Significance of Strength of Con cret With Waste Tyre And Steel Fibres

Er. Sweta Devi, Er. Vedpal Mehla, Er. Ravinder Kumar

***Abstract*— The present study aims to investigate the fresh, strength and durability of rubcrete and rubcrete with steel fibres. A superplasticizer of Fosrock chemicals CONPLAST SP430)(G8) (an aqueous solution of sulphonated naphthalene polymer) was used to increase the workability of concrete. carried out to compare the properties of control mix (replacement of coarse aggregate 0%) with other mixes (replacement of coarse aggregate 10%,20% and 30%). The work was further extended to fiber reinforced concrete i.e by incorporating steel fibres for the above stand replacement mixes. Various mechanical characterstics were investigated in terms of compressive strength, tensile strength and flexural strength. Test result shows that compressive strength, tensile strength and flextural strength decreases with increase in rubber content but increases with increases in fiber content. The durability properties which includes carbonation was also studied in which concrete indicater basicity in nature.The aim of the present work was to use waste tyres as to increase the strength of cement concrete. A series of tests were conducted to study the effect of 10% ,20% and 30% replacement of cement by solid waste.The compressive strength, split tensile strength and the flexural strength test were determined for the mixes at the curing age of 7 days and 28 days. The results obtained for the above mixes were compared to investigate the effects of partial compressive strength of steel fibres. Use of waste tyres in concrete can prove to be economical as it was non useful waste and free of cost.**

Key Words: 1.Solid waste 2.Aggregate 3.Fibres 4. Compressive Strength 5. Tensile Strength
Sub Area : Structural Engineering
Broad Area : Civil Engineering

INTRODUCTION

One of the most popular methods to dispose used tyres is landfills but due to low Emmy and poor degradation they cannot be buried in landfills. These tyres can 115- e be placed in stockpiles on the ground. However these stockpiles serve as a par breeding ground for mosquitoes and due to the fact that mosquitoes are responsible for the spread of many diseases, this becomes a dangerous health hazard. In order to prevent this problem, vehicle tyres should be reused in economy and valued in new usage areas as addition agents. In the last three years, more than 33 million vehicles have been added to the Indian roads. About 80 million tyres are the part of these 33 million vehicles which include two, three, four and six wheelers and pose a potential threat to the environment. In India, old tyres are used for burning in brick kilns and the bulk quantity is decomposed by land filling with certain problems. Whole tyres landfilling requires a large amount of space. Tyres tend to float or rise in a landfill and come to the surface.The void space provides potential sites for the harboring of rodents like snakcs,rats etc.

Fig: Stock piles of waste tyres

Waste tyres pose a health hazard since tyre piles are excellent breeding grounds for mosquitoes. Because of the shape and impermeability of tyres, they may hold water for long periods providing sites for mosquito larvae development. Waste tyres also pose a serious fire hazard since waste tyres and waste tyre stockpiles are difficult to ignite. Solid waste is one of the important issues in the world. Among these the waste fyie rubber is a severe issue which is creating big environmental problems. The &composition of the waste tyre is not so easy because it requires large space for landfill and incineration cause air pollution. Stock piles is the harbour of rodents like rats, snakes etc. So to overcome this problem, Various scientists and researchers had work done on the waste tyre rubber so that it can be used for human benefits.

EXPERIMENTAL PROGRAM

CONCRETE MIX DESIGN

The process of selecting suitable ingredients of concrete determining their relative amounts with the objective of producing a concrete

the required, strength, durability, and workability as economically as possible, a termed as the concrete mix design.ss The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, if cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

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The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g, quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing.

Requirements of concrete mix design

The requirements which form the basis of selection and proportioning of mix ingredients are:

a) The minimum compressive strength required from strength consideration

b) The adequate workability necessary for full compaction with the compacting equipment available.

c) Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions

d) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

In the present study, M30 grade of concrete has been used.

