"USE OF WASTE TIRE RUBBER IN A PARTIAL REPLACEMENT OF AGGREGATE IN CONCRETE"

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ABSTRACT

The waste problem considered as one of the most crucial problems facing the world as a source of the environmental pollution. During last recent years, many improvement in India have occurred in all parts of life such as social, industrial, economical etc., this will lead to generate new ways of living and increase the human requirements, and will also increase types and quantities of the waste in India, without any active processes to provide solution to this problem. Waste rubber tires cause serious environmental problems all over the world. One of the potential means of utilizing the waste tires is to process this waste material for the protection of the environment and society. It is suggested to use this waste tires as an additive in portland cement concrete mixes, which would partially help in solving this problem.

India manufacture 11.92 Crore tires in year 2010 – 11 increase by 22.72% than year 2009 – 10 (ATMA – Automotive Tire Manufacturer Association). With the exponential growth in number of automobiles in India during recent years, the demand of tires as original equipment and as replacement has also increased. The quantity of scrap tires produced in India is not exactly available but the increasing trend of use of road transportation will definitely create a problem of disposal in very near future. The total number of registered buses, trucks, cars/jeeps/taxis and two wheelers up to 1997 in India were 0.5 million, 2.25 million, 4.7 million and 26 million, respectively. Considering the average life of the tires used in these vehicles as 10 years after rethreading twice, the total number of waste disposable tires will be in the order of 112 million per year. That's why this is one of the most crucial environmental issues all around the world is the disposal of the waste materials.

Keyword: - *Rubber, aggregate concret*

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1. INTRODUCTION

Waste-Tire rubber is one of the significant environmental problems worldwide. With the increase in the automobile production, huge amounts of waste tire need to be disposed. Due to the rapid depletion of available sites for waste disposal, many countries banned the disposal of waste tire rubber in landfills The main objectives of this research were to provide more scientific evidence to support the use of legislation or incentive-based schemes to promote the reuse of accumulated waste tires. This research focused on using scrap tires as a replacement for a percentage of the local fine aggregates used in the concrete mixes. In order to prevent the environmental problem from growing, recycling

tire is an innovative idea or way in this case.
Recycling of waste tire rubber is a substitute. Recycled waste-tire rubbers have been used in different application. It has been used as a fuel for cement kiln, as feedstock for making carbon black, and as artificial reefs in marine environment (Siddique and Naik, 2004). It has also been used as a playground matt, erosion control, highway crash barriers, guard rail posts, noise barriers, and in asphalt pavement mixtures. Other construction products are also based on rubber powder obtained from the cryogenic milling of tires mixed with asphalt or bituminous materials. Over the past two decades, research had been performed to study the availability of using waste tire rubber in concrete mixes.
Recycling tire is the processes of recycling vehicles tires that are no longer suitable for use on vehicles due to wear or irreparable damage (such as punctures). The cracker mill process tears apart or reduces the size of tire rubber by passing the material between rotating corrugated steel drums. By this process an irregularly shaped torn particles having large surface area are produced and this particles are commonly known as crumb rubber. Unfortunately, not much attention has been paid to use the waste tires in Portland cement concrete mixtures, particularly for highway use. Limited work was done by researchers to investigate the potential use of rubber tires in conventional concrete mixtures.
Tire waste is one such waste material. It is basically a hard rubber material and as such is sparingly biodegradable. There is a tremendous scope to re-use tire waste in cement concrete. This is a nascent concept and needs due nourishing. The use of accumulated waste materials in third world countries is still in its early phases. It will take courage for contractors and others in the construction industry to recycle selected types of waste materials in the concrete mixes. Different concrete specimens were prepared and tested in terms of uniaxial compression and splitting tension. The main variable in the mixture was the volumetric percentage of crumb tires used in the mix. The test results showed that even though the compressive strength is reduced when using the crumb tires, it can meet the strength requirements of light weight concrete. In addition, test results and observations indicated that the addition of crumb rubber to the mix has a limited effect toward reducing the workability of the mixtures. The mechanical test results demonstrated that the tested specimens of the crumb rubber concrete remained relatively intact after failure compared to the conventional concrete specimens.

