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Study of aggregate in concrete and effect of mixing rubber to the aggregate

[1]Adil Bashir Bhat, [2]Ranadip Mandal

Introduction : Aggregates are defined as inert, granular, and inorganic materials that normally consist of stone or stone-like solids. Aggregates can be used alone (in road bases and various types of fill) or can be used with cementing materials (such as Portland cement or asphalt ce- ment) to form composite materials or concrete. The most popular use of aggregates is to form Portland cement concrete. Approximately three-fourths of the volume of Portland ce- ment concrete is occupied by aggregate. It is inevitable that a constituent occupying such a large percentage of the mass should have an important effect on the properties of both the fresh and hardened products. As another important application, aggregates are used in as- phalt cement concrete in which they occupy 90% or more of the total volume.

Classification of aggregates.

Aggregates can be divided into several categories according to different criteria.

1). In accordance with size:

Coarse aggregate: Aggregates predominately retained on the No. 4 (4.75 mm) sieve. For mass concrete, the maximum size can be as large as 150 mm.

Fine aggregate (sand): Aggregates passing No.4 (4.75 mm) sieve and predominately retained on the No. 200 (75 μm) sieve.

2). In accordance with sources:

Natural aggregates: This kind of aggregate is taken from natural deposits without changing their nature during the process of production such as crushing and grinding. Some exam- ples in this category are sand, crushed limestone, and gravel.

Manufactured (synthetic) aggregates: This is a kind of man-made materials produced as a main product or an industrial by-product. Some examples are blast furnace slag, lightweight aggregate (e.g. expanded perlite), and heavy weight aggregates (e.g. iron ore or crushed steel).

3). In accordance with unit weight

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Light weight aggregate: The unit weight of aggregate is less than 1120 kg/m3. The corresponding concrete has a bulk density less than 1800 kg/m3. (cinder, blast- furnace slag, volcanic pumice).

Normal weight aggregate: The aggregate has unit weight of 1520-1680 kg/m3. The concrete made with this type of aggregate has a bulk density of 2300-2400 kg/m3.

Heavy weight aggregate: The unit weight is greater than 2100 kg/m3. The bulk density of the corresponding concrete is greater than 3200 kg/m3. A typical example is magnesite limonite, a heavy iron ore. Heavy weight concrete is used in special structures such as radiation shields.

Environmental implications of conventional concrete:

The environmental impact of concrete, its manufacture and applications, is complex. Some effects are harmful; others welcome. Many depend on circumstances. A major component of concrete is cement, which has its own environmental and social impacts and contributes largely to those of concrete. In spite of the harm that badly planned use of concrete can do, well-planned concrete construction can have many sustainable benefits. The cement industry is one of the primary producers of carbon dioxide, a major greenhouse gas. Concrete is used to create hard surfaces which contribute to surface runoff that may cause soil erosion, water pollution and flooding. Conversely, concrete is one of the most powerful tools for proper flood control, by means of damming, diversion, and deflection of flood waters, mud flows, and the like. Concrete is a primary contributor to the urban heat island effect.

Need for light weight & eco friendly concrete:

The use of lightweight aggregate concrete for building and bridge construction has intrinsic and easily documented benefits that contribute to the sustainability of our built environment. The traditional benefits associated with a 20 to 30% reduction in density and up to a 50% reduction in heat conductivity as compared to normal weight concrete are well known and will be noted. Lightweight aggregates can fill many roles that will make human activity more environmentally responsible. The green house gas emission associated with both the processing of the raw material and from the fuel burned to produce the expansion of the raw material pales in comparison to the environmental rewards derived from its use

Waste rubber as coarse aggregate:

Waste rubber can be used as partial replacement of coarse aggregate by bringing it to the size comparable to normal aggregates.

Scrap Tyres: The possible use of scrap tyres is in the form of chips and crumb rubber tyre aggregate. There is a US Patent on a crumb rubber-reinforced concrete which is based on the research conducted on concrete with tyre chips and crumb rubber aggregate. Another development is in the use of finely ground scrap or crumb rubber in asphalt. There are three manufacturing methods:

- Wet process; where the crumb rubber is added to the hot mix asphalt during the manufacturing process using special mixing equipment.
- Dry process; where the crumb rubber is added to the aggregate prior to the addition of the asphalt concrete.
- Terminal blend process; where the rubber is added to the asphalt concrete at the bi-tumen refinery.The current use of scrap rubber in Australia is in specialised sprayed bitumen seals for road Works.