Design for M30 grade concrete

Specific gravity of cement = 3.10
Specific gravity of coarse aggregate =7,06
Specific gravity of coarse aggregate =6.07
Specific gravity of fine aggregate = 2.20
Target mean strength = fck + 1.65 S
=30 + 1.65 S
= 38.25 MPa

Assume W/C ratio = 0.45
Percentage of fine aggregate =29%
Water content =182.4 litres
Cement content =405.5 Kg/m3
Volume of aggregates s
1 - [0.02 + 405.5/3.15 x 1000 + 182.4/1000]
1- [0.02 + 0.129 + 0.183]
Total aggregates = 0.6689 m3
Fine aggregates = 0.1914 m3
Coarse aggregates = 0.4745 m3

TableA : Ratio for M30 grade mix

(Kg/m^3) (Kg/m3) (Kg/m3) (Kg/m3) (Kg/m3) 408.5 510.22 1250.3 184.4 2.357 1.05 1.15 3.22 0.43 0.0058

Cement (Kg/m^3)	Fine Aggregates (Kg/m^3)	Coarse Aggregates (Kg/m^3)	Water (Kg/m^3)	S.P. (Kg/m^3)
408.5	510.22	1250.3	184.4	2.357
1.05	1.15	3.22	0.43	0.0058

Compressive strength test

Compressive strength tests were carried out on 150 mm x 150 mm x 150 mm cubes with compression testing machine of 3000 KN capacity as shown in Fig.The specimens after removal from the curing tank were cleaned and properly dried. The surface of the testing machine was cleaned. The cube was then placed with the cast faces in contact with the plates of the testing machine. Cubes were tested at 7, 28, 56 and 90 days of casting.

Mix	Cement (Kg/m^3)	Water (L/m^3)	Sand(Kg /m^3)	Coarse Aggregates (Kg/m^3)	Fiber(Kg/m^3)	Rubber(K g/m^3)	w/c	S.P. %	Slump Value (mm)	Comp. Facotor Value
M1	408.5	510.22	503.40	754.78	-	-	0.43	0.57	50	0.83
M2	408.5	510.22	503.40	679.40	-	75.79	0.43	0.57	60	0.85
M3	408.5	510.22	503.40	604.02	-	151.58	0.43	0.57	70	0.87
M4	408.5	510.22	503.40	528.64	-	227.37	0.43	0.57	85	0.89
M5	408.5	510.22	503.40	752.78	1%	-	0.43	0.57	50	0.80
M6	408.5	510.22	503.40	68.840	1%	75.79	0.43	0.57	60	0.82
M7	408.5	510.22	503.40	604.02	1%	151.58	0.43	0.57	65	0.85

Split tensile strength test

Split-tensile strength test is an indirect method to determine tensile strength of concrete. The test consists of applying compressive line loads along the opposite generators of concrete cylinder placed with its axis horizontal between the platens as shown in Fig.. Cylinders of size 150mm diameter and 300mm height were cast to check the splitting tensile strength of the concrete. Specimens were tested at 7, 28, 56 and 90 days of casting.

Flexural strength test

Flexural tensile strength test is essential to estimate the load at which the concrete members may crack. The specimens cast for this test were of shape of a square prism of side 100 mm and axis length of 500 mm as shown in Fig. Specimens were tested at 7 and 28 days of casting.

Durability studies (Carbonation)

A durable concrete is one which can withstand the conditions for which it has been designed, without deterioration over a period of years. There are various conditions that affect durability of concrete. These conditions may be physical, chemical like leaching out of cement, actions of sulphates, sea water or slightly acidic water; environmental such as extreme temperatures, abrasion; attack by natural or industrial liquids and gases, alkali-aggregate reaction etc. Cylinders of 150 mm diameter and 300mm height were cast to check the durability of rubcrete as shown in Fig. Testing was done at 28, 56 and 90 days and carbonation with pH value was calculated.

The affected depth from the concrete surface can be readily shown by the use of phenolphthalein indicator solution. This is available from chemical suppliers.. Phenolphthalein is a white or pale yellow crystalline material. For use as an indicator it is dissolved in a suitable solvent such as isopropyl alcohol (isopropanol) in a I% solution.

The phenolphthalein indicator solution is applied to a fresh fracture surface of concrete. If the indicator turns purple, the pH is above 8.6. When the solution remains colourless, the pH of the concrete is below 8.6, suggesting carbonation. A fully-carbonated paste has a pH of about 8.4.

In practice, a pH of 8.6 may only give a faintly discernible slightly pink colour. A strong, immediate, colour change to purple suggests a pH that is rather higher, perhaps as Ph as 9 or 10.

