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Experimental Investigation on Strength Behaviour of No-Fine Concrete Incorporating With Stainless Steel Fiber

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Abstract: Today in the present world we are very much fond of sustainable and eco-friendly means of construction. Particularly in a country like India where flooding and water-logging problems are the major environmental issues sustainable development has become a necessity. Various sustainable and eco-friendly means are being implemented to tackle these problems where No-fine concrete pavement is one among them. Working on rain-drain‟ concept No-fine concrete allows a significant amount of storm water to seep into the ground, thereby recharging the ground water and reducing the storm water runoff. No-fine concrete is a light-weight concrete produced by omitting the fines from conventional concrete. No-fine concrete (sometimes referred to as porous or open-textured concrete) is a concrete consisting of cement, coarse aggregate and water. No-fine concrete can be used for a number of applications, but its primary use in road pavement such as in rural areas. This report focus on the strengthened pavement application of the concrete. No-fine concrete has been in use in many countries over more than a century. Its higher porosity helps in percolating rain water directly to ground and thereby helps in recharging groundwater aquifer. In this study, 3 batches of no-fine concrete each with three different (1%, 3%, 5%) percentage of Stainless steel was prepared to find the mix that generated high flexural strength and study the effect of percentage of stainless steel on the flexural strength of no-fine concrete. The purpose of this project is to analyze the feasibility of producing highly sustainable no-fine concrete mixtures, stainless steel fiber and evaluating the effect of fine aggregate on their properties. No-fine concrete is produced by using ordinary Portland cement, coarse aggregates (10mm), and water. This concrete is tested for its properties, such as compressive strength, permeability and flexural strength. The results showed that permeability has significant effect on compressive strength of no-fine concrete.

Keywords: No –Fine Concrete, Water-cement ratio, Cement- aggregate ratio, Stainless Steel Fiber, Split tensile test, Compression test, Flexural test, Permeability.

I. INTRODUCTION

Due to an increase in infrastructure developments the demand for the concrete would be increased. Concrete is one of the most widely used construction material. Worldwide concrete consumption was estimated to be 10.2 billion tons per year. The concrete is the composition of paste material (water + cement), filling material (fine aggregate), and compression material (coarse aggregate). Increasing of concrete quantity the need of fine aggregate is increased by about 2 % of the total quantity of concrete but the source of fine aggregate is very less. And another one nowadays rigid pavement is constructing widely rural areas. The rigid pavement creates waterlogging problems and surface run-off. The surface water not percolating under the rigid pavement at the same time the purest water of rainwater is consoled with wastewater to create the demand for drinking water problem and under-ground recharge of water. So consider those problems to provide the concrete in omitting of fine aggregate. it means no-fine concrete. No-Fines Concrete is a lightweight concrete made up of only coarse aggregate, cement and water by omitting fines (sand or fine aggregates) from normal concrete. Very often only single sized coarse aggregate, of size passing through 20 mm retained on 10 mm is used. The single sized aggregates make a block of good no-fine concrete, which in addition to havinglarge voids and also offers an architecturally attractive look. Similarly, the no-fine concrete has adequate compressive strength and low flexural strength. The no-fine concrete directly approaches in water. So try improving the M_{25} grade of no-fine concrete strength behaviour in addition to stainless steel fibre (corrosion resistant) in 1 %, 3% and 5% in the weight of cement. The concrete designed to mix manually and the

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specimen like cube's, cylinders and beams are cast. Then the all specimens are tested to analyse the results in 7 days, 14 days and 28 days.

II. OBJECTIVE AND SCOPE OF INVESTIGATION

To investigate the strength Behavior in aggressive environment studies on no-fine concrete incorporating with stainless steel fibre.

According to the journal's statement, the use of no-fine concrete decreases the flexural strength rate. Hence it improves its strength.

To measure the flexural strength of fibre used no-fine concrete compared with conventional no-fine concrete. In this study, the following parameters were analyzed.

1. Sieve analysis.
2. Specific gravity.
3. Compressive strength test.
4. Split tensile strength test.
5. Flexural strength test.

