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Roadstone Innovation Trial High Reclaimed Asphalt Use – 60% RA

William Wilson

Objectives of the Trial

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- Demonstrate that:
  - RA is suitable to be added to new pavements at levels in excess of the current maximum allowable level of 30%
  - Materials incorporating RA can provide equivalent performance to virgin mixes
  - Equivalent compaction levels are achievable when using RA
  - Durability of the materials containing RA is not compromised
  - Demonstrate the environmental benefits of increasing RA in new pavements

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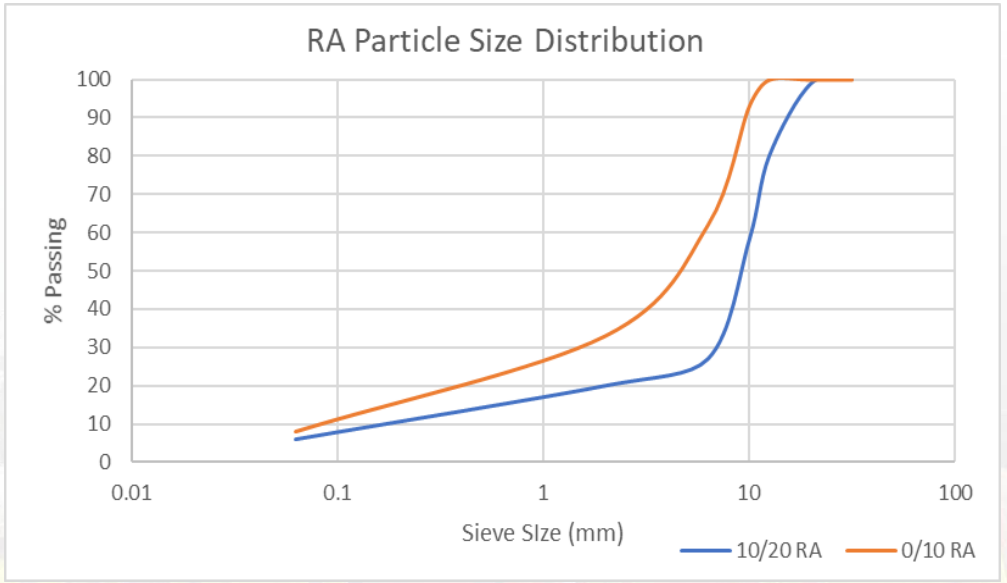
Lab Design

Analysis of the RA Utilised

Average values for gradation and recovered binder properties were assessed

	10/20	0/10
Binder Content (%)	3	5.2
Penetration (dmm)	26	26
Softening Point (°C)	68	65



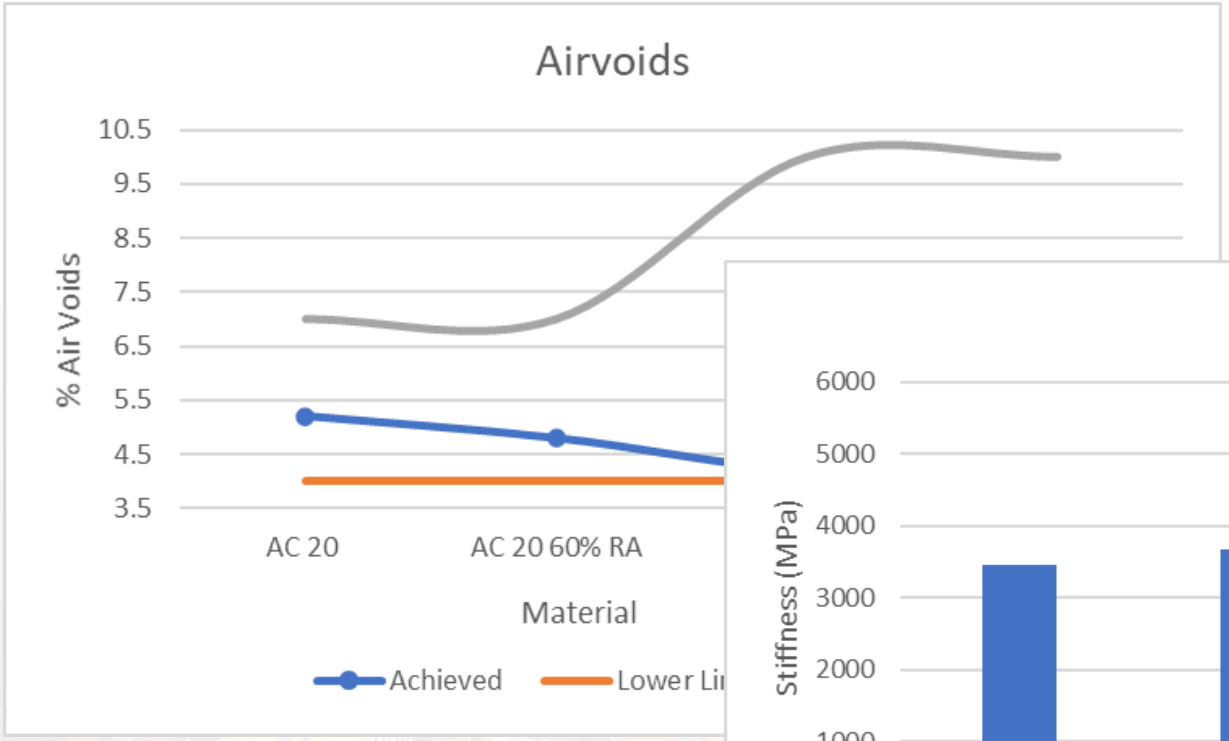
Binder contents and properties are in line with typical values

