Performance and Evaluation Of Rubber As Concrete Material

Nikhil Ramchandra Pardeshi[1], Digvijay P. Singh[2], Sakshi Ramesh Patil[3], Pravin J. Gorde[4] ,Prachity P.Janrao[5]

[123] *Student, Dept of Civil Engineering,*
Dr. D.Y.Patil Institute Of Engineering Management and Research, Akurdi.Pune, India

[45] *Assistant Professor Dept of Civil Engineering,*
Dr. D.Y.Patil Institute Of Engineering Management and Research, Akurdi.Pune, India

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Abstract—Concrete is an excellent structural material and considered as useful for the modern civilization and human society. Concrete is most widely used building material in the world, and about 12.6 billion tons of natural resources are used to make the concrete. Hence, the use of waste tyres in concrete has become technically possible and this concrete is being considered as light weight concrete. The major part of concrete apart from cement is the aggregate. Aggregate include sand and crushed stone / Gravel. Waste tyre rubber is generated in large amount as a waste and does not have useful disposal till now. Used tyres are one of the important parts of solid waste which causes a serious environmental problem. Recent EU policies on the Land filling of Waste (Council Directive 1999/31/EC) banned the land filling of whole or shredded tyres. Therefore, there is an urgent need to find alternative outlets for these used tyres. But rubber is found to possess properties that are required for practical replacement of fine and coarse aggregate in concrete. Two types of waste tyres are used as crumb rubber and chipped rubber by percentage of (0%, 10%, 15%, and 20%) in the replacement of coarse and fine aggregate in concrete. Hence we in this project have aimed to study the use of rubcrete concrete in structural and non-structural members and show how it is suitable for the concrete, its uses, barriers and benefits and way to future study. And To determine characteristics of concrete containing tyre materials. From some results we concluded that there is a decrease in compressive strength of the concrete in other hand an increase in their toughness with good approach properties and also solve a serious problem posed by waste tires. And also Based on the results of some tests, concrete containing shredded tire particles as aggregates is still not recommended for structural uses because of the low compressive strength comparing with the normal concrete containing natural rock aggregates. So, This type of concrete shows promise for becoming an additional sustainable solution for tyre rubber waste management.

Keywords— ***Rubcrete concrete, scrap tyre aggregate, waste tyre aggregate, compressive strength.***

INTRODUCTION

"The use of rubber product is increasing every year in worldwide. Waste tires are major environmental problem for many metropolitan areas in the India. There are more than 1 billion scrap tires, approximately one tire per person, generated each year in the India. This creates a major problem for the earth and their livings. For this issue, the easiest and cheapest way of decomposing of the rubber is by burning it. This creates smoke pollution and other toxic emission and it create global warming. Currently 75-80% of scrap tyres are buried in landfills. Burying scrap tyres in landfills is not only wasteful, but also costly. Recent EU policies on the Land filling of Waste (Council Directive 1999/31/EC) banned the land filling of whole or shredded tyres. So many recycling methods for the rubber tyre are carried according to the need. From this one of the processes is to making the tyre rubber in to crumb and chipped rubber. This crumb and chipped waste tires are different to other wastes materials with a potential for re-use because there production method is now well developed, the reuse of this material in concrete could have both environmental advantage and at the same time ensure economic viability with improvement the characteristic design properties of concrete mix. It is used in many works such as Road construction, light weight construction, flooring, Mold making etc. in the form of rubcrete concrete.

CHALLENGES IN ENVIRONMENTAL PROTECTION:

The wastages are divided as Solid Waste Disposal, Liquid Waste Disposal and Gaseous Waste Disposal. There are lots of disposal ways for liquid and gaseous waste materials. Some solid waste materials such as plastic bottles, papers, steel, etc can be recycled without affecting the environment. But there is no way to dispose the solid wastes such as waste tires. If the tire is burned, the toxic product from the tire will damage the environment and thus creating air pollution. Since it is not a biodegradable material, this may affect the fertility of the soil and vegetation. Sometimes they may produce uncontrolled fire. Similarly, there is an another challenge to the human society is in the form carbon dioxide emission and green house emission, which are considered as another type of waste, which is threatening the universe.

RUBCRETE CONCRETE:

The concrete mixed with waste rubber added in different volume proportions is called rubcrete concrete. Partially replacing the coarse or fine aggregate of concrete with some quantity of small waste tire in the form of crumb and chipped can improve qualities such as low unit weight, high resistance to abrasion, absorbing the shocks and vibrations, high ductility and brittleness and so on to the concrete.

