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Experimental Study on Strength Properties of Red Mud Concrete with the addition of steel fibre

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ABSTRACT: Concrete is the most used construction material in construction industries all over the world. Concrete is a composite material composed of fine and coarse aggregate with a fluid cement that hardens over time. In recent times, the metallurgical industries contribute significantly towards generation of industrial wastes and creation of substantial environmental pollution. Such a type of industrial waste is bauxite residue which contains high concentration of red mud. This paper is an overview of utilization of red mud in concrete and reduces the impact on the environment. The production of 1 ton alumina generates 1-2 ton of red mud. The cement industry is the second largest producer of the green house gas. To overcome these environmental problems there is a need of cost effective and alternatively innovative materials to be used in concrete. It reviews comprehensively the disposal and neutralization methods of red mud and gives the detailed assessment of the work carried until now for the utilization of red mud in fields. In this, cement can be partially replaced by cement with certain percentages 0%, 5%, 10%, 15% and 20%. An attempt is made here to study the effect of addition of a small percentage of steel fibres on the improvement of compressive strength of red mud concrete. Steel fibres in varying proportions such as 0, 0.5, and 1% are added to red mud concrete. This study describes about such utilization and their effective usage in the concrete.. Various mixes with different proportions of these industrial wastes were casted and tested. **Keywords:** Compressive Strength, Steel slag, Water Absorption, Paver Block.

I. INTRODUCTION

Disposal of industrial by-products into the environment may cause major issues and this can be overcome by utilising industrial wastes in the construction industry, thereby protecting the environment. In recent times, the metallurgical industries contribute significantly towards generation of industrial wastes and creation of substantial environmental pollution. Red mud (bauxite residue) is an industrial waste of aluminium industry formed during Bayer's process in the reaction of bauxite-ore with caustic soda. Such a type of industrial waste is bauxite residue which contains high concentration of red mud. Proper disposal red mud costs companies around 5% of production value of minimum and a huge land area is required for storage of red mud. Hence utilization of red mud is necessary in several areas such as cement production, road construction, geo polymers, metal extraction, waste water treatment, recovery of rare earth metals, etc. Replacing natural raw materials in concrete with industrial wastes may offer a much sought after opportunity to mitigate today's waste management problems. Upgrading industrial waste to alternative raw materials in concrete is both technically and economically advantageous for a wide range of applications, including the fabrication of concrete and mortars. The search for an economically and environmentally viable alternative has led to the study of red mud for various applications in construction industry. Use of natural fibres has been gaining momentum due to lower cost, easy availability and non hazardous nature.

II LITERATURE REVIEW

Kaliprasanna Sethy et al (2019) studied the effects of red mud used as a partial replacement of cement in concrete production. In this study cement is partially replaced by cement in different proportions (0%, 5%, 10% and 15%). Various tests like compression strength, split tensile strength and flexural strength of concrete were performed. In this experimental study, M20 grade concrete was used. The compressive strength of the mixtures at the ages of 7 and 28 days were studied. It was concluded that red mud replaced beyond 15% affects the concrete standards. So, the replacement % up to 15 can be effectively used as cement for good concrete production.

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Keneth Celestine et al (2019) investigated the influence of steel fibre and also compare the performance. Concrete containing steel fibres was evaluated and four different fibre dosages of 0.5%, 1%, 1.5% and 2% were used. This tells us an experimental study o compressive, flexural and split tensile strength at the age of 7 and 28 days. The fibres in concrete deep beams prepares a improved crack control and deformation characteristic of beam. Maximum compressive strength was observed for steel fibre at a dosage of 1.5%.

M.P. Deshmukh et al explained that the effect of addition of small percentage of steel fibres on the improvement of compressive strength of red mud concrete. Steel fibres in varying proportions such as 0, 0.25, 0.5, 0.75 and 1% are added to red mud concrete, prepared by 20% replacement of cement with red mud. Author concluded that addition of 0.25% steel fibre to red mud concrete gives better compressive strength than cement concrete reinforced with 0.25% of steel fibres. Hence the red mud and fibre is used as a combination as partial replacement of cement to improve compressive strength of the composite.

