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Impact of Steel Scrap on Compressive Strength of Concrete

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Abstract – The investigation reported in this paper was carried out to study the feasibility of using steel scrap obtained from lathe machine in fibre reinforced concrete by checking the compressive strength and splitting tensile strength of M20 concrete and thus optimizing the fibre proportions.

Key Words – Steel Scrap Fibre, Aspect Ratio, Compressive Strength, Tensile Strength

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INTRODUCTION

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that Fibre Reinforced Concrete (FRC) provide improvements in tensile strength, toughness, ductility, post cracking resistance, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. Due to these benefits, the use of FRC has increased during the last two decades. Literature survey indicates that very limited study has been conducted on FRC using industrial waste fibres. In the present experimental investigation, an attempt will be made to analyze the mechanical characteristics of the waste steel scrap material which is available from the lathe machine is used as a steel fibre in cement concrete for various construction works and to optimize fibre content. Scrap Steel Fibre Reinforced Concrete is a composite material consisting of hydraulic cement, sand, coarse aggregate, water and fibre (steel scrap). Furthermore, with increase in population and industrial activities, the quantity of waste fibres generated from various metal industries will increase in the coming years. These industrial waste fibres can effectively be used for making high-strength low-cost FRC after exploring their suitability. The outcome of this project shall be useful for various industries and workshop generating steel scrap from lathe machine. Their scrap material will get more cost and concrete with innovative properties will be produced.

CONVENTIONAL REINFORCED CONCRETE

Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal microcracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such microcracks, eventually leading to brittle fracture of the concrete. In the past, attempts have been made to impart improvement in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to the concrete members, they however, do not increase the inherent tensile strength of concrete itself. In plain concrete and similar brite materials, structural cracks (micro-cracks) develop even before loading, particularly due to drying shrinkage or other causes of volume change. When loaded, the micro cracks propagate and open up, and owing to the effect of stress concentration, additional cracks form in places of minor defects. The structural cracks proceed slowly or by tiny jumps because they are retarded by various obstacles, changes of direction in by passing the more resistant grains in matrix. The development of such micro-cracks is the main cause of inelastic deformations in concrete. Thus need for multidirectional and closely spaced steel reinforcement arises. That can't be practically possible. Steel fibre reinforcement gives the solution for this problem. The addition of small, closely spaced and uniformly dispersed fibres to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as Fibre Reinforced Concrete (Prakash et al., 2006). Fibre Reinforced Concrete: Fibre reinforced concrete is a concrete mix that contains short discrete fibres that are uniformly distributed and randomly oriented. As a result of these different formulations, four categories of fibre reinforcing have been created. These include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres the character of Fibre Reinforced Concrete changes with varying concrete's fibre materials, geometries, distribution, orientation and densities. The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed Volume Fraction (V). V typically ranges from 0.1 to 3%. Aspect ratio (l/d) is calculated by dividing fibre length (l) by its diameter (d). Fibres with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the modulus of elasticity of the fibre is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increase in the aspect ratio of the fibre usually segments the flexural strength and toughness of the matrix. However, fibres which are too long tend to "ball" in the mix and create workability problems (Shende, 2011).

APPLICATIONS:

1) Rock slope stabilization and support of excavated foundations, often in conjunction with rock and soil anchor systems.

2) Industrial floorings, road pavements, warehouse, Foundation slabs.

3) Channel linings, project bridge abutments.

4) Rehabilitation of deteriorated marine structure such as light stations, bulkheads, piers, sea walls and dry docks.

5) Rehabilitation of reinforced concrete is structure such as bridges, chemical processing and handling plants.

