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Review Paper on Use of Waste Plastic, Waste Rubber and Fly Ash in Bituminous Mixes

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Abstract: *The population growth, industrialization, consumerism and technology development have led to uncontrollable accumulation of waste. Plastic and rubber user friendly but not eco-biodegradable. Proper waste disposal is of great importance in both rural and urban areas. Utilization of waste plastic and waste rubber in bituminous mixes have proved. That the properties of mix are improved and disposal problems are also solved to some extent. Since these are not disposal scientifically and possibility to create ground and water pollution. These waste plastic and waste rubber partially replaced the conventional material to improve desired mechanical characteristics of road mix. and also by additional of fly ash ,waste plastic and waste rubber modified bitumen mix show better binding property , stability , stiffness , density and extra resistant to water . As well as will help to reduce the environmental pollution.*

Key word: *Marshall stability test, bitumen, waste plastic, waste rubber, fly ash*

1. Introduction

The polymer modified bitumen show properties for road construction and plastic waste can find its use in this process and this can help solving problem of pollution. The better binding property of waste plastic in its molten state has helped in finding out a method of safe disposal of waste plastic. Due to its low cost, easy manufacturing and impervious to water, plastics and rubbers are used in an excessive and manufacturing wide range of products. Disposal of waste plastic and waste rubber in an eco-friendly way is the substance area of today's research. The waste plastic and the crumb rubber for the construction of road material which would give a better solidity, durability resistance and strength to the road as compared to the conventional rubber are remarkably non-biodegradable thus can be used as a modifier in bitumen and aggregate to increase their strength.

Fly ash has successfully been used as filler for bitumen mixes for a long time and has the advantage of increasing the resistance of bitumen mixes to moisture damage. In addition to filling voids, fly ash was reported to have the ability to work as a bitumen extender.

1.1 Introduction of Materials

Coarse aggregate

The Coarse aggregate consists of crushed rock, crushed gravel or other gravel or other hard material retained on 2.36 and passing on 4.75 mm IS sieve.

Fine aggregate

Fine aggregate consists of crushed or naturally occurring material or their combination passing 2.36 mm IS sieve but retained on 75µm.

Fly ash

Fly ash as a filler passing 75µm IS sieve. It is one of the residues generated in combustion of coal. Comprises of fine particles which rise with the flue gases. One of the major pollutants which originate from combustion.

Bitumen

Bitumen is a black or dark coloured solid or viscous cementitious substance having an adhesive properties. And it consists chiefly high molecular weight hydrocarbons derived from distillation of petroleum or natural asphalt. And also it is a semi-solid hydrocarbon product produced by removing the lighter fractions (such as liquid petroleum gas, petrol and diesel) from heavy crude oil during the refining process.

Waste plastic

A plastic material is any of a wide range of synthetic or semi-synthetic organic solids that are malleable. And they are usually synthetic. Most commonly derived from petrochemicals. Plastic waste (bags, cups, bottles) made out of PE, PP and PS cut in to a size between 2.36mm and 4.75mm using shredding machine.

Waste rubber

Crumb rubber is obtained from truck or automobile tyres. Whole truck tyres contain 18% natural rubber compared to 9 percent in automobile tyre. And the scrap tyre is shredded into small pieces by the help of mechanical blades up to sizes of 1mm-75µm.

2. Use of waste plastic in bituminous mixes

Prasad (2013) by using 2 , 4, 6, 8, 10% of PET(polyethylene terephthalate) density increases and flow value also increases, Marshall stability value with 5.3% waste plastic in 2900 kg and the percentage increases in stability value has been found to be 75.76% as compared to the mix without plastic.(1)

Soni& Punjabi (2013) the consumption of waste polythene in bituminous concrete mixture thus formed. The waste polythene consumed in the mix will get coated over aggregates of the mixture and reduces porosity, absorption of moisture and improves binding property, the bitumen modified with 4.5% polythene waste id showing better performance as compared to other mixes.(2)

Santosh(2013) In the present study, the importance was to add the shredded waste PP to use bituminous concrete (BC) mix and to evaluate the various mix properties like Marshall Stability number, flow, bulk density, voids in the mix and voids field with bitumen (VFB) and 8% PP coated on aggregates which had yielded the highest marshal stability**.** (3)

Kazami & Govardhana Rao (2015) waste materials of polythene were collected and 5 to 11% were mixed with bitumen (60/70) grade. The studies conclusively showed that the waste plastic materials could be incorporated as a binding agent for the construction of road low density polyethylene (LDPE) to extent of 9% sample was found to be the most effective binder proportion. (4)

Soyal (2015) states that addition 1%, 2%, 3%, 4%, 5% by weight of processed plastic for the preparation of modified bitumen. The results 4% polythene waste is showing better performance as compared to other mixes. Marshal stability value increase with 4% polythene waste. (5)

Rokdey (2015) in this study plastic will increase the melting point of the bitumen and also this innovative technology not only strengthened the road construction but also increase the road life. By using plastic coating over aggregate compressive strength and bending strength is increased. (6)

S.A(2016) marshal stability was conducted for different percentage of bitumen on ordinary aggregate and plastic coated aggregate. Plastic coated aggregate improved water absorption, stripping value and soundness. When used for road construction it can withstand higher temperature. (7)

Rajput (2016) in this study the shredded plastic waste id mixed. In hot aggregate and the plastic modified mix is prepared using 6,8,10,12 and 14% plastic by weight of bitumen. The results by increasing the percentage of waste plastic in to the mix the marshal stability value is increased, and maximum stability is found for the mix containing 12% plastic by weight of the bitumen, at 14% plastic content the stability value has decreased. (8)

