Hydraulically bound mixtures - a technique to reduce congestion

When to use hydraulically bound mixtures

QWIRC9 covers the use of hydraulically bound mixtures (HBMs) for the sub-base and base layers of reinstatements. HBMs can be used as an alternative to granular sub-base material in the options given in Appendices A3 to A7 of the Specification for the Reinstatement of Openings in Highways. The advantages of using HBM include that on-site materials, such as some excavated soil, can be re-used which reduces waste material going to landfill, the need to import virgin materials when not produced in local central facilities, thus reducing distances travelled and conserving finite resources.

The Mayor of London and Transport for London (TfL) have introduced a targeted Lane Rental scheme that allows TfL to charge companies a daily fee for undertaking roadworks on London’s busiest roads at the busiest times. The Lane Rental scheme will help incentivise more efficient working practices and reduce disruption from roadworks, which it is estimated costs the Capital’s economy around £750 million a year. Around £300 million of this is on the Transport for London Road Network (TLRN) or on Red Routes.

To help to minimise the amount of time that works disrupt traffic, either by ensuring works are carried out as speedily as possible, or by ensuring that more works are carried out outside of peak traffic hours, there is need to encourage the highway construction industry to deliver a step change in the way that roadworks are planned and carried out.

This is the ninth of a series of ‘Quick Win Innovation to Reduce Congestion’ (QWIRC) Notes, produced on behalf of TfL and the DfT, and aimed at providing roadworks contractors, utility companies, highway authorities and equipment suppliers with information on how to employ the most up to date and practical technologies to reduce the impact of road works on traffic congestion.

Definition

A hydraulically bound mixture (HBM) is a mixture of aggregate, water and hydraulic binder. The possible binders include cement, fly-ash, ground and/or granulated slag, lime, pozzolan and combinations thereof and can be generic or proprietary. It is one of the most commonly used materials for pavement sub-bases where cement-treated bases or cement-bound materials have traditionally been used.

There are two layers where HBM have been used:
- The sub-base layer, which is very important in terms of the expected performance of the pavement. The sub-base is often the main load carrying layer of the pavement, as opposed to the base, and is designed to distribute the stresses and strains
exerted from passing traffic loads down to the foundation. This distribution needs to be replicated in any reinstatement.

- The base needs to be strong in order to prevent shear or structural failure. In addition to providing strength, a well designed and constructed base will provide good drainage and prevent settlement.

HBMs can be produced both in situ and ex situ, but the in situ method, where the hydraulic binder is rotovated into the existing aggregate present, is more appropriate for larger-scale works than trench reinstatements. The ex situ method enables greater control of the finished product. Selecting and/or grading the ‘aggregate’ can lead to the use of a limited number of mixture designs. It can also provide better facilities for testing the final product used in relatively small reinstatements.

The HBM plant ex situ process involves:
- Laboratory mixture design.
- Stockpile aggregate (which can be selected trench risings) as opposed to in-situ aggregate.
- Mix in mobile or fixed plant.
- Transport to construction site.
- Tipping, spreading and compacting of the material.

The equipment needed for laying and compacting HBM is similar to that used for laying and compacting unbound layers and bituminous bound products. The main advantage is that the compaction, whilst necessary, is not as critical as for many unbound materials. Therefore, there should be less need to repeat the reinstatement because of deformation, increasing any traffic disruption.

**Environmental impact**

The use of HBM is regarded energy efficient because there is significant energy savings associated with cold mix technology. In addition, by-products from the power and steel industries, such as fly-ash and slag, can be incorporated into the hydraulic binders.

The introduction of recycled and secondary aggregates into HBM design reduces the need to use primary materials, particularly given that the demand for such materials is increasing due to environmental and sustainability pressures. The majority of these materials are recycled from construction, demolition and excavation waste from highway works. Secondary materials come in the form of by-products such as slag or fly-ash and can also be used as aggregates.
Specification

HBMs are explicitly included in the Specification for the Reinstatement of Openings in Highways (SROH) in Appendix A.9 as Structural Materials for Reinstatement (SMRs). The specification of HBM as a material is covered by several different parts of BS EN 14227, which avoids the need for Approval Trials under Appendix A.9 of the SROH. The 800 series of the Specification for Highway Works covers the production, handling, transportation, use and testing of HBM.

HBMs are classified under different grades, based on the strength of binding agent and aggregate gradation. The different grades of HBM include:

- Soil treated by cement, lime, slag or hydraulic road binder.
- Cement stabilised soil.
- Lean concrete.
- Roller compacted concrete (RCC).
- Cement bound granular mixture (CBGM).
- Slag bound mixture (SBM).
- Fly-ash bound mixture (FABM).
- Hydraulic road binder bound mixture (HRBBM).

Each of these materials is usually produced in different classes, depending on cement content or strength. For instance, CBGM, FABM, and HRBBM all contain three different classes whereas SBM contains seven different classes. Cements used for HBMs may include ground limestone, ground granulated blastfurnace slag or fly-ash.

Testing

The tests for HBMs are defined in the various parts of BS EN 13286. BS EN 13286-47 for the immediate bearing index (IBI) test gives a value that can be used to determine whether the material is suitable for immediate trafficking. The value will vary with the type of mixture, the traffic loading and the water content.

Any HBMs not covered by BS EN 14227 will require Approval Trials in accordance with Appendix A9 of the SROH. However, very few HBMs will require such trials.

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