Influence of damage during installation on the tensile strength of asphalt reinforcement products

Reflective cracking is of major interest to road engineers facing the problem of road maintenance and rehabilitation. HaTelit® as asphalt reinforcement has been used for many years to delay or even prevent the development of reflective cracks in asphalt layers. This has been proven in countless projects worldwide having different applications as roads, highways and airports during the last 40 years. HaTelit® is a cost-saving and economically viable alternative to conventional construction solutions.

Asphalt reinforcement must resist as much damage as possible from the stresses and strains applied during installation and overlaying/ compaction of the asphalt. Polyester as raw material exhibits very good resistance to installation damage compared to other products with stiffer and more brittle raw materials which is explained below.

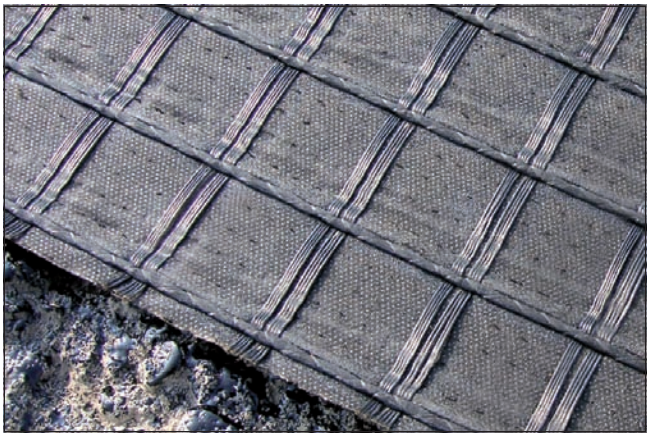

Fig. 1.: Asphalt reinforcement ***HaTelit® C 40/17***

Currently there are a number of different asphalt reinforcement products and systems made of different raw materials (e.g. Polyester-fibres, Glass-fibres, ...) available in the market. It is not disputed that all these systems have an effect; however there are differences in the behaviour and effectiveness of such systems.

1. Influence of damage during installation

The properties of asphalt reinforcement (e.g. tensile strength, tensile strain) are influenced during their installation, the paving procedure (paver and truck passes) and the compaction of the asphalt (Figure 2).

After an asphalt reinforcement product is placed, many asphalt delivery trucks have to pass over the grid. The influence, respectively the loss of tensile strength of the asphalt

Fig. 2.: Influences on asphalt reinforcement

reinforcement grid during the paving procedure, is known as installation damage. Additionally there is the compaction of the hot mix asphalt, during which the individual filaments or strands of the asphalt reinforcement are largely influenced by the movement of aggregates, in particular of coarse and sharpedged aggregates.

Next to the reinforcement characteristics (flexible or brittle raw materials), the degree of installation damage by roller compaction not only depends on the number of passes and the type of compaction (e.g. rubber tired, static, dynamic). The degree of installation damage is additionally influenced by the weight of the compactor and the condition of the base layer (e.g. smooth, milled).

To successfully counteract reflective cracking, placed reinforcement products must resist the installation influences without damage and as much as possible without serious loss of strength.

There is currently a lack of experience and knowledge concerning the real residual properties (what could be termed “effective tensile strength”) of asphalt reinforcement products following their installation and the subsequent paving installation procedure.

In the context of a diploma thesis at the RWTH Aachen University [1], a test procedure to describe installation damage was developed. One of the aims was to analyze and quantify the “effective tensile strength” for two different asphalt reinforcement products with different raw materials (Polyester (**HaTelit®**) and Glass-fibres) after the influence of installation damage.

2. Diploma Thesis at the RWTH Aachen University considering installation damage

As part of the work to assess the resistance of asphalt reinforcement products to installation influences, siteappropriate tests were performed at the institute's installation test track. As one goal, comparable tensile strengths of the tested products by the following influences were intended to be achieved:

- Only the influence of trafficking asphalt trucks
- Only the asphalt compaction
- Combination: Trafficking of asphalt trucks and compaction of the asphalt

2.1. Test procedure

To determine the impact of truck traffic only, undamaged specimen of the reinforcement products were placed on a clean and even road and loaded by a truck. The applied load was

Fig. 3.: Influences on the installation of asphalt reinforcement products

carried out by 35 passes of a 2-axes truck (forward and backward) with a speed of 20±5 km/h without any steering movements or breaking activity (Figure 3). Considering a typical asphalt delivery truck with 5 axes, this corresponds to 7 passes of a truck on site.

In preparation for the tests, an asphalt binder course (AC 16 B S) was installed on the base of the test track first. Onto the binder course, the reinforcement grids have been placed according to the manufacturer´s installation guidelines. Some of the predamaged specimen (truck passes) have also been used in the test-track for further exposure to simulate the double load-effect, truck passes and compaction. To differ between undamaged, predamaged and the different loading types, the specimen had been placed into separate sections. Subsequent to the installation of the reinforcement specimen a 50 mm asphalt wearing course was installed and compacted with 6 roller passes (2 static and 4 dynamic) (Figure 4).

