Effects on Availability of Road Network (EARN)

Recycling: Road construction in a post-fossil fuel society

TRL UNIKASSEL VERSITÄT UCD DUBLIN Shell Bitumen Lagan TU Delft

Overview

- Increased trend of using reclaimed materials in greater quantities when manufacturing new materials
- Provides an initial environmental benefit
- Longer term benefit? uncertain – changes in durability?
- Effects of change? cost of maintenance, financially to the client and environmentally to society in general
- So savings may be transitory
- Need a method for assessing and comparing… The EARN project

EARN project

- A CEDR Transnational Road Research Programme, Call 2012, Recycling: Road construction in a post-fossil fuel society
- Funded by Denmark, Finland, Germany, Ireland, Netherlands and Norway
- Academic partners:
- Industry partners:

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

Work packages

- Site trial of mixtures with and without reclaimed asphalt (RA)
- Review of existing service lifetime data
- Assessing mixture durability from early-life properties and monitoring initial in situ performance.
- Laboratory trials concentrating on the effects of ageing and moisture damage on the performance of the trial mixtures
- Develop life-cycle analysis models for using alternative materials to establish the availability of the network and the financial and environmental cost

Reclaimed Asphalt (RA)

RA Feedstock

- Supplied from the M1 motorway in North County Dublin
- A 14mm Porous Asphalt Surface Course with a Polymer Modified Binder laid circa 10 years
- Milled off Surface Course only to provide a feedstock of high PSV aggregate
- The milled stockpile was stored on the project before transferring to a Lagan depot in Kinnegad, Co Meath

Reclaimed Asphalt (RA)

RA Feedstock

Typical size: 20mm down

Reclaimed Asphalt (RA)

RA Processing

	+16mm	-16mm to +12,5mm	-12,5mm to +6mm	-6mm
Quantity	40t	45t	35t	50t
Percentage of total	24%	26%	21%	29%

- Powerscreen Chieftain for screening – not crushed
- Visual inspection: +16mm contained large particles of limestone material. Therefore the milling process must have taken some of the Binder course with it.

Reclaimed Asphalt (RA)

-16mm to +12,5mm

-12,5mm to +6mm

-6mm

Reclaimed Asphalt (RA)

RA Processed

The -16 to +12,5mm and -12,5 to +6mm combined for production purposes

Mixture components

SMA 10 Surf PMB 65/105-60 (based on NRA Clause 942)

- Reclaimed Asphalt
- Fresh 10mm gritstone
- Fresh Crushed Rock Fines (gritstone)
- Limestone filler
- Polymer Modified Binder
- Cecabase RT 945 warm mix additive

Mixtures

SMA 10 Surf PMB 65/105-60 (based on NRA Clause 942)

Mixture No.	Proportional content (%)					
	RA	10 mm	CRF *	Filler	Fresh Binder	Warm Mix Additive
1	0	65.9	21.8	6.7	5.6	0
2	28.6	43.8	17.0	5.7	4.9	0
3	38.1	34.4	17.1	5.7	4.7	0.5 **
4	28.6	43.8	17.0	5.7	4.9	0.5 **

