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An Experimental Investigation on Behavior of Fibre Reinforced Concrete with Fly Ash

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ABSTRACT: Concrete is a most widely used construction material in the civil engineering work. The concrete is having a high structural strength and stability. The concrete is a mixture of cement, fine aggregate, coarse aggregate and water. The manufacturing of the cement the carbon dioxide is emitting from the industry. These will lead to the global warming. In order to avoid these problem, the flyash is used as cement replacement. So the investigation is carried out by varying the cement by its weight at a percentage of 10% ,20% ,25% and 30%. The concrete is strong in compression and the weaker in tension. So in order to get more strength properties for a concrete the polypropylene fibre is used in the concrete. The polypropylene fibre is used at a rate of 1% by the volume of the concrete. The series of tests carried out by varrying the flyash and polypropylene fibre. The tests was carried out are compression strength, split tensile and flexural strength. The prepared specimen are tested at the age of 7 and 28 days. The mix design is carried out as per IS10262:2019. The final conclusion of these investigation is that the flyash of 25% of the cement with the polypropylene fibre of 1% by the volume of concrete will obtain the optimal strength for the concrete.

KEYWORDS: Fly Ash, Polypropylene fibre, workability strength.

I. INTRODUCTION

Concrete is an important engineering material that is utilized in the majority of civil engineering structures. Cement, fine aggregate, coarse aggregate, water, and admixtures make up concrete. The processing of cement manufacture which lead to emit lots of CO₂. As the day passes the usage of the cement will be more so these will lead to global warming. The ecofriendly concrete produces less carbon dioxide compared to traditional concrete. The industrial wastes such as Rice husk, Fly ash, Silica fume is used as a ecofriendly concrete. The concrete has more compressive strength but less tensile strength, so fibres are employed to increase the tensile strength. Fibrous material is included in the concrete, which improves structural behaviour. These fibres are incorporated in with the concrete during the mixing process. The fibres possess their own properties when it is incorporated with the concrete. The fibres can be added to concrete at different percentages. There are many experiments are going on in order to get a concrete for a good strength by replacing the cement and also many ingredients are incorporated to the concrete.

II. LITERATURE REVIEW

K.Murahari , Rama Mohan Rao P (2013) ^[1]

The experiment is carried out with the different proportions of polypropylene Fibre and fly ash used in concrete. The fly ash in the concrete is replaced at a percentage of 30%, 40% and 50%. The polypropylene Fibre is added to concrete by its volume fraction of 0.15%, 0.20%, 0.25% and 0.30%. The results obtained by this experiment is that the fly ash possesses good strength in concrete and as the percentage of polypropylene fibre 0.15% to 0.30% will leads to good strength.

Okan karahan , Cengiz Duran Atis (2013) ^[2]

This investigation is about the durability of concrete containing polypropylene fibre with Fly ash. The percentages of Fly ash utilized in concrete are 15% and 30%. The polypropylene fibre used in concrete by volume fraction of concrete was 0.05%, 0.10% and 20%. The results obtained in this investigation is that polypropylene fibre decreases

the workability and drying shrinkage of concrete. In addition to this polypropylene fibre with the Fly ash or Portland cement concrete will not improve the elastic modulus and compressive strength.

Milind V. Mohod (2015) ^[3]

In this investigation they explain about the influence of different proportions of PPF in high strength concrete (M30, M40). They used various proportions of PPF are 0%, 0.5%, 1%, 1.5%, 2% to find the optimal content of polypropylene fibre in the concrete. They justify the strength on the basis of curing of the concrete. Initially for irregular curing it gave appreciable strength but it gave satisfactory strength at later stages.

T.Ch.Madhavi, S.Martin Luther et al (2015) ^[4]

They investigated the chloride penetration of fly ash in concrete in this study. They used the Rapid chloride permeability test to solve penetrability properties in this experiment. In this test, fly ash of class F is utilized to substitute cement in percentages of 30%, 40%, 50%, and 60% by weight and volume. The laboratory test results that penetration of chloride decreased by up to 82.2% after adding 60% fly ash content at 90 days curing.

M C Choudhary, Vanita Rai Aggarwal (2016) ^[5]

In this investigation a literature review on the report of the Polypropylene Fibre reinforced fly ash concrete. In this report the many researchers over exhibit their experience in their work. Among all the reports the main aim is to reduce the OPC content by replacing the cement with the eco-friendly material. The fly ash, polypropylene fibre, silica fume are the industrial by-products.