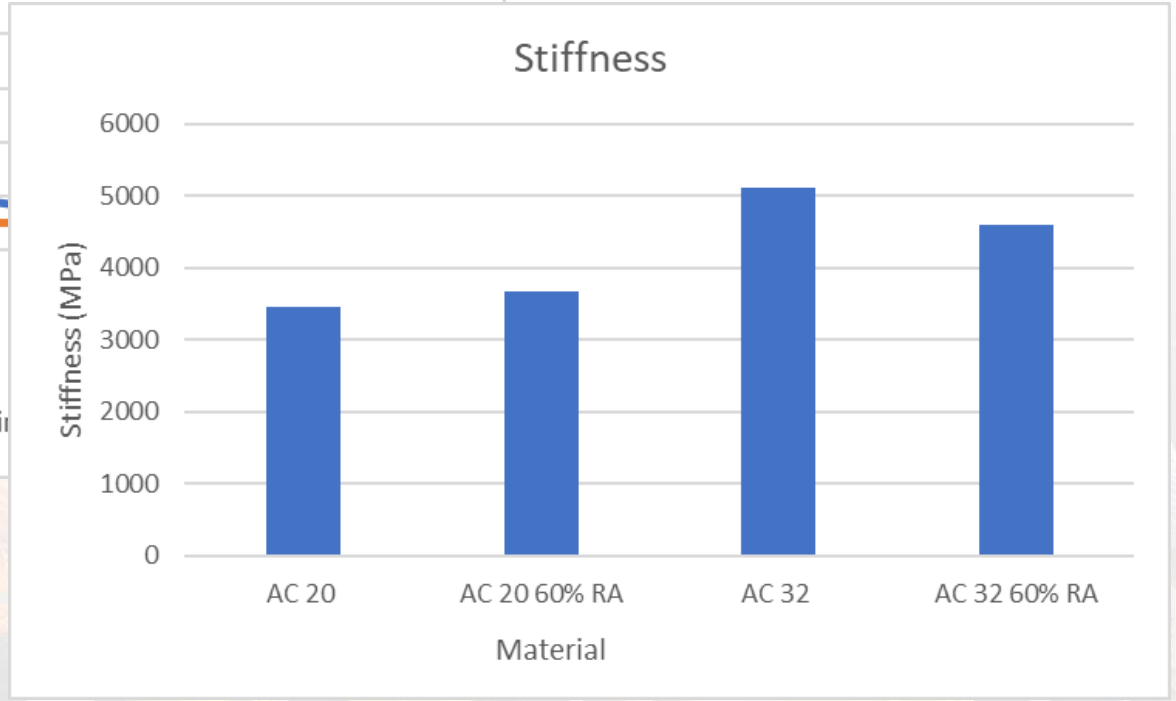
Lab Design

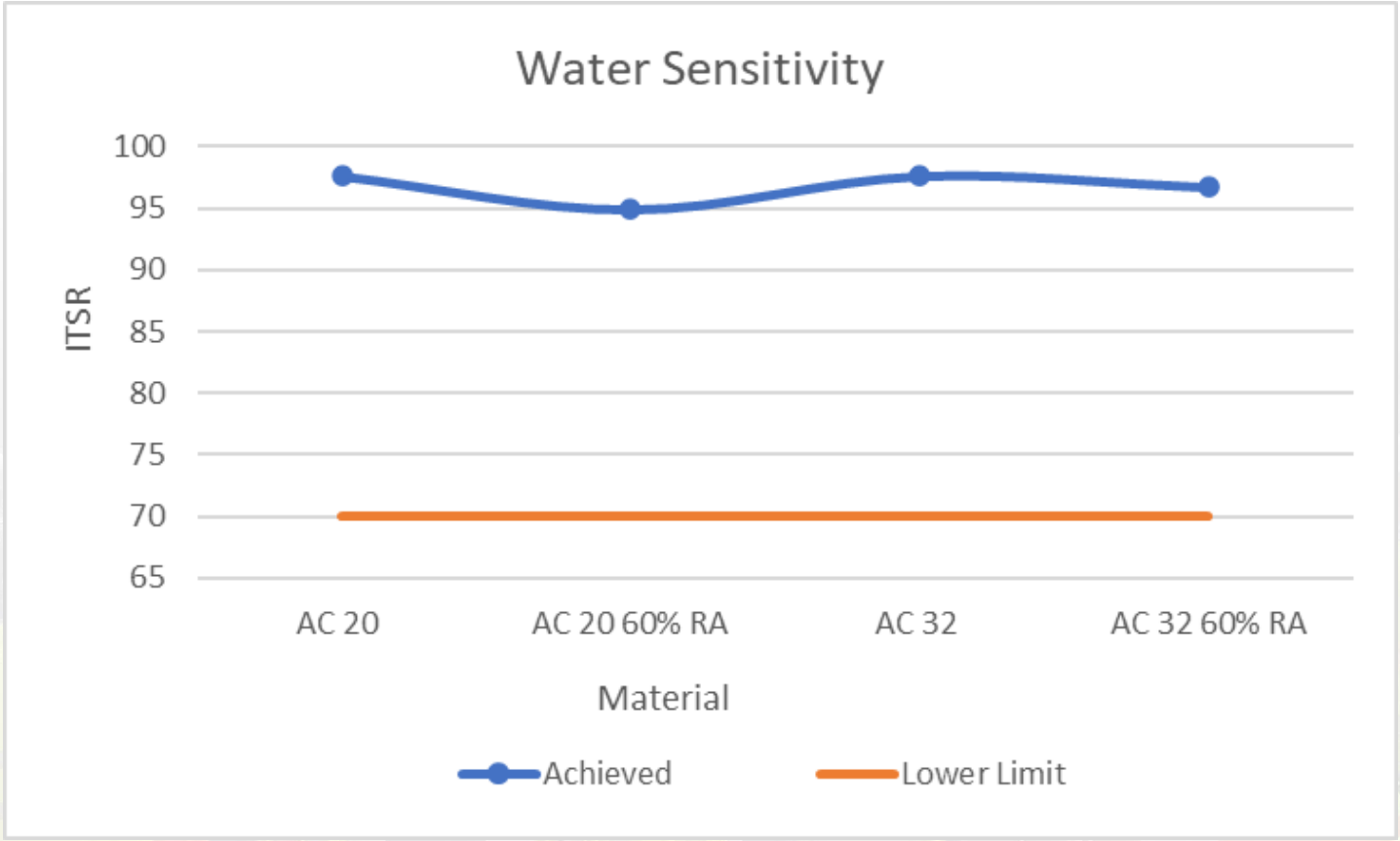
- Provide an equivalent performing product to standard virgin materials
- Materials:
- Ac 20 dense bin 40/60 des Cl. 3.1.4

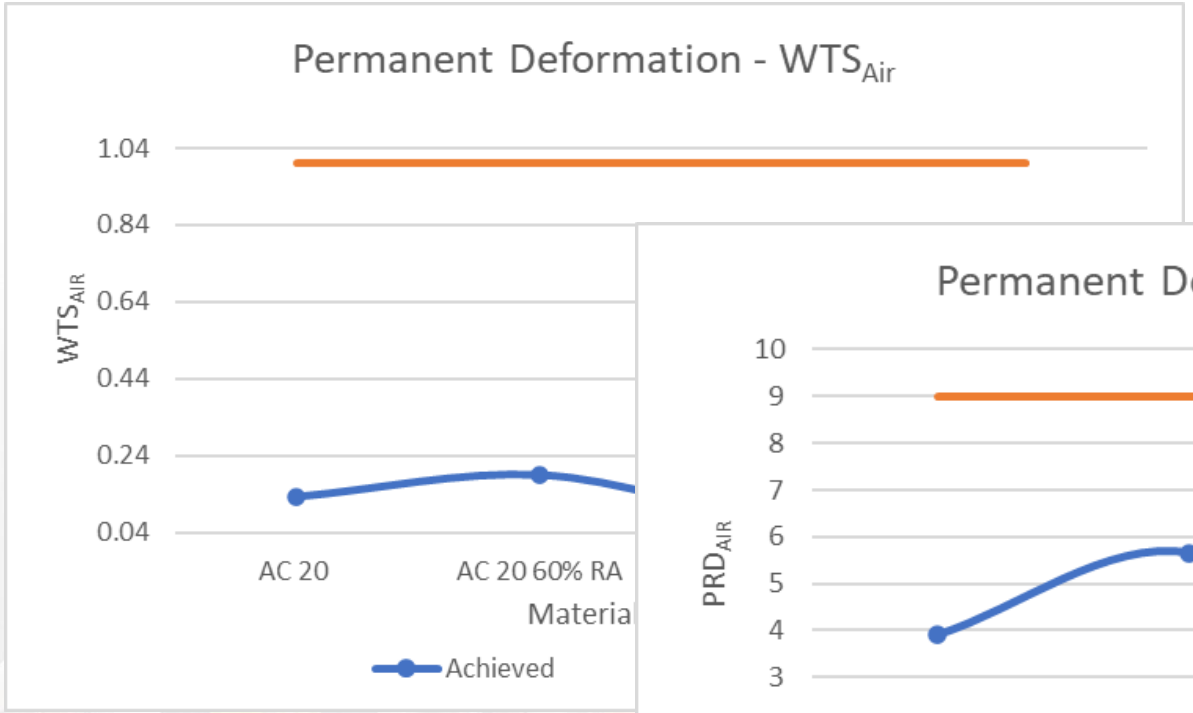
- Ac 32 dense base 40/60 des Cl. 3.1.1

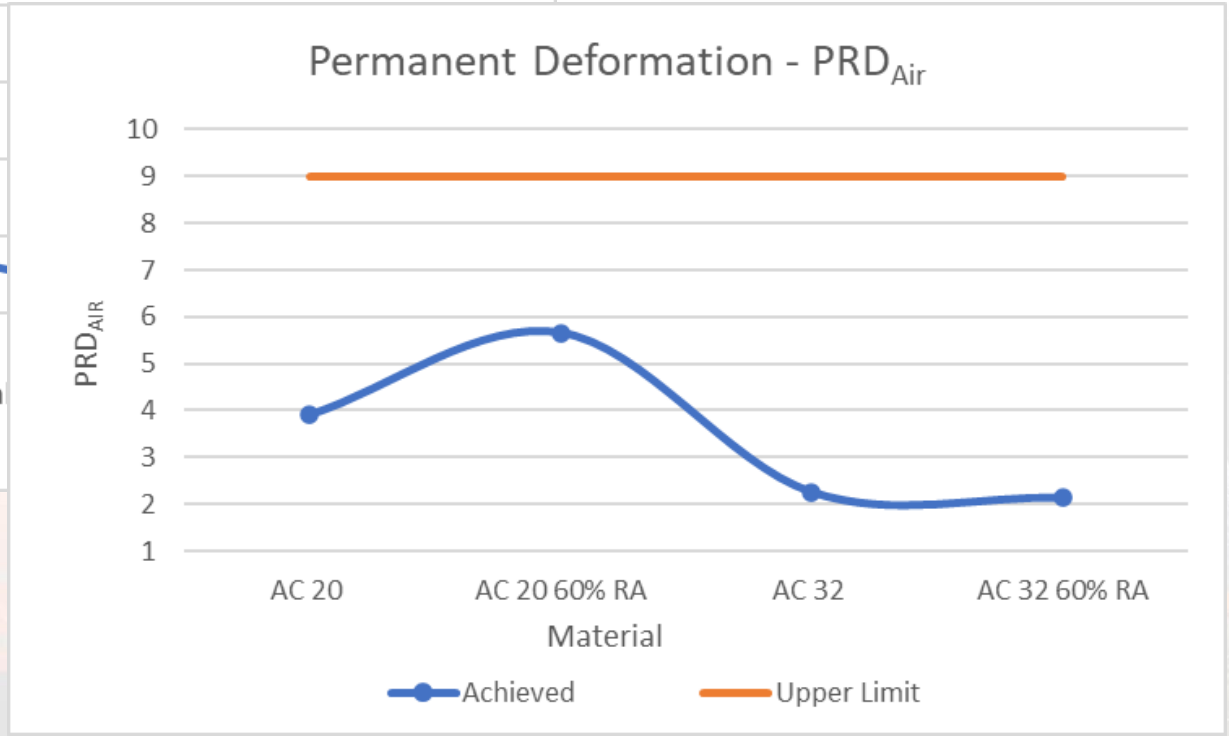
- Design work Completed on Ac 32 and Ac 20 virgin and 60% RA materials
- A Rejuvenator (ReLIXER®) was used to improve the characteristics of the RA
- Performance characteristics examined were
  - Compaction levels
  - Stiffness
  - Water Sensitivity
  - Permanent Deformation were all tested


