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A Comparative Review on: Flexible Pavement with Plastic Waste Material

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ABSTRACT—*The main objective of this paper is the use of waste materials such as waste tire rubber and plastic waste material and analyzes the physicochemical properties of flexible pavement. On the other side the road traffic is increasing. The traffic intensity is increasing and the loads on the road are also increased. Our project work is helping to take care of both these aspects. Plastic waste consisting LDPE(low density polyethylene) and HDPE(high density polyethylene) can be used as a blending material with bitumen and this can be used for surface course of flexible pavement in road construction. Secondly the waste tires are powdered (30 mesh) and the powder is blended with bitumen and this blend is also used as a surface course of flexible pavement in road construction. So by using above materials, they increase the strength, durability, Permanent deformation and water resistance as well as providing a mean to dispose of wastes. At the end, it concludes that the modified bitumen is cheaper than conventional bitumen. The test result of modified bitumen is better than conventional bitumen.*

Keywords: *Plastic waste, Cost efficiency, Plastic waste characteristics,Plastic waste, Waste in Road*

I. INTRODUCTION

The road transport carries close to 90% of passenger traffic and 70% of freight transport. Investigations in India and countries abroad have revealed that properties of bitumen and bituminous mixes can be improved to meet requirements of pavement with the incorporation of certain additives or blend of additives.

These additives are called “Bitumen Modifiers” and the bitumen premixed with these modifiers is known as modified bitumen. Modified bitumen is In India, it is estimated that over 33 lakh kilometers of road existsexpected to give higher life of surfacing (up to 100%) depending upon degree of modification and type of additives and modification process used. Different types of modifiers used are Polymers (LDPE-low density polyethylene), waste tire rubber and recycling of polymers (LDPE) and waste tire rubber. Plastics are user friendly but not eco-friendly as they are non-biodegradable. Generally it is disposed by way of land filling or incineration of materials which are hazardous. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying.

Generally, permanent deformation (rutting) occurs due to heavy axial loads coming on the sub grade and also rutting appears on the surface due to poor mixing of bitumen and as a result sub grade is damaged. The bituminous mix used in the surface course should not only sufficient the required strength but also is required to have enough internal resistance to withstand repeated heavy load. Commercially available bitumen in the country needs modification as they have characteristics that are not able to satisfy the performance requirements resulting in premature failure of bitumen surfacing. Bituminous materials with modified binders provide higher strength and longer lives as provide better resistance to rutting, stripping, and exhibit lower rate of weathering.

II. WASTE

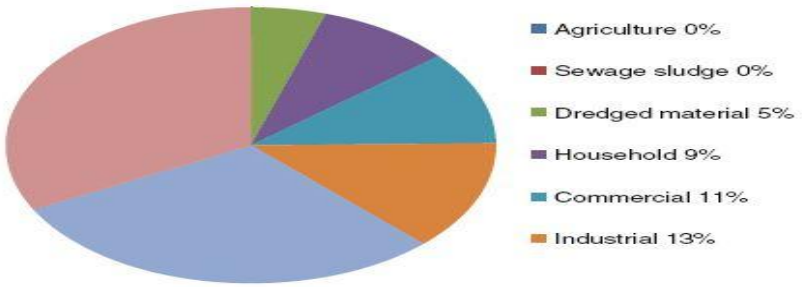

Figure 1: Composition of Waste Production
Source: *https://www.google.co.in/search?q=waste+production+pie+chart*

Waste is defined as a material which cannot be use further. To overcome this ribbing demand at construction material various materials which has binding properties can be used in partial replacement of bitumen. So as for fine aggregate and course aggregate with reference to this approach we are using plastic waste, crumb rubber etc. to replace bitumen content.For the sustainable development issues, the purpose of this section is to discuss the concept of material waste, and its related topics such as waste minimization and management strategies and current practices in construction.

III. EFFECT ON FLEXIBLE PAVMENT DESIGN

Recently, there is a lot of variability in guide to design a pavement. To overcome the problems, there is a need to study the comparative pavement thickness analysis using various pavement design methods so that it will be cost effective and long lasting. The input parameters in flexible pavement design are identified and have been used in obtaining different pavement layer thickness by conducting various pavement design method, that is ArahanTeknik (Jalan) 5/85 JabatanKerja Raya (JKR), AASHTO Method and Asphalt Institute Thickness Design Program (SW-1). Finding from this study indicate that thickness from ArahanTeknik (Jalan) 5/85 JabatanKerja Raya (JKR) gave better results than the others because it produced more thinner flexible pavement layer compared to the two other design method. In terms of cost, it will be more cost effective since the cost of material can be reduced.

The methodology adopted for this study has been limited to three design method that are, JabatanKerja Raya (JKR) "ArahanTeknikJalan 5/85" design procedure, American Association of State Highway and Transportation Officials (AASHTO) 1993 design procedure and Asphalt Institute Design Procedure.

