Retraction

Retraction: Experimental Investigation on Construction of Masonry wall with Crumb Rubber Concrete Blocks (*IOP Conf. Ser.: Mater. Sci. Eng. 1145* 012036)

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IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the *Problematic Paper Screener* [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Experimental Investigation on Construction of Masonry wall with Crumb Rubber Concrete Blocks

Preethi Gopalakrishnan¹, Nikhil N Joshi¹ and Gokulraj R¹
¹Department of Civil Engineering, Sri Krishna College of Engineering and Technology, Coimbatore
preethig@skcet.ac.in¹

Abstract. Waste Management is a challenging task in most developing countries. In India, researches are made to minimize waste generation and also to reuse or recycle waste in all possible ways. (1) Rubber waste is produced equal to plastic waste in India and contributes 10-12% in total waste generation. Industries manufacturing tyres generate more rubber waste followed by the disposal yards dealing with rubber scarp. (2) Among the building materials concrete has a long life span and therefore Crumb Rubber Concrete(CRC) is proven research for rubber waste management for its flexural property. This paper explains the experimental study made for the construction of a masonry wall using crumb rubber concrete with the replacement of fine aggregate with crumb rubber.(3) The results show that Crumb Rubber Concrete would be the best choice for the construction of non-load bearing structures with 20% replacement of Fine aggregate with crumb rubber.

Keywords: Crumb Rubber Concrete, Waste Management, Non-Load Bearing Structure

1. Introduction
Solid waste disposal is one of the world’s most critical challenges. Annually, the Country generates more than 5 billion tonnes of non-hazardous solid waste [1-3]. Every year, around 280 million scrap tyreare made into scrap tyre. Dumping of it a major pollution problem that municipalities all over the world are dealing with. Owing to their longevity and massive numbers of recycled tyres per year, scrap tyres are one of the biggest and most troublesome sources of waste in western communities.[4] Per year, one billion tyres hit the end of their usable lives around the world, with 0.5 billion more predicted to be discarded by 2030. The tremendous increase in waste tyres leads to the opportunity in look for new ways to use this rubber [5]. One technique under research is using crumbed rubber from tyre waste to substitute some of the natural aggregates in conventional concrete, resulting in Crumb Rubber Concrete (CRC)[6].The rubber helps to conserve natural resources and reduces the amount of rubber that goes to landfill. The addition of pulverized tyres to concrete can contribute to the reduction of further exploitation of worn tyres while also boosting the properties of the concrete [7-9]. The idea behind using these worthless tyres is to reduce the use of natural sand (as a fine aggregate) while enhancing the mechanical properties of green concrete, such as compressive strength and ductility [10]. As a result, chemical agents were used to improving the bond between crumb rubber and concrete in order to maximize the concrete's compressive ability. Some of research work reports that the addition of rubber powder to reinforced concrete enhanced crack resistance, blast wave absorption and acoustic wave damping and reduced product weight and thermal conductivity[11].

This study concentrated on the construction of masonry wall with Crumb Rubber Concrete
with partial replacement of fine aggregate with crumb rubber in different mix ratio.

The objective of the research are given below:

• To analyse the physical property of Natural Fine aggregate and Crumb Rubber.

• To relate the fresh concrete property of convectional concrete and Crumb Rubber concrete (CRC).

• To contrast the compression strength of conventional concrete and Crumb Rubber concrete (CRC).

2. Methodology

Crumb Rubber (CR) is a fine material so it can be used as a substitute for fine aggregate. In this study, two particle sizes of crumb rubber were used as a partial replacement for sand in the construction of masonry walls: 1 – 3 mm and 3 – 5 mm. Replacement of fine aggregate was done using 1-3 mm sized CR and 3-5 mm sized CR. The properties of 3-5 mm CR was found to have similar properties to fine aggregation. Therefore further experiments were carried out using 3-5 mm CR. This paper concentrates on finding the optimum percentage of replacement of sand with CR in concrete and cased into Crumb Rubber Concrete Blocks used in construction of masonry wall Figure 1.

![Figure 1. Work Flowchart](image)

3. Material Used

3.1 Cement: Cement is the binding element, a construction material which sets, hardens, and adheres to other materials to bond them together. Cement of OPC grade 43 is used for this experimentation

3.2 Aggregates: M-sand is the commonly used fine aggregate in recent times in all construction. M-sand of sized less than 4.75mm was used.

3.3 Coarse Aggregate: They are irregular broken stones or, naturally, rounded gravel used to make concrete. Materials that are wide to be stored in a sieve size of 4.7 mm are considered coarse aggregates and can have a potential size of up to 63 mm. Sizes of 16mm and 20mm are used for this study.
3.4 Water: The percentage of water added to concrete decides the concrete properties such as workability, compressibility, durability, shrinkage, etc. Normal potable water of pH not less than 6 is used in concrete mix. All the above mentioned materials are tested for its quality and properties as per the Indian codal standards.

