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Enhancement of Higher Performance Concrete (Hpc) By Using Waste Tyre Rubber Powder and Waste Plastic In Modified Road Construction Process

Rishi Seth Manik, Shashikant B.Dhobale (Assistant Professor)
Department of Civil Engineering
Jawaharlal institute of Technology, Borawan
Dist. Khargone, Madhya Pradesh

Abstract- Now-a-days it is necessary to utilize the wastes effectively with technical development in each field. The old abandoned tyres from cars,trucks,farm and construction equipment and off-road vehicles are stockpiled throughout the country. This leads to various environmental problems which include air pollution associated with open burning of tyres and other harmful contaminants like (polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen) and aesthetic pollution. They are non-biodegradable; the waste tyre rubber has become a problem of disposal. This paper is intended to study the feasibility of waste tyre rubber as binding material in bitumen, the waste tyre rubber is used with aggregate in different layer and also on the top surface layer mixed with bitumen in percentage and carried out different test result based on it, finding through it the difference in result by forming normal and rubber pavement and calculate the increase in strength of road pavement and also economically achieve.This is not only minimizes the pollution occurred due to waste tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity.

Keywords- Rubber aggregate, Crumb rubber, bitumen,Marshal stability test.

I. INTRODUCTION

Concrete is a widely used material throughout the world. Concrete, usually Portland cement concrete is a composite material composed of fine and coarse aggregate bonded together with cement (cement paste) that hardens over time. When aggregate is mixed together with dry Portland cement and water, the mixture forms fluid slurry that is easily poured and moulded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or super plasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material.

II. CEMENT CONCRETE REPLACEMENT

Cement concrete is the most commonly used building material in the world. It is plastic and malleable when it is mixed, strong and durable when hardened. The workability, strength, durability and the cost effectiveness make cement concrete a popular material in the construction industry. Strength and durability are essential properties of concrete that govern a wide range of structural abilities including permeability resistance, toughness, energy absorption and impact resistance. Conventional cement concrete is not much efficient with reference to durability and performance. On the downside, cement concrete is vulnerable to deterioration unless specific precautionary measures are taken during its design and production.

III. HIGH PERFORMANCE CONCRETE

High Performance Concrete (HPC) is prepared by using a specific combination of cement, SCMs, mineral & chemical admixtures determined through many trial batches/mix designs to meet a specific performance requirement for a given application. The performance criteria are achieved by ensuring proper mix, transportation, placement and curing. In recent years, the usage of HPC has increased in various structural applications like high-rise buildings, bridges, masonry applications, parking lots, residential buildings and pavement construction etc.

It is well known that relatively low strength and elastic properties of concrete are due to the heterogeneous microstructure of the material, particularly the porous and weak transition zone that exists at the cementpaste and aggregate interface. The mechanical properties of concrete can be improved by densification and strengthening of the transition zone. This can be achieved by reducing the quantity of mixing water and increasing the cement content without compromising the workability by adding powerful cement dispersant like superplasticizer.

Ordinary Portland Cement (OPC) is a widely used binding material and an essential constituent of normal strength concrete and HPC. Over exploitation of cement to meet the demand has led to various harmful consequences that in turn necessitated the research to include the industrial wastes that have pozzolanic properties in the production of cement concrete. The important milestone of this research is probably the incorporation of SCMs into the concrete. By adding both pozzolanic materials and superplasticizer, it is now possible to attain both high strength and high performance in concrete composites.

III.WASTE TYRE RUBBER AND ITS IMPACT ON ENVIRONMENT

Due to the rapid urbanization-taking place in and around the world, the use of automobiles has increased dramatically. To meet the demands of the automobile sector, production of tyres increased rapidly. At the end of the service life of tyres, the disposal is necessary. Tyre wastes are simply dumped over the earth surface or burnt under certain restrained conditions. These type of disposal leads to harmful impacts on the environment and human health. The concrete mix comprises aggregates, binder, reinforced materials and admixtures. Natural aggregates are taken from natural resources, which lead to the depletion of natural resources. Therefore, the construction experts urged to search an alternate material in the place of natural aggregates. Scrap tyre aggregates are taken into account for this alternate material suggestion, and these types of aggregates usage provide eco-friendly measures for scrap tyres recycling (Gupta et al. 2014;Kumar et al 2014)). Incorporation of tyre aggregates in concrete specimens in the form of crumb rubber increased the durability properties of concrete.

