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EFFECT OF GLASS POWDER ON HARDENED PROPERTIES OF CONCRETE

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Abstract- The purpose of this paper is to study the effect and use of glass in the compressive strength and the abrasion resistance of concrete. It has been a general practice to work with various mix design parameters simultaneously to optimize the concrete properties and hence it appears that this eco-friendly approach to use glass, is yet to be exclusively explored in terms of compression and abrasion. Glass powder obtained by crushing waste bottles was used in 0%, 2.5%, 5% , 7.5% and 10% of the weight of cement as a replacement of sand maintaining a water cement ratio of 0.57.Each sample contained 3 specimen and were tested by the compression testing machine and the tile testing machine after 28 days of curing .Peak points were obtained in both the test and surface finish tremendously improved with the increase in percentage of glass.

Keywords – Mix design, Los Angeles testing machine, tile testing machine.

I. INTRODUCTION

The waste glass is considered as an important solid waste and can be found in majority of the world's countries and is being not much affected by the weather conditions due to which the existence is leading to a lot of environmental problems. Accordingly valuable researches have been conducted to show the possibility of using waste glass as a building material and adding it as a partial replacement to the concrete mixture without affecting the concrete on the whole. Replacing cement and .sand with partially or fully will have two advantages. Firstly the depletion of natural resources. Secondly it will considerably reduce the environmental risks by producing non conventional concrete as known as glasscrete .

II. MIX DESIGN

Concrete mix design for grade M15 was done as per IS 10262-2009. The water cement ratio is selected from the graph plotted between 28 day compressive strength and water cement ratio as per IS10260-2009(Figure number 1)

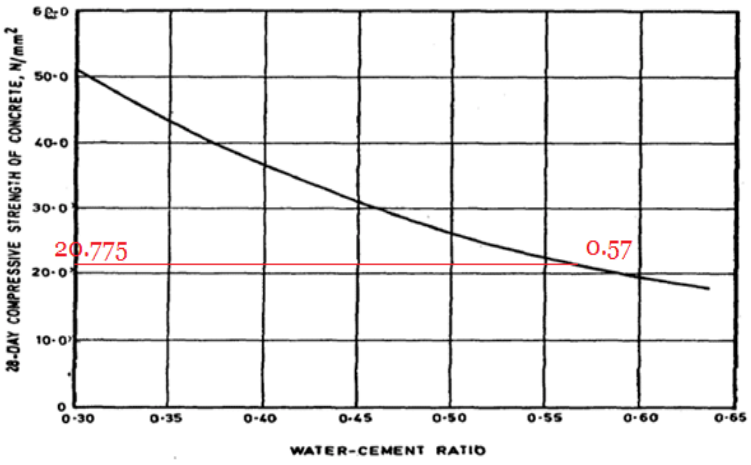

Figure 1 : Graph between water-cement ratio and compressive strength

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The nominal size of aggregate was taken as 20mm .The air content was calculated from the table number 1 as per IS10260-2009.

TABLE 1
NOMINAL SIZE OF AGGREGATE AND AIR CONTENT

S.No	Nominal Size of Aggregate(mm)	Air Content (%)
1	10	5
2	20	2
3	40	1

The water content was considered from the following table by taking the aggregate size as 20 mm .

TABLE 2
NOMINAL SIZE OF AGGREGATE AND WATER CONTENT

S.No	Nominal Size of Aggregate(mm)	Water content
1	10	208
2	20	186
3	40	165

. For cement calculation, the ratio of water and cement was used for algebraic calculation. For the aggregate ratio for concrete table number 2 as per IS10260-2009 was used

TABLE 3
NOMINAL SIZE OF AGGREGATE AND VOLUME OF COARSE AGGREGATE FOR DIFFERENT ZONES OF FINE AGGREGATE

S.No	Nominal Maximum Size of Aggregate(mm)	Volume of a Coarse Aggregate per unit of Total Aggregate for different zones of Fine Aggregate			
		Zone I	Zone II	Zone III	Zone IV
1	10	0.50	0.48	0.46	0.44
2	20	0.66	0.64	0.62	0.60
3	40	0.75	0.73	0.71	0.69

The final quantity of the ingredients comes out to be as given in table 4 .

