International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.14, pp 287-293, 2017

Experimental Study on Replacing Waste Rubber as Coarse Aggregate

K. Paul Sibiyone*, M Lenin Sundar

Department of Civil Engineering, Sri Krishna College of Technology, Coimbatore, India

Abstract : The disposal of used tires is a major environmental problem throughout the world which causes environmental hazards. Flap rubber is a waste material that is ideal for use in concrete applications. The aim of this study is achieved to use of rubber waste as partial replacement of coarse aggregate to produce rubberize concrete in M20 mix. Different partial replacements of flap rubber (10, 20,30 and 40%) by volume of coarse aggregate are cast and test for compressive strength, flexural strength and split tensile strength. The results showed that there is a reduction in all type of strength for flap rubber mixture, but slump values increase as the flap rubber content increase from 0% to 20%. Meaning that flap rubber mixture is more workable compare to normal concrete and also it is useful in making light weight concrete. It is recommended to use the rubberized concrete for non-structural applications and structural applications.

Introduction

1.1 General

The use of recycled 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. In general, concrete has low tensile strength, low ductility, and low energy absorption. Concrete also tends to shrink and crack during the hardening and curing process. These limitations are constantly being tested with hopes of improvement by the introduction of new admixtures and aggregates used in the mix. One such method may be the introduction of rubber to the concrete mix. It is a perfect way to modify the properties of concrete and recycle rubber tires flaps at the same time.

1.1.1 Rubberised Concrete

About one crore 10 lakhs all type flaps of new vehicles are added each year to the Indian roads. The increase of about three crores discarded tire flaps each year pose a potential threat to the environment. Large quantities of scrap tires flaps are generated each year globally. This is dangerous not only due to potential environmental threat, but also from fire hazards and provide breeding grounds for rats, mice, vermin’s and mosquitoes, Over the years, disposal of tire flaps has become one of the serious problems in environments. Land filling is becoming unacceptable because of the rapid depletion of available sites for waste disposal. In order to prevent the environmental problem from growing, recycling tire is an innovative idea or way in this case. Recycling tire is the processes of recycling vehicles tires that are no longer suitable for use on vehicles due to wear or irreparable damage. So the research has already been conducted on the used of waste tyre flap as aggregate replacement in concrete showing that a concrete with enhanced toughness and sound insulation properties can be achieved It has been reported that the addition of rubber to structural high strength concrete slabs improved fire resistance, reducing the spalling damage concluded in their research that rubberized concrete can successfully be used in secondary structural components such as culverts, crash barriers, sidewalks, running tracks, sound absorbers, etc. However, most of the developing third world countries have yet to raise their awareness regarding recycling of waste materials and have not developed effective legislation with respect to the local reuse of waste materials. Building on previous research carried out internationally, this study may provide the technical information necessary to improve local awareness of the reuse of flap rubber as a substitute for natural aggregates in the production of concrete. The proposed work presents an experimental study of effect of use of solid waste material in concrete by volume variation of rubber. One of the objectives of this paper is to make these data regarding the basic properties of modified concrete using flap rubber in the concrete mix available to aid in the development of preliminary guidelines for the use of flap rubber in concrete.

If tire flap are reused as a construction material instead of being burnt, the unique properties of tire flap can once again be exploited in a beneficial manner. In this context, the use of tire flap chips in lightweight concrete is considered a potentially significant avenue. Thus, the use of scrap tire flaps in concrete manufacturing is a necessity than a desire. The use of scrap tires flaps in concrete is a concept applied extensively over the world. The use of scrap tire flap rubber in normal strength concrete is a new dimension in concrete mix design and if applied on a large scale would revolutionize the construction industry, by economizing the construction cost and increasing the worn out tire flap disposal. It is with this intension, an experimental study is proposed to be conducted by using flap rubber as sand in cement concrete.

1.2 Objectives

The primary objectives of this study are to:

- Examine the effects of increasing the coarse aggregate replacement percentage with recycled tire chips on concrete fresh properties, compressive strength, split-tension, flexural strength, permeability and freeze/thaw resistance, and determine an optimum replacement percentage of coarse aggregate with recycled tire flap chips for concrete mixtures.

- Provide recommendations for the use of recycled tire flap chips as a coarse aggregate replacement in a concrete mixture designed for field implementation.

- The main benefit of the research is to find an alternative to recycle waste tire flaps in concrete. If tire flap chips can successfully replace the coarse aggregate in concrete mixes, the people of Colorado will benefit from the value gained in extending natural resources, reducing land space needed for waste products, and potentially decreasing costs associated with the product development and construction.