According to Farcasiu (1993) and Brown (2002), about 1.2 billion of waste tyres are produced globally in a year. Among them, 11% of used tyres are exported, 62% are reused, recycled or sent for energy recovery, 27% are sent to landfills, stockpiled or dumped in illegal tyre dumps and about 4% of waste tyres are used for civil engineering projects. Waste tyres need a larger storage space due to their large volume and fixed shape. Piled tyres trap water, thus becoming a breeding ground for mosquitoes and bacteria. After the imposition of the landfill ban, there is a high possibility of an increase in stockpiling and dumping of used tyres, legally or illegally.

These stockpiles cause environmental issues as well as a potential fire hazard. Uncontrolled combustion of tyres releases a significant amount of unburnt hydrocarbons and toxic emissions into the atmosphere. Melting of tyres also produces a large quantity of the oil that contaminates soil and groundwater. Hence, there is necessity arises to identify alternative ways of using waste tyres in line with a waste management program. The most effective way for management of waste tyres are: reducing the used tyre generation rate by technological development, retreading, erecting as artificial reefs, setting up in stabilizing deep wells and erosion control. Another way includes: assembling them into innovative products like floor mats, using them as plastic compounds and for a wide variety of die cut products and crash barriers, breakwaters, and mixing them with asphalt in the construction of pavements. Another important usage is in energy recovery as a fuel source for cement kilns.

IV. NEED OF THE RESEARCH

One of the burning environmental issues in the global context is environmental pollution. Rapid urbanization created an acute necessity for infrastructure development leading to exhaustive use of natural resources embossing a series threat to environmental sustainability. Researches have to focus on the identification of alternative building material, which can effectively substitute the conventional building materials paving the way to eco-friendly construction practice. In this work, the feasibility of the use of tyre rubber waste, which is generated in large quantities, has been investigated. If it terms out to improve the properties of concrete, then it may be extensively used in concrete and thereby creating an opportunity for effective waste management.

In some applications of concrete, it is desired that the concrete should have low unit weight, high toughness and impact resistance. For Portland cement concrete, rubber from granulated tyre may be used as an elastic aggregate modifying the brittle failure of concrete and increasing its ability to absorb large amounts of energy before failure. As mentioned early, there is a very large market for concrete products, including non-primary structural applications for which products incorporating rubber aggregate could be feasible. This study investigates engineering properties of concrete containing rubber as aggregates and reinforcement considered as Tyre Rubber Aggregate Concrete (TRAC) and Tyre Rubber Reinforced Concrete (TRRC) in various Civil Engineering applications.

V.PROBLEM OF WASTE TYRE RUBBER

The use of rubber in so many applications results in a growing volume of rubber waste. With the increase in demand of automobiles, the manufacturing and use of tyres has been increased tremendously both in the developed and less developed countries. Since at least 65% of worldwide rubber production, and likely an even higher percentage of rubber disposals consists of automobile and truck tyres, this study has been chosen to focus on rubber waste from tyres. After finishing their working life, tyres wear out and have to be discarded and replaced. It is estimated that throughout the world an average of one used tyre per person per year is discarded.

Used tyres are a challenging problem, since tyres have virtually unlimited life span.

VI. DISPOSAL OF WASTE TYRE RUBBER

Rubber materials are durable, flexible and elastic which are the basic properties required for manufacturing of tyre that itself engender critical problem of managing when it become waste. These waste tyres are source of environmental concern in developed countries, where land filling is still a common waste disposal strategy. Tyres decompose very slowly, at taking over a century to disintegrate at ambient temperatures. Tyres are bulky and trap air when disposed, which may make landfills unstable. Even worse, tyres do not stay buried, but float on the top of a landfill. Piled tyres trap water, and thus can become breeding grounds for mosquitoes and other water-incubating insects and bacteria.

VII. LITERATURE REVIEW

[1] Base Paper-Rokiah Othman, Evaluation on the rheological and mechanical properties of concrete incorporating eggshell with tire powder: The construction industry is the largest consumer of raw materials which are under the risk of exhaustion and depletion in the near future, which has prompted the usage of waste materials for the conservation of resource and as a solution for waste management. Two wastes that are widely produced but often inefficiently disposed are eggshell and waste tire.

