

In a second stage the carbon fibre grid was placed underneath the wearing course. Thanks to the carbon fibre grid the stiffness (modulus of elasticity) of the 4-cm thick upper layer as well as the 4-cm thick bottom layer is increased by approx. 30 %.

Asphalt layer	Thickness (cm)	Elasticity modulus (MPa)	Layer designation	Load Number	Vertical load (kN)	Vertical stress (MPa)
1	4 cm	4000 (+ 25 – 30 %)	New wearing course (+ 30 % stiffness)	1	20	0.577
2	4 cm	5000 (+ 25 – 30 %)	New binder layer (+ 30 % stiffness)	2	20	0.577
2 a	8 cm	4000 (no influence)	New binder layer (no influence of the asphalt reinforcement)	2	20	0.577
3	Old, existing sub-base	1500	Existing sub-base			

Expansion beneath wearing course (μ): (Software BISAR 3.0 result)	XX = 47.4 (- 19 %) YY = 28.1 (- 17 %) ZZ = 39.5 (- 34%)
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Table 12: Dimensioning with BISAR 3.0 “with S&P Carbophalt grid”

The results determined using the BISAR 3.0 software show a reduction in expansion of 19% to 34%. The results verify the tests carried out by EMPA. A simple dimensioning of carbon-fibre reinforced asphalt pavement layers is thus possible using the BISAR 3.0 software. The influence of the C-fibre reinforcement is reproduced as an increase in stiffness of the asphalt layer lying above and beneath the C-fibre reinforcement.

9. Deflection measurements on C-fibre reinforced asphalt pavement layers

In autumn 2003, the load-bearing capacity of the Andermatt-Hospental main road in Switzerland was tested before and after installation of a 4-cm thick new asphalt overlay reinforced with S&P Carbophalt. Measurements were conducted with a Lacroix deflectograph at a rear axle load of 10 t.

