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# Super Pave Mix Design (Rutting Behavior of Flexible Pavement)

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## ABSTRACT

**This paper contains an extensive study on the "Super Pave Mix Design" method which is used in the "Advanced Pavement Design" Technique. It helps in study and characterization of asphalt mixtures which are used as road pavement materials. By using the state of art laboratory test equipment and the technical literature obtained from the different information sources the several aspects of asphalt concrete mixtures has been expressed. This paper is divided into various parts. In Part one the detailed analysis of performance characteristics of asphalt concrete mixtures and design procedure is present with analytical method of aggregate blending which is used to design the aggregate structures. In part two the comparison between the Super pave and Marshall Stability hot asphalt mix designs have done. Various materials like: Coarse aggregates, fine aggregates, Bitumen etc. are considered for the Selection of materials on the basis of their properties. Such that the aggregates are selected on the basis of their various properties like strengths, soundness and shapes etc.**


**Key words: Super pave, Rutting, Permanent deformation, Hot Mix Asphalt, Pavement, Flexible pavement**

## INTRODUCTION

An efficient transportation system plays a vital role for the development of any country. The rutting behavior of pavement is the accumulation of permanent deformation in all or a portion of the layers in a pavement structure that results in a distorted pavement surface. The rutting or permanent deformation in flexible pavements is not a new problem. As long as the flexible pavement has been used the recognition of rutting behavior takes place as a primary distress mechanism and a primary design consideration. In fact, the 1986 AASHTO Guide for Design of Pavement structures is based on performance models developed at the AASHO Road Test where tire inflation pressures were nominally 80 psi. Asphalt pavement design concepts are based on providing sufficient pavement structure (rutting resistant materials) to reduce stresses in the subgrade to the point where rutting will not develop, and on providing asphalt quality and thickness to resist fatigue cracking. The Super pave (Superior Performing Asphalt Pavements) mix design method was developed at a great extent which provides excellent performance under worst conditions like diverse temperature changes and heavy traffic loading. It provides a better platform to the highway agencies, contractors and engineers such that they can improve the condition of roads. Super pave implementation varies by state like pressure, temperature etc. It depends upon the nature of load acting and environmental conditions. Due to use of light motor vehicles and heavy motor vehicles at high rate increased the traffic volume and heavy loads on the pavement surface which leads to the initiation of use of qualitative mix designs Marshall or Hveem methods during mid-1990s.

## II. LITERATURE SURVEY

The Super pave mix  esign method contained all the qualities of the mix design and was introduced to replace the Marshall mix design methods. For this a large number of papers have reviewed to get an optimum binder content which depends upon the VMA (Void Mineral Aggregates). For Super pave mix design method it was analyzed that for an optimum binder content which depends upon the VMA and seems to cover a range a range of air void content from 2% to 5%. As the rutting problem occur in flexible pavements the air void content reaches to 2% or less. If the air void content percentage in the constructions of flexible pavement is very low then it shows that there is less potential to resist from the rutting or permanent deformation. So, it is required that the air void content for a suitable mix may varies from 3% to 5% [3]. By Huber and Heiman (1987) it was studied that the permanent deformation occurs due to lateral movement of soil subgrade and due to laying of week layers of HMA (Hot Mix Asphalt). It is the result of acting repeated loads which increase the pressure on road due to increase in traffic volume and cause movement of materials used in the pavement layers.

## III. OBJECTIVE AND SCOPE OF STUDY

**A. Objective:**

- Critical analysis of the available information relating to permanent deformation of bitumen asphaltic concrete.
- Characterization of the available materials such as fine and coarse aggregates and asphalt binder according to Super pave mix design criteria.

**B. Scope of Work:**

- This specification for a Super pave volumetric mix design uses aggregates and mixture properties to produce a hot mix asphalt (HMA).
- This standard specifies minimum quality requirements for binder, aggregates, and hot mix asphalt for Super pave volumetric mix design.

## IV. ANALYSIS AND FINDINGS

By Huber and Heiman (1987) it was studied that the permanent deformation occurs due to lateral movement of soil subgrade and due to laying of week layers of HMA (Hot Mix Asphalt). It is the result of acting repeated loads which increase the pressure on road due to increase in traffic volume and cause movement of materials used in the pavement layers [4]. In this the American Association of State Highway Officials (AASHO) Road test report (1962) has given the main idea that due to lateral movements of subgrades permanent deformation occurs [5]. The report present in the study of joint paper that permanent deformation is caused due to traffic volumes, axle loads and tyre pressure. It was commented that hot mix asphalt is considered as the visco-elastic material because it has both elastic and viscous property.

**A. Types of Rutting in Asphaltic Concrete:**

It was determined that asphalt flow is the cause of rutting behavior in pavements. Also, it was found that the post compaction and plastic flow in the asphalt layers considered as the reason behind the deformation of pavement. The post compaction is defined as the continued compaction which is caused due to the repeated traffic loads. At constant volume conditions and results which is caused due to the movement of mix laterally away from the wheel path due to shear strain the plastic flow usually occurs. It was also determined that the permanent deformation may also be due to low bearing capacity of asphalt layers and quantity which is not be able to fulfill a requirement of compaction of asphalt layers. As the number of load applications increases the permanent deformation increases gradually which results in the formation of longitudinal depression in the wheel path in addition to small upheavals to the sides. The permanent deformation is most common in the areas where the climate is very warm and the traffic rate of heavy vehicles is very high, approaches to intersection and climbing lanes.

