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Analysis of Stone Matrix Asphalt (SMA) with Interactive Properties of Gradation

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ABSTRACT

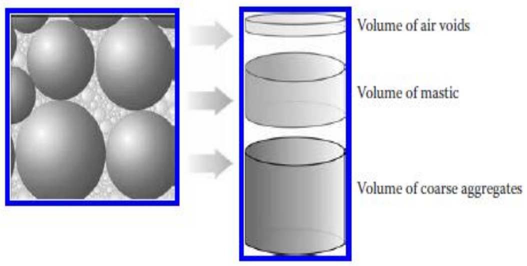
SMA called stone mastic asphalt. It has been taking over the global asphalt paving market at a remarkably high speed. Stone Matrix Asphalt was originally developed in Europe as in impervious /highly durable wearing surface for bridge decks. Based on its performance history "split matrix asphalt" began to be used as a surface layer for roadways carrying heavy truck traffic throughout Germany and other European countries. Today, it is the pavement surface of choice where long term performance and durability is needed. We have studied the effect of gradation on the fatigue life of asphalt mixtures using the SHRP-M009 four point bending fatigue test. Fatigue test specimens were prepared using a lightweight steel roller compactor with a target air void level of 7%.All tests were performed at 20⁰C in strain control mode.

Keywords: *Mastic, asphalt, bitumen, gradation, rutting, fatigue*

I. INTRODUCTION

Concept of SMA:

The study of physical properties of the bitumen and aggregates used for SMA Mix. SMA samples are prepared by varying the binder content in Marshall Method and Super pave Gyratory Compactor (SGC). These specimens are Analyzed for the density - voids and stability - flow. The optimum bitumen content for the mix with CRMB - 55 and Terrasil treated aggregates are determined. The laboratory performances of the SMA mixes are checked for moisture susceptibility, rutting and repeated load tests. Drainage test was conducted to check for the binder drainage. Permeability tests were on ducted to study permeable nature of SMA mixes with CRMB 55 and treated aggregates. Moisture susceptibility tests include the evaluation of Indirect Tensile Strength, Tensile Strength Ratio and boiling test for stripping.(Figure 1.0).The high amount of coarse aggregate in the mixture forms a skeleton type structure providing a better stone on stone contact between the coarse aggregate particles which of us high resistance rutting. Improve binder durability is a result of higher bitumen content and also play vital role of gradation selection. Previously many mix design have been developed to achieve desired properties such as durability, fatigue resistance, strength and stability. Stabilizers are used to reduce the air void present between the aggregates and also to bind them together so that no bleeding of bitumen can occur due to which compaction increases and drain down of bitumen decreases.



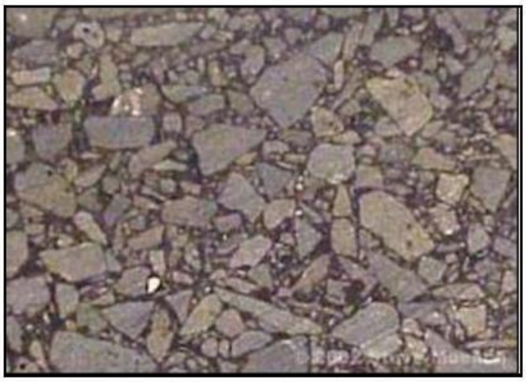


Fig. 2: Dense graded HMA

Fig. 3: Open graded HMA

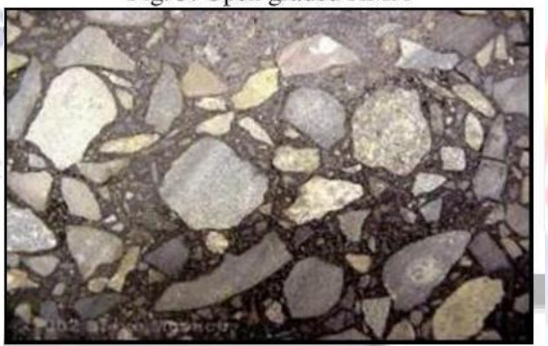


Fig. 4: Stone matrix asphalt

(Figure 1.1) Division of SMA into Basic components.

