Layman's Report

LIFE12/ENV/ES/000072

Lifesure

Self-sustaining urban road: A way to improve environmental performance of urban areas

PROJECT DATA

Project number: LIFE 12 ENV ES 000072
Project location: Madrid
Total Budget: 2.376.248€
EC co-funding: 1.186.040€
Project Duration: from 01/09/2013 to 31/12/2018
LIFESURE project has been co-funded by the European Commission as part of the LIFE programme under the component Environment Policy and Governance.

PROJECT PARTNERS

COORDINATOR

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ENVIRONMENTAL PROBLEM

In recent years, within the current growing awareness and tightening of the environmental regulations, it has been attempting to correct the impacts that the manufacture and application of Asphalt Mixtures causes on the environment. The concept of sustainability has come to the field of bituminous mixtures with three main components: reducing costs, reducing emissions and reducing consumption of raw materials, preserving resources for the future.

The environmental impact of the hot mix asphalt industry is not all negligible or insignificant. Without undertaking any evaluation of the impacts produced during the process of manufacturing components (aggregates and binders) and equipment used in the manufacture and laying, the manufacturing of hot mix asphalt (HMA) requires significant energy consumption and generates a certain volume emissions of greenhouse gases.

Rehabilitation and Maintenance activities of road pavements generate an increasing amount of waste from the milling of the damaged layers of bituminous mixtures. We are more obliged to provide solutions that will minimize the consumption of natural resources by using a new generation of Bituminous Mixtures.

PROJECT SOLUTION

With changes in construction materials economics, stricter environmental regulations, and an emphasis on “green” technologies and sustainable pavements, these innovative recycled mixtures constitutes a “treasure trove” for the urban road heritage conservation.

This project will develop a new technology for the construction, maintenance and rehabilitation of roads based on the use of Half-Warm Mix Asphalt, with a recovery rate up to 100% that applies low temperatures at the production (90-100 ºC) and compaction (70-80ºC) stages of road/street construction.

This Project will provide roads more sustainable, greener, ultimately more environmentally friendly.

WORK DESCRIPTION

LIFESURE Project has been co-funded by the European Commission as part of the LIFE programme, under the component Environment Policy and Governance.

The overall goal of this project is to develop an innovative technology to produce half-warm mix asphalt with a recovery rate up to 100% on wearing and intermediate courses.

These mixtures will contribute to improve the sustainability of urban areas by reusing materials of high quality, reduction in energy consumption and reduction in GHG emissions with a hefty lower impact on the environment.

To achieve these general objectives, a series of specific objectives were set:

1. **Study of the potential locations of experimental section**
2. **Milling products characterisation and LIFESURE eco-asphalt design**
3. **Design and construction of an innovative prototype of asphalt plant to produce LIFESURE eco-asphalt**
4. **Asses technical feasibility of LIFESURE eco-Asphalt**
5. **Life Cycle Assessment**
6. **Pre-normative study to standardise the implementation of LIFESURE eco-asphalt**

Study of the potential locations of experimental section

Madrid City Council prepared a list of streets that requires pavement rehabilitation, based on the information available in their street inventory.

Once the streets requiring rehabilitation were identified, those sections with the following criteria were identified:

- Area of 18,000 m^2 of roadway, to test three asphalt mixes.
- Traffic level
- Bus traffic to verify the tangential efforts

The list of the preselected streets:

LIST OF PRESELECTED STREETS

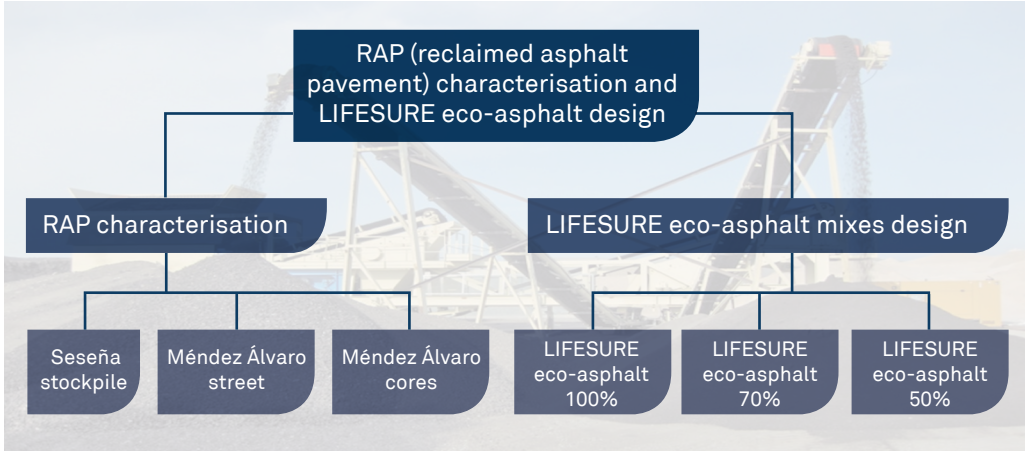
Calles por tramos uniformes en tráfico y sección	Longitud (metros)	Nº carriles	Tráfico IMD	IMD/carril	Bandas de estacionamiento	Parada Bus
Pº Delicias (general Palanca-Gta Carlos V)	880	4	26.959	6.740	SI	SI
Pº Yeserias	997	4	10.713	2.678	SI	SI
C/Goya (de Alcalá a Serrrano)	998	6	34.619	8.655	SI	SI
Pº Castellana (Pza Lima-Pza. Cuzco) Tronco	658	6	63.000	15.750	NO	NO
Pº Castellana (Pza cuzco-Pza Castilla) Tronco	658	6	64.000	16.000	NO	NO
Pº Castellana (túnel Pza Castilla-Nudo Norte) Tronco	1350	6	80.844	20.211	NO	NO
Av. Hnos. García Noblejas entre Alcalá -Av. Arcentales (pares)	1650	6	50.153	8.359	SI	SI
C/Alcalá entre C/Raquel Meller-C/Arturo Soria	1820	4	32.195	8.049	SI	SI
Avenida de Logroño entre Av. General-M13	1013	4	18.189	4.547	SI	SI
Av. Canillejas a Vicálvaro entre C/Alcalá y Arcentales	1065	4	18.287	4.572	SI	SI
Av. Pablo Neruda entre Av. Buenos aires -C/Candilejas	900	4	15.146	3.787	SI	SI
Av. De la Democracia	900	2	15.681	7.841	NO	SI
Av. De los Poblados (C/Aliseda-C/Ontanilla)	1100	4	38.709	9.677	SI	SI
Av. De los Poblados (A42-Av. Andalucía)	2000	4	28.578	7.145	SI	SI
Av. De los Poblados entre A5- Padre Piquer	800	6	42.978	7.163	NO	SI
Av. De los Poblados entre Padre Piquer- General Fanjul	900	6	29.972	4.995	SI	SI
C/Mendez Alvaro entre M-30 y C/Ancora	1400	4	40.000	10.000	SI	SI

Table 1. List of pre-selected street.

Based on the technical and administrative requirements, the test section was finally implemented in Méndez Álvaro street between Bustamante Street and Pedro Bosch Street.

