

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 25°C	1426	0,1 mm	15-25	10-20	
Softening point	1427	°C	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	°C	≤ 8	≤ 10
Penetration index	12591 Annex A	-	From -1,5 a +0,7	From -1,5 a +0,7	
Fraass breaking point	12593	°C	TBR	TBR	
Flash point	ISO 2592	°C	≥ 245	≥ 245	
Solubility	12592	%	≥ 99,0	≥ 99,0	

To Be Reported [TBR].

RECOMMENDATIONS FOR USE

Recommended temperature ranges for application	Mixing	175 - 180°C
	Laying and compaction	165 - 170°C

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.

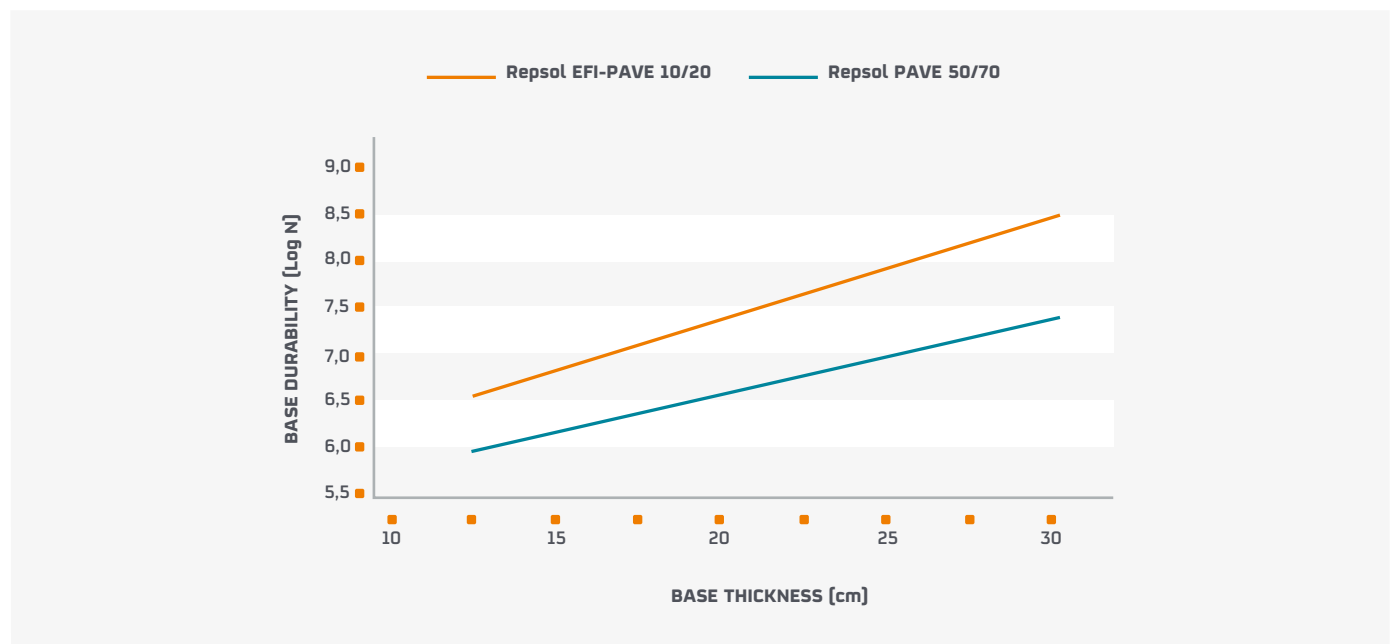


Figure 1. Structural behaviour. Data are indicative, not contractual, nor subject to specification.

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 25°C	1426	0,1 mm	10-40	25-55	45-80	45-80	45-80	75-130
Softening point	1427	°C	≥ 70	≥ 65	≥ 60	≥ 65	≥ 75	≥ 60
Cohesion. Force-ductility	13589	J/cm ²	≥ 2 to 15°C	≥ 2 to 10°C	≥ 2 to 5°C	≥ 3 to 5°C	≥ 3 to 5°C	≥ 1 to 5°C
Fraass breaking point	12593	°C	≤ -5	≤ -7	≤ -12	≤ -15	≤ -15	≤ -15
Elastic recovery at 25°C	13398	%	TBR	≥ 50	≥ 50	≥ 70	≥ 80	≥ 60
Storage stability	Softening point difference	13399 1427	°C	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9	≤ 9	≤ 9	≤ 13
Flash point	ISO 2592	°C	≥ 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	°C	≤ 8	≤ 8	≤ 10	≤ 10	≤ 10	≤ 10
Decreased the softening point	1427	°C	≤ 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 25°C		1426	0,1 mm	45-80	45-80	45-80	10-40
Softening point		1427	°C	≥ 65	≥ 75	≥ 80	≥ 80 [***]
Cohesion. Force-ductility		13589	J/cm ²	≥ 3 to 5°C [*]	≥ 3 to 5°C	≥ 3 to 5°C [**]	≥ 2 to 10°C
Fraass breaking point		12593	°C	≤ -15	≤ -15	≤ -15	≤ -5
Elastic recovery at 25°C		13398	%	≥ 70	≥ 80	≥ 80	≥ 70
Storage stability	Softening point difference	13399 1427	°C	≤ 5	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 13	≤ 9	≤ 9
Flash point		ISO 2592	°C	≥ 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	°C	≤ 10	≤ 10	≤ 8	≤ 10
Disminución del punto de reblandecimiento		1427	°C	≤ 5	≤ 5	≤ 5	≤ 5

