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A Study On Quality Concepts And Quality Control Of Concrete

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ABSTRACT

The quality control of concrete is the most important issue in achieving its desired strength and durability. The principal aim of the study was to investigate the existing practices on the quality control of concrete production in Dhaka city. In doing so the key factors involved quality control of concrete production were identified. Various questions on the factors that affect quality control of concrete production were prepared for the purpose of this study. A total of forty five construction sites were visited at different location in Dhaka city and relevant data were collected. During the survey the necessary information was collected by eye observation, asking question to the site engineer and from written documents kept in the site. The survey results have shown that in Dhaka city most of the concrete production companies are neither aware of the key factors nor following the quality control of concrete. Eventually, an inferior quality of concrete is being achieved in Dhaka city which can affect both the strength and the durability of the most of structures those are being constructed currently.

Keywords: Concrete, Strength, Aggregate, Quality Control and Durability.

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I. INTRODUCTION

Quality is depending on planning, architectural dimensioning, structural design construction, material, etc. In different situation meaning of quality is different. Equality of product value is maximum or minimum which depends on user's
need. There is a so many meaning of quality

For example-

(1) Fitness for purpose
(2) Conformance to requirements
(3) Grade

- appearance
- performance
- life
- taste
- odour

In short it means, what-ever purpose you may adopt for product that purpose can be maintained by

(1) Suitability
(2) Reliability
(3) Durability
(4) Safe
(5) Affordability
(6) Maintainability
(7) Economical
(8) Versatility

Building damaged due to poor materials

- Poor cement
- Poor steel
- Chemical water
- Inferior sand and other inferior materials of construction

In the previous chapter we have discussed various properties of Portland cement in general. We have seen that cements exhibit different properties and characteristics depending upon their chemical compositions. By changing the fineness of grinding or the oxide composition, cement can be made to exhibit different properties. In the past continuous effort swarm dot produce different kinds of cement, suitable for different situations by changing oxide composition and fineness of grinding. With the extensive use of cement, for widely varying conditions, the types of cement that could be made only by varying the relative proportions of the oxide compositions, were not found to be sufficient.

Types of Cement

(*a*) Ordinary Portland Cement
(*b*) Rapid Hardening Cement
(*c*) Extra Rapid Hardening Cement
(*d*) Sulphate Resisting Cement
(*e*) Portland Slag Cement
(*f*) Quick Setting Cement
(*g*) Super Sulphated Cement
(*h*) Low Heat Cement
(*j*) Portland Pozzolana Cement
(*k*) Air Entraining Cement
(*l*) Coloured Cement: White Cement
(*m*) Hydrophobic Cement

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(*n*) Masonry Cement
(*p*) Oil Well Cement
(*r*) Concrete Sleeper grade Cement
(*o*) Expansive Cement
(*q*) Rediset Cement
(*s*) High Alumina Cement

Testing of cement can be brought under two categories:

(*a*) Field testing
(*b*) Laboratory testing.

- **Field Testing**

It is sufficient to subject the cement to field tests when it is used for minor works. The following are the field tests:

(*a*) Open the bag and take a good look at the cement. There should not be any visible lumps. The colour of the cement should normally be greenish grey.

(*b*) Thrust your hand into the cement bag. It must give you a cool feeling. There should not be any lump inside.

(*c*) Take a pinch of cement and feel-between the fingers. It should give a smooth and not a gritty feeling.

(*d*) Take a handful of cement and throw it on a bucket full of water, the particles Should float for some time before they sink.

(*e*) Take about 100 grams of cement and a small quantity of water and make a stiff paste. From the stiff paste, pat a cake with sharp edges. Put it on a glass plate and Slowly take it under water in a bucket. See that the shape of the cake is not disturbed While taking it down to the bottom of the bucket. After 24 hours the cake should retain its original shape and at the same time it should also set and attain some strength.

If a sample of cement satisfies the above field tests it may be concluded that the Cement is not bad. The above tests do not really indicate that the cement is really good for Important works. For using cement in important and major works it is incumbent on the part of the user to test the cement in the laboratory to confirm the requirements of the Indian Standard.

