TO STUDY THE INFLUENCE OF SHAPE OF COURSE AGGREGATE ON DBM MIX

MOHAMMED NAIM MANSURI*
DR. V. M. PATEL**
PROF. H.K. DAVE***

*Final Year M.E. Transportation, Engg., Govt. Engineering College, Modasa, Guajrat, India
**Head, Dept. of Civil Engg., Govt. Engineering College, Modasa, Guajrat, India
***Associate Professor, Dept. of Civil Engg., Govt. Engineering College, Modasa, Guajrat, India

ABSTRACT

Aggregates are the principal material in pavement construction. The shape of aggregate particle has significant influence on performance of the Bitumen pavement. The strength serviceability requirements of Bitumen mixes such as stability, flow, voids in mineral aggregate (VMA), voids filled with bitumen (VFB) and air voids are highly depend on the physical properties of aggregate. Dense bituminous macadam (DBM) mixes were analyzed with different proportions of different shape of aggregates were studied.

KEYWORDS: Coarse Aggregate, Aggregate Shape, DBM

INTRODUCTION

The shape of aggregate particle has a significant influence on the performance of the bituminous pavement. Particle shape can be described as cubical, flat, elongated and round. The presence of flaky aggregates is considered as undesirable in bituminous mixtures because of their tendency to break down during construction and subsequent traffic operations. The voids present in a compacted mix depend on the shape of aggregates. Highly flaky aggregates have more voids and reduce the workability. Hence it was felt that the study on the effect of the flaky aggregates on bituminous mixtures is relevant and essential.

Need of study

- For the academic purpose studies and experiment has revealed that aggregate shape has effect on percentage voids ratio, percentage bitumen content and performance of the mix under applied load condition.
- To evaluate the influence of shape of aggregate on Dense Bituminous Macadam the various individual properties of materials (Aggregates & Bitumen) are determined.
Objectives
To study the shape effect of aggregate particles & to examine their influence on the behaviour and performance characteristics of Dense Bituminous Macadam mix.

Scope of work
In order to this study, the performance behaviour of DBM mix with coarse aggregate of different shape experimental work need to be conducted is as bellow.

- Marshall Stability
- Marshall Flow
- Density
- % Voids in mix
- % Voids in mineral aggregate
- % Voids fill with bitumen

Methodology:
1. Selection of Materials
2. Test on aggregate & bitumen
3. Preparation of JMF (MoRTH-2004)
4. Marshall Mix Design (MS-2)
5. Experimental Work and Analysis
   - Bitumen content vs Marshall Stability
   - Bitumen content vs Marshall Flow
   - Bitumen content vs Density
   - Bitumen content vs VIM
   - Bitumen content vs VMA
   - Bitumen content vs VFB
6. Optimum Bitumen Content

7. Conclusion and Suggestion
Experimental Work: The aggregates used in this study were 16-25 mm, 7-16 mm, 4-7 mm and 0-4. Bitumen of penetration grade 60/70 was used. The properties of the materials used are given in Table 1 and Table 2.
Table 1 Physical Properties of Aggregate

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Method</th>
<th>Test Method</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aggregate Impact value</td>
<td>IS:2386</td>
<td>%</td>
</tr>
<tr>
<td>2</td>
<td>Water Absorption</td>
<td>IS:2386</td>
<td>%</td>
</tr>
<tr>
<td>3</td>
<td>Specific Gravity</td>
<td>IS:2386</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Fl &amp; EI</td>
<td>IS:2386</td>
<td>%</td>
</tr>
</tbody>
</table>

Table 2 Properties of 60/70 Grade Bitumen

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Method</th>
<th>Test Method</th>
<th>Units</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Penetration</td>
<td>IS:1203</td>
<td>Mm</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>Ductility</td>
<td>IS:1208</td>
<td>Cm</td>
<td>82.33</td>
</tr>
<tr>
<td>3</td>
<td>Specific Gravity</td>
<td>IS:2386</td>
<td>-</td>
<td>1.020</td>
</tr>
<tr>
<td>4</td>
<td>Softening Point</td>
<td>IS:1203</td>
<td>U C</td>
<td>50.5</td>
</tr>
<tr>
<td>5</td>
<td>Flash Point</td>
<td>IS:1209</td>
<td>U C</td>
<td>239</td>
</tr>
</tbody>
</table>

