DESIGN AND EXECUTION OF FLEXIBLE PAVEMENT REHABILITATION USING REINFORCING INTERLAYER

CONTENT

1 INTRODUCTION

The objective of planning and designing maintenance and repairs is to maintain or improve the reliability of pavements in road networks (hereinafter referred to as roads) and airports while optimizing social costs.

The document summarizes the key principles for the use of fiberglass asphalt reinforcement in the construction, repair of roads and traffic areas. Defines the key conditions and needed steps to meet the objective required by road administrators, as well as organizations and persons ensuring the assessment and design of road maintenance or repairs, processing construction documentation and performing maintenance or repair. This document summarizes and updates the existing available technical background (European harmonize standards, BSI, ASTM, technical guidelines) with more than 35 years of experience of paving grids and composites worldwide.

In the case of unprofessional design and integration into the pavement structure, there is a risk of issues caused by unsatisfactory bound of layers, and therefore a reduction in the service life of the pavement can be expected. To achieve the required design goals, it defines the selection conditions, the necessary product specifications, the conditions for implementation on site and final quality control on site.

2 CATALOGUE OF SOLUTIONS

Repair type	Possible origin	Repair process	Recommended reinforcement	Cross section including specification and installation process	Application example
Repair of a larger surface area > 500 m2 AREA-WIDE REPAIR	 Block cracking  Reflective cracking  Thermal cross cracking  Alligator cracking  Thermal longitudinal cracking	**Milled surface** 1. Wearing course replacement 2.* wearing + binder courses replacement	**Composite reinforcement grid** KEY BENEFITS: The geocomposite contains an ultra-light non-woven which, after emulsion retention, ensures fixation to the surface and the subsequent required bonding of the asphalt layers.	Minor Country Road - wearing cou Regional Roads - binder course Highways - binder course	
		Smooth/even surface 1. Wearing course replacement 2.* wearing + binder courses replacement	**Self-adhesive reinforcement grid** KEY BENEFITS: The self-adhesive layer ensures very quick and effective fixation to the surface without the use of nails or other anchor elements. It resists to damage and peeling off during truck driving over.	Minor Country Road - wearing cou Regional Roads - binder course Highways - binder course	

2* - Recommendation for high traffic load roads (1st class roads, motorways, highways)

FIGURE 1: Solution for area-wide repairs

Repair type	Possible origin	Repair process	Recommended reinforcement	Cross section including specification and installation process	Application example
Line widening & edge break	 Reflective cracking in the joint area of line widening  Edge break cracking	**Milled or combination of milled and new surface** 1. Wearing course replacement 2.* wearing + binder courses replacement	**Composite reinforcement grid** KEY BENEFITS: The geocomposite contains an ultra-light non-woven which, after emulsion retention, ensures fixation to the surface and the subsequent required bonding of the asphalt layers.	Minor Country Road - wearing cou Regional Roads- binder course Highways - binder course	
			Self-adhesive composite reinforcement grid with bitumen layer KEY BENEFITS: The self-adhesive layer ensures fast application and strong fixation to the surface and replacement of tack coat. This reduces the number of technological steps and technicians on site. The composite is covered by the sand on the top to resist to damage and peeling off during construction truck driving over. The composite is suitable for all surfaces.	Minor Country Road - wearing cou	

2* - Recommendation for high traffic load roads (1st class roads, motorways, highways)

FIGURE 2: Solution for line widening and edge break

Repair type	Possible origin	Repair process	Recommended reinforcement	Cross section including specification and installation process	Application example
Local repair	 Utility trench cracking	**All surface types** 1. Wearing course replacement 2.* wearing + binder courses replacement	**Self-adhesive composite reinforcement grid with bitumen layer** KEY BENEFITS: The self-adhesive layer ensures fast application and strong fixation to the surface and replacement of tack coat. This reduces the number of technological steps and technicians on site. The composite is covered by the sand on the top to resist to damage and peeling off during construction truck driving over. The composite is suitable for all surfaces.	Minor Country Road - wearing cou Regional Roads - binder course Highways - binder course	
	 Concrete joints cracking				
	 Local cracking/potholes				

2* - Recommendation for high traffic load roads (1st class roads, motorways, highways)

FIGURE 3: Solution for local repairs

3 BENEFITS

Paving grids and composites are used in pavement repair to prevent and slow down the development of reflective, shrinkage and fatigue cracks as well as cracks propagating after connecting new and old pavement structure (e.g., in pavement widening), when repairing sunken pavement edges (in the renovation and reinforcement of overlays) and possibly to reduce the formation of permanent deformations (transverse and longitudinal unevenness in the vehicle path). In the above-mentioned cases, it is possible to increase the service life of the surface courses by using fiberglass asphalt reinforcement. Application of high strength paving grids and composites leads to the so-called stiffening of the structure. Thanks to this, the overall service life of the designed structure is also positively affected, more traffic can be handled by such structure with reinforcement than traditional structure with no reinforcement.

Based on 35+ years of experience with manufacturing, design, and installations worldwide, fiberglass reinforcement extends the service life of structures 2-3 times and saves up to 50% in maintenance and repairs (maintenance, repairs, additional investments) over the entire pavement lifecycle.

