PERFORMANCE ON MECHANICAL PROPERTIES OF CONCRETE BY USING STEEL FIBER WITH ARTIFICIAL SAND

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Abstract —The modern civil engineering construction have their own structural and durability requirements related with concrete to better suit intended function of the structure. It is necessary to develop the concrete of special properties, so that the structure continues to perform its intended purpose. Conventional concrete possesses a very low tensile strength and little resistance to cracking. Internal micro-cracks, leading to brittle failure of concrete. Development of such types of concrete that have more tensile strength is needed to suit infrastructure demand. This paper presents the study of steel fiber reinforced concrete with artificial sand as fine aggregate. Three matrices with compressive strength 40 MPa were designed and reinforced with crimpled steel fibers at dosage rate of volume fraction 1.0%. The specimens were prepared, cured and tested for compressive strength. The strength of steel fiber reinforced natural sand concrete (SFRNSC) and steel fiber reinforced artificial sand concrete (SFRASC) have been compared with the test data from the present study. The promotional use of artificial sand will conserve the natural resources for the sustainable development of the concrete in construction industry.

Keyword : SFRASC – Steel fibre reinforced artificial sand concrete
SFRNSC: Steel fibre reinforced natural sand concrete

1. INTRODUCTION

One major challenge facing the civil engineering community is to execute projects in harmony with nature using the concept of sustainable development involving the use of high performance, environment friendly materials produced at reasonable cost.Replacement of natural sand to the artificial sand with dust, artificial sand can be used for making good concrete. It helps in conservation of natural sand. The sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand.There is scarcity of natural sand due to heavy demand in growing construction activities which forces to find the suitable substitute. The cheapest and the easiest way of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade which would be free from all impurities. For the purpose of experimentation concrete mixes are designed for M40 grades by 100% replacement of natural sand to artificial sand. The artificial sand concrete is reinforced

with crimpled steel fibers at the dosage rate of volume fraction 1.0%, its mechanical properties namely cube compressive strength are steel.The main objective of the present investigation is to study the strength and durability performance of concretes made with natural sand and artificial sand with dust. The durability properties were investigated through micro-structure related properties of concrete, such as, permeability, water absorption, chloride diffusion, and also through chemical attack. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cemetitious material, aggregate and water and by adding some special ingredients.

ARTIFICIAL SAND : Natural sand are weathered and worn out particles of rocks and are of various grades or size depending on the accounting of wearing. The main natural and cheapest resource of sand is river. Dams are constructed on every river hence these resources are erasing very fast. Now a days good sand is not readily available, it should be transported from long distance. Those resources are also exhausting very rapidly. So it is a need of the time to find some substitute to natural river sand.

The artificial sand produced by proper machines can be a better substitute to river sand. The sand should be sharp, clean and course. The grains should be of durable material. The grain sizes must be such that it should give minimum voids. The presence of clay and silt retards the setting of the cement and makes the mortar weaker and the walls or the slab leaks and holds dampness.

STEEL FIBRE : Steel fibers are short, discrete lengths of steel with an aspect ratio (ratio of length to diameter) from about 20 to100, and with any of several cross-sections. Some steel fibers have hooked ends to improve resistance to pullout from a cement-based matrix (Fig.).

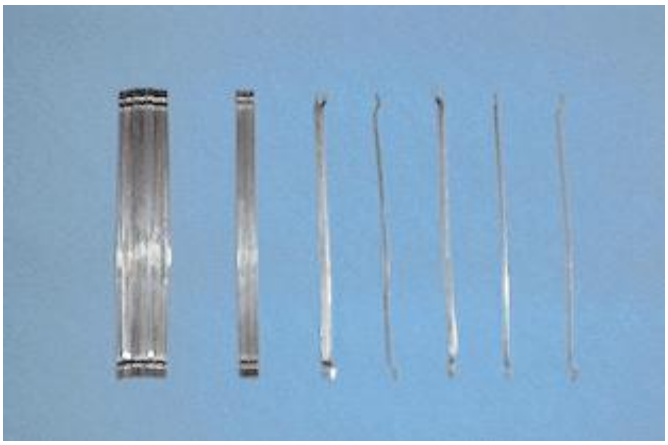

Fig. Steel fibers with hooked ends are collated into bundles to facilitate handling and mixing. During mixing the bundles separate into individual fibers.

In this work, effects on strength of concrete with two hook end steel fibers. Mild steel wire form, Hook end 30mm length having density of 6.85 g/cm3 and minimum tensile strength as 325MPa , at 1% by volume of concrete collected from Stewols Pvt. Ltd. Nagpur, Maharashtra, India, were used. The different aspect ratios adopted were 50 with diameter of fibers 0.6mm respective. It was found that SFRC containing hook-ended stainless steel wires has better physical properties than that containing straight fibers. This is attributed to the better anchorage provided & higher effective aspect ratio than that for the equivalent length of straight fiber. In addition, the high tensile stresses localized at cracks necessitate that steel fibers have high tensile strength. Typical steel fiber tensile strengths are ranged between 1100 and 1700Mpa

The addition of steel fibers to concrete significantly improves the tensile strength of concrete. The strength improvement is a complex function of the matrix strength, matrix-fiber interaction, type and shape of fiber, its aspect ratio and content. Considering the scarcity of natural sand, one of the important concrete constituent, artificial sand finds better applicability in steel fiber reinforced concretes (SFRC).

