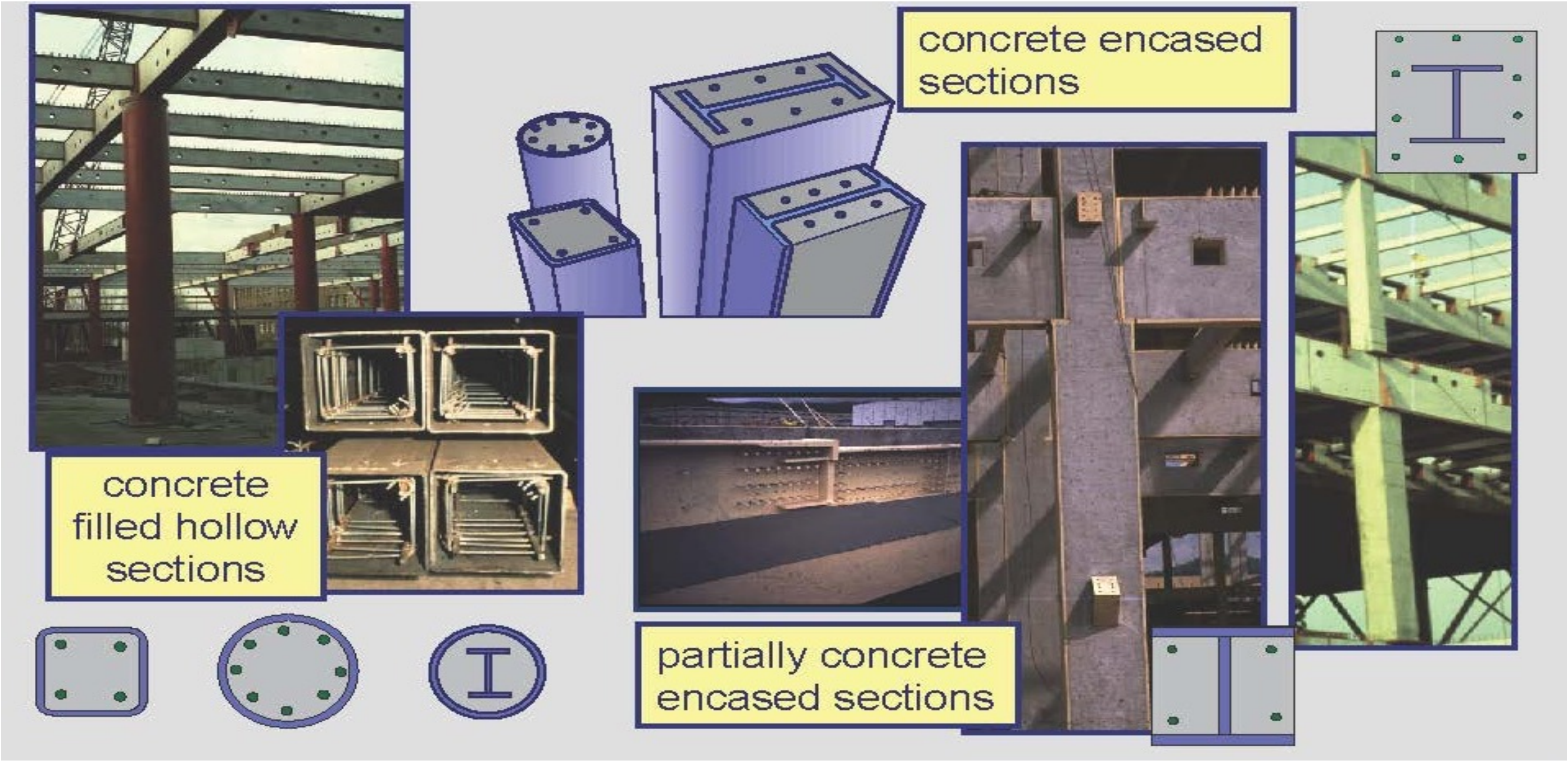
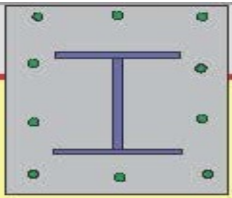
Slides in English

Design



Source: G. Hanswille, Univ. Wuppertal

Concrete encased sections



advantages:

