According to a recommendation of the standard DIN 4125, version of November 1990, the aptitude test for permanent soil anchors must be executed from an expert institute which also judges the results of the necessary soil investigations (see also ASTM Designation D 4435 - 84, 1989).

To execute the aptitude test at least three permanent soil anchors are set at each site at points where the most unfavourable results are to be expected according to the foundation exploration. Fig. 1 and 2 show a test at the roof of an investigation gallery where the aptitude of resin anchors and SN-anchors should have been proved regarding the carrying capacity of the injection body.

Fig. 1 Mounted rock bolt anchor pull device with load cell (1), error limit smaller than 1 % related to the final value, and dial gauge (2) with a reading accuracy of ± 0.01 mm

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Fig. 2 Set up of the loading and measuring device

As a ram a hollow-centre hydraulic ram is used (0.5 MN load). The hydraulic pressure is recorded by a calibrated precision manometer (class 0.6 according to the weights and measures regulations), the load is determined by the aid of a conversion factor. Simultaneously the load is directly read off by a load cell.

The extension of the tensioned bolt is recorded at the top end of the ram by a mechanical displacement sensor with scale intervals of 0.01 mm. To guarantee an uninfluenced measurement the displacement sensor is fixed at rods which are doweled in the side walls of the tunnel independent of ram and rock bolt.

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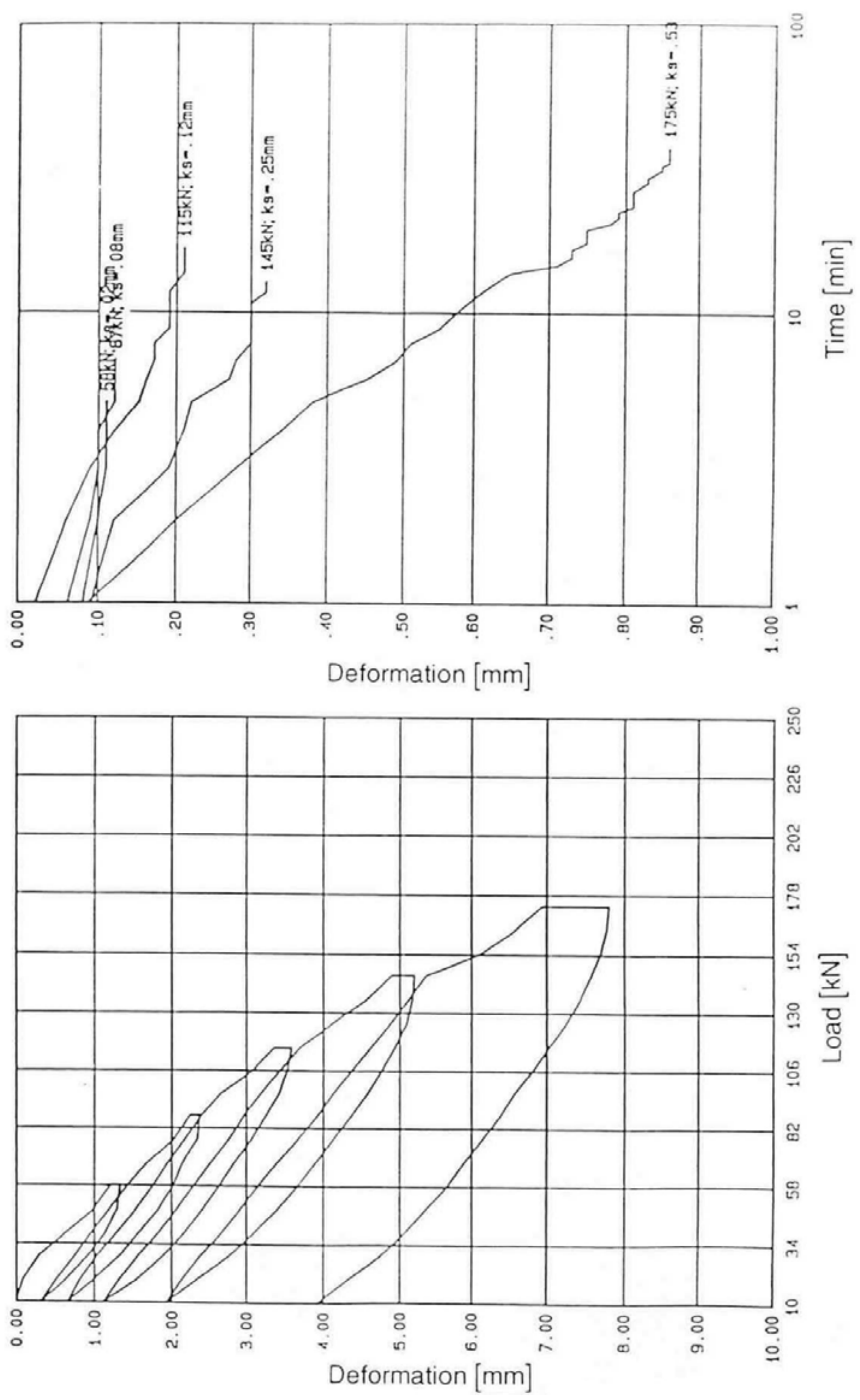