*** Crushed Rock Fines**

**** Warm mix additive added to Mixtures 3 & 4 at 0.5 % of the total binder content in the mixture.**

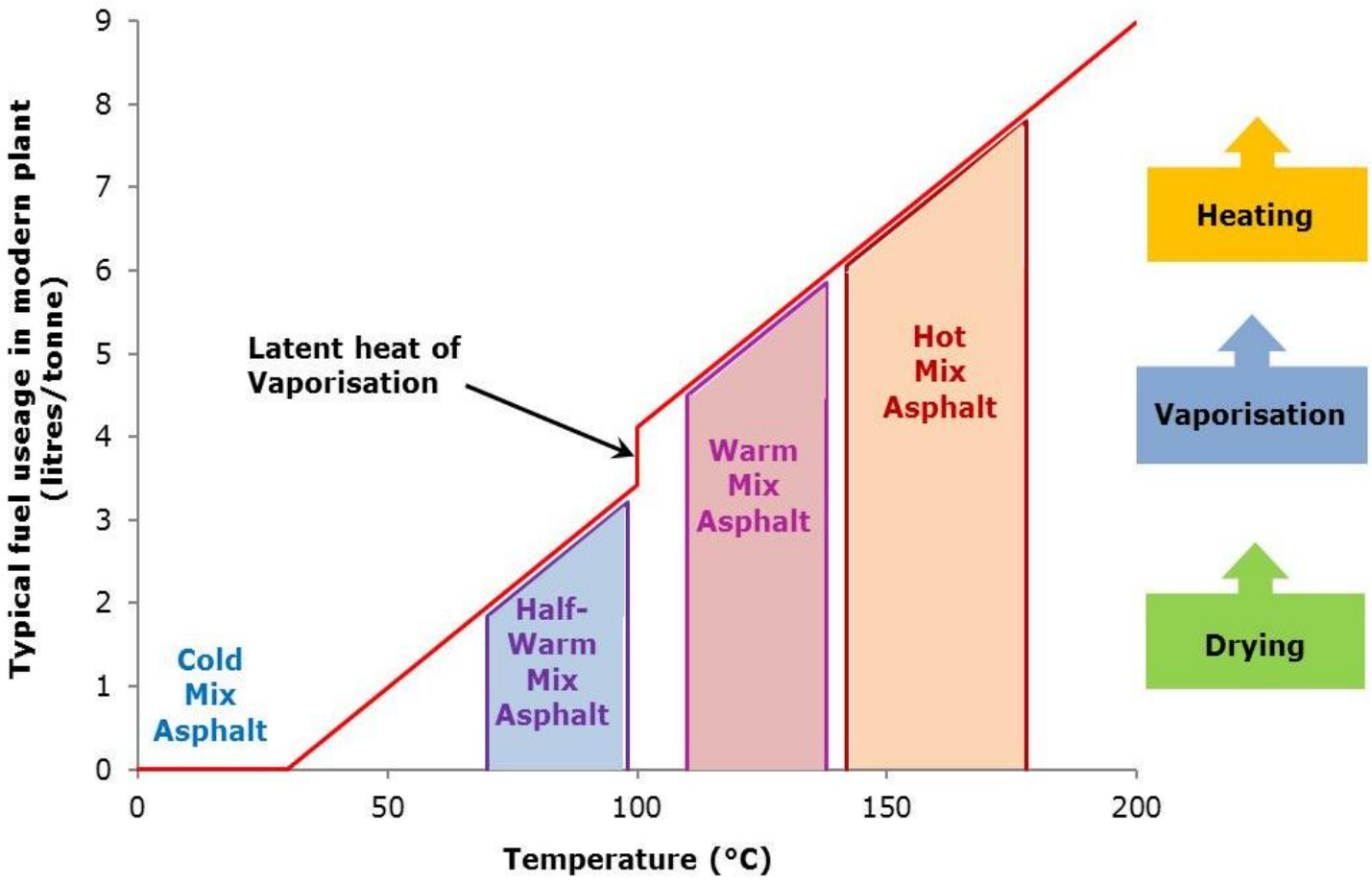
Binder Content

- Binder content of the RA was on average 4.5% for the two coarse fractions
- Recovered Penetration was 20 and Softening Point 65.4
- Is the binder still ‘active’ or is it just ‘black aggregate’?
- Debatable! So to be on the safe side we targeted 5.6% ‘total’ binder content and assumed only 50% of the binder was active
- Therefore even if the binder was 100% ‘active’ it would still only amount to a fluid binder content of 6.3% - 6.5%

How much RA?

- Conventional hotmix plants with the facility to add RA can generally add 10-15% cold RA and still remain in the hotmix temperature window by ‘superheating’ the fresh aggregate
- We wanted to push this boundary!
- Using graded RA and an additive normally used for Warm Mix
- The theory being we could add a greater quantity of RA with an output temperature in the ‘warm mix’ range
- We targeted 30% and 40% RA mixtures

How much RA?


