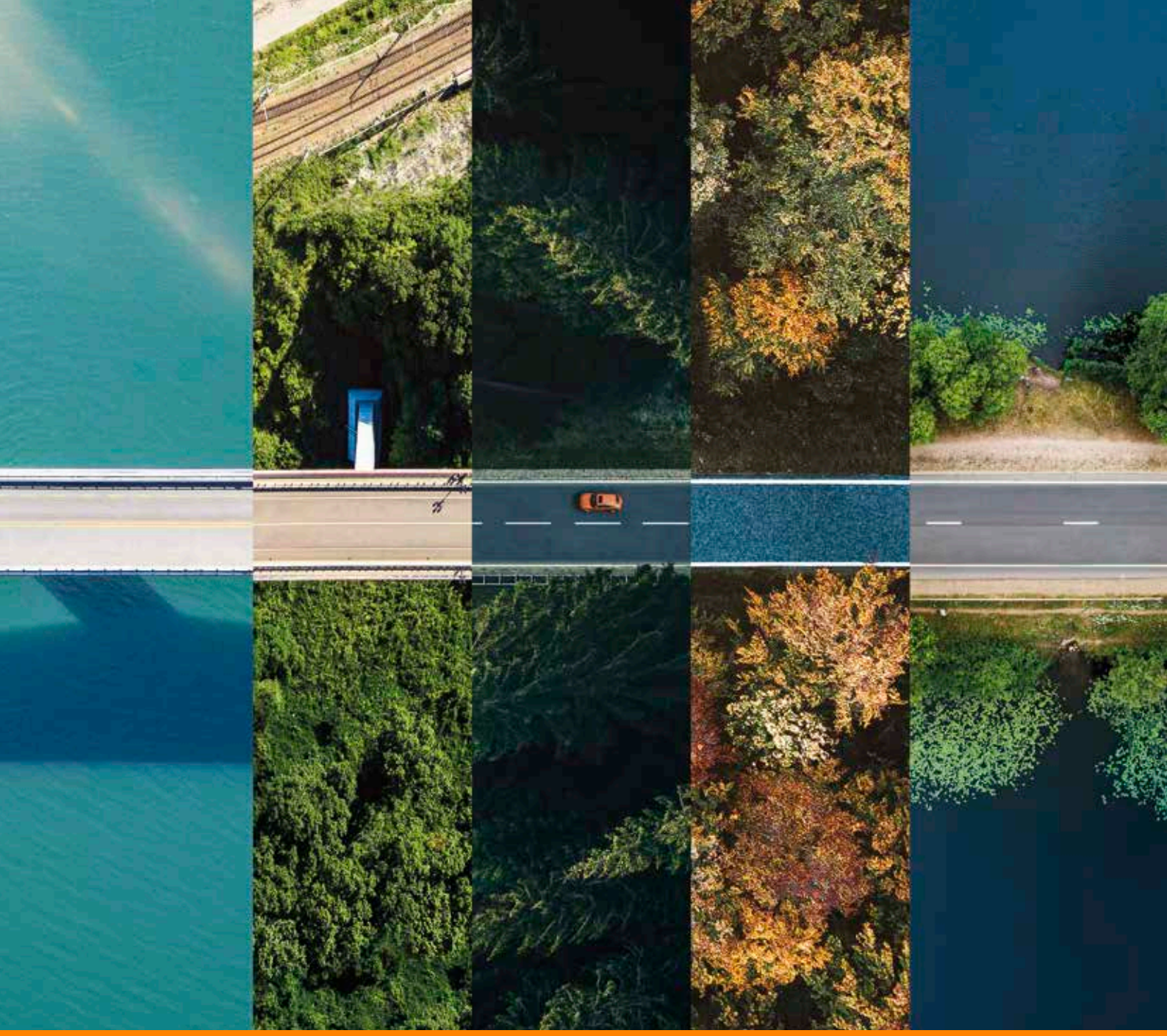


Asphalt
catalogue

REPSOL

PAVE | PERFORM | COLOR | ADVANCE | ISOLATE

PAVE

- Repsol PAVE
- Repsol EFI-PAVE

PERFORM

- Repsol PERFORM and EFI-PERFORM
- Repsol EFI-PERFORM HP
- Repsol EFI-PERFORM 45/80-65 AUTL and EFI-PERFORM 45/80-75 AUTL
- Repsol EFI-PERFORM PMB 10/40-70 BUS
- Repsol EFI-PERFORM C
- Repsol PERFORM B35/50 AC
- Repsol EFI-PERFORM B35/50 ACTIV, B50/70 ACTIV
- Repsol PERFORM MG 35/50-59/69
- Repsol EFI-PERFORM B35/50W, B50/70W, PMB 45/80-60W, PMB 45/80-65W and PMB 45/80-75W HP
- Repsol EFI-PERFORM B REJUV

ADVANCE

- Repsol ADVANCE and EFI ADVANCE
- Repsol EFI ADVANCE TER
- Repsol ADVANDE and REFI ADVANCE EXPORT
- Repsol ADVANCE and EFI ADVANCE LONG LIFE
- Repsol EFI ADVANCE C50B4 IMP HPP
- Repsol ADVANCE C50B2 and C50BP2 PROTECT
- Repsol EFI ADVANCE C65BP4 MIC d HP
- Repsol EFI ADVANCE C60B5 REC REJUV
- Repsol ADVANCE C67BF3 MBA EFIMUL
- Repsol EFI ADVANCE HW and REC HW

COLOR

- Repsol COLOR RECOFAL
- Repsol COLOR RECOFAL S-100 HP

ISOLATE

- Repsol ISOLATE

INTRODUCTION

When you choose Repsol asphalt, you choose so much more. That is because its asphalt products are of the highest quality and come with all the assurance that Repsol offers you. This integrated and global energy company pursues exploration, production, refining, distribution and marketing activities in over 80 countries, providing millions of people and companies around the world with the most efficient, responsible and innovative energy solutions..

With trusted products based on a careful selection of crudes, we produce our bituminous binders with rigorous quality control that guarantees compliance with national and international specifications. Therefore, Repsol Asfaltos operates with a complete management system that integrates quality (ISO 9001), the environment (ISO 14001) and safety (OSHAS 18001), as well as CE Marking..

ENVIRONMENTAL COMMITMENT

The asphalt line is **committed to manufacturing environmentally friendly products** and is aligned with the search for a neutral environmental impact, while operating according to the top standards of safety and reliability.

We seek answers to society's current and future needs with respect for and commitment to our environment.

Technological innovation

We promote technological innovation as a basic part of our business, focused on an ongoing search for eco-efficient solutions and the development of special products adapted to our customers' needs.

In its firm commitment to innovation, Repsol promotes its capacity for technological development in line with its business growth. This is backed by the Repsol Technology Lab, a benchmark research centre in Spain and internationally. The commitment to innovation is supported by the development of environmentally friendly technologies, an essential value in managing all businesses.

In addition to its highly qualified technical staff, renowned in the sector, the research centre stays abreast of the latest technological progress in the research and development of bituminous binders, as well as the equipment necessary to measure their performance.

The Asphalt Laboratory is fully equipped to characterise bituminous mixtures, enabling us to verify the suitability of our products under service conditions.

Technical assistance and development

As an essential part of the service we offer to our customers, we provide the Technical Support and Development Department, which is in charge of :

- Advance consulting.
- Assistance in execution.
- Custom product design.
- Training.

FORMATS

In response to the sector's demands and customers' new needs, Repsol has worked to implement the most intelligent transport logistics best adapted to constantly evolving market demands.

BULK

Due to reliability, experience and capacity, bulk supply (in petrol tankers) is our main mode of delivery in the Spanish and international markets in our scope of supply, which lets us serve our customers efficiently and with guarantees for any products manufactured and marketed. Repsol also has enough capacity and experience to transport by sea, especially when delivering large amounts of bituminous products to maritime terminals in Spain and around the world.

DRUMS

The main advantages of presentation in 208-litre, 220-litre and 250-litre drums are the possibility of maintaining large stocks and ease of handling, both during transport and at the destination. This type of packaging is very suitable for long-distance transport, as it can store between 16 and 20 tonnes of any of our products in a standard 20-foot container, depending on the type of drum.

BITUBAG

The BituBag is an innovative container that allows for the transport and storage of bitumen and modified bitumen in a solid state with a significant reduction in logistic and energy costs, as well as bituminous emulsions. With this format, standard 20-foot containers (TEU) can be delivered with around 22 tonnes of product, thereby facilitating transport over long distances (road, ship and train).

From the point of view of safety. The BituBag is a system that offers great advantages since transport and storage take place at room temperature in highly resistant bags. The system avoids risks inherent to the product in a liquid state and facilitates its handling compared to traditional common solutions.

BITUCONTENEDOR

The Bitucontenedor is an innovative mode of transport that can deliver the product in bulk at temperatures suitable for transfer thanks to an independent heating system in the container itself. It also facilitates transport over long distances thanks to its adaptation to the standard 20-foot container (TEU). These advantages allow the transport of our products, making their industrial transfer and handling less complicated and using the Bitucontenedor as the final or intermediate tank.

PELLET

Repsol has developed specific formulations to make its pigmented synthetic binders susceptible to pelletisation. This pellet or pillow format allows the binders to be stored cold with the advantages that this entails from the point of view of safety and the environment. The packaging of the pellets in bags or boxes facilitates handling and storage of the product.

INTERMEDIATE BULK CONTAINER (IBC)

The Intermediate Bulk Container (IBC) is a moulded cubic tank with a 100-litre capacity covered by a rigid tubular grid with a filler neck and emptying valve on a pallet that can be handled on all four sides, which makes it highly versatile in that regard. With this format, standard 20-foot containers (TEU) holding between 18 and 20 tonnes of product can be delivered.

The great innovation that Repsol brings to this container is the development of a range of over-stabilised emulsions with a specific formulation that allow for its transport over long distances without storage for long periods of time, affecting any of the properties of this type of product.

Repsol PAVE

Repsol PAVE Asphalt Bitumen is a hydrocarbon binder produced via petroleum distillation that exhibits a temperature-dependent viscoelastic behaviour and great chemical stability. It is also called penetration bitumen because this property is used to classify it.

Bitumen is the component that agglomerates and gives cohesion in bituminous mixtures and is mainly responsible for their properties. Its consistency can be modified by temperature, which allows its handling, the covering of aggregate, the compaction of the mixtures and its suitable behaviour at service temperatures.

After performing a suitable selection of the basket of crudes, Repsol obtains **Repsol PAVE Asphalt Bitumen** Bitumen that meets the most demanding specifications.

APPLICATIONS

Repsol PAVE asphalt bitumens are used in:

Roads

- Conventional bituminous mixtures.
- Bitumen for manufacturing binders:
  - Repsol PERFORM and EFI-PERFORM
  - Repsol EFI-PERFORM C
  - Repsol PERFORM AC
  - Repsol PERFORM ACTIV
  - Repsol ADVANCE emulsions

Industrial applications

- Emulsions and mastics for waterproofing and industrial paving.
- Asphalt fabrics.
- Pipe coating.
- Hydraulic works.
- Joint sealants.
- Asphalt paints, etc.

The most common conventional Repsol PAVE bitumen in Spain, mainly for climatic reasons, is PAVE 50/70 penetration-grade bitumen, used in the manufacture of conventional bituminous mixtures.

The following map shows the climate zones in Spain that determine the type of bituminous binder to be used.

PRODUCT CHARACTERISTICS

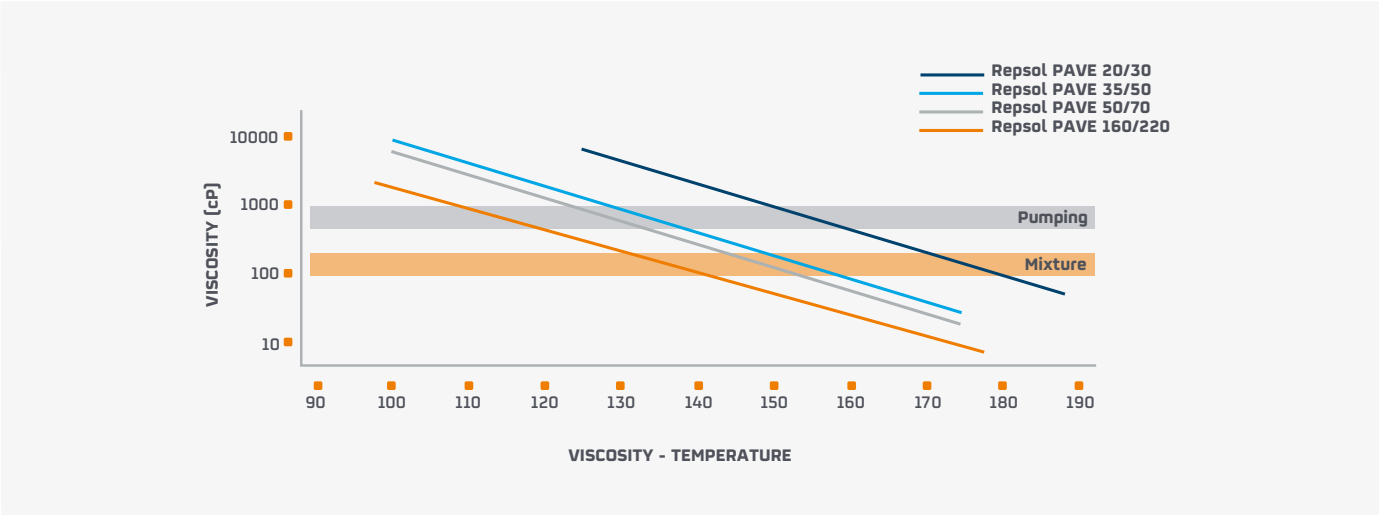
All the asphalt bitumen marketed by Repsol complies with CE Marking requirements according to the EN 12591 standard. The following table shows the characteristics of Repsol PAVE asphalt bitumens for roads sold in Spain:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol PAVE 20/30	Repsol PAVE 35/50	Repsol PAVE 40/60	Repsol PAVE 50/70	Repsol PAVE 70/100	Repsol PAVE 100/150 SOFT	Repsol PAVE 160/220 SOFT
Penetration at 25ºC		1426	0,1 mm	20-30	35-50	60-60	50-70	70-100	100-150	160-220
Softening point		1427	ºC	55-63	50-58	48-56	46-54	43-51	39-47	35-45
Ageing resistance EN 12607-1	Mass change	12607-1	%	≤ 0,5	≤ 0,5	≤0,5	≤ 0,5	≤ 0,8	≤0,8	≤ 1,0
	Retained penetration	1426	%	≥ 55	≥ 53	≥0,5	≥ 50	≥ 46	≥43	≥ 37
	Increased softening point	1427	ºC	≤ 8	sev 1: ≤ 8 and sev 2: ≤ 11	≤9	sev 1: ≤ 9 and sev 2: ≤ 11	sev 1: ≤ 9 and sev 2: ≤ 11	≤12	sev 1: ≤ 11 and sev 2: ≤ 12
Penetration index		12591 Annex A	-	From -1,5 a +0,7	From -1,5 a +0,7	From -1,5 a +0,7	From -1,5 a +0,7	From -1,5 a +0,7	From -1,5 a +0,7	From -1,5 a +0,7
Fraass breaking point		12593	ºC	NR	≤ -5	≤-7	≤ -8	≤ -10	≤-12	≤ -15
Flash point		ISO 2592	ºC	≥ 240	≥ 240	≥ 230	≥ 230	≥ 230	≥ 230	≥ 220
Solubility		12592	%	≥ 99,0	≥ 99,0	≥99,0	≥ 99,0	≥ 99,0	≥ 99,0	≥ 99,0

Specifications collected in Article 211 of the Spanish General Technical Specifications for Road and Bridge Works (PG-3).

RECOMMENDATIONS FOR USE

The most appropriate temperatures for using bitumen are given by viscosity (see figure).



These data are illustrative and not binding, nor subject to specification. These values may change depending on the origin of the product.

Repsol EFI-PAVE

Based on a careful selection in the crude basket, Repsol makes different grades of hard bitumen available to its customers for paving, as described in standard EN 13924-1, which allows mixtures with a modulus of rigidity two times higher than that corresponding to a mixture made with conventional bitumen.