Reinforcement effect - stress reduction in the area of cracks, joints

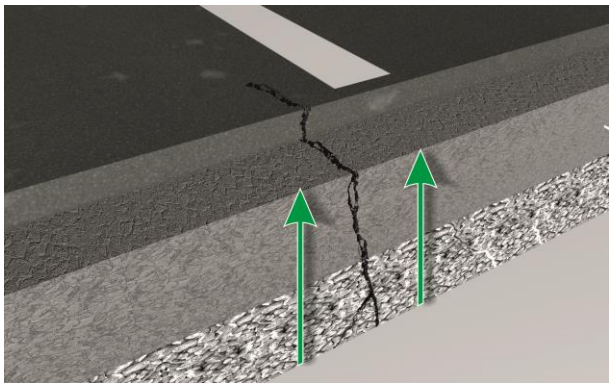

FIGURE 4: Crack propagation in an unreinforced pavement structure

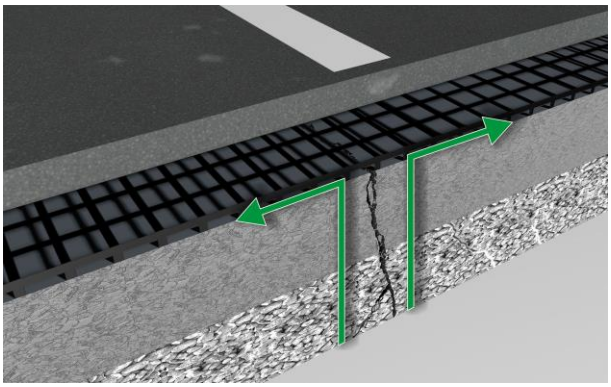

FIGURE 5: Crack mitigation in a reinforced pavement structure

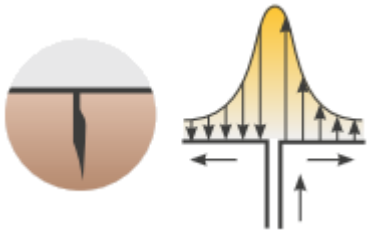

FIGURE 6: Stress at the crack location in an unreinforced pavement structure

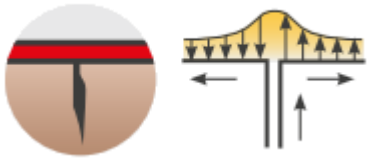

FIGURE 7: Stress reduction at the crack location in a reinforced pavement structure

Reinforcement of asphalt layers can be used during the repair of flexible and semi-rigid pavements. In asphalt layers, the reinforcement helps to reduce a tension, as well as a stress caused by a traffic and temperature changes. Fiberglass paving grids and composites are laid between asphalt layers where contribute to reflective crack mitigation. Are commonly used:

- as a full-area solution covering asphalt pavement with cracks caused by an asphalt ageing, usually only with the paving over a minimum as wearing course,
- to cover transverse or longitudinal cracks,
- to bridge different pavement structures (e.g., when connecting new and old parts of pavements, when widening pavements, local pavement repairs, overlapping excavations and ditches, etc.),

- to reduce cracks at the edges of pavements (the fiberglass grid or the composite does not prevent a possible sinking of the pavement edge, but prevents cracks in the wearing course),
- for the preventive reduction of reflective cracks from cement-bonded layers to the first levelling thin asphalt layer,
- for installation on the first levelling thin asphalt layer absorbing stress in the area of the load on the joint of cement-concrete overlays caused by a traffic, a shrinkage, and an expansion of cement-concrete slabs.

Service life:

1. A reduction and slower propagation of cracks through rehabilitated asphalt layers and, as a result, prolonging of the service life 2-3 times.
2. A reduction of future investments in repairs and an additional maintenance up to 50% (repair of cracks, a replacement of overlay layers)
3. Additional protection against water penetration into pavement layers and improved a drainage by up to 10%.
4. Helps to reduce rutting by up to 25% compared to unreinforced layers.
5. Thanks to the additional reinforcement of the asphalt layers, the fatigue characteristics of the layers are improved by up to 60% depending on the reinforcement type used.

Reusability and Environment

1. Up to 5 times higher resistance to the crack propagation in new layers consisting of recycled asphalt with glass fibres.
2. Easy milling of glass fibres.
3. Thermal and chemical stability.
4. Reduction of CO_2 emissions thanks to the increased service life of pavements.

With regards to the benefits and the fact that in most cases, these construction issues cannot be solved by other alternative methods at the same volume of work without a major overhaul of the pavement structure. The requirement of Technical and economical comparison of alternative solutions with reinforcement is fulfilled:

„The alternative pavement must have similar or better performance and the total cost of its construction, maintenance and repair, including the costs of pavement users arising from the traffic closures required by maintenance and repair works in the analysed period "

Reinforcement benefits – Prevention or reduction of:

FIGURE 8: Reflective cracks from PPC

FIGURE 9: Reflective cracks caused by temperature changes

FIGURE 10: Reflective cracks from dilatations

FIGURE 11: Cracks caused by unstable subsoil - excavations, trenches

FIGURE 12: Cracks due to unstable subsoil

FIGURE 13: Interlacing fractures due to structural changes

4 TERMS AND DEFINITIONS

4.1 PAVING GRID

Self-adhesive grid **Figure 14** is fiberglass paving grid made of knitted strands of glass fibres, with protective coating protecting the grid from damage during the installation and laying of asphalt mixtures. According to EN15381 provide reinforcing function (R), stresses are absorbed and distributed by the reinforcement ribs.
The fixation of the grid on the surface of the asphalt layer is ensured by adhesion activated by pressure on the grid. The adhesive component is factory manufactured part of the product - grid.

