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AN EXPERIMENTAL INVESTIGATION ON POLYPROPYLENE FIBER REINFORCED CONCRETE USING REDMUD AS A PARTIAL REPLACEMENT OF CEMENT

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Abstract - *This experiment is conducted to investigate the performance of fresh and hardened concrete with replacement of cement by redmud in various percentages such as 5%,10%, 15%, and 20% and flyash used as an supplementary cementitious material in 20% (constant) to the total weight of cement. Polypropylene fiber are added to concrete in various percentages such as 0.5%,1%,1.5% and 2% to the total weight of concrete. Tests are conducted to determine the optimum percentage of polypropylene fiber. Based on test results obtained 1.5% of polypropylene fiber addition found to be optimum percentage of polypropylene fibers. The optimum percentage of polypropylene fiber 1.5% is used in the experiment. M_{25} grade of concrete performance is evaluated with respect to slump test, compressive strength, split tensile strength and flexural strength.*

Key Words: Redmud, flyash, Polypropylene Fibers, Compressive Strength, Split Tensile Strength, Flexural Strength

1.INTRODUCTION

Concrete is a second highest using material on earth. Carbon dioxide is a major atmospheric pollutant emission from cement production industries, because one ton of clinker produces one tonne CO_2 emission into the atmosphere. To control the pollution due to cement production, some of the industrial by-products like Redmud, Fly ash, GGBS etc.., are used as secondary cementitious materials.

Redmud is an industrial waste product generated in the bayer process of alumina production (Al_2O_3) from bauxite ore. Redmud contains 10-40% of iron content. Redmud and flyash are used as a replacement for cement in the production of concrete along with polypropylene fiber with different percentages. A supplementary cementitious material, when used in conjunction with Portland cement, contributes to the properties of the hardened concrete through hydraulic or pozzolanic activity or both. Polypropylene fiber increases tensile strength and reduce cracks.

2. LITERATURE REVIEW

Kaliprasanna Sethy et. al., (2019) [1]

Partly substitution of cement with redmud was occurred in this test for the improvement of redmud concrete. Complete five quantities of concrete created in lab to evaluate new and solidified attributes. This specific task works around the compelling use and reasonable of locally accessible redmud for the replacement with cement. The red mud rate for substitution of cement is differed from 0% to 20%. From the exploratory work it was tracked down that 5 to 10 rate substitutions have no huge impact on 28 days strength properties where as past 10% extraordinary drop in compressive strength was taken note. For every rate substitution of 10% compressive strength upsides of redmud substantial appearance more noteworthy strength esteem than regular concrete. Be that as it may, past 10% there is diminishing in the strength of ordinary concrete. Substitution of 15% compression strength upsides of redmud concrete to ordinary concrete. However, past 10% there is a decrease in the strength worth of the substantial. Ideal level of substitution of cement by weight is discovered is 10%. From this substitution results are more noteworthy than to the consequences of regular concrete. From the exploratory work was discovered that increment in redmud (more than 10%) diminishes the compressive strength just like tensile strength.

Amsa M et. al., (2018) [2]

This paper gives information of study of propertiesvof concrete containing polypropylene fiber. The properties contemplated incorporate unit weight and functionality of the new concrete. Compression, tensile and flexural strength of solidified concrete. Fiber volume portion are 0%, 0.2%,0.3% and 0.5%. The outcomes shows that utilizing polypropylene strands works on mechanical properties. It is shown that utilizing 0.5%vpolypropylene fiber increases split tensile and flexural strength. Silica fumes is utilized as concrete substitution material at 8% load of concrete. The addition of polypropylene strands had created setback for the beginning the corruption interaction by lessening permeability, decreasing in the measure of shrinkage and development of the concrete that

can fundamentally influence the life expectancy of the construction.

Sithar Pateliya et. al., (2017) [3]

This exploration researches tests conduct of red mud with cement. In this investigation cement supplanted with different level of redmud in concrete and looked at different mechanical properties. Redmud supplant with concrete beginning to 16 % to 24% at one percent span. That is checked for various 3 grades of cement M_{20}, M_{25} and M_{30}. The mechanical properties researched in this investigation incorporate compressive, split tensile, flexural strength and study on durability. The M_{20}, M_{25} and M_{30} grade of concrete expanded with expanding level of redmud up to 18% supplanting after compressive strength diminishing with expanding content of redmud. Compressive, Splitting Tensile, Flexural Strength and ductility ideal outcomes are get by utilizing redmud content of 18%.

Vinod Goud et. al., (2016) [4]

This exploration closes the investigation of the impact of flyash (0%, 10%, 20% and 30%) on concrete of grade M_{25}. 10% and 20% flyash addition gives maximum strength. for 30% flyash addition compressive strength of concrete declines.