APPLICATIONS

- Base coats on new pavement.
- Airport pavements.
- Pavement reinforcement or partial reconstruction.
- In an intermediate anti wheel track layer when a thinner layer is used for the surface course.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of Repsol EFI-PAVE hard bitumen for paving:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PAVE 15/25 HM	Repsol EFI-PAVE 10/20 HM
Penetration at 25ºC		1426	0,1 mm	15-25	10-20
Softening point		1427	ºC	60-76	61-71
Ageing resistance EN 12607-1	Mass change	12607-1	%	≤ 0,5	≤ 0,5
	Retained penetration	1426	%	≥ 55	≥ 55
	Increased softening point	1427	ºC	≤ 8	≤ 10
Penetration index		12591 Annex A	-	From -1,5 a +0,7	From -1,5 a +0,7
Fraass breaking point		12593	ºC	TBR	TBR
Flash point		ISO 2592	ºC	≥ 245	≥ 245
Solubility		12592	%	≥ 99,0	≥ 99,0

To Be Reported (TBR).

RECOMMENDATIONS FOR USE

Recommended temperature ranges for application	Mixing	175 - 180ºC
	Laying and compaction	**165 - 170ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

BEHAVIOUR OF THE PRODUCT IN THE MIXTURE

Structural capacity

The high modulus obtained with this bitumen offers us the following advantages when designing pavement structures with a bituminous base:

- Reach higher structural performance and expected life values much higher than normal (see Figure 1).
- Design thinner pavement packages for the same structural capacity.

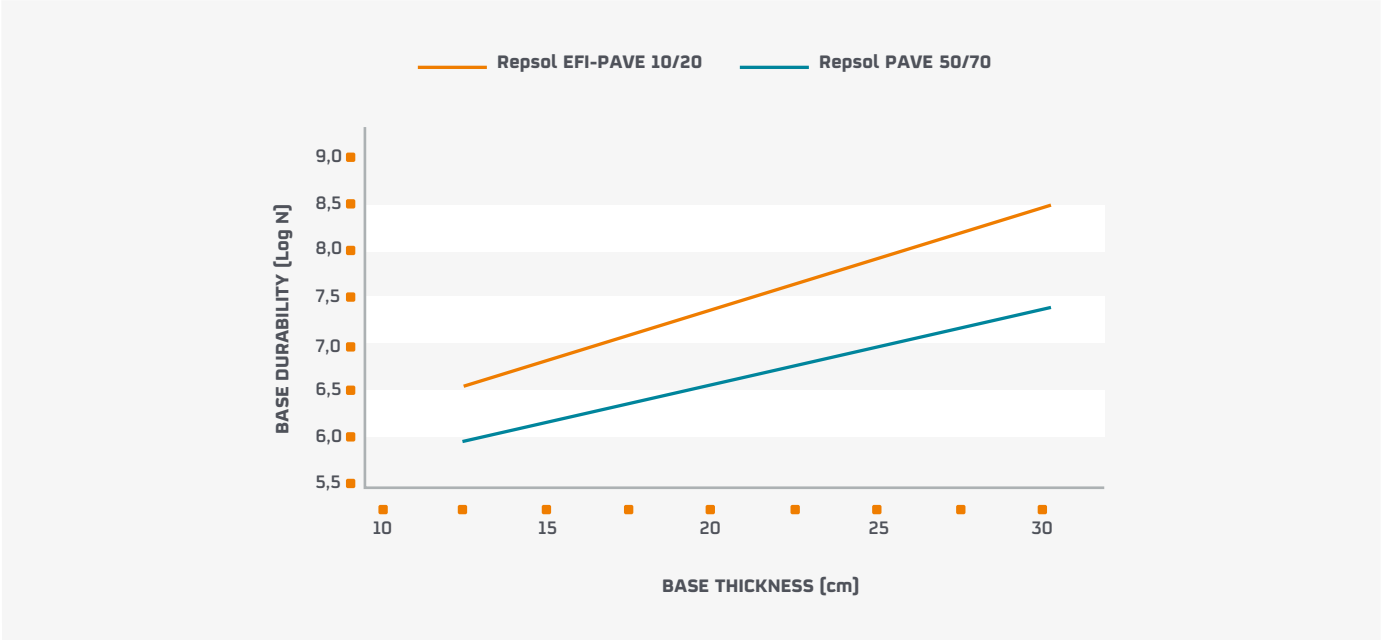


Figure 1. Structural behaviour. Data are indicative, not contractual, nor subject to specification.

Plastic deformations

Repsol EFI-PAVE hard paving bitumen gives the designed mix extraordinary behaviour against plastic deformation.

Repsol PERFORM and Repsol EFI-PERFORM

Repsol has a complete range of Repsol PERFORM and EFI-PERFORM polymer modified bitumens that meet CE Marking requirements, described in standard EN 14023 and included in Article 212 of the Spanish General Technical Specifications for Road and Bridge Works (PG-3), in addition to other specific products. Most of our modified bitumen products are produced using a self-developed chemical crosslinking system that provides a uniform structure that guarantees its properties and storage stability.

Modifier bitumen makes it possible to manufacture bituminous mixtures with greater mechanical and functional performance that allow bituminous mixtures for roads to be adapted to the increase in traffic and the greater demands stemming from it, which results in **greater durability** and **savings in maintenance costs**.

APPLICATIONS

The following table shows the main uses of the different types of Repsol PERFORM and EFI-PERFORM polymer modified bitumens to manufacture hot bituminous mixtures.

Repsol EFI-PERFORM PMB 10/40-70[1]	High modulus mixtures with better resistance to fatigue.
Repsol PERFORM PMB 25/55-65	Mixtures in the rolling course and intermediate layer in hot summer areas with T00 and T1[2] category traffic, resistant to plastic deformation on slow roads, improving resistance to fatigue in reinforcement and new construction.
Repsol PERFORM PMB 45/80-60	Asphalt Concrete mixtures for surface courses and intermediate layers for T1, T2 and T3 category traffic in all climate zones and T00 and T0 in mean and temperate climate zones, resistant to plastic deformation and with better fatigue properties. Asphalt concrete for very thin layers and porous asphalt for T1 and T2 traffic.
Repsol PERFORM PMB 45/80-65	Asphalt Concrete mixtures for T00 and T0 category traffic in all climate zones, including T1 for the hot summer zone, resistant to plastic deformation and better fatigue. Asphalt concrete for very thin layers and porous surface courses, including stone mastic asphalt (SMA) mixtures. Porous asphalt mixtures with a high percentage of air voids. Asphalt for Ultra Thin layer.
Repsol EFI-PERFORM PMB 45/80-75	Anti-fissure mixtures for surface courses. Anti-fissure mixtures for intermediate or thin layers. High-performance SMA and Asphalt concrete for very thin layers. High-performance porous asphalt. Asphalt for Ultra Thin layer.
Repsol PERFORM PMB 75/130-60	High quality surface course treatments. Reflective cracking prevention membranes.

(1) See specific data sheet for Repsol EFI-PERFORM PMB 10/40-70 BUS
(2) The traffic categories described correspond to the Spanish regulations.

All polymer modified bitumens have their version with tyre powder outside their useful life. And its version for low paving temperatures. See specific data sheet.

PRODUCT CHARACTERISTICS

All the bitumens modified with polymers REPSOL that Repsol sells meet CE Marking requirements according to the EN 14023 standard. The table below shows the characteristics of the most commonly used Repsol PERFORM and EFI-PERFORM polymer modified bitumens in Spain, reported in the Spanish General Technical Specifications for Road and Bridge Works (PG-3):

EN 14023 NAME				Repsol EFI-PERFORM PMB 10/ 40-70	Repsol PERFORM PMB 25/ 55-65	Repsol PERFORM PMB 45/ 80-60	Repsol PERFORM PMB 45/ 80-65	Repsol EFI-PERFORM PMB 45/ 80-75	Repsol PERFORM PMB 75/ 130-60
CHARACTERISTICS		EN STANDARD	UNIT	TESTS ON THE ORIGINAL BITUMEN					
Penetration at 25ºC		1426	0,1 mm	10-40	25-55	45-80	45-80	45-80	75-130
Softening point		1427	ºC	≥ 70	≥ 65	≥ 60	≥ 65	≥ 75	≥ 60
Cohesion. Force-ductility		13589	J/cm²	≥ 2 to 15ºC	≥ 2 to 10ºC	≥ 2 to 5ºC	≥ 3 to 5ºC	≥ 3 to 5ºC	≥ 1 to 5ºC
Fraass breaking point		12593	ºC	≤ -5	≤ -7	≤ -12	≤ -15	≤ -15	≤ -15
Elastic recovery at 25ºC		13398	%	TBR	≥ 50	≥ 50	≥ 70	≥ 80	≥ 60
Storage stability	Softening point difference	13399 1427	ºC	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9	≤ 9	≤ 9	≤ 13	≤ 13
Flash point		ISO 2592	ºC	≥ 235	≥ 235	≥ 235	≥ 235	≥ 235	≥ 220
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1									
Mass change		12607-1	%	≤ 0,8	≤ 0,8	≤ 1,0	≤ 1,0	≤ 1,0	≤ 1,0
Retained penetration		1426	%	≥ 60	≥ 60	≥ 60	≥ 60	≥ 60	≥ 60
Increased softening point		1427	ºC	≤ 8	≤ 8	≤ 10	≤ 10	≤ 10	≤ 10
Decreased the softening point		1427	ºC	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5

Specifications reported in Article 212 of the Spanish General Technical Specifications for Road and Bridge Works (PG-3).
To Be Reported (TBR).

The use of polymers significantly improves the properties of bitumens, particularly:

- Increased softening point.
- Lower temperature susceptibility.
- Increased penetration index.
- Increased plasticity range.
- Increased viscosity.
- Greater ductility.
- Better performance at low temperatures.
- Higher resistance to ageing.

RECOMMENDATIONS FOR USE

Due to their rheological behaviour and configuration, the recommendations for use for Repsol PAVE conventional bitumens cannot be applied to Repsol PERFORM and EFI-PERFORM polymer modified bitumens.

Repsol's Technical Support and Development Department can advise customers on the best conditions of use in each case.

PRODUCT BEHAVIOUR IN THE MIXTURE

Repsol PERFORM and EFI-PERFORM polymer modified bitumens greatly improve the performance of bituminous mixtures:

- Greater cohesion and ductility, allowing for more critical particle size structures of bituminous mixtures.
- Greater resistance to fatigue, reducing the risk of cracking.
- Greater resistance to ageing in the most adverse conditions (greater service durability).
- Greater adhesion to aggregates.
- Increased service temperature range.
- Greater resistance to plastic deformations (wheel track).

Repsol EFI-PERFORM HP

Repsol EFI-PERFORM HP high-performance modified bitumen is a technologically innovative binder with high polymer content obtained by means of a chemical reticulation process that presents a microscopically uniform structure and is fully stable in storage. The binders are modified to a very high degree, with a high softening point, internal cohesion and ductility.

These binders achieve mixture properties greatly exceeding those obtained with traditional modified bitumens, giving them greater cohesion, tenacity and ductility, which allows for more critical granulometric structures and greater resistance to plastic deformation.

Repsol EFI-PERFORM HP modified binders include three grades with particular characteristics in each of them:

• **Repsol EFI-PERFORM PMB 45/80-75 HP** high-viscosity modified bitumen makes this binder especially suitable for use in high-performance mixtures for surface courses exposed to high tangential stress, minimising the risk of rutting and possible binder drainage and exudation, improving its ductility due to its elastic component, resilience, ageing and resistance to fatigue. It is also designed for use in anti-crack mixtures and other special mixtures. In both cases, the binder provides greater durability on the pavement and less maintenance. The different magnificent benefits that this product provides the mixtures allow for the creation of specific formulations depending on the application and/or characteristic desired..

• **Repsol EFI-PERFORM PMB 45/80-75 HP** and **Repsol EFI-PERFORM PMB 45/80-65 HP** modified bitumens include characteristics to improve performance with greater durability, enhancing their behaviour at high service temperatures and maintaining their characteristics at intermediate and low temperatures, achieving a microscopically uniform structure that is stable in storage, with excellent product manageability due to the specific manufacturing process and the additives used. Furthermore, the development of **Repsol EFI-PERFORM PMB 10/40-80 HP** allows for its use for very heavy-duty traffic and warmer weather conditions.

APPLICATIONS

The main applications of Repsol EFI-PERFORM are:

PMB 45/80-75 HP

- Asphalt concrete for very thin layers (BBTM) or Stone Mastic Asphalt (SMA) for surface courses exposed to high traffic demands and tangential stress.
- Mixtures for high-performance surface courses. This binder can be used to manufacture open-graded/gap-graded mixtures with a bitumen content of 5.5-7% and great resistance to fatigue.
- Porous mixtures with a high percentage of air voids. Twin-layer mixtures are an example of this.

PMB 45/80-65 HP and PMB 10/40-80 HP

- Mixtures for high-performance, resistant and ductile open-grade or gap-grade surface courses or intermediate layers with high levels of bitumen with great resistance to fatigue at different service temperatures.

PRODUCT CHARACTERISTICS

The characteristics appear in the table below:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 45/80-65 HP	Repsol EFI-PERFORM PMB 45/80-75 HP	Repsol EFI-PERFORM PMB 45/80-75 HHP	Repsol EFI-PERFORM PMB 10/40-80 HP
TESTS ON THE ORIGINAL BITUMEN							
Penetration at 25ºC		1426	0,1 mm	45-80	45-80	45-80	10-40
Softening point		1427	ºC	≥ 65	≥ 75	≥ 80	≥ 80 (***)
Cohesion. Force-ductility		13589	J/cm²	≥ 3 to 5ºC (*)	≥ 3 to 5ºC	≥ 3 to 5ºC (**)	≥ 2 to 10ºC
Fraass breaking point		12593	ºC	≤ -15	≤ -15	≤ -15	≤ -5
Elastic recovery at 25ºC		13398	%	≥ 70	≥ 80	≥ 80	≥ 70
Storage stability	Softening point difference	13399 1427	ºC	≤ 5	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 13	≤ 9	≤ 9
Flash point		ISO 2592	ºC	≥ 235	≥ 235	≥ 235	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1							
Mass change		12607-1	%	≤ 1,0	≤ 1,0	≤ 1,0	≤ 1,0
Retained penetration		1426	%	≥ 60	≥ 60	≥ 60	≥ 60
Increased softening point		1427	ºC	≤ 10	≤ 10	≤ 8	≤ 10
Disminución del punto de reblandecimiento		1427	ºC	≤ 5	≤ 5	≤ 5	≤ 5

(*) Force-ductility values >5 J/cm² to 5ºC. There is no class for this value in standard EN 14023.
(**) Force-ductility values >7 J/cm² a 5ºC. There is no class for this value in standard EN 14023.
(***) Designed to achieve values >90 ºC. There is no class for this value in standard EN 14023.

RECOMMENDATIONS FOR USE

Recommended temperature range for application	Mixing*	160 - 180ºC
	Laying and compaction**	**160 - 175ºC**

(*) These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.
(**) For the modified binder PMB 45/80-75 HP in particular, mixing temperatures can be reduced to 165ºC, with wide ranges of laying and compaction between 140-160ºC.

PRODUCT BEHAVIOUR IN THE MIXTURE

The most interesting field of application for these binders is that of hot mixes with good resistance to high-performance temperatures, maintaining the same behaviour at intermediate and low temperatures as their equivalents. The bitumen gives the mixture reinforced characteristics of resistance to repetitive loads at high temperatures.
The viscosity of these bitumens greatly improves their manageability without compromising the ability to be applied in special granulometric compositions that allow for a high amount of binder without slippage, which gives the desired behaviour and properties to the mixture.

Repsol EFI-PERFORM 45/80-65 AUTL and Repsol EFI-PERFORM 45/80-75 AUTL

Repsol EFI-PERFORM PMB 45/80-65 AUTL and **EFI-PERFORM PMB 45/80-75 AUTL** modified bitumens are specially designed for manufacturing ultrafine mixes < 20 mm.

These bitumens are designed to resist tangential stresses on the surface and counteract problems due to the decrease in their compaction temperatures.

These modified bitumens comply with CE Marking requirements, described in the standard EN 14023.