Applications and limitations:- Concretes with tyre chips and crumb rubber aggregate were found to exhibit lower compressive strength and splitting tensile strength. However, they have ductile characteristic and ability to absorb a large amount of plastic energy under compressive and tensile loads. It is particularly suitable for use in overlaying fati-gued/cracked pavements, and can also be used as a durable crack-resistant asphalt sur- face in new construction. Although it is more expensive, the longer life and higher coverage makes scrap rubber asphalt an economically attractive alternative pavement.With more than six million tyres consigned to landfills every year, the recovery and recycling of scrap tyres is of national importance and a key priority. The current application in specialised sprayed bitumen seals in road works diverts a relatively small amount of the scrap rubber waste stream from landfills.Approximately nine million of the US‟s 250 million scrapped tyres are converted into crumbed rubber each year. Ground tyre rubber is used as a fine aggregate addition (dry process) in asphalt friction courses.

Testing: Following tests were conducted on the materials used.

a). Cement tests:- Consistency test, determination of initial and final setting time, compres-sive strength test.

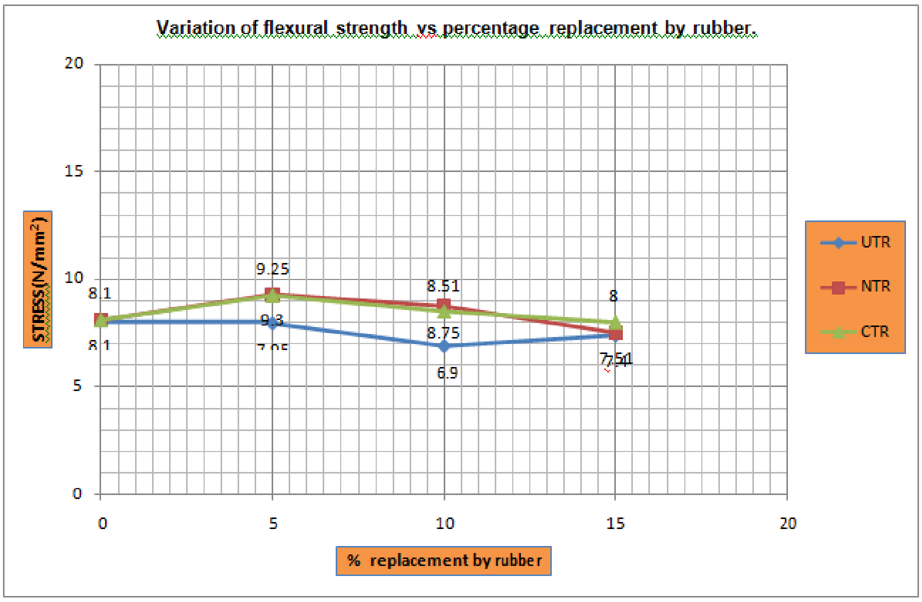
b). Tests For fine aggregate:-

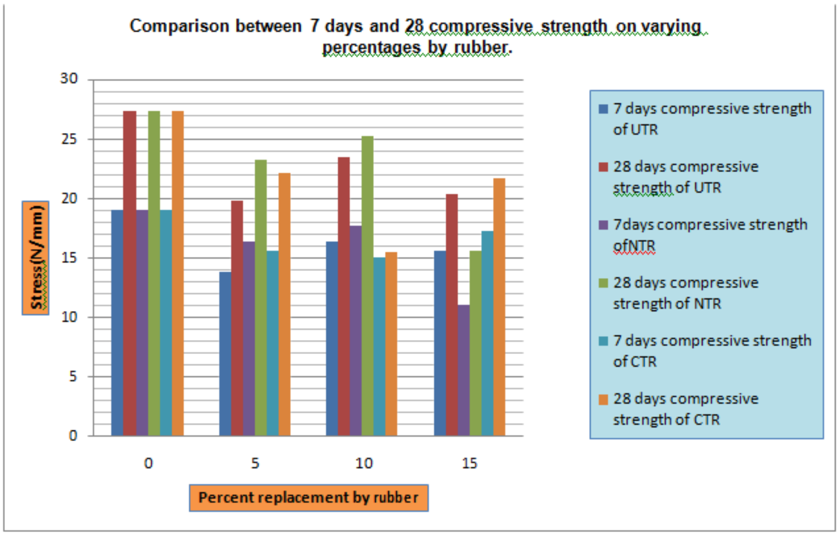
Tests for sand :- Determination of specific weight, sieve analysis.

c). Tests for coarse aggregates:-

Tests for gravel:- Sieve analysis, crushing test, impact test, abrasion test, water absorp- tion test.