PROPERTIES OF INGREDIENTS OF CONCRETE :

CEMENT : The ingredients of cement include limestone, shells and chalk combined with shale, slate, clay, silica sand, blast furnace slag and **iron** ore. These ingredients are heated at high temperatures to form a rock-like substance, which is then ground into cement powder. Portland cement is the material used to form concrete.

Material	Na,me of test	Observed value	Permissible value
Cement	Specific gravity	3.15	3.12-3.19
Coarse aggregate	Specific gravity	2.74	2.6-2.8
	Water absorption test	0.5%	0.5%-1%
Fine aggregate	Specific gravity	2.74	2.6-2.8
	Water absorption test	1.0%	0.5%-1%

SAND : Sand is primarily composed of finely granulated silica and, depending on its location, can include various rock, coral, shell or lava fragments. It is **lightweight** and easily transported by wind and water. Its **composition** directly affects its **color**, resulting in black, white, pink and green coloring.

METAL : The carbon content of steel is between 0.002% and 2.1% by weight for plain **iron**–**carbon alloys**. These values vary depending on alloying elements such as manganese, **chromium**, **nickel**, **iron**, tungsten, carbon and so on. Basically, steel is an **iron**-carbon alloy that does not undergo eutectic reaction.

CONCRETE MIX PROPORTION :

For M40 Grade concrete

A-1 Design stipulations for proportioning

a) Grade designation: M40

b) Type of cement :PPC grade confirming to IS 8112

c) Maximum nominal size of aggregates: 20 mm

d) Minimum cement content : 300 kg/m3

e) Maximum water cement ratio: 0.5

f) Workability : 100 mm (slump)

g) Exposure condition :Severe(for reinforced concrete)

h) Method of concrete placing: Pumping

i) Degree of supervision : Good

j)Type of aggregate: Crushed angular aggregate

k) Maximum cement content : 450kg/m3

l)Chemical admixture type: Super plasticizer.

TESTING OF CONCRETE :

FRESH STAGE :

Workability

A theoretical w/c ratio calculated from the consideration discussed above is not going to give an ideal situation from maximum strength. Hundred per cent compaction of concrete is an important parameter for contributing to the maximum strength. Lack of compaction will result in air voids whose damaging effect on strength and durability is equally or more predominant than the presence of capillary cavities.

SLUMP CONE TEST:

The slump test is used vary often in concrete work. It is easily performed at a job site and is useful in detecting variations in mixes of given properties.

The slump test cone is placed on a smooth, level surface with the smaller opening at the top. It is filled in three layers of equal volume, each of, which is compacted 25 times with a standard rod having a hemispherical tip. The rod is then struck off, and the cone is slowly lifted and set beside the unsupported concur the rod is laid across the cone and a measure of the distance from the bottom of the rod to the average top of the concrete is taken.

A vary stiff mix will have near zero slump. Lean mixes tend to be harsh and slumps can vary from true to shear in different sample of the same mixes. The same slump can be recorded for concrete of different workability, depending on the aggregate Used. The slump test is not a true determination of workability, but it is a useful for on-site checks of variations in material or mixing condition.

HARDEN STAGE :

COMPRESSIVE STRENTH TEST : The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7, 14 and 28days. It is most common test conducted on hardened concrete as it is an easy test to perform and also most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. Steel mould made of cast iron dimension 150mm x 150mmx150mm used for casting of concrete cubes filled with steel fibers 0%, 1% by volume of concrete.. The mould and its base rigidly damped together so as to reduce leakages during casting. The sides of the mould and base plates were oiled before casting to prevent bonding between the mould and concrete. The cube was then stored for 24 hours undisturbed at temperature of l8°C to 22°C and a relative humidity of not less than 90% (IS 516-1959).It also stated in IS 516-1959 that the load was applied without shock and increased continuously at the rate of approximately 140 Kg/sq cm/ min until the resistance of specimen to the increasing loads breaks down and no greater load can be sustained. The maximum load applied to the specimen was then recorded as per IS: 516-1959

TENSILE STRENGH TEST : After the Splitting tensile test another common test performed for determination of tensile strength is the Flexure test.The test could be performed in accordance with as per BS 1881 : Part 118 : 1983. A simple plain concrete beam is loaded at one-third span points. Normal standard size of specimen is 150x150x750 mm. If the largest nominal size of the aggregate doesnot exceed 25mm, size of 150x150x500 mm may also be used. Span of the beam is three times its depth.

Conclusion

The specimen with steel fibre was found to be good in compression which had the compressive strength of 3.82 % more than the control concrete.

The paper concluded that the addition of steel fibers at 1 % by volume of concrete reduces the cracks under different loading conditions

It is concluded that to get the design degree of workability, the use of super plasticizer was essential. The excessive bleeding of concrete is reduced by using artificial sand.

The brittleness of concrete can also be improved by addition steel fibers than glass fibers. Since concrete is very weak in tension, the steel fibers are beneficial in axial-tension to increase tensile strength.