CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

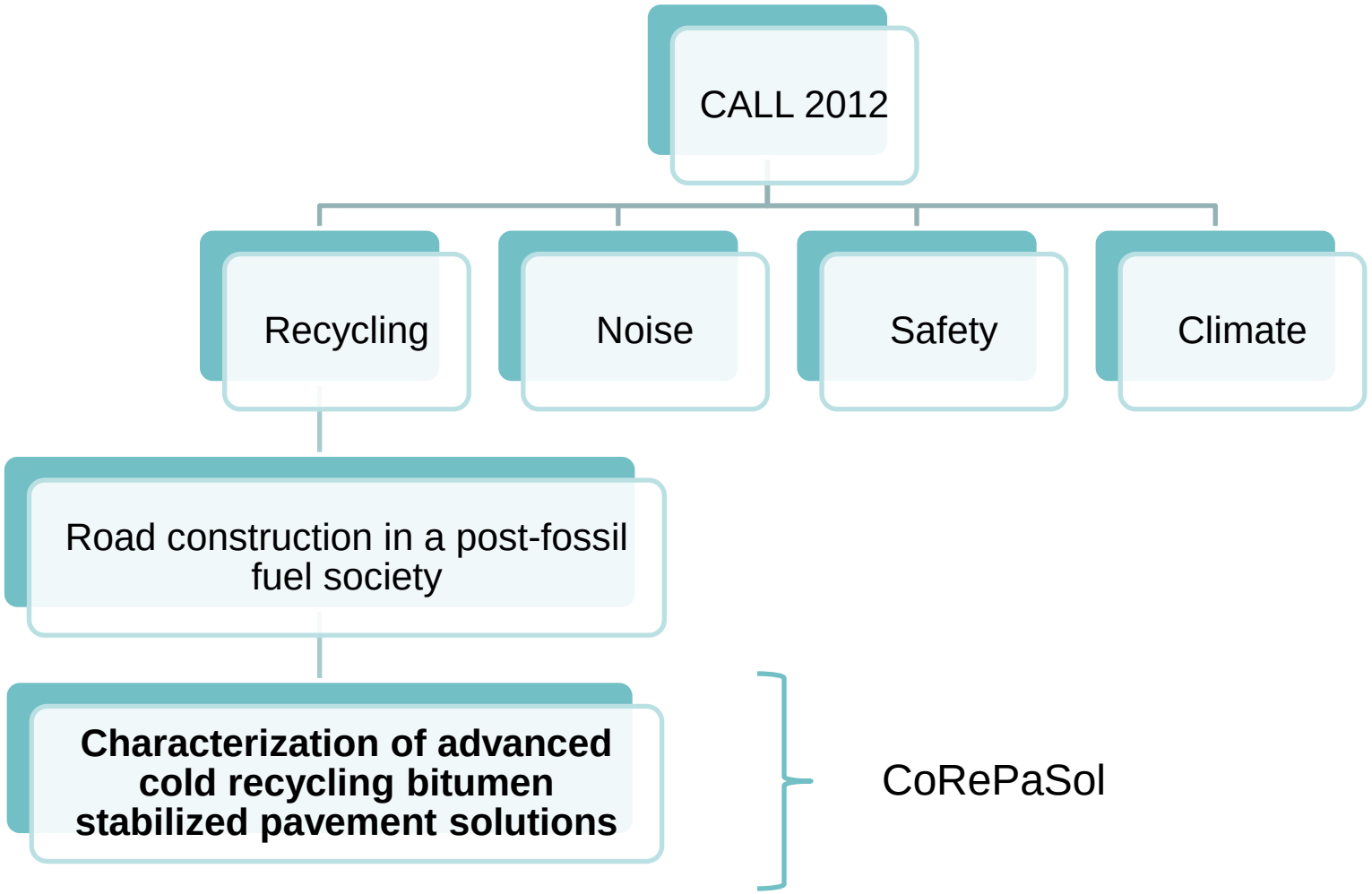
CEDR Transnational Road Research Programme Call 2012

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Dr Ciaran McNally
UCD School of Civil, Structural & Environmental Engineering

UCD DUBLIN

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions



Project information

- Project coordinator: Czech Technical University
- Starting date: 01/01/2013
- Planned End date: 31/12/2014
- Project costs: ~ €373,000
- 5 partners

