IMPACTS OF TOTAL SHAPE FACTOR ON THE PRESENTATION OF BLACK-TOP BLEND

AKULA V N L M S SASTRY
M.Tech , Dept of CIVIL, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem.

K RAMU
Asst.Prof, Dept. of CIVIL, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem

ABSTRACT:

Aggregates are a principal material in black-top. Standard road aggregates in India are ordinary sums obtained by beating of rocks. The physical properties of coarse aggregates are more tremendous in new age bituminous mixes. All out characteristics, for instance, particle size, shape, and surface effect the introduction and organization limit of hot-mix dark top black-top. The condition of all out atom influences the introduction of the dark top black-top. Particle shape can be delineated as cubical, level, drawn out and round. The quality and functionality prerequisites of black-top blends, for example, Stability, Flow, Voids in Mineral Aggregate (VMA), Voids Filled with Bitumen (VFB), Air Voids (Va) and Tensile Strength exceptionally rely upon the physical properties of totals. Thick Bituminous Macadam (DBM) blends were broke down with various extents (0%, 10%, 20%, 30%, 40%, and half) of various state of totals was contemplated. Blends in with cubical and pole shape totals has been indicated acceptable outcomes on solidness and rigidity of blends. The boundaries, for example, air voids and voids in mineral total increments with increment in extent of sharp edge sort of totals in DBM blends. The Particle Index estimation of coarse total essentially influenced the building properties of a HMA blend. The molecule shape decided how total was stuffed into a thick setup and furthermore decided the interior opposition of a blend.

1. INTRODUCTION

1.1 GENERAL:

Aggregates are a principal material in pavement. Conventional road aggregates in India are natural aggregates obtained by crushing of rocks. In Hot Mix Asphalt (HMA), aggregates are combined with an asphalt binding medium to form a compound material. By weight, aggregate generally accounts for between 92 and 96 percent of HMA. They comprise the majority of pavement volume but only account for a minority of total pavement material costs. Therefore, knowledge of aggregate properties is crucial in designing a high quality pavement.

Aggregates can either be natural or manufactured. Natural aggregates are generally extracted from larger rock formations through an open excavation (quarry). Usually the rock is blasted or dug from the quarry walls then reduced in size using a series of screens and crushers. Some quarries are also capable of washing the finished aggregate. Manufactured rock typically consists of industrial by-products such as slag (by-product of the metallurgical processing – typically produced from processing steel, tin and copper) or specialty rock that is produced to have a particular physical characteristic not found in natural rock (such as the low density of lightweight aggregate).

1.2 INFLUENCE OF AGGREGATE PROPERTIES ON HMA PERFORMANCE

Aggregate particles can be defined in terms of three independent shape properties: shape (or form), angularity, and surface texture (Barrett, 1980). These three aggregate shape properties fully characterize particles based on their geometry. The form property characterizes aggregate particles based on ratios of particle dimensions. The angularity property measurement describes particles based on the variations at the edges of particles. This measurement defines particles in a range from rounded to angular.

The final property is surface texture. This property describes the surface roughness of a particle at a small scale, which is not influenced by changes in form or angularity. These three properties are independent of each other: an increase or decrease in one of these properties does not necessarily influence the other two properties (Rousan, 2004). A schematic diagram illustrating the differences between these three aggregate shape properties is shown in Fig 1.1

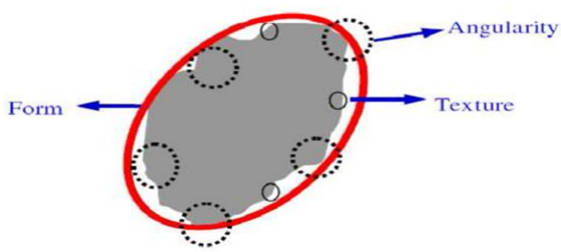


Fig.1.1 Components of aggregate shape: form, angularity, and texture (Masad et al., 2003)

1.3 OBJECTIVES AND SCOPE OF THE PRESENT WORK

This study was undertaken to achieve the following objectives:

1. To quantify the different shape of aggregate sizes.
2. To evaluate the effect of aggregate shape factors on the performance of asphalt mixes.

