TENCATE Polyfelt

Handbook

PGM & PGM-G

Paving Fabrics and Geocomposites for Road Maintenance

MA/RL/TH 2007

TENCATE Polyfelt

Table of Content

1. Requirements of Modern Road Pavements

Functioning roads are a prerequisite of a functioning economy. Permanently increasing traffic volume and increasing axle loads make high demands on the road pavements.

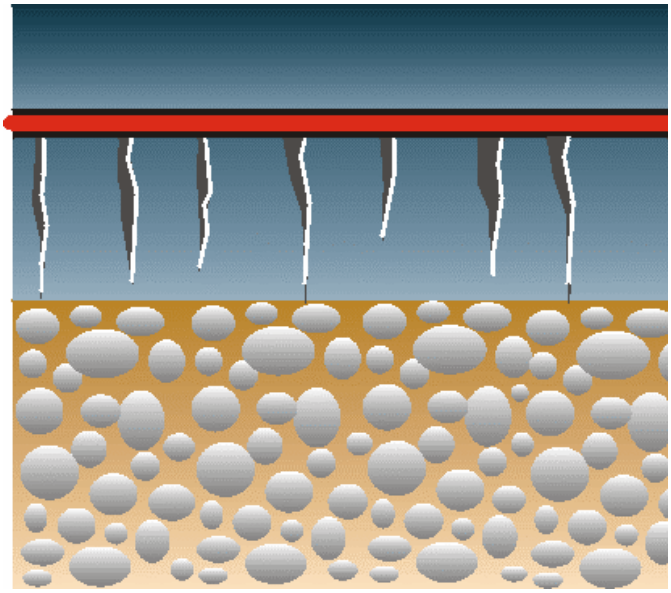
In detail these demands are:

Requirement	**Measure**	**Possible Solution**
Increasing axle loads	Higher bearing capacities	Polymer-modified bitumen Combined binders cement-bitumen Perfect bonding
Environmental compatability	Choice of materials Recycling technology Noise reduction	Emulsion technologies Noise reducing overlays and bridge pavings
Traffic safety	Adequate traffic guidance High grip surfaces	Draining asphalts Surface treatment Filling of cracks
Low construction costs	Optimized design Low cost technologies	Polymer-modified bitumen Recycling technology Use of emulsions
Low maintenance costs	Optimized maintenance methods	***Geosynthetic interlayers*** Surface treatment Filling of cracks Micro-layers
Long life-time	Optimized design Optimized maintenance in-time	***Geosynthetic interlayers*** Polymer-modified bitumen Surface treatment Filling of cracks Micro-layers Perfect bonding Combined binders

2. Geosynthetic Interlayers in Asphalt Road Systems

2.1. Application

Maintenance by using Asphalt Pavement

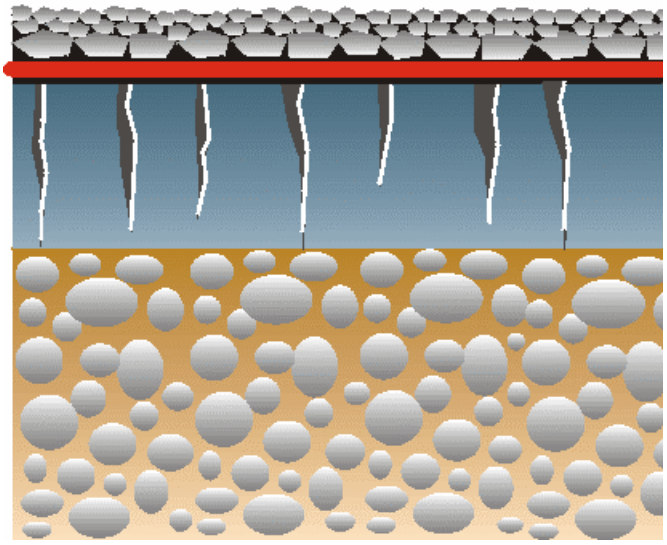


New Wearing Coarse

PGM & PGM-G
Tack Coat

Damaged road surface

Maintenance by using Surface Dressing



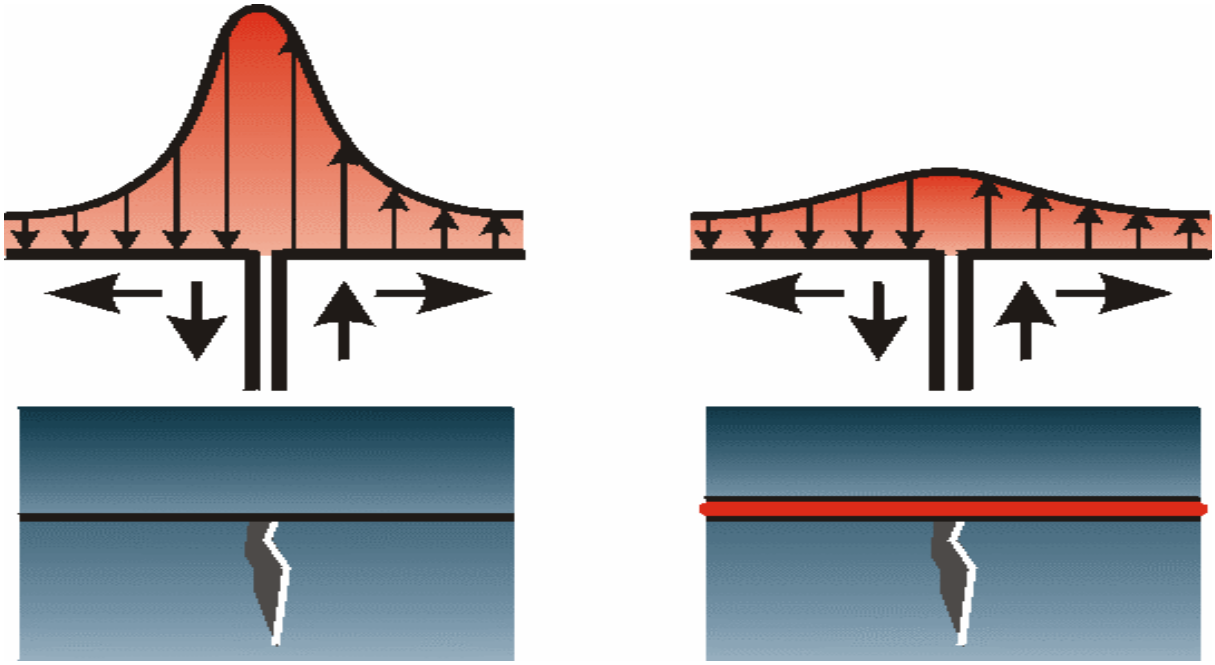
Chippings

Tack Coat
PGM
Tack Coat

Damaged road surface

2.2. Objective

Asphalt can take up tensile stresses only to a minor extent. Therefore the life-time of new asphalt surfaces applied on top of old cracked asphalt and concrete surfaces is limited. Interlayers within the structure can reduce the tensile stresses and thus retard reflection cracking.



Stresses in the new asphalt overlay without (left) and with paving fabric interlayer (right).

2.3. Types of Geosynthetic Interlayers

 Paving fabrics are nonwovens (e.g. TenCate Polyfelt PGM) made from synthetic, non-water-absorbant fibres. They are bonded solely mechanically by needle-punching. Chemically or heat bonded nonwovens are not suitable for this purpose as the bitumen saturation capacity of such products is limited.

 Geocomposites consist of nonwovens which are bonded with other synthetic mats, such as grids or yarns (e.g. TenCate Polyfelt PGM-G = nonwoven + glass filaments).

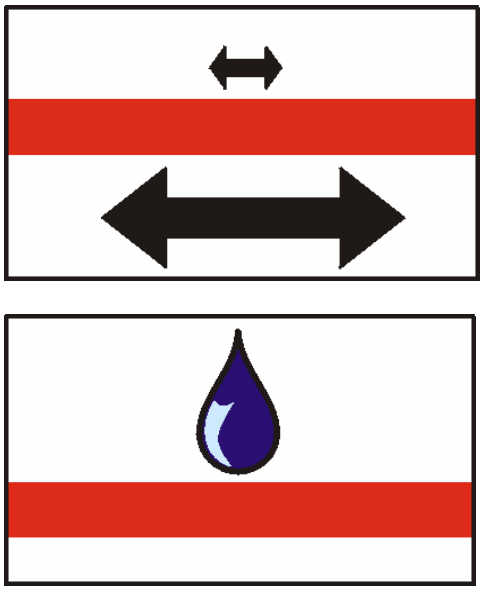
 Geogrids are made from punched and stretched synthetic sheets.

 Wovens or Meshes consist of two yarn systems which cross each other at right angles. The yarns can be made from polymers, glass filaments or from galvanized steel wires.

