USE OF WASTE PLASTIC AND RECLAIMED ASPHALT PAVEMENT IN FLEXIBLE PAVEMENT

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Abstract : A huge amount of new roads are overlaid on existing road pavement from which a layer of existing bitumen pavement is removed for road development reasons. Use of such waste as Reclaimed Asphalt Pavement to replace natural aggregates partially could be helpful both for environmental and economic aspects in the construction industry. Also disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Use of waste plastic in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Bituminous materials are extremely used for road construction because of their perfect binding properties and as well as water repellent properties. The purpose of this study is to find the effects of reclaimed asphalt pavement (RAP) and Plastic content on various characteristics of Bituminous wearing course. The bearing capacity of the wearing course depends on the Reclaimed Asphalt Pavement (RAP) content mixed with the conventional aggregate.

IndexTerms Waste Plastic, Reclaimed Asphalt Pavement (RAP), Bitumen, Flexible Pavement.

I. Introduction

Plastics create considerable amount of solid waste in the world due to their usage in many areas of our lives like packaging, building and construction, automotive, electric and electronic applications. They are synthetic materials derived mainly from petroleum or natural gas and composed substantially of carbon, hydrogen and oxygen combinations. Since they have high decomposition temperature, high resistance to ultraviolet radiation and are mostly not biodegradable, they can remain on both land and sea for years causing environmental pollution. Plastics tend to break into smaller fragments called macro/meso/micro-plastics which have specific and significant set of impacts on ecosystem and can affect human and animal health negatively associated with their chemical structure. Toxic chemicals within the plastic can bio accumulate up the food chain through ingestion by wildlife meaning that human can also be subjected to those chemicals.

Being lighter, more durable and less bulky than many alter-native materials, one of the main application and so the main post-consumer waste for plastics is packaging generate considerable part of this sec-tor. Carry bag plastic has exceptional gas and moisture barrier properties with high shatter resistance and can contain carbon dioxide which makes it ideal for use in water. Single-use carry bag plastic have a short service life and therefore turn into res-identical (post-consumer) plastic waste in a short period of time. Since carry bag plastic recycling has not been carried out in the same amount as its production, it would be worthwhile to find out new application areas for carry bag wastes to maximize their end-of-service life management effectiveness. The usage of carry bag waste as a reinforcement component for asphalt concrete pavement material, Hot Mix Asphalt (HMA), can be a research area for such an aim which is still in its infancy. In the previous studies, carry bag waste was generally added to the asphalt mixture with dry process (mix-true modification) or used as aggregate in the asphalt mixture (aggregate replacement) in order to improve HMA performance. Researches have shown that permanent deformation resistance, Marshall Stability, stiffness and fatigue life of the asphalt mixtures were increased while moisture damage resistance was decreased when carry bag was used as additive in the mixture (mixture modification). The replacement of aggregate with carry bag was also found to increase permanent deformation resistance but decrease Marshall Stability and stiffness of the mixtures. However, specific gravity of the asphalt mixtures was found to be decreased by either method. Different from the mentioned studies above, asphalt was modified with additive derived from carry bag by aminolysis and found to improve the Marshall Stability depending on the asphalt and additive contents.

The inclusion of waste materials such as reclaimed asphalt pavement (RAP) in pavement mixtures has become increasingly common due to numerous environmental and economic benefits. Practitioners around the world are constantly assessing the advantages of allowing higher percentages of RAP in pavement while also maintaining the highest performance standards to meet the increasing demands and regulations. Many transport authorities and departments have limited the maximum amount of RAP used in surface layers, certain mixtures types and in some cases large or critical projects. The amount of RAP used in surface layers was usually less than 15 percent initially as there was no significant advantage economically for using a larger percentage of RAP.

The selected additive can be incorporated to the asphalt mixture by dry process or wet process. The dry process covers mixing the additive with aggregates prior to adding the binder to the mixture while wet process refers to the modification of the binder with the additive at an elevated temperature prior to adding the binder to the mixture.