TABLE 4
INGREDIENT OF CONCRETE AND THEIR QUANTITY

S.No	Ingredient	Quantity(kg)
1	Cement	337
2	Fine aggregate	674
3	Coarse aggregate	1120

Mix proportion ration comes out to be = cement: fine aggregate: coarse aggregate=1:2:3.3

III. GLASS POWDER

The source of glass was from the waste liquor and alcohol bottles. The bottles were later crushed by the Los Angeles machine to obtain its powder form. The glasses bottles were added along with the 11 steel balls of diameter 47mm. The cover of the cylinder was fixed and the machine was set at a speed of 30-33 revolutions per minute. A total of 2000 revolutions were given and the glass was discharged from the cylinder and collected in a tray.

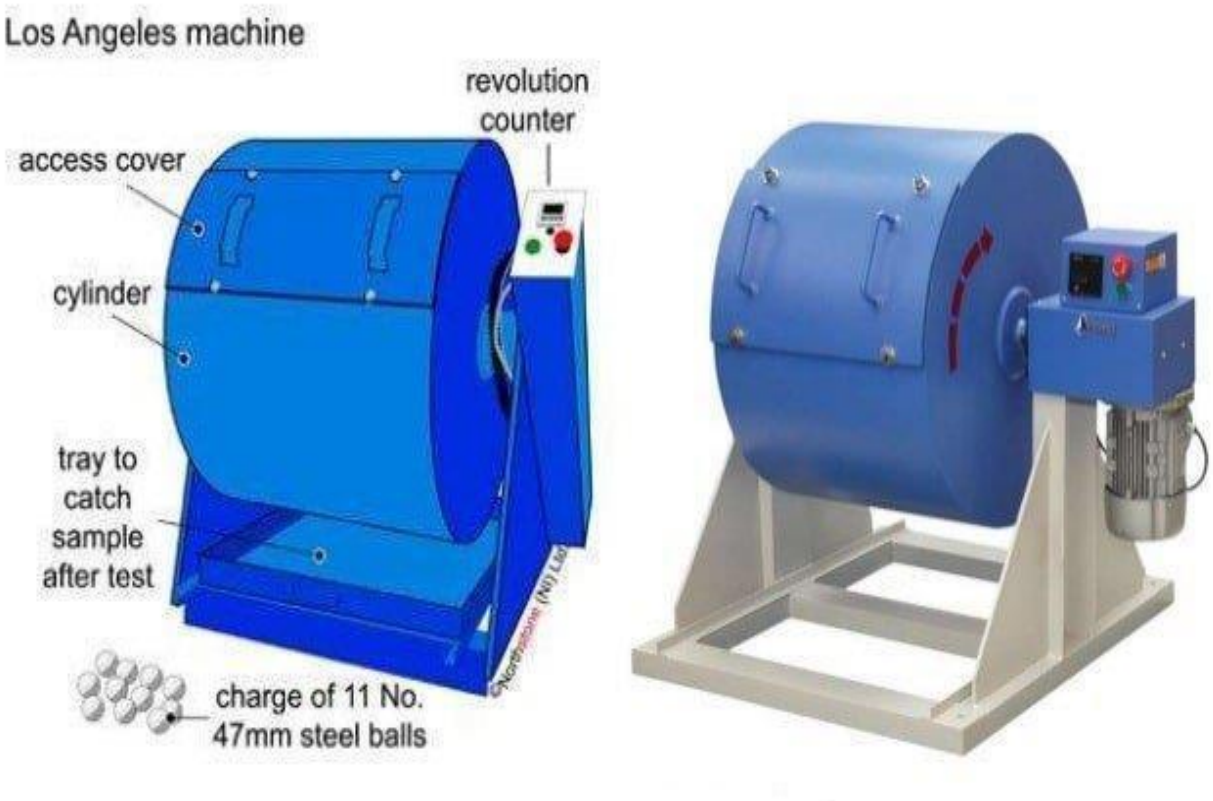

Figure 2: Los Angles Machine

Since the glass sample was very flaky and had large diameter particles in it, the sample was sieved through an IS300 sieve to obtain the finely size powder. The glass was measured as percentages of cement. One sample consisted of 3 specimens in the form of cube. The amount of cement used to form one cube of concrete was 1.4kg. Therefore, the amount of cement used in one sample was 4.2kg.

TABLE 5
WEIGHT OF GLASS ADDED IN SAMPLE

Sample	Weight of cement in a sample(kg)	Percentage of glass needed	Weight of glass added in one sample(g)
1	4.2	0	0