Fig. 4.: Asphalt installation and compaction

To test their tensile strength after the asphalt installation and compaction, some of the specimen had to be removed close after the installation of the wearing course. For this reason these specimen have been wrapped into an aluminium foil and coated with a separating agent to create a very bad interlayer bond (Figure 5 and 6).

Fig. 5.: Placed products.
Right: Wrapped in foil with separating agent

To investigate the different influences the test track was divided into four different sections:

- An undamaged Glass-fibre reinforcement was placed onto which the asphalt wearing course was installed and compacted. (Load influence: Compaction only)
- A Polyester reinforcement was placed onto which the asphalt wearing course was installed and compacted. (Like „A“, load influence: Compaction only)
- A predamaged Glass-fibre grid was installed. Subsequently the asphalt wearing course was installed and compacted. (Load influence: Truck passes and compaction)
- A predamaged Polyester reinforcement was placed. Subsequently the asphalt wearing course was installed and compacted. (Like „C“, load influence: Truck passes and compaction)

2.2. Results

In the context of the research the final material characteristics (e.g. tensile strength)

Figure 6. Uncovering the products

have been tested with the wide width tensile test according to EN ISO 10319. To compare the separate types of tests (variants) the definition „residual strength“ had been chosen. The residual strength describes the maximum tensile strength after the installation damage tests, corresponding to the maximum tensile strength of the undamaged reference material. The detailed results can be found in Chart 1.

After the load influence “truck passes” only, the Polyester grid showed a residual strength of 85%, whilst the Glass-fibre grid had only 44%. After the load influence “compaction” only, the Polyester grid showed a residual strength of 71%, whilst the Glass-fibre grid had only 21%.

The Polyester-grid (HaTelit®) specimen which were loaded by the asphalt compaction and the truck passes still had a residual strength of 70% whilst the Glass-fibre grid revealed further damage with a residual strength of 11% only (of the measurable areas, see Figure 7).

The results revealed the considerable difference of the influence from truck traffic and asphalt compaction on the tensile strength of the specimen. For this it must be mentioned, that for the damaged glass-fibre grids the test samples had to be taken from the side of the specimen, as the middle parts had been completely destroyed during the installation damage test and therefore have been impossible to test (Figure 7).

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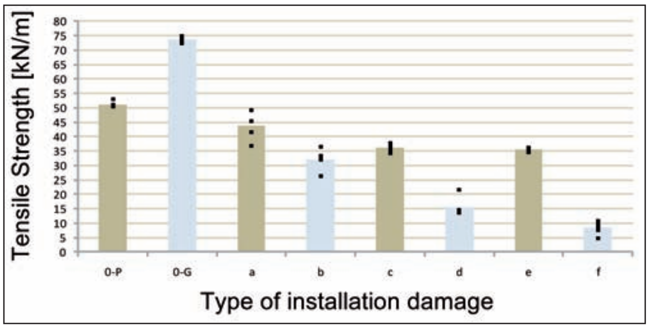
Chart 1: Results of the wide width tensile test before and after installation damage tests



O-P:	*Polyester grid*	*- undamaged reference*
O-G:	*Glass-fibre grid*	*- undamaged reference*
a:	*Polyester grid*	*- Only truck passes*
b:	*Glass-fiber grid*	*- Only truck passes*
c:	*Polyester grid*	*- Only compaction*
d:	*Glass-fibre grid*	*- Only compaction*
e:	*Polyester grid*	*- Combination*
f:	*Glass-fibre grid*	*- Combination*

2.3. Summary

After detailed test series it was found that installation damage plays an important role on the "effective tensile strength" of asphalt reinforcement products. It was found that the Polyester grid lost max. 30% after loading from truck passes and asphalt compaction. In contrast to this the Glass-fibre grid showed a loss of strength up to approx. 90%. This revealed that the Glass-fibre grid had been damaged significantly more compared to the Polyester grid reinforcement.

3. Conclusion

By means of a diploma thesis at the Institute of Road and Traffic Engineering of the RWTH Aachen University, which analyzed and quantified the "effective tensile strength" for two different asphalt reinforcement products with different raw materials (Polyester and Glass-fibres), it was shown that installation damage can have a noticeable influence on the

Figure 7.: Results of installation damage test
Left: PET-Grid; Right: Glass-fibre grid

properties of an asphalt reinforcement grid.

It has become clear that products with a brittle raw material (like Glass-fibres) can loose a significant part of their tensile strength when trafficked by asphalt delivery trucks and after the asphalt compaction. The results of the demonstrated research are also confirmed by results of tests performed according to EN ISO 10722-1 [2]. Furthermore it can be expected, that especially for Glass-fibre grids the results would be worse on a milled surface.

The tests reveal and prove that Polyester, as a raw material, exhibits a very good resistance to installation damage compared to other products with stiffer and more brittle raw materials. It can therefore permanently and successfully counteract reflective cracking.

REFERENCES:

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[2] Institut für textile Bau- und Umwelttechnik GmbH (tBU), Test Report Nr. 1.1/17810/493-2003e and 1.1/17810/494-2003e, Test method: Procedure for simulating damage during installation (acc. to ISO EN DIN 10722-1)

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