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Study on Properties of Concrete Using Steel Burr in M30 Design Mix

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Abstract

Scarcity of resources and the need to reduce the environmental impacts of winning and processing construction materials and products is placing a greater emphasis on resource efficiency within the construction industry. In this study steel burr are used as construction materials which is commonly created after machining operations such as grinding, drilling, milling, engraving or turning etc. These scrap steel can be recycled by using it as a additional admixture in concrete to increasing the strength of the concrete.

In this project we choose that lathe steel burr as additive material for the M30 design concrete mix. First properties of material like cement, fine aggregate, course aggregate and water are identified then the properties of steel burr are identified and it's added in various percentage like 0%, 3%, 5% and 7% and the mechanical properties of object are identified. The mechanical properties of burr added concrete specimens compared with the conventional concrete specimens. In this work M30 grade of concrete with w/c ratio of 0.45 is used for conventional concrete mix. The strength and durability properties of steel burr concrete are better when compared to the conventional concrete up to a maximum adding of 5% steel burr. The maximum compressive strength is 4% more and split tensile strength is about 14% more than the conventional concrete.

Keywords: Steel burr • Compressive strength • Flexural strength • Mechanical properties

Introduction

Concrete is the primary building material utilised in modern civil engineering projects. The use of fibre reinforcement in concrete highlighted the benefits of construction approaches. Fibre reinforced concrete is a type of concrete that has the potential to be used due to its advantages in enhanced monotony, energy absorption, dynamic tensile strength and fatigue strength [1]. The addition of fibres by homogeneous dispersion in the concrete stimulates isotropic characteristics, which is not observed in standard concrete without fibres. The introduction of fibres in concrete has solved the problem of microcracking in concrete, which causes early concrete degradation. In comparison to normal concrete, fibres utilised as micro-reinforcements in concrete produced better outcomes [2].

Fibre reinforced concrete is made up of cement, water, aggregate and fibres. It is primarily composed of aggregate, cement and water, with fibres added to the traditional concrete mix. The addition of fibres to concrete can improve its mechanical characteristics, compressive strength, split tensile strength and durability [3]. The addition of steel fibres to the concrete matrix can significantly improve the strength and hardness of the concrete, particularly for high strength concrete.

Despite a number of recent studies aimed at determining the overall mechanical properties of high strength Fibre Reinforced Concrete (FRC), quantitative assessments of load distribution between reinforcement and matrix, as well as fibre bridging for opening fractures, are sparse [4]. As a result, the current work focuses on high strength fibre reinforced concrete in the context of multi-scale analyses. To simulate the behaviour of fibre reinforced concrete at the meso-level, a better numerical model is constructed. Steel fibres are represented by a large number of truss elements placed at random within the concrete matrix. The concrete is represented by a 3D solid element [5].

Micro-mechanics resolves the homogenised stress and strain in the continuum level based on the stress and strain distributions modelled at the meso-level. The multi-scale damage model might also be used to calculate the homogenised damage evolution curve, which is necessary for the continuum damage model-based structural nonlinear analysis. The suggested method provides a hierarchical multi-scale framework for investigating the nonlinear behaviour of FRC structures [6].

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Flexural power

The primary function of fibre is to reduce fractures in concrete and to increase the flexibility of the concrete parts. The cracking behaviour of concrete has improved due to the fibre content in the concrete. It also minimises concrete permeability and water bleeding. Steel fibre is a very frequent type of fibre. Steel fibre converts brittle concrete into ductile concrete. It also helps to reduce cracks [7].

Concrete is the primary engineering material utilised in the majority of civil engineering projects. It is widely utilised due to its great compressive strength and ability to be moulded into any desired shape. Fibres are added into the matrix to compensate for concrete's low tensile strength. Burr wastes obtained from the CNC turning process in the lathe business were discarded of as wastes in open lands near the enterprises, posing an environmental threat. As a result, these wastes were evaluated as fibre material as micro-reinforcements in concrete. Burr wastes were mixed with concrete in volume fractions ranging from 0% to 2.0% and tested for split tensile strength, compressive strength and flexural strength [8].