Aggregates and Testing of Aggregates

Concrete can be considered as two phase materials for convenience; paste phase and aggregate phase. Having studied the paste phase of concrete in the earlier chapters, we shall now study the aggregates and aggregate phase in concrete in this chapter. The study of aggregates can best be done under the following sub-headings:

(*a*) Classification
(*b*) Source
(*c*) Size
(*d*) Shape
(*e*) Texture
(*f*) Strength
(*g*) Specific gravity and bulk density
(*h*) Moisture content
(*i*) Bulking factor
(*j*) Cleanliness
(*k*) Soundness
(*l*) Chemical properties
(*m*) Thermal properties
(*n*) Durability
(*o*) Sieve analysis
(*p*) Grading

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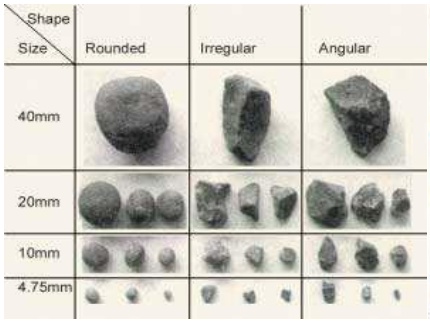

Factors Affecting Workability

Workable concrete is the one which exhibits very little internal friction between particle and particle or which overcomes the frictional resistance offered by the formwork surface or reinforcement contained in the concrete with just the amount of compacting efforts forthcoming. The factors helping concrete to have more lubricating effect to reduce internal friction for helping easy compaction are given below:

(*a*) Water Content (*b*) Mix Proportions
(*c*) Size of Aggregates (*d*) Shape of Aggregates
(*e*) Surface Texture of Aggregate (*f*) Grading of Aggregate
(*g*) Use of Admixtures

Measurement of Workability

It is discussed earlier that workability of concrete is a complex property. Just as it eludes all precise definition, it also eludes precise measurements. Numerous attempts have been made by many research workers to quantitatively measure this important and vital property of concrete. But none of these methods are satisfactory for precisely measuring or expressing this property to bring out its full meaning. Some of the tests, measure the parameters very close to workability and provide useful information. The following tests are commonly employed to measure workability.

(*a*) Slump Test (*b*) Compacting Factor Test
(*c*) Flow Test ((*d*) Kelly Ball Test
(*e*) Vee Bee Consist meter Test.

Process of Manufacture of Concrete

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting to note that the ingredients of good concrete and bad concrete are the same. If meticulous care is not exercised, and good rules are not observed, the resultant concrete is going to be of bad quality. With the same material if intense
care is taken to exercise control at every stage, it will result in good concrete. There fore, it is necessary for us to know what are the good rules to be followed in each stage of manufacture of concrete for producing good quality concrete. The various stages of manufacture of concrete are:

(*a*) Batching (*b*) Mixing (*c*) Transporting
(*d*) Placing (*e*) Compacting (*f*) Curing
(*g*) Finishing.

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Concrete can be transported by a variety of methods and equipments. The precaution to be taken while transporting concrete is that the homogeneity obtained at the time of mixing should be maintained while being transported to the final place of deposition. The methods adopted for transportation of concrete are:
(*a*) Mortar Pan *(b*) Wheel Barrow, Hand Cart
(*c*) Crane, Bucket and Rope way *(d*) Truck Mixer and Dumpers
(*e*) Belt Conveyors *(f*) Chute

Concrete Mix Design
Concept of Mix Design

It will be worthwhile to recall at this stage the relationships between aggregate and Paste which are the two essential ingredients of concrete. Workability of the mass is provided by the lubricating effect of the paste and is influenced by the amount and dilution of paste. The strength of concrete is limited by the strength of paste , since mineral aggregates with rare exceptions, are far stronger than the paste compound. Essentially the permeability of concrete is governed by the quality and continuity of the paste, since little water flows through aggregate either under pressure or by capillarity. Further, the predominant contribution to drying shrinkage of concretes is that of paste. Since the properties of concrete are governed to a considerable extent by the quality Of paste, it is helpful to consider more closely the structure of the paste. The fresh paste is a suspension, not a solution of cement in water.
The more dilute the paste, the greater the spacing between cement particles, and Thus the weaker will be the ultimate paste structure. The other conditions being equal, for Workable mixes, the strength of concrete varies as an inverse function of the water/cement ratio.

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Since the quantity of water required also depends upon the amount of paste, it is important That as little paste as possible should be used and hence the importance of grading.

Variables in Proportioning

With the given materials, the four variable factors to be considered in connection With specifying a concrete mix are:

(*a*) Water-Cement ratio
(*b*) Cement content or cement-aggregate ratio
(*c*) Gradation of the aggregates
(*d*) Consistency.

