Pilot application of modified asphalt mixture with End of Life Tires (ELTs) and Reclaimed Asphalt Pavement (RAP)

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2004-2022

According to the European Tyre & Rubber Manufactures Association (ETRMA) approximately 3 million tons of end-of-life tyres (ETL) are produced, in the European Union, with a cycle utilization of 92%.

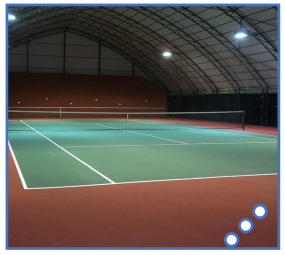
In addition, 50 million tons of reclaimed asphalt pavement (RAP) are recovered annually in the European Union, which can be reused in the construction of new roads, as well as in the maintenance of existing ones.

APPLICATIONS OF CRUMB RUBBER THAT PRODUCED FROM THE MECHANICAL TREATMENT OF ELTs

Artificial Turf in Fields

Rubber floor tiles

Rubber floors for sports grounds



Thermoplastic Elastomers

Asphalt

One of the least common applications of ELT's, in the EU, is to modify the asphalt with crumb rubber that is derived from their mechanical treatment.

This use achieves:

- 100% tire recycling
- A significant contribution to the circular economy.

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RECLAIMED ASPHALTS PAVEMENT - RAP

- Material from the removal of asphalt pavement (asphalt and aggregates)
- Contains high quality aggregate covered in asphalt
- Typical use of RAP up to 30%
- Main barrier :
- ↑ asphalt stiffness

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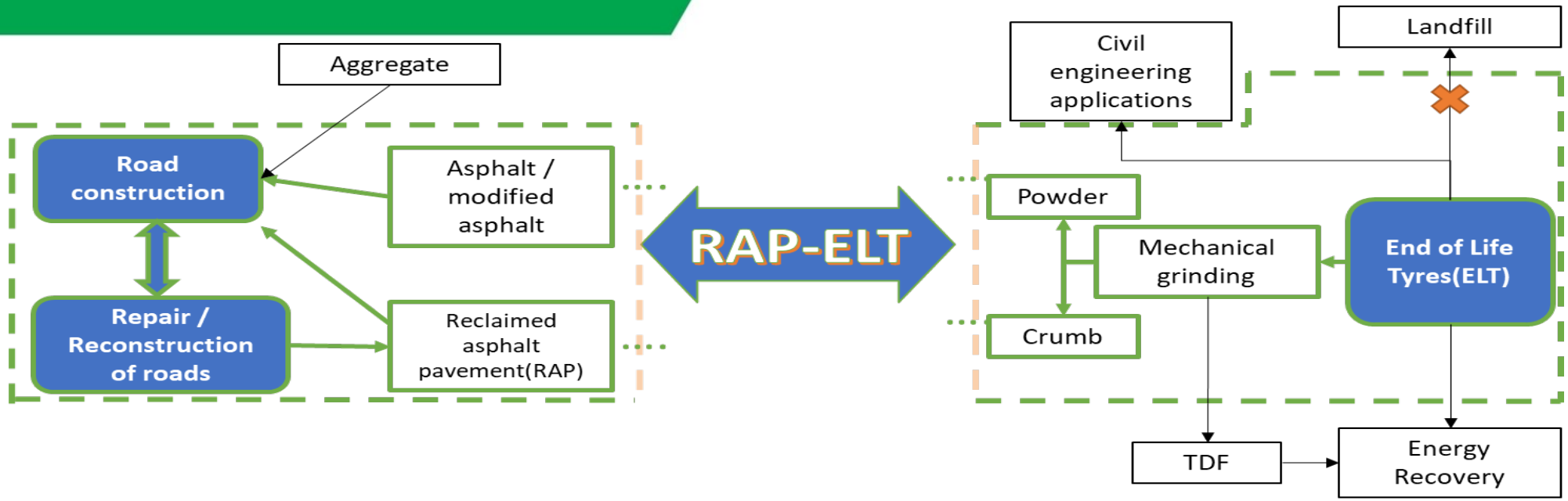
SCOPE OF THE PROJECT



The RAP-ELT project studied the possibility of increasing the recycling rate of Reclaimed Asphalt Pavement (RAP) in the production of asphalt mixtures due to the modification of asphalt with rubber granulate, aiming the:

- Production of Asphalt pavement with superior characteristics
- Utilization of two waste flows (ELT & RAP)
- Utilization of ELTs with techniques more environmentally efficient compared to energy recovery