III. METHODOLOGY

For our study M_{25} grade of no-fine concrete was used and the tests were conducted for addition in various proportions of Stainless Steel Fibre (1%, 3% & 5%) in concrete. Cubes, cylinder and beam specimens were cast and tested for compression, split tensile strength and flexural strength studies.

- In our study, the M_{30} grade of concrete is going to use for casting all kind of concrete specimens. This study is concerned with the addition of steel fibre at 1%, 3% and 5%.
- Cubes are used to find the compressive strength.
- Cylinders are used for splitting tensile strength.
- Beams are used for flexural strength.

IV. EXPERIMENTAL INVESTIGATION

In this section, M25 grade of no-fine concrete specimens was involved under compression, tension and flexural. Cubes cylinders and beams of no-fine concrete are tested in a hydraulic compression testing machine in accordance with Indian standards. Specimens of cubes of size 150×150×150 mm, cylinders of size 150 dia. × 300 mm and beam size of 1000×150×150 mm are used to determining the compressive strength, split tensile strength and flexural strength of stainless steel fiber used no-fine concrete.

Compressive strength formula:

$$Fc = P/A$$

Where,
P – Failure load in KN,
A – Area of the loading face in mm^2.

Table I compressive strength for 7 days

Mix ID	specimen ID	Load (KN)	Compressive strength(N/mm^2)	Average (N/mm^2)
SS_{100}	A11	221	9.82	9.77
	A12	216	9.64	
	A13	222	9.86	
SS_{101}	B11	346	15.38	14.78
	B12	330	14.68	
	B13	321	14.28	
SS_{103}	C11	514	22.86	22.69
	C12	504	22.42	
	C13	512	22.78	
SS_{105}	D11	591	26.28	26.62
	D12	589	26.18	
	D13	617	27.40	

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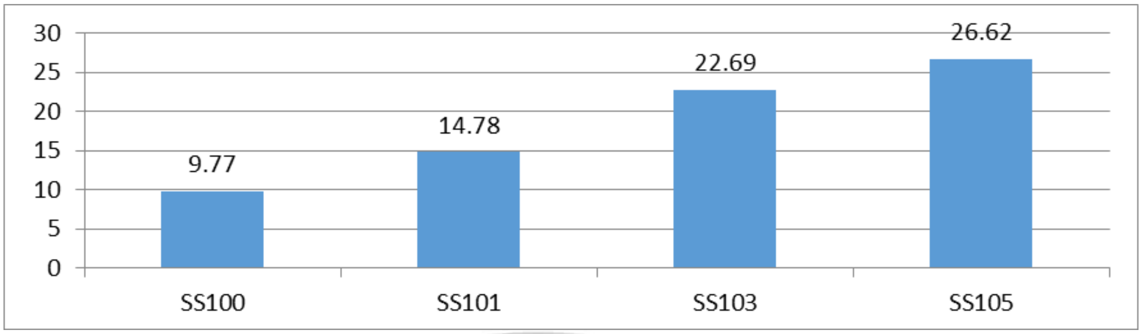

Fig: 1 Compressive strength for 7 days

Table II Compressive strength for 14 days

mix ID	specimen ID	load(KN)	Compressivestrength (N/mm^2)	Average (N/mm^2)
SS_{100}	A21	286	12.68	12.86
	A22	291	12.92	
	A23	292	12.98	
SS_{101}	B21	448	19.92	19.61
	B22	446	19.80	
	B23	430	19.10	
SS_{103}	C21	671	29.83	29.85
	C22	667	29.65	
	C23	677	30.06	
SS_{105}	D21	747	33.24	33.29
	D22	754	33.50	
	D23	745	33.13	

Fig: 2 Compressive strength for 14 days

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Table III compressive strength for 28 days

mix ID	specimen ID	load (KN)	Compressive strength (N/mm^2)	Average (N/mm^2)
SS_{100}	A31	342	15.22	18.83
	A32	371	16.46	
	A33	356	15.82	
SS_{101}	B31	606	26.94	26.97
	B32	594	26.46	
	B33	620	27.52	
SS_{103}	C31	824	36.62	36.74
	C32	821	36.48	
	C33	835	37.12	
SS_{105}	D31	890	39.58	39.64
	D32	884	39.26	
	D33	902	40.06	

