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A REVIEW PAPAR ON USE OF STEEL FIBRE IN NO-FINES CONCRETE

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ABSTRACT

Fiber reinforced concrete has been successfully used in slabs on grade, shot Crete, architectural panels, precast products, offshore structures, structures in seismic regions, thin and thick repairs, crash barriers, footings, hydraulic structures and many other applications. Fibers are specially used as resistance of cracking and strengthening of concrete. In this project, I am going to carry out test on steel fiber reinforced concrete to check the influence of fibers on strength of concrete. According to various research papers, it has been found that steel fibers give the maximum strength in comparison to glass and polypropylene fibers. Now a days steel fiberexists many reinforcement techniques for improving the strength of those materials which lacks load carrying and less durable capacity. Steel fiber is used to enhance the strength and reduce maintenance is an effective technology established in recent times. Thevarious usefulness of steel fiber reinforced concrete in Civil Engineering applications is thus indisputable. This study of this review is a trial of giving some highlights for inclusion of steel fibers especially in terms of using them with new types of concrete.

I. INTRODUCTION

There are, of course, other (and probably cheaper) ways of increasing the strength of concrete. The contribution of the real steel fibres is to increase the toughness of the concrete (defined as some function of the area under the load vs. deflection curve), under any type of loading. Fibre reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres. The steel fibre reinforcement can be used in the form of three – dimensionally randomly distributed fibres throughout the structural member when the added advantages of the fibre to shear resistance and crack control can be further utilised. On the other side, the steel fibre concrete may also be used as a tensile skin to cover the steel reinforcement when a more efficient two – dimensional orientation of the fibres could be obtained. Now, why we would wish to add such fibres to concrete? Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of steel fibre is randomly distributes discontinuous fibres is to bridge across the cracks that develop provides some post- cracking “ductility”. If the steel fibres are, sufficiently bonded to material,sufficiently strong and permit the FRC to carry significant stresses over a relatively large strain capacity in the post-cracking stage. They act effectively as rigid inclusions in the concrete matrixWhen the fibre reinforcement is in the form of short discrete fibres,. Physically, the presence of fibres in the body of the concrete or the provision of a tensile skin of fibre concrete can be expected to improve the resistance of conventionally reinforced structural members to cracking, deflection and other serviceability conditions. They have thus the same order of magnitude as aggregate inclusions; steel fibre reinforcement cannot therefore be regarded as a direct replacement of longitudinal reinforcement in reinforced and prestressed structural members. However, because of the inherent material properties of fibre concrete,

No-Fines Concrete is a method of producing light concrete by omitting the fines from conventional concrete. This concrete is made up of onlycement,coarse aggregateand water. No-fines concrete is having large voids and hence light in weight, also offers architecturally attractive look.The strength of no-fines concrete is dependent on the water/cement ratio, aggregate cement ratio and unit weight of concrete No-fines concrete is generally made with the aggregate/ cement ratio from 6:1 to 10:1 Aggregates used are normallyof size passing through 20 mm and retained on 10 mm.

II. LITERATURE REVIEW

The initial use of no-fines concrete was in the United Kingdom in 1852 with the construction of two residential houses and a sea groyne. It was a further 70 years before any further recorded use of no-fines concrete occurred when it was reintroduced into the United Kingdom in 1923 from Holland. The use of no-fines concrete became more important after the conclusion of World War II with the associated material shortages (Malhotra 1976).

Malhotra : (1976) found that the density of no-fines concrete is generally about 70 percent of conventional concrete when made with similar constituents. The density of no-fines concrete using conventional aggregates varies from 1602 to 1922 kg/m3. A clinker aggregate was trialled and the no-fines concrete produced a density of 961 kg/m3.

Adequate vibration is imperative for strength of conventional concrete. The use of no-fines concrete is different and is a self-packing product. Malhotra (1976) suggests that the use of mechanical vibrators and ramming is not recommended with no-fines concrete. A light rodding should be adequate and used to ensure that the concrete reaches all sections of the formwork. This is not a problem with conventional concrete since it has greater flow ability than no-fines concrete. The light rodding ensures that the concrete has penetrated all the areas impeded by reinforcing steel.

