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State of-the-Art Review on: Utilization of Crumb Rubber in Concrete

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***Abstract*: Waste Rubber tires are one of the major solid wastes in the world after revolutionary in automobile sector. The disposal of rubber waste tires continues to pose a serious threat to environmental protection and health. These wastes are illegally disposed of solid waste in the Country and Waste tires fire are the biggest problem because of the toxic fumes that are released from burning tires. The Utilization of crumb rubber from waste tires could benefit the environment and construction industry. The main aims of this review study are the utilization of Crumb rubber material in the Concrete as well as investigate the strength properties.**

***Keywords*: Crumb rubber, fine aggregate, rubber fibre, tup load, abrasion resistance, rubber ash**

1. Introduction

India is one of the largest country in which population exceeds 1.35 billion. So the use of conveyance is also increases day by day, therefore the use of tyres for the vehicles increased. The use of rubber product enlarges every year in the planet, So the amount of waste tyres is increasing. This produces a big problem on the earth and their livelihood. For this problem the waste tyres are decomposed by burning. it is the very easy and cheapest process. But this process creates toxic fumes and other environmental Pollution, it also creates global warming. The other process is disposal process, the disposal of waste tyre has been found that it is an environmental concern due to waste rubber tires resisting degradation, but it is also occupying very large landfill space that contain nesting and rats. In order to overcome the unnecessary landfills and protect the environment, waste tyres can likely used as an alternative raw material in the construction work. The vital building materials in concrete construction work are aggregate and cement. The utilization of crumb rubber from tyre in construction can overcome the cost and enhance performance; although not all recycled materials are suitable for concrete construction applications. In industry higher amount of waste rubber tyre can be utilized as fuel, roof and floor cover. The utilization of crumb rubber reduces the scrap tyre waste management natural resources demand of concrete production. This result in recovery of different properties like mechanical, dynamic, ductility gives resistance to fracture. So the utilization of crumb rubber mainly deals with the strength and mass parameter.

2. Literature review

Royano, V, Barra, M., Vazquez, E. In the investigation they did the Intending to assess the influence of the volume of CR incorporated into a conventional concrete, a first group of specimens is created, replacing 5%, 10% and 15% of the volume of sand in the original mix by grains of rubber 1-4 mm. In order to study the influence of the size of the incorporated grains of CR, a second group of specimens is produced substituting the content of the gravel for grains of rubber 10-16 mm, which leads us to three other types of concrete. The addition of CR increases the rate of entrapped air due to the bad adherence between the cement paste and the CR grains. The consequence is a higher absorption and porosity. The compressive strength and the elasticity modulus decrease with the addition of rubber, but the tensile strength remains at the same level. The final result of the study is that the use of concrete with CR is possible in several applications taking into account the limitations and advantages deduced from this experimental project in this experimental study: The workability is good, making fast on site placement possible. The Compressive strength is not high, achieving values between 25 and 32 N/mm2. Tensile strength is not altered when rubber is added. The capacity to deform when there are compressive stresses below the maximum strength is high.

Mustafa Maher Al-Tayeb, B. H. Abu Bakar, Hazizan Md Akil and Hanafi Ismail. They investigated that the effects of partial replacements of sand by waste fine rubber on the long term performance of concrete under low impact three-point bending loading. Specimens were prepared for 5% and 10% replacements by volume of sand. The result appeared that the average compressive stress of the plain concrete in 28 days is 37 MPa. As the sand is replaced by fine crumb rubber, the compressive stress reduces by 14 and 22% with 5and 10 % of volumes respectively. The variation of tup load with time in which the peak amplitude of the tup load increase by 5 and 7% with replacements of 5 and 10% of sand volume by fine crumb rubber. The increases in tup load and bending load are attributed to the high plastic energy capacity of rubber which when added to the concrete, improves the mix ductility and the ability to absorb the impact load.