The Indian construction industry consumes about 400 million tons of concrete every year and it is expected that this may reach a billion tons in less than a decade. Basically concrete consists of aggregates which are bonded together by cement and water. The major part of concrete besides the cement is the aggregate. Aggregate include sand and crushed stone/gravel. All these materials required to produce such huge quantities of concrete come from the earth̀s crust, thus depleting its resources every year creating ecological strains. So, we are planned to utilize the steel wastes for the requirement of high strength concrete. On the other hand human activities on earth produce solid wastes in considerable quantities to the extent of over 2500 million tons per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies. Recent technological development has shown that these materials are valuable inorganic and organic resources and can produce various useful products [9].

During the 20th century there was an increase in the consumption of mineral admixtures and granite stones by the concrete industries. Due to over exploitation of granite stones for construction, scarcity of granite stones occur and it will lead to illegal mining. The illegal mining has a curse destroying the fragile ecosystem. To reduce the granite consumption in concrete the steel burr as additional admixture is proposed. It is a mixture of cement, sand, coarse aggregate and steel waste like burr and water. This concrete can be used for both load bearing and non-load bearing structures. Now a day the waste recycling is crucial problem. Hence, to decide on the best ways of making steel waste useful and profitable [10].

Materials and Methods

Concrete is the 2nd most used material on the earth after water. According to the surveys, 58% of concrete production increases CO_2. So, the best way to decreases the content of CO_2 some other admixtures were replaced with cement. To improve the properties of concrete with the help of many other materials like silica fume, fly ash, metakoalin, GGBS, rice husk ash, etc. These admixtures play an important role in the formation of concrete. A new high performance hybrid material has been developed by combination of Ground Granulated Blast Furnace Slag (GGBS) and steel fiber. So, the advantages of both materials, namely high strength, durability, surface quality and cost efficient production. It can be implemented in one hybrid material. Hybrid concrete is which integrates precast concrete and cast in situ concrete to make best advantages of their different inherent qualities. Researchers at all over the world are attempting to develop high performance concrete by using hybrid material. Fibers provide improvements in tensile strength, durability, shrinkage characteristics of concrete. GGBS improve mechanical and durability properties of concrete. Concrete has high compressive strength but, weak in tensile. So, to improve the behavior of tensile in concrete we used stainless steel fibers. The main reason for incorporating fiber with cement matrix is to increase the tensile strength, flexural strength of concrete and also it improves the cracking deformation characteristics of the concrete composite.

Steel waste

Steel wastes are commonly created after machining operations such as grinding, drilling, milling, engraving or turning etc. Steel burr is available in plenty from various industries, lathes etc, to make product as part of its production process. A construction industry in India generates around 10 to 20 million tones of waste annually. This steel wastes are a great environment threat causing damage to the land and the surrounding area in which it is dumped. Economical disposal of this steel waste is a problem of growing concern to the steel industries. Steel burr particles can be used to cement blocks and slabs, hard base flooring. Steel burr presently used to manufacture heavy flooring required areas. Steel burr fibers combined with water and cement can be used to produce cement-bonded material. Steel burr fiber can also be mixed with chemical admixture to produce strengthened concrete. Steel burr is an ideal material to produce heavy weight concrete [11].

Steel burr concrete

Steel burr used concrete offers a speedier, cost effective, environmentally sound alternative to conventional concrete materials. It is based on the principle of densification of a lean concrete mix to make a regular shaped, uniform, high performance concrete. Steel burr concrete technology can be easily adapted to suit special needs of users by modifying design parameters such as mix proportion, water/cement ratio and type of production system. This technology has high potential in areas where raw materials are easily available. The basic raw materials are cement, fine aggregate, coarse aggregate, steel burr and water.

The unique features of steel burr concrete are as follows:

- Cost effective compared to other traditional systems.
- Maximum utilization of wastes and local resources.
- Structural performance can be engineered.
- Offers business opportunities.

