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EFFECT ON STRENGTH OF M-40 BY PARTIAL REPLACEMENT OF FA WITH STEEL WASTE & CEMENT WITH FLYASH

1GONAPA AKHIL, 2VELAMALA DIVYASRI
1PG STUDENT, 2ASSITANT PROFESSOR
1ADITYA INSTITUTE OF TECHNOLOGY,TEKKALI.,
2ADITYA INSTITUTE OF TECHNOLOGY,TEKKALI.

Abstract :

The waste generated from industries causes severe environmental problems. Hence the reuse of this waste material can be emphasized. Fly ash and steel waste is a developing composite material that will allow the concrete industry to optimize material use, generate economic benefits and built structures that will be strong, durable, and sensitive to environment. Fly ash is major by-product of thermal power plants after combustion of coal at high temperature. Steel scrap is another by-product from construction sites, mechanical workshops . In this project, tests were conducted in observation for different combinations , first combination for compressive strength, split tensile strength test for M40 mix by replacing cement with fly ash by keeping constant at 10% and fine aggregate replaced by steel scrap ,other to evaluate results on compressive strength, split tensile strength test by replacing only fine aggregate with steel scrap, third being evaluation of test results on compressive strength , split tensile strength by adding steel scrap as fibre. All these 3 different specimens were cured thereby to evaluate test observations for compressive strength &split tensile strength which are done for 7days,14days, 28days, 60days and 90 days for optimistic percentage of replacement was determined. This study results reviewed that highest compressive strength occurs at the 2% replacement of steel scrap as fibre type added.

Key words : Fly ash, Steel waste, Fine aggregate, Compressive strength , Tensile strength

Introduction:

Due to the ever increasing demand of cement in infrastructure projects, it is essential to find a material to replace cement in concrete mix up to a acceptable percentage. Cement contributes almost 70% of the total embodied energy in the constituents used for production of concrete and it accounts for 5% of the manmade production of carbon dioxide. If an alternative material for cement which is eco-friendly is used, it would aid in mitigating the indiscriminate dumping of wastes and also simultaneously helps in reducing the amount of carbon dioxide produced up to a certain extent and contribute for better environment. The production of concrete generates huge pollutions and makes an intensive amount of CO2, which is the decline in natural resources and the most evident impacts on greenhouse emissions. Therefore, it is rational to use industrial waste materials to produce sustainable concrete.

1.2 Steel Waste :

As the steel processing industry continues to expand, large amounts of bi-product in the form of steel scrap is generated and released into the environment. A significant growth in steel scrap has been seen, but the increase in extent has not been documented. It is estimated that almost two to three million tons of steel scrap is generated per annum. This waste is dumped on baren lands , road sides and near dumping yards thus causing environmental degradation and escalating soil problems in the surrounding areas. The very fine particulate matter present in the waste causes ground water pollution. Also, the clogs in steel scrap lead to long-term damage to the soil and crops of agriculture land. Hence, there is a direct need to utilize this waste material in one or the other way to minimize its harmful impact on the environment. Additionally, with advancement in technology the reprocessing of this material is very expensive.

1.3 Fly Ash

Fly ash is a residual material of energy production using coal. Several types of fly ash are produced depending on the coal and its combustion process. It is a pozzolanic material and has been classified into two classes. Fly ash is one of the residues generated in combustion, and comprises of the fine particles that rise with the flue gases and about 150 million tons of fly ash generated every year during burning of coal. Hence, this secondary material which is of no use must be emphasized from environmental point of view

Objective

The main objective of this project is to make economical and cost effective

Particulars	Test Method	Results
Specific Gravity	Density bottle (IS:4031 part-2)	3.12
Initial Setting Time	VICAT APPARATUS(IS:4031PART-5)	30 Minutes
Final Setting Time	VICAT APPARATUS(IS:4031PART-5)	500 Minutes
Normal consistency	VICAT APPARATUS(IS:4031PART-4)	32%
Fineness	Sieve test on no:9 (IS:4031 part-6)	96%

➢ MATERIAL AND PROPERTIES:

a) Cement :

Literally cement means a binding material. It has the property of setting and hardening when mixed with water to attain strength. The cement may be natural or artificial. Natural cement is manufactured by burning and then crushing natural cement stones, which contain argillaceous and calcareous matter. Artificial cement is manufactured by burning appropriately proper proportioned mixture of argillaceous and calcareous materials at a very high temperature and then grinding the resulting burnt mixture to a fine powder. Ordinary Portland cement of good consistency and grade 53 is used in this project .