FIGURE 14: Self-adhesive grid

4.2 PAVING COMPOSITE

Paving composite **Figure 15** used in pavement construction is a composite material consisting of fiberglass grid and lightweight non-woven fabric (≤ 40g/m2). The grid has a protective coating and is laminated to the non-woven fabric. The glass fibre grid is designed to absorb horizontal forces in the pavement structure and the binder-saturated geotextile allows application with subsequent adhesion to the milled or uneven existing surface. The composite provides reinforcing (R) function.

FIGURE 15: Composite

4.3 PAVING PATCH

Paving reinforcement patch **Figure 16** used in pavement construction is a composite material consisting of a grid and geotextile saturated with highly polymer modified bitumen. The glass fibre grid is designed to absorb horizontal forces in the pavement structure and the asphalt pre-saturated geotextile allows the installation and consequent adhesion to any surface. As having maximum 1000g/m2 of PMB modified bitumen it allows speed up construction time allowing paving of top of new asphalt concrete layer. Such reducing pavement time as no additional emulsion or bitumen is needed for interlayer installation and bond. Is specify design for cement concrete pavements (joint repair) and detail repair of cracks. The paving sheet provides reinforcing (R), stress relief (STR) and interlayer barrier (B) functions.

FIGURE 16: Paving patch

5 FIBERGLASS REINFORCEMENT QUALITY

The reinforcing intermediate layer consists of a fiberglass paving grid knitted from high-strength glass fibres, coated with a thermally stable elastomeric polymer, which withstands high temperatures when laying asphalt layers. The fabric and the coating provide the necessary rigidity and load-bearing capacity in the structure. They also protect against damage during installation, loading by construction machines and asphalt layer laying. Also, the coating resists the effect of melting with the hot asphalt mixture and is not subject to damage during compaction. The reinforcement applied in asphalt layers must be harmless to the environment, with demonstrable tests for recyclability at the end of the service life of the structure.

5.1 CRACKING BENEFIT

The objective of this research [- 1] was to evaluate the effect of the reinforcement by a fiberglass grid with tensile strength 100 – 100 kN/m on the performance of a new flexible pavement, with a relatively thin bituminous wearing course (80 mm). For that purpose, one reinforced pavement section, and one reference section, without reinforcement, have been tested on the IFSTTAR accelerated pavement testing facility **Figure 17**. They were submitted to a traffic consisting of 1 million

FIGURE 17: Accelerated load test

dual wheel 65 kN load cycles (representing the French standard axle load), and then 200 000 additional cycles, with loads increased to 70 kN. The conclusions of the study indicate a very positive effect of the fibreglass grid on the resistance to cracking of flexible pavements, **Figure 18**.

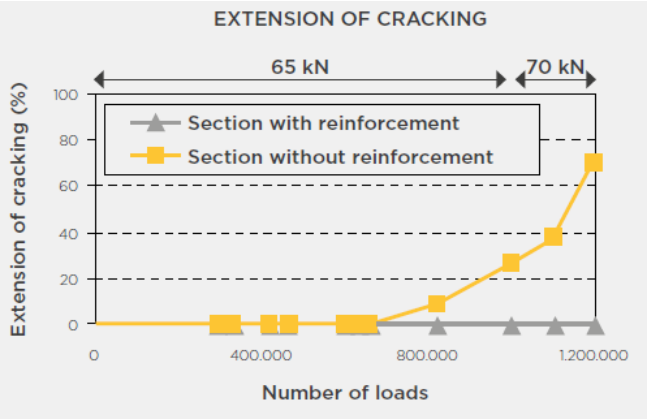

FIGURE 18: Crack propagation during accelerated load test

- **Cracking appeared first on section without grid after 800 000 cycles. At the end, 70% of the section was cracked, Figure 19**
- **Section with grid presents no cracking until the end of the test (1,2 M cycles), Figure 20**

FIGURE 19: non-reinforced section after test

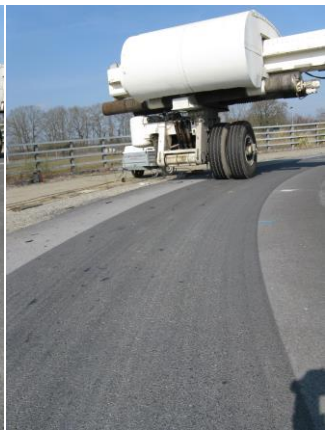

FIGURE 20: Reinforced section after test

5.2 STRUCTURAL BENEFIT

Aim of the test is quantifying the benefit of reinforced bituminous layer on the structural performance [1- 2]. In general, the fatigue is an accumulation of damage in a material under the action of repeated stress, leading to cracking of the material. Pavement cracking layers is the main mode of degradation.

Tests were performed on beams of non-reinforced asphalt concrete (NR) and reinforced by a fiberglass reinforcement using a fatigue press, specially designed for this study while respecting European standards. Results are summarized in **Figure 21**.

	Without reinforcement	With reinforcement
Allowable stress ε6	113	124,7
Traffic PL/Hour	143 468	233 161
Increase in service life in %	0	+ 61,5 %

FIGURE 21: Quantified benefit of fiberglass reinforcement interlayer

Result of the test verified that fiberglass reinforcement grid in the bituminous concrete structure increases the value of epsilon6 (ε6) from 7,5% to 12,3% (average 10%) compared to the initial value of beam without grid.

For the assumptions, the life of BBSG / fiberglass grid complex is increased by about 60%. Allowing 60% more traffic pass on the reinforced section compared to standard solution.

