

## **Behavior of crushed rock aggregates used in road construction exposed to cold climate conditions**

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Presently, about 90% of the aggregate production in Europe comes from naturally occurring resources: quarries and pits. Due to the increased demand for sand and gravel for construction purposes, not only in building but also in road construction, the last decade has seen a significant trend towards the use of more crushed rock aggregates. This resource has been more and more preferred to sand and gravel thanks to the significant technological development of its process and use phase.

The performance of the aggregates is generally evaluated depending on three main factors: the geological origin (mineral composition, texture, structure, degree of weathering), the aggregate processing (crushing, sieving, washing, storing) and the user technology for a specific area of use (e.g. road construction, asphalt binders). Nevertheless climatic conditions should carefully be taken into account in application such as road construction. Large temperature gradients and high levels of humidity are known to significantly affect the performance of the material.

Although the problem is, at least in the asphalt field, considered mostly from the binder point of view, this article aims to investigate the effect of aggregate properties on road performance in cold climatic conditions. Two different climatic areas will be taken into account: Norway and Spain. While both these countries are listed among the main European producers of aggregates, they represent significantly different climatic regions. While Norwegian weather is characterized by humid cold winters and relatively mild summers, Spain has temperate climate with cold regions in mountainous and internal areas. Both countries have been significantly affected by climate change with increasing temperature variations and instability. At the same time, similar winter maintenance measures, including the use of a considerable amount of solid and liquid chemicals to avoid ice formation (e.g. NaCl) and/or to provide better friction, are carried out in both countries.

The use of crushed aggregates in both the frost protection layer and asphalt layers is the main topic for our investigations. In existing standards there is large focus on mechanical properties of aggregates and their grain size distribution, but little focus on mineralogy and its behaviour at low temperatures.

With the purpose to study the effect of winter climatic conditions and the use of salts during winter maintenance, different samples of aggregates and asphalt mixtures used in Norwegian and Spanish roads were subjected to freeze-thaw cycles in the laboratory. To evaluate the impact of these cycles to the mechanical properties of the selected materials, Los Angeles test on aggregates and Cantabro test on asphalt have been done and compared with results from the same aggregates and asphalt mixtures but untreated in the laboratory. The results obtained were related to the petrographical analysis of the rocks that compose the aggregates in order to estimate the influence of the rock properties (mineralogy, texture and structure) in road materials behavior, especially when they are exposed to winter conditions.