Malhotra (1976) stresses that in situations where normal conditions are not achieved during placement and curing, the formwork should not be removed after 24 hours as with conventional concrete. No-fines concrete has very low cohesiveness and formwork should remain until the cement paste has hardened sufficiently to hold the aggregate particles together. However, this is more of a consideration in low temperature conditions and when used in non-pavement applications where the concrete is not sufficiently supported by the ground or other means.

Ghafoori et al :- (1995) Undertook a considerable amount of laboratory investigation to determine the effectiveness of no-fines concrete as a paving material. The curing types were investigated to determine if there was any difference between wet and sealed curing. There appeared to be only a negligible difference in strength between the different curing methods. It was clear from the test results that the strength development of no-fines concrete was not dependent upon the curing conditions.

The indirect tensile test conducted by Ghafoori et al (1995) found that the sample tests varied between 1.22 and 2.83 MPa. The greater tensile strength was achieved with a lower aggregate-cement ratio. Ghafoori et al (1995) explained the more favourable properties obtained by the lower aggregate-cement ratio by an improved mechanical interlocking behaviour between the aggregate particles.

Abadjieva et al :- Determined that the compressive strength of no-fines concrete increases with age at a similar rate to conventional concrete. The no-fines concrete specimens tested had aggregate-cement ratios varying from 6:1 to 10:1. The 28 day compressive strength obtained by these mixes ranged from 1.1 and 8.2 MPa, with the aggregate-cement ratio of 6:1 being the strongest. He concluded that the most plausible explanation for the reduced strength was caused by the increased porosity of the concrete samples. This strength is sufficient for structural load bearing walls and associated applications. Ghafoori et al (1995) produced no-fines concrete with a compressive strength in excess of 20 MPa when using an aggregate-cement ratio of 4:1.
Abadjieva et al investigated the influence of the aggregate-cement ratio on the tensile and flexural strength of no-fines concrete. This study only assessed aggregate-cement ratios ranging from 6:1 to 10:1. The highest strengths were obtained with an aggregate-cement ratio of 7:1 and the strength decreased with an increasing aggregate-cement ratio. He found that the tensile and flexural strengths of no-fines concrete were considerably lower than those obtained from conventional concrete, but he could not explain why the sample with the highest strength had a ratio of 7:1.

Krishna Raju :- A study conducted by Krishna Raju et al (1975) focused on the optimum water content for no-fines concrete. It was determined that for the particular aggregate-cement ratio there is a narrow range for optimum water-cement ratio. This water-cement ratio was imperative to gain the maximum possible compressive strength. A higher than ideal water-cement ratio would cause the cement paste to drain from the aggregate particles. Alternatively, a water-cement ratio too low would stop the cement paste from adhering sufficiently to the aggregate. When the optimum water-cement ratio was not obtained, sufficient compaction could not be achieved, further compounding the loss of compressive strength.

The large air voids in no-fines concrete does not allow water to penetrate using capillary action. Malhtora (1976) noted that the depth of penetration in no-fines concrete by this method under conditions of high humidity and no air movement is generally no greater than two or three times the largest aggregate diameter. The penetration of moisture was higher in no-fines concrete made from conventional aggregates than clinker aggregate.

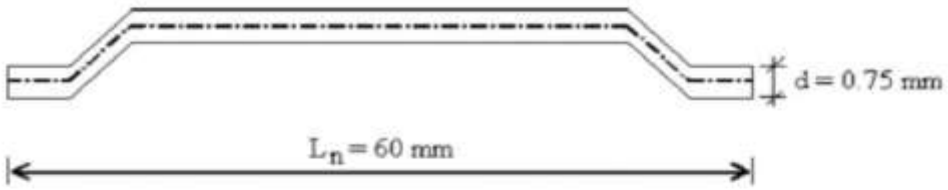
Meininger :- (1988) investigated the effect on the properties of no-fines concrete with the addition of sand. He found that when a small amount of sand was added to the mixture, the compressive strength of the concrete increased from 10.3 MPa to 17.2 MPa. The sand added was between 10 and 20 percent of the aggregate by weight. The increased fines filled some of the voids, reducing the air content from 26 to 17 percent. A decrease in the voids causes the concrete to bond more effectively, thus increasing the compressive strength. With more than 30 percent sand the concrete started to display the properties of conventional concrete and did not have sufficient voids necessary for water flow.

