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Analytical Study on Fiber Reinforced Concrete Using Different Types of Virgin Polypropylene Fiber in Preparation of Concrete Sample

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Abstract: Fiber-reinforced concrete (FRC) has become popular in recent years due to its superior performance compared to ordinary concrete. Fire resistance is an unavoidable risk when the FRC is used in residential and municipal buildings and other structures. Based on the known test results, the FRC varies with different fiber types, fiber configurations, and cement matrix patterns. This paper provides a comprehensive overview of current FRC fire resistance research. Permeability, delamination, compressive strength, tensile strength, modulus, strength and loss ratio are some of the temperature dependent load parameters reported for steel fiber reinforced, polypropylene fiber reinforced and hybrid fiber reinforced concrete. In particular, the current FRC policy framework is described.
In this research work using two different types of Virgin Polypropylene fiber in preparation of concrete sample. First geo-polymer fiber is BC-48 (Virgin Polypropylene) as an Admixtures- HRWR also used in concrete at various percentage like 0.0%, 0.2% and 0.4%. Using Virgin Polypropylene fibers at various percentages like 0.0, 0.3, 0.6, 0.9, 1.2 and 1.5. Testing of concrete samples for some parameters like workability and strength of cubes.

Keywords: FRC, Concrete, Virgin Polypropylene, Cement.

I. INTRODUCTION

Portland cement is very malleable, but weak from stress and cracking [1]. Weaknesses and stresses can be prevented by using standard steel reinforcements mixed to some extent with various special fibers [2]. The addition of fiber increases the strength of the fiber matrix composite, which will change its behavior after failure. The purpose of this document is to provide information on the quality and compatibility of common fibers and their use in the production of concrete with specific properties. A new type of fibrous concrete is made from cellulose fibers [3]. Fiber is a smart little power source made from a variety of materials, including steel, plastic, glass, carbon, and natural materials, and comes in a variety of shapes and sizes.

II. FIBER REINFORCED CONCRETE (FRC)

Fiber-reinforced concrete is a cementitious mixture, aggregate or compact, mixed with suitable, discrete, well-defined and well-dispersed fibers. There are many types and levels of fiber, each with its own benefits. The various fibers do not include continuous nets, braids, cables or long bars. Fibers are little things that make them strong with special properties [4]. They can be round or flat and come in a variety of shapes and sizes. Aspect ratio is a useful parameter commonly used to characterize cables. The diameter of a fiber is the ratio of its length to its diameter. The proportions are generally between 30 and 150. FRC is a type of concrete with fibrous material to increase its strength properties. It is made up of small insulating fibers that continuously distribute and rotate randomly. Fibers include metallic fibers, glass fibers, synthetic fibers and natural fibers [5]. The properties of fiber reinforced materials depend on the materials used, the fiber materials, the shape, distribution, orientation and density of these different fibers. Shotcrete supports multiple threads and can be used with a normal computer. Traditional concrete floors are often used for flooring and walkways, but can be used for a variety of other building materials. (Beams, fixtures, foundations, etc.) Alone or in combination with hand-bonded rebar, fiber concrete (usually steel, glass, or "plastic") is ten times cheaper than rebar

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[6]. The shape, size and length of the fiber are important. Short fibers, such as short-hair glass fibers, are only effective in the first few hours after the concrete is poured (reducing shrinkage as the concrete hardens), but they do not increase the concrete's tensile strength.

III. METHODOLOGY

Mix Design for M 35 Grade of Concrete

Step 1: Target mean strength

$f_t = f_{ck} + K.S.$

Where,

f_t = target average compressive strength at 28 days,

f_{ck} = characteristic compressive strength at 28 days,

s = standard deviation

$f_t = 35 + 1.65*5$

$f_t = 43.25$ N/mm^2

Step 2: Water cement ratio

W/c ratio = 0.45 {From SP 23, Table 31}

This is equal to 0.45 (severe condition), so it is ok.

