

# **Experimental Investigation to Assess the Mechanical Properties of Concrete with Partial Replacement of Fly Ash and Recron 3S Fibre**

Ninad P.Pawar, Prof.U.S. Ansari

Research Scholar, Department of Civil Engineering, SND College of Engineering and Research Centre, yeola.,  
Maharashtra, India

Assistant Professor, Department of Civil Engineering, SND College of Engineering and Research Centre, yeola,  
Maharashtra, India

**ABSTRACT:** This paper describes the enhancement in the properties of concrete with respect to strength and durability. In the present scenario, the experimental investigation has been carried out to study the mechanical properties of concrete using fly ash content with recron 3s fibre. To determine the compressive, split tensile and flexural strength of M20 and M25 grade concrete mix by addition of Polypropylene fibre (recron3s) in the proportion of 0.0%, 0.1%, 0.2%, 0.3%, 0.4% by volume of concrete. Fly ash was used as a replacement to cement. Replacement percentages used during the present study were 10%, 20%, 30%, 40%, 50%. The concrete specimen was tested at different age level 7, 14, 28 days.

It is found that addition of fly ash and Recron 3s fibers have beneficial effects on the mechanical properties of concrete.

**KEYWORDS:** Polypropylene fiber (Recron3s), Compressive strength, split tensile strength, flexural strength etc.

## **I. INTRODUCTION**

The focus of current research is to enhance the mechanical properties of concrete by using Polypropylene fibre (Recron3s) in fly ash concrete. The polypropylene fiber (Recron3s) are randomly dispersed throughout the concrete matrix providing for better distribution of both internal and external stresses.

Fiber reinforcement concrete is considered as a material of improved properties and not as reinforced cement concrete where in reinforcement is provided for local strengthening of concrete in tension reason. Since in fiber reinforcement concrete, fibers are uniformly dispersed (Recron 3s) which has better properties to resist internal stress due to shrinkage.

Also reduces segregation and bleeding and also results in a more homogeneous mix. This leads to better strength and reduced permeability which improves durability. During the present research, an attempt has been made to utilize the sludge and Recron 3s fibers for making concrete.

Fly ash was used as supplementary cementing material which contributes the sustainability issue for concrete technology.

# International Journal of Innovative Research in Science, Engineering and Technology

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## II. LITERATURE REVIEW

Ashish kumar Dash (2011), used Recron 3s fibre and silicafume for making concrete. The compressive and flexural strength of concrete specimens were determined. It is found that the optimum strength was obtained at 0.2% fibre content.

Praveen and Ankit Sharma (2013) suggested that the effect of variation of polypropylene fibres ranging from 0.1% to 0.4% along with 0.8% steel fibres on the behavior of fibrous concrete. The mechanical properties of the concrete such as compressive and tensile strength were investigated. The result showed that addition of polypropylene fibre has a little effect on the compressive strength, but there was significant increase in the tensile strength with increase in fibre volume fraction. Investigation revealed an increase of 47% of split tensile strength and 50% of flexural strength.

Jo Jacob Raju and Jino John (2014) studied on the improving mechanical properties of HVFA concrete with addition of Recron 3s fibre at 0.1, 0.2 and 0.3 % of cement and with 60% fly ash replacement with cement. It is found that fibres addition have increased its strength characteristics over ordinary Portland cement.

Damgir and Hugal (2015) studied on prediction of compressive strength by incorporating steel fibres. For the study, M50 grade of concrete was considered. Steel fibres of varying volume fractions 0% to 5% were considered. Steel fibres of commercial brand were used. Cubes were tested for 7 days to 28 days strength. It is observed that strengths attained at 5% volume fraction of steel fibres is same as the strength obtained at 0% volume fraction steel fibres.

Many researchers have investigated the effect of various types of fibres on the mechanical properties of concrete. However, the research on polypropylene fibre reinforced concrete is limited.

## III. MATERIALS USED

### A. Cement

The cement used was Ultra Tech 53 grades Ordinary Portland cement is used for this study with a specific gravity of 3.15.

### B. Aggregate

Fine Aggregate : Natural sand of river bed of size 4.75 mm is used conforming to grading Zone –I of table 1 of IS 383 were procured from Tapi river Nandurbar, Maharashtra.