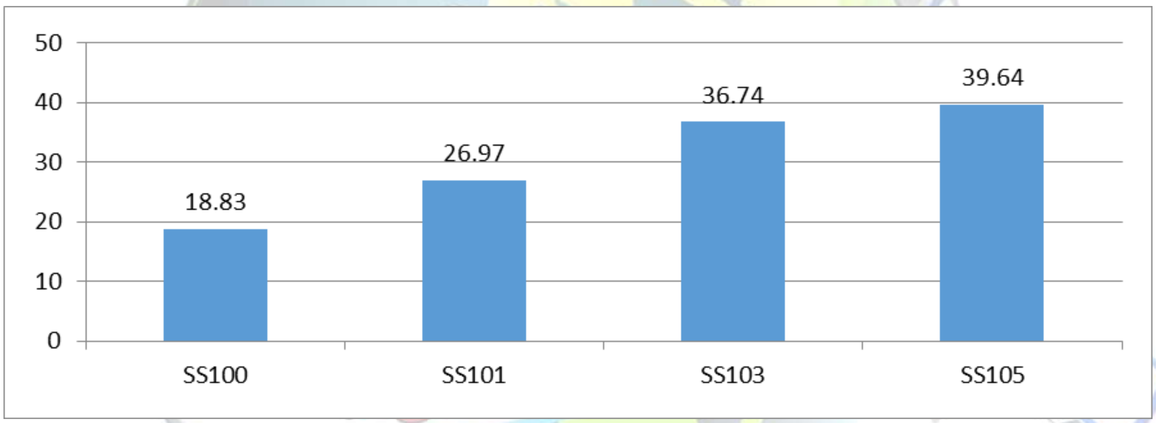

Fig: 3 Compressive strength for 28 days

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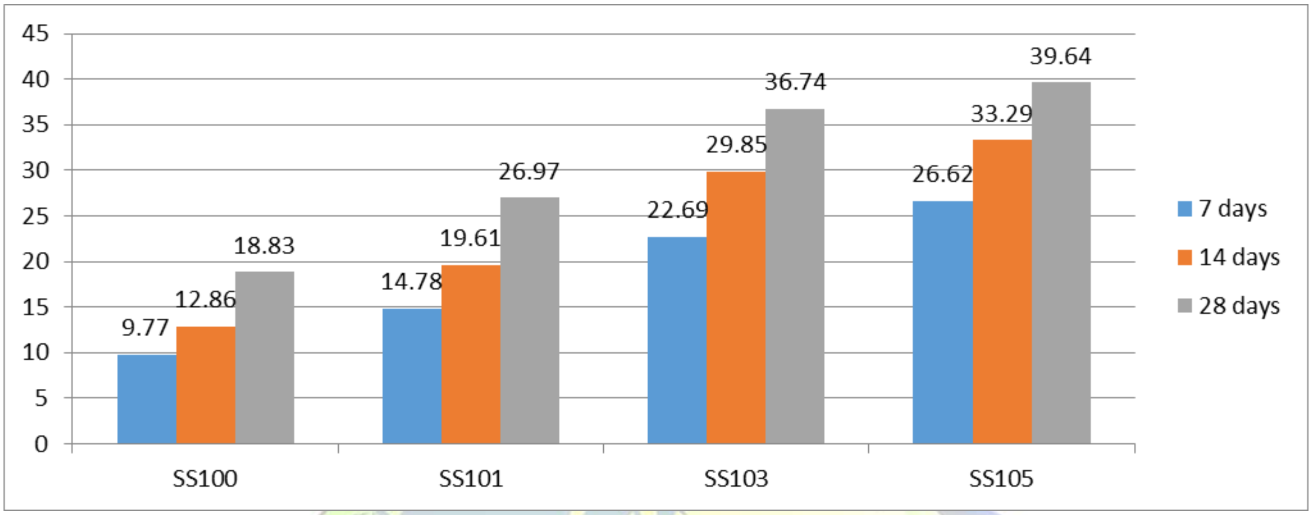