APPLICATIONS

The main applications of **Repsol EFI-PERFORM PMB 45/80-65** and **EFI-PERFORM PMB 45/80-75 AUTL** are:

- Mixtures for ultra thin layer surface courses.
- Special mixtures for gap-grade surface layers or SMA.

PRODUCT CHARACTERISTICS

The characteristics appear in the table below:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 45/80-65 AUTL	Repsol PERFORM PMB 45/80-75 AUTL
Penetration at 25ºC		1426	0,1 mm	45-80	45-80
Softening point		1427	ºC	≥ 65	≥ 75
Cohesion. Force-ductility		13589	J/cm²	≥ 3 to 5ºC	≥ 3* to 5ºC
Fraass breaking point		12593	ºC	≤ -15	≤ -15
Elastic recovery at 25ºC		13398	%	≥ 70	≥ 80
Storage stability	Softening point difference	13399 1427	ºC	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9
Flash point		ISO 2592	ºC	≥ 235	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1					
Mass change		12607-1	%	≤ 1,0	≤ 1,0
Retained penetration		1426	%	≥ 60	≥ 60
Increased softening point		1427	ºC	≤ 10	≤ 10
Decrease of the softening point		1427	ºC	≤ 5	≤ 5

* Force-ductility values > 5 J/cm² to 5ºC. There is no class for this value in standard EN 14023 on the specification structure of polymer modified bitumens.

RECOMMENDATIONS FOR USE

		Repsol EFI-PERFORM PMB 45/80-65 AUTL	Repsol EFI-PERFORM PMB 45/80-75 AUTL
Recommended temperature range for application	Mixing	165 - 140ºC	165 - 145ºC
	Laying and compaction	**160 - 135ºC End 120ºC**	**160 - 145ºC End 130-125ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

PRODUCT BEHAVIOUR IN THE MIXTURE

The most interesting field of application for these binders is in mixtures for ultra thin layers. The binder gives the mixture reinforced cohesion characteristics in a thin layer to withstand the stresses of road traffic.

Repsol EFI-PERFORM PMB 10/40-70 BUS

Repsol EFI-PERFORM PMB 10/40-70 BUS modified bitumen is a technologically developed binder for high specific traffic demands on roads or pavements where heavy vehicles travel.

This binder achieves mixed properties with better resistance to plastic deformation. It is a modified binder with polymers and special additives that enhance this characteristic.

Repsol EFI-PERFORM PMB 10/40-70 BUS is a low penetration binder with additives that increases the modulus of the mix compared to traditional softer binders and with a polymeric composition that additionally helps to optimise the modulus-fatigue pair, considering the loading, unloading and channelling cycles of medium-heavy traffic. It also improves the behaviour of the mixture against fuel spills..

APPLICATIONS

The main applications of Repsol **EFI-PERFORM PMB 10/40-70 BUS** are:

- Asphalt Concrete (AC) type continuous grading mixtures and stone mastic asphalt (SMA) gap-graded mixtures for surface courses that are resistant to plastic deformations and can withstand channelled heavy-duty traffic.
- High-modulus mixtures for intermediate layers with improved stiffness modulus values in warm and/or temperate climates, when thin surface courses are used.

PRODUCT CHARACTERISTICS

The main applications of Repsol EFI-PERFORM PMB 10/40-70 BUS are:

CHARACTERISTICS	EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 10/40-70 BUS
TEST ON GENERAL BITUMEN			
Penetration at 25ºC	1426	0,1 mm	10-40
Softening point	1427	ºC	≥ 70
Cohesion. Force-ductility	13589	J/cm²	≥ 2 to 15ºC
Fraass breaking point	12593	ºC	≤ 0
Elastic recovery at 25ºC	13398	%	TBR
Flash point	ISO 2592	ºC	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1			
Mass change	12607-1	%	≤ 0,8
Retained penetration	1426	%	≥ 60
Increased softening point	1427	ºC	≤ 10
Decreased the softening point	1427	ºC	≤ 5

TBR (To Be Reported): the value shall be reported.

RECOMMENDATIONS FOR USE

Recommended temperature range for application	Mixing	170 - 180ºC
	Laying and compaction	**165 - 175ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

PRODUCT BEHAVIOUR IN THE MIXTURE

The Repsol **EFI-PERFORM PMB 10/40-70 BUS** binder gives the asphalt mixture the following advantages:

- High resistance to plastic deformations.
- Improved structural characteristics.
- High stiffness modulus values.

Repsol EFI-PERFORM C

Repsol has developed its own technology to incorporate and reuse rubber from end-of-life tyres (PNFVU) for the purpose of technically improving the behaviour of bitumens and collaborating environmentally in the reuse of end-of-life tyres.

Bearing in mind the regulations in application in Spain on the use and specifications with which binders and bituminous mixtures using rubber from end-of-life tyres must comply, as well as criteria to be considered for their manufacture, Repsol employs a wet industrial manufacturing process that helps to ensure traceability in the production, quality and digestion of the product.

The stability and uniformity of the final product has been achieved via a special process and the use of previously selected bitumens, resulting in the following range of products: Rubber-Improved Bitumen, Rubber-Modified Bitumen, High-Performance Rubber Modified Bitumen and High-Viscosity Rubber Modified Bitumen.

Rubber-improved bitumens

APPLICATIONS

Rubber improved bitumens are mainly used in asphalt concrete mixtures in base, intermediate and course layers.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of rubber improved bitumens that correspond to the Spanish regulations published in the circular orders (OC 21/2007 and OC 21bis/2009):

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM BC 35/50	Repsol EFI-PERFORM BC 50/70
TESTS ON THE ORIGINAL BITUMEN					
Penetration at 25ºC		1426	0,1 mm	35-50	50-70
Softening point		1427	ºC	≥ 58	≥ 53
Cohesion. Force-ductility		13589	J/cm²	≥ 0,5 to 5ºC	≥ 0,5 to 5ºC
Fraass breaking point		12593	ºC	≤ -5	≤ -8
Elastic recovery at 25ºC		13398	%	≥ 10	≥ 10
Storage stability	Softening point difference	13399 1427	ºC	≤ 10	≤ 10
	Needle penetration difference	13399 1426	0,1 mm	≤ 8	≤ 10
Flash point		ISO 2592	ºC	≥ 235	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1					
Mass change		12607-1	%	≤ 1,0	≤ 1,0
Retained penetration		1426	%	≥ 65	≥ 60
Increased softening point		1427	ºC	≤ 8	≤ 10
Decreased the softening point		1427	ºC	≤ -4	≤ -5

RECOMMENDATIONS FOR USE

The following table shows the recommended mixing, laying and compaction temperatures for the types of rubber-improved bitumens.

Repsol EFI-PERFORM C rubber-improved bitumens		Repsol EFI-PERFORM BC35/50	Repsol EFI-PERFORM BC50/70
Recommended temperature range for application	Mixing	165 - 175ºC	160 - 170ºC
	Laying and compaction	**155 - 165ºC**	**150 - 160ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

PRODUCT BEHAVIOUR IN THE MIXTURE

Rubber-improved bitumens provide hot asphalt mixtures with certain advantages compared to conventional bitumens, although to a lesser extent than rubber-modified bitumens::

- Greater resistance to fatigue.
- Greater resistance to ageing.
- Increase in service temperature range.

Crumb rubber-modified bitumens

APPLICATIONS

Rubber-modified bitumens can be used for the same applications as polymer modified bitumens, especially in the following:

- BBTM and SMA surface courses.
- PA porous asphalt.
- Asphalt concrete in an intermediate layer with improved fatigue and/or plastic deformation properties.

PRODUCT CHARACTERISTICS

The technical specifications of rubber-modified bitumens are as established in Article 212 of the Spanish General Technical Specifications for Road and Bridge Works (PG-3), in accordance with OC 21/2007.

RECOMMENDATIONS FOR USE

As is the case with polymer modified bitumens, due to their configuration and rheological behaviour, the temperatures for use in Repsol rubber-modified bitumens are made available by the Technical Support and Development Department, which can advise customers on the best conditions for use, handling and storage of these types of special binders.

PRODUCT BEHAVIOUR IN THE MIXTURE

The behaviour of rubber-modified bitumens in the mixture have the following advantages compared to those made with conventional bitumens:

- Greater cohesion.
- Greater resistance to fatigue.
- Greater resistance to ageing.
- Greater adhesion to aggregates.
- Better performance at low temperatures.
- Lower temperature susceptibility.
- Greater resistance to plastic deformations.

Repsol EFI-PERFORM PMB 45/80-70 C high-viscosity rubber-modified bitumen

APPLICATIONS

The main applications of **Repsol EFI-PERFORM PMB 45/80-70 C** are:

- Mixtures for high-performance intermediate layers resistant to the propagation of cracks on the surface.
- Asphalt concrete for very thin layer (BBTM) or stone mastic asphalt (SMA) for surface courses subjected to high traffic demands and significant tangential stresses.
- This binder can be used to manufacture open-graded/gap-graded mixtures with a bitumen content of 5.5-7.5% and great resistance to fatigue.
- Anti-cracking mixtures in interlayer systems.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of **Repsol EFI-PERFORM PMB 45/80-70 C** bitumen.

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 45/80-70 C
TESTS ON THE ORIGINAL BITUMEN				
Penetration at 25ºC		1426	0,1 mm	45-80
Softening point		1427	ºC	≥ 70
Cohesion. Force-ductility		13589	J/cm²	≥ 3 to 5ºC
Fraass breaking point		12593	ºC	≤ -15
Elastic recovery at 25ºC		13398	%	≥ 80
Storage stability	Softening point difference	13399 1427	ºC	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 13
Flash point		ISO 2592	ºC	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1				
Mass change		12607-1	%	≤ 1,0
Retained penetration		1426	%	≥ 60
Increased softening point		1427	ºC	≤ 10
Decreased the softening point		1427	ºC	≤ 5

RECOMMENDATIONS FOR USE

Recommended temperature range for application	Mixing	170 - 180ºC
	Laying and compaction	**165 - 175ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

PRODUCT BEHAVIOUR IN THE MIXTURE

The most interesting field of application for these binders is in hot mixtures that are highly resistant to reflective cracking. The bitumen reinforces the mixture's elastomeric recovery characteristics and also provides very good resistance to plastic deformations at high temperatures and excellent flexible behaviour at low temperatures.
The higher viscosity of Repsol EFI-PERFORM PMB 45/80-70 C modified bitumen and a special aggregate particle size composition allow a high binder content without binder drainage, which influences the desired behaviour and properties of the mix.

Repsol PERFORM B35/50 AC

Repsol PERFORM B35/50 AC fuel-resistant bitumen is a binder designed especially for the production of bituminous mixtures that are applied in areas where fuel and lubricant spills are frequent. They are generally used in fuel loading/unloading areas in industrial zones, airports, service stations and vehicle parking areas.

Fuel-resistant bitumens provide resistance to dissolution of the asphalt bitumen in the event of a hydrocarbon spill, minimising the loss of cohesion between the aggregate and the binder in the bituminous mixture. This deterioration would be made worse by the passage of vehicles.

APPLICATIONS AND RECOMMENDATIONS FOR USE

The main application of fuel-resistant bitumens, known as Repsol PERFORM B35/50 AC, are areas in frequent contact with hydrocarbons: taxiways, airport areas, bus lanes, long-term parking or waiting areas for fleets, freeway tolls, service stations and garages.

AC D-type mixtures (close/dense graded mixtures) are the most suited to the use of Repsol **PERFORM B35/50 AC**. It is highly recommended to adjust the formulation so that the mixture void content is around 3%.

Temperatures of use are similar to Repsol PAVE conventional bitumen.

Recommended temperature range for application	Mixing	155 - 160ºC
	Laying and compaction	**145 - 150ºC**

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

PRODUCT CHARACTERISTICS

As fuel-resistant bitumen has a solubility in organic solvents of around 97%, for the purpose of quality control, this low solubility must be taken into account when determining the soluble binder content obtained in the solvent extraction test performed on the bituminous mixture.
The following table shows the characteristics of the fuel-resistant bitumen **Repsol PERFORM B35/50 AC**:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol PERFORM B35/50 AC
TESTS ON THE ORIGINAL BITUMEN				
Penetration at 25ºC		1426	0,1 mm	35-50
Softening point		1427	ºC	≥ 75
Fraass breaking point		12593	ºC	≤ -14
Elastic recovery at 25ºC		13398	%	≥ 15
Storage stability	Softening point difference	13399 1427	ºC	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 5
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1				
Mass change		12607-1	%	≤ 0,5
Retained penetration		1426	%	≥ 65
Increased softening point		1427	ºC	≤ 5

PRODUCT BEHAVIOUR IN THE MIXTURE

Compared to conventional binders (Repsol PAVE and Repsol PERFORM polymer modified bitumens) used in bituminous mixtures for roads, **Repsol PERFORM B35/50 AC** fuel-resistant bitumen has the following advantages:

- Greater resistance to hydrocarbons compared to paving grade bitumens.
- Lower sensitivity to temperature and ageing.
- Very high resistance to high-service temperatures.
- Easy handling and installation (like a Repsol PAVE conventional bitumen).

Mixtures designed with **Repsol PERFORM B35/50 AC** fuel-resistant bitumen give good results in the resistance to fuel test (EN 12697-43) compared to mixtures designed with conventional bitumens.

Repsol EFI-PERFORM B35/50 ACTIV, B50/70 ACTIV y PMB 45/80-65 ACTIV

With certain types of aggregate, both conventional and modified bitumens can have adhesion problems due to a lack of physicochemical affinity between the aggregate and the binder.

In some cases, the use of quality fillers such as lime or cement can improve the behaviour of mixtures with water. Another solution is the addition of adhesion activators. Aware of this problem, Repsol has developed a wide range of additives that ensure reliable aggregate-binder behaviour in the mixture, along with a selection of the most suitable bitumens.

The activator adhesive is added to the bitumen in the production process at the refinery, which guarantees a uniform end product.

APPLICATIONS

Activated bitumens are used in asphalt mixtures that lack aggregate-binder adhesion. Therefore, the applications are the same as Repsol PAVE asphalt penetration-grade bitumens and Repsol PERFORM polymer modified bitumens.

All bitumens have CE Marking according to standards EN 12591 and EN 14023, as appropriate, for equivalents to conventional penetration-grade bitumens or polymer modified bitumens, respectively..

PRODUCT CHARACTERISTICS

Activated bitumens have the following characteristics:

- They provide the cohesion needed in hot bituminous mixtures.
- They increase the range of aggregates that can be used.
- They reduce the use of added fillers and the recovery filler can be used in many cases.