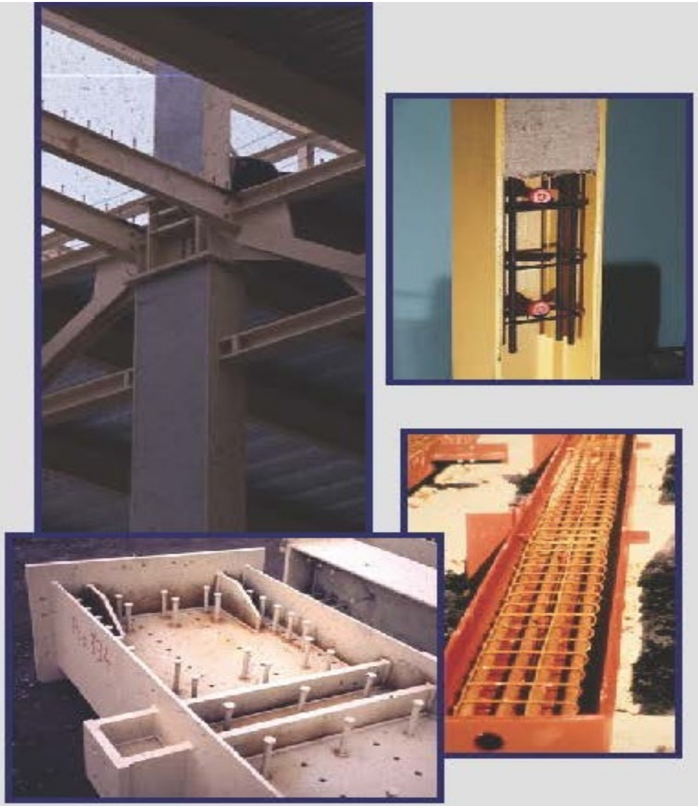
- high bearing resistance
- high fire resistance
- economical solution with regard to material costs

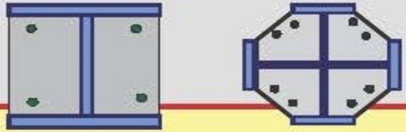
disadvantages:

- high costs for formwork
- difficult solutions for connections with beams
- difficulties in case of later strengthening of the column
- in special case edge protection is necessary

Source: G. Hanswille, Univ. Wuppertal

Partially concrete encased sections





advantages:

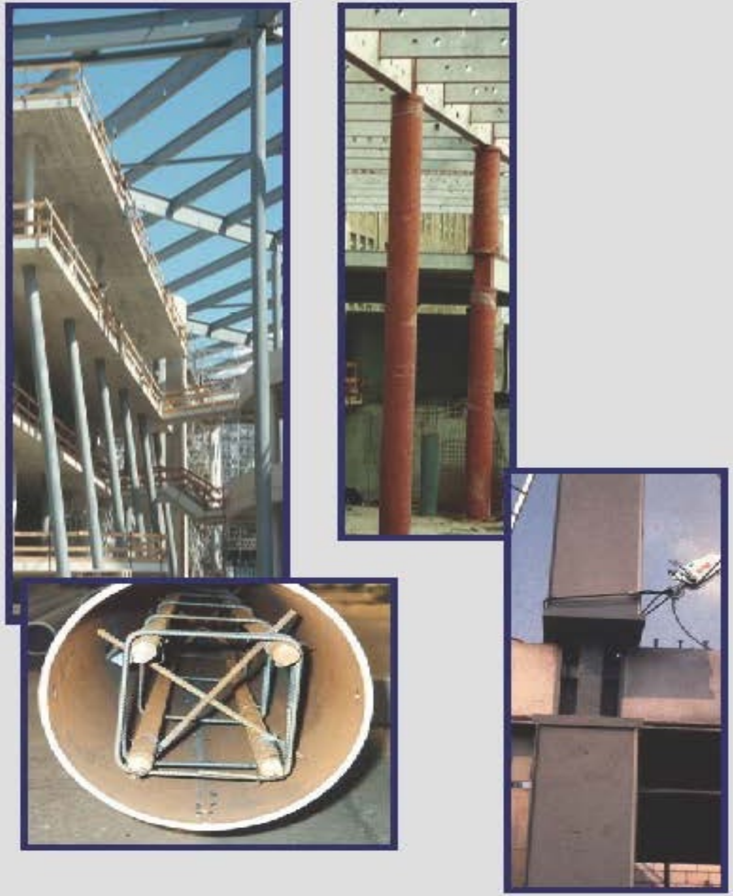
- high bearing resistance, especially in case of welded steel sections
- no formwork
- simple solution for joints and load introduction
- easy solution for later strengthening and additional later joints
- no edge protection

disadvantages:

- lower fire resistance in comparison with concrete encased sections.