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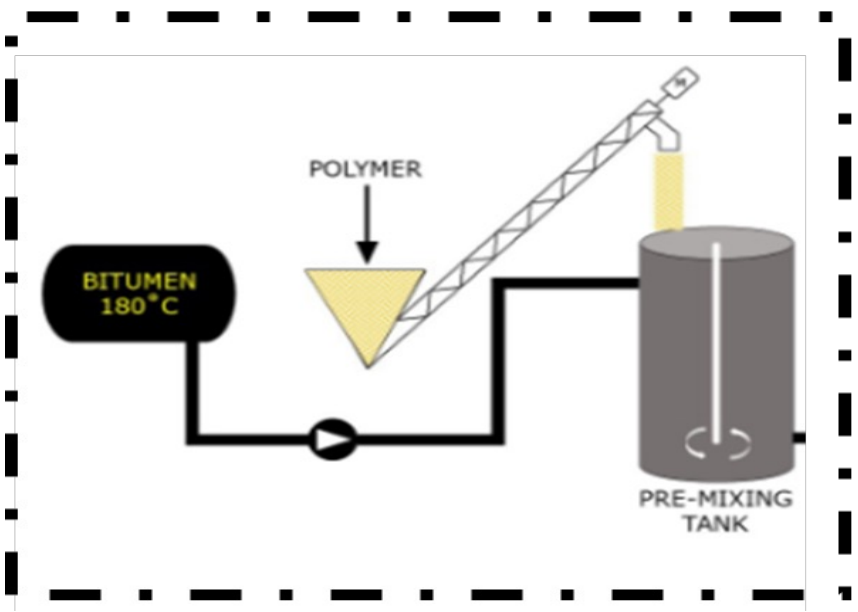
ASPHALT MODIFICATION METHODS

(A) Dry Method

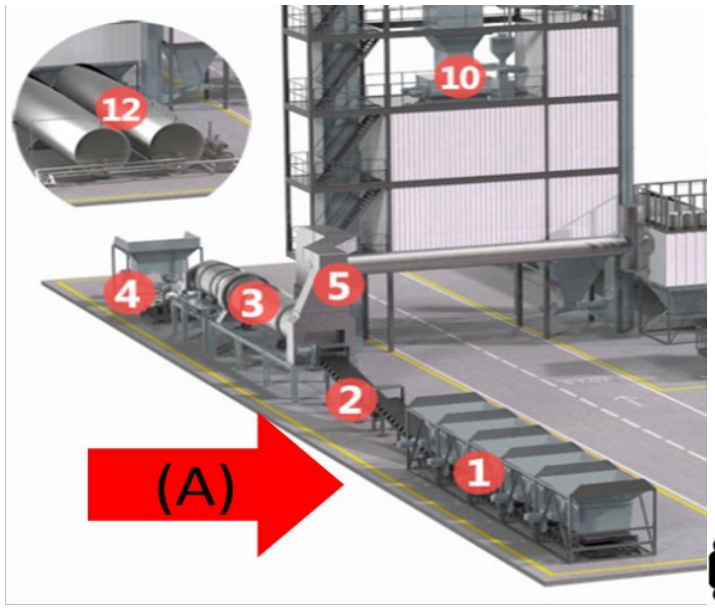
Uses Styrene Butadiene Rubber- SBR (size 2/4mm) instead of aggregates (3% by weight) directly in the asphalt mixing plant

(B) Wet Method

Uses SBR (size 0/0.4mm) instead of Styrene Butadiene Styrene- SBS as elastomeric modifier (<20% w/v) in modified asphalt plant and then transferred to asphalt mix plant



(B)



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ASPHALT MODIFICATION METHODS

Parameters	Dry Methods	Wet Methods
Production Flexibility	✓	
Production Cost	✓	
SBR Incorporation	✓ (<30 Kg/ tn)	(<1 Kg/tn)
Production Process Certification		✓

(A)

(B)

Dry Method
Composition based on the Marshall Method
(Aggregate, RAP, Asphalt*, SBR 2/4mm < 3%)

Failure to produce a sample at **150°C**

Wet Method
Composition based on the Marshall Method
Production of Modified Asphalt
(Asphalt*, SBR Powder 0/0.4mm)

#4+1 Samples
0 – 5 – 10 – 15 – 20 % w/w

MODIFIED ASPHALT

ELTs was grinded in RETIRE SA

The crumb rubber was delivered to Netoil SA

The crumb rubber (5%w/w of modified asphalt) and the asphalt was mixed in a low shear mixer at 180oC until homogenized

The modified asphalt was delivered to the asphalt plant of Asfalter SA

Asfalter produced 4 different asphalt mixtures using conventional asphalt,modified asphalt, primary aggregates and secondary aggregates(RAP) accordingly.

A pilot application of a heavy traffic road was occurred in the Municipality of Aspropyrgos.