The purpose of this study was to determine if waste materials such as rubber enhances the characteristic properties of concrete.The data presented in this project shows that there is great potential for the utilization of waste rubber. It is considered that the waste rubber form would provide much greater opportunities for value adding and cost recovery, as it could be used as a replacement for expensive materials such as coarse aggregate.





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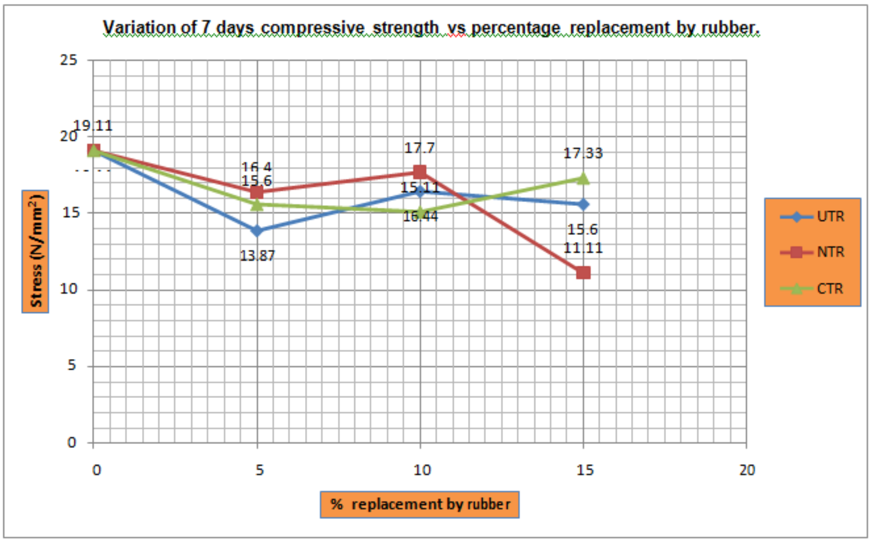

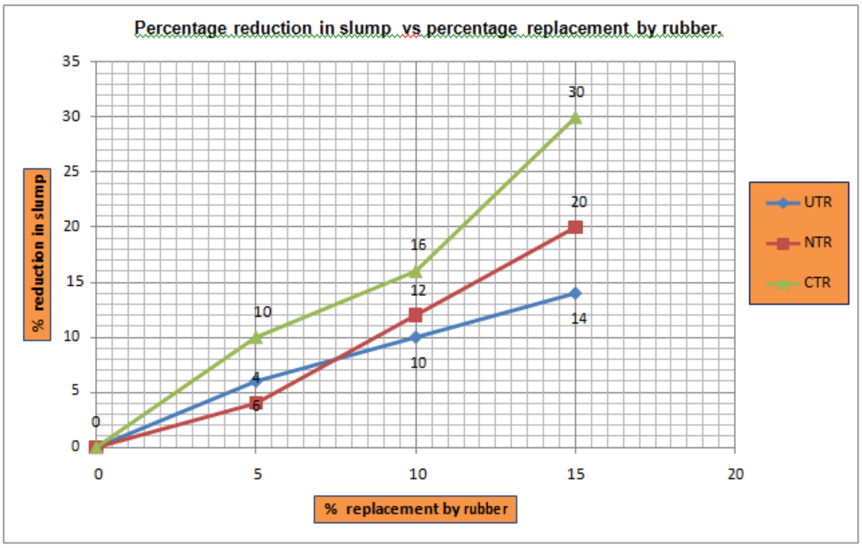

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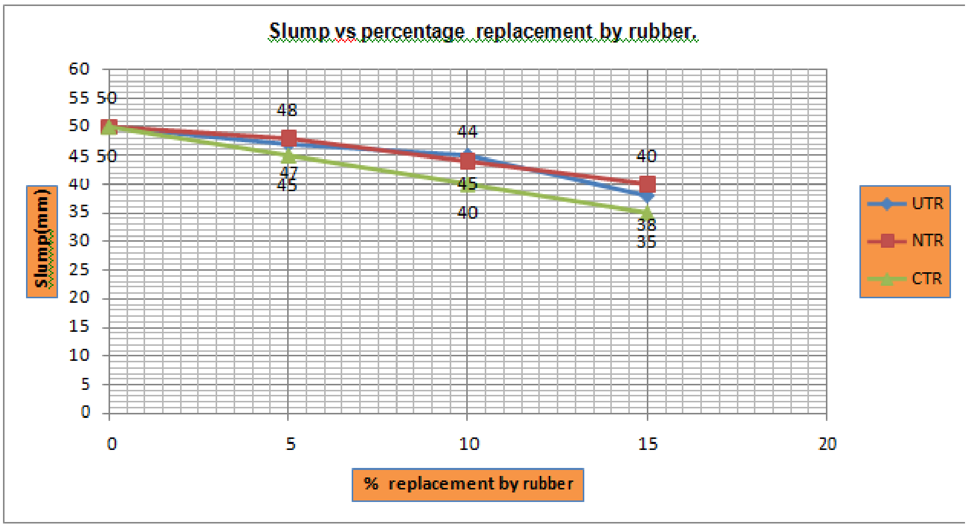

