Effect of Particle Size Reduction on Strength and Water Absorption of Concrete Mix

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Abstract— Experimental study on the effect of particle size reduction on the strength and water absorption of the concrete has been carried out. For concrete mix particle size reduction done according to reduced scale of 1:5 for five different proportions 1:6:12, 1:5:10, 1:4:8, 1:2:4 and 1:1.5:3 with constant water cement ratio of 0.6. concrete cubes were tested and variation in strength and water absorption due to scaling had been noted.

Key words: Scaled concrete, Particle size reduction, Compressive Strength, Water absorption

I. INTRODUCTION

Computational softwares are widely used for the purpose of analysis and design of the structures. Some softwares are also available to do performance based analysis of the structures. However, the output result could generally be varying due to different assumptions regarding boundary conditions, material properties, etc. made by software and analysist. Hence to check actual performance of the structure, experiments study is required and should be done by applying actual loads to the actual structure in laboratory. Unfortunately, our structures and loadings on it are very large that experiments can't be possible on them in a laboratory. To get experiments done within the laboratory structure and its dimensions has to be reduced to a particular scale. However, physical dimensions of the structure should reduce but inherent properties of materials should not change under scaling. However, for the material like concrete one cannot use same proportion of concrete mix for modelling purpose which intended to use for original prototype concrete mix because the scaling of constituent particles ultimately effect the primary properties like compressive strength, water absorption, flexure strength, modulus of elasticity, etc. Hence, effect of particle size reduction of concrete mix on the basic properties of concrete as a whole material should be understood.

II. SCALING OF CONSTITUENTS

For reduced scaling purpose all constituents were approximately reduced to one fifth of their original dimensions. The size of coarse aggregate used in prototype concrete mix was approx. 19 mm (0.75 inch). The size of grit used in prototype concrete mix was approx. 12.7 mm (0.5 inch). Coarse aggregate and grit were used in ratio of 1:1 to form total portion of aggregate. The sand particles passing through the sieve of 4.75 mm were used in prototype concrete mix. OPC of grade 53 was used as cement for prototype concrete mix. Sand particles were sieved to get particles for reduced scaled concrete mix. The sand particles passing through the sieve of 4.75 mm and retained on the sieve of 1.18 mm were used as coarse aggregate in model concrete mix. The sand particles passing through the sieve of 1.18 mm and retained on the sieve of 600 µm were used as grit in model concrete mix. The same ratio of 1:1 was used to form total aggregate from coarse aggregate and grit. The sand particles passing through the sieve of 600 µm were used as sand in model concrete mix. As cement is very finer material, its scaling would be insignificant hence same cement was used for model concrete mix which was used for prototype concrete mix. However, cement used for model concrete mix was sieved through 150 µm to avoid any lumps present in cement.

III. EXPERIMENT

Concrete cube testing was done according to IS516:1959 to get compressive strength of the concrete. Three cubes were casted of dimensions 15 cm× 15 cm× 15 cm for all different five proportions of 1:6:12, 1:5:10, 1:4:8, 1:2:4 and 1:1.5:3 for both prototype concrete mix and model concrete mix. Water cement ratio used during the casting of all concrete cubes was 0.6. Wet cubes were tested at 28 days from casting for compressive strength using UTM (Universal testing machine). After the testing of wet cube, sample material of 100 gm was taken from the core of the tested cube to get oven dried for 24 Hrs. to get water absorption ratio of the cube.

Fig. 1: Testing of concrete cube

IV. RESULTS

Average strength and water absorption of tested cubes for all proportions of concrete mix is shown in table: 1

Concrete mix proportion	Compressive Strength (MPa)		Water absorption (%)	
	Prototype	Model	Prototype	Model
1:6:12	2.52	0.89	8.7	13.3
1:5:10	6.24	1.2	5	11.7
1:4:8	11.5	3.2	5	9.7
1:2:4	12.6	8.9	5.3	8
1:1.5:3	13.9	9.5	5	6.7

Table 1: Compressive Strength And Water Absorption For Different Concrete Mix

Variation in compressive strength for different proportion of model and prototype concrete mix is shown in fig. 2.