Source: G. Hanswille, Univ. Wuppertal

Concrete filled hollow sections



advantages:

- high resistance and slender columns
- advantages in case of biaxial bending
- no edge protection

disadvantages :

- high material costs for profiles
- difficult casting
- additional reinforcement is needed for fire resistance

Source: G. Hanswille, Univ. Wuppertal

Concrete filled hollow section with core

advantages:

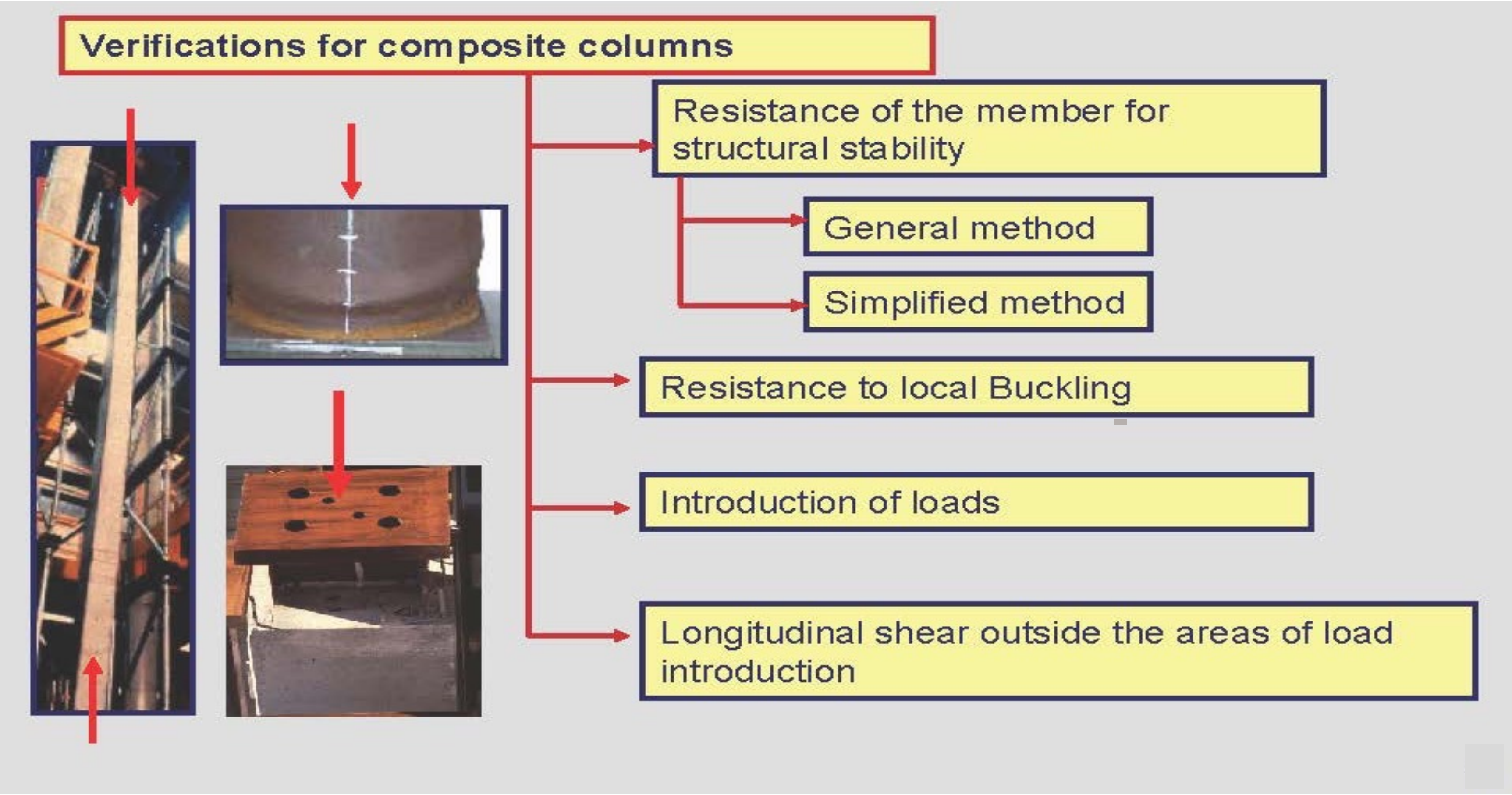
- extreme high bearing resistance in combination with slender columns
- constant cross section for all stories is possible in high rise buildings
- high fire resistance and no additional reinforcement
- no edge protection

