



Creating markets for recycled resources

Promoting the use of applications incorporating recycled and secondary aggregates in hydraulically bound materials

Appendix A: Technical guidance
No 2: Minor roads and paved areas

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No 2: Minor roads and paved areas

Unlike major roads for which there are well known and documented procedures for the application of HBM (see Technical guidance document 1), the situation for minor roads and paving is less clear and obvious. The information is available but is scattered across a number of not so obviously applicable documents. This guidance sheet is an attempt to bring all the relevant references together.

Specifically the guidance here covers the use of hydraulically bound materials (HBM) for minor roads, such as residential and commercial roads, and paved areas such as car parks for retail and leisure developments and hardstandings for commercial vehicles. With a particular focus on design, the document highlights the advantages in using recycled and secondary aggregates (RSA). The guidance will be of interest to developers, contractors, and civil engineering consultancy practices.

It should be noted that this document covers the use of HBM in applications designed to carry traffic up to and including the normal legal road axle of 10 tonnes or wheel loads of 5 tonnes. The application of HBM for heavy duty paving for ports and airfields, where wheel loads of 10 tonnes and more are commonplace, is beyond the scope of this document. This application is covered by Technical guidance document 3 in this series.

1. What are hydraulically bound materials (HBM)?

HBM are mixtures that set and harden by hydraulic reaction and have a water content suitable for compaction by rolling. They include cement bound mixtures (CBM) based on the fast setting and hardening characteristics of Portland (CEM 1) cement, as well as mixtures based on slow setting and hardening hydraulic binders such as (CEM 1) pulverised fuel ash (PFA) and granulated blastfurnace slag (GBS).



Production facilities of HBM mixtures.



Stockpile of HBM mixtures

2. The benefits of using HBM and RSA in minor roads and paved areas

HBM has potential to be use in a range of paving and non-paving applications. Use of RSA in the HBM offers some additional benefits. Use of HBM offers the following general advantages:

- HBM construction is well known and versatile in terms of availability of plant and materials.
- HBM can be produced by mix in plant or mix in place equipment by in-situ stabilising existing material.
- Plant for laying and compaction is similar to that required for other paving materials such as unbound and bituminous bound products.
- Some HBM mixtures allow the re-use of materials available on site (eg soil, demolition wastes) with savings on imported material (Aggregates Levy) and disposal costs.
- HBM has proven energy saving benefits. ETSU General Information Report 49. illustrates the energy benefits of using HBM
- HBM assists in winning work by meeting or exceeding client requirements for “green” procurement.

Current limitations regarding the use of HBM relate to availability and to a lesser extent, the size of area that is economically viable. For sites areas of less than 10,000m², on site production is unlikely to be viable. Such sites may need to use HBM from ready-mix outlets but those capable of producing HBM with significant RSA content are limited. It is possible though in the future that HBM will become more readily available (some are already in existence) from central recycling plants that are equipped with a stationary mixing plant.

Table 1: RSA suitable for use in HBM (adapted from Sherwood, 1994)

Potential	RSA
High	China clay sand, recycled concrete aggregates, air-cooled blastfurnace slag, GBS*, burnt colliery spoil, PFA*, spent oil shale, recycled asphalt, other road arisings, slate aggregate, incinerator bottom ash aggregates (IBAA).
Medium**	Unburnt colliery spoil, general demolition debris
Low**	basic oxygen (BOS) slag, electric arc furnace (EAF) slag

*Can be used as 'aggregate' or as part of the binder

**It is possible that the materials listed may produce, through physical or chemical unsoundness, mixtures with volume stability problems. This will need checking during laboratory mixture design procedures.

3. Design of minor roads, car parks and hard-standings utilising HBM – key guidance

Table 2: Key guidance

Subject	Reference (also refer to other reading)
Thickness design	TRL report TRL 611 Merrill, Nunn & Carswell. A guide to the use and specification of cold recycled materials for the maintenance or road pavements – 2004. ISBN 0968-4107. Replaces TRL report TRL 386 (see "further reading")
Specification	Residential and commercial roads Irish Cement Ltd. Design and construction of road pavements. Dublin, Ireland, 1994.*
Material selection, mixture design, construction and control	British Cement Association publication 46.048 Kennedy & Hopkins. Cement bound materials for pavements. Material selection, mix design, construction and testing. BCA – 2000. ISBN:0 7210 1551 4. TRL 611 (above) for all HBM including CBM Irish document above (CBM, asphalt, concrete, drainage etc) See also further reading

* Available from BCA / Concrete Centre Library

Note: The earlier TRL 386 published in 1999 on covered structural in situ recycling using cement. The more recent document, TRL 611 broadened this to include ex situ work and slow setting and hardening HBM based on fly ash and slag.

For thickness designs, reference can be made to Table 7.4 in TRL 611, which covers traffic up to 5 msa. This table should cater for the majority of minor roads, car parking and hardstandings and gives the designer a choice of surfacings from surface dressings to 100 mm of asphalt, depending on the intended life of the pavement and serviceability requirements.

There is however an important difference between 386 and 611. For traffic less than 5 msa, TRL 611 is more conservative than TRL 386 regarding HBM strength recommendations. This was not intentional but is a feature of the design approach and certain assumptions used in TRL 611. It is also contrary to the good performance of roads recycled to TRL 386 guidelines. It is suggested here, *safely*, that the TRL 386 recommendations for CBM strength can be used in general for HBM designed to TRL 611 for traffic less than 5 msa.

