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# INFLUENCE OF COARSE AGGREGATE SHAPE FACTORS ON BITUMINOUS MIXTURES

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**ABSTRACT:**

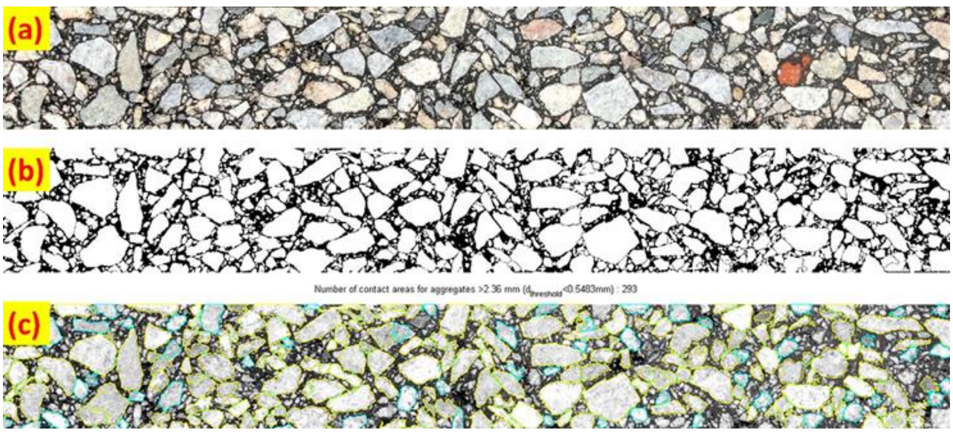
Pavement building relies heavily on aggregates. Indian roadways make use of crushed rock. Modern bituminous mixes are progressively taking into account coarse aggregate characteristics. The size, shape, and texture of the aggregate particles impact the performance and serviceability of hot mix asphalt pavements. Bitumen pavement performance is determined by the geometry of the aggregate particles. The particle shapes include disk, road, blade, and cubic. The strength and serviceability of a bitumen mix are determined by flow, stability, VMA, VFB, and air voids. Multiple aggregate morphologies were studied in dense bituminous macadam (DBM) combinations of 10%, 20%, 30%, 40%, and 50%. stable cubic-rod particle combinations. Larger blade-type aggregates in DBM mixes result in more mineral aggregate air gaps and voids. The technical attributes of hot mix asphalt were determined by the coarse aggregate particle index. The form of the particles determined the mix's internal resistance and aggregate density. Twenty-percent aggregate blends are more stable. Cubic particles have more mechanical stability than blade, rod, and disk aggregates due to interlocking and internal friction. Cubical aggregates have better particle shape features than blade-shaped aggregates.

**Keywords: -** Aggregates, physical and geometrical properties, shape index, strength, asphalt mixtures.

## Introduction

Asphalt concrete requires gravel, bitumen binder, and mineral filler. Physical, mechanical, geometrical, bituminous binders, mineral filler, fine and coarse aggregate, and other elements all influence the quality of asphalt concrete (AC) pavements. Road pavement (SRC) asphalt mixed aggregate layers may be strained statically, dynamically, stationaryly, changeably, or cyclically. Heat, water, and other environmental factors degrade asphaltic concrete pavement [1]. After 10-20 years, well-designed non-standard pavement and SRC are smooth and have fewer defects [2-5]. The mechanical strength and deformation of sandy soil were evaluated by modeling and testing [6]. Studies reveal that AC pavement, SRC, railway ballast, and concrete structures operate well in dynamic, changing environments. Automobiles and other external loads erode the granular materials in these structures. Asphalt degrades when the bituminous binder membrane comes into contact with aggregate or particles. The majority of the asphalt mixture's internal strain occurs at aggregate contact locations during truck loading. Inhomogeneity, particle size, and shape all contribute to crumbling. SRC operating conditions and exploitation requirements should impact aggregate selection [7-9]. Asphalt mixed aggregate flakiness and form are determined by particle size and oblongity. The impact value SZ and Los Angeles coefficient LA best capture aggregate mechanical and physical characteristics. These factors influence the strength and stability of asphalt mixes. Since strain buildup only matched physical and mechanical indices, SZ and LA examine how geometrical factors affect particle strength in Figure 1. To address this difficulty, the physical and mechanical consequences of aggregate particle geometric indices must be investigated. Crushing and impact resistance may differ between oblong and flat particles [10-12]. Crushing-resistant asphalt extends the life of the pavement. Statistics are used to investigate how index means, variation, and geometrics affect strength.