Airvoids
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
% Air Voids
AC 20
AC 20 60% RA
Material
Achieved
Lower Li


Stiffness
6000
5000
4000
3000
2000
1000
0
Stiffness (MPa)
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material


Water Sensitivity
100
95
90
85
80
75
70
65
ITSR
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material
Achieved
Lower Limit


Permanent Deformation - WTS$_{Air}$
1.04
0.84
0.64
0.44
0.24
0.04
WTS$_{AIR}$
AC 20
AC 20 60% RA
Materia
Achieved


Permanent Deformation - PRD$_{Air}$
10
9
8
7
6
5
4
3
2
1
PRD$_{AIR}$
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material
Achieved
Upper Limit

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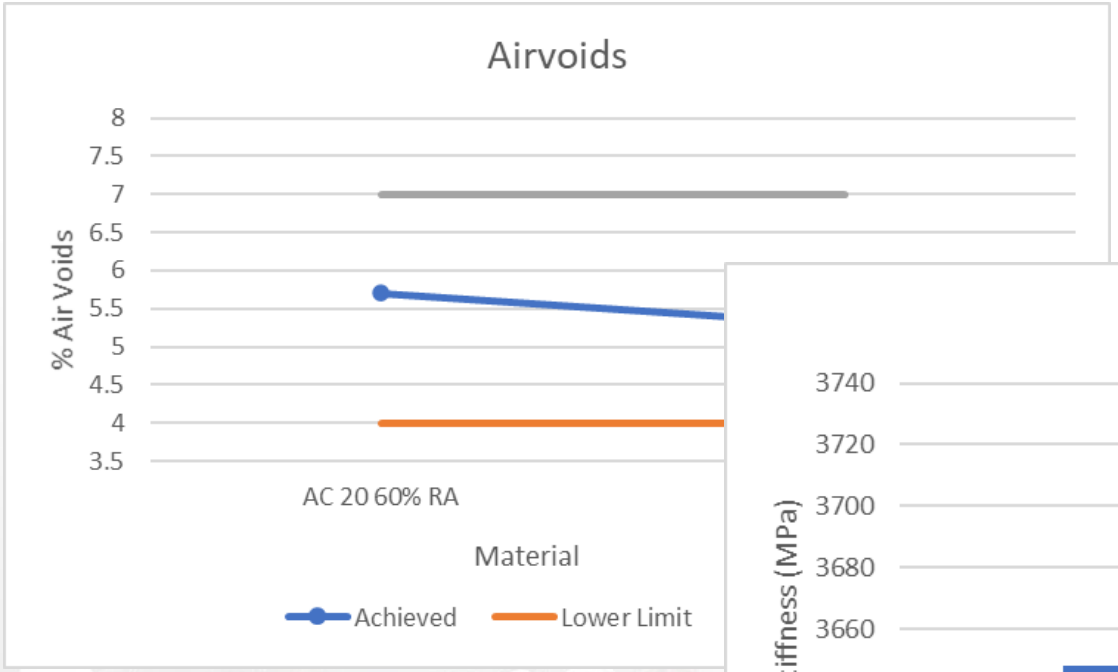
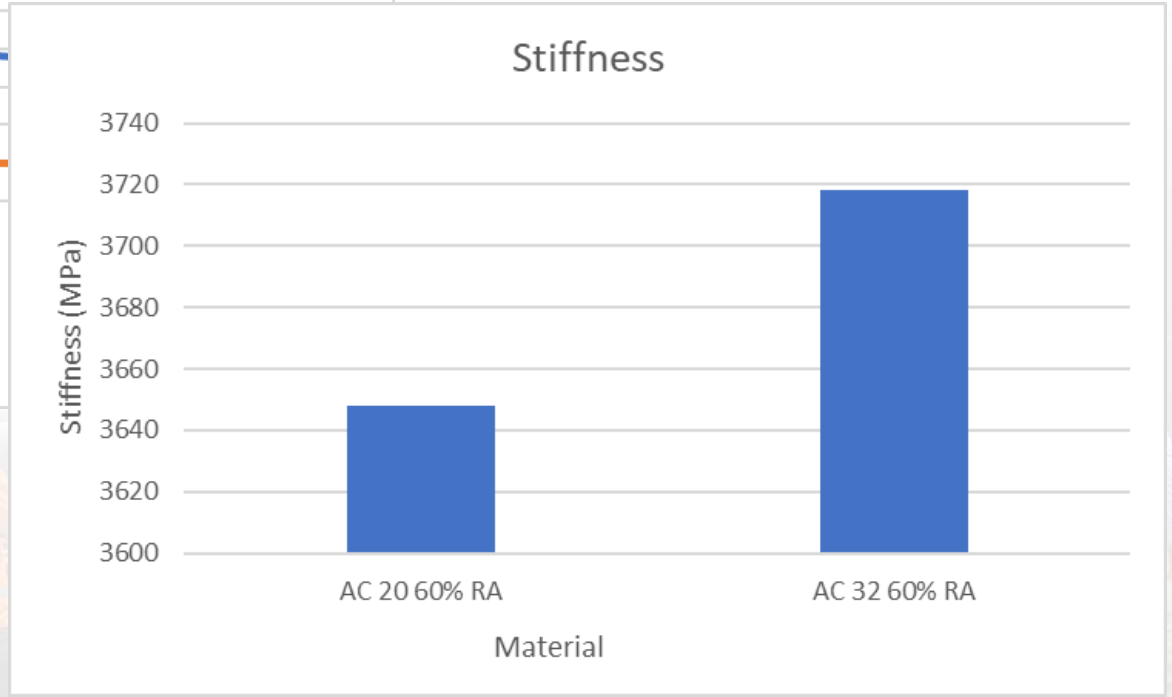
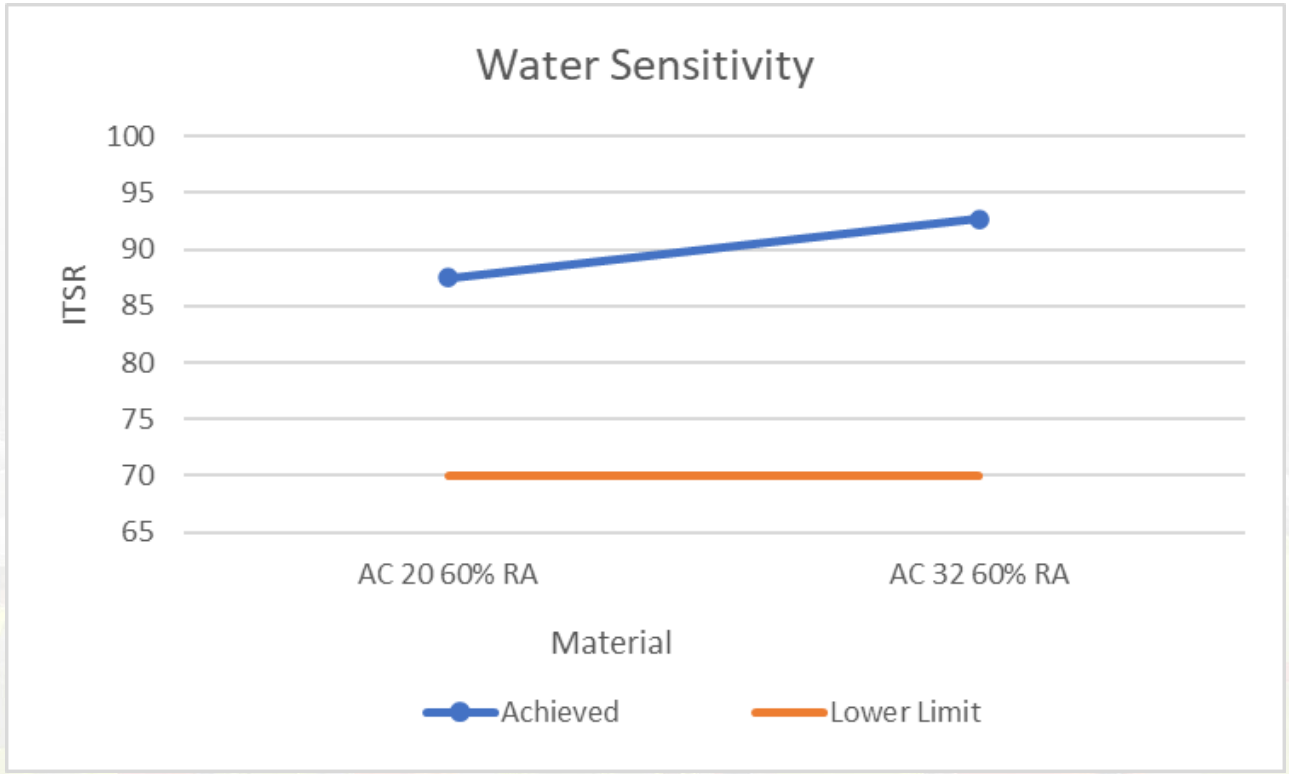
Plant Trial