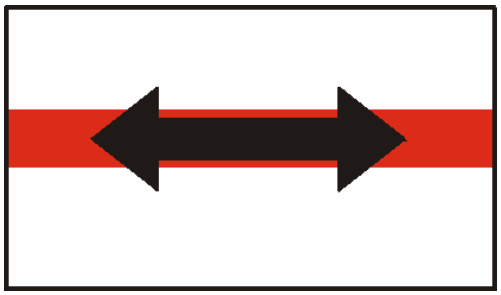
 Reinforcement fibres are endless or cut fibres from glass or polymer which are spread into the tack coat by means of a special equipment.

2.4. Criterias of Application for Geosynthetic Interlayers

 Paving fabrics are installed with the following objectives:
- To retard the formation of reflection cracks in the overlays by allowing a controlled horizontal flexibility.
- To seal underlying layers against penetration of surface water and oxygen, the fabric is characterized by a high bitumen storage capacity.



 Geogrids and Meshes are intended to fulfill two functions:
- Increasing the tensile strength of the asphalt layer.
- Taking up horizontal tensile stresses in the asphalt layer, irrespective of the bitumen plasticity.



A reinforcing effect can only be achieved under optimum bonding conditions and at low elongation. As cold asphalt can break under tension at an elongation of a few per mil (depending on the viscosity of the bitumen), an effective reinforcement must be able to take up tensile strength at a very low elongation (<3%).

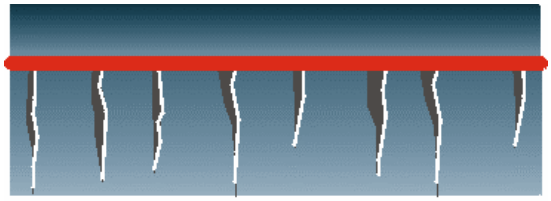
 Geocomposites were developed in order to fulfill both the functions of a nonwoven as well as the reinforcing function of a net or geogrid.

2.5. Crack Retarding Interlayers

2.5.1. SAMI (Stress Absorbing Membrane Interlayer)

= interlayer consisting of a highly elastic hot bitumen

On the area to be treated 1,8 - 2,5 kg/m² pure hot bitumen (or 2,6 - 3,6 kg/m² highly polymer modified 70% emulsion) will be sprayed, followed by the application of 7 to 15kg/m² chippings 8/11 mm. On this SAMI the new asphalt wearing course will be installed using a conventional paver.

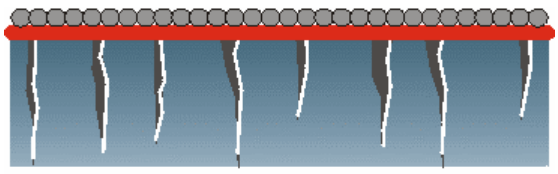


SAMI

2.5.2. SAM (Stress Absorbing Membrane)

SAM - layers have the same objective than SAMI - layers. However, instead of the asphalt wearing course, a surface dressing (chip sealing) will be applied on top.

On the area to be treated 1,8 - 2,1 kg/m² pure hot bitumen (or 2,6 - 3,0 kg/m² highly polymer modified 70% emulsion) will be sprayed, followed by the surface treatment. Chipping quantity 12 - 18 kg/m², Chip size 8/11 mm.



SAM

2.5.3. Interlayers (prefabricated)

a) Paving fabrics (e.g. TenCate Polyfelt PGM)
b) Geocomposite (e.g. TenCate Polyfelt PGM-G)
c) Geogrids (Polymer)
d) Woven or Meshes (Polymer, Glass or Steel)
e) Reinforcement fibres mixt with asphalt on site (Polymer or Steel)

3. TenCate Polyfelt PGM

3.1. TenCate Polyfelt PGM paving fabric

3.1.1. Product Description

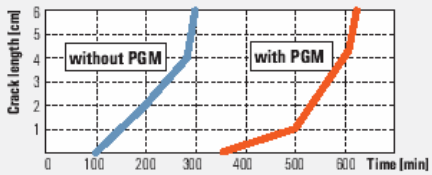
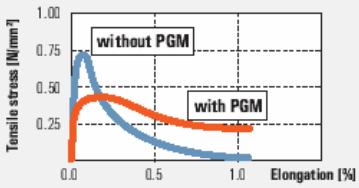
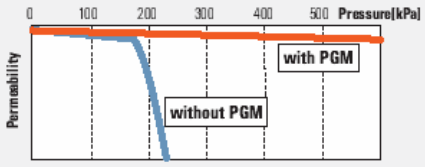
TenCate Polyfelt PGM is made from polypropylene continuous filaments mechanically bonded by needle punching.

3.1.2. Technical Data (s. data sheet)

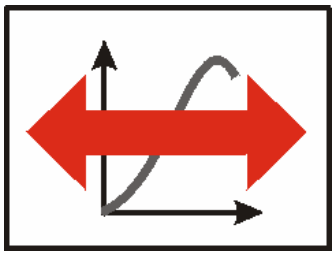
Properties	Standard	Unit	PGM 14
Type of product	-	-	Mechanically bonded continuous filament nonwoven
Raw material	-	-	100% polypropylene UV stabilized
Asphalt retention	Texas DOT Item 3099 ASTM D6140-97	kg/m²	1.1
Tensile strength	EN ISO 10319	kN/m	9
Elongation at maximum load (md+cd)/2		%	55
Grab tensile strength	ASTM D 4632	N	520
Grab elongation		%	> 50
Tensile strength (md/cd) *		kN/m	-
Elongation at break *	ISO 3341	%	-
Strength at 2 % strain *		kN/m	-
E-Modulus of the glass filaments		MPa	-
Mesh width of the glass filaments		mm	-
Thickness at 2 kN/m² load	EN ISO 9863-1	mm	1.1
Mass per unit area	EN ISO 9864	g/m²	140
Variation coefficient		%	< 10
Melting point	ASTM D 276	°C	165

3.1.3. System Properties (s. data sheet)

System properties
(PGM 14, installed between asphalt layers)

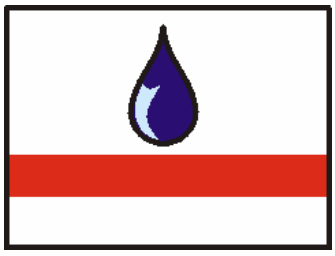
Dynamic Flexural Tensile Test:		
Break of AC 0/10 after ... (AC thickness 6 cm, polymer modified bitumen) [LRPC Autun]	625 min	
Low Temperature Behaviour:		
Transfer of tensile stresses at -10 °C Max. stress (in % of control sample) After 0,5 % extension [TU Braunschweig]	< 60% > 0,28 N/mm²	
Sealing:		
Insignificant head loss up to ... [Resource Int. Inc.]	< 500 kPa	

3.1.4. Features and Benefits



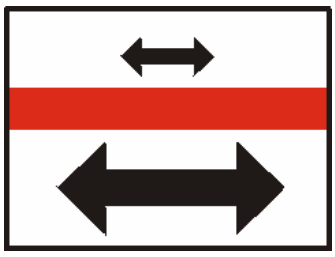
☐ Tensile Strength

The stress-strain behaviour of PGM & PGM-G shows that the stresses occuring upon laying are harmlessly absorbed, while it is possible to lay around curves without creases. The tensile strength and the endless fibre construction of polyfelt.PGM also guarantees good resistance to traffic. Trucks pulling away and braking will cause no damage provided polyfelt.PGM is laid correctly.



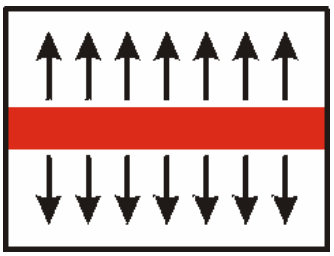
☐ Sealing

The bitumen impregnated PGM & PGM-G prevents intrusion of precipitation water and atmospheric oxygen into underlying layers of the road structure. Tests have shown that because of the high storage capacity of the felt, the sprayed bitumen retains its sealing effect even under high pressures.



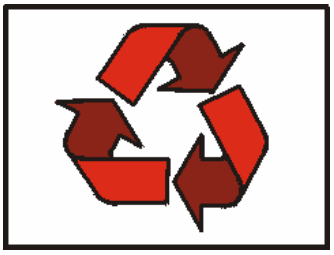
☐ Stress Relief

Differential stresses between the substrate and the new surface layers (asphalt concrete, surface dressing) are reduced in the bitumen-filled PGM & PGM-G. Crack propagation and reflective cracking are prevented or reduced in the new road surface.



Adhesive Bonding

The higher quantity of bitumen and the easy adaptation of PGM & PGM-G to uneven substrates guarantee excellent, uniform adhesion between layers (old pavement – polyfelt.PGM - new asphalt overlay). This bonding effect reduces flexural tensile stresses and thereby extends the life of the road surface.

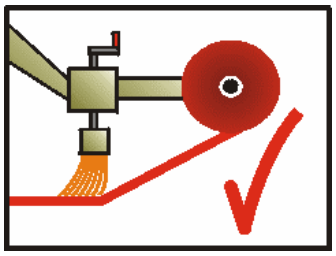


Recycling

Asphalt road surfaces repaired with PGM & PGM-G can be ground off if necessary. The resulting material can be recycled and used in bituminous mixtures without difficulty. If dumped, PGM & PGM-G is completely neutral in the environment; it forms no toxic waste products whatsoever.