Typical fuel useage in modern plant (litres/tonne)
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
Temperature (°C)
Latent heat of Vaporisation
Cold Mix Asphalt
Half-Warm Mix Asphalt
Warm Mix Asphalt
Hot Mix Asphalt
Heating
Vaporisation
Drying

Laboratory work

- **Mixing, handling & 'perceptual' properties of the RA mixtures**

  Aggs. 190^{o}C, Binder 180^{o}C, Filler, additive and RA ambient ^{o}C
  - Resultant 'output temperature' of RA mixes 135 - 145^{o}C
  - Lab mixture was difficult to handle, looked dry and formed 'lumps' of material particularly with the 40% RA

- **Gyratory compaction**

  Mixtures maintained at 130^{o}C for 1 hour
  - Easy to compact in range of 90 - 110 ^{o}C
  - 50 gyrations of compaction effort resulted in 4 to 6% voids

- **Binder Drainage**

  Schellenberg method used at a temperature of 190^{o}C for 1 hour
  - The binder drainage was less than 0.3%

Laboratory work

- **Wheel tracking**

  Carried out at 60^{o}C for 45 min in accordance with BS 598

  - Both materials compliant with Clause 942
  - Increase in RAP did however appear to increase rutting - 3.1mm compared to 2.3mm

- **Water sensitivity**

  Compared the dry and soaked ITSR of 100mm diameter specimens
  Soaking period was 7 days at 40^{o}C

  - Both mixtures achieved ITSR of 92%, (NRA minimum is 80%)
  - The ITS of the 40% RA mixture was higher, this could be the result of the additional hard binder coating the RA

