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Mechanical and Flexural Properties of Concrete Made with Polypropylene Fibre and Rice Husk Ash

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ABSTRACT

This paper the experimental investigation on polypropylene fiber reinforced concrete was carried out by researchers. The properties evaluated include compressive strength, splitting tensile strength and Flexural strength test, an experimental program was planned. Ordinary Portland cement (OPC) was partially replaced with RHA up to 10% constant for all mixes and addition of PP fiber different percentage as 0.50%, 0.75%, 1%, 1.5% and 2% by weight of binder. The use of RHA in concrete mixes was found to increase the compressive strength at later ages and higher amount of PP Fiber with decreases compressive strength.

.Keywords: - rice husk ash, polypropylene fiber, compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

By adding (super) fine materials such as Fly Ash (FA), Silica Fume (SF), Metakaolin (MK), and Rice Husk Ash to cement paste in the interfacial transition zone (ITZ), the microstructure of the cement paste in the ITZ can be greatly enhanced (RHA). India is the world's second-largest rice producer. Rice husk is made from the rice grain's outer covering, which is made up of two interlocking parts (Xu et al., 2011). Fiber dispersion in concrete is one of the techniques for improving concrete's structural qualities. Synthetic fibres obtained as a by-product of the textile industry are known as polypropylene fibres. These come in a variety of aspect ratios and are economical. Polypropylene fibres have a low specific gravity and are affordable. Its application allows for the dependable and effective use of the material's intrinsic tensile and flexural strength, as well as a significant reduction in plastic shrinkage cracking and the minimization of thermal cracking.

2. Literature reviews

The mechanical properties of PP hybrid fiber-reinforced concrete were examined by Hsie et al. (2008). The effects of combining coarse monofilament PP fibres with staple PP fibres of various volume fractions were studied. They came to the conclusion that hybrid FRC performed better than single FRC. The compressive strength, splitting tensile strength, and modulus of rupture of PP hybrid FRC increased by 17.31 percent, 13.35 percent, and 24.60 percent, respectively, when compared to plain concrete. The characteristics of PP fibre reinforced silica fume expansive-cement concrete were studied by Toutanji H A (1999). The fibrillated PP fibres, which ranged in length from 6 to 51 mm, were added to the mix at 0.1, 0.3, and 0.5 percent volume fractions, respectively. The application of 5% silica fume improved the bond strength between the restoration materials and the old substrates, according to the author. When the SF content was increased from 5% to 10%, the rate of growth in bond strength slowed. The introduction of PP fibre, on the other hand, increased binding strength, particularly in mixes containing 10% silica fume. Furthermore, increasing the PP fibre volume percentage in fibre reinforced silica fume expansive-cement concrete improved the postpeak flexural strength. The author also came to the conclusion that the addition of PP fibre had a negative impact on the chloride. Mazaheripour et al. (2011) investigated the effects of PP fibre on the properties of lightweight self-compacting concrete, both fresh and hardened. In the mixture, different volume percentages of 12 mm long PP fibre were added. The inclusion of PP fibres significantly reduces slump flow, according to the authors. In the U-box test, increasing the volume percentage of PP fibres reduces the filling height. They also claimed that PP fibres had no effect on the composites' compressive strength or elastic module. Furthermore, when the volume percentage of PP fibres increased, splitting tensile strength and flexural strength increased.

3. Materials and Methodology

3.1 Cement

Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement as determined from various tests 30 conforming to Indian Standard IS: 1489-1991(Part-1) are listed in Table 3.1. All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture.

3.2 Fine aggregate

River sand was used as fine aggregate. The specific gravity and fineness modulus was 2.55 and 2.93 respectively. This is passing from 4.75mm sieve.

3.3 Course Aggregate

Crushed angular granite metal from a local source was used as coarse aggregate. The specific gravity was 2.71, flakiness index of 4.58 percent and elongation index of 3.96.

3.4 Rice husk ash

RHA is an agro-based material. RHA utilized was of grey colour and light in weight. Specific gravity of RHA was 1.96.