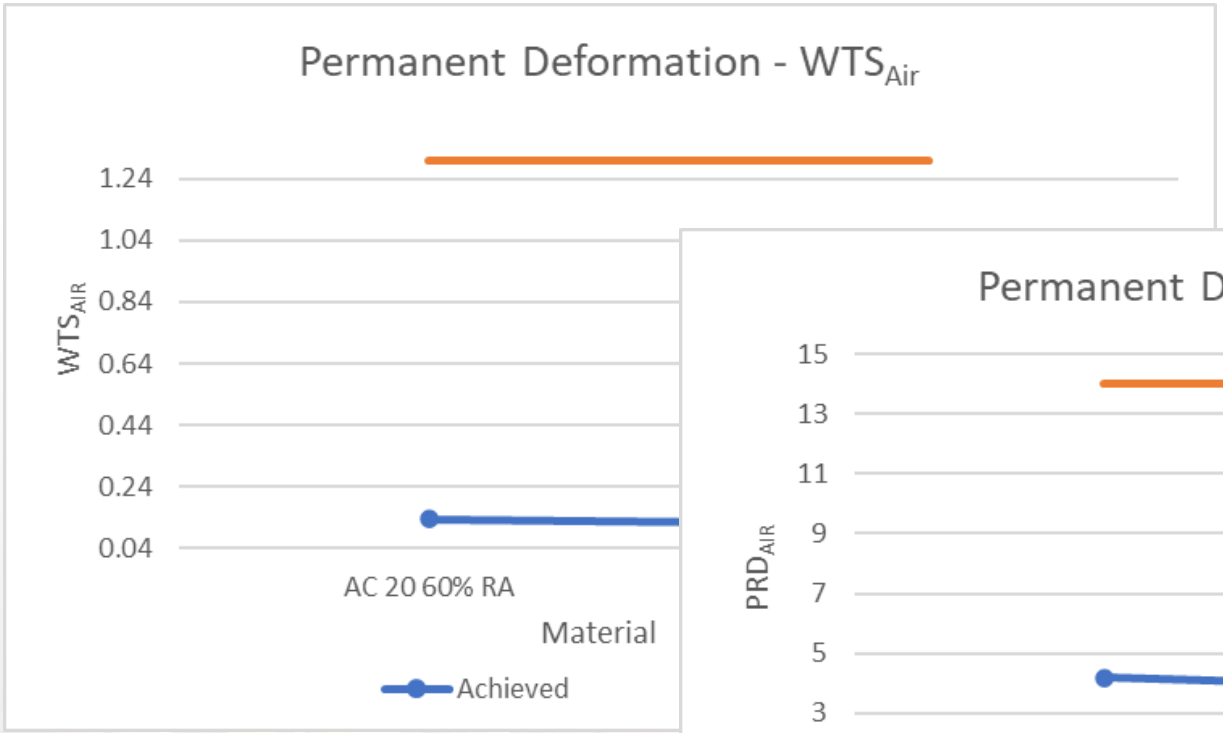
Material Properties of the Plant Trial

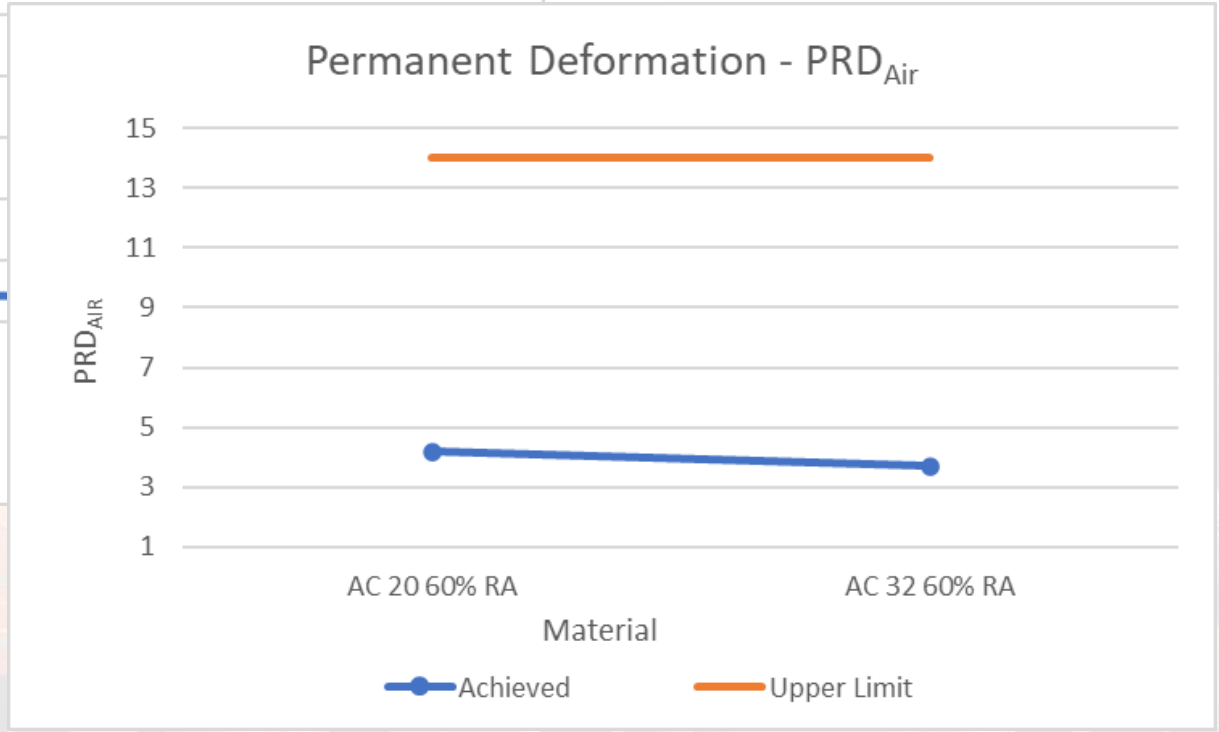
- Plant trial was carried out off site, to ensure:
  - The materials performed as expected when produced at plant scale.
  - Material properties are comparable to laboratory prepared material.
  - The plant can produce consistent material with very high percentages of RA which perform as expected.
- 0% RA materials were not required for this trial as they are standard materials produced in the plant.


