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 site 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.**

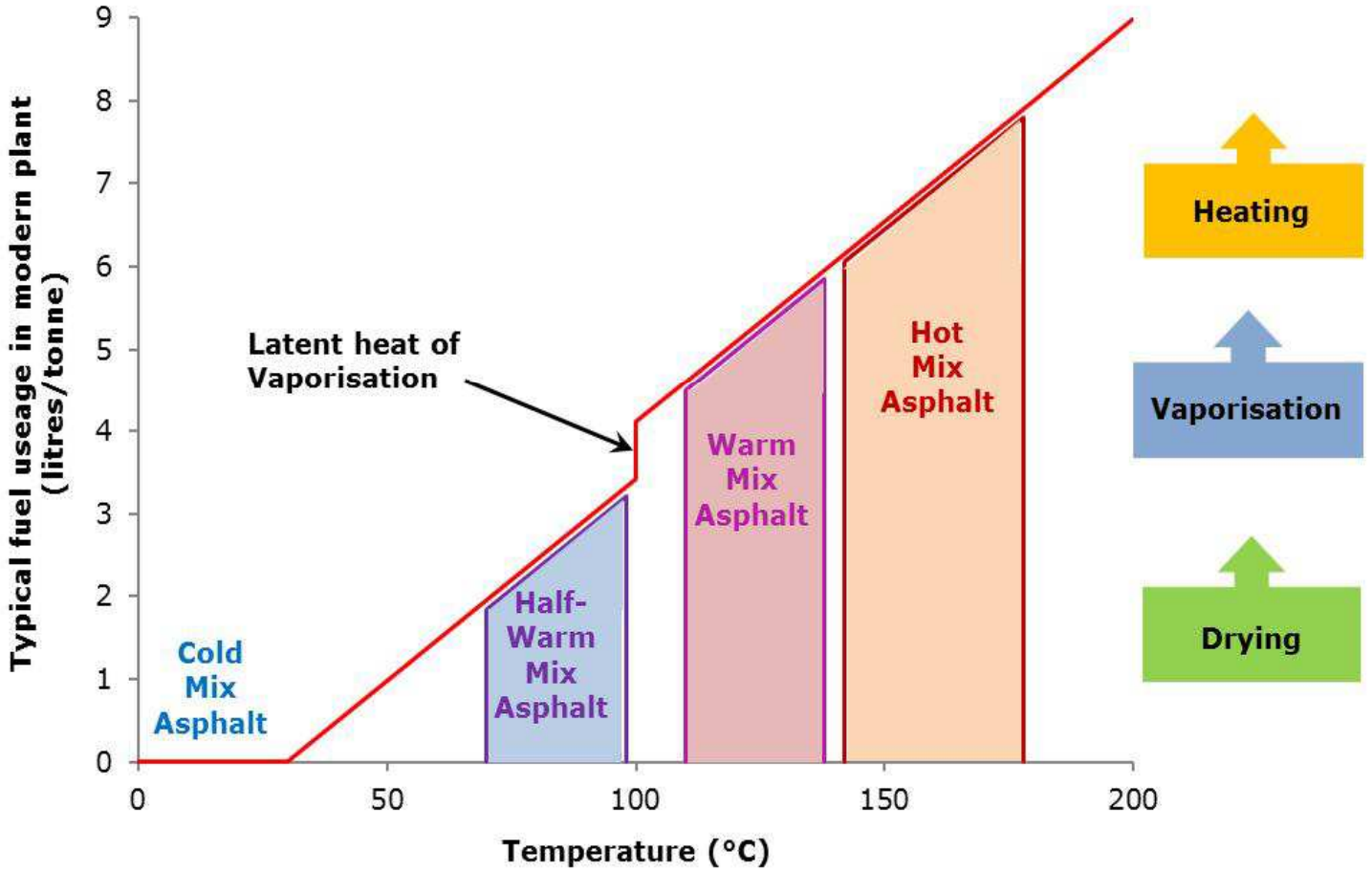
Binder Content

- 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 NRA Cl 942 (Max rate 5mm/hr, Depth 7mm)
  - 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

