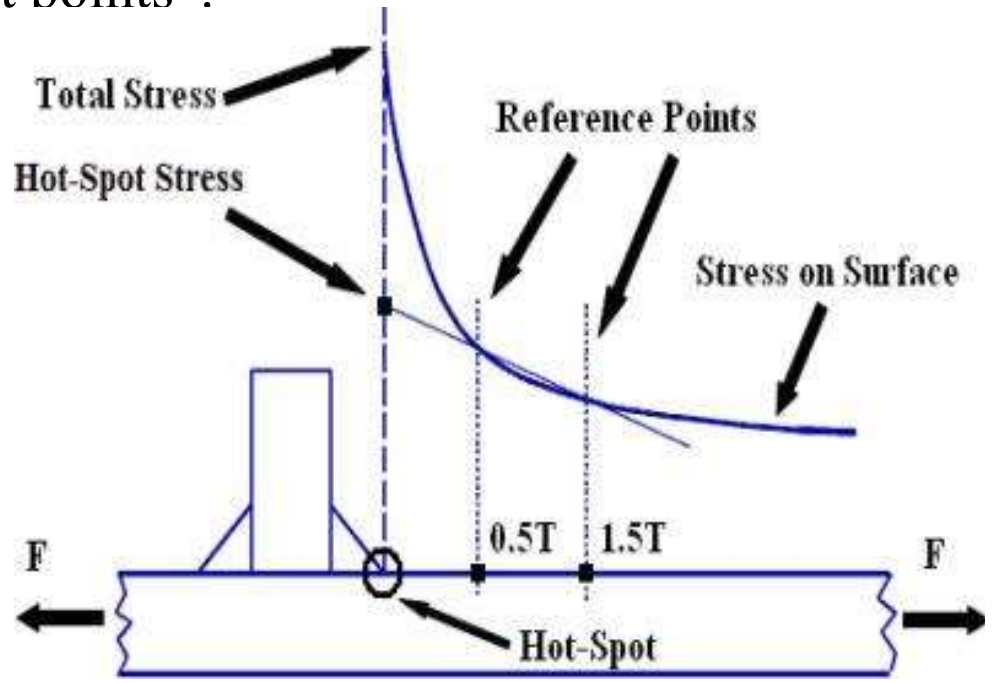
Structural Hot Spot Method

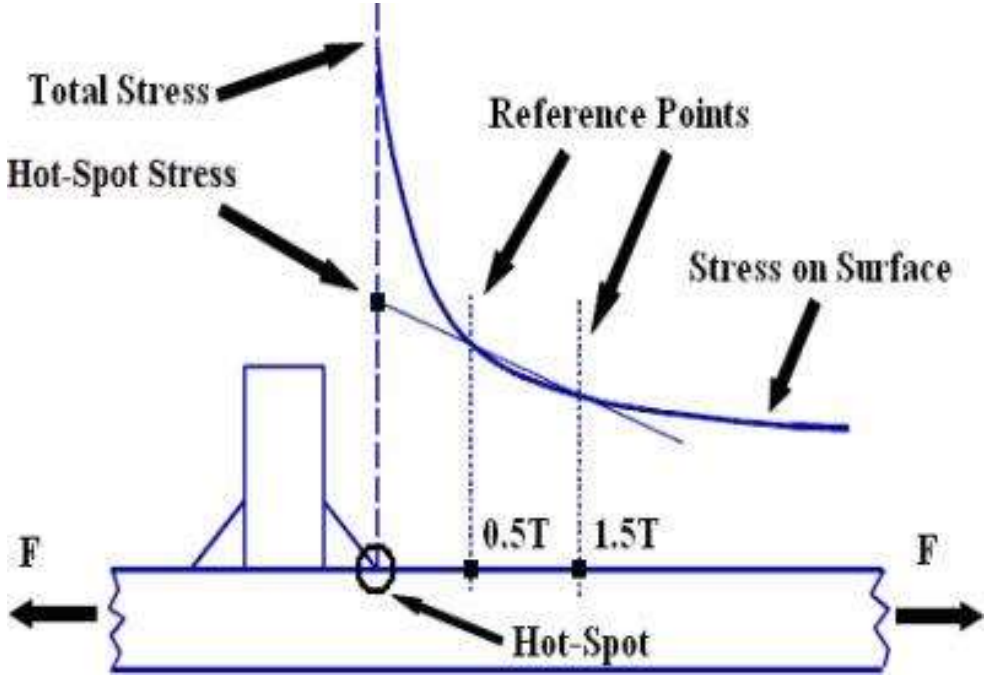
Structural Hot Spot Approach

- Developed for evaluating the fatigue strength of welded structures in cases where the nominal stress is hard to estimate because of geometric/loading complexities.
- This method has been used in the fatigue design of welded structures since 1960s.
- Become a codified procedure for evaluating the fatigue life of welded structures.
- The philosophy of the structural hot-spot stress method is to base the fatigue verification on the structural/geometric stress at the point of crack initiation (usually a weld toe), the, so called, "hot-spot points".

