International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

EXPERIMENTAL STUDY ON BEHAVIOUR OF RUBBER CONCRETE ON PARTIAL REPLACEMENT OF COARSE AGGREGATE

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ABSTRACT

Concrete is the most widely used construction material.it is produced by mixing cement, fine aggregate, coarse aggregate and potable water. Increase in demand and rapid growth of construction industry results in the need to identify alternative materials for coarse aggregate and cement. Alternative Materials like waste tire rubber is available in the environment. Waste tire rubber is one of the significant environmental problems worldwide. With increase in the automobile production, huge amounts of waste tire need to be disposed. Research had been in the progress for long time to find alternatives to the waste tire disposal Among these alternatives is the recycled waste-tire rubber is a promising material in the construction industry due to its lightweight elasticity energy absorption and heat insulating properties. Recycled waste tire rubber has been used in this study to replace the coarse aggregate by weight using different percentages (0%,5%,10%,15%) The results shows that, although, there was a significant reduction in the compressive strength of concrete utilizing waste tire rubber than normal concrete, concrete utilizing waste tire rubber demonstrated a ductile plastic failure rather than brittle failure. The highest compressive strength of M25 grade concrete(22.22Mpa) is observed at 5% waste tire rubber.

Key words: aggregate, compressive strength

I. INTRODUCTION

Cement and aggregate, which are the most important constituents used in concrete production, are the vital materials needed for the construction industry. This inevitably led to a continuous and increasing demand of natural materials used for their production. Parallel 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 alternative materials that are either recycled or discarded as a waste.

Concrete strength is greatly affected by the properties of its constituents and the mix design parameters. Because aggregates represent the major constituent of the bulk of a concrete mixture, its properties affect the properties of the final product. An aggregate has been customarily treated as an inert filler in concrete.

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It is possible, however, to take an opposite view and to look on aggregate as a building material connected into a cohesive whole by means of the cement paste, in a manner similar to masonry construction. In fact aggregate is not truly inert and its physical, thermal, and sometimes chemical properties influence the performance of concrete.

Aggregate is cheaper than cement and it is, therefore, economical to put into the mix much of the former and as little of the latter as possible. Nevertheless, 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.

According to Kumaran S.G. et al, the goal of sustainability is that life on the planet can be sustained for the foreseeable future and there are three components of sustainability: environment, economy, and society. To meet its goal, sustainable development must ensure that these three components remain healthy and balanced. Tire is a thermoset material that contains cross-linked molecules of sulphur and other chemicals. The process of mixing rubber with other chemicals to form this thermoset material is commonly known as vulcanization. This makes postconsumer tires very stable and nearly impossible to degrade under ambient conditions. Consequently, 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 tires all around the world is becoming higher and higher through time. This keeps on increasing every year with the number of vehicles, as do the future problems relating to the crucial environmental issues.

II. METHODS AND MATERIALS

The general properties of the concrete are tested and to know the basic properties of the concrete material have satisfies the grade strength. In order to replace the amount of fine aggregate in normal concrete by using the waste material (tyre rubber powder), the materials used are cement, sand, coarse aggregate, tyre rubber and water Sand which passes in between 4.75mm and 0.15mm in size is used for this project

2.1 Characteristics of Concrete

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together . In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates. Concrete is the world’s most important construction material. The quality and performance of concrete plays a key role for most of the infrastructures including commercial, industrial, residential and military structures, dams, power plants and transportation systems The worldwide use of concrete materials accounts for nearly 780 billion dollars in annual spending.