Table 1. Cement test results

b) Fine Aggregate :

The material which is passed through 4.75mm IS sieve is termed as Fine Aggregate. Usually natural river sand conforming zone II was used as fine aggregate. The specific gravity of fine aggregate is 2.621.

Table 2. Fine Aggregate results

Particulars	Result
Sieve analysis	2.48
Specific Gravity	2.61
Fineness Modulus	2.73
Zone	3

c) Coarse Aggregate :

The material which is retained on 4.75mm size IS sieve is termed as a coarse aggregate. Broken stone is generally used as an aggregate. Natural crushed aggregate with maximum size of20mm is used. The specific gravity of coarse aggregate is 2.

Table 3. Fine Aggregate results

Particulars	Test results
Specific Gravity	2.83
Crushing test	26.10%
Impact test	26.25%
Zone	3
Particles size	10 mm and 20mm

Steel waste :

Steel waste is generated from steel industries, construction sites and mechanical workshops during their operations.

1. Drilling
2. Cutting
3. Knurling
4. Threading
5. Chamfering
6. Facing
7. Form turning
8. Cut off
9. Boring

Which is mainly done by using different type of machine such as lathe machine, drilling machine, milling, drill process etc. Machine operations conducted at machine shops , metal stamping facilities and other metalworking operations typically generate various types of waste. Waste material generated from machining process is a prime candidate for recycling if the waste is not co-mingled with metals or otherwise contaminated. The waste should be free from corrosion, if it is corrosive waste it should be treated with corrosive agent while mixing concrete.

Fig 1: Steel waste

Table 4: Test results of the Steel waste

Particulars	Test results
Specific gravity	2.93
Bulk density	1191.11 kg/m^3
Surface texture	Rough
Shape	Angular

Fly Ash:

Fly ash is formed during combustion of coal. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filter sand then it is generally stored at coal power plants or placed in landfills.

Fig 2 : Fly Ash

Table 5: Test results of the Fly ash

Particulars	Test results
Specific gravity	2.2
Type of fly ash	F
Surface texture	Sandy silt
Fineness	290m^2/kg
Colour	Light grey

Mix Proportions : The concrete used for the study is of M40 grade. The mix design is carried out as per the guidelines of IS 10262 (2009) and IS 456- 2000. The mix proportions of the concrete were 1:1.131 :3.526 (Cement: Fine Aggregate: Coarse Aggregate :Water-Cement ratio).

- First mix proportion as Cement replaced by Fly ash at 10% constant for all mix proportions and Steel waste in the order of 0%,2%, 4%, 6% ,8% and 10% is used in concrete as a replacement of fine aggregate. The mixing can be done manually.

- Second mix proportion as Steel waste in the order of 0%,2%, 4%, 6% ,8% and 10% is used in concrete as a replacement of fine aggregate.

- Similarly Third mix proportion as Steel waste is added as fibre in the order of 0%,2%, 4%, 6% ,8% and 10% is used in concrete.

