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Studying the properties of Rubberized Concrete: A Review

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Abstract: As the vehicles increases day by day, waste generated from the vehicle also increases. Rubber tyre is one of them. Rubber tyre is an non biodegradable waste that`s why it is not easy to decomposed it. Landfills of rubber tyre create soil and water pollution so unacceptable. One of the solution suggested by researcher that using the waste scrap rubber tyre in cement concrete. Rubberised concrete is good alternative for disposal of such waste to protect the environment. Many researcher studying the properties of rubberised concrete. This study present an overview of some of the research published regarding using of waste rubber tyre as aggregate in cement concrete and investigation of its properties such as compressive strength, workability, tensile strength etc. This paper show test output and conclusion from some previous research published.

Keywords: Rubberised concrete, Compressive strength, Tensile strength, Workability.

I. INTRODUCTION

Large amount of used rubber tyres accumulated in the world each year. India produced 90000 tonnes of waste tyre each year. Different countries of the world has different rate of producing rubber waste. Approximately 270 million scrap tire are produced in US each year and more than 300 million tires are currently piled throughout the US (Rafat siddique, 2004) . Iran produces 100000 tonnes of rubber per year (A. Abdollahzadeh). 180 millions of waste tyre accumulated each year in European Union (Venu Malagavelli, 2016). Malaysia produces 200000 tonnes of rubber waste per year (A Mohammad).

Various methods was adopted to manage such waste. Scrap rubber tyre are not easily decomposed under normal environmental condition. According to Guneyisi 2004 [5] rubber waste is not easily biodegradable even after a long span passes after the landfill treatment. Naik and Singh (1991) state that stockpiles of waste tyre are dangerous not only due to environment threat, but also risk of fire hazard and breeding of rats and mosquitoes. Landfilling is not adopted because of rapid depletion of available sites for waste disposal.

Siddique and Naik (2004) suggested use of rubber tyre in asphaltic concrete mix, reuse of rubber tyre in production of number of plastic and rubber product, incineration for production of electricity, as fuel for cement kilns and as artificial reefs in marine environments.

Scrap tyre rubber are used as a fuel in many of the industries such as thermal power plant, cement kilns and brick kilns. (Rahul Mahla, 2015)

The use of rubber tyre in making carbon black eliminates shredding and grinding cost but carbon black from rubber tyre pyrolysis is more expensive [paul, 1985]. As per Venu and Rajnish, (2016) rubber tyre waste used as fuel, roof and floor covers and for paving industry, pigment soot in bitumen pastes.

Many techniques are developed to recycle the waste tyres. Rubberized concrete is one of them. Aggregates from cement concrete partially or completely replaced by scrap rubber tyre to make rubberized concrete.

Siddique and Naik (2004) state that it has been a growing practice among researchers to use the scrap rubber tyre in concrete mix. The rubber tyre shows better performance in concrete. Best management strategy for scrap tires that are worn out beyond hope for reuse is recycling. Utilization of scrap tires should minimize environmental impact and maximize conservation of natural resources.

II. MATERIALS:

1 Classification of scrap tyre

A. Ground rubber

This are the shredded or chopped whole tyre in small size in the range of .0075mm to .475mm. (Heitzman,1992)

B. Crumb rubber

Crumb rubber consists of particle ranging in size from .475 mm to 4.75mm. Following methods are used to convert scrap tyre into crumb rubber. Cracker mill process, granular process and micro-mill process. (Rafat siddique, 2004)

C. Shredded/Chipped tyre

To get shreds type of particles primary, secondary or both shredding operation performed. By primary shredding we get particle of rubber tyres from 300mm to 460mm and width 100mm to 230mm and secondary operation applied to get particle of length from 100mm to 150mm. Both operations are required for production of chipped tyre having length from 13mm to 76mm. (Rafat siddique, 2004)

G.Nagesh, sandeep and sudharani (2014) used chipped rubber of dimension 20mm to replace the coarse aggregate and rubber powder to replace fine aggregate and study the various strength properties of concrete such as compression strength, split tensile strength, flexural strength ,modulus of elasticity, water absorption , density, and thermal insulation

Ganjian and Khorami (2009) done their research work by used crumb rubber as partial and complete replacement of fine aggregate in concrete and perform the tests like flexural bending stress, shear bending stress, shrinkage, workability and normal consistency of cement paste.

Venu and Rajnish (2016) used tyre chips from light passenger vehicles along with steel strands of 10mm size to 10% and 20% replacement of course aggregate.

