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The DIRECT-MAT web database – A source of knowledge in road recycling

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Abstract

This paper describes the DIRECT-MAT web database which gathers European knowledge and practices about the demolition and road-recycling or safe disposal of old road materials. This database has been developed within a three-year coordination and support action under the EC 7th Framework program “Sustainable Surface Transport” for the purpose of supporting the daily work of practitioners, researchers and standardization bodies working in the field of road infrastructures.

The database addresses unbound, hydraulically bound and asphalt road materials. It also addresses other materials related to road use but not commonly recycled into road construction. These include tire shreds, sediment from ditches, road reinforcement materials and industrial by-products as long as they come from the demolition of a road into which they were recycled a first time. The database provides on-line access to Best Practice Guides, practical application case studies and international literature reviews elaborated from the review of national documents.

There are three different ways for searching the database: 1) Via specific documents – Literature reviews, Case study reports and Best Practice Guides – for each material type; 2) Via quick or advanced search for specific terms; 3) Via a map where case studies are geo-tagged.

The DIRECT-MAT database has been developed by some fifty experts from fifteen European countries. This means that national documents, working sites data and research results have now become easily available to road authorities, CEN technical committees and researchers from other countries. This share of national knowledge and practices is expected to boost recycling, thus DIRECT-MAT will contribute to reducing waste disposal associated with roads. Furthermore, the DIRECT-MAT web database is expected to serve as a reference tool for recording and sharing working site data on the demolition and recycling of road materials throughout Europe.

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Keywords: recycling ; road ; demolition ; maintenance ; database ; unbound ; hydraulically bound ; asphalt ; tyre sheds ; by-products

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1. Introduction

DIRECT-MAT (Dismantling and RECYcling Techniques for road MATerials) is a three year coordination and support action of the EC 7th Framework program that has already been presented elsewhere (ENVIROAD 2009; WASCON 2009; IRF 2010; EUWM 2010). Basically, this project addresses the end of life strategies of road infrastructures and focuses on:

- facilitating the sharing of national experiences on the recycling of road materials at the European level;
- making research results from various countries more available to practitioners
- providing European standardisation bodies with practical experience and data, and
- forming a basis for coordination of future research within this subject

Between 2009 and 2011, twenty partners – research institutes, universities and private companies – consisting of some fifty experts from fifteen participating countries (Table 1) have contributed to collecting, analyzing and formatting national as well as international information. The strategy adopted consists of three steps: first, examine national documents describing the demolition and recycling of roads and summarize common processes as well as major differences across Europe; second, capture the wide variety of actual European practices by collecting data on practical application case studies; third, benchmark documented and actual road demolition and recycling practices in order to produce European guides on best possible end of life strategies for road materials and to identify knowledge gaps and research issues that will form a basis for coordinating future European road research. In order to reach a consensus, national reference groups consisting of potential end users in the participating countries have been consulted namely through national seminars and during a European workshop held in autumn 2011. Further information about the project may be found at <http://direct-mat.fehrl.org/>.

Table 1. Partners in the DIRECT-MAT European project

Partner organisation name	Country
IFSTTAR Centre de Nantes (former LCPC) Coordinator	France
The Research Institute of VÖZ	Austria
Belgian Road Research Centre (BRRC)	Belgium
Centrum dopravního výzkumu (CDV)	Czech Republic
Danish Road Institute (DRI)	Denmark
NIAS Strasbourg	France
Braunschweig Institute of Technology (TUBS/ISBS)	Germany
Dresden University of Technology (TUD)	Germany
Institute for Transport Sciences (KIT)	Hungary
University College Dublin (UCD)	Ireland
Branchevereniging Recycling Breken en Sorteren (BRBS)	The Netherlands
Road and Bridge Research Institute (IBDiM)	Poland
Laboratório Nacional de Engenharia Civil (LNEC)	Portugal
RECIPAV	Portugal
The Highway Institute (IP)	Serbia
Slovenian National Building and Civil Engineering Institute (ZAG)	Slovenia
CEDEX	Spain
Swedish Geotechnical Institute (SGI)	Sweden
VTI	Sweden
Forum of European National Highway Research Laboratories (FEHRL)	

This paper focuses on the description of the main product of the DIRECT-MAT project, a web accessible database (<http://www.direct-mat.eu>) that gathers European knowledge and practices about the demolition and recycling or safe disposal of road materials for a broad range of potential users – road owners, standardization experts, road designers, contractors, material producers, researchers, laboratory personal, professional associations, equipment manufacturers as well as teachers in professional education. Knowledge gaps and research issues that have been identified and will form a basis for coordination of future European road research will be described and published elsewhere.