2	42	2.5	105
3	42	5	210
4	4.2	7.5	315
5	4.2	10	420

IV COMPRESSION STRENGTH TESTING OF CUBES

The characteristic compressive strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fail. The specimens of size 150mm were stored in water were tested immediately on removal from the water .The specimen was wiped clean and any loose sand or other material was removed from the surface of the specimen .

Figure 3: Concrete Specimen Mould

The specimen was placed in the machine in such a manner that the load was applied to opposite sides of the cubes as cast, that is, not to the top and the bottom.

Figure 4: Hydraulic Compression Testing Machine

The measured compressive strength of the specimen were calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest kg per cm square. Average of the three values was taken as the representative of the batch provided the individual was not more than ± 15 percent of the average.

The correction factor according to the height diameter ration of the specimen after capping was obtained by the curve shown in figure number 5.

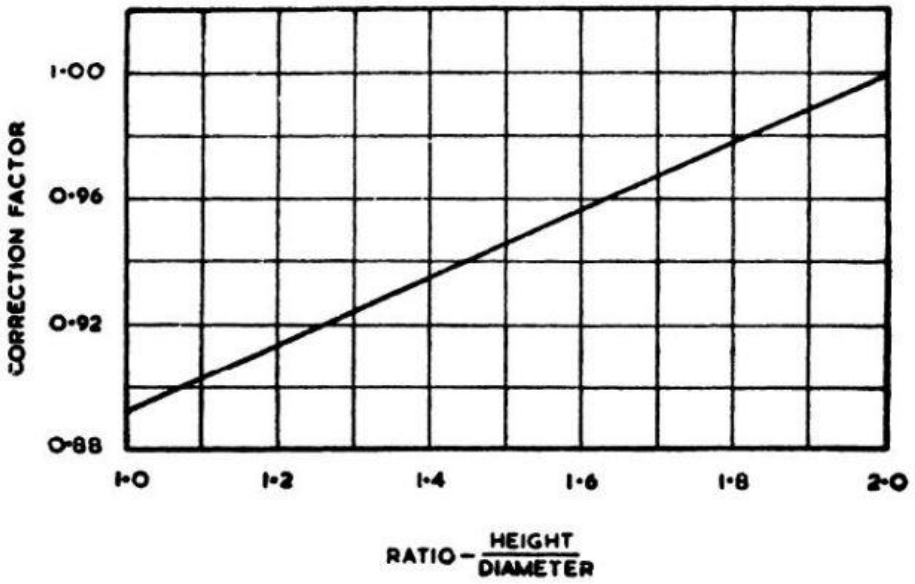

Figure 5: Graph plotted between the ratio of height-diameter and correction factor

The equivalent strength of a concrete shall be determined by multiplying the corrected cylinder strength by 1.25.

