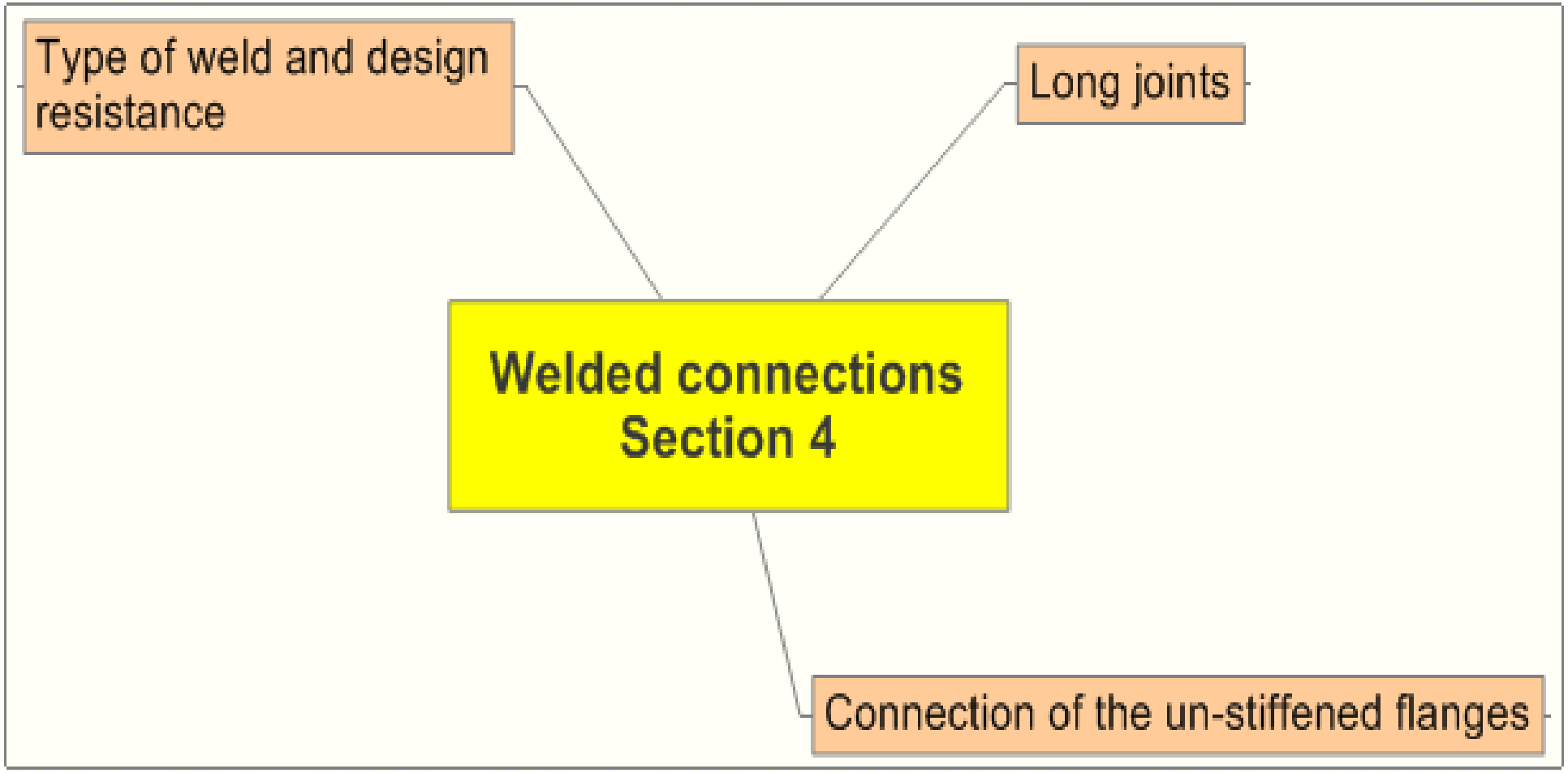
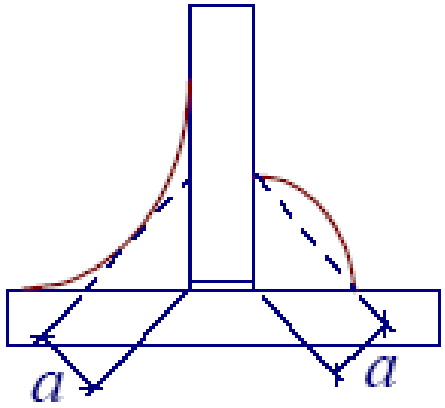
Welded Connection



