



# Effect of Gradation on HMA Dynamic Creep & Marshall Stability, Using Bailey Method

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## Abstract

The link between aggregate gradation and asphalt mixture performance has been recognized since asphalt mixtures were first used. Almost all of HMA properties are affected by aggregate gradation of the mix. In this study, type 4 and 5 mid-limit gradations of Iran Highway Asphalt Paving Code were chosen and adjusted by Bailey method. An excel spread sheet was developed so that time was saved in calculations. Optimum bitumen content for each mix was determined, using Marshall method. Experiments of Marshall Stability and dynamic creep revealed that mixtures using Bailey method gradations were improved, both in Marshall and creep properties.

**Keywords:** HMA, Gradation, Bailey Method, Marshall Stability, Dynamic Creep

## 1. INTRODUCTION

The effect of gradation on hot-mix asphalt (HMA) performance has long been a contentious issue. Gradation is perhaps the most important property of an aggregate. The link between aggregate gradation and asphalt mixture performance was recognized early in the development of mix design methods. Gradation affects almost all the important properties of HMA, including stiffness, stability, durability, permeability, workability, fatigue resistance, frictional resistance, and resistance to moisture damage.[1]

Historically, in Iran and many other countries gradations for dense-graded Hot Mix Asphalt (HMA) are specified, using gradation limits recommended by asphalt paving codes. In this case, the gradation curve in the middle of the upper and lower limit curve, known as "mid-limit", is recognized as the most proper gradation. Certainly, these recommended gradations are just guidelines and any other available gradation which results in a reasonable performance for a special area, can be applied as well. For instance, in a study, intended in Idaho, to investigate the effects of Idaho aggregate gradation on paving mix design, it was found that out of four Idaho aggregate sources, chosen for the study, gradation of aggregates from 2 sources should be kept close to the lower limit of the gradation guide, and for one, three-quarter of aggregates also should be kept close to the lower limit of the gradation guide (not the mid-limit).[2]

The Bailey Method is a means to design the aggregate interlock and aggregate structure in an asphalt mixture. The principles in the method can be used from the asphalt mix design through the quality control process, but are not a mix design method.[3]

In this study, type 4 and 5 mid-limit gradations of Iran Highway Asphalt Paving Code (No. 234) were chosen and adjusted by Bailey method. As mentioned in Code-No.234, gradation No.4 is appropriate for both binder and surface course, while gradation No.5 is just appropriate for surface course. The Bailey Method calculations is time consuming; As a result, an excel spreadsheet was developed for time saving. Optimum bitumen content for each mix was determined, using Marshall mix design method (ASTM D1559) and Marshall stability and dynamic creep tests was implemented on specimen with Optimum bitumen content.

## 2. THE BAILEY METHOD

The Bailey Method was originally developed by Mr. Robert Bailey (retired) of the Illinois Department of Transportation, and have been refined by Dr. Bill Vavrik, ERES Consultant Division of Applied Research Associates, Inc., and Mr. Bill Pine, Heritage Research, to present a systematic approach to aggregate blending that is applicable to all dense-graded asphalt mixtures, regardless of the maximum size aggregate in the mixture. This method can be used with any method of mix design, including Superpave®, Marshall, or Hveem. [3]