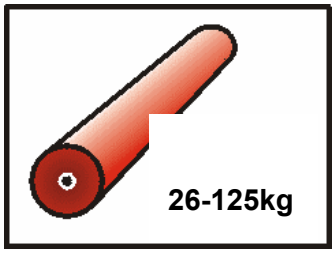
Quality Control

PGM & PGM-G is subject to a stringent quality control and quality assurance according to the latest international standards. The Polyfelt Quality Management System is certified according to ISO 9001. In order to avoid mixing up with probably unsuitable other material, every 5m “PGM“ or “PGM-G” is printed on the fabric.



Simple Laying Procedure

Using a laying machine, PGM & PGM-G can be laid easily and economically. Even laying around curves presents little difficulty. In exceptional cases, smaller areas can be laid by hand.



Ease of Handling

PGM is supplied in relatively light rolls. This means it can be installed economically, even on small rojects. If necessary, PGM & PGM-G can be cut with an ordinary knife.

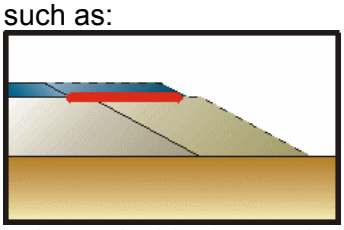
3.2. TenCate Polyfelt PGM-G Geocomposite

3.2.1. Product Description

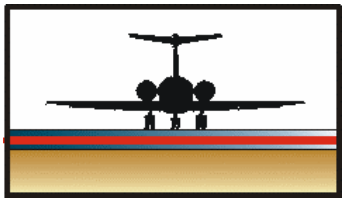
PGM-G is a composite paving reinforcement comprised of the well-proven PGM paving fabric combined with a high strength glass grid reinforcement, offering high tensile strength with the sealing, bonding and crack control features of PGM.

3.2.2. Application and Function

PGM-G shall be used in cases where high horizontal and vertical stresses are likely to occur, such as:



 In road widening works (construction of additional lanes): PGM-G takes up tensile stresses and reduces the danger of slope failures.



 In cases of extremely high traffic stress, such as airport runways, or roads with high daily traffic.

 In cases where high punctual forces are applied, such as those caused by loaders in saltworks.

 In close bends and curves.

 Construction of new roads over weak subgrade.

 In cases where high temperature differences occur in a short period of time (changing conditions, such as an icy section followed by a section in the sun)

3.2.3. Properties and Benefits

- Glass fibres show no loss of strength when in contact with hot bitumen or asphalt.
- Glass fibres are chemically neutral in contact with bitumen or asphalt.
- Glass fibres have a low extention at break: 3 %
  Extention at break of asphalt: 0,1 to 2 %
- Sealing against penetration of surface water
- High resistance against dynamic stresses
- No immediate propagation of old cracks into the new overlay
- Easy and quick installation: No pre-tensionning required; can be laid even easier than PGM, as the glass grid stabilizes the paving fabric.
- Can be ground off and recycled without problem.

3.2.4 Technical Data (s. data sheet)

Properties	Standard	Unit	PGM-G 50/50	PGM-G 100/100	PGM-G 200/200
Type of product	-	-	Composite (mechanically bonded continuous filament nonwoven + glass filaments)		
Raw material	-	-	Polypropylene, UV stabilized + Glass filaments		
Asphalt retention	Texas DOT Item 3099 ASTM D6140-97	kg/m²	1.1	1.1	1.1
Tensile strength	EN ISO 10319	kN/m	-	-	-
Elongation at maximum load (md + cd)/2		%	-	-	-
Grab tensile strength	ASTM D 4632	N	-	-	-
Grab elongation		%	-	-	-
Tensile strength (md/cd) *	ISO 3341	kN/m	50 / 50	100 / 100	200 / 200
Elongation at break *		%	3	3	3
Strength at 2 % strain *		kN/m	34 / 34	68 / 68	136 / 136
E-Modulus of the glass filaments		MPa	73,000	73,000	73,000
Mesh width of the glass filaments		mm	40 x 40	40 x 40	40 x 40
Thickness at 2 kN/m² load	EN ISO 9863-1	mm	-	-	-
Mass per unit area	EN ISO 9864	g/m²	300	430	495
Variation coefficient		%	-	-	-
Melting point	ASTM D 276	°C	Glass filaments are incombustible and temperature resistant up to 400 °C		

Forms of supply

Dimensions	Unit	PGM 14	PGM-G 50/50			PGM-G 100/100			PGM-G 200/200	
Width	m	1.00 / 1.90 / 3.00 / 3.80	0.95	1.90	3.80	0.95	1.90	3.80	0.95	1.90
Length	m	150	100	100	75	100	100	75	100	75
Area	m^2	150 / 285 / 450 / 570	95	190	285	95	190	285	95	142.5
Roll diameter	m	0.50	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Roll weight	kg	26 / 46 / 72 / 92	34	63	90	45	86	125	52	73
Inner core diameter	m	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

Other forms of supply are available on request.

4. Damage Configurations - Causes and Repair

One prerequisite for the use of geosynthetic interlayers in asphalt road construction is a careful analysis of the reasons of the damage. This shall not only comprise of a visual inspection of the damage configuration, but must also include e.g. the taking of drill cores which allow to investigate the layer thicknesses, the composition of the asphalt mix and the thickness of the frost resistant base course.

4.1. Defective Asphalt Surfaces

Defects in asphalt concrete surfaces can be divided into the following categories:
- Cracks
- Material loss
- Unevenness
- Insufficient surface grip

4.1.1. Cracks

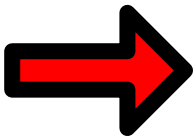
4.1.1.1. Cracks caused by horizontal movement

Cracks caused primarily by horizontal movements due to temperature changes can appear in the following forms:

a) Cracks in longitudinal and transversal direction in asphalt surfaces with insufficient binder content, with too hard or aged binder on a subgrade with suffient bearing capacity and non-susceptible to deformations.

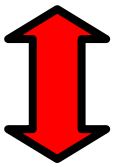
b) Propagating cracks:
- over cracked cement stabilized base courses or improved subgrades with too high stiffness
- over cracked brittle asphalt binder or base courses
- over joints or seams in asphalt binder or base courses
- over digged up and refilled ditches etc.
- over joints in overlaid concrete surfaces

c) Opening of longitudinal and transversal joints and seams



In the case of cracks caused by horizontal movement, a limited horizontal movement of the overlay must be allowed; nonwoven paving fabrics impregnated with bitumen are very suitable for this purpose.

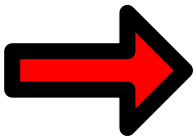
4.1.1.2. Cracks caused by vertical movement



Cracks caused primarily by vertical movements can appear in the following forms:

a) Propagation of joints and cracks in concrete surfaces and in cement stabilized base courses.

b) Single cracks and alligator cracks in wearing courses over asphalt layers with reduced bearing capacity (e.g. caused by ageing of the binder, loss of binder etc.)



The use of geosynthetic interlayers in the case of vertical movements cannot be recommended, as the vertical stresses cannot be taken up by the interlayer.

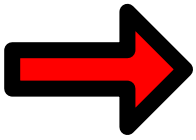
4.1.1.3. Cracks caused by horizontal and vertical movement

Cracks caused by horizontal and vertical movements can appear in the following forms:

a) Alligator cracks in a thin asphalt overlay over a structure with insufficient frost resistance. Typical cracks caused by frost are local circle or ellipse shaped cracks which are caused by heavings and pressed down by the traffic.

In this case a bitumen impregnated interlayer can reduce the penetration of surface water and therefore improve the frost resistance of the structure indirectly.

b) Cracks in the wheel track caused by insufficient bearing capacity of the base course and/or subgrade, or caused by excessive traffic stress.

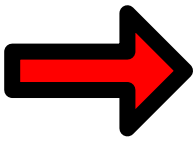


The use of geosynthetic interlayers is not recommended, as the bearing capacity cannot be increased.

Cracks: Possible Causes

Single cracks Landslides,	settlements, frost heave, insufficiently corresponding properties of the layers, cracks, joints or grooves in the substrate, faulty installation, thermal overstressing
Alligator cracks	insufficient bearing capacity of underlaying layers, insufficient thickness of asphalt layer, faulty construction materials, faulty installation, ageing, insufficient adhesive bonding
Open joints	Faulty construction materials, faulty installation, thermal overstressing
Open grooves Settlements, faulty installation, thermal overstressing .	

The exclusive repair of defects can only be a short to medium term measure. Elimination of causes together with repair of defects are long term measures and should therefore preferred from a technical point of view.