Divya S Dharan, Aswathy Lal (2016) ^[6]

In this investigation they studied about the effect of polypropylene fibre in concrete. By using the polypropylene Fibre with different percentage that is 0.5%, 1.5% and 2% added in concrete. They concluded that the 1.5% of polypropylene fibre possess good strength compared to 0.5% and 2% added to concrete

Dr.Shiv Kumar et al (2016) ^[7]

In this investigation they conducted the impact effect of fly ash in concrete. The experiment is carried out to find compression and flexural strength in the concrete contains fly ash. The W/C ratio is 0.4 for 35%, 45% and 55% replacement of cement by fly ash. The W/C ratio 0.4 in turns gives the good result for the flexural strength for the replacement of cement by fly ash.

Pandurangan.S , Vimalanandan .G , Dr.S.Senthel Selvan (2016) ^[8]

In this investigation the experiment is carried out about the behavior of high volume fly ash concrete. In this test the cement had replaced with fly ash at a percentage of 55%, 65%, 75% and 85%. The test is carried out are Rapid chloride penetration test, Impact strength and flexural strength. Among all percentages of replacement, the 55% gives good strength behavior of concrete.

R.D.Padhye, N.S.Deo (2016) ^[9]

In this investigation, concrete is made utilising fly ash instead of cement. At the curing period of 7, 28, and 45 days, compression strength is assessed. Fly ash in concrete can be substituted up to 40%, but any more than that is unsafe for the concrete mix. The presence of fly ash in concrete will decrease the strength of the concrete. They also discovered that M50 with 60% fly ash provides better strength and is more cost-effective than M30 with 40% fly ash.

V.Prabhakaran, M.Lingaeswari (2017) ^[10]

The experimental study on PPFRC with mineral admixtures is presented in this work. Rice husk ash, silica fume, and fly ash were used in place of cement. This research is an experiment on mineral admixtures in PPFRC. They finally concluded that for the best concrete the 1% polypropylene fibre 7.5% silica fume and 1.5% rice husk ash is to be used. The more fibres in the concrete enhance flexural strength of concrete. They also observed that the crack widths are smaller in service loads.

Chetan.C.Patil, P.Shivananda (2017) ^[11]

In this investigation is the experimental study on the performance of PPFRC. The polypropylene fibre used various percentages are 0.5%, 1%, 1.5% and 2%. Comparing all the results obtained, the 1.5% replacement possess good strength in compressive and tensile strength. At 2% of polypropylene fibre used in concrete will leads to reduce the strength by 5% of obtained results by using of 1.5%.



Amsa M, Ariyannan P (2018) ^[12]

In this investigation is the experimental study on polypropylene fibre reinforced concrete. The tests carried out are compressive strength, durability and workability of concrete. The polypropylene fibre used at various dosage are 0.2%, 0.3% and 0.5% by the volume of concrete. The results obtained is that 0.5% of polypropylene fibre increases the split tensile strength and flexural strength. The compressive strength will be decreases with increase of polypropylene fibre more than 0.2%.

Dara Sruthilaya et al (2019) ^[13]

In this investigation the study of PPF on mechanical qualities of concrete contains fly ash is done. The polypropylene Fibre at a volume fraction of 0.5%, 1%, 1.5%, 2% and 2.5%. Fibres more than 1.5% will leads to problem in placing of concrete. So the results obtained is that the using of 1.5% possess good response for the mechanical properties.

Pankaj Kumar, Shivam Singh Patel (2020) ^[14]

In this investigation is about the analysis of fly ash blended concrete. The cement is replaced by fly ash at a percentages are 5%, 10%, 15% and 20% by weight of cement. The 20% replacement of cement by fly ash will leads to give more strength compared to 5%, 10% and 15% replacement

V.Pavalan (2020) ^[15]

In this investigation is an experimental study of polypropylene Fibre with fly ash for an RC beams under flexural condition. The polypropylene Fibre is used at the percentages of 0.2% and 0.4%. The replacement of cement is done with 10% fly ash for the compression strength evaluation. Comparing the results obtained by this investigation is that the polypropylene Fibre can be used as the replacement of cement. The flexural strength can be increased considerably by the incorporation of fibres in concrete.