Step 3: Weight of water

W_w = 186 litre {From Table 4 of IS: 10262-2019, Coarse aggregate= 20mm}

For 100 mm slump,

$W_w = 186 + 186 * (6/100)$

$W_w = 197.16$ kg/m^3

For use of plasticizer

$W_w = 197.16 – 197.16 * (8/100)$

$W_w = 181.37$ kg/m^3

This value is maximum limit, so we will take value based on experience

$W_w = 181.38$ kg/m^3

Step 4: Cement Content

W_c = Ww/ w/c

= 181.38/0.45

= 403.06 kg/m^3

This is greater than 320 kg/m^3 (severe) so, it is ok.

$W_c = 403.06$ kg/m^3

Step 5: Proportion

Proportion = 0.6 {from table 5 of IS 10262-2019, Coarse aggregate = 20mm, Zone I}

For w/c = 0.44

Proportion = 0.6 + (2*0.01) = 0.62

Step 6: Quantity of Fine aggregate and coarse aggregate

Total volume of concrete = 1m^3

a. Volume of concrete mass = 1- air content

= 1 -1 * (1.5/100)

= 0.985 m^3

b. Volume of cement = W_c/ (S_c*1000)

= 403.06/ (3.15*1000

= 0.127 m^3

c. Volume of water = W_w/1000

= 181.38/1000

= 0.181 m^3

d. Volume of admixture = W_{adm}/ (S_{adm} *1000)

= (403.06/1000)/ (1.145*1000)

= 0.00035 m^3

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e. Volume of total aggregate = a – (b+c+d)
= 0.985 – (0.135+0.181+0.00035)
= 0.6686 m^3

f. Weight of coarse aggregate = Proportion * e * S_{ca} * 1000
= 0.62*0.6686*2.67*1000
= 1106.8 kg

g. Weight of Fine aggregate = (1- proportion) *e* S_{fa} *1000
= (1-0.62) *0.6686*2.65*1000
= 673.280 kg

IV. RESULT AND DISCUSSION

Table 1: Slump Flow Value with Virgin Polypropylene and 0.0% HRWR-Super Plasticizer

Mix	HRWR (SP)	Virgin Polypropylene	Slump Flow (mm)
Mix-1	0.0%	0.0	577
Mix-2	0.0%	0.3	677
Mix-3	0.0%	0.6	622
Mix-4	0.0%	0.9	412
Mix-5	0.0%	1.2	192
Mix-6	0.0%	1.5	77

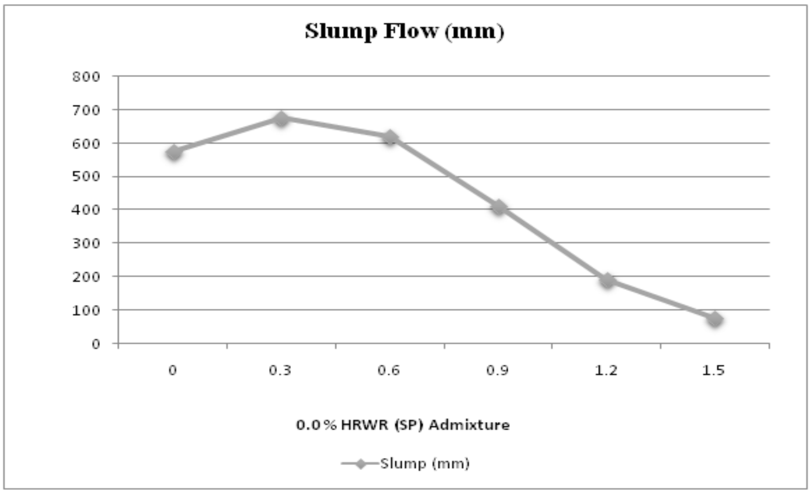

Fig 1: Slump Flow Value with Virgin Polypropylene and 0.0% HRWR-Super Plasticizer

Maximum value of Slump flow test for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 577mm after addition of HRWR and virgin Polypropylene this will reduced to 77mm in mix-6.

