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Effect of Mixing Fibers on Flexural Strength of Concrete Mix

Nikunj Patel[1], C. B. Mishra[2]
1(M. Tech. Transportation Engineering Student, Department of Civil Engineering, BVM Engineering College, V. V. Nagar, Anand, India - 388120.
2(Associate Professor, Department of Civil Engineering, BVM Engineering College, V. V. Nagar, Anand, India - 388120.

***Abstract** : Economic growth of the country depends on good infrastructural facilities, as good roads are the life line of country to meet ever increasing demands of users. The sustained efforts need to be made from long run point of view with respect to quality and quantity of roads in terms of load carrying capacity; performance of pavement, durability, length and economy is needed. Nano innovation is most encouraging region of science. Now-a-days different types of Fibres are used as a part of the Fibre Reinforced Concrete Pavement. In this study, M40 concrete with and without additive Brass Coated Micro Steel Fibers (BMSF) is prepared and strength values using Compressive strength test, Flexural strength test is found out and from such values the optimum dosage of additives is determined which can be suggested to highway contractors.*

***Keywords :**Brass Coated Micro Steel Fiber, Compressive, Fibre Reinforced Concrete, Flexural S, M40 Grade*

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I. Introduction

The rigid pavements which are built by plain concrete has some unfavorable structural characteristics such as low tensile strength, low post cracking capacity, brittleness and low ductility, limited fatigue life, incapable of accommodating large deformations, low impact strength etc. Due to these undesirable features of plain concrete, generally the steel reinforcement is provided in the form of continuous steel bars. On the other hand, presently a composite concrete known as a Fibre Reinforced Concrete (FRC) is widely used in rigid pavement as well as Transportation Infrastructure. FRC is a relatively new composite construction material which consisted short, thin, and relatively tensile fibre. The plain concrete structure is very weak in tension, so it cracks into two pieces when the structure is carrying to the peak tensile load and cannot withstand more tensile load thus permanent deformation is occurs at the early age. However, the FRC structure cracks at the same peak tensile load but does not separate and can maintain a load to very large deformations. FRC also provides several other advantages like low maintenance cost, longer life, increased load carrying capacity, fuel efficiency, good riding quality etc.

There are several fibre which are used in the FRC for a Rigid Pavement such as Steel Fiber, Polypropylene Fiber, Glass Fiber, Asbestos Fibers, Carbon Fibers, Organic Fibers. Recently, Brass Coated Micro Steel Fibre is widely used to significantly improves the general properties of the rigid pavement concrete.

II. Literature review

A.M. SHENDE, A.M. PANDE, M. GULFAM PATHAN (2012) critical investigation for M-40 grade of concrete having mix proportion 1:1.43:3.04 with water cement ratio 0.35 to study the compressive strength, flexural strength, split tensile strength of steel fibre reinforced concrete (SFRC) containing fibers of 0%, 1%, 2% and 3% volume fraction of fibres and investigated that strengths were on higher side for 3% fibers. (1)

ABDUL AHAD, ZISHAN RAZA KHAN, SHUMANK DEEP SRIVASTAVA (2015) they conclude that use of steel fibers is economical as well as effective in increasing the strength of pavement. Using steel fibers, the thickness of road reduces up to 25% to 30% with the increase in the durability of the road pavement, so it can decrease the Overall cost of the road construction. (2)

K. VAMSHI KRISHNA, J. VENKATESWARA RAO (2014) had carried out experimental investigation on mechanical properties of M20 grade concrete by incorporating polyester fibers in the mix and stated that as the fiber content increases, compressive, split tensile and flexural strengths are proportionally increasing as compared to the conventional concrete at 28 days. (3)

RACZKIEWICZ WIOLETTA (2017) had estimated that the addition of 1% steel fibers to the concrete reduced the progress of corrosion of the main reinforcement bars and reduces the shrinkage progress in the concrete specimens.(4)