In order to solve this environmental problem partly and at the same time to improve the performance of Stone Matrix Asphalt (SMA), CRMB -55 was used for the investigation. Another attempt of SMA Mix
using an anti -stripping additive was done. The objective of the present investigation is given below:

- ❖ To reduce anti-stripping by treating aggregates using anti -stripping agents. Also study the characteristics of SMA mixes using CRMB - 55 binders and a mix using treated aggregates and VG-30.
- ❖ To evaluate the stability, flow value and volumetric properties of SMA mixes with CRMB - 55 and treated aggregates by using Marshall Method and Super pave Gyratory Compactor.
- ❖ To study the indirect tensile strength, permeability, Rut depth and amount of stripping of SMA mixes with CRMB-55 and treated aggregates.
- ❖ To study the performance of SMA mixes with CRMB-55 and treated aggregates under repeated loads.

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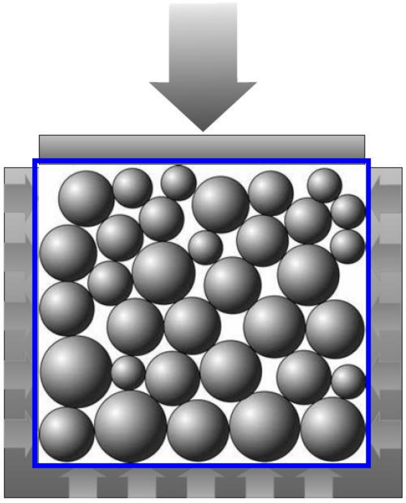
II. Methodology

Stone Matrix Asphalts (SMA) is a gap graded bituminous mixture containing a high proportion of coarse aggregates and filler with relatively less medium sized aggregates. It has high binder content and low air voids with high levels of macro texture and laid resulting in water proofing with good surface drainage. The effect of aggregate gradation and filer type in properties of SMA. Hydrated Lime of SMA mixes has been improves air voids and Moisture Susceptibility in the same gradations of sample with Crushed Stone.

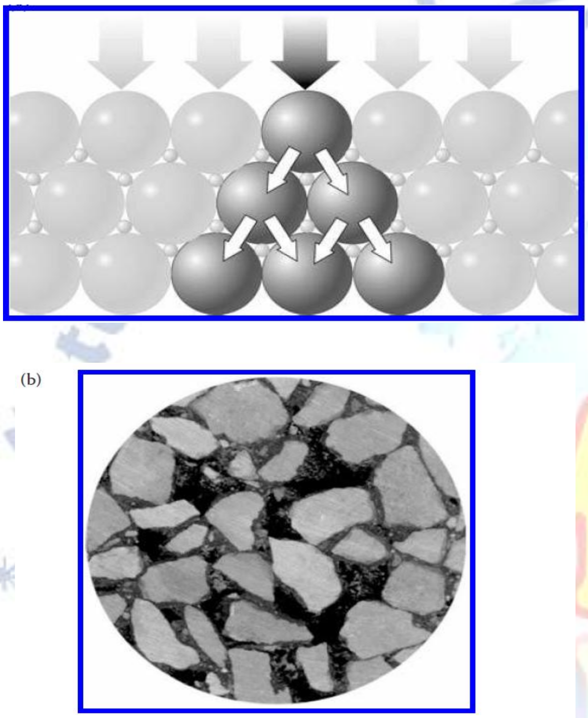


(Figure:2.0) vertically loaded grains with side support.

They recommend to use the weight to change in grade to evaluate the resistance of aggregate particles to gradations in SMA mixes .Our aim in designing an SMA ‘s aggregate structure has already been identified a strong skeleton of coarse grains .lets us now consider what are the requirements an aggregate mix as to meet to create such a desirable skeleton .Gap gradation is a disruption in the occurrence of consecutive aggregate fractions in an aggregate blend ,that disruption results from a lack or minimal amount of one or more aggregate fractions looking .(Figure 3.0).we can see the formation process of a skeleton with coarse grains and some of the finest grains but without sizes in between **.gap gradation means a lack or minimal share of specified fractions of intermediate aggregates.** The roll of the gap gradation is so essential that lack of definite size grains must be evident .But which fraction or sizes of grains or fractions.