The following table shows the characteristics of activated bitumens::

CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM 35/50 ACTIV	Repsol EFI-PERFORM 50/70 ACTIV
Penetration at 25ºC		1426	0,1 mm	35-50	50-70
Softening point		1427	ºC	50-58	46-54
Resistance to ageing EN 12607-1	Mass change	12607-1	%	≤ 0,5	≤ 0,5
	Retained penetration	1426	%	≥ 53	≥ 50
	Increase of the softening point	1427	ºC	≤ 8 (sev 1)	≤ 9 (sev 1)
Penetration index		12591 Annex A	-	-1,5 to +0,7	-1,5 to +0,7
Fraass breaking point		12593	ºC	≤ -5	≤ -8
Flash point		ISO 2592	ºC	≥ 240	≥ 230
Solubility		12592	%	≥ 99,0	≥ 99,0

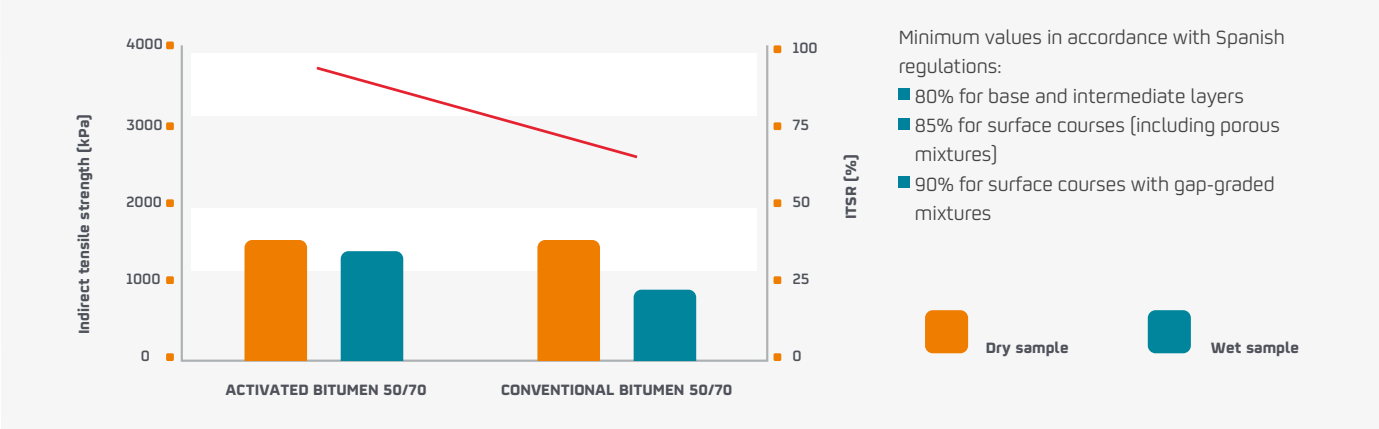
CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 45/80-65 ACTIV
TESTS ON THE ORIGINAL BITUMEN				
Penetration at 25ºC		1426	0,1 mm	45-80
Softening point		1427	ºC	≥ 65
Cohesion. Force-ductility		13589	J/cm²	≥ 3 to 5ºC
Fraass breaking point		12593	ºC	≤ -15
Elastic recovery at 25ºC		13398	%	≥ 70
Storage stability	Softening point difference	13399 1427	ºC	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9
Flash point		ISO 2592	ºC	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1				
Mass change		12607-1	%	≤ 1,0
Retained penetration		1426	%	≥ 60
Increased softening point		1427	ºC	≤ 10
Decreased the softening point		1427	ºC	≤ 5

PRODUCT BEHAVIOUR IN THE MIXTURE

The additives used are adhesion promoters that improve the chemical reaction between the aggregate and bitumen, providing the mixture with excellent cohesion, greater durability and reduced ageing, while also facilitating binder coverage of aggregate surface courses.

Aggregate-binder adhesion is assessed through the water sensitivity test according to standard EN 12697-12, applying Method A, which measures indirect tensile strength on cylindrical samples prepared in wet and dry conditions.

The graph below shows the results of this test for activated bitumen compared with conventional bitumen, using the same type of aggregate.



Water sensitivity test results (EN 12697-12) (AC22G mixture, with a porphyry aggregate and 4.1% bitumen 50/70 without additives). These values are illustrative and not binding, nor subject to specification.

This binder improves both active adhesion (the binder's ability to make contact with the aggregate) and passive adhesion (its ability to not separate due to the effect of water, aggregate and binder, once they have come into contact).

Repsol PERFORM MG 35/50-59/69

Multigrade bitumens are special binders that are less sensitive to temperature than conventional bitumens. In other words, they are less fragile at low temperatures and more consistent at high temperatures. They also have a positive penetration index. This type of bitumen is included in the EN 13924-2 standard.

Although the standard considers different grades, the multigrade bitumen MG 35/50-59/69 is the most suitable for the different summer thermal zones established in Spanish legislation, offering optimum performance on roads subject to extreme service temperatures and temperature gradients.

APPLICATIONS

These bitumens are suitable for use in all types of bituminous mixtures and especially in surface courses and intermediate layers subject to demanding traffic and weather conditions, such as slow lanes, heavy and channelled traffic, motorways, toll plaza, road intersections, port docks, airports, parking areas in general and mountain roads.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of Repsol PERFORM MG 35/50-59/69 multigrade bitumen compared with Repsol PAVE 35/50 and 50/70 conventional bitumens:

CHARACTERISTICS		EN STANDARD	UNIT	Repsol PAVE 35/50	Repsol PERFORM MG 35/50- 59/69	Repsol PAVE 50/70
Penetration at 25ºC		1426	0,1 mm	35-50	35-50	50-70
Softening point		1427	ºC	50-58	59-69	46-54
Resistance to ageing EN 12607-1	Mass change	12607-1	%	≤ 0,5	≤ 0,5	≤ 0,5
	Retained penetration	1426	%	≥ 53	≥ 50	≥ 50
	Increase of the softening point	1427	ºC	≤ 8	≤ 10	≤ 11
Penetration index		12591 Annex A	-	From -1,5 to +0,7	0,1-1,5	From -1,5 to +0,7
Fraass breaking point		12593	ºC	≤ -5	≤ -8	≤ -8
Flash point		ISO 2592	ºC	≥ 240	≥ 235	≥ 230
Solubility		12592	%	≥ 99,0	≥ 99,0	≥ 99,0

As seen in the table above, Repsol PERFORM MG 35/50-59/69 bitumen has a higher softening point and penetration index, as well as a lower Fraass breaking point.

CHARACTERISATION ACCORDING TO PERFORMANCE GRADE (PG) GRADING

Figure 1 shows the performance grade (PG) achieved from testing two conventional bitumens: Repsol PAVE and Repsol PERFORM MG 35/50-59/69. As can be seen, the service temperature range of Repsol PERFORM MG 35/50-59/69 is much greater than either of the two bitumens analysed. This implies a much lower risk of rut formation at high temperatures and failures resulting from fatigue or cracks due to fragility at low temperatures.

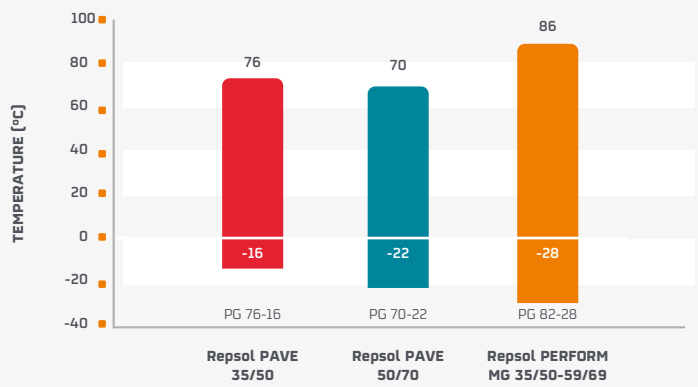


Figure 1.
PG grade of multigrade bitumens

These data are illustrative and not binding, nor subject to specification.

RECOMMENDATIONS FOR USE

Due to the special characteristics of these binders, slightly higher temperatures are recommended (10-20ºC) than for conventional binders (see Figure 2)..

Recommended temperature range for application	Mixing	170 - 180ºC
	Laying and compaction	**160 - 165ºC**

The temperatures will depend on the specific viscosity curves of each product.

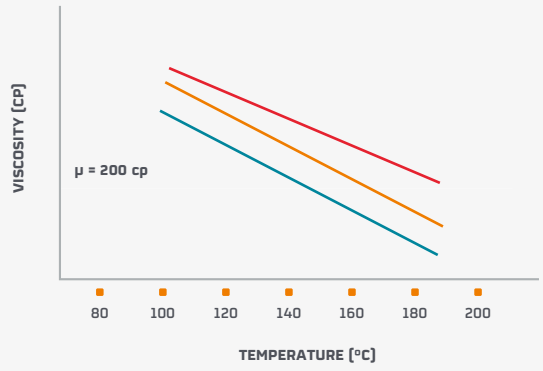


Figure 2.
Viscosity-Temperature Diagram

Repsol PAVE 35/50

Repsol PAVE 50/70

Repsol PERFORM MG 35/50-59/69

These data are illustrative and not binding, nor subject to specification.

PRODUCT BEHAVIOUR IN THE MIXTURE

Compared to conventional bitumens used for road asphalt mixtures, **Repsol PERFORM MG 35/50-59/69** multigrade bitumens developed by Repsol have:

- Greater resistance to plastic deformations.
- Greater resistance to fatigue.
- Greater resistance to ageing.

Repsol EFI-PERFORM B35/50 W, B50/70 W, PMB 45/80-60 W, PMB 45/80-65 W y PMB 45/80-75 W HP

Low-temperature bitumens like the ECOBET **Repsol EFI-PERFORM W** range for conventional bitumens and the **Repsol EFI-PERFORM PMB W** range for polymer modified bitumens are special bituminous binders with a lower handling temperature (manufacture and installation) compared to conventional bitumens with a similar penetration grade.

Repsol has made a great effort in the research and development of these new binders, which, once applied, offer the same performance as conventional binders or even better.

Due to the decrease in temperature during manufacturing (between 20 and 40ºC), this range of products provides the following advantages:

- Reduction of emissions in the atmosphere.
- Energy efficiency.
- Improved working conditions.

APPLICATIONS

These types of bitumens are used for the same applications as conventional and polymer modified bitumens with the same penetration grade.

ECOBET and ECOBET IP ranges

ECOBET bitumens have CE Marking, in accordance with the guidelines of the EN 12591 standard.

CHARACTERISTICS		EN STANDARD	UNIT	ECOBET RANGE		ECOBET IP RANGE	
				Repsol EFI-PERFORM 35/50 W	Repsol EFI-PERFORM 50/70 W	Repsol EFI-PERFORM 35/50 W ECOBET IP	Repsol EFI-PERFORM 50/70 W ECOBET IP
Penetration at 25ºC		1426	0,1 mm	35-50	50-70	35-50	50-70
Softening point		1427	ºC	50-58	46-54	≥ 70	≥ 65
Resistance to ageing EN 12607-1	Mass change	12607-1	%	≤ 0,5	≤ 0,5	≤ 0,8	≤ 0,8
	Retained penetration	1426	%	≥ 53	≥ 50	≥ 60	≥ 55
	Increase of the softening point	1427	ºC	≤ 8 (sev 1) ≤ 11 (sev 2)	≤ 9 (sev 1) ≤ 11 (sev 2)	≤ -5	≤ -5
Penetration index		12591 Annex A	-	-1,5 to +0,7	-1,5 to +0,7	> 2,5	> 2,5
Fraass breaking point		12593	ºC	≤ -5	≤ -8	≤ -10	≤ -12
Flash point		ISO 2592	ºC	≥ 240	≥ 230	-	-
Solubility		12592	%	≥ 99,0	≥ 99,0	-	-

Repsol EFI-PERFORM PMB W polymer modified bitumens have CE Marking according to the EN 14023 standard.

CHARACTERISTICS		EN STANDARD	UNIT	PMB 45/80-60 BT Repsol EFI-PERFORM PMB 45/80-60 W	PMB 45/80-65 BT Repsol EFI-PERFORM PMB 45/80-65 W	PMB 45/80-75 AV BT Repsol EFI-PERFORM PMB 45/80-75 W HP
TESTS ON THE ORIGINAL BITUMEN						
Penetration at 25ºC		1426	0,1 mm	45-80	45-80	45-80
Softening point		1427	ºC	≥ 60	≥ 65	≥ 75
Cohesion. Force-ductility		13589	J/cm²	≥ 2 to 5ºC	≥ 3 to 5ºC	≥ 3 to 5ºC
Fraass breaking point		12593	ºC	≤ -12	≤ -15	≤ -15
Elastic recovery at 25ºC		13398	%	≥ 50	≥ 70	≥ 80
Storage stability	Softening point difference	13399 1427	ºC	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9	≤ 13
Flash point		ISO 2592	ºC	≥ 235	≥ 235	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1						
Mass change		12607-1	%	≤ 1,0	≤ 1,0	≤ 1,0
Retained penetration		1426	%	≥ 60	≥ 60	≥ 60
Increased softening point		1427	ºC	≤ 10	≤ 10	≤ 10
Decreased the softening point		1427	ºC	-	-	≤ 5

RECOMMENDATIONS FOR USE

The recommended temperatures for use appear below:

	Repsol EFI-PERFORM B35/50 W	Repsol EFI-PERFORM B50/70 W	Repsol EFI-PERFORM PMB 45/80-60 W	Repsol EFI-PERFORM PMB 45/80-65 W	Repsol EFI-PERFORM PMB 45/80-75 W HP
Storage	160 ºC	150 ºC	150 ºC	150 ºC	160 ºC
Mixing	130-135 ºC	125-130 ºC	135-140 ºC	135-140 ºC	145-150 ºC
Start of laying and compaction	Min. 120 ºC	Min. 120 ºC	125-130 ºC	125-130 ºC	135-140 ºC
End of compaction	Min. 100 ºC	Min. 100 ºC	-	-	-

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

APPLICATIONS AND PRODUCT BEHAVIOUR IN THE MIXTURE

Repsol's low-temperature bitumens are applied to all types of mixtures with the usual bitumen content, from the production of conventional asphalt mixtures with Repsol EFI-PERFORM B35/50 W and Repsol EFI-PERFORM B50/70 W to anti-cracking mixtures with Repsol EFI-PERFORM PMB 45/80-75 W HP and gap-graded mixtures with Repsol EFI- PERFORM PMB 45/80-60 W and Repsol EFI-PERFORM PMB 45/80-65 W bitumens. They provide the following advantages:

- They increase the durability of the mixture by reducing the manufacturing temperature, which leads to less ageing of the binder.
- They reduce GHG emissions, which improves the environment.
- Less energy is required due to lower manufacturing temperatures (around 30ºC), which saves on costs in the bituminous mixture production plant.
- They improve working conditions for operators during production and installation.

Together, all these advantages lead to better results for our customers thanks to lower costs resulting from less energy consumption, increased safety and productivity and the social benefit of the increased durability of road services.

Repsol EFI-PERFORM B REJUV

Special bitumens for recycling developed by Repsol are binders that are custom-designed for each case, providing the components that the bitumen in the mixture has lost due to ageing and restoring the original physical and chemical characteristics and properties.

Social concern for environmental issues and the use of natural resources makes it increasingly critical and necessary to recycle pavement materials.

Aware of the economic, social and environmental benefits of recycling techniques, Repsol has developed a range of bitumens with rejuvenators to optimise current regeneration techniques for aged road layers.

Our technical service carries out a prior study of the courses that will be recycled in order to formulate and manufacture an ad-hoc product.

APPLICATIONS

Special bitumens for recycling are used to make new bituminous mixtures that include a certain amount of aged bituminous material from the road. It can be used in production plants of both gap-graded and continuous grading bituminous mixtures, preferably with medium and high degrees of RAP content.

There are several special bitumens for recycling, called **Repsol EFI-PERFORM B REJUV**, that can be used for different technologies:

- Specific bitumens for use in the production of bituminous emulsions such as **Repsol EFI-ADVANCE C60B5 REC REJUV**.
- Specific bitumens for use in the production of hot bituminous mixtures with medium and high degrees of RA content.

PRODUCT CHARACTERISTICS

Bitumen is composed of several types of hydrocarbons that can be grouped into four categories: saturates, aromatics, resins and asphaltenes. To maintain the physicochemical structure, each of these components must be present in specific ratios, which will ensure that the bituminous mixture performs properly when subject to the demands of traffic. Therefore, the custom-designed special bitumen for recycling provides the fractions that the aged binder has lost, regenerating it and restoring its original characteristics.

CHARACTERISTICS	TYPICAL VALUE
CRR (Durability)	0,4 - 1,0
C (Compatibility)	> 0,5
IC (Colloidal Instability)	< 1

The composition of special bitumens for recycling must be adapted to fulfil the values required by certain indices that give an approximate idea of the bitumen's possibilities in terms of durability (oxidative stability of the bitumen), colloidal stability, etc. These indices are:

- Chemical reactivity ratio (CRR), which indicates the influence of maltenes on the bitumen's oxidative stability (durability parameter).
- Compatibility (C), which indicates the ratio of nitrogenous components of maltenes to saturated hydrocarbons or paraffins.
- Colloidal Instability (CI), which indicates the ratio of solids (asphaltenes and paraffins) to dispersant liquid components in the system.

The composition of the special bitumen for recycling is determined by two factors:

- The working formula of the mixture to restore, which is influenced by the percentage of recycled material used and the physical characteristics (penetration, softening point, etc.) of the binder to be restored.
- The components (lost fractions) that must be provided to the aged binder to give it the appropriate characteristics.

PRODUCT BEHAVIOUR IN THE MIXTURE

Proper design of special bitumen for recycling must simultaneously meet the following requirements:

- Restore the optimum composition of the aged bitumen to maintain the mixture's durability.
- Give the aged bitumen an appropriate consistency (penetration).
- Provide the mixture with an adequate amount of binder.

Repsol's Technical Support and Development Department can advise customers on the best conditions of use in each case.