Divya S dharan et. al., (2016) [5]

In this paper polypropylene fibers added to concrete from 0.5% to 2% at 0.5% interval. Workability tests and tests on hard concrete like compression, tensile, flexural strength and modulus of elasticity are done. for 1.5% of polypropylene fiber added gives 17% expansion in strength. 22% increase in split tensile, 24% increase in flexural strength and flexural strength and 11% increment in flexural strength concrete. The optimum percentage of PP is 1.5%.

D. Linora Metilda et. al., (2015) [6]

The Aim of the project is to explore the possibilities of cement replacement by redmud in concrete and conduct tests on strength properties of concrete. The test outcomes uncovered that 15% is ideal worth of substitution of cement with redmud past strength begins diminishing.

3. OBJECTIVES OF THE PROJECT

- To examine the workability characteristics of Polypropylene fiber reinforced concrete (PPFRC) and redmud PPFRC.
- To decide optimum percentage of polypropylene fiber utilized in M_{25} grade concrete by adding at different percentage 0.5%, 1.0%, 1.5% and 2.0%.
- To check the compressive, split tensile and Flexural strength, of M_{25} grade concrete by replacing cement with redmud (5%, 10%, 15% and 20%) and flyash (20%), and optimum percentage of polypropylene fiber is added to concrete.
- To determine the optimum content of polypropylene and redmud mix to further develop the strength properties.
- Comparison of results with conventional M_{25} grade concrete outcomes.

4. METHODOLOGY

This research is conducted to investigate the performance of fresh and hardened concrete with replacement of cement by Redmud (5%, 10%, 15%, and 20%) and Flyash used as an supplementary cementitious material (20%). . Polypropylene fiber are added to concrete in various percentages such as 0.5%,1%,1.5% and 2% to the total weight of concrete. Tests are conducted to determine the optimum percentage of polypropylene fiber. Based on test results obtained 1.5% of polypropylene fiber addition found to be optimum percentage of polypropylene fibers. The optimum percentage of polypropylene fiber 1.5% is used in the experiment. M_{25} grade of concrete performance was evaluated with respect to compressive strength, split tensile strength, flexural strength.

5. EXPERIMENTAL INVESTIGATION

5.1Test on fresh concrete

Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labour and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e. without bleeding or Segregation. The workability of concrete is measured by compaction factor test and slump test.

5.2 Test on hardened concrete

Various tests on hardened concrete is done to ensure the design strength of concrete and quality of concrete construction is achieved. It includes compressive strength test, flexural tensile strength test and split tensile strength test

6. MIX DESIGN

Concrete mix proportion

Cement = 329 kg/ m^3
Water = 148 lt/ m^3
Coarse aggregate = 1106.4 kg/m^3

Fine aggregate = 845 kg/ m^3
Chemical admixture = 6.58 kg/m^3

w/c ratio = 0.45

Mix Ratio = 1 : 2.57 : 3.36

Mix Designation	% of Flyash	% of PPF	% of Redmud
M_1	0%	0%	0%
M_2	20%	1.5%	5%
M_3	20%	1.5%	10%
M_4	20%	1.5%	15%
M_5	20%	1.5%	20%

7. RESULTS AND DISCUSSIONS

7.1SLUMP TEST RESULTS

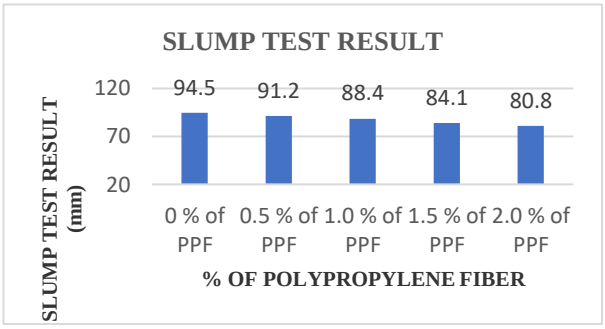

Chart -1: SLUMP TEST RESULTS FOR PPFRC

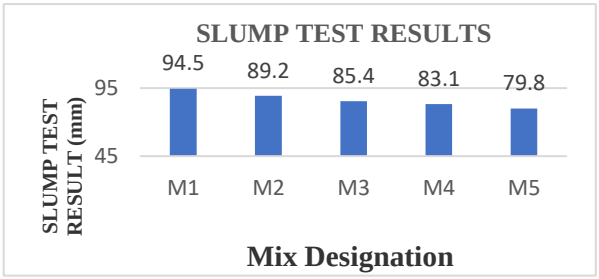

Chart -2:SLUMP TEST RESULTS FOR REDMUD PPFRC

The slump values of polypropylene fiber reinforced concrete are decreased by 3.49%, 6.45%, 11% and 14.49% for 0.5%, 1.0%, 1.5% and 2.0% of polypropylene fibers addition respectively when compared to conventional concrete.
The slump values of redmud PPFRC are decreased by 5.39%, 9.62%, 12.06% and 15.55% for M2, M3, M4 and M5 mixes respectively when compared to conventional concrete.