S. A. MAHADIK, S. K. KAMANE, A. C. LANDE (2014) in this paper effect of steel fibers on the strength of concrete for M 40 grade have been studied by varying the percentage of fibers in concrete. The

percentage increase in the flexural strength and compressive strength for the concrete with steel fibers 0.25 %, 0.50 %, 0.75 % and 1 % compared to the concrete without steel fibers are (27.92 %, 11.56 %), (38.33%, 21.05 %), (43.29%, 24.15 %) and (34.19%, 10.52 %) respectively. From the results it has been observed that flexural strength and compressive strength is a maximum for the 0.75 % steel fibers.(5)

SHAHID IQBAL, AHSAN ALI, KLAUS HOLSCHEMACHER, THOMAS A. BIER (2015) had studied the behaviour of concrete strengths with the different dosage of steel fibers like 0.5 % to 1.25 % by volume of concrete. There is around 7% reduction in compressive strength, 18% and 70% increase in splitting tensile strength and flexural strength respectively, with increase of steel fiber content from 0.5% to 1.25%, while the modulus of elasticity remains almost the same.(6)

YAZIC HALIT (2012) had concluded that addition of micro steel fibers reduces the expansions of mortar upto 65% as compared to the control specimens without fibers. The effect of cement hydration is procced up to 28 days and flexural strength, compressive strength and toughness increased compared to the conventional mortar. (7)

III. Laboratory Investigation For Material Used

3.1 CEMENT

Ordinary Portland Cement of Ultra Tech Cement Brand with 53 Grade of cement was used. All the laboratory tests were performed as per the IS: 4031 – 1988. Tests results and properties of the cement is as shown in Table No. 1.

Table 1: Properties of Cement

Cement		
1	Specific Gravity of Cement	3.15
2	Standard Consistency of cement	30.50%
3	Initial Setting Time	117 mins
4	Final setting Time	230 mins
5	Fineness of Cement	2.48%
6	Soundness of cement	2.3 mm
7	Compressive Strength of Cement (28 Days)	60.09 N/mm^2

3.2 COARSE AGGREGATE

Coarse aggregate size of 20 mm and 10 mm, crushed, free from organic impurities conform from IS: 2386 – 1963 were used. All the laboratory tests were performed as per the Indian codal provisions. Results and properties of the coarse aggregate is as shown in Table No. 2 and the gradation curve of the Coarse aggregate.

Table 2: Properties of Coarse Aggregate

Coarse Aggregate		
1	Specific Gravity of 20 mm Aggregate	2.92
2	Specific Gravity of 10 mm Aggregate	2.96
3	Water Absorption of 20 mm Aggregate	0.98 %
4	Water Absorption of 10 mm Aggregate	1.06 %
5	FI / EI Index of 20 mm Aggregate	12.11 / 12.33 %
6	FI + EI Index of 20 mm Aggregate	24.44 %
7	FI / EI Index of 10 mm Aggregate	13.44 / 12.29 %
8	FI + EI Index of 10 mm Aggregate	25.73 %
9	Aggregate Impact Value	13.47 %
10	Loss Angeles Abrasion Value	18.20 %
11	Aggregate Crushing Value	26.48 %

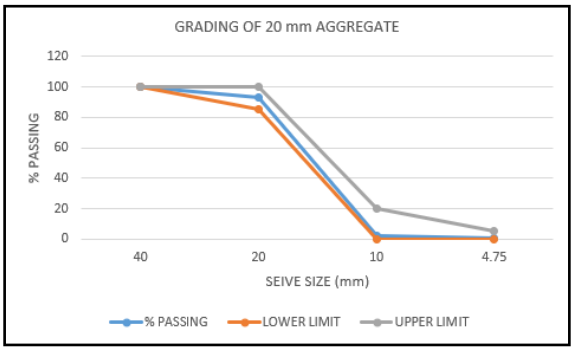

Figure 1: Gradation Curve of 20 mm Aggregate

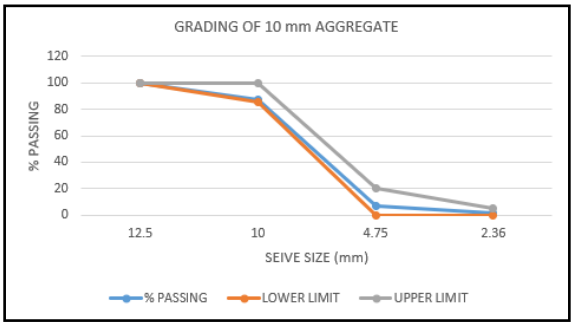

Figure 2: Gradation Curve of 10 mm Aggregate

3.3 FINE AGGREGATE

Fine aggregate obtained from river, free from organic impurities conform from IS: 2386 – 1963 and IS: 383 - 1970 were used. All the laboratory tests were performed as per the Indian codal provisions. Results and properties of the Coarse aggregate is as shown in Table No. 3 and the gradation curve of the fine aggregate.