II. LITERATURE REVIEW

Asphalt construction were first introduced to the world in 1870, so apparently, they have been vastly improved since then. However, in our current society, due to environmental and economic concerns, merely creating new asphalt construction is just not good enough. To overcome this problem, many studies are carried out by researchers. In 1992 researcher Khandal stated that, in more recent times, other recycled materials have been incorporated into asphalt mixtures. It includes waste printer toner, crushed glass, incinerator waste, municipal waste and coal mine overburden. Many researches have been conducted for the past two decades. In 2018 the author Zhen Leng, Anand Sreeram, Rabindra Kumar Padhan, Zhifei Tan investigates that the use of reclaimed asphalt pavement (RAP) in road pavement construction has been widely encouraged due to its environmental and economic benefits. This research has shown that the addition of waste plastic materials such as Polyethylene Terephthalate (PET) or their functionalized additives into asphalt pavement may potentially improve the durability of pavement and also help alleviate the environmental problems caused by plastic.

In 2018 researchers Dharamveer Singh, Shashibhushan Girimath discusses about utilization of ground tire rubber (GTR) binder in combination with reclaimed asphalt pavements (RAP) binder can provide added benefits in terms of material, cost and environmental saving, and hence a promising step toward sustainable construction of pavements. The GTR binder was blended with different percentages (15%, 25% and 40% by weight of binder) of RAPs (RAP-A and RAP-S). Thus, a total of seven binders were prepared viz., GTR binder, GTR + 15%RAP-A, GTR + 25%RAP-A, GTR + 40%RAP-A, GTR + 15%RAP-S, GTR + 25%RAP-S, and GTR + 40%RAP-S. The researcher M.A. Ilin, E.S. Svintsov, presents the article that analyses the problems of lack the system approach to using reclaimed asphalt pavement technologies (RAP) in Russia in 2017. The purpose of this article is to review global experience with RAP, identify common issues of implementation of this technology and develop methods to ensure a comprehensive approach to the use of RAP in Russia.

Dulal Chandra Saha, J. N. Mandal from Procedia Engineering, presents research about Laboratory investigations on Reclaimed Asphalt Pavement (RAP) for using it as base course of flexible pavement in 2017. This research states that Reclaimed Asphalt Pavement (RAP) materials are also used for granular subbase and granular base of flexible pavement.

In 2016 the researchers Imran M. Khan, Shahid Kabir, Majed A. Alhussain, Feras F. Almansoor provides their research on use of Crumb-rubber Waste for Sustainable Pavement Construction. This study states that the seasonal change in temperature and loading nature has a significant effect on asphalt behavior because of its viscoelastic nature.

Feipeng Xiao, Ningyi Su, Shenglei Yao, Serji Amirkhanian, Jingang Wang provides research on Performance grades, environmental and economic investigations of reclaimed asphalt pavement materials in 2018. This research explored the high and low temperature performance grades as well as energy saving, greenhouse gas (GHG) emission reduction, and cost saving of reclaimed asphalt binders incorporated into the commonly used base binders. Again in 2017 Farshad Saberi.K, Mansour Fakhri, Ahmad Azami carried research on evaluation of warm mix asphalt mixtures containing reclaimed asphalt pavement and crumb rubber. This study investigates the potential use of crumb rubber and Reclaimed Asphalt Pavement (RAP) in Warm Mix Asphalt (WMA). In 2018, researchers gives performance evaluation of warm mix asphalt involving natural zeolite and reclaimed asphalt pavement (RAP) for sustainable pavement construction. This study present an experimental study to characterize the mechanical behaviour of warm mix asphalt (WMA) mixtures designed with Chilean natural zeolite and different amounts of reclaimed asphalt pavement (RAP) for sustainable pavement construction.

III. PROBLEM STATEMENT

Development of Bituminous mix where bitumen is replaced by Waste Plastic and natural aggregates replaced by Reclaimed asphalt pavement (RAP) for sustainable construction purpose. Various replacement levels of bitumen with Waste Plastic and Natural Aggregates with Reclaimed Asphalt Pavement will be done and Results of test will give guideline for desired properties of materials. As well as to check strength and durability parameters of bitumen replaced with Waste Plastic and Natural aggregates replaced by Reclaimed asphalt pavement (RAP) various tests will be performed.