WELDED CONNECTIONS

- When using metal arc welding, the mechanical properties of weld metal should be compatible with the parent metal
- The material thickness should be at least 4 mm
- Welds are classified as fillet welds, butt welds, plug welds and flare groove welds
- For a fillet welds, the throat thickness, a is defined as below:

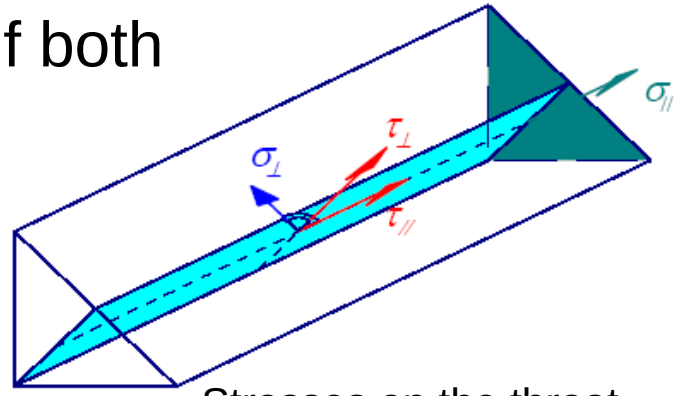


Design Resistance of Fillet Weld

Directional method

- The internal force is resolved into normal stresses and shear stresses on the critical plane of the weld throat.
- The design resistance is sufficient if both conditions below are satisfied:

$$\sqrt{\sigma_{\perp}^2 + 3\left(\tau_{\perp}^{\ 2} + \tau_{//}^{\ 2}\right)} \leq \frac{f_u}{\beta_w \gamma_{M2}}$$



Stresses on the throat section of a fillet weld

$$\sigma_{\perp} \leq 0.9 \frac{f_u}{\gamma_{M2}}$$

Design Resistance of Fillet Weld

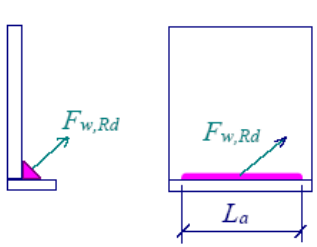
Simplified method

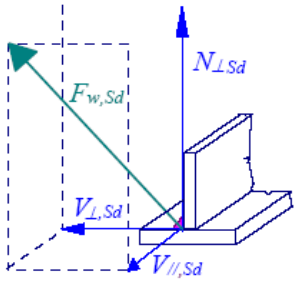
– Independent of the orientation of the weld throat plane to the applied force, the design resistance per unit length,

$$F_{w,Rd} = f_{vw.d}\, a$$

– The design shear strength $f_{vw.d}$ of the weld:

$$f_{vw.d} = \frac{f_u / \sqrt{3}}{\beta_w \gamma_{M2}}$$



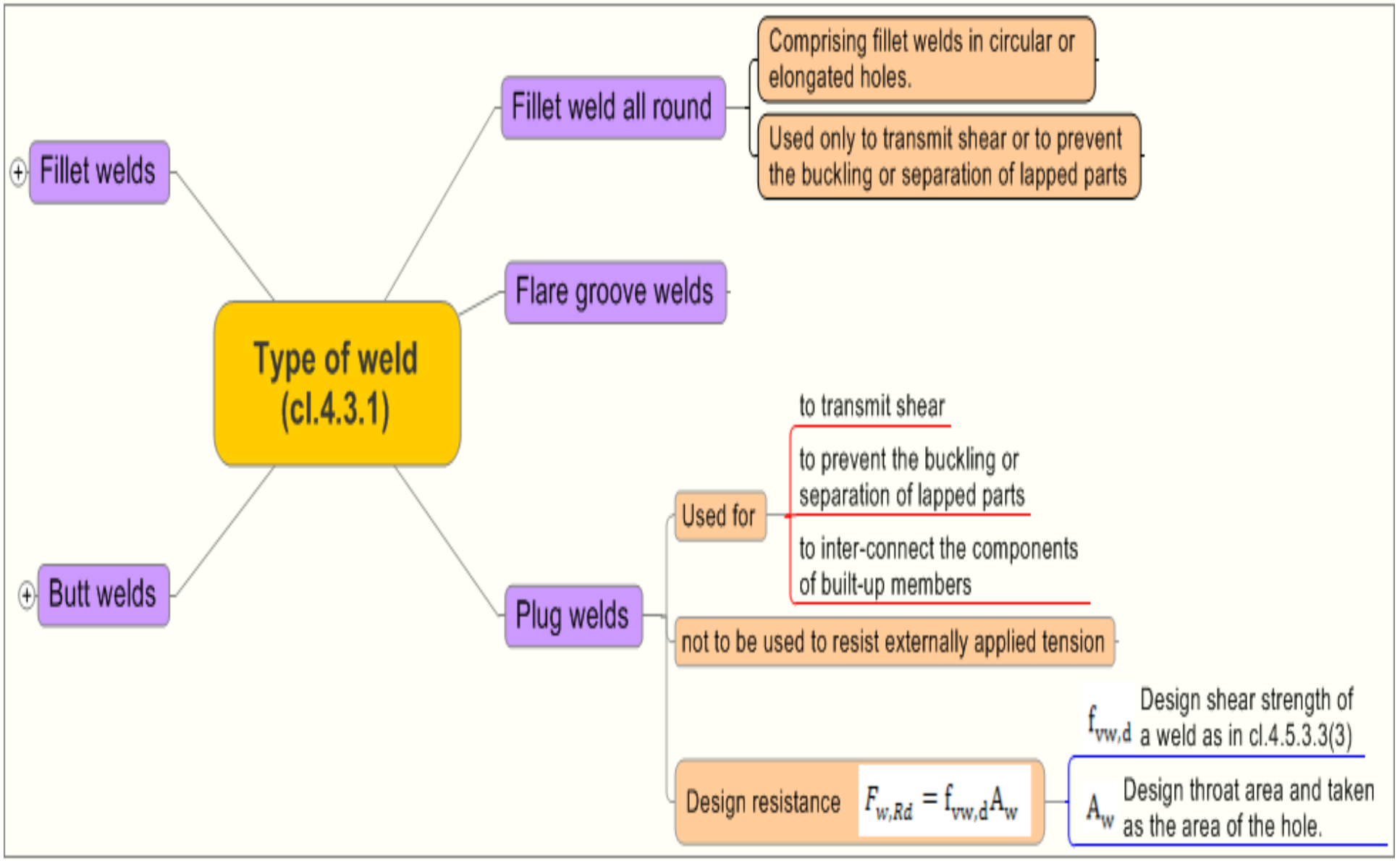


Design of fillet weld independent of the direction of loading

Table 3.1 Correlation factor βw for weld resistance

Standard and steel grade			Correlation factor βw
EN 10025	**EN 10210**	**EN 10219**	
S 235 S235 W	S 235 H	S 235 H	0,8
S 275 S 275 N/NL S 275 M/ML	S 275 H S 275 NH/NLH	S 275 H S 275 NH/NLH S 275 MH/MLH	0,85
S 355 S 355 N/NL S 355 M/ML S 355 W	S 355 H S 355 NH/NLH	S 355 H S 355 NH/NLH S 355 MH/MLH	0,9
S 420 N/NL S 420 M/ML		S 420 MH/MLH	1,0
S 460 N/NL S 460 M/ML S 460 Q/QL/QL1	S 460 NH/NLH	S 460 NH/NLH S 460 MH/MLH	1,0