**Figure 1. Shape and size of Aggregate**



Aggregates are crucial to pavement. India's road developments use crushed rock. Aggregates and asphalt binding material make hot mix asphalt (HMA). This technique is repeated. HMA's aggregate takes up 92-96% of its weight. They monopolize road traffic. To make good pavement, you must understand aggregate qualities. Aggregates may be natural or mass-produced. Open excavation extracts these natural aggregates from deep-buried rock formations. Blasted or quarry wall rock is reduced using screens and crushers. Some quarries wash aggregate before usage. Most generated rock is industrial by-products like slag from steel, tin, and copper manufacturing or specialized rock having a specific physical property. Industrial by-product slag.

## HMA Pavement

Loaded HMA pavements flex entirely. Flexible pavement is made in many steps. The layer above receives loads from the layer below after dispersion. The surface receives less stress from lower pavement layers. Bitumen pavements are flexible, which is good.

Flexible pavements are made using layers of material that are sorted in a decreasing order of cost, with the layer that is the most expensive being put on top and the layer that is the least expensive being placed beneath. This allows the flexible pavements to have the capacity to withstand loads. Because of this, the material is able to facilitate a reduction in the total weight that is supported by the pavement. Due to the fact that this is the typical procedure, the construction of flexible pavements often entails the use of the following components:
Abrasive surface. This is the deadliest drug trafficking. There may be many HMA sublayers.

1. Essentials. Subsurface aggregate, stabilized or unstabilized, or high-mass aggregate (HMA), is often found.
2. Subbaseline. Each level is subordinate to the ground. Sometimes subbases are needed.

**1. Material: Aggregate**

Pavements' load-bearing capability depends on their aggregates. It must be extensively tested before use in the construction sector. To achieve monolithic pavement response, aggregates should be robust, long-lasting, and the right shape and size. This ensures the pavement is usable. A multitude of tests assess aggregate strength, toughness, hardness, shape, and water absorption. Natural or artificial aggregates. Quarrying, or open excavation, is a typical way to recover aggregates from large rock formations. Mechanical crushing reduces rock size to an acceptable level. Many manufacturers produce manufactured aggregate as a byproduct. Made with Bitumen Binder Bitumen binder makes up 5–6% of a typical bitumen pavement. This component covers and binds aggregate particles to produce the substance. Bitumen cement is used in hot mix asphalt. Cold mix asphalt pavements and surface treatments use liquid asphalt as a binder. Liquid asphalt is asphalt cement mixed in water with an emulsifier or solvent. Additives and modifiers are routinely used to improve binders. These compounds and modifiers increase adhesion, flow, oxidation, and elasticity. Modifiers feature several ingredients. These additives include oil, filler, powders, fibers, wax, solvents, emulsifiers, wetting agents, and others. Rock particle shape, roundness or large-scale smoothness, and surface roughness may indicate its form. There are three methods to describe the form. Although these qualities may naturally connect owing to shared physical variables, they are geometrically distinct particle form components. In this study, four shape parameters were calculated. Angularity, convexity, roughness, and elongation were measured. This research investigated if compressive strength and these characteristics are related. Example of coarse aggregate particle index: The ASTM Test Method for Index of Aggregate Particle Shape and Texture (D 3398) investigated the effects of aggregate particle shape and surface texture. The assignment was completed using this method. This test just needs a cylindrical steel mold with a diameter of 152 mm (6 inches) and a height of 178 mm (7 inches). The equipment also includes a 16-millimeter (5/8-inch) steel rod with a hemispherical tamping end and 610-millimeter (24-inch) length. A cleaned, washed, and oven-dried single-size aggregate fraction was employed in this test. After crushing each mold layer with the tamping rod, each blow was evenly distributed. Ten times, the procedure was used. The mold has three equal layers. Each tamp was done by lowering the tamping rod 51 mm (two inches) above the crushed layer. This time, the approach was used with the same material. Each of the three levels received fifty strikes this time. The bulk specific gravity of each aggregate fraction was used to compute the percentage of voids that matched the mold contents' weight. This calculated the weight-related vacancy ratio. The following equation calculates particle index (PI).