Repsol ADVANCE and EFI ADVANCE

Bituminous emulsions are colloidal dispersions of (conventional or modified) bitumen droplets in an aqueous phase, composed of water and one or more anionic and cationic emulsifying agents, in addition to other additives such as latex for modified emulsions, which have the purpose of dispersing the bitumen, ensuring the emulsion is stable and guaranteeing adhesion to aggregates at room temperature.

The main characteristic of bituminous emulsions is that they can be used as a binder at lower temperatures than usual, even at room temperature. Their consistency allows them to be used as a tack coat to improve adhesion between the different layers of the road surface courses or mixed and/or bound with aggregates. This is achieved during the emulsion breaking process, where the free bitumen particles provide cohesion to the whole. Bituminous emulsions are the fundamental base that has made it possible to develop cold-mix technology for roads. Moreover, modified bituminous emulsions can be used in road surface layers that require high performance in the presence of heavy-duty traffic and adverse weather conditions, guaranteeing excellent bonding between layers and exceptional cohesion to aggregates.

Repsol produces all kinds of bituminous emulsions (cationic and anionic, conventional and modified) that cover all fields of use of these materials. The cationic emulsions meet CE Marking requirements, as according to the EN 13808 standard, and anionic emulsions meet the requirements established in Spain the UNE 51603 standard.

APPLICATIONS

Repsol ADVANCE and EFI-ADVANCE emulsions can be applied as an auxiliary treatment, such as in tack coats, or combined with quality aggregates for different types of high-performance treatments.

Anionic bituminous emulsions

APPLICATION	TYPE OF EMULSION
Primer coats	Repsol ADVANCE A60BFL
	Repsol ADVANCE A50BFL
Tack coats	Repsol ADVANCE A60BR
Seal coats	Repsol ADVANCE A60BR
Anti-dust coats	Repsol ADVANCE A50BR
Cold microsurfacing and slurry seals	Repsol EFI ADVANCE A60BL
Surface dressing with gravel chippings	Repsol ADVANCE A65BR
Open-graded bituminous mixtures	Repsol ADVANCE A67BFM

Conventional and modified cationic bituminous emulsions

APPLICATION	TYPE OF EMULSION
Primer coats	Repsol ADVANCE C50BF4 IMP
	Repsol ADVANCE C60BF4 IMP
	Repsol EFI ADVANCE C50B4 IMP HPP
Tack coats	Repsol ADVANCE C50B3 ADH
	Repsol ADVANCE C60B3 and C60B2 ADH C60BP2 ADH C60BP3 ADH C60BP3 ADH d
	Repsol ADVANCE C60B3 ADH d Repsol ADVANCE C69BP3 ADH d
	Repsol EFI ADVANCE C60B3 TER and TER PLUS C60BP3 TER and TER PLUS
Seal coats	Repsol ADVANCE C50B3 CUR
	Repsol ADVANCE C60B3 and C60B2CUR
	Repsol ADVANCE C60B3 CUR d
Cold microsurfacing and slurry seals	Repsol EFI ADVANCE C60B4 MIC C60BP4 MIC C60BP4 MIC b C65BP5 MIC d HP
Gravel emulsion	Repsol ADVANCE C60B5 GE
Surface dressing with gravel chippings	Repsol ADVANCE C65B2 and C65B3TRG C65BP2 TRG C65BP3 TRG
	Repsol ADVANCE C65B3 TRG d C65BP2 TRG d C65BP3 TRG d
	Repsol ADVANCE C69B3 and C69B2 TRG C69BP2 TRG C69BP3 TRG
Open-graded bituminous mixtures	Repsol ADVANCE C67BF3 MBA C67BPF3 MBA
	Repsol ADVANCE C67BF3 MBA d
	Repsol ADVANCE C69BF3 MBA d
Half war mix asphalt	Repsol EFI ADVANCE C67B2 HW and C69B2 HW C67PB2 HW and C69BP2 HW
Anti-dust coat emulsions	Repsol ADVANCE C35B3 ERP
Emulsions for cold-mix recycling	Repsol EFI ADVANCE C60B5 REC C60B5 REC REJUV
Surface dressing with emulsion	Repsol ADVANCE C50B2 PROTECT and C50BP2 PROTECT

PRODUCT CHARACTERISTICS

The following table shows the characteristics of bituminous emulsions:

Conventional cationic bituminous emulsions described in the national annex in Spain of the EN 13808 standard

Standard EN 13808			Repsol ADVANCE C50BF4 IMP	Repsol ADVANCE C60BF4 IMP	Repsol ADVANCE C60B3 ADH[1]	Repsol EFI ADVANCE C60B3 TER PLUS
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION			
Particle polarity	1430	-	Positive	Positive	Positive	Positive
Breaking value	13075-1	-	110-195 class 4	110-195 class 4	70-155 class 3	70-155 class 3
Binder content (per water content)	1428	%	48-52 class 4	58-62 class 6	58-62 class 6	58-62 class 6
Binder content recovered by distillation	1431	%	≥48 class 4	≥58 class 6	≥58 class 6	≥58 class 6
Fluxing agent content recovered by distillation	1431	%	5-15 class 7	≤ 8 class 5	≤ 2,0 class 2	≤ 2,0 class 2
Fluency time (2 mm, 40°C)	12846-1	s	15-70 class 3	15-70 class 3	15-70 class 3	15-70 class 3
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431						
Needle penetration at 25ºC	1426	0,1 mm	≤ 270 class 6	≤ 220 class 5	≤ 220 class 5	≤ 50 class 2
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≥ 35 class 8	≥ 50 class 4
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1						
Needle penetration at 25ºC	1426	0,1 mm	90-170 class 8	≤ 330 class 7	≤ 330 class 7	≤ 50 class 2
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≥ 35 class 8	≥ 50 class 4
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2						
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 220 class 5	≤ 220 class 5	≤ 50 class 2
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≥ 35 class 8	≥ 50 class 4

Standard EN 13808			Repsol ADVANCE C60B3[1] CUR	Repsol EFI ADVANCE C60B4 MIC	Repsol ADVANCE C60B5 GE	Repsol EFI ADVANCE C60B5 REC
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION			
Particle polarity	1430	-	Positive	Positive	Positive	Positive
Breaking value	13075-1	-	70-155 class 3	110-195 class 4	> 170 class 5	> 170 class 5
Binder content (per water content)	1428	%	58-62 class 6	58-62 class 6	58-62 class 6	58-62 class 6
Binder content recovered by distillation	1431	%	≥ 58 class 6	≥ 58 class 6	≥ 58 class 6	≥ 58 class 6
Fluxing agent content recovered by distillation	1431	%	≤ 2,0 class 2	≤ 2,0 class 2	≤ 2,0 class 2	≤ 2,0 class 2
Fluency time (2 mm, 40ºC)	12846-1	s	15-70 class 3	15-70 class 3	15-70 class 3	15-70 class 3
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431						
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 100 class 3	≤ 220 class 5	≤ 270 class 6
Softening point	1427	ºC	≥ 35 class 8	≥ 43 class 6	≥ 39 class 7	≥ 35 class 8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1						
Needle penetration at 25ºC	1426	0,1 mm	≤ 330 class 7	≤ 100 class 3	≤ 220 class 5	≤ 330 class 7
Softening point	1427	ºC	≥ 35 class 8	≥ 43 class 6	≥ 39 class 7	≥ 35 class 8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2						
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 100 class 3	≤ 220 class 5	≤ 270 class 6
Softening point	1427	ºC	≥ 35 class 8	≥ 43 class 6	≥ 39 class 7	≥ 35 class 8

[1] Emulsions are available with class 2 rupture index value <110.

Standard EN 13808			Repsol ADVANCE C65B2[2] TRG	Repsol ADVANCE C69B2[2] TRG	Repsol ADVANCE C67BF3 MBA
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION		
Particle polarity	1430	-	Positive	Positive	Positive
Breaking value	13075-1	-	<110 class 2	<110 class 2	70-155 class 3
Binder content (per water content)	1428	%	63-67 class 7	67-71 class 9	65-69 class 8
Binder content recovered by distillation	1431	%	≥ 63 class 7	≥ 67 class 9	≥ 65 class 8
Fluxing agent content recovered by distillation	1431	%	≤ 2,0 class 2	≤ 2,0 class 2	≤ 10 class 6
Fluency time (4 mm, 40ºC)	12846-1	s	5-70 class 5	5-70 class 5	5-70 class 5
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 5 class 2	≤ 5 class 2
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 220 class 5	≤ 330 class 7
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≤ 35 class 9
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1					
Needle penetration at 25ºC	1426	0,1 mm	≤ 330 class 7	≤ 330 class 7	140-260 class 9
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≤ 35 class 9
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 220 class 5	≤ 220 class 5
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≥ 39 class 7

(2) Emulsions with class 3 rupture index value 70-155 are available.

Modified cationic bituminous emulsions described in the national annex in Spain of the EN 13808 standard

Standard EN 13808			Repsol ADVANCE C60BP2 ADH	Repsol EFI ADVANCE C60BP3 TER	Repsol EFI ADVANCE C60BP4 MIC
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION		
Particle polarity	1430	-	Positive	Positive	Positive
Breaking value	13075-1	-	<110 class 2	70-155 class 3	110-195 class 4
Binder content (per water content)	1428	%	58-62 class 6	58-62 class 6	58-62 class 6
Binder content recovered by distillation	1431	%	≥ 58 class 6	≥ 58 class 6	≥ 58 class 6
Fluxing agent content recovered by distillation	1431	%	≤ 2,0 class 2	≤ 2,0 class 2	≤ 2,0 class 2
Fluency time (2 mm, 40°C)	12846-1	s	15-70 class 3	15-70 class 3	15-70 class 3
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 50 class 2	≤ 100 class 3
Softening point	1427	ºC	≥ 43 class 6	≥ 55 class 3	≥ 50 class 4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1					
Needle penetration at 25ºC	1426	0,1 mm	≤ 330 class 7	≤ 100 class 3	≤ 100 class 3
Softening point	1427	ºC	≥ 35 class 8	≥ 50 class 4	≥ 50 class 4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 50 class 2	≤ 100 class 3
Softening point	1427	ºC	≥ 43 class 6	≥ 55 class 3	≥ 50 class 4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1

(1) There are emulsions with a class 2 breaking value of <110..
(2) There are emulsions with a class 3 breaking value of 70-155.

Modified cationic bituminous emulsions described in the national annex in Spain of the EN 13808 standard

Standard EN 13808			Repsol ADVANCE C65BP2[2] TRG	Repsol ADVANCE C69BP2[2] TRG	Repsol ADVANCE C67BPF3 MBA
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION		
Particle polarity	1430	-	Positive	Positive	Positive
Breaking value	13075-1	-	<110 class 2	<110 class 2	70-155 class 3
Binder content (per water content)	1428	%	63-67 class 7	67-71 class 9	65-69 class 8
Binder content recovered by distillation	1431	%	≥ 63 class 7	≥ 67 class 9	≥ 65 class 8
Fluxing agent content recovered by distillation	1431	%	≤ 2,0 class 2	≤ 2,0 class 2	≤ 10 class 6
Fluency time (4 mm, 40ºC)	12846-1	S	5-70 class 5	5-70 class 5	5-70 class 5
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 10 class 3	≤ 5 class 2
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 220 class 5	≤ 220 class 5
Softening point	1427	ºC	≥ 43 class 6	≥ 43 class 6	≥ 39 class 7
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1					
Needle penetration at 25ºC	1426	0,1 mm	≤ 330 class 7	≤ 330 class 7	≤ 330 class 7
Softening point	1427	ºC	≥ 35 class 8	≥ 35 class 8	≥ 35 class 8
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2					
Needle penetration at 25ºC	1426	0,1 mm	≤ 220 class 5	≤ 220 class 5	≤ 220 class 5
Softening point	1427	ºC	≥ 43 class 6	≥ 43 class 6	≥ 39 class 7
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5 class 6	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	DV class 1	DV class 1	DV class 1

[1] There are emulsions with a class 2 breaking value of <110..
[2] There are emulsions with a class 3 breaking value of 70-155.

Conventional and modified anionic bituminous emulsions not included in the national annex in Spain but described in the UNE 51603 standard

Denominación UNE 51603			Repsol ADVANCE A50BR	Repsol ADVANCE A50BFR	Repsol ADVANCE A60BR	Repsol ADVANCE A65BR
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION			
Particle polarity	1430	-	Negative	Negative	Negative	Negative
Binder content (per water content)	1428	%	48-52	48-52	58-62	63-67
Fluxing agent content recovered by distillation	1431	%	<3	3-5	3-8	<3
Fluency time (2 mm, 40ºC)	12846-1	s	15-70	15-70	15-70	
Fluency time (4 mm, 40ºC)	12846-1	s	-	-	-	5-70
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1	≤ 0,1	≤ 0,1	≤ 0,1
Sedimentation tendency (7 days)	12847	%	≤ 10	≤ 10	≤ 10	≤ 5
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431						
Needle penetration at 25ºC	1426	0,1 mm	≤ 220	≤ 220	≤ 220	≤ 220
Softening point	1427	ºC	<35	<35	> 35	> 35

Denominación UNE 51603			Repsol ADVANCE A67BFM	Repsol ADVANCE A67BPFM	Repsol ADVANCE A60BFL	Repsol EFI ADVANCE A60BL	Repsol ADVANCE A50BFL
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION				
Particle polarity	1430	-	Negative	Negative	Negative	Negative	Negative
Binder content (per water content)	1428	%	65-69	65-69	58-62	58-62	48-52
Fluxing agent content recovered by distillation	1431	%	3-10	3-10	3-8	<3	5-15
Fluency time (2 mm, 40ºC)	12846-1	s	-	-	15-70	40-130	15-70
Fluency time (4 mm, 40ºC)	12846-1	s	5-70	5-70	-	-	-
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1	≤ 0,1	≤ 0,1	≤ 0,1	≤ 0,1
Sedimentation tendency (7 days)	12847	%	≤ 5	≤ 5	≤ 10	≤ 10	≤ 10
Stability by mixing with cement	12848	%	-	-	-	≤ 2	-
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431							
Needle penetration at 25ºC	1426	0,1 mm	≤ 270	≤ 220	≤ 220	≤ 220	220-330
Softening point	1427	ºC	≥ 35	≥ 39	≥ 35	≥ 35	≥ 35
Elastic recovery	13398	%	-	≤ 40	-	-	-

Other cationic bituminous emulsions with special applications included in the standard EN 13808

Repsol has developed specific emulsions for different types of applications not included the national annex in Spain, but for which the CE Marking is available, according to standard EN 13808, whose characteristics are described in different data sheets. It is possible to manufacture emulsions that are highly stable in storage for the Export and Long-Life emulsion ranges.

Repsol EFI ADVANCE TER

Thermoadherent emulsions are quick-breaking emulsions with special characteristics to ensure adhesion between layers, adhesion to support structures and little or no stickiness to construction vehicle tyres.

Due to the product's thermoadherent properties, no elements become sticky until the hot bituminous mixture is applied, modifying the viscosity of the binder and facilitating adhesion between layers.

The residual bitumen from conventional emulsions used in tack coats tends to come off the road surface as construction traffic and mixture-spreading machinery passes by. This reduces adhesion between layers due to a lack of solidity, which in turn significantly diminishes the surface course's service life.
Repsol EFI-ADVANCE TER thermoadherent emulsions prevent this situation, providing the following advantages:

- The adherence coating is not removed after application.
- It allows significant cost savings by optimising the amount of emulsion and the means used to implement it by not having to go over areas not covered by the emulsion.
- It is not necessary to stop the construction traffic (greater availability).

Repsol's range of thermoadherent emulsions includes the following types: **Repsol EFI-ADVANCE C60B3 TER, Repsol EFI-ADVANCE C60B3 TER PLUS, Repsol EFI-ADVANCE C60BP3 TER** and **Repsol EFI-ADVANCE C60BP3 TER PLUS**. They are all quick-breaking cationic emulsions and are made from hard bitumens or low-penetration, polymer modified bitumens.