**B. Rutting Due To Densification:**

It was found that the densification is caused due to the additional loads in the underlying layers that may be base course, sub-base course and surface course. When the road is open to traffic then the repeated loads act on it which results in the permanent deformation by densification. At the time of construction of the flexible pavements when there is insufficient compaction takes place then it results to the permanent deformation when these roads came under contact with traffic loading. In the initial stage the void content in the bitumen asphalt concrete is about 7% to 8% and as the further compaction takes place for the stabilization of asphalt concrete it is expected hopefully reduced at about 4%. Rutting occurs when the densification cause due to traffic loading but also when the proper drainage system is not provided at the time of pavement design then it results in the permanent deformation of pavement surface

**C. Aggregate selection**

It can be specified in 3 ways are as under:

- Aggregate gradation: Based on the gradation specifications.
- Physical Properties: Based on shape like angularity, flakiness, and elongation particles.
- Source Properties: The source properties considered as the soundness of the aggregate materials. As the sodium or magnesium sulphate soundness test is done then the loss of percentage of materials from the aggregate is

considered as the soundness. By this test we can determine the resistance of aggregate to in-service deterioration is determined by using this test.

**Table 1: The sample of aggregates were tested for their suitability are as given below:**

| S. No. | Parameters | 20mm | 10mm | MORT and H-Limits |
|---|---|---|---|---|
| 1 | % Abrasion Value | 25.9 | 36.3 | Max. 40 |
| 2 | % Impact Value | 22.1 | 22.8 | Max. 30 |
| 3 | % Flakiness and Elongation | 17.5 | 24.8 | Max. 30 |
| 4 | % Water Absorption | 0.56 | 0.61 | Max. 2 |

## V. TESTING OF MATERIALS

Flexible pavements involves the performance based testing which is further to predict the permanent deformation of the desired pavements. Here we have considered two mix designs to compare with each other which we can use in formation of pavements i.e. Super pave mix design and marshall mix design. Following tests were performed to evaluate the comparative performance of asphalt mixes;

- Indirect Tensile Modulus Test
- Uniaxial Loading Strain Test (Creep Test)

For every test proper test conditions have been made so that we get an appropriate test results.

## VI. FINAL DISCUSSION ON TEST RESULTS

In all the test carried out in the "Analysis and Findings" we prepared the test conditions. The following test conditions were kept and result analysis was done:

### A. Indirect Tensile Modulus Test:

#### 1) Test Conditions:

We compared two mix designs Marshal Mix design and Super pave Mix design and kept the samples of Marshal Mix and Super pave Mix designs at 250C and 550 C respectively. Test pulse period = 1000ms, Pulse Width = 400ms, Peak loading force = 500N.

#### 2) Test Result:

The void mineral aggregates (VMA) are present in the greater amount in Super pave Mix design, it makes the mix more compact and enhance the hardness, durability and capability to bear more impact, as compared to the Marshal Mix Design.

### B. Uniaxial Loading Strain Test:

#### 1) Test Conditions:

We compared two mix designs Marshal Mix design and Super pave Mix design and kept the samples of Marshal Mix and Super pave Mix designs at 250C and 550 C respectively. The creep testing parameters are: No. of Pulse= 3600, PulsePeriod= 2000ms, Pulse width= 500ms, Rest Period= 1500.

#### 2) Test Results:

We tested both the samples at different loading and took their average. It was found that Super pave Mix design showed better result than Marshal Mix design.

## CONCLUSION

The aim of present paper work was to check whether Super pave mix design method using indigenous materials, under local traffic loading conditions and prevailing temperature regime has superiority over the other mixes with respect to rutting or not. Basically two dense graded mix was studied. Dense graded mixes were prepared using Super pave and Marshall Mix Design approaches. The main conclusions drawn from the current paper work are being presented. Super pave mix showed better performance in terms of low accumulated strains (%) (Permanent deformation) as compared to Marshall mixes which is an indication of highly rut resistant mix. Accumulated strains increased with the increase in number of load repetitions, stress level and temperature but percent increase in accumulated strains (%) was more in the case of Marshall Mixes to that of Super pave. It reflects that under conditions of heavy traffic loadings and high temperatures, Super pave mix can be a better option against rutting. Super pave mix showed better performance in terms of low accumulated strains (%) (Permanent deformation) as compared to Marshall mix which is an indication of highly rut resistant mix. Accumulated strains increased with the increase in number of load repetitions, stress level and temperature but percent increase in accumulated strains (%) was more in the case of Marshall mix to that of Super pave. It reflects that under conditions of heavy traffic loadings and high temperatures, Super pave mix can be a better option against rutting. Super pave mix showed in better performance in terms of low resilient strains (%), high resilient modulus and high creep stiffness as compared to Marshall mix. During Indirect Tensile Modulus Testing, higher values of Modulus of Resilience were observed in case of Super pave mixes. Even at the maximum testing temperature (55o C), Super pave mix performed better than the other two mixes.

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