The following paragraphs describe the content of the database, illustrate the various available tools to search the database and discuss its maintenance and update strategy beyond the project life.

2. Database content

2.1. General

The DIRECT-MAT web database addresses the demolition and recycling or safe disposal of *Unbound*, *Hydraulically bound* and *Asphalt* road materials. It also addresses some *Other* materials used in road constructions which may need special consideration during road maintenance and demolition work. These include tire shreds, tar asphalt, road reinforcement materials and industrial by-products used when the road was initially constructed, as well as sediment from ditches.

The database (Fig. 1) provides on-line access to:

- best practice guides (BPG);
- practical application case studies (CS);
- harmonized literature reviews (LR);
- national document references.

The database also includes functions for Help, Frequent Asked Questions and users' Satisfaction survey.



Fig. 1. The DIRECT-MAT web database home page (www.direct-mat.eu)

2.2. Literature Reviews

For each type of road material – Unbound, Hydraulically bound, Asphalt and Other materials – the database contains a harmonized Literature Review describing common demolition and recycling documented practice and highlighting major differences between European countries. Each LR is based on several national literature reports, one from each contributing country, and also on some international (non European) documents.

The national reports summarize national literature as well as information collected during interviews with practitioners. It was the first task of the DIRECT-MAT partners to look through existing national published documents describing the demolition and recycling of various road materials and their reuse in road construction contexts. This

was done by consulting national reference sources such as laws, regulations, technical and environmental specifications, guidelines and scientific papers within the participating countries as well as some international documents. For each document reviewed, a Document Review Form (DRF) has been drafted. These DRFs contain the original title, a short abstract and often a direct link to the source document (Fig. 2).

DIRECT-MAT		Document Review Form	WP2	Date of publication	Status
		DRF2.SE8	016 – VT1	2010-06-03	PP
Title	General technical description Crushed concrete in road constructions				
Original title	Allmän teknisk beskrivning Krossad betong i vägkonstruktioner				
Reviewed document type	<ul style="list-style-type: none"> • Specification 				
Main content	<ul style="list-style-type: none"> • Theoretical 				
Abstract	<p>The document contains information about requirements by the Swedish Road Administration on using crushed concrete in road constructions. The document should be used together with laws and regulations, technical descriptions and standards referred to in the document. The requirements are based on research literature referred to in the document.</p> <p>WP2: Unbound layers containing <ul style="list-style-type: none"> x reclaimed unbound materials x reclaimed hydraulically bound materials x reclaimed asphalt (RA) </p>				
Demolition product	<ul style="list-style-type: none"> • Hydraulically bound material 				
New material	<ul style="list-style-type: none"> • Unbound material 				
Country	Country where the information originates from (multiple choice possible): <ul style="list-style-type: none"> • Sweden 				
Author(s) of the reviewed document	Swedish Road Administration: Contact persons Klas Hermelin and Peter Dittlau.				
Publication year of the reviewed document	2004				
Writing date	2010-06-03				
References	Publikation 2004:11 20pages. Download at http://www.vv.se An English translated version is available as a part of the SPENS project. http://spens.fehr.org/?m=32&d_directory=372 (Crushed Concrete-SwedishTechnicalDescription.pdf - 208.08 KB)				
Geographical Information	Sweden				
Type of paper	Technical description				
Keywords	Crushed concrete, environmental impact, sub-base, Sweden, Swedish				
Contractor: 016 – VT1 Author: F. HELLMAN		Page 1 / 1		Contract: SC57-GA-2008-218866 File: DRF2 SE8 SRA crushed concrete	

Fig. 2. Example of a Document Review Form (DRF, www.direct-mat.eu)

2.3. Case Studies

In order to illustrate the practical implementation of demolition and recycling techniques for various materials, the partners have collected and analyzed information gathered at actual construction sites, recycling plants and laboratories (Fig. 3). Each of these Case Studies is detailed in a synthetic report that explains how the road work was performed, describes the experiences gained and, if available, also provides information about volumes and test results. Most of the case studies are geo-tagged.



Fig. 3. Practical implementation of road demolition and recycling (the DIRECT-MAT project)

2.4. Best Practice Guides

The Best Practice Guides contain consensual recommendations about best possible end of life strategies (demolition, recycling or disposal) for road materials and summarize identified knowledge gaps and research issues. The database contains one guide for each type of road material (Fig. 4). The guides are written after comparing the theoretical approach provided by the Literature Review and Document Review Forms with the actual practice gathered in the Case Studies. Examples or hyperlinks to relevant source documents, either relevant literature or case studies, are provided where appropriate.