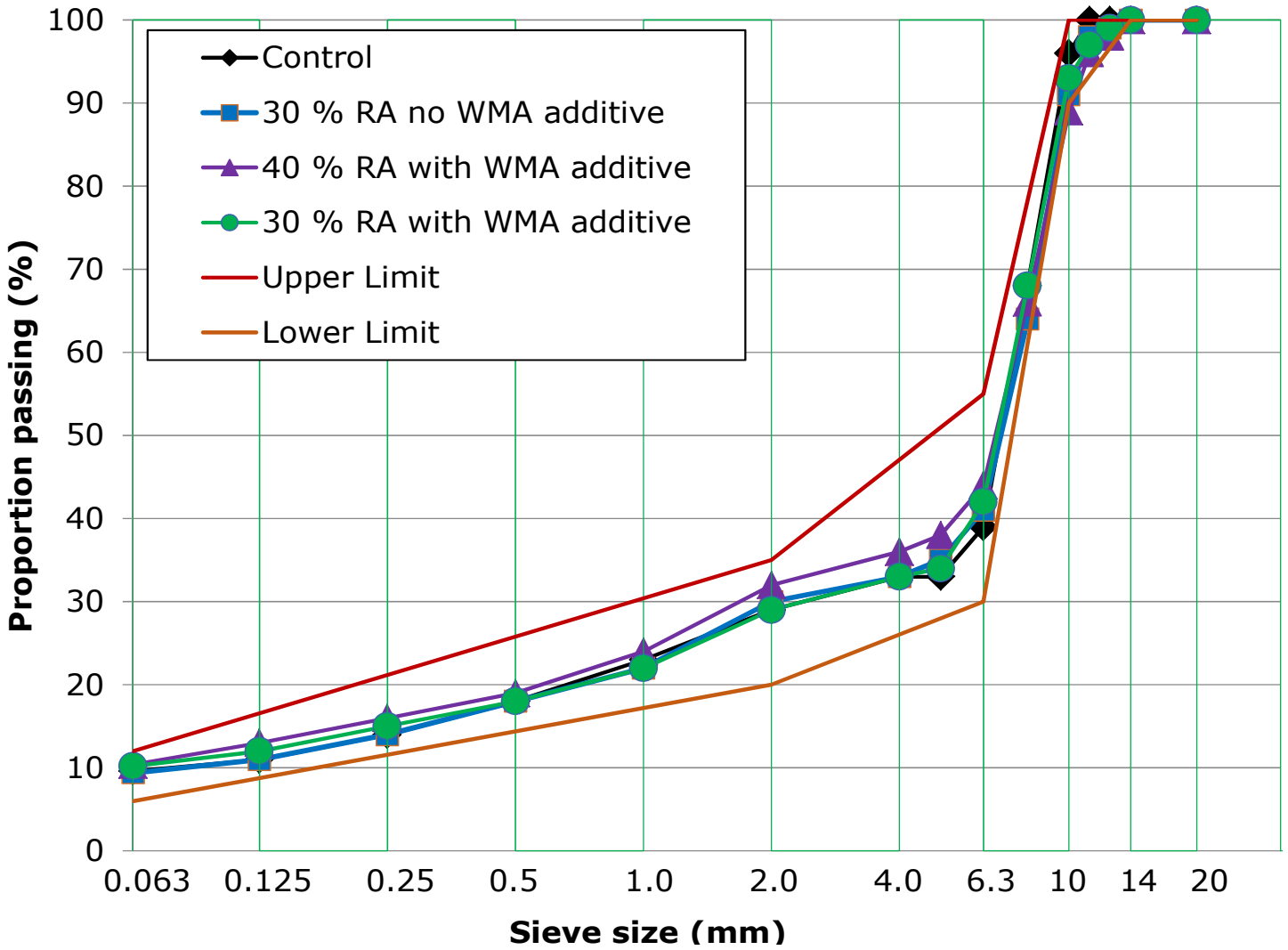
Gas Oil consumption per minute

Electricity consumption over the trial

Manufacturing – points of note

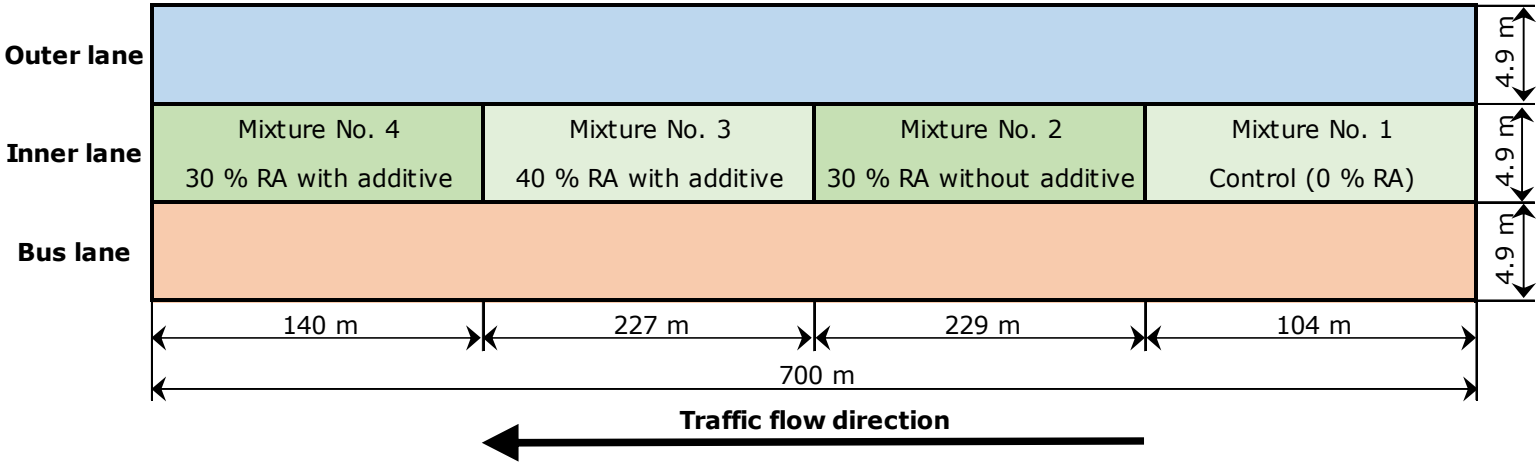
- RA feed capacity / mixer capacity
- Moisture and fumes
- Raw material feed temperature
- Final output temperature
- Overflow of aggregate hotbins
- Addition of additive

Manufacturing - composition



Trial site

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



Trial site

- Existing HRA Surface Course 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 the aid of a shuttle buggy
- All materials laid on 11th July 2013 in good weather conditions

Trial site

Trial site

Trial site

Trial site

Trial site - cores

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 - monitoring

Section No	Test Period (month)	IRI (m/km)			MPD (mm)
		Left	Right	Average	
1	0	1,25	1,23	1,24	0,86
2		0,96	0,99	0,98	0,76
3		1,04	1,10	1,07	0,68
4		1,33	1,43	1,38	0,77
