



Creating markets for recycled resources

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

Appendix A: Technical guidance No 1: Major roads

Project code: DTI/WRAP Aggregates Research Programme STBF 13/10C

Published by:

The Waste & Resources Action Programme

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May 2005

ISBN: 1-84405-181-1

No 1: Major Roads

This guidance document covers the use of hydraulically bound materials (HBM) for major roads including motorways, bypasses, and significant town or city roads including their structural maintenance. It particularly highlights the advantages in using recycled and secondary aggregates (RSA) in HBM. It covers the opportunities, benefits, and procedures for the use of HBM in such applications and highlights case studies and other key documents for further reference. The guidance will be of particular value and interest to consultants, local authorities, developers and contractors.

The application of HBM incorporating RSA for minor roads and paved areas, including residential/commercial roads, car parks and lorry parks, and for heavy duty paving such as airfields and ports, is beyond the scope of this document. These applications are covered by Technical guidance documents 2 and 3 respectively in this series.

1. What are hydraulically bound materials (HBM)?

HBM are mixtures that set and harden by hydraulic reaction and that 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

2. The benefits of using HBM and RSA in major roads

HBM has potential to be used 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.

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 and recycled aggregates
Low**	basic oxygen 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 major roads utilising HBM – key guidance

Table 2: Key guidance for the design of major roads utilising HBM

Subject	Reference (also refer to other reading)
Thickness design	<ul style="list-style-type: none"> • Design Manual for Roads and Bridges. Volume 7. HD25 (pavements) & 26 (pavement foundations). • TRL report TRL 615. Versatile design method (to be published autumn 04). • These documents apply to traffic over 1 million standard axles (msa).
Material selection, mixture design, construction and control	<ul style="list-style-type: none"> • 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 report TRL 611 (below) for all HBM including CBM. • See also "further reading".
Specification	<ul style="list-style-type: none"> • Specification for Highway Works (SHW). • BS EN14227 – 1 to 5 and 10 to 14. Detailed in further reading
Structural maintenance	<ul style="list-style-type: none"> • TRL report TRL 611 Merrill, Nunn & Carswell. A guide to the use and specification of cold recycled materials for the maintenance of road pavements, 2004, ISBN 0968-4107. (This publication replaces TRL report TRL 386, see "further reading"), but is more conservative regarding HBM strength for traffic less than 5 msa despite the good performance of roads recycled according to TRL 386 guidelines. It is suggested here, <i>safely</i>, that the TRL 386 recommendations for CBM strength are used for all HBM for traffic less than 5 msa.



Laying of a major road with HBM mixture containing RSA.

4. Case studies

There are a number of case studies illustrating the technical and cost benefits of using HBM containing RSA in major roads. 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
A52 reconstruction for Staffordshire County Council – 1997	Froghall to Kingsley Bank, Staffordshire	Sub base and base	Total reuse of existing construction involving treatment based on fly ash. Total direct saving of approximately £16,000.*
Burntwood Bypass for Staffordshire County Council – 2001	Lichfield to Cannock, Staffordshire	Sub base and base	Use of incinerator bottom ash as aggregate with coal fly ash* as part of the binder. Total direct saving of approximately £63,000.
A259 Ramsgate Harbour Kent Highways - 2000	Ramsgate Harbour Approach Road, Kent	Sub base	Use of fly ash as part of the binder. Total direct saving of approximately £50,000.

* Fly ash is the European name for PFA

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 the SHW
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 standards and how to specify the new HBM
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 foundation - 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.	More relevant than TRL 611 for recycling with regards to traffic less than 5 msa

* Fly ash is the 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.



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