In the repair of single cracks, alligator cracks, opon joints and grooves the installation of a geotextile interlayer is beneficial in the following cases:

- **Insufficient asphalt quality due to ageing and fatigue**
- **Thermal overstressing of the asphalt layer**
- **Reflection cracks from underlying layers**
- **Insufficient bearing capacity of underlying layers due to penetrating precipitation water**

Cracks: Possible Maintenance Methods

Measure	*Defect*	*Method*	*Procedure*
Short to long term	Narrow single cracks, open joints / grooves	Joint filling	Cutting or grounding if necessary, cleaning and filling with crack filler
	Wide single and alligator cracks, open joints / grooves	Filling with asphalt mix	Cutting out or grounding in req.d width and depth, cleaning, applic-ation of tack coat, installation of asphalt mix of req.d composition and thickness, compaction
	Open joints	Joint remix	Grounding hot, adding asphalt mix, adding binder if necessary, compaction
Short to medium term	Alligator cracks	Surface treatment	According to the relevant standards or guidelines
	Alligator cracks	„Micro-layer“	According to the relevant standards or guidelines
Long term	Alligator cracks	Reinforcement	Cleaning, application of tack coat, installation of asphalt mix, compaction
	Alligator cracks	Renewal	Removing, peeling or grounding of defective surface layer, applic-ation of a new wearing course

4.1.2. Material Loss

Material loss: Possible Causes

Loss of binder	Insufficient quality of filler or sand, influence of weather
Loss of grains	Insufficient quality of grains, insufficient bonding between grains
Loss of binder and grains	Insufficient quality of grains and binder, faulty mixing, faulty installation, influence of weather, abrasion, insufficient bonding, defects not repaired in time

Material loss: Possible Maintenance Methods

Measure	*Defect*	*Method*	*Procedure*
short term	Pot holes	Filling with asphalt mix	Cutting out, cleaning, filling with asphalt mix, compaction
short to medium term	Loss of binder	Surface treatment	According to the relevant standards or guidelines
	Loss of grains	„Micro-layer“	According to the relevant standards or guidelines
medium to long term	Loss of binder and grains	Reinforcement	Cleaning, application of tack coat, installation of asphalt mix, compaction
		Renewal	Removing, peeling or grounding of defective surface layer, application of a new wearing course
		Recycling (Reshape, Re-pave, Remix)	According to the relevant standards or guidelines

4.1.3. Unevenness

Unevenness: Possible Causes

Rutting	Insufficient bearing capacity of underlying layers, insufficient resistance against deformation, post-compaction, traffic on hot layers, thermal overstressing, surface abrasion
Transversal ruts	Insufficient resistance against deformation, post-compaction, traffic on hot layers, thermal overstressing, insufficient adhesive bonding
Settlements	Sliding, post-compaction of base courses, insufficient subgrade bearing capacity, insufficient drainage
Deformations	Insufficient quality of construction materials, insufficient resistance against deformation, insufficient compaction, insufficient adhesive bonding

Unevenness: Possible Maintenance Methods

Measure	*Defect*	*Method*	*Procedure*
short to medium term	Ruts Settlements Deformations	Profiling	Grounding if necessary, cleaning, application of tack coat, filling with asphalt mix, compaction
	Ruts Transv. ruts Deformations	Grounding	Removal of bulges etc.
		„Micro-layer“	According to the relevant standards or guidelines
short to long term	Ruts Settlements	Reinforcement	Profiling if necessary, cleaning, application of tack coat, installation of asphalt mix, compaction
	Ruts Transv. ruts Deformations	Recycling (Reshape, Re-pave, Remix)	According to the relevant standards or guidelines
long term	Ruts Transv. ruts Deformations	Renewal	Removing, peeling, grounding of defective layer, application of a new wearing course

4.1.4. Insufficient Surface Grip

Insufficient Grip: Possible Causes

Binder surplus	Wrong composition
Squeezing out of binder	Faulty installation, traffic on hot layers
Other smooth road surfaces	Insufficient quality of grains, wrong composition of asphalt mix, faulty installation

Insufficient Grip: Possible Maintenance Methods

Measure	*Defect*	*Method*	*Procedure*
short to medium term	Insufficient surface grip	Roughing	Mechanical treatment of the surface
		Surface treatment	According to the relevant standards or guidelines
		„Micro-layer“	According to the relevant standards or guidelines
		Reinforcement	Cleaning, application of tack coat, installation of asphalt mix, compaction
		Recycling (Regrip, Re-pave, Remix)	According to the relevant standards or guidelines

4.2. Defective Concrete Surfaces

The use of geosynthetic interlayers is advisable when only thin overlays can be applied. The thickness of an overlay applied over an interlayer shall however not be less than 8 cm (e.g. 5cm bituminous bound base + 3cm wearing course).

A prerequisite for the use is that no significant vertical and/or horizontal movements can occur at the edges. This can be achieved by relaxation, cutting or injection.

When major unevennesses appear on this treated surface, it is recommended to install a levelling layer prior to the installation of the paving fabric, in order to achieve full contact between substrate and interlayer.

When only minor unevennesses appear, the paving fabric can be applied directly on the pre-treated surface.

It must be stated that the use of a geosynthetic interlayer does NOT allow to reduce the required layer thickness derived from conventional design.

5. Installation and Construction

These installation guidelines are valid only for TenCate Polyfelt PGM and TenCate Polyfelt PGM-G.
Installation guidelines of other producers must be followed strictly.

The installation procedures depend on the type of overlay (asphalt concrete, surface treatment, „micro-layer“ etc.)

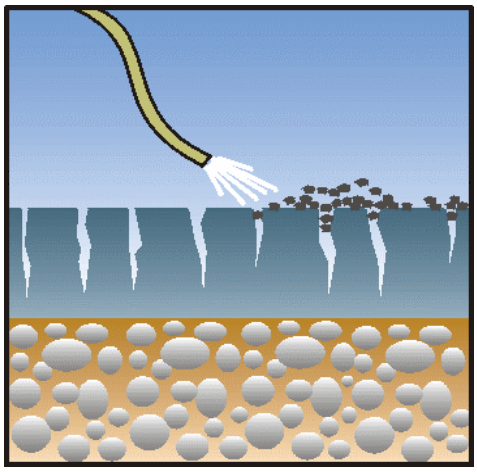
Generally, the paving fabric is installed on the cleaned, pre-treated old surface after application of the required tack coat quantity.

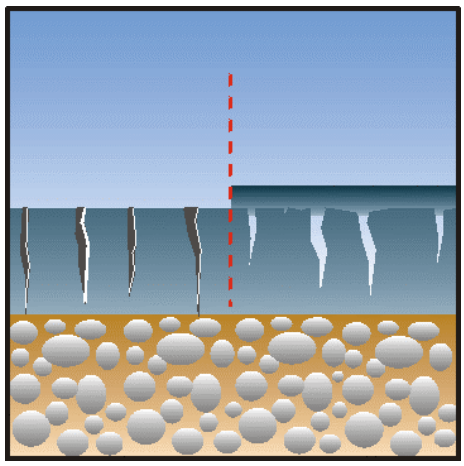
5.1. Preliminary Works

 Cleaning of surface and cracks from dirt, dust and vegetation.

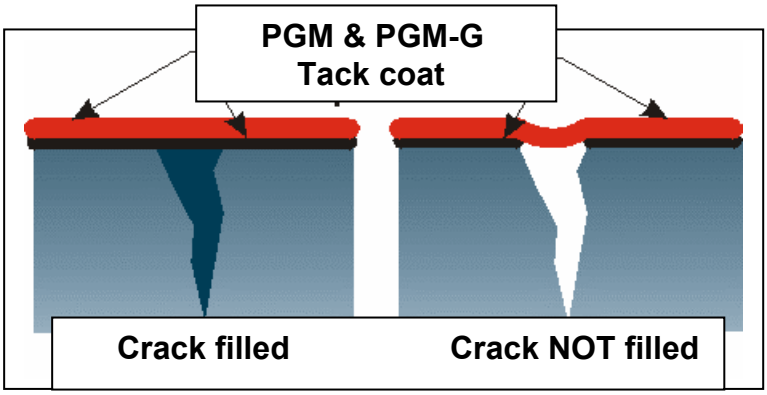
 Filling of pot holes and large cracks (wider than 4 mm) with asphalt mix or other adequate material.

 Relaxation of concrete slabs; in the case of complete damage, a levelling layer must be applied.

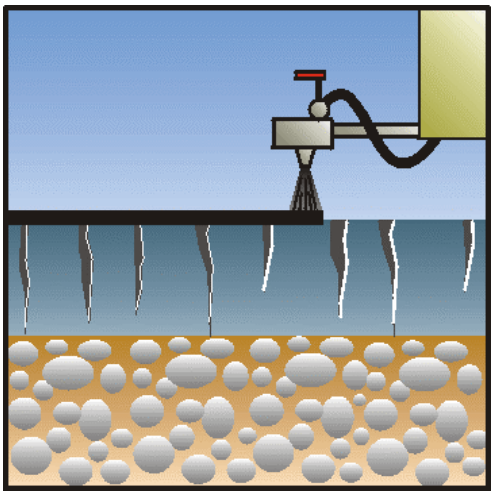




 A careful filling of cracks is of decisive importance, as the paving fabric cannot be saturated with bitumen over an unfilled crack.