The experimental investigation considered aggregate from only one source. One aggregate gradation has been adopted in this study. Only 60/70 grade asphalt was used.

2. REVIEW OF LITERATURE

According to Roberts, et al. (1991) mixtures with flat and elongated particles tend to densify under traffic, ultimately leading to rutting due to low voids and plastic flow.

Herrin and Goetz (1954) studied the effects of the percentage of aggregates in the mix and aggregate shape . They concluded that the rutting problem can be addressed by using large top aggregates, increasing the specified void percentage in mineral aggregate (14 to 15 percent minimum) by replacing most or all the natural sand in the mix with manufactured angular particles

Boutilier (1967) studied the relation between the particle index of the aggregate and the properties of the bituminous aggregate mixtures and by increasing the amount of crushed material in the coarse and fine aggregates. Varying the percentages in coarse aggregates (0% to 100%) with 35% increment and FA constant. Varying the % FA from (0%, 50%, and 100%) and CA constant. CA from 0% to 100%, they observed that the little variation in air voids ,VMA, VFB, particle index increasing indicating a rough surfaced, more angular particle, the flow decreases and the Marshall Stability increases.

This results showing particle index is the method available which measures the geometric properties of coarse aggregates.

Stephens and Sinha (1978) observed that HMA mixes containing 30 percent or more flat particles maintained higher voids content compared to some other blends with less percentage of flat particles.

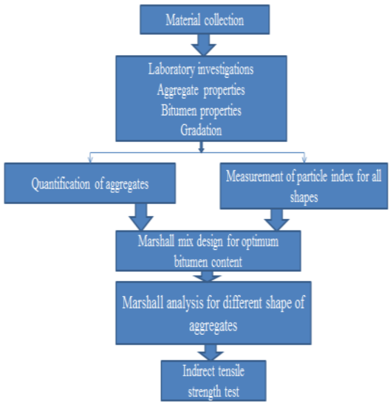
Kalcheff and Tunnicliff (1982) evaluated the effect of fine aggregate shape on the properties of HMA. They found that the use of manufactured sand instead of natural sand improved the mix behaviour in terms of resistance to permanent deformation from repeated traffic loadings, tensile strength, and tensile fatigue resistance. The image analyzer was used to quantifying the morphological characteristics of coarse aggregate.

A wheel-tracking test was performed to evaluate the susceptibility of a mixture to permanent deformation. Cubical aggregate shown the best rutting resistance compared to other shapes.

Flaky and/or elongated aggregate was shown to have lower compactibility and higher breakage.

D. Sakthibalan (2007) study was conducted on influence of aggregate flakiness on Dense Bituminous Macadam & Semi Dense Bituminous concrete mixes were analysed with different proportions of flaky aggregate. Stability, flow, voids filled with bitumen and tensile strength decreases with increase in proportion of flaky aggregates for both DBM and SDBC mixes

3. MATERIAL AND METHODOLOGY



3.2 MATERIALS:

Aggregates influence, to a great extent, the load transfer capability of pavements. Hence it is essential that they should be thoroughly tested before using for construction.

Not only that aggregates should be strong and durable, they should also possess proper shape and size to make the pavement act monolithically. Aggregates are tested for strength, toughness, hardness, shape, and water absorption.

The asphalt binder component of an asphalt pavement typically makes up about 5 to 6 percent of the total asphalt mixture, and coats and binds the aggregate particles together.

Gradation for this study dense bituminous macadam

3.3 QUANTIFICATION OF AGGREGATE SHAPES:

- Aggregates which happen to fall in a particular size range may have rounded, cubical, angular, flaky or elongated particles.
- Visual examination is the most common method of judging aggregate shape and this method is adopted for this study.
- Segregation of aggregates is the major task in this study

- Some of the shapes are not available .Impact testing machine is used for breaking of aggregates and getting the shapes.
- For this study the aggregate shapes of sizes up to 4.75 mm is used.