2. LITRATURE SURVEY

1) Emira Nadim A., Bajaba Nasser S. et al (9) The results of this study indicate that there is a great potential for the utilization of waste tires in concrete mixes upto 10%, 20%, and 30%. Based on these results, they concluded that, increasing the curing time tend to increase the compressive strength for all crumbed rubber sizes. The rubberized concrete mix using recycled tires agreed with the values of compressive test for light and moderate weight structural concrete. Although the strength of rubberized concrete is reduced with an increase in the rubber content, its lower unit weight meets the criteria of light weight concrete that fulfill the strength requirements. Although it is not recommended to use this rubberized concrete in structural elements where high strength is required, it can be used in many other construction elements like partition walls, road barriers, pavements, sidewalks, etc. which are in high demand in the construction industry. Rubberized concrete can be used in applications where energy and impact attenuation is required due to its high flexibility.(Nadim A. Emira et al 2012).

2) Gammal El, Abdel Gawad A.K. et al (10) investigated the effect of waste tire rubber as a replacement to natural aggregate in concrete mixture on the density and compressive strength of concrete. They conclude that, there was a significant reduction in the compressive strength of concrete. During testing of the specimens, a significant amount of compressibility was observed allowing the specimen to absorb a large amount of energy under compressive loads. There was a ductile, plastic failure of concrete utilizing waste tire rubber rather than brittle failure. As the amount of rubber in the mix decreases the density of concrete increases. It can be used in the production of curbs, roads, concrete pavements and non-bearing concrete wall. (EI-Gammal 2010)
3) Gintautas Skripkiunas, Audrius Grinys, Benjaminas Cernius et al (12) analyzed the effect of fine composition of the elastic aggregate made up from rubber waste on the elastic properties of concrete under the static and dynamic load. They conclude that, rubber waste additives reduced both static and dynamic modulus of elasticity. Ultimate strain on concrete failure load is 36% - 47% higher for concrete with tire rubber waste additives. (Gintatutas Skipkiunnas 2007)

4) Gobba Sara, Giuseppe Carlo Marano, Massimo Borsa And Marcello Molfetta identified optimal types and quantities of aggregates in concrete mixtures for engineering applications. They observed that, rubcrete mix possesses interesting properties that can be useful in structural and non-structural applications. Mix 07-PR with rubber particles from truck tires and mix 010-PR with rubber from car tires satisfied the required qualifications of having a low specific gravity (<2100 Kg/m3) and acceptable compressive strength for possible structural applications. Mix 08-PR with particles from truck tires and 012-PR with rubber from car tires showed very low density (even <1000 kg/m3), offering concrete useful for non-structural applications. (Sara Gobba et al 2010)

3. RESULTS & OBSERVATIONS OF LABORATORY TEST ON CEMENT

3.1 Fineness of cement (IS: 4031 PART 1)-1996

Type of cement - Ordinary Portland Cement (OPC) Weight of cement - 500grams
Observations and Calculation to Determine Fineness of Cement
RESULT:- 7.6% [Which is not exceed 10% as per BIS 269-1976]

3.2 Standard consistency of cement (IS: 4031 PART 4)-1988

Standard consistency of cement is expresses amount of water as a percentage (By Weight) of dry cement. Weight of cement- 300 grams

RESULT: The percentage by weight of water with respect to cement to produce standard consistency = 35%

3.3 Initial and final setting time of cement (IS: 4031 PART 5)-1988

The initial and final setting time is the interval between the times when water is added to cement.

Weight of sample = 300 gms
Weight of water added = 0.85x35 =29.75 gms .
Where, Pn=% of water for standard consistency.

Initial setting time 35 minutes
Final setting time 310 minute
3.4 Soundness of cement (IS: 4031 PART 3)-1988
The observed elongation between indicators of Le-Chateliars apparatus is not more than 10 mm for each assembly.
Result: the observed average elongation is 9.7mm
3.5 Compressive strength of cement (IS: 4031 part 6)-1988
The compressive strength of cement is the most important property of cement.
RESULT: The compressive strength of cement mortar at age of 3 days is 26.33 N/mm_2 and at age 7 days is 35.13 N/mm_2, thus it satisfies as per IS specification.

3.6 OBSERVATION OF LABORATORY TEST ON COARSE AGGREGATE
The coarse aggregates are collected from local approved Rajendra Stone Crusher Unit, Dhulia, Maharashtra, India.

3.7 Fineness Modulus and Sieve Analysis of Coarse Aggregate
The sieve analysis is conducted to determine the gradation in the sample of aggregate for carrying out sieve analysis the materials are sieved through various IS sieves. Weight of sample = 5 Kg

3.8 CRUSHING STRENGTH OF AGGREGATE (IS: 2386 PART 4)-1963
As per IS 383-1970 permissible limit of Crushing strength is up to 30%.
Result: crushing strength is 13.93% Therefore calculated Crushing strength is within permissible limit.

