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A Review on Study of Partial Replacement of Fine Aggregate with Crumb Rubber and Coarse Aggregate with Steel Slag Aggregate

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Abstract: Steel slag and crumb rubber are industrial byproducts that have disposal issues and pose a threat to the environment. aggregates are in demand in concrete consumption is rising quickly along with the construction industry. These two materials are crucial in the search for future aggregate alternatives. Concrete that is typically fragile has been given a boost in impact resistance and hardness using crumb rubber. Because regular concrete is prone to failure from fatigue and impact loads, rubber aggregates' flexibility may hold the key to finding a solution. Even though crumb rubber concrete's mechanical characteristics have slightly decreased, this can be fixed by properly treating the crumb rubber aggregates.

Crumb rubber aggregates could be treated using techniques including mechanical, chemical, thermal, and microwave treatment to improve their adhesion to the cement mortar. In this study, steel slag aggregate was used to substitute natural coarse aggregate to varying degrees (10%, 20%, 30%, and 40%), in order to determine the obtained optimal value of steel slag utilised concrete replaces a portion of the natural fine aggregate and the fine aggregate at varied ratios of 5%, 10%, and 15% with crumb rubber. The compressive strength, split tensile strength, and flexural strength of concrete of grade M30 were tested. The outcomes were contrasted with traditional concrete.

Keywords — Steel slag, Crumb rubber, Natural coarse aggregate and fine aggregate workability, Compressive strength, Split tensile strength, Flexural strength.

I. INTRODUCTION

Reusing solid waste materials has come under scrutiny in many industrialised countries due to concerns about waste creation, resource preservation, and reduced material costs. Waste materials are handled effectively, they can satisfy a variety of design requirements in the building sector. Therefore, recovering usable materials from industrial waste not only benefits the environment but also aids in the preservation of natural resources. Slag is a by-product of the process used to make iron and steel; without the manufacture of blast furnace slag, iron cannot be produced in the blast furnace. Similar to how steel cannot be produced in an electric arc furnace (EFA) or a basic oxygen furnace (BOF) without producing steel slag as a by-product. A very interesting idea is to use steel slag aggregate in place of natural aggregate in concrete.

Crumb rubber is recycled rubber made from used tyres from cars and trucks. Steel and tyre cord are eliminated during recycling, leaving just tyre rubber with a grainy texture. The size of the particles can be further decreased by processing using a granular or cracker mill, either with cryogenics or by mechanical means. The size and classification of the particles are determined by a number of factors, including colour (black and white). The size of the granulate is determined by passing it through a screen with a mesh or dimension of (1/4 inch). As fine aggregate in concrete, crumb rubber is frequently utilised in the building industry.

II OBJECTIVES OF THE STUDY

The work's main goal is to effectively replace the coarse aggregate in M30 grade concrete with steel slag and the fine aggregate with crumb rubber were evaluated in comparison to traditional concrete.

- Steel slag aggregate was used to substitute natural coarse aggregate to varying degrees (10%, 20%, 30%, and 40%), in order to determine the obtained optimal value of steel slag utilised concrete.
- Replace a portion of the natural fine aggregate and the fine aggregate at varied ratios of (5%, 10%, and 15%) with crumb rubber.

III LITERATURE REVIEW

Parmender Gill , Parveen Jangra , Rajeev Roychand , Moh ammad Saberian , Jie Li (2023)

With the use of additives like cement and fibres, this work seeks to remedy any ensuing loss in strength and durability. When evaluated in accordance with ASTM standards, geopolymer specimens with CR replacement of fine particles

by volume (0, 5, 10 and 15%) displayed a compressive strength loss of up to 17%.

Sreesha. S, Esakkiraj, Manoj Prabaakar. (2020)
The main objective of his research was to use the M30 mix design, a partial replacement of fine particles with steel slag, and crushed aggregate with rubber tyre to explore experimentally the impact on the various strength properties of concrete. After 7 days, 14 days, and 28 days of curing, the research specimens of 0%, 5%, 10%, and 15% are cast and tested for compressive strength and split tensile strength, with 20% of the coarse aggregate replaced with steel slag and the fine aggregate with rubber tyres.

janaki raman , jeevitha , kalyani kumar , nivedha , nandhini (2020)
Here, the qualities of the clay soil, steel slag, and rubber crumbs are combined in varying proportions. By increasing the percentage of rubber crumbs (5%, 10%, 15%) and maintaining the same level of steel slag (20%), the soil's strength qualities were enhanced. Standard proctor tests, California bearing ratio tests, and unconfined compressive strength tests were carried out in the clay soil at varied ratios. The investigation's findings indicate that the combination of steel slag (20%) and rubber crumbs (10%) is more efficient for enhancing the characteristics of clay.