V DETERMINATION OF ABRASION RESISTANCE

The testing of tiles required concrete tile testing machine and fused aluminum oxide was used as and chemical. A concrete specimen of size 60mm x 60mm x 25mm was used. The contact face and the opposite face of the specimen were parallel and flat. The test was based on the reduction in weight of the specimen upon abrasion. The specimen were dried to constant mass at a temperature of 105 degree Celsius The grinding path of the disc was evenly strewn with 20g of the standard abrasive powder (Fused aluminum oxide) . The specimen was fixed in the holding device such that the testing surface faces the grinding disc. The specimen shall be centrally loaded with 294±3 N.

Figure 6: Tile Testing Machine

The grinding disc was moving at speed of 30 rpm. The disc was stopped after one cycle of 22 revolutions. The disc and contact face of the specimen was cleaned of abrasive powder and debris. The specimen was turned 90° in the clockwise direction and 20g of abrasive powder was evenly strewed on the testing track before starting the next cycle .The test cycle was repeated 10 times . The loss in weight of the specimen was noted after the procedure and reduction in the thickness

should be calculated using vernier scale. The loss in weight to the ration of the original weight gives us the abrasive strength of the specimen.

VI OBSERVATION

A. Compression Testing

TABLE 6
AVERAGE COMPRESSION

S.No	% of glass added	Peak compression (KN)	Average peak compression(KN)	Average peak compression (Mpa)
1	0	412	395	17.45
2	2.5	514.4	458.66	20.37
3	5	650	630.13	27.4
4	7.5	503.8	465.7	20.65
5	10	473.2	458.83	20.39

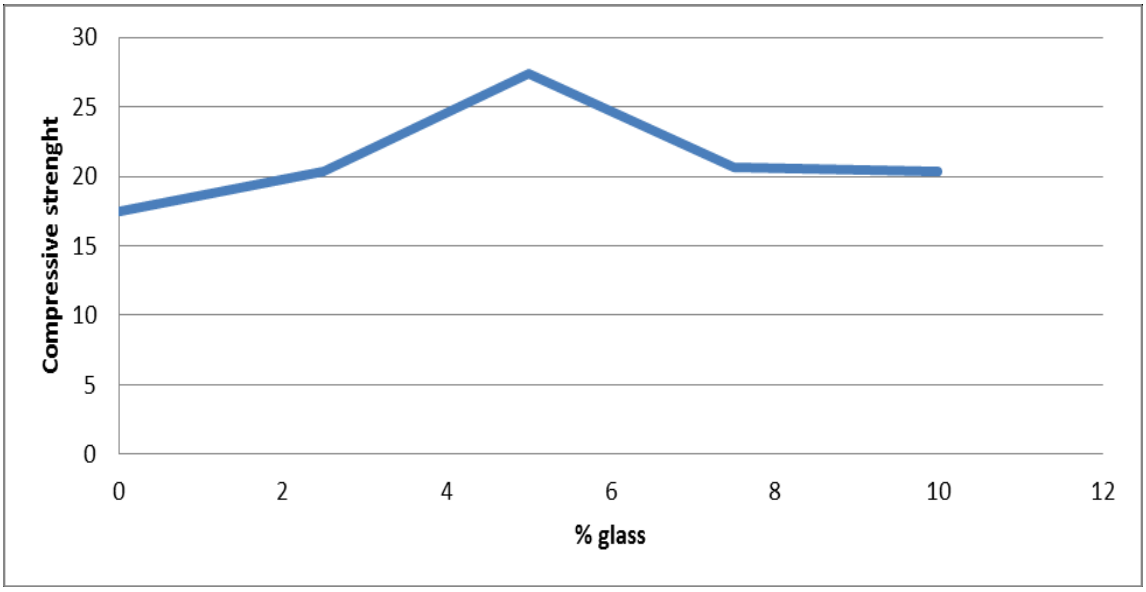

Figure 7: Graph between compressive strength and percentage of glass added

The surface finish of the samples having glass content in them is quite smooth and finished as compared to the sample without glass. Glass was added in four samples and it replaces the amount of sand in the samples . This allows the cement to react with more water and create stronger bonds as glass does not absorb water , whereas sand absorbs water leaving very litlle water for the cement to react with . Therefore a finished surface is obtained in samples containing glass.

