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# Empirical Superpave Mix-Design of Rubber-Modified Hot-Mix Asphalt in Railway Sub-Ballast

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**Abstract :** The design of an unmodified bituminous mixture and three rubber-aggregate mixtures containing rubber-aggregate by a dry process (RUMAC) was evaluated, using an empirical-analytical approach based on experimental findings obtained in the laboratory with the volumetric mix design by gyratory compaction. A reference dense-graded bituminous sub-ballast mixture (3% of air voids and a bitumen 4% over the total weight of the mix), and three rubberized mixtures by dry process (1,5 to 3% of rubber by total weight and 5-7% of binder) were used applying the Superpave mix-design for a level 3 (high-traffic) design rail lines. The railway trackbed section analyzed was a granular layer of 19 cm compacted, while for the sub-ballast a thickness of 12 cm has been used. In order to evaluate the effect of increasing the specimen density (as a percent of its theoretical maximum specific gravity), in this article, are illustrated the results obtained after different comparative analysis into the influence of varying the binder-rubber percentages under the sub-ballast layer mix-design. This work demonstrates that rubberized blends containing crumb and ground rubber in bituminous asphalt mixtures behave at least similar or better than conventional asphalt materials. By using the same methodology of volumetric compaction, the densification curves resulting from each mixture have been studied. The purpose is to obtain an optimum empirical parameter multiplier of the number of gyrations necessary to reach the same compaction energy as in conventional mixtures. It has provided some experimental parameters adopting an empirical-analytical method, evaluating the results obtained from the gyratory-compaction of bituminous mixtures with an HMA and rubber-aggregate blends. An extensive integrated research has been carried out to assess the suitability of rubber-modified hot mix asphalt mixtures as a sub-ballast layer in railway underlayment trackbed. Design optimization of the mixture was conducted for each mixture and the volumetric properties analyzed. Also, an improved and complete manufacturing process, compaction and curing of these blends are provided. By adopting this increase-parameters of compaction, called 'beta' factor, mixtures modified with rubber with uniform densification and workability are obtained that in the conventional mixtures. It is found that considering the usual bearing capacity requirements in rail track, the optimal rubber content is 2% (by weight) or 3.95% (by volumetric substitution) and a binder content of 6%.

**Keywords :** empirical approach, rubber-asphalt, sub-ballast, superpave mix-design
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