Hence, this paper aims to evaluate the rheological and mechanical properties of concrete incorporating eggshell and waste tire rubber using Response Surface Methodology (RSM). Concrete with eggshell as cement replacement and waste tire rubber as sand replacement was prepared with an interval of 5% up to 15% replacement of both materials. Rheological properties of concrete were accessed using slump cone test while mechanical properties were studied through compressive strength and flexural strength test. Result showed that eggshell replacement has a minor effect on concrete slump while tire rubber reduces workability considerably. Result also showed that concrete mechanical strength was optimum at 5% and 10% eggshell replacement, while tire rubber reduced mechanical strength with percentage of replacement. Non-destructive tests indicated that concrete has excellent quality but excessive tire replacement beyond 10% compromised structural integrity of concrete. Overall, RSM models were able to model the properties of concrete with high accuracy and minimal deviation.

[2] Blessen Skariah Thomas, A comprehensive review on the applications of waste tire rubber in cement concrete: Disposal of waste tire rubber has become a major environmental issue in all parts of the world. Every year millions of tires are discarded, thrown away or buried all over the world, representing a very serious threat to the ecology. It was estimated that almost 1000 million tires end their service life every year and out of that, more than 50% are discarded to landfills or garbage without any treatment. By the year 2030, there would be 5000 million tires to be discarded on a regular basis. Tire burning, which was the easiest and cheapest method of disposal, causes serious fire hazards.

[3] Soudabeh Dezhampanah, Environmental performance and durability of concrete incorporating waste tire rubber and steel fiber subjected to acid attack: Corrosion of sewage concrete pipes is a major dilemma in the modern world and annually considerable amounts of money are spent for the maintenance. On the other hand, the use of waste materials in concrete mixes has recently attracted the attention of engineers due to the environmental importance. In this study, the effects of different dosages of steel fibers (SFs) by volume (0, 0.25, 0.5, and 1. %) and different contents of recycled crumb rubber (CR) waste with different fine aggregate (sand) replacement ratios (0, 10, and 20%) were evaluated on the durability properties. The corrosion resistance of the specimens was measured in terms of weight loss, crushing load, ultrasonic wave velocity, impact resistance, and X-ray diffraction analysis (XRD) in different immersion cycles of 15, 30, 45, 60, and 90 days.

[4] Blessen Skariah Thomas, Recycling of waste tire rubber as aggregate in concrete: durability-related performance: This paper presents the results of an experimental investigation to comparatively study the depth of chloride penetration, resistance to acid attack and macrocell corrosion of rubberized concrete and control mix concrete. Waste tire rubber in the form of crumb rubber was replaced for natural fine aggregates from 0% to 20% in multiples of 2.5%. Analytical studies were performed with Abaqus and the results were compared with compressive and flexural strength obtained in the laboratory. It was observed that the depth of chloride penetration of the concrete with 2.5–7.5% crumb rubber was lower than or equal to the control mix concrete.

[5] Iman.M. Nikbin, Fracture behaviour of concrete containing waste tire and waste polyethylene terephthalate: An sustainable fracture design: This paper illustrates the results of an experimental investigation on fracture characteristics and ductility of normal concrete (NC) and rubberized concrete (RC), involving the tests of 128 three-point bending specimens with different polyethylene terephthalate (PET) aggregate volumes. Generally, the parameters were analyzed by the size effect method (SEM) and boundary effect method (BEM).

[6] Mehdi Mousavimehr, Mahdi Nematzadeh, Post-heating flexural behavior and durability of hybrid PET–Rubber aggregate concrete: Previous research regarding the flexural performance and durability of concrete

incorporating hybrid polymeric waste in particular after exposure to heat is scarce. Therefore, this research effort addressed the flexural behavior and durability of concrete incorporating PET and tire aggregates as well as their combination as a volumetric substitution for sand after experiencing elevated temperatures.

[7] Nahla Naji Hilal, Hardened properties of self-compacting concrete with different crumb rubber size and content: This paper aims at investigating the effect of crumb rubber size and content on hardened characteristics of self-comp

[8] Hassan Abdolpour, Recycling of steel fibres and spent equilibrium catalyst in ultra-high performance concrete: Literature review, research gaps, and future development: Recently the Ultra-High Performance Fibre Reinforced Concrete (UHFRC) presents remarkable advantages compared to the other types of concrete. Compared to the ordinary concrete, higher packing density was achieved using refine aggregates which resulted in increasing density by the percentage of 15% and consequently compressive strength of 160%. Additionally, higher durability focusing lower water absorption factor of 1 and chloride ion diffusion of 1 mm were reported.