B. Abrasion Testing

TABLE 7
PERCENTAGE REDUCTION IN THE WEIGHT OF TILE

Percentage of glass	Original weight of the tile (g)	Weight after testing(g)	Reduction in weight	% Reduction in weight
0	219.3	215.1	4.2	1.91
2.5	269.3	264.8	4.5	1.67
5	217..5	213.5	4	1.83
7.5	213.5	209.7	3.8	1.78
10	247.1	244.5	2.6	1.05

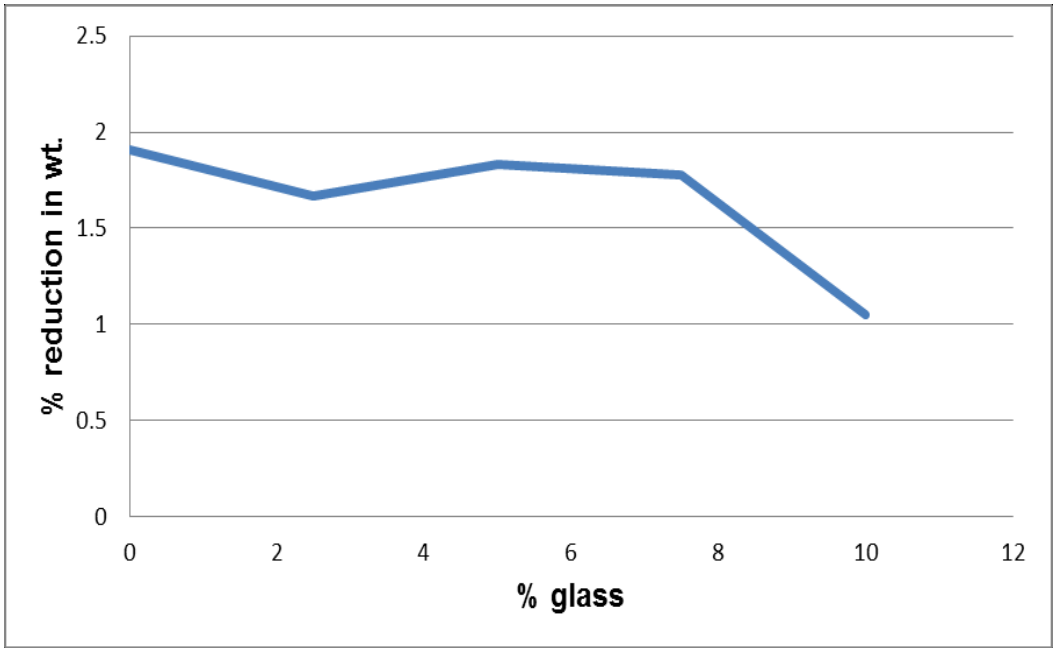

Figure 8 : Graph between % Reduction in weight and percentage of glass

The sample goes through approximately the same amount of abrasion till the sample containing 7.5% glass. By increasing the glass content from 7.5% to 10%, a sudden decrease in the percentage of weight loss was noted. As the amount of weight decreases, the resistance to abrasion of the sample increases. This implies that the abrasion resistance of tile suddenly increases as the percentage of glass is increases from 7.5 % to 10%.

VII RESULT

The highest compressive strength of the concrete is obtained at adding 5% glass (as weight of cement) and after this point the compressive strength decreases but otherwise stays greater than that of sample having no glass. The abrasion resistance of the tile suddenly increases from 7.5% to 10% glass used but otherwise shows an almost constant trend without major differences.

VIII CONCLUSION

The addition of glass powder up to a certain percentage to the concrete increases the compressive strength of the concrete block. The addition of glass powder provides a smooth finishing .The abrasion of the concrete increases with the increase in the percentage of the glass powder.

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