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Experimental Study on Partially Replacement of Coarse Aggregate by Rubber Tyre

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***ABSTRACT* :**Non-biodegradable waste has become a big problem in the world in recent years. Increased consumption of materials such as plastic, rubber, and glass in domestic and industrial operations in quickly emerging countries such as India has impacted our daily lives. Our research focuses on how to correctly use waste Rubber as a Coarse Aggregate Replacement Material in Concrete while minimising the use of coarse aggregate. By substituting rubber for coarse aggregate, the environment will be protected from rubber pollution and aggregate extraction through quarrying. This will be really beneficial to the environmental. The results of replacing fine and coarse particles in concrete mix with tyre rubber are proposed in this research. It goes through the effects of using rubberized concrete in structural elements on ultimate compressive strength. Rubcrete also has strong mechanical qualities, making it one of the most efficient and cost-effective ways to recycle used tyres. The M25 grade concrete specimen was chosen as the reference concrete specimen in this experimental study. In place of typical coarse aggregate, scrap tyre rubber chips were used as coarse aggregate.

Index Terms - Aggregate, Compressive strength, Concrete, Rubber Tyre, Workability.

I. INTRODUCTION

Rubber items are becoming more popular every year all across the world. In many Indian cities, waste tyre disposal is a big environmental issue. Each year, India produces almost 1 billion waste tyres, or about one tyre per individual. This is a major concern for the planet and its population. Burning rubber is the easiest and cheapest way to degrade material in this situation. Pollution from smoke and other dangerous emissions, as well as global warming, result as a result of this. Researchers tried to use as much waste product as possible for environmental impact on occasion, with waste product recycling being the most important component of research. We used discarded tyre rubber as coarse aggregate in this study, which replaced 10% of normal coarse aggregate. Rubber dumping is a serious problem in India, hence the potential of rubber in concrete is being investigated. These tyre wastes rapidly increased due to the depletion of land filling. Furthermore, these areas may serve as mosquito breeding grounds and breeding grounds. The aggregation of these tyre piles will take more than 100 years to disintegrate. Sri NarendhraModi Sir Delivered an elaborate speech in Delhi on October 2, 2014 at the Swacha Bharat Program on eliminating pollution in the environment, which was our nation's father, Mahatma Gandhi's goal. By increasing the concrete mix's characteristic design attributes, the reuse of this material in concrete could benefit the environment while also maintaining economic feasibility. It is used in a number of applications, including road construction, light weight construction, flooring, mould forming, and so on, in the form of rubcrete concrete.

II. LITERARTURE REVIEW

1]G. N. Kumar,et.al. (2014) : For varying percentages of mixes, the compressive strength of rubber powder mixtures falls as the percentage of sand substituted by rubber powder increases. For varied percentages of mixes, density falls as the fraction of rubber powder replacement increases. When the percentage of rubber powder concentration increases, water absorption also increases. The concrete has a slump of 75 to 100 mm. As the amount of rubber powder replaced rises, the modulus of elasticity lowers, resulting in increased flexibility. As the percentage of rubber powder increases, results in increase of thermal insulation. Chipped rubber was used to replace coarse aggregate at a rate of 2.5 percent. Rubcrete Mix is another lightweight concrete option. The usage of an alternative to traditional aggregates that have been in use for many years might aid in environmental protection. Because of its reduced density and conductivity, the use of tyre rubber powder results in a low permeability value.

[2]T R MORE,et.al.(2015): The findings demonstrate show that adding recycled crumb rubber aggregates to a standard concrete mix reduces the workability of the various mix samples. When 3 percent sand is replaced by crumb rubber aggregates, the flexural strength of concrete drops by around 40%, and the strength drops even more as the amount of crumb rubber aggregates increases. Rubberized concrete can be utilised in non-load bearing members, such as lightweight concrete walls and other light architectural elements, therefore concrete with fine rubber granules could be a viable alternative in situations where strength isn't a priority.

3] ISHTIAQ ALAM,et.al.(2015): When compared to control concrete specimens, rubberized concrete exhibits a fall in density. Relative to concrete containing chipped rubber as coarse aggregate, crumb rubber as fine aggregate has a lot of strength. There was no noticeable increase in the compressive strength of concrete density when various percentages of rubber were used as fine particles. Rubberized concrete should be used in construction of small structures such as road curbs, non-bearing walls.