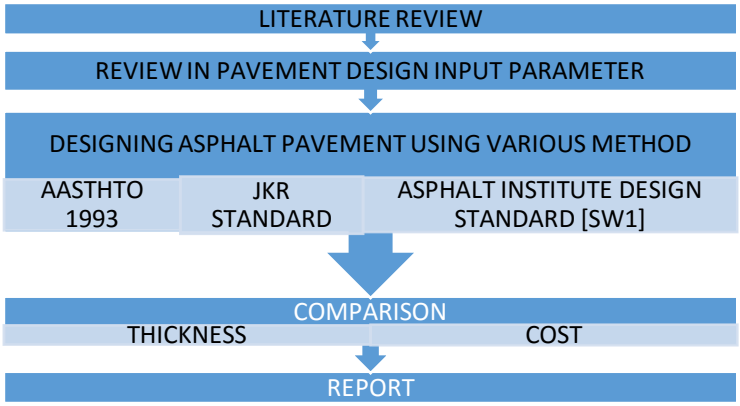

Figure 2 Flow Chart Methodology
Source*: *International Journal of Research in Engineering and Technology

SW-1 was designed for pavement design professionals who may have the need to design pavements for a wide variety of uses including airports, roadways, and parking lots. Rather than turn to individual specialty programs for each type of pavement, the SW-1 integrates its pavement thickness design tools in a single program for exceptional versatility. The key to this versatility lies in the Project Definition screen, SW-1's opening screen. On the Project Definition screen you can define the project to be designed by selecting the Pavement Use (i.e. General aviation airport or highways, roadways, and streets) and the Project Type (i.e. new pavement or overlay). Once you define the project, SW-1 creates the proper tabs to step you through the specific design problem-at-hand.

IV. EFFECT ON PHYSICOMECHANICAL PROPERTIES

Preservation of road infrastructure requires a systematic approach for the good performance of roads keeping in mind the future condition and maintenance scenarios. Now-a-days pavements are subjected to various kinds of loading which affects the pavement performance condition that causes various distresses. These distresses include rutting, fatigue cracking, and temperature cracking. Looking forward to the environmental condition, complete ban on plastic cannot be made.

The research methodology for present study has adoptedvarious tests to investigate the results on aggregate, bitumen and plastic and aggregate-bitumen-plastic mix. The testsconducted were Water Absorption, Aggregate Impact, Loss Angeles and Aggregate Crushing Test [IS: 2386 (part 4)-1963] for aggregates and Softening Point, Penetration Test andDuctility Test [IS: 1203-1978] for bitumen.

For mixing the ingredients of road mix, dry process wasadopted. In this process, waste plastic is mixed with aggregates and blends of polymer modified aggregate are prepared by mixing bitumen in it. These blends are later tested in laboratory and required optimum results are obtained.

The blends using aggregates and bitumen were prepared along with the use of different percentage of waste plastic in it separately and were kept for water bath at least 24 hrs. Later these blends were tested under marshal stability apparatus to check its stability for road pavements.

Figure 3: Blends of Aggregate and Bitumen and blends of Aggregate-bitumen-plastic mix

The results of various tests conducted on aggregate and bitumen and aggregate-bitumen-plastic mix are given in subsequent section.

For the asphalt pavement, stone aggregate with specific Characteristics are used for road laying. The aggregates are chosen on their strength, porosity and moisture absorption capacity.

The shredded waste plastic was sprayed over the hot aggregate which got coated on aggregate when molted. The extent of coating was varied by using different percentage of plastic. Increase in the percentage of plastic increases the properties of aggregates.

V. CASE STUDY WASTE PLASTIC AND WASTE RUBBER TIRES IN FLEXIBLE PAVEMENT

In this case Plastics are user friendly but not eco-friendly as they are non-biodegradable. Generally it isdisposed by way of land filling or incineration of materials which are hazardous. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying.

The Semi Dense Bituminous Concrete (SDBC) mix was prepared using Marshall Method of bituminous mix design. The SDBC was prepared with conventional 60/70 grade bitumen, 60/70 grade bitumen added with varying percentages of LDPE and 60/70 grade bitumen added with varying percentages of Crumb Rubber.

The study on the use of LDPE and CRMB reveals that the Marshal Stability value, which is the strength parameter of SDBC, has shown increasing trend and the maximum values have increased by about 25 % by addition of LDPE and CRMB. The density of the mix has also increased in both the cases of LDPE and CRMB when compared with 60/70 grade bitumen. This will provide more stable and durable mix for the flexible pavements. The serviceability and resistance to moisture will also be better when compared to the conventional method of construction. The values of other parameters i.e. Vv, VMA and VFB in both the cases LDPE and CRMB have found out to be within required specifications. This study not only constructively utilizes the waste plastic and tires in road construction industry but it has also effectively enhanced the important parameters which will ultimatelyhave better and long living roads

VI. CONCLUSION

Study on different research paper of flexible pavement with plastic waste material finally it concludes that the modified bitumen is cheaper than conventional bitumen. The test result of modified bitumen is better than conventional bitumen. Modified bitumen pavement durability (life span of pavement) is theoretically improved which is 1.5-2.5 times

higher than conventional bitumen. We can say that the modified bitumen is more suitable and more economical than conventional bitumen.

We also conclude that, Plastic coating on aggregates is used for the better performance of roads. This helps to have a better binding of bitumenwith plastic wasted coated aggregate due to increased bonding and increased area of contact between polymers andbitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumenby entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads canwithstand heavy traffic and show better durability.

In short we can conclude that, using plastic waste in mix will help reduction in need of bitumen by around 10%,increase the strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste byincineration and land filling and ultimately develop a technology, which is ecofriendly.

Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of prevention andultimately will be the cure. It will save millions of dollars in future and reduce the amount of resources used forconstruction.

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