Airvoids
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
% Air Voids
AC 20 60% RA
Material
Achieved
Lower Limit


Stiffness
3740
3720
3700
3680
3660
3640
3620
3600
Stiffness (MPa)
AC 20 60% RA
AC 32 60% RA
Material


Water Sensitivity
100
95
90
85
80
75
70
65
ITSR
AC 20 60% RA
AC 32 60% RA
Material
Achieved
Lower Limit


Permanent Deformation - WTSAir
1.24
1.04
0.84
0.64
0.44
0.24
0.04
WTSAIR
AC 20 60% RA
Material
Achieved


Permanent Deformation - PRDAir
15
13
11
9
7
5
3
1
PRDAIR
AC 20 60% RA
AC 32 60% RA
Material
Achieved
Upper Limit

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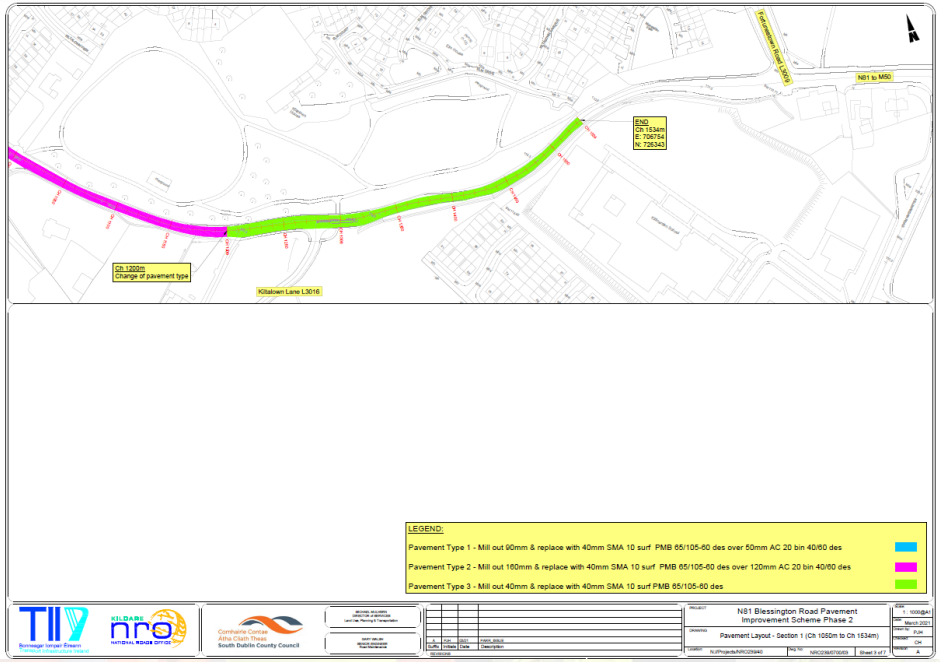
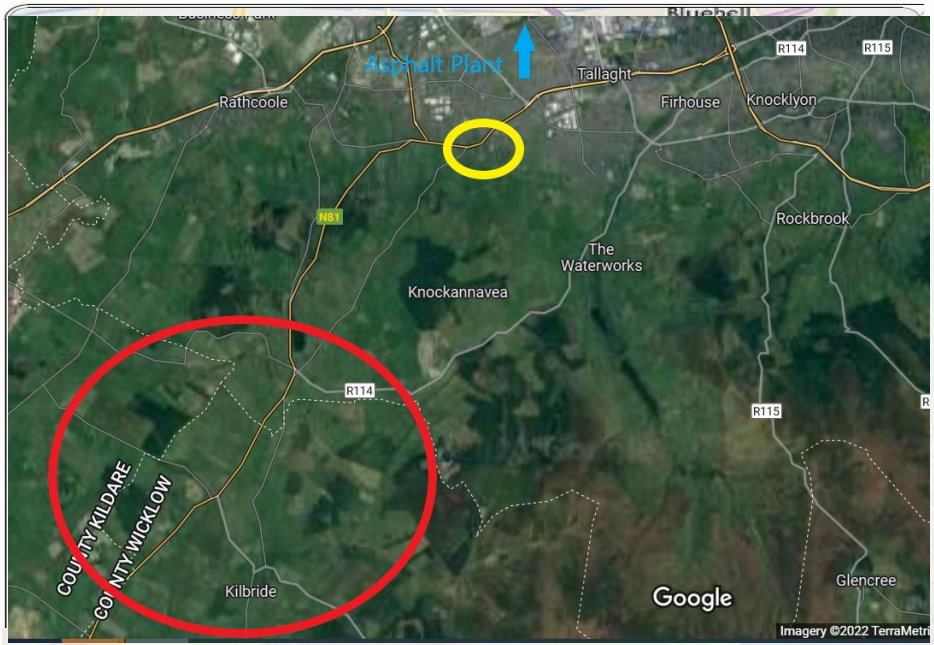
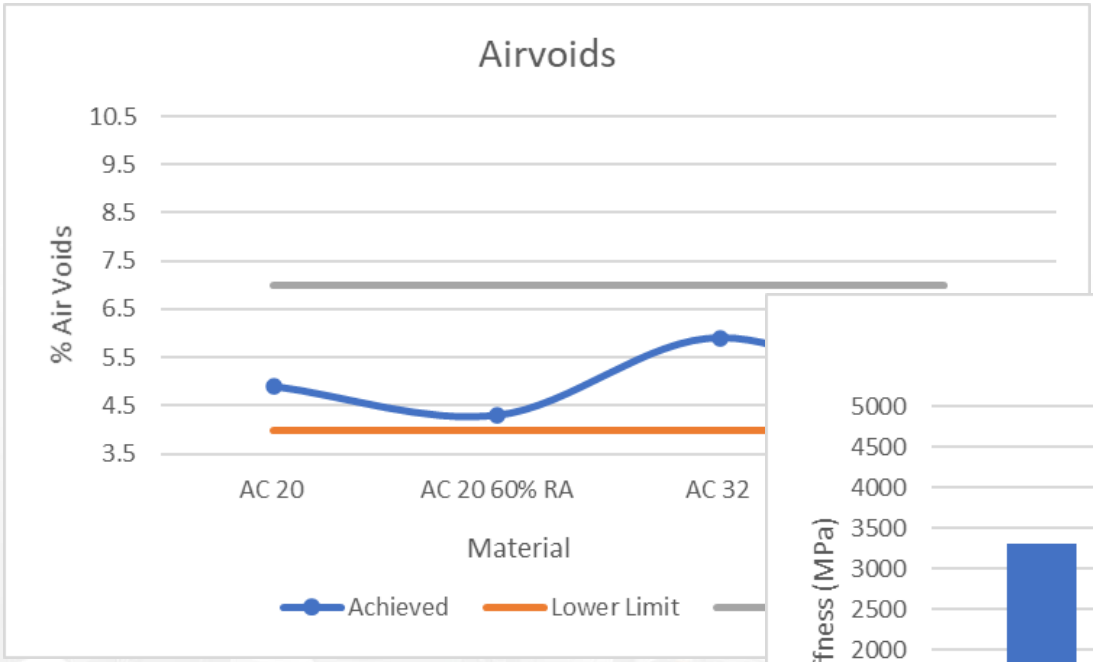
Site Trial