Design for M30 grade concrete

Specific gravity of cement = 3.15
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Specific gravity of coarse aggregate =6.07
Specific gravity of fine aggregate = 2.20
Target mean strength = fck + 1.65 S
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Assume W/C ratio = 0.45
Percentage of fine aggregate =29%
Water content =182.4 litres
Cement content =405.5 Kg/m3
Volume of aggregates
1 - [0.02 + 405.5/3.15 x 1000 + 182.4/1000]
1- [0.02 + 0.129 + 0.183]
Total aggregates = 0.6689 m3
Fine aggregates = 0.1914 m3
Coarse aggregates = 0.4745 m3

Table :Ratio for M30 grade mix

(Kg/m^3) (Kg/m3) (Kg/m3) (Kg/m3) (Kg/m3) 405.5 513.22 1256.3 182.4 2.357 1 1.25 3.12 0.45 0.0058

Cement (Kg/m^3)	Fine Aggregates (Kg/m^3)	Coarse Aggregates (Kg/m^3)	Water (Kg/m^3)	S.P. (Kg/m^3)
405.5	513.22	1256.3	182.4	2.357
1	1.25	3.12	0.45	0.0058

Strength Properties

Compressive strength test

Compressive strength tests were carried out on 150 mm x 150 mm x 150 mm cubes with compression testing machine of 3000 KN capacity as shown in Fig 3.3. The specimens after removal from the curing tank were cleaned and properly dried. The surface of the testing machine was cleaned. The cube was then placed with the cast faces in contact with the plates of the testing machine. Cubes were tested at 7, 28, 56 and 90 days of casting.

RESULTS

The mechanical properties (Compressive strength, split tensile strength, and flexure strength), along with carbonation of various mixes containing different percentages of rubber and rubber with steel fibers are discussed below.

Compressive Strength Results (Rubberized Concrete)

M1 is the control mix of grade M30. The M2, M3, M4 arc the mix in which coarse aggregate are replaced by rubber aggregate with 10%, 20% and 30%. From Fig F1. it was observed that at 7 days, the compressive strength of M2, M3, M4 decreases when compared with M1 by 12%, 21% and 25%. At 28 days, the compressive strength of M2, M3, M4 decreases when compared with MI by 13%, 20% and 22%. At 56 days, the compressive strength of M2, M3, M4 decreases when compared with MI by 16%, 22% and 25%. At 90 days, the compressive strength of M2, M3, M4 decreases when compared with MI by 17%, 25% and 28%.The rubberized concrete values are given in Table B.

Table B : Compressiwe Strength Results (Rubberized Concrete)

Mix	7Days	28Days	56Days	90Days

M1 (MPa)	31.49	44.8	52.23	55.74
M2 (MPa)	27.55	38.67	43.5	46.24
M3 (MPa)	24.6	35.53	40.2	41.27
M4 (MPa)	23.18	34.7	38.8	39.54

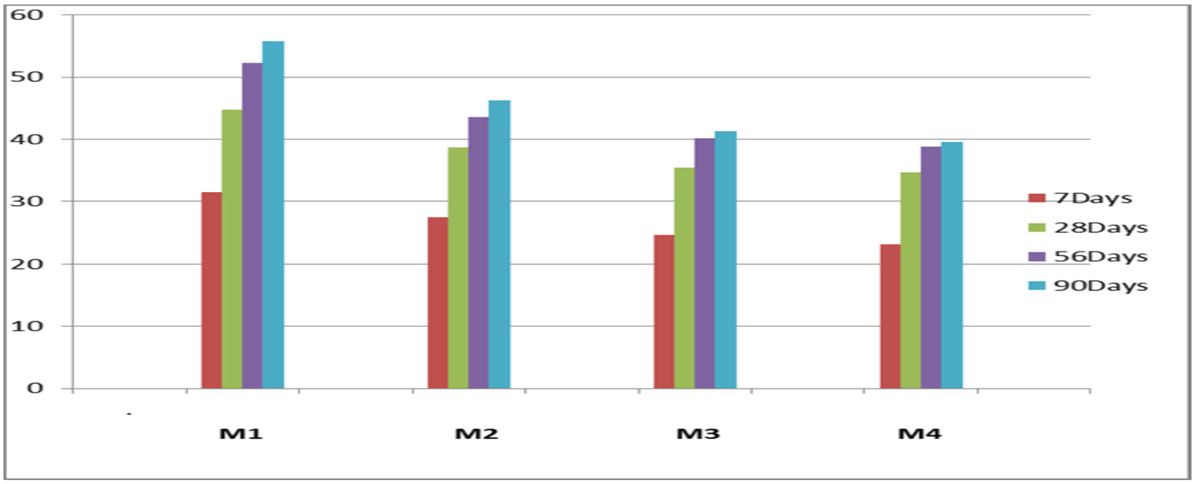

Fig.F1: Compressiwe Strength Results (Rubberized Concrete)