5.3 GUARANTEED TENSILE STRENGTH AFTER APPLICATION AND PAVEMENT

Fiberglass reinforcement with thermal stable elastomer polymer coating underwent a test by the dynamic load in accordance with the test method EN ISO 10722:2020 which simulates damage and tensile strength loss of reinforcement during installation and paving. The test [· 3] results show that polymer coating used for protection of glass fibres has very positive effect on the damage behaviour. Test results in the **Figure 22** show that significantly higher tensile strength of elastomeric polymer coated reinforcement were determined in comparison with non-coated or bitumen coated reinforcement after testing. **The damage test proves effectiveness of thermal stable polymer coating and confirms resistance of ADFORS GlasGrid® against damage during installation and paving.**

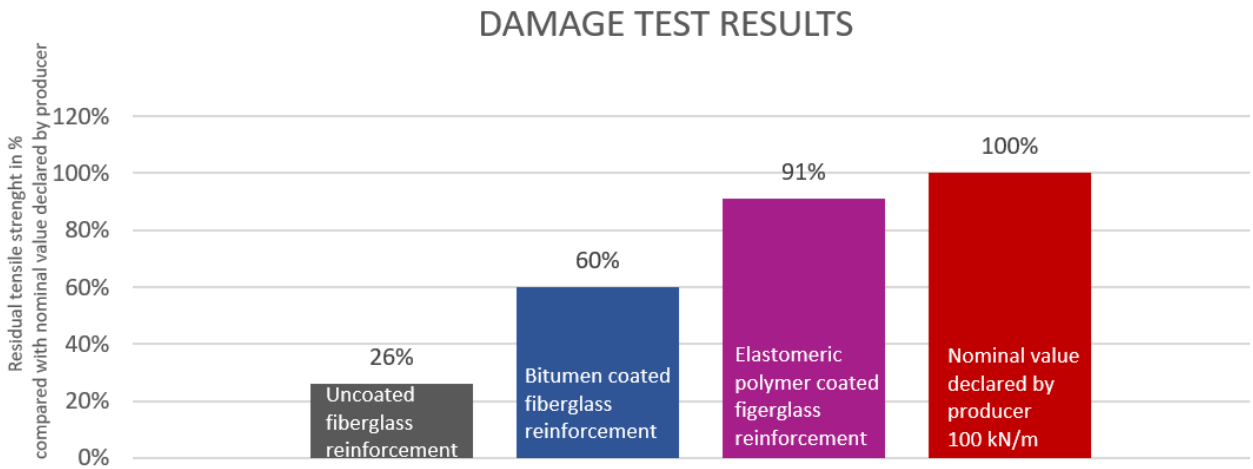

FIGURE 22: Damage test result

5.4 ALKALI RESISTANCE ALLOWING APPLICATION ON CONCRETE EN 12960:2021(EN 14030)

All region norms and standards in Europe and Worldwide set procedures and process to eliminate alkali reaction in cement-based layers (aggregate, binder, additives requirements). Several standards depending on technique for cement-based layers needs to be used.

Requirements for reinforcement used in Asphalt interlayers mentioning specifically in standard EN 15381:

A. Data on the alkaline resistance is needed for all functions if the product is to be used **in direct contact with an unprotected fresh concrete or cement stabilized surface with pH > 9**.
B. This requirement is defined in standard as **S: relevant to specific conditions of use**.
C. Geotextile or geotextile-related product **exposed to fresh concrete** or a cement stabilized surface **with pH > 9** shall include testing according to EN ISO 12960:2021 (replaced EN 14030). **The percentage retained strength shall be greater than 50%.**

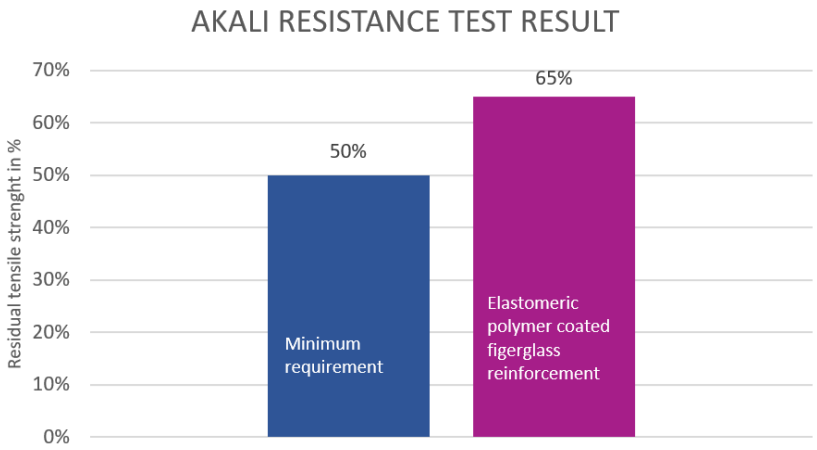

FIGURE 23: Alkali resistance test result

The test for determination of the resistance to alkaline [-4] approved effectiveness of thermal stable polymer coating and that every component of the geogrid matrix is inert in the environment with pH > 9.

5.5 WEATHER & ENVIRONMENT

All geotextiles shall pass the accelerated weathering test unless they are to be covered on the day of installation. The tensile strength retained at the end of this test will determine the length of the time that the material may be exposed on construction site. Fiberglass reinforcement with thermal stable elastomer polymer coating was tested in accordance with test method EN 12224 and achieve very high tensile strength after exposure QUV, see result in the **Figure 24 .**[-4]

The test for determination of the resistance to weathering approved effectiveness of thermal stable polymer coating and that every component of the geogrid matrix is stabilized against ultraviolet degradation.

