Deconstruction of Bridges - New Recycled Aggregates for Granular Layers

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Summary

This article describes the recovery process of one of the "wastes" produced in a big motorway construction project located in Portugal. This by-product was the Construction and Demolition Waste (CDW) and was obtained by crushing the concrete resulted from the demolition of five bridges (all of them were made with pre-stressed concrete) in the existing national road (constructed 20 years ago). In order to fulfil all the parameters required in the technical specifications the crushed material was combined with soils (with some plasticity) from the excavation inside the stretch under reconstruction. The results obtained with this innovative "eco-Aggregate" exceeded the expected specifications and met two of the most important objectives for sustainability: the reuse of available resources and a reduction of the energy consumption.

Keywords: Demolition, deconstruction, recycling, capping layers, eco-aggregates, pavements.

1. Introduction

An illustrative example of the characteristics of one "eco-Aggregate" obtained by the rearrangement of two original products (one of them was recovered from several bridges that had been demolished) and the quality control in its application is presented in the full paper. This new aggregate was applied as a capping layer in the Motorway (AE) 33 - Sections 1/2, in the *Lower Tagus Sub-concession*, located in the South of Lisbon, Portugal. In the base project the use of the selected soils was considered for the implementation of the sub-base/capping layer, but these kinds of good soils were rare in the area and its acquisition was very expensive. On the other hand, when in the presence of high humidity, it was very difficult to deal with these soils and sometimes the work fronts had to stop during many days. This very ecological aggregate allowed its application in adverse weather conditions (since it is quite insensitive to humidity), so that the execution time of the layer was also reduced, when compared to what would have been considered in the base solution (with soils).

https://doi.org/10.2749/222137813806521027

2. Deconstruction of existing bridges

The works began with the implementation of the necessary signalling schemes. All the traffic (normal and those with origin in the works) was reorganized in a most rational way to prevent damages or accidents. The demolition of each overpass was a set of hydro cut operations to divide the central span of the slab and *in-situ* demolition of the side bays of the platform and pillars. It was included the removal of the cut parts and its referral to recycling and reuse. After crushing, the material passed through a magnetic separator which removed all the metal debris that remained in the concrete. The CDW was mixed with soils by the use of hydraulic excavators and loaders. All the complete process is shown in the *Figure 1*. The proportion for each of the two materials in the final blend was estimated at 50%. The quality control performed on the applied layers was carried out using the following tests: determination of gradation of the aggregate after compaction; the moisture content and compaction of the layers, using a bottle of sand; characterization parameters of deformability and compacting of the layer, with load plate test. It was possible to verify that the properties of the resulting mix aggregate fulfilled the necessary conditions to make a capping layer with stiffness characteristics far superior to those required (Ev_2 > 100 MPa). The use of these alternative materials instead of the initially planned to implement the sub-base / capping layer didn´t force to change the methods of work already defined in the schedule of works and due to the higher rate in the delivery of material in the front of spreading it was possible to obtain some improvement in the execution time when compared with the originally intended. Moreover, because these materials are more moisture insensitive, it was possible to keep some work fronts in operation, even during the most adverse meteorological conditions, such as those occurring during the seasons of winter/spring.

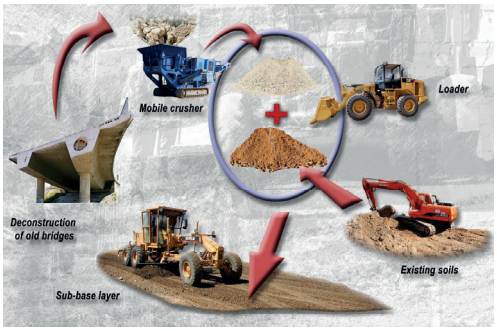

Fig. 1: The sequence of the works

3. Results

Due to the regulation and the great experience we have ever achieved in Portugal (related with the reuse of CDW on pavements), which includes some guidelines and the reuse of the demolished materials in many big projects (e.g. in the new stadiums for the *Euro Cup 2004* and in the largest Portuguese resort *Troiaresort*), these aggregates could be applied in sub-base/capping layers, without concerns about their performance. After the whole project had been completed the final pavement characterization was made which included the measurement of the stiffness modulus for all the layers built. This evaluation was performed with a FWD equipment and the results were much higher than those considered in the base project design. It seems clear that there was an important contribution during the execution of the works to have this kind of results: a slight moistening of the CDW must be done prior to mixing and/or during spreading, so that part of the fine fraction of the soil can be attached on the surface of the coarse aggregates. This will lead to a better distribution of the fine particles in the layer and a larger overlapping of the aggregates consequently favouring the occurrence of higher mechanical strengths.

4. Conclusions

The incorporation of CDW (obtained by crushing pre-stressed concrete from old bridges) results in reducing some impacts. The final cost for the finishing layer was reduced and other reductions took place, for example: the natural resource exploitation (depletion of natural resources); decrease the land use by reducing the amount of CDW sent to landfill; reduction of greenhouse gases emission, fossil fuel consumption and road accidents due to minimization of time and transport distances; less degradation of the pavement on the existing roads used; discomfort to the population due to the reduction / elimination of heavy vehicle traffic which would result in noise and air pollution (waste to landfill and forwarding transport equipment loan).