The ability of concrete to be cast to any desired shape and configuration is an important characteristic that can offset other shortcomings. Good quality concrete is a very durable material and should remain maintenance free for many years when it has been properly designed for the service conditions and properly placed. Of course, proper use of the structure for the

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IJARST ISSN: 2457-0362

intended function can have a significant role. Through choice of aggregate or control of paste chemistry and microstructure, concrete can be made inherently resistant to physicalattack, such as from cycles of freezing and thawing or from abrasion and from chemical attack such as from dissolved sulfates or acids attacking the paste matrix or from highly alkaline pore solutions attacking the aggregates. Judicious use of mineral admixtures greatly enhances the durability of concrete. The main advantages of concrete as a construction material are the ability to be cast, being economical, durability, fire resistance, energy efficiency, on-site fabrication and its aesthetic properties. Whereas the disadvantages are low tensile strength, low ductility, volume instability and low strength to weight ratio.

2.1.2 Constituents of Concrete

2.1.2.1 Cement

Cement is a generic name that can apply to all binders. Portland cement, the basic ingredient of concrete, is a closely controlled chemical combination of calcium, silicon, aluminum, iron and small amounts of other ingredients to which gypsum is added in the final grinding process to regulate the setting time of the concrete. Lime and silica make up about 85% of the mass. Common among the materials used in its manufacture are limestone, shells, and chalk or marl combined with shale, clay, slate or blast furnace slag, silica sand, and iron ore.

2.1.2.1.1 Types of Portland Cements

Different types of portland cement are manufactured to meet different physical and chemical requirements for specific purposes.

TYPE I

Type I is a general-purpose portland cement suitable for all uses where the special properties of other types are not required. It is used where cement or concrete is not subject to specific exposures, such as sulfate attack from soil or water, or to an objectionable temperature rise due to heat generated by hydration. Its uses include pavements and sidewalks, reinforced concrete buildings, bridges, railway structures, tanks, reservoirs, culverts, sewers, water pipes and masonry units.

TYPE II

Type II portland cement is used where precaution against moderate sulphate attack is important, as in drainage structures where sulphate concentrations in ground waters are higher than normal but not unusually severe. Type II cement will usually generate less heat at a slower rate than Type I. With this moderate heat of hydration (an optional requirement), Type II cement can be used in structures of considerable mass, such as large piers, heavy abutments, and heavy retaining walls. Its use will reduce temperature rise which is especially important when the concrete is placed in warm weather.

TYPE III

Type III is a high-early strength portland cement that provides high strengths at an early period, usually a week or less. It is used when forms are to be removed as soon as possible, or when the structure must be put into service quickly. In cold weather, its use permits a reduction in the controlled curing period. Although richer mixtures of Type I cement can be used to gain high early strength, Type III, high early-strength portland cement, may provide it more satisfactorily and more economically.

TYPE IA, IIA, IIIA

Specifications for three types of air-entraining portland cement (Types IA, IIA, and IIIA) are given in ASTM C 150. They correspond in composition to ASTM Types I, II, and III, respectively, except that small quantities of air-entraining materials are inter ground with the clinker during manufacture to produce minute, well distributed, and completely separated air bubbles. These cements produce concrete with improved resistance to freeze-thaw action.

TYPE IV

Type IV is a low heat of hydration cement for use where the rate and amount of heat generated must be minimized. It develops strength at a slower rate than Type I cement. Type IV portland cement is intended for use in massive concrete structures, such as large gravity dams, where the temperature rise resulting from heat generated during curing is a critical factor.

TYPE V

Type V is sulfate-resisting cement used only in concrete exposed to severe sulfate action principally where soils or ground waters have high sulfate content.

2.1.2.2 Aggregates

Aggregates generally occupy 70 to 80 % of the volume of concrete and can therefore be expected to have an important influence on its properties. They are granular materials derived for the most part from natural rock and sands. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Based on their size, aggregates are divided into coarse and fine fractions. The coarse aggregate fraction is that retained on the 4.75 mm sieve. While the fine aggregate fraction is that passing the same sieve. Based on their origin, aggregates can be classified as natural aggregates and non natural Aggregates.

III. RESULTS

The compressive strengths of concrete specimens were determined after 7, 14,21and 28 days of standard curing. For rubberized concrete, the 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.