Milling products characterization and LIFESURE eco-asphalt design

The aim of this action is the physical and chemical characterisation of the milling to be used in the experimental sections and design the specific mixtures to be manufactured in the prototype of asphalt plant.



RAP Characterisation

The RAP was recovered by means of milling techniques from the existing surface layer to a depth of 60mm, thus the RAP homogeneity was completely ensured. Then, the material was separated and classified into two fractions: the fine fraction (0/5mm) and coarse fraction (5/25mm). RAP aged binder was extracted by the centrifuge extractor method in order to be tested in the laboratory as per (EN 12697-3), testing 3 samples which confirm the homogeneity of the RAP binder.

Table 1. Determination of soluble binder content

Asphalt binder Content (EN 12697-1)		
Fraction	0/5mm	5/25mm
% binder/mixture	7,67	3,39
% binder/aggregate	8,31	3,51

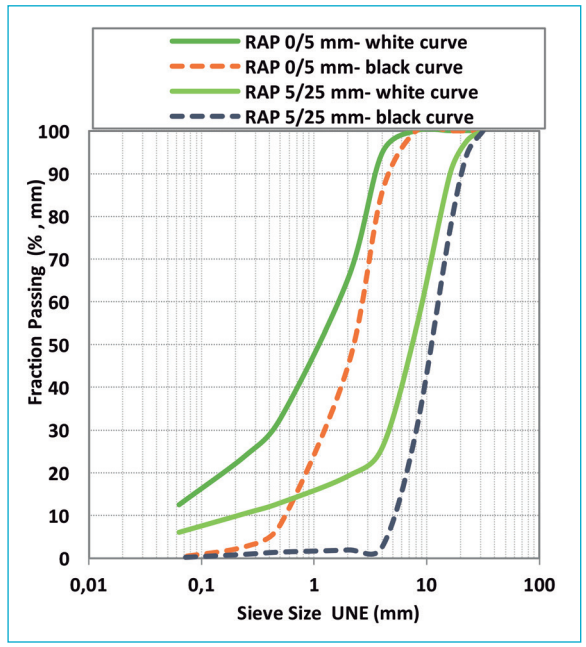
Table 2. Recovery of asphalt binder for its characterization (EN 12697-3)

Properties	Unit	Test Method	Value
Penetration test	0,1 dmm	EN 1426	10
Softening Point	°C	EN 1427	81,8

Table 3. Analysis of particle size distribution of RAP

Sieve size UNE (mm)	RAP Particle size distribution			
	0/5 mm		5/25mm	
	black	white	black	white
31,5	100	100	100	100
22,4	100	100	94,2	97,5
16	100	100	76,8	89,9
8	100	100	29,7	53,7
4	85,7	94,8	2,6	25,9
2	45,2	65,5	1,9	19,3
0,5	7,9	32,7	1,4	13,0
0,25	2,8	24,2	0,9	10,6
0,063	0,2	12,5	0,1	6,1

Figure 1 . RAP original gradations and after extraction aged binder



Job Mix Formula

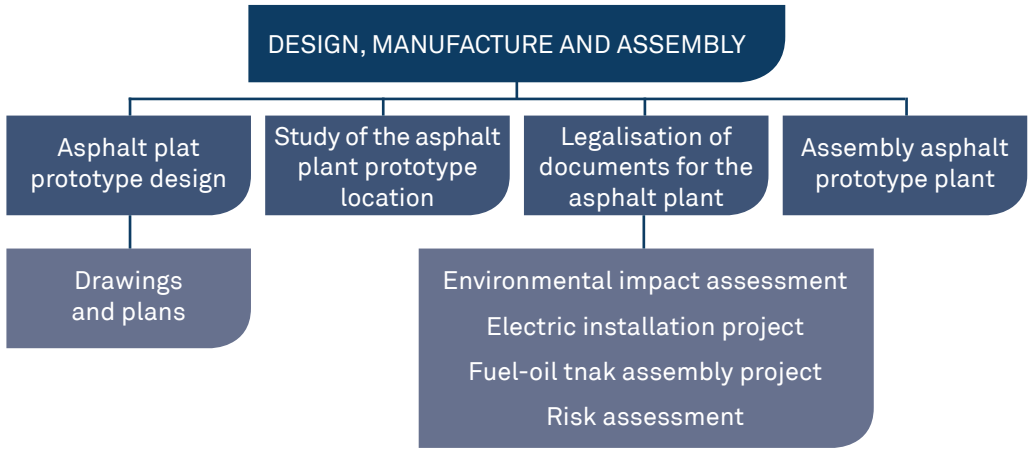
The original mix design was made according to the Job Mix Formula (JMF), which has consisted of defining the optimum proportions of each type of RAP fraction, binder content and aggregates to verify its compliance in terms of indirect tensile strength (ITS) at 15°C, stiffness modulus at 20°C, air void content, apparent and maximum density, varying the bitumen emulsion content in mix.

Table 4. Proportion of RAP aggregates

Materials	Fraction mm	Composition (%)	
		Lifesure eco-Asphalt 70%	Lifesure eco-Asphalt 100%
RAP	0/5	35	30
RAP	5/25	35	70
Virgin Aggregates	6/12	18	-
	12/18	12	-
% emulsion		4,0%	2,50%

Design and construction of an innovative prototype of asphalt plant to produce LIFESURE eco-asphalt

The aim of this activity is to design and build a specific prototype for the manufacture LIFESURE eco-asphalt (100%) suitable to be used in small applications to generalize the use of theses mixes in urban roads rehabilitation.



Technical feasibility of the technology

To evaluate the viability of the Lifesure eco-asphalt, 2 experimental test sections were carried out, to monitoring, in order to evaluate the mechanical behavior of the Lifesure eco-asphalt compared to a conventional mixture.

CEDEX Test track Section Accelerated pavement testing under controlled traffic conditions

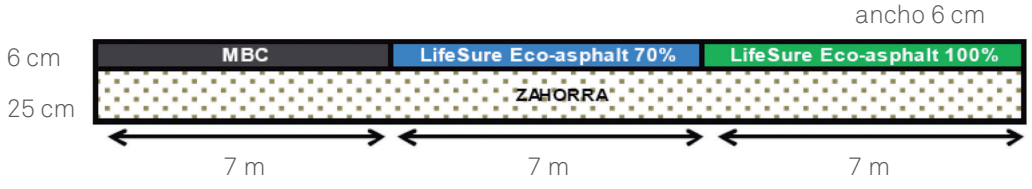
The objective of this action is to implement Lifesure eco-asphalt and assess their behavior under controlled traffic conditions.