III. METHODOLOGY

This investigation is to test the behavior of concrete by using polypropylene fibre and fly ash. The specimens prepared are cubes, beams and cylinders. These specimens are casted and curing is done for 7 and 28 days. The tests conducted are Compressive strength, Split tensile strength and flexural strength. Design mix was prepared as per IS 10262: 2019

MATERIALS USED

Cement: The cement is a major binding material of the concrete. In concrete the cement binds all aggregates in the presence of water. The cement plays an important role in the construction of engineering works. In this investigation the OPC 43 grade of Ultra tech company cement is used.

Fine Aggregate: Usually the M sand is made from specific hard rock granite. The M sand size used in these experiment is less than 4.75MM.

Coarse Aggregate: In this investigation the 20MM down size aggregates was used. In this investigation the coarse aggregates are obtained from Local quarry aggregates.

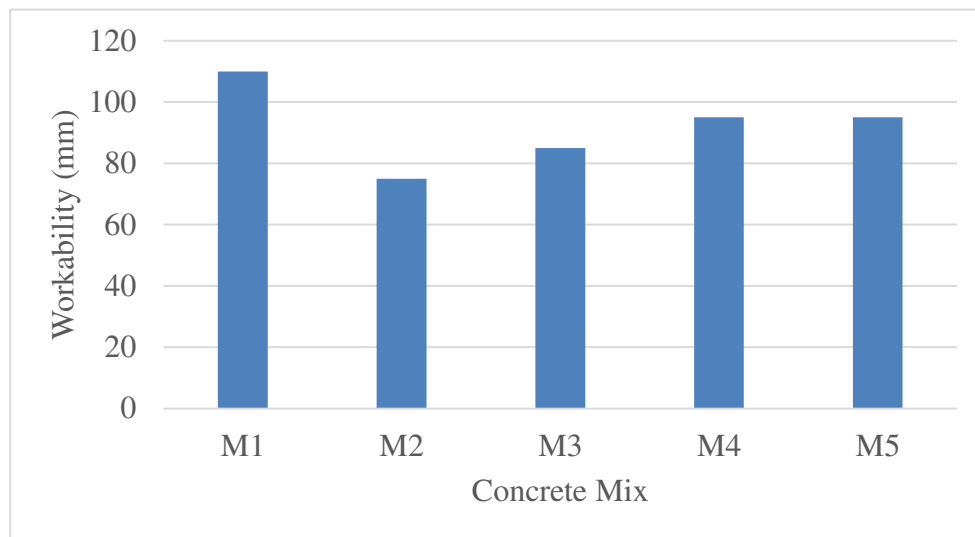
Polypropylene fibres The polypropylene fibre in this investigation is monofilament in nature and the colour is brilliant white. The 1% dosage of polypropylene fibre is used for the mix with the concrete. In this investigation the polypropylene obtained from Jogani concrete fibres

Fly Ash: Fly ash is the powder form by-product which is obtained from the thermal power plant. In this investigation the Class C fly ash is used. This fly ash is taken from the Raichur thermal power station, shakthinagar, Raichur. The cement is replaced by fly ash at a percentage of 10%, 20%, 25% and 30%.

IV. EXPERIMENTAL RESULTS

4.1 Workability

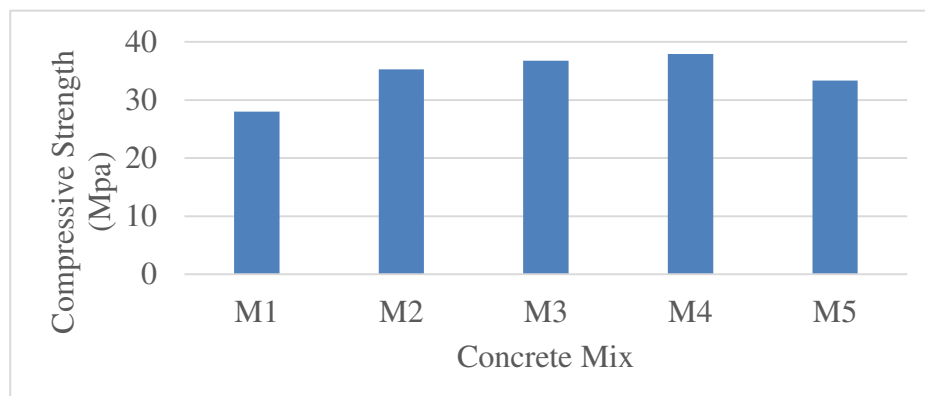
Mix	Workability (mm)
M1	110
M2	75
M3	85
M4	95
M5	95



In the present investigation the workability of concrete is measured by slump test. The workability of concrete without any admixtures shows the slump value 110mm. By using 10% of fly ash and 1% of polypropylene fibre the workability reduces to 75mm, but as the percentage of fly ash increases for the other trials the slump value gradually increases. So the replacement of 25% and 30% the slump value is 95mm.