Fig 4: compressive strength test for 7, 14 & 28 days

SPLIT TENSILE STRENGTH TEST

- The tensile strength of concrete is one of the basic and important properties. The Splitting tensile strength test on the concrete cylinder is aimed to determine the tensile strength of concrete.
- The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. Thus, it is necessary to determine the tensile strength of concrete.

Split Tensile Strength Test (Fct) Formula

$$fct = 2P/\pi dl$$

Where,

P- Maximum applied the load,
d- Diameter of cylinder specimen,
l- Length of the cylinder specimen.

Table IV Split Tensile strength for 7 days

Mix ID	Specimen ID	Load (KN)	Tensile strength (N/mm^2)	Average (N/mm^2)
SS_{100}	A11	78	1.10	1.32
	A12	88	1.24	
	A13	114	1.62	
SS_{101}	B11	168	2.38	2.48
	B12	172	2.45	
	B13	185	2.62	
SS_{103}	C11	210	2.98	3.12
	C12	224	3.16	
	C13	228	3.22	
SS_{105}	D11	400	5.64	5.74
	D12	416	5.88	
	D13	404	5.70	

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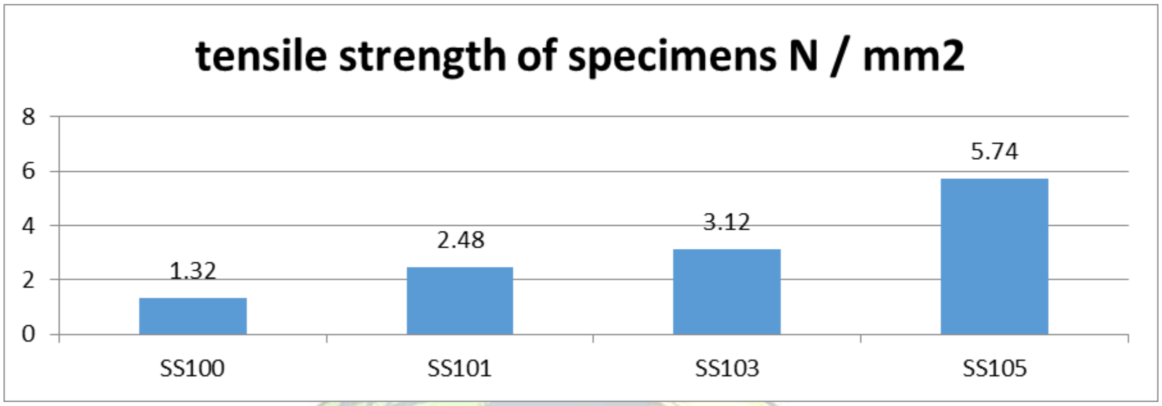

Fig. 5 Split Tensile strength for 7 days

Table V Split Tensile strength for 14 days

Mix ID	Specimen ID	Load (KN)	Tensile strength (N/mm^2)	Average (N/mm^2)
SS100	A21	89	1.25	1.56
	A22	102	1.46	
	A23	130	1.84	
SS101	B21	258	3.64	3.68
	B22	264	3.74	
	B23	260	3.66	
SS103	C21	348	4.94	5.10
	C22	362	5.12	
	C23	370	5.24	
SS105	D21	584	8.26	8.60
	D22	614	8.68	
	D23	626	8.86	