The screenshot displays the DIRECT-MAT website interface. At the top, a navigation bar includes 'BEST PRACTICES', 'CASE STUDIES', 'LITERATURE REVIEWS', 'GLOSSARY', and 'ABOUT DIRECT-MAT'. The 'BEST PRACTICES' tab is highlighted with a red oval. Below the navigation bar, there is a search box and a sidebar menu titled 'Best Practice Guides'. The sidebar menu lists categories such as 'Bituminous bound materials', 'Main text', and 'Hydraulically bound materials'. The main content area shows the title '3 - DEMOLITION OF ROAD MATERIALS TO ENABLE RECYCLING IN FLEXIBLE OR SEMI RIGID PAVEMENTS' and a 'Download' button. Below the title, there is a paragraph of text: 'This best practice guide aims to summarise the findings of 3-year DIRECT-MAT project work on the synthesis of international experience in asphalt recycling. For the various available recycling techniques, this report shows common trends and noticeable divergences for international practices on demolition and characterisation of reclaimed road materials as well as mix design, construction techniques, quality control for new asphalt containing reclaimed road material. Where possible, recommendations for best practices are highlighted.' Below this text, there is a table with columns for 'Title', 'Year', 'Status', and 'Date of issue'. The table contains one entry: 'Delimiting BTR - Best practice guide', '2010', 'Best practice guide', and '2011-03-07'. Below the table, the text continues: '3 - DEMOLITION OF ROAD MATERIALS TO ENABLE RECYCLING IN FLEXIBLE OR SEMI RIGID PAVEMENTS. Existing pavements can be demolished by block crushing or milling. For block crushing the entire bound pavement structure is demolished, whereas the depth of milling can be varied between some millimetres and more than 30 centimetres, depending on the milling equipment. Some recycling techniques are less dependent on the characteristics of the reclaimed road material than others. For high quality asphalt mixes (usually hot-in-place) the requirements on composition and for homogeneous reclaimed materials, in which grading and binder content as well as aggregate and binder properties meet the requirements for virgin materials, in hot-in-place recycling, for example, the binder of reclaimed materials is melted during the mixing process and therefore recombined. This may require separate milling of single layers, which is of importance especially if PRA is used in surface asphalt mixes. Other recycling techniques only need homogeneous conditions whereas the actual'.

Fig. 4. Example of a Best Practice Guide (www.direct-mat.eu)

3. Searching the database

3.1. General

There are three different ways for searching the database:

1. Via specific documents – Best Practice Guides / Case Studies / Literature Reviews – for each material type;
2. Via a quick or advanced search for specific terms;
3. Via a geographical search tool for geo-tagged case studies.

3.2. Searching via specific documents

Searching via specific documents consists in selecting a document type, either Literature Review or Best Practice Guide and a material type. Each chapter of the selected document may then be displayed sequentially. When a harmonized literature review document is selected, both the harmonized part and the individual national literature reports annexed to this document may be accessed (fig. 5). These annexes may also be accessed by clicking on any occurrence of the country name in the harmonized LR. The DRFs may be accessed via hyperlinks located in the four Literature Reviews or the annexed national literature reports.