Eshmaiel Ganjian, Morteza Khorami, Ali Akbar Maghsoudi. In this research they investigated that the performance of

concrete mixtures incorporating 5%, 7.5% and 10% of discarded tyre Rubber as aggregate and cement replacements in the investigation the result stated that: (1) Compressive strength was reduced with increased percentage of rubber replacement in concrete, though with 5% replacement of aggregate or cement by rubber, decrease in compressive strength was low (less than 5%) without noticeable changes in other concrete properties. The highest reduction was related to 7.5% and 10% replacement for both grades of rubber used. The reduction in compressive strength at 28 days of age was about 10–23% for aggregates and 20–40% for cement replacement. (2) Modulus of elasticity of concrete was reduced with the replacement of rubber for aggregate or cement. Reduction in modulus of elasticity was 17–25% in the case of 5–10% aggregate replacement by chipped rubber and the corresponding reduction for powdered rubber was 18–36%. (3) Tensile strength of concrete was reduced with increased percentage of rubber replacement in concrete. The most important reason being lack of proper bonding between rubber and the paste matrix, as bonding plays the key role in reducing tensile strength. Tensile strength of concrete containing chipped rubber (replacement for aggregates) is lower than that of concrete containing powdered rubber (for cement replacement). In the case of 5–10% aggregate replacement by chipped tyre rubber, the reduction in tensile strength was about 30–60% where for 5–10% cement replacement by powdered rubber the reduction was about 15–30%. (4). Replacement of rubber for aggregate or cement in concrete caused a reduction in its flexural strength for both grades, but the rate of reduction was different. The reduction was about 37% for coarse aggregates replacement and 29% for cement replacement. (5). Replacement of rubber increased water permeability depth in the concrete mixtures and increases the water absorption in case of coarse aggregate replacement but reduced the water absorption in case of cement replacement.

Trilok Gupta, Sandeep Chaudhary, Ravi K. Sharma. In their study attempt has been made to utilize waste rubber tire as partial replacement of fine aggregate in the form of rubber ash and rubber ash with rubber fibers. Workability of rubber ash concrete for each selected w/c ratio, decreases with increasing rubber ash content however, workability of modified concrete (10% rubber ash and varied Percentage of rubber fibers) is not affected by adding rubber fibers. The compressive strength of rubber ash is decreased with the increasing percentage of rubber ash for the w/c of 0.35and 0.45 whereas for w/c ratio 0.55, compressive strength is marginally increased. In the case of modified concrete, the compressive strength is decreased with the increase of the percentage of rubber fibers content for all selected w/c ratios. The flexural strength of rubber ash concrete decreases with the increase of percentage of rubber ash whereas in the case of modified concrete, the flexural strength is increased with the increase of the percentage of rubber fibers content. Carbonation depth of rubber ash concrete and modified concrete increases with increasing the replacement level.

Kunal Bisht, P. V. Ramana. In the investigation they evaluated Mechanical properties and Durability properties for the different proportion 0%, 4%, 4.5%, 5% and 5.5 % of crumb rubber of concrete. It has been observed that with an increment of crumb rubber workability of concrete decreases. The output of flexural strength and compressive strength slight decreases with 4% replacement of fine aggregate by crumb rubber. Water absorption and abrasion resistance were also decreases at same substitution level of crumb rubber in concrete.

Tushar R More, Pradip D Jadhao and SM Dumme. In their study the aim was to study of waste tyre as partial replacement of fine aggregate to produce rubberizes concrete in M25 grade of mix. Different partial replacement of crumb rubber i.e., 0%, 3%, 6%, 9% and 12% by volume of fine aggregate are casted and tested for flexural strength and split tensile strength. The result shows that there is a reduction in all type of strength for crumb rubber mixture, but crumb rubber content concrete become more lean due to increase in partial replacement of crumb rubber as fine aggregate i.e. 3%, 6%, 9% and 12%. Flexural strength of concrete decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber. For split tensile strength decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber. This is mainly due to lower bond strength between cement paste and rubber tyre aggregate. It also gives more strength at 28th days for 5% replacement for M20 grade of cement and split tensile strength decreases at the maximum at the maximum of 25% when crumb rubber is replaced up to 10% of fine aggregate. Thus by replacing fine aggregate by crumb rubber safeguards the environment.