4]K.Charankumar,et.al.(2015): According to their test results, the addition of rubber aggregate to Concrete resulted in consid erable drop in concrete's compressive strength when compared to standard concrete, As the percentae of Rubber aggregate was increased, the compressive strength reduced further. The overall findings of this study demonstrate that recycled rubber tyres can be used as a partial replacement for coarse aggregates in concrete production. However, the percentage replacement should be confined to specified levels, and the application should be limited to specific circumstances when the benefits of using rubber aggregates outweigh the downsides of using them.

5] M k khan, et.al. (2015): The substitution of natural sand to stone dust is taken to 30% replacement of weight of sand in ratio 1:1.5:3 of concrete the ultimate strength more somewhat same to the ultimate strength of concrete without substitution. The substitution of natural sand to stone dust up to 40% replacement of weight of sand in ratio 1:1.5:3 of concrete led to a corresponding drop in the strength. This is due to the fact that above the 30% weight the presence of stone dust tends to reduce the bonding between cement and aggregate Lending to a consequent decrease in strength.

6] WarudkarA.A, et.al.(**2015**) : Their experimental study concluded that Rubberized concrete has a lower compressive strength than regular concrete. Its strength, on the other hand, is within acceptable bounds. Concrete products including rubber aggregate have a large potential market, allowing for the reuse of old rubber tyres, which are a major cause of pollution in the environment. Traditional concrete is more expensive than rubberized concrete. Rubberized concrete may be beneficial for architectural applications such as stone baking, interior construction, building as an earthquake shock wave absorber, and where vibration damping is required, such as equipment foundations and railway stations, due to its relatively low weight. It is possible to save a certain amount of traditional stone aggregate.

7] S Arulkesava,et.al. (2015): The findings demonstrate that enabling chemical bonding can improve the binding between rubber particles and concrete.In comparison to the control mix, the rubber mixtures had higher flexural strengths and similar toughness.When compared to the control mix, the unit weight of the crumb rubber concrete mix dropped.The rubber concrete specimen remained intact during all tests, showing that the rubber particles may be absorbing forces exerted on it. Such behaviour could be advantageous for a building that requires high impact resistance. The ability to tolerate considerable deformation in crumb rubber concrete is a purpose of this material used in concrete, as is the management of solid waste.

8] VenkateshP, et.al.(2015) : Maximum compressive strength, split tensile strength, and flexural strength were reached at M3 (F10T5) using 10% reused foundry sand and 5% waste tyre rubber in the experiment. Compressive strength increased by 9.86%, split tensile strength climbed by 14.19%, and flexural strength grew by 7.54% of the mix, while other attributes such as impact resistance and toughness improved in the meantime.Theconcrete made using chipped rubber has given the lowest density as the amount of rubber in the mix decreases the density increase. This is due to the fact that rubber has a lower density than coarse material and sand.When compared to concrete mixes having just waste tyre rubber, the results of this study show that concrete comprising used foundry sand and surface modified waste tyre rubber has positive effects on compressive, tensile, flexural, and impact properties.

9] N. D. Luong, el.al. (2015) : The degree of compressive strength reduction varied depending on the amount and size of the rubber particles that were replaced. The compressive strength of the specimens containing fine rubber particles was reduced by 8.7% and 9.7% at 7 and 28 days, respectively, at a replacing proportion of 10%, whereas the counterpart for the specimens containing coarse rubber particles was reduced by 16.2% and 30.3 percent, respectively, at 7 and 28 days. This indicates that coarse rubber particles reduced the compressive strength of rubberized concrete more than fine rubber particles. When the replacement proportions were increased to 20, 30, and 40% by volume, the compressive strengths correspondingly dropped. However, at the same replacing proportions, the degrees of decrease between two cases (fine and coarse rubber particle specimens) gradually grew smaller than those at the 10% replacing proportion, particularly for the specimens at the 28-day curing time. The compressive strength of specimens containing fine and coarse rubber particles was reduced the most at 7 and 28 days when the replacement ratio was 50%. The test results suggest that replacing fine rubber particles with fine natural aggregate at a modest replacement proportion (up to 10%) may not have a major impact on the compressive strength of rubberized concrete.

10] Mr.yadav S. P.et.al. (2016): Theirtest results show that the use of rubber aggregate in concrete mixes produces a significant reduction in concrete compressive strength which increases with increasing rubber aggregate content. However, if the amount of rubber in the concrete is limited (2% in the project), a normal strength concrete can still be produced.

11] Mohammed m. A. Siddiqui (2016) : His test findings for rubberized concrete revealed that adding rubber particles resulted in a considerable loss in compressive strength when compared to normal concrete, which has compressive strengths ranging from 28.95 percent to 55.21 percent. Although the compressive strength is still within acceptable limits for a 5% replacement. With increasing curing time, the compressive strength of concrete with rubber decreased.