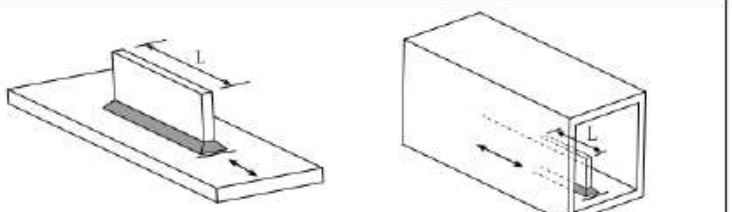
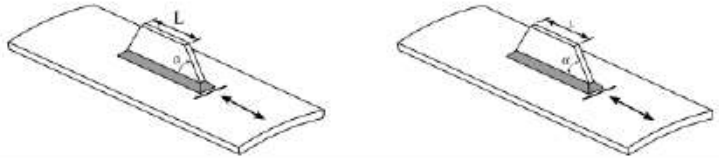
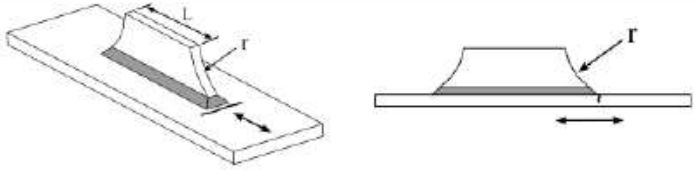


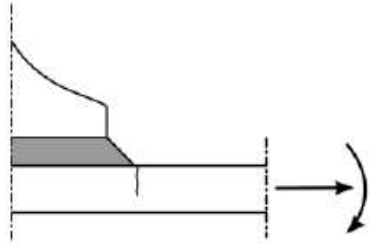
Structural Hot Spot Approach

- The major advantage of the structural hot-spot stress approach is that the "global" stress raising effects caused by the geometry of the detail are implicitly taken into account in the stress calculations.
- One consequence of this is that the number of *S*–*N* curves needed for fatigue evaluation with the structural hot-spot stress method is substantially reduced, which is another advantage of this method.



Nominal Stress vs Hot Spot Approach

Nominal stress method		
Detail category	Construction detail (Longitudinal attachments)	
C80	L ≤ 50mm	
C71	50 < L ≤ 80mm	
C63	80 < L ≤ 100mm	
C56	L > 100mm	
C71	L > 100mm α < 45°	
C80	r > 150mm	

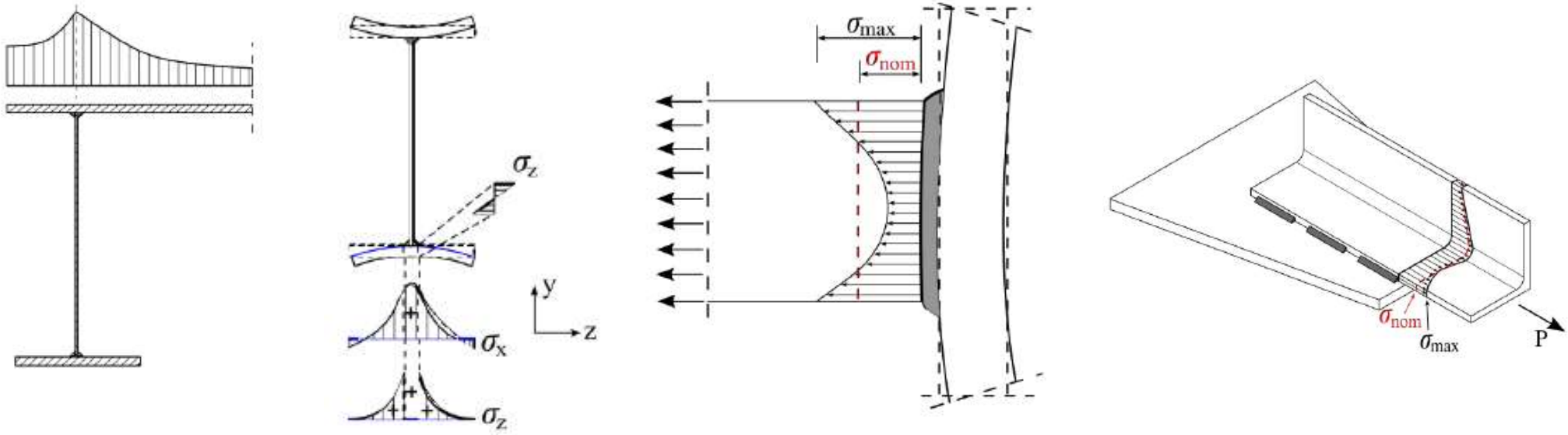
Hot spot stress method	
Detail category	Construction detail (Longitudinal attachments)
C100	