5.2. Application of Tack Coat



5.2.1. Binder Quality

The correct choice of the adequate type of tack coat is the decisive parameter for the function of the geosynthetic interlayer.

In the case of thin overlays (< 40 mm) polymer-modified binders have to be used.

The quality of the binder must be such that even due to the high quantity applied (e.g. 1,9 kg/m² of a 70% emulsion) it does not run off the road or create pools.

The use of pure bitumen as tack coat offers the advantage that the whole installation procedure is only influenced to a minimal extent, as the curing needs not to be awaitened.

When an emulsion is used, it is recommended to use an improved, rapidly curing (cationic) emulsion with at least 65% of bitumen content, in order not to retard the construction procedure. Emulsions should have a viscosity as high as possible (more than 500 mPa at 40°C).

5.2.2. Binder Quantity

 Tack coat quantity with hot applied asphalt mix layers:
pure bitumen = appr. 1,3 kg/m²
≅ emulsion 65 % = appr. 2,0 kg/m²
emulsion 70 % = appr. 1,9 kg/m²

 Tack coat quantity with cold applied asphalt mix layers:
pure bitumen = appr. 1,2 kg/m²
≅ emulsion 65 % = appr. 1,8 kg/m²
emulsion 70 % = appr. 1,7 kg/m²

In the case of a cold applied overlay the tack coat quantity is splitted. Firstly, approx. 0,9 - 1,1 kg/m² emulsion is sprayed onto the road surface, into which the paving fabric is laid. After that, the rest of the tack coat is sprayed on top of the laid paving fabric. In order to guarantee the trafficability prior to the installation of the asphalt overlay, a layer of chippings is applied on top.

 Tack coat quantity with surface dressing (chip and spray):
emulsion 65 % = 1,8 kg/m²
emulsion 70 % = 1,7 kg/m²

The following increasing or decreasing factors for the quantity of pure binder should be taken into account, based on the condition of the old surface:

upper limits: + 0,10 rough, uneven concrete surface
+ 0,10 open binder layers
+ 0,10 old aged brittle asphalt concrete layers

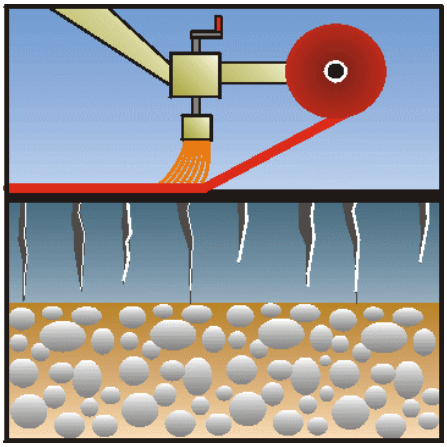
lower limits - 0,10 wearing courses
- 0,10 newly constructed roads
- 0,10 mastic asphalt
- 0,10 very smooth asphalt surfaces in hot climat areas

These factors have to be summed up; the maximum change in effective binder quantity must not be higher than + 0,20 kg/m² or lower than - 0,10 kg/m².

5.2.3. Working Procedure

 In the case of asphalt concrete the whole tack coat quantity is applied in one step
 In the case of surface dressing the tack coat quantity is splitted (see section 5.4.2.)
 The bitumen shall be sprayed evenly over the whole fabric width, with a maximum of 10 cm projecting the edge
 Only these areas shall be sprayed which will be covered with paving fabric
 No additional tack coat shall be applied on top of the laid fabric (danger of excessive tack coat, coiling up, or sliding of trucks and pavers)

5.3. Installation of TenCate Polyfelt PGM & PGM-G



Generally, the installation of paving fabric shall be done by machine. In exceptional cases, small quantities can also be laid by hand.

Special care should be taken with regard to the following aspects:

 When pure bitumen is used as tack coat, the installation of PGM & PGM-G shall be carried out immediately after spraying of the tack coat.

 When emulsions are used, the curing or partly curing has to be awaitened before PGM & PGM-G can be installed.

 Wrinkles must be avoided.

 Adjacent panels have to border each other (overlapping is not required)

 When overlaps cannot be avoided, care should be taken that the second panel is placed underneath the first one, in order to avoid a displacement during installation of the asphalt mix. In the overlap area, an additional 0,9 kg/m² effective bitumen shall be applied.

 When only one lane is installed (to allow for traffic continuity) at least 25 cm alongside the fabric shall not be covered with asphalt mix in order to allow a proper joint to the second lane.

 In the case of rain all remaining water must have been evaporated before the installation can continue.

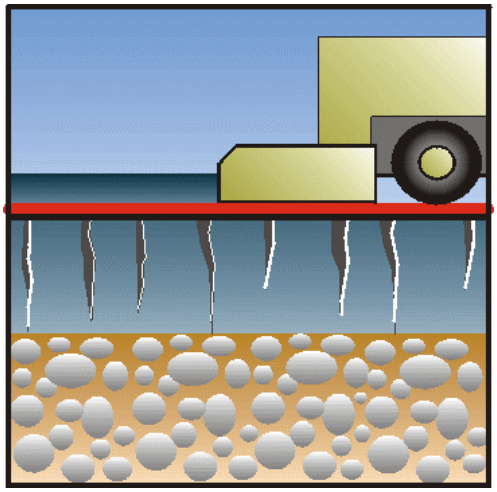
 In the case of interruption of the works, the traffic can run slowly on the laid PGM & PGM-G.

 A wrinkle-free installation shall be aimed at, as the quality of the installation is of decisive importance for the long term performance of the new overlay.

Therefore we recommend the paving fabric to be installed only by a skilled team by means of an adequate laying device.

5.4. Installation of the Road Surface

5.4.1. Asphalt Concrete



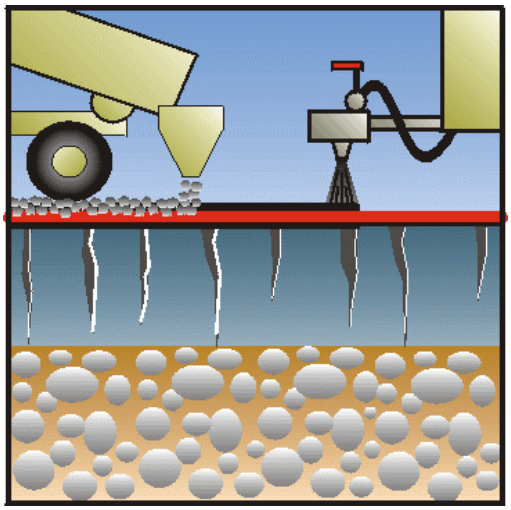
 The installation of the asphalt concrete (thickness ≥40mm) is done immediately after installation of PGM & PGM-G

 The use of crawler type pavers shall be preferred

 The temperature of the asphalt mix during installation shall be between 120°C and 165°C, depending on the thickness of the layer

 The sticking of the fabric to the tires can be avoided by spraying some asphalt mix or chippings onto the wheel tracks. This sticking can occur at high ambient temperatures or excessive tack coat quantity.

5.4.2. Surface Dressing



General installation recommendations:

 The tack coat is applied both before and after the installation of the PGM paving fabric.

 Immediately before installation of the surface treatment the whole substrate has to be cleaned carefully. The old surface shall be dry; when emulsions are used, it can be slightly damp.

 Immediately after application of the tack coat (in the case of emulsions before its curing) the chips shall be applied evenly in the required size and quantity. This shall be followed by compaction, preferably with a rubber-tired roller.

 In the case of multiple-layer surface treatments it must be assured that the binder for the second layer is fully bonded to the first layer, and no isolation layer is created by loose chips.

 After trafficking (running traffic over period of time) for 1 to max. 3 days, surplus chips shall be removed by a suitable road sweeper.

 In the case of spot maintenance the PGM paving fabric can be laid into the not cured emulsion. The surface has then to be covered with sand to allow the traffic to run over the fabric.

Recommendations with regard to the choice of materials:

 Fine grained surface treatments (2/4 mm) tend to have excessive binder.

 On roads with gradient and curves emulsions with high viscosity shall be used.

 On uneven road surfaces, on asphalts with excessive binder content and on roads with high traffic stress coarser chips shall be used.

 In the case of extreme stresses, such as a daily traffic of more than 1000 trucks or 5000 cars, special bitumen or flux binders shall be used.

Working procedure referring to standard emulsion (cold applied) used in Europe:

 Cleaning of the surface to be treated.

 Spraying of the 1. bitumen emulsion quantity (A) amounting to 0,9 - 1,0 kg/m² of a 65% emulsion (0,8 - 0,9 kg/m² of 70% emulsion) onto the area where the paving fabric shall be applied.

 The installation of the paving fabric is done after beginning of the curing process.

 Special care must be taken to lay the fabric wrinkle-free.

 Spraying of the 2. bitumen emulsion quantity (B)

 Application of the chips

<u>The emulsion quantity (B) consists of the following parts:</u>

- Part (B1) for the saturation of the paving fabric
  = appr. 0,8 - 0,9 kg/m² of 70/65% emulsion
- Part (B2) for the embedding of the chips can be read from tables provided by the emulsion manufacturers. This quantity depends on size, shape and quantity of the used chips.