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Project partners

University College Dublin

Czech Technical University

University of Kassel

Laboratório Nacional de Engenharia Civil

Wirtgen GmbH

Background – strategic outlook

- Assessment of European cold recycling pavement techniques and national designs
- Harmonized mix design procedures
- Suitable performance based tests for cold recycling
- Effective inclusion of cold-recycled mixture in existing pavement design manuals
- Multiple recycling and activity of RAP
- Utilization of alternative binders
- Environmental aspects

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Project objectives

- Harmonized European cold recycled design procedures
- Performance based mix design for more effective use
- Estimate material parameters
- Recyclability of cold-recycled material

  (RA activity)
- Environmental stability

  (leaching, tar detection, etc.)
- Carbon footprint /life cycle analysis

Work program

WP	Work package title
1	Advanced mix design for cold-recycled materials
2	Durability of cold-recycled bitumen stabilized material
3	Pavement design with cold-recycled bitumen stabilized base
4	Recyclability of cold-recycled BSM applications
5	Environmental compatibility of cold-recycled BSM applications
6	Dissemination and management

Cold recycling material and its stabilizing agents

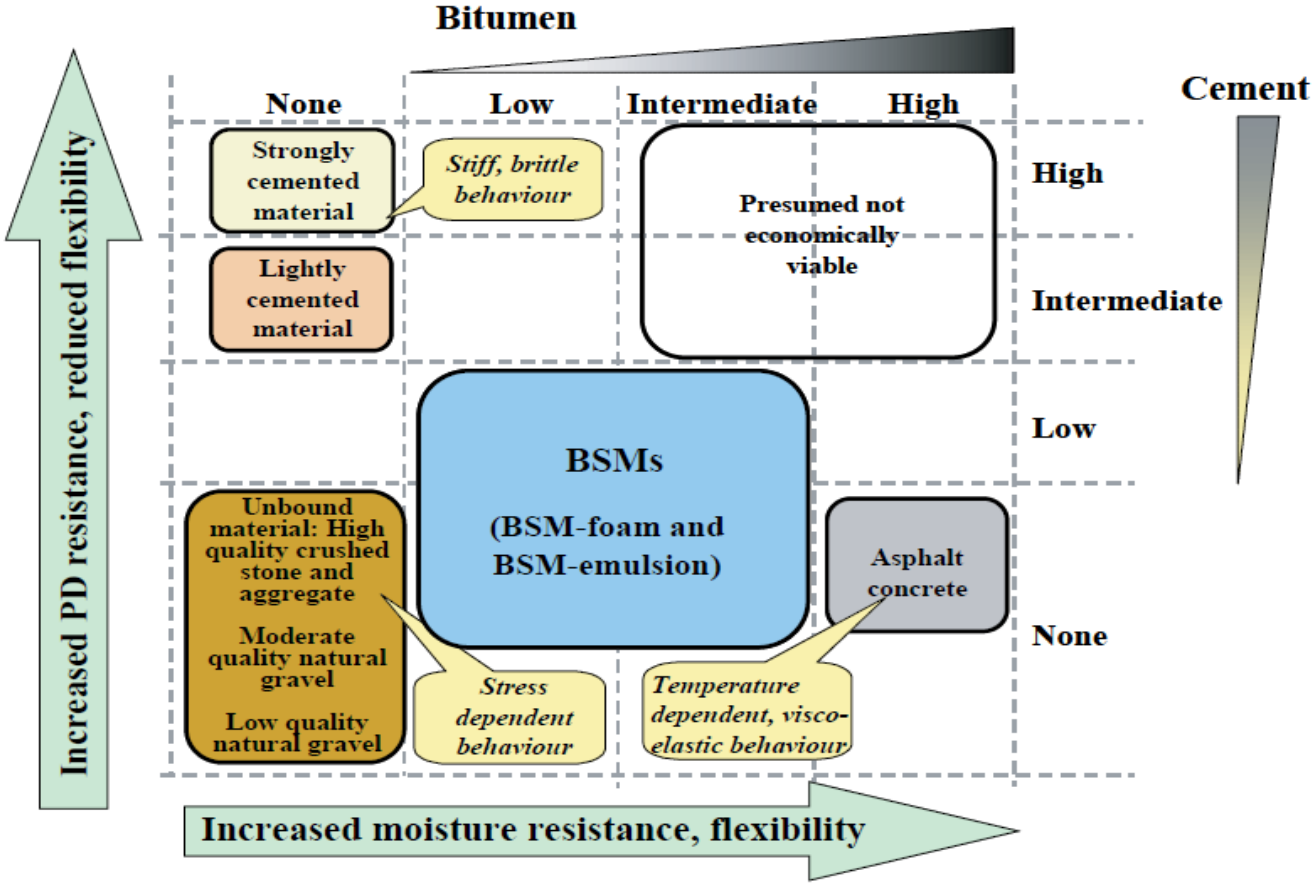
Foamed bitumen

Hydraulic binder

Bituminous emulsion

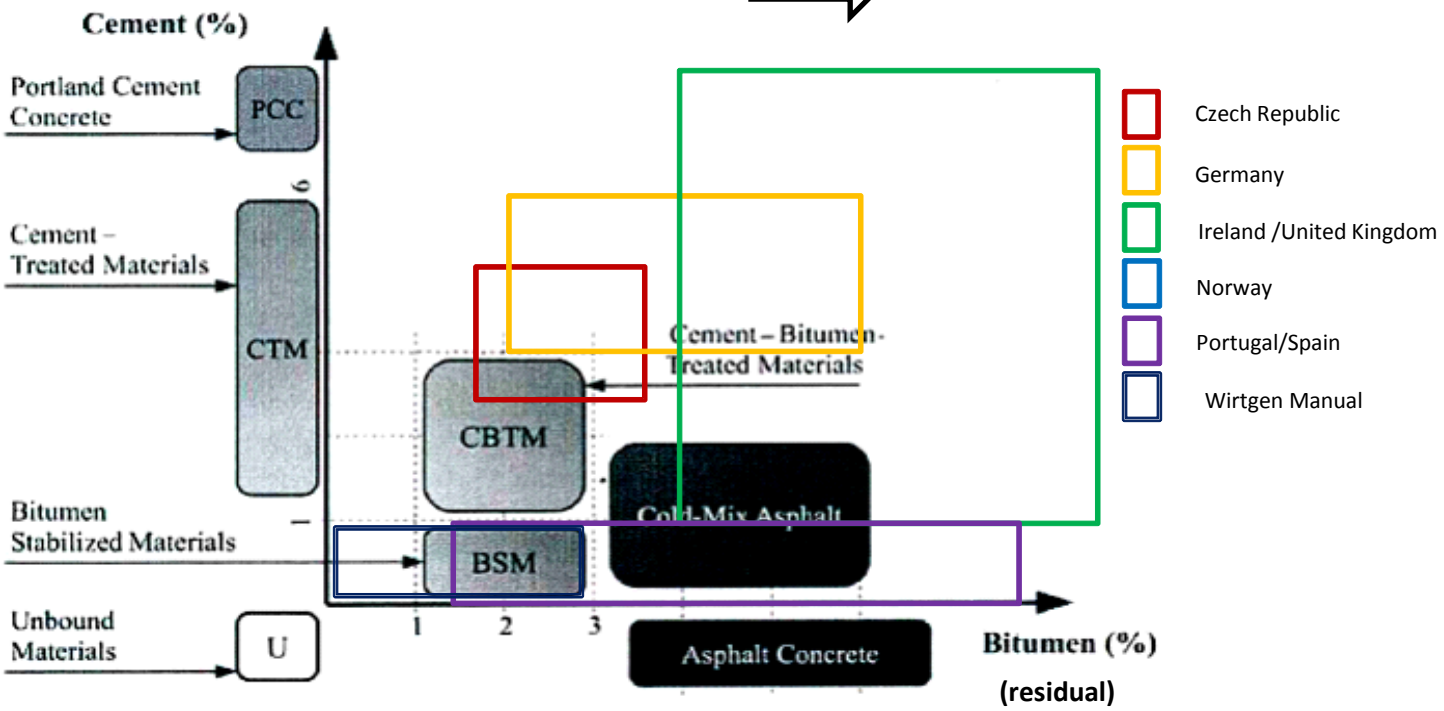
Bitumen stabilised cold recycling mixtures