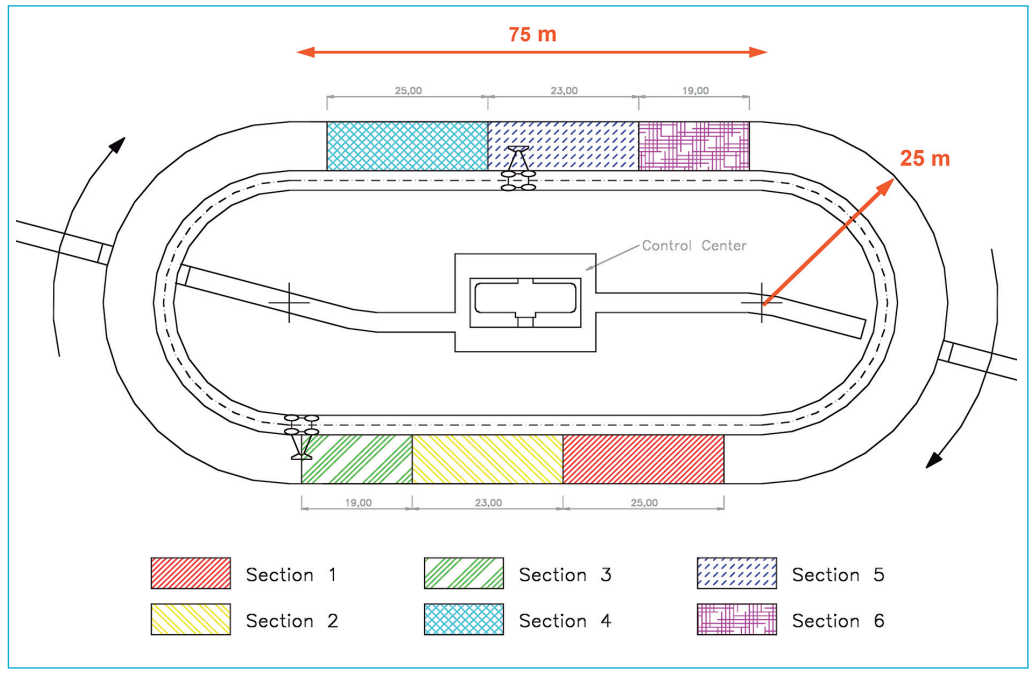
Accelerated Pavement Testing can determine pavement response and performance under a controlled, accelerated accumulation of damage in a compressed time period. Traffic is simulated using heavy vehicle simulator (HVS). Instrumentation is placed at surface and in-depth in order to obtain data on the response and performance of the mixtures used.

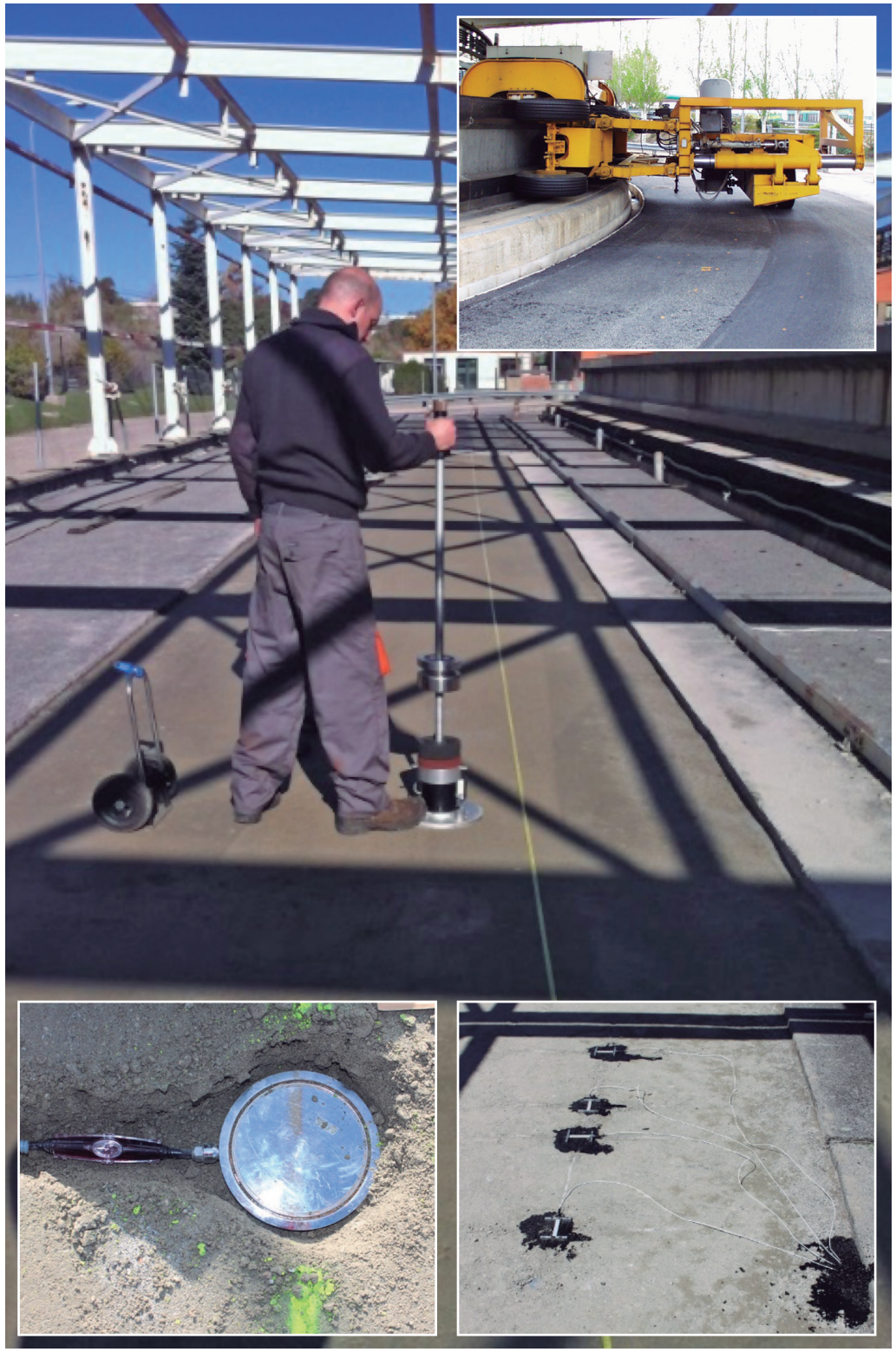
The test sections have been built in the center of one of the straight sections of the installation

The length of the test was 25 meters, divided into three sections of 8 meters plus 2 transition zones at the start and end of the test area of 0.5 m each. The structural section is detailed in the following table.

