An Roinn Iompair
Department of Transport

Comhairle Contae Mhuineacháin
Monaghan County Council

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Development of a Low Energy Bound Material

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Introduction

- Initial Trial – 2020
- Working Group
- 2022 Trial
- Environmental Benefits
- Video
- Next Steps

Initial Trial 2020

- Existing Stock of LEBM/RAP – Accumulated 5000 -10000t
- EPA Article 27 Process (New Guidance 2022)
- Successfully repurposed 3000t of RAP Asphalt Millings on 4km of local Roads
  - Produced Cold-mix Asphalt using 100% RAP
- Peer Review - Recommendations
  - Cement inclusion – to help with early life strength
  - Site selection & pavement design
  - Establish a Working Group to help direct and monitor future Trials

Working Group - Collaboration

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Working Group Focus

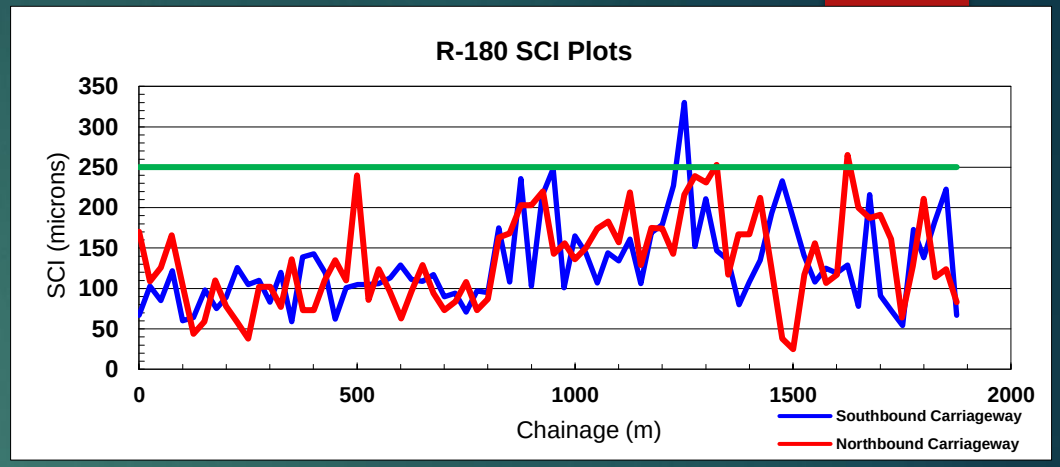
- Develop an alternative “low carbon” pavement material for use on Ireland’s road network
- Propose the most efficient production method for use of the RAP feedstock
- Mixture design and pavement design to optimise material use and maximise performance
- Continuous assessment to determine performance and lifecycle costs
- To propose a new mix specification for TII Series 900

The 2022 Trial

- Site Selection
- Pavement & Mix Design
- RAP Processing
- Site works – Transportation & Installation
- Performance Testing & Monitoring