SULPHUR RUBBER CONCRETE :

Sulphur rubber concrete (SRC) is an innovative idea. In sulphur rubber concrete, melted element sulphur, instead of Portland cement, act as a binder. This is why the concrete is called sulphur rubber concrete, because there is no Portland cement in it. Production of sulphur concrete is a hot mix procedure similar to the process for manufacturing of asphalt concrete. Sulphur concrete can be manufactured in a modified asphalt batch plant or a continuous mix facility. When rubber is used in the sulphur concrete to replace some of the natural aggregates, the hot mix process for the sulphur concrete makes the rubber aggregates undergo a vulcanization process, i.e., reacting to sulphur under temperature about 140C.As a result, the strength of the sulphur rubber concrete is higher than the strength of the regular concrete with rubber aggregates.

THE AIM OF THIS RESEARCH IS TO:

1 .Design a standard concrete mix.

2.Replacement a fine and coarse aggregate of standard concrete mix with different weight ratios of scrap tires (both crumb and chipped rubber) as (0%, 10%, 15%, and 20%) respectively.

3. To check the physical, chemical, and mechanical properties for both standard and modification concrete mix.

4. To find which one of additive has excellent properties for civil construction applications.

ADVANTAGES OF RUBCRETE CONCRETE :

1. The rubcrete concrete are affordable and cost effective.
2. It resist the high pressure, impact and temperature.
3. They have good water resistance with low absorption, improved acid resistance, low shrinkage, high impact resistance, and excellent sound and thermal insulation.
4. If we use magnesium oxychloride cement instead of Portland cement it gives more compressive and tensile strength.
5. Also, if we react this rubcrete concrete with hot sulphur under temperature about 140oCit shows increase in strength of concrete.

DIS-ADVANTAGES OF RUBCRETE CONCRETE :

1. They are sometimes weak in compressive and tensile strength.

APPLICATION OF RUBCRETE CONCRETE :

1. In non-load bearing members as lightweight concrete walls.
2. In highway constructions as a shock absorber.
3. In sound barriers as a sound absorber.
4. In buildings as an earthquake shock-wave absorber.
5. It may also used in runways and taxiways in the airport, industrial floorings and even as structural member.

II. LITERATURE REVIEW

Biel&Lee[1]in 1994, In this paper authors have published that used recycled tire rubber in concrete mixes made with magnesium oxychloride cement, where the aggregate was replaced by fine crumb rubber up to 25% by volume. The results of compressive and tensile strength tests indicated that there is better bonding when magnesium oxychloride cement is used. The researchers discovered that structural applications could be possible if the rubber content is limited to 17% by volume of the aggregate.

IlkerBekirTopcu[2] in 1995 'the properties of rubberized concretes', proposed the concrete was modified by mixing with crumb rubber in coarse aggregate in the ratio of 15%, 30% and 45%. In this study the changes of the properties of rubberized concrete were investigated according to the terms of both size and amount of rubber chips added. In this the physical and mechanical properties were determined according to that the stress strain diagram were developed from that the toughness value and the plastic and elastic energy capacities were determined.

Fattuhi [3]in 1996, proposed that, the cement paste, mortar, and concrete (containing OPC or grade rubber obtained from shredding scrap tyres. Properties examined for the 32 mixes prepared included density, compressive strength, impact and fire resistances, and nailability. Results showed that density and compressive strength of various mixes were reduced by the addition of rubber. (Rubber type had only marginal effect.) Density varied between about 1300 and 2300 kg/m3. Compressive strength reduced by 70% when the proportion of rubber to total solid content by mass of concrete reached about 13%.

GuoqiangLi[4] in 2004, conducted investigation on chips and fibre's. The tyre surfaces are treated by saturated NaOH solution and physical anchorage by drilling hole at the centre of the chips were also investigated and they concluded that fibre's perform better than chips: NaOH surface treatment does not work for larger sized tire chips: using physical anchorage has some effect. Further efforts will be geared toward the enlarging he hole size and insuring that the hole be through the chip thickness entirely. Fibre length restricted to less than 50mm to avoid entangle: steel belt wires provide positive effect on increasing the strength of concrete.

Gintautas skripkiūnas, et al[5], proposed that, Rubber waste additives reduced both static and dynamic modulus of elasticity. Strains of the concrete with the same compressive strength with rubber waste from used tires (3.2% from aggregate by mass) deformations are 56 % – 63 % higher after the static loading, while set deformations after the unloading is 219 % – 360 % higher than for the none rubberised concrete. Cyclic loading of 20 cycles have no influence on the prismatic compressive strength of both concrete with and without rubber waste (3.2% from aggregate by mass). And Ultimate strains on concrete failure load are 36 % – 47 % higher for concrete with tyre rubber waste additive.

G.Senthil Kumaran, et al[6], proposed that, Recycling technology for concrete has significantly developed in the recent years, making the material sufficiently recyclable. It is evident that from the above discussion, the reduction of compressive and tensile strength can be increased by adding some super plasticizers and industrial wastes as partial replacement of cement will definitely increase the strength of waste tyre rubber modified concrete. Many studies reveal that there will be increase in strength enhancements as well as environmental advantages. The future NGC using waste tyre rubber could provide one of the environmental friendly and economically viable products. Though problems remain regarding the cost of production and awareness among the society the wastes can be converted into a valuable product. But further research is needed to increase performance against fire.