disadvantages:

- high material costs
- difficult casting

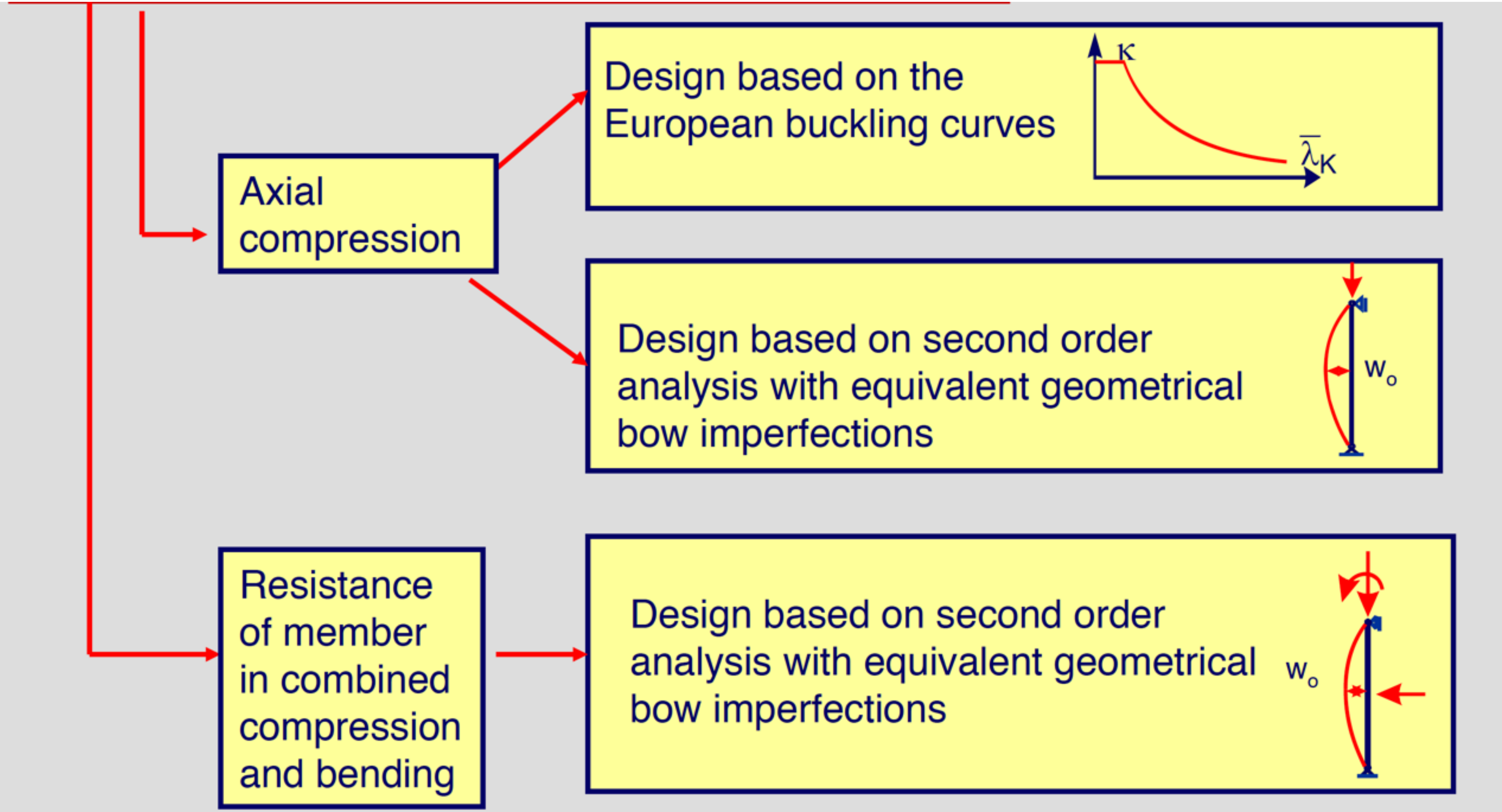
Source: G. Hanswille, Univ. Wuppertal

Verifications according to EN 1994-1-1



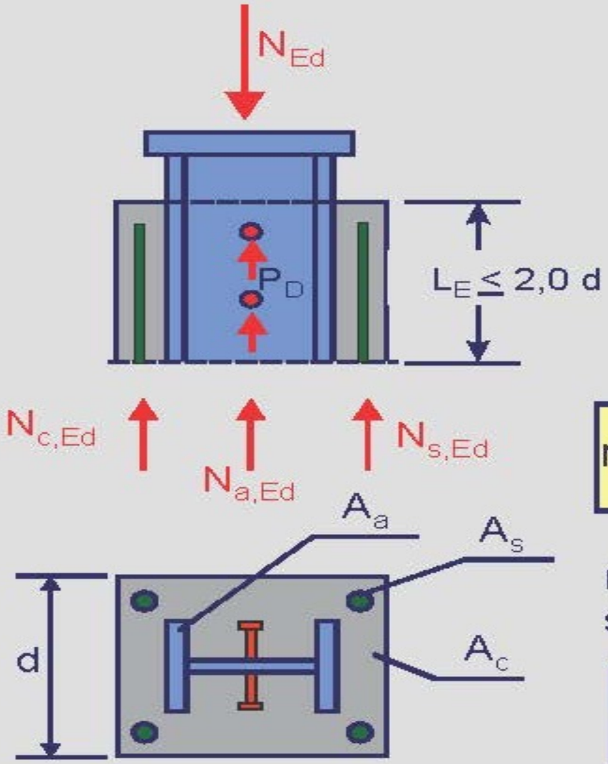
Source: G. Hanswille, Univ. Wuppertal

Simplified method verification method



Source: G. Hanswille, Univ. Wuppertal

Load introduction over the steel section



load introduction by headed studs within the load introduction length L_E

$$L_E \leq \begin{cases} 2d \\ L/3 \end{cases}$$