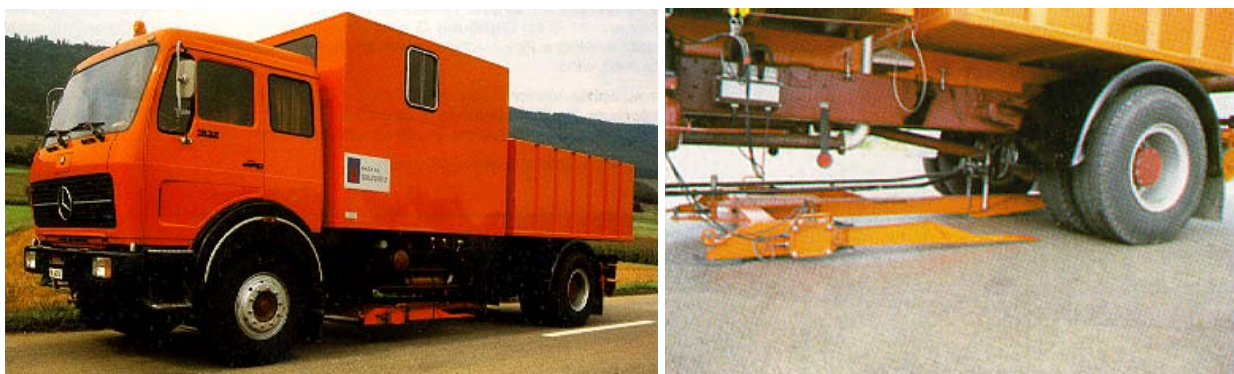
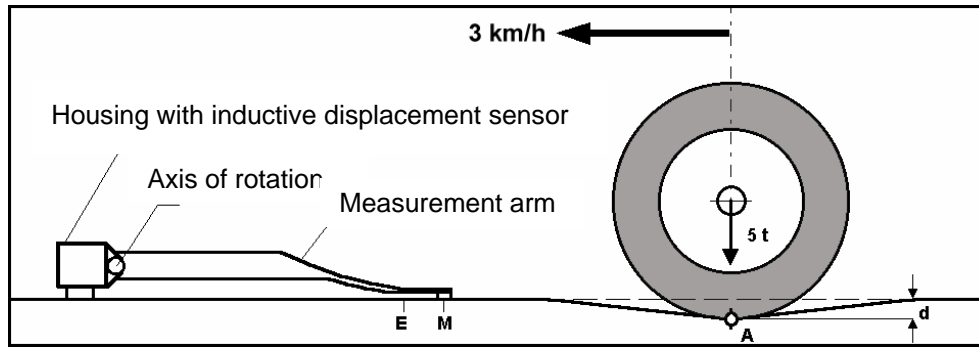
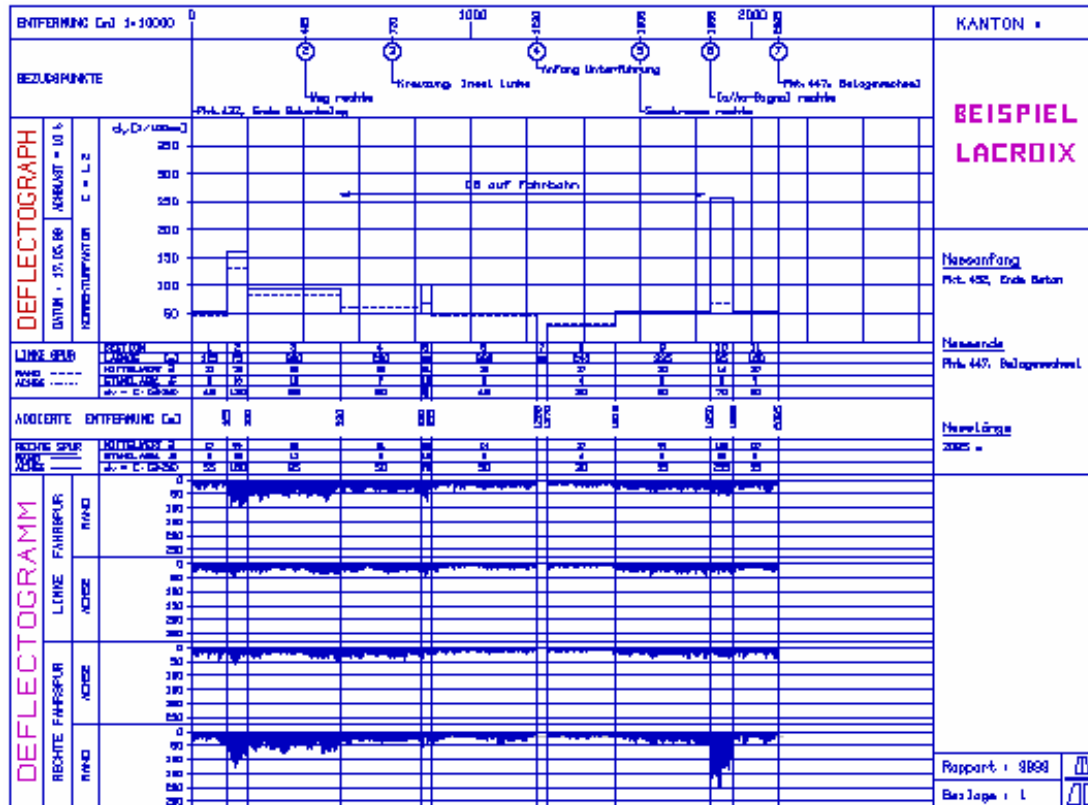


Image 7/8: Lacroix measurement vehicle and beam in the measurement position



Graphic 12: Principle of dynamic deflection measurement

Deflection measurements were carried out at 5.5-metre intervals over the entire route length of $2 \times 1.9 \text{ km} = 3.8 \text{ km}$. The measuring principle is illustrated in Figure 12. For evaluation of the results, the measured route was divided into homogeneous sections. These sections were mapped in a graph together with the related characteristic deflection parameters (d_v , 1/100 mm) (Graphic 13).



Graphic 13: Excerpt of graphic representation of measurement results

In a number of sections, S&P Carbophalt was installed as an intermediate layer under the new, 4 cm thick asphalt layer. The theoretically expected reduction in d_v values resulting from reinforcement of a 4 cm thick overlay (without a grid interlayer) serves as a basis for rating the strengthening effect of the S&P carbon-fibre interlayer. The Lacroix table shows the measured strengthening effect of a 4 cm thick asphalt overlay and S&P carbon-fibre grid in the area of the road axis.