4.2 Compressive strength test after 7 days of curing

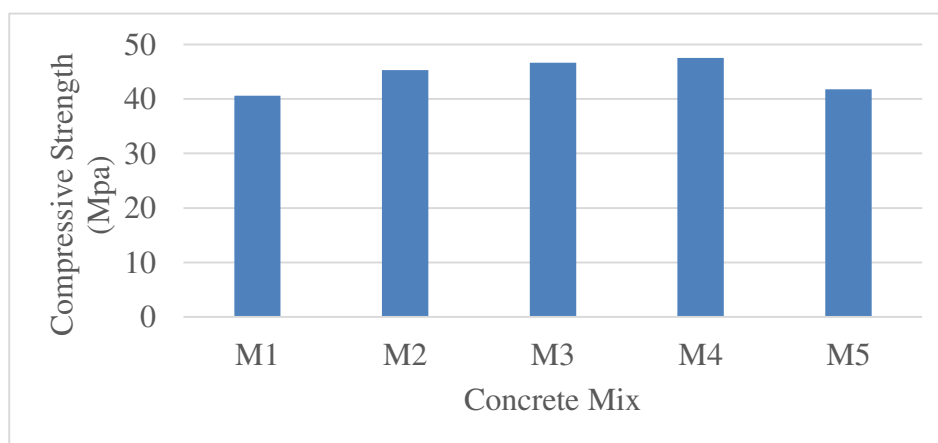
Mix	Trial 1	Trial 2	Trial 3	Avg Compressive Strength (Mpa)
M1	27.56	28	28.44	28
M2	35.11	34.67	36	35.26
M3	37.33	36	36.89	36.74
M4	37.78	38.67	37.33	37.93
M5	35.56	32	32.44	33.33



The compressive strength is evaluated by using the CTM. The above table and fig shows the strength of concrete at 7 days of curing period. The nominal mixed concrete has the compressive strength of 28MPa. As the percentage of fly ash increases upto 25% the value of compressive strength has increased to 37.93MPa. Above 25% the compressive strength decreases. The 30% replacement of fly ash has the compressive strength of 33.33MPa

4.3 Compressive strength after 28 days of curing

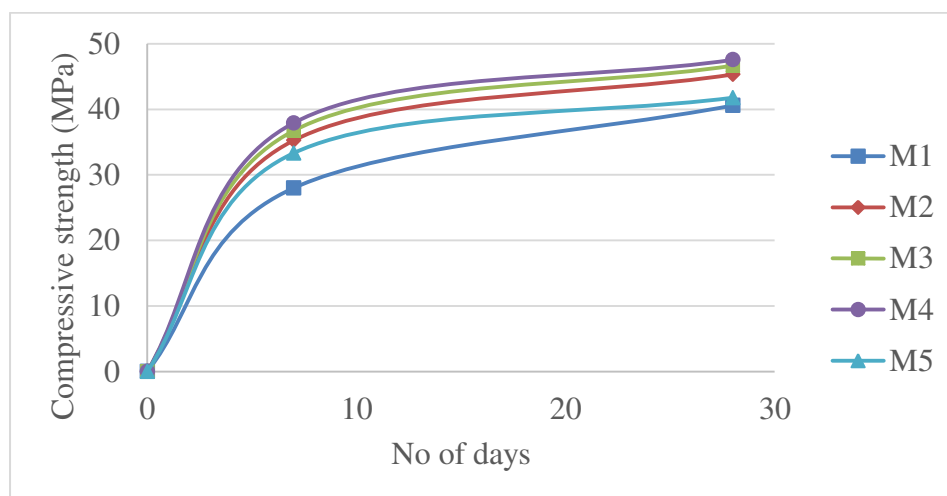
Mix	Trial 1	Trial 2	Trial 3	Avg Compressive Strength (Mpa)
M1	39.56	40.89	41.33	40.59
M2	45.33	44.89	45.78	45.33
M3	46.67	46.22	47.11	46.67
M4	47.56	47.11	48	47.56
M5	42.22	41.78	41.33	41.78