3.5 Polypropylene fiber

Polypropylene fibres (PP) use in concrete with a length of 45 mm and 0.25 diameters were used in the concrete mix and specific gravity of 0.71.

4. Result and Discussions

4.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure given in chapter 3. w/b ratio was kept constant 0.4 for all the concrete mixes. Super-plasticizer SP 430 was used to maintain the required slump.. The workability results of different concrete mixes were shown in Table 4.1

Table 4.1 Workability values for different concrete mixes

Mix no.	Description	Super plasticizer (%) by weight of binder	Slump (mm)
1	90%OPC+10%RHA+0%PP	1.00	114
2	90%OPC+10%RHA+0.5%PP	1.00	112
3	90%OPC+10%RHA+0.75%PP	1.00	108
4	90%OPC+10%RHA+1%PP	1.00	100
5	90%OPC+10%RHA+1.5%PP	1.00	95
6	90%OPC+10%RHA+2%PP	1.25	90

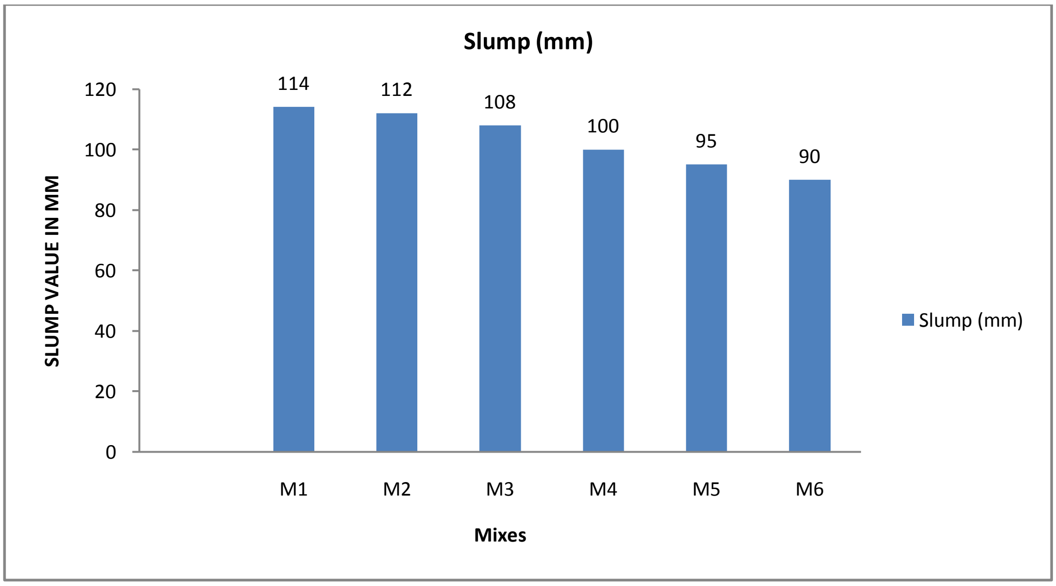


Table 4.1 shows that as the addition of fibres to concrete mix increases, the workability of concrete mix was found to decrease as compared to control mix.

4.3 Compressive Strength Test Results

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, and 28 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 4.2. Variation of compressive strength of all the mixes cured at 7, 14, and 28 days is also shown in Fig. 4.1.

Table 4.2 Compressive strength (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 days	14 days	28 days
1	90%OPC+10%RHA+0%PP	30.00	32.00	35.00
2	90%OPC+10%RHA+0.5%PP	36.00	37.00	40.40
3	90%OPC+10%RHA+0.75%PP	37.30	36.40	40.20
4	90%OPC+10%RHA+1%PP	35.20	34.80	39.10
5	90%OPC+10%RHA+1.5%PP	33.10	33.90	37.50
6	90%OPC+10%RHA+2%PP	31.00	32.20	34.50