Course Aggregate : Natural crushed stone with 20 mm size as per IS 383-1970. were used as coarse aggregate. It must be clean and free from impurities. (see Table 2)

Table 1 : Properties of fine aggregates

Properties	Fine aggregate
Specific gravity	2.62
Fineness modulus	3.49

Table 2 : Properties of course aggregates

Properties	Course aggregate
Specific gravity	2.75
Fineness modulus	7.64
Aggregate impact value	4.47 %

**C. Polypropylene Fibre (Recron 3s) :** Recron-3s is a polypropylene monofilament, discrete, discontinuous short fiber that can be used in concrete to control and arrest cracks. This type of fibre taken from Reliance Industries Limited, Mumbai. (Table 3 shows the Test Results of Recron 3s Fiber,)

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Table 3, Test Results of Recron 3s Fiber

Sr.no.	Property	Specification
1	Product Code/Material	CTP 2016/Polyster
2	Packing type	Pouch
3	Dispersion	Excellent
4	Application	Concrete
5	Shape	Triangular
6	Cut length	12.5 mm
7	Aspect Ratio	300
8	Specific gravity	0.90
9	Melting point	200-250oC
10	Tensile strength	6000 kg/cm2
11	Color	White
12	Alkaline Resistance	Good

**D. Superplastizers :** CONPLAST SP 430 Plastisizers is used as as chemical admixture to enhance the workability of concrete. .(see Table 4)

Table 4 : Test results of Superplastisizers

Colour	Brown
Sp.gravity	1.25
Chloride Content	Nil
Solid Content	40 %

**E. Fly Ash :** Class F fly ash is used collected from Eklahere Thermal Power station, Maharashtra which confines as per IS 3812-2000.Its physical properties and chemical composition are given in Table 5 (a) (b).

**Table 5 (a), Chemical Properties of Fly ash**

Sr.no.	Charactristics	Results obtained in %
1	Silicon dioxide + Aluminum oxide+ Iron oxide in %by mass minimum	95
2	Magnesium oxide in %by mass maximum	0.50
3	Total sulphur as sulphur tri oxide in %by mass maximum	0.30
4	Total chlorides in %by mass maximum	0.035
5	Loss on ignition in %by mass maximum	1.20
6	Moisture content	1.30

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**Table 5 (b), Physical Properties of Fly ash**

Sr.no.	Name of test	Observation
1	Fineness-specific surface in m <sup>2</sup> /kg	395
2	Lime reactivity ,N/mm <sup>2</sup>	2.50
3	Compressive Strength N/mm <sup>2</sup>	79.00
4	Drying Shrinkage	0.21
5	Soundness	0.33

**F.Water :** Portable water is used for casting and curing of all specimens. The quality of water was found to satisfy the requirements of IS: 456-2000.

## IV. EXPERIMENTAL INVESTIGATION

The experimental investigation consisted of making M20 and M25 grade of concrete containing different proportions of fly ash and Recron 3s fiber. M20 and M25 concrete was designed as per IS 10262:2009 and the mix proportions are given in Table 6 (a) (b).

**Table 6 (a) Quantity of Materials for M20 concrete**

Cement	425.73kg
Fine Aggregate	655.3829kg
Course Aggregate	1145.6235kg
Water	191.58 litres

**Table 6 (b) Quantity of Materials for M25 concrete**

Cement	445.53 kg/m <sup>3</sup>
Fine Aggregate	516.35 kg/m <sup>3</sup>
Course Aggregate	1212.01 kg/m <sup>3</sup>
Water	191.58 lit/m <sup>3</sup>

**Table 7 Various Percentages of Materials Used**

% replacement of cement with fly ash	% addition of Recron 3s fiber				
	0	0.1	0.2	0.3	0.4
10	0	0.1	0.2	0.3	0.4
20	0	0.1	0.2	0.3	0.4
30	0	0.1	0.2	0.3	0.4
40	0	0.1	0.2	0.3	0.4
50	0	0.1	0.2	0.3	0.4

### **Casting of Specimens :**

For compressive strength of concrete, Cubes were casted and mixing was done by hand. For each proportion of M20 and M25 grade of concrete 9 cubes of each size 150x150x150mm were casted. For each mix slump test was conducted to measure workability. Totally 54 cubes were casted and remolding was done after 24 hours of casting. Cubes were cured for 7,14,28,days.

For tensile strength of concrete, Cylindrical mould were casted and mixing was done by hand. For each proportion of and M25 grade of concrete 3 Cylindrical mould of size 150mm in diameter and 300mm in length were casted. Total 18 Cylindrical mould were casted and remolding was done after 24 hours of casting. Cubes were cured for 7,14,28,days.

For flexural strength of concrete, 18 beams were casted and mixing was done by hand. For each proportion of M20 and M25 grade of concrete 3 beams of each size 1000x150x150 mm were casted. Total 18 beams were casted and remolding was done after 24 hours of casting beams. Beams were cured for 7,14,28,days.