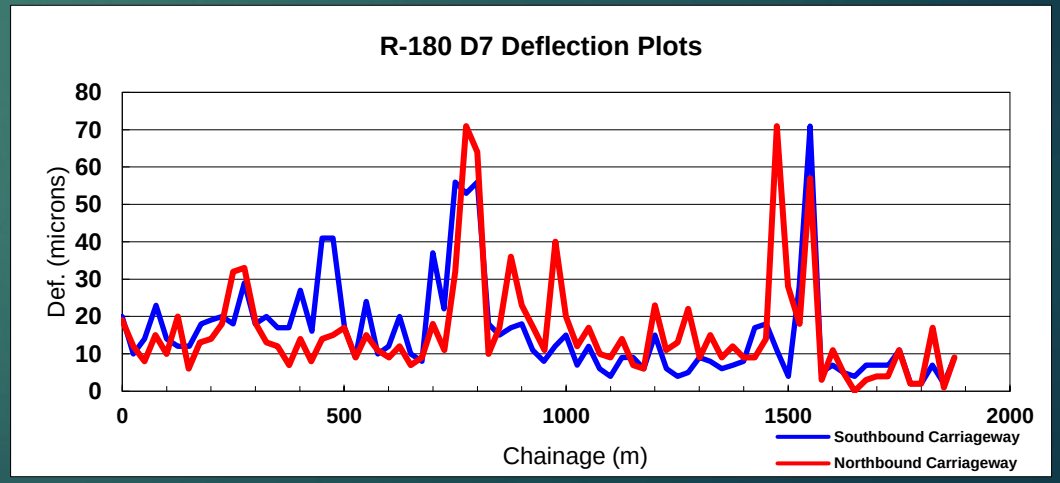
2022 Trial Site Selection

- Proposal to carry out the trial on a regional or Local Primary road using the following criteria:
  - PSCI rating of between 1-4
  - High AADT level (National Secondary)
  - Has the appropriate structural characteristics
- Non Destructive - Testing of 3 sites:
  - GPR - Ground Penetrating Radar testing
  - Falling Weight Deflectometer (FWD) testing
- Visual assessment:
  - Deformation in wheel paths
  - Fatigue cracking in wheel paths
  - Pavement failures in wheel paths
  - Surface ravelling



Outer Deflection (D7)	
<15	Stiff subgrade
15-30	Stiff to moderate subgrade
31-45	Moderate to weak subgrade
>45	Weak subgrade

SCI (D1-D2)	
<150	Good Load Spreading Ability
150-250	Good to poor load spreading ability
251-400	Poor to bad load spreading ability
>400	Bad load spreading ability

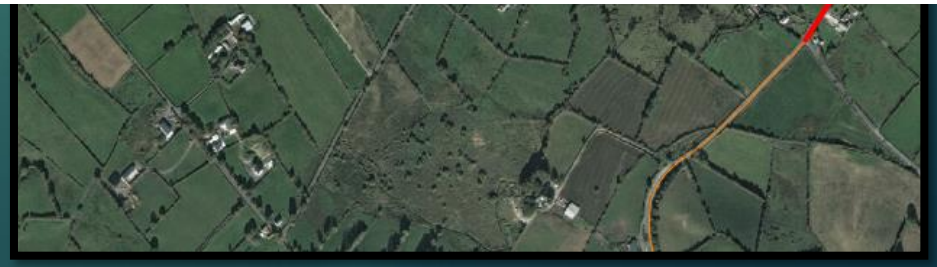


2022 Trial Site Selection

- The R-180 regional road in Monaghan was selected as the most suitable road to carry out the trial.
  - PSCI Rating 1-4
  - AADT 1941
  - 12.2 % HGV's
- Destructive testing was carried out to develop an appropriate pavement design:
  - Core samples of the existing pavement
  - Trial holes (c. 1m depth) at various locations identified from non-destructive test analysis
  - Trial Pits - Samples were taken of the granular layers in each trial pit and tested:
    - Gradation
    - Atterberg limits
    - Moisture Content
    - Optimum Moisture Content

Table 1: Trial Pit 1 Pavement Profile

Trial Hole	Dir.	Ch. (m)	Material	D(mm)	Photo
1	SB	501	Bituminous	120	
			Granular	240	
			Soil	-	



Processing of the RAP Stockpile

Screening & Feedstock Management

- Screening of existing RAP stockpile → 0/32 mm grading
- NB. Best practice = Segregate RAP stockpiles, e.g. HRA, binder course layers, etc

Before **After**

Laboratory Mix Design Process

- Samples from RAP stockpile were provided to Colas Contracting Ltd.
  - Lab tests conducted include:
    1) Moisture content of the RAP
    2) RAP binder content and analysis of recovered binder
    3) Grading of RAP aggregate
- Mix recipe:
  - % RAP
  - % corrective aggregate (if any)
  - % water (if any)
  - % emulsion to be added and % oil in the emulsion
- Mix performance tests:
  1. % Air Voids content
  2. ISTM Stiffness Modulus
  3. Resistance to Rutting
  4. Resistance to Water Sensitivity

