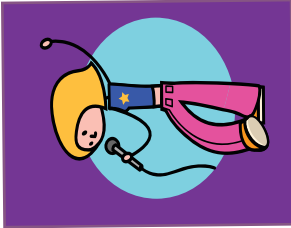


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# Understanding Density Requirements: Marshall vs. Superpave

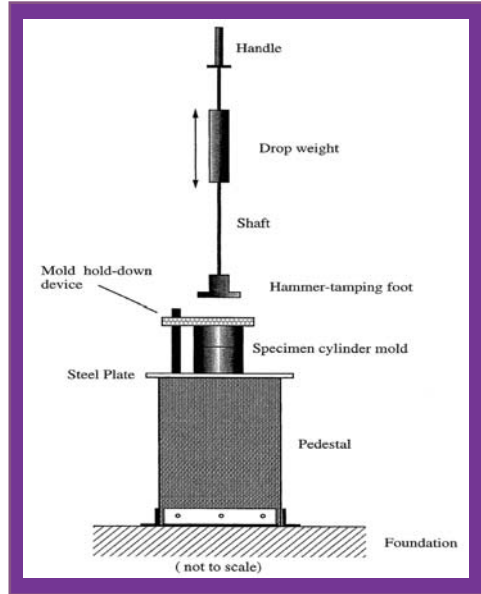


# The Asphalt RAP

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"The Asphalt RAP" is a publication of the  
Colorado Asphalt Pavement Association



The Marshall Compaction Hammer (Left), Pine (center) and Troxler Superpave Gyrotory Compactors (Above)

## Background

Hot mix asphalt pavement designs are critical to optimizing Hot Mix Asphalt performance and serviceability for Colorado roadways. The Asphalt Institute, established in 1919, has provided invaluable technical and engineering services for the asphalt industry during its long history and has authored two technical manuals on asphalt mix design. The **MS-2 booklet "Mix Design Methods for Asphalt Concrete and Other Hot Mix Types"** provides methodology for Marshall

and Hveem designs. The **SP-2 booklet "Superpave Mix Design"** provides the methodology for the Superpave procedure. The differences between the mix designs are well documented in the SP-2 booklet and are presented below.

Although the Marshall mix design method has

### ASPHALT INSTITUTE PUBLICATIONS

The MS-2 booklet "Mix Design Methods for Asphalt Concrete and Other Hot Mix Types"

The SP-2 booklet "Superpave Mix Design" provides the methodology for the Superpave procedure

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## Understanding Density Requirements for Marshall vs. Superpave

been used for many years, many engineers believe that the impact compaction used with the Marshall method does not simulate mixture densification as it occurs in real pavement. Furthermore, Marshall stability does not adequately estimate the shear strength of HMA. These two situations make it difficult to assure the rutting resistance of the designed mixture. Consequently, there has been a growing feeling among asphalt technologists that the Marshall method has outlived its usefulness for modern asphalt mixture design."

**S**uperpave (Superior Performing Asphalt Pavements) is a product of the SHRP asphalt research. The Superpave system incorporates performance-based, asphalt materials characterization with the design environmental conditions to improve performance by controlling rutting, low temperature cracking and fatigue cracking. The three major components of Superpave are the asphalt binder specification, mixture design and analysis system, and a computer software system. The Superpave mix design system is commonly incorporated Federal, State, and Local specifications.

**T**he Superpave mix design system integrates material selection and mix design into procedures based on the project's climate and design traffic. One of the key features in Superpave mix design is the change in laboratory compaction methods. Laboratory compaction is accomplished using a Superpave

## ASPHALT THE SMOOTH QUIET RIDE



The Asphalt Institute publication, SP-2

gyratory compactor (SGC). While its main purpose is to compact test specimens, the SGC can provide information about the compactability of the particular mixture by capturing data during compaction. The SGC can be used to design mixtures that do

not exhibit classic tender mix behavior and do not densify to dangerously low air void contents under traffic.

**S**uperpave mix design procedures depend on the traffic level of the pavement for which the HMA is being designed. The procedure called volumetric design, can be used for all pavement projects. It entails compacting test specimens using the SGC and selecting asphalt content on the basis of volumetric design requirements.

**H**ow do the differences between the two mix design procedures affect us in Colorado? A quick survey of local municipal governments that specify the use and construction of asphalt pavement sheds some light on the answer. Currently, many local agencies (cities, counties, metro districts, etc.) are members of the



## ASPHALT THE SMOOTH QUIET RIDE

### Understanding Density Requirements for Marshall vs. Superpave

Metropolitan Government Pavement Engineers Council (MGPEC). MGPEC was created in 1998 to unify the design, specification and construction of regional pavement projects in Colorado. At its initial inception, MGPEC allowed for the design of asphalt pavements by either the Marshall or Superpave procedures. However, by the end of 2001, the Marshall mix design procedure had been phased out and MGPEC solely relied on the use of the Superpave design procedure. The Colorado Department of Transportation has solely specified the use of the Superpave procedure since 1998.

The majority of specifying agencies in the State of Colorado that are not members of MGPEC are still relying on the use of the outdated Marshall mix design procedure. The continued use of the Marshall procedure by these agencies is likely due to a combination of the use of outdated specifications and/or lack of knowledge to update the technical



Paving with Superpave HMA

specifications.

Updating agencies that still specify the use of the Marshall mix designs to the use of the Superpave system, would help improve the serviceability of that agencies asphalt pavements, and over time, that benefits all of us in Colorado.

### Implementation

The implementation of the use of Superpave specifications had challenges in the beginning. Several of the challenges included changes in terminology in regards to required density, Voids in Mineral Aggregate (VMA), Voids Filled with Asphalt (VFA), Voids (Va), and performance graded binder (PG binder) rather than Asphalt Cement (AC).



Paving City streets utilizing the "Superpave" Technology

The Superpave mix design system integrates material selection and mix design into procedures

The Superpave Gyrotratory Compactor can provide information about the compactability of the particular mixture by capturing data during compaction

- Extended paving temperature
- Reduction in fumes/odors
- Less plant wear



With the advent of Superpave engineers, laboratory and field technicians, contractors and end users need to understand the two design/construction methods are as different as day and night, when comparing required density of a compacted HMA layer. The Marshall design/construction method required in most cases compaction 95% or greater of the maximum lab value. It was possible to achieve greater than 100% of maximum density due to the limitations on the control sample in the lab and the unlimited compactive effort available in the field.

Superpave specifications generally require 94% compaction with an allowable variance of +/-2% of Maximum Theoretic Value. Maximum Theoretic Value is often referred to as the "Rice" value due to the origin of the research. The contractors still have the ability to over compact the materials in the field but it is virtually impossible to achieve a density greater than 100%.

If an HMA mat was to be compacted over 100%, it would mean the air voids had been completely removed from the mat during construction. This would result in a significantly reduced life of the HMA since the Engineer accounted for 6% air in the HMA mixture during design. More properties must be met when using the Superpave method thus providing more control of the HMA mixture during production and additional information as to the projected long term life of the pavement.



In the last 10 years, the Superpave method has proven to be a much superior method of mix design for HMA pavements. The actual performance has more closely been related to laboratory information than when using the Marshall method.

This issue of "The Asphalt RAP" was compiled from information provided by Mr. Mike Skinner, P.E., CTL/Thompson, Inc, and Tom Clayton, SET, Director of Training, CAPA. The information contained within is opinion of the authors or from sources indicated in the publication and personal experience.

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