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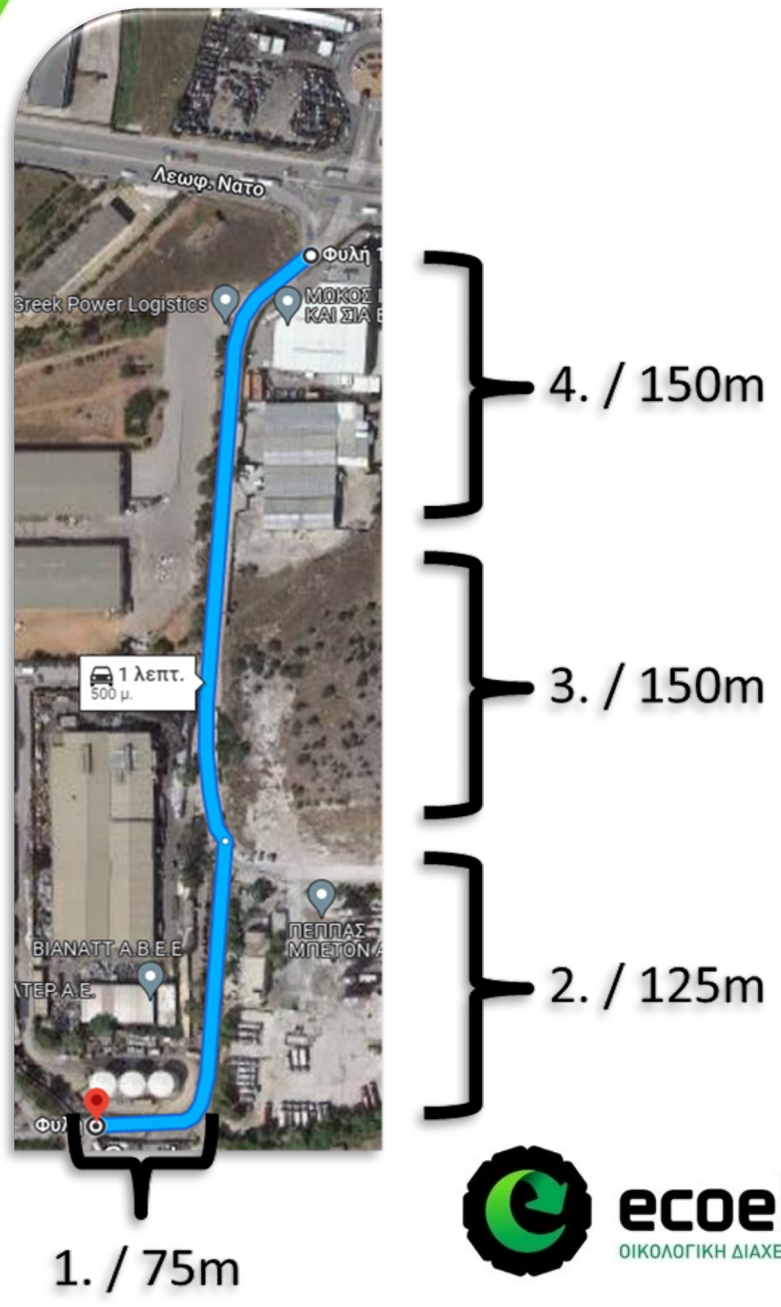
PILOT APPLICATION

A total of 4 consecutive sections were paved along the 300 m long road in Asporyrgos.

- 75 m conversional asphalt
- 125 m modified asphalt mixture with crumb rubber
- 150 m modified asphalt mixture with crumb rubber and 30% RAP
- 150 m modified asphalt mixture with crumb rubber and 50% RAP

The temperature of asphalt mixtures was 170°C.



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MEASUREMENTS

Two series of Measurements
- May 2021
- September 2021

Environmental noise measurement

Skid resistance measurement

Rutting resistance- Wheel bolts measurement

Visual observation of splash & spray

Expected Results
- Increased lifetime of the pavement
- Higher resistance in high temperatures (reduced rutting) and low temperatures (reduced cracking)
- Reduced noise from vehicle traffic
- Reduced “spraying” from vehicle traffic on wet roads

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MEASURING INSTRUMENTS

- Skid Resistance (Grip tester)
- Rutting Resistance – Wheel bolts (Walking Profiler)
- Environmental Noising (Nti xl2-sound level meter, Bruel & Kjaer 4230-Sound level calibrator)

Nti xl2(left), Bruel & Kjaer 4230 (right)

Grip tester

Walking Profiler

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SPLASH and SPRAY

Splash & Spray: the phenomenon of the ejection of water particles due to the movement of car tires on the wet road surface