$$PI = 1.25\ V10 - 0.25\ V50 - 32.0$$

Where V10 = percent voids in the aggregate compacted with 10 blows per layer,
V50 = percent voids in the aggregate compacted with 50 blows per layer.
Calculated voids

$$V10 = [1-(M_{10}/sv)]\ X\ 100$$

$$V50 = [1-(M_{50}/sv)]\ X\ 100$$

Where M10 = Average mass of the aggregate in the mold compacted at 10 drops Per layer-„g" M50 = Average mass of the aggregate in the mold compacted at 50 drops Per layer -„g" S = Bulk-dry specific gravity of the aggregate size fraction
V = Volume of the cylindrical mold „mL"

***Significance and Use***

This test determines an index and describes the form and texture of aggregate particles. Pavement and road mixture performance may be affected by aggregate shape and textural characteristics, which are evaluated by this value. These variables impact the compaction and strength of soil-aggregate and asphalt concrete mixes, according to this testing procedure.

## The Marshall Experiment

The stability of a Marshall test is defined by the resistance to plastic flow of cylindrical mixture specimens of bituminous asphalt applied to the side surface. Marshall stability necessitates opposition. At 600 degrees Celsius, the combination is expected to have a load-bearing capability in kilonewtons. How much heat is applied to a mixture determines its capacity. The mixture must have the following qualities before it can be built: stability, density, durability, flexibility, resistance to skidding, and workability. A crucial feature of figure 2.