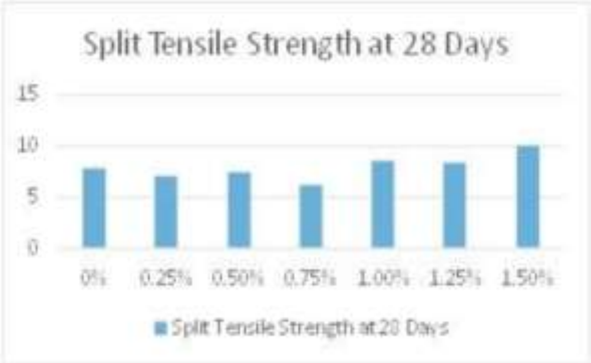
MATERIALS AND METHODS

Portland Pozzolona cement of Birla gold conforming to IS 269-1976 and IS 4031-1968 was adopted in this work. The cement used is 53 grade. Coarse aggregate: The aggregate used in this project mainly of basalt rock which comes under normal weight category. The aggregates are locally available. 50% of the aggregate used are of 10-12 mm size and remaining 50% are of 20mm size. The coarse aggregate was also tested for various properties like impact value test, crushing value test, elongation and flakiness index test to check their suitability for the experiment. The impact value and crushing value is 7.49% and 24.40% respectively which are under limits as per Indian standards. Sand: Natural sand which is easily available and low in price was used in the work. It has cubical or rounded shape with smooth surface texture. Being cubical, rounded and smooth texture it give good workability. Sand which is used here is taken from Girna River. Particles of this sand have smooth texture and are blackish. Sieve analysis was done to find out fineness modulus which comes out to be 3.14% which is under limit as per IS 383-1970. Scrap Steel Fibre: Steel Scraps of length 20 mm to 30 mm, width 1.5 to 2 mm and thickness 0.3 to 0.6 mm which is obtained from the lathe machines as waste or by product was used as reinforcing material in the concrete. So, the aspect ratio will vary from 50 to 70. The shape of its cross- section is polygonal with bright and twisted appearance. It possess high modulus of elasticity (about 200 GPa). Concrete Mix Design: In the present study, M20 grade with nominal mix as per IS 456-

2000 was used. The concrete mix proportion (cement: fine aggregate: coarse aggregate) is 1: 1.5: 3 by volume and a water cement ratio of 0.5. Casting and Testing Detail: Total number 21 cubes and 21 cylinder were casted. Scrap Steel Fibre were added in concrete in 5 different percentage starting from 0.0%, and raised the mixing of Scrap Steel fibre upto 1.5%, at an interval of 0.25%. For each percent of scrap steel fibre addition, 3 cubes and 3 cylinders were casted. Final strength of cube and cylinder were tested after 28 days curing. Compression testing machine is used for testing the compressive strength of cube and split tensile strength of cylinder. The crushing loads were noted and average compressive strength and tensile strength for three specimens is determined for each which is given in tables respectively.

RESULTS AND DISCUSSIONS

A graphical representation of the compressive strength test result plotting percentage of scrap steel fibre in abscissa (X- axis) and compressive strength of concrete at ordinate (Y- axis) is shown in fig.1.From the graph, it is observed that the addition of fibres in the concrete increases the Compressive Strength.In M20 concrete, 0.25% steel dosage shows 22.81% of higher strength than control concrete and 1.0% and 1.5% steel dosage shows 25.50% and 49.31% higher strength than control concrete respectively.With the inclusion of scrap steel fibre, the strength of concrete gradually increases upto a certain limit but then gradually decreases. A graph is drawn showing the variations in split tensile strengths at different percent of scrap steel fibre as shown in fig.2. With the inclusion of scrap steel fibre, the tensile strength gain in concrete is high. In M20 concrete, 0.25% steel dosage decrease of higher strength than control concrete and 1.0% and 1.5% steel dosage shows 8.0% and 26% higher strength than control concrete respectively. In all the SSFRC cylinders, the specimen was not broken into two as that of control concrete.



SPLIT TENSILE STRENGTH

CONCLUSION

The study proves that the mechanical properties of the concrete are increased by increasing the proportion of the steel scrap up to 1.5%. Addition of scrap steel fibres to concrete increases the compressive strength of concrete. The percentage increase in tensile strength of SSFRC is less as compared to its compressive strength. By the addition of scrap steel fibres. Thus, Scrap steel fibre obtained from lathe machine industry as a waste can be used in an innovative way in minor amount as an additive to enhance the properties of concrete. In this way, the scrap steel fibre can be used as a substitute for factory made steel fibre.

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