[9] Jinxu Mo, Experimental study on damping properties of rubber powder modified styrene-acrylic emulsion concrete beam: In this paper, 4.5% rubber powder is added to improve the damping properties of styrene-acrylic emulsion concrete. A total of 66 specimens were manufactured, including eleven groups of prisms and cantilever beam specimens. Through the axial compression test of the prism specimen, the basic mechanical properties of rubber powder modified styrene-acrylic emulsion concrete were studied, and the interface morphology of rubber powder modified styrene-acrylic emulsion concrete was observed by scanning electron microscope (SEM).

[10] Jinxu Mo, Mechanical properties and damping capacity of polypropylene fiber reinforced concrete modified by rubber powder: In this paper, the effects of rubber powder on mechanical properties and damping capacity of polypropylene fiber reinforced concrete (PFRC) were explored. Axial compression tests were carried out on concrete cubes and prisms, and the digital image correlation (DIC) technique were employed to monitor the full field strain and track the crack development of concrete specimens.

VIII. SIGNIFICANCE OF THE RESEARCH

Attempts are made for the effective utilization of industrial waste materials such as fly ash, silica fume, metakaoline and alccofine, thereby reducing environmental pollution. Disposal of waste tyres is also a major waste management issue. Finding a better way to utilize waste tyre in the field of civil engineering is still under research. Further, the effect of inclusion of waste tyre rubber strip or fibre along with SCMs in the production of HPC has not been studied well. To fill this gap, an experimental investigation is carried out to utilize the industrial waste in ternary form as SCMs, in the production of HPRFC. Earlier, very few studies undertaken to investigate the effects of the ternary combination of mineral admixtures on the high performance rubber fibre concrete. The present research aims to fill this gap through the study of mechanical and durability characteristics of HPRFC.

IX.SCOPE OF THE STUDY

The objective of the present investigation is to identify the potential use of tyre rubber in concrete. Henceforth an extensive research has been carried out to study the mechanical properties and durability. The replacement of rubber aggregates with fine aggregate, coarse aggregate, both fine and coarse aggregate varied between 2% and 10% of aggregates in steps of 2% by weight fraction. Cylindrical specimens of 6% rubber aggregate replacement are cast to derive the impact resistance and ductility index, hollow block specimens with the rubber replacement of 5%, 10% and 15% by volume are cast to derive the mechanical properties and beams are cast with optimal percentage of rubber aggregate replacement for studying the flexural strength. The flow chart in Figure 1.3 demonstrates the investigation process.

X.RESEARCH HYPOTHESIS

Concrete is the second most widely used material in the world because of its favourable properties. However, an important ingredient in concrete, natural aggregates, are greatly used. This is disappointing for sustainable development because sand and gravels are nonrenewable materials. Meanwhile, with the development of society, more and more new buildings have been constructed, especially in developing counties. Correspondingly, many old buildings are or will be demolished, which causes a generation of large amount of construction wastes. In the last few decades, a variety of recycling methods for construction and demolition wastes have been explored and well developed. Recycled aggregates can be treated into different size to replace fine or coarse aggregate respectively.

Many conclusions and recommendations have been drawn. However, the study of using recycled aggregate in concrete with scrap tyre rubber together has not been researched. Therefore, this will be studied in the present research. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories--fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.75 mm sieve. Coarse aggregates are any particles greater than 4.75 mm. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

XI. CONCLUSIONS

Waste plastic binders and mixtures are gaining increasing attention due to their engineering performance and economic and eco-friendly benefits. This paper presented a review of the waste plastics most commonly used in asphalt binders and mixtures, analyzed and compared various approaches for waste plastics-modified asphalt and mixture production, and discussed the influence of the main factors on the properties of modified asphalt and mixtures. The paper discussed the current challenges for waste plastic-modified asphalt, such as the stability, low-temperature performance, the modification mechanism, and laboratory problems. Based on this review, the following points can be drawn:

(1) The use of waste plastic as an asphalt modifier expands the application field of waste plastic and avoids the waste of resources. It is also an effective way to solve the waste plastic disposal problem and reduce environmental pollution. However, more attention should be paid to PS and PVC, as these plastics produce harmful emissions when heated at high temperatures.

(2) The source of waste plastics is one of the main factors that affect the performance of the modified asphalt due to the differences in chemical composition and structure, resulting in different basic characteristics. High melting point plastics, such as PVC, PS, and PVC, are more suitable for the dry processes; LDPE, HDPE, PP, and EVA, with low melting points, are more appropriate for the wet processes.

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