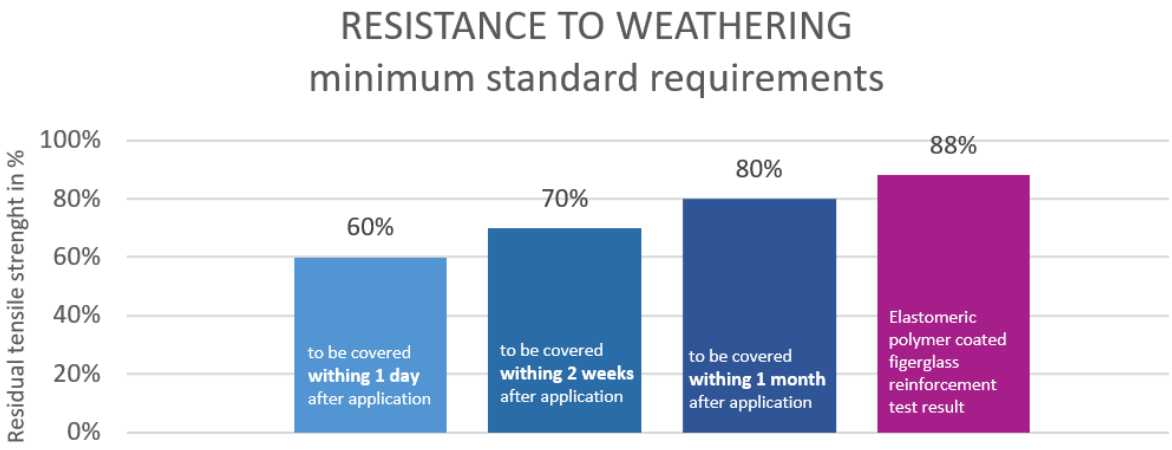

FIGURE 24: Minimum standard requirements & polymer coated fiberglass reinforcement test result

5.6 MILLING & CO2 REDUCTION

Milling performance of elastomeric polymer coated fiberglass reinforcement with 200 kN tensile strength was tested in RWTH Aachen University [1-5]. The reinforcement was installed on an existing binder course AC 16 B S and covered with 4cm thick top layer SMA 8 S. The upper part of the binder course including the reinforcement grid were picked up by the milling machine in a single step. No adverse effects were realized, and milling depth was not affected (see **FIGURE 26 - FIGURE 25**). A second test, the Cycling Tension test, concluded that the partial reuse of milled asphalt granulates (including glass fibres) in a new asphalt mixture improved the fatigue behaviour of the recycled asphalt. Both results confirm positive behaviour of the glass fibre grid with elastomeric polymer coating during milling and recycling.

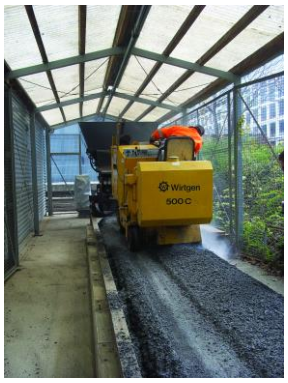

FIGURE 26: Milling process

FIGURE 26: Milling drum with drilling bits after the milling operation

FIGURE 25: Milled material with glass fibre

6 INSTALLATION

Local conditions must be followed. In European union superior standard is EN15381 overseeing all local technical guidelines and recommendations.

6.1 ROAD PREPARATION

A. Store and transport the product in original packaging in dry, dust and dirt-free environment at temperatures between -30 °C and +80 °C.
B. The actual condition of the surface must be assessed, and all the necessary repairs must be carried out in accordance maintenance guidelines.
C. Seal potholes, cracks in the range from 3 mm to 6 mm in an acceptable way according to the type of the defect.
D. Level any unevenness and ensure that the surface is clean and dry.
E. Before the installation of the paving grid, the surface must be mechanically cleaned by sweeping and vacuuming; it must be free of oil or greasy stains, water, vegetation, sand, dust, soil, and other impurities.
F. The temperature of the road surface when installing the paving grid shell be in the range from 5 °C to 40 °C and in accordance with the temperature range specified for laying the asphalt layers.
G. Paving grid/composite shall not be installed, if the defects have not been rectified or it is raining, and the rain doesn't stop when laying the asphalt overlay.

6.2 GENERAL CONDITIONS FOR APPLICATION

A. The application must be performed by a person, or a company trained and certified by the supplier.
B. The installation must be performed according to the manufacturer's installation instructions.

C. The paving grid/composite must be applied in a plane without waves and creases. A broom can be used to press and smooth the surface. In sharp bends, the reinforcement should be cut, and the overlapping belt fold must be folded in the direction of travel of the finisher (shingle overlap system).
D. The connection of the ends of the rolls must overlap by at minimum 50 mm and maximum 200 mm, the overlap of the grid strips on the sides must be at minimum 50 mm and maximum 200 mm, unless otherwise specified by the manufacturer.
E. Paving grids / composite can be laid over sewers, drains etc. After laying, this part must be cut out.
F. Wrinkles with risk of multiple lapping should be cut to ensure the correct position of reinforcement without additional lapping. These wrinkles cannot be simply removed by pressing down by asphalt mix to the surface.
G. Before laying the overlay, only construction and rescue vehicles at speeds of up to 20 km/h may cross the paving grids /composite. If damage occurs due to the movement of vehicles, remove and replace the damaged sections with new ones according to the manufacturer's recommendations.
H. After volatilization of the emulsion, lay the asphalt overlay.
I. The paving grid/composite must be covered with an asphalt overlay in accordance with producer installation instructions, recommended is within 24 hours of application.
J. If necessary, apply a thin layer of asphalt or finely ground aggregate to prevent the transfer and sticking of sprayed bonding to the construction machinery tires.
K. **The minimum thickness of the overlay** above the grid paving grids/composite grids is 40 mm, i.e., with regard to the unevenness of the sublayers a design thickness of the wearing course of 50 mm is recommended in case of pavement repairs.