Appendix

A. Facts about Bitumen

A. 1. Bitumen for Roads Construction

For roads construction, mainly soft bitumen types produced by vacuum destillation, and medium hard bitumen types produced by vacuum destillation and short oxidation, are used.

Typical grades of bitumen used for road constructions are:
B 70, B 100, B 200
PMB 60 - 90, PMB 90 - 140, PMB 130 - 230

The quality is defined by the relevant national standards.

A. 1.1. Types of Bitumen and their Application

Bitumen Emulsions
B200

Asphalt Concrete
B 200, B 100, B 70
B 100 is the standerd bitumen used for asphalt concrete. Sometimes, B 70 is used in order to achieve a higher bearing capacity. It must be considered that the designation of the bitumen indicates the quality at the point of production. However, due to transport, mixing and installation in practice the bitumen will be harder by one penetration class.

Mastic Asphalt
B 40

PMB (Polymer-Modified Bitumen)
With polymer-modified bitumen much better properties can be achieved. The difference between softening point and breaking point is considerably higher. The bitumen has higher elasticity, ageing is reduced. The softening point goes up to 80°C without getting brittle (standard bitumen appr. 60°C). The adhesion between tack coat and the stones is considerably improved.

Polymer-modified bitumen leads to
- better temperature resistance
- better fatigue resistance
- better cold temperature behaviour

of the asphalt concrete

A. 1.2. Properties

Influence of Temperature
The higher the temperature of the asphalt (in summer up to 70°C or even higher!) the more plastic and prone to deformation it will be. The lower the temperature, the more brittle and prone to cracking it will be.

Penetration
This is the penetration depth of a standardized needle with 100gr weight at 25°C during 5 seconds. The penetration will be given in 1/10 mm. The designation B 100 for example means that the mean value of penetration is 100 1/10 mm.

Penetration Index
Roads construction bitumen shall have a penetration index of approx. +0,5 to +1,0. A penetration index below 0 indicates a bitumen with high paraffine content and thus insufficient performance. A penetration index above 2,0 is an indication for blown bitumen which shall not be used in roads construction due to its proneness to cracking.

Softening Point
The softening point is measured with the „ring and ball“ test and is an indication for the viscosity. It is defined as the temperature at which a bitumen layer is deformed to a defined extent by a steel ball. The softening point is the upper limit of practical use, as above this temperature the bitumen gets increasingly liquid.

Breaking Point acc. Fraaß
This test gives an indication for the cold temperature behaviour of bitumen. It is defined as the temperature at which a bitumen film melted onto a steel sheet cracks under a defined deformation. The breaking point is the lower limit of practical use, as below that temperature the bitumen gets increasingly brittle.

Plasticity Range
Below the breaking point the bitumen gets brittle, above the softening point it will get soft and liquid. The range inbetween the two point is the plasticity range. Standard bitumen has a plasticity range of up to 60°C, polymer-modified bitumen of up to 100°C.

Ductility

The ductility corresponds to the extensability of a bitumen specimen under defined conditions. It is measured in cm. The practical relevance is low, as the penetration has a crucial effect on the results.
Of major relevance is the „force-ductility“ which also takes into account the applied forces which are necessary to reach a certain deformation.The area under the stress-strain curve is a measure for the energy which is required to tear a specimen.

Elastic Relaxation

The elastic relaxation describes the ability of bitumen to retain its initial form after being deformed (can be applied only to polymer-modified bitumen!). The values are given in %, the test procedure is equivalent to that of the ductility test. This value has a great influence on the service life time of a bituminous layer, and can only be increased by increasing the polymer content of the polymer-modified bitumen.

Bonding Behaviour

The bonding behaviour is of relevance for the ability of bitumen to create a film on the surface of the stones, and its ability to displace water. Therefore it describes the interaction between bitumen and stones. It is measured in % of covered surface area.

De-Mixing Stability

The de-mixing stability describes the stable or instable behaviour of polymer-modified bitumen during hot storage. It is measured in °C and is defined as the difference of softening points of samples taken form the top and the bottom of a tube.

A. 2. Bitumen Emulsions

Bitumen emulsions are mixtures of bitumen and a solvent. They can be distinguished with regard to the type of solvent and the pH-value. An emulsion can be processed hot or cold (depending on the type). It creates a bitumen film when it comes in contact with the chip surface, and thus „glues“ the chips together.

Generally, two types can be distinguished:
Anionic and cationic emulsions. Furthermore, it can be distinguished between stable (slowly curing) and unstable (rapidly curing) emulsions.

A. 2.1. Anionic and Cationic Emulsions

A. 2.1.1. Anionic Emulsions

In anionic bitumen emulsions, the emulsion droplets have a negative charge. Therefore, in an electrical field, the particles migrate to the anode with positive charge.

These emulsions have a negative charge and an alkaline medium as solvent. The curing process is started by the adsorption of parts of the solvent by the stone surface. The equilibrium is disturbed, thus the emulsion cures and the bitumen creates a film on the stone surface. Anionic emulsions are suitable for alkaline aggregates, such as limestone, dolomite, or basalt. Acid materials, such as quartz, granite etc. require specially improved emulsions.

A. 2.1.2. Cationic Emulsions

In cationic bitumen emulsions, the emulsion droplets have a positive charge. Therefore, in an electrical field, the particles migrate to the cathode with negative charge. They are used in conjunction with acid aggregate (quartz etc.).

These emulsions have a positive charge and an acid medium as solvent. As all stone materials (alkaline as well as acid materials) have a negative charge, the positive bitumen particles are attracted due to the electrostatic attraction. The moisture is displaced, the emulsuion cures due to the exchange of charges, and the bitumen particles stick strongly to the stone surfaces.

A. 2.2. Curing of an Emulsion

The „curing“ of the emulsion is the transition from the stable condition (bitumen droplets are evenly distributed in the solvent) to the unstable condition (the bitumen droplets coagulate, the water is displaced).

The curing process is completed by mechanical stresses (compaction!) and evaporation, which is of utmost importance for the rooads construction practice.

Alkaline aggregates such as limestone or basalt have a good absorption capability and are therefore suitable for anionic emulsions. Acid aggragates such as quartz or granite have no absorption capability, and anionic emulsions do not cure with these materials. Cationic emulsions however stick very well on the surface of the stones due to the strong negative current.

The beginnig of the transition of the emulsion from the liquid, homogenious form to the pure bitumen is calles **curing**. The bitumen then starts to coagulate and create a film, the water evaporates, until the pure bitumen remains. This process is called **setting**.

The curing behaviour is one of the most important properties of emulsions. Mostly used are emulsions which cure rapidly (so called „unstable emulsions“). These start to cure when it comes in contact with the chip surface.

A. 2.3. Bitumen used for Emulsions

Usually B 200 is used to produce bitumen emulsions. Not every crude oil basis is suitable for the destillation of a B 200 which can be used for emulsions.

In order to produce a high quality emulsion,
- the bitumen must have a good colloide stability,
- the asphalene content must not be too high,
- no „blown“ bitumen shall be used,
- the tuning of the emulsion composition shall be based on bitumen quality,
- the refinery supplying the bitumen shall not be changed without needs.

Harder bitumen types can be used for special purposes, such as for building protection or for cold applied micro-layers.

Especially polymer-modified bitumen can also be used. Special care shall be taken in the choice of the polymer-modified bitumen, and adequate laboratory testing series shall be carried out prior to the use of such bitumen.

A. 2.4. Characteristics of Emulsions for Roads Construction

PROPERTIES	TYPICAL VALUES
Binder content	40 - 70 %
Viscosity	20 - 2000 mPa.s (at 40°C)
pH - value	1 - 12
Type of charge	(anionic), cationic
Visual condition	brown, homogenious, bitumen type odour
Stability	unstable (semi stable, stable) dep. on aggregate
Curing behaviour	Curing time from 10 seconds to 5 hours
Storing resistance	4 weeks to several years
Adhesion performance	50 to 100 %
Binder recovery	B 300 to B 25, PmB
Particle size	1 to 50 µm

The viscosity of an emulsion characterizes its flowing behaviour. A low viscosity means „thin-flowing“ (such as water), a high viscosity means „thick-flowing“ (such as honey). The viscosity strongly depends on the temperature. The higher the temperature, the lower the viscosity. At 70°C almost all bitumen emulsions are thin-flowing. At lower temperatures (below 55°C) the differences become more visible. Therefore the viscosity is always referred to a standard temperature of 40°C.

Typical viscosity values for bitumen emulsions (temperature 40°C)

Product	Viscosity [mPa.s]	Run-out time 4 mm-nozzle [s]
Water	1	appr. 2
Honey, not critallized	appr. 10.000	many minutes
50 to 60 % bitumen emulsions	20 - 100	5 - 12
65 to 70 % bitumen emulsions	80 - 1500 (ideal 800 - 1000)	10 - 60
over 70 % bitumen emulsions	300 - 10.000	20 - many min.
Bitumen at softening point (ring and ball)	appr. 1. 000. 000	not measurable

B. Bituminous Base Courses

Bituminous base courses are not suitable for taking up traffic stresses permanently. However, they should be able to take up traffic for a certain period of time.