Table 2: Slump Flow Value with Virgin Polypropylene and 0.2%HRWR-Super Plasticizer

Mix	HRWR (SP)	Virgin Polypropylene	Slump Flow (mm)
Mix-1	0.2%	0.0	575
Mix-2	0.2%	0.3	675
Mix-3	0.2%	0.6	620
Mix-4	0.2%	0.9	410
Mix-5	0.2%	1.2	190
Mix-6	0.2%	1.5	75

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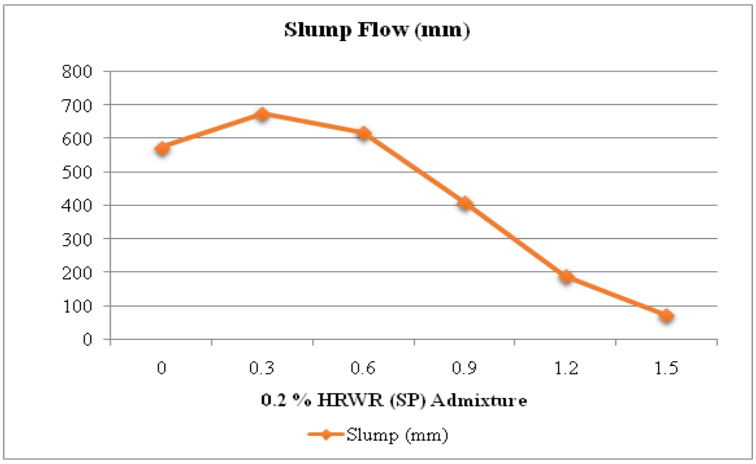

Fig 2: Slump Flow Value with Virgin Polypropylene and 0.2%HRWR-Super Plasticizer

Maximum value of Slump flow test for 0.2% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 575mm after addition of HRWR and virgin Polypropylene this will reduced to 75mm in mix-6.

Table 3: Slump Flow Value with Virgin Polypropylene and 0.4%HRWR-Super Plasticizer

Mix	HRWR (SP)	Virgin Polypropylene	Slump Flow (mm)
Mix-1	0.4%	0.0	572
Mix-2	0.4%	0.3	672
Mix-3	0.4%	0.6	617
Mix-4	0.4%	0.9	407
Mix-5	0.4%	1.2	187
Mix-6	0.4%	1.5	72

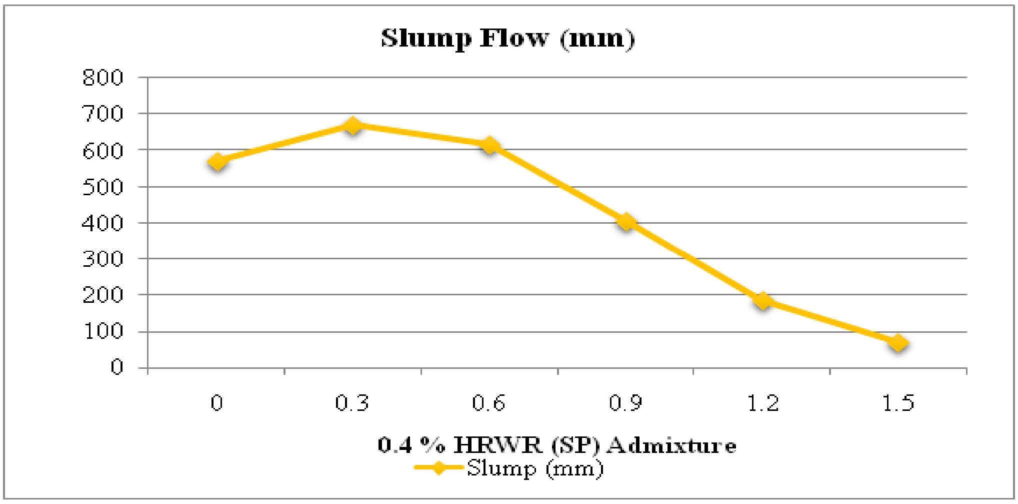

Fig 3: Slump Flow Value with Virgin Polypropylene and 0.4%HRWR-Super Plasticizer

Maximum value of Slump flow test for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 572mm after addition of HRWR and virgin Polypropylene this will reduced to 72mm in mix-6.

