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A PATH FOR HORIZING YOUR INNOVATIVE WORK

AN EXPERIMENTAL STUDY OF FLEXIBLE PAVEMENT BY USING CRUMB RUBBER AS BINDING MATERIAL.

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Abstract

Today most tires, especially those fitted to motor vehicles, are manufactured from synthetic rubber. As the number of vehicles is increasing so are the heaps of discarded rubber tires. One of the main issues associated with the management of scrap tires has been their proper disposal. In this project work, an effort has been made to make use of these waste tires in surface coating of the flexible pavement. Modified Bitumen is one of the important construction materials for flexible pavements. Use of Crumb Rubber i.e. the rubber obtained from the waste tires of vehicles, in the construction of flexible pavement is gaining importance. It is also worth mentioning that, the modifier raw-material has been sourced from disposed crumb rubber. This not only allows us to collect modifier raw material at low cost, but also provides a solution towards ecological menace posed by increased use of rubber (non-biodegradable). In the present study, an attempt has been made to use Crumb Rubber, blended using wet process .Marshal method of Bituminous mix design was carried out for varying percentages of Crumb Rubber to determine the different mix design characteristics.

Introduction:

In India, it is estimated that over 33 lakh kilometers of road exists. 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. Crumb rubber binders have been used very successfully in sprayed seals for many years. The presence of rubber improves the properties of the binder, and also permits a higher application rate to be used. Thicker binder films are more resistant to reflection cracking and any cracks are more liable to heal during the summer months.

Clearly there are major advantages to be gained in terms of pavement performance and waste material utilization if the key factors affecting the performance of crumb rubber and modified bitumen can be identified.

Materials and Methods:

Bitumen:

Bitumen is a sticky, black and highly viscous liquid or semi-solid, in some natural deposits. It is also the residue or by-product of fractional distillation of crude petroleum. Bitumen Composed primarily of highly condensed polycyclic aromatic hydrocarbons, containing 95% carbon and hydrogen (± 87% carbon and ± 8% hydrogen), up to 5% sulfur, 1% nitrogen, 1% oxygen and 2000ppm metals. Also bitumen is Mixture of about 300 - 2000 chemical components, with an average of around 500 - 700. It is the heaviest fraction of crude oil, the one with highest boiling point (525ºC).

DIFFEREN FORMS OF BITUMEN

Cutback Bitumen:

A suitable solvent is mixed to reduce viscosity. Bitumen Emulsion: bitumen is suspended in finely divided condition in aqueous medium 60% bitumen and 40% water.

Bituminous Primers:

Mixing of penetration bitumen with petroleum distillate.

Modified Bitumen:

Blend of bitumen with waste plastics & or crumb rubber.

Various Grades of Bitumen used for pavement purpose:

Grade: 30/40; Grade: 60/70; Grade: 80/100

Crumb tire rubber grinding process:

The crumb rubber is made by shredding scrap tire, which is a particular material free of fiber and steel. The rubber particle is graded and found in many sizes and shapes. The crumb rubber is described or measured by the mesh screen or sieve size through which it passes during the production process. To produce crumb rubber, generally, it is important to reduce the size of the tires. There are two techniques to produce crumb rubber: ambient grinding and the cryogenic process

The ambient grinding process can be divided into two methods granulation and cracker mills. The ambient describes the temperature when the waste tires rubber as its size is reduced. The material is loaded inside the crack mill or granulator at ambient temperature. The cryogenic grinding is a cleaner, slightly faster operation resulting in production of fine mesh size. The high cost of this process is a disadvantage due to the added cost of liquid nitrogen.

Crumb tire are small pieces of waste tire scrapped from light motor vehicles. In this study the scrapped tire pieces passing IS 2.36 mm sieve were considered as crumb tire rubber (Fig. 1). Waste tire pieces are small pieces of waste tires of tractors that are approximately cut into square and rectangular shapes passing IS 25 mm sieve and retained on IS 20mm sieve (Fig. 2).

