ABSTRACT

Crumb rubber (CR) reclaimed from used automobile tyres is being increasingly used to modify bitumen for enhancing the properties of bituminous mixtures as well as to reduce the solid waste disposal problem. Crumb rubber modified binder (CRMB) is highly suitable for special applications, where traffic is extremely heavy, and/or climatic variations are large. The present thesis is concerned with the use of CR reclaimed from discarded tyres of trucks and buses for modification of neat bitumen. Available literature deals mostly with CR obtained from passenger car tyres whose chemical composition is different that of from the tyres of buses and trucks which are available in plenty in India.

Mixing parameters such as speed of stirring, mixing time and temperature play an important role in the preparation of modified binders using CR. There are wide variations in the blending parameters reported in research publications. It has also been seen from literature that the CRMBs are evaluated mostly in terms of properties that are used for the evaluation of normal binders also. Similarly, the mixes containing these binders are evaluated in terms of fatigue, low temperature cracking and permanent deformation characteristics. Information available on the procedures and specifications for the testing and evaluation of CRMB and the mixes prepared using CRMB is scanty. It is thus necessary that additional investigation is taken up to evaluate the structural parameters of the material for the traffic and climatic conditions prevailing in India.

Considering the wide variations in the blending parameters reported in literature, a number of CRMB blends prepared by varying blending temperature and time, speed of stirrer and CR content were evaluated for selecting the optimum conditions of blending.

On the basis of some basic tests such as temperature susceptibility, oxidative hardening, elastic recovery test, loss on heating test etc. the modified binders were found to have significantly improved properties compared to the normal binder. Binder containing 10% CR by weight of bitumen showed the best performance among all the modified binders investigated.

To evaluate the effect of aggregate gradation on the performance of bituminous mixes, (i) Ministry of Surface Transport (MOST), India, (ii) Superpave aggregate gradation given by Strategic Highway Research Program (SHRP) and (iii) gap-graded aggregate gradations were used. For providing kneading and shearing action during the compaction of the bituminous

mixtures, a modified Marshall compaction method was used in the investigation. Marshall specimens were used for evaluating Marshall properties, tensile strength, moisture and temperature susceptibility, permanent deformation and fatigue characteristics of the bituminous mixes.

A repeated load indirect tensile test set-up was fabricated for determining various properties of the mixes and for evaluating the fatigue characteristics of the mixes. Tensile strength, Poisson's ratio and resilient modulus of the mixes were measured. Static indentation and repeated indirect tensile tests were conducted for evaluating the rutting potential of the bituminous mixes.

Results obtained from the investigation indicate that

- Mixtures prepared using modified binders have significantly higher (a) tensile strength (b) resilient modulus at higher temperature (c) resistance to permanent deformation and (d) fatigue life compared to normal mixes.
- Modified binders have more environmental adjustability compared to normal binder as they have (a) greater resistance to oxidative hardening (b) lower temperature susceptibility and (c) lower moisture sensitivity.
- Mixtures prepared using modified compaction showed better performance compared to those prepared using normal Marshall compaction.
- Mixtures prepared by wet process showed significantly higher performance compared to mixtures prepared in dry process.
- In general, mixes prepared using Superpave aggregate gradation performed better than those prepared with other gradations.

KEY WORDS

Bitumen Modifier, Crumb Rubber, Bitumen, Blending Parameters, Aggregate Gradation, Modified Compaction, Marshall Properties, Resilient Modulus, Fatigue Life, Permanent Deformation, Indirect Tensile Test, Static Indentation Test.