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Partial Replacement of Coarse Aggregate by Waste Tyre Rubber

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Abstract: *The waste-Tyre rubber create the significant environmental problems in worldwide. With the increase in the automobile production, large amounts of waste tyre is generated from it, and need to be disposed. Due the rapid depletion of available sites for waste disposal, many countries banned the disposal of waste tyre rubber in landfills so that Research had been in progress from long time to find alternatives to the waste tyre disposal. 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. Among the all alternatives Utillization of waste-tyre rubber in as a partial replacement of coarse aggregate in different praportion is the best option. waste Tyre Rubber is light weight, elasticity energy absorption, and have sound and heat insulating properties so that it is used in construction sector. So that In this research, we are doing replacement of coarse aggregate by waste rubber tyre in 0%, 5%, 10%, 15%, 20% and then its compressive strength of its cube can be checked at 28 days. Ordinary Portland Cement (OPC) of 43 grade is taken and It can be help to environment to reduce pollution and also achieve Economy. In this project our main objective is to study the influence of partial replacement of coarse aggregate with waste tyre, and to compare it with the compressive strength of ordinary M25 concrete.*

Keywords: Compressive Strength, Waste tyre Rubber, light weight ,Energy absorption, Economy

I. INTRODUCTION

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics.The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts waste tyre are generated with an important impact on environment and humans.This project describes the feasibility of using the waste tyre rubber in coarse aggregate production as partial replacement of coarse aggregate. In INDIA, The waste generated from the industries cause environmental problems. Hence the reuse of this waste material can be emphasized. Waste tyre rubber is a developing composite material that will allow the concrete industry to optimize materiel use, generate economic benefits and build structures that will strong, durable and sensitive to environment. Now-a-days waste tyre rubber causes the pollution. Rubber contains the chemical compound such as silica and carbon black and coarse aggregate contains silica and calcium. So, rubber has slightly similar to coarse aggregate. Hence it can be replace. The compressive strength of concrete was measured for 28 days. In order to evaluate the effects of waste tire on mechanical behaviour, many different mortar mixes were tested. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. The research on rubberized concrete could promote the recycling of end-

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of-life tires and reduce natural resource extraction. To mitigate the greatly reduced compressive strength and fully utilize the desirable characteristics such as improved ductility and energy absorption of confinement through a steel outer tube could be adopted. Rubberized concrete is the new age construction material which can be effectively used in seismic prone regions due to its high ductility. Adding rubber to concrete not only facilitates handling of waste rubber and reduces consumption of natural raw materials but also improves certain properties of concrete. However, due to the hydrophobic nature of rubber, the hydraulic phase migrates out of the rubber and causes a weak interfacial transition zone between the rubber and cement matrix. Rubberized concrete has the benefit of utilizing waste material, preventing resource extraction and improving concrete ductility, however at the cost of reduced strength and stiffness.

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. 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 caused of its population. Burning rubber is the easiest and cheapest way to degrade material in this situation. But Pollution from smoke created from it caused global warming. Rubber dumping is a serious problem in India, hence the potential of rubber in concrete investigated 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.

1.1 Waste Tire rubber (CRUMB RUBBER)-

Crumb rubber is defined as the coarse pieces of rubber obtained from vehicle tires. This type of rubber is obtained by a process called Ambient Grinding. This type of grinding is a multi-step process and uses car or truck tires in the form of shred, or sidewalls, chips, or treads. After this, the tires are passed through a shredder, where the tires are broken into smaller chips.Management of waste-tyre rubber is very difficult for municipalities to handle because the waste tyre rubber is not easily biodegradable even after long-period of landfill treatment. So that recycling of waste tyre rubber is an alternative option. Recycled waste-tyre rubber have been used in different application. It has been used as a fuel for cement kiln. Crumb rubber is defined as the coarse pieces of rubber obtained from vehicle tires. This type of rubber is obtained by a process called Ambient Grinding. This type of grinding is a multi-step process and uses car or truck tires in the form of shred, or sidewalls, chips, or treads. After this, the tires are passed through a shredder, where the tires are broken into smaller chips. The crumb rubber normally used in the size of 4.75mm to 0.075mm.

