9. Design concepts

The recommended working loads N_{rec} and V_{rec} are suitable for use in typical working load designs. If a partial factor of safety design method is to be used, the N_{rec} and V_{rec} values are conservative when used as N_{Rd} and V_{Rd}. Alternatively, the design resistance may be calculated from the recommended loads by multiplying by the factor 1.4, which considers the uncertainties from the load on the fasteners. Exact values for N_{Rd} and V_{Rd} can be determined by using the safety factors where given and or reviewing test data. Based on cyclic tests it can be stated that DX fastenings can be said to be robust, even when the actual loading turns out to be in part cyclic. Design loads (characteristic strength, design resistance and working loads) for the **X-HVB** shear connector are listed and specified per design guideline.

The designer may encounter two main fastening design concepts:

Working load concept

$$N_S \leq N_{rec} = \frac{N_{Rk}}{\gamma_{GLOB}}$$

where γ_{GLOB} is an overall factor of safety including allowance for:
• errors in estimation of load
• deviations in material and workmanship

and N_S is in general a characteristic acting load.
$$N_S \cong N_{Sk}$$

Partial factors of safety

$$N_{Sk} \times \gamma_F = N_{Sd} \leq \frac{N_{Rk}}{\gamma_M} = N_{Rd}$$

where:
γ_F is a partial factor of safety to allow for errors in estimation on the acting load and
γ_M is a partial factor of safety to allow for deviations in material and workmanship.

The characteristic strength is defined as 5 % fractile:

$$N_{Rk} = N_{u,m} - k \times s$$

The k factor is a function of the sample size and the accuracy required. The characteristic strength of fastenings to concrete is determined based on a 90% probability while fastenings to steel are based on a 75% probability.

Structural analysis of the fastened part (e.g. roof deck panel or pipe hung from a number of fastenings) leads to calculation of the load acting on a single fastening, which is then compared to the recommended load (or design value of the resistance) for the fastener. In spite of this single-point design concept, it is necessary to ensure adequate redundancy so that failure of a single fastening will not lead to collapse of the entire system. The old saying "one bolt is no bolt" can also be applied to DX fastening.

For standard DX fastenings on concrete, a **probability-based design** concept based on multiple fastening is applied in order to allow for fastener driving failures and the large scatter in holding power observed. This concept applies to tensile as well as shear loading and is described in following chapter.