1.3 Scope of Study

This research evaluated the reuse potential of recycled tire flap chips as coarse aggregate in CDOT Class P pavement concrete mixes. An extensive literature review was performed on the rubberized concrete focusing on the tire chips as coarse aggregate replacement. Chapter 2 summarized the research findings which are related to the engineering properties of tire chips, design, construction, and performance evaluation of the rubberized concrete mixtures since early 1980s. One concrete control mixture was designed, which well exceeded CDOT Class P concrete requirements. The coarse aggregate component of the mixture was replaced in 40, 30, 20, and 10 percent by volume using tire chips. The fresh concrete properties, compressive strength, flexural strength, splitting strength, permeability, and freeze/thaw durability were tested in the lab in order to determine if there is a promise in developing the pavement concrete mixtures including tire chips.

2 Materials

2.1 Collection of Raw Materials

The constituent materials used in the investigation are OPC of 53 grade, flap chips, fine aggregate & coarse aggregate were collected from local sources.

2.2 Cement

Ordinary Portland cement of 53 grade conforming to Indian Standard IS 12269-1987 was used in the experimental program. Cement is a binder, a substance that sets and hardens and can bind other materials together.

2.3 Fine Aggregate

Fine aggregate is a material that will pass a no of sieve and retained on 200 sieve. For increased workability and for economy as reflected by use of cement, the fine aggregate should have round shape. The purpose of fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. To investigate the properties and suitability of aggregates for its intended application, the tests are conducted as (1) sieve analysis and fineness modulus (2) specific gravity (3) water absorption (4) silt content.

2.4 Coarse Aggregate

It gives body to the concrete, reduces shrinkage and effect economy, the aggregate occupy 70%- 80% of volume of concrete. The size of coarse aggregate is less than 10mm. Building durable structures and pavements requires use of high quality aggregates or mixture of sand, gravel and crushed rock.

2.5 Flap Chips

The replacement of coarse aggregate by scrap flap rubber effects on the workability and strength of the concrete. The size of coarse aggregate is less than 10mm. As with fine aggregate, for increased workability and economy as reflected by the use of less cement, the flap rubber should be rinsed in the water and it should be dried.

3 Mix Design

3.1 General

Concrete mix design is the method of proportioning of ingredients of concrete to enhance its properties during plastic stage as well as during hardened stage, as well as to find economical mix proportions.

Designed mix concrete suggests proportions of cement, sand, aggregates and water (and sometimes admixtures) based on actual material quality, degree of quality control, quality of materials and their moisture content for given concrete compressive strength required for the project. Designed mix concrete are carried out in laboratory and based on various tests and revisions in mix designs, the final mix proportions are suggested.

4 Experimental Works

In this experimental study, the fundamental properties of the concrete were determined from compressive strength test, split tensile test and flexural strength test. Cube size of 150 x 150 x 150mm was cast to determine the compressive strength. Splitting strength was measured on cylinder of size 150 x 300 mm. Prismatic specimen of size 100 x 100 mm cross section and 500 mm length is used to determined flexure strength. The materials involved in this experimental work ordinary Portland cement, fine aggregate, coarse aggregate, flap tyres.

5 Results and Discussion

5.1 Compressive Strength

Table gives the test results of compressive strength at 7th and 28th day with various percentages of rubber. Compressive strength increases with increasing percentage of rubber. 10% addition of rubber into the concrete shows maximum benefits in compressive strength Even 40% gives more strength than the nominal concrete.

5.2 Split Tensile Strength

Table gives the test results of flexural strength at 28 days. Tensile strength increases with increasing percentage of rubber. 10% addition of rubber into the concrete shows maximum benefits in tensile strength Even 40% gives more strength than the nominal concrete

5.3 Flexural Strength

Table gives the test results of flexural strength at 28 days. Flexural strength increases with increasing percentage of rubber. 10% addition of rubber into the concrete shows maximum benefits in flexural strength. Even 40% gives more strength than the nominal concrete

Table 3.1 Mix Proportion

Ingredients	**Nominal mix** Kg/m^3	**Mix 1** Kg/m^3	**Mix 2** Kg/m^3	**Mix 3** Kg/m^3	**Mix4** Kg/m^3
Cement	313.3	313.3	313.3	313.3	313.3
Fine aggregate	563.0	563.0	563.0	563.0	563.0
Coarse aggregate	1224	1101.9	979.5	857.80	734.6
Flap rubber	-	280.4	310.6	342.2	366.7
Water	191.6	191.6	191.6	191.6	191.6