12] M. DeepikaSree, et.al. (2017) : The weight of coarse aggregate is replaced by 5% of the weight of waste tyre in concrete, and the compressive strength is similar to that of concrete without substitution. At the same time, when 15% of the weight of coarse aggregate is replaced, the compressive strength of the concrete is reduced when compared to normal concrete. Tyres with a weight of more than 5% tend to weaken the bonding between cement and aggregate, resulting in a reduction in strength. The usage of waste tyre rubber aggregates addresses a number of difficulties, including reducing the environmental risks posed by waste tyres.

13] Aravind V M, et.al. (2018): As the quantity of rubber in the concrete increases, the strength of the concrete falls.The addition of PVA (Polyvinyl Alcohol) to Rubcrete increased the mechanical qualities of the material and the amount of PVA added to Rubcrete increased the compressive strength of the material. When 2.5 percent PVA was added, the compressive strength reached its maximum.

14] N. N.Gerges, el.al. (2018): Concluded, With increasing powdered rubber content in the mixture, there is always a decrease in rubberized concrete strength (compressive and tensile strength). There are two possible explanations for the loss of strength. First, because the rubber particles are much softer (elastically malleable) than the surrounding mineral components, cracks form quickly around the rubber particles in the mix when loaded, speeding up the rubber–cement matrix failure. Second, due to a lack of adhesion between the rubber particles and the cement paste, soft rubber particles may appear as gaps in the concrete mixture.

15] Mr. P Gorde, et. al. (2018): Tyre rubber is a non-degradable substance that has a negative impact on the environment and generates several disposal concerns. Because the use of tyre rubber diminishes its compressive, tensile, and flexural strength, it also impairs the workability of new concrete, studies are being conducted to minimize these negative effects. This may be accomplished by restricting the amount of rubber used in tyres. It may be employed in earthquake-prone concrete buildings as well as structures that are sensitive to dynamic forces, such as railway sleepers and road pavement.

16] Reza Hassanli, et.al.(2019) : As the percentage of rubber used rises, the compressive strength, split tensile strength, and flexural strength are seen to decrease.The compressive strength was reduced by 30 %, 34 %, and 43 %, respectively, when 15 %, 20% and 30% rubber was used. The indirect tensile strength was reduced by 14.5% and 28.5% respectively, when 15% and 30% rubber content were used, while the flexural strength was reduced by 17% when 20% rubber content was used. The reduced adhesion at the rubber/cement contact is often attributed to these strength losses when crumb rubber partially replaces sand in concrete. This makes it simpler for rubber to separate from the cement paste around it under low loads, resulting in weak spots at the surface. Furthermore, the large stiffness difference between rubber particles and concrete paste, and therefore the relative deformations, causes early cracking and thus a reduction in strength.

17] Sulagno Banerjee, et. al. (2019) : It is advised that 5-10% of waste tyer rubber aggregate be replaced with coarse aggregate, which is the best replacement in concrete composites. despite the lower compressive strength of rubberized concrete compared to conventional concrete, there is a large market for concrete products that include rubber aggregates, allowing for the reuse of discarded rubber tyres, which is a major source of pollution in the environment.

18] L A Khan, et.al (2019): When 10% of the silica fume is replaced with cement and 2.5 percent of the rubber aggregate is replaced with coarse aggregates, the compressive strength of the concrete increases. To achieve the best split tensile strength of concrete, 10% silica can be replaced with cement and 2.5 percent rubber aggregates can be replaced with coarse aggregates. When 15% of silica is replaced with cement and 2.5 percent of rubber aggregates is replaced with coarse aggregates, concrete's flexural strength improves.

19] S. A. A. Mustafa,et. al. (2020): When compared to standard concrete mixtures, rubberized concrete has a lower compressive strength. If the total aggregate material is replaced with rubber at a rate of less than 20%, the loss in compressive strength can be tolerated. There is a significant drop in compressive strength over this ratio. Any coupling agent can be used to reduce the loss of compressivestrength in rubber particles.

20] Prof. (Dr) J. Bhattacharjee, et. al. (2020): When compared to regular concrete, the compressive strength of crumb rubber concrete at 10% rubber mix with fine aggregate is practically good. We may utilise the rubber to replace 10% of the fine aggregate and achieve strength of more than 65 percent of compressive strength after 7 days and 99 percent after 28 days. The concentration of rubber at the top surface is greater due to the lower specific gravity of crumbed rubber particles compared to fine aggregates.

