



# WELD DESIGN — STRESS COMPONENTS & VERIFICATION (IMPROVED)

Design the stress path, not just the weld size.



## 1. STRESS COMPONENTS BY ACTION

WELD	$N$ (AXIAL)	$M_y$ (BENDING)	$M_z$ (BENDING)	$V_y$ (SHEAR)	$V_z$ (SHEAR)	TORSION $T$
FLANGES 	$\sigma_{\perp} + \tau_{\perp}$	$\sigma_{\perp} + \tau_{\perp}$	$\sigma_{\perp} + \tau_{\perp}$	$\tau_{\parallel}$ (parallel)	–	$\tau_{\parallel} + \tau_{\perp}$ + warping + $\sigma_{\perp}$
WEB 	$\sigma_{\perp} + \tau_{\perp}$	$\sigma_{\perp} + \tau_{\perp}$ (linear)	negligible	–	$\tau_{\parallel}$ (parallel)	$\tau_{\parallel} + \tau_{\perp}$

### STRESS COMPONENT DEFINITIONS

$\sigma_{\perp}$  = from  $N$ ,  $M_y$ ,  $M_z$ , warping  
 $\tau_{\perp}$  = from  $N$ ,  $M_y$ ,  $M_z$ , torsion  
 $\tau_{\parallel}$  = from  $V_y$  (flanges),  $V_z$  (web), torsion

### ✓ KEY POINT

$N$  contributes only to  $\sigma_{\perp}$  and  $\tau_{\perp}$ .  
**Avoid  $\tau_{\parallel}$  whenever possible.**

### LEGEND

$\sigma_{\perp}$  Perpendicular (normal) stress  
 $\tau_{\perp}$  Perpendicular shear stress  
 $\tau_{\parallel}$  Parallel shear stress  
 – Not applicable

## 2. VERIFICATION (EUROCODE PLASTIC CRITERION)

FULL PLASTIC INTERACTION

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

AND

PERPENDICULAR  
NORMAL  
STRESS

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

$f_u$  Ultimate tensile strength of weld metal  
 $\beta_w$  Correlation factor (Eurocode)  
 $\gamma_{M2}$  Partial safety factor

## 3. WHY THIS IS VALID



### LOWER BOUND THEOREM

Any stress field that satisfies equilibrium and nowhere exceeds the yield criterion is safe.

Therefore, we are free to design how forces flow through the weld group, provided:

- Resultants match the external loads
- Stresses remain admissible



By transmitting  $N$  through  $\sigma_{\perp}$  and  $\tau_{\perp}$ , we avoid  $\tau_{\parallel}$ , which often governs the design.  
***This reduces equivalent stress and improves weld efficiency.***

## 4. BOTTOM LINE



This is not just a correction.  
 It is a shift from:

*“following the elastic stress path”*



*designing the stress path*



DESIGN THE **STRESS PATH**. VERIFY THE RESULT. BUILD WITH **CONFIDENCE**.