Table 5.1 Compressive strength results

Compressive strength (N/mm^2)		
% of rubber	**7th day**	**28th day**
Nominal	15.1	24.9
10	19.06	29.33
20	18.77	28.89
30	18.20	28.00
40	17.04	26.22

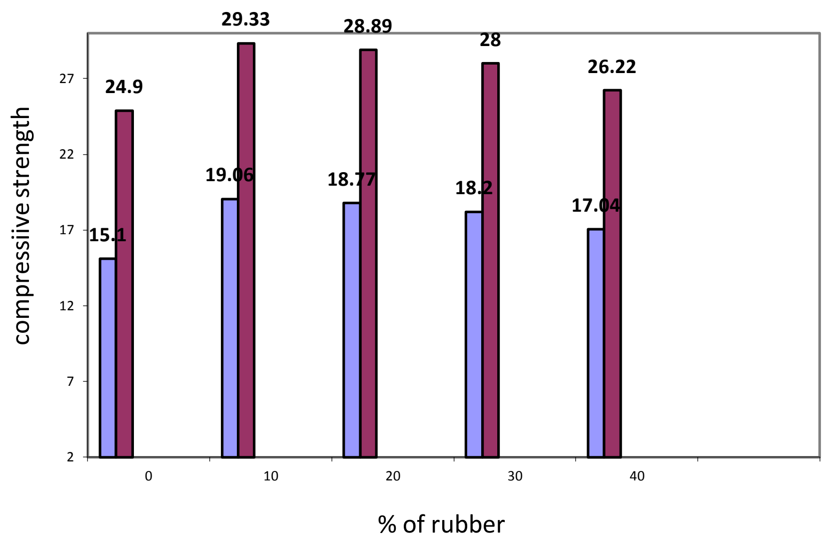

Fig 5.1 Graph showing compressive strength result

Table 5.2Tensile Strength

Tensile strength (N/mm^2)		
% of rubber	**7th day**	**28th day**
Nominal	1.27	2.40
10	1.93	2.97
20	1.83	2.68
30	1.55	2.546
40	1.41	2.26

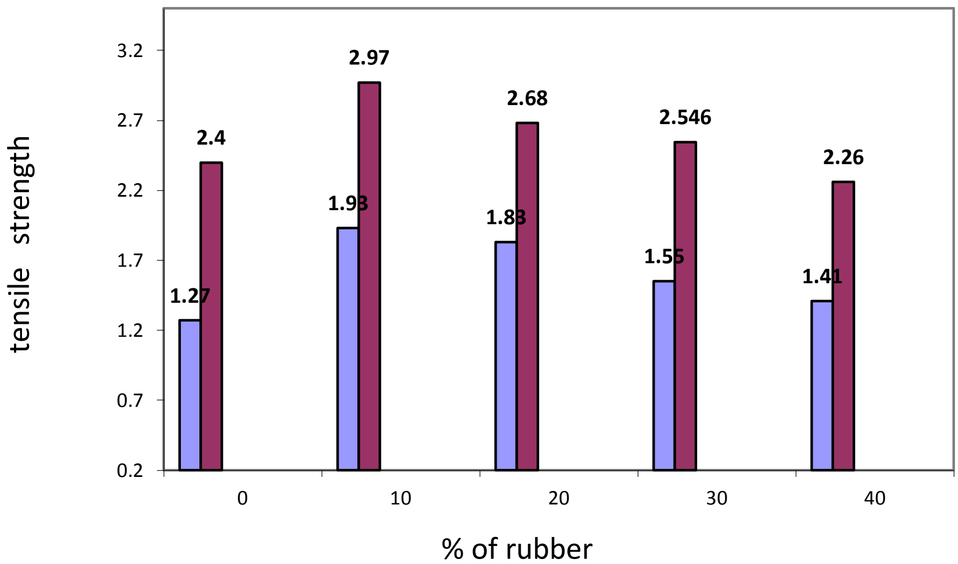

Fig 5.2 Graph showing Tensile strength result

Table 5.3Flexural Strength

Flexural strength (N/mm^2)		
% of rubber	**7th day**	**28th day**
Nominal	2.01	3.1
10	2.47	3.8
20	2.27	3.5
30	2.21	3.4
40	2.08	3.2