Definition of cold recycled material – binder effect



Binder contents of cold recycling mixtures with bituminous emulsion in Europe

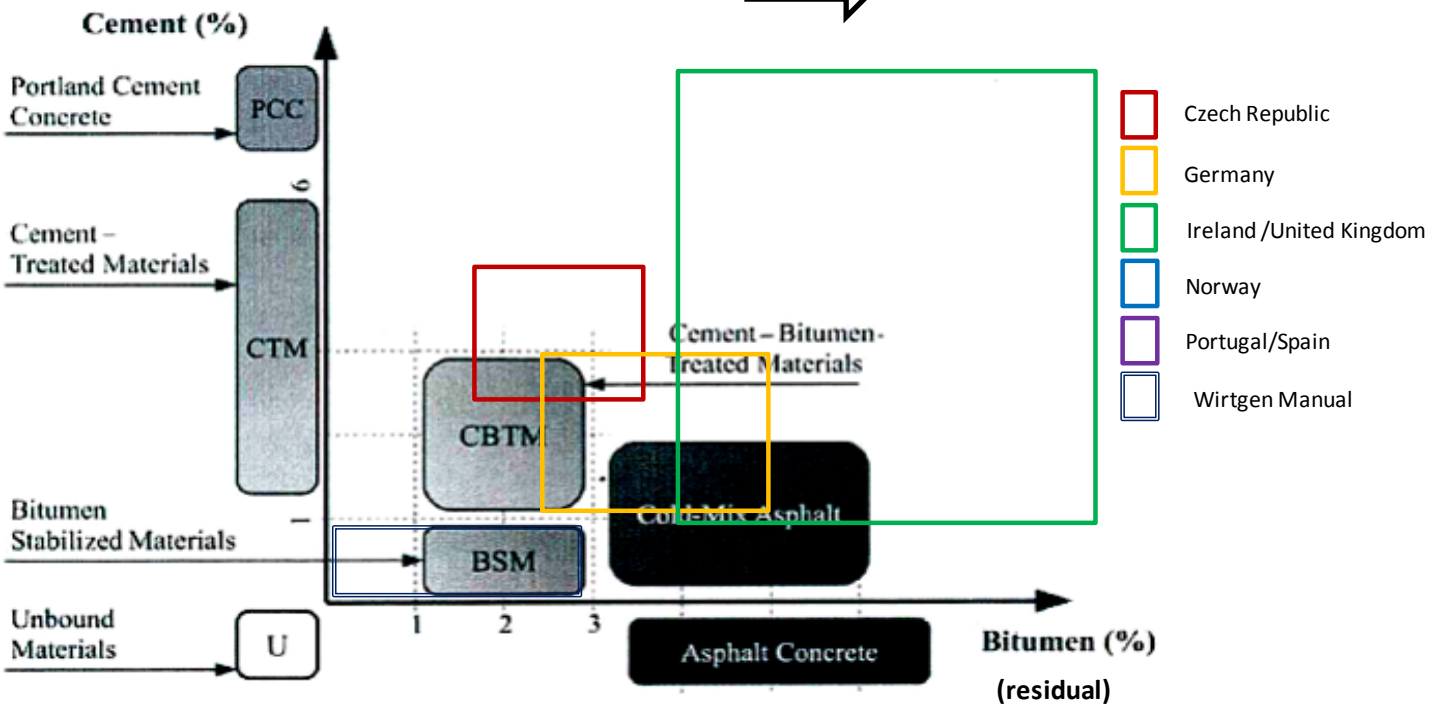
Different definitions



reference : Grilli et al. (2012)

Binder contents of cold recycling mixtures with foamed bitumen in Europe

Different definitions



reference: Grilli et al. (2012)

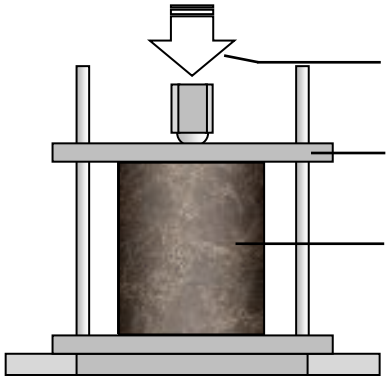
Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Comparison compaction methods used in Europe