21] Rahul Jaiswal, et. al. (2021) : Have research the disposal problem by substituting natural aggregate with rubber aggregate. It has been discovered that replacing 10% of the aggregates with normal concrete produces identical effects. It lowers the structure's dead load. If we use 10% replacement concrete, the cost of the concrete is lowered.

III. MATERIALS

Cement, coarse aggregate, sand, water, and rubber are the main requirements for this process.

1) Cement-Cement is an important component of construction. We used ordinary Portland cement of grade 53 [**IS** 12269 (1987)] for this project because it has cohesive and adhesive properties.

2) Aggregate- The coarse aggregate has been used in this project. The aggregate that passes through a 4.75mm screening is known as coarse aggregate aggregate gives concrete better volume stability and durability. It reduces shrinking and takes up 70-80% of the available space.

3) Sand-Sand is a type of fine aggregate. Sand adds bulk to the concrete and fills the voids between the coarse aggregates, and also limiting shrinkage of concrete.

4) Rubber- Rubber 5% of coarse aggregate was replaced by rubber, having the dimension of about 20 - 25mm.

Sr.no	Materials	Concrete [M25]	Rubcrete [M25]
1	Cement	4.27kg	4.27kg
2	Sand	7.26kg	7.26kg
3	Aggregate	12.51kg	11.31kg
4	Rubber 5%	-	1.25kg

Table no.1 : Shows the content of Different Materials

IV.METHODOLOGY: This steps are followed during researchPreparation of Rubcrete

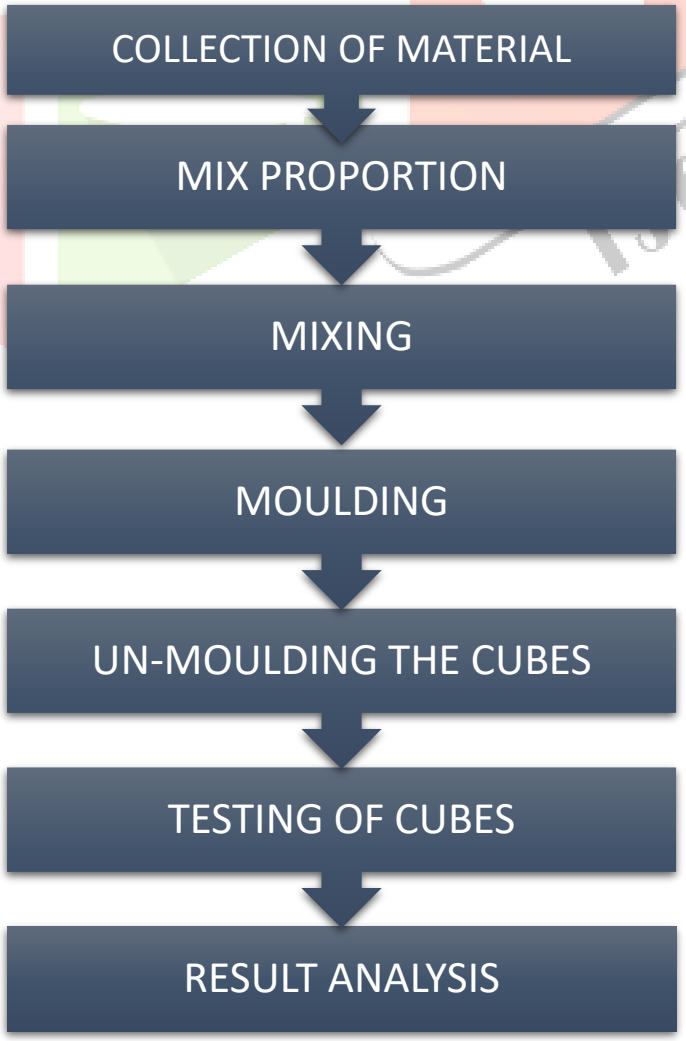

Fig no.1: Preparation of Rubberised Concrete

1)Batching: To make the concrete mix, the quantity or proportion of materials such as cement, aggregates, water, and other materials are measured by weight. According to the M25 mix design, it is a process of estimating and mixing the required concrete ingredients with both weight and volume according to the mix design, then putting them into the mix to generate a consistent quality of concrete.

2)Mixing: The concrete mixing ratio is determined by the strength that you want to obtain. A mix ratio of 1: 1: 2 means that 1 component cement, 1 part sand, and 2 parts aggregate should be added to make concrete. On a building site, there are a few method.

3) Placing of concrete / Rubcrete: Concrete casting is a major task that has a significant impact on a structure's performance and long term durability.

4)Curing of concrete / rubcrete cubes:
Curing is a way of preventing the concrete from Losing the moisture it needed to hydrate and keeping it with in the proper temperature range. Curing hardened concrete improves its strength and reduces its permeability.