3.4 SHAPE TESTS:

Particle index test is common method is used for measuring the particle shape characteristics.

The coarse size fractions of DBM were evaluated for the influence of aggregate shape on engineering properties of a HMA mix.

Aggregate shape analysis was carried out through the use of the Zingg diagram on the basis of the particle longest diameter (dL), the intermediate diameter (dI), and the shortest diameter (dS).

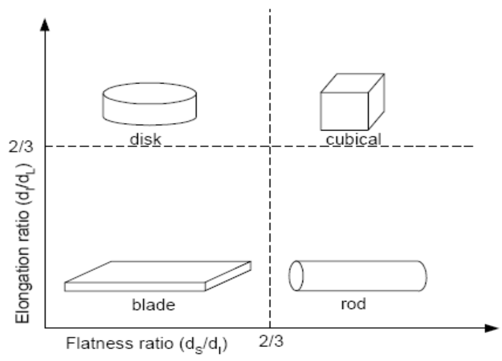


Fig: 3.1 Aggregates Shapes Used in this Study

3.5 PARTICLE INDEX TEST:

- The combined effects of particle shape and surface texture of an aggregate were determined in accordance with ASTM Test Method for Index of Aggregate Particle Shape and Texture (D 3398).
- The equipment required for this test consists basically of a cylindrical steel mold 152 mm (6 in.) in diameter by 178 mm (7 in.) high, and a steel rod 16 mm (5/8 in.) in diameter by 610 mm (24 in.) long with the tamping end rounded to a hemispherical tip.
  The mold was filled in three equal layers, with each layer compacted with 10 well-distributed blows of the tamping rod. Each tamp consisted of a drop with the tamping rod from 51 mm (2 in.)
- This procedure was repeated using the same material but applying 50 blows on each of the three layers.

3.6 MARSHALL ANALYSIS FOR OBC

- In this study, the behavior of DBM mixes was studied with aggregates having different shapes and different proportions (0%, 10%, 20%, 30%, 40%, and 50%). Since the aim of this study is to quantify the effects of the different shape of the aggregates.
- The following properties were investigated in this study by conducting Marshall tests. Stability, Flow, Percent of air voids (Va), Voids in Mineral Aggregate (VMA), and Percent Voids Filled with Bitumen (VFB).

3.7 INDIRECT TENSILE STRENGTH TEST:

This test measures the strength or resistance to cracking either fatigue related or temperature related. High strength values indicate greater resistance to fracture. Mixes with high strength have the ability to absorb energy without fracture.

$$\sigma_x = \frac{2P}{\pi d t}$$

σx = Horizontal tensile stress at center of specimen,(kg/cm2)

P = Applied load, (kg)

t = Thickness of the specimen, (cm)

d = Diameter of the specimen, (cm)