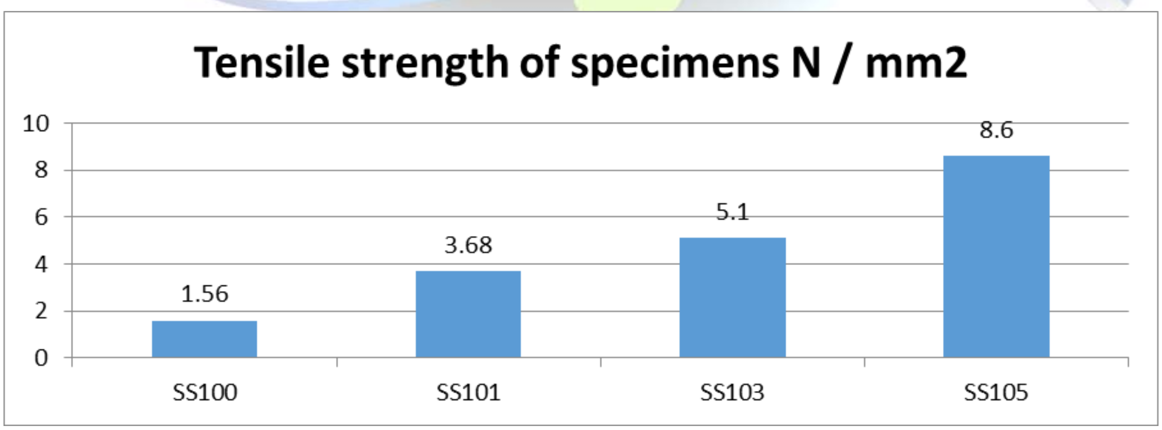

Fig: 6. Split Tensile strength for 14 days

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Table: VI Split Tensile strength for 28 days

Mix ID	Specimen ID	Load (KN)	Tensile strength (N/mm^2)	Average (N/mm^2)
SS_{100}	A31	110	1.58	1.98
	A32	150	2.12	
	A33	158	2.24	
SS_{101}	B31	432	6.12	6.24
	B32	454	6.40	
	B33	440	6.22	
SS_{103}	C31	572	8.08	8.16
	C32	578	8.16	
	C33	582	8.24	
SS_{105}	D31	830	11.72	11.82
	D32	834	11.80	
	D33	844	11.94	

