Dynasol
Group
dynasolgroup.com

Polymer modified Asphalt for paving aplications

SUSTAINABILITY

Dynasol Group has established sustainability of the business as one of the pillars for the innovation of new products to continue being a relevant player in the asphalt industry. Our multidisciplinary teams are working together to introduce new product to meet the needs and demands of the market. All this while taking into account the impact on the environment, the society and the contribution to a more circular economy to meet the growing population needs for infrastructure.

One of our Global concerns is about meeting the growing populations' need for infrastructure. In the infrastructure industry, concrete roads can take a month to be fixed and result in long construction times that generate high CO2 emissions due to increased traffic. A good alternative for these impacts is Highly Modified Asphalt that can repair roads overnight reducing the CO2 emissions.

Dynasol has a broad portfolio of products to meet highly modified asphalt demands to resist extreme weather conditions. Our SBS High vinyl also have self-crosslinking capabilities. This reduces or eliminates the need of sulfur, therefore reducing the Hydrogen sulfide emissions. This is a friendlier environmental alternative for paving.

Our SBS's High vinyl helps to optimize your Asphalt Modified process due to the capability to reduce viscosity and save energy when you make high concentrated batches and reduce emissions efficiently to our customers operations.

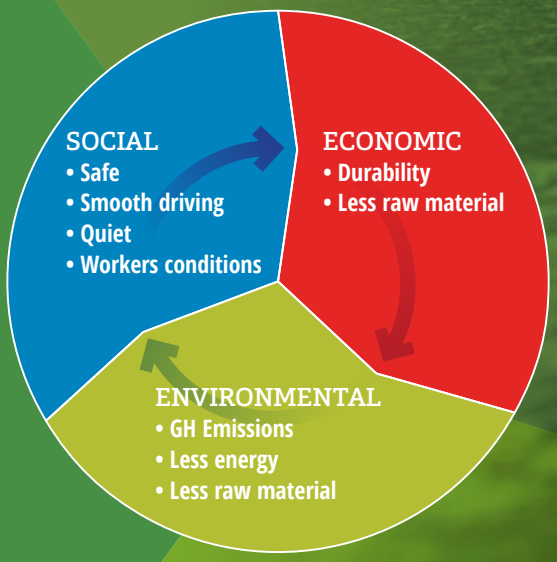

Figure 1. Sustainability in asphalt market

ADVANTAGES OF PMA IN PAVING APPLICATIONS

Conventional asphalts perform well on the majority of roads, but certain roads or areas which are highly stressed require high quality standards that can only be obtained by modifying asphalt. There are a lot of additives to modify asphalt such as tire rubber, carbon black, sulfur, chemical modifiers, plastomers, but the most suitable additives are elastomers. Of the four main groups of thermoplastic elastomers, styrene block copolymers have proved to present the greatest potential when blended with asphalt.

Dynasol styrene block copolymers provide countless benefits for asphalt used in road construction such as:

- Improvement of fatigue resistance and resistance to deformation caused by heavy loads. Avoid rutting deformation.
- Prevention of softening at high temperature.
- Improvement of the resistance to cracking caused by low temperature and/or abrupt changes in loads in high traffic zones.
- Superior adhesion and cohesion.
- Self-draining surfaces. Safety driving.
- They allow safer, quieter and long-lasting highways.
- Reduction of maintenance costs.

RECOMMENDED DYNASOL POLYMERS IN PMA APPLICATIONS

Dynasol Group has an excellent portfolio of styrene block copolymers to meet customers' needs and maintains market trends. Dynasol group offers the following products for this application:

SOLPRENE ® SSBR: S-1205, S-1110.
SOLPRENE ® SBS: S-4301, S-4302, S-4318.
CALPRENE ® SBS: C-411, C-580, C-501, C-401

Table 1. Recommended Dynasol polymers in PMA applications

Type	Brand	Grade	Styrene, %	Block polystyrene, %	Structure	Mooney Viscosity, ML (1+4) @ 100°C	Toluene Solution Viscosity, cP	Toluene Solution Viscosity (5.23%) cSt
SSBR	Solprene	1110	15	10	Tapered	147		
SSBR	Solprene	1205	25	17.5	Tapered	47		
SBS	Solprene	4318	32	31	Linear		700	6.3
SBS	Solprene	4302	33	31	Linear		890	7
SBS	Calprene	580	31.5	31	Linear		9700	9.5
SBS	Solprene	4301	33	31	Linear		3000	11
SBS	Calprene	501	31	29	Linear		5000	13
SBS	Calprene	401	20	18	Radial		9700	20
SBS	Calprene	411	30	30				26

Polymer modified asphalt may be the best solution for paving markets, but other factors must be taken into account such as the type of asphalt, the type and loading of polymer, and mixing conditions (temperature, agitation and time).