4. MIX DESIGN FOR M20 GRADE CONCRETE
Control mixture for M-20 grade concrete was designed as per IS:10262-2009.
Mix design is the process of selection of suitable ingredients of concrete and to determine their properties with object of producing concrete of certain maximum strength and durability, as economical as possible. The purpose of designing is to achieve the stipulated minimum strength, durability and to make the concrete in the most economical manner.
Data required for mix design:
1. Specific Gravity of cement = 3.15
2. Specific Gravity of Coarse Aggregate = 3.14
3. Specific Gravity of Fine Aggregate = 2.5
4. Water absorption for coarse aggregate = 3.76
5. Water absorption for fine aggregate = 3.76
1) To find target mean strength of concrete for a tolerance factor of 1.65 and using Table 1 of BIS 10262:1982, the target mean strength for specified characteristics cube strength is, σ = fck + 1.65 x Standard deviation
= 20+1.65x4 =26.6 MPa
2) To find selection of water cement ratio from fig. 2 of IS 10262:1982, the free water cement ratio required for the target mean strength of 26.6N/mm_2 is 0.50
3) Selection of water content and fine to total aggregate ratio : from table 4 of IS 10262:1982, for maximum size aggregates and sand conforming to grading zone II,

i. Water content for per cubic meter of concrete = 186Kg
ii. Sand content as percentage = 3% of total aggregate by absolute volume
adjustment of values in water content and sand percentage for other conditions as percentage for other conditions as percentage of per table –6 of IS 10262:1982
Determination of cement content
Water cement ratio = 0.50 Water = 186Kg
0.50 Water = 186Kg
Determination of fine and coarse aggregate contents-
From table 3 of IS: 10262:1982, for the specified maximum size of aggregate of 20mm the amount of entrapped air in the wet concrete is 2.0% taking this into account and applying equations from IS: 10262-1982

5. RESULT AND DISCUSSION

5.1 Results of test carried on Aggregate

Discussion –

1. As per IS 383-1970 permissible limit of Crushing strength is up to 30%. Therefore calculated Crushing strength is within permissible limit.
2. As per IS 383-1970 permissible limit of Impact value is up to 30%. Therefore Calculated impact value is within permissible limit.
3. As per IS 2386(part-3)-1963 the permissible limit of Water absorption is in between 0.5 to 2%. Therefore calculated Water absorption is within permissible limit
4. As per IS 2386(part-1)-1963 permissible limit of Flakiness index is in between 10 to 15%. Therefore calculated Flakiness index is within permissible limit.
5. As per IS 2386(part-1)-1963 permissible limit of Elongation index is up to 15%. Therefore calculated Elongation index is not within permissible limit.

5.2Results of test carried on sand

1. As per IS 2386(part-3)-1963 the permissible limit of Water absorption is in between 0.5 to 2%. Therefore calculated Water absorption is within permissible limit

6. CONCLUSION

1. The test conducted on materials like Aggregate, Sand, Cement and rubber having all test results within permissible limit as per IS codes.
2. The modified concrete mix using recycled tires performs satisfactorily on various tests, with acknowledgement to the proportional relationship between its rates of strength-loss and contain of the rubber in the mix. Mixing, casting and compacting the concrete mix using 20mmscrap tire rubber aggregate with local materials can be carried out in a similar fashion to that of traditional concrete mix.
3. Modified concrete casted using 20mm scrap tire rubber aggregate as a replacement to coarse aggregate shows reduction in density of concrete compare to

traditional concrete.
4. As density of concrete is reduces, self-weight (Dead load) of the structure is reduces. Therefore design becomes economical.
5. Up to 6% replacement of 20mm scrap tire rubber aggregate, compressive strength is nearly equal to compressive strength of traditional concrete at 28 days.
6. Up to 12% replacement of 20mm scrap tire rubber aggregate, split tensile strength is less than split tensile strength of traditional concrete.
7. The test result of this study indicate that there is a great potential for the utilisation of 20mmscrap tire rubber aggregate in concrete mixes up to 6%.

7 FUTURE SCOPE

1. Although it is not recommended to use this modified concrete in structural Element where high strength is required, it can be used in other construction elements like partition walls, road barriers, pavements, sidewalks, etc. which are high demand in construction industries
2. With the addition of 20mm scrap tire rubber aggregate, the reduction of strength cannot be avoided. However, this data provides preliminary guidelines of strength-loss of locally produced modified concrete in comparison with the traditional concrete.
3. The amount of scrap tires being accumulated in 21th centuries has created a big challenge for their disposal, thus obliging the authorities to invest in felicitating the use of 20mmscrap tire rubber aggregate in concrete as the use of concrete is fundamental to the booming construction industry

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