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## V.RESULTS AND DISCUSSION

Experimental results summarized in Table 8 represents 7,14 and 28 days compressive, split tensile and flexural strength of various specimens.

Table 8 (a),(b),(c) Compressive, Tensile and Flexural Strength of M20 grade for various Specimens at 7 days,14 days and 28 days.

**Table 8 (a) Compressive Strength of Cubes for M20**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Compressive strength of Cubes (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	14.81	21.52	26.67
	0.1	15.98	21.06	26.92
	0.2	13.56	22.14	28.58
	0.3	14.78	21.66	26.12
	0.4	10.46	21.01	25.36
20 %	0.0	15.96	23.12	30.96
	0.1	15.55	24.65	31.89
	0.2	16.31	25.33	30.70
	0.3	16.63	25.38	31.38
	0.4	0.4	22.72	24.76
30%	0.0	0.0	16.23	28.39
	0.1	0.2	13.64	28.84
	0.2	0.3	12.71	29.33
	0.3	0.4	13.99	29.89
	0.4	1.02	12.90	30.45
40%	0.0	0.0	12.20	22.78
	0.1	0.2	12.01	22.46
	0.2	0.4	11.40	24.64
	0.3	0.4	12.58	23.85
	0.4	0.6	13.89	25.13
50%	0.0	0.0	16.84	20.98
	0.1	0.3	15.74	19.38
	0.2	0.2	14.12	16.56
	0.3	0.3	10.59	18.90
	0.4	0.4	12.32	21.36

**Table 8 (b) Split tensile Strength of Cylinder for M20**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Split tensile strength of Cylinder (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	0.98	1.14	1.00
	0.1	0.89	1.12	1.20
	0.2	0.84	1.14	1.60
	0.3	0.80	1.00	1.62

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	0.4	0.74	1.05	1.51
20 %	0.0	1.00	1.25	2.55
	0.1	1.05	1.18	2.29
	0.2	0.96	2.00	2.05
	0.3	0.98	2.10	2.20
	0.4	1.10	1.98	2.10
30%	0.0	1.02	1.45	2.74
	0.1	1.30	1.40	1.60
	0.2	0.94	1.68	1.89
	0.3	0.80	2.00	1.38
	0.4	0.92	1.58	1.90
40%	0.0	0.80	1.06	2.04
	0.1	1.92	0.98	2.10
	0.2	0.78	1.16	1.75
	0.3	0.74	1.14	1.48
	0.4	0.80	1.24	1.36
50%	0.0	0.90	0.84	1.54
	0.1	0.88	1.24	1.29
	0.2	0.82	0.56	0.94
	0.3	0.82	0.98	0.82
	0.4	0.80	0.69	0.90

**Table 8 (b) Flexural strength of Beam for M20**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Flexural strength of Beam (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	2.12	3.65	6.30
	0.1	2.10	3.48	6.56
	0.2	2.78	4.74	7.26
	0.3	3.26	4.98	7.84
	0.4	3.12	5.00	8.46
20 %	0.0	3.48	5.09	7.56
	0.1	3.10	6.05	8.55
	0.2	3.76	5.10	8.55
	0.3	4.05	5.09	9.58
	0.4	4.92	6.70	10.12
30%	0.0	4.16	5.00	8.44
	0.1	4.36	5.68	8.18
	0.2	3.96	6.26	7.34
	0.3	3.70	5.48	7.78
	0.4	4.12	4.90	8.38
40%	0.0	4.32	4.12	8.00
	0.1	4.28	4.24	8.05
	0.2	3.68	3.00	7.76
	0.3	3.98	3.20	7.35
	0.4	4.58	4.68	8.00

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50%	0.0	3.40	2.71	6.70
	0.1	3.38	3.14	5.32
	0.2	2.89	4.72	5.66
	0.3	2.91	4.78	6.40
	0.4	3.61	5.01	7.30

Table 9 (a),(b),(c) Compressive, Tensile and Flexural Strength of M25 grade for various Specimens at 7 days,14 days and 28 days.