Overall, the increase in the amount of elastomer in asphalt affects the final PMA properties as follows:

- Increase in the R&B temperature and elasticity.
- Decrease in penetration, fraass fragility and flow.
- Exponential increase in the final viscosity.

Thanks to the ability to modify asphalt, Dynasol elastomers are used in the following paving applications:

- Hot mix polymer modified asphalt.
- Warm mix polymer modified asphalt.
- Polymer modified asphalt emulsions.

HOT MIX POLYMER MODIFIED ASPHALT

The polymer addition to asphalt is normally done at high temperatures (170ºC to 190ºC) in order to make sure that we have properly swelled the product in the asphalt and to properly handle the mixture in the industrial installations.

Depending on the elastomer used we can divide these blends in two types:

BLENDS DONE WITH SSBR

Solprene ® SSBR are widely used as asphalt modifiers for paving grades due to the ease in which it can be dissolved in liquid asphalt. When blended with asphalt and a cross-linking agent, the product creates a chemical structure in the asphalt which increases the temperature service range and gives stability for the final mixture.

The following table depicts the influence of Solprene ® SSBR in mixture with a compatible 70/100 asphalt.

Table 2. PMA properties with S-1205 and S-1110

	Asphalt 70/100 (A)	PMA 45/80-60	S-1205			S-1110		
			2%	4%	6%	2%	4%	6%
Tª R&B, ºC	41	≥60	60	64	69	58	63	73
Pen, 25ºC, dmm	75	45 – 80	58	48	43	51	49	47
Viscosity 160 ºC, cps	365		400	615	840	480	770	2350
Viscosity 180 ºC, cps	203		220	240	480	210	220	640
Fraass point, ºC	-13	≤-5	-16	-19	-25	-14	-21	-23
Elastic recovery at 25ºC, %	Not available	≥50	NA	72	81	NA	73	84

The low final viscosity for the PMA permits better pumping efficiency of polymer modified asphalt and has the option to reduce the process temperature offering a low energy alternative for polymer modified asphalt producers.