Conventional Asphalt

At conventional wet asphalt, dangerous spraying is created

Modified Asphalt with Crumb Rubber

At modified wet asphalt the spraying is reduced

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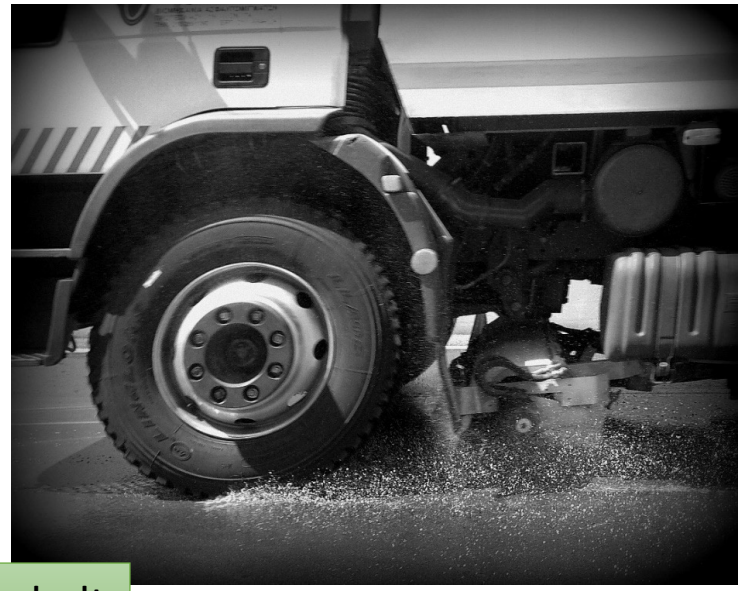


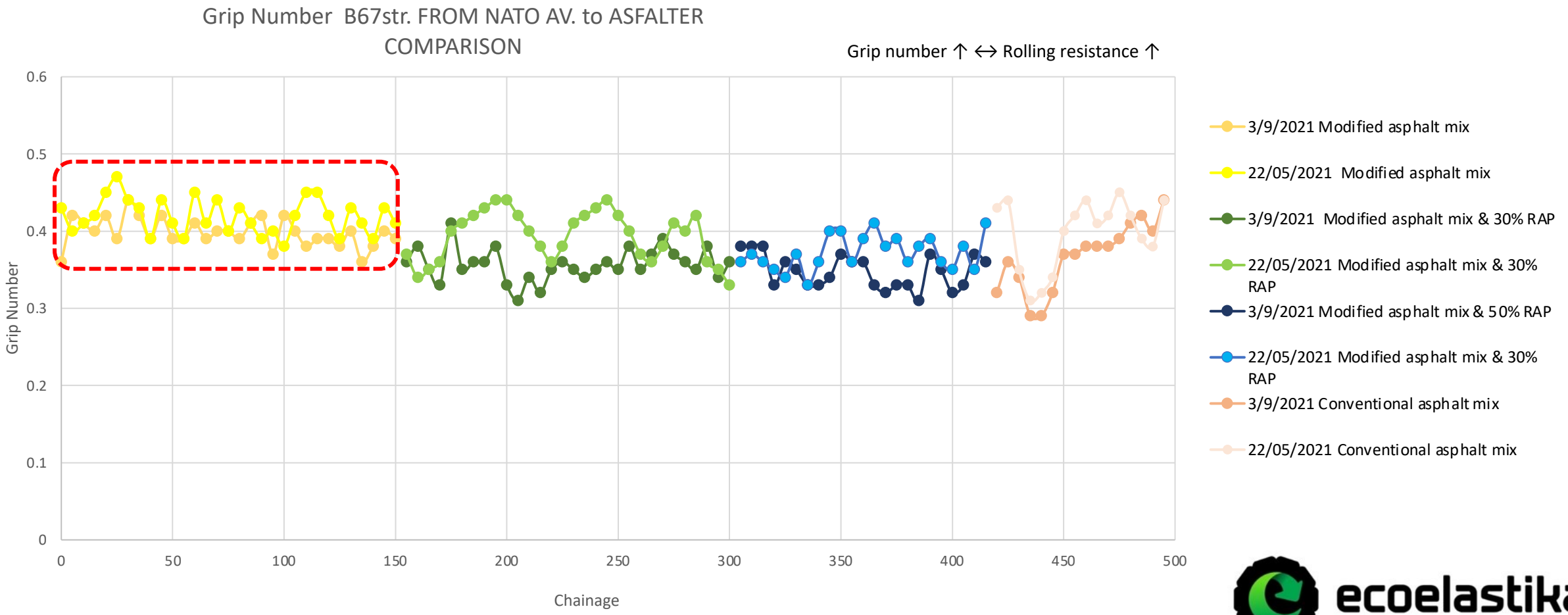
Convectional Asphalt

Modified Asphalt

SKID RESISTANCE

Increased friction value → increased resistance to sliding → greater safety.