The maximum grain size depends on the thickness of the layer:

Max. grain size	Thickness of layer
16 mm	5 to 7 cm
22 mm	6 to 8 cm
32 mm	8 to 12 cm

The admissible temperatures for mixing and installation are as follows:

Bitumen type	maximum mixing temperature	minimum installation temperature
B 70	190 °C	140 °C
B 100	190 °C	130 °C
B 200	190 °C	120 °C

B. 1. Bituminous Wearing Courses

B. 1.1. Types of Bituminous Wearing Courses

Bituminous wearing courses can be distinguished as to their maximum grain size. The choice of the suitable type depends on the traffic stress: Generally, higher traffic stresses reqire coarser grain sizes. Layers with 4 to 8 mm grain size are mainly used for minor areas, such as footpaths, bicycle paths, parking lots etc.

Typical designations are: AC 4, AC 8, AC 11, AC 16, AC 22

B. 1.2. Properties

Types of bitumen:

Wearing courses			Binder courses	
			open	dense
		AC 11	BO 11	BD 11
AC 4	AC 8	AC 16	BO 16	BD 16
		AC 22	BO 22	BD 22
B 200	**B 100**	**B 100**	**B 70**	**B 70**

Maximum grain size (mm) as a function of layer thickness (mm)

Max. grain size	Asphalt concrete AC	Binder course
4 mm	20 to 30 mm	----------
8 mm	25 to 35 mm	----------
11 mm	30 to 40 mm	30 to 60 mm
16 mm	40 to 50 mm	30 to 60 mm
22 mm	50 to 80 mm	30 to 60 mm

Mixing and installation temperature

Bitumen type	maximum mixing temperature	minimum installation temperature
B 70	190 °C	140 °C
B 100	190 °C	130 °C
B 200	190 °C	120 °C

Compaction temperatures

Temperature range for compaction	80 °C - 180 °C
Starting of compaction at	appr. 160 °C - 140 °C
optimum compaction temperature at	appr. 140 °C - 100 °C
End of compaction at	appr. 100 °C - 80 °C

B. 2. Surface Dressing

Surface treatments are thin bituminous layers where the chips and the binder (bitumen) are applied to the old surface one after the other. Normal temperatures to carry out a surface treatment is above +15°C; it shall not be done at surface temperatures below +5°C.

B. 2.1. Objectives

- Protection of the road structure against penetration of surface water
- Sealing of aged road surfaces
- Increase of surface grip

B. 2.2. Construction types

a) Single surface dressing

The tack coat is sprayed evenly to the prepared surface. This is then covered by one layer of chips 4/8 or 8/11 mm and compacted by 3 to 5 passes with a rubber tired roller. After a certain traffic time surplus chips are removed by means of a road sweeper.

b) Single surface dressing with double chip layer

The tack coat is sprayed evenly to the prepared surface. Then one open layer of chips 8/11 or 11/16 mm is applied and compacted by one pass. Then the second layer of chips is applied, with a size 2/4 mm (for primary layer 8/11) or 4/8 mm (for primary layer 11/16), filling the gaps between the coarse grains of the first chip layer. By 3 to 5 compaction passes the chips are entangled. After a certain traffic time surplus chips are removed.

c) Double surface dressing

Thge double surface treatment consists of two single surface treatments with adequate chip sizes and binder quantities. Firstly, the tack coat is sprayed evenly onto the prepared surface and covered with one layer of 8/11 or 11/16 mm chips. After 3 to 5 compaction passes and a certain traffic time surplus chips are removed. The second layer is applied in a similar way, using chip sizes 2/4 or 4/8 mm. Again surplus chips are removed after 3 to 5 compaction passes and a certain traffic time.

d) Sandwich surface dressing

Firstly, a layer of chips is applied to the prepared surface and compacted. Then the tack coat is sprayed onto this chip layer, followed by the application of smaller chips.

B. 2.3. Choice of Grain Sizes

Type of surface dressing	Medium daily heavy traffic	Condition of substrate	
		Loss of material Cracks (aged, open)	Reduced surface grip
single	up to 1000	4 / 8 or 8 / 11	8 / 11
single + double chips	over 1000	8 / 11 and 2 / 4 11 / 16 and 4 / 8	11 / 16 and 4 / 8
	up to 1000	8 / 11 and 2 / 4 11 / 16 and 4 / 8	8 / 11 and 2 / 4
double	over 1000	8 / 11 and 4 / 8 (2 / 4) 11 / 16 and 4 / 8	11 / 16 to 4 / 8 (2 / 4)
	up to 1000	8 / 11 and 4 / 8 11 / 16 and 4 / 8	8 / 11 + 4 / 8 (2 / 4) 11 / 16 and 4 / 8

SPECIFICATION
OF MECHANICALLY BONDED CONTINUOUS FILAMENT NONWOVEN USED IN ROAD MAINTENANCE

Type of geocomposite: Mechanically bonded continuous filament nonwoven (TenCate Polyfelt PGM14 or equivalent)

Raw material: 100% polypropylene (UV-stabilised)

Type of fibre: uncurled, smooth, hydrophobic continuous filaments, round cross section

Quality management: Delivery of a mechanically bonded continuous filaments, nonwoven made from 100% PP, produced by a manufacturer with an **ISO 9001** certified quality management system.

1) Cleaning of the road surface, removal of debris, dust, soil, vegetation etc. by means of air jet cleaning, down to the depth of cracks, potholes and damages of all kind. If necessary, the surface has to be milled.

2) Concrete slabs must have full contact to the base course, without allowing any movement. Relaxation of slabs if required. Vertical and tilt movements have to be avoided in any case.

3) Filling of cracks, potholes and other damages, elimination of major unevenness with hot asphalt mix. Cracks wider than 4 mm must be carefully filled by hand with hot bitumen, so that a uniform even surface is achieved. In the case of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a paver is recommended.

4) Delivery and spraying of a polymer modified hot bitumen or bitumen emulsion, suitable for the use of paving felts, in a quantity 1.1 to 1.3 kg/m² effective binder content. The type of tack coat material and its quantity has to be adjusted to the present site specific and climatic conditions. Guidelines of the manufacturer of the paving fabric must be followed. The application of the tack coat has to be done by a suitable machine equipped with electronic dosage control.

5) Delivery and installation of a recyclable, mechanically bonded paving fabric made from 100% polypropylene continuous filaments, externally controlled according DIN 18200, with the following technical parameters (e.g. TenCate Polyfelt PGM14 or equivalent):

Asphalt retention	1,1	kg/m2	Texas DOT Item 3099/ ASTM D6140-97
Tensile Strength	9	KN/m	EN ISO 10319
Elongation at maximum load (MD+CD)/2	55	%	EN ISO 10319
Grab Tensile Strength	520	N	ASTM D4632
Grab Elongation	> 50	%	ASTM D4632
Thickness at 2 kN/m² load	1.1	mm	EN ISO 9863-1
Mass per unit area	140	g/m2	EN ISO 9864
Melting Point	165	°C	ASTM D276
Recycling	100	%	with conventional method

6) Internal quality control reports of the current production batch must be available on demand.

7) Recycling and cold milling suitability must be proved by an independent certificate.

8) The paving fabric must be stored along-side of the road in accordance with the manufacturer's guidelines. They must be stored under absolutely dry condition. The installation has to be carried out by trained personnel of experienced installation companies, using a suitable installation machine, without wrinkles and folds and without additional fixing measures. Installation guidelines of the manufacturer must be followed strictly.

9) When tack coat bleeds through or when tyres stick to the paving fabric, chips shall be applied on top of the paving fabric.

10) Installation of the bituminous material (binder and wearing course) is done in the conventional way. The guidelines of the manufacturer of the paving fabric must be followed. (2007/01/01)

SPECIFICATION
OF GLASS FILAMENT REINFORCED GEOCOMPOSITES
USED IN ASPHALT REINFORCEMENT

Type of geocomposite: High strength Geocomposite consisting of a mechanically bonded continuous filament nonwoven, reinforced with glass filaments (TenCate Polyfelt PGM-G 50/50 or equivalent)

Raw material: 100% polypropylene (UV-stabilised), glass filaments

Type of fibre: uncurled, smooth, hydrophobic continuous filaments, round cross section

Quality management: Delivery of a mechanically bonded continuous filaments, nonwoven made from 100% PP, reinforced with high strength glass filaments, produced by a manufacturer with an ISO 9001 certified quality management system.

1) Cleaning of the road surface, removal of debris, dust, soil, vegetation etc. by means of air jet cleaning, down to the depth of cracks, potholes and damages of all kind. If necessary, the surface has to be milled.

2) Concrete slabs must have full contact to the base course, without allowing any movement. Relaxation of slabs if required. Vertical and tilt movements have to be avoided in any case.