Dinesh Choudhary, Jayashri Poojary,Khushboo Shukla, Abhishek Singh, Prajakta Mukadam (2019)
This project study was carried out by substituting crumb rubber for the aggregate and using slag cement in place of the whole amount of cement. By adding 3%, 5%, or 7% of the total weight of coarse aggregate, crumb rubber is added. Compressive strength and flexural strength tests were conducted after casting and curing to determine the strength of the concrete, and the behaviour of the concrete during the tests was examined.

Mr.Ra.Arvinth, Sharmilha.K, Mohan Babu.M, Mathan Kumar.M (2019)
This study examines the compressive strength, tensile strength, and flexure strength of crumb rubber-containing composites after 7, 14, and 28 days. This experimental investigation's goal is to better understand how Crumb Rubber Concrete (CRC) behaves in terms of strength. In this study, CRC was produced using standard elements such cement, fine and coarse sand, water, polyvinyl alcohol (PVA) at different replacement levels, as well as a certain quantity of crumb rubber. The ratio of constant water to cement is 0.40. The mixtures are poured with varying percentages of crumb rubber replacing fine aggregate, PVA being added at 4% and 6%, and mechanical parameters like compressive strength, split tensile strength, and flexural strength are measured.

R. Rajendran, M. E.Mubarak Ali, P.Nagendran, T. Subash, D. Vasudevan (2018)
In this study, to determine the optimal value of steel slag usage in concrete, the natural fine aggregate was partially replaced with crumb rubber at various proportions of 5%, 10%, and 15%. The natural coarse aggregate was partially replaced with steel slag aggregate at various proportions of 10%, 20%, 30%, and 40%. The compressive strength, split tensile strength, and flexural strength of concrete of grade M30 were tested. The outcomes were contrasted with typical concrete.

IV. MATERIALS

Steel Slag Aggregate

Steel slag aggregates are one of the essential elements of concrete. Every year, hundreds of tonnes of steel slag, a by-product of metal smelting, are created worldwide in the process of refining metals and making alloys. Metallurgical slag and blast furnace slag are the two primary forms of aggregates made from steel slag. Slag is created during the manufacture of steel and is then separated into blast furnace and metallurgical slag before being recycled. The aggregate steel slag material was provided by the Jabalpur Steel factory in Jabalpur, Madhya Pradesh, India.

Fig No.1 Steel Slag Aggregate

Crumb Rubber

Rubber that has been recycled from old truck and vehicle tyres is known as "crumb rubber." During recycling, steel and tyre cord (fluff) are removed from the tyre rubber, leaving behind granular tyre rubber. Through extra processing in a granulator or cracker mill, maybe using cryogenics or mechanical methods, the size of the particles is further reduced. The colour (black alone or black and white) and other characteristics, like the size and classification of the particles, are among them. The granulate is run through a screen with holes spaced out at intervals of 1/4 inch (10, 20, etc.) to determine its size. Artificial grass commonly uses crumb rubber as a cushion.

Fig No. 2 Crumb Rubber

Cement: Ordinary Portland cement of grade 53 is used for this experimental work.

Fig No. 3 Cement

Fine aggregate: The material which passes through BIS test sieve number 4 (4.75mm) is termed as fine aggregate usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates. In our region fine aggregate can be found from bed of Krishna River. It conforms to IS 383 1970 comes under zone II.

Fig No. 4 Sand

Coarse aggregate: The material which is retained on BIS test sieve number 4 (4.75mm) is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. Coarse aggregate used is locally available crushed angular aggregate of size 20mm and 10mm are used for this experimental work.

Fig No. 5 Coarse Aggregate

V. PROPOSED METHODOLOGY

Procedure

For the M30 mix, the fine aggregate has been proportionately replaced by crumb rubber in the following ranges: 5%, 10%, and 15%. For the M30 mix, the steel slag aggregate has taken the place of the coarse aggregate in the following proportions: 10%, 20%, 30%, and 40%. Concrete mixtures were created, tested, and compared to standard concrete in terms of compressive, flexural, and split tensile strength.

VI. CONCLUSIONS

In the current study an attempt has been made to make the use of industrial waste in concrete mix grade M30 by studying the mechanical behaviour of this concrete mix by partial replacing with advanced mineral admixtures such as steel slag aggregate and crumb rubber in concrete mix. In this study, steel slag aggregate was used to substitute natural coarse aggregate to varying degrees (10%, 20%, 30%, and 40%), in order to determine the obtained optimal value of steel slag utilised concrete replaces a portion of the natural fine aggregate and the fine aggregate at varied ratios of 5%, 10%, and 15% with crumb rubber. The compressive strength, split tensile strength, and flexural strength of concrete of grade M30 were tested. The outcomes were contrasted with traditional concrete.

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