Skid resistance is the result of the friction that develops between the road surface and vehicle tires



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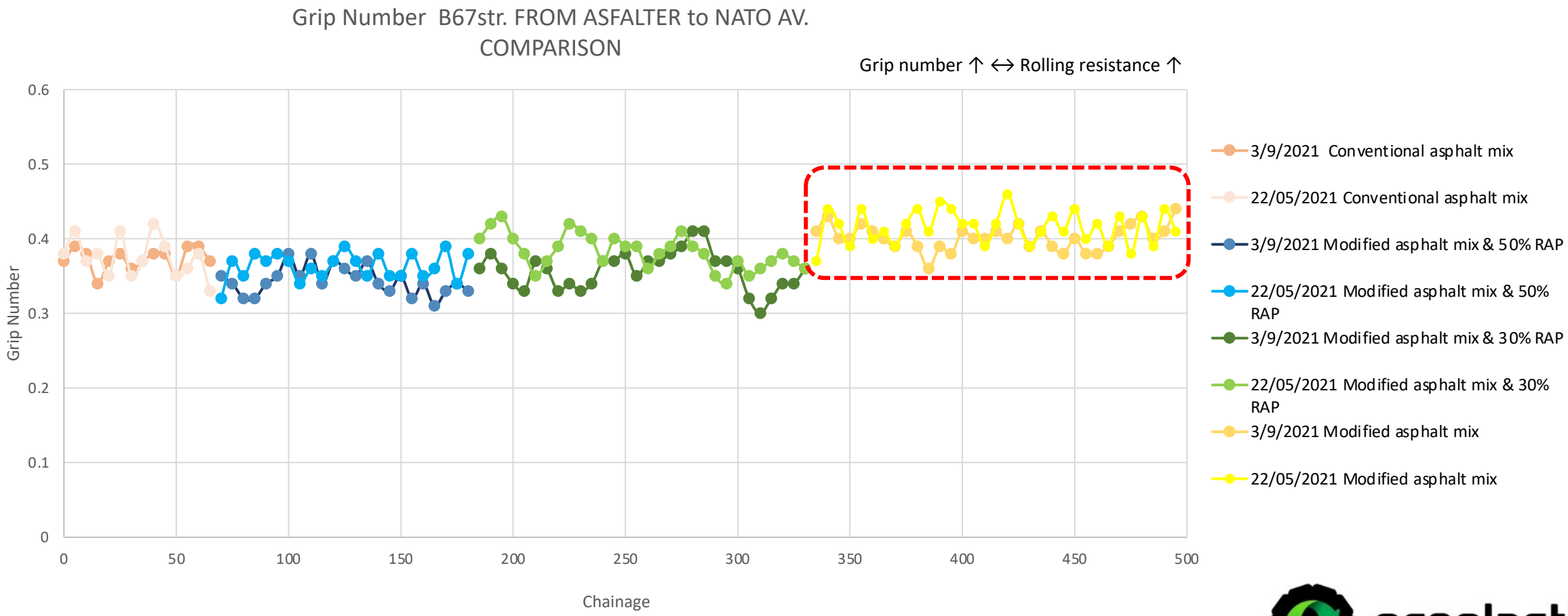
SKID RESISTANCE



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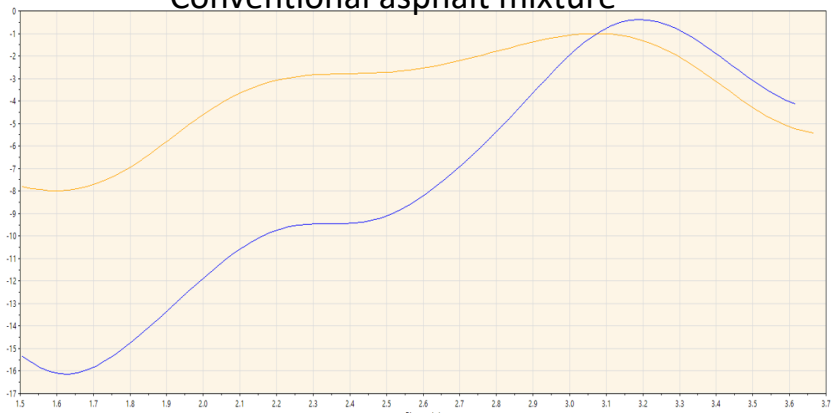
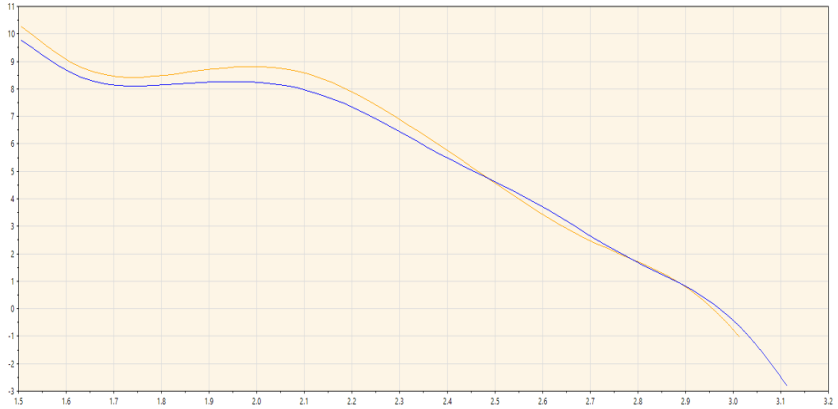
RUTTING RESISTANCE