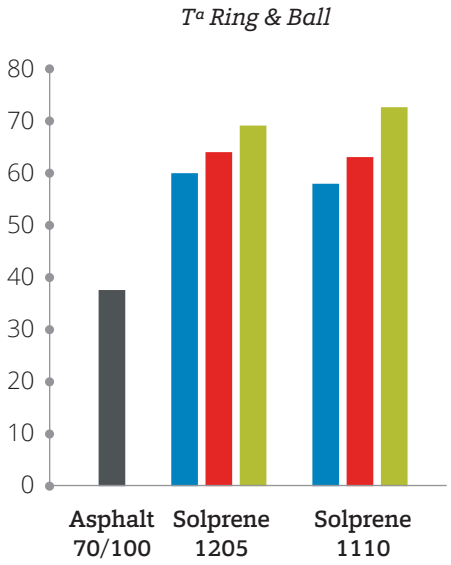

Figure 2. R&B temperature HMA with SSBR

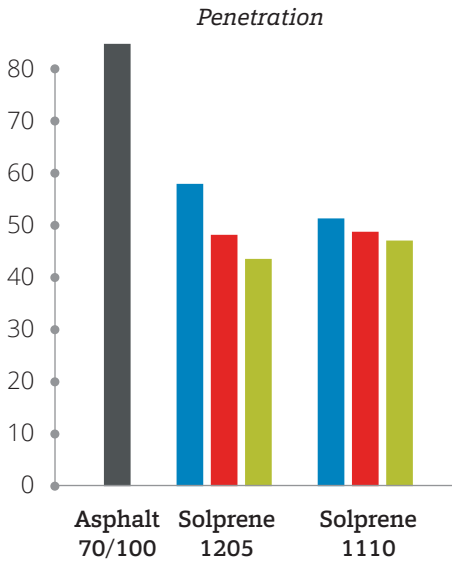

Figure 3. Penetration HMA with SSBR

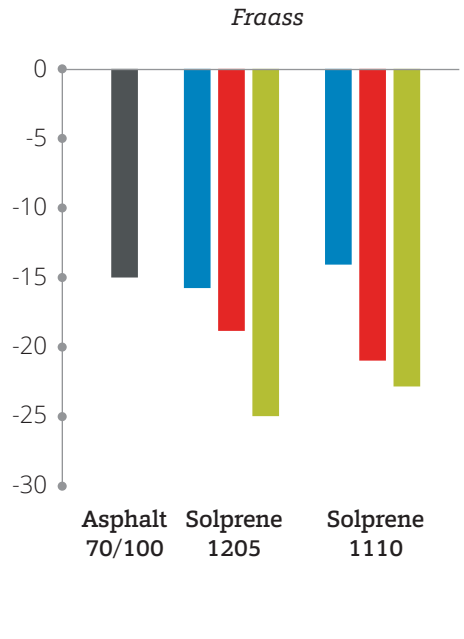

Figure 4. Fraass HMA with SSBR

As we can see from the tables, even in concentrations as low as 2%, SSBR products have a clear modifying effect upon the asphalt.

BLENDS DONE WITH SBS

Solprene ® and Calprene ® SBS provide the same properties as Solprene ® SSBR, however a cross-linking agent is not required.

SBS products are offered in granule form, so they can be blended directly in the asphalt avoiding a previous milling step.

The following tables depict the influence of Calprene and Solprene SBS in mixture with a compatible 70/100 asphalt.

Table 3. PMA properties with Calprene and Solprene SBS

	Asphalt 70/100 (B)	PMA 45/80-65	S-4318			S-4302			S-4301			C-580			C-501			C-401			S-411		
			2%	4%	6%	2%	4%	6%	2%	4%	6%	2%	4%	6%	2%	4%	6%	2%	4%	6%	2%	4%	6%
Tª R&B, ºC	38	≥65	55	62	70	56	64	74	56	73	98	56	73	93	49	75	95	49	78	93	55	82	97
Pen, 25ºC, dmm	85	45-80	60	58	52	62	60	55	62	59	55	66	59	54	69	60	48	70	55	50	65	58	50
Viscosity 160 ºC, cps	190	NA	370	490	710	170	255	410	200	350	560	190	310	690	223	420	920	280	420	1070	350	580	1400
Viscosity 180 ºC, cps	75	NA	95	220	410	80	185	280	110	210	340	110	200	310	110	250	390	110	250	362	130	300	450
Fraass point, ºC	-15	≤-5	-17	-21	-26	-14	-17	-22	-14	-18	-26	-13	-15	-19	-17	-18	-22	-17	-20	-26	-17	-19	-22
Elastic recovery at 25ºC, %	Not available	≥70	40	65	90	50	78	92	54	85	93	54	69	96	55	81	98	50	88	99	54	92	99
ΔTª R&B after RTFOT, ºC	Not available	≥- 5 ≤+10	1	0	-1	1	0	0	2	0	-3	0	0	-1	4	-1	-3	5	-1	-5	5	-5	-8

The following figures represent the asphalt modification degree in terms of:

- Ring and ball temperature
- Penetration
- Fraass fragility
- Elastic recovery

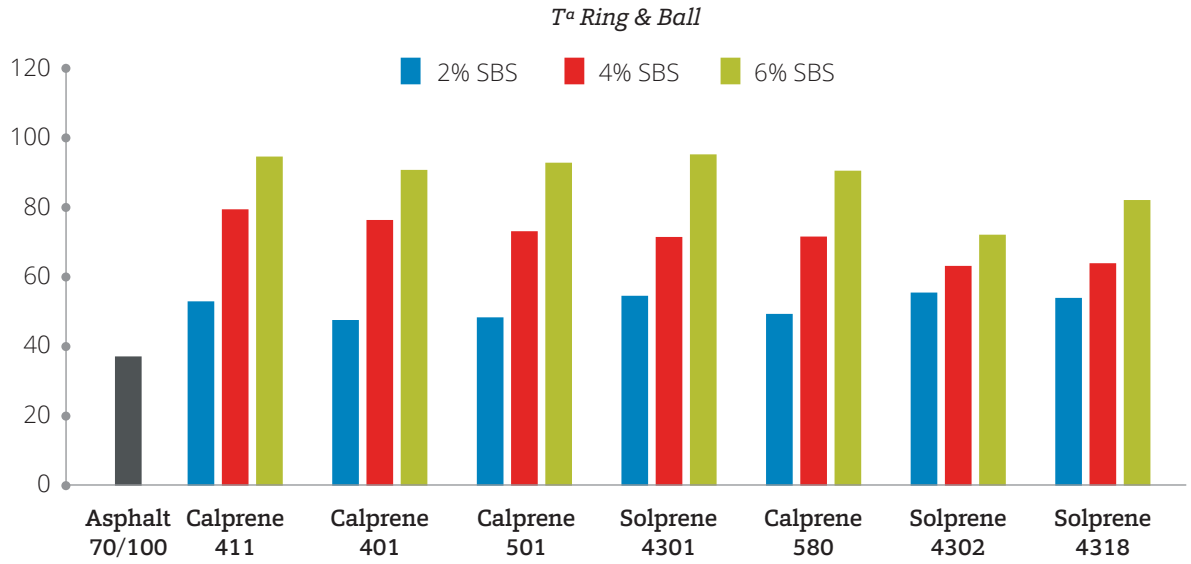

Figure 5. R&B temperature HMA with SBS

Penetration results depend on the viscosity of the polymer selected specifically in the styrene/butadiene percentage of the polymer. With the exception of C-401 which is a radial product with a styrene/butadiene ratio of 20/80, the rest of products have a ratio close to 30/70, for this reason we obtain similar results for every polymer studied.