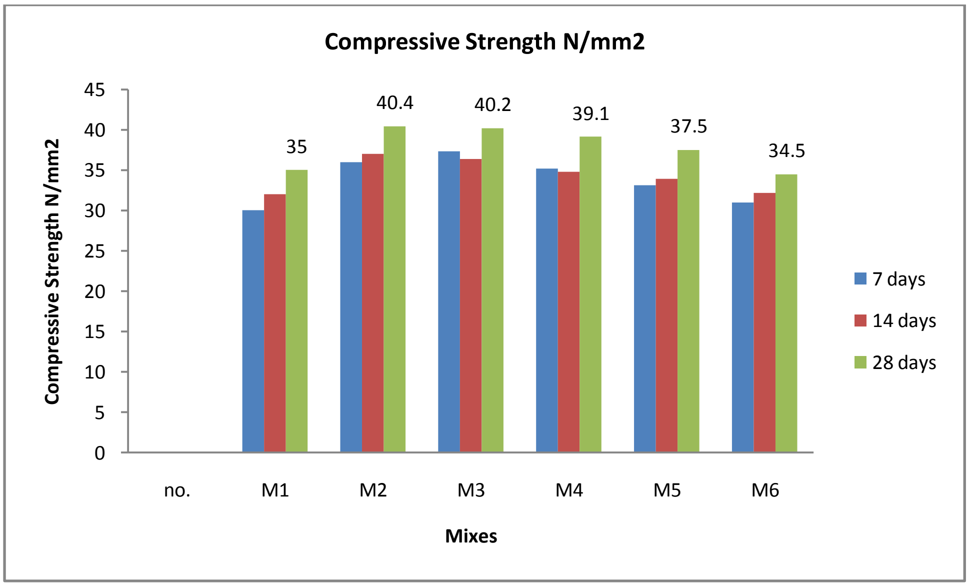


Fig. 4.1 Variation of compressive strength of concrete with age

4.4 Split Tensile Strength Test Results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 7, 14, and 28 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table 4.3.Variation of splitting tensile strength of all the mixes cured at7,14, and 28 days is also shown in Fig.

Table 4.3 Splitting tensile strength (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 days	14 days	28 days
1	90%OPC+10%RHA+0%PP	3.00	3.34	3.46
2	90%OPC+10%RHA+0.5%PP	3.71	4.09	4.48
3	90%OPC+10%RHA+0.75%PP	3.50	4.13	4.61
4	90%OPC+10%RHA+1%PP	3.64	3.71	4.81
5	90%OPC+10%RHA+1.5%PP	3.63	3.65	4.24
6	90%OPC+10%RHA+2%PP	2.77	2.91	3.00