Results and Discussion

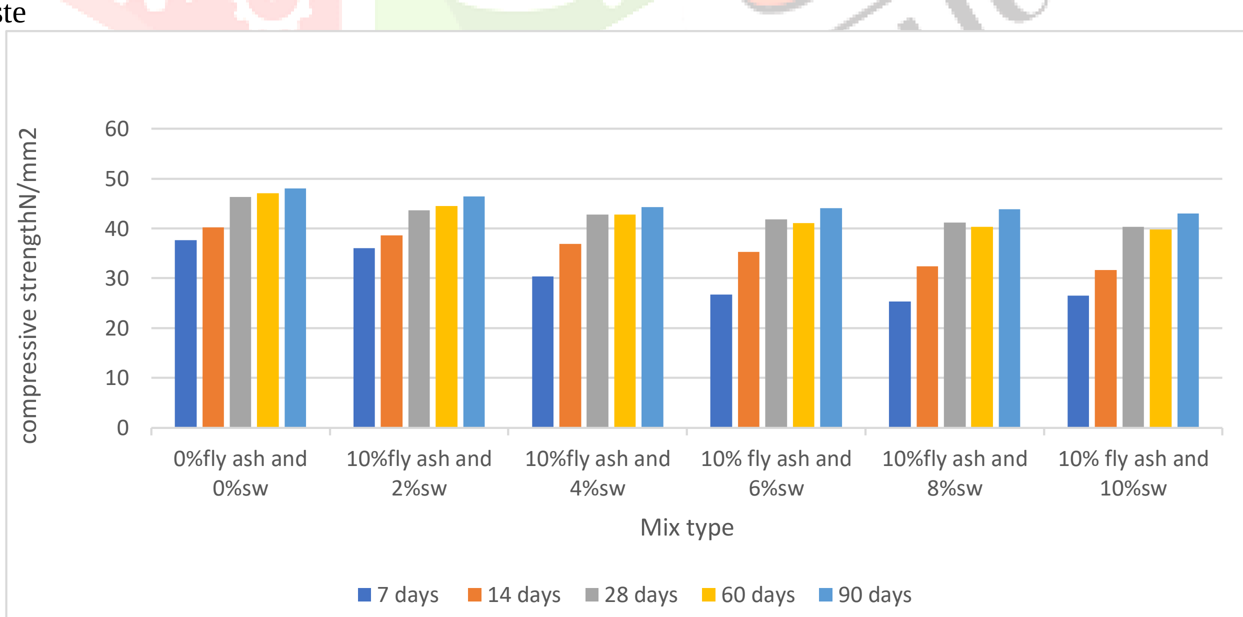
The compressive strength tests and split-tensile strength tests were conducted on prepared concrete specimens. The specimens were cured for 7 days and 28 days before testing. The results have been tabulated in the tables below :

- Compressive Strength Test:

The compressive strength test has been conducted for conventional concrete (i.e., 0% replacement) &Cement replaced by Fly ash keeping 10% constant and fine aggregate replaced by Steel waste. The fine aggregate is replaced by 2%, 4%, 6% 8% and 10% . The test results of 7 days ,14 days,28 days,60 days and 90 days are shown in table and figure

sl.no	Mix type	7 days	14days	28days	60days	90days
1	0%fly ash and 0%sw	37.6N/mm^2	40.25N/mm^2	46.27N/mm^2	47.12N/mm^2	48.01N/mm^2
2	10%fly ash and 2%sw	36.02N/mm^2	38.65N/mm^2	43.68N/mm^2	44.53N/mm^2	46.42N/mm^2
3	10%fly ash and 4%sw	30.33N/mm^2	36.92N/mm^2	42.74N/mm^2	42.82N/mm^2	44.27N/mm^2
4	10% fly ash and 6%sw	26.69N/mm^2	35.32N/mm^2	41.86N/mm^2	41.08N/mm^2	44.08N/mm^2
5	10%fly ash and 8%sw	25.37N/mm^2	32.45N/mm^2	41.21N/mm^2	40.28N/mm^2	43.85N/mm^2
6	10% fly ash and 10%sw	26.47N/mm^2	31.65N/mm^2	40.29N/mm^2	39.75N/mm^2	43.00N/mm^2

Fig 3:Compressive strength versus % replacement of Cement with Fly ash and Fine aggregate with Steel waste