II. LITERATURE REVIEW

[1] Badugu Manisha, Ajmeera Lavanya, Darsi Gopi Kalyan, Kesana Kodhanda Vamsi Mahesh, Manepalli Vaishnavi, P. Narendra Babu, NAGK Manikanta Kopuri (March 2024) A Study on Concrete with Waste Rubber Tyre as Partial Replacement to Coarse Aggregate: This experimental study is conducted to analyze the behaviour characteristics of rubberized concrete where rubber tyre is partially replaced with coarse aggregate.M30 grade concrete has been chosen as the reference concrete specimen. This will not only allow the sustainable use of aggregates available to us but also provide an effective and mass management of waste rubber tyre. This waste rubber tyre aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study compressive strength and split tensile of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.

[2] P. Jeevana Ashamoina Anil Kumar, Banoth Nomeshwar Nayak, Arikela Jyothirmai, Maddela Vishnu Vardhan, Dharma Raju Reddy (2023) -Partial Replacement of Coarse Aggregate with Crumb rubber chips in the preparation of Concrete : This experimental study is conducted to analyze the behaviour characteristics of rubberized concrete where tire rubber is partially replaced with coarse aggregate. It is estimated that more than 270 million scrap-tires are arising each year. In India the disposal of waste tire in landfills is a major issue handled by local municipalities and government sectors. This waste being non-biodegradable possess severe fire, environmental and health risks. A side

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from tire derived fuel, the most promising use of tires in engineering applications as artificial reefs, erosion control and aggregates for asphalt and concrete. The use of recycled tire rubber as partial aggregate in concrete has great potential to positively affect the properties of concrete in a wide spectrum. Concrete is one of the most popular construction materials. Due to this fact, the construction industry is always trying to increase its uses and applications and improving its properties, while reducing cost. M30 grade concrete has been chosen as the reference concrete specimen. Scrap tire rubber chips has been used as coarse aggregate with the replacement of conventional coarse aggregate. This will not only allow the sustainable use of aggregates available to us but also provide an effective and mass management of rubber tire waste. The rubber tire waste is split into coarse chips and then in this crumb tire aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study, workability and compressive of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.

[3] Vaishali Kesalkar, Sanket Awaghane, Shruti Madame, Ravina Danao, Sanket Ghugul, Palash Nagdevt ,Rohit Mehar (April 2022) -Experimental Study on Partially Replacement of Coarse Aggregate by Rubber Tyre: 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.

[4] Waqar Ahmed ,Er. Rabinder Singh and Insha Kouser (August 2022) --Experimental Study on Effect of Partial Replacement of Coarse Aggregates in Concrete by Waste Tyre Rubber Aggregates in Rigid Pavements : This study intends to explore the flexural and split tensile strength, light weight, higher impact and toughness resistance which means prolonged and better resistance to formation of cracks, upgraded ductility, etc most effective use of the waste tyre rubber as a constituent of concrete mix replacing the coarse aggregate partially. In this research work, emphasis is given on the pre-treating of the rubber particles and then using them as the partial replacement of the conventional rock aggregates. To get the best results, the rubber aggregates used are surface treated by sodium hydroxide and cement paste before using them in the concrete.M20 grade concrete is used. Using untreated rubber aggregates, the compressive strength of the resultant concrete reduced rapidly, but when treated rubber aggregates were introduced, it resulted in the regaining of more than 90% of the 28 day compressive strength of normal concrete which can be considered quite satisfactory considering the easy and cheap availability of the used tyres and the negative impacts it can have on the environment if left unused. This much compressive strength is enough for treated-rubberized concrete for its use in different areas where compressive strength is not much important like in floors and concrete road pavements. Flexural and split tensile strength is found to be higher than that of the normal concrete but only when treatment is given to the rubber aggregates before using them. Workability is decreased. Flexibility gets increased and due to the lower unit weight of the rubber particles, it is also lighter than the normal concrete.