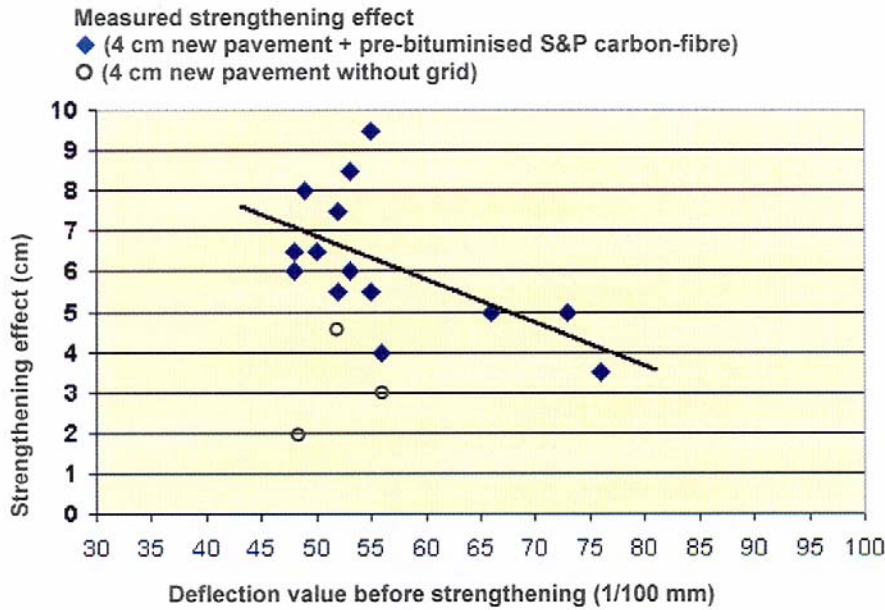
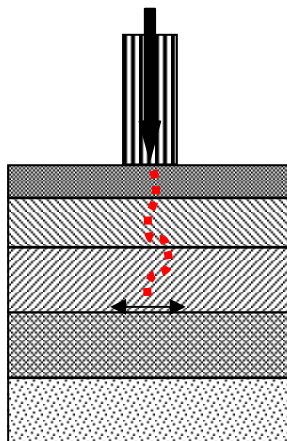


Figure 14: Lacroix results

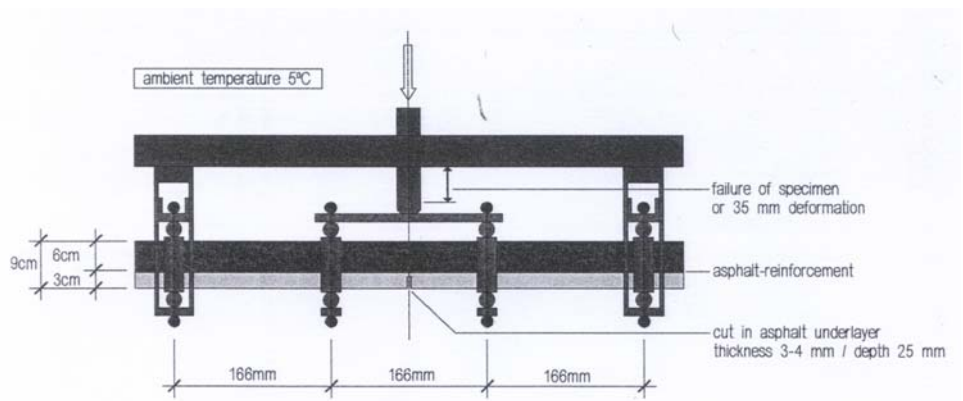
The effect of the carbon-fibre grid (S&P Carbophalt) is equivalent to that of a 3-4 cm thick new pavement layer. The definite influence of the S&P carbon-fibre grid on the load bearing capacity is verified.

10. Investigations at NPC (Netherland Pavement Consultants) “Asphalt reinforcement against fatigue cracks“

Fatigue cracks in the bituminous pavement layer occur as a result of stress exertion (wheel loads).



Graphic 15: Typical crack formation from bottom to top



Graphic 16: NPC test configuration