Manufacturing

Monitoring – Carbon footprint

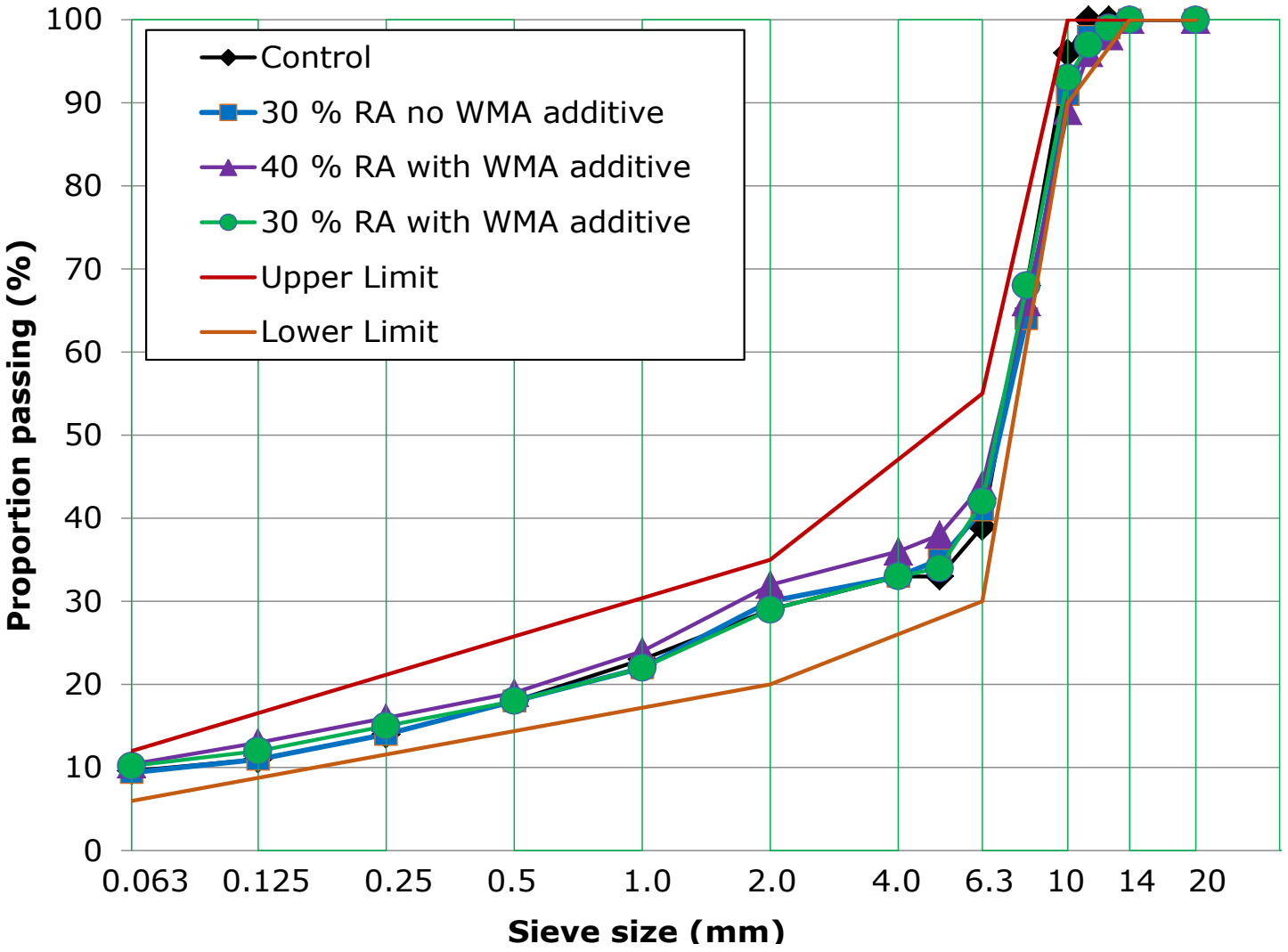
Gas Oil consumption per minute

Electricity consumption over the trial

Manufacturing – points of note

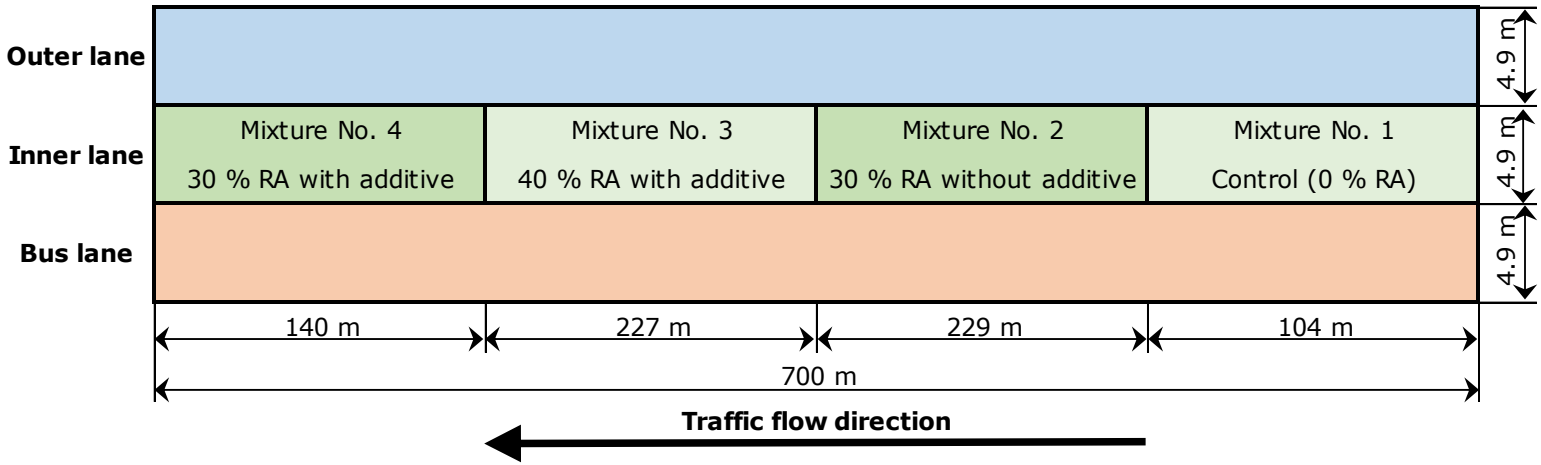
- RA feed capacity / mixer capacity
- Moisture and fumes
- Raw material feed temperature
- Final output temperature
- Overflow of aggregate hotbins
- Addition of additive