In general all four of these inter-related variables cannot be chosen or manipulated arbitrarily. Usually two or three factors are specified, and the others are adjusted to give minimum workability and economy. Water/cement ratio expresses the dilution of the pastecement
content varies directly with the amount of paste. Gradation of aggregate is controlled by varying the amount of given fine and coarse aggregate. Consistency is established
by practical requirements of placing. In brief, the effort in proportioning is to use a minimum amount of paste (and therefore cement) that will lubricate the mass while fresh and after hardening will bind the aggregate particles together and fill the space between them. Any excess of paste involves greater cost, greater drying shrinkage, greater susceptibility to percolation of water and therefore attack by aggressive waters and weathering action. This is achieved by minimising the voids by good gradation.

Various Methods of Proportioning

(*a*) Arbitrary proportion
(*b*) Fineness modulus method
(*c*) Maximum density method
(*d*) Surface area method
(*e*) Indian Road Congress, IRC 44 method
(*f*) High strength concrete mix design
(*g*) Mix design based on flexural strength
(*h*) Road note No. 4 (Grading Curve method)
(*i*) ACI Committee 211 method
(*j*) DOE method
(*k*) Mix design for pumpable concrete
(*l*) Indian standard Recommended method IS 10262-82

Out of the above methods, some of them are not very widely used these days Because of some defficulties or drawbacks in the procedures for arriving at the satisfactory proportions. The ACI Committee 211 method, the DOE method and Indian standard recommended methods are commonly used. Since concrete is very commonly placed by pumping these days method of mix design of pumpable concrete has become important. Therefore, only the more popular and currently used methods are described.

Before we deal with some of the important methods of concrete mix design, it is necessary to get acquainted with statistical quality control methods, which are common to all the methods of mix design.

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Statistical Quality Control of Concrete

Concrete like most other construction processes, have certain amount of variability Both in materials as well as in constructional methods. This results in variation of strength from batch to batch and also within the batch. It becomes very difficult to assess the strength of the final product. It is not possible to have a large number of destructive tests for evaluating the strength of the end products and as such we have to resort to sample tests. It will be very costly to have very rigid criteria to reject the structure on the basis of a single or a few standard samples. The basis of acceptance of a sample is that a reasonable control of concrete work can be provided, by ensuring that the probability of test result falling below the design strength is not more than a specified tolerance level.The aim of quality control is to limit the variability as much as practicable. Statistical quality control method provides a scientific approach to the concrete designer to understand the realistic variability of the materials so as to lay down design specifications with proper tolerance to cater for unavoidable variations. The acceptance criteria are based on statistical evaluation of the test result of samples taken at random during execution. By devising a proper sampling plan it is possible to ensure a certain quality at a specified risk. Thus the method provides a scientific basis of acceptance which is not only realistic but also restrictive as required by the design requirements for the concrete construction.

The quality of concrete will be of immense value for large contracts where the specifications insist on certain minimum requirements. The efforts put in will be more than repaid by the resulting savings in the overall concreting operations.

The compressive strength test cubes from random sampling of a mix, exhibit variations, which are inherent in the various operations involved in the making and testing of concrete. If a number of cube test results are plotted on histogram, the results are found so follow a bell shaped curve known as “Normal Distribution C urve”. The results are said to follow a normal distribution curve if they are equally spaced about the mean value and if the largest number of the cubes have a strength closer to the mean value, and very few number of results with much greater or less value than the mean value. However, some divergence from the smooth curve can be expected, particularly if the number of results available is relatively small. Fig 11.1 and Fig 11.2 show the histogram and the normal distribution curve respectively.

The arithmetic mean or the average value of the number of test result gives no Indication of the extent of variation of strength. However, this can be ascertained by relating the individual strength to the mean strength and determining the variation from the mean with the help of the properties of the normal distribution curve.

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CONCLUSION

Concrete is the most rapidly used engineering material in the world of construction business. To achieve a high standard, high durability and an attractive building structure, the key is to obtain a quality concrete during a construction project. Too much water occupies space in concrete and on evaporation, voids are created in concrete, which reduces the concrete's strength and durability.

The volume change in concrete results in crack formation and the factor which contributes the volume change is the permeability.

Permeability is the contributing factor for volume change and water-cement ratio is the fundamental cause of higher permeability. Thus, the use of higher water-cement ratio – *permeability – volume change – cracks – disintegration – failure of concrete* is a cyclic process in concrete. Hence, for a durable and a high strength concrete, use of lowest possible water-cement ratio is the fundamental requirement to produce dense and impermeable concrete. Quality control can be expressed as the application of the operational techniques and activities, which sustain the quality of a product or service to satisfy given needs

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