3.5 Crumb Rubber: Crumb Rubber (CR) is a crumbled rubber from tyre waste and rubber products. It is grinded by two methods of cryogenic grinding and mechanical grinding. Of the two processes, the cryogenic grinding process is more expensive but effective in producing smaller and smoother crumbs. Crumb Rubber has applications in manufacturing mats, vehicle mud guards, carpet padding, adhesives, etc. Even these recycled products also reach the dump site at the end of its short lifetime. Therefore the alternative use of crumb rubber with maximum lifetime is the need of the hour. For this study Crumb Rubber was purchased from a local market of size 3-5 mm produced by the process of mechanical grinding figure 2. Since the size of CR is 3-5 mm, it is chosen to replace fine aggregate in concrete mix.

![Figure 2. Crumb Rubber](image)

4. Experimental Program

4.1 Properties of Crumb Rubber: The concrete mix for M25 grade was designed for nominal concrete mix and the properties of Crumb Rubber were studied. The Table 1. shows the crumb rubber properties in comparison with natural fine aggregate.

| Sl.No | Properties                | Crumb Rubber | M-Sand |
|-------|---------------------------|--------------|--------|
| 1     | Water Absorption (%)      | 0            | 3.98   |
| 2     | Specific Gravity          | 1.63         | 1.95   |
| 3     | Moisture Content (%)      | 1.25         | 16.8   |
| 4     | Fineness Modulus          | 0.98         | 2.35   |

4.2 Concrete Mix
This study involved fifteen trial mixes containing 3 phases of crumb rubber substitution (10%, 20%, and 30%) by volume, as well as a control mix (10) as shown in table 2.

| S.NO | MIXES | DESCRIPTION | Water |
|------|-------|-------------|-------|

Table 2. Concrete Mix Ratio
4.3 Workability Test on Fresh concrete Test
A concrete slump test, also known as a slump cone test, is used to measure the workability or strength of a concrete mix formulated in the laboratory or on the building site fig 3. Concrete slump checks are performed from batch to batch to ensure that the consistency of the concrete remains consistent during the construction process. According to Indian standards Slump 50-100mm will have high workability in construction process as shown in table 3.

**Table 3. Slump Cone Value**

| Sl.No | Concrete Mix | Slump Value (mm) |
|-------|--------------|------------------|
| 1     | CRC0         | 50               |
| 2     | CRC10        | 52               |
| 3     | CRC20        | 57               |
| 4     | CRC30        | 63               |

**Figure 3. Slump Cone Test**

All four concrete mixes found to have slump value are in range of 50-75mm therefore it has medium workability and suitable for construction of masonry wall.

**Figure 4. Casting of Concrete Cubes with CRC**

4.4 Hardened Concrete Test
4.4.1 Compressive Strength Test
Concrete compressive strength is the hardened concrete strength as determined by the compression
Concrete compression strength is a measurement of the material's ability to withstand compressive loads [fig 4]. It is measured by crushing cylindrical concrete specimens in a compression testing unit. [9] Concrete cubes are tested for compression strength on the 7th, 14th, and 28th days after curing. After the 28th day, the compressive strength of the concrete reaches its optimum strength in relation to the design mix. Measurements were performed on 150 mm cubes. Measured values are shown in Table 4.

| Sl.No | Concrete Mix | Compressive Strength (N/mm²) | 7 days | 14 days | 28 days |
|-------|--------------|------------------------------|--------|---------|---------|
| 1     | CRC0         | 15.2                         | 20.1   | 25      |
| 2     | CRC10        | 15.8                         | 21.9   | 24.3    |
| 3     | CRC20        | 15.6                         | 21.6   | 24      |
| 4     | CRC30        | 11.7                         | 16.2   | 18      |

The results show that the concrete mixes with 10% and 20% of replacement give the good replacement for fine aggregate as the strength was not lowered down. But as the replacement increases to 30%, the compressive strength reduces to the maximum extent as the binding of drum rubber with cement and coarse aggregates is getting lesser [fig 5]. Therefore, replacement of fine aggregate with 20% of Crumb Rubber was found to be the optimum replacement ratio.

4.5 Construction of Masonry Wall using CRC Block: Of fine aggregate replacement with 20% of Crumb Rubber was found to have good results, so the same is used to construct the masonry wall for length of 2m with thickness 200mm. With one month observation of constructed masonry wall, it was found that it has good durability and crack free [fig 6].
5. Conclusion

The Conclusions drawn from above research are:

- Crumb Rubber can be a good replacement for fine aggregate.
- Compressive strength of CRC was found satisfactory with 20% replacement of fine aggregate with Crumb Rubber.
- CRC would be best choice for rubber waste management.
- CRC increases the elastic nature of concrete.
- CRC can be preferred for all non-structural elements.

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