Experimental Study on Concrete Utilizing Waste Tyre Rubber as an Aggregate

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Abstract - Solid waste management has recently got a lot of interest from the scientific community. Because of its non-biodegradable nature, accumulating waste tyre has become a subject of interest among diverse solid waste. The majority of waste tyre rubbers are utilized as fuel in a variety of businesses, including thermal power plants, cement kilns, and brick kilns, among others. Unfortunately, this type of consumption is both environmentally unfriendly and expensive. As a result, using scrap tyre rubber in the manufacturing of concrete has been proposed as an alternate method of disposing of such trash in order to safeguard the environment. Cubes, cylinders, and beam examples were cast with shredded rubber crumbs replacing fine aggregate in proportions of 2%, 4%, 6%, 8%, and 10% by weight and compared to conventional specimens.

***Key Words*: Solid Waste Management, Waste tyre rubber, Rubber Crumbs, Replacing Fine Aggregate**

1. INTRODUCTION

Aggregates are in great demand in the business sector. It is a well-known fact that most aggregates used in concrete are mined. Unfortunately, mining has a negative impact on the ecosystem by reducing the ground water table. It also disintegrates rock layers, which is the primary cause of earthquakes and landslides. Modern transportation growth resulted in a high number of cars, which resulted in a significant volume of waste tyres. The disposal of waste tyre rubbers is costly, and the ever-dwindling number of landfills leads to hoarding. Stockpiles of this non-biodegradable waste tyre rubber create a drop in the water table, resulting in draught and other disasters. Because of the combustible nature of tyres and the geometry of tyres, fires are difficult to put out, and runoff pollutes ground water. Attempts have been made in this approach to utilise rubber tyres in building in various ways. Several recent research have demonstrated that adding used rubber tyre particles to concrete improves several of the poor features of ordinary concrete, such as low tensile strength, ductility, energy absorption, shrinkage, and cracking. The use of used rubber tyres as aggregate has lately been the topic of a lot of studies across the world, although our country has done very little study in this field. The limited quantity of information on the behaviour and qualities of concrete combined with rubber in various forms found in the literature review accessible in this field of research. Due to its lightweight, flexibility, energy absorption, sound and heat insulating capabilities, recycled scrap tyre rubber appears to be a promising material in the building business.

Unfortunately, the use of discarded tyres in Portland cement concrete mixes, particularly for highway usage, has received little attention. Researchers have only done a limited amount of investigation into the usage of rubber tyres in ordinary concrete. Tire rubber as an aggregate in concrete is the focus of the literature on the use of tyre rubber particles in cement-based products. The majority of the studies, as noted above, have revealed a significant reduction in the mechanical qualities of concrete when tyre rubber particles are used as aggregate. Solely using coarse rubber particles has a detrimental impact on the characteristics, whereas only using fine rubber particles has a positive impact. They've been studied for a long time as a resource reutilization as an aggregate in concrete, resulting in the rubcrete mix, which may be utilised in a variety of applications and has promising results. Rubcrete produces a finished product with high mechanical qualities and is a cost-effective and efficient solution to recycle waste tyres by partially or completely substituting natural aggregates. Nowadays, there is a lot of focus on the research community. Because of its non-biodegradable nature, accumulating waste tyres has become a subject of attention among the numerous solid wastes. The majority of waste tyre rubbers are utilised as fuel in a variety of businesses, including thermal power plants, cement kilns, and brick kilns, among others. This type of consumption is both environmentally unfriendly and expensive. As a result, the use of scrap tyre rubber in the production of concrete has been proposed as an environmentally friendly alternative to disposal of such trash. The samples will be tested for three days, seven days, and twenty-eight days. We'll look at the influence on fresh concrete's compressive, split tensile strength, and slump qualities, as well as the best degree of substitution to achieve the highest quality, and compare it to the test results of control specimens.

1.1 Objective

Objective of this study is to look at the effects of partial fine complete replacement with scrap tyre rubber and compare the resulting conventional concrete specimens to reference examples.

- To see how varying percentages of rubber tyre aggregates in M25 mix affected the effect of partial replacement of fine particles with rubber aggregates. Rubber tyre aggregates, which are a waste product, may be used in concrete construction and are both cost-effective and ecologically friendly.
- To see if crumb rubber could be reused in concrete mixes for building purposes.
- To reduce the impact of waste tyre on the environment as a pollutant.
- To find a cost-effective and efficient method of recycling used tyres.

2. MATERIAL INVESTIGATION

Scrap tyre rubber, which is inappropriate for use by cars on the road, has been offered as an alternative to coarse aggregate that provides concrete with a reasonable advantage. It's utilized to make concrete stronger than concrete created with the same amount of coarse particles. Scrap tyre rubber has been utilized in the construction sector for a variety of purposes, including daily cover in landfills, septic fields, and road bed building. Scrap rubber tyres were gathered from a local plant for this investigation.

Fine aggregate replacements are made from shredded rubber fragments. It has a specific density of 1.16 gm/cc and a fineness modulus of 5.35.

The cement used was standard portland cement with a grade of 53 according to IS:2269-2013. The specific gravity of the cement is 3.04.

As fine aggregate, the best grade river sand complying to IS:383-1970 grading zone 11 was employed. The specific gravity of the sand was 2.3.

