Product	**Longitudinal** **Tensile strength /Elongation**	**Transverse** **Tensile strength /Elongation**
S&P Carbophalt G	120kN / 2.5%	200kN / 1.4%
S&P Glasphalt G	120kN / 2.5%	120kN / 2.5%

Table 3

Determination of the tensile strength in compliance with EN ISO 10319 is not possible. The brittle fibre-rovings are damaged by the clamping action of the tensile tester. To achieve satisfactory results in the tensile test it is essential that the fibre strands undergo preliminary impregnation.

4. Reinforced asphalt pavement as a composite material

RC (reinforced concrete) is the best known composite material in the construction industry. In reinforced concrete the rebar is applied in a matrix of concrete. Table 4 compares the E-moduli of the components.

E-modulus of matrix	E-modulus of tension member	**Ratio between E-modulus of matrix & tension member**
Concrete	Steel	**RC (reinforced concrete)**
20 – 30 kN/mm²	210 kN/mm²	**~ 1 : 7**

Table 4: Ratio between the E-moduli of the matrix and tension member in RC

The E-modulus of a fibre grid is always lower than the theoretical E-modulus of the fibre. The grid configuration results in a less than ideal fibre arrangement. Accordingly, a reduction factor needs to be applied to the fibre's theoretical elasticity modulus for the comparison of reinforced asphalt pavement (*Table 5*).

Recommended reduction factor = **1.5**

	E-modulus of fibre	**E-modulus of fibre grid**
Carbon fibre	240,000	160,000
Glass fibre	70,000	47,000
Polyester fibre	15,000	10,000

Table 5: Reduced E-moduli of fibres

Table 6 compares the relevant E-moduli of various fibre-reinforced pavement layers. The E-modulus of a bituminous pavement layer lies between 3 – 15 kN/mm², depending on the ambient temperature.

The reduced E-modulus can now be used to prepare a comparative table.

E-modulus of matrix	E-modulus of fibre grid	E-modulus ratio between matrix & fibre grid
Asphalt covering 6 kN/mm^2 complex modulus CAST at 0°C (5 Hz)	Carbon fibre grid Glass grid Polyester grid	**~ 1 : 26** **~ 1 : 7.5** **~ 1 : 1.6**

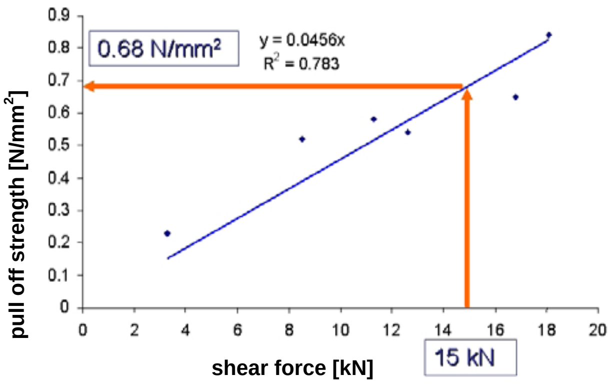
Table 6: Ratio between the E-moduli of the matrix and fibre grid in reinforced asphalt pavement

The comparisons in table 6 clearly indicate that the presence of polyester fibres in reinforced asphalt layers does not increase the tensile strength. The glass grid is effective as tensile reinforcement. The carbon-fibre reinforcement increases the tensile strength and the crack resistance of the asphalt layer substantially. The interlayer bond of the reinforced asphalt layer must be perfect in order to guarantee the effect of the reinforced asphalt layer. The interlayer shear bond has to be specified by the developer and monitored by the site management.

5. Interlayer shear bond of reinforced bituminous pavement layers

A grid is only effective with a perfect interlayer shear bond with the matrix. The tensile forces from the grid are transferred to the upper and lower bituminous layer via the interlayer bond. In various EU directives and road construction standards respectively, a shear force >15kN (Leutner method, Ø150mm test core) is required between the old and new bituminous layer (*Image 1*). In some countries it is not the shearing force that is tested, but rather the pull off strength. Graphic 2 shows the relationship of the shear force to the pull off strength.

Image 1: Leutner test setup



Graphic 2: Shear force/pull off strength