d minimum transverse dimension of the cross-section

L member length of the column

sectional forces of the cross-section :

$$N_{a,Ed} = N_{Ed} \frac{N_{pl,a}}{N_{pl,Rd}} \qquad N_{s,Ed} = N_{Ed} \frac{N_{pl,s}}{N_{pl,Rd}} \qquad N_{c,Ed} = N_{Ed} \frac{N_{pl,c}}{N_{pl,Rd}}$$

required number of studs n resulting from the sectional forces $N_{Ed,c} + N_{Ed,s}$:

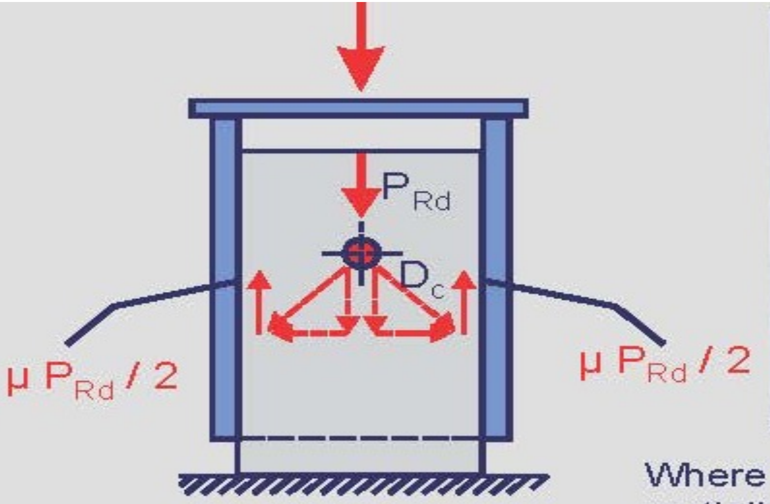
$$V_{L,Ed} = N_{c,Ed} + N_{s,Ed} = N_{Ed} \left[1 - \frac{N_{pl,a}}{N_{pl,Rd}} \right]$$

