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NEEDS AND ATTEMPS FROM ROAD INDUSTRY

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Abstract

Road construction evolves in different ways depending on the geographical areas, but tends inexorably once the networks are structured, towards an activity of maintenance and development of existing infrastructures rather than towards new constructions.

For road materials, this is also done under the pressure of societal and environmental constraints which are becoming more and more significant: climate change, HSE constraints, policies to limit greenhouse gas emissions. Road construction already had strong qualities in its genes, being inherently adept at short circuits given the impossibility of transporting aggregates over long distances. But it must now develop recycling and new production methods to limit impacts and seek possible sustainable alternatives to bitumen. All this while integrating notions of durability and lifespan which are not necessarily part of the current technical corpus and on which certain points do not reach consensus.

The profession must therefore act strongly with university research teams simultaneously on methods and solutions, to define the tools to objectively qualify the relevance of proposals, whether on components, production and application processes. This requires an expansion of skills, beyond historical hydrocarbon binders, through an understanding of the aging of pavements, an appropriate qualification of asphalt aggregates to define optimal solutions for their recycling, through an understanding of the interactions between alternatives bitumen and other components of mixtures and their impact on aging, through a methodology qualifying the durability of solutions and therefore their relevance, through better asset management. And same questions are also relevant for cold technologies which are another existing strong lever to contribute to decarbonization. The variety of topics should not lead to a jungle of tests and standards. Their complexity, however, will surely impose additional costs compared to previous practices which will have to be contained within reasonable limits. These are the projects that must be carried out head-on and disseminated quickly to enable them to fully contribute to the challenges ahead. And this action can only be envisaged through expanded collaborations between industry and research, with Rilem being a strong stakeholder.

Extended abstract

Road construction, even if it generates fewer emissions than transport, must contribute to the overall effort to reduce GHG Emissions. Main actions levers have already been identified and are already available or mastered : lowering production temperatures, recycling, alternative binders, cold techniques, and their combination. Their implementation involves regulatory changes, through opening the markets to these solutions, which requires convincing contractors of their reliability, investments in new plants and tools that allow their production, a selection of most suitable alternative materials technically and economically adapted, and the transparent demonstration of the benefits of these developments.

The first point is a political component, which is built with administrations on the basis of documented feedback and often national choices. The second is the responsibility of the companies in their decisions on production and application technologies, with developments in plants and recycling capacities, in the choice of energies, in the research efforts carried out to deploy these solutions in involving their customers. The use of alternative materials to totally or partially replace bitumen is also an old story. And If we stay focus on classic solutions, where color is not the main characteristic, even if this last property has gained in importance with needs to mitigate urban heat islands, we must identify raw materials organically sourced, at a cost compatible with road works, which is not in competition with sectors linked to food and which will show good compatibility with bitumen. Cold bituminous mixtures with emulsion are also well-known but their use is still limited.

Finally, demonstrating the relevance of these solutions requires an increased understanding of the performance of these materials and the demonstration of their durability. It is this specific point which concerns us more particularly here because it covers all the options considered for road materials.

It must be recognized that the development of road materials was based until recently on simple approaches, sometimes called ”empirical”, for which the focus was on the composition (grading curve and bituminous binder content). The main objective being to have a reduced percentage of voids in place and a good resistance to water and permanent deformation. It has evolved to integrate more complex mechanical characteristics, such as the modulus, to allow optimization of the pavement thicknesses. But with the environmental issues we must address, this is no longer enough.

It is becoming essential to transparently quantify the carbon footprint of all construction solutions, with a framework which is currently still under construction despite studies on LCA of road materials started a long time ago [1]. But now the notion of lifespan becomes a criterion that can no longer be neglected. A reduction in the carbon footprint in production will only be of interest if the proposed product provides the same service for a duration at least equivalent to the replaced solution.

This notion implies a very significant research effort to be carried out jointly between industry, university and administration because the scope of the subjects to be treated is very large.

Lowering temperatures is perhaps the part that will require the least effort since it is widely documented, integrated into technical guides and regulations and practiced by manufacturers. Additional costs generated have partly limited the deployment of these solutions, but it can be easily spread.

Recycling is also an old practice. But to limit the consumption of natural resources, the road must become our main quarry. Indeed, even at the end of its life, it remains made up of good quality aggregates and binder. Although aged it can constitute a significant part of a new mix. In countries where the network is almost totally built, its maintenance must be considered by maximizing recycling, including for wearing courses. We must therefore remove the fears caused by this approach. How can we ensure, through a proven and shared methodology, that the incorporation of high RAP content into a new mix will guarantee satisfactory in-place behavior?