- 6 different detail categories are needed to describe the fatigue strength of a simple non-load carrying attachment, based on different geometrical parameters
- Effect of stress concentration caused by the geometry of the detail is covered on the resistance side

- Only one fatigue category is needed when the structural hot-spot stress method is applied
- Effect of stress concentration caused by the geometry of the detail is accounted for on the load-effect side

Structural Hot Spot Approach

- The structural hot-spot stress is usually derived from finite element models of the structure or the structural element or detail under consideration.
- Therefore, both global and local stress effects, such as those mentioned above are directly and accurately accounted for in the calculation of load effects.



Structural Hot Spot Approach

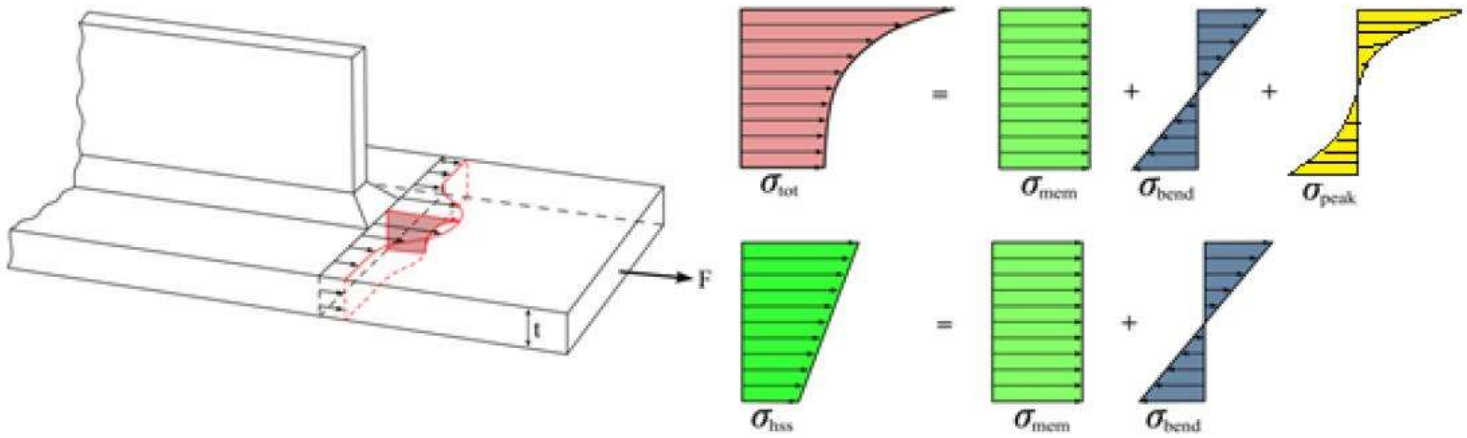
- The **fatigue strength** of any welded detail is, basically, a function of three main parameters:
  1) The stress concentration effects caused by detail geometry, also called geometric discontinuities
  2) The local stress raising effects caused by the shape and dimensions of the weld and the surrounding region
  3) Local weld defects such as undercuts, porosities, lack of fusion and similar

- When fatigue verification is performed with the conventional nominal stress (S-N) method, all these parameters are accounted for on the fatigue resistance side, i.e. in the process of selection of a suitable S-N curve.

Structural Hot Spot Approach

- On the contrary, the stress range used in fatigue design with the structural hot-spot stress method already includes the stress raising effects, emanating from geometrical discontinuities and/or caused by complex loading conditions (point 1 in previous slide).
- As a result, the S-N curves to be used with this method need only to cover the local stress raiser effects and the local weld defects in different welded details, which require only a few S-N curves.
- However, local stress effects due to the weld itself (point 2 in previous slide), are excluded in the derivation of the hot-spot stress and need to be accounted for on the fatigue resistance side.

Structural Hot Spot Approach



Total stress = Nominal membrane stress + Bending stress due to detail geometry + Non-linear stress due to local weld geometry

Hot-spot stress = Nominal membrane stress + Bending stress due to detail geometry