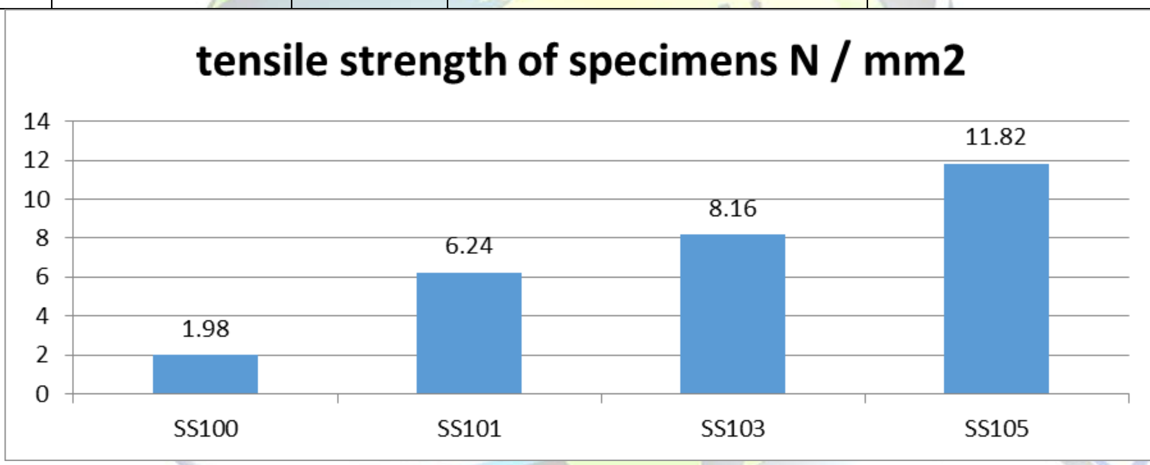

Fig: 7. split Tensile strength for 28 days

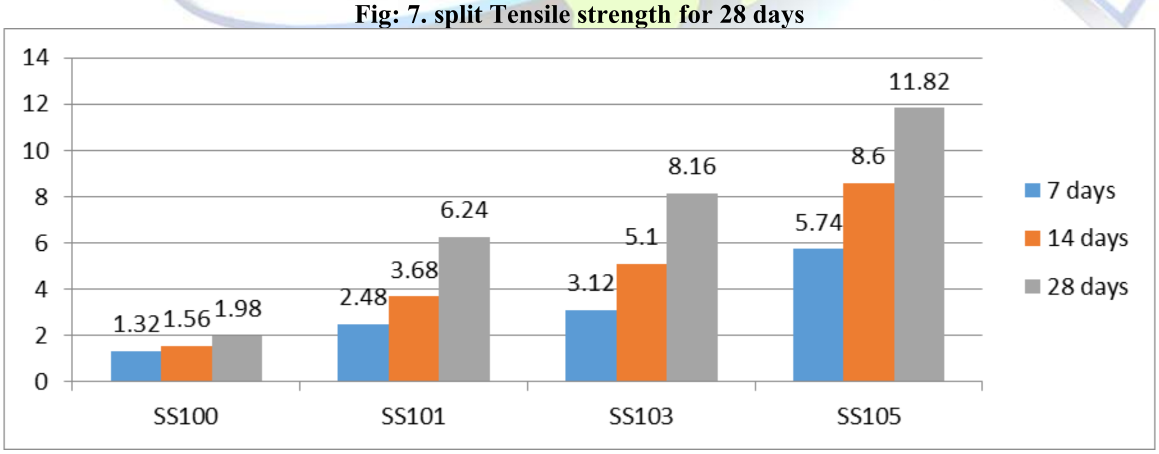

Fig 8. The split tensile test of specimensfor 7, 14 & 28 days

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The maximum percentage (5%) increase in strength is found to be 11.82 N/mm^2 at SS105. The important observation is that the addition of stainless steel is increased the split tensile strength of no-fine concrete.

FLEXURAL STRENGTH TEST

- The flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending. The results of the flexural test on concrete expressed as a modulus The loading rate as per ASTM standard can be computed based on the following equation:

$$r = Sbd^2 / L$$

- Finally, measure the cross-section of the tested specimen at each end and at the centre to calculate average depth and height.
- The following expression is used for estimation of modulus of rupture:

$$MR = 3PL / 2bd^2$$

Table VII Flexural strength for 7 days

MIX ID	Specimen ID	Load (KN)	Flexure strength (Mpa)	Average (Mpa)
SS_{100}	A11	0.042	1.56	1.22
	A12	0.036	1.14	
	A13	0.030	0.96	
SS_{101}	B11	0.053	2.46	2.32
	B12	0.046	2.24	
	B13	0.049	2.38	
SS_{103}	C11	0.098	3.66	3.14
	C12	0.093	2.92	
	C13	0.078	2.85	
SS_{105}	D11	0.141	6.59	6.37
	D12	0.130	6.43	
	D13	0.122	6.10	

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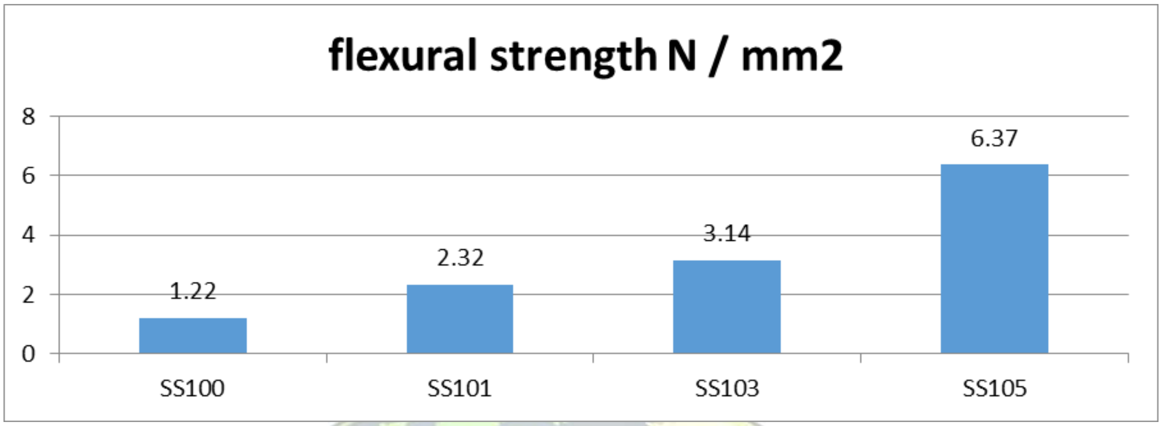