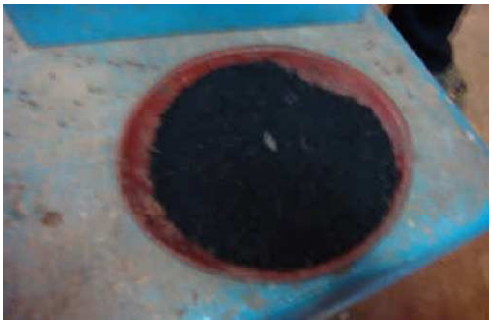

Fig.1

Fig.2

Wet Process

Waste crumb rubber is ground and made into powder; 5 to 10 % crumb rubber is mixed with the bitumen. Crumb rubber increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Use of shredded crumb rubber waste acts as a strong "binding agent" for tar making the asphalt last long. By mixing crumb rubber with bitumen the ability of the bitumen to withstand high temperature increases. The crumb rubber waste is melted and mixed with bitumen in a particular ratio. Normally, blending takes place when temperature reaches 45.5°C but when crumb rubber 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.

Advantages of Wet Process:

This Process can be utilized for recycling of any type, size, shape of waste material (Plastics, Rubber etc.)

Result and Discussion:

Performance of crumb rubber in Bituminous Material:

There are two rather different methods in usage of tire rubber in bitumen binders. Firstly, crumb rubber in the bitumen is dissolved as binder modifier. Second, is by substituting a portion of fine aggregates with ground rubber that does not completely react with bitumen Numerous factors can influence the modification effects which consist of base bitumen constituents, blending time and temperature, the percentage of rubber, the

gradation of crumb rubber, the type of mixing (wet or dry) grinding process method It observed that during the bitumen-rubber blending, due to higher stiffness and tensile strength at elevated temperatures, the mixture had decreased rutting capability .The design method for conventional bitumen mixture can be used for bitumen-rubber mixture as the mix stability being the primary factor. Also, standard paving machinery can be used for placement of bitumen-rubber mixture. However, a pneumatic tire roller is not suitable as asphalt rubber will stick onto the roller tires Rubber pavement association found that using tire rubber in open-graded mixture binder could decrease tire noise by approximately 50%. In addition, in spray applications, rubber particles of multiple sizes had a better sound absorbing. Moreover, another advantage of using asphalt rubber is to increase the life-span of the pavement. However, recommendations were made to assess the cost effectiveness of asphalt rubber.

PHYSICAL AND RHEOLOGICAL PROPERTIES OF RUBBERISED BITUMEN

Penetration properties

The penetration is a measure of hardness or softness of bitumen binder which shows an effect by adding crumb rubber to bitumen binder; it decreases as rubber content is increased. The penetration shows lower values as rubber content increases at different mix conditions of Rubberized bitumen binder, indicating that the binder becomes stiff and more viscous investigated the properties of rubberized bitumen prepared by physical blending of bitumen 80/100 penetration grade with different crumb rubber content and various aging phases. The results of penetration values decreased over the aging as well as before aging by increasing the rubber content in the mix. Also, the modified binders have lower penetration values than unmodified binders.

Elastic recovery properties

The elastic recovery or elasticity describes the ability of a bitumen binder to elongate when the tension is applied and to recover its original shape when the tension is released. The degree of elastic recovery was

used as an indicator of permanent deformation in pavement

Materials the elastic recovery property is very important in both fatigue and rutting resistance selection and evaluation. The elastic recovery is a property that indicates the quality of polymer components in bitumen binders concluded from his study, that the elastic recovery of rubberized bitumen binders leads to an increase as the rubber particle size decreases. Modified bitumen binders showed a significant enhancement on the elastic recovery, and, in contrast, the ductility decreased with respect to unmodified binders.

Ductility properties

The ductility is a distinct strength of bitumen, allowing it to undergo notable deformation or elongation. The ductility is defined as the distance in centimeter, to which a standard sample or briquette of the material will be elongated without breaking. The studies of concluded that finer rubber particles resulted in higher ductility elongation and also, that toughness would increase as rubber content increases. A combined effect of both time and temperature was noted with minimum elastic recovery value improved at maximum time and maximum temperature of two hours and 240°C, respectively. The bitumen-rubber modification resulted in a better rutting resistance and higher ductility. However, the modified binder was susceptible to decomposition and oxygen absorption. There were problems of low compatibility, because of the high molecular weight. Furthermore, the recycled tire rubber decreases reflective cracking, which in turn increases durability. In using waste tire rubber, there are however, several practical and experimental issues, such as it requires an elevated composite of temperatures and extended digestion time during the mixing process for it to be diffused in the bitumen .