APPLICATIONS

Thermoadherent emulsions are generally used in tack coats below layers of bituminous mixtures applied at temperatures of over 100 ºC.
The **Repsol EFI-ADVANCE C60BP3 TER PLUS** emulsion is normally used for wearing course tack coats, especially when the course contains porous asphalt (PA) mixtures or thin-layer mixtures (BBTM, SMA or AUTL). **Repsol EFI-ADVANCE C60B3 TER and EFI-ADVANCE C60B3 TER PLUS** emulsions are preferably used for the tack coats of all other layers.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of thermoadherent bitumens:

Standard EN 13808			Repsol EFI ADVANCE C60B3 TER[1]	Repsol EFI ADVANCE C60B3 TER PLUS[2]	Repsol EFI ADVANCE C60BP3 TER[1]	Repsol EFI ADVANCE C60BP3 TER PLUS[2]
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION			
Particle polarity	1430	-	Positive	Positive	Positive	Positive
Breaking value	13075-1	-	70-155 class 3	70-155 class 3	70-155 class 3	70-155 class 3
Binder content (per water content)	1428	%	58-62 class 6	58-62 class 6	58-62 class 6	58-62 class 6
Binder content recovered by distillation	1431	%	≥ 58 class 6	≥ 58 class 6	≥ 58 class 6	≥ 58 class 6
Fluxing agent content recovered by distillation	1431	%	≤ 2,0 class 2	≤ 2,0 class 2	≤ 2,0 class 2	≤ 2,0 class 2
Fluency time (2 mm, 40ºC)	12846-1	s	15-70 class 3	15-70 class 3	15-70 class 3	15-70 class 3
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2	≤ 0,1 class 2
Sedimentation tendency (7 days)	12847	%	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3	≤ 10 class 3
Adhesion	13614	%	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3	≥ 90 class 3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431						
Needle penetration at 25ºC	1426	0,1 mm	≤ 50 class 2	≤ 50 class 2	≤ 50 class 2	≤ 50 class 2
Softening point	1427	ºC	≥ 50 class 4	≥ 50 class 4	≥ 55 class 3	≥ 55 class 3
Cohesion by pendulum test	13588	J/cm^2	-	-	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	-	-	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1						
Needle penetration at 25ºC	1426	0,1 mm	≤ 100 class 3	≤ 50 class 2	≤ 100 class 3	≤ 50 class 2
Softening point	1427	ºC	≥ 50 class 4	≥ 50 class 4	≥ 50 class 4	≥ 55 class 3
Cohesion by pendulum test	13588	J/cm^2	-	-	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	-	-	DV class 1	DV class 1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2						
Needle penetration at 25ºC	1426	0,1 mm	≤ 50 class 2	≤ 50 class 2	≤ 50 class 2	≤ 50 class 2
Softening point	1427	ºC	≥ 50 class 4	≥ 50 class 4	≥ 55 class 3	≥ 55 class 3
Cohesion by pendulum test	13588	J/cm^2	-	-	≥ 0,5 class 6	≥ 0,5 class 6
Elastic recovery, 25 ºC	13588	%	-	-	DV class 1	DV class 1

(1) Emulsion made using bitumen with a penetration grade of 35/50.
(2) Emulsion made using bitumen with a penetration grade of 15/25.

RECOMMENDATIONS FOR USE

The emulsions are installed at temperatures of 50º and 70ºC. Breaking occurs more or less quickly, depending on the surface course temperature, the weather conditions (temperature, wind, humidity and sun) and the type of support structure. This can vary from five to 10 minutes in ideal conditions and up to 60 minutes in more extreme conditions.

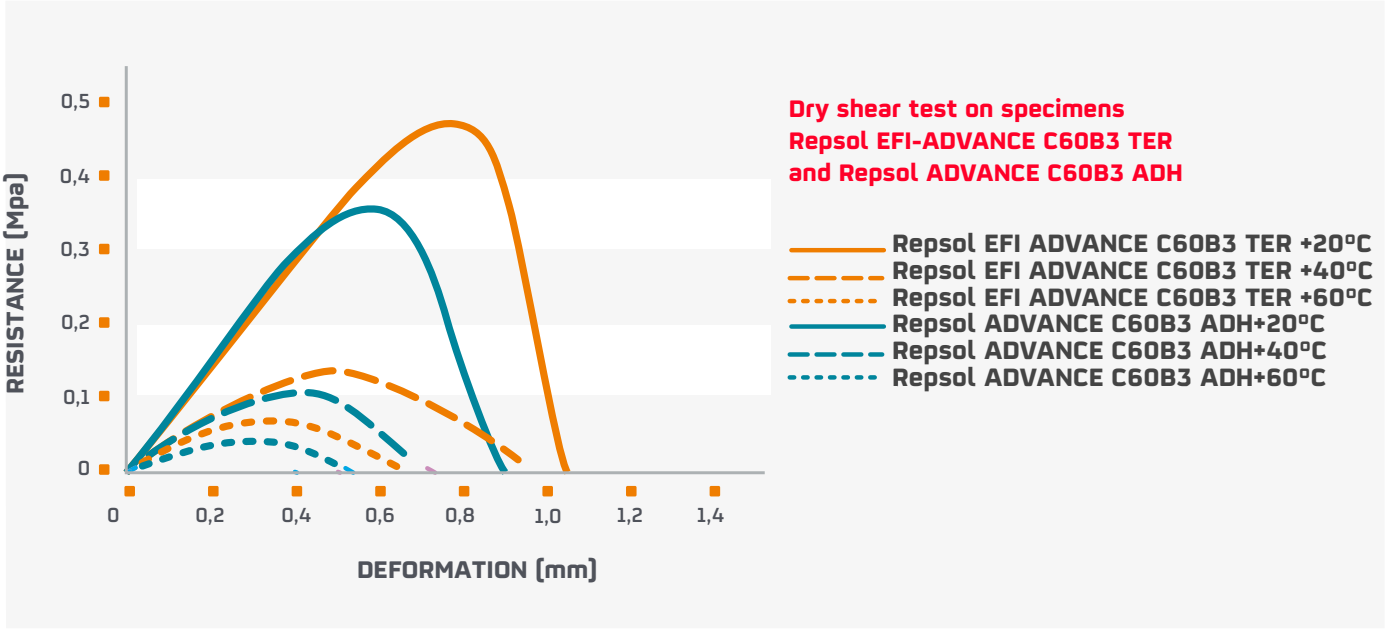
A sprayer tank with clean injectors in good condition is necessary for installation. A spray wand should be avoided. Once the emulsion has broken, the hot bituminous mixture is laid.
The characteristics of hardness of the residual binder of the **Repsol EFI-ADVANCE TER PLUS** emulsion does not require the application of lime milk as an auxiliary treatment to prevent the binder from being removed by construction traffic.

If these simple rules are respected, this type of emulsion behaves excellently against construction traffic.

EVALUATION AND CONTROL OF THERMAL-ADHESIVE EMULSIONES

To verify the optimal behaviour of emulsions made with a bitumen with less penetration compared to the Repsol ADVANCE C60B3 ADH conventional emulsion, a comparative study was carried out using the LCB cut-off test developed at the Polytechnic University of Catalonia (UPC).

This study found that adhesion between layers when using a Repsol EFI-ADVANCE C60B3 TER thermal-adhesive emulsion is superior to that of the Repsol ADVANCE C60B3 ADH emulsion. This result is shown in the graph below:



Repsol ADVANCE and Repsol EFI ADVANCE EXPORT

Emulsions are defined as a heterogenous, thermodynamically unstable system that is composed of two phases: the bitumen phase and the water phase, formed by water, emulsifiers and pH regulators. Due to this natural instability, a process takes place over time that causes decantation of the binder phase, with the water and bitumen gradually separating. This ultimately causes the emulsion to break down in part or in full, going from a typical phenomenon of flocculation to coalescence and finally sedimentation.

To solve these problems, Repsol has developed a range of emulsions called **Repsol ADVANCE and EFI-ADVANCE EXPORT,** which have great storage stability, improving the natural sedimentation process during prolonged periods of storage in customs and transport over long distances.

APPLICATIONS

Repsol ADVANCE EXPORT and **EFI-ADVANCE EXPORT** emulsions have the same applications as cationic bituminous emulsions for roads:

- Primer coats.
- Tack coats.
- Seal coats.
- Cold microsurfacing and slurry seals.
- Gravel emulsion.
- Surface dressing with gravel chippings.
- Open-graded bituminous mixtures.
- Cooled mixtures made using emulsion.

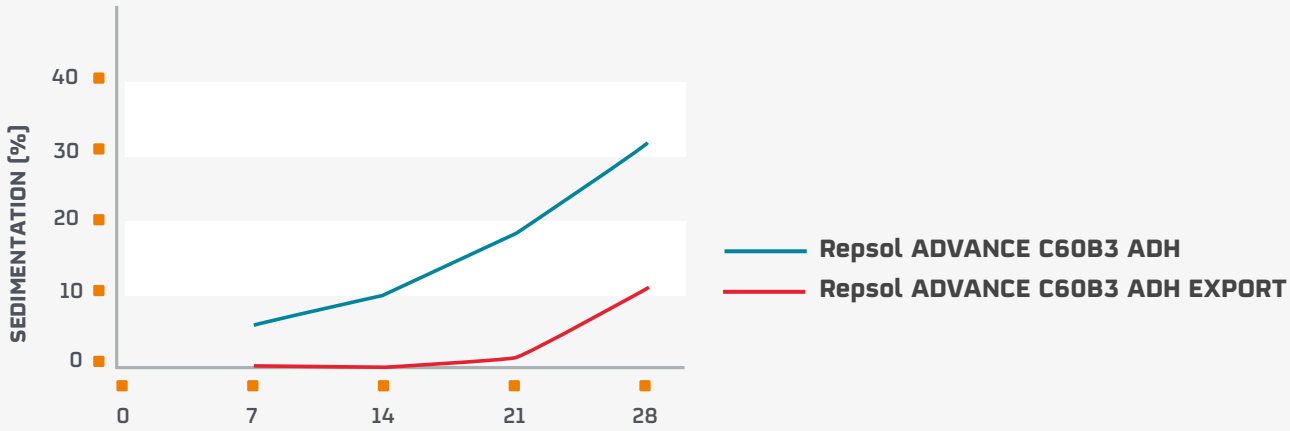
PRODUCT CHARACTERISTICS

The **Repsol ADVANCE EXPORT** and **EFI-ADVANCE EXPORT** emulsion range meets the requirements of European standard EN 13808 for cationic emulsions. The main characteristic of this type of emulsion is a lower tendency to sediment than conventional emulsions of the same type, confirming an extended storage period and preserve suitable properties for use.

SEDIMENTATION TENDENCY	STORAGE PERIOD*			
	7 days	14 days	21 days	28 days
Repsol ADVANCE C60B3 ADH	3,5	10	18	32
Repsol ADVANCE C60B3 ADH EXPORT	0,1	0,2	1,3	10,4

* These data are illustrative and not binding..

Repsol ADVANCE C60B3 emulsions



ADVANTAGES

- Good storage stability compared to conventional emulsions, improving sedimentation results.
- Repsol ADVANCE EXPORT and EFI-ADVANCE EXPORT emulsions can be stored for long periods, such as during shipping in maritime transport, while waiting to be loaded and unloaded in ports and during long-distance land transport.
- They are ideal for use in projects that require prolonged storage and can be transported and stored in IBC containers, flexitanks or conventional tanks.

Repsol ADVANCE and Repsol EFI ADVANCE LONG LIFE

Emulsions are defined as a heterogeneous, thermodynamically unstable system that is composed of two phases: the bitumen phase and the water phase, formed by water, emulsifiers and pH regulators. Due to this natural instability, a process takes place over time that causes decantation of the binder phase, with the water and bitumen gradually separating. This ultimately causes the emulsion to break down in part or in full, going from a typical phenomenon of flocculation to coalescence and finally sedimentation.

To solve these problems, Repsol has developed a range of emulsions called **Repsol ADVANCE and EFI-ADVANCE LONG LIFE,** which have a great storage stability, improving the natural sedimentation process over time.

These types of emulsions can be stored in tanks for use in small, sporadic actions, making them available in suitable handling conditions and with all the proper characteristics for use.

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APPLICATIONS

Repsol ADVANCE and **EFI-ADVANCE LONG LIFE** Emulsions have the same applications as cationic bituminous emulsions for roads:

- Primer coats.
- Tack coats.
- Seal coats.
- Cold microsurfacing and slurry seals.
- Gravel emulsion.
- Surface dressing with gravel chippings.
- Open-graded bituminous mixtures.
- Cooled mixtures made using emulsion.

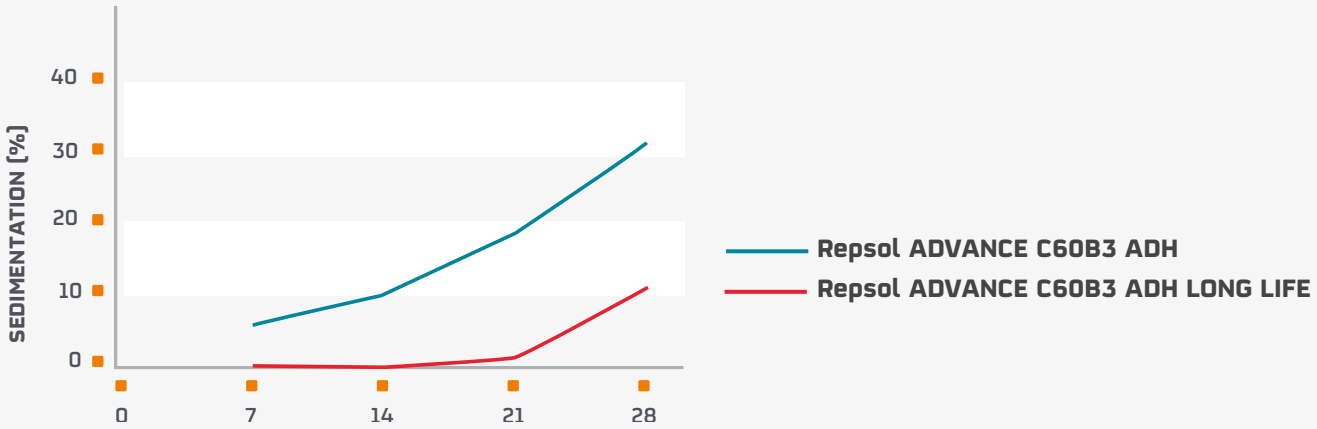
PRODUCT CHARACTERISTICS

The **Repsol ADVANCE** and **EFI-ADVANCE LONG LIFE** emulsion range meets the requirements of European standard EN 13808 for cationic emulsions. The main characteristic of this type of emulsion is a lower tendency to sediment than conventional emulsions of the same type, confirming an extended storage period and suitable properties for use.

SEDIMENTATION TENDENCY	STORAGE PERIOD*			
	7 days	14 days	21 days	28 days
Repsol ADVANCE C60B3 ADH	3,5	10	18	32
Repsol ADVANCE C60B3 ADH LONG LIFE	0,1	0,2	1,3	10,4

*These data are illustrative and not binding.

Repsol ADVANCE C60B3 ADH LONG LIFE emulsions



ADVANTAGES

- Good stability in storage compared to conventional emulsions, with improved sedimentation results.
- Repsol ADVANCE LONG LIFE and EFI-ADVANCE LONG LIFE emulsions can be stored for prolonged periods of time, such as those required for maintenance in tanks when they are used in small amounts over time in project operations.

Repsol EFI ADVANCE C50B4 IMP HPP

This is a primer coat emulsion that does not contain a fluxing agent and has greater penetration of granular layers, named **Repsol EFI-ADVANCE C50B4 IMP HPP**.

In accordance with EU guidelines and national bodies, Repsol has developed this line of products with a lower environmental impact and improved performance.

Repsol EFI-ADVANCE C50B4 IMP HPP is a low-concentration, slow-breaking emulsion with high penetration power and a lower environmental impact. It contains no fluxing agents/fluidisers and is more stable in storage than its traditional equivalent, Repsol ADVANCE C50BF4 IMP.

APPLICATIONS

The main application of the **Repsol EFI-ADVANCE C50B4 IMP HPP** Emulsion:

- Priming of granular support structures.