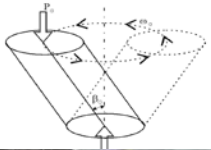
Static compaction

Marshall compaction

Proctor compaction

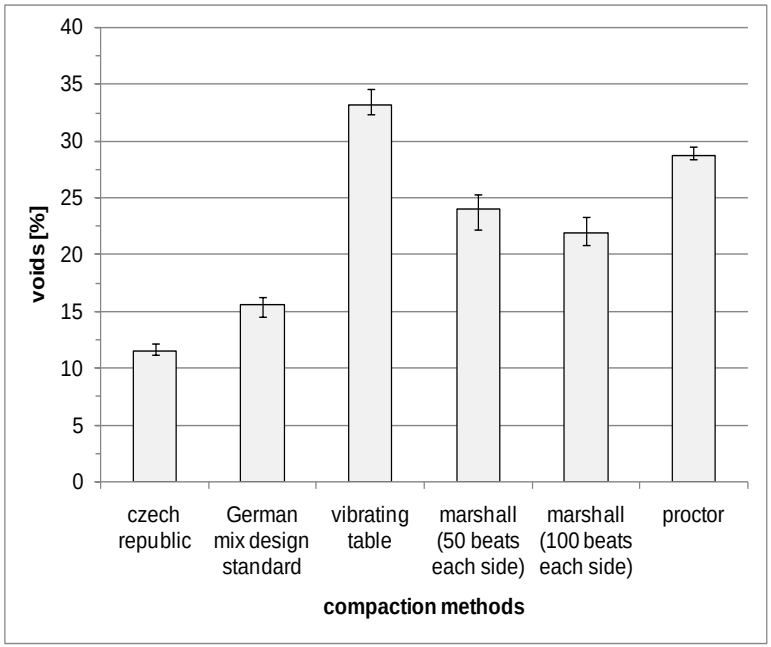


Duriez test



Gyratory compaction

Lowest void content with static compaction!



Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

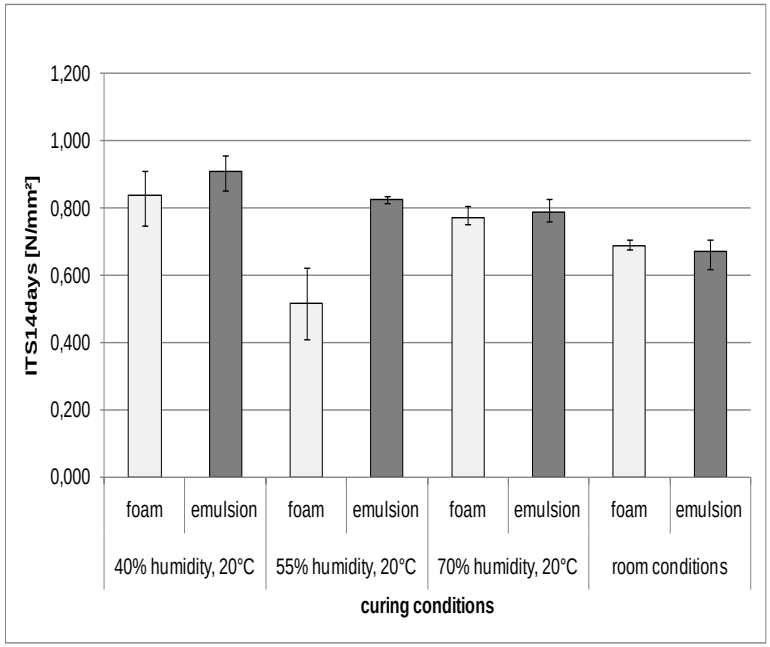
Influence of curing

Simulate different humidity...

...in climate chamber under well-defined conditions

...under room conditions

Cold recycling mixtures (foamed bitumen/emulsion)



