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USE OF WASTE POLYETHYLENE IN BITUMINOUS MIXES

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Abstract **-** The waste generated from plastic and its disposal is a major trouble to our environment, resulting in pollution and global warming. The use of plastic waste in bituminous roads/pavements enhances its properties and its strength. In Addition, it will be boon for India as a solution to manage plastic disposal and various defects in roads/pavements viz., ruts, potholes corrugation, etc. The plastic waste used are polythene, poly-styrene, and poly-propylene. The waste plastic is cut up & coated over aggregate & mixed with hot bitumen and resulted mix is used for road/pavement construction. This will not only strengthen the pavement but also increases its durability. This innovative technology will also be suitable for Indian hot-humid climate. It is eco-friendly as well as economical. In this paper, we have discussed the method of using plastic waste in construction of roads and how it is better than the ordinary roads. This project is a comparative study of normal bitumen and waste plastic added bitumen.

Keywords-: Bitumen, Ductility, Penetration, Softening Point, Specific Gravity

1. Introduction

With increasing world population, the amount of waste production will increase substantially. This amount of waste causes a huge rise in the cost of waste disposal and also is filling the future sites for land fields. To solve the problem, considerable effort is being put into recycling waste and producing re-useable items [1]. Reusing is a kind of recycling which can reduce the amount of waste, reduce the cost for transport and production energy, lessen the demands for new resources and contribute to solve the disposal of waste problem [2]. Under the Environmental Public Health Act (EPHA), "waste" is defined as any substance or particle which is required to be disposed of as being broken, worn out, contaminated, or otherwise spoiled, and for the purpose of this Act anything which is discarded or otherwise dealt with as if it were waste shall be presumed to be waste unless the country is proved [3]. Recently, environmental issues have become more and more important in our society. Social life scientists, politicians and economists are becoming more and more concerned about the environment. In most developed countries, lifestyle changes have contributed to grater national waste production. This change has called for concern over conservation of resources and a need for recycling and reusing to reduce waste production. Many studies are going on to research about advantages of reusing waste material in an economically and environmentally sustainable way [4]. Many investigations on the effect of reusing hazardous material on the construction material properties and its environmental impacts have been done [5]. Due to the lack of raw material and natural resources, using waste solid material in civil engineering projects especially roads construction has become a considerable issue [4,5,6]. Recycling of waste materials can include some solid and non-decomposable materials such as plastic bottles, plastic bags, containers, or covers, which, due to their longer biodegradation period, cause serious harm to the environment disturbing the balance of the ecosystem. Therefore, to minimize the negative effects of such materials on the environment, it is totally reasonable and logical to recycle such materials through civil construction and industrial production [7,8]. Due

to urbanization and the growing population, the day-to-day requirements are also increasing which has led to the development of various industries which in turn has increased the generation of plastic waste on a large scale. All the sectors of the economy are revolutionized due to the use of plastic.

2. Processes for Manufacturing Bitumen Mix Road Using Waste Plastic -:

There are two important processes namely dry process and wet process used for bitumen mix flexible pavement.

Dry Process:-For the flexible pavement, hot stone aggregate (170°C) is mixed with hot bitumen (160 °C) and the mix is used for road laying. The aggregate is chosen onthe basis of its strength, porosity and moisture. absorption capacity as per IS coding. The bitumen is chosen on the basis of its binding property, penetration value and viscoelastic property. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and soundness. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement. It is to be noted here that stones with <2% porosity only allowed by the specification.

- Plastic waste like bags, bottles, etc are cut into size between 2.36mm and 4.75mm using shredding machine.
- The aggregate mix is heated to 170° and then it is transferred to mixing chamber.
- Similarly the bitumen is to be heated up to a maximum of 160°.
- At the mixing chamber, the shredded plastics waste is added over the hot aggregate.

Wet Process

Waste plastic is ground and made into powder; 6 to 8 % plastic is mixed with the bitumen. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Use of shredded plastic waste acts as a strong "binding agent" for tar making the asphalt last long. By mixing plastic with bitumen the ability of the bitumen to withstand high temperature increases. The plastic waste is melted and mixed with bitumen in a particular ratio. Normally, blending takes place when temperature reaches 45.5°C but when plastic is mixed, it remains stable even at 55°C. The vigorous tests at the laboratory level proved that the bituminous concrete mixes prepared using the treated bitumen binder fulfilled all the specified Marshall mix design criteria for surface course of road pavement. There was a substantial increase in Marshall Stability value of the mix, of the order of two to three times higher value in comparison with the untreated or ordinary bitumen. Another important observation was that the bituminous mixes prepared using the treated binder could withstand adverse soaking conditions under water for longer duration.

- Waste plastics by direct mixing with hot bitumen at 160°C.
- Mechanical stirrer is needed.
- Addition of stabilizers and proper cooling.
- Since the wet process require a lot of investment and bigger plants.

3. Result & Discussion-:

Performance Evaluation: Stability: The waste plastic-modified mixes demonstrated higher stability values compared to conventional bituminous mixes.

Durability and Long-Term Performance: The waste plastic-modified bituminous mixes showed promising durability characteristics, as indicated by their ability to withstand aging effects, weathering, and distresses like stripping and fatigue cracking.

Environmental Benefits: The use of waste plastic in bituminous mixes offers significant environmental benefits by reducing plastic waste accumulation in landfills or water bodies. By incorporating waste plastic into road construction, a substantial amount of plastic waste can be effectively recycled and utilized.

Economic Considerations: The economic feasibility analysis revealed potential cost savings in terms of reduced material consumption and enhanced pavement performance. Although there may be some initial costs associated with incorporating waste plastic, the long-term benefits, such as improved pavement durability and reduced maintenance requirements, can result in overall cost savings throughout the life cycle of the pavement.

Field Testing Data: Include detailed data collected during the field application of the waste plastic-modified bituminous mixes. This can include information on pavement performance measurements, such as rut depth, cracking, skid resistance, and roughness. Include any visual documentation, photographs, or videos of the pavement condition.

Laboratory Test Results: Provide additional laboratory test results conducted on the waste plastic-modified bituminous mixes. This can include data on specific engineering properties, such as stiffness modulus, fatigue life, moisture susceptibility, and dynamic creep. Include detailed test methods, equipment used, and the raw data obtained.

Cost Analysis: Present a comprehensive cost analysis comparing the use of waste plastic-modified bituminous mixes with conventional mixes. This should include data on material costs, construction costs, maintenance savings, and any other economic factors considered. Provide a breakdown of the cost components and assumptions made in the analysis.

Field Implementation Challenges: Include a detailed discussion on the challenges faced during the field application of the waste plastic-modified bituminous mixes. This can include technical difficulties, equipment limitations, material handling issues, and any lessons learned from the implementation process.

4. Conclusion-:

i The experimental process of coating of plastic with aggregate was successfully carried out.

ii The coating of aggregate with plastic initially showed feasible results with increase in physical property of aggregate but after a point reduction was observed.

iii Due to the plastic coating on the surface of the aggregates the permeability is reduced which means that the mixture becomes more intact thus providing a

iv solution up to some extent for stagnant water on the roads.

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