Compressive Strength Results (Fiberous Rubberized Concrete)
M5 is the fiberous control mix with inclusion of 1% steel fiber. The M6, M7, M8 are the mix in which coarse aggregates are replaced by rubber aggregate with 10%, 20% and 30% with inclusion of 1% steel fiber. From Fig B, it was observed that at 7 days, the compressive strength of M6, M7, M8 decreases when compared with M5 by 10%, 18% and 25%. At 28 days, the compressive strength of M6, M7, M8decreases when compared with M5 by12%. 19% and 22%. At 56 days, the compressive strength M6, M7,M8 decreases when compared with M5 by 15%, 20% and 24%. At 90 days, the compressive strength of M6, M7, M8 decreases when compared with M5 by 3%. and 27%. The fiberous rubberized concrete values are given in Table 4.2.

Table 4.2 Compressive Strength Results (Fiberous Rubberized Concrete)

Mix	7Days	28Days	56Days	90Days
M5 (MPa)	33.8	46.99	54.4	57.56
M6 (MPa)	30.31	41.34	46.34	50.3
M7 (MPa)	27.7	38.35	43.69	44.7
M8 (MPa)	25.6	37.28	41.73	42.43

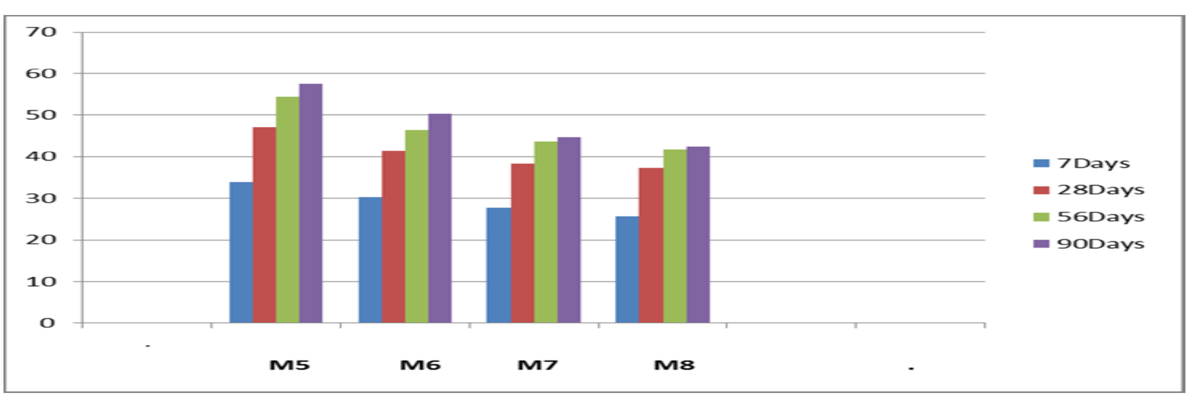

Fig. B: Compressive Strength Results (Fiberous Rubberized Concrete)

Compressive Strength (Rubberized Concrete VS Fiberous Rubberized Concrete)

Further for 7 days when M2, M3, M4 are compared with M6, M7, M8 there is an increase of compressive strength of M6, M7, M8 by 2%, 4% and 1 %. At 28 days the compressive strength of M6, M7, and M8 increases by 1 %, 2% and 1% when compared with M2, M3, M4. At 56 days the compressive strength of M6, M7, M8 increases by 1 %, 3% and 2% when compared with M2, M3, M4. At 90 days the compressive strength of M6, M7, M8 increases by 4%, 3% and 2% when compared with M2, M3, M4.The values for decrease in compressive strength were found to be lower than those observed for mixes without steel fibres

