ISSN: 2278-0181
ICONNECT - 2017 Conference Proceedings

Strength Properties of High Performance Concerte using Various Fibers

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***Abstract*: Concrete is a building material used in the construction. It makes the building as strength and durable. High Performance Concrete is a kind of concrete with the ingredients of silica fume, OPC Cement, Superplastizer with the fine aggregate and coarse aggregate..HPC is familiar for its low cost, high durable and more strength. To make HPC as a more strengthen some extra ingredients are to be included. There is Steel Fiber, Polypropylene Fiber and Jute fiber are added. As per ancient results steel fiber and polypropylene fiber are added with concrete for the strength. To improve the strength of the HPC jute is added. Jute fiber is 100% bio degradable and recycled and thus environmentally friendly. Using jute fiber as a natural fiber in concrete jute fiber increases the property of concrete such as compressive strength and bending strength, greater resistance to cracking and hence improved impact strength and toughness. The combination of HPC with steel, polypropylene and jute fiber results in more strength, durable, low cost and high quality of the building. The present investigation aimed to get the optimum proportion of HPC and the Steel fiber, polypropylene fiber and jute fiber to get more strengthen concrete.**

I. INTRODUCTION

Concrete is the most widely used construction material in India with annual consumption exceeding 100 million cubic meters. It is well known that conventional concrete designed on the basis of compressive strength does not meet many functional requirements such as impermeability, resistance to environment exposure, resistance to frost, thermal cracking adequately. As a result, innovations of supplementary materials and composites have been developed. Therefore, it is felt necessary to improve the strength and performance of concrete with suitable admixtures to cater present need. Due to enhanced mechanical properties and durability, high performance concrete (HPC) has gained wider acceptance in the construction of tall buildings, bridges and marine structures. Aitkin defines HPC as slow water/binder concrete with an optimized aggregate – binder ratio to control its dimensional stability (i.e. drying shrinkage), and which receives an adequate water-curing (to control autogenously shrinkage). For the past few decades, HPC has undergone many developments based on the influence of cement type, type and proportions of mineral admixtures, type of super plasticizer and the mineralogical composition of coarse and fine aggregates. For producing HPC, it is well recognized that the use of supplementary cementations materials (SCM), such as fly ash (FA), are necessary. These materials, when used as mineral admixtures in HPC, can improve either or both the strength and durability properties of concrete. Concretes with these cementations materials are used extensively throughout the world. Some of the major users are power, gas, oil and nuclear industries. The applications of such concretes are increasing with the passage of time due to their superior structural performance, environmental friendliness and low impact on energy utilization. 2 1 Effect of fibers in concrete

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact–, abrasion–, and shatter–resistance in concrete. Generally fibers do not increase the flexural strength of concrete, and so cannot replace moment–resisting or structural steel reinforcement. Indeed, some fibers actually reduce the strength of concrete.

The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (V_f). V_f typically ranges from 0.1 to 3%. The aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d). Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. However, fibers that are too long tend to "ball" in the mix and create workability problems.

Some recent research[*where?*] indicated that using fibers in concrete has limited effect on the impact resistance of the materials.[1][2] This finding is very important since traditionally, people think that ductility increases when concrete is reinforced with fibers. The results also indicated that the use of micro fibers offers better impact resistance to that of longer fibers.[1]

The High Speed 1 tunnel linings incorporated concrete containing 1 kg/m³ of polypropylene fibers, of diameter 18 & 32 μm, giving the benefits noted below.[1]

II. TEST PROGRAM AND PROCEDURES

A. NATURE OF FIBERS & MIX PROPORTIONS

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Jute needs a plain alluvial soil and standing water. The suitable climate for growing jute (warm and wet) is offered by the monsoon climate, during the monsoon season. Temperatures from 20˚C to 40˚C and relative humidity of 70%–80% are favourable for successful cultivation. Jute requires 5–8 cm of rainfall weekly, and more during the sowing time. Soft water is necessary for the jute production.

Polypropylene (**PP**), also known as **polypropene**, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

Polypropylene has a relatively slippery "low energy surface" that means that many common glues will not form adequate joints. Joining of polypropylene is often done using welding processes.

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B. TESTING

SLUMP TEST : The apparatus for conducting the slump test essentially consists of a frustum of a cone having the bottom diameter of 20 cm, top diameter of 10 cm and height of 30 cm .For slump test, tamping rod of steel 16 mm in diameter, 0.6 m long and rounded at one end is used for compaction. The internal surface of the slump cone shall be thoroughly cleaned and should be free from any set concrete before commencing the test. The mould should be placed on smooth horizontal, rigid and non – absorbent surface such as carefully leveled metal plate. The mould should be filled in 4 layers each approximately one quarter of the height of mould. Each layer shall be tamped with 25 blows. The stroke should be distributed in a uniform manner over the cross section of mould. For the 2nd and subsequent layers tamping rod should penetrate into underlying layer. The bottom layer should be tamped throughout its depth. After the top layer has been rodded the concrete shall be struck off level with trowelor rod. The mould shall be removed from concrete immediately by raising it slowly and carefully in vertical direction. This will allow the concrete to subside and the slump shall be measured immediately by determining the difference between height of mould and that of highest point of slumped concrete specimen.