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Table 2 - Grading requirements of target composition

Table 3 – Mix performance test results

Mix characteristic	Test Method	Laboratory Curing Regime	Results	Specification
Maximum dry density	EN 12697-5 Procedure A	N/A	2373 kg/m^3	N/A
Percentage of air voids	EN 12697-31 Gyratory compaction with setting of 600 kPa load, 1° angle,12 revs/min. and 100 gyrations	N/A	6.2%	$V_{max\ 13,0}$
Stiffness Modulus	EN 12697-26, IT-CY at 20 °C, 124 ms	Conditioning for 14 days at 35 °C and 20 % R.H. The conditioning at test temperature over nigh, before testing.	2769 MPa	$ITSM_{2000}$
Resistance to Water Sensitivity	EN 12697-12, Method B	Conditioning all specimens for 7 days at 18 °C and 40 to 70 % R.H. Then conditioning "Dry" subset at 18 °C and 40 to 70 R.H. for further 7 days, while conditioning "Wet" subset in water at 18 °C for 7 days.	**80**	$i/C_{min\ 70}$
Resistance to Permanent Deformation	EN 12697-22, Procedure B at 45 °C, small device	Conditioning for 14 days at 35 °C and 20 % R.H. The conditioning at test temperature over nigh, before testing.	4.2%	$PRD_{AIR\ max\ 10,0}$

Pavement Design - IAPDM

- IAPDM = Irish Analytic Pavement Design Method
  - For overlay or inlay pavement designs, the input factors include:
    1) Existing pavement structure (trial holes/trenches)
    2) Stiffness modulus of the existing layers and foundation (FWD analysis)
    3) ISTM Stiffness Modulus of the proposed new pavement layers
    4) Design life of 20 years = 2.3 msa Design Traffic
- Proposed Pavement Options:
  A. 150 mm of LEBM cold-mix