Manufacturing - composition



Trial site

N3 city bound between Clonee and Blanchardstown
average daily traffic >15,000



Trial site

- Existing HRA milled
- Nominal 20mm depth of SMA 6 reg laid to provide a uniform substrate throughout
- Nominal 40mm depth of 10mm SMA Surf for all trials
- Laid with shuttle buggy
- Ride quality good

Trial site - temperatures

Mix No.	RA content (%)	Containing warm mix additive	Load No.	Start Chainage (m)	End Chainage (m)	Discharge temp. (°C)	Rolling temp. (°C)
1	0	No	1	0	104	150	134
2	30	No	2	104	155	115	105
			3	155	220	130	115
			4	220	333	150	130
3	40	Yes	5	333	385	137	125
			6	385	458	135	125
			7	458	560	134	128
4	30	Yes	8	560	618	125	118
			9	618	672	132	124
			10	672	700	136	128

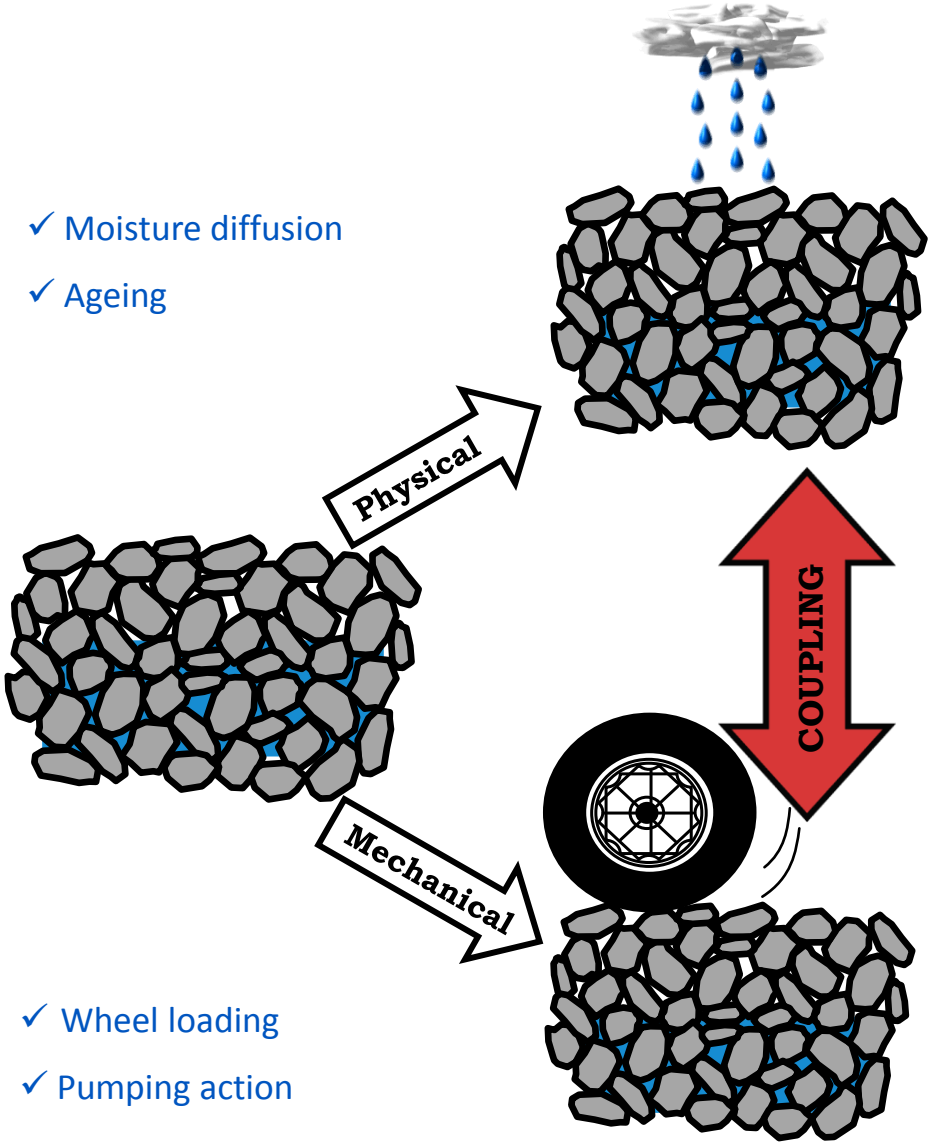
- 30% RA mix without additive – temperature issue with 1st load
- 40% and 30% RA mix with additive - consistent temperature