IV. OBJECTIVES

• To study the effect of Waste Plastic and Reclaimed Asphalt Pavement on properties of bituminous mix by conducting different laboratory tests on prepared specimens, it is intended to analyse the result.
• To compare Conventional bituminous mix with the bituminous mix partially replaced by Waste Plastic and reclaimed asphalt pavement.
• To optimize the cost of Flexible road pavement by partially replacing bitumen with waste plastic and natural aggregates with Reclaimed Asphalt Pavement.

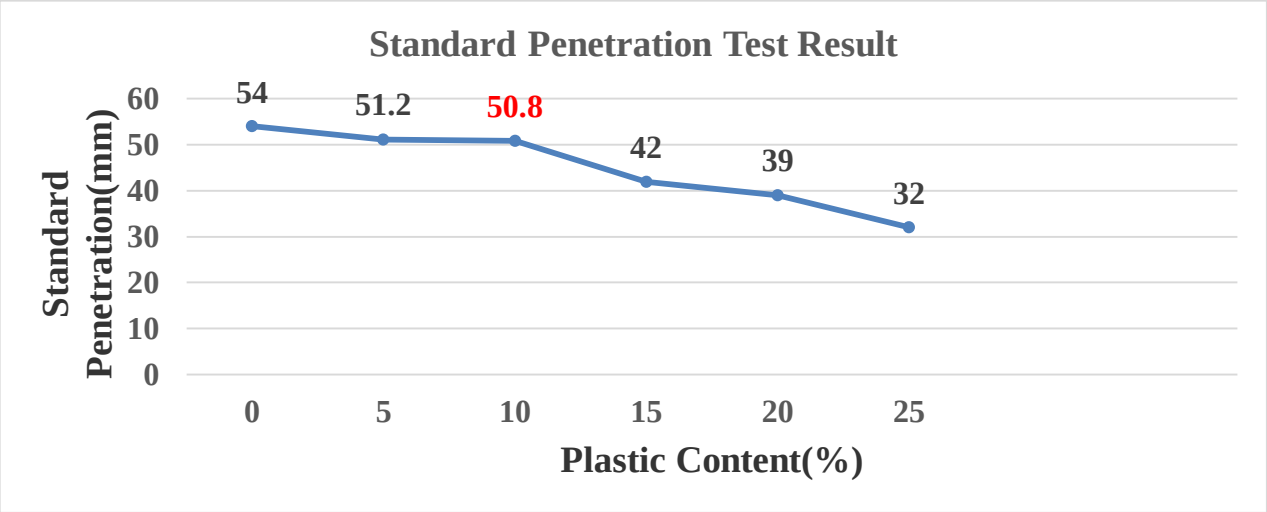
V. MATERIALS AND METHODOLOGY

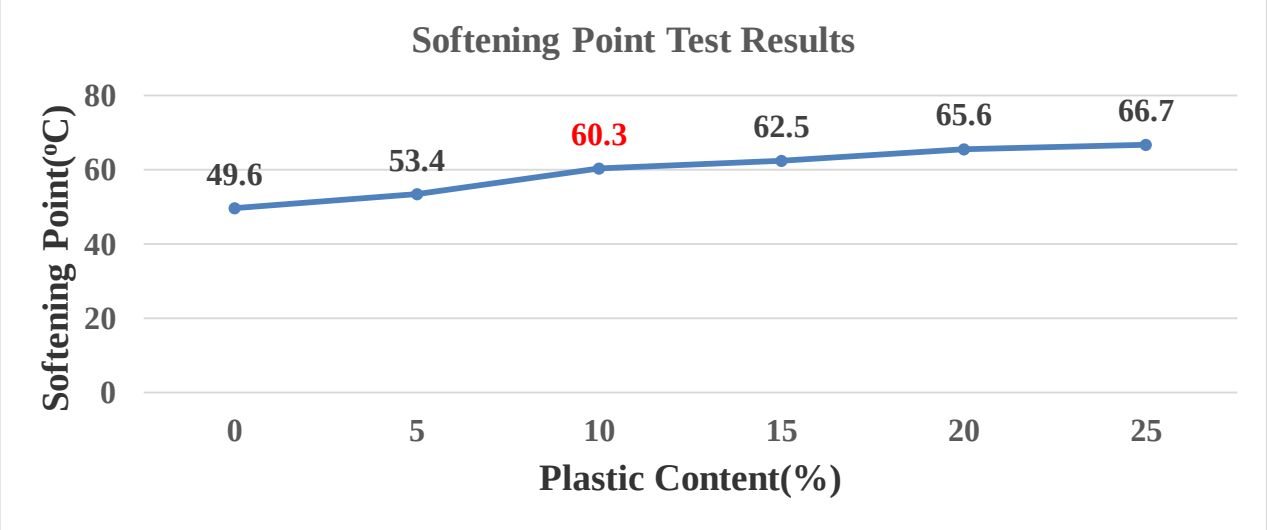
- Materials
  - Bitumen : VG 30 Grade Bitumen was used for the experiments. VG-30 is primarily used to construct extra heavy duty Bitumen pavements that need to endure substantial traffic loads. It can be used in lieu of 60/70 Penetration grade.
  - Plastic : Waste plastic such as carry bags, product wrappers shredded in small pieces of size 1.5mm to 4.5mm was used.
  - Reclaimed Asphalt Pavement(RAP) : Reclaimed asphalt pavement (RAP) is defined as removed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. Using RAP material has well-recognized financial and environmental benefits. The RAP Aggregates used for this study were obtained by milling process and using dry sieving process to obtained the required size and quantity of RAP aggregates.