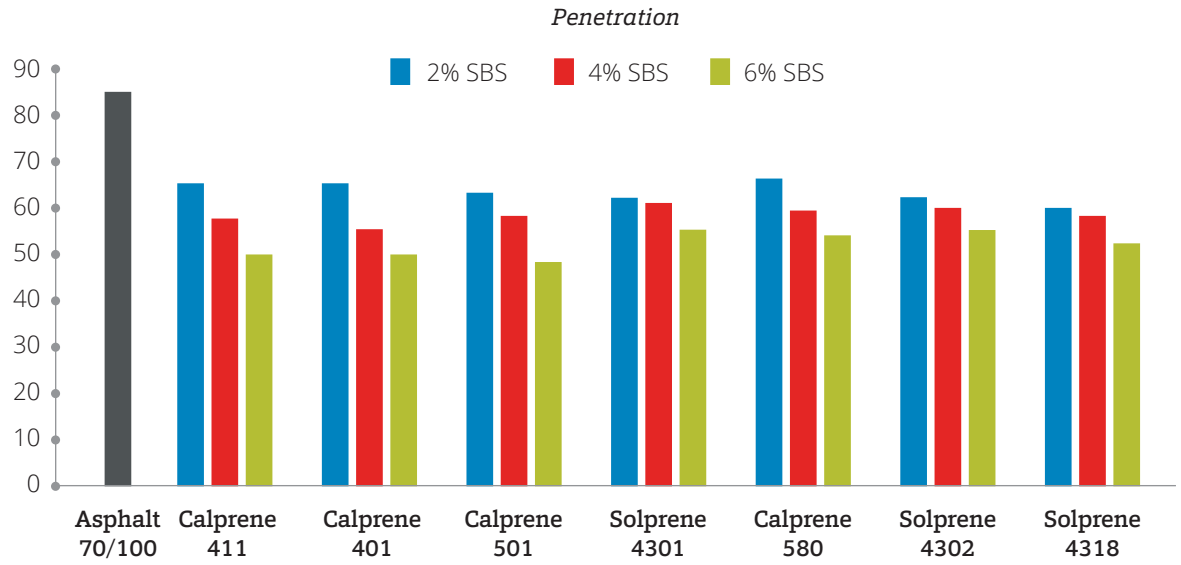

Figure 6. Penetration HMA with SBS

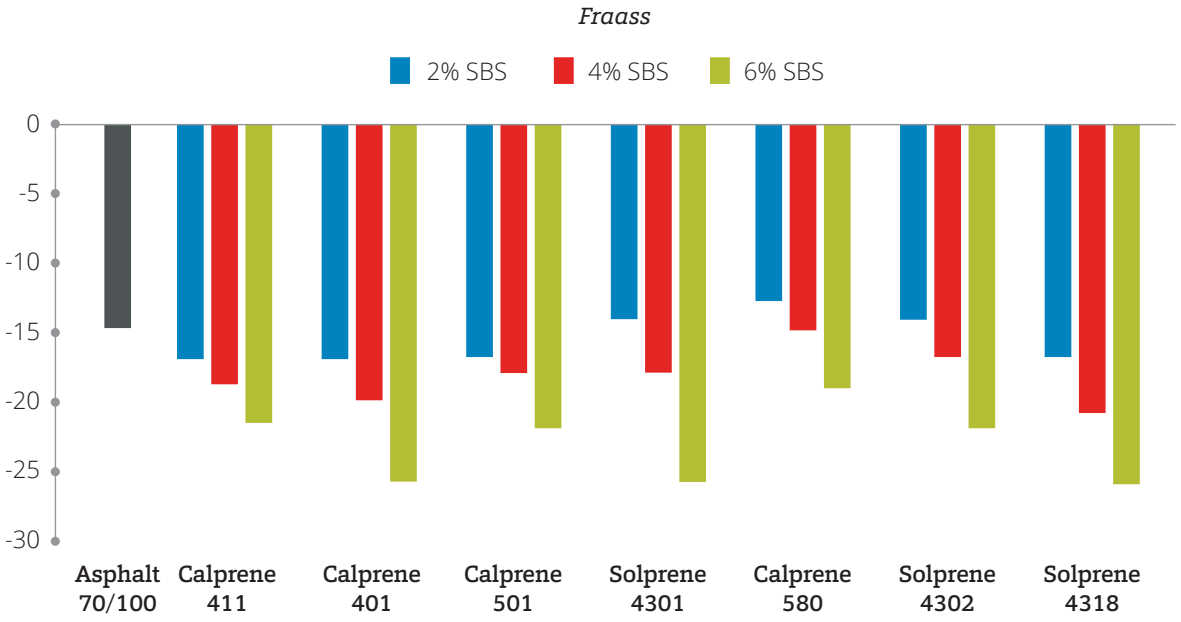

Figure 7 . Fraass HMA with SBS

As we can see in the following table, the use of SBS has very good elastic properties to modified asphalt. With most of the SBS recommended from Dynasol we are expect to obtain very good results at 4% of modification.