[*] Force-ductility values >5 J/cm² to 5°C. There is no class for this value in standard EN 14023.

[**] Force-ductility values >7 J/cm² a 5°C. There is no class for this value in standard EN 14023.

[***] Designed to achieve values >90 °C. There is no class for this value in standard EN 14023.

RECOMMENDATIONS FOR USE

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

[*] 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 165°C, with wide ranges of laying and compaction between 140-160°C.

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 25°C		1426	0,1 mm	45-80	45-80
Softening point		1427	°C	≥ 65	≥ 75
Cohesion. Force-ductility		13589	J/cm ²	≥ 3 to 5°C	≥ 3* to 5°C
Fraass breaking point		12593	°C	≤ -15	≤ -15
Elastic recovery at 25°C		13398	%	≥ 70	≥ 80
Storage stability	Softening point difference	13399 1427	°C	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9
Flash point		ISO 2592	°C	≥ 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	°C	≤ 10	≤ 10
Decrease of the softening point		1427	°C	≤ 5	≤ 5

* Force-ductility values > 5 J/cm² to 5°C. 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 - 140°C	165 - 145°C
	Laying and compaction	160 - 135°C End 120°C	160 - 145°C End 130-125°C

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 25°C	1426	0,1 mm	10-40
Softening point	1427	°C	≥ 70
Cohesion. Force-ductility	13589	J/cm ²	≥ 2 to 15°C
Fraass breaking point	12593	°C	≤ 0
Elastic recovery at 25°C	13398	%	TBR
Flash point	ISO 2592	°C	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1			
Mass change	12607-1	%	≤ 0,8
Retained penetration	1426	%	≥ 60
Increased softening point	1427	°C	≤ 10
Decreased the softening point	1427	°C	≤ 5

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

RECOMMENDATIONS FOR USE

Recommended temperature range for application	Mixing	170 - 180°C
	Laying and compaction	165 - 175°C

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 25°C		1426	0,1 mm	35-50	50-70
Softening point		1427	°C	≥ 58	≥ 53
Cohesion. Force-ductility		13589	J/cm ²	≥ 0,5 to 5°C	≥ 0,5 to 5°C
Fraass breaking point		12593	°C	≤ -5	≤ -8
Elastic recovery at 25°C		13398	%	≥ 10	≥ 10
Storage stability	Softening point difference	13399 1427	°C	≤ 10	≤ 10
	Needle penetration difference	13399 1426	0,1 mm	≤ 8	≤ 10
Flash point		ISO 2592	°C	≥ 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	°C	≤ 8	≤ 10
Decreased the softening point		1427	°C	≤ -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 - 175°C	160 - 170°C
	Laying and compaction	155 - 165°C	150 - 160°C

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 25°C		1426	0,1 mm	45-80
Softening point		1427	°C	≥ 70
Cohesion. Force-ductility		13589	J/cm ²	≥ 3 to 5°C
Fraass breaking point		12593	°C	≤ -15
Elastic recovery at 25°C		13398	%	≥ 80
Storage stability	Softening point difference	13399 1427	°C	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 13
Flash point		ISO 2592	°C	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1				
Mass change		12607-1	%	≤ 1,0
Retained penetration		1426	%	≥ 60
Increased softening point		1427	°C	≤ 10
Decreased the softening point		1427	°C	≤ 5

RECOMMENDATIONS FOR USE

Recommended temperature range for application	Mixing	170 - 180°C
	Laying and compaction	165 - 175°C

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 - 160°C
	Laying and compaction	145 - 150°C