7.2 COMPRESSIVE STRENGTH TEST RESULTS

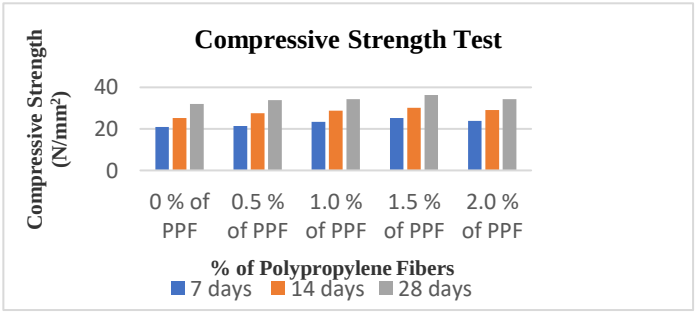

Chart -3: COMPRESSIVE STRENGTH OF PPFRC

The compressive strength values for polypropylene fiber reinforced concrete are increased upto 1.5% polypropylene fiber addition. For 2% polypropylene fiber addition compressive strength begins decreasing.

It is seen that 17.05% increase in compressive strength for 7 days, 17.02% increment in compressive strength for 14 days and 11.93% increment in compressive strength in 28 days for 1.5% of polypropylene fiber addition compared with regular concrete mix.

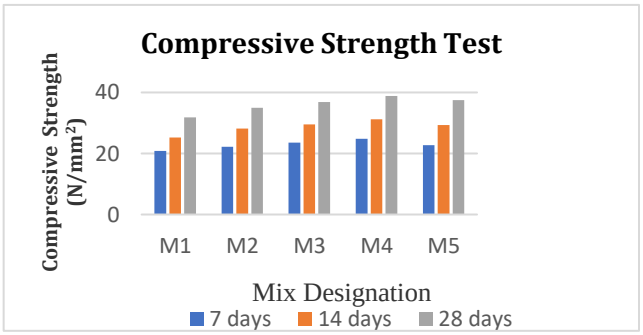

Chart -4: COMPRESSIVE STRENGTH OF REDMUD PPFRC

The compressive strength results for redmud PPFRC are increased upto 15% replacement of cement by redmud after 15% compressive strength begins decreasing.

The 15% replacement of redmud gives 16.05% higher compressived strength than the conventional concrete for 7 days, 19.2% higher compressive strength for 14 days and 18.01% higher compressive strength for 28 days.
The maximum compressive strength is obtained for M4 concrete mix compared with other concrete mix.

7.3 SPLIT TENSILE STRENGTH TEST RESULTS

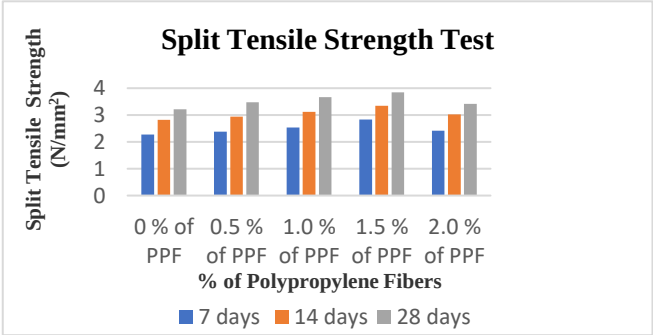

Chart -5: SPLIT TENSILE STRENGTH OF PPFRC

The spilt tensile strength values for polypropylene fiber reinforced concrete are increased upto 1.5% polypropylene fiber addition. For 2% polypropylene fiber addition spilt tensile strength begins decreasing.

It is seen that 19.71% increment spilt tensile strength for 7 days, 15.82% increment in spilt tensile strength at 14 days and 18.48% increment in spilt tensile strength in 28 days for 1.5% of polypropylene fiber addition compared with normal concrete.

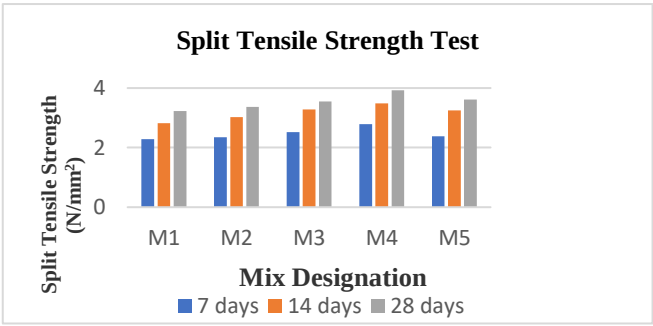

Chart -6: SPLIT TENSILE STRENGTH OF REDMUD PPFRC

The spilt tensile strength results for redmud PPFRC are increased upto 15% replacement of cement by redmud above 15% spilt tensile strength begins decreasing.