6.3 APPLICATION TO A SMOOTH/EVEN SURFACE

Self-adhesive asphalt reinforcement shall be applied to a flat new surface or only slightly damaged existing surface without the need for sprayed bonding and other anchoring elements. Road surface must be dry, clean, and dust-free with temperature 5 ° – 40 °C. The adhesive layer is used to fix paving grid to the surface. A self-adhesive layer on the underside of the paving grid must be laid down. The adhesive function shall be activated by pressure - e.g., by a roller. The adhesion test must be carried out immediately after application. Test the adhesion of the grid to the surface with a pull off the hook measurement attached below the junction of the glued grid. The result ≥90 N must be achieved. A value of ≥90 N ensures that the installed grid does not move/skid and is safe for construction equipment to move over the applied grid. After laying the paving grid, the sprayed emulsion/bond coat is applied only in the design amount to ensure the connection of the asphalt concrete layers. The amount of the sprayed emulsion is recommended in **TABLE 1**. That means at least 0.3 kg/m^2 of residual bitumen to fill the asphalt structure and the installed grid. The overlay shell be applied after emulsion is fully cured. Minimum thickness of the overlay is 40 mm after compaction.

6.4 APPLICATION TO A MILLED SURFACE

The composite grids shell be applied primarily to the milled surface with a coarser structure up to 8 mm height of the recess created by the milling machine. For this purpose, the reinforcements have a light nonwoven fabric on the underside which works as bonding layer after emulsion saturation and curing. Road surface must be dry, clean, and dust-free with temperature 5 ° – 40 °C. The composite grids shell be applied immediately following spraying of emulsion and be pressed by brooms to achieve appropriate saturation of emulsion. The dosing of the sprayed emulsion must be according to **TABLE 1.** That means at least 0.6 kg/m^2 of residual bitumen to fill the asphalt structure and saturate the fabric. The adhesion test must be carried out after emulsion is fully cured. Test the adhesion of the grid to the surface with a pull off the hook measurement attached below the junction of the glued grid. The result ≥90 N must be achieved. A value of ≥90 N ensures that the installed composite does not move/skid and is safe for construction equipment to move over the applied composite. The overlay shell be applied after emulsion is fully cured. Minimum thickness of the overlay is 40 mm after compaction.

6.5 ANCHORING LENGTH

Because of the tensile load of fiberglass paving grids, a requirement for anchoring length of min. 0,5m is recommended. That means that a single crack shall be covered by a grid sheet of min 1m width.

6.6 ASPHALT BINDER

The key parameter for the installation of paving grids and composites is not only the product selection but also the type and quantity of finally applied emulsion (asphalt binder) required for laying or additional bonding of asphalt layers. Modified cationic asphalt emulsions meeting the requirements listed in EN 13808 is recommended.

- Breaking class: ≥ 3
- Binder content: ≥ 65 %

The dosage of the sprayed material depends on the texture and void content of the base course, the quantity of binder on the base course surface, as well as binder and void content of the subsequently applied asphalt layer. The residual content of asphalt binder for laying of reinforcement is listed in **TABLE 1.**

		GRIDS Self-adhesive	Composite Grid	Fast repair
Adfors GlasGrid interlayer		**GG**	**CGL**	**RAPID**
Interlayer function		R	R	R/STR/B
Installation surface	**Well milled surface**	Not recommended use, adapted installation procedure must be considered	0,6-0,8 *kg/m²*	No need
	Very poorly milled surface		0,8-1 *kg/m²*	No need
	Current heavily oxidized surface	0,4-0,6 *kg/m²*	0,4-0,6 *kg/m²*	No need
	New surface	0,3-0,5 *kg/m²*	0,3-0,5 *kg/m²*	No need

TABLE 1: Residual binder recommendation

6.7 PROTECTIVE LAYER

Protective layers enable the laying of the asphalt concrete layers. The following can be used as a protective layer:

- Crushed aggregates according to EN 13043, with fraction and dosage depending on the binder dosage are specified in Chyba! Nenalezen zdroj odkazů.**TABLE 2**.

Aggregate fraction	Binder content (kg/m²)	Aggregate dosage (kg/m²)
2 - 4	2	4 -5
4 - 8	3	Approx. 5
8 - 11	3	Approx. 8

TABLE 2: Dosing of crushed aggregates in the protective layer

6.8 ADHESION TEST

A. Place 1 m² of self-adhesive fiberglass paving grid or composite with the necessary sprayed emulsion on the asphalt layer that represents the base for the installation.
B. Activate the adhesion of the self-adhesive fiberglass paving grid by a road roller. In the case of a composite placed in a fresh sprayed emulsion (according to the type and amount of emulsion as in 0) wait for complete volatilization of the emulsion.
C. Use a calibrated spring load cell (or hanging scale) and slide the load cell hook below the centre of the junction of the grid strands.
D. When measuring, the measuring person stands at a sufficient distance from the inserted hook and pulls vertically upwards until the grid or composite begins to detach from the surface of the asphalt layer.
E. Note the measurement result in N (in kg in the case of a balance).