COMPACTION FACTOR TEST BS 1881 stated that compacting factor test as one of the test to determine the workability of the concrete. This test is usually being carried out in the lab and in specific condition i.e. construction site. It was a sensitive and more accurate test compared to the slump test and suitable for low workability of concrete mixture. Never the less the accuracy of the result will be reduced with the increased of the aggregate size (size exceed 20mm).The sample of concrete is placed in the upper hopper upto the brim in Figure 5.4.2 The trap-door is opened so that the concrete falls into the lower hopper. The trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades. The concrete in the cylinder is weighed. This is known as weight of partially compacted concrete. The cylinder is filled with a fresh sample of concrete and vibrated to obtain full compaction. The concrete in the cylinder is weighed again. This weight is known as the weight of fully compacted concrete. It should normally be stated to the nearest second decimal place.
Compaction factor = weight of partially compacted concrete/ weight of fully compacted concrete

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ICONNECT - 2017 Conference Proceedings

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FLEXURAL STRENGTH TEST: The Flexural strength of concrete is determined as per BIS: 516-1959 at the age of 28 days using 100 x 100 x 500 mm prisms. For each trail mix three prisms were tested to determine the flexural strength of concrete. The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two lines spaced 20.0 or 13.3 cm apart in Figure 5.5.2. The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers. The load shall be applied without shock and increasing continuously at a rate such that the extreme fiber stress increases at approximately 7 kg/sq.cm/min, that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens. The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure shall be noted. The flexural strength of the specimen shall be expressed as 36 the modulus of rupture Fb, which, if ‗a' equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows: Fb= PL BD^2 ---- (5.3) Where, B= measured width in cm of the specimen, D= measured depth in cm of the specimen at the point of failure, L= length in cm of the span on which the specimen was supported, P= maximum load in kg applied to the specimen**.**

*SPLIT TENSILE STRENGTH TEST:*The splitting tensile strength of concrete is determined at the age of 28 days of curing using 150 x 300 mm cylinder as per BIS:5816-1999. The test specimen shall be placed in the centering jig with packing strip and/or loading pieces carefully positioning along the top and bottom of the plane of loading of the specimen. The jig shall then be placed in the machine so that the specimen is located centrally in Figure 5.5.3. The load shall be applied without shock and 37 increased continuously at a nominal rate within the range 1.2 N/(mm2 /min) to 2.4 N/(mm2 /min). Maintain the rate, once adjusted, until failure. On manually controlled machines as failure is approached the loading rate will decrease; at this stage the controls shall be operated to maintain as far as possible the specified loading rate. The maximum load applied shall then be recorded. The appearance of concrete and any unusual features in the type of failure shall also be noted. The measured splitting tensile strength Fct, of the specimen shall be calculated to the nearest 0.05 N/mm2 using the following formula: Fct = 2P πLD Where, P = maximum load in New tons applied to the specimen, I = length of the specimen (in mm), and d = cross sectional dimension of the specimen

III. RESULTS AND DISCUSSIONS

A. Compressive Strength :

The results of the tests that were carried out on the trial mixes of M60 grade of high performance concrete to determine their workability, strength related properties are presented. The workability test results like slump test, compaction factor test, tests on fresh concrete were conducted.

Jute fiber, steel fiber and lime in separate usage increase the UCS value of native soil. The best UCS of native soil is due to the combination of 0.75% J.F. + 0.25% S.F. + 4% lime. The brittleness index of fine-grained soil is relatively affected by the jute fiber. The resilient modulus is best increased by the combination of 0.25% S.F. + 4% lime. Water-binder ratio is very low. Concrete quite often contains cement replacement materials that drastically change the properties of fresh and hardened concrete. Slump or compaction factor can be adjusted using high range water reducing admixture (HRWRA) without altering water content.

7th day (N/mm2)	*14th day (N/mm2)*	*28th day (N/mm2)*
35	*39*	*58*
37	*41*	*56*
33	*46*	*60*

Table : 1.1 –compressive strength

7th day (N/mm2)	14th day (N/mm2)	28th day (N/mm2)
2.9	3.1	3.9
2.6	3.2	3.4
2.7	3.0	4.2

Table: 1.2 –Flexural Strength

7thday (N/mm2)	14thday (N/mm2)	28th day (N/mm2)
1.9	*2.2*	*3.6*
2	*2.4*	*3.3*
2.1	*2.2*	*3.2*

Table: 1.3- Split Tensile Strength

IV. CONCLUSION

Based on the observations and the test results of experimental work following conclusions are drawn:

A.Most of the existing mix design methods of HPC are not applicable for tropical climatic conditions due to wide variations in relative humidity and temperatures prevailing in different regions of tropical countries. B.Various parameters or variables involved in the mix design process have not been quantified in the existing methods and are usually left to the judgment of designer. C. The mix design method developed for HPC mixes in the present study involves the parameters like w/b ratio, ambient relative humidity and temperature, desirable contents of various ingredients, coarse to fine aggregate ratio suitable for tropical climatic conditions. D. The mix design procedure is found to give the desirable design parameters in a minimum number of trials.

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