International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 11 | Nov 2018 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON BEHAVIOUR OF RUBBERIZED C0NCRETE

Mr. A.Varadharaj[1], Mr. S. Mathivanan [2]

[1]Assisstant Professor, Department of Civil Engineering, RVS Technical Campus, Coimbatore-641402, India,
[2] PG student, Department of Civil Engineering, RVS Technical Campus, Coimbatore-641402, India

---

Abstract - *Utilization of industrial waste products in concrete has grab the attention all around the world due to the rise of environmental consciousness. In the world wide, Waste-Tyre Rubber is one of the significant environmental problems. In this work, experiments were carried out by using recycled Rubber Tyres (Crumb rubber) as a partial replacement for coarse aggregates and Silica Fume as a partial replacement for cement. The mechanical properties of Rubberized Concrete were determined for 7th day and 28th day and compared with the conventional concrete. The mix was designed for M30 grade concrete of 1:1.37:2.56. The waste tyre rubbers of 20mm size were used. The specimens were prepared by replacing coarse aggregate by 5, 10, 15 and 20% of weight of Rubber aggregate and replacing cement by 2.5, 5, and 7.5, of weight of Silica Fume. A total of 45 cubes, 45 cylinders, 30 prisms and 15 cylindrical disk of size 150mm diameter and 100mm height (impact test) specimens were cast. The results of test were compared with the respective conventional concrete properties. The strength of Rubberized Concrete decreased, among which 5% replacement of Rubber shows better result. There was a reduction in Compressive strength of 6.5%, Split tensile strength of 16%, flexural strength of 5%, and Impact strength of 62.5% and young's modulus of 16%. The addition of Silica Fume (5%) in 5% replacement of coarse aggregate by Rubber aggregate improves the compressive strength by 10% compared to conventional concrete.*

Key Words: **Crump rubber, silica fume, recycled of coarse aggregate.**

1. INTRODUCTION

Cement and aggregate, which are the most significant constituents used in concrete production. Similar to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as aggregate, by using substitute materials that are either recycled or discarded as a waste. Due to the increasing awareness of the role played by aggregates in determining many important properties of concrete, the traditional view of the aggregate as an inert filler is being seriously questioned. As a matter of fact aggregate is not truly inert and its physical, thermal, and sometimes chemical properties influence the performance of concrete.

Aggregate is inexpensive than cement and it is, therefore, economical to put into the mix much of the former and as little of the latter as possible. In spite of that, economy is not the only reason for using aggregate: it confers considerable technical advantages on concrete, which has a higher volume stability and better durability than hydrated cement paste alone.

Among the many threats that affect the environment are process or discarded after a specific material ends its life time or the intended use. The wastages can be divided into solid waste, liquid waste and gaseous wastes. There are many other disposal ways for liquid and gaseous waste materials. Some solid waste materials such as plastic bottles , steel, papers, etc can be recycled without affecting the environment. Though, studies on how to dispose some solid wastes such as waste tyres in the most favourable ways are not yet fully exhausted.

Tyre is a thermo set material that contains cross-linked molecules of sulphur and other chemicals. The process of mixing rubber with other chemicals to form this thermo set material is commonly known as vulcanization. This makes postconsumer tyres very stable and nearly impossible to degrade under ambient conditions. Accordingly, it has resulted in a growing disposal problem that has led to changes in legislation and significant researches worldwide.

On the other hand, disposal of the waste tyres all around the world is becoming higher and higher through time. This continuously keeps on increasing every year with the number of vehicles, as do the future problems relating to the crucial environmental issues. If the tyre is burned, the toxic product from the tyre 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 it may produce uncontrolled fire. Similarly, the other challenge to the human society is in the form of carbon dioxide emission and green house emission. These emissions are considered as highly threatening wastes to the universe. Since 1990, it has been the policy of the State of Arizona that the recycling and reuse of waste tyres are given the highest priority. The Arizona Department of Transportation (ADOT) has long supported the use of recycled waste tyre rubber in asphalt rubber hot mix.

2. LITERATURE REVIEW

Abrham Kebede Seyfu et al has investigated in progress for long time to find alternatives to the waste tyre disposal. Recycled waste tyre rubber has been used in this study to replace the coarse aggregate by using different percentages. The results of this paper shows that although, there was a significant reduction in the compressive strength of concrete utilizing waste tyre rubber than normal concrete, concrete utilizing waste tyre rubber demonstrated a ductile, plastic failure rather than brittle failure. For rubberized concrete, the test results show that the addition of rubber aggregate resulted in a significant reduction in concrete compressive strength compared with the control concrete. This reduction increased with increasing percentage of rubber aggregate. Losses in compressive strength ranging from 11.38 % to 64.02 % were observed. The reason for the strength reduction could be attributed both to a reduction of quantity of the solid load carrying material and lack of adhesion at the boundaries of the rubber aggregate, soft rubber particles behave as voids in the concrete matrix. Therefore, rubber aggregate tends to behave like weak inclusions or voids in the concrete resulting in a reduction in compressive strength. Although the compressive strength values have considerably decreased with the addition of waste tyre pieces, their values are still in the reasonable range for a 10 % and 25 % replacement values because the intended compressive strengths of 15, 25, 30 and 40 MPa were achieved in this categories.