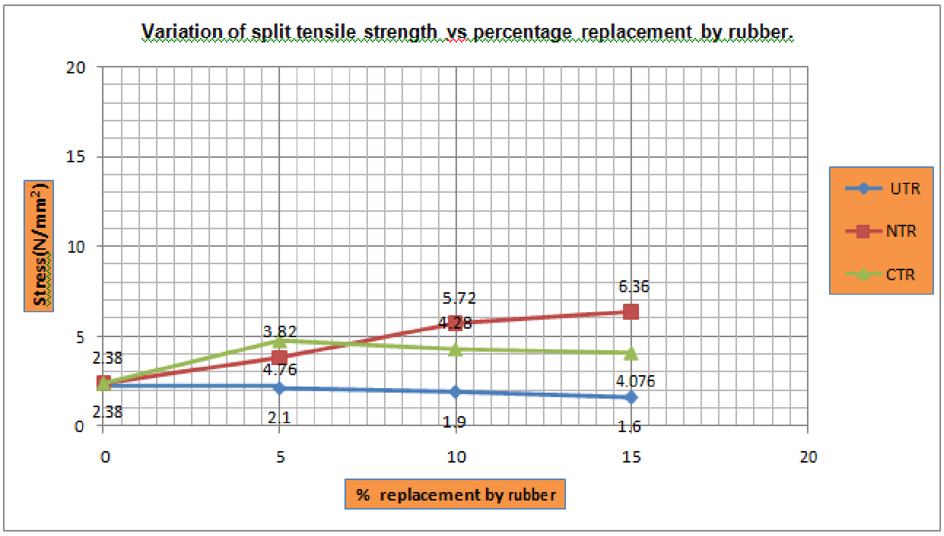

In this project, the performance of concrete made rubber aggregates was studied. The following conclusions were drawn:

1. Fresh concrete properties such as Unit weight and Slump decreased with the higher replacement levels of rubber.

2. Increase in rubber content decreased the compressive strength of the concrete significantly.

3. There is a great potential for rubber to be used in the concrete, thus saves area from becoming as landfill and is thus eco-friendly with environment.

4. The combined action of air and rubber creates a discreet thermal insulation that pre- vents the transport of heat. If we analyze such properties in relation to density in the hardened state, we can note an increase of the thermal conductivity with the density increasing, the increase of density corresponds to a more compact structure, so to a reduction of its porosity.

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5. In reference to the test concerning the resistance of rubbercrete to Sulphatic attack, it is evident that, all the blends have lower compressive strength compared to the normal condition, consequently they are all vulnerable to attack by sulphate ions.

6. During the tests it was noted that as the percentage amount of shredded tyres in- creased, the amount of energy required for casting specimens increased substantial- ly, because of the reduction of workability in the concrete.

7. The purpose of this study was to determine if a waste material like worn out tyres enhance the characteristic properties of concrete.The data presented in this project

shows that there is great potential for the utilization of tyres as aggregates. It is con- sidered that used tyres would provide much greater opportunities for value adding and cost recovery, as it could be used as a replacement for more expensive material such as rock aggregate.

8. The flexibility of the rubber tyres is far better than natural aggregates,thus it is very useful in the formation of road pavements and flexible slabs.

Thus we can conclude that Reduced compressive strength of concrete due to the in- clusion of rubber aggregates do limit its use in some structural applications, but it has few desirable characteristics such as lower density, higher impact and tough- ness resistance, enhanced ductility, and better sound insulation etc. These proper- ties can be advantageous to some construction applications. It is also possible to make relatively high-strength rubber concrete using NaoH and cement paste treat- ment to rubber aggregates , which gives better bonding characteristics to rubber and significantly improves the performance of rubbercrete.

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