Trial site

Trial site - cores

Ageing & moisture induced damage

- ✓ Moisture diffusion
- ✓ Ageing



- ✓ Wheel loading
- ✓ Pumping action

***Degradation** of the **cohesive strength** of the binder*

***Loss** of the **adhesion bond** between aggregate & binder*

Testing Protocol

Water bath conditioning at 60°C for various time intervals

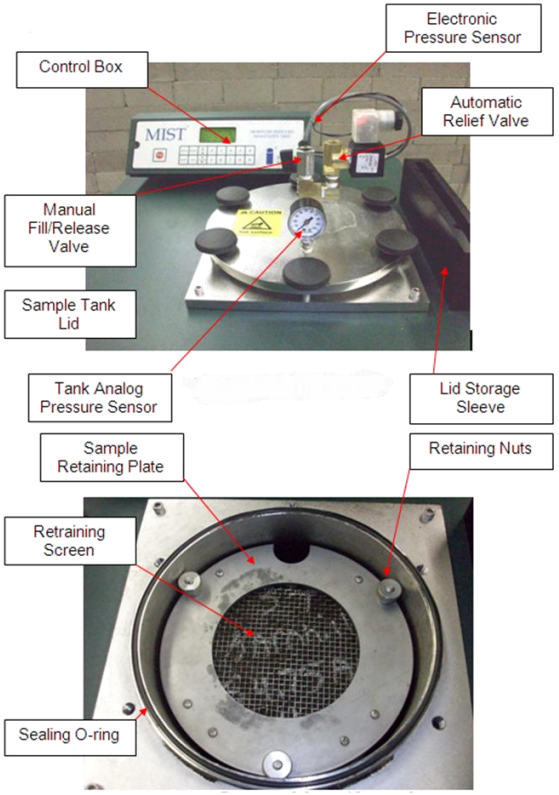
Water bath conditioning at 20°C for 2 hrs

MIST conditioning for 3500 cycles

Stored at a chamber at 20°C

Water bath conditioning at 20°C for 2 hrs

Indirect Tension Test (ITT)



Moisture Induced Sensitivity Tester (MIST)

TU Delft

Trans national benefits

The benefits of a methodology for evaluating the true potential financial and environmental “loss” from using reclaimed asphalt, secondary materials or warm asphalt will be of benefit to all organisations that are developing alternative strategies for dealing with a post-fossil fuel society.

This view applies to suppliers, consultants and road authorities working on local, national or international projects.

There are various options being used evermore frequently in efforts to make better use of the resources available. However, the true sustainability of them is needed to ensure that they are worthwhile.

Whilst the intentions are genuine, the full implications of any change are rarely reviewed to check that an option does provide a whole-life financial and /or environmental cost reduction.

Thank you