Water

Water should be free from all injurious amounts of acids, organic and inorganic impurities. And it should be used for proper mixing and curing of concrete.

Results and Discussion

Steel burr

Steel wastes are commonly created after machining operations such as grinding, drilling, milling, engraving or turning etc [12]. Steel burr is available in plenty from various industries, lathes etc to make product as part of its production process (Figure 1). The various physical properties of steel burr waste were determined and given in Table 1.

Figure 1. Steel burr.

Sl. no.	Properties	Experimental values
1	Tensile strength (min.) in Mpa	410
2	Bend test	3t* (*t is 3 times thickness)
3	% of elongation at gauge length 5.65	23%
4	Compressive strength	>20 mm, 20 mm-40 mm, <40 mm

Table 1. Physical properties of steel burr.

Cement

Cement is the important binding material in concrete. Portland Pozzolona cement is the common form of cement. It is the basic ingredient of concrete, mortar and plaster. It consists of mixture of oxides of calcium, silicon aluminum and fly ash.

Cement of various strengths is available. Depends on the requirement of concrete, it is to be chosen. Portland Pozzolona Cement (PPC)-43 grades confirming to IS: 1489-1991 (part-1) was used. The various properties of cement were tested and their values are given in Table 2 [13].

Sl. no.	Properties	Experimental value	Permissible limits as per IS: 1489-1991
1	Fineness (by sieving)	390 m^2/kg	Not less than 300 m^2/kg
2	Specific gravity	3.15	Not less than 3.15
3	Normal consistency	33.5%	-
4	Initial setting time	150 minutes	Not less than 30 min
5	Final setting time	03 hours 45 minutes	Not more than 10 hours

Table 2. Physical properties of cement.

Fine aggregate

Fine aggregate, which may be granular material or crushed stone, is a fundamental component of concrete. The quality of the fine aggregate and the density of the fine aggregate both have a significant impact on the hardened qualities of the concrete. The properties of fine aggregate (river sand) are determined by conducting test in accordance with IS: 2386 (part-I)-1963. The physical properties of fine aggregate are given in Table 3.

Sl. no.	Properties	Experimental value
1	Fineness modules	2.81%
2	Specific gravity	2.61%
3	Water absorption	1.23%

Table 3. Physical properties of fine aggregate.

Coarse aggregate

Crushed stone coarse aggregate conforming to IS: 383-1987 was used. The values of loose and compacted bulk density values of coarse aggregates were 1600 and 1781 kg/m^3 respectively and physical properties are given in Table 4, Figures 2 and 3.

Sl. No.	Properties	Experimental values
1	Specific gravity	2.884%
2	Fineness modulus	7.2%
3	Water absorption	0.97%
4	Crushing strength	9.26%
5	Impact value	6.44%

Table 4. Physical properties of coarse aggregate.

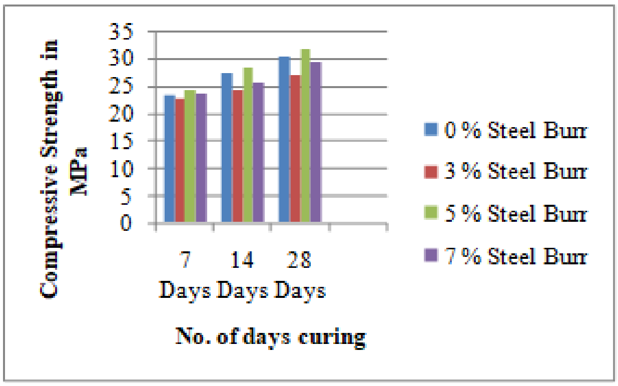

Figure 2. Comparison of compressive strength at 7, 14 and 28 days.