[5] Mr. Jaydeo Phadtare, Dr. N. K. Patil, Dr. A.D. Katdare- (November 2022) Study of Partial Replacement of Coarse Aggregate in Concrete by Different Proportions of Un-Treated Waste Tyre Rubber: The aim of this Research is to find out the effect of partial replacement of coarse aggregate by waste tyre rubber in untreated condition that is as it is without any pre-surface treatment. With the help of tests such as compressive strength, spilt tensile strength, flexural strength and slump cone test. In India number of vehicles are growing day by day so, because of it waste tyre generation also increased. So, recycling of this large quantity waste is not an easy work. Our main focus is to use this waste tyre rubber in concrete without affecting its properties which are mentioned earlier. Study and Analysis of partially replaced concrete with respect to various strengths under 7 and 28 days of curing.

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III. DATABASE AND METHODOLOGY

3.1 Materials :

1. Aggregate:

Gravels are obtained by crushing natural basalt stone from quarries nearby Jalgaon. They are hard, strong, tough, clear and free from veins, alkali, vegetable matter and other deleterious substances. Aggregates are free from such material, and confirming as per IS 383-1970.

2. Cement:

Ordinary Portland Cement (OPC) of 43 grades, date of manufacturing is 3rd week before utillization confirming to Indian standard code IS 8112-1989.

3. Water:

Water is used for mixing; curing purpose should be clean, portable, fresh and free from any bacteria and desire matter confirming to IS 3025-1964 is used for mixing.

4. Waste Tyre:

We are using Waste Tyre which partially replaces coarse aggregate in step of 0%, 5%, 10%, 15% in concrete. This partial replacement of coarse aggregate with waste tyre which improves the properties of concrete in various ways.We are casting the cubes to check compressive strength of concrete. In this project our main objective is to study the influence of partial replacement of coarse aggregate with waste tyre, and to compare it with the compressive strength of ordinary M25 concrete. We are also trying to find the percentage of waste tyre replaced in concrete that makes the strength of the concrete maximum. Waste Tyre has become a pollutant. So, by partially replacing coarse aggregate, we are proposing a method that can be of great use in reducing pollution to a great extent.

3.2 Experimental Investigation:

we are doing replacement of coarse aggregate by waste rubber tyre in 0%, 5%, 10%, 15%, 20% and then its compressive strength can be checked. Here, Ordinary Portland Cement (OPC) of 43 Grade is used.

3.3 Preparation and Testing of Specimen:

In order to prepare the recycled crumb rubber concrete specimen, coarse aggregate can be replaced by 0%, 5%,10%,15%,20% for M25 grade of concrete. The sand used was cleaned from the impurities and use for mixing of concrete. For each mix, cubes 150mm*150mm*150mm is prepared. All the specimens was fabricated and cured in water for 28 days in according to the Indian standard (IS 10262-2009).After the 24 hours of casting, cubes are taken out from the mould and pored in the water tank for curing. All the tests were conduct at the “Well equipped Laboratory ".The load was applied until the failure and crushing load was noted.

Compressive strength=Crushing load/Effective area

Totally 5 cubes can be prepared of M25 grade of concrete for this study with 0%, 5%,10%,15%,20% replacement of coarse aggregate by crumb rubber can be carried out.

3.4 Compressive Strength:

The compressive strength of specimens for M25 grade of concrete with replaced of coarse aggregate by crumb rubber. The casted cubes can cured for 28 days. Then the cubes can be tested in the compression testing machine.