The compressive strength is evaluated by using the CTM. The above table and fig shows the strength of concrete at 28 days of curing period. The nominal mixed concrete has the compressive strength of 40.59MPa. As the percentage of fly ash increases upto 25% the value of compressive strength has increased to 47.56MPa. Above 25% the compressive strength decreases. The 30% replacement of fly ash has the compressive strength of 41.78MPa

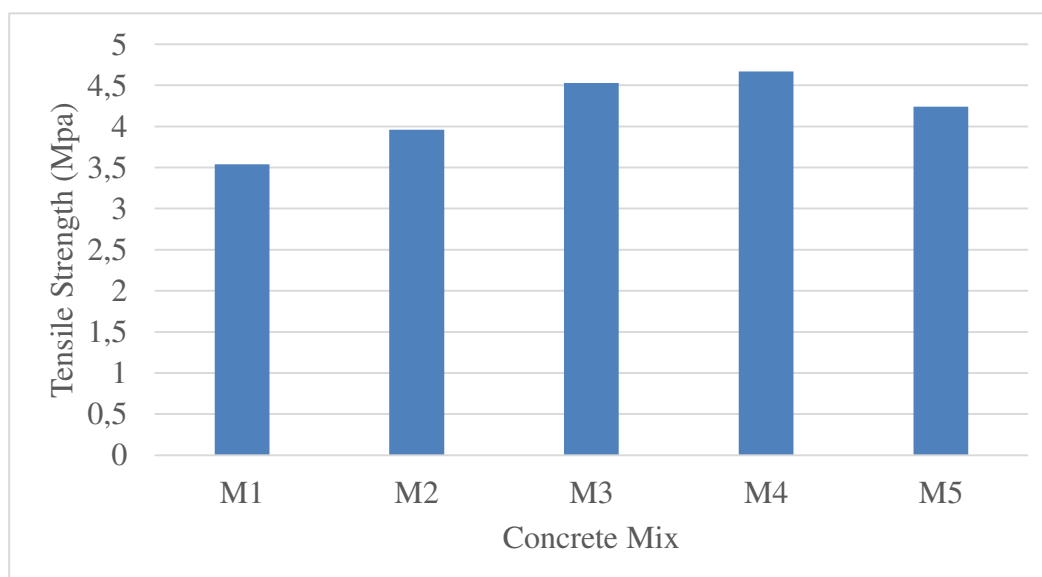
4.4 Comparison between compressive strength after 7 and 28 days of Curing

Mix	No of days of curing	
	7	28
M1	28	40.59
M2	35.26	45.33
M3	36.74	46.67
M4	37.93	47.56
M5	33.33	41.78



4.5 Split tensile strength after 28 days of curing

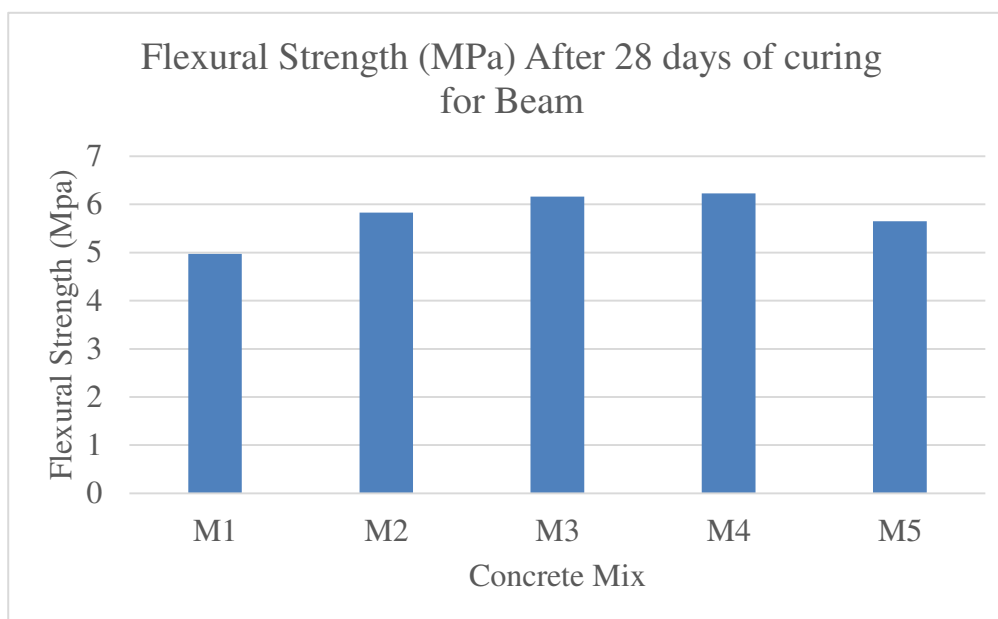
Mix	Trial 1	Trial 2	Trial 3	Avg Tensile Strength (Mpa)
M1	3.4	3.54	3.68	3.54
M2	3.96	3.82	4.1	3.96
M3	4.53	4.39	4.67	4.53
M4	4.67	4.53	4.81	4.67
M5	4.39	4.24	4.1	4.24