Type of weld


Type of weld (cl.4.3.1)
Fillet welds
Fillet weld all round
Comprising fillet welds in circular or elongated holes.
Used only to transmit shear or to prevent the buckling or separation of lapped parts
Flare groove welds
Butt welds
Plug welds
Used for
to transmit shear
to prevent the buckling or separation of lapped parts
to inter-connect the components of built-up members
not to be used to resist externally applied tension
Design resistance $F_{w,Rd} = f_{vw,d} A_w$
$f_{vw,d}$ Design shear strength of a weld as in cl.4.5.3.3(3)
A_w Design throat area and taken as the area of the hole.

Design of Fillet weld (cl.4.5 EN 1993-1-8)

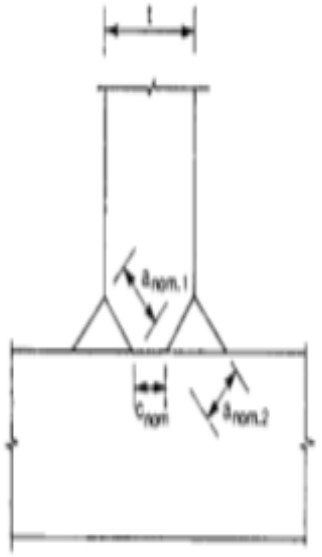
Fillet welds

- **General**
  - Angle between 60 and 120
  - Smaller than 60 is considered as partial penetration butt weld
  - Greater than 120, resistance should be check using EN 1990 Annex D
  - Intermittent fillet welds
- **Design**
  - $[\sigma_\perp{}^2 + 3(\tau_\perp{}^2 + \tau_\parallel{}^2)]^{0.5} \leq \frac{f_u}{\beta_w \gamma_{M2}}$ and $\sigma_\perp \leq \frac{f_u}{\gamma_{M2}}$ Directional method
    - $\sigma_\perp$ normal stress perpendicular to throat
    - $\sigma_\parallel$ normal stress parallel to the axis of the weld
    - $\tau_\perp$ shear stress perpendicular to axis of weld
    - $\tau_\parallel$ shear stress parallel to the axis of weld
    - f_u nominal ultimate tensile strength of the weaker part joined
    - β_w the appropriate correlation factor (Table 4.1)
  - Simplified method
    - $F_{v,Ed} \leq F_{w,Rd}$
      - $F_{w,Ed}$ design value of weld force per unit length
      - $F_{w,Rd}$ design weld resistance per unit length
    - $F_{w,Rd} = f_{vw,d}\, a$ Subtopic
    - $f_{vw,d} = \frac{f_u/\sqrt{3}}{\beta_w \gamma_{M2}}$
      - $f_{vw,d}$ design shear strength

Design of butt weld (cl.4.7 EN 1993-1-8)