Site Trial Overview – N81 Plant Trial






Iostáin Choill Leamháir
KILTALOWN COTTAGES


Airvoids
10.5
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8.5
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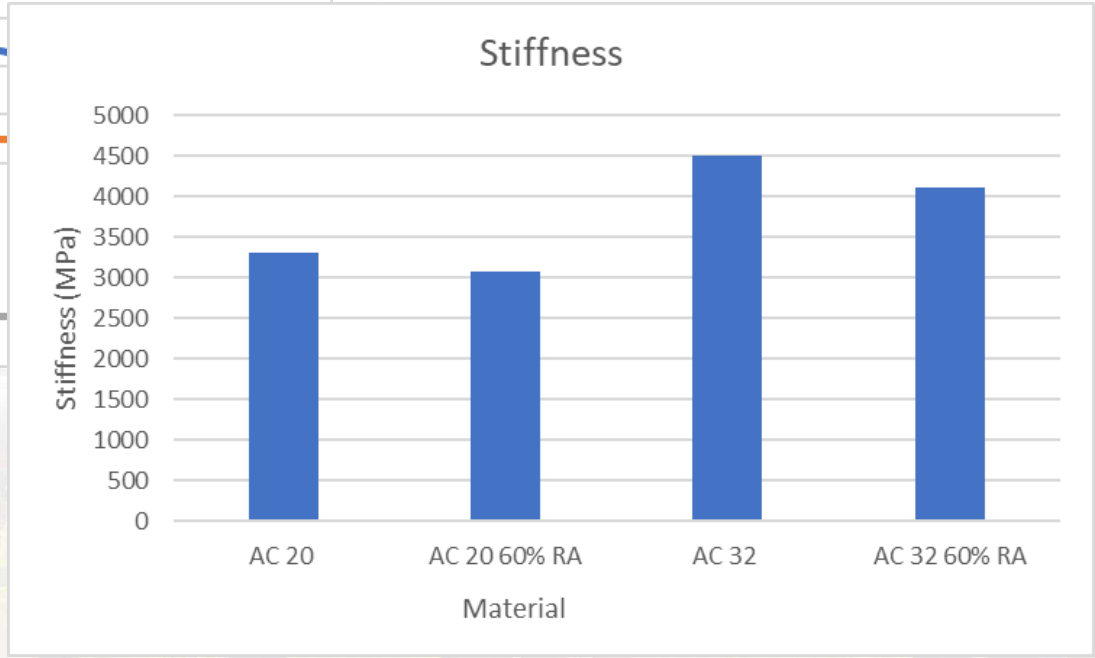
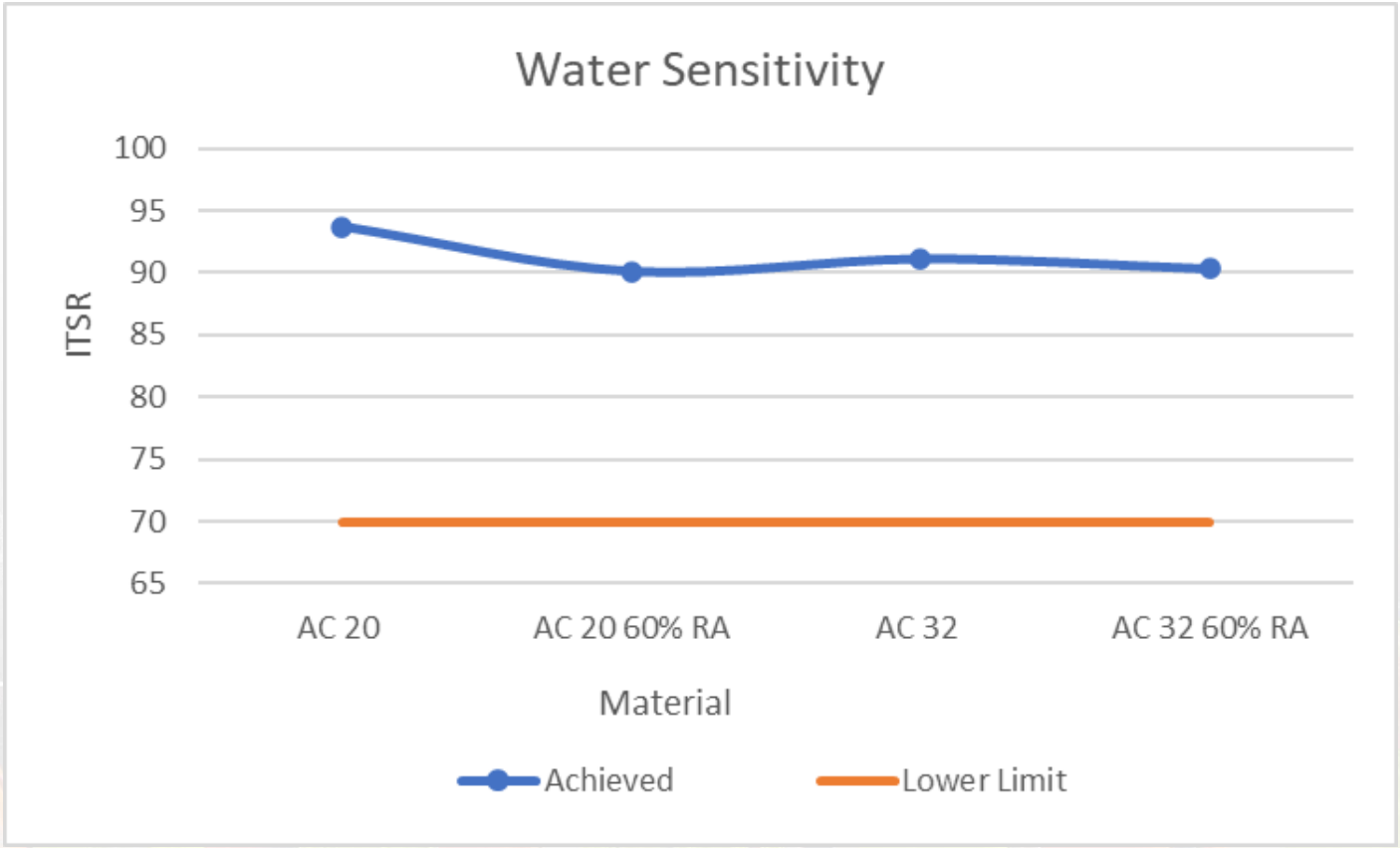
6.5
5.5
4.5
3.5
% Air Voids
AC 20
AC 20 60% RA
AC 32
Material
Achieved
Lower Limit


Stiffness
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Stiffness (MPa)
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material


Water Sensitivity
100
95
90
85
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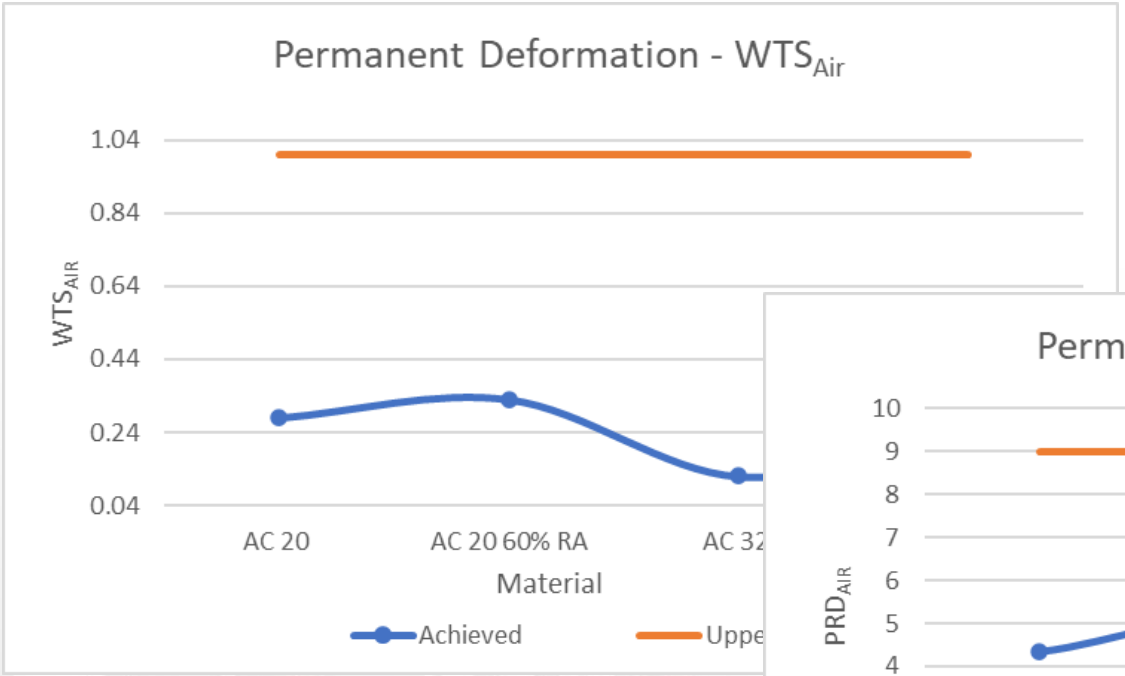
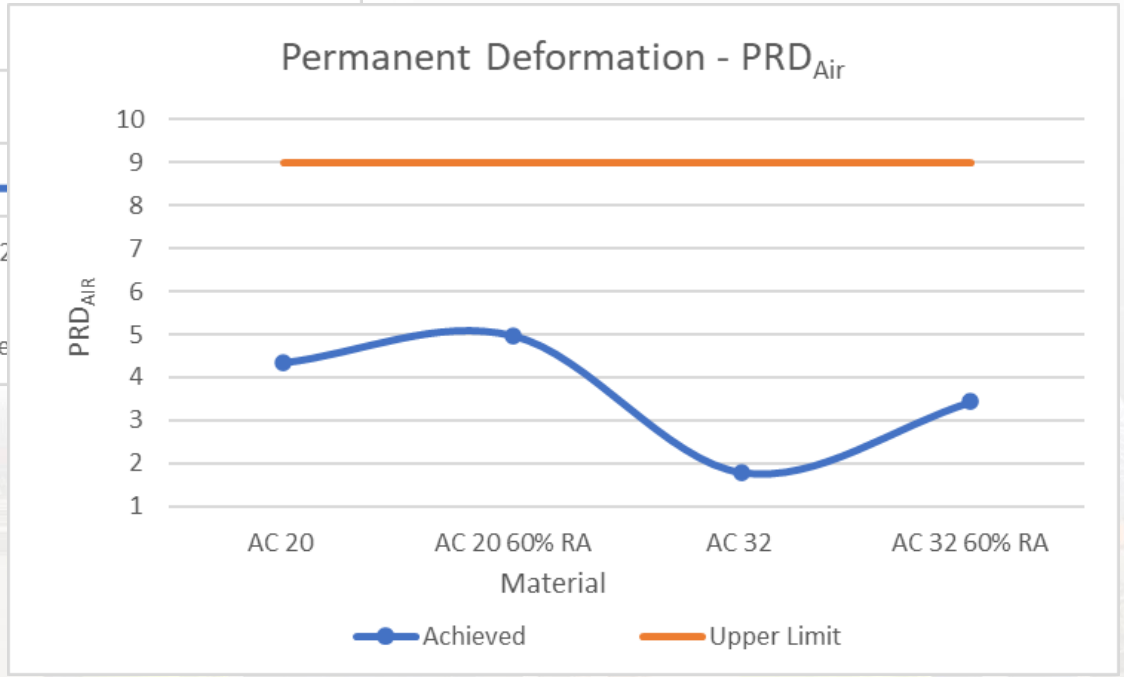
75
70
65
ITSR
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material
Achieved
Lower Limit