PRODUCT CHARACTERISTICS

The characteristics appear in the table below:

Standard EN 13808			Repsol EFI ADVANCE C50B4 IMP HPP	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION	
Particle polarity	-	1430	Positive	-
Breaking value	-	13075-1	110-195	4
Binder content (per water content)	%	1428	48 a 52	4
Binder content recovered by distillation	%	1431	≥ 48	4
Fluxing agent content recovered by distillation	%	1431	≤ 2	2
Fluency time (2 mm, 40°C)	s	12846-1	15-70	3
Residue after sieving (0.5 mm sieve)	%	1429	≤ 0,1	2
Sedimentation tendency (7 days)	%	12847	≤ 10	3
Adhesion	%	13614	≥ 90	3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431				
Penetration at 25ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1				
Penetration at 15ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2				
Penetration at 25ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8

ADVANTAGES

The **Repsol EFI-ADVANCE C50B4 IMP HPP** emulsion provides the following advantages in application:

- Better priming of the support structure.
- Improved passage of construction traffic.
- Makes it possible to adapt the base binder depending on the application objective.
- Greater sealing of the support structure.
- Lower environmental impact.

Repsol ADVANCE C50B2 and C50BP2 PROTECT

Repsol has a technologically conceived emulsion for preventive conservation treatments on pavements that are aged, microcracked or show signs of particle loss.

The **Repsol ADVANCE C50B2** and **Repsol ADVANCE C50BP2 PROTECT** emulsions are formulated for use in preventive protection coats for pavement maintenance operations.

Conservation treatments are used to prevent pavement from deteriorating as a result of ageing, loss of superficial aggregates and cracking, as well as for sealing and waterproofing. They work by sealing the surface courses of asphalt pavements, thereby impeding the entry of water and reducing bitumen oxidation. This provides greater surface course tenacity, slowing down the deterioration process and extending the pavement's service life.

Repsol ADVANCE C50B2 and **Repsol ADVANCE C50BP2 PROTECT** are low-concentration, quick-breaking emulsions with residual binders designed to seal surface courses without the need to use protective aggregates and/or sand in the coat. These residual binders can be rheologically modified with polymers to improve their tenacity and/or resistance.

Moreover, depending on the needs of the surface course to be protected, the use of rejuvenators may be considered in these emulsions to enhance this quality.

APPLICATIONSt

The main applications of the emulsions **Repsol ADVANCE C50B2** and **C50BP2 PROTECT** are:

- Protective coats for pavements that show signs of particle loss.
- Protective coats for aged, microcracked pavements.
- Pavement sealing coats.
- Sealing of surface courses dressing with gravel chippings.
- Tack coats between layers.




PRODUCT CHARACTERISTICS

The characteristics appear in the table below:

Standard EN 13808			Repsol ADVANCE C50B2 PROTECT		Repsol ADVANCE C50BP2 PROTECT	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION			
Particle polarity	-	1430	Positive	-	Positive	-
Breaking value	-	13075-1	<110	2	<110	2
Binder content (per water content)	%	1428	48 a 52	4	48 a 52	4
Binder content recovered by distillation	%	1431	≥ 48	4	≥ 48	4
Fluxing agent content recovered by distillation	%	1431	≤ 2,0	2	≤ 2,0	2
Fluency time (2 mm, 40ºC)	s	12846-1	15 a 70	3	15 a 70	3
Residue after sieving (0.5 mm sieve)	%	1429	≤ 0,1	2	≤ 0,1	2
Sedimentation tendency (7 days)	%	12847	≤ 10	3	≤ 10	3
Adhesion	%	13614	≥ 90	3	≥ 90	3
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1						
Penetration at 25ºC	0,1 mm	1426	≤ 50	2	≤ 50	2
Softening point	ºC	1427	≥ 50	4	≥ 55	3
Cohesion by pendulum test	J/cm²	13588	-	-	≥ 0,5	6
Elastic recovery at 25ºC	%	13398	-	-	DV	1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2						
Penetration at 25ºC	0,1 mm	1426	≤ 50	2	≤ 50	2
Softening point	ºC	1427	≥ 50	4	≥ 55	3
Cohesion by pendulum test	J/cm²	13588	-	-	≥ 0,5	6
Elastic recovery at 25ºC	%	13398	-	-	DV	1
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431						
Penetration at 25ºC	0,1 mm	1426	≤ 50	2	≤ 50	2
Softening point	ºC	1427	≥ 50	4	≥ 55	3
Cohesion by pendulum test	J/cm²	13588	-	-	≥ 0,5	6
Elastic recovery at 25ºC	%	13398	-	-	DV	1

ADVANTAGES

The emulsions **Repsol ADVANCE C50B2** and **ADVANCE C50BP2 PROTECT** allow:

- Preventive maintenance operations that lengthen the pavement's service life, avoiding the need for more costly paving operations.
- Quick reopening to traffic, with no risk of the protection coat being eliminated by vehicles and no need for protection with virgin aggregates.
- Rejuvenation of pavement surface courses.

Repsol EFI ADVANCE C65BP4 MIC d HP

Repsol has developed the high-performance emulsion **Repsol EFI ADVANCE C65BP4 MIC d HP** which makes it possible to achieve very fast-breaking cold micro-agglomerates and very high cohesion, capable of withstanding the most adverse working conditions.

This emulsion is suitable for areas that require excellent cold-mix microsurfacing performance, both to obtain strong macrotextures and for safety reasons, preventing the projection of particles by vehicle traffic or to minimise pavement conservation needs.

APPLICATIONS

- Airport runways and platforms.
- Reflective cracking prevention techniques using polymer or metallic mesh.
- Wearing courses with high levels of traffic, such as highways and motorways.
- Treatments to improve adhesion in areas with winding curves.
- Safety and warning pavements in hazardous road sections.

PRODUCT CHARACTERISTICS

The following table compares the characteristics of the Repsol EFI-ADVANCE C65BP4 emulsion with Repsol EFI-ADVANCE C60BP4 emulsion.

Standard EN 13808			Repsol EFI ADVANCE C60BP4 MIC		Repsol EFI ADVANCE C65BP4 MIC d HP	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION			
Particle polarity	1430	-	-	-	-	-
Breaking value	13075-1	-	110-195	4	110-195	4
Binder content (per water content)	1428	%	58-62	6	63-67	7
Binder content recovered by distillation	1431	%	≥ 58	6	≥ 63	7
Fluxing agent content recovered by distillation	1431	%	≤ 2	2	≤ 2	2
Fluency time (4 mm, 40ºC)	12846-1	s	-	-	40-130	4
Fluency time (2 mm, 40ºC)	12846-1	s	15-70	3	-	-
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1	2	≤ 0,1	2
Sedimentation tendency (7 days)	12847	%	≤ 10	3	≤ 10	3
Adhesion	13614	%	≥ 90	3	≥ 90	3
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1						
Needle penetration at 25ºC	1426	0,1 mm	≤ 100	3	≤ 100	3
Softening point	1427	ºC	≥ 50	4	≥ 50	4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5	6	≥ 0,5	6
Elastic recovery, 25ºC	13398	%	DV	1	DV	1
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2						
Needle penetration at 25ºC	1426	0,1 mm	≤ 100	3	≤ 100	3
Softening point	1427	ºC	≥ 50	4	≥ 50	4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5	6	≥ 0,5	6
Elastic recovery, 25ºC	13398	%	DV	1	DV	1
RESIDUO POR EVAPORACIÓN, SEGÚN UNE EN 1431						
Needle penetration at 25ºC	1426	0,1 mm	≤ 100	3	≤ 100	3
Softening point	1427	ºC	≥ 50	4	≥ 50	4
Cohesion by pendulum test	13588	J/cm^2	≥ 0,5	6	≥ 0,5	6
Elastic recovery, 25ºC	13398	%	DV	1	DV	1

PRODUCT BEHAVIOUR IN THE MIXTURE

Compared to conventional emulsions used in cold micro-agglomerates, the **Repsol EFI-ADVANCE C65BP4 MIC d HP** emulsion developed by Repsol offers the following advantages:

- Increased cohesion (greater resistance to breaking under torque and tensile stress).
- Improved resistance to skidding due to the improved surface course macrotexture.
- Greater adhesion to aggregates.
- Better resistance to ageing.
- Better performance at low temperatures.

This high-performance emulsion has **excellent performance in terms of cohesion and abrasion.**
As seen in Graph 1, in the EN 12274-4 torque test, Repsol EFI-ADVANCE C65BP4 MIC d HP high-performance emulsion achieves a minimum torque value of 20 kg*cm, which makes it possible to reopen the road to traffic in half the time of the conventional Repsol EFI-ADVANCE C60BP4 MIC emulsion. The time required to reopen the road to traffic is even lower when compared to the Repsol EFI-ADVANCE C60B4 MIC emulsion.

As can be seen, less mass is lost in g/m2 with the use of the Repsol EFI-ADVANCE C65BP4 MIC d HP emulsion.
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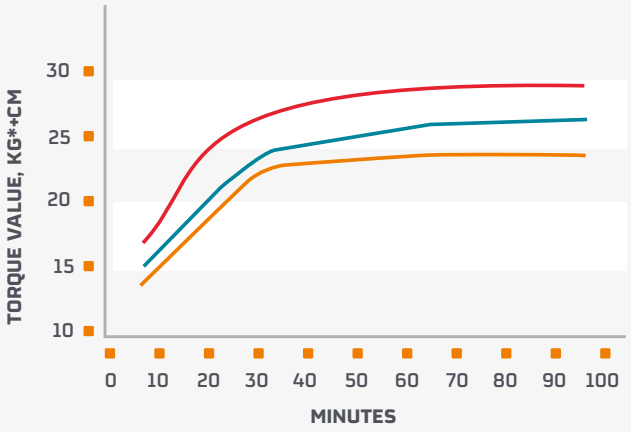

Graph 1

Difference in cohesion between the emulsions Repsol EFI-ADVANCE C60B4 MIC, Repsol EFI- ADVANCE C60BP4 MIC and Repsol EFI-ADVANCE C65BP4 MIC d HP for the same type of aggregate and a grain size corresponding to the MICROF 5 category

Repsol EFI ADVANCE C65BP4 MIC d HP
Repsol EFI ADVANCE C60BP4 MIC
Repsol EFI ADVANCE C60B4 MIC

LOSS OF MASS (g/m²)*		
Repsol EFI ADVANCE C65BP4 MIC d HP	Repsol EFI ADVANCE C60BP4 MIC	Repsol EFI ADVANCE C60B4 MIC
175	270	440

*EN 12274-5 wet track abrasion test.

Repsol EFI ADVANCE C60B5 REC REJUV

The emulsion **Repsol EFI ADVANCE C60B5 REC Rejuv,** especially developed for Repsol for the cold-mix recycling of aged surface courses, is a slow-breaking emulsion with rejuvenating binders that meets the requirements of the National Annex of standard EN 13808 in Spain, on the recycling of bituminous surface courses and pavements in relation to Repsol EFI-ADVANCE C60B5 REC-type emulsions. This product is specifically designed for each project and provides the components that the original bitumen has lost due to ageing, restoring its original characteristics.

Repsol has extensive experience in the use of special emulsions for cold-mix recycling with rejuvenators (Repsol EFI-ADVANCE C60B5 REC REJUV), achieving excellent results in installation.

APPLICATIONS

Repsol EFI-ADVANCE C60B5 REC REJUV is an emulsion that has been specifically designed for use in cold-mix recycling that requires high-quality standards.

It is recommended for cold-mix recycling with **Repsol EFI-ADVANCE C60B5 REC REJUV** as a binder in the following situations:

- Structurally conceived surface courses.
- Aged surface courses.
- Irregular pavements.
- Selective rehabilitation (on roads with heavy-duty traffic, for example).

Repsol's technical team designs the emulsion's specific formula based on the surface course to be rehabilitated, establishing the ideal emulsion formulation to guarantee optimal performance in the final resulting mixture.

Repsol has co-developed an application system for the emulsion **Repsol EFI-ADVANCE C60B5 REC REJUV**, called RFE.API (a Spanish acronym for Cold-Mix Recycling with Initial High-Performance Emulsion), which involves a new formulation for cold-mix recycling with emulsion that overcomes the existing problems in this procedure when used on roads with high traffic and quality demands. The aim of this emulsion was to overcome two obstacles of these mixtures: their low mechanical performance in the initial phase and the need for a maturing period before the next levels are laid. This system allows for the reinforcing and/or wearing course layer to be laid right away, thereby speeding up curing, minimising the amount of pre-mix water, ensuring it is eliminated in a short period of time and guaranteeing that the mixture quickly becomes rigid to rapidly reduce deflections of the wearing course and consume less of its service life.

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PRODUCT CHARACTERISTICS

The following table shows the characteristics of the **Repsol EFI-ADVANCE C60B5 REC REJUV** emulsion:

Standard EN 13808			Repsol EFI ADVANCE C60B5 REC REJUV	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION	
Particle polarity	-	1430	Positive	-
Breaking value	-	13075-1	> 170	5
Binder content (per water content)	%	1428	58 to 62	6
Binder content recovered by distillation	%	1431	≥ 58	6
Fluxing agent content recovered by distillation	%	1431	≤ 2,0	2
Fluency time (2 mm, 40ºC)	s	12846-1	15 to 70	3
Residue after sieving (0.5 mm sieve)	%	1429	≤ 0,1	2
Sedimentation tendency (7 days)	%	12847	≤ 10	3
Adhesion	%	13614	≥ 90	3
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1				
Penetration at 25ºC	0,1 mm	1426	≤ 330	7
Softening point	ºC	1427	≥ 35	8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2				
Penetration at 25ºC	0,1 mm	1426	≤ 270	6
Softening point	ºC	1427	≥ 35	8
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431				
Penetration at 25ºC	0,1 mm	1426	≤ 270	6
Softening point	ºC	1427	≥ 35	8

PRODUCT BEHAVIOUR IN THE MIXTURE

The **Repsol EFI-ADVANCE C60B5 REC REJUV** emulsion provides mixtures with excellent initial cohesion, allowing roads to be reopened to traffic quickly without the need for a protective coat. This leads to flexible and efficient project organisation, thereby reducing execution times.

To achieve the working formula, tests are carried out to evaluate the resistance of the recycled mixture and the effect of water on it.
The optimum content of emulsion with rejuvenating agents to be used in the mixture is achieved with these tests.

The points on which greater attention should be paid for the technique to be successful are the following:

- Design of a custom emulsion depending on the material to be treated and the development of a suitable working formula.
- Careful installation and strict control of the evolution of the mixture over time.

ADVANTAGES

The advantages that the “in situ” cold recycling technique with emulsion offers to a surface course can be summarised as: the achievement of gradual mechanical resistance, improvement in fatigue behaviour, energy and resource savings and efficient execution.

The use of the **Repsol EFI-ADVANCE C60B5 REC REJUV** emulsion also provides the following benefits:

- The road can be reopened to traffic thanks to the mixture’s excellent initial cohesion.
- The mixture gains stability quickly, shortening waiting times to install the top layer.
- Vehicle traffic safety is improved as particles are not detached or projected
- There is no need for a sealing treatment, with its execution being recommended in adverse weather conditions.

Repsol ADVANCE C67BF3 MBA EFIMUL

Repsol has developed the medium-breaking bituminous **Repsol ADVANCE C67BF3 MBA EFIMUL,** formulated ad-hoc for open-graded mixtures that can be stored and handled at room temperature. It is specially designed to use the versatility and mobility offered by machinery for manufacturing and spreading bitumen slurry.

APPLICATIONS AND PRODUCT BEHAVIOUR IN THE MIXTURE

In some cases, it is not possible to install cold-mix surface course plants due to the characteristics of the project, either because there are no suitable locations or because of problems in getting the required administrative and/or industrial licences.

The **Repsol ADVANCE C67BF3 MBA EFIMUL** emulsion can be used to manufacture open-grade cold mixtures in a bitumen slurry manufacturing unit, providing the following properties:

- Stability with regard to the aggregate studied.
- Stability in storage.
- Optimal adhesion conditions to the aggregate/binder.
- Suitable viscosity for the aggregate used and the components of the manufacturing equipment.
- Versatility and easy handling in manufacturing and supply.