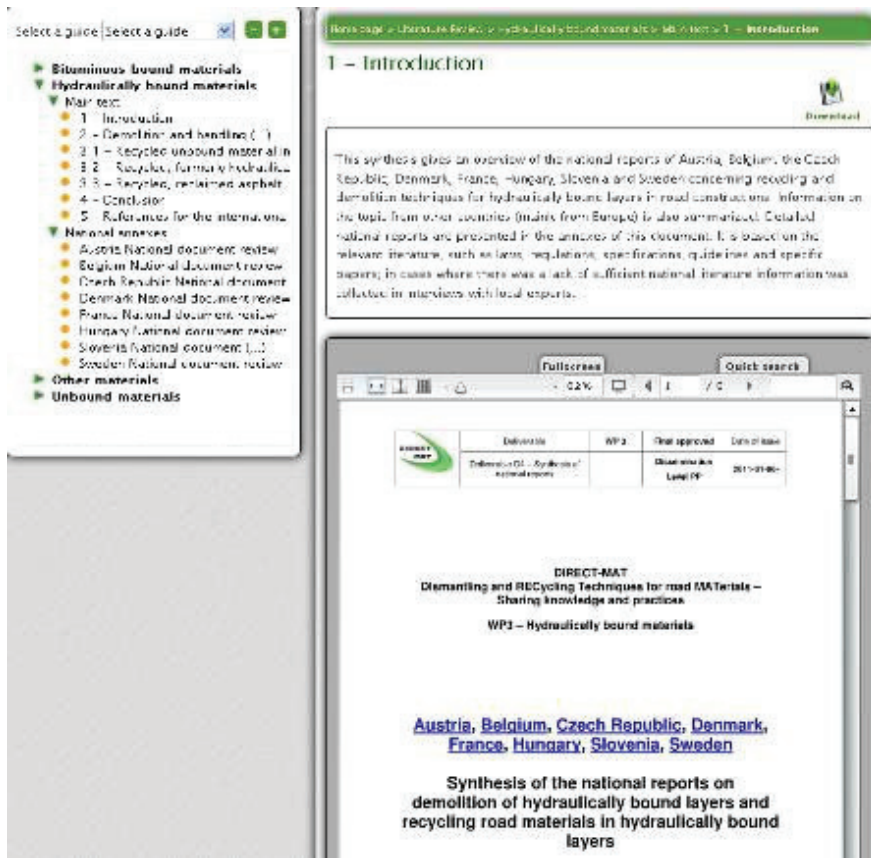


Fig. 5. Searching via specific documents – Example of result (Literature Review about dismantling and recycling of hydraulically bound materials on www.direct-mat.eu)

3.3. Search for specific terms

The Quick search and Advanced search functions give possibilities to search for specific terms in the whole database. The Advanced search function allows specifying more criteria, such as the nature of the demolished layer (surface course, base course...) to be searched or that of the layer in which the material was recycled, thus reducing the list of results. A glossary helps searching the database for specific terms. It has been found suitable to adapt the glossary to the terminology recommended by the World Road Association (PIARC).

Each search result is displayed with a title, a short abstract and a note about the document type – a literature review (LR) or a case study (CS), with the searched keyword highlighted using yellow font (Fig 6).

Search results: recycling		See on the map (Case studies only)		
Title	Abstract	Demolition products	New material	Type of document
In-place recycling of surfacing concrete A1, France, 1976/77	In-place recycling of surfacing concrete A1, France, 1976/77			CS
Synthesis of national documents on existing knowledge regarding recycling road materials in unbound layers	This report was prepared on the base of national reports of DIRECT-MAT WP2 members on existing knowledge regarding recycling of road materials and their use in unbound (...)			LR
Synthesis of the national and international documents on demolition hydraulically bound layers and recycling road materials in hydraulically bound layers	This synthesis gives an overview of the national reports of Austria, Belgium, the Czech Republic, Denmark, France, Hungary, Slovenia and Sweden concerning recycling and demolition techniques of (...)			LR

Fig. 6. Example Quick search results (www.direct-mat.eu)

3.4. Geographical search/Search via a map

Case studies may be searched either using filters on the demolition products and new materials in which they were recycled, or by direct selection on a map since most case studies (not all) have been geo-tagged and may be clicked (Fig 7). In the latter case, the search results will show a short description of the selected case study that may be expanded to the full case study report by clicking on a 'read more' hyperlink.

4. Database maintenance and update

The development of the DIRECT-MAT database was made possible thanks to EC funding and the involvement of some fifty experts from fifteen European countries, who summarized their national practices on the demolition and recycling of road materials, then collected data from actual construction sites, recycling plants and laboratories and finally drafted best practice guides. In order not to jeopardize such a huge initial investment, the database will have to be maintained. Besides obvious software interface issues that will show up with the evolution of web browsers, this maintenance work will consist of updating the literature reviews and best practice guides with knowledge progress as well as collecting, examining and incorporating new data into the database. These tasks will require skilled people in the framework of road infrastructure. Depending on the database success, the maintenance work could take significant time and therefore justify a dedicated budget to cover maintenance expenditures. Therefore, various solutions were discussed during the project life, ranging from a paying access to the database to a free access supported by stakeholders. Despite the absence of sponsors, it was eventually found preferable not to activate the paying access and a few researchers involved in DIRECT-MAT have volunteered to help maintain the database for free at least for some time. However, this 'maintenance team' will closely follow the success of the database in order to assess a maintenance budget consistent with their involvement and track financing opportunities (ERANET-ROAD, state agencies, road companies advertisements...).