Section 1	Section 2	Section 3	Thickness (cm)
Lifesure eco-asphalt 70%	Lifesure Eco-Asphalt 100%	Hot Mix Asphalt (AC16S)	5
Artificial Graded aggregate			12
Soil Type 1			60
Soil type 2			40
Soil			108
Concrete slab			







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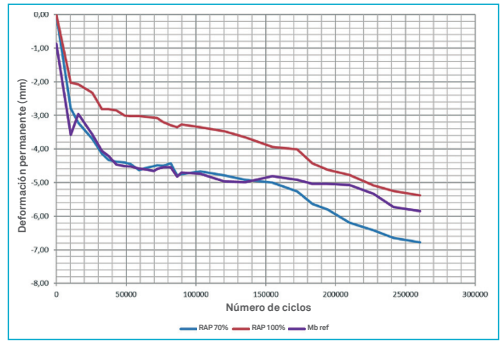
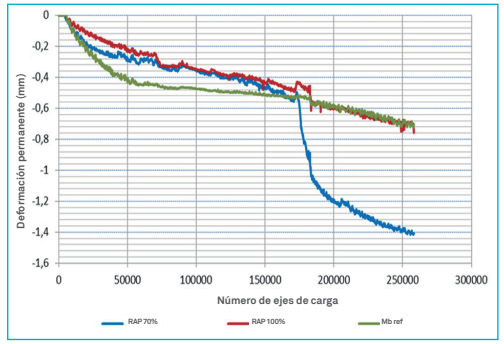
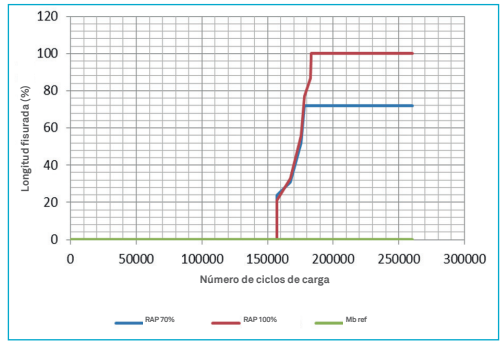
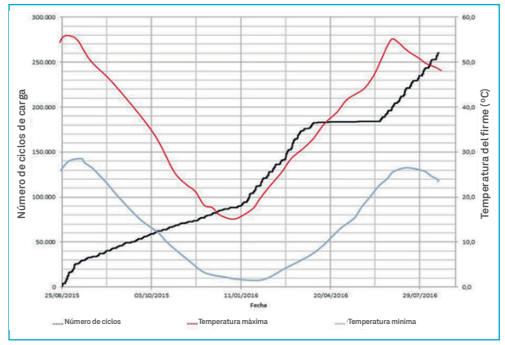


Permanent Deformations

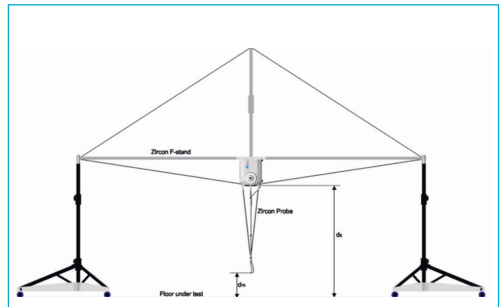


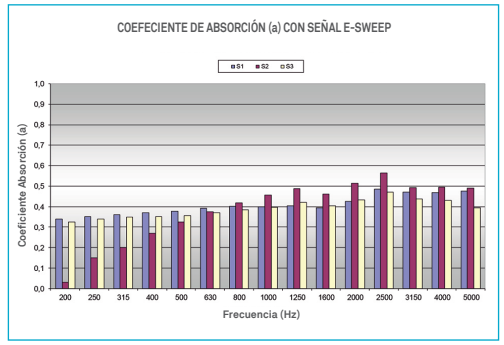
Cracking





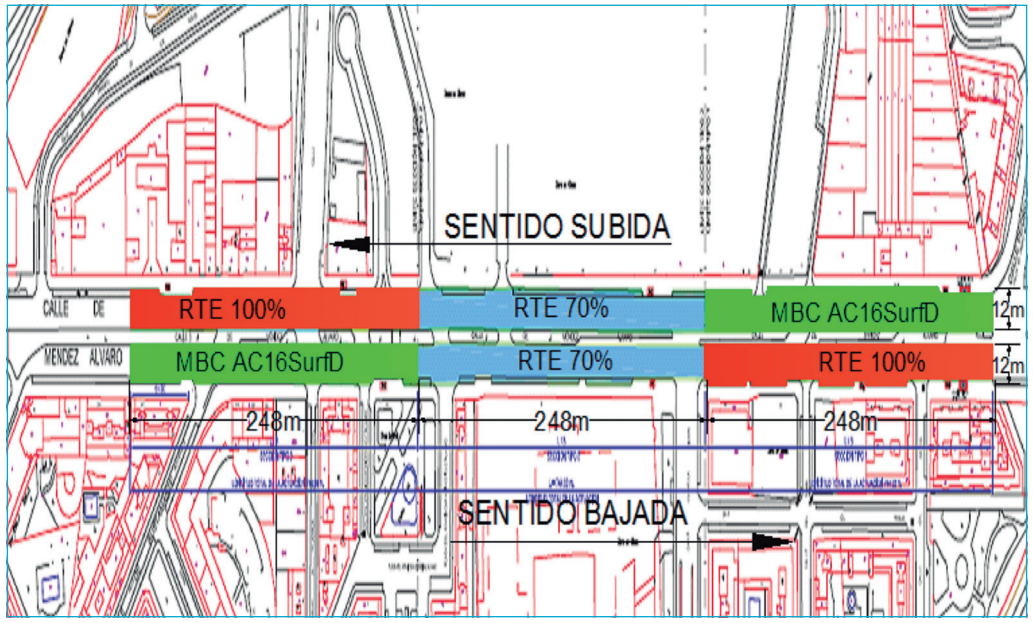
Noise absorption measure





Madrid test section

The aim of this task is the implementation of Lifesure eco-asphalt in 18.000 m² under real conditions in Méndez Álvaro street between Pedro Bosch and Bustamante Street.

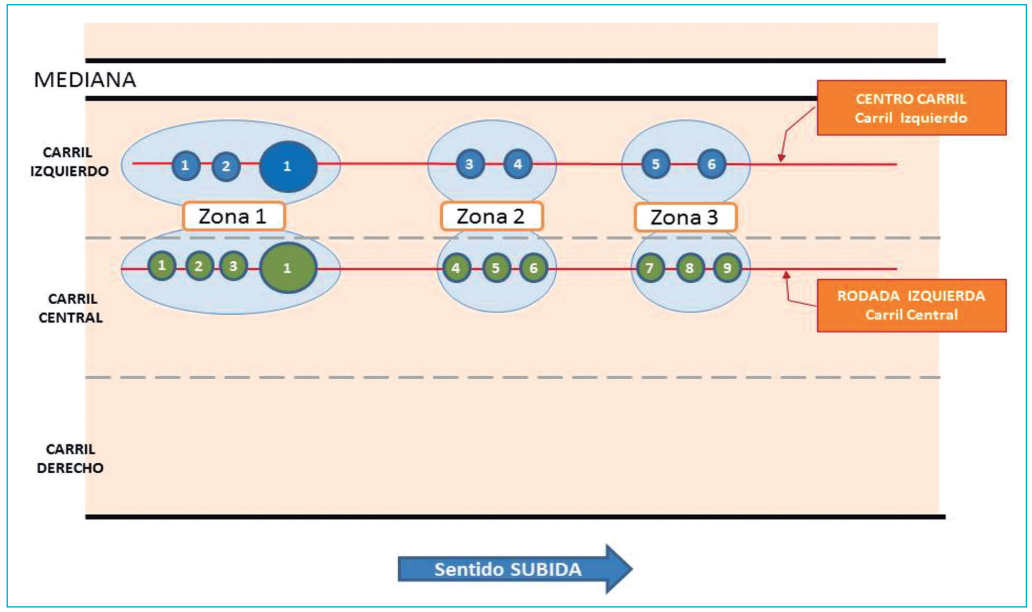


Monitoring Lifesure eco-asphalt in Méndez Álvaro test section

The aim of this task is to evaluate the mechanical performance of LIFESURE eco-asphalt in the short or medium term. For that purpose, a monitoring plan has been drawn up consisting:

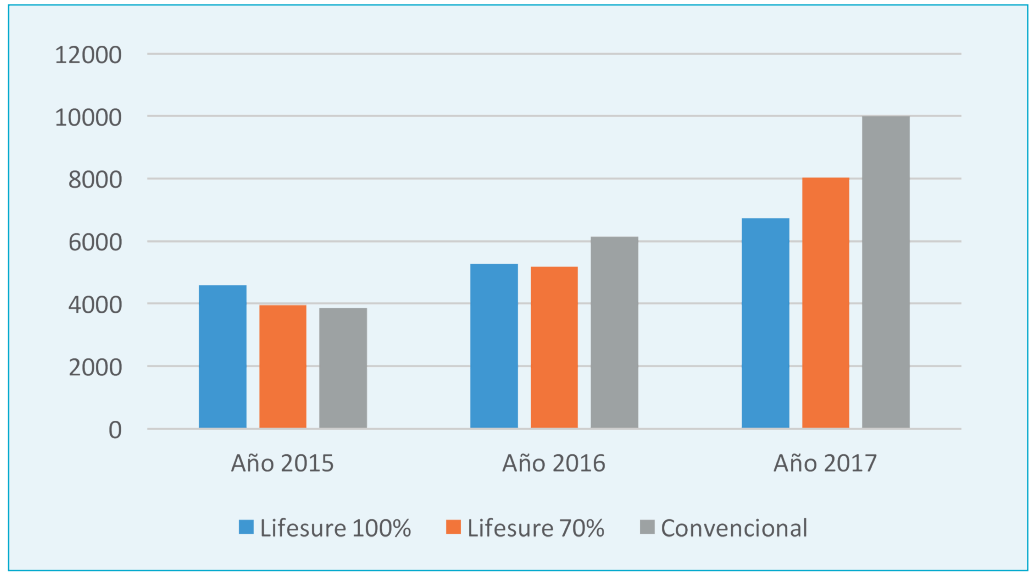
- Asphalt Core testing
- Visual Inspections

Asphalt Core testing diagram

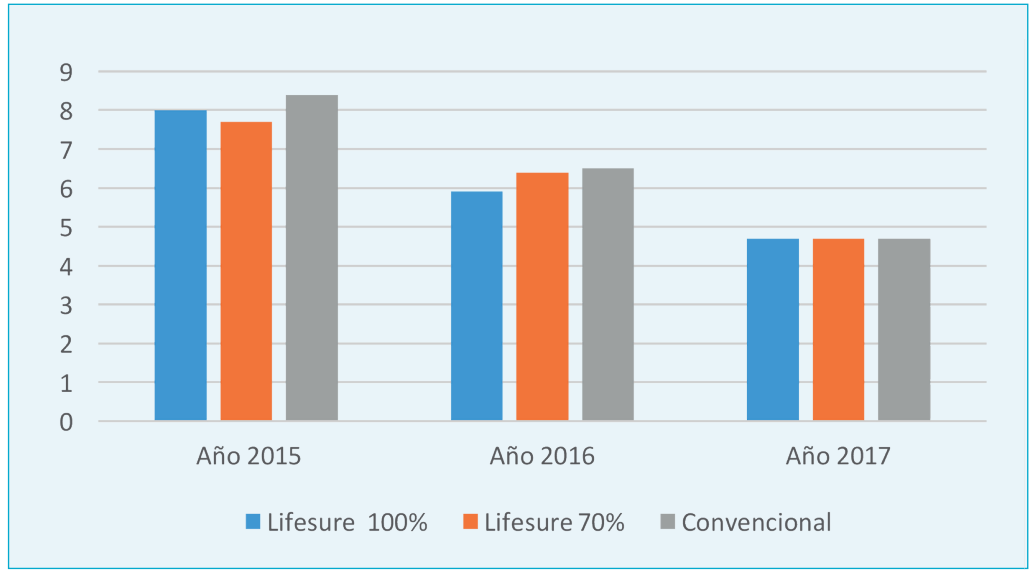


Evolution of the stiffness modulus of bituminous mixtures, air void content and bitumen characterization are shown in the following figures.

Stiffness modulus 20ºC (Mpa) Evolution



Air void content (%) Evolution



Bitumen characterisation

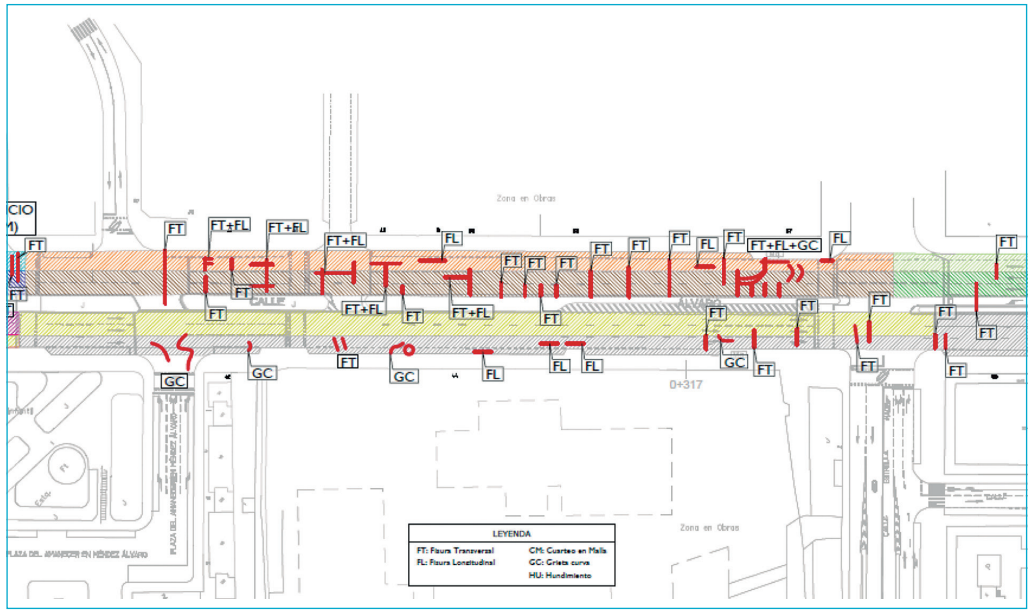
Lifesure eco-asphalt 100%		
	2015	2017
Penetration test (0,1 mm)	17	15
Softening point (ºC)	68,7	73,3

Conventional mixture (Hot mix asphalt)		
	2015	2017
Penetration test (0,1 mm)	-	16
Softening point (ºC)	-	79,7