3. Use of rubber in bituminous mixes

Baraiya (2013) The addition of rubber aggregate in bituminous mix decreases the quantity of stone aggregate by volume and increases the flexibility and flexural strength of the carpet layer of the highways. Aggregate is the granular material used in bitumen concrete mixtures, which makes up 90 to 95 percent of mixture weight and provide most of the load bearing characteristics of the mix. Due to which the quantity of aggregate is gradually decreasing which will need the alternative material as aggregate for the highway construction**.** (9)

Chhabra(2014) The waste Tyres can be used as well sized aggregate in the various bituminous mixes if it is cut in the form of aggregate and can be called as rubber aggregate. This not only minimizes the pollution occurred due to waste Tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity. (10)

Onyango (2015) Crumb rubber of sieve fraction 2.36 mm was used to substitute a fraction of the fine mineral aggregates of similar sieve size (2.36 mm) so that the overall grading was maintained. Proportions of 0%, 1% 2%, 3%, 4% and 5% of crumb rubber by weight of the aggregates were used in the asphalt mix and desired plastic to asphalt ratio was added from 2-10% by weight of bitumen. At the result highest flow values are exhibited by 5% crumb rubber and 10% LDPE content (11)

Kumar k& Rajakumara (2016) By Adding 0-4% Crumb rubber in bitumen specific gravity, softening point, flash & fire point are increasing and ductility, penetration are decreasing. But up to 1% addition of crumb rubber obtain value are within the limit. Stability and flow of bitumen mix are within the limit up to 1% of crumb rubber. By replacing 5% aggregate of size passing 19mm & retained on 13.2mm by rubber aggregate obtained Marshall Stability and flow value are within optimum limit. (12)

Kshirsagar& Deshmukh (2017) Penetration value test result shows that Penetration value decreased with the increased amount of the rubber waste added. Lower Penetration thereby making a harder grade of asphalt, giving additional strength to the road and reduces water damage. The biggest advantage of using rubberized bitumen is that the road life increases in comparison to the normal bitumen whereas the cost increase on the road. (13)

4. Use of waste plastic and rubber in bituminous mixes

Barad (2015) the mix polymer coated aggregate and tyre modified bitumen have shown higher strength by using plastic in bitumen moisture absorption id decreasing than without plastic coating and the polymer coating reduces the voids. And also better binding property, higher softening point; without high temp. (14)

Somani (2016) state that addition of 4 to 8% waste plastic and 2 to 12% waste rubber for the preparation of modified bitumen. The result 8% plastic and 12% crumb rubber is blended in the mix the marshal stability value increasing as compared to the conventional mix. (15)

Islam (2016) From the present investigation it is concluded that the specimen prepared by using 2% waste plastic and 2% waste rubber as modifying agent, optimum bitumen content becomes minimum and stability becomes maximum. These results also indicated that the waste modified bituminous mix is much stronger (61%) than that of conventional mix. Marshal Quotient (MQ) increased by 52% compared to that of conventional mix. Thus it meant that asphalt concrete having higher MQ values indicated a high stiffness mix with a greater ability to spread the applied load and the pavement being more resistance to pavement deformation. (16)

Bansal (2017) Various materials which become waste, after their service life, like rubber tyres and plastic bottles may be utilized as partial replacement in bituminous concrete mix, which can help in satisfying the increasing bitumen demand in the road construction. Research findings of the study indicate that use of rubber tyres and waste plastic bottles improves the strength and overall durability of the BC mix by increasing its overall performance manifold. Therefore with application of these waste materials in the fixed proportions, targeted characteristics of BC can be achieved. (17)

5. Use of fly ash as a filler in bituminous mixes

Kar (2014) in this paper observed that the value of retained stability for mixes prepared with cement as filler offers highest retained stability value followed by stone dust and fly ash filler. However; the variations are so small to be considered significant and all the mixes satisfy the minimum retained stability value requirement. (18)

Kumar & Kumar Chhotu (2014) fly ash was used as filler material replaced by stone dust at different percentage (0%,50% and 100%). The results stability is increase but flow values tended to decrease. This indicates Improvement in the resistance to permanent deformation of mixes with addition of fly ash in bitumen. (19)

Mistry& Kumar roy(2016) by using fly ash as alternative filler in hot mix asphalt. Fly ash addition of 2,4,6 and 8% according to obtained marshal parameters, the addition of fly ash up to 4% in DBM(dense bituminous macadam) mix. By replacing conventional mineral filler like hydrated lime shows a 7.5% reduction in OBC (optimum bitumen content) compared to the control mix. Fly ash generally dumped may be used as replacement of common filler to support global sustainability. (20)

6. Conclusion

- By using waste plastic stability is increased and also reduces porosity& absorption of moisture and improves property. Plastic coating over aggregate compressive strength, binding strength and life road increased and improve soundness. It can withstand higher temperature.

- The addition of rubber aggregates in bituminous mix the quantity of stone aggregate by volume and increase the flexibility and flexural strength. This not only minimizes the pollution occurred due to waste tyre but also minimizes the use of conventional aggregate. By add crumb rubber in bitumen specific gravity, softening point, flesh& fire are increasing and ductility, penetration are decreasing.

- By using waste plastic and waste rubber as modifying agent, optimum bitumen content becomes minimum and stability becomes maximum. These result also indicate that the waste modified bituminous mix is much stronger than the of conventional mix. Marshall Stability is also increased.

- Fly ash was used as filler material replaced by stone dust. The results stability maybe increase but flow values stended to decrease. Fly ash generally dumped maybe used as replacement of common filler to support global sustainability.

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