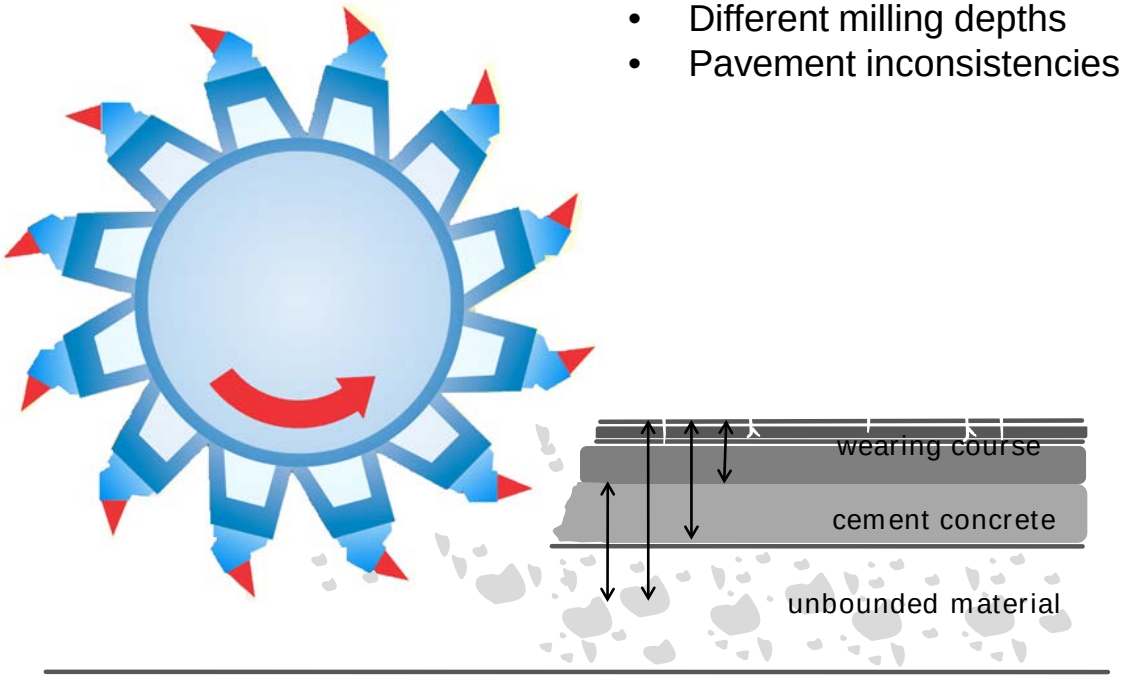
Activity of reclaimed asphalt bitumen

Cold recycling mixtures (w/ foam bitumen and/or bituminous emulsion)

Mix variables:

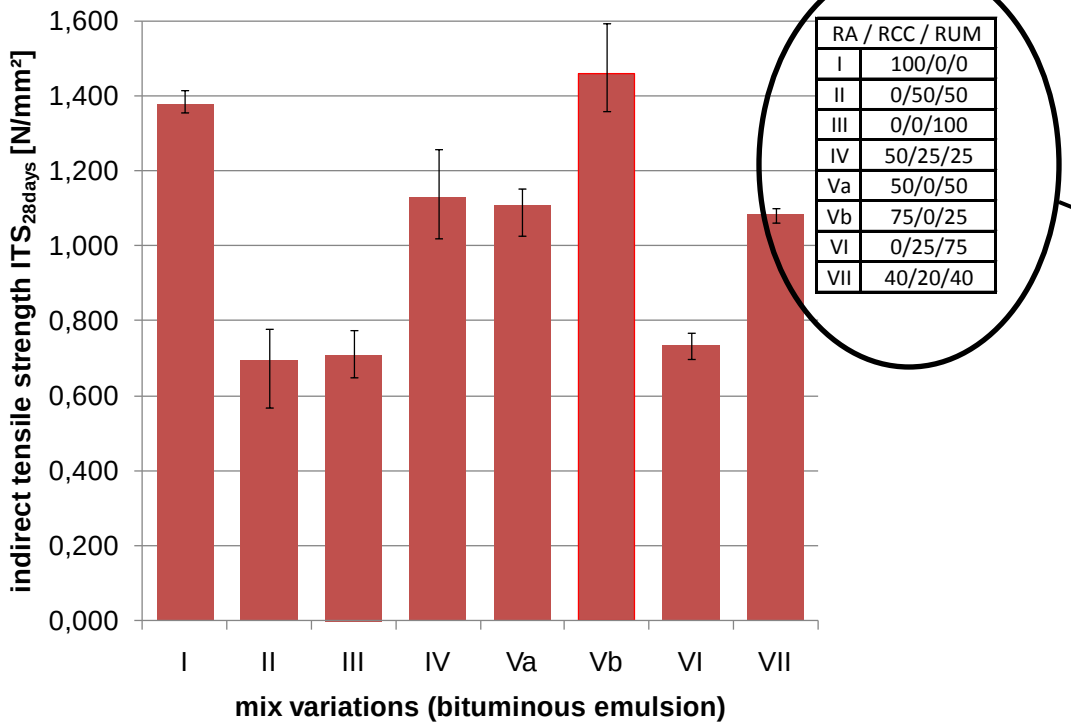
- Reclaimed asphalt
- Reclaimed concrete
- Reclaimed unbound material
- Different milling depths
- Pavement inconsistencies