Split Tensile Strength Results (Rubberised Concrete)

The M2, M3, M4 are the mix in which coarse aggregate are replaced by aggregate with 10%, 20% and 30%. From Fig C, it was observed that at '7 days the split tensile strength of M2, M3, M4 decreases when compared with M I by 24%, 28% and 38%. At 28 days, the split tensile strength of M2, M3, M4 decreases when compared with M1 by 14%, 18% and 22%.Similarly at 56 days, the split tensile strength of M2, M3, M4 decreases when compared with MI by 14%, 17% and 20%. At 90 days, the split tensile strength of M2, M3, M4 decreases when compared with MI. by 13%, 15% and 19%.

Table 4.3 Split Tensile Strength Results (Rubberized Concrete)

Mix	7Days	28Days	56Days	90Days
M1 (MPa)	2.81	3.37	3.51	3.49
M2 (MPa)	2.14	2.92	3.06	3.05
M3 (MPa)	2.05	2.77	2.92	2.95
M4 (MPa)	1.78	2.65	2.83	2.88

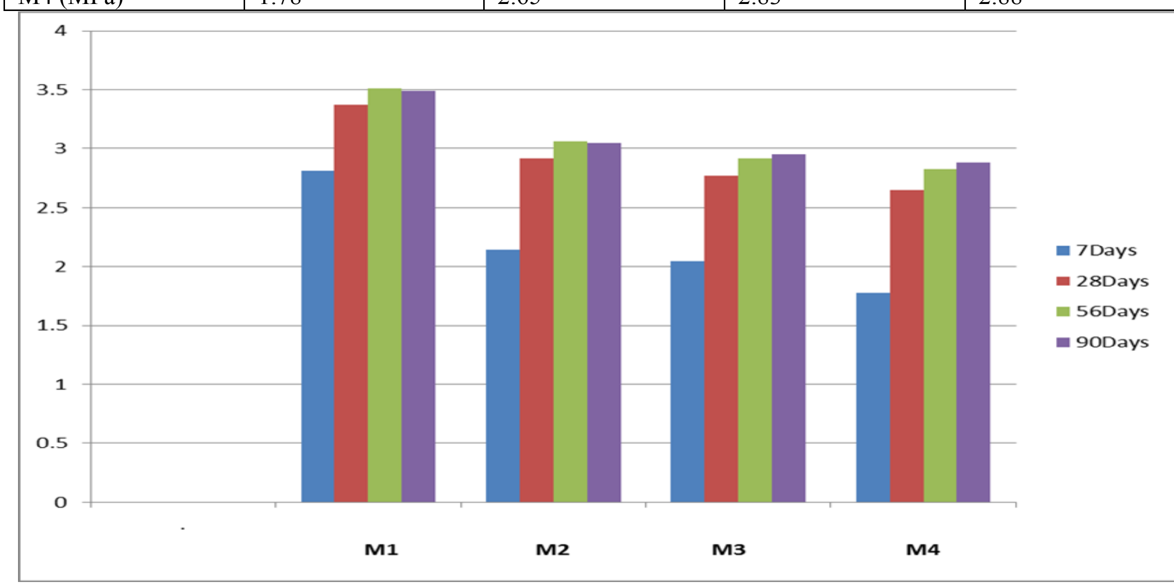

Fig.C: Split Tensile Strength Results (Rubberized Concrete)

Split Tensile Strength Results (Fiberous Rubberized Concrete)

It was observed from Fig D, that at 7 days, split tensile strength of M6, MI, M8 decreases when compared with M5 by 24%, 28% and 43%. At 28 days, the split tensile strength of M6, MI, M8 decreases when compared with M5 by 12%, 17% and 23%. At 56 days, the split tensile strength of M6, M7, M8 decreases when compared with M5 by 8%, 14% and 19%. At 90 days, the split tensile strength of M6, M7, M8 decreases when compared with Ml by 9%, 15% and 20%. The fiberous rubberized concrete values are given in Table 4.4.

