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Feasibility Analysis of Rubber as Crushed Sand and Fly Ash as Cement

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Abstract: Currently, the disposal of waste tyre is becoming a major waste management problem worldwide. It is estimated that Approximately 1.4 billion tons of waste tire rubber produced globally per year. The present study aims to investigate the optimal use of waste tyre rubber crumbs as a substitute for crushed sand in concrete composites. This study determines the compressive strength performance of rubber concrete and the disposal of waste tyres. Concrete is a mixture of cement, aggregate, water, and admixtures. In concrete, fly is used as a cementitious material. A comparative study is carried out, and the use of fly ash as a cement replacement in concrete can be analyzed and compared. The feasibility analysis aims to assess the practicality and viability of using rubber as crushed sand and fly ash as cement in concrete. Using rubber as crushed sand and fly ash as cement in concrete has shown promise in several studies. Additionally, incorporating fly ash as a cement replacement in concrete mixtures has been found to improve compressive strength.

This research highlights the feasibility of adopting such alternative materials in small-scale construction applications. Thus, it contributes to the development of the construction industry in a sustainable way.

I. INTRODUCTION

The vehicle tyres which are disposed to landfills constitute one important part of solid waste. Stockpiled tire also present many types of health, environmental and economic risks through air, water and soil pollution. The other part of the problem is that aggregate production for construction purpose is continuously leading to the depletion of natural resources. Therefore, the use of recycled waste tyres as an aggregate can provide the solution for two major problems. According to the Automotive Tyre Manufacturers Association (ATMA), in India, more than 217.4 million tyres of various categories were manufactured in year 2023.

The Concrete is the most important material for any construction work like building construction and cement concrete pavement. There are some modifications perform in concrete by the introduction of fly ash in the concrete. Fly ash increase the workability of concrete, but when the percentage of fly ash increase in concrete then the compression strength of concrete decreases.

Hence, a comparative study can be done and use of fly ash as a cement replacement in concrete can be analyzed and compared through various methods. This analysis is structured to delve into the material properties, mix design considerations, performance testing methodologies, cost analysis with using rubber as crushed sand and fly ash as cement in concrete.

II. METHODOLOGY

A. For making this economical concrete the ingredients which are using as follows

- Cement: Ordinary Portland cement having compressive strength 20 mpa after 28 days.
- Tyre rubber: Tyre rubber, also known as rubber powder or crumb rubber, are finely ground particles of recycled tires. They are typically obtained through a mechanical grinding or shredding process that breaks down waste tires into smaller pieces.

The size of tyre rubber is near about 0.14 mm. The source of the rubber aggregate is recycled tyres which were collected from the local market.

Fig.1. Tyre rubber

- Fly ash: From the combustion of pulverized coal and transported by the flue gases of boilers by pulverized coal, Fly Ash is produced which is replacing 10% of cement as shown in fig 3

Refer from :- https://www.sement.heidelbergmaterials.no/en/fly-ash
Fig.2 Fly ash

- Crushed sand: sand with maximum size of 4.75 mm was used with rubber straps (15%) replacing of crushed sand as shown in fig 3. Is also known as fine aggregate.
- Coarse Aggregate: Natural aggregates with maximum size of 40 mm were used.
- Water: The quality was uniform and the water samples were potable. For M20 grade concrete, a water-cement ratio of around 0.55 to 0.60 is commonly used.

B. Mix Proportion

The concrete mix was designed for M20 grade and the mix design was done as per IS 10262-1982 and IS 456-2000.
Mix design for concrete was made considering the properties of constituents of concrete. concrete mixes with varying fly ash content percentage were produced as 10% and tyre rubber is about 15% was mix in M20 grade concrete as shown in fig.3.

1) Cement: For M20 grade concrete, the cement content typically ranges from 240 to 300 kg/m per cubic and fly ash replaced with 10% of the total cement.
2) Fine Aggregate (Crushed Sand): The proportion of fine aggregate (sand) in M20 grade concrete ranges from 40% to 45% by weight of total aggregate and tyre rubber replaced with 15% of the crushed sand.

Fig.3 Mix proportion of cement as fly ash & crushed sand as rubber.

C. Test Performed

Following tests such as the slump cone test and compressive strength testing is crucial in the feasibility analysis of using rubber as sand and fly ash as cement in concrete. These tests provide valuable data regarding the workability and strength characteristics of concrete mix.
Slump Cone Test: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not suitable method for very wet or very dry concrete and stiff mix.
The slump cone test was conducted to evaluate the workability of concrete mixes containing rubber as sand and fly ash as cement as shown in this suggests that rubber as sand and cement as fly ash can be effectively incorporated into concrete mixes without compromising workability.

Fig.4 slump cone test.