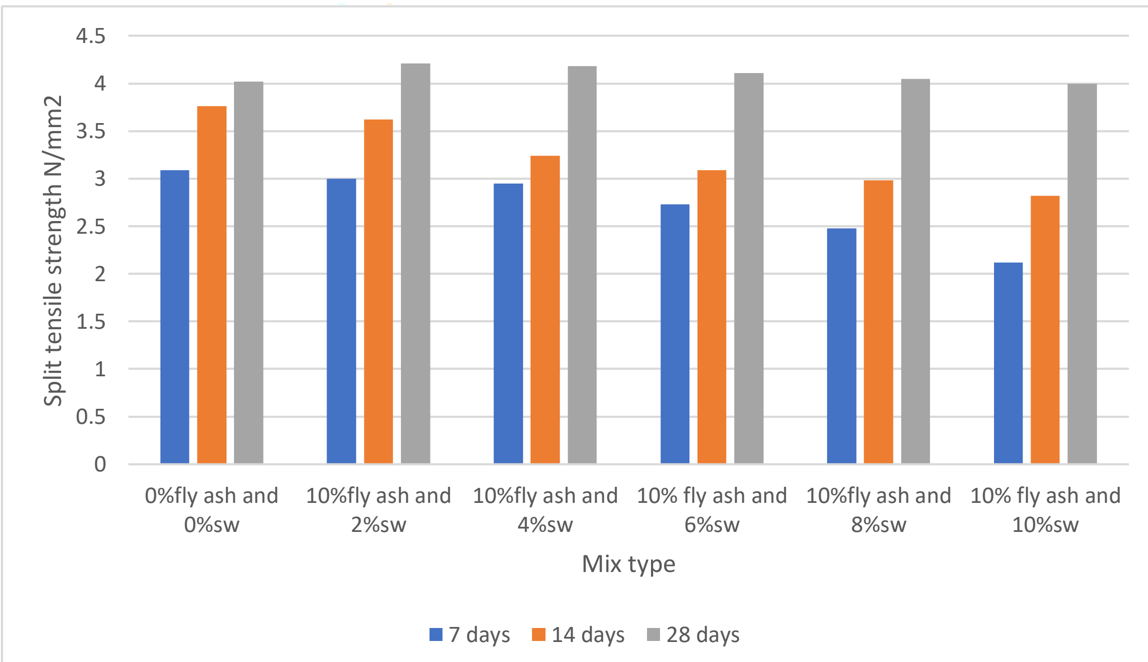
It shows that optimum Compressive strength observed at 10% Fly ash and 2% Steel waste but reduction in Compressive strength was further observed at 10% Fly ash and 4% Steel waste due to the chemical reaction between the Fly ash and Steel waste.

❖ Split Tensile Strength Test :

The Split Tensile strength test has been conducted for conventional concrete (i.e., 0% replacement) &cement replaced by Fly ash keeping 10% constant and fine aggregate replaced by Steel waste. The fine aggregate is replaced by 2%, 4%, 6% 8% and 10% . The test results of 7 days ,14 days,28 days,60 days and 90 days are shown in table and figure

sl.no	Mix type	7days	14days	28days
1	0%fly ash and 0%sw	3.09N/mm^2	3.76N/mm^2	4.02N/mm^2
2	10%fly ash and 2%sw	3.00N/mm^2	3.62N/mm^2	4.21N/mm^2
3	10%fly ash and 4%sw	2.95N/mm^2	3.24N/mm^2	4.18N/mm^2
4	10% fly ash and 6%sw	2.73N/mm^2	3.09N/mm^2	4.11N/mm^2
5	10%fly ash and 8%sw	2.48N/mm^2	2.98N/mm^2	4.05N/mm^2
6	10% fly ash and 10%sw	2.12N/mm^2	2.82N/mm^2	4.00N/mm^2

Fig 4 :Split tensile strength versus % replacement of Cement with Fly ash and Fine aggregate with Steel waste



It shows that optimum Split tensile strength observed at 10% Fly ash and 2% Steel waste but reduction in Split tensile strength was further observed at 10% Fly ash and 4% Steel waste due to the chemical reaction between the Fly ash and Steel waste

❖ Compressive Strength Test :