2 Specimen preparation and testing

Nithya and Kalpana (2014) prepare 150×150×150 mm^3 cube each for 10% and 12% replacement of coarse aggregate by 20mm size rubber aggregate. G.Nagesh, 2014 prepare 15 mixes and 45 cube specimens of 150×150×150 mm^3 for compression test, 45 cylindrical specimens of diameter 150mm and 300mm height for split tensile test and 45 beam specimens of 100×100×500 mm^3 for flexural test. Fine aggregate replaced by 10%, 20%, 30% and 40% by rubber powder and Coarse aggregate was replaced with chipped rubber of 2.5%.

M.M. Reda Taha and Abdel Hameed (2008) prepare the mix by replacing coarse and fine aggregate by chipped and crumbed rubber tyre particle. The level of replacement were 25%, 50%,75% and 100% by volume of the coarse and fine aggregates.

III. RESULTS AND DISCUSSSIONS:

A. Effect on workability

Khatib and Bayomy noted that on increasing the percentage of rubber in concrete the slump value decreases but still gave a workable mix when compared with cement concrete. They further noted that at 40% rubber contain, slump was almost zero.

B. Effect on density

G.Nagesh (2014) concludes that density will reduce by increasing the portion of tyre rubber powder in place of sand. It is founded that reduction will reach up to 5.7% on replacing fine aggregate with rubber tyre powder from 0% to 40%

C. Effect on compression strength

M.Gesoglu et al notice that rubber particle marks negative effect on the compressive strength. Compressive strength decreases with using rubber. Compressive strength also affected by the size of rubber tyre. Minimum compressive strength of 6.45MPa was obtained at the mix 10TC10CR. The reduction in strength was between 16% to 68% on using rubber tyre 10TC to 10TC10FCR. Kumaran S.G. et al conducted various test on rubberised concrete using crumb rubber of 18mm, 24mm and 36mm and found that there is reduction of 50% of split tensile strength and 85% reduction in compressive strength. Rahul and Er.R.P, (2015) observe that on replacing 25% and 50% coarse aggregate with rubber aggregate in M_{25} sample get 35.05% and 58.46% reduction in compressive strength respectively

D. Effect on flexure strength

G.Nagesh (2014) published that on replacing 40% of sand by rubber powder there is 34% reduction in flexural strength. Rahul Mahla described that concrete mix containing 25% and 50% rubber aggregate show 22.83% and 48.03% reduction in flexural strength respectively as compare to the M_{25} concrete mix.

E. Effect on impact resistance or toughness

Tantala et al (1996) investigate the toughness of normal concrete and rubberized with 5% and 10% rubber tyre by volume of coarse aggregate. They conclude that toughness were higher for rubberized concrete, also for 10% of rubber aggregate mix more toughness were recorded as compare to mix with 5% of rubber aggregate.

F. Effect on modulus of elasticity

Modulus of elasticity reduces in same pattern as seen in compressive strength of rubberized concrete. Control mix gave a modulus of elasticity of 28 GPa which decreases to 4.5GPa for mix 10TC10FCR. The modulus of elasticity was affected by the amount of rubber particle. There was no significant difference between the static elastic modulus when different aggregate size were used. (Crouch LK, 2007)

The modulus of elasticity will decreases by increasing the percentage of rubber powder to replace the fine aggregate. For replacing 10% and 20% fine aggregate with rubber powder there is reduction of 3.02% and 13.7% in modulus of elasticity. (G.Nagesh Kumar, 2014)

IV. CONCLUSIONS:

The following conclusions have been drawn after reading previous research paper on use of rubber tyres as aggregate in concrete.

- Compressive strength of rubberized concrete depends on type, size and percentage of rubber aggregate. It is observed that compressive strength of control mix reduced by replacement of coarse aggregate with rubber aggregate. Also observed that reduction percentage increases with increasing in the level of replacement.
- The flexural strength increases as compare to M_{15} mix on using 10% of rubber aggregate. But on further increases the rubber aggregate flexure strength started to decreases. Generally flexural strength reduces by replacement of coarse aggregate with rubber tyre. It is also concluded that as the size of rubber aggregate increases, the reduction in the flexural strength also increases.
- Due to low specific gravity of rubber particle, density of the concrete mix reduces.
- It is observed that modulus of elasticity will reduce by increasing the size and percentage replacement of fine aggregate with rubber powder.
- It is observed that slump value decreases with increase in percentage of rubber aggregate means it produce a less workable concrete.
- Rubberized concrete may utilize for the construction of parking area, footpath area, road with low traffic and etc.

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