



Using hydraulically bound mixtures at road works

This is one in a series of Traffic Advisory Leaflets providing guidance on methods of working and innovative techniques aimed at reducing traffic congestion due to road works. The series is aimed at utility companies, highway authorities, contractors, equipment suppliers and others involved in road (or street) works. Each leaflet in this series is based on research carried out by TRL Limited on behalf of the Department for Transport and Transport for London.

Introduction

This Traffic Advisory Leaflet covers the use of hydraulically bound mixtures (HBMs) in the sub-base and base layers of reinstatements. HBMs can be used as an alternative to granular sub-base material in accordance with the options given in the *Specification for the Reinstatement of Openings in Highways* (SROH). One of the environmental advantages of using HBMs is that fewer lorry trips to and from the site are likely to be required. This, combined with the potentially quicker compaction times sometimes associated with HBMs, can help reduce congestion for road users.

A hydraulically bound mixture is a mixture of aggregate, water and hydraulic binder. Possible binders include cement, fly-ash, ground and/or granulated slag (see Figure 1), lime, pozzolan and combinations thereof. Binders can be generic or proprietary. HBM is one of the most commonly used materials in pavement sub-base layers where cement-treated bases or cement-bound materials have traditionally been used.

Figure 1 - Granulated slag for use in HBMs



Environmental benefits

Using HBMs has a number of environmental benefits.

- There are significant energy savings associated with the cold mix technology used to produce HBMs,
- HBMs reduce the demand for primary materials because recycled and secondary materials can be used instead,
- The ability to re-use some of the material excavated on site reduces the amount of waste material going to landfill.
- Reduced demand for primary materials and the re-use of excavated materials can result in fewer lorry trips to and from site.

The reduction in lorry delivery or disposal trips helps to reduce traffic congestion on the network in general and, where traffic has to be stopped to allow lorries to enter or leave, at the site in particular. It also offers the potential for less time spent waiting for lorries to arrive or depart.

Most materials for recycling into HBMs come from construction, demolition and excavation waste from highway works. Secondary materials come in the form of by-products from the power and steel industries such as fly-ash or slag, some of which can also be used as aggregates as well as being incorporated into binders.

Performance requirements

HBMs can be used in sub-base and base layers.

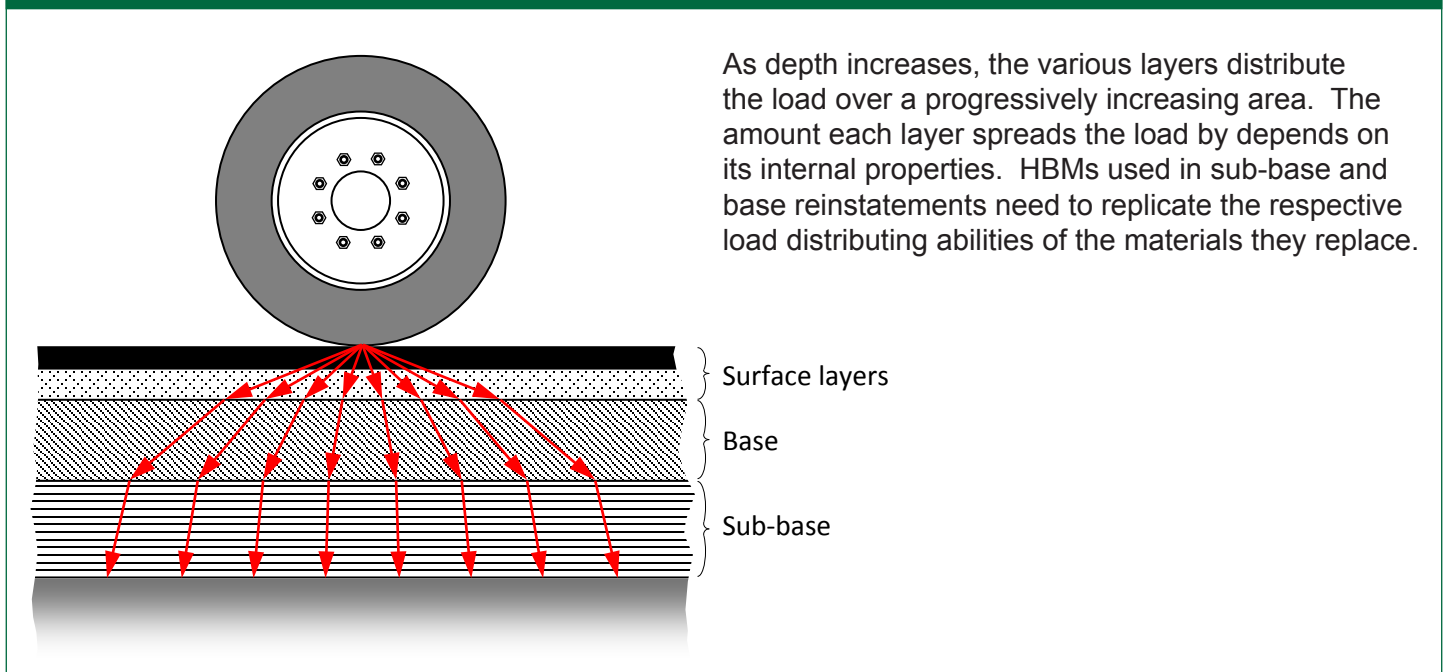
The sub-base is very important in terms of the expected performance of the pavement and is often the main load carrying layer. Although not as strong as the base layer, it is capable of redistributing loads in a similar way so that the foundation is not over stressed.