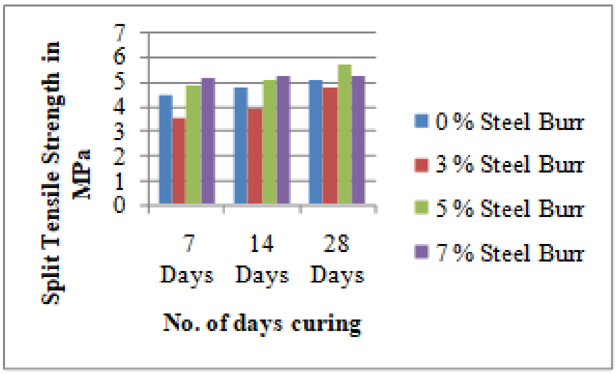

Figure 3. Comparison of split tensile strength at 7, 14 and 28 days.

Conclusion

The compressive strength of steel burr concrete up to 5%additional admixture is more than the conventional concrete (4%more than the conventional concrete).

- The split tensile strength of steel burr concrete up to 5% additional admixture gives more value than the traditional concrete (14% higher than the traditional concrete).
- The rebound hammer test steel burrconcrete gives the quality is good and excellent respectively.
- Less percentage (5%) additional admixture of steel burrin concrete is found to be durable in fire.

References

1. Abbas, A. "Management of Steel Solid Waste Generated from Lathes as Fiber Reinforced Concrete." *Eur J Sci Res* 50 (2011): 481-485.
2. de Gutierrez, RM, LN Diaz and S Delvasto. "Effect of Pozzolans on the Performance of Fiber-Reinforced Mortars." *Cement Concrete Comp* 27 (2005): 593-598.
3. Qasrawi, Hisham, Faisal Shalabi and Ibrahim Asi. "Use of Low CaO Unprocessed Steel Slag in Concrete as Fine Aggregate." *Const Building Mater* 23 (2009): 1118-1125.
4. Yaprak, Hasbi, Huseyin Aruntas, Ilhami Demir and Osman Simsek, et al. "Effects of the Fine Recycled Concrete Aggregates on the Concrete Properties." *Intern J Phys Sci* 6 (2011): 2455-2461.
5. Wang, Youjiang, HC Wu and Victor C. "Concrete Reinforcement with Recycled Fibers." *J Mater Civil Engg* 12 (2000): 314-319.
6. Daniel, R Johnson and SP Sangeetha. "Experimental Study on Concrete Using Waste Ceramic as Partial Replacement of Aggregate." *Mater Today Procee* 45 (2021): 6603-6608.
7. Kumar, Mukesh. "Experimental Study of Fiber Reinforced Rigid Pavement." *Mater Today Procee* 37 (2021): 3520-3522.
8. Velrajkumar, G, J Ajith, S Muthulakshmi and R Dinesh Kumar, et al. "Characterization of Carbon Fibre Reinforced Polymers Sheet Bonded RC Beam with End Anchorage Under Static and Cyclic Response." *J Balkan Tribol Assoc* 28 (2022).
9. Gilberg, Mark, Frank Preusser, Elisabetta Perfetti and Ermanno Carbonara, et al. "Conservation of Watts Towers: A Case Study." *Stud Conserv* 68 (2023): 18-35.
10. Parashar, Arun Kumar and Ankur Gupta. "Investigation of the Effect of Bagasse Ash, Hooked Steel Fibers and Glass Fibers on the Mechanical Properties of Concrete." *Mater Today Procee* 44 (2021): 801-807.
11. Long, Wanpeng, and Yonggang Wang. "Effect of Pine Needle Fibre Reinforcement on the Mechanical Properties of Concrete." *Construc Building Mater* 278 (2021): 122333.
12. Shi, Jicun, Lei Zhao, Chun Han and Hongxing Han. "The Effects of Silanized Rubber and Nano-SiO_2 on Microstructure and frost Resistance Characteristics of Concrete Using Response Surface Methodology (RSM)." *Constr Building Mater* 344 (2022): 128226.
13. Hoover, Christian G and Franz-Josef Ulm. "Experimental Chemo-mechanics of Early-age Fracture Properties of Cement Paste." *Cement Concrete Res* 75 (2015): 42-52.

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