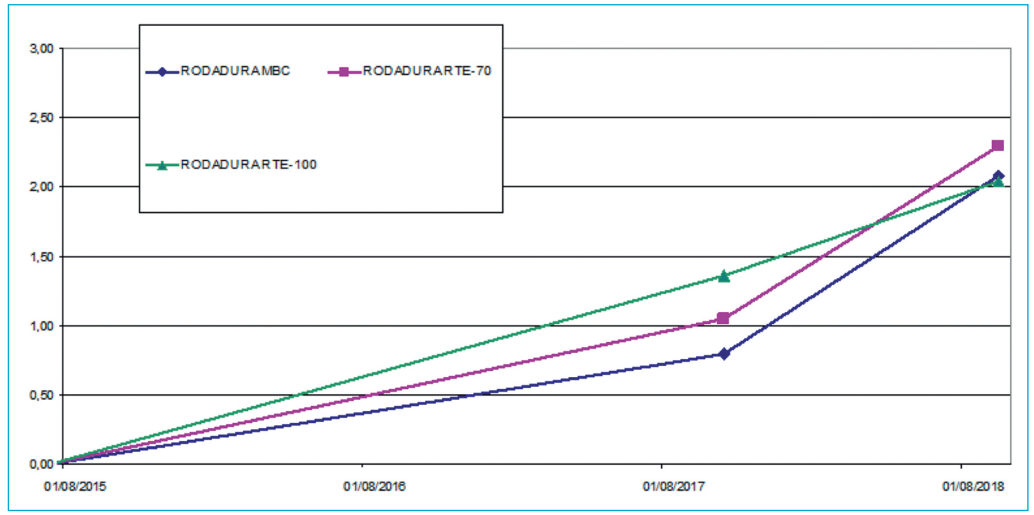
Lifesure eco-asphalt 70%		
	2015	2017
Penetration test (0,1 mm)	15	12
Softening point (ºC)	69,9	78,8

Regarding the visual inspections carried out, several reports have been prepared for each of them, with plans and charts of cracking as shown below:

Crackin plane

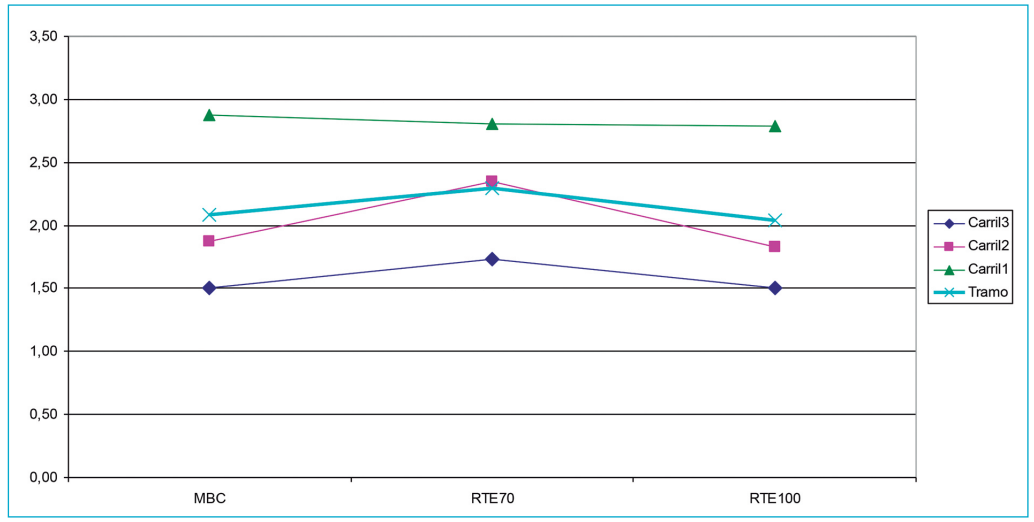


Average number of transverse cracks per decameter. Northbound carriageway



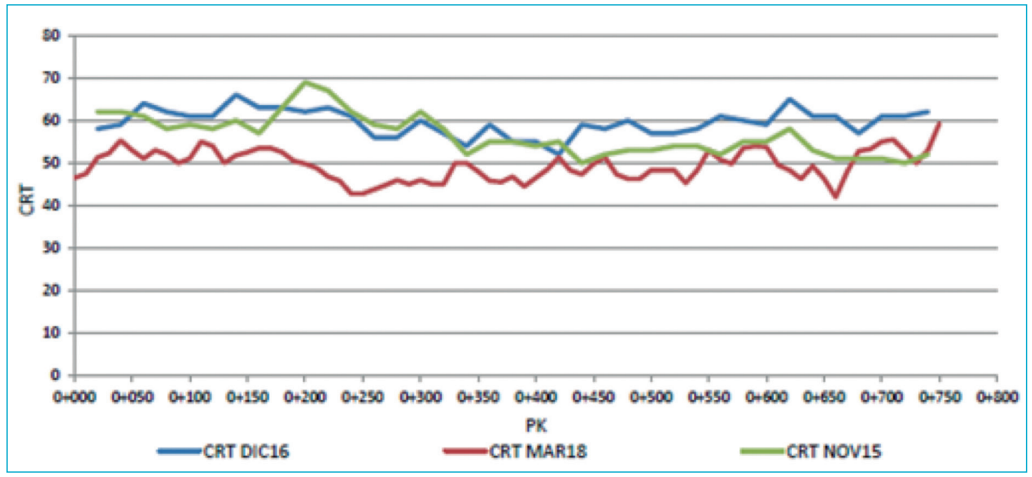
Average number of transverse cracks per decameter. Northbound carriageway

Inspection 17/09/2018

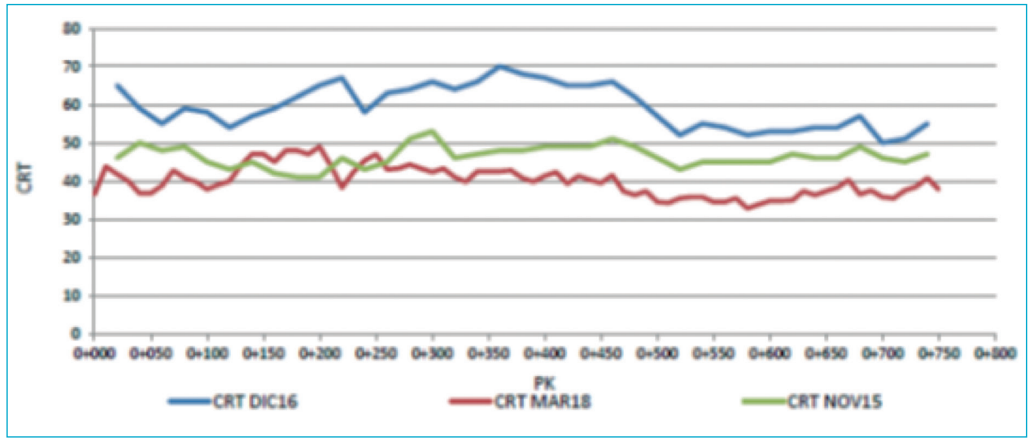


Skid resistance measurements have also been made: CRT

CRT central roadway. Down direction



CRT central roadway. Up direction



Méndez Álvaro Street monitoring conclusions:

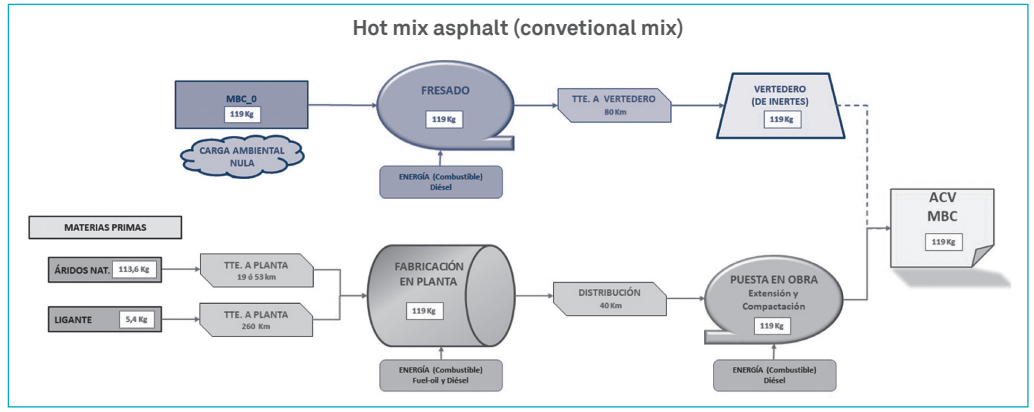
- Mechanical behavior of Lifesure eco-asphalt mixtures is like conventional mixture.
- There is an increased in stiffness of all mixtures. More accused in the conventional mix.
- Bitumen ageing has not been a significant factor in the increase of stiffness modulus.
- Air void content does seem to have an influence the stiffness modulus.
- In the light of the results obtained, these mixtures are technically feasible and can be used both in urban roads and in any other type of roads.

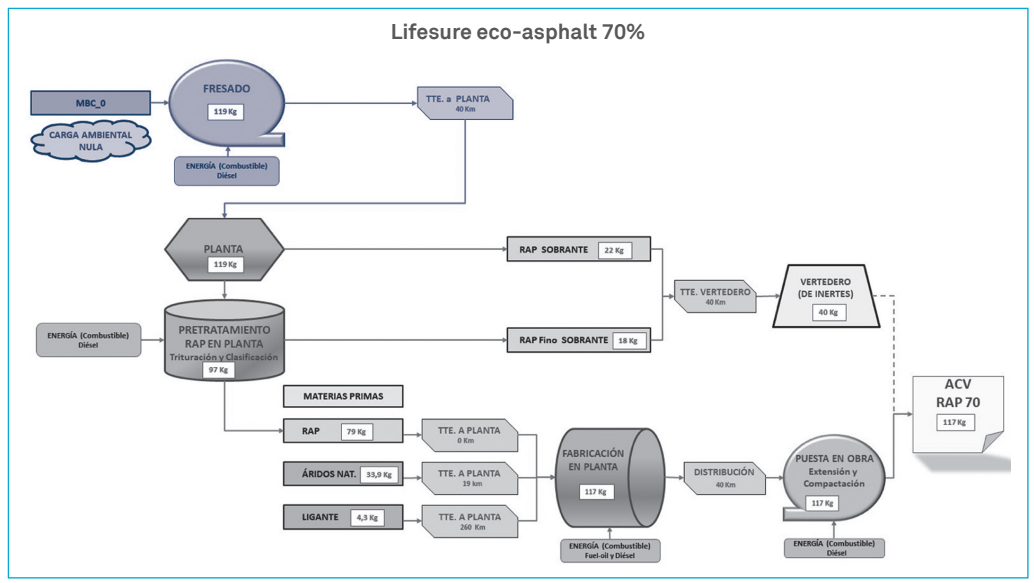
Life Cycle Assessment

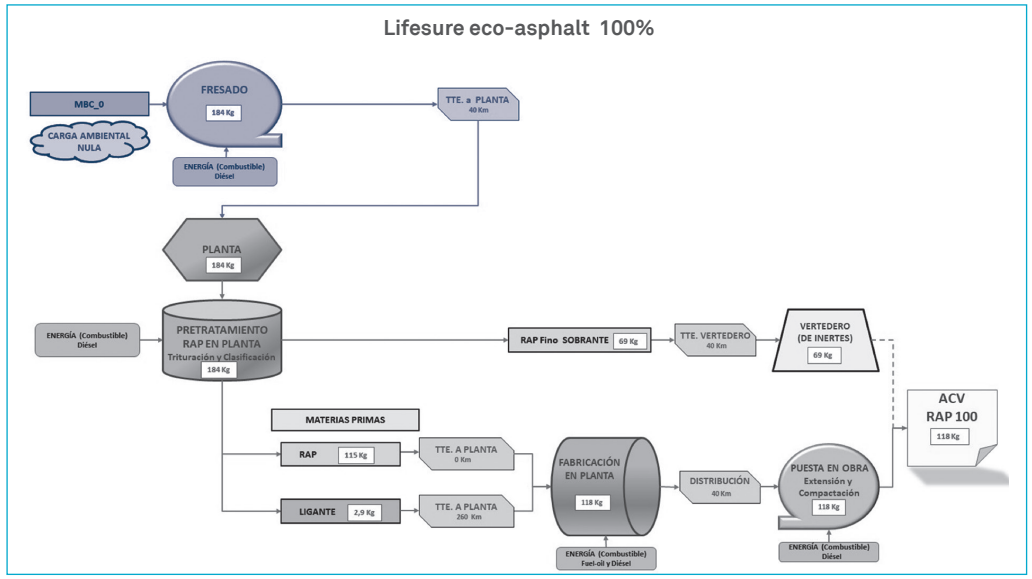
The goal of this action is to quantify the environmental impact of Lifesure eco-asphalt (100% and 70%) throughout the life cycle of the asphalt mixtures.

For that purpose, it will be necessary to collect all the environmental data (consumption, emissions, waste), linked to the manufacturing process of Lifesure eco-asphalt mixtures and conventional mixture. A methodology will be developed to analyse the environmental impacts at all stages of the process (extraction of raw materials to the manufacture and lying if the mixtures).