The reason for the compressive strength reductions could be attributed both to a reduction of quantity of the solid load carrying material and to the lack of adhesion at the boundaries of the rubber aggregate. Soft rubber particles behave as voids in the concrete matrix. Considering the very different mechanical properties of mineral aggregates and rubber aggregates, mineral aggregates usually have high crushing strength and they are relatively incompressible, whereas rubber aggregates are ductile, compressible and resilient. Rubber has a very low modulus of elasticity of about 7MPa and a Poisson's ratio of 0.5. Therefore, rubber aggregates tend to behave like weak inclusions or voids in the concrete, resulting in a reduction in compressive strength. It is well known that the presence of voids in concrete greatly reduces its strength. The existence of 5 % of voids can

International Journal For Advanced Research In Science & Technology
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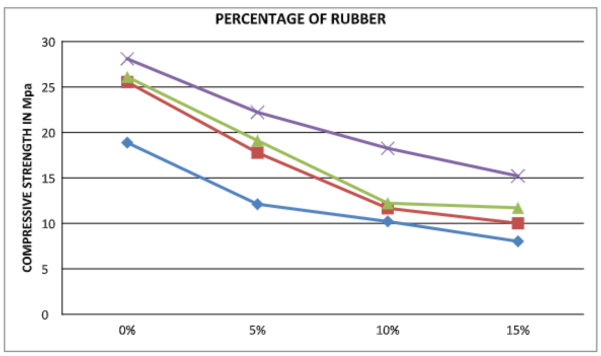
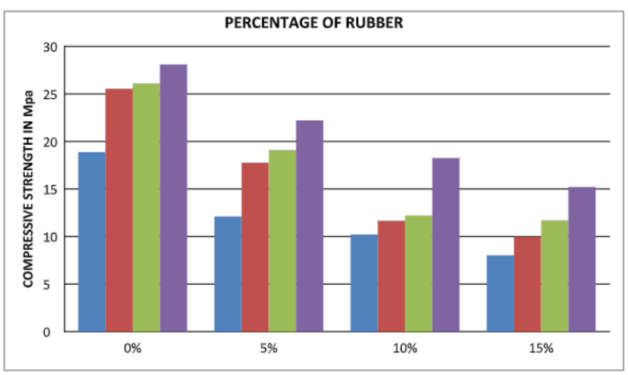
ISSN: 2457-0362

lower strength by as much as 30 % and even 2 % voids can result in a drop of strength of more than 10%. Another observation while carrying out the compressive strength test was the nature of crack formation. In rubberized concrete, crack formation is different from plain concrete because bond strength between rubber and cement paste is poor than that of between aggregate and cement paste. Therefore, initial cracks were formed around rubber aggregates and cement paste in rubberized concrete.



Graph 1:% of rubber vs compressive strength



Barchart 1:% of rubber aggregate vs compressive strength

CONCLUSIONS

1.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 tire 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.

2.The visual observation of the patterns of failure mode revealed that the rubberized concrete does not exhibit typical compression failure behavior. The control concrete shows a clean split of the sample into two halves, whereas the rubber aggregate tends to produce a less well defined failure. Moreover, the mode of failure was a gradual type rather than the brittle failure in the control concretes. This may be an indication more ductility in rubberized concrete than the control concrete. However, it has to be clearly investigated by carrying out ductility tests.

3. A reduced compressive strength of concrete due to the inclusion of rubber aggregates limits its use in some structural applications. Nevertheless, it has few desirable characteristics such as lower density, higher impact and toughness resistance, enhanced ductility, and a slight increase in flexural strength in the lower strength concretes. 4. The use of rubber

aggregates from recycled tires addresses many issues. These include; reduction of the environmental threats caused by waste tires, introduction of an alternative source to aggregates in concrete, enhancing of the weak properties of concrete by the introduction of different ingredients other than the conventionally used natural aggregates and ultimately leading to the conservation of natural resources. In addition to meeting recycling and sustainability objectives, it aims is to produce products with enhanced properties in specific applications.

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