F. If the result is 9kN (approx. 9.17 kg) or more, the required adhesion value is met, and the laying of the self-adhesive grid or composite can continue. If the result is less than 9 kN, do not proceed with the installation of the grid without taking appropriate measures (e.g. cleaning the surface). In case of unsatisfactory adhesion of the composite, the type, dosage, and volatilization time of the emulsion must be verified.
G. If even after the measures taken, the self-adhesive grid does not achieve the required adhesion, the product cannot be assessed as self-adhesive and must be replaced by a functional product.
H. The test shall also be performed as a control test on min. each 500 m^2 of the grid or composite laid. Before covering with the asphalt mixture, the adhesion value from any of the tests must not be lower than the specified required values.

6.9 INSTALLATION WORK SUPPLIER

The Contractor must demonstrate experience in the application of coatings, sprays, flexible asphalt sheets, grouting of joints, laying of reinforcing inserts and elements, and laying of asphalt mixtures in road construction. Building materials and products are used in accordance with the provisions of the relevant EN standards, technical quality specifications and regulations. Before starting work, the contractor must prove the competence of workers and machinery. The work must be carried out by experienced and responsible personnel who has been trained and instructed in the used technology. Machinery and vehicles must be in good technical condition.

7 SUPPLIER

The supplier of paving grids and composites must provide:

A. Documented 5 projects with the application of fiberglass paving grids and composites in asphalt layers of the appropriate size and scope.
B. Documented 5 projects with at least three years of service life.
C. History of at least 2 years of production of the final product, including records of the program of established and applied quality control to ensure a product with consistent compliance with the parameters of the specification.
D. Valid manufacturer´s certificates and documents: certificate of conformity of production control, declaration of performance, installation, handling and storage recommendations, test reports from external laboratory for validation of declared values, ISO 14001:2015, ISO 9001:2015, ISO 50001:2018 certificates of approval.
E. Based on an agreement between the responsible persons representing the investor, the contractor and the supplier, the supplier shall provide sufficient material to prepare two samples of fiberglass paving grid/composite. Each sample must have the dimensions of min. 300mm x 200mm and contain a minimum of 5 ribs in both directions.
F. Additional information requested by persons representing the investor for a full assessment of the suitability of the reinforcing system.

8 PRODUCT CONFORMITY

A. The product must be certified according to EN 15381:2008 and manufactured in company facilities with an approved management system according to ISO 9001, ISO 14001, ISO 50001 standards.
B. Each roll shall be visibly labelled with a label indicating the minimum average values and product properties in accordance with EN 15381:2008, including test methods and Certificate of conformity of the factory production control number.
C. For positive identification of the product on site in accordance with EN ISO 10320, reinforcing grids and composites shall be marked directly on the product to identify the type of reinforcement even if the product is no longer in its original labelled packaging. The marking of geogrids and composites shall be made every minimum 5 metres.

9 DESIGN

Fiberglass reinforcement must be always covered by asphalt concrete layer. Two options are possible in use:

- **Flexible pavement** – pavement structure with asphalt surface course on base courses of asphalt-bonded or unbounded materials.
- **Semi-rigid pavement** - pavement structure with asphalt layers on hydraulically bonded base courses.

The disadvantage of flexible and semi-rigid pavement structures is the formation of cracks. The quantity and depth of these cracks depend on the age of the pavement, the traffic load, climatic conditions, type and strength characteristics of the materials of individual structural layers, especially in the hydraulic binder of the bonded layer. It is necessary to treat or repair cracks as soon as possible after their occurrence to prevent the penetration of water and dirt into the base layers leading to reduction of the service life of the pavement structure as a system. Failure to treat and/or improper treatment of the cracks will result in gradual damage or destruction of the individual pavement layers. Adverse effects of rainwater are further enhanced by the traffic load. In winter, due to negative temperatures (freezing of the water present around the crack), the edges of the crack are lifted and broken, especially in lanes with heavy traffic loads.

- Self-adhesive paving grids are installed on the existing surface made of asphalt mixture or on the levelling, binder, or base courses according to the type of load the asphalt layers are exposed to.

- Composite grids are applied primarily on the milled surface of an asphalt layer with a structure up to 8 mm height of the milling cuts created by the milling machine.

- Self-adhesive paving patch with build in bitumen layer is used for any type of surface. Specifically design for detail or small area repairs. Due to bitumen layer secures rapid easy to do installation in harsh weather. Specifically protecting cement concrete joints, road widening joints, pavement connections (old and new road) as due to B – barrier function limits water and gas penetration.

The minimum thickness of the overlay above the grid paving grids/composite grids is 40 mm, i.e. with regard to the unevenness of the sublayers a design thickness of the wearing course of 50 mm is recommended in case of pavement repairs.

9.1 PRODUCT SPECIFICATION

For the necessary definition of the parameters of fiberglass paving grids, composites, and sheets. Such specification defines technical parameters of the asphalt reinforcement and secures its quality and final performance in the construction. The specifications of the reinforcement product and boundary conditions must be kept. Chose on of the option from sections 9.1.1or 0 or 9.1.3. ***Either copy Bold text or Table.***

9.1.1 *SELF-ADHESIVE REINFORCEMENT*

Asphalt interlayer shall be composed of high strength glass filament yarns knitted into a grid with ≥100x100kN/m. C**oated with a thermal stable elastomeric polymer with melting point >220°C. Shall ensure protection against damage during installation, under trafficking and paving ≥80% and resist to melt under hot asphalt mix compaction. Product shall be self-adhesive with product adhesion ≥150N in accordance with EN 13596 allowing interlayer installation on asphalt surface without addition of tack coat or any other installation aid. Bond to surface after installation and adhesive layer activation shall be verified on site ≥90N. Asphalt interlayer shall be alkali resistant > 60%, tested and proven environmental harmless and remain recyclable after life cycle.**

Can be used GlasGrid GG100 or alternative.

