

Sustainable technologies for road construction

Editorial

The “sustainability” concept relates to the prolonging of human economic systems with as little detrimental impact on ecological systems as possible. Construction that exhibits good environmental stewardship and practices that conserve resources in a manner that allow growth and development to be sustained for the long-term without degrading the environment are indispensable in a developed society.

Past, current and future advancements in road construction as an environmentally sustainable paving material are especially important because the quantities of asphalt used annually in Europe as well as in the U.S. and all over the world are large. This editorial is aimed to demonstrate the dual value of some new technologies in regards to the environmental and mechanical performance and to suggest a low environmental impact design procedure. In fact, the use of eco-friendly materials is the first phase towards an eco-compatible design but it cannot be the only step. The eco-compatible approach should be extended also to the design method and material characterization because only with these phases is it possible to exploit the maximum potential properties of the used materials.

The relationship between environment – pavement and road materials are numerous, complex and highly topical. You should also consider that the road construction materials in recent years have undergone a remarkable evolution to meet the demands for more performance, in addition with new instances derived from new and more modern methods of “integrated design” of road infrastructures. With this in mind you can then immediately identify two different fields of study and research inter-connected with each other that exist between road construction and environmental protection : the first refers to the “ micro-scale “ typical of the environment crossed by the road infrastructure and , more generally, to the sustainability of the motion and the functional characteristics of the pavement, and the second refers to a larger scale (macro - scale) that directly impacts on the environment and available resources for the construction, management and maintenance the road pavement. We should try to predict, assess and minimize these in the design phase. At the “micro-scale “level we do not have impacts in the absence of traffic, the eco-friendliness of the motion is directly related to the presence of vehicles on the road. At the “macro- scale “ level instead the impacts of roads on the environment are independent by traffic.

In order to clarify the first of the two fields of study is appropriate to define the key performance parameters required the asphalt surface and the top layers in particular.

You can identify and classify the functional characteristics that are directly related to the performance offered by the road pavement during exercise, they can be summarized as:

I. Bearing Capacity, defined in terms of structural strength and adequate deformation response to traffic loads. It is closely linked to the service life of the pavement. With reference to the asphalt layers, the performance characteristic must be able to evaluate and assess the mechanical behavior - rheology of the mixture and the durability of the materials.

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- II. Adherence, a fundamental parameter for achieving the objectives of road safety and connected directly to the compositional characteristics of the bituminous mixture and the surface texture.
- III. Evenness, with reference to the objectives of safety and ride comfort, together with the characteristics of the pavement bearing capacity and structural strength of the conglomerate described above.
- IV. Surface drainage, which is also linked to the needs of safety and dependent on the composition of mixtures of asphalt used.
- V. Visibility, function of color and light absorption characteristics of the material forming the top layers and also closely related to the objectives of safety.
- VI. Together with these features can be added three more specifically related to the eco-friendliness of the motion and the protection of the environment surrounding the infrastructure.
- VII. Noise, in terms of definition and certification of the acoustic qualities of asphalt and study of compositional characteristics most suitable for the minimization of the noise in the generation process and of maximizing the absorption in the propagation phase.
- VIII. Vibration, in terms of minimization of the contribution of the surface of the materials and components of the pavement to the phenomenon of generation of vibrations and exaltation of the effects of damping in the process of propagation through the road platform.
- IX. Rolling resistance, in terms of minimization of fuel consumption and tire to reach a reduction of costs for the user and the impacts on the environment.
- X. All three parameters are directly related to the environment and its protection at the level of micro- scale, as defined previously.

With a proper and a careful study of the mixture leading to an assessment of surface texture and sound absorption properties of the material is already possible to give technical answers to new demands of environmental protection. In addition to the requests for reduction of noise and vibration and minimizing impacts on the environment of vehicular traffic (micro-scale) we must also consider the higher level (macro-scale) connected to the needs of environmental protection and of an “integrated design” of road infrastructure as already mentioned earlier.

The construction, maintenance and upgrading of the road infrastructures determine, in addition to a high outlay of money, an also high demand for quality raw materials. Over the last fifty years the transport infrastructures, especially the roads, have experienced an unprecedented development. Many of them have been in use for over twenty years and, having reached the end of their service life; requiring increasing maintenance works to maintain acceptable levels of service. In addition, over the years, the number of vehicles is steadily increasing; the resulting increase in traffic and the stress caused by vehicles, the higher axle load and the pavement “old age” are all factors that contribute to the deterioration of road surfaces. To address the problems related to it is becoming increasingly widespread technique of recycling of flexible pavements.

The reasons that argue for the need to recycle are numerous and all equally important from the point of view of environmental protection, as well summarize the general lines of the OECD study¹

- a) Reducing the use of raw materials
- b) Reduction of the areas used as landfills
- c) Reducing pollution of the soil and the atmosphere due to the transport of waste;
- d) Conservation of energy
- e) Money saving
- f) Technical advantages

The recycling of asphalt becomes crucial for the correct policies for the protection of natural resources and for the design of new road constructions “integrated” in environmental terms. For both fields of study described the technical experience and scientific innovations are manifold the correlations between road materials in general and in particular asphalt and environment are indeed numerous. At the end is important to highlight the most topical and most relevant areas of research for the coming years in the field of environmental protection in relation to the road construction. New potentials and consequently new areas of research open up for the correct use of asphalt in terms of reduction of impacts.

Among the most interesting topics we can remember:

- i. The use of foamed bitumen for recycling foundation layers in situ or for the realization of base layers.

- ii. The actual applicability of the techniques of cold recycling with bitumen emulsion and cement with use of RAP up to 100% for the realization of base and foundation layers
- iii. The possibilities for use of the techniques of recycling asphalt also for draining layers
- iv. The study, the design and construction of new asphalt layers for anti-vibration base with part of the skeleton consists of granules of rubber
- v. The possibilities for development of a new pavement with a sound-absorbing double drainage layer in urban areas
- vi. The potential from the point of view of the protection of the environment from new road pavement “perpetual” (perpetual pavements) or with zero maintenance;
- vii. The study and evaluation of the transport of pollutants on the road surface and their relationship with the characteristics of the asphalt
- viii. The possibilities of use of titanium dioxide, already used in paving blocks of concrete as an anti-pollutant elimination of nitric oxide, even in the asphalt.

They are numerous and all equally interesting the challenges that lie ahead both in research and in the road construction techniques for the future, we must be ready to face them also to meet the current and increasingly stringent environmental protection requirements.

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Conflict of interest

The author declares no conflict of interest.

References

1. OECD. *Road Transport and Intermodal Linkages Research Programme: Recycling Strategies for Road Works*. France: OECD publishing; 1997. 131 p.