5)Compressive strength: The concrete compressive strength is a measure of it's own capacity to withstand load that compress it. The failure load can be used to calculate compressive strength which is divided by the load resisting cross sectional area. Each cube was loaded into the compressing machine until it was crushed. After that, the crushing force was measured. This was done to determine the concrete's compressive strength. Total 9cubes were casted. Rubber tyre were partially replaced with coarse aggregate in concrete in 2 different percentage 0% and 5%. For each percent of rubber tyre addition 3 cubes were casted. Final Strength of cube tested after 7,14,28days of Curing. Compression test machine was used for testing the compressive strength of cubes of (150*150*150).

Fig no.2: Shows the testing of Concrete Cubes by CTM

V. RESULTS

Compression Strength: The concrete cubes were cast and tested after 7 days ,14 days 28 days of curing period. Results were represented in Table no.2 .It shows the compressive strength of the cubes after curing . It is observedthat the 5% replacement of rubberized concrete cubes gives more compressive strength than the plain concrete **.**The addition of rubber tyres increases the concrete's strength for 7 days, 14 days, and 28 days.This is due to the bond between the tyre rubber flakes and the composition of sand and aggregates.

Specimen	Compressive strength in N/mm^2		
	7days	14 days	28days
(PLAIN CONCRETE 0%)	17.62	22.67	27.65
(RUBBERIZED CONCRETE 5%)	19.28	25.67	29.65

Table no.2 : Shows the Compresiive Strength of 7 days ,14 days and 28 days Concrete cubes.

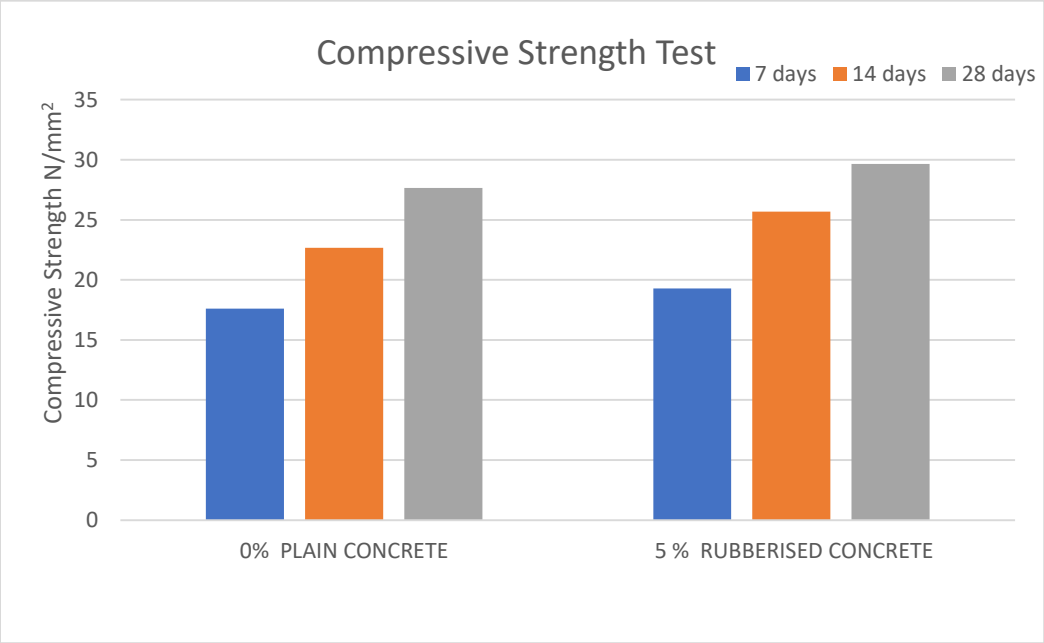

Fig no.3 Compressive Strength Result

VI. CONCLUSION

1. Rubberized concrete can be used in wide range of applications.
2. Rubberized concrete's compressive strength decreases as the rubber component increases
3. It's essential to identify the exact locations where this blend can be used.
4. Rubberized concrete is more fire resistant than regular concrete.
5. Experimental results of study shows that, it is possible to use recycled rubber tyre in terms of aggregates in concrete construction as partial replacement to natural fine aggregates.

VII. ACKNOWLEDGEMENT

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VIII. LISTS OF INDIAN STANDARD CODES

1. **IS**10262 (2009): Guidelines for concrete mix design proportioning [CED 2: Cement and Concrete]

2. **IS**12269 (1987): 53 grade ordinary Portland cement [CED 2: Cement and Concrete]

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