Fig: 9. Flexural strength for 7 days

Table VIII Flexural strength for 14 days

MIX ID	Specimen ID	Load (KN)	Flexure strength (Mpa)	Average (Mpa)
SS_{100}	A21	0.043	2.12	2.43
	A22	0.071	2.76	
	A23	0.051	2.40	
SS_{101}	B21	0.108	4.08	4.15
	B22	0.118	4.26	
	B23	0.112	4.11	
SS_{103}	C21	0.146	6.78	6.62
	C22	0.152	6.92	
	C23	0.126	6.17	
SS_{105}	D21	0.202	12.05	12.34
	D22	0.210	12.22	
	D23	0.212	12.76	

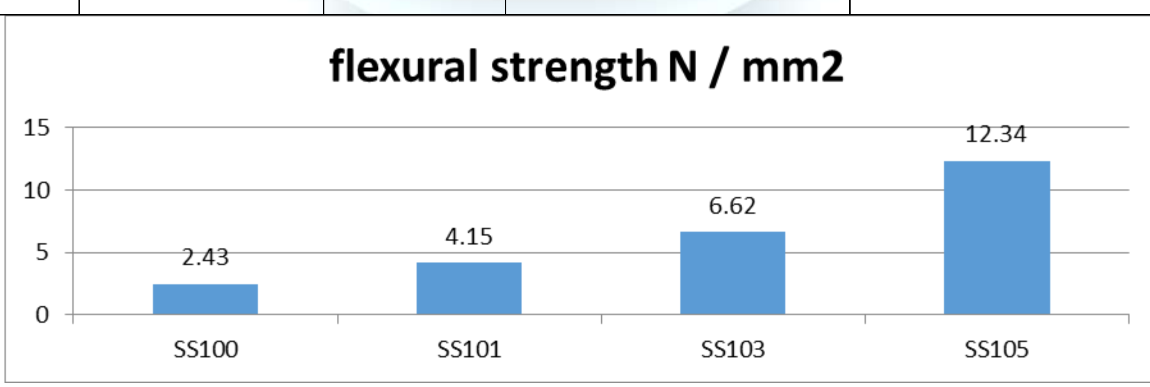

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Fig: 10 Flexural strength for 14 days

Table IX Flexural strength for 28 days

MIX ID	Specimen ID	Load (KN)	Flexure strength (Mpa)	Average (Mpa)
SS_{100}	A31	0.076	2.83	2.56
	A32	0.048	2.32	
	A33	0.062	2.53	
SS_{101}	B31	0.144	6.76	7.12
	B32	0.158	7.18	
	B33	0.160	7.42	
SS_{103}	C31	0.172	10.18	10.40
	C32	0.176	10.27	
	C33	0.182	10.75	
SS_{105}	D31	0.238	16.89	16.84
	D32	0.234	16.66	
	D33	0.240	16.97	