ITS, water susceptibility, CBR



Activity of reclaimed asphalt bitumen

ITS Results (bituminous emulsion)



RA / RCC / RUM	
I	100/0/0
II	0/50/50
III	0/0/100
IV	50/25/25
Va	50/0/50
Vb	75/0/25
VI	0/25/75
VII	40/20/40

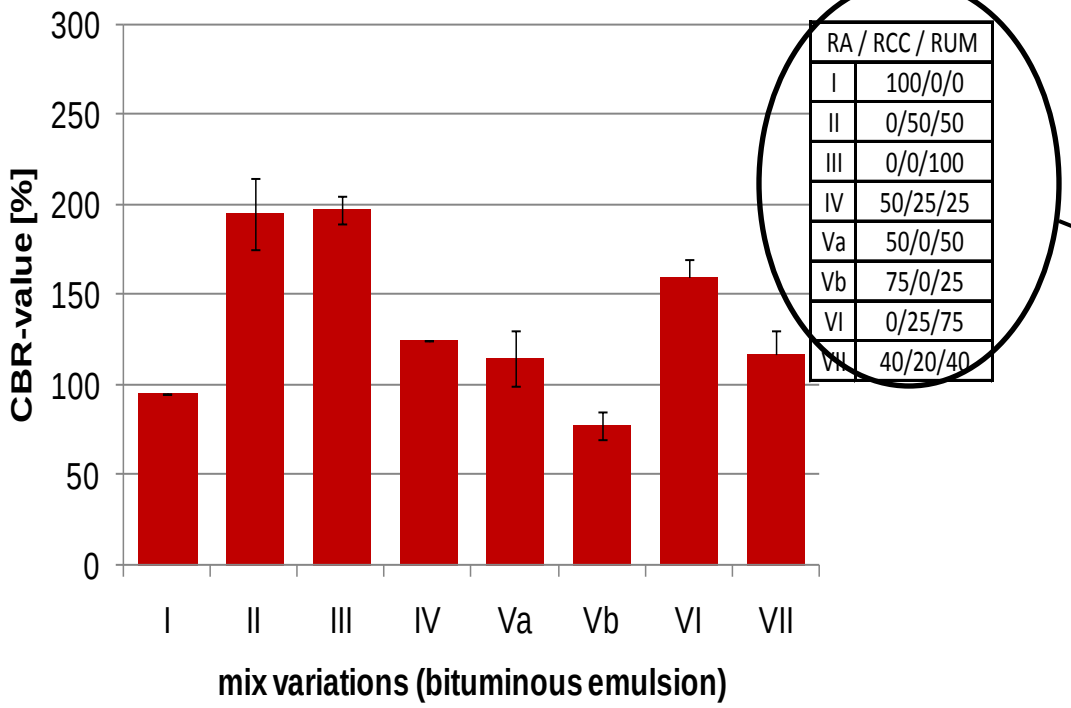
Different content of
- reclaimed asphalt
- reclaimed cement concrete
- reclaimed unbound material

Same content of
- water
- binder

Same grading

Activity of reclaimed asphalt bitumen

CBR Results (bituminous emulsion)



RA / RCC / RUM	
I	100/0/0
II	0/50/50
III	0/0/100
IV	50/25/25
Va	50/0/50
Vb	75/0/25
VI	0/25/75
VII	40/20/40

Different content of
- reclaimed asphalt
- reclaimed cement concrete
- reclaimed unbound material

Same content of
- water
- binder

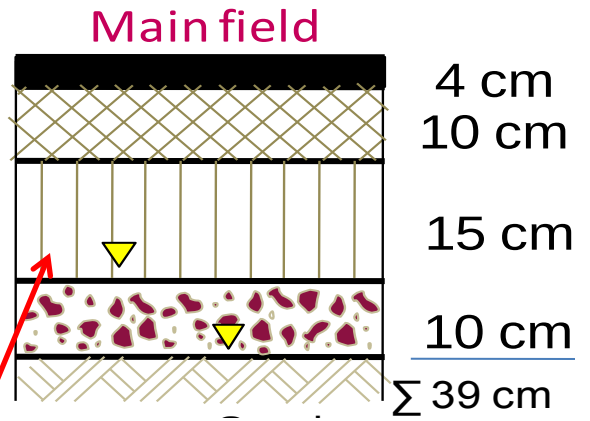
Same grading

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Selected job sites: Germany

Core drilling for leaching tests with tar contained layer immobilized by cold recycling and known mechanical properties