Butt welds

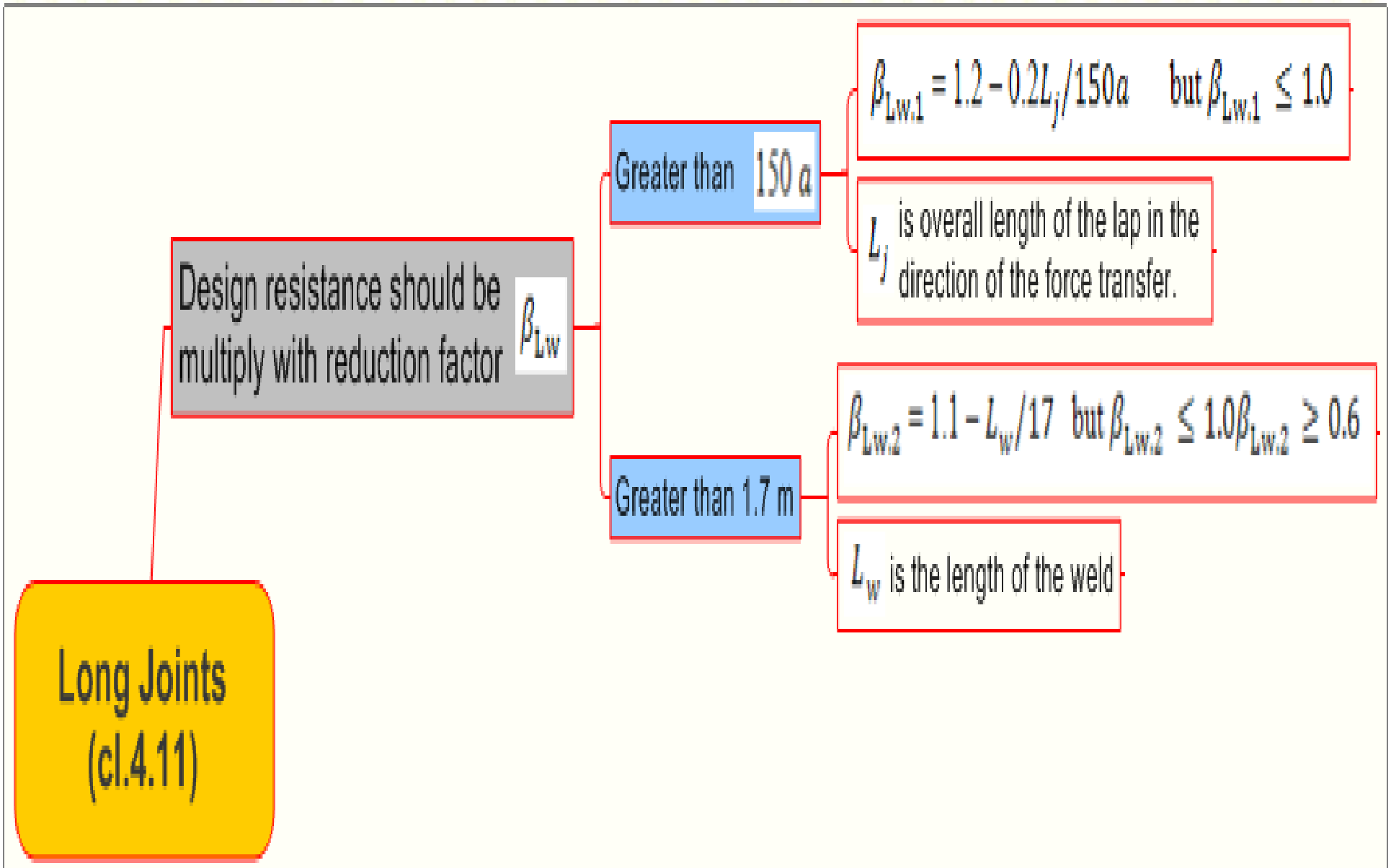
- **Full**
  - Complete penetration and fusion of weld and parent metal throughout the thickness of the joint
  - Design resistance should be taken equal to the design resistance of the weaker parts connected
- **Partial**
  - Joint penetration is less that full thickness of the parent metal
  - Design resistance is accordance to deep penetration of fillet weld cl.4.5.2(3)
- **T-but joints**



$a_{nom,1} + a_{nom,2} \geq t$

c_{nom} should be the smaller of $t/5$ and 3 mm

Long joints for weld



Weld unstiffened flanges (cl.4.10 EN 1993-1-8)