For this investigation, coarse material was acquired from adjacent quarry units. The aggregate used has a maximum size of 20mm and a specific gravity of 2.67.

Both mixing and curing of concrete are done using clean potable water.

3. EXPERIMENTAL PROGRAMME

The fundamental engineering features of rubberized concrete mixes were explored in this study, which included an experimental investigation. When compared to normal concrete, the five authorized mixes comprise 2%, 4%, 6%, 8%, and 10% partial replacement of crumb rubber with fine aggregate.

3.1 Mix Proportions

The mix proportions of different sorts of percentages of replacement mixes and the resultant amounts for mixes. The % replacement of fine aggregate with crumb rubber and cement with Silica fume for the grade M25 is shown in the table. IS 10262: 2009 was followed in the mix design process. All mix proportions are designed to have a drop of 50-75mm while maintaining a water content of 192 kg/m^3. For all mixtures, the water-to-cement ratio of 0.42 was maintained. Crumb rubber, ranging from 2% to 10% by weight, was used to substitute fine aggregate.

3.2 Fresh Concrete Properties

The slump factor is used to determine the horizontal free flow of concrete, often known as workability. The test was done on M25 grade concrete, and the findings showed that all of the rubber that was replaced with fine aggregate concrete reacted poorly as compared to ordinary concrete. As a result, workability with a 0.42 water cement ratio is chosen.

3.3 Hardened Concrete Properties

1) A. Compressive Strength: The compression test is used to assess the hardened concrete's crushing strength. A compression test was performed on a cube with dimensions of 150mm*150mm*150mm. At 3, 7, and 28 days, the strength was measured. The strength of concrete was measured using the average of three specimens at different ages. The compressive strength test is performed using a 3000 kN compression testing equipment. The specimens' ultimate strength is measured when they can no longer withstand additional stresses. Formula can be used to compute compressive strength. Failure load divided by cross sectional area equals compressive strength.

2) Flexural Strength: The purpose of the experimental test is to determine the beam specimens' maximum load bearing capability. IS:519-1959 was followed and the load at which the specimen fails is recorded. Flexural strength tests were performed on 100mm*100mm*500mm beam specimens at 7 and 28 days of life. The specimens were tested using a flexure machine with a capacity of 100KN. $fb = (Pl/bd^2)$ can be used to compute flexure strength, where p is the failure load, l is the specimen length, b is the breath, and d is the depth.

4. RESULTS

A. **Workability:** Slump test of various mix proportions of scrap tyre rubber in concrete are conducted in laboratory From slump results, it is observed that as scrap rubber tyre percentage is increasing the workability increases.

B. **Compressive Strength Test:** The drop in fine aggregate content in these mixes is mostly responsible. When rubber was utilized in concrete the compressive strength values were found in decline. Results were shown in Table-1

C. **Flexural Strength**: As a result, the absence of effective bonding between rubber particles and cement paste is the most critical element in lowering flexural and compressive strength. After breaking the concrete samples for flexural strength testing.

As the amount of crumb rubber in concrete increased, the compressive and flexural values steadily decreased.

Table -1: Compressive strength test results

Notation	3 days specimen		14 days specimen		28 days specimen	
	Collapse Load (kn)	Comp. Strength (N/mm²)	Collapse Load (kn)	Comp. Strength (N/mm²)	Collapse Load (kn)	Comp. Strength (N/mm²)
0%	350	15.55	625	27.77	921	40.93
2%	350	15.55	510	22.66	825	36.66
4%	340	15.11	420	18.66	745	33.11
6%	325	14.44	355	15.77	550	24.44
8%	195	8.66	325	14.44	425	18.88
10%	180	8.00	300	13.33	390	17.33

5. CONCLUSIONS

- It can be concluded that, 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.

- As compared to ordinary concrete The unit weight of crumb rubber concrete was found to be lower than that of ordinary concrete. The reduction was discovered to be related to the amount of crumb rubber present. The crumb rubber concrete not only had a lower unit weight, but it also had excellent acoustic and thermal qualities. The mechanical parameters of crumb rubber concrete looked to be poorer than ordinary concrete due to the low strength and stiffness of rubber.

- Ultimately, tyre rubber may be utilized in a wide range of civil engineering projects. It has a lot of potential for growth, but it will be primarily dependent on the capacity of the architectural and construction designers engaged to persuade the authorities and necessary contractors of the benefits of these applications.

- Although additional study is needed in all of the industries indicated above, even tiny amounts of tyre rubber added to some applications might eliminate significant volumes of stored tyres while saving natural resources.

6. FUTURE SCOPE OF WORK

Reduced concrete strength is caused by a decrease in compressive strength and split tensile strength of the specimen owing to a lack of appropriate bonding between rubber and cement, therefore addressing this aspect is also advantageous.

A microscopic examination of the microstructure of concrete is also necessary for more accurate observations and conclusions.

Rubberized concrete behaviour at various chemical admixture dosages is required.

The compressive ability of blocks may be tested for equivalent extents of materials by varying the water cement percentage and using dispersion agents. To increase the capabilities of concrete, admixtures such as fly ash, ground granulated blast furnace slag, and silica fumes can be used.

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