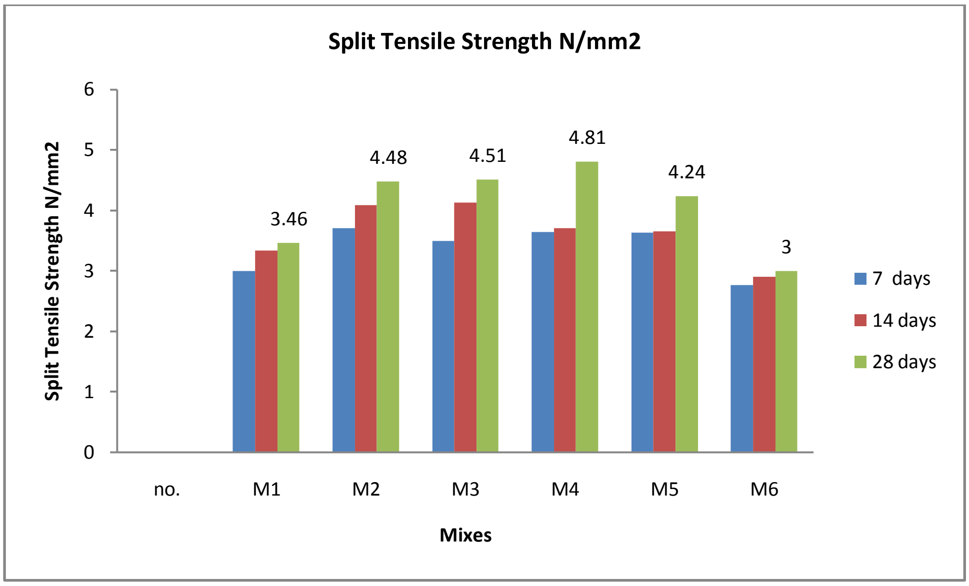


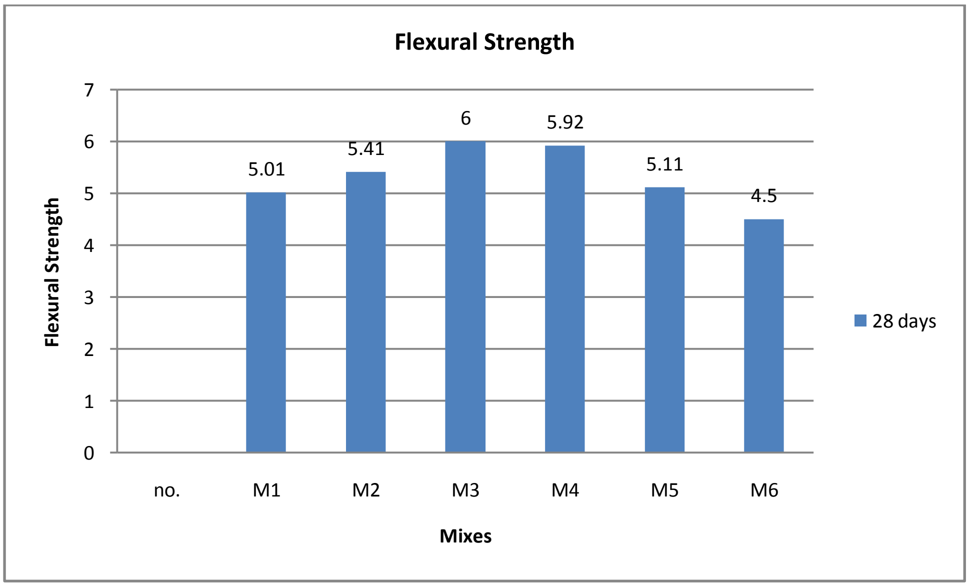
Fig. 4.2 Variation of split tensile strength of concrete with age

4.5.Flexural strength Tests Results

The results of the flexural strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. Flexural strength test was conducted at curing ages of 28 days. The flexural strength test results of all the mixes at different curing ages are shown in Table 4.3.Variation of splitting tensile strength of all the mixes cured at 28 days is also shown in Fig.

Table 4.3 Flexural strength (MPa) results of all mixes at different curing ages.

Mix no.	Description	28 days
1	90%OPC+10%RHA+0%PP	5.01
2	90%OPC+10%RHA+0.5%PP	5.41
3	90%OPC+10%RHA+0.75%PP	6.00
4	90%OPC+10%RHA+1%PP	5.92
5	90%OPC+10%RHA+1.5%PP	5.11
6	90%OPC+10%RHA+2%PP	4.50



5. CONCLUSIONS

In the current investigation, (PPF) with RHA were used to examine the strength and acid resistance characteristics test. The experimental data obtained has been analyzed and discussed in Chapter-4, to fulfil to the best of ability, the objectives set forth for the present investigation. This chapter gives the broad conclusions that are drawn from the investigation. Based on the scope of work carried out in this investigation, following conclusions are drawn.

a. It was observed that as the addition of PP fibres to concrete mix increases, the workability of concrete mix was found to decrease as compared to control mix.
b. At optimum dosage of PP fibres the increase in compressive strength of PP fibre concrete mixes compared with control mix of concrete at 28 days.
c. It was observed that tensile strength of concrete decreasing with increasing percentage of PP fiber.
d. It was observed that flexural strength of concrete increasing with optimum addition percentage of PP fiber as 1%.
e. The effect of RHA in concrete to fill the presence void in mix due to increasing all mechanical properties of RHA concrete.

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