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 25°C		1426	0,1 mm	35-50
Softening point		1427	°C	≥ 75
Fraass breaking point		12593	°C	≤ -14
Elastic recovery at 25°C		13398	%	≥ 15
Storage stability	Softening point difference	13399 1427	°C	≤ 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	°C	≤ 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 25°C		1426	0,1 mm	35-50	50-70
Softening point		1427	°C	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	°C	≤ 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	°C	≤ -5	≤ -8
Flash point		ISO 2592	°C	≥ 240	≥ 230
Solubility		12592	%	≥ 99,0	≥ 99,0

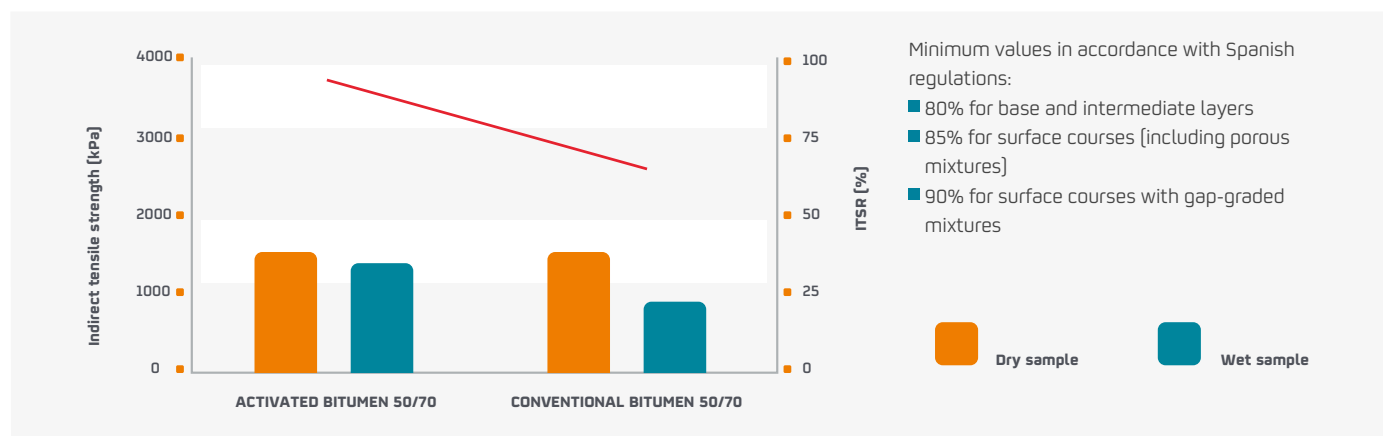
CHARACTERISTICS		EN STANDARD	UNIT	Repsol EFI-PERFORM PMB 45/80-65 ACTIV
TESTS ON THE ORIGINAL BITUMEN				
Penetration at 25°C		1426	0,1 mm	45-80
Softening point		1427	°C	≥ 65
Cohesion. Force-ductility		13589	J/cm ²	≥ 3 to 5°C
Fraass breaking point		12593	°C	≤ -15
Elastic recovery at 25°C		13398	%	≥ 70
Storage stability	Softening point difference	13399 1427	°C	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9
Flash point		ISO 2592	°C	≥ 235
DURABILITY-AGEING RESISTANCE, ACCORDING TO EN 12607-1				
Mass change		12607-1	%	≤ 1,0
Retained penetration		1426	%	≥ 60
Increased softening point		1427	°C	≤ 10
Decreased the softening point		1427	°C	≤ 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 25°C		1426	0,1 mm	35-50	35-50	50-70
Softening point		1427	°C	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	°C	≤ 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	°C	≤ -5	≤ -8	≤ -8
Flash point		ISO 2592	°C	≥ 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.