     versus

  B. 125 mm of AC 20 dense bin hot-mix


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R180 Monaghan Rap Trial

Pavement Rehabilitation Design Report

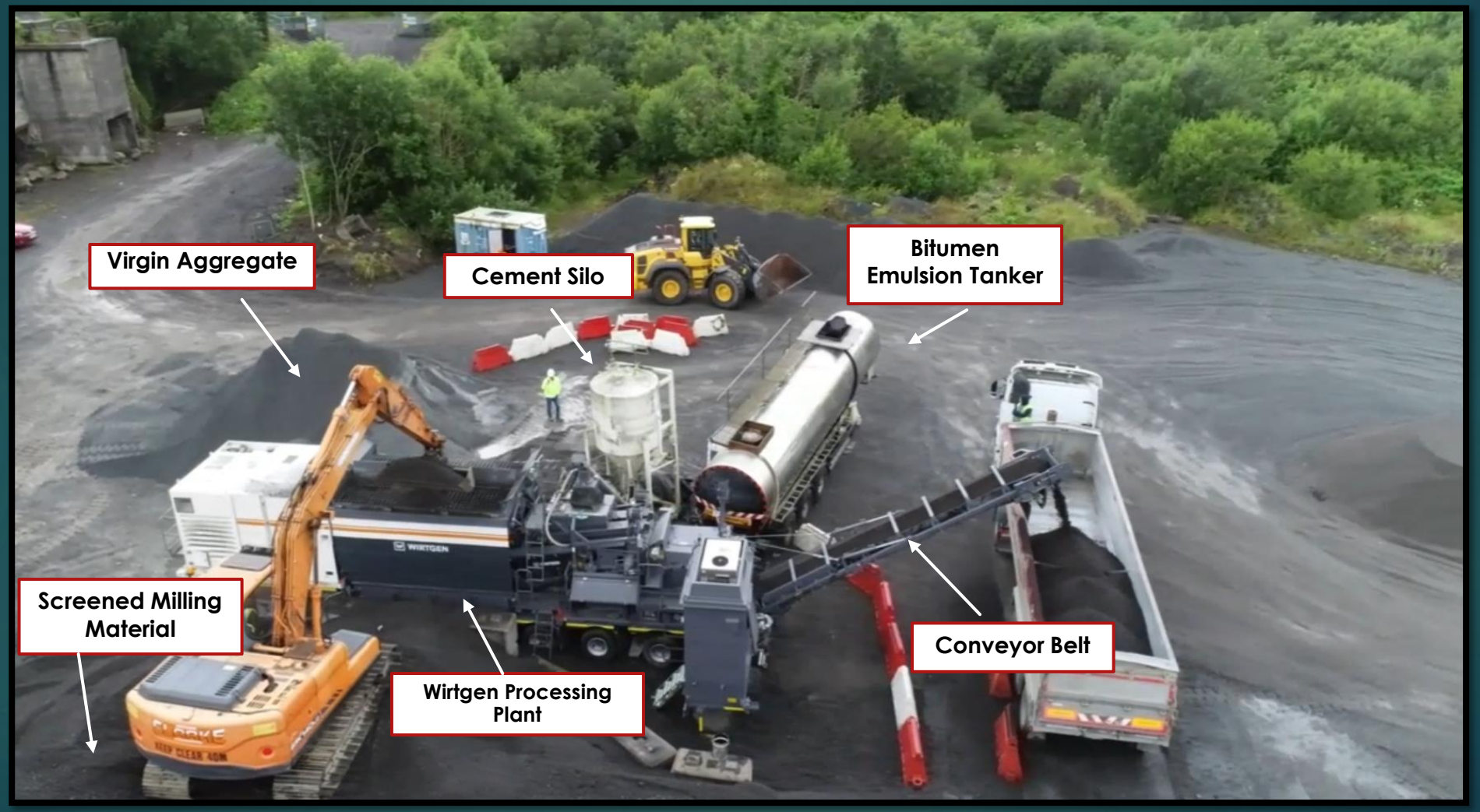
Draft 2 | 11 July 2022

Southbound		Overlay Thickness (mm)	
From km	To km	LEBM L2	AC20 70/100
0	500	50	50
500	800	80	70
800	1475	145	125
1475	1900	145	125

Table 15: Overlay design thickness per homogeneous section - Northbound

Northbound		Overlay Thickness (mm)	
From km	To km	LEBM L2	AC20 70/100
0	500	50	50
500	800	80	70
800	1475	150	125
1475	1900	110	90

Cold-Mix Asphalt Production Process



QC & Performance Testing & Monitoring

During the works operation, QC testing included:

1. Moisture content, grading and binder content of the RAP stockpile
2. Moisture content, grading and binder content of the mixed material
3. Void Content & In-situ Density – Sand Replacement Test