D. Compressive Strength Test

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. Compressive strength testing was performed to assess the strength development of the concrete specimens over time. CTM is used as shown in fig.5. Specimens are tested by compression testing machine after 7days curing, 14 days curing or 28 days curing. Load should be applied gradually at the rate of 140kg/cm2 per minute till the Specimens fails.

Prepare concrete cubes of standard dimensions (typically 150 mm x 150 mm x 150 mm) using the desired concrete mix design that includes rubber (15%) and fly ash cement (10%) with in fixed percentage according to, others research paper.

We prepare the 4 cubes as shown in fig.6a&b of (150 mm x 150 mm x 150 mm) dia. With mix proportion and there is 1 normal cube is prepared for analyse the compressive force after 28 days.

Fig.5 compressive testing machine.

Fig.6a Mould sample

Fig.6b Mould sample

III. RESULTS

These test results suggest that the use of rubber as sand and fly ash as cement in concrete shows promise in terms of both workability and strength characteristics, paving the way for further optimization and implementation in construction projects aiming for sustainability and performance excellence.

A. Slump Cone Test

The slump value obtained in a slump cone test indicates the workability of concrete, which is influenced by factors such as water content, aggregate size, and mix proportions.

The result is of a slump value is 35 mm which is low degree of workability.

B. Compressive Strength Test

Compressive strength testing was performed to assess the strength development of the concrete specimens over time. The results revealed that the concrete mixes incorporating rubber aggregates and fly ash cement exhibited comparable or slightly improved compressive strength compared to conventional concrete mixes.

And fig.7 shows the difference between the compressive strength of normal cubes and invented cubes and Table no.1 and table no.2 shows the compressive strength as per days.

For normal Casted Cube:-

Sr.No	Days	Date of Casting	Date of Testing	Reading In KN	Compressive Strength (N/mm*2)
01.	7	15/03/24	22/03/24	340	15.11
02.	14	15/03/24	29/03/24	385	17.11
03.	28	15/03/24	13/3/24	450	20

For Casted Cube:-

Sr.No	Days	Date of Casting	Date of Testing	Reading In KN	Compressive Strength (N/mm*2)
01.	7	15/03/24	22/03/24	275	12.22
02.	14	15/03/24	29/03/24	305	13.55
03.	28	15/03/24	13/3/24	365	16.22

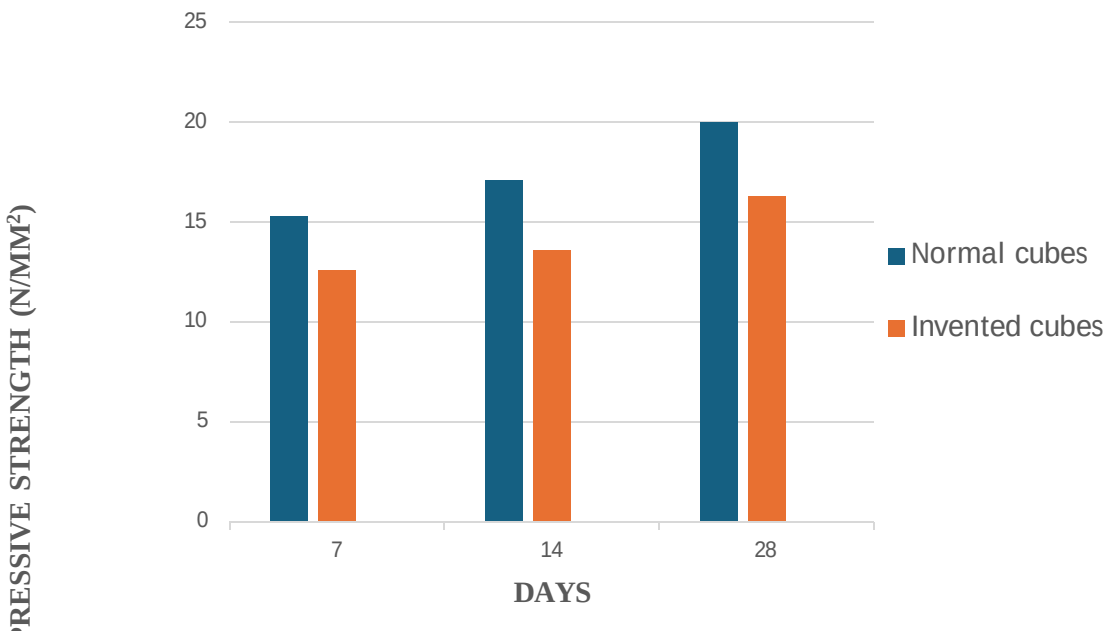

Fig.7 difference between the normal cubes compressive strength and invented cubes.