$$V_{L,Rd} = n\,P_{Rd}$$

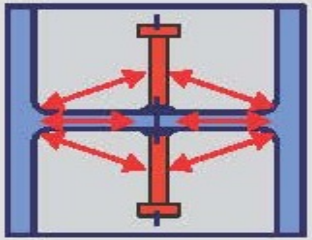
P_{Rd} – design resistance of studs

Source: G. Hanswille, Univ. Wuppertal

Shear resistance of stud connectors welded to web of part. encased I section



$V_{L,Rd} = P_{Rd} + V_{LR,Rd}$

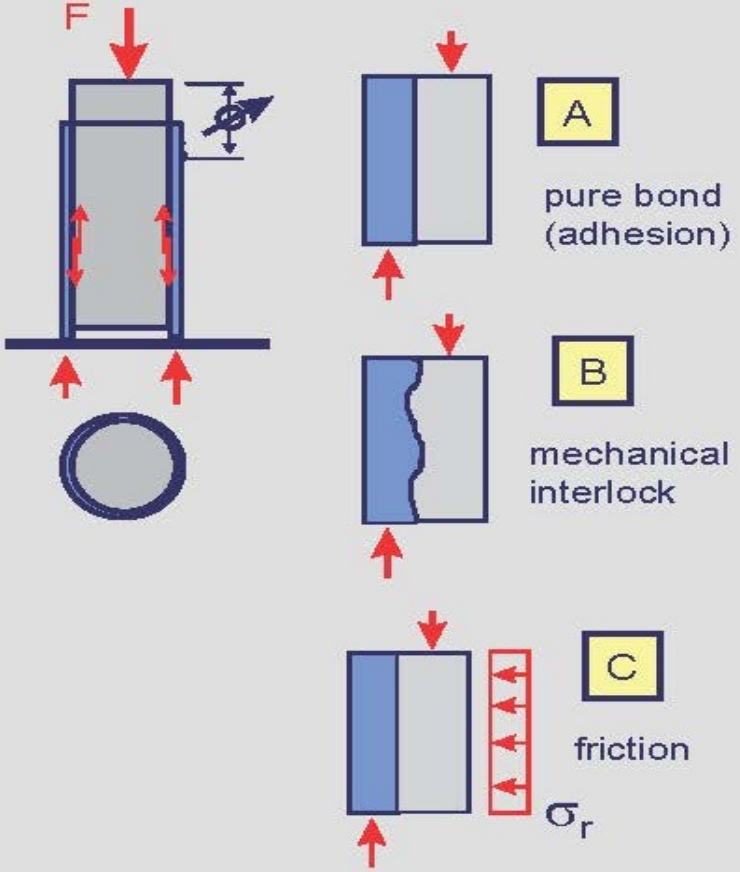


$V_{LR,Rd} = \mu \, P_{Rd}$

Where stud connectors are attached to the web of a fully or partially concrete encased steel I-section or a similar section, account may be taken of the frictional forces that develop from the prevention of lateral expansion of the concrete by the adjacent steel flanges. This resistance may be added to the calculated resistance of the shear connectors. The additional resistance may be assumed to be on each flange and each horizontal row of studs, where μ is the relevant coefficient of friction that may be assumed. For steel sections without painting, μ may be taken as 0,5. P_{Rd} is the resistance of a single stud.

Source: G. Hanswille, Univ. Wuppertal

Verification ouside the areas of force introduction



Outside the area of load introduction, longitudinal shear at the interface between concrete and steel should be verified where it is caused by transverse loads and / or end moments. Shear connectors should be provided, based on the distribution of the design value of longitudinal shear, where this exceeds the design shear strength τ_{Rd}.

In absence of a more accurate method, elastic analysis, considering long term effects and cracking of concrete may be used to determine the longitudinal shear at the interface.

Source: G. Hanswille, Univ. Wuppertal