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### New methodologies to distinguish a rejuvenating effect of an additive from a mere softening effect on aged bitumens

Bitumen is a substance derived from the fractional distillation of crude oil. It is a complex substance consisting of several components some of which are organic complexes. This means that bitumen is easily oxidized during pavement service life when exposed to thermal and/or ultraviolet radiation conditions. Bitumen is considered a colloidal system particularly as a multidisperse micellar system with a complex internal structure which is constituted by asphaltene micelles dispersed in a mix of oils, resins and waxes known as the maltene phase. When aged (oxidized) road pavements are removed and processed, bituminous layers become Reclaimed Asphalt Pavement (RAP) which still contains valuable bitumen binder and aggregates. In recent years, many studies have been conducted on the use of RAP materials in the production of recycled asphalt. When bitumen is oxidized, the aromatic compounds and resins in the binder which are responsible for a certain grade of mobility are oxidized to asphaltenes and reduced to saturates hence making the bitumen very rigid in texture. Asphaltene micelles thus become larger and the fluidity of the system is reduced. Currently, additives which act on the chemical structure of aged bitumen, reversing the effect of oxidation on its compounds and restoring its physical properties to a state very similar to virgin bitumen are often used to mitigate this problem. These additives are called rejuvenators. Alternatively, softening agents can be used to mitigate this problem but these are only capable of restoring

the physical properties of the bitumen binder. The objective of this study is to find techniques and develop methodologies to evaluate the different performances between a rejuvenating additive and a softening additive and to also distinguish the former from the latter by mechanism of action. In this study, the effects of these additives on aged bitumen gotten from Reclaimed Asphalt Pavement (RAP) is investigated by Dynamic Shear Rheology (DSR) analysis, Atomic Force Microscopy (AFM), Nuclear Magnetic Resonance (NMR) Relaxometry, Differential Scanning Calorimetry (DSC) and Scanning Electron Microscopy (SEM)

#### Speaker Biography

Cesare Oliviero Rossi was born in 1974 in Cosenza, Italy. He received his Degree in Chemistry, cum laude, in 1997 at the University of Calabria, and his Ph.D. in "Chemical Sciences" in 2002 at the same University, working on the structural characterization of lyotropic systems. From 2002 up to now" he has worked abroad as team member or research leader, running different research projects, at University of Lund (Sweden), University of Coimbra (Portugal), ETH Zurich, High Research Institute of Kazakhstan. In 2015 he was awarded the gold medal for contribution to the Road Science by the High Research Institute of Kazakhstan. His publication track record, including more than 140 papers in international peer reviewed journals, is impressive. Nowadays, his major area of expertise is the study of colloidal systems. In particular, he has recently been focusing on the chemistry of bitumen and its additives, approaching the open challenges in this area of research from a chemical point of view, also making use of investigation and analytical techniques never used before to study asphalt binders.

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