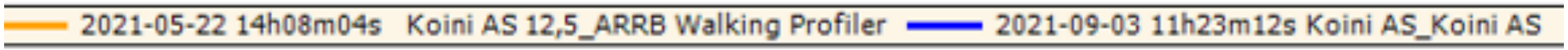
Rutting created mainly due to the increased traffic of vehicles as well as due to their heavy weight

Conventional asphalt mixture

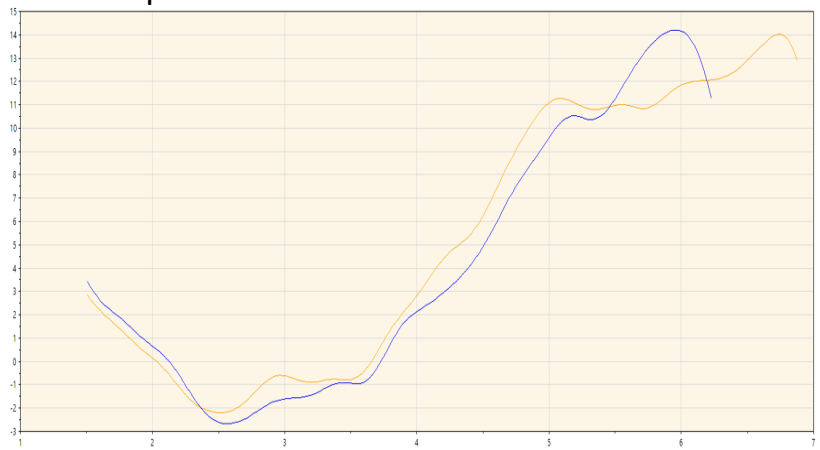


Modified asphalt mixture with crumb rubber and 50% RAP

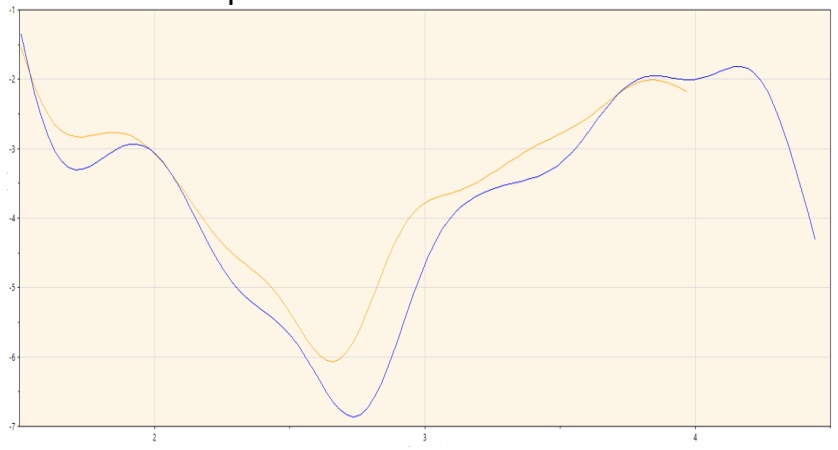




Modified asphalt mixture with crumb rubber and 30% RAP



Modified asphalt mixture with crumb rubber



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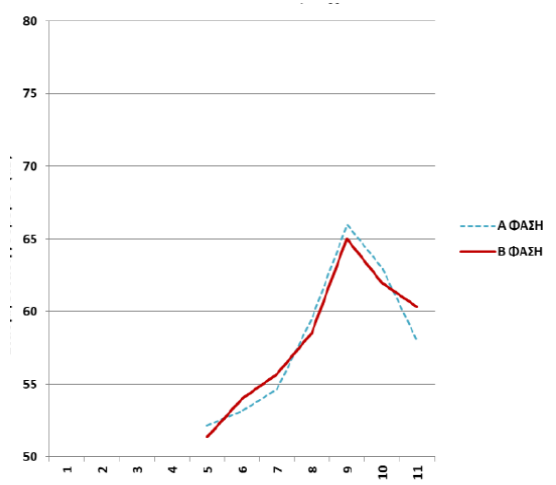
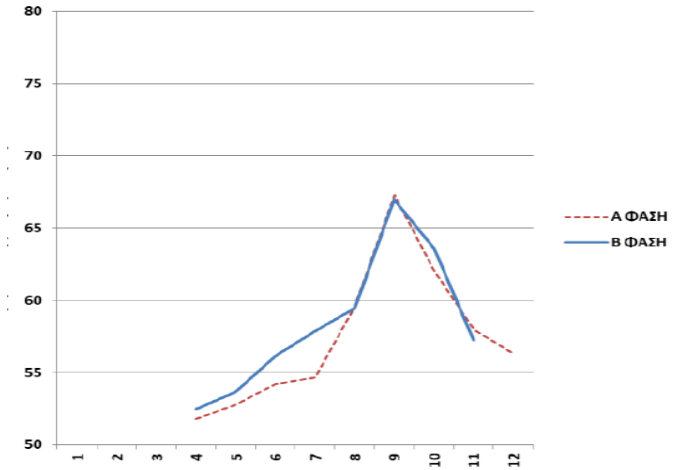
ENVIRONMENTAL NOISE