Table 3: Properties of Fine Aggregate

Fine Aggregate		
1	Specific Gravity of Fine Aggregate	2.61
2	Water Absorption of Fine Aggregate	1.55%
3	Fineness Modulus of Fine Aggregate	2.61

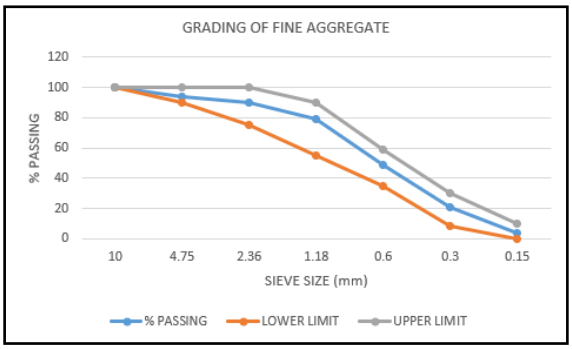

Figure 3: Gradation Curve of Fine Aggregate

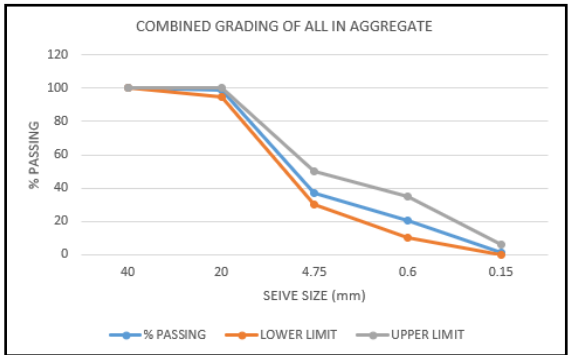

Figure 4: Gradation Curve of All in One Combined Aggregate

3.4 BRASS COATED MICRO STEEL FIBRES

Brass Coated Micro Steel Fibres was used as a partial volumetric replacement of the concrete mixed. Three different dosage, 0.5 %, 1.0 % and 1.5 % of the volume of concrete was used to determine the properties of the concrete mixed. Physical properties of the Brass Coated Micro Steel Fibres is as shown in Table No. 4.

Table 4: Properties of Brass Coated Micro Steel Fibre

Brass Coated Micro Steel Fibres		
1	Specific Gravity	7.86
2	Tensile Strength	> 285 MPa
3	Length	6 - 13 mm
4	Diameter	0.18 - 0.25 mm

Figure 5: Brass Coated Micro Steel Fibre

3.5 SUPER PLASTICIZER

Rheobuild 821 (EJ) was used as the supper plasticizer in the concrete mixed. The physical and chemical properties of the Rheobuild 821 (EJ) is as shown in Table No. 5.

Table 5: Properties of Supper Plasticizer

Super Plasticizer		
1	Appearance	Liquid (Yellow)
2	PH	6 (min)
3	Dosage	0.8 % by Volume
4	Specific Gravity	1.22

IV. Pqc Concrete Mixed Design And Experimental Investigation

4.1 PQC CONCRETE MIXED DESIGN

There are several methods to design the concrete mixed. Out of those method IRC – 44 method is used to design the concrete mixed. At the end of all consideration and steps mass of the all material (Concrete Mixed Design) is as shown in Table No. 6.