Biao Li et al (2019) studied the flexural behaviour of steel polypropylene hybrid fibre reinforced concrete on 51 samples using four point bending tests. Monofilament polypropylene fibre and three types of steel fibres i.e., straight, hooked end and corrugated fibre are used. Four fibre volume fraction of 0.5%, 1%, 1.5% and 2% corrugated steel fibre with the aspect ratios of 40, 60 and 80 were taken and three volume fractions of 0.1%, 0.15% and 0.2% of polypropylene fibre were respectively adopted. Tests like compressive strength, tensile strength and flexural behaviour in terms of load deflection curves, toughness, cracking properties as well as synergetic effect of hybrid fibres is studied. An increase in the volume fractions for both steel and polypropylene fibres leads to an increase in the flexural strengths and post peak ductility of concrete.

Linora Metilda et al (2016) investigated that optimum possibility of replacing cement partially by red mud in concrete and evaluating its compressive strength split tensile and flexural strength. This study examines the effect of red mud on the properties of hardened concrete and they are using various proportions of red mud such as 0%, 5%, 10%, 15%, 20% and 25% with design mix concrete of grade M30. They observed that the rate of gain in strength properties increases with increase in red mud content up to 15% and then it started decreasing. Author concluded that red mud up to 15% is effectively used and also it can be used as an innovative supplementary cementitious alternative.

III MATERIALS FOR RED MUD CONCRETE

- ✓ Fine Aggregate
- ✓ Coarse aggregate
- ✓ Cement
- ✓ Red Mud
- ✓ Steel Fibre

3.1 FINE AGGREGATE

A concrete with better quality can be made with sand consisting of rounded grains rather than angular grains. River or M-sand sand must be used but sand from sea which contains salt and other impurities. In this study, M-sand has been used as fine aggregate.

3.2 COARSE AGGREGATE

Locally available crushed stone aggregates of nominal size 20mm wherever possible size of aggregate 20mm used in the project.

3.3 CEMENT

Cement is a binding material in concrete which binds the other material to forms a compact mass. It is a substance used for construction that sets, hardens and adheres to other materials to bind them together.

3.4 RED MUD

Red mud, also known as bauxite residue is an industrial waste generated during the refinement of bauxite into alumina using the Bayer process. It is composed of various oxide compounds, including the iron oxides which give its red colour. Over 95% of the alumina produced globally is through the Bayer process, for every tonne of alumina produced approximately 1 to 1.5 tonnes of red mud are also produced. Annual production of alumina was approximately 126 million tonnes resulting in the generation of over 160 million tonnes of red mud.

3.5 STEEL FIBRE

Steel fibre are used as a reinforcement material for concrete. Different types of steel fibres are available with different aspect ratios. When steel fibres are added to Portland cement concrete or refractory concrete, the flexural strength of the composite is increased from 25% to 100% depending on the proportion of fibres added. It has effect in reducing plastic shrinkage cracking, increases the tensile strength and toughness, resistance to freezing & thawing and reduces the

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maintenance & repair cost. In this hooked steel fibres are used.

IV EXPERIMENTAL PROCEDURE

` This investigation has to study the strength properties and workability of concrete with the addition of the steel fibre of 1%. Specimens were casted at different percentages. Initially the mould is oiled to ease the removal of specimen from the mould. The specimens were casted in a way that the specimens were free from voids. The top surface are smoothened and kept undisturbed for 24 hours. Cubes are casted for compression test , cylinders are casted for tensile strength and prisms were tested for flexural strength.

4.1 COMPRESSIVE STRENGTH

Cubes of size 150 x 150 x 150 mm were casted and to study the compressive strength of concrete with the steel fibre of 1%. The compressive strength for M25 grade concrete were listed in the table. It is observed that the maximum compressive strength were obtained at 15 % replacement of cement of red mud.

% of red mud	At 7 days (N/mm^2)	At 28 days (N/mm^2)
0%	15.26	33.74
5%	15.72	34.39
10%	16.83	36.61
15%	17.57	39.42
20%	16.21	36.94