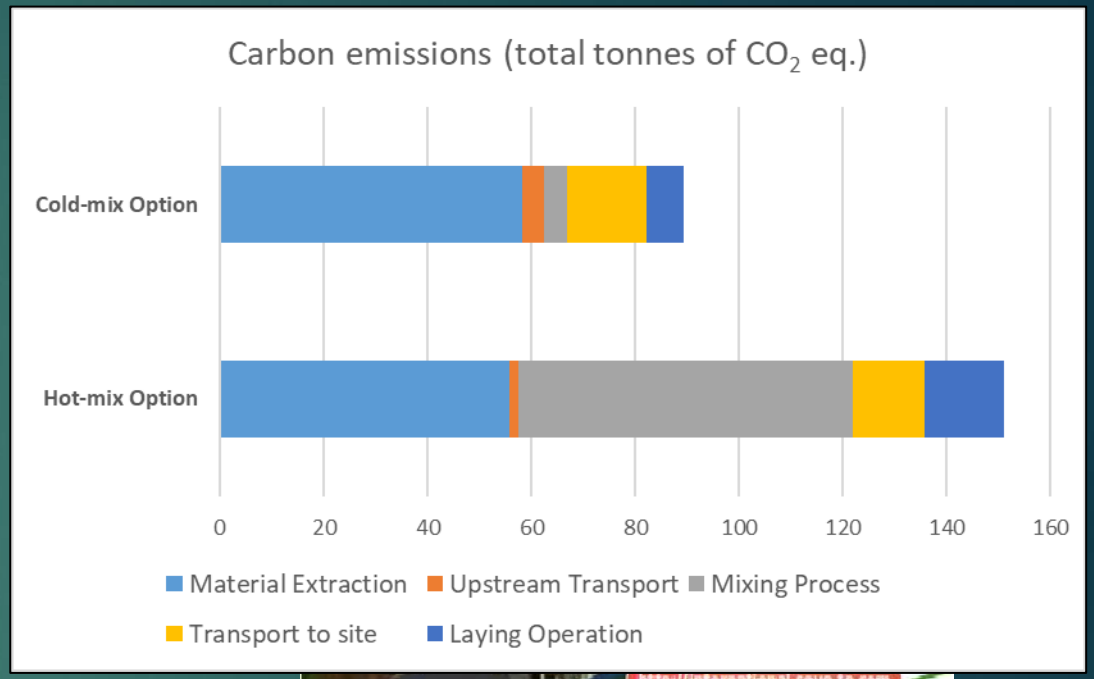
Environmental Benefits

- Used a carbon calculating software tool to compare the carbon footprint of the two proposed pavement solutions:
  - A. 150 mm of LEBM cold-mix

    versus
  - B. 125 mm of AC 20 dense bin hot-mix

- Analysis includes factors such as:
  - Carbon footprint of the raw materials used
  - Energy used in the mixing process
  - Transport distances – of both raw materials and the asphalt mix

- Carbon savings = 61.8 tonnes or 40.8 %
  - Equates to 44 tonnes per km or 8.8 kg/m^2



Pavement Solution	Material Extraction	Upstream Transport	Mixing Process	Transport to site	Laying Operation	Total
Hot-mix Option	55.9	1.5	64.6	13.8	15.4	151.2
Cold-mix Option	58.3	4.2	4.5	15.1	7.3	89.4

Site Trial – Transport & Installation

- Laid 150 mm of LEBM/RAP cold-mix in 2 layers @ 75 mm depth
- Laid using conventional paving methods
- Compacted two stage process –
  1. Larger steel drum roller for deep compaction
  2. PTR – to squeeze out moisture and help curing
- Material was left to cure for 5 days - lightly trafficked the following day
- Double surfaced dressed directly on to LEBM/RAP cold-mix
- Key Learning: General laying methods – operatives training

Site Trial – Transport & Installation

Post Construction Performance Testing

The following schedule of testing is ongoing:

1. Post Construction FWD and visual assessment:
   - Weekly for 1st Month
2. Post construction FWD and visual assessment
   - at 3, 6 & 12 months
3. Post construction profilometer same:
   - at 3, 6 & 12 months
4. Post construction coring:
   - as soon as practicable at 3, 6 & 12 months.
5. Medium to long term monitoring to be decided following review of test results after 1year.

Video

Next Steps

- TII Standard Series 900 - 2023
- Potential Usage – Appropriate roads throughout National, Regional and Local Road Network (Greenways)
- Continue to monitor scheme to determine Material/Pavement performance.
- Determine Lifecycle costs and compare with conventional methods
- LA's to take lead in processing of materials & continue to develop alternatives product methods
- Programme for Government: 51% Reduction in CO_2 by 2030
- EPA New requirements – Article 27, 28 End of waste status ?

Thank you!

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