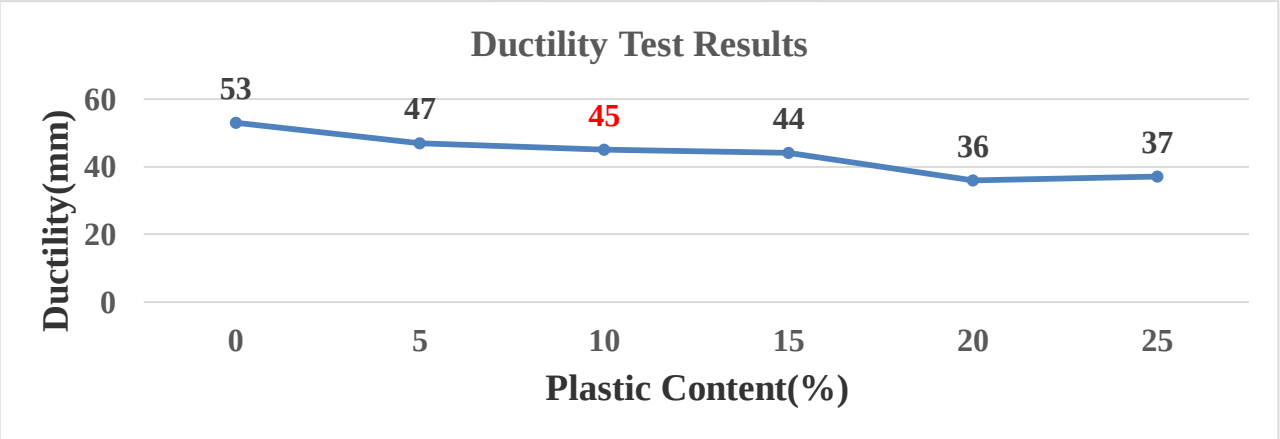
- Methodology
  - A Bituminous mix will be done for Bitumen with 5%, 10%, 15%, 20% and 25% replacement of Waste Plastic and Natural Aggregates with 10%, 20%, 30%, 40% and 50% replacement of Reclaimed Asphalt Pavement.
  - Experimental work is to be performed for various parameters like strength (Maximum load carrying capacity) and durability (penetration test and Softening Point Test).

VI. RESULTS

- Test results for Bitumen Partially Replaced With Waste plastic







VII. CONCLUSION

As a result, it can be concluded that the addition of plastic wastes, such as Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) to neat binder can play a significant role in improving the elastic behavior of binder in order to extend the service life of pavements. In addition, the use of these reclaimed asphalt pavement (RAP) will play a significant role in reducing the use of non-renewable resources such as natural aggregates in constructing sustainable pavements.

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