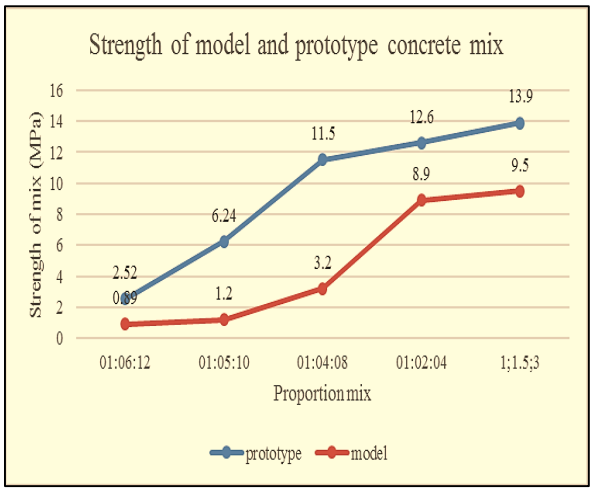

Fig. 2: Strength of model and prototype concrete mix

Variation in percentage of water absorption for different proportion of model and prototype concrete mix is shown in fig. 3.

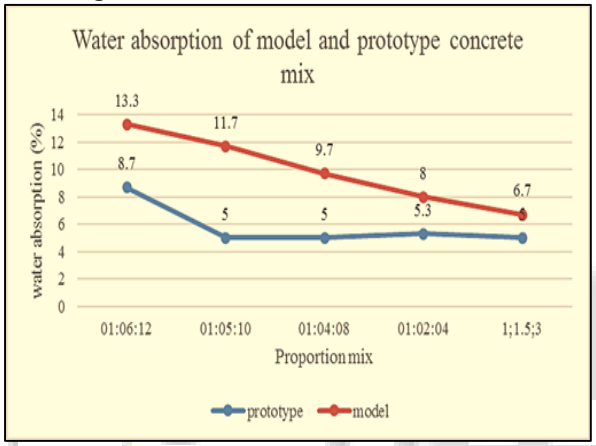

Fig. 3: Water absorption of model and prototype concrete mix

As per fig. 2 for the same proportion of concrete mix, model concrete mix shows less strength compared to the prototype concrete mix. That percentage decrement in strength with respect to prototype concrete mix along the percentage volume of cement used of total volume of concrete mix has shown in fig.4.

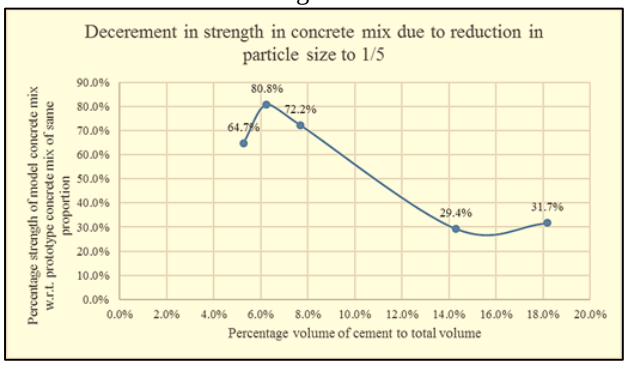

Fig. 4: Percentage decrement in strength of concrete mix due to scaling

As per fig. 3 for the same proportion of concrete mix, model concrete mix shows higher water absorption compared to the prototype concrete mix. That percentage increment in water absorption with respect to prototype concrete mix along the percentage volume of cement used of total volume of concrete mix has shown in fig.5.

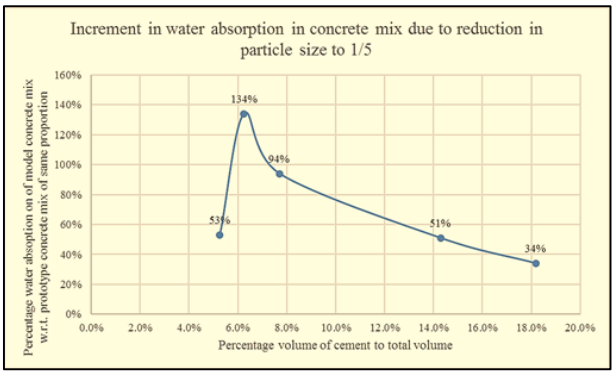

Fig. 5: Percentage increment in water absorption of concrete mix due to scaling

V. Conclusion

Percentage of Water absorption for prototype concrete mix tends to constant through proportion of 1:05:10 to 1:1.5:3 of concrete mix while it has been continuously reducing for model concrete mix through same proportion of concrete mix. Percentage decrement in strength of concrete with respect to prototype concrete mix is at the peak when the percentage volume of cement used of total volume of concrete mix is nearly 6%. After the percentage volume of cement is nearly 14% the decrement in strength of concrete is nearly constant. The percentage increment in water absorption with respect to prototype concrete mix is at the peak when the percentage volume of cement used of total volume of concrete mix is nearly 6%. It can be fairly analysed from data that strength of prototype concrete mix is higher than the strength of model concrete mix and water absorption is higher in model concrete mix than prototype concrete mix for the same proportion. The following study can be further enhanced by taking different scales or by taking more proportions of concrete mix.

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