3.5 Mixed design proportions for rubberized Concrete:

In this research work Standard cubic specimens of size 150mm (Three sample for each percentage of crumb rubber) were casted for the compressive strength of concrete and it was kept under curing for 28 days of age. Total cubes for compressive strength testing were 15 (3 cubes * 5 proportions). Mass of ingredients required will be calculated for 3 no’s cubes assuming 10% wastage.

Volume of the Cube = 1.1*(0.15)3 =0.037969 m3

1. Cement- OPC 43 Grade.

2. Coarse Aggregate- Coarse Aggregates of 10 mm and 20 mm with sizes of 38% and 62% were used.

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3. Fine Aggregate- Artificial sand (Crushed sand) was used.
4. Waste tyre chipped rubber pieces are used cutting by manually by hand and in varying sizes ranging from 10 mm.
5. Water – ordinary portable water (PH ranges between 6.0 to 8.5)
6. Concrete grade – M20 and water cement ratio-0.48

3.6 Sample Production:
The cement, fine and coarse aggregates were weighted according to mix proportion of M30.
All are mixed together until mixed properly and water was added at a ratio of 0.45.
The water was added gradually and mixed until homogeneity is achieved. Any lumping is found at any stage was taken out, loosened and again added to the mix. For the second series of the mixture, the modified rubber chips was added at 5%,10%,15%,20% by volume of coarse aggregate. Immediately after mixing, slump test were carried out for all the concrete series mixture. A standard 150×150×150mm cube specimens were casted. The specimens were covered with gunny immediately after placing in the mould for complete moisture retention. The samples were then stripped after 24hours of casting and are then be ponded in a water curing. As casted, a total of (15) 150×150×150mm cubes specimens were produced.

Figure 1. Cutting of waste tyre in Nominal size of Coarse Aggregate

3.7 Objectives :
1) To develop mix design methodology for mix 25 MPa.
2) To determine the workability of freshly prepared concrete by Slump test .
3) The main purpose of this study is to examine the effect of addition of chipped waste tire rubber as a aggregates into the Ordinary Portland cement concrete in different proportions i.e. 5%,10%,15 % & 20% by coarse aggregates by weight and evaluate the rubberized concrete properties.
4) To analyse the effects of partial replacement of coarse aggregate by tre waste in concrete with respect to strengths and workability.

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IV. RESULTS AND DISCUSSION

4.1 Results of Test on Materials :

4.1.1 Result of test on Fine Aggregates:

Test	Fineness Modulus	Specific Gravity	Moisture Content
Result	2.55	2.67	3.53 %

4.1.2 Result of test on coarse Aggregates:

Test	Fineness Modulus	Specific Gravity	Moisture Content
Result	3.69	2.71	2.49 %

4.1.3 Result of test on tyre Rubber:

Test	Fineness Modulus	Specific Gravity
Result	2.29	1.12

4.1.4 Result of test on Cement:

Test	Fineness Modulus	Specific Gravity
Result	3.34 %	3.05

Standard Consistency – 31 %
Initial Setting Time – 108 minutes
Final Setting Time - 272 minutes

4.1.5 Result of test on Slump Cone Result:

Sr.No	% of Rubber	Slump Value (mm)
1	0 %	75
2	5 %	60
3	10 %	53
4	15 %	45

4.1.6 Result of Compressive Strength:

The Standard size of a concrete cube for testing is 15 cm x 15 cm x 15 cm. This means the surface area of each face of the cube is 15 cm x 15 cm = 225 cm2.

=225 cm2 /10

=22.50 mm2 (As we know 1cm=10 mm)

% Waste Tyre	Avg. Strength (KN/mm^2)
0 %	48.87
5 %	69.40
10 %	78.12
15%	75.92
20%	75.20

Table 4.1.6 . Results of compressive strength of cubes

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Sample calculation 1.

Compressive strength = Max. Load Applied to the Specimen (KN/mm^2)
Cross-sectional Area of Specimen

Here, the Cross-sectional Area of Specimen is 15 cm x 15 cm x 15 cm. This means the surface area of each face of the cube is 15 cm x 15 cm = 225 cm2.