Viscosity and softening point properties

The viscosity refers to the fluid property of the bitumen, and it is a gauge of flow-resistance. At the application temperature, viscosity greatly influences the potential of the resulting paving mixes. During compaction or mixing, the low or high viscosity has been observed to result in

lower stability values. The softening point refers to the temperature at which the bitumen attains a particular degree of softening. The use of crumb rubber in bitumen modification leads to an increase in the softening point and viscosity as rubber crumb content increases claimed that there is a consistent relationship between viscosity and softening point at different aging phases of rubberized bitumen binder. Also, it is reported that the higher crumb rubber content leads to higher viscosity and softening point. The viscosity is a continuously increasing non linear function of rubber content and the relative increase is a factor related to the application of temperature.

CONCLUSIONS

This review intended to find the effective ways to reutilize the hard Crumb rubber particles as bitumen modifier for flexible pavements. The use of recycled waste Crumb rubber in pavement asphalt represents a valuable outlet for such materials. The use of modified bitumen with the addition of processed waste Crumb rubber of about 5-10% by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal saving in bitumen usage. The process is environment friendly. The use of waste Crumb rubber in the manufacture of roads and laminated roofing also help to consume large quantity of waste Crumb rubber. Thus, these processes are socially highly relevant, giving better infrastructure.

REFERENCE

1. Punith, V.S. and Veeraraghavan, A., “Laboratory Fatigue Studies on Bituminous concrete Mixed Utilizing Waster Sherdded Plastic Modifier”, Proceedings of 21st ARRB Transport Research (ARRB) and 11th Road Engineering Association and Australia (REAAA) Conference, Caims, Australia, May 19-23, 2003.

2. S.S. Verma. “Roads from Plastic Waste”, The Indian Concrete Journal, p. 43-44. November 2008.

3. FHWA, User guidelines for waste and by-product materials in pavement construction; 1997.

4. Dr.Y. P. Gupta, Shailendra Tiwari & J. K. Pandey, "Utilisation of Plastic Waste in Construction of Bituminous Roads "NBM & CW MARCH 2010, p.92.

5. L.R Schroceder, "The Use of Recycled Materials in Highway construction', Public Roads, Vol 58(Issue 2), 1994.

6. Sunil Bose, Sridhar Raju,"Utilization of waste plastic in Bituminous Concrete mixes", Roads and Pavements, 2004.

7. Zoorob SE, Suparma LB. Laboratory design and investigation of the properties of continuously graded asphaltic concrete containing recycled plastics aggregates replacement (plastiphalt). Cement Concrete Composites 2000; 22:233–42.

8. D N Little, "Enhancement of asphalt concrete mixtures to meet structural requirements through the addition of recycled polythene, use of waste materials in hot mix asphalt", ASTM Special Tech Publication, 1193(1993).

9. L.Flynn, "Recycled Plastic finds it home in Asphalt Binder", Roads and Bridges, (1993).

10. Bindu C.S & Dr. K.S.Beena., "Waste plastic as a stabilizing additive in Stone Mastic Asphalt", International Journal of Engineering and Technology Vol.2 (6), 2010, 379-387.

11. AAPA Asphalt Guide, "Stone Mastic Asphalt Surfacing, Austroads and Pavement Design", volume 5, (Issue. 2), 239 – 249.

12. BCA Specification for Stone Mastic Asphalt, BCA 9808, New Zealand Pavement & Bitumen Contractors' Association, August, 1-10, (1999).

13. Qadir A, Imam M., "Use of recycled plastic waste aggregate as a partial substitution material in pavement structure". In: Proceedings of the International Symposium on Pavement Recycling; 2005.

14. Kumar, S and Gaikwad, SA "Municipal Solid Waste Management in Indian Urban Centres: an approach for betterment", in Gupta K.R.(Ed): Urban Development

Debates in the New Millennium, Atlantic Publishers and Distributors, New Delhi, pp. 100-111,(2004).

15. Manual on Municipal Solid Waste Management , Government of India (2000).

16. Narayan, Priya, 2001, ”Analyzing Plastic Waste Management in India: Case study of Polybags and PET bottles” published by IIIEE, Lund University, Sweden, pp 24-25 accessed at http://www.iiiee.lu.se/information/library/publications/reports/2001/Priya-Narayan.pdf