IV. CONCULSION

The feasibility analysis of using rubber as sand and fly ash as cement in concrete has provided valuable insights into the potential benefits and challenges associated with these alternative materials.

1) This is found that there are positive result and decreases in the properties of M-20 grade of concrete due to the used of rubber as crushed sand and fly ash as cement.
2) When rubber was used instead of crushed sand in concrete it shows less compressive strength when compared with ordinary concrete.
3) The compressive strength of concrete mixes decrease with increase in fly ash. The fly ash can be replaced up to 10%-15% for better result.
4) As a recommendation for future work, a proper study on small range percentages of the rubber between 3%-6.5% could be performed. The curing time should also be extended to 90 days.
5) replacing cement with fly ash in concrete offers a sustainable and benefits in terms of environmental, cost- effectiveness.
6) This mix proportion, should used only in small construction project And for plastering work.

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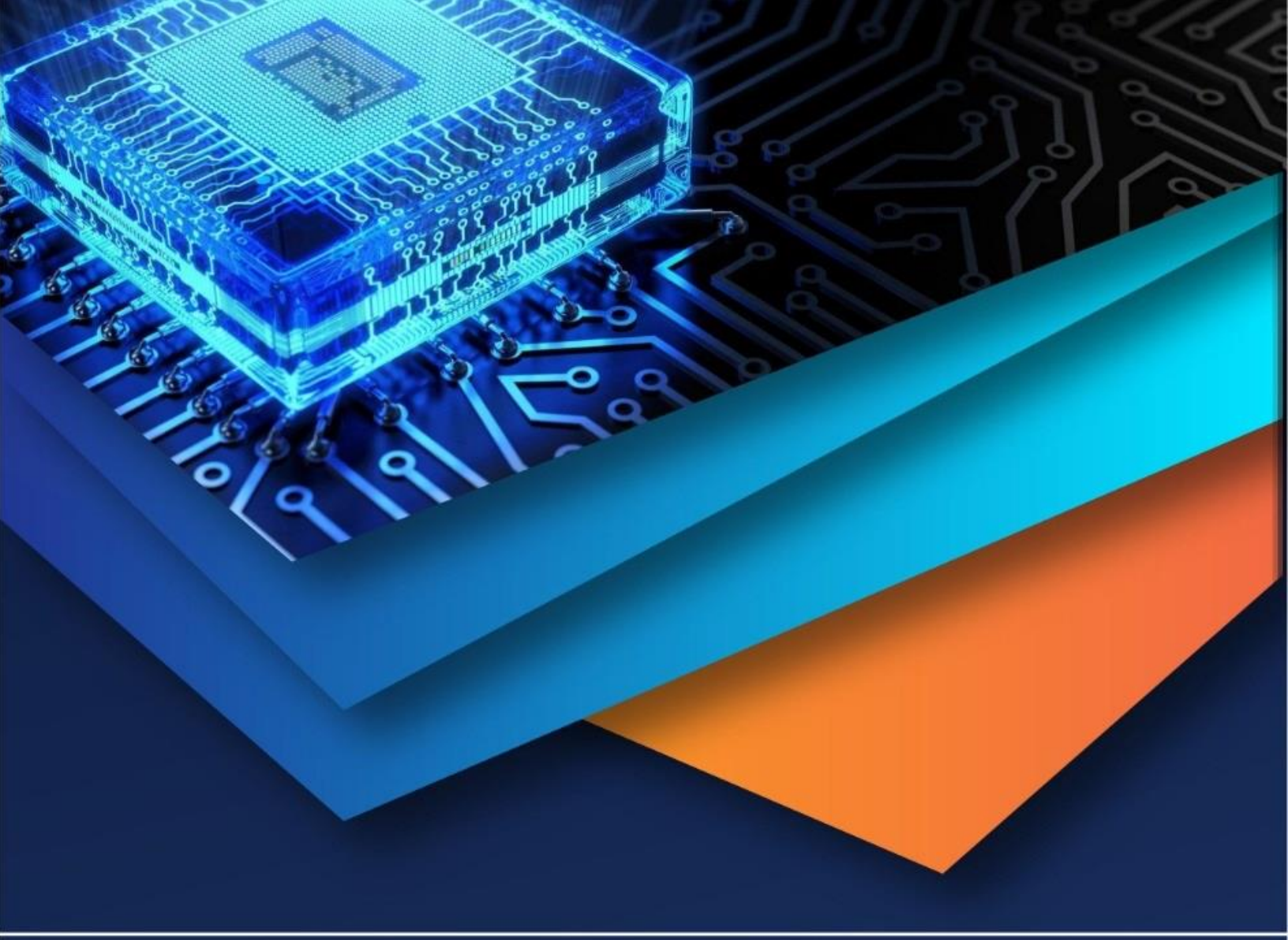

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