=225 cm2 /10
=22.50 mm2 (As we know 1cm=10 mm)

So that Compressive strength = (425.00) / (22.50)
= 18.88 KN/mm2

The concrete cubes were cast and tested after 28 days of curing period. Results were represented in Table no.2.It shows the compressive strength of the cubes after curing.It is observed that the 10% replacement of rubberized concrete cubes gives more compressive strength than the plain concrete. The addition of rubber tyres increases the concrete's strength for 28 days. This is due to the bond between the tyre rubber flakes and the composition of sand and aggregates. The optimum percentage for replacement of waste tyre with coarse aggregate is 10%.

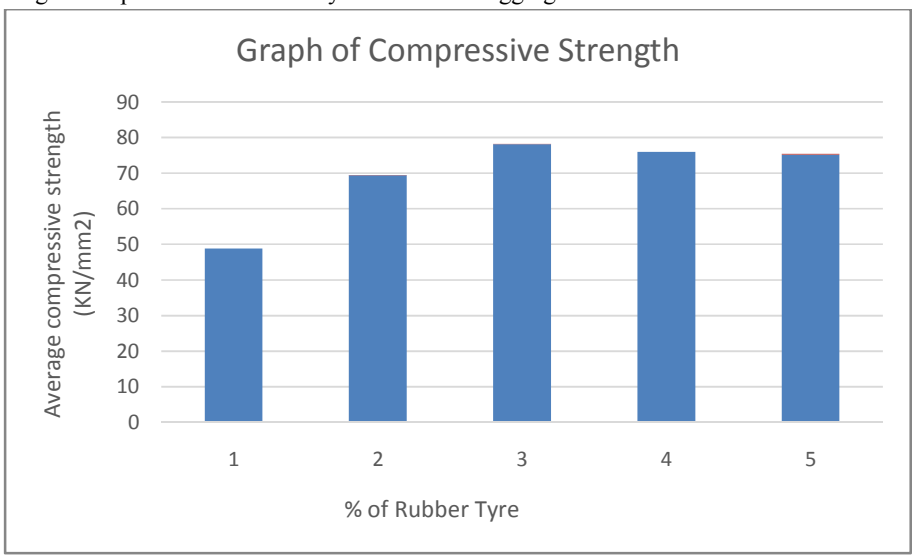

Figure 2. Graph of Compressive Strength

V. CONCLUSION

Literature is evident of different benefits of waste tyre. According to most of research papers and with my study, it is clear that, There are many general advantages of waste tyre.

1. Compressive strength of cubes increased from 48.87 kN/mm2 to 69.40 kN/mm2 for 5% replacement of waste tyres and from 69.40 kN/mm2 to 78.12 kN/mm2 for 10% replacement of waste tyre with coarse aggregate.
2. But compressive strength of cubes decreases from 78.12 kN/mm2 to 75.92 kN/mm2 and 75.92 kN/mm2 to 75.20 kN/mm2 for 15% and 20% replacement respectively of waste tyre with coarse aggregate.
3. The test conducted on materials like Aggregate, Cement and Tyre Rubber having the entire test within permissible limit as per IS code.
4. The optimum percentage for replacement of waste tyre with coarse aggregate is 10%
5. If Rubber crumb can be used in excess quantity, then beyond certain limit Rubber particles can create more void space within the pavement mix. This can reduce the material's ability to transfer loads effectively, leading to a decrease in compressive strength.

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7. In general, while waste tires can offer some beneficial properties like increased durability and sound insulation, It show lower strength and density can negatively impact the compressive strength of pavements if It is used in excessive quantities.

5.1 Future Scope

1. Ongoing research is focused on finding the optimum percentages and proportions of waste tire rubber replacement to maximize the benefits of rubberized concrete.
2. Various treatments and admixtures are being explored to improve the bonding between rubber aggregates and cement paste and enhance the strength and durability of the concrete.

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