Table 4.4 Split Tensile Strength Results (Fiberous Rubberized Concrete)

Mix	**7Days**	**28Days**	**56Days**	**90Days**
M5 (MPa)	2.87	3.42	3.53	3.63

M6 (MPa)	2.21	3.02	3.26	3.29
M7 (MPa)	2.08	2.84	3.04	3.11
M8 (MPa)	1.67	2.64	2.87	2.95

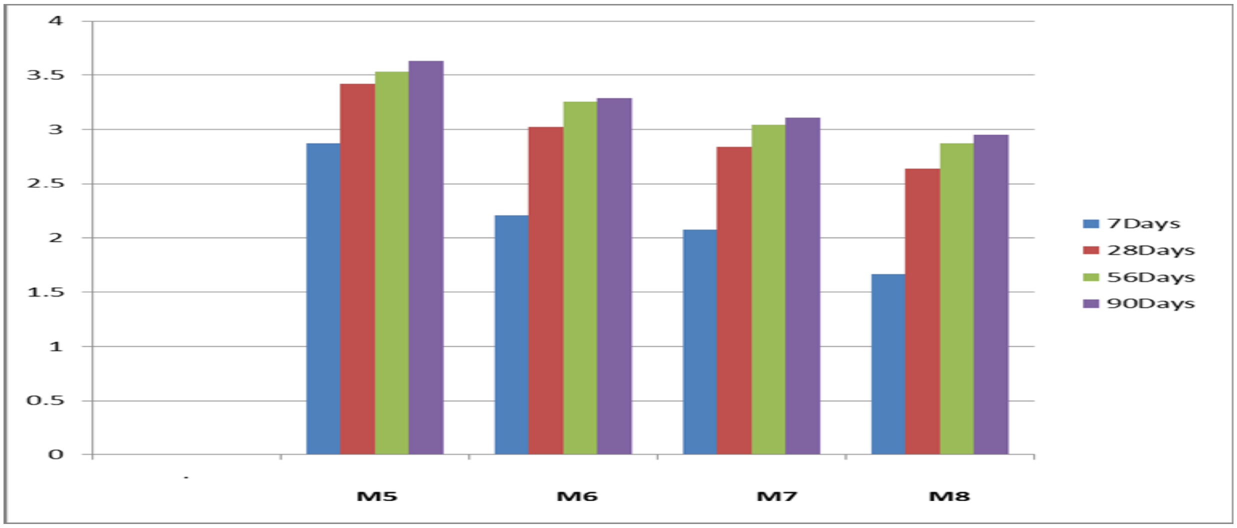

Fig. D: Split Tensile Strength Results (Fiberous Rubberized Concrete)

Spit Tonic Strength (Rubberized Concrete VS Fiberous Rubberized Cloacae)

Further for 7 days when M2, M3 are compared with M6, M7 there is an increase spilt tensile strength of M6, M7 by 3%, 1% while M8 is decreased by 6% when compared with Mat. At 28 days the split tensile strength of M6, M7 increases by 3%, when compared with M2, M3 while M8 remain same as of M4. At 56 days the split tensile strength of M6, M7, M8 increases by 6%, 4% and 1% when compared with M2, M3, M4. At 90 days the split tensile strength of M6, M7, increases by 6%, 3% when compared with M2, M3 while M8 remain same as of M4. The values for decrease in split tensile strength were found to be lower than those observed for mixes without steel fibres.

Flexure Strength 'Results (Rutiberized Concrete)

It was observed from Fig E, that at 7 days,, flexure strength of M2, M3, M4 decreases when compared with M1 by 12%, 19% and 25%. At 28 days, the flexure strength of M2, M3, M4 decreases when compared with MI by 12%, 17% and23%. At 56 days, the flexure strength of M2, M3, M4 decreases when compared with M1 by 12%, 16% and 22%. At 90 days, the flexure strength of M2, M3, M4 decreases when compared with M1 by 11%, 18% and 24%. The rubberized concrete values are given in Table 4.5.