### 1. Experimental results

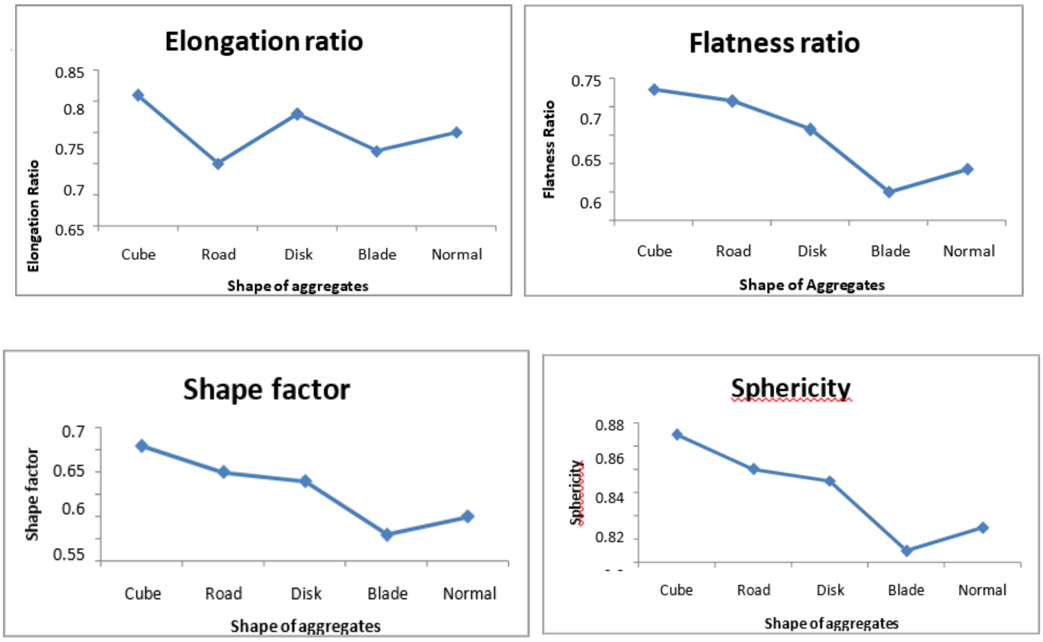
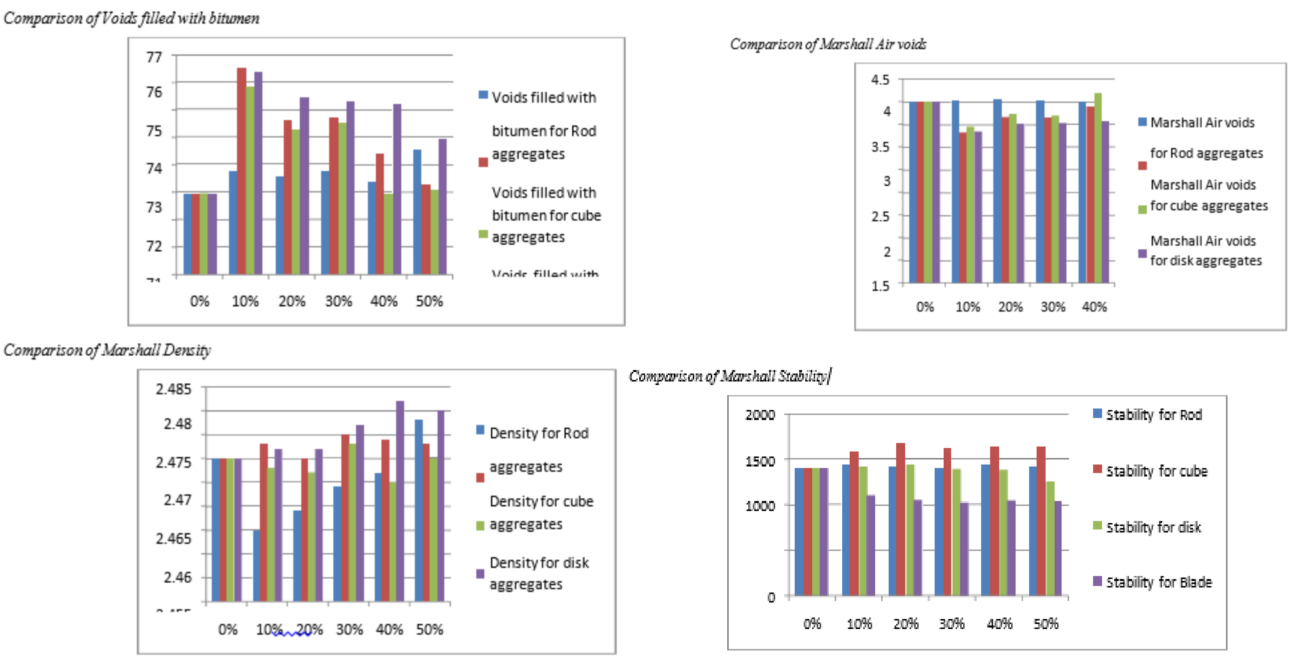



