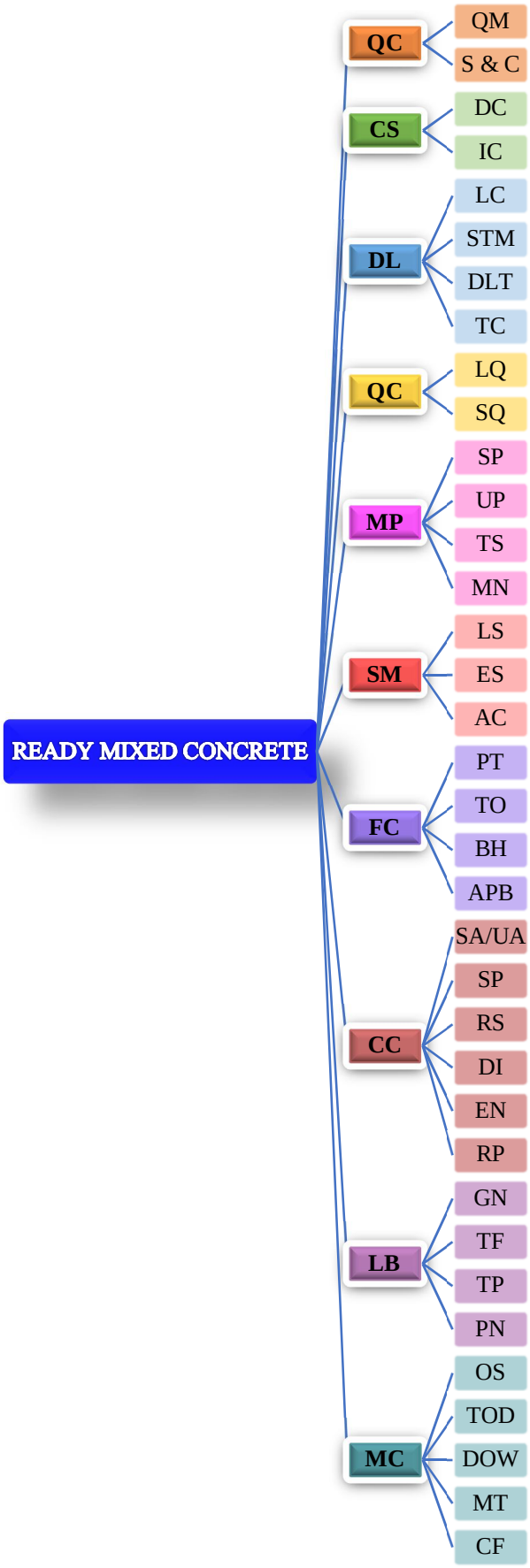
- Uniform and assured quality of concrete.
- Durability of RMC.
- Faster construction speed.
- Storage needs at Construction sites eliminated.
- The addition of admixtures is easier.
- Documentation of the mix design.
- Reduction in Wastage of Materials.
- RMC is eco-friendly.
- Elimination of Procurement / Hiring of plant and machinery.
- Labor associated with production of concrete is eliminated.
- Noise and dust pollution at site is reduced.
- Organization at the site is more streamlined.
- Lower labor and supervisory cost.
- Availability of concrete of any grade.

OF THE STUDY

This paper has an objective to develop criteria framework which contributes to Ready Mixed Concrete selection of construction companies. Secondly, it suggests the technique for Ready Mixed Concrete selection in Indian context.

CRITERIA FRAMEWORK FOR READY MIXED CONCRETE SELECTION

Ready Mixed Concrete selection depends upon many factors. Literature study and interview with construction professionals were carried out to prepare the hierarchical framework for Ready Mixed Concrete selection. Criteria which contribute towards Ready Mixed Concrete selection are divided in 10 major groups as: Quality Control, Cost, Delivery, Quantity, Manpower, Safety Measures, Financial Capability, Commercial Capability, Laboratory, and Managerial Capability. These criteria are further subdivided into sub criteria. A final framework for Ready Mixed Concrete selection criteria is given in Figure 3.



- **ABRAVIATION:**
  - **QC - Quality Control**
    - QM - Quality of Material
    - S & C - Standard & Certification
  - **CS - Cost**
    - DC - Direct cost
    - IC - Indirect cost
  - **DL - Delivery**
    - LC - Location
    - STM - Size of Transit Mixture
    - DLT - Delivery Lead Time
    - TC - Time Consuming
  - **QC - Quantity**
    - LQ - Large quantity
    - SQ - Small (Less) quantity
  - **MP - Manpower**
    - SP - Skill person
    - UP - Unskilled person
    - TS - Technical staff
    - MN - Manager
  - **SM - Safety Measures**
    - LS - Labor Safety
    - ES - Equipment Safety
    - AC - Accidents
  - **FC - Financial Capability**
    - PT - Profit Trends
    - TO - Turnover
    - BH - Banking History
    - APB - Amount of Past Business
  - **CC - Commercial Capability**
    - SA / UA - Sales / Utilization area (For Buildings, Road, Canal, Bridges, & other Industries)
    - SP - Sales Policy
    - RS - Responsiveness
    - DI - Discipline
    - EN - Environment
    - RP - Reputation & Position
  - **LB - Laboratory**
    - GN - General
    - TF - Test Facility
    - TP - Testing Procedures
    - PN - Personnel
  - **MC - Managerial Capability**
    - OS - Organization Structure
    - TOD - Type of Decision Maker
    - DOW - Direction of Work
    - MT - Maintenance
    - CF - Customers Feedback