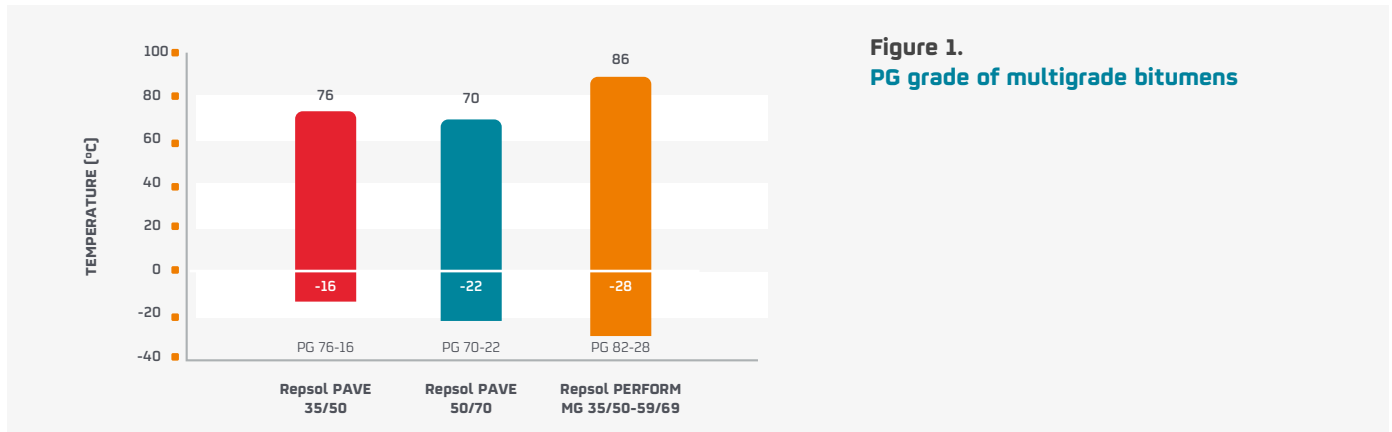


Figure 1. PG grade of multigrade bitumens

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 [10-20°C] than for conventional binders [see Figure 2].

Recommended temperature range for application	Mixing	170 - 180°C
	Laying and compaction	160 - 165°C

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

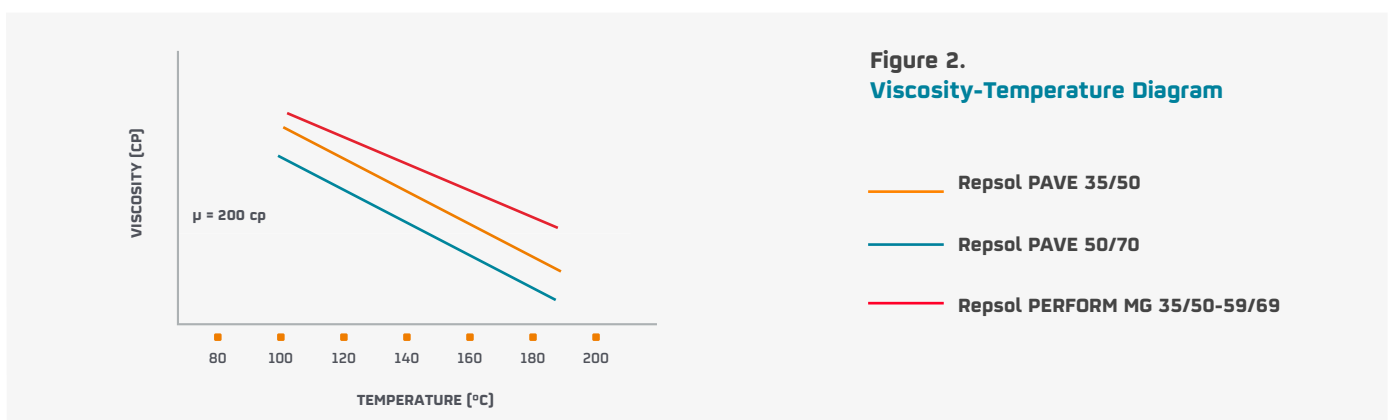


Figure 2. Viscosity-Temperature Diagram

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 40°C), 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 25°C	1426	0,1 mm	35-50	50-70	35-50	50-70	
Softening point	1427	°C	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	°C	≤ 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	°C	≤ -5	≤ -8	≤ -10	≤ -12	
Flash point	ISO 2592	°C	≥ 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 25°C		1426	0,1 mm	45-80	45-80	45-80
Softening point		1427	°C	≥ 60	≥ 65	≥ 75
Cohesion. Force-ductility		13589	J/cm ²	≥ 2 to 5°C	≥ 3 to 5°C	≥ 3 to 5°C
Fraass breaking point		12593	°C	≤ -12	≤ -15	≤ -15
Elastic recovery at 25°C		13398	%	≥ 50	≥ 70	≥ 80
Storage stability	Softening point difference	13399 1427	°C	≤ 5	≤ 5	≤ 5
	Needle penetration difference	13399 1426	0,1 mm	≤ 9	≤ 9	≤ 13
Flash point		ISO 2592	°C	≥ 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	°C	≤ 10	≤ 10	≤ 10
Decreased the softening point		1427	°C	-	-	≤ 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 °C	150 °C	150 °C	150 °C	160 °C
Mixing	130-135 °C	125-130 °C	135-140 °C	135-140 °C	145-150 °C
Start of laying and compaction	Min. 120 °C	Min. 120 °C	125-130 °C	125-130 °C	135-140 °C
End of compaction	Min. 100 °C	Min. 100 °C	-	-	-

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 30°C), 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

Let's invent the future