Table 4.5 Flexure Strength Results (Rubberized Concrete)

Mix	7Days	28Days	56Days	90Days
M1 (MPa)	3.67	4.55	4.69	4.83
M2 (MPa)	3.24	3.98	4.12	4.28
M3 (MPa)	2.97	3.76	3.92	3.96
M4 (MPa)	2.77	3.51	3.65	3.70

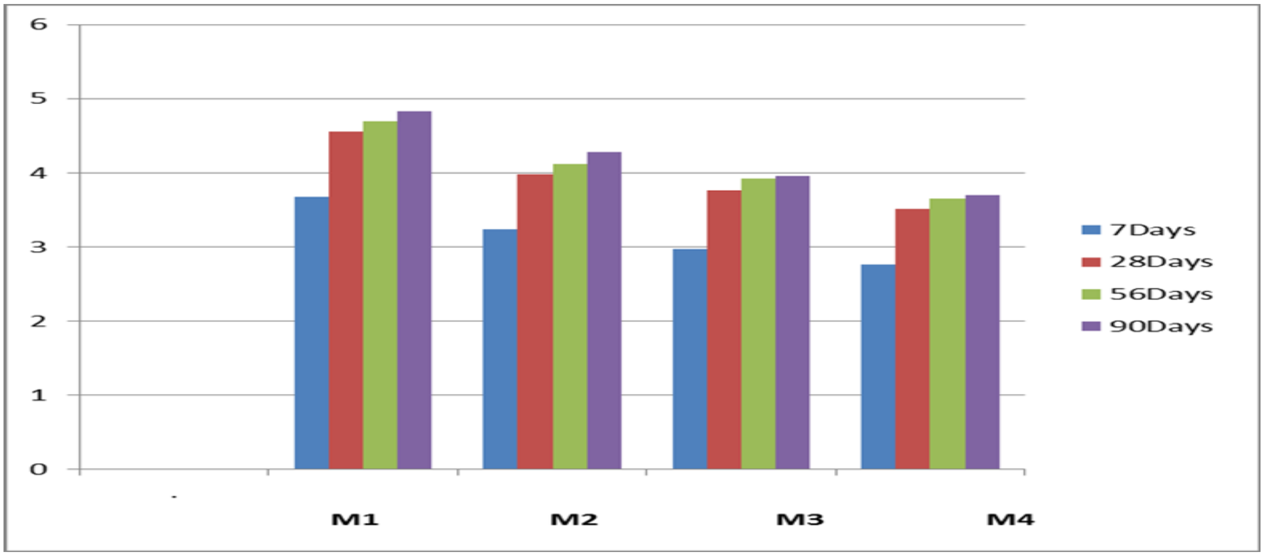

Fig. :E

Flexure Strength (Rubberized Concrete VS Fibrous Rubberized CONCRETE)

Further for 7 days when M2, M3, M4 are compared with M6, M7, M8 there is an increase of flexure strength of M6, M7, M8 by 6%, 6% and 3%.. At 28 days, the 'flexure strength of M6, M7, M8 increases by 3%,1% and 6% when compared with. M2, M3, M4, At 56 days, the flexure strength of M6, M7, M8 increases by 4%, 2% and 6% when compared with M2, M3, M4, At 90 days, the flexure strength of M6, M7, M8 increases by 1 %, 3% and 7% when compared with M2, M3, M4. The values for decrease in flexure strength were found to be lower than those observed for mixes without steel fibres. Due to inclusion of small proportion i.e. 10% of crumb rubber in the concrete, may be rubber particles were easily distorted and filled the voids between the solid particles (natural aggregates). Bul on increasing the rubber ratio, the deformity of rubber particles became more predominant than filling mechanism. Also, rebound stress of rubber particles may have occurred, resulting in micro cracks between interfaces in concrete matrix, causing loss of strength significantly.

CONCLUSIONS

1. For all ages, an increase of compressive strength was observed for the mixes with I% steel fibers when compared to corresponding mixes which were without steel fibers.
2: For all ages, an increase of split tensile strength was observed for the mixes with 1% steel fibers when compared to corresponding mixes which were without steel fibers.
3. For all ages, an increase of flexure strength was observed for the mixes with 1% steel fibers when compared to corresponding mixes which were without steel fibers.
4.. For all the mixes, the strengths were found to increase with age (7 days, 28 days, 56 days and 90 days).
5. All concrete mixes had shown zero carbonation depth at 28 days, 56 days and 90 days.
6. All the concrete mixes possessed basic nature when observed at 28 days, 56 days and 90 days.
7. The study helps in resolving the problem of disposing waste vehicle tyres.
8. Presence of rubber in concrete demonstrated ductility as was evident from the specimens after flexural test.
9. Using waste tyres in concrete instead of coarse aggregates decreases. the mechanical strength of concrete. This problem may be overcome by increasing the adhesion of the tyre particles with the concrete