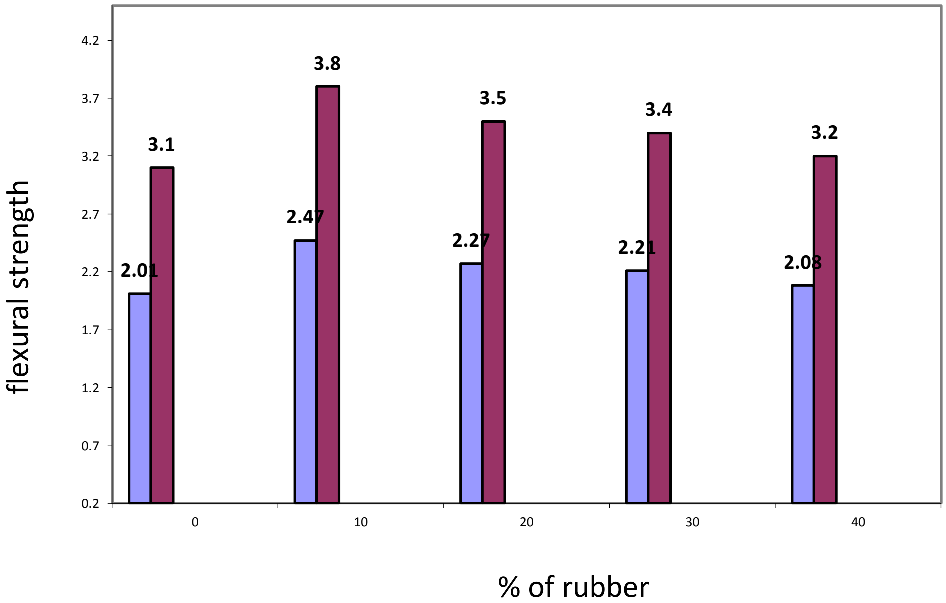

Fig 5.3 Graph showing flexural strength result

Conclusion

The test results of this study indicate that there is great potential for the utilization of waste tyres in concrete mixes in several percentages, ranging from 10 to 40 percent. From this present study it has been concluded that maximum strength is obtained by 10% replacement of coarse aggregate even 40 percent of replacement of coarse aggregate give more strength than the nominal concrete. Concrete with higher percentage of flap rubber possess high toughness From the present experimental study, Rubberized concrete strength may be improved by improving the bond properties of rubber aggregates.

References

1. Anjerick J. Topacio, Nikko C. Gozo , Sydh Roeth V. Marquez, Rommel, “Use of Recycled Rubber Tire Crumbs for Waterproofing of Concrete”, International Journal of Civil and Structural Engineering Research ISSN 2348-7607, 2016 (95-132)
2. Ishtiaqalam, “Use of Rubber as Aggregate in Concrete”, University of technology, nowshera. International Journal of Advanced Structures and Geotechnical Engineering, IJASGE Vol. 04, No. 02, April 2015.
3. Indian Standard Specification IS: 10262(2009).
4. Jadhao, s. m. dumneEffect of chipped rubber aggregates on performance of concreteISSN 2320-0936Vol03,,2014.
5. Khatib, Z.K., Bayomy, F.M., Rubberized Portland cement concrete. ASCE Journal of Materials in Civil Engineering. Vol 11,1999.
6. Kotresh K.M, Mesfin Getahun Belachew, ‘Study On Waste Tyre Rubber As Concrete Aggregate”, International Journal of Scientific Engineering and Technology,,Vol 3 ,2014.

7. Mehta PK, Monteiro PJM "Concrete structure, properties, and materials" ISBNvol 4, 1993.
8. Michelle Danko, Purdue University Calumet ,Edgar Cano, "Use of Recycled Tires as Partial Replacement of Coarse Aggregate in the Production ofConcrete". IJAER april 2014.
9. Neeladeshpande, s. s. kulkarni, tejaswineepawar & vijaygunde, "Experimental investigation on strength characteristics of concrete using tyre rubber as aggregates in concrete" IJAER vol 4 ,2014.
10. Parveen, SachinDass, Ankit Sharma, "Rubberized Concrete: Needs of Good Environment JSCER Vol. 4, 2015.
11. YogenderAntilS.E, "An Experimental Study on Rubberized Concrete" ijetaevol 4 2012.
12. Zeineddineboudaoud, miloudbeddar, "Effects of recycled tires rubber aggregates on the characteristics of cement concrete", Open Journal of Civil Engineering 2012.

*****