3) Filling of cracks, potholes and other damages, elimination of major unevenness with hot asphalt mix. Cracks wider than 4 mm must be carefully filled by hand with hot bitumen, so that a uniform even surface is achieved. In the case of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a paver is recommended.

4) Delivery and spraying of a polymer modified hot bitumen or bitumen emulsion, suitable for the use of paving Geocomposites, in a quantity 1.1 to 1.3 kg/m² effective binder content. The type of tack coat material and its quantity has to be adjusted to the present site specific and climatic conditions. Guidelines of the manufacturer of the paving Geocomposite must be followed. The application of the tack coat has to be done by a suitable machine equipped with electronic dosage control.

5) Delivery and installation of a recyclable, mechanically bonded paving Geocomposite made from 100% polypropylene continuous filaments with glass filament reinforcement, externally controlled according DIN 18200, with the following technical parameters (e.g. TenCate Polyfelt PGM-G 50/50 or equivalent):

Asphalt retention	1,1	kg/m²	Texas DOT Item 3099/ ASTM D6140-97
Tensile Strength (MD / CD)*	50/50	KN/m	ISO 3341
Elongation at break *	3	%	ISO 3341
Strength at 2% strain *	34/34	KN/m	ISO 3341
E-Modulus of the glass filaments	73.000	MPa	-
Mesh Width of the glass filaments	40 x 40	mm	-
Mass per unit area	300	g/m²	EN ISO 9864
Melting Point	Glass filaments are incombustible and temperature resistant up to 400 °C		
Recycling	100	%	with conventional method

**) The tensile strength values refer to the glass filament reinforcement*

6) Internal quality control reports of the current production batch must be available on demand.

7) Recycling and cold milling suitability must be proved by an independent certificate.

8) The paving Geocomposite must be stored along-side of the road in accordance with the manufacturer's guidelines. They must be stored under absolutely dry condition. The installation has to be carried out by trained personnel of experienced installation companies, using a suitable installation machine, without wrinkles and folds and without additional fixing measures. Installation guidelines of the manufacturer must be followed strictly.

9) When tack coat bleeds through or when tyres stick to the Geocomposite, asphalt mixture shall be sprayed on top of the Geocomposite.

10) Installation of the bituminous material (binder and wearing course) is done in the conventional way. The guidelines of the manufacturer of the paving Geocomposite must be followed.(2007/01/01)

TENCATE Polyfelt

SPECIFICATION
OF GLASS FILAMENT REINFORCED GEOCOMPOSITES
USED IN ASPHALT REINFORCEMENT

Type of geocomposite: High strength Geocomposite consisting of a mechanically bonded continuous filament nonwoven, reinforced with glass filaments (TenCate Polyfelt PGM-G 100/100 or equivalent)

Raw material: 100% polypropylene (UV-stabilised), glass filaments

Type of fibre: uncurled, smooth, hydrophobic continuous filaments, round cross section

Quality management: Delivery of a mechanically bonded continuous filaments, nonwoven made from 100% PP, reinforced with high strength glass filaments, produced by a manufacturer with an ISO 9001 certified quality management system.

1) Cleaning of the road surface, removal of debris, dust, soil, vegetation etc. by means of air jet cleaning, down to the depth of cracks, potholes and damages of all kind. If necessary, the surface has to be milled.

2) Concrete slabs must have full contact to the base course, without allowing any movement. Relaxation of slabs if required. Vertical and tilt movements have to be avoided in any case.

3) Filling of cracks, potholes and other damages, elimination of major unevenness with hot asphalt mix. Cracks wider than 4 mm must be carefully filled by hand with hot bitumen, so that a uniform even surface is achieved. In the case of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a paver is recommended.

4) Delivery and spraying of a polymer modified hot bitumen or bitumen emulsion, suitable for the use of paving felts, in a quantity 1.1 to 1.3 kg/m² effective binder content. The type of tack coat material and its quantity has to be adjusted to the present site specific and climatic conditions. Guidelines of the manufacturer of the paving composite must be followed. The application of the tack coat has to be done by a suitable machine equipped with electronic dosage control.

5) Delivery and installation of a recyclable, mechanically bonded paving composite made from 100% polypropylene continuous filaments with glass filament reinforcement, externally controlled according DIN 18200, with the following technical parameters (e.g. TenCate Polyfelt PGM-G 100/100 or equivalent):

Asphalt retention	1,1	kg/m²	Texas DOT Item 3099/ ASTM D6140-97
Tensile Strength (MD / CD) *	100/100	KN/m	ISO 3341
Elongation at break *	3	%	ISO 3341
Strength at 2% strain *	68/68	KN/m	ISO 3341
E-Modulus of the glass filaments	73.000	MPa	-
Mesh Width of the glass filaments	40 x 40	mm	-
Mass per unit area	430	g/m²	EN ISO 9864
Melting Point	Glass filaments are incombustible and temperature Resistant up to 400 °C		
Recycling	100	%	with conventional method

**) The tensile strength values refer to the glass filament reinforcement*

6) Internal quality control reports of the current production batch must be available on demand.

7) Recycling and cold milling suitability must be proved by an independent certificate.

8) The paving Geocomposite must be stored along-side of the road in accordance with the manufacturer's guidelines. They must be stored under absolutely dry condition. The installation has to be carried out by trained personnel of experienced installation companies, using a suitable installation machine, without wrinkles and folds and without additional fixing measures. Installation guidelines of the manufacturer must be followed strictly.

9) When tack coat bleeds through or when tyres stick to the Geocomposite, asphalt mixture shall be sprayed on top of the Geocomposite.

10) Installation of the bituminous material (binder and wearing course) is done in the conventional way. The guidelines of the manufacturer of the paving Geocomposite must be followed. (2007/01/01)

TENCATE Polyfelt

SPECIFICATION
OF GLASS FILAMENT REINFORCED GEOCOMPOSITES
USED IN ASPHALT REINFORCEMENT

Type of geocomposite: High strength Geocomposite consisting of a mechanically bonded continuous filament nonwoven, reinforced with glass filaments (TenCate Polyfelt PGM-G 200/200 or equivalent)

Raw material: 100% polypropylene (UV-stabilised), glass filaments

Type of fibre: uncurled, smooth, hydrophobic continuous filaments, round cross section

Quality management: Delivery of a mechanically bonded continuous filaments, nonwoven made from 100% PP, reinforced with high strength glass filaments, produced by a manufacturer with an ISO 9001 certified quality management system.

1) Cleaning of the road surface, removal of debris, dust, soil, vegetation etc. by means of air jet cleaning, down to the depth of cracks, potholes and damages of all kind. If necessary, the surface has to be milled.

2) Concrete slabs must have full contact to the base course, without allowing any movement. Relaxation of slabs if required. Vertical and tilt movements have to be avoided in any case.

3) Filling of cracks, potholes and other damages, elimination of major unevenness with hot asphalt mix. Cracks wider than 4 mm must be carefully filled by hand with hot bitumen, so that a uniform even surface is achieved. In the case of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a larger number of single cracks, application of tack coat and installation of a hot asphalt mix levelling layer by means of a paver is recommended.

4) Delivery and spraying of a polymer modified hot bitumen or bitumen emulsion, suitable for the use of paving felts, in a quantity 1.1 to 1.3 kg/m² effective binder content. The type of tack coat material and its quantity has to be adjusted to the present site specific and climatic conditions. Guidelines of the manufacturer of the paving composite must be followed. The application of the tack coat has to be done by a suitable machine equipped with electronic dosage control.

5) Delivery and installation of a recyclable, mechanically bonded paving composite made from 100% polypropylene continuous filaments with glass filament reinforcement, externally controlled according DIN 18200, with the following technical parameters (e.g. TenCate Polyfelt PGM-G 100/100 or equivalent):

Asphalt retention	1,1	kg/m²		Texas DOT Item 3099/ ASTM D6140-97
Tensile Strength (MD / CD) *	200/200	KN/m		ISO 3341
Elongation at break *	3	%		ISO 3341
Strength at 2% strain *	136/136		KN/m	ISO 3341
E-Modulus of the glass filaments	73.000	MPa		-
Mesh Width of the glass filaments	40 x 40	mm		-
Mass per unit area	495	g/m²		EN ISO 9864
Melting Point	Glass filaments are incombustible and temperature Resistant up to 400 °C			
Recycling	100	%		with conventional method

**) The tensile strength values refer to the glass filament reinforcement*

6) Internal quality control reports of the current production batch must be available on demand.

7) Recycling and cold milling suitability must be proved by an independent certificate.

8) The paving Geocomposite must be stored along-side of the road in accordance with the manufacturer's guidelines. They must be stored under absolutely dry condition. The installation has to be carried out by trained personnel of experienced installation companies, using a suitable installation machine, without wrinkles and folds and without additional fixing measures. Installation guidelines of the manufacturer must be followed strictly.

9) When tack coat bleeds through or when tyres stick to the Geocomposite, asphalt mixture shall be sprayed on top of the Geocomposite.

10) Installation of the bituminous material (binder and wearing course) is done in the conventional way. The guidelines of the manufacturer of the paving Geocomposite must be followed. (2007/01/01)