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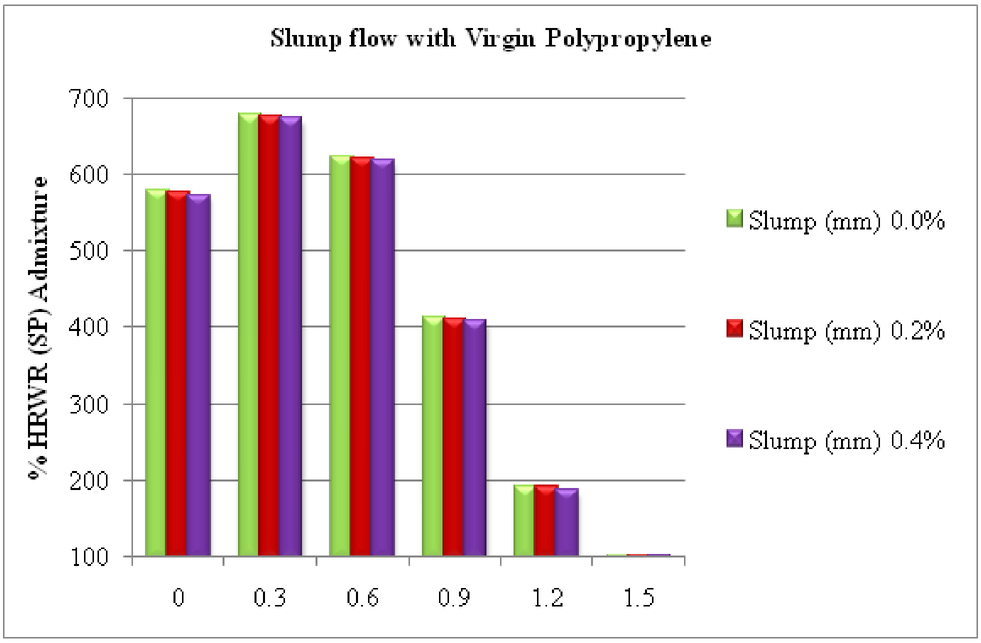

Fig 4: Slump Flow Value with Virgin Polypropylene and 0.0%, 0.2% and 0.4% HRWR-Super Plasticizer

V. CONCLUSION

- Maximum value of Slump flow test for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 577mm after addition of HRWR and virgin Polypropylene this will reduced to 77mm in mix-6.
- Maximum value of Slump flow test for 0.2% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 575mm after addition of HRWR and virgin Polypropylene this will reduced to 75mm in mix-6.
- Maximum value of Slump flow test for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 572mm after addition of HRWR and virgin Polypropylene this will reduced to 72mm in mix-6.
- Maximum value of Compressive Strength test at 7 days for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 24.28N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 33.24N/mm^2 in mix-2.
- Maximum value of Compressive Strength test at 7 days for 0.2 HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 25.64N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 34.60N/mm^2 in mix-2.
- Maximum value of Compressive Strength test at 7 days for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 26.67N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 35.63N/mm^2 in mix-2.
- Maximum value of Compressive Strength test at 14 days for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 31.28N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 35.35N/mm^2 in mix-4.
- Maximum value of Compressive Strength test at 14 days for 0.2 HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 33.28N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 37.35N/mm^2 in mix-4.
- Maximum value of Compressive Strength test at 14 days for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 35.28N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 39.35N/mm^2 in mix-4.
- Maximum value of Compressive Strength test at 28 days for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 35.47N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 44.25N/mm^2 in mix-3.

- Maximum value of Compressive Strength test at 28 days for 0.2 HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 37.47N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 46.25N/mm^2 in mix-3.
- Maximum value of Compressive Strength test at 28 days for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 39.47N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 48.25N/mm^2 in mix-3.
- Maximum value of Flexural Strength test at 28 days for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 4.853N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 5.420N/mm^2 in mix-3.
- Maximum value of Flexural Strength test at 28 days for 0.2 HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 4.988N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 5.542N/mm^2 in mix-3.
- Maximum value of Flexural Strength test at 28 days for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 5.119N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 5.660N/mm^2 in mix-3.
- Maximum value of In-direct tensile Strength test at 28 days for 0.0% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 3.284N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 4.097N/mm^2 in mix-3.
- Maximum value of In-direct tensile Strength test at 28 days for 0.2 HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 3.469N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 4.282N/mm^2 in mix-3.
- Maximum value of In-direct tensile Strength test at 28 days for 0.4% HRWR Super Plasticizer as admixture and varying of Cement substitute with Virgin Polypropylene is 3.655N/mm^2 after addition of HRWR and virgin Polypropylene this will increased to 4.468N/mm^2 in mix-3.

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