This product is custom-designed for each project (depending on the type of aggregate and location). Repsol's Technical Support and Development Department can help customers to create ideal work formulas.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of the Repsol ADVANCE C67BF3 MBA EFIMUL emulsion:

Standard EN 13808			Repsol ADVANCE C67BF3 MBA EFIMUL	
CHARACTERISTICS	EN STANDARD	UNIT	TESTS ON ORIGINAL EMULSION	
Particle polarity	1430	-	Positive	Positive
Breaking value	13075-1	-	70-155	3
Binder content (per water content)	1428	%	65-69	8
Binder content recovered by distillation	1431	%	≥ 65	8
Fluxing agent content recovered by distillation	1431	%	≤ 10	6
Fluency time (4 mm, 40ºC)	12846-1	s	5-70	5
Residue after sieving (0.5 mm sieve)	1429	%	≤ 0,1	2
Sedimentation tendency (7 days)	12847	%	≤ 5	2
Adhesion	13614	%	≥ 90	3
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431				
Needle penetration at 25ºC	1426	0,1 mm	≤ 330	7
Softening point	1427	ºC	< 35	9
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1				
Needle penetration at 25ºC	1426	0,1 mm	140-260	9
Softening point	1427	ºC	< 35	9
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2				
Needle penetration at 25ºC	1426	0,1 mm	≤ 220	5
Softening point	1427	ºC	≥ 39	7

ADVANTAGES OF USING A COMPACT MACHINE + EMULSION Repsol ADVANCE C67BF3 MBA EFIMUL

- Versatility as a project unit.
- Efficient manufacturing/application system.
- System that makes it possible to use the available resources, without replacing the traditional system.
- Savings in assembly and disassembly of manufacturing machines compared to traditional means.
- Eco-efficient system: emission-free and low electricity and fuel consumption.
- System adapted to the geographical area of the project, nature of the aggregates, transport possibilities, worksite location, etc.

Repsol EFI ADVANCE HW and REC HW

Repsol has developed the **Repsol EFI ADVANCE HW** and **REC HW** emulsion ranges specifically for the use and manufacturing of half-warm asphalt mixtures.

In recent years, the use of special emulsions in the manufacture of half-warm asphalt mixtures has made it possible to lower temperatures, which in turn entails a reduction in greenhouse gas emissions, increased occupational health and safety and energy savings in this activity.

The **Repsol EFI-ADVANCE HW** range meets the following requirements:

- Good wetting/coverage of the aggregate at the manufacturing temperature.
- Low percentage of water in the composition.
- Possibility of handling the mixture in the application area.
- Base binder with required properties for the intended use of the mixture.

The **Repsol EFI-ADVANCE REC HW** range combines the aforementioned advantages, in addition to those associated with the reuse of milled or demolition material coming from the road. With these emulsions and a suitable mixture manufacturing process, it is possible to reuse 100% of the recycled material in manufacturing the new mixture.

All emulsions have CE Marking, in accordance with the EN 13808 standard.

APPLICATIONS

The Sustituir por Repsol EFI-ADVANCE HW y Repsol EFI-ADVANCE REC HW emulsions that can be used to produce open- and closed-grade half-warm bituminous emulsions are as follows:

TYPE OF EMULSION	APPLICATION	TIPO MEZCLA
Repsol EFI ADVANCE C69B2 MBA HW	Open-graded half-warm bituminous mixtures for road maintenance and construction	BBTM, SMA, PA
Repsol EFI ADVANCE C69BP2 MBA HW	Open-graded half-warm bituminous mixtures for road maintenance and construction	BBTM, SMA, PA
Repsol EFI ADVANCE C69B2 MBC HW	Closed-graded half-warm bituminous mixtures for road maintenance and construction	AC
Repsol EFI ADVANCE C67B2 MBC REC HW	Recycled closed-graded half-warm bituminous mixtures for road maintenance and construction	AC

PRODUCT CHARACTERISTICS

The following table shows the characteristics of **Repsol EFI-ADVANCE HW** and **EFI-ADVANCE REC HW** emulsion ranges:

Repsol EFI ADVANCE HW

Standard EN 13808			Repsol EFI ADVANCE C69BP2 HW		Repsol EFI ADVANCE C67BPF3 HW		Repsol EFI ADVANCE C69B2 HW	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION					
Particle polarity	-	1430	Positive	-	Positive	3	Positive	-
Breaking value	-	13075-1	<110	2	70-155	8	<110	2
Binder content (per water content)	%	1428	67 to 71	9	65 to 69	8	67 to 71	9
Binder content recovered by distillation	%	1431	≥ 67	9	≥ 65	5	≥ 67	9
Fluxing agent content recovered by distillation	%	1431	≤ 2,0	2	≤ 8,0	5	≤ 2,0	2
Tiempo de fluencia (4 mm, 40ºC)	s	12846-1	40 to 100	6	5 to 70	2	40 to 100	6
Residue after sieving (0.5 mm sieve)	%	1429	≤ 0,1	2	≤ 0,1	3	≤ 0,1	2
Sedimentation tendency (7 days)	%	12847	≤ 10	3	≤ 10	3	≤ 10	3
Adhesion	%	13614	≥ 90	3	≥ 90	3	≥ 90	3
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1								
Penetration at 25ºC	0,1 mm	1426	≤ 100	3	≤ 150	4	≤ 100	3
Softening point	ºC	1427	≥ 43	6	≥ 43	6	≥ 43	6
Cohesion by pendulum test	J/cm^2	13588	≥ 0.5	6	≥ 0.5	6	-	-
Elastic recovery	%	13398	DV	1	DV	1	-	-
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2								
Penetration at 25ºC	0,1 mm	1426	≤ 100	3	≤ 100	5	≤ 100	3
Softening point	ºC	1427	≥ 43	6	≥ 50	7	≥ 43	6
Cohesion by pendulum test	J/cm^2	13588	≥ 0.5	6	≥ 0.5	6	-	-
Elastic recovery, 25ºC	%	13398	DV	1	DV	1	-	-
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431								
Penetration at 25ºC	0,1 mm	1426	≤ 100	3	≤ 220	3	≤ 100	3
Softening point	ºC	1427	≥ 43	6	≥ 39	6	≥ 43	6
Cohesion by pendulum test	J/cm^2	13588	≥ 0.5	6	≥ 0.5	-	-	-
Elastic recovery, 25ºC	%	13398	DV	1	DV	-	-	

Repsol EFI ADVANCE REC HW

Standard EN 13808			Repsol EFI ADVANCE C67B2 REC HW*	
CHARACTERISTICS	UNIT	EN STANDARD	TESTS ON ORIGINAL EMULSION	
Particle polarity	-	1430	Positive	-
Breaking value	-	13075-1	<110	2
Binder content (per water content)	%	1428	67 to 71	9
Binder content recovered by distillation	%	1431	≥ 67	9
Fluxing agent content recovered by distillation	%	1431	≤ 2,0	2
Fluency time (4 mm, 40ºC)	s	12846-1	5 to 70	5
Residue after sieving (0.5 mm sieve)	%	1429	≤ 0,1	2
Sedimentation tendency (7 days)	%	12847	≤ 10	3
Adhesion	%	13614	≥ 90	3
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1				
Penetration at 25ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8
RECOVERY BY EVAPORATION, ACCORDING TO EN 13074-1 AND STABILISATION EN 13074-2				
Penetration at 25ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8
RECOVERY BY DISTILLATION, ACCORDING TO EN 1431				
Penetration at 25ºC	0,1 mm	1426	≤ 220	5
Softening point	ºC	1427	≥ 35	8

*The base binder must be adapted depending on the amount of recycled material used, the condition of the aged binder, the type of mixture and the layer..

PRODUCT BEHAVIOUR IN THE MIXTURE

Emulsions in the **Repsol EFI-ADVANCE HW** and **EFI-ADVANCE REC HW** ranges can be used to manufacture half-warm mixtures with a similar mechanical performance to hot bituminous mixtures.

Due to the lower manufacturing temperature, the bitumen ages less, thereby improving the durability of the mixture. From the point of view of half-warm bituminous mixture manufacturing, other advantages include notable fuel savings and the fact that hot-mix production plants can be adapted to use these techniques.

Furthermore, use of the **Repsol EFI-ADVANCE REC HW** range leads to a savings in raw material consumption due to the reuse of material coming from the road.

Repsol COLOR RECOFAL

Pigmented Synthetic Binders are binder products with properties similar to bitumen that are obtained from a mixture of resins, oils and polymers. They are colourless in a thin film and can be given the desired colouration by incorporating mineral pigments.

Repsol sells Pigmented Synthetic Binders under the **Repsol COLOR RECOFAL** standard. These product ranges have been developed for the manufacture of pigmented mixtures in special areas where colour is an essential requirement.

With these binders, pavements can be obtained in a wide range of colours or can be used without pigment, resulting in the colour of the mixture similar to that of the aggregate used, being suitable for achieving natural tones and fully integrated with the environment.

APPLICATIONS

Synthetic binders developed by Repsol are applied in special areas such as:

- Paving of roads in parks and gardens.
- Bicycle paths.
- Pedestrian areas.
- Sports tracks.
- Island.
- Differentiated pavement elements.
- Tracks and paved roads in protected areas, natural parks, etc.
- Special areas for security purposes.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of **Repsol COLOR RECOFAL** binders:

CHARACTERISTICS	EN STANDARD	UNIT	REPSOL COLOR RECOFAL S-50	REPSOL COLOR RECOFAL S-50 HP	REPSOL COLOR RECOFAL S-100
Penetration at 25 °C	1426	0.1 mm	35-70	35-70	35-70
Softening point	1427	°C	≥ 45	≥ 75	≥ 60
Fraass breaking point	12593	°C	≤ -5	≤ -10	≤ -8
Elastic recovery at 25 °C	13398	%	≥ 20	≥ 30	≥ 40

RECOMMENDATIONS FOR USE

RECOFAL		Repsol COLOR RECOFAL S-50 and S50 HP	Repsol COLOR RECOFAL S-100
TESTS ON THE ORIGINAL BITUMEN			
Temperature ranges recommended for their application	Mixing	140ºC	150ºC
	Laying and compaction	130ºC	140ºC
	Max. plant heating temperature	160ºC	170ºC
	Min. storage temperature	120ºC	120ºC

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

Excessive overheating of both the binder and the mixture must be avoided, since it can lead to colour changes and/or possible degradation of the binder itself.

Repsol's Technical Support and Development Department can advise customers on the best conditions of use in each case.

SPECIFIC USES

Our **Repsol COLOR RECOFAL** pigmented synthetic binders make it possible to manufacture hot mixes with mechanical characteristics similar to those achieved with conventional bitumen. They have the following advantages:

- Easy pigmentation for any colour.
- Good resistance to ageing and oxidation.
- Possibility of mixing with the natural colour of the aggregate.
- Uniform product for all types of applications.

The breadth of the **Repsol COLOR RECOFAL** range is designed according to the different applications and manufacturing possibilities of colour mixtures:

Repsol COLOR Recofal S-50 and S50 HP

This is the most standardised and most widely used pigmented synthetic binder for the manufacture of colour mixtures applied to singular elements. It allows for bulk supply in manufacturing plants with tanks set up for it, as well as for supply in drums.

Repsol COLOR Recofal S-100

Repsol COLOR RECOFAL S-100 allows the same applications as Repsol COLOR RECOFAL S-50 while improving both the mechanical behaviour of the mixture and the desired tonality, enabling a much clearer range of final colours.

Repsol COLOR Recofal S100 HP

Repsol COLOR RECOFAL S-100 HP is a binder product with properties similar to those of bitumen that is obtained from a mixture of resins, oils and polymers. It is a high-performance pigmented synthetic binder for use in the manufacture of pigmented hot mixes.

Its granular format in the form of “pellets” allows for a direct dosage on the mixer of the mix manufacturing plant, as well as handling and storage in solid state at room temperature.

This enables its use in small volume projects, as well as its transport over both short and long distances.

APPLICATIONS

Synthetic binders developed by Repsol are applied in special areas such as:

- Paving of roads in parks and gardens.
- Bicycle paths.
- Pedestrian areas.
- Sports tracks.
- Islets and lane divisions.
- Differentiated pavement elements.
- Tracks and paved roads in protected areas, natural parks, etc.
- Special areas for security purposes.
- Wearing layer with light tones in tunnels: more light, safety and lower energy consumption.

PRODUCT CHARACTERISTICS

The presentation of Repsol COLOR RECOFAL S-100 HP allows it to be stored and handled in a solid state at room temperature. The amount strictly necessary can be used, without the need for prior conditioning. The ideal conditions of use (softening and viscosity) occur when the binder comes into contact with the hot aggregates in the mixer at the manufacturing plant.

The Repsol COLOR RECOFAL S-100 HP formulations has been specially studied to resist UV radiation to minimise possible colour changes. The product is presented in a neutral colour, thereby facilitating the option of using pigments for the manufacture of colour mixtures.

The following table shows the specifications of Repsol COLOR RECOFAL S-100 HP:

CHARACTERISTICS	EN STANDARD	UNIT	REPSOL COLOR RECOFAL S100HP
Penetration at 25 °C	1426	0.1 mm	20-50
Softening point	1427	°C	≥ 85
Fraass breaking point	12593	°C	≤ -20

RECOMMENDATIONS FOR USE

Repsol COLOR RECOFAL S-100 HP will be dosed in granular format directly on the asphalt plant mixer. It is recommended that the volume of the mix batches be adjusted to 75% of the maximum capacity of the mixer unit.

Operations to lay and compact a pigmented mixture will be carried out following the same criteria as its bituminous equivalent, maintaining the same parameters for its implementation.

All the elements involved in the manufacturing, spreading and compaction processes must maintain optimum cleanliness conditions to avoid undesirable contamination or possible colour changes in the mixture.

Taking into account the conditions of the manufacturing plant, weather, plant-work distances, etc., the indicative recommended working temperatures for Repsol COLOR RECOFAL S-100 HP are as follows:

Temperature of aggregates	Máx. 180ºC
Temperature of compaction	Mín. 135ºC

These data are illustrative and not binding, nor subject to specification. The temperatures will depend on the specific viscosity curves of each product.

Repsol's Technical Support and Development Department can advise customers on the best conditions of use for the product.

PRODUCT BEHAVIOUR IN THE MIXTURE

Repsol COLOR RECOFAL S-100 HP allows for the manufacture of any pigmented hot mix, also presenting the following advantages:

- Good resistance to ageing and oxidation.
- Greater resistance to discoloration than traditional synthetic binders.
- Mixture of easy pigmentation for any tonality of colour.
- Possibility of mixing with the natural colour of the aggregate.
- Better mechanical characteristics due to its enhanced formulation.

Repsol ISOLATE

Repsol sells the following products from the Repsol ISOLATE industrial asphalt line in its domestic and export markets:

- **Repsol ISOLATE:** bitumen specifically formulated to make polymeric waterproofing sheets in combination with rubber.
- **Special emulsions:** emulsion for priming and sealing surfaces, as well as for manufacturing other products for waterproofing. These emulsions are designed to adapt to the customer's particular needs.

APPLICATIONS

- Asphalt sheets for waterproofing.
- Bituminous waterproofing systems.
- Acoustic sheets for the automotive sector.
- Mortars for industrial waterproofing and paving.
- Bituminous putties and paints
- Joint sealing.
- Pipe coating.
- Industrial bituminous emulsions.
- Other applications: waste treatment, waterproofing of construction elements, adhesives, dune stabilisation, crop protection, etc.

PRODUCT CHARACTERISTICS

The following table shows the characteristics of the industrial asphalts specifically formulated to create polymeric waterproofing sheets in combination with virgin polymers:

CHARACTERISTICS	UNIT	EN STANDARD	Repsol ISOLATE 15	Repsol ISOLATE 30	Repsol ISOLATE 35
ORIGINAL BITUMEN					
Penetration at 25˚C	0,1 mm	1426	15 - 25	160 - 220	35 - 50
Softening point (Ring and Ball)	˚C	1427	60 - 76	35 - 43	50 - 58
Fraass breaking point	˚C	12593	≤ 0	≤ -15	≤ 5

CHARACTERISTICS	UNIT	EN STANDARD	Repsol ISOLATE 55	Repsol ISOLATE 90	Repsol ISOLATE Flex
ORIGINAL BITUMEN					
Penetration at 25˚C	0,1 mm	1426	50 - 70	70 - 100	275 - 350
Softening point (Ring and Ball)	˚C	1427	46 - 54	43 - 51	≥ 30
Fraass breaking point	˚C	12593	≤ -8	≤ -10	≤ 20
Flash point	˚C	ISO 2592	-	-	≥ 275

REPSOL

Let's invent the future

Customer service hotline
(+34) 901 101 101
repsol.com