III. OBJECTIVE

- To determine Compessive strength of no fines concrete, fibre no fines concrete and compare it by normal concrete.

IV. MATERIALS

- Cement: The cement used in this experimental work is “Ultratech 53 grade Ordinary Portland Cement”.
- Water: Portable water is used for mixing & curing of concrete.
- Coarse Aggregates
- Steel Fibres
- Hook Ended Steel fibre



V. TEST ON FRESH CONCRETE

Slump Test

Procedure

1. Make sure the internal surface of the slump cone is free from hard concrete.
2. Wet the internal surface with a damp cloth before commencing test.
3. Place the mould on the base plate and hold in place by standing on the foot pieces provided during the filling procedure.
4. Fill the mould in three equal layers and tamp each layer 25 times. The tamping must occur uniformly over the entire cross section of the concrete.
5. Ensure that the top layer of the concrete is in line with the top of the mould on completion of the filling and tamping procedures.
6. Carefully remove the slump mould without disturbing the concrete sample.
7. Measure the slump by determining the difference in height between the mould and the average height of the top surface of the concrete.

Result of Slump Test

This test was undertaken on each sample of concrete used for the hardened concrete tests. The slumps obtained on the concrete samples are as follows:

Table No. 5.1 – Result of Slump Test

Type of Concrete	Slump (mm)
No Fines Concrete (6:1)	170
Fibered No Fines Concrete (1%)	150
Fibered No fines Concrete (2%)	135

Compacting Factor Test

The compacting factor test is used to determine the extent with which the fresh concrete compacts itself when allowed to fall without the application of any external compaction. The compaction obtained from the free falling is compared with the same sample under standard compaction practices (that is 3 layers, each tamped 25 times). The sample falls from the initial cone and is captured in a second cone. It is then allowed to fall into a test cylinder with a diameter of 150 mm and height of 300 mm.

This test is another test for consistency of a fresh concrete sample and as with the other tests it should not vary considerably for different batches with the same mix proportions. This is probably the most appropriate method for testing the consistency of no-fines concrete as it is considered to be a self compacting material and can be dropped from height without affecting its properties.

Apparatus

1. Compacting Factor Apparatus – consists of 2 conical hoppers mounted above a cylinder.
2. Trowel – requires the use of two trowels.
3. Rod – constructed of 16 mm diameter metal rod approximately 600 mm long with a tapered and spherical end with a radius of 5 mm.
4. Balance – capable of measuring to an accuracy of 0.1 percent.

Figure 5.1 – Apparatus Used to Conduct the Compacting Factor Test

Procedure

1. Ensure the internal surfaces of the hoppers and cylinders are free from hardened concrete.
2. Moisten all the internal surfaces with a damp cloth before commencing each test.
3. Gently fill the upper hopper with concrete using the trowel, then immediately open the trapdoors to allow the concrete to fall into the second hopper.
4. Immediately after the concrete has come to rest, open the lower trapdoor allowing the concrete to fall into the cylinder.
5. Level the top of the cylinder and wipe clean any concrete on the mould.
6. Determine the mass of the concrete in the cylinder to the nearest 10 grams. This mass is known as the 'mass of the partially compacted concrete (m1)'.
7. Empty the cylinder and fill with a new sample of concrete and compact by tamping the concrete in three layers. Carefully strike off the top surface and clean the outside of the cylinder.
8. Determine the mass of the concrete in the cylinder to the nearest 10 grams. This mass is known as the 'mass of fully compacted concrete (m2)'.
9. Calculate the compacting factor with the following equation:

$$\text{Compacting Factor} = \frac{(m_1)}{(m_2)}$$

Result of Compacting Factor Test

The results from the compacting factor test conducted on the concrete samples are found in table 5.2

Table No. 5.2 – Result of Compacting Factor Test

Type of Concrete	**Partially Compacted (m_1)**	**Fully Compacted (m_2)**	**Compacting Factor**
No Fines Concrete (6:1)	10.925	11.435	0.96
Fibered No Fines Concrete(1%)	10.145	11.200	0.90
Fibered No fines Concrete (2%)	13.000	13.450	0.97

VI. TESTING ON HARD CONCRETE

Compressive Strength

The compressive strength tests are conducted to ensure a minimum strength is achieved by the particular mix. Cylinder and cube testing are methods of determining the compressive strength. The cylinder testing is an Australian Standard for testing compressive strength, while cube testing is a British Standard.