This question will be resolved by an increased understanding of the characteristics of aged binders and the possibilities of corrections available, with softer bituminous binders or bio-sourced compounds. It must restore the desired mechanical characteristics. Significant work in this direction has been carried out in many countries, and for France we can cite the Mure project on the multi-recycling of asphalt mixtures which made it possible to reach shared conclusions. [2]

We can clearly see that this development of recycling will complicate the studies: selection of binders and adaptation according to the characteristics of the aged binders and verification of initial performances of the final product. But the sustainability of performance will necessary suppose that initial type testing will be completed by adding long-term characteristics. This point will add a cost but the methodology has not yet been definitively selected, even if the work conducted through cluster F has contributed to providing solid foundations [3]. Recycling cannot be dissociated from future alternatives to bituminous binders. The use of bio-sourced raw materials is considered as a means of contributing to the reduction of the carbon footprint through the sequestration of biogenic carbon. This hypothesis is relevant because pavement materials, even at the end of their life, are not intended to be burned. But for this it is also necessary to ensure the performance of the mixtures. This requires an understanding of the interaction between these bio-sourced compounds, a new bituminous binder and the aged binder from the RAP. This new component involves the development of shared knowledge on the characteristics of aged bituminous binders and bio-sourced compounds which will ensure good compatibility of the mixture and satisfactory behavior in place. This also requires an appropriate evaluation of the mixes. Indeed, it is possible that the addition of new components in the bitumen induces behaviors that are not captured with existing asphalt mix design testing, due to interaction with the aggregates or water. [4]. This again implies an evolution and complexity of studies, whose costs will have to be controlled while maintaining their relevance.

The selection of a suitable method to ensure the durability of new solutions also requires significant work to understand the damage mechanisms, which result in complex studies, often incompatible with the realities of the construction sites (accessibility to resources, in particular to RAP, work completion schedule). If we take the example of resistance over time and damage linked to freeze-thaw cycles, their demonstration may require particularly long protocols, impossible to implement in a routine manner but possibly necessary in an initial validation step [5].

For biobased sourced raw materials it is possible that the evolution depends on the nature of the raw material itself. A systematic evaluation of different modes of damage (aging, effect of water) seems difficult to envisage. A classification by chemical family of the predominant risks and approaches allowing them to be quantified is essential. It will have to be done through protocols making it possible to approach changes in place, even if it is not possible to perfectly simulate the state of a wearing course after several years of service, the latter no longer being homogeneous, with a marked aging gradient depending on the thickness and its porosity [6].

A particular point about biobased raw materials is their great variability, depending on the industrial sectors from which they come. This can impact their purity, their composition, their interaction with the bitumen and the behavior that the coating will have in the end. It seems obvious that adaptations will be necessary on a case-by-case basis. The objective remains the same, a solution at least equivalent in performance and durability to an existing bituminous solution, but this knowledge will ultimately be more developed in local ecosystems where its products will be accessible and will have acquired viability in a local circular economy.

As for cold techniques, these are also solutions already mastered by many manufacturers. Their deployment, which will remain for a long time to be restricted to more limited traffic than hot-mix asphalt but already corresponding to the majority of local service networks, requires progress in their understanding. This important use, but for networks with limited trafic, has not given rise to studies allowing a good understanding of their performance, even though they are much more complex. Their characteristics evolve over different time scales (a few seconds for the interaction of the emulsion at the interface with the aggregates, a few days-weeks for the curing phase which corresponds to the formation of the binder film and the elimination of the water, a few years for the evolution in place). This complexity also requires a collective effort to define main questions and provide answers and a methodology to significantly develop their use.

Finally, to go beyond the materials framework, the maintenance of road network also requires greater sharing of knowledge between research on the theoretical part focused on the behavior in situ and the knowledge and constraints of the management of this infrastructure. High-performance monitoring tools and AI-based approaches make it possible to envisage a better knowledge of the network and optimize its maintenance, which from a more global vision will also allow the best use of the appropriate solution to guarantee greater overall lifespan. We can clearly see that these developments, which can also integrate other societal and environmental aspects [7] will greatly complicate the data to be integrated into the choice of optimal solutions and require a more coordinated joint effort. It will also have to be disseminated and shared because these

questions concern all countries, not all of which necessarily have the means to fully reproduce this work. But this offers unique opportunities to promote the expertise acquired on our materials and to contribute to the objectives of reducing our impacts. And it's a topic Rilem and Industry must work on.

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