4. RESULTS AND DISCUSSION

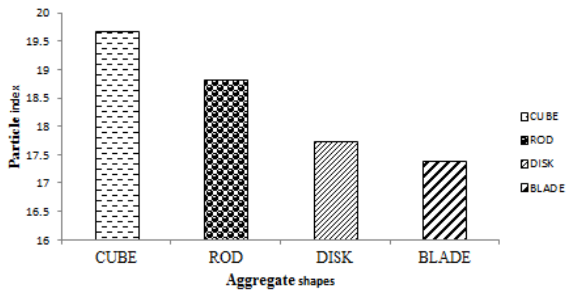
4.1 BASIC MATERIAL PROPERTIES

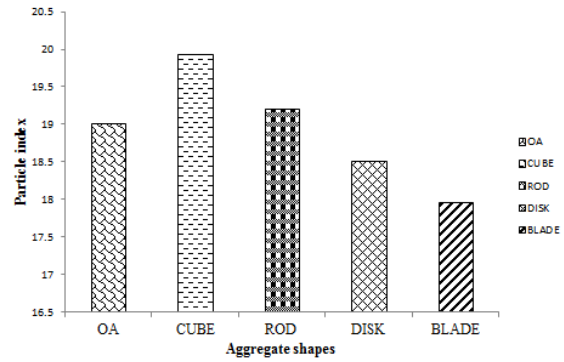
SL No	Properties	Test method	Results (%)
1	Specific Gravity	IS:2386 part III	2.70
2	Toughness	IS:2386 part V	10.93
3	Abrasion	IS:2386 part IV	31.20
4	Water absorption	IS:2386 part III	0.80
5	Combined elongation and flakiness index	IS:2386 part I	25.20%

4.2 PARTICLE INDEX TEST

This test method provides an index value to the relative particle shape and texture characteristics of aggregates.

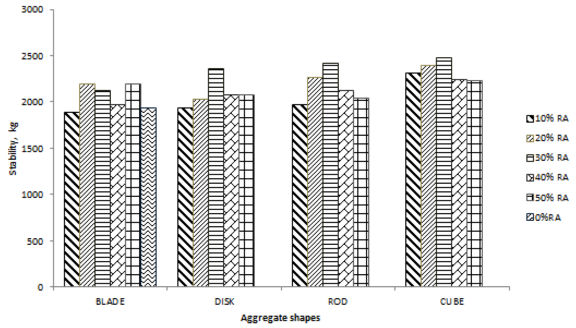
Showing the measured Particle index value for coarse aggregate 10% replacement of different aggregate shapes.





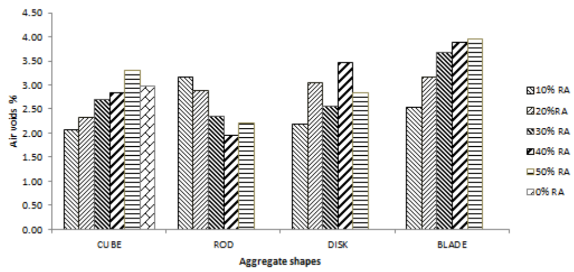
4.3 STABILITY:

Showing the variation of stability values with different type of aggregate shapes (Replacement of original aggregates with 0% to 50% of different aggregate shapes).



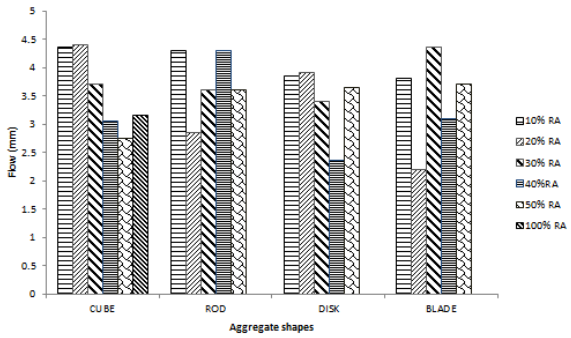
4.4 AIRVOIDS:

Showing the variation of percentage of air voids with using different aggregate shapes. (Replacement of original aggregates with 0% to 50% of different aggregate shapes)



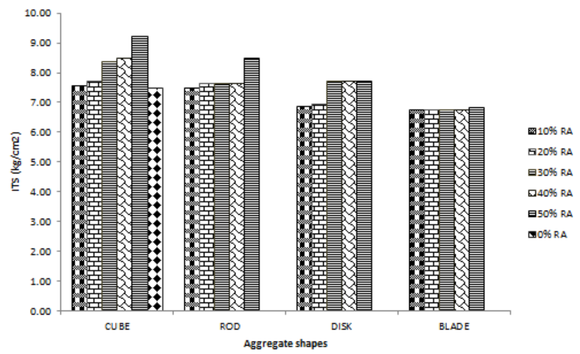
4.5 FLOW:

Showing the variation of flow values with using different aggregate shapes. (Replacement of original aggregates with 0% to 50% of different aggregate shapes)



4.6 INDIRECT TENSILE STRENGTH

- Indirect tensile test was conducted to indicate the internal resistance in a mix. Mixes were prepared to observe the effect of aggregate shape on the strength of the mixes.