The cube test, due to the method by which it is implemented, should give a more stable test specimen than the cylinders. This test will determine the strength of the sample along the entire length of the sample and eliminate problems encountered with the edge aggregate dislodging and failing. The cube method usually determines a concrete strength increased by 10 and 40 percent in comparison to the equivalent cylinder test.

Apparatus

1. Testing Machine – complying with the appropriate requirements.
2. Bearing Strips – require two tempered grade hardboard, 5 mm thick.

Testing Procedure

1. The measuring and testing of test specimens was undertaken as soon as possible after being removed from the water.
2. All specimens were tested in a wet condition and excess water removed from the surface.
3. The dimensions of the test specimens were measured and recorded.
4. The platens were cleaned when necessary to ensure no obstruction from small particles or grit.
5. It was ensured there was no trace of lubricant on the bearing surfaces.
6. The 150 by 150 mm plate was placed on top and bottom of the specimen directly opposite each other.
7. The specimens were centered on the bottom platen of the testing machine.
8. The upper platen was lowered until uniform pressure was provided on the specimen.
9. A force was applied at the required rate shown by the rotating disc on the testing machine.
10. The maximum force applied to the cylinder was recorded and the compressive strength calculated:

$$pressure = \frac{Force}{Area}$$

Results of Compression Strength

The maximum force determined in the cube tests and the associated compressive strength is shown in Table 7.1.

Table No. 6.1 – Compressive Strength of Concrete Cubes for 3 Days

Sr. No.	Specimen Type	Force (kN)	Cross Sectional Area (mm²)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	No Fines (6:1)	113	22500	5.02	5.11
2	No Fines (6:1)	117	22500	5.18	
3	No Fines (6:1)	115	22500	5.13	
4	Fibered No Fines (1%)	136	22500	6.04	6.38
5	Fibered No Fines (1%)	150	22500	6.67	
6	Fibered No Fines (1%)	145	22500	6.44	
7	Fibered No fines (2%)	140	22500	6.22	6.76
8	Fibered No fines (2%)	162	22500	7.2	
9	Fibered No fines (2%)	155	22500	6.88	

Table No. 6.2 – Compressive Strength of Concrete Cubes for 7 Days

Sr. No.	Specimen Type	Force (kN)	Cross Sectional Area (mm²)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	No Fines (6:1)	142	22500	6.30	5.95
2	No Fines (6:1)	154	22500	6.84	
3	No Fines (6:1)	106	22500	4.73	
4	Fibered No Fines (1%)	150	22500	6.67	7.66
5	Fibered No Fines (1%)	175	22500	7.78	
6	Fibered No Fines (1%)	192	22500	8.53	
7	Fibered No fines (2%)	155	22500	6.88	8.10
8	Fibered No fines (2%)	202	22500	8.97	
9	Fibered No fines (2%)	190	22500	8.44	

Table No. 6.3 – Compressive Strength of Concrete Cubes for 28 Days

Sr. No.	**Specimen Type**	**Force (kN)**	**Cross Sectional Area (mm^2)**	**Compressive Strength (MPa)**	**Average Compressive Strength (MPa)**
1	No Fines (6:1)	330	22500	14.69	12.71
2	No Fines (6:1)	219	22500	9.73	
3	No Fines (6:1)	308	22500	13.71	
4	Fibered No Fines (1%)	330	22500	14.67	14.67
5	Fibered No Fines (1%)	280	22500	12.44	
6	Fibered No Fines (1%)	380	22500	16.89	
7	Fibered No fines (2%)	355	22500	15.78	16.44
8	Fibered No fines (2%)	405	22500	18	
9	Fibered No fines (2%)	350	22500	15.55	

VII. CONCLUSION

- The strength of No fines concrete is lower, then also this concrete is used for road pavement.
- The compressive strength of No fines concrete is increased by using steel fibres.
- The workability of No fines concrete is lower than conventional concrete.
- The cost of No fines concrete is less than conventional concrete, because of omitting the fine aggregate from concrete.

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