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ORIGINAL ARTICLE

MATHEMATICAL MODELLING OF CONCRETE MIXES AND IT'S PROPERTIES IN FRESH AND HARDENED STATE

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ABSTRACT

This paper presents the results of an experimental research on the workability and compressive strength of ordinary and standard concrete. The work focused on concrete mixes having water/cement ratios of 0.50 with different grade of concrete. The concrete mixes contained three different dosages of a superplasticizer 0.2%, 0.4% and 0.6% by weight of cement based on carboxylic. The workability tests utilized in this research were the slump flow and compacting factor test. These admixtures are used as dispersants to avoid particle aggregation, and to improve the flow characteristics of suspensions such as in concrete applications. This effect directly improves the performance of the fresh and hardened state of concrete. In this project for a particular grade of concrete by varying the percentage of superplasticizers from 0.2% to 0.6% various mixes are design by IS 10262:2009. Compressive strength at 7 and 28 days was also considered. The graphs between percentage of superplasticizers with W/C ratio, CF and strength are plotted. Same work is done with other grades of concrete also.

KEYWORDS

Concrete, Water Cement ratio, Strength, Superplasticizers and Workability etc.

INTRODUCTION

Concrete is the most widely used structural material in the world for construction. In concrete mix design and quality control, the strength of concrete and water cement ratio is the most important property. Superplasticizers, also known as high range water reducers, are chemicals used as admixtures where well-dispersed particle suspensions are required. The capability of superplasticizers to reduce water requirements 12-25% without affecting the workability of concrete. Their addition to concrete or mortar allows the reduction of the water to cement ratio, not affecting the workability of the mixture. This effect directly improves the performance of the fresh and hardened state of concrete. It is seen that workability depends on a number of factors such as water content, aggregate type and grading, mix proportions, the fineness of cement and dosage of superplasticizers. The main objective of this research was to find the effect of the dosages of superplacticizers on the fresh and hardened properties of the concrete mixes.

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MATERIALS

This part of the paper presents the specifications of the mixes used for obtaining the workability and compressive strength of ordinary and standard concrete. The cementitious materials used were Portland Slag cement (PSC) of 53 grades. Natural river sand and crushed gravel with a nominal maximum size of 20 mm were used as the aggregates. The water/cement ratios were 0.50. The different mix is prepared with and without using superplasicizers for different grade of concrete with same water/cement ratio. The superplasticizers have been selected among those of most widespread in used based on carboxylic.

Table 1: Mix proportions of Concrete

Cement (kg/m3)	372
Water (kg/m3)	186
Fine Aggregates (kg/m3)	601.5
Coarse Aggregates (kg/m3)	1249
Water-Cement Ratio	0.5

RESULTS AND DISCUSSION

The test of Specific gravity of cement, fine and coarse aggregates is done in the laboratory. Grading of fine and coarse aggregates is done by sieve analysis method and water absorption test of fine and coarse aggregates is also done. In this part of the paper, the experimental results of concrete mixes on compressive strength and workability are discussed. The workability tests performed in this research were ordinary slump and compacting factor test. To investigate the effect of superplasicizers on workability slump tests were carried out and to check the effect on compressive strength cubes were tested at the ages of 7 and 28 days.

Slump Test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not suitable method for very wet and very dry concrete. The apparatus for conducting the slump test essentially consists of metallic mould in the form of a cone having internal dimensions as under bottom diameter 20 cm, top diameter 10 cm and height 30 cm. for tamping the concrete , a steel tamping rod 16 mm diameter, 60 cm long is used. The mould is filled in three layers, each approximately ¼ of the height of the mould. Each layer is tamped 25 times by the tamping rod taking care to distribute the strokes evenly over the cross section. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod. The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside. This subsidence is referred as slump of concrete. Difference in level between height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete.

Compacting Factor Test

The compacting factor test is designed for use in the laboratory. This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. The sample of concrete to

be tested is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. The concrete is filled up exactly up to the top level of the cylinder. It is weighted. This weight is known as weight of partially compacted concrete. The cylinder is emptied and then refilled with the concrete from the same sample. The layers are heavily vibrated so as to obtain full compaction and weighted. This weight is known as weight of fully compacted concrete. The degree of compaction, called the compacting factor is measured by the density ratio i.e., the ratio of the density actually achieved in the density to the density of same concrete fully compacted.

Compressive strength

For concrete stored in water, the development of compressive strength with age is shown in Table 2. It is clear that the compressive strength development of concrete mixtures containing different dosages of the superplasticizer were quite different.

Table 2: Test result showing effect of superplasicizers on compressive strength and workability of concrete at constant water cement ratio (Mix Ratio 1: 1.5: 3), PSC

Superplasticzers Used	W/C Ratio	Slump (mm)	Compacting factor	Compressive strength (MPa) 7 days
Nill	0.5	25	0.87	20
0.2%	0.5	40	0.88	23.1
0.4%	0.5	60	0.89	22.4
0.6%	0.5	65	0.90	21.3

28 days compressive strength is also tested for different grade of concrete.

Conclusions

Superplasticizer, designed mainly to modify of traditional concretes, significantly influences the concrete mixtures fluidity. In the standard concrete mix the effects of the dosage of the superplasticizers improve the workability with same water cement ratio. Comparing the results of the mixes containing different dosages of the superplasticizer shows the effect on compressive strength of concrete

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