**Figure 2. Experimental result of Marshall design test**

**Marshall Design Values**

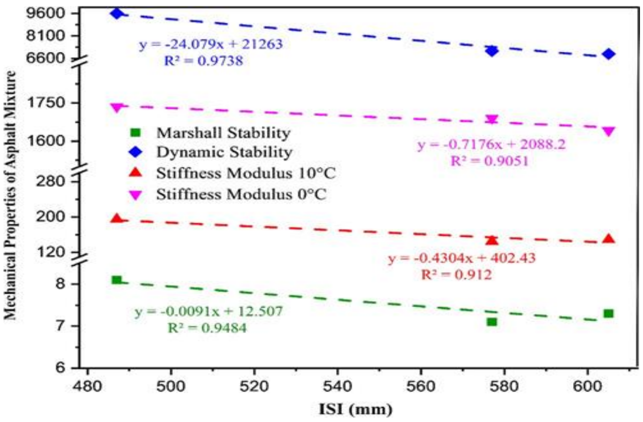
The Marshall test is often used to determine strength indices in HMA mixtures. These strength ratings encompass both stability and flow. This test also evaluates density, air voids, bitumen-filled voids (VFB), and mineral aggregate voids. Figure 5 shows a table of aggregate mixing properties.

**Figure 5. Mechanical properties of Marshall design value**



## Analysis results

The Grey Relational approach (GRA), which is also known as the Grey Relational Approach, is the method that is the most appropriate choice when it comes to addressing the complex interrelationships that exist between a wide variety of variables and components. Another name for this method is the Grey Relational Approach. There is another name for this approach, which is the Grey Relational Approach. The Grey Relational Approach is another name for this method, which is used in some academic circles. It is possible that the gray connection grade might be closer to one (1) if the specific factor in question has a significant impact. This is something that is possible. In contrast, the gray connection grade would be closer to zero (0) on the scale if the component did not have a substantial influence on the overall outcome. This is due to the fact that the component being considered would not have a major impact. One of the most important steps that has to be performed is to determine whether or not the particular component in question has a significant impact on the end outcome that it generates. To accomplish the goals that were set for this study, a gray relational analysis was carried out. The aim of this analysis was to achieve the objectives that were specified. Seven distinct asphalt mixture performance characteristics were used in the process of carrying out the investigation. The computations for these indices not only took into consideration the results of four different mechanical performance tests, but they also included three skeletal characteristics into their calculations. There were a number of other attributes that the skeleton had in addition to the total contact line length, the average contact length, and the number of contact sites. For example, the overall contact line length was one of these characteristics. The material was subjected to temperatures of 0 degrees Celsius and 10 degrees Celsius, respectively, in order to evaluate its mechanical performance. The results of the mechanical performance tests, which included the Marshall stability test, the dynamic stability test, and the three-point bending beam test, were used to evaluate the material's mechanical performance. These temperatures were used in order to ascertain the mechanical performance of the material.




## Conclusions

Conclusions from this research: Marshall The stability values of mixes created with cubical aggregates were higher than those made with other materials, at 16.77 kN. Something similar was found originally. Material stability improves when the proportion of cubical aggregates increases to 20%.

1. Cubic particles have much higher mechanical stability than flat, thin, or elongated particles. Because cubic particles interlock and generate friction inside, not the other way around. This is because cubic particles are more stable than rectangular ones.

2. Increasing the volume of cubical aggregates in DBM mixes improves stability, flow, and bitumen-filled voids. Increased mixed properties.

3. DBM mixes with more blade-type aggregates include air gaps and voids in the mineral aggregate. Because particles of the same kind cannot fill gaps between bitumen mixes, the situation remains as it is.

4. Mixes containing 20% cubical, blade, rod, and disk aggregates are more stable than those without. The study's results showed this.

5. Despite the 9 kN minimum requirement, a combination of several aggregates is stable enough.

Because of significant disintegration following compaction, blade-shaped aggregates have the lowest VMA levels, whereas cubical aggregates have the highest percentage. Because blade shape yields the lowest values. In terms of particle form, cubical aggregates are more spherical than bade aggregates. 6. This is because the aggregate blade shape is not as spherical as the cubical form. This is because a higher sphericity score corresponds to a more spherical aggregate. This occurs for the following reasons. We were able to attain particle index values that matched the minimal requirements for cubical particles.

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