The compressive strength test has been conducted for conventional concrete (i.e., 0% replacement) & fine aggregate replaced by Steel waste. The fine aggregate is replaced by 2%, 4%, 6% 8% and 10% . The test results of 7 days ,14 days,28 days,60 days and 90 days are shown in table and figure

sl.no	Mix type	7days	14days	28days	60days	90days
1	0%sw	37.6N/mm^2	40.25N/mm^2	46.27N/mm^2	47.12N/mm^2	48.01N/mm^2
2	2%sw	34.97N/mm^2	38.48N/mm^2	43.78N/mm^2	44.82N/mm^2	46.91N/mm^2
3	4%sw	34.12N/mm^2	36.21N/mm^2	43.15N/mm^2	42.98N/mm^2	46.02N/mm^2
4	6%sw	33.84N/mm^2	35.18N/mm^2	42.08N/mm^2	42.76N/mm^2	45.81N/mm^2
5	8%sw	32.33N/mm^2	34.89N/mm^2	41.86N/mm^2	42.12N/mm^2	45.03N/mm^2
6	10%sw	31.92N/mm^2	34.08N/mm^2	40.29N/mm^2	41.28N/mm^2	43.12N/mm^2

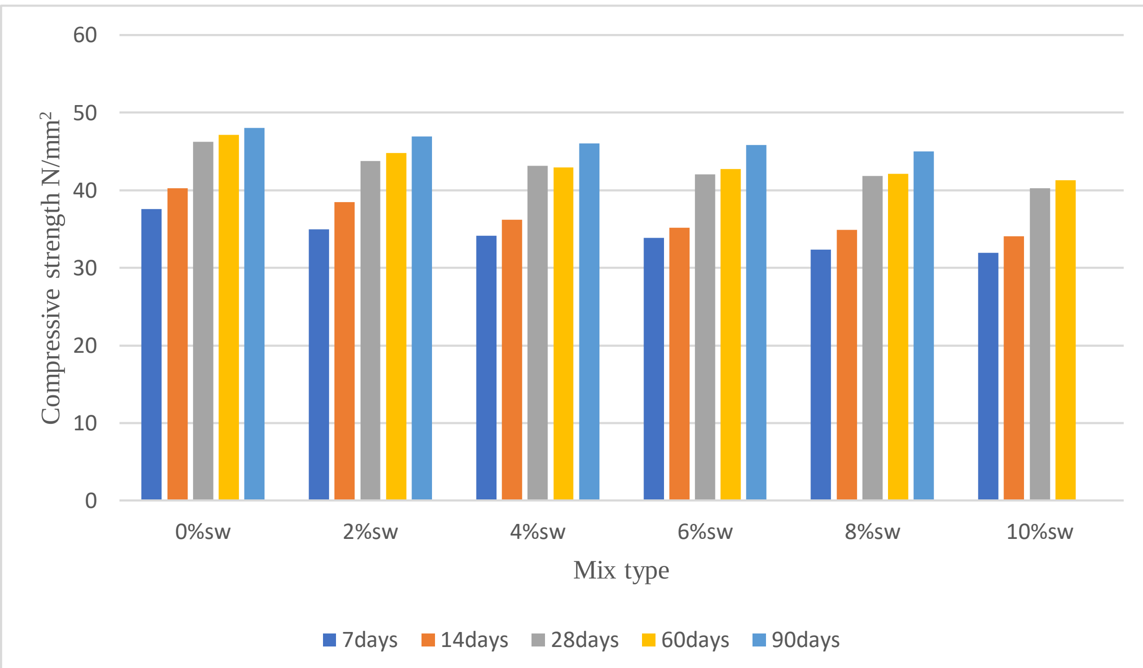


Fig 5 :Compressive strength versus % replacement of Fine aggregate with Steel waste

It shows that optimum Compressive strength and Split tensile strength observed at 2% Steel waste but reduction in strength was further observed at 4% Steel waste due to the chemical reaction between Steel waste and cement , no corrosive agent is added.