Showing the variation of ITS values for different shapes of aggregates (Replacement of original aggregates with 0 to 50% of four aggregate shapes)

CONCLUSION

- Higher Marshall Stability values were obtained from the mixes prepared with cubical shape aggregates i.e 24.27kN. It is observed that stability increases with increase in proportion of cubical aggregates up to 30%.
- Cubical particles exhibit interlock and internal friction, and hence result in greater mechanical stability than do flat, thin, and/or elongated particles.
- The parameters such as stability, flow, voids filled with bitumen increases with increase in proportion of rod aggregates for DBM mixes.
- The parameters such as air voids and voids in mineral aggregate increases with increase in proportion of blade type of aggregates in DBM mixes, because the same type of particles will not replace the gaps between the asphalt mixes.
- Mixes prepared with 30% replaced aggregates shown higher stability values
- The stability of mix with different type of aggregates is shown good results, against satisfying the minimum requirement of 9kN.
- The peak indirect tensile strength values are observed at the 50% replacement of different aggregate shapes for the DBM mix. Cubical shape aggregate attains the maximum value and lower values for blade shape aggregates.
- Cubical shape aggregates attains the maximum % VMA, and blade shape aggregates attains the lower values because may be the aggregates tend to break down excessively during compaction.
- Particle shape parameter, higher sphericity value obtained for cubical shape aggregates and lower value for blade shape aggregate, because the sphericity value higher indicates the roundness of the aggregate. Obtained particle index values satisfying the minimum requirement for cubical particles i.e more than 18.
- Particle index values obtained from this study shows higher values for cubical aggregates and the same higher ITS values obtained for cubical

aggregates comparative to the other shapes.

REFERENCE

[1]. *Ahlrich, Aho and Rismantojo F (2005), 'Investigation of the influence of aggregate properties on performance of heavy duty HMA pavements', NCHRP Report 539.*

[2]. *Aschenbrener, T. and MacKean, C (1994), "Factors that Affect the Voids in the Mineral Aggregate of Hot-Mix Asphalt," Transportation Research Record 1469, National Research Council, Washington, pp. 1-8.*

[3]. *Brown, E.R., McRae, J.L, and Crawley, A.B. (1989) Effect of aggregate on performance of bituminous concrete. ASTM STP 1016, Philadelphia, 34-63.*

[4]. *Boutilier, O.D. (1967) A study of the relation between the particle index of the aggregate and the properties of bituminous aggregate mixtures. Proceedings of Association of Asphalt Paving Technologists, 36, 157-179.*

[5]. *Benson, F. J. (1970), "Effects of Aggregate Size, Shape, and Surface Texture on the Properties of Bituminous Mixtures," A Literature Survey, In Special Report 109, Highway Research Board, National Research Council, Washington, D.C., pp. 12-22.*

[6]. *Barrett, P. J. (1980). "The shape of rock particles, a critical review." Sedimentology, 27, 291-03.*

[7]. *Erol tutumluer, Tongyan pan C (2005), 'Investigation of aggregate shape effects on hot mix performance using an image analysis approach', Department of Civil and Environmental Engineering University of Dlinois at urbane champaign urbana, Dlinois.*

[8]. *Fletcher, T., Chandan, C., Masad, E., Sivakumar, K. (2002), "Measurement of Aggregate Texture and Its Influence on HMA Permanent Deformation," Journal of Testing and Evaluation, American Society for Testing and Materials, ASTM, Vol. 30, No. 6, 524-531.*

[9]. *Huang, E.Y. (1970) A study of strength characteristics of asphalt-aggregate mixtures as affected by the geometric characteristics and gradation of aggregate. Proceedings of Association of Asphalt Paving Technologists, 39, 98-133.*

[10]. *Herrin, M. and Goetz, W.H (1954), "Effect of Aggregate Shape on Stability of Bituminous Mixes," Proceedings, Highway Research Board, Vol. 33.*