It should be noted that TRL 611 and 386 just cover HBM under asphalt surfacings. Where advice on surfacing in general is required, concrete or asphalt or precast, reference can be made to a document published by Irish Cement, also referenced in the table above, which usefully complements TRL 611 and 386 in this respect, as well as providing key guidance in all areas of design, specification and construction.

4. Case studies

There are a number of case studies illustrating the technical and cost effectiveness benefits of using HBM containing RSA in car parks and hard standing. These include:

Table 3: List of case studies illustrating the technical and cost benefits of using HBM containing RSA (available on the AggRegain website).

Case study title	Location	Application	Advantage of using the RSA in that case
Lichfield Southern Relief Road for Staffordshire County Council – 2002	Lichfield, Staffordshire	Base and sub-base for estate roads	HBM made from recycled asphalt and coal fly ash*. Total direct saving of £63,000.

*Fly ash is the European name for PFA



Large paved areas, such as car park for retail, leisure developments and hardstanding for commercial vehicles



Lichfield Southern Relief Road 2002

5. Further reading

Table 4: Further reading related to the use of RSA in HBM mixtures

Title	Content
ETSU General Information Report 49. Energy minimisation in road construction and maintenance. ETSU, Harwell, Didcot, Oxon OX11 0RA. July 1997.	Energy benefits of using HBM
BS EN 14227-1:2004. Hydraulically bound mixtures – Specifications – Part 1: Cement bound granular mixtures (CBGM). – Part 2: Slag bound mixtures (SBM). – Part 3: Fly ash* bound mixtures (FABM). – Part 4: Fly ash* for hydraulically bound mixtures. – Part 5: Hydraulic road binder bound mixtures (HRBBM). pr EN 14227-10. Hydraulically bound mixtures – Specifications – Part 10: Soil treated by cement (SC). – Part 11: Soil treated by lime (SL). – Part 12: Soil treated by slag (SS). – Part 13: Soil treated by hydraulic road binder (SHRB). – Part 14: Soil treated by fly ash* (SFA).	Specifies constituents, types and performance classes of HBM. Construction and control is covered by TRL 611.
BRITPAVE. Information on the new European standards, BS EN 14227 parts 1 to 5, for cement and other hydraulically bound mixtures. [To be published late autumn 2004]	Describes the scope of the new BS ENs for HBM, how they compare to earlier UK HBM and how to specify the new HBM

Table 4: Further reading related to the use of RSA in HBM mixtures (followed)

Title	Content
TRL report TRL 248 Chaddock & Atkinson: Stabilised sub-bases in road foundations: structural assessment and benefits – 1997. ISSN: 0968-4107	Structural comparison of unbound and stabilised subbases - useful reference for thickness design and specification
BRITPAVE BP/08 Stabilised Soils – as sub-base or base for roads and other pavements – 2004.	Reference on mixture design, construction and testing for treated soils particularly clays and other fine-grained materials
BRE Client report 215-993 Recycled and Secondary aggregates in construction: Final specification and design documents – February 2004.	Information on slow setting slow hardening HBM
TRL report TRL 408 Atkinson et al: Enabling use of secondary aggregates and binders in pavement foundations – 1999.	Structural properties of slow setting slow hardening HBM – useful for design and specification
TRL report TRL 386 Milton and Earland. Design guide and specification for the structural maintenance of highway pavements by cold in-situ recycling – 1999.	Deals with HBM strength for traffic less than 5 msa – now replaced by TRL 611. Covers structural in situ recycling using cement. TRL 611 includes ex situ work and slow setting and hardening HBM based on fly ash and slag.

* Fly ash is European name for PFA

6. Website links

www.bre.co.uk – Building Research Establishment (www.smartwaste.co.uk – a set of tools to help companies apply the concept of sustainable waste management).

www.trl.co.uk – Transport Research Laboratory (www.trl.co.uk/scip – The use of RSA in construction: a SCiP roadshow).

www.viridis.co.uk – Sister company of TRL, developing a series of projects to provide achievable and effective solutions to move our economy towards sustainable development.

www.wrap.org.uk – Waste Resources Action Programme

(www.wrap.org.uk/publications/ImplicationsStandardHarmonisationAgg.pdf - Implications of the use of harmonisation of construction product standards for the use of RSA)

www.aggregain.co.uk – sustainable aggregate information service provided by WRAP – provides numerous case studies on the use of RSA in various applications.

www.concretecentre.com – Aims to assist all those who design and construct in concrete.

www.ciria.org - provides services in construction related industries (www.ciria.org/recycling - a database of construction related recycling sites in Great Britain accepting or selling materials).

www.tso.co.uk/bookshop - The Stationary Office bookshop.

www.euroslag.org - European Association for suppliers of slag from iron and steel manufacture – information on air-cooled slags and hydraulic slags.

www.jkpavementconsulting.co.uk - Independent pavement engineering consultancy specializing in the use of hydraulic binders and pozzolans to produce environmentally, energy and cost efficient long life pavements.

www.ballastphoenix.co.uk – IBAA supplier.

www.sitebatch.co.uk - Specialises in the mass production of hydraulically bound materials.



Ballast Phoenix Ltd

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