**Table 9 (a) Compressive Strength of Cubes for M25**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Compressive strength of Cubes (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	16.44	24.50	30.90
	0.1	15.98	23.65	30.78
	0.2	15.33	23.10	26.89
	0.3	14.20	22.80	26.12
	0.4	13.40	21.35	25.72
20 %	0.0	15.96	29.33	31.96
	0.1	15.55	28.65	32.89
	0.2	16.31	27.90	30.70
	0.3	16.63	27.15	33.38
	0.4	17.54	24.76	32.32
30%	0.0	16.23	31.75	30.54
	0.1	13.64	30.89	30.35
	0.2	12.71	29.33	27.04
	0.3	13.99	29.89	22.77
	0.4	12.90	26.12	27.45
40%	0.0	15.04	26.77	32.00
	0.1	14.45	26.10	31.56
	0.2	11.91	25.19	25.35
	0.3	12.27	23.66	26.11
	0.4	13.47	22.87	28.65
50%	0.0	14.20	18.98	30.22
	0.1	12.42	16.96	28.38
	0.2	9.49	16.46	20.20
	0.3	10.59	14.70	22.53
	0.4	11.33	16.42	24.11

**Table 9 (b) Split tensile Strength of Cylinder for M25**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Split tensile strength of Cylinder (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	0.86	0.89	1.92
	0.1	0.84	1.00	1.90
	0.2	0.79	1.18	1.75
	0.3	0.73	0.78	1.62

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	0.4	0.68	1.24	1.51
20 %	0.0	1.13	1.28	2.52
	0.1	1.00	1.10	2.00
	0.2	0.92	2.09	2.05
	0.3	0.96	2.30	2.14
	0.4	1.03	1.98	2.30
30%	0.0	1.23	0.98	2.73
	0.1	1.35	1.16	1.82
	0.2	0.82	1.68	1.87
	0.3	0.84	2.13	1.46
	0.4	0.88	1.56	1.95
40%	0.0	0.89	0.99	1.98
	0.1	1.00	0.74	1.48
	0.2	0.56	1.36	1.24
	0.3	0.58	1.14	1.30
	0.4	0.60	1.54	1.33
50%	0.0	0.65	0.84	1.44
	0.1	0.49	1.24	1.12
	0.2	0.28	0.56	0.63
	0.3	0.34	0.98	0.77
	0.4	0.41	0.69	0.91

**Table 9 (c) Flexural strength of Beam for M25**

% replacement of cement with fly ash	% addition of Recron 3s fiber	Flexural strength of Beam (N/mm <sup>2</sup> )		
		7 Days	14 Days	28 Days
10 %	0.0	3.22	3.86	7.31
	0.1	3.38	4.19	7.78
	0.2	3.54	4.75	8.05
	0.3	3.91	5.28	8.88
	0.4	4.30	5.00	9.77
20 %	0.0	4.37	6.69	9.94
	0.1	4.13	6.05	9.48
	0.2	3.76	5.46	8.55
	0.3	4.41	5.09	10.02
	0.4	5.33	5.54	12.11
30%	0.0	4.61	5.33	10.47
	0.1	4.26	6.78	8.16
	0.2	3.19	6.26	7.26
	0.3	3.43	4.88	7.81
	0.4	3.81	4.94	8.66
40%	0.0	3.54	4.33	8.05
	0.1	3.10	4.58	8.42
	0.2	2.91	3.05	6.62
	0.3	3.26	3.64	7.42
	0.4	3.54	5.68	8.04
	0.0	3.28	2.78	7.46
	0.1	3.12	3.86	5.66



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50%	0.2	2.55	4.09	5.79
	0.3	2.69	4.89	6.12
	0.4	2.82	5.10	6.41

## VI.CONCLUSION

From the results, it is found that the optimal replacement percentage of cement with fly ash is 20% for M20 and 40 % for M25 when Recron 3s fibers are not added.

- On addition of Recron 3s fiber with cement matrix, the compressive strength and split tensile strength decrease with increase in Recron 3s fiber content, however the flexural strength increases with increase in Recron 3s fiber content.
- The usage of fly ash will reduce the ill effects on the environment. It is recommended over the ordinary concrete as it considerably saves cement and also prevents environmental pollution.
- Usage of Recron 3s fiber will reduce the cost of maintenance by reducing the micro cracks and permeability and hence the durability will increase. It is found that use of Recron 3s fiber reduces the segregation.

## ACKNOWLEDGEMENT

We sincerely express our deep sense of gratitude towards my respected guide **Prof. Ansari U.S.** for his valuable guidance, profound advice, persistent encouragement and help during the completion of this work. His time to time helpful suggestion boosted us to complete this task successfully. He has helped me in all possible ways right from gathering the materials to report preparation. We extend our sincere thanks to **Prof. Kale R.S.**, Head of Civil Engineering Department for providing all kinds of cooperation during the course. We express our thanks to **Dr. Hari N Kudal**, Principal S.N.D. College of Engg. & Research center, Bhabhulgaon for their kind cooperation during our project's specimen casting and experimental work. Finally we are thankful to the supporting staff of civil engineering department and all those who directly or indirectly contributed to complete this Project work.

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