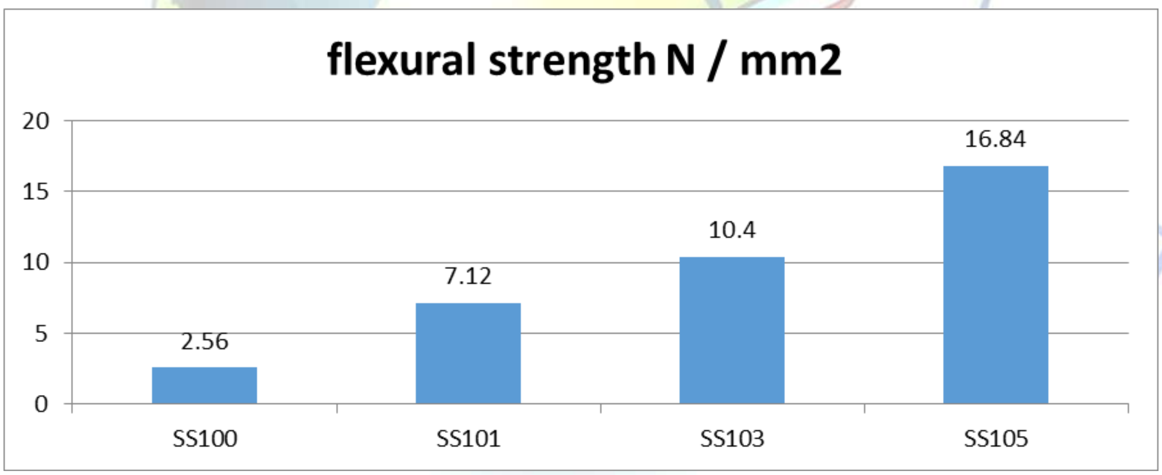

Fig: 11. Flexural strength for 28 days

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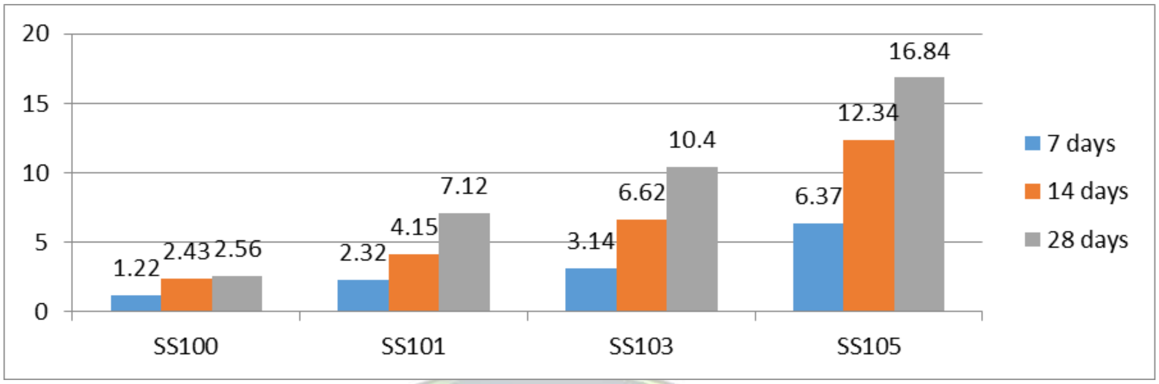

Fig: 12. The flexural strength test for 7,14 & 28 days

V. CONCLUSION

Strength properties of no-fine concrete can improve by using stainless steel fibers. The following items achieved in this research:

- The No-fine concrete with addition of stainless steel fibers, the compressive strength increased from 14.78 Mpa to 39.64Mpa. The increment of the compressive strength is 58.8 % for 1% of fiber adding. Then the increment is slightly increased in adding of high percentage of stainless steel fiber.
- The tensile strength of this concrete increased from 2.48 to 11.82Mpa. The increment of split tensile strength is 47.66 % for 1% of fiber adding. Then the increment is slightly increased in adding of high percentage (5%) of stainless steel fiber.
- The flexural strength of this concrete increased from 2.32 to 16.84Mpa. The increment of split tensile strength is 72.58 % for 1% of fiber adding. Then the increment is slightly increased in adding of high percentage (5%) of stainless steel fiber.
- Strength properties of investigated stainless steel fiber no-fine concrete are found to be higher than that of conventional (NFC) concrete.
- The void content is depended upon the aggregate cement ratio and thus varies grately.
- From the project it clarifies that stainless steel fiber used NFC can be easily use for the application of parking pavements, river draining works with medium volume traffic road as per IRC

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