Achieving the proper volume of mastic is critical there must be the amount of mastic to coat the coarse grains but at the same time to leave some free, unoccupied space.SMA mixtures belong to a group of coarse aggregate sand mixtures with a continues coarse grain matrix that is there skeletons are formed by interlocked coarse aggregate particles that transmit loads.

a)

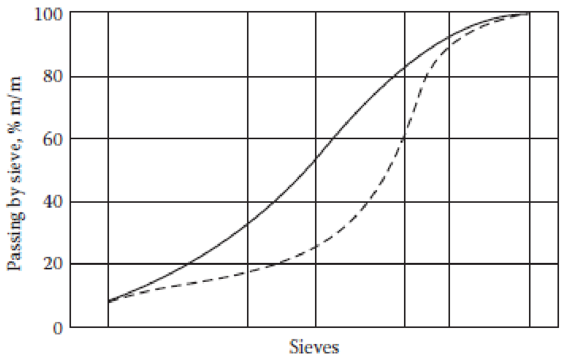


(Figure: 3.0): Load distribution among balls in case of uniform load distribution and cross section of a sample.

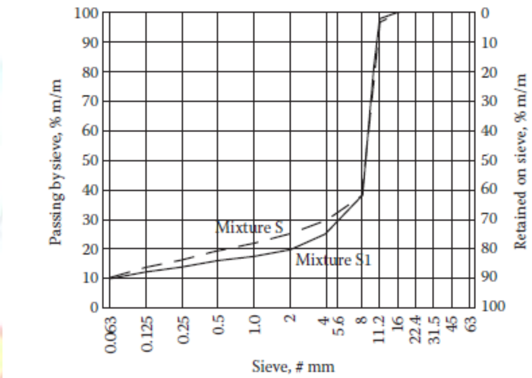
III. DESIGNING A GRADATION CURVE

Gradation curve is the one passing exactly in the middle of the space between the upper and lower gradation limits. The shape of a design gradation curve exerts a significant impact on mix properties.

- The actual gradation of the coarse aggregate fraction .Distribution of coarse aggregate on sieves larger than 2mm.
- The density of the coarse aggregate particles.
- Gradation should be equally sieved in suitable I.S sieve. By considering the gradation w.r.to the elasticity loads can be taken in the three dimensional system that's way it act as strong graded pavement coarse.



(Figure 4.0): position of gradation curves of aggregate mixture (solid line-asphalt concrete Dotted line- SMA (gap graded)).



(Figure: 5.0): Grading curves of S; solid line indicates mixes of SMA.

The aggregate blends included coarse aggregate, fine aggregate and medium gradation and to poorly graded. From this investigation, they conclude that

- Variations in gradation have the greatest effect when the general shape of the gradation curves is changed (i.e. coarse-to-fine & fine-to-coarse gradations).

Fine gradation produced the highest Marshall stability, while the fine-to-coarse poorly graded gradation (with hump at sand sized) produced the lowest Marshall stability. (Elliot.et al., 1991)

IV. THE INTERACTIVE PROPERTIES OF GRADATION

Gradation should be expressed in mass percentages of the total aggregate mix, the accuracy of the percentages passing. All sieves (with the exception of the 0.063 mm sieves) should be expressed to 1%. To the 0.063 mm sieve should be expressed to 0.1%. the content of binder and additives should be expressed in mass percentage of the asphalt mixture, with an accuracy of 0.1%.

The gradation of an SMA mixture should be established with a minimum of sieves: 0.63,2.0, D, 1.4D, and the characteristic coarse sieve (a selected sieve between 2.0 mm and D). Basically, the gradation limits, which are given in the standard, must adhere to the rules for preparing NADs to the standard En 13108-5. Each country, by its NAD, may determine an SMA Mix's gradation.

V. CONCLUSION

Gradation can be improving the durability of pavement. Mix proportion has to be deciding the quality of pavement materials. Stone matrix asphalt is depends upon the gradation aggregates. The interactive properties can be defined the material characteristics, homogeneity of mix etc. here gradation improves the performance of material and bonding capacity of the mix. Finally it is a good significant behavior of the fresh aggregate mix materials. In some times pavement surface can be predict the external forces acting on the top of the wearing coarse like adhesive ,abrasion forces. Gradation of the material have to improve toughness of the surface course. It provides resistance to deformation at high pavement temperatures and improved skid resistance and also improves resistance to fatigue effects and cracking at low temperatures. It results into noise reduction over conventional alternative pavement surface.

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