❖ Split Tensile Strength Test :

The Split Tensile strength test has been conducted for conventional concrete (i.e., 0% replacement) & fine aggregate replaced by Steel waste. The fine aggregate is replaced by 2%, 4%, 6% 8% and 10% . The test results of 7 days ,14 days,28 days,60 days and 90 days are shown in table and figure

sl.no	Mix type	7days	14days	28days
1	0%sw	3.09N/mm^2	3.76N/mm^2	4.02N/mm^2
2	2%sw	3.40N/mm^2	3.80N/mm^2	4.40N/mm^2

3	4%sw	3.18N/mm^2	3.58N/mm^2	4.34N/mm^2
4	6%sw	2.95N/mm^2	3.28N/mm^2	4.28N/mm^2
5	8%sw	2.78N/mm^2	3.04N/mm^2	4.16N/mm^2
6	10%sw	2.48N/mm^2	2.94N/mm^2	3.96N/mm^2

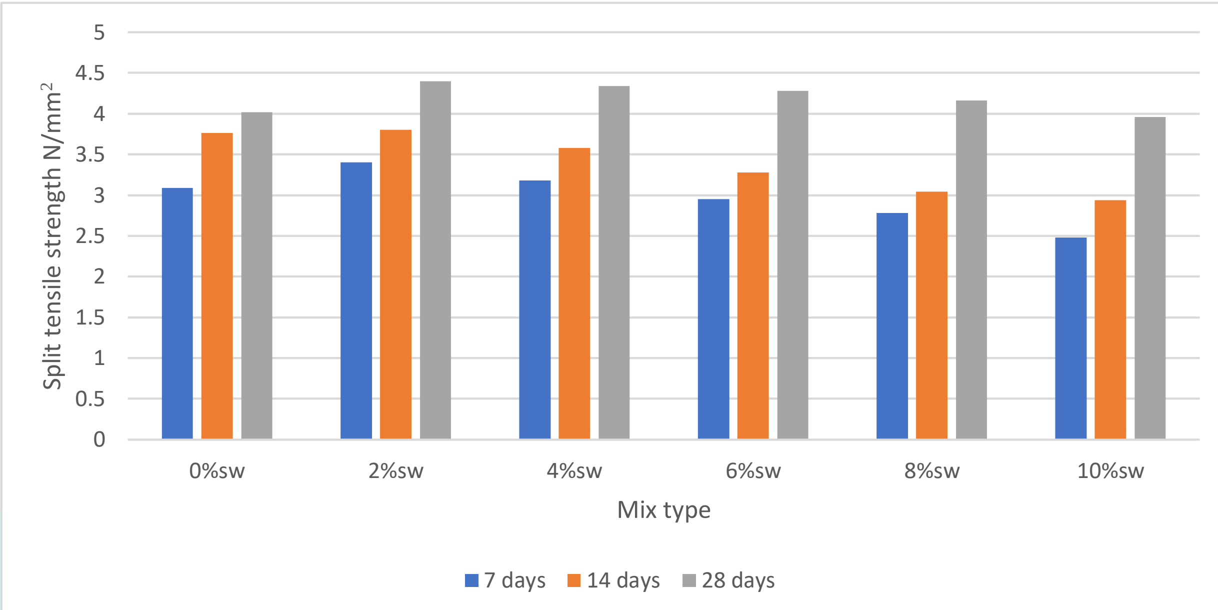


Fig 6 :Split tensile strength versus % replacement of Fine aggregate with Steel waste

It shows that optimum Split tensile strength observed at 2% Steel waste but reduction in strength was further observed at 4% Steel waste due to the chemical reaction between Steel waste and chemical , no corrosive agent is added.

❖ Compressive Strength Test :

The compressive strength test has been conducted for steel waste added in order as 0% , 2%, 4%, 6% 8% and 10% for fibre. The test results of 7days,14 days,28 days,60 days and 90 days are shown in table and figure