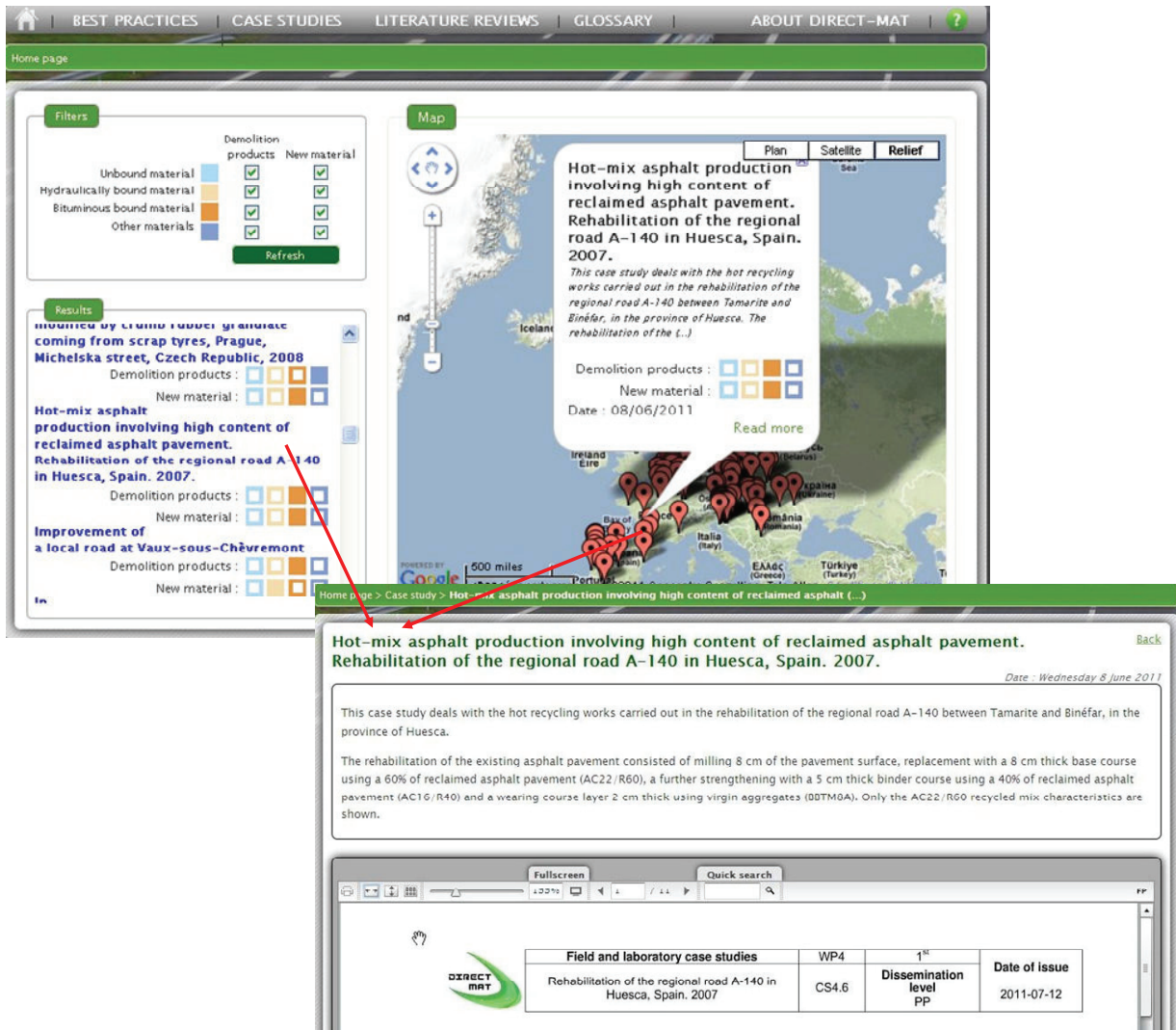


Fig. 7. The geographical search tool (www.direct-mat.eu)

5. Conclusion

The DIRECT-MAT database has been developed by some fifty experts from fifteen European countries. Thanks to this big effort sponsored by the European Commission, national documents, working sites data and research results not widely implemented before have now become easily available to road authorities, CEN technical committees and researchers from other countries. This share of national knowledge and practices is expected to boost recycling, thus DIRECT-MAT will contribute to reducing waste disposal associated with roads. Furthermore, the DIRECT-MAT web database is expected to serve as a reference tool supporting the daily work of practitioners, researchers and standardisation bodies namely in terms of recording and sharing working site data on the demolition and recycling of road materials throughout Europe. In this perspective, the maintenance work could take significant time to the maintenance team and therefore a dedicated budget will have to be found to cover maintenance expenditures.

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