H. M. A. Al-Mattarnehetal carried out to develop information about the mechanical properties of rubberized concretes. A control Ordinary Portland cement concrete mix (OPC) is designed using Indian Standard mix design methods and crumb rubber contents of 0, 5, 10, 15 and 20% by volume were chosen by partially replacing the coarse aggregate with crumb rubber. Totally 60 specimens were cast and tested for compressive strength, splitting tensile strength, flexural strength and modulus elasticity. The results revealed that although there is a reduction in strength for crumb rubber mixture, but slump values increase as the crumb rubber content increase from 0% to 20%. Meaning that crumb rubber mixture is more workable compare to normal concrete and can be acceptable to produce crumb rubber concretes. The results also indicated that inclusion crumb rubber in concrete reduced the static modulus elasticity. Although there is a reduction in modulus elasticity but the deformability crumb rubber concrete increasing compared to normal concrete. The results of the splitting tensile strength tests show that, there is a decrease in strength with increasing rubber aggregate content like the reduction observed in the compressive strength tests. However, there was a smaller reduction in splitting tensile strength as compared to the reduction in the compressive strength. One of the reasons that splitting tensile strength of the rubberized concrete is lower than the conventional concrete is that bond strength between cement paste and rubber tyre particles is poor. Besides, pore structures in rubberized concretes are much more than conventional concrete. The Impact resistance test results show that the addition of rubber aggregate resulted in a significant increase in impact resistance compared with the control concrete. These results show that the addition of rubber aggregate to concrete at lower replacements of 10 and 25 % enhanced the impact resistance of the concrete greatly. Hence, the application of rubberized concrete can be of great help in structures that are exposed to vibrations and impact loads.

Wesam Amer Aules et al tyre is an assembly of numerous components that are built up on a drum and then cured in a press under heat and pressure. Heat facilitates a polymerization reaction that crosslink rubber monomers to create long elastic molecules. These polymers create the elastic quality that permits the tyre to be compressed in the area where the tyre contacts the road surface and spring back to its original shape under high-frequency cycles. The fundamental materials of modern tyres are rubber and fabric along with other compound chemicals. Their constructive make-up consists of the tread and the body. The tread provides traction while the body ensures support. Before rubber was invented, the first versions of tyres were simply bands of metal that fit around wooden wheels in order to prevent wear and tear. The most recent and popular type of tyre is pneumatic, pertaining to a fitted rubber based ring that is used as an inflatable cushion and generally filled with compressed air. Pneumatic tyres are used on many types of vehicles. Table below shows the typical composition of a passenger tyre and track tyre respectively

Methods of Recycling Tyres

The numerous techniques and technologies available for processing postconsumer tyres are enumerated below.

- Shredding and Chipping: This is mechanical shredding of the tyres first in to bigger sizes and then into particles of 20 – 30 mm in size.
- Crumbing: It is the processing of the tyre into fine granular or powdered particles using mechanical or cryogenic processes. The steel and fabric component of the tyres are also removed during this process.
- DeVulcanising: This is the treatment of tyre with heat and chemicals to reverse the vulcanisation process in the original tyre production.
- Pyrolysis and Gasification: These are two thermal decomposition processes carried out under different conditions. The processes produce gas, oil, steel, and carbon black (char).
- Energy Recovery: It is the incineration of tyres to generate energy.

Kamil et al this research is to find a means to dispose of the crumb rubber in Portland cement concrete and still provide a final product with good engineering properties. With this objective in mind the Arizona Department of Transportation (ADOT) and Arizona State University (ASU) initiated several crumb rubber concrete (CRC) test sections over the past few years. The test sections were built throughout the state of Arizona and are being monitored for performance. Laboratory tests were conducted at ASU to support the knowledge learned in the field. The unit weight of the crumb rubber concrete decreased approximately 6 pcf for every 50 lbs of crumb rubber added. The compressive and flexural strength also decreased as the rubber content increased. Further investigative efforts determined that the entrapped air (causing excessive reductions in compressive strength) could be substantially reduced by adding a de-airing agent into the mixing truck just prior to the placement of the concrete. The laboratory test results also showed that as the rubber content increased, the tensile strength decreased, but the strain at failure increased. Higher tensile strain at failure is indicative of more ductile (energy absorbent) mixes. The coefficient of thermal expansion tests indicated that the CRC are more resistant to thermal changes. In all of the mechanical tests, the CRC specimens remained intact after failure (did not shatter) compared to a conventional concrete mix. Such behaviour may be beneficial for a structure that requires good impact resistance properties. If no special considerations are made to maintain a higher strength value, the use of CRC mixes are recommended in places where high strength concrete is not required.