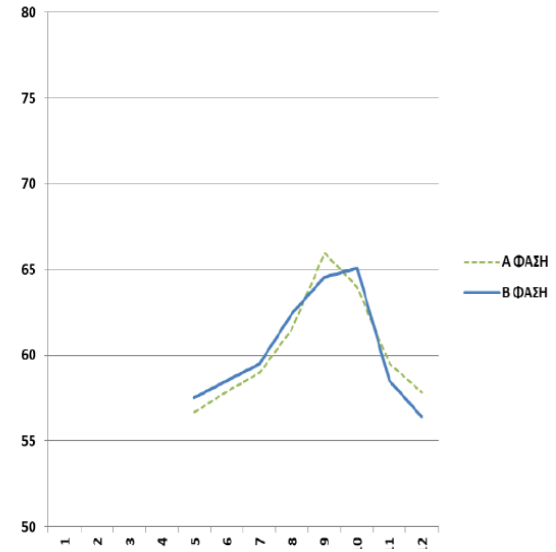
Conventional asphalt mixture



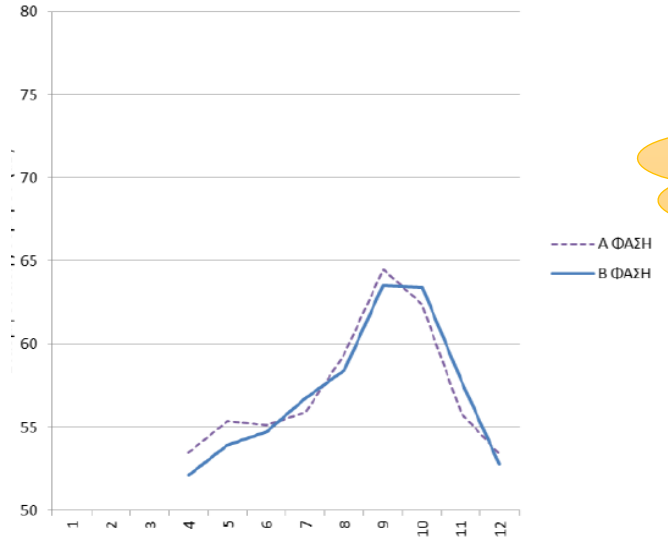
Modified asphalt mixture with crumb rubber and 50% RAP

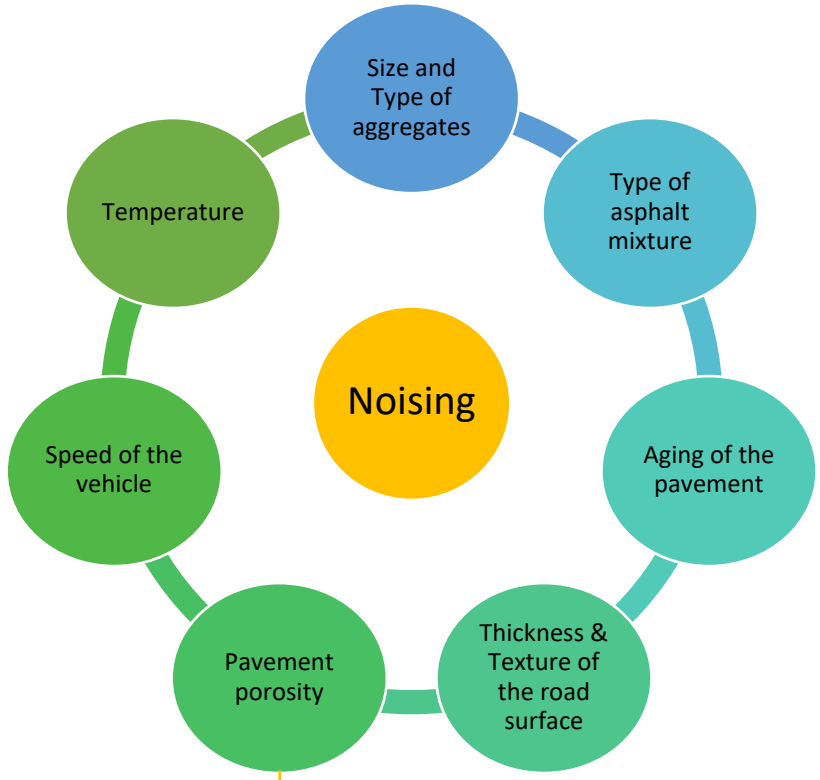


Modified asphalt mixture with crumb rubber and 30% RAP



Modified asphalt mixture with crumb rubber





Greater porosity = Greater absorption = Lower noise levels

Crumb rubber → Porosity increase

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RESULTS - CONCLUSIONS

Skid Resistance	• Best performance: Modified asphalt mix with crumb rubber
Rutting resistance	• No significant differences between modified mixes • Rutting : Conventional asphalt mix
Noising	• Best performance: Modified asphalt mixture with crumb rubber
Splash & Spray	• Best performance: Modified asphalt mixture with crumb rubber