Table 4.1 Compressive strength Result

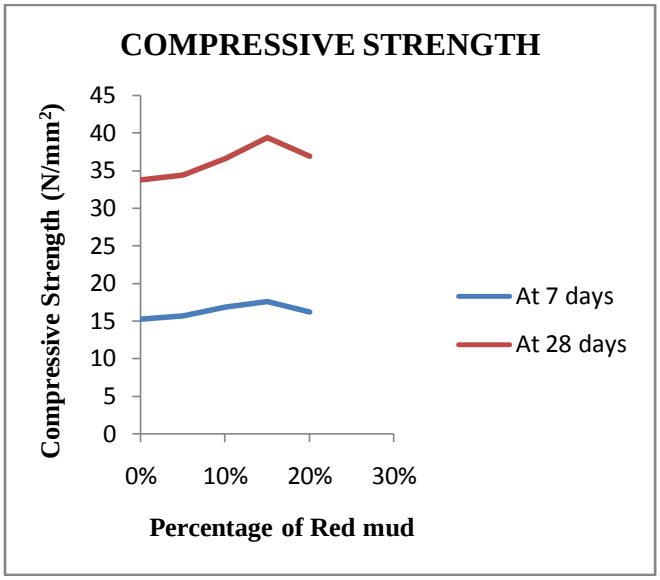

Fig 4.1 Compressive strength Result

4.2 SPLIT TENSILE STRENGTH

The cylinders were tested and split tensile strength of concrete at 28 days are presented in table. The variation of spilt tensile strength were observed from the partial replacement of red mud with the addition of steel fibres. It is observed the the split tensile strength of red mud concrete increases up to 15% and then gradually decreases.

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% of red mud	At 7 days (N/mm^2)	At 28 days (N/mm^2)
0%	3.45	3.89
5%	3.59	4.56
10%	3.73	4.98
15%	3.96	5.82
20%	3.71	4.72

Table 4.2 Split Tensile strength Result

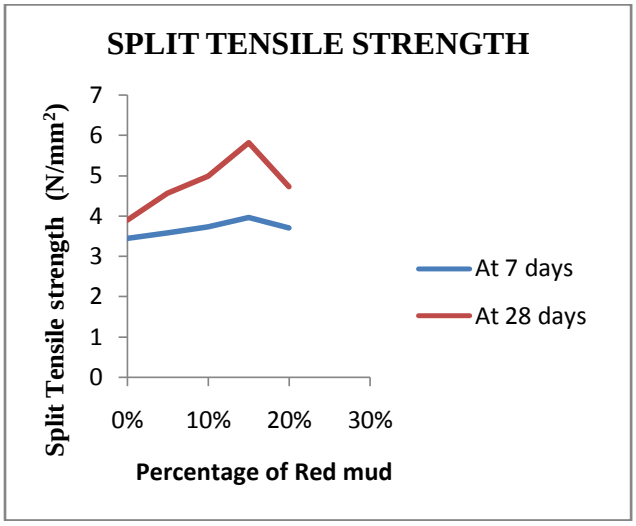

Fig 4.2 Split Tensile strength Result

4.3 FLEXUAL STRENGTH

All the samples are tested in flexural testing machine and the values are shown in the table. It is observed that the flexural strength increases at 15% of replacement of red mud and then it started decreasing.

% of red mud	At 7 days (N/mm^2)	At 28 days (N/mm^2)
0%	3.29	4.15
5%	3.52	4.56
10%	3.71	4.88
15%	3.92	5.06
20%	3.82	4.84

Table 4.3 Flexural strength Result

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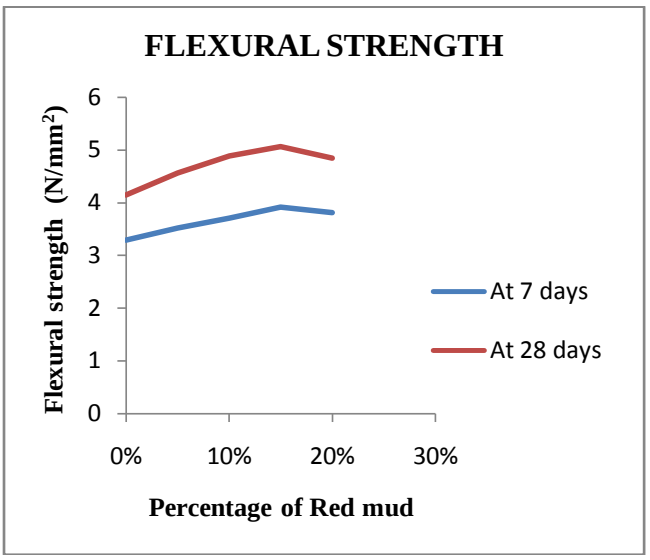

Fig 4.3 Flexural strength Result

V CONCLUSION

In our effort to utilize red mud and steel fibre in concrete, we have to identify the optimum percentage of red mud and steel fibre can be replaced in concrete to attain the high strength. The choice of selecting red mud as a replacement is 15% material not only increases the strength, but also protects the environment as it is one of the source for causing environmental pollution. The optimum percentage has been identified by compression test, split tensile test and flexural strength test.

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