A pinned connection with fixtures of steel angle section screwed to the sides of the column is a simple and appropriate method suitable for small horizontal forces (see figure 13.3). The fixtures are bolted into the foundation with expansion bolts or adhesive anchors, which permits exact measurement and reduces the risk of incorrect placing. Symmetrical placing is recommended, with an angle on either side of the column.

The transfer of forces between the angles and the glulam column is by bolts or wood screws, if necessary combined with connectors. Connectors should be factory-fitted.

Various types of angle fixture, intended to be fixed with expansion bolts to the concrete construction below, are manufactured and sold by a number of firms. The fixtures can also be specially made of folded steel sheet or of rolled steel sections.

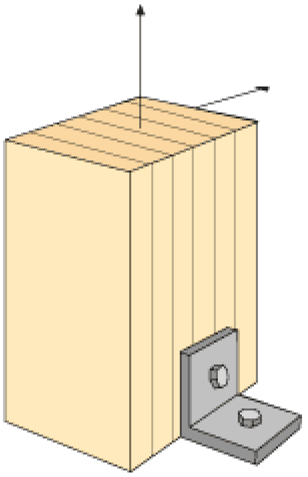

Figure 13.3 Pinned fixing of column base with steel angle fixture. Principles.

DESIGN

In the design the vertical part of the angle is regarded as a cantilever rigidly fixed in the foundation, loaded with a horizontal force and in certain cases with a vertical force (uplift), both acting in the centre of the group of bolts (see figure 13.4). Downward vertical forces in the column are transferred direct to the foundation by contact pressure.

Fixing in the column and the vertical flange of the angle are checked in the same way as for fishplates of nailplate of flat steel (13.2.1).

The design condition for the horizontal flange of the angle is:

$$\sqrt{\sigma^2 + 3\tau^2} \leq f_{yd}$$

Formula 13.9

where

f_{yd} = design value of the yield tension limit of steel

σ = longitudinal stress

τ = shear stress

calculated at the same point on the flange.

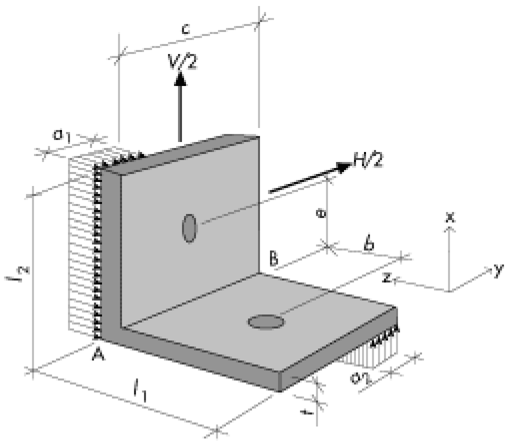

Figure 13.4 Fixture of steel angle. Symbols.

If σ and τ are calculated with the Elastic Theory as the starting point at the same time as a biaxial stress condition applies, f_{yd} in formula 13.9 can be replaced by $1{,}1f_{yd}$.

The maximum longitudinal stress σ_{max} occurs at points A and B and can be calculated using:

$$\sigma_{max} = \frac{0{,}5H_d \cdot b}{W_x} + \frac{0{,}5V_d \cdot b}{W_y}$$

Formula 13.10

where
H_d and V_d are the total design horizontal reaction and the upward vertical reaction from the column
W_x and W_y are the section moduli of the flanges
D is given in figure 13.4.
The shear stress τ = 0 at points A and B.

If the upward vertical force is small, the maximum shear stress τ_{max} occurs halfway between points A and B and can be calculated from the formula:

$$\tau_{max} = 1{,}5\frac{0{,}5H_d}{A} + \frac{0{,}5H_d \cdot e}{W_v}$$

Formula 13.11

where
A = cross-sectional area
W_v = torsion constant of the flange (=*A*x *t*/3)
e is given in figure 13.4.

The longitudinal stress σ at the same point on the cross-section can be calculated using the formula:

$$\sigma_{max} = \frac{0{,}5V_d \cdot b}{W_y}$$

Formula 13.12

If only one expansion bolt per fixture is used the moment of eccentricity $0{,}5H_d \times b$ is taken up by the column. The design condition regarding the contact pressure between the column and the fixture is then:

$$0{,}5H_d \cdot b \le f_{c90d} \cdot a_1 \cdot l_2\left(\frac{c-a_1}{2}\right)$$

Formula 13.13

where

f_{c90d} = design value of the compression strength of the glulam column perpendicular to the grain.
a_1 = the width of the vertical compressive block diagram

Other symbols are given in figure 13.4.

The width of the compressive block diagram a_1 can be calculated from the formula:

$$\frac{c}{2} \geq a_1 = t \cdot \sqrt{\frac{f_{yd}}{2 f_{c90d}}}$$
Formula 13.14

where
f_{yd} = design value of the yield tension limit of steel
t = thickness of the fixture.

The design condition for the fixing of the horizontal flange of the angle in the foundation is:

$$\left[\frac{F_v}{R_{vd}}\right]^2 + \left[\frac{F_t}{R_{td}}\right]^2 \leq 1$$
Formula 13.15

where
$F_v = 0{,}5H_d/n$ and
$F_1 = (0{,}5V_d + F)/_n$.
R_{vd} = design strength value in shear for the expansion bolt
R_{td} = design value of the withdrawal strength of the expansion bolt
n = number of expander bolts per fixture
F = withdrawal force caused by eccentricity of horizontal force H_d x *e*.

With symbols as in figure 13.4, *F* can be calculated using the formula:

$$F = \frac{0{,}5 H_d \cdot e}{(c - a_2)/2}$$
Formula 13.16

The width of the horizontal compressive block diagram a_2 can be calculated by the formula

$$\frac{c}{2} \geq a_2 = t \cdot \sqrt{\frac{f_{yd}}{2 f_{cc}}}$$
Formula 13.17

where
f_{cc} is the design value of the strength of the concrete in local compression.

The design condition for contact pressure between concrete and the angle fixture is:

$$0{,}5 H_d \cdot e \leq f_{cc} \cdot a_2 \cdot l_1 \cdot \left(\frac{c - a_2}{2}\right)$$
Formula 13.18

For concrete of strength class K25 the characteristic value of compressive strength can be taken as f_{cck} = 30 N/mm^2, provided the distance to the edge or other factors do not reduce the strength.

The surrounding concrete is designed according to Eurocode 2 (EN 1992).