Table 6: PQC Concrete Mixed Design

Mass of All Materials For 1 M3 of Concrete				
Material	**Mass (Kg)**			
Percentage by Volume	**0.00 %**	**0.50 %**	**1.00 %**	**1.50 %**
Brass Coated Micro Steel Fibers	0	39.3	78.6	117.9
Cement	410	408	405	404
Water	139.5	138.8	138.1	137.4
20 Mm Aggregate	850	846	842	837
10 Mm Aggregate	539	536	533	530
Fine Aggregate	667	661	658	655
Admixture (0.8 %)	3.28	3.29	3.29	3.29
Density (Kg/M3)	2608.78	2632.09	2658.28	2684.55
Mixed Proportion	1 : 1.62 : 3.39	1 : 1.62 : 3.39	1 : 1.62 : 3.39	1 : 1.62 : 3.39

4.2 SLUMP TEST

Concrete slump test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test was carried out from batch to batch to check the uniform quality of concrete during construction. Slum test was carried out as per the IS: 1199 – 1959. The result of the slump test is as shown in Table No. 7.

Table 7: Slump of Fresh Concrete (mm)

	Normal Concrete	**NC + 0.5 % BMSF**	**NC + 1.0 % BMSF**	**NC + 1.5 % BMSF**
	Mm	Mm	Mm	mm
Required	25 ± 15	25 ± 15	25 ± 15	25 ± 15
Initial	84	80	76	70
30 min	62	59	54	50
45 min	48	45	41	39
60 min	36	34	31	30

V. Results

5.1 COMPRESSIVE STRENGTH

Concrete cubes, size of 150 mm X 150 mm X 150 mm were casted to get the Compressive Strength of the concrete mixed. Compressive strength was examined after 3, 7 and 28 days of curing. Result of compressive strength is as shown in Table No. 8.

Table 8: Compressive Strength of Concrete Mixed

Compressive strength			
Type of Concrete	**Average Compressive strength (N/mm2)**		
	3 Days	**7 Days**	**28 Days**
NC	35.35	46.79	59.75
NC + 0.5 % BMSF	47.39	54.58	65.08
NC + 1.0 % BMSF	**57.24**	**64.96**	**70.24**
NC + 1.5 % BMSF	39.93	52.55	64.96

5.2 FLEXURAL STRENGTH

Concrete beam, size of 150 mm X 150 mm X 700 mm were casted to get the Flexural Strength of the concrete mixed. Flexural strength was examined after 7 and 28 days of curing. Result of flexural strength is as shown in Table No. 9.

Table 9: Flexural Strength of Concrete Mixed

Flexural strength		
Type of Concrete	**Average Flexural strength (N/mm2)**	
	7 Days	**28 Days**
NC	5.10	6.73
NC + 0.5 % BMSF	5.91	7.27
NC + 1.0 % BMSF	**6.15**	**8.41**
NC + 1.5 % BMSF	6.01	6.92

VI. Conclusion

1. Scientifically evaluated test reports on cement, coarse aggregates, fine aggregates for pavement slab, it shows that engineering properties are fulfilled as per IS Codes. From the plot of all-in combined aggregate gradation chart as shown in figure, it shows specifically the obtained gradation line falls within the limit lines which means that the selected aggregate proportion fulfil the Ministry of Road Transport and Highways (MORTH, 2004) specification.
2. The concrete slump test results of M40 grade concrete with and without Brass Coated Micro Steel Fibers indicates that slump decreases fundamentally at 0.1% rate of Brass Coated Micro Steel Fibers. So, in order to balance the slump and make the concrete workable, dose of 0.8% Superplasticizer Rheobuild 821 (EJ) is accomplished by various trials and up to 15% of water decrease is possible. Also, the movements on account of additives are satisfying the properties as set down in codal provisions.
3. The compressive and flexural Strength test results of M40 grade concrete with and without Brass Coated Micro Steel Fibers indicates that compressive and flexural strength increases with increase in dosage of fibre i.e. 0.5%,1.0% and 1.5% rate of Brass Coated Micro Steel Fibers. However, the laboratory investigation shows compared to M40 concrete mix the maximum compressive and flexural strength of concrete at 1% Brass coated micro steel fibre i.e. 70.24 N/mm2 (28 days) and 8.41 N/mm2 (28days) respectively.
4. The Laboratory Investigation Reveals That Brass Coated Micro Steel Fibers In Concrete Proves To Be An Ideal New Approach In Road Construction.

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