Self-adhesive reinforcement tender specification			
Parameters	**Value**		**Standard**
Mesh size (centre to centre)	≥25 x 25	mm	
Melting point of grid protective coating	> 220	°C	EN ISO 3146 (ASTM E276)
Tensile strength (MD x CMD)	≥ 100 x 100	kN/m	EN ISO 10319
Tensile strength at 2 % elongation	≥ 75 x 75	kN/m	EN ISO 10319
Tensile elongation (MD x CMD)	≤ 3 x 3	%	EN ISO 10319
Adhesion to the surface	≥ 150	N	EN 13596
Residual strength after installation damage test	≥ 80	%	EN ISO 10722
Alkali Resistance, %	YES > 60%		EN 14030

9.1.2 *COMPOSITE REINFORCEMENT*

Asphalt interlayer shall be composed of high strength glass filament yarns knitted into a grid with ≥100x100kN/m. Coated with a thermal stable elastomeric polymer with melting point >220°C. Shall ensure protection against damage during installation, under trafficking and paving ≥80% and resist to melt under hot asphalt mix compaction. Product shall have light nonwoven backing with ≤40g/m² and CBR ≥ 50mm allowing interlayer installation on milled or rough asphalt surface. Asphalt interlayer shall be alkali resistant > 60%, tested and proven environmental harmless and remain recyclable after life cycle.

Can be used GlasGrid CG100L or alternative.

Light composite reinforcement tender specification			
Parameters	**Value**		**Standard**
Mesh size (centre to centre)	≥25 x 25	mm	
Melting point of grid protective coating	> 220	°C	EN ISO 3146 (ASTM E276)
Tensile strength (MD x CMD)	≥ 100 x 100	kN/m	EN ISO 10319
Tensile strength at 2 % elongation	≥ 75 x 75	kN/m	EN ISO 10319
Tensile elongation (MD x CMD)	≤ 3 x 3	kN/m	EN ISO 10319
Installation nonwoven backing (dynamic perforation)	≥ 50	mm	EN ISO 13433
Residual strength after installation damage test	≥ 80	%	EN ISO 10722
Alkali Resistance, %	YES > 60%		EN 14030

9.1.3 *RAPID ASPHALT REINFORCEMENT*

Asphalt interlayer shall be composed of high strength glass filament yarns knitted into a grid with ≥100x100kN/m and coated with elastomeric polymer with melting point >220°C. Protection against damage during installation, under trafficking and paving must be ≥80%. PES nonwoven-based backing shall be pre-saturated by ≥300 ≤800 g/m² polymer modified bitumen allowing installation on asphalt or concrete surface achieving product adhesion ≥200N. The product has a layer of silica sand on the

surface for winding on tires prevention. No additional emulsion or bitumen spray is required as interlayer bond of asphalt layers is secured by PMB melt. Asphalt interlayer shall be alkali resistant > 60%, tested and proven environmental harmless and remain recyclable after life cycle.

Can be used GlasGrid Rapid or alternative.

RAPID asphalt reinforcement tender specification			
Parameters	**Value**		**Standard**
Adhesive surface for bonding	≥300 PMB ≤800	g/m^2	
Adhesion to the surface	≥ 200	N	EN 13596
Melting point of grid protective coating	> 220	°C	EN ISO 3146 (ASTM E276)
Tensile strength (MD x CMD)	≥ 100x100	kN/m	EN ISO 10319
Tensile strength at 2 % elongation	≥ 75 x 75	kN/m	EN ISO 10319
Tensile elongation (MD x CMD)	≤ 3 x 3	%	EN ISO 10319
Residual strength after installation damage test	≥ 80	%	EN ISO 10722
Alkali Resistance, %	YES > 60%		EN 14030

Explanatory notes:

1) MD – in the direction of laying, CMD – transversely to the laying
2) PMB – SBS polymer modified asphalt binder
3) For reinforcing asphalt sheets, it is not necessary to apply any emulsion for laying and installation; the asphalt layer ensures adhesion and subsequently, the bond of layers, the width of the rolls is max. 1m.

10 REFERENCE

- **1** IFSTTAR full scale tests report on grid reinforced flexible pavements on the French fatigue carrousel, 2012.
- **2** EPSILON ENGENIERIE fatigue test report, 2016, JL Duchez.
- **3** Kiwa GmbH expertise for the assessment of mechanical damages under repeated loading for asphalt pavement fiberglass reinforcement.
- **4** INSTITUT PRO TESTOVÁNÍ A CERTIFIKACI, a.s. screening test method for determination of the resistance to acid and alkaline liquids in accordance with EN 14030 and determination of the resistance to weathering according to EN 12224:2001.
- **5** RWTH report on investigation on millability and recycling of asphalt layers with fiberglass reinforcement, 2012
- **6** EN 15381:2008 Geotextiles and geotextile-related products – Characteristics required for use in pavements and asphalt overlays
- **7** RSTA Guidance on the use of paving fabrics and grids as asphalt reinforcement, 2012
- **8** Related EN and ISO standards for mechanical properties of geogrids and geocomposites.