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# Effects of bitumen characteristics on the recovery capability in asphalt mixtures: A discussion

**Pooyan Ayar[1], Hamed Shabani[2]**

**1- University of Granada, Granada, Spain.**
**2- Babol Noshirvani University of Technology, Babol, Iran.**

payar@correo.ugr.es

**Abstract**

The recovery capability of bituminous mixtures has been used as an important base for developing newfound technologies in order to prolong the service life of pavements. There are many factors that could influence the recovery capability of bituminous materials. Among the various factors that affect the recovery capability in these materials, bitumen characteristics play a decisive role. In order to promote a better understanding of this issue, the current article aimed at reviewing and analysing the effects of physical, chemical, morphological and micro-structural characteristics of the bitumen on the recovery capability in asphalt mixtures. According to the reviewed studies, the recovery capability in bitumen can be affected by the content and structure of its components. Generally, a higher concentration of the molecules with lower weight (i.e. higher maltenes content) can enhance the fluidity and consequently the molecular mobility, which is necessary for the occurrence of the healing phenomenon. Additionally, the recovery capability is more sensitive to the molecular structure (i.e. morphology) than the large molecule content.

**Keywords: Bitumen, Recovery, Healing, Thixotropy, Molecular mobility**

## 1. INTRODUCTION

Some studies have recently emphasized the importance of developing long-life roads as a new sustainability strategy that can be applied in the field of pavement engineering [1]. In particular, investigators believe that an asphalt pavement with an extended service life is an achievable aim, since the recovery capability of bitumen may be able to counter the development of micro-cracks [2, 3]. In this respect, the recovery capability of bituminous mixtures has been used as an important base for developing newfound technologies (e.g. induction heating, healing agents) in order to prolong the service life of pavements [1, 4].

There are many scientific references that discuss the recovery of properties in bituminous materials. However, it should be clarified that recovery could happen due to a range of different phenomena [4]. In this regard, although many researchers have traditionally connected the recovery observed during rest periods to the healing phenomenon [4, 5], the recovery can also be observed as a result of the reversibility of viscoelastic phenomena (i.e. dissociation/deformation of molecular bonds such as thixotropy and/or heating) during rest periods. In fact, healing is related to the recovery of structural damage (cracks) while reversible phenomena such as heating or thixotropy occur because of the rearrangement of the molecular network [6-9].

On the one hand, the mechanism of the reversible phenomena (i.e.thixotropy) has been described based on the Sol-Gel transformation theory. In fact, thixotropic property of bitumen causes a progressive change from a gel to a sol structure (ascribed to the dissociation and deformation of inter- and intra-molecular bonds) while during rest periods the gel structure starts to reform. As a consequence, the re-establishment of the gel structure causes a recovery in some properties such as stiffness and phase angle [9, 10]. Figure 1 shows a schematic outline of the behavior of the thixotropic materials. In thixotropic material, applying a sheared condition results in the breakdown (i.e. separation) of the gel networks, while under a stationary condition (i.e. during rest periods) the regelation process occurs (the regelation process is slower when materials are subjected to higher shear rates) [11].