The base needs to be strong enough to prevent shear or compressive failure. It also reduces the stress from wheel loading by redistributing the relatively concentrated load over a larger area as depth increases (see Figure 2). In addition to providing strength, a properly designed and constructed base provides good sub-surface drainage and prevents settlement.

In both layers, the ability to redistribute loads needs to be replicated in any reinstatement.

HBMs can be used as an alternative to granular sub-base material in the options given in the *Specification for the Reinstatement of Openings in Highways*.

Figure 2 - Load re-distribution in a flexible pavement



Production

HBM can be produced on or off site. The on-site method, where the binder is rotovated into existing aggregate, is more appropriate for large scale works than for, say, minor trench reinstatements. The off-site method enables greater control of the finished product for small scale works but some of the environmental advantages arising from reduced lorry trips are likely to be lost.

Selecting and/or grading the aggregate (see Figures 3 and 4) means that mixture design can be rationalised so that a wide range of materials can be used to meet a mixture specification. Off-site production also means that better facilities for testing the final product can be provided.

Producing HBM off site can involve:

- designing the mixture using materials parameters derived from laboratory tests;
- using stockpiled aggregate (which can be selected trench arisings from a number of excavations as opposed to in-situ aggregate from a single trench);
- using mobile or fixed mixing plant; and
- transporting to site.

The equipment needed for laying and compacting HBMs is similar to that used for laying and compacting unbound layers, although compacting HBMs is often quicker and easier, resulting in immediate time savings. Overall traffic delay is also reduced because return visits to remedy poorly compacted reinstatements are less likely.

HBM are explicitly included in Appendix A9 of the SROH as Structural Materials for Reinstatement (SMRs). The specification of HBM is covered by several different parts of BS EN 14227, which avoids the need for Approval Trials under Appendix A9 of the SROH. The 800 series of the *Specification for Highway Works* at http://www.dft.gov.uk/ha/standards/mchw/vol1/pdfs/series_0800.pdf covers production, handling, transportation, use and testing of HBMs.

HBM are classified under different grades, based on the strength of the 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 can be produced in three different classes and there are seven different classes for SBM. Cements used for HBMs may include ground limestone, ground granulated blast furnace slag or fly-ash.

Figure 3 - Ungraded aggregate



Figure 4 - Graded aggregate



Testing

For laboratory testing purposes, HBM samples can be cast in cubes or cylinders (see Figure 5). Where agreed, coring may be used to obtain cylindrical specimens. However, low strength HBMs (i.e. anything less than strength class C6/8) or mixtures using slow hydraulic binders, standard unconfined compressive strength tests tend not to give reliable results. In-situ testing can also be used to determine stiffness (e.g. via Light Weight Deflectometer) and density (e.g. via Nuclear Density Meter).

Tests for HBMs are defined in the various parts of BS EN 13286. The BS EN 13286-47 immediate bearing index (IBI) test gives a value that can be used to determine whether the material is suitable for immediate trafficking. This 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.

Recommended further reading

- Specification for the Reinstatement of Openings in Highways. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/11042/sroh.pdf
- Specification for Highway Works. <http://www.dft.gov.uk/ha/standards/mchw/vol1/>
- Manual handling. (The Health & Safety Executive). <http://www.hse.gov.uk/toolbox/manual.htm>
- The safe use of vehicles on construction sites: A guide for clients, designers, contractors, managers and workers involved with construction transport. (The Health & Safety Executive). <http://www.hse.gov.uk/pubns/books/hsg144.htm>
- BD 21/01 The Assessment of Highway Bridges and Structures. <http://www.dft.gov.uk/ha/standards/dmr/vol3/section4/bd2101.pdf>
- HD 27/04 Pavement Construction Methods. <http://www.dft.gov.uk/ha/standards/dmr/vol7/section2/hd2704.pdf>
- The Construction (Design and Management) Regulations. <http://www.legislation.gov.uk/uksi/2007/320/contents/made>
- New Roads and Street Works Act 1991. <http://www.legislation.gov.uk/ukpga/1991/22/contents>
- The Street Works (Records) (England) Regulations 2002. http://www.legislation.gov.uk/uksi/2002/3217/pdfs/uksi_20023217_en.pdf

Figure 5 - HBM cubes and cylinders for testing



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