COST ANALYSIS ($2000\ m^2$)

	Conventional asphalt	Modified asphalt mixture with crumb rubber	Modified asphalt mixture with crumb rubber and 30% RAP	Modified asphalt mixture with crumb rubber and 50% RAP
Removal of old asphalt	2.850,00 €	2.850,00 €	2.850,00 €	2.850,00 €
Application of adhesive coating	900,00 €	900,00 €	900,00 €	900,00 €
Paving of asphalt mixture	15.228,00 €	17.549,46 €	16.442,95 €	15.557,13€
Total Cost	18.978,00 €	21.299,46 €	20.192,95 €	19.307,13 €
Total Cost per m^2	9,49 € +RAP disposal cost	10,65 €	10,10 €	9,65 €
Total Cost per tn	82,66 €	91,73 €	86,33 €	81,98 €

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LIFE CYCLE ASSESSMENT ($2000\ m^2$)

	Conventional asphalt	Modified asphalt mixture with crumb rubber	Modified asphalt mixture with crumb rubber and 30% RAP	Modified asphalt mixture with crumb rubber and 50% RAP
Asphalt mixture (tn CO_{2eq})	5,42	6,21	5,35	4,68
Emulsion (tn CO_{2eq})		0,36		
Pilot application (tn CO_{2eq})		0,25		
Total **emissions**	6,03	6,82	5,96	5,29
Total **emissions** $CO_{2eq}\ per\ tn\ asphalt$	26,26	29,37	25,48	22,46
Emissions savings CO_2 (%)	-	11,84	-2,97	-14,47

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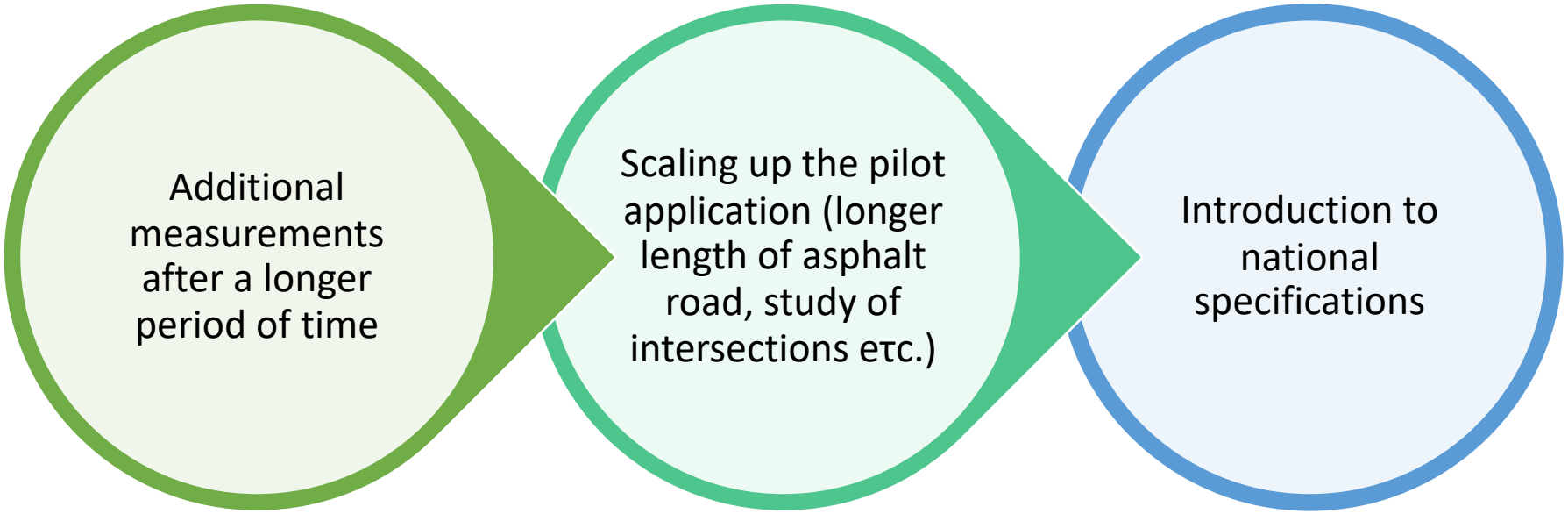
NEXT STEPS



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Thank you!