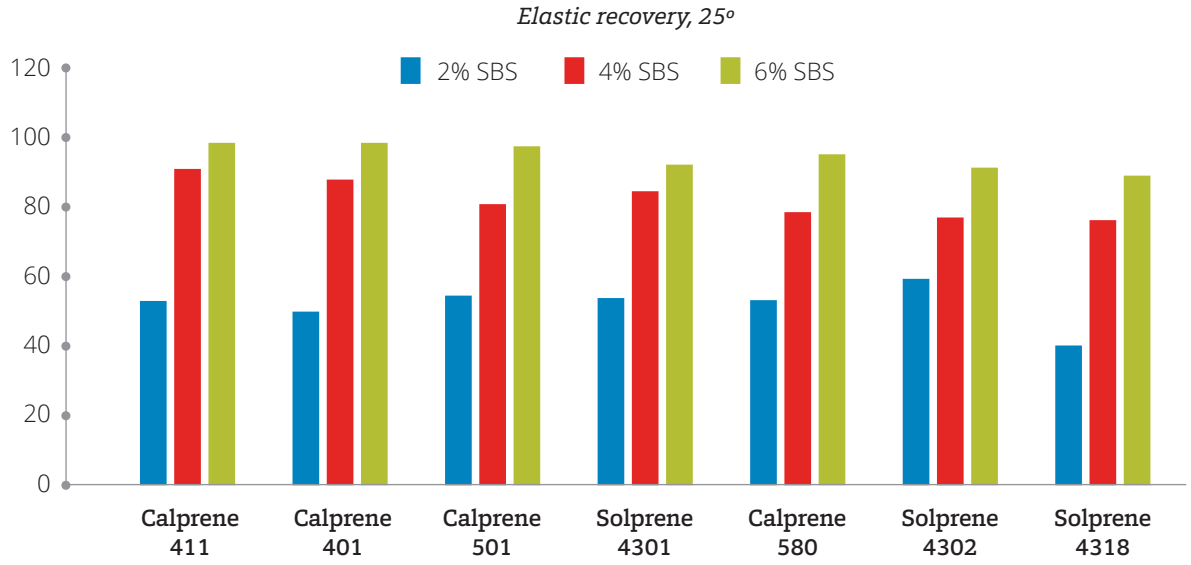

Figure 8. Elastic recovery 25º HMA with SBS

In the following figure the polymer influence in the asphalt modification degree is synthetized qualitatively in terms of:

- Ring and ball temperature
- Penetration
- Fraass fragility
- Dynamic viscosity
- Elastic recovery
- Ductility
- Force ductility
- Aging
- Storage stability

Table 4. PMA properties depending on polymer type

Brand Grade	Structure	Styrene Content, %	TSV, cP	Tª R&B	Pen	Fraass	Viscosity	Elastic Recovery	Ductility	Force Ductility	Aging	Storage stability
Calprene 411	Radial SBS	20	20	●	●	●	●	●	●	●	●	●
Calprene 401	Radial SBS	20	20	●	●	●	●	●	●	●	●	●
Calprene 501	Linear SBS	31	13	●	●	●	●	●	●	●	●	●
Solprene 4301	Linear SBS/SBR	33	11	●	●	●	●	●	●	●	●	●
Calprene 580	Linear	31	9,5	●	●	●	●	●	●	●	●	●
Calprene 4302	Linear	31	7	●	●	●	●	●	●	●	●	●
Solprene 4318	Linear SBS/SBR	32	6,3	●	●	●	●	●	●	●	●	●
Solprene 1205	Linear SBR	25	47*	●	●	●	●	●	●	●	●	●
Solprene 1110	Linear SBR	15	147*	●	●	●	●	●	●	●	●	●

Requirement performance ● Excellent ● Good ● Adequate
Condition test: 2 hr mixing, 180ºC, 4000 rpm high shear mixer, asphalt 70/100, 4% polymer.
*Mooney viscosity, ML1-4. Cross-linking agent is required in SBR products.

WARM-MIX POLYMER MODIFIED ASPHALT

Due to the high consumption of energy to prepare a hot mix PMA, the trend of the application is to reduce the temperature used in the mixing phase to decrease the energy consumption.

There are two techniques in the market for warm mix PMA, to use additives in the mixture or to use polymers with low viscosity and high compatibility with asphalt.

The following table depicts the properties obtained with 4% Dynasol SBS products prepared at high and medium temperatures:

Table 5. Warm-mix PMA properties

	Asphalt 70/100 (C)	S-4318		S-4302	
		180°C	135°C	180°C	135°C
Tª R&B, °C	47	61	58	63	56
Pen, 25°C, dmm	78	54	61	52	60
Viscosity 160 °C, cps	243	322	290	380	320
Viscosity 180 °C, cps	110	155	144	180	175
Fraass point, °C	-18	-34	-13	-34	-18
Elastic recovery at 25°C, %	Not available	81	78	88	81

These properties have been also represented in the following figures:

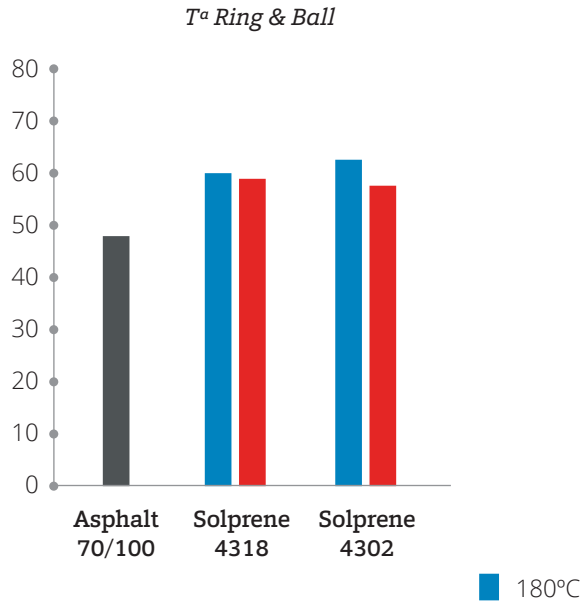

Figure 9. R&B temperature WMA

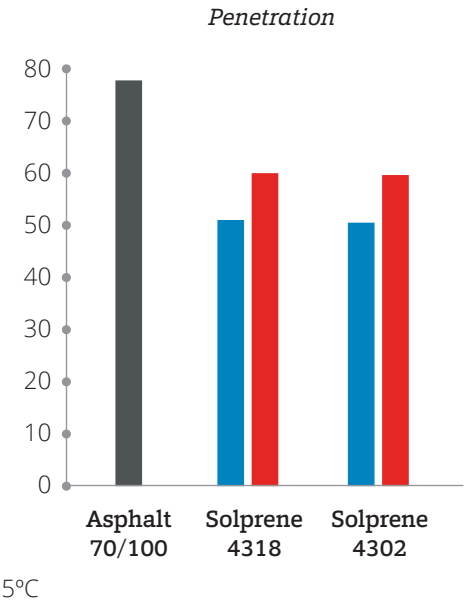

Figure 10. Penetration WMA

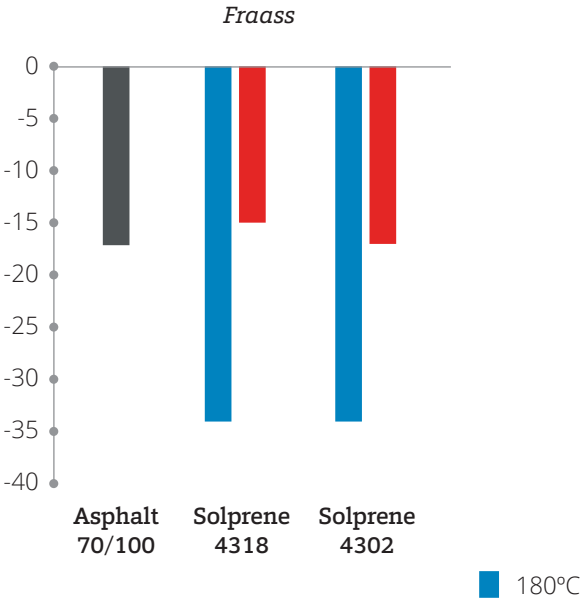

Figure 11. Fraass point WMA

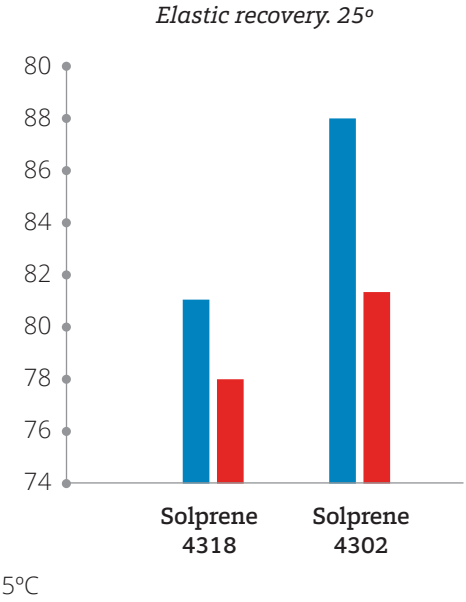

Figure 12. Elastic recovery WMA

POLYMER MODIFIED ASPHALT EMULSION

Polymer modified asphalt emulsion offers improvements in mitigation of pavement distress and reduces life cycle cost when compared to unmodified asphalt emulsion.

