LABORATORY EVALUATION OF MODIFIED BITUMINOUS CONCRETE LAYER WITH CRUMB RUBBER

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***Abstract*—The rapid increase in the traffic load, higher traffic volume, substantial variation in daily and seasonal temperature led to thermal and fatigue cracking, rutting and many severe distresses in the flexible pavements in India. Because of this failure during service time there is a demand for modification of bitumen. Five percentages (4%, 8%, 10%, 12% and 16%) of crumb rubber are used as modifier in this study. Crumb Rubber modified bitumen shows more stability and less bitumen optimization in the mix when compared to unmodified bitumen. This study shows that the maximum Marshall stability is obtained at a bitumen content of 5% mixed with a crumb rubber quantity of 10%.Crumb rubber has more resistant to temperature susceptibility, moisture susceptibility and less resistant to short term ageing than unmodified bitumen. Therefore, it can be concluded that the application of crumb rubber is suitable for lowering production temperature with satisfactory performance.**

***Keywords*—Crumb rubber, modified binder, marshall mix design.**

I. INTRODUCTION

Crumb rubber is the term usually applied to recycled rubber from automotive and truck scrap tires. During the recycling process steel and fluff is removed leaving tire rubber with a granular consistency. Continued processing with a granulator and/or cracker mill, possibly with the aid of cryogenics or mechanical means, reduces the size of the particles. Crumb rubber modified (CRM) asphalt is a general type of modified asphalt that contains scrap tire rubber. Modified asphalt paving products can be made with crumb rubber by several techniques, including a wet process and a dry process. Binder modification of this type is due to physical and compositional changes in an interaction process where the rubber particles swell in the bitumen by absorbing a percentage of the lighter fraction of the bitumen, to form a viscous gel. In the dry process, granulated or ground rubber and/or crumb rubber is used as a substitute for a small portion of the fine aggregate.

II. REVIEW OF LITERATURE

Nabin. (2014), modification of bitumen with 15% by weight of crumb rubber with varying size and observed that stability increase first and then decrease. OBC was determined at 15%. It was concluded that best size was finer size [1]. **Mahrez. et. al. (2011),** claimed that the use of crumb rubber in bitumen modification leads to an increase in the softening point and viscosity as crumb rubber content increases. There is a consistent relationship between viscosity and softening point at different aging phases of rubberized bitumen binder [2]. **Mashaan. et. Al. (2012),** the penetration is a measure of hardness and softness of bitumen binder which shows an effect by adding crumb rubber to bitumen binder, it decreases as rubber content 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 [3].

III. OBJECTIVE OF THE STUDY

The aim of this research project is to develop an understanding of the way in which recycled particulate rubber modifies the mechanical performance of the bituminous material and crumb rubber modified bitumen (CRMB) mixture following wet process. The overall aim of the study is as follows:

A. To evaluate the various physical and engineering properties of bitumen and to compare the test results with plain and crumb rubber modified bitumen.

B. To evaluate the performance of aggregates by testing various physical and engineering properties.

C. To evaluate the optimum percentage of bitumen by conducting Marshall Test for different percentage of bitumen and crumb rubber and comparing the test results.

IV. METHODOLOGY AND WORK OVERVIEW

Asphalt concrete is a widely used material throughout the world. To meet the requirement of the present era, more material is required. Aggregate and bitumen are important ingredient materials of asphalt concrete. As there are limited sources of ingredient material, in near future, there will be a shortage of important ingredient materials. An extra material which can enhance the properties of asphalt concrete by modifying the low grade materials, a great amount of material can be saved without compromising with the desired quality. The methodology consists of two basic stages. First is to check the basic properties of ingredient materials and secondly the Marshall mix design of unmodified bitumen and bitumen mixed with crumb rubber at various percentages starting from 4% up to 16%.

V. MATERIALS AND APPARATUS

VG-30 bitumen, Crumb rubber, softening point apparatus, Penetration test apparatus, Bitumen mixing setup, Marshall test apparatus, air void apparatus.

VI. EXPERIMENTAL PROGRAMS AND RESULTS

Experimental investigation consists of two specific stages. The primary stage is to carry out all the basic physical attribute tests of ingredient materials which are mineral aggregate and unmodified bitumen. The second stage consists of Marshall Mix design and to obtain the optimum quantity of crumb rubber to be mixed with the optimum bitumen content that will give the maximum Marshall Stability value. The initial stage consists of checking the material properties with respect to the standard values as proposed by the Indian Road Congress. The second stage consists of preparation of Marshall Test specimens and to obtain the optimum bitumen content. Results showed that the optimum bitumen content was 5%. Next modified Marshall Samples were prepared at optimum bitumen content with varied proportions of crumb rubber starting from 4% to 16%. The relation between the percentages of crumb rubber and Marshall Stability value is described in the following bar chart.

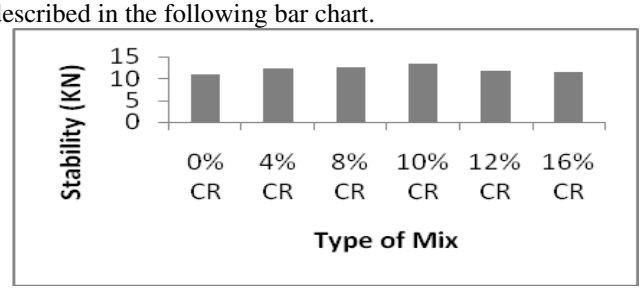

Figure 1:- Stability vs. % CR (Crumb Rubber)

The following figure shows the relationship between unit weight (gm/cc) and percentage of crumb rubber.

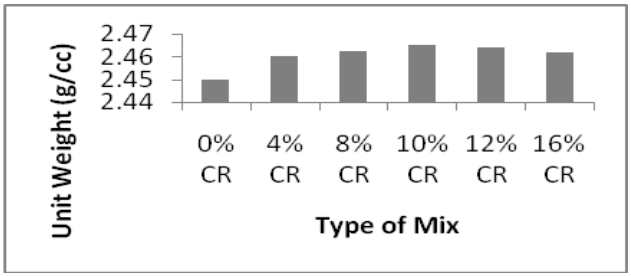

Figure 2:- Unit weight vs. % CR (Crumb Rubber)

VII. CONCLUSION

The study shows that for an optimum bitumen content of 5% the dosage of crumb rubber for modification is to be limited to 10%. This indicates that a design of such modified flexible pavement layer to last long, 10% crumb rubber is to be added. This result is supported with the fact that at 10% crumb rubber content the unit weight of the Marshall mix is also maximum. Hence, it shows that the packing is at its densest state when a 10% of crumb rubber content is maintained.

VIII. REFERENCES

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