M.Mavroulidou, J.Figueiredo[7], proposed that, From the present experimental study and literature review it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include non primary structural applications of medium to low strength requirements, benefiting from other features of this type of concrete. Even if rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used tyres.

Piti Sukontasukkul[8] in 2008, proposed the paper on crumb rubber concrete. In their study they decided to replace the coarse and fine aggregate in concrete for moulding pedestrian blocks. They believe that the concrete acting as a binder mixed with crumb rubber can make the concrete blocks more flexible and it provide softness to the surface. In this study they saw that the pedestrian blocks with crumb rubber performed quite well in skid and abrasion resistance. In this study the process of making the concrete is economical due to the simplicity of the manufacturing process.

Amjad A. Yasin[9], proposed that, Based on the results of tests, concrete containing shredded tire particles as aggregates is still not recommended for structural uses because of the low compressive strength comparing with the normal concrete containing natural rock aggregates. During the tests it was noted that as the percentage amount of shredded tires increased, the amount of energy required for casting specimens increased substantially, because of the reduction of workability in the concrete. In another hand, it was observed that the pieces of concrete cubes tested tend to stay together linked through the rubber particles, which means that the usage of shredded tires as aggregates in concrete may produce a much more tough concrete and may reduce the cracks in the aging concrete. Although synthetic lightweight aggregates specially shredded tires are more expensive than normal-weight or natural rock aggregates, the increased strength-to-weight ratio offers sufficient overall saving in materials, through the reduction of dead load to more than offset the higher aggregate cost per cubic meter of the concrete. Lower total loads mean reduced supporting sections and foundations, and less reinforcement.

III. METHODOLOGY

We have to make six concrete mixes. The ratios of the mix designs are given in the Table 1.

TABLE I. DESIGN MIX RATIOS PROPOSED FOR THE TESTS

Mix No.	Cement	Fine Agg.	Coarse Agg.	Chipped Rubber	Crumb Rubber
1	✓	✓	✓	-	-
2	✓	✓	✓	10% Of Coarse	-
3	✓	✓	-	-	10% Of Fine

A. PREPERATION OF CONCRETE CUBES

The concrete cubes were prepared in accordance to IS : 516.The binder, sand and aggregates first premixed dry for 1 min. to ensure homogeneity. Then Wet mixing with a total mix time of 4.5 min. Cast the concrete in a steel molds with the dimensions of (150 x 150 x 150) mm. Demold the concrete specimens after 24 hours, and then keep the cubes for water-curing in an opened container. Test the three cubes to check its compressive strength after 7, 28, 56 and 90 days.

B. SLUMP CONE TEST

Slump test was carried out to determine the workability of each mix. The tests were carried out in all cases in accordance with the requirements of BS 1881: Part 102(1983) for slump test and BS 1881: Part103 (1983) for compacting factor tests.

C. TESTING FOR COMPRESSIVE STRENGTH

By testing the concrete cubes using CTM with a some constant loading rate find the average of the strength of three cubes per test.

D .FLEXURAL STRENGTH TEST

The tensile strength testing machine was used to test the flexural strength of the concrete beams at 7, 14 and 28 days respectively according to IS 516-1959 after taking their weights in order to ascertain their densities. Results were recorded based on the average tensile strength.

IV MIX PROPORTIONS

1. Mix proportion for trial mix 1 (Control Sample) for 1m^3 in kg (weight batching)

Cement	Water (w/c=0.45)	Fine Agg.	Coarse Agg.	Chipped Rubber	Crumb Rubber	Admix-ture
413.33	186	703	1250.60	-	-	4.13
Mix Proportion - 1:1.70:3.02						

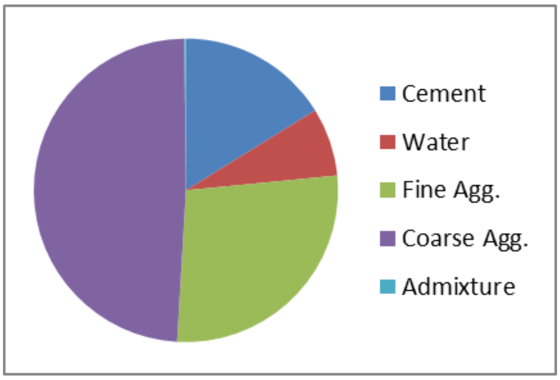


Chart 1: Mix Proportion Of Trial 1

2. Mix proportion for trial mix 2 (10% replacement of coarse aggregate by chipped rubber) for 1m3 in kg (weigh batching)

Cement	Water (w/c=0.45)	Fine Agg.	Coarse Agg.	Chipped Rubber	Crumb Rubber	Admix-ture
413.33	186	703	1125.54	125.06	-	4.13