The 15% replacement of redmud gives 17.98% higher spilt tensile strength than the conventional concrete for 7 days, 18.96% higher split tensile strength for 14 days and 17.85% higher spilt tensile strength for 28 days.

The maximum spilt tensile strength is obtained for M4 concrete mix compared with other concrete mix.

7.4 FLEXURAL STRENGTH TEST RESULTS

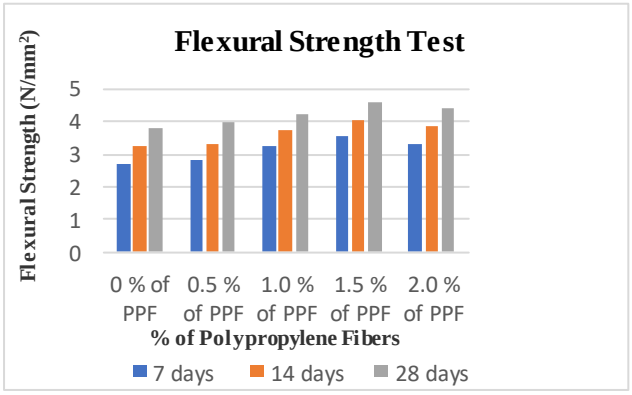

Chart -7: FLEXURAL STRENGTH FOR PPFRC

The flexural strength values for polypropylene fiber reinforced concrete are increased upto 1.5% polypropylene fiber addition. For 2% polypropylene fiber addition flexural strength begins decreasing.

It is seen that 23.8% increases flexural strength for 7 days, 20.58% increment in flexural strength at 14 days and 17.31% increment in flexural strength in 28 days for 1.5% of polypropylene fiber addition compared with traditional concrete mix.

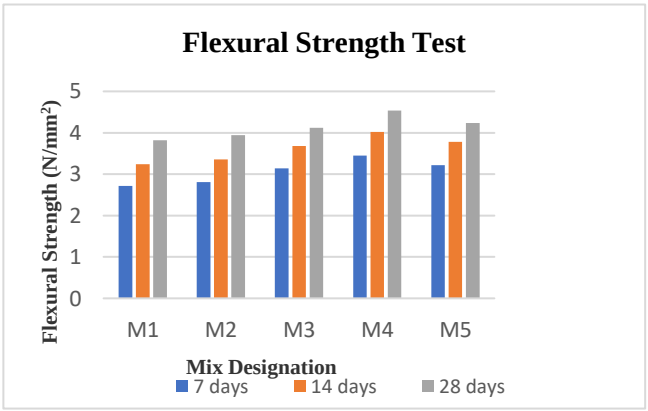

Chart -8: FLEXURAL STRENGTH FOR REDMUD PPFRC

The flexural strength results for redmud PPFRC are increases upto 15% replacement of cement by redmud above 15% flexural strength begins decreasing.

The 15% replacement of redmud gives 21.15% higher flexural strength than the ordinary concrete for 7 days, 19.4% higher flexural strength for 14 days and 15.85% higher flexural strength for 28 days.

The maximum flexural strength is obtained for M4 concrete mix compared with other concrete mix.

8. CONCLUSIONS

- From the test results it is seen that the workability of concrete slightly decrease with increase in percentage of polypropylene fiber addition. It is seen that 11% of workability decreased for 1.5% of polypropylene fiber addition compared to conventional concrete.
- Based on the test results obtained it is observed that the compressive strength, split tensile strength and flexural strength for 1.5% polypropylene fiber reinforced concrete are increased by 11.93%, 18.48% and 17.31% respectively when compared to conventional concrete at 28 days of curing. Hence optimum percentage polypropylene fibers utilized in concrete is 1.5% of total weight of concrete.
- The polypropylene fibers addition in concrete increases the strength of concrete this is maybe due to decrease in early age shrinkage and moisture loss of the concrete mix.
- From the test results it is seen that the workability of concrete slightly decrease with increase in percentage of redmud and flyash replacement. It is seen that 12.06% of workability decreased for M4 concrete mix compared to conventional concrete.
- Based on the test results obtained it is observed that the compressive strength, split tensile strength and flexural strength for M4 concrete mix are increased by 18.01%, 17.85% and 15.85% respectively when compared to conventional concrete at 28 days of curing.
- Red mud speeds up the heat of hydration in concrete and it prompts increase in strength of concrete.
- Optimum level of redmud replacement in concrete is found to be 15%.
- In redmud polypropylene fiber reinforced concrete 35% of cement is replaced by 15% redmud and 20% flyash.

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