Sl.no	Mix type	7days	14days	28 days	60days	90 days
1	0% fibre	37.60N/mm^2	40.25N/mm^2	46.27N/mm^2	47.12N/mm^2	48.01N/mm^2
2	2%fibre	37.41N/mm^2	39.21N/mm^2	46.56N/mm^2	46.98N/mm^2	47.68N/mm^2
3	4%fibre	34.56N/mm^2	39.01N/mm^2	45.29N/mm^2	46.28N/mm^2	45.92N/mm^2
4	6%fibre	33.84N/mm^2	37.78N/mm^2	43.72N/mm^2	44.97N/mm^2	45.02N/mm^2
5	8%fibre	32.59N/mm^2	36.82N/mm^2	42.96N/mm^2	44.12N/mm^2	44.83N/mm^2
6	10%fibre	32.28N/mm^2	36.27N/mm^2	42.02N/mm^2	43.62N/mm^2	44.02N/mm^2

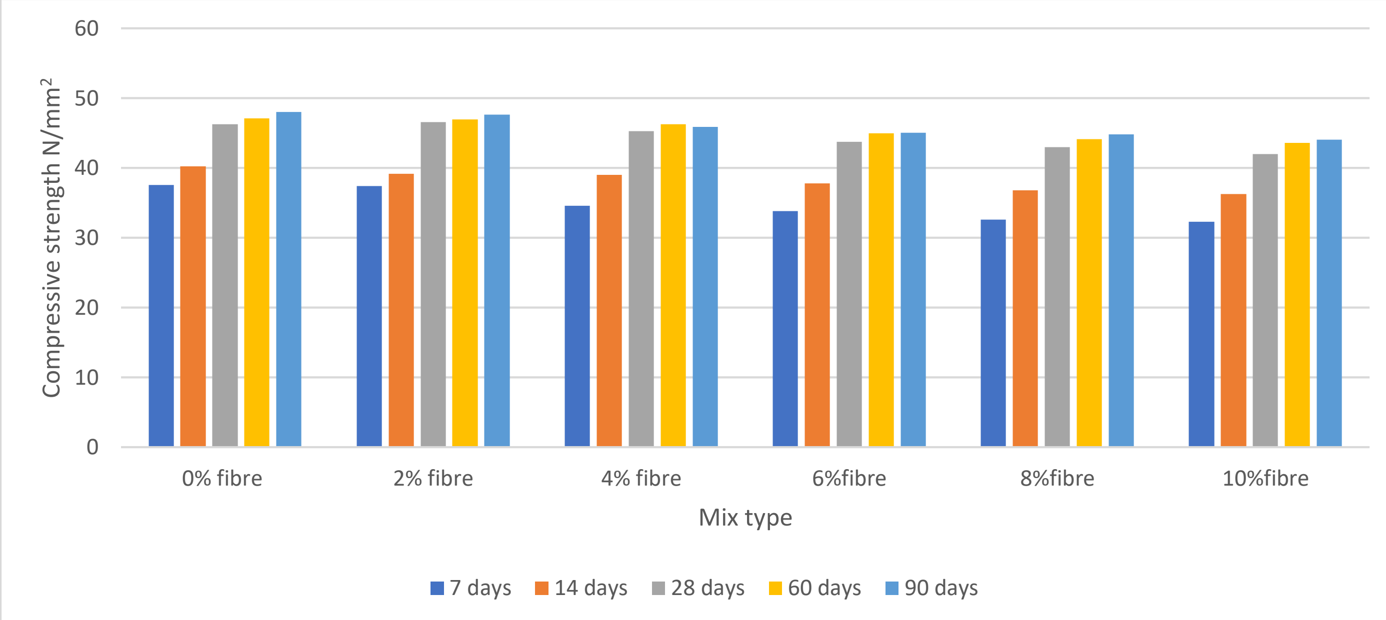


Fig 7: compressive strength versus % of fibre added(steel waste) to mix proportions

It shows that optimum Compressive tensile strength observed at 2% Steel waste but reduction in strength was further observed at 4% Steel waste due to the chemical reaction between Steel waste and cement , no corrosive agent is added.