The Tensile strength is evaluated by using the CTM. The above table and fig shows the strength of concrete at 28 days of curing period. The nominal mixed concrete has the Tensile strength of 3.54MPa. As the percentage of fly ash increases upto 25% the value of Tensile strength has increased to 5.09MPa. Above 25% the Tensile strength decreases. The 30% replacement of fly ash has the Tensile strength of 4.24MPa.

4.6 Flexural strength after 28 days of curing

Concrete Mix	Trial 1	Trial 2	Trial 3	Avg Flexural Strength (Mpa)
M1	4.96	5.04	4.92	4.97
M2	5.76	5.92	5.8	5.83
M3	6.2	6.16	6.12	6.16
M4	6.24	6.28	6.16	6.23
M5	5.6	5.64	5.72	5.65



The Flexural strength is evaluated by using the CTM. The above table and fig shows the strength of concrete at 28 days of curing period. The nominal mixed concrete has the Flexural strength of 4.97MPa. As the percentage of fly ash increases upto 25% the value of Flexural strength has increased to 6.23MPa. Above 25% the Flexural strength decreases. The 30% replacement of fly ash has the Flexural strength of 5.65MPa

V. CONCLUSION

- As the fly ash is a waste material using it as a replacement to cement will reduce the CO₂ emission caused by manufacture of cement and also the construction becomes economical.
- The normal concrete is weak in tension so by using the polypropylene fibre the concrete will possess more strength in tension. The polypropylene fibre used in this research at 1% by the volume of concrete.
- The varying in fly ash at a percentage of 10% ,20% ,25% and 30%. The optimum strength of concrete is obtained at 25 %.
- The workability of concrete will increase for the usage of fly ash because as the fly ash is of spherical shape it acts as a lubricant thus increasing the flow but the usage of polypropylene fibre reduces the workability as it affects the flow of concrete.
- For the usage of optimum dosage of fly ash in the FRC will leads to increase of compressive strength by 35.46% after 7 days of curing and 17.17% after 28 days compared to mix M1.
- For the usage of optimum dosage of fly ash in the FRC will leads to increase of tensile strength by 31.92% after 28 days of curing compared to mix M1.
- For the usage of optimum dosage of fly ash in FRC will leads to increase of flexural strength by 25.35% after 28 days of curing compared to mix M1.

5.3 SCOPE FOR FUTURE STUDY

- In this experiment M30 grade concrete is used, for the future study different grades of concrete can be used.

- For the future study the durability tests can be carried out such as sulphate attack, acid attack tests.
- Other than fly ash, different industrial by products or waste materials can be used as the admixtures for concrete.
- The class C Fly ash is used in these experiment. The varying of classes of Fly ash can be studied for further study.
- The different fibres can be used in the concrete other than polypropylene fibre.
- As the use of fly ash helps concrete to gain high early strength, the tests can be carried out after 3 days of curing.
- For the future study the interval of percentage of replacement of cement with fly ash can be reduced and the percentage of replacement should be adjacent to the optimum value.
- The 12 mm length of polypropylene fibre is used in these experiment. The varying in the length of polypropylene fibre can be studied for future study.
- On the other hand, keep the fly ash quantity constant and vary the percentage of polypropylene fibre in concrete.

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