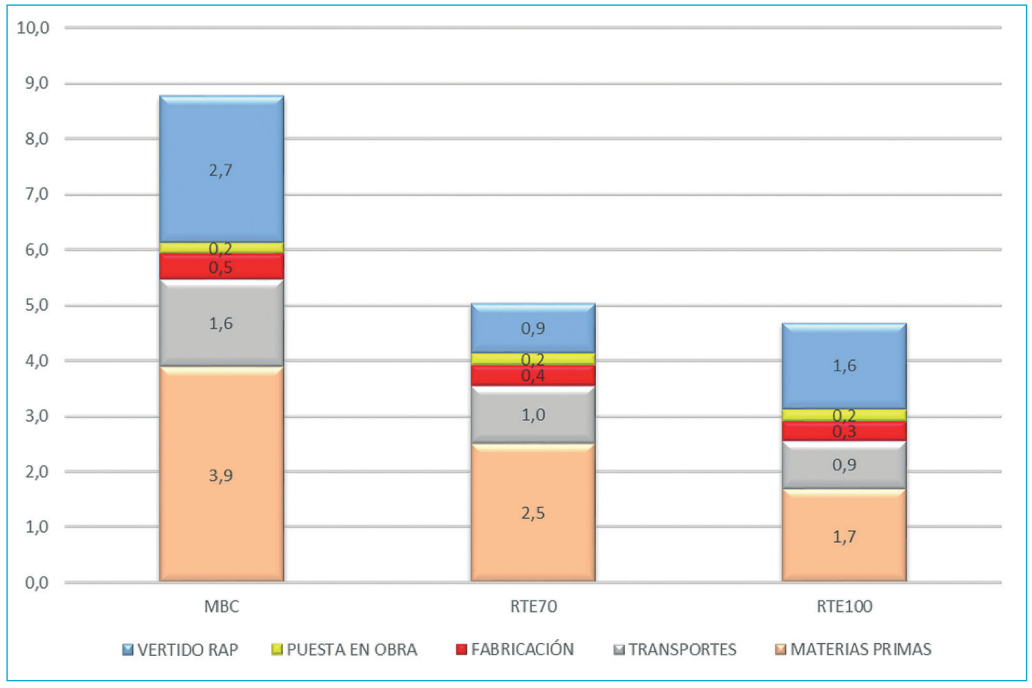
Diagram of process



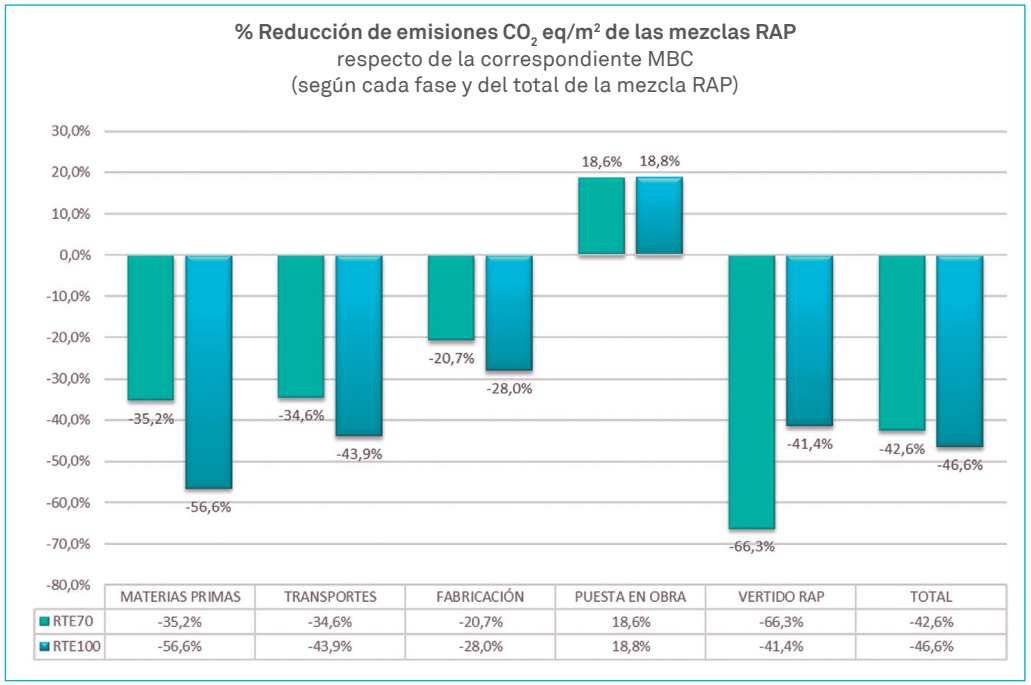




Life Cycle Analysis Results



GHG emissions at different stages of the asphalt mixtures (kg CO2eq / m2 pavement)



	MATERIAS PRIMAS	TRANSPORTES	FABRICACIÓN	PUESTA EN OBRA	VERTIDO RAP	TOTAL
RTE70	-35,2%	-34,6%	-20,7%	18,6%	-66,3%	-42,6%
RTE100	-56,6%	-43,9%	-28,0%	18,8%	-41,4%	-46,6%

Considering the results achieved, we can say that Lifesure eco-asphalt mixes are environmentally more sustainable than conventional hot mixes (reduction of GHG emissions at all stages assessed (raw materials, transport, manufacturing, laying and landfill).

CONCLUSIONS AND RECOMMENDATIONS

- The development of Lifesure eco-asphalt mixtures means a firm commitment to promote an innovative solution technique and cleaner production technology aiming to positively bring environmental sustainability advantages to the road asphalt pavements, such the reduction in consumption of natural resources and the emission of gases into the atmosphere.

- This project has shown technical feasibility of manufacturing more competitive and environmentally sustainable mixtures than hot conventional mix asphalt.

- These mixtures present a huge competitive advantage over conventional hot mix asphalt since it only incorporates half of binder consumption and half of heating energy.

- The production of these asphalt mixtures must necessarily incorporate industrial technologies that should be able to transfer heating to the reclaimed asphalt pavement (RAP) without causing thermal damage to the binding agent.

PHOTOS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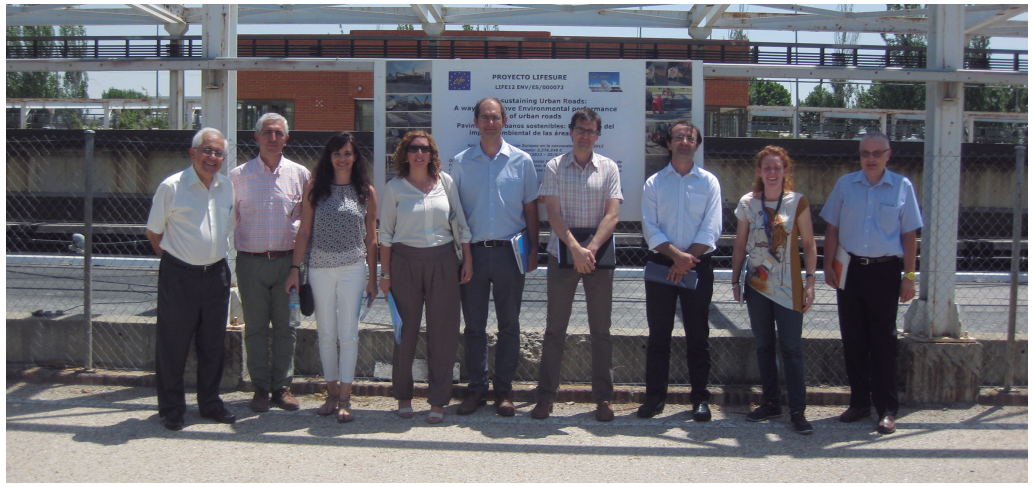
WORKSHOP LIFESURE


PROYECTO LIFESURE
LIFE12 ENV/ES/000973


Con capacidad de
adaptación
El liderazgo está e
los valores que for
nuestro ADN
life

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