Nithiya P, Portchejian G. It this research paper the mix design was done as per IS: 10262-2009 to achieve the target strength. The concrete mixes were made by replacing fine aggregate with 5%, 10%, 15% and 20% for M20 grade concrete. So they founded that compressive strength decreases with the replacement of crumb rubber increased and 5% replacement of crumb rubber proves exceptionally well in Compressive strength and tensile strength.

S. Selvakumar, R. Venkatkrishnaiah. In the investigation they did Strength properties of concrete with partial replacement fine aggregate with 5%, 10%,15% ,20% of crumb rubber Based on the test results the following conclusions were made. The compressive strength of rubber concrete with 5% replacement is 38.66N/mm2; it is higher than the strength of normal concrete (36.73N/mm2) on 28th day. The compressive strength of rubber concrete with 10% replacement is 33.47N/mm2.In split tensile strength of crumb rubber concrete is lower than the strength of normal concrete. In flexural strength conducted on concrete it shows a decrease in strength when compared to the strength of normal concrete.From the test results, it is found that the crumb rubber possess less bonding ability which has affected on strength of the concrete

Subarna Lamichane, Anjit Kaur. This study mainly portrays the use of crumb rubber as a replacement of sand. The mix was

designed for M35. The replacement proportions are taken as 0%, 5%, 10%, 15% and 20% of fine aggregate. Further, the reaction of sulphuric acid in the crumb rubber concrete (CRC) has been studied. Replacing the fine aggregate with crumb rubber decreased the compressive strength of concrete. The low bonding between crumb rubber and concrete can be assumed as the reason for decrease in compressive strength. The reaction of sulphate in concrete is gradual but the problem of acid attack in concrete cannot be simply avoided.

3. Conclusion

1) The variation of tup load with time in which the peak amplitude of the tup load increase by 5 and 7% with replacements of 5 and 10% of sand volume by fine crumb rubber. The increases in tup load and bending load are attributed to the high plastic energy capacity of rubber which when added to the concrete, improves the mix ductility and the ability to absorb the impact load.
2) Replacement of rubber increased water permeability depth in the concrete mixtures and increases the water absorption in case of coarse aggregate replacement but reduced the water absorption in case of cement replacement.
3) The Compressive strength and the elasticity modulus decrease with the addition of rubber, but the tensile strength remains at the same level. The Compressive strength is not high, achieving values between 25 and 32 N/mm^2. Tensile strength is not altered when rubber is added.
4) Compressive strength was reduced with increased percentage of rubber replacement in concrete, though with 5% replacement of aggregate or cement by rubber, decrease in compressive strength was low (less than 5%) without noticeable changes in other concrete properties.
5) In the modified concrete, the flexural strength is increased with the increase of the percentage of rubber fibers content. Carbonation depth of rubber ash concrete and modified concrete increases with increasing the replacement level.
6) The flexural strength and compressive strength slight decreases with 4% replacement of fine aggregate by crumb rubber.
7) After the addition of 6% %, 12% of crumb rubber further decreases the strength.
8) 5% replacement of crumb rubber proves exceptionally well in Compressive strength and tensile strength. It also gives more strength at 28th days for 5% replacement for M20 grade of cement
9) The compressive strength of rubber concrete with 5% replacement is 38.66N/mm^2; it is higher than the strength of normal concrete (36.73N/mm^2) on 28th day. The compressive strength of rubber concrete with 10% replacement is 33.47N/mm^2.
10) The low bonding between crumb rubber and concrete can be assumed as the reason for decrease in compressive strength.

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