1	6	1,06	1,36	1,21	0,62
2		1,17	1,06	1,11	0,61
3		1,17	1,13	1,15	0,55
4		1,70	1,45	1,58	0,73
1	12	1,24	1,33	1,29	0,77
2		1,18	1,03	1,11	0,64
3		1,21	1,12	1,16	0,53
4		1,51	1,37	1,44	0,70
1	24	1,69	1,56	1,62	0,76
2		1,15	1,08	1,11	0,63
3		1,15	1,06	1,11	0,55
4		1,41	1,52	1,46	0,62

Trial site - monitoring

Section No	Test Period (month)	SFC	SC
1	6	0,72	0,50
2		0,68	0,47
3		0,64	0,44
4		0,68	0,46
1	12	0,54	0,49
2		0,52	0,48
3		0,49	0,45
4		0,50	0,46
1	24	0,59	0,47
2		0,57	0,45
3		0,54	0,43
4		0,58	0,46

Trial site – monitoring

- Relatively consistent performance across trial sections
- Good Ride Quality - IRI values < 2m/km
- Mean Profile Depth slightly low – 0.53 to 0.86
- Scrim Coefficient – reduced with higher RA content

Site trial – link to other Work Packages

- Moisture sensitivity of cores taken from site (MIST testing)
- LCA (environmental & financial) on the impacts of using high RA content


Thank you
Quality
Asphalt