Figure 3 - Framework for Ready Mixed Concrete selection criteria

ANALYTIC HIERARCHY PROCESS

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

It has particular application in group decision making, and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education. Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goals and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

APPLICATION OF ANALYTIC HIERARCHY PROCESS

It is widely used for decision making. AHP technique is widely applied to various fields as given below:

- Choice - The selection of one alternative from a given set of alternatives, usually where there are multiple decision criteria involved.
- Ranking - Putting a set of alternatives in order from most to least desirable.
- Prioritization - Determining the relative merit of members of a set of alternatives, as opposed to selecting a single one or merely ranking them.
- Resource allocation - Apportioning resources among a set of alternatives.
- Benchmarking - Comparing the processes in one's own organization with those of other best-of-breed organizations.
- Quality management - Dealing with the multidimensional aspects of quality and quality improvement.
- Conflict resolution - Settling disputes between parties with apparently incompatible goals or positions.

ADVANTAGES OF ANALYTIC HIERARCHY PROCESS

- It illustrates how possible changes in priority at the upper levels have an effect on the priority of criteria at lower levels.
- The method is able to rank criteria according to the needs of the buyer which also leads to more precise decisions concerning supplier selection.
- It provides the buyer with an overview of criteria, their function at the lower levels and goals at the higher levels.

PROCESS OF ANALYTIC HIERARCHY PROCESS

The procedure for using the AHP can be summarized as:

- Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, and the criteria for evaluating the alternatives.
- Establish priorities among the elements of the hierarchy by making a series of judgments based on pair wise comparisons of the elements. For example, when comparing potential real estate purchases, the investors might say they prefer a location over price and price over time.
- Synthesize these judgments to yield a set of overall priorities for the hierarchy.
- Check the consistency of the judgments.
- Come to a final decision based on the results of this process.

PROPOSED READY MIXED CONCRETE SELECTION PROCESS

Ready Mixed Concrete selection is a multi-criteria decision making problem and hence AHP fits to it. It is suggested to use AHP technique for Ready Mixed Concrete selection. So, a survey questionnaire can be prepared based on AHP technique. It will require the experts to compare various criteria and sub-criteria on 1 to 9 scales. While doing this comparison they have to use their past knowledge and information of criteria as well as available Ready Mixed Concrete Plants. Following Figure 4. Explains proposed AHP based Ready Mixed Concrete selection process.

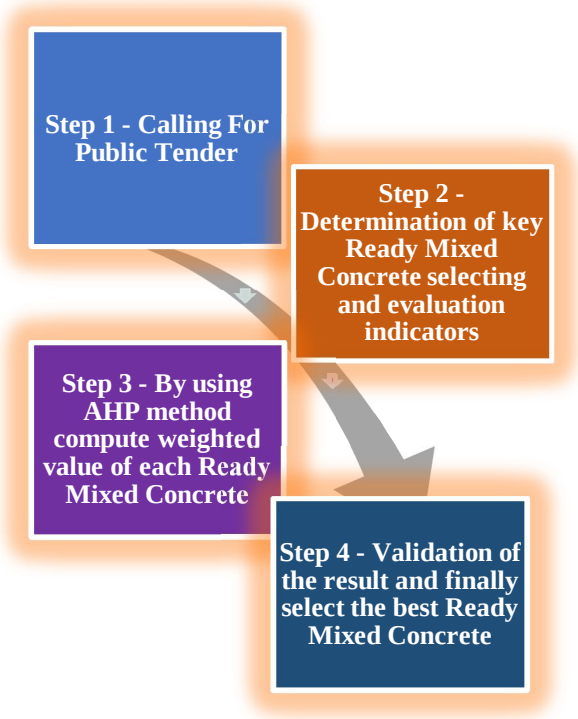


Figure 4 - Proposed AHP based Ready Mixed Concrete selection process

CONCLUSION

- RMC operations are highly mechanized and fully controlled through electronic controls and hence reduce the probability of errors in various operations.
- It is also environmentally friendly and brings down pollution due to dust at construction can also be accelerated with the use of the RMC.
- Ready mix concrete has gained acceptance in Indian industry due to several advantages including quality control and overall economy.
- The present study has developed a framework of criteria which contributes for Ready Mixed Concrete selection. As Ready Mixed Concrete selection is a multi-criteria decision making problem, Analytic Hierarchy Process is suggested for the solution. AHP based Ready Mixed Concrete selection approach is suggested in this study.
- Such approach will be more comprehensive and will include the relative importance of criteria in the final decision making. Engineers are encouraged to use such innovative and simple tool like AHP to support their decisions which will finally help the project success achievement.

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