Permanent Deformation - WTSAir
1.04
0.84
0.64
0.44
0.24
0.04
WTSAIR
AC 20
AC 20 60% RA
AC 32
Material
Achieved
Upper Limit


Permanent Deformation - PRDAir
10
9
8
7
6
5
4
3
2
1
PRDAIR
AC 20
AC 20 60% RA
AC 32
AC 32 60% RA
Material
Achieved
Upper Limit

Site Trial – Summary

- The addition of RA and Rejuvenator to AC 20 and the AC32 improved compaction levels, similar to lab prepared samples.
- All materials gave excellent water sensitivity (<90%), wheel tracking and stiffness results.
- All results meet TII specifications.

Summary of Binder Recovery Testing

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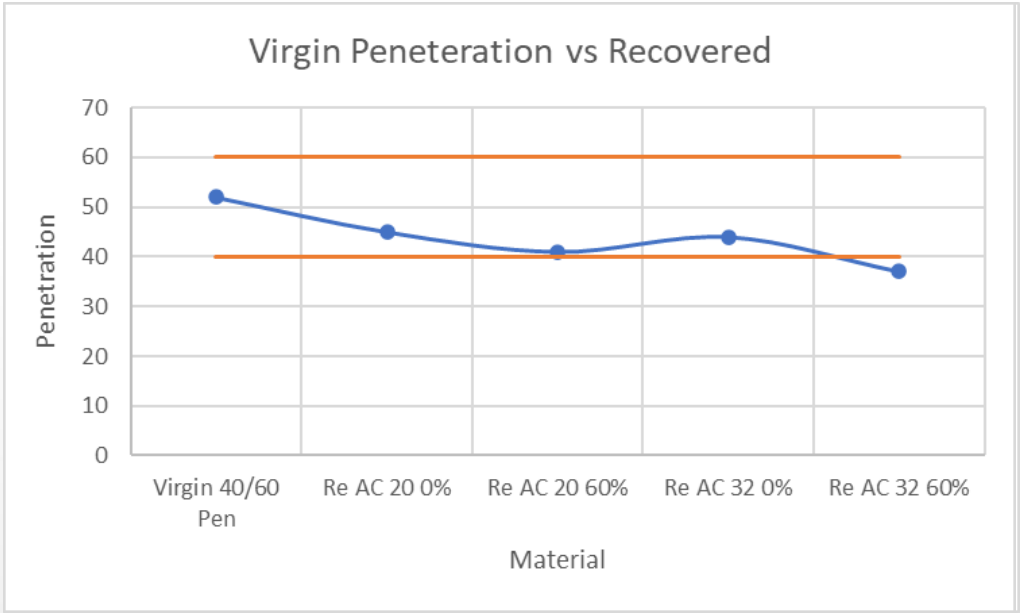
Binder Recovery



- Addition of RA resulted in an increase in softening point and a corresponding decrease in penetration.
- Recovery process can result in hardening of binder, providing results as seen.

Material Performance at all Trial Stages

- The performance of all materials at all stages of this investigation meets and exceed all requirements specified by TII.
- As expected, there is some variability in properties going from lab trials to site trials.
- Results for materials containing 60% show good consistency throughout the process.
- The plant is capable of handling high percentages of RA and producing a consistent material.

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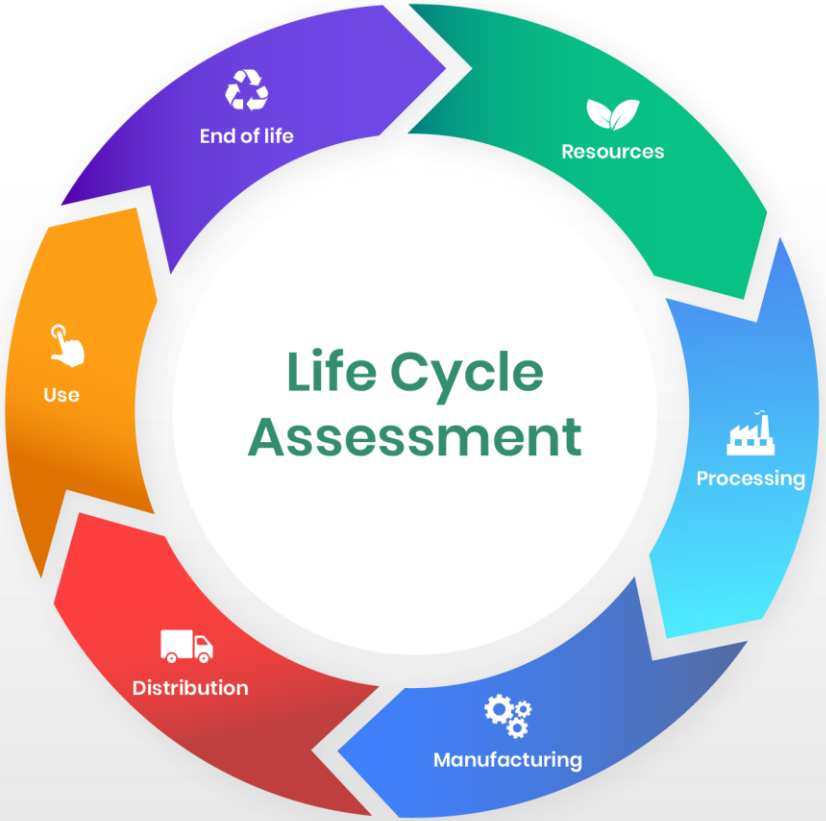
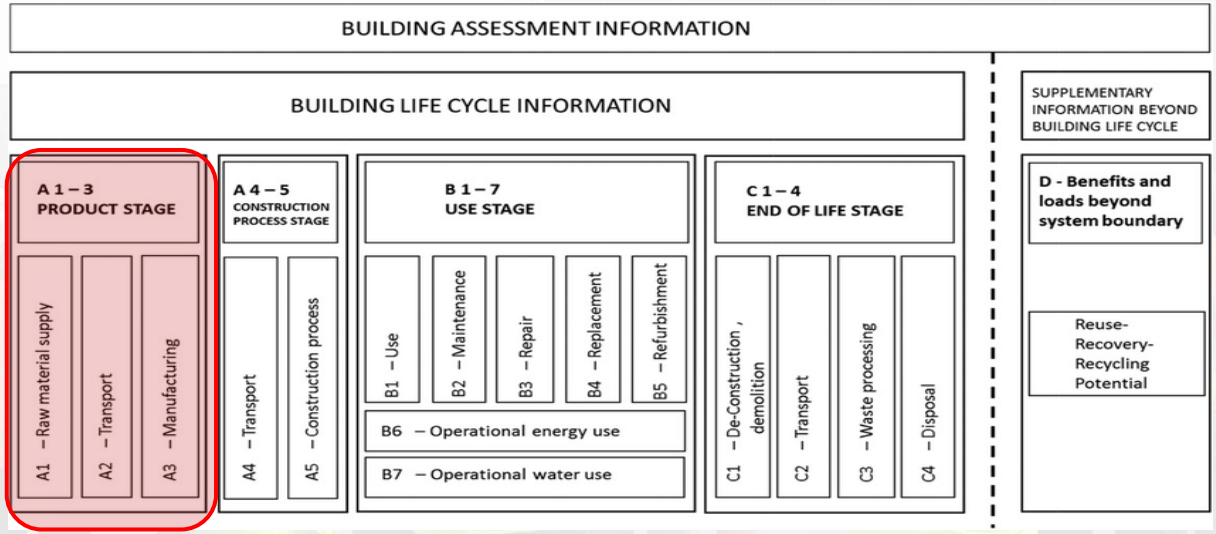
Life Cycle Assessment