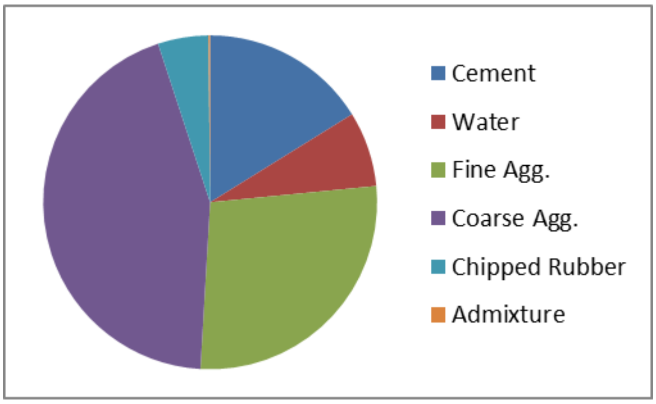


Chart 2: Mix Proportion Of Trial 2

3. Mix proportion for trial mix 3 (10% replacement of fine aggregate by crumb rubber) for 1m^3 in kg (weigh batching)

Cement	Water (w/c=0.45)	Fine Agg.	Coarse Agg.	Chipped Rubber	Crumb Rubber	Admix-ture
413.33	186	632.7	1250.60	-	70.3	4.13

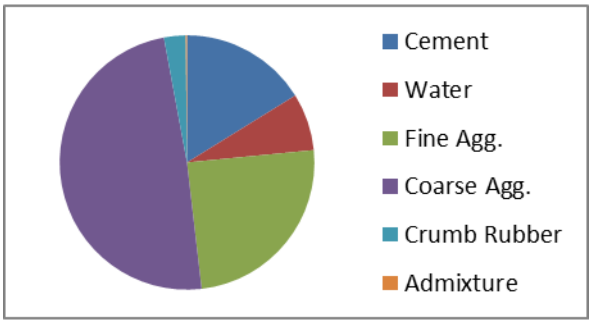


Chart 3: Mix Proportion Of Trial 3

V RESULTS

I. Compressive Strength Test (3rd Day)

Trial 1 (Control Sample) M30

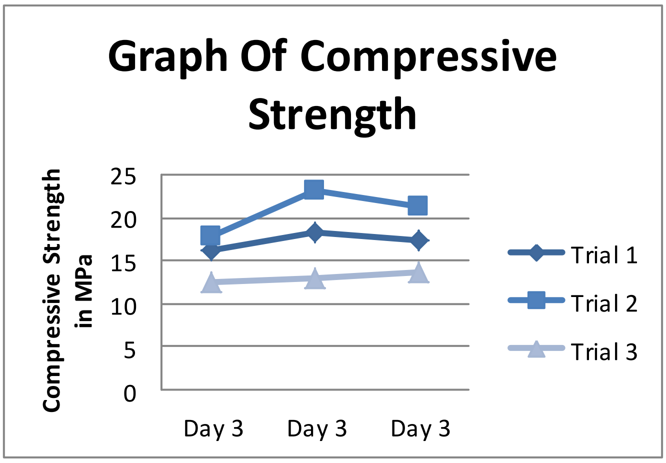
Cube	3rd Day Strength	Weight
1	16.3 MPa	9.2
2	18.2 MPa	9.1
3	17.3 MPa	8.8

Trial 2 (10% replacement of coarse aggregate by chipped rubber)

Cube	3rd Day Strength	Weight
1	17.77 MPa	8.63
2	23.11 Mpa	8.47
3	21.33 Mpa	8.41

Trial 3 (10% replacement of fine aggregate by crumb rubber

Cube	3rd Day Strength	Weight
1	12.44 MPa	8.48
2	12.88 Mpa	8.27
3	13.77 Mpa	8.34



Graphical Representation Of Compressive Strength

VI. CONCLUSION

From the case studies it can be concluded that the waste tyre rubber in the form of crumb and chipped rubber in replacement of coarse and fine aggregate is possible in the concrete but it is still not recommended for structural uses because of the low compressive strength comparing with the normal concrete containing natural rock aggregates. In some cases, it was observed that the compressive strength of concrete is decreases as we increased the percentage of rubber in concrete also there are several properties that can be improved by adding rubber aggregate to the concrete. It is also possible to make high strength rubcrete concrete using magnesium oxychloride cement, it improves the performance and bonding in the rubcrete concrete. This waste material exists in the environment with almost no cost. The use of rubber in concrete is an excellent choice for feaseability, a cleaner environment, and a reduction in insulation cost.

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