- Split Tensile Strength Test :

The Split Tensile strength test has been conducted for steel waste added in order as 0% , 2%, 4%, 6% 8% and 10% for fibre. The test results of 7 days ,14 days,28 days,60 days and 90 days are shown in table and figure

sl.no	Mix type	7days	14days	28days
1	0%sw	3.09N/mm^2	3.76N/mm^2	4.02N/mm^2
2	2%sw	4.25N/mm^2	5.15N/mm^2	6.40N/mm^2
3	4%sw	4.32N/mm^2	5.30N/mm^2	6.54N/mm^2
4	6%sw	4.57N/mm^2	5.95N/mm^2	6.58N/mm^2
5	8%sw	5.05N/mm^2	6.32N/mm^2	6.62N/mm^2
6	10%sw	5.13N/mm^2	6.13N/mm^2	6.75.N/mm^2

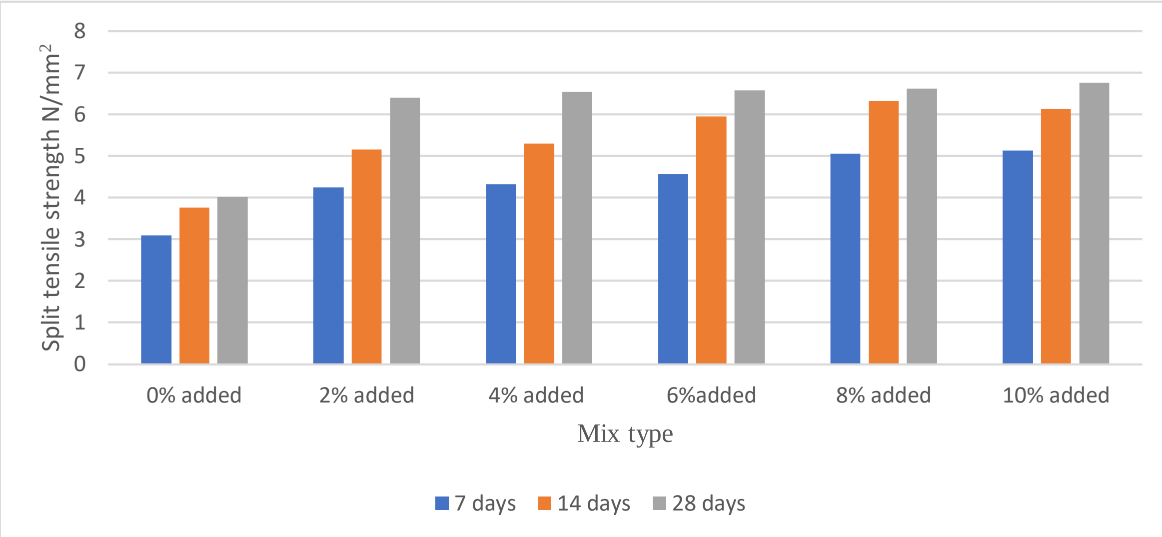


Fig 8: Split tensile strength versus % of fibre added(steel waste) to mix proportion

It shows that optimum Compressive tensile strength observed at 2% Steel waste but reduction in strength was further observed at 4% Steel waste due to the chemical reaction between Steel waste and cement , no corrosive agent is added.

CONCLUSIONS

In this project, tests were conducted in observation for defined combinations. Specimens were cured thereby to evaluate test observations for compressive strength &split tensile strength which are done for 7days,14days, 28days, 60days and 90 days for defining the optimum percentage of replacement. Based on the analysis of experimental results and discussion, the following conclusions can be drawn.

- The range of fly ash replacement in cement is 10%-30% from theory.
- The compressive strength of concrete is optimum at 2% of steel waste added as fibre type third mix proportion.
- The split tensile strength of concrete is optimum when 10% of steel waste is added as fibre type and later on the strength goes on decreasing.
- From all the test results obtained, observation that steel waste added as fibre gained more strength when compared to ordinary M40 cubes compressive strength.
- Use of lathe waste in concrete is beneficial as compared to conventional concrete reduces the environmental pollution as well as providing economical value for the waste material.

The best possible way of disposal of steel waste and fly ash can be by using it in concrete, which will reduce environmental burden .Therefore from this project, A potential step to minimize the costs for construction with usage of steel waste and fly ash which is freely or cheaply available significantly. The realm of saving the environmental pollution by cement production being our main objective as a responsible Civil Engineer.

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