The aggregate gradation for DBM mix was selected from Ministry of Road Transport & Highways (MoRT&H) specifications. The proportions of aggregate sizes were determined by trial and error method to achieve the combined gradation as per the requirements. The proportions arrived for different aggregate sizes for DBM mix are as given below

- 16-25mm aggregate – 32 %
- 7 - 16mm aggregate – 18 %
- 4 - 27mm aggregate – 16 %
- 0 - 4mm aggregate – 34 %

**Marshal Stability**

The variation of stability with increase in Binder content is shown in Figure 1. It is observed that stability is increase to the certain point, further increase in bitumen content the stability going to decreases in all case. The maximum stability can be observed by using the cubical aggregate.
Marshall Flow
The variation of flow value with increase in binder content is shown in Figure 2. It is observed that flow value increases with increase in proportion of binder content.

![Figure 2](image)

Density
The variation of density with increase in binder content is shown in Figure 3. It is observed that density increases with increase in proportion of binder content to a certain point then after it is decrease with increase in proportion of bitumen content.

![Figure 3](image)

Percentage Air Voids
The variation of Va with increase in binder content is shown in Figure 4. It is observed that Va decreases with increase in proportion of binder content.

![Figure 4](image)

Voids in Mineral Aggregate
The variation of VMA with increase in binder content is shown in Figure 5. It is observed that VMA decreases with increase in proportion of binder content to the certain point then after it is increase with increase in proportion of bitumen content.
Voids Fill with Bitumen
The variation of VFB with increase in binder content is shown in Figure 6. It is observed that VFB increases with increase in proportion of binder content.

Optimum Bitumen Content

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Properties</th>
<th>Bitumen content By wt. Of mix (%)</th>
<th>Optimum Bitumen Content By wt. Of mix (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>cube</td>
<td>pyramid</td>
</tr>
<tr>
<td>1</td>
<td>Max. Bulk density (gm/cc)</td>
<td>4.56</td>
<td>4.77</td>
</tr>
<tr>
<td>2</td>
<td>4.5% VIM</td>
<td>4.39</td>
<td>4.81</td>
</tr>
<tr>
<td>3</td>
<td>70% VFB</td>
<td>4.37</td>
<td>4.81</td>
</tr>
<tr>
<td>5</td>
<td>3mm Flow</td>
<td>4.70</td>
<td>4.49</td>
</tr>
</tbody>
</table>

Conclusion
- Experimental study indicates that, of the various shape of aggregates used in mix, the mix with cubical aggregates has minimum value of OBC = 4.51%. For spherical and pyramidal aggregates it is 4.71% and 4.66% respectively.
- As per MoRTH specification (cl. no. 507.3.1) permissible value for Voids Fill with Bitumen = 65% to 75%. Observed experimental value for cubical, spherical and pyramidal shaped aggregate are 74.88%, 70.12% & 71.21% respectively which is indicative of the fact that all types of shape are meeting the MoRTH requirements initially under sample preparation condition(after 75 no. of blows).
As per MoRTH specification (cl. no. 507.3.1) minimum Marshall Stability is 9KN. Observed Maximum Stability value for cubical, spherical and pyramidal shaped aggregate are 12.95KN, 11.95KN & 12.40KN respectively which is indicative of the fact that all types of shape are meeting the MoRTH requirements but mix with cubical aggregate give maximum stability compare to other.

As per MoRTH specification (cl. no. 507.3.1) permissible value for Marshall Flow = 2mm to 4mm. Observed experimental value for cubical, spherical and pyramidal shaped aggregate are 2.70mm, 3.45mm & 3.60mm respectively which is indicative of the fact that all types of shape are meeting the MoRTH requirements but mix with cubical aggregate give closer value to the mid limit of flow value.

To achieve economy considering minimum % bitumen content with maximum stability, bulk density and optimum flow (3mm to 6mm) the most suitable shape of aggregate appears to be cubical through our experimental study.

References:
2. Is 2386 (Part-1)-1997, Methods Of Test For Aggregate For Concrete, Part 1, Particle Size And Shape.
12. Is 2386 (Part 5) – 1963, Method Of Test For Aggregates For Concrete.
14. Overseas Road Note 31