PMAE process starts with polymer modified asphalt preparation (typically 1.8 to 2.2% by weight of polymer into asphalt). The following table depicts the properties of different PMAE mixtures prepared with recommended Dynasol products:

Table 6. PMAE properties with Solprene and Calprene products

	Standard specification CRS-1P	S-1205 2.2%	S-4318 2.2%	S-4301 2.2%	C-401 2.2%
Polymer modified asphalt emulsion properties					
Saybolt viscosity, SSF	50 to 200	56	79	85	85
Sieve test, %	0.1 max.	0.05	0.07	0.07	0.06
Storage stability at 1 day, %	1 max.	0.5	0.6	0.7	0.6
Residue, %	65 min.	65	65	65	6.5
Polymer modified asphalt residual					
Tª R&B, ºC	Report	50	53	55	58
Pen, 25ºC, dmm	225 to 300	280	250	225	230
Ductility at 4ºC, cm	50 min	55	50	55	51
Elastic recovery at 10ºC, %	55 min	48	55	60	55

From this table we can see the main advantages versus SBR latex are high ductility and high elastic recovery of asphalt residuals. Due to the nature of these products, asphalt emulsions are typically used in:

- Chip seal
- Tack coats
- Cold mix and recycling

Besides this, SBR and SBS products improve adhesive strength from asphalt residual after emulsion set. This is extremely important to increase quality from chip seal and durability.

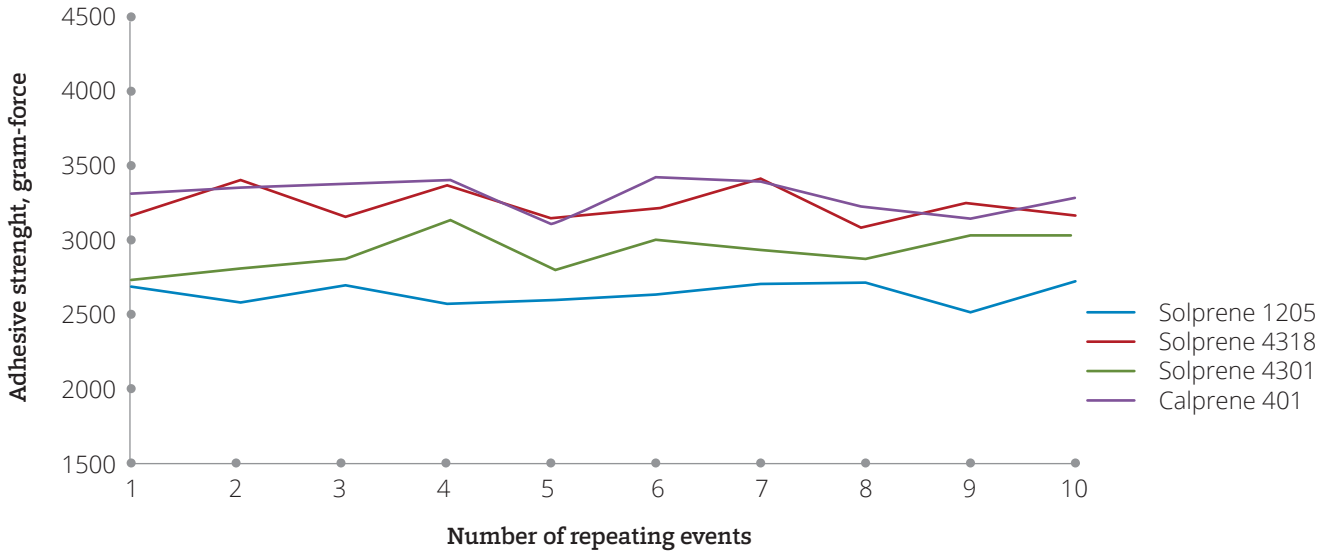

Figure 13. Adhesive strength from asphalt residual

TECHNICAL ASSISTANCE CENTERS

Dynasol Group has a technical assistance center in Europe and in America where we can conduct tests to show items in this catalog to your customers:

Our technical center staff have more than 20 years of experience in PMA technical assistance and those centers are provided with the proper equipment to carry out the following tests in the Polymer Modified Asphalt industry:

- Rheology performance (DSR, Superpave- SHRP+, MSCR, RTFO, PAV, BBR)
- Thermal-mechanical properties: R&B, Penetration, Torsion elastic recovery, ductility, RED
- Brookfield viscosity
- Asphalt composition (Iatroscan)
- Fluorescence microscopy
- Cold Bending Beam
- Polymer-Asphalt emulsion pilot plant

RESEARCH & DEVELOPMENT CENTERS

Dynasol Group has an R&D center in Europe and in America where we can develop new grades to satisfy new requirements from our customers.

To reach our Technical Assistance and Research & Development centers please contact us at:

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