El-Gammal et al has investigated a replacement to the coarse aggregate in the rubberized concrete. The compressive strength was reduced significantly by 90% when using chipped rubber as a full replacement to the coarse aggregate in the concrete mix. Moreover, the figure shows that there was no significant increase in the compressive strength of concrete casted using crumb rubber replacing 50% of the sand compared to the compressive strength of concrete casted using crumb rubber as a 100% replacement to the sand in the concrete mix. This paper presented the effect of waste tyre rubber as a replacement to aggregate in concrete mixtures on the density and compressive strength of concrete. From the results of this study, the following conclusions and recommendation are drawn:

- Concrete casted using chipped rubber as a full replacement to coarse aggregate shows a significant reduction in the concrete strength compared to the control specimen. However, significant ductility was observed before failure of the specimens.
- Concrete casted using chipped rubber as a full replacement to coarse aggregate shows a significant reduction in the density of concrete compared to the control specimens.
- Concrete casted using crumb rubber as a full replacement to sand shows a significant increase in the concrete strength compared to the concrete casted using chipped rubber as a replacement to coarse aggregate.

3. PROPERTIES AND MATERIAL USED

3.1 Coarse aggregate

Table 3.1-Properties of coarse aggregate

S. No	Properties	Value	Requirements of IS 383:1970
1	Specific Gravity	2.74	2.5-3.0
2	Fineness Modulus	5.67	3.5-6.5
3	Bulk Density	1507.5 kg/m^3	-
4	Water Absorption	0.80%	0.2%-4%

3.2 Fine aggregate

Table 3.2- Properties of Fine Aggregate

S. No	Properties	Value	Requirements of IS 383:1970
1	Specific Gravity	2.52	2.5-3.0
2	Percentage of voids	24.50%	<40%
3	Fineness Modulus	2.786	2-3.5
4	Bulk Density	1650 kg/m3	-
5	Water Absorption	1.20%	<2%

3.3 Cement

Table 3.3- Physical properties of cement

S. No	Properties	Value	Standard values
1	Specific Gravity	3.17	3.10- 3.20

2	Standard Consistency	28%	25 – 35
3	Initial Setting Time	45 minutes	>30 min
4	Final Setting Time	512 minutes	<600 min

3.4 Crumb rubber aggregate

Table3.4- Properties of crumb rubber aggregate

S. No	Properties	Value	Standard values
1	Specific Gravity	3.17	3.10- 3.20
2	Standard Consistency	28%	25 – 35
3	Initial Setting Time	45 minutes	>30 min
4	Final Setting Time	512 minutes	<600 min

3.5 Silica Fume

Table 3.5-Properties of silica fume

Property	Value
Particle Size	< 1 µm
Specific Gravity	2.22
Surface Area	13,000–30,000 m^2/kg
Bulk Density	480 – 720 kg/m^3

3.6 Chemical Composition of Silica Fume

Chemical Properties	Values
SiO	92.1%
Al_2O_3	0.5%
MgO	0.3%
SO_3	0.17%
CaO	0.5%

4.MIX DESIGN

4.1 Mix proportion-Control mix

Cement	= 594.3 Kg
Fine aggregate	= 716.56 Kg
Coarse aggregate	= 878.58 Kg
Water cement ratio	= 0.35
Mix proportion in M_{30}	**= 1:1.2:1.5**

5. CONCLUSION

Different views of various authors on bond strength flexural strength of concrete silica fume, crumb rubber and recycled aggregate have been discussed. This gives theoretical knowledge about utilization of silica fume, crumb rubber and recycled aggregate to replace the cement, fine aggregate, course aggregate from the conventional concrete by various ratios. From the literature review, the scope and idea to replace various concrete components can bring several characteristic changes in concrete physical and mechanical properties. The material testing for various materials used in the project are carried out to determine their properties, convenient to obtain required quality and strength. Design of concrete mix had done in this phase for the M30 concrete and the mix proportion for control mix is 1:1.2:1.5.

REFERENCES

1. El-Gammal,"Compressive Strength of Concrete Utilizing Waste Tire Rubber" Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 96-99.

2. Eldin, Neil N, "Rubber-tired Particles as Concrete Aggregate," Journal of Materials in Civil Engineering, 5(4), 478-496, 1993.

3. Gintautas, Skripkiūnas, "Deformation properties of concrete with Rubber waste additives" ISSN 1392–1320 Materials Science (medžiagotyra). vol. 13, no. 3. 2007.

4. J. Figueiredo, "Discarded tyre rubber as Concrete Aggregate: a possible outlet for used tyres". Global nest journal, vol 12, no 4, pp 359-367, 2010.

5. Mohammad Reza sohrabi, "An experimental study on compressive strength of concrete containing crumbs rubber" International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol 11 No: 03.

6. N. J. Azmi, B. S. Mohammed, "Engineering Properties of Concrete Containing Recycled Tire Rubber" ICCBT2008.

7. Tarun R. Naik, "Properties of concrete containing scrap tire rubber-an overview." The University of Wisconsin-Milwaukee-1990.

8. Wesam Amer, "Utilization of Crumb Rubber as Partial Replacement in Sand for Cement Mortar" European Journal of Scientific Research ISSN 1450-216X Vol.51 No.2 (2011), pp.203-210.