→ long term experience (25 years old)



Cold recycling layer with tar

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

Selected job sites: Finland

Material samples of asphalt top layer, gravel, asphalt top layer, unbound material

Sampling for studying material properties

Preparing Marshall specimens

The result…

Selected job sites: Finland

Bitumen tank in front of the WR recycler

Water for the right water content

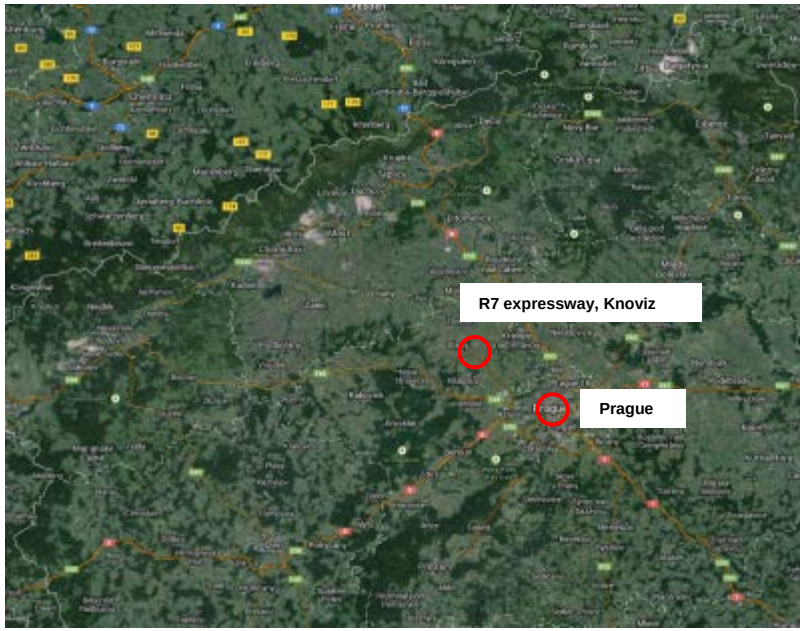
Milling and mixing gravel, asphalt top layer and unbound material

Compaction

Compaction check by Troxler sensor head

Selected job sites: Czech Republic

- rehabilitation of R7 expressway
- base layer cold recycling – depth of 18 cm
- length: 1,5 km



Cement application

Cold in-situ recycling by DCR machine

Selected job sites: Czech Republic

- use of foamed bitumen (2,8 %) and cement (4 %)
- overlay by 2 asphalt layers

Texture of recycled layer

Sufficient compaction

Water spraying on fresh CR

Selected job sites: Ireland

- N77: Hennebry's Cross, Kilkenny
- Legacy road, variable pavement structure
- 2 km trial section
- Bitumen emulsion and foamed bitumen

Characterization of Advanced Cold-Recycled Bitumen Stabilized Pavement Solutions

- Step 1: Recycling – 300mm depth (Emulsion or Foam Mix)
- Step 2: Sealing – at the end of each day (binder course)
- Step 3: HRA Overlay – 7 days after recycling

Selected job sites: Ireland

- 5 trial sections: 4 emulsion & 1 foamed bitumen
- Residual binder content: 2.2 – 3.0 %
- Cement content: 0 – 1.5%

- 12,000 tonnes of material recycled
  - 4,000 tonnes of bituminous
  - 8,000 tonnes of granular

- Data being used for:
  - Conditioning assessment
  - Environmental assessment (leaching & LCA)

Project Team

Coordinator: Dr Jan Valentin (CTU)

Project Team: Dr Fátima Batista (LNEC), Dr Michael Engels (Wirtgen), Mr Eanna Fallon (UCD), Dr Ana Cristina Freire (LNEC), Dr Ciaran McNally (UCD), Dr Konrad Mollenhauer (UoK), Ms Aoife Quinn (UCD), Ms Diane Simnofske (UoK), Mr Vaclav Snížek, Dr Amir Tabaković (UCD)

Thank you for your attention

ciaran.mcnally@ucd.ie