Life Cycle Assessment Comparison

- Purpose of LCA to determine effect of RA on GWP (CO2e)
- EcoInvent 3.6 database used for GWP (CO2e) inputs for all materials.
- A1-A3 (Cradle to Gate) Impact Modelled.

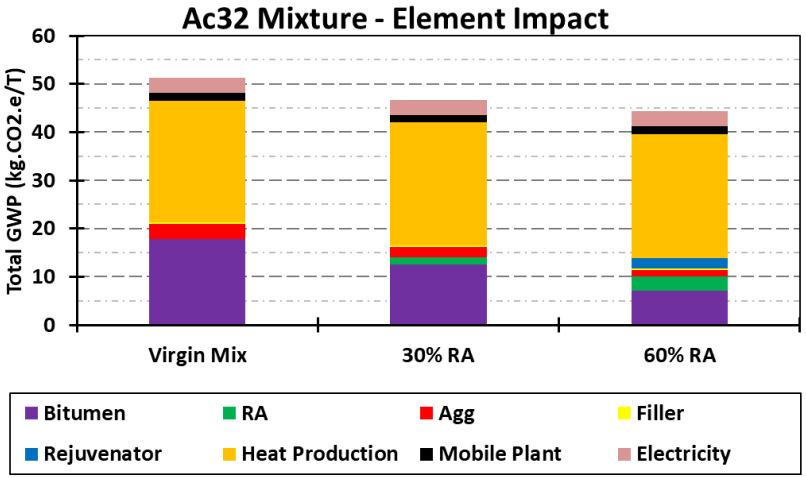
LCA conducted using the OneClickLCA software.

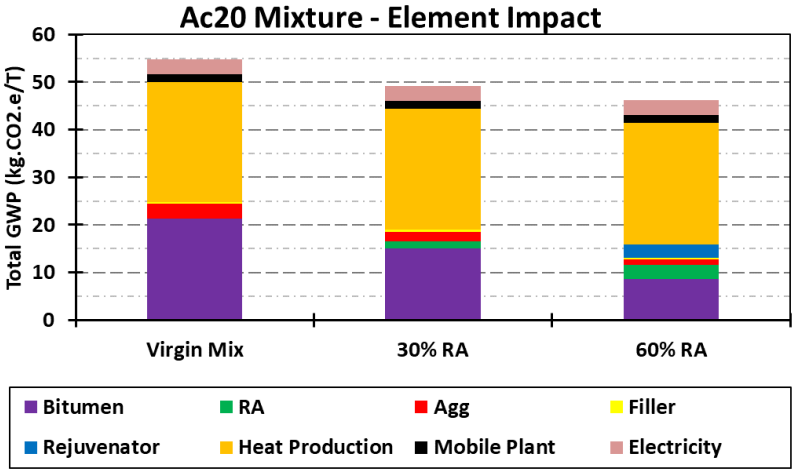


Life Cycle Assessment Modelling Assumptions

- Bitumen has a GWP of 0.40kg.CO2e/kg & 200km Transport Distance to Plant.
- Batching Plant uses Gas Oil as fuel source.
- Aggregates Produced at Quarry Onsite.
- Road Transport (To Plant) using Diesel.
- Rejuvenator required for 60% RA mixtures – 1.20kg.CO2e/kg
- GWP Impact of RA transport to Batching Plant & Crushing Included.
- Transport distance of 50km of RA from Demolition Site to Batching Plant.

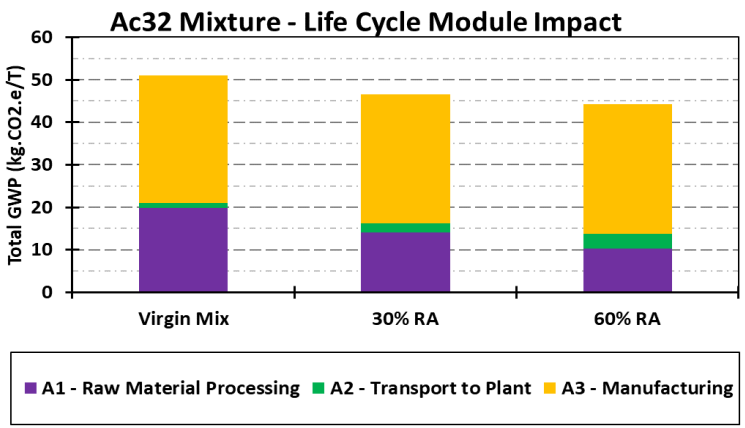
Mixture Total GWP by Impact Category

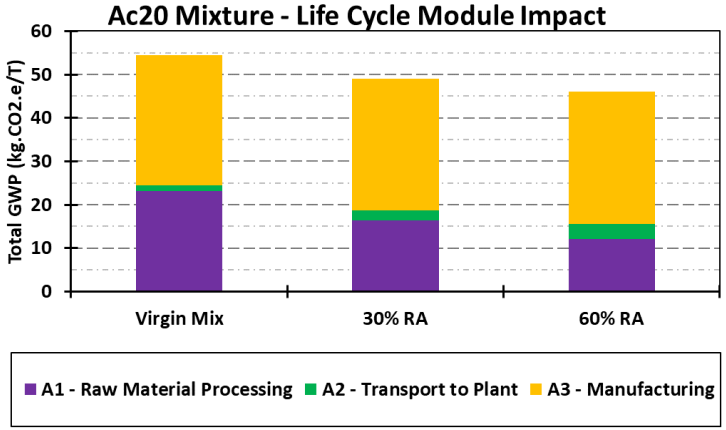




- Materials account for 40-45% the total GWP of the Virgin Mixes.
- 30% RA results in total GWP savings of 10% vs the control virgin mix.
- 60% RA results in total GWP savings of 13-16% vs the control virgin mix.
  - Rejuvenator limits savings (Conservative values used for embodied co2 and transport distance)

Mixture Total GWP by Life Cycle Module





- Transport larger in 60% RA mix due to Rejuvenator and RA Transport
- Considering A1 and A2 only:
  - Using 60% RAP up to 35-40% of the embodied A1-A2 GWP can be recovered.
- Future Potential Savings:
  - With WMA & Alternative Transport Fuels - Overall GWP Reduces, and 60% RA could give up to 40% savings vs control virgin mix.
  - Bio Binders – Reduce GWP of virgin Bitumen impact.

Conclusions

Conclusions

- All materials tested during the different stages of the study were within the specification set out by TII.
- For several of the measured properties the addition of RA resulted in improved performance, such as bulk density and air voids.
- The percentage retained stability after the water sensitivity test was very similar for both RA containing and virgin materials, indicating good binder adhesion.
- A significant reduction in CO2 and GWP can be achieved with the addition of RA, particularly when high RA contents are used.
- RA was managed in line with Article 27 of the European Communities (Waste Directive) Regulations 2011.
- From results shown a review of current RA use limits is advisable.

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Thank You

William Wilson