Fig. 3 Pull test at SN-anchor. A) Load-Deformation diagram; b) Time-Deformation diagram at different load steps

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To execute the tests the load is increased step-by-step to 0.5 F_w, 0.75 F_w, 1.0 F_w, 1.25 F_w until the test load F_p = $\eta_K \cdot F_W = \leq 0.9 \cdot F_S$ starting from a pre-load F_i ($F_i \leq 0.2$ F_w). After having reached a load step the load is stabilised according to Fig. 3a and the displacement sensor is read off every minute. The final reading is reached when the displacement is smaller than 0.1 mm per minute.

To evaluate the creep amount the test results are applied according to Fig. 3b. The curves enable to quickly judge the fading of the rock bolt head displacement and thus to specify the magnitude of the injection body displacement in the rock under constant load. The creep amount is

$$k_s = (s_2 - s_1)/\lg(t_2/t_1).$$

According to the standard DIN the creep amount should be ≤ 2.0 mm.

The ultimate capacity F_K can be extrapolated by presenting the creep amounts of the different load steps as a function of the test load at the creep amount k_s = 2 mm.

The length of the non-injected part of the rock bolt cal l_{fS} can be calculated mathematically by approximation from the curves of the displacements (Fig. 4). It follows from the slope of the nearly straight-lined section of the curve of the displacement s_{el}

$$\text{cal } l_{fS} = \frac{\Delta s_{el}}{\Delta F_p} \cdot E \cdot A_S$$

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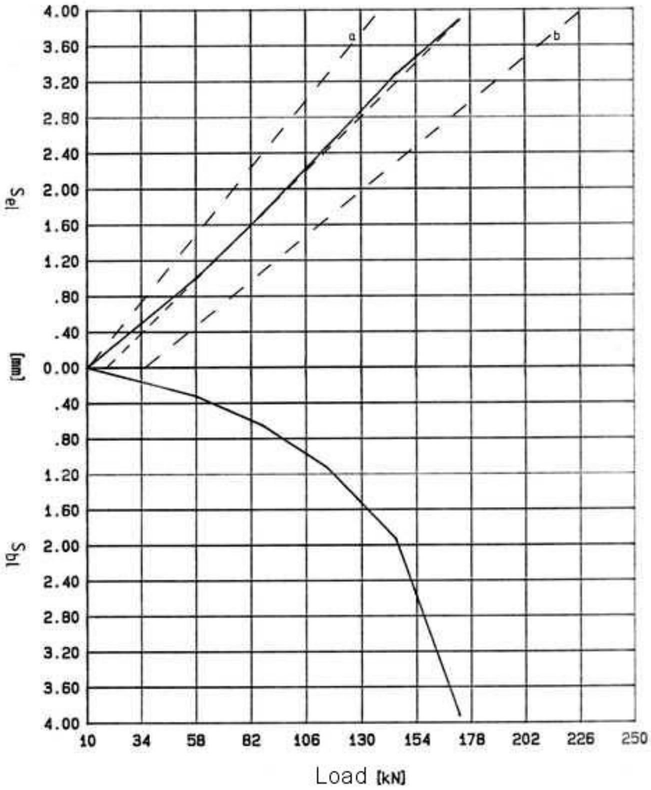

Fig. 4 Distribution of elastic and permanent deformations during a pull test at an SN anchor

The drawn-in lines a and b correspond to the lines between those the curve of the determined elastic deformations should run that the calculated length of the non-injected rock bolt section doesn't mainly differ from the provided length of the non-injected rock bolt section and that the friction loss rests within admissible limits. The top limit line a is calculated from

$$s_{el} = \frac{F_p - F_i}{E \cdot A_S}\left(l_{fS} + \frac{l_v}{2}\right)$$

and the bottom line b from

$$s_{el} = 0.8 \frac{F_p - F_i}{E \cdot A_S} l_{fS}$$

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