Errata ECCS manual fatigue design of steel and composite structures

3.3.4 "stress in welds", pages 99-100

The book says "sigma parallel" should be considered and combined to find "sigma w", this is wrong and thus the formula 3.23 contains an error.

The formulas in EN 1993-1-9, section 5 (6), page 12 are correct, see below.

(6) The relevant stresses in the welds are (see Figure 5.1)

- normal stresses σ_{wf} transverse to the axis of the weld: $\sigma_{wf} = \sqrt{\sigma_{\perp f}^2 + \tau_{\perp f}^2}$
- shear stresses τ_{wf} longitudinal to the axis of the weld: $\tau_{wf} = \tau_{\| f}$

for which two separate checks should be performed.

NOTE The above procedure differs from the procedure given for the verification of fillet welds for the ultimate limit state, given in EN 1993-1-8.

One has to combine the sigma and tau perpendicular, which acts on the same facet to get the normal stress transverse to the axis of the weld.
Then one has two other stresses, longitudinal, that can act on the weld:
- the shear stress longitudinal to the axis of the weld, equation (3.24)
- the normal stress on the whole section longitudinal to the axis of the weld, and thus acting also on the weld, $\sigma_{//}$

Correct formulas :

- Nominal resulting normal stress :

$$\sigma_w = \sqrt{\sigma_\perp^2 + \tau_\perp^2} \quad with \quad \tau_\perp = \frac{F_x}{w \cdot \ell} \qquad (3.23)$$

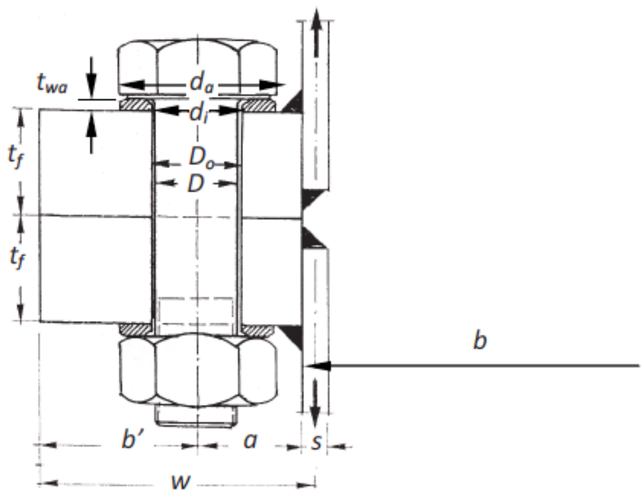
- Nominal resulting shear stress :

$$\tau_w = \tau_{//} = \frac{F_y}{w \cdot \ell} \qquad (3.24)$$

Suppress equation (3.25)

Figure 3.34, page 132

Some legends are not placed appropriately, see corrected version below.



Example 5.5, pages 211- 213

The notation in the formula for the stress range is inappropriate and may lead to errors regarding the partial safety factors considerations. The correct formulas on pages 211 and 213 are:

$$\Delta\sigma\left(\gamma_{Ff}Q_k\right)=\sigma_{\max}\left(\gamma_{Ff}Q_k\right)-\sigma_{\min}\left(\gamma_{Ff}Q_k\right)=23.2\ MPa$$
$$\Delta\sigma_{E,2}=\lambda\cdot\Delta\sigma\left(\gamma_{Ff}Q_k\right)=2.0\cdot 23.2=46.4\ MPa$$

Example 5.7, pages 216- 217

The table with damage sum is wrong.
For the lorries causing damage, lorry no 3, ni for 100 years is 100 millions and Ni should be 69424000 cycles. And for lorry no 5, ni is 20 millions and Ni = 88396000 cycles. Then we get Di = 1.44+ 0.226 = 1.667. It will effectively not meet the 100 years life, but only 100*1/1.667 = 60 years.
Thus, this example shows that FLM 4 is more detrimental than FLM3, and that effectively they are not well matched/calibrated. Especially since the engineer is not rewarded for making the effort of using a longer verification procedure with FLM4 instead of FLM3.

Corrected table 5.4

FLM4 Lorry	Traffic share (%)	ni/year	Sr (MPa)	ni	Ni	Di=ni/Ni
1	20	400000	9.7	40000000	infini	0.000
2	5	100000	12.5	10000000	infini	0.000
3	50	1000000	21.2	100000000	69423784.58	1.440
4	15	300000	18.6	30000000	infini	0.000
5	10	200000	20.2	20000000	88395619.25	0.226
Total	**100**	**2000000**		**200000000**		**1.667**

Working life= **60.0** years

5.4.5 Verification of tension components, page 218

EN 1993-1-11 does not give any indication about either a CAFL or a cut-off limit, see figure below. From literature, we have assumed that there is endurance limit [1].
A CAFL might exists but since the fatigue strength of wires, cables is highly depending on: 1) anchorages and thus a combination of tension, bending fatigue as well as fretting fatigue, 2) the mean stress value. Thus it cannot be taken into account in the design. Note that in the EN 1993-1-11 (§ 2.4.2) the γ_{Mf} value should be chosen in function of the measures employed to suppress bending effects.

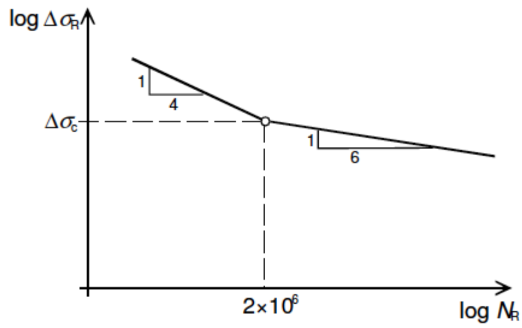


Figure 9.1: Fatigue strength curves for tension components

In view from the above, it cannot be taken for granted that a CAFL exists and formula 5.8 is wrong. It should read :

$$\lambda_{\max} \cdot 1.92 \cdot \Delta\sigma\left(\gamma_{Ff} Q_k\right) \leq \frac{\Delta\sigma_C}{\gamma_{Mf}} \quad (5.8)$$

Then, the explanation below formula 5.8 should be adapted as follows :
Where the translating factor is now computed from the S-N curve with a slope m = 6 as $\Delta\sigma_C / \Delta\sigma_L = (10^8 / 2 \cdot 10^6)^{1/6} = 1.92$. Practically, this means that all cycles must remain below the value at 100 million cycles, which is a conservative approach. As in equation (5.6), the factor λ_{max} is used in this specific case, even if the S-N curves under constant and variable amplitude loadings are both the same and with two slopes. Finally, note that specific lambda factor values should be computed for the S-N curve for cables, but the λ_i, λ_{max} given for welded joints for each type of structure may be used as one can neglect the small differences in the S-N curves slopes (slopes 4 and 6 instead of 3 and 5, and knee point at a slightly different nb of cycles). Computations have shown that the influences of such slope changes affect the λ_{max} values by less than 15% [2].

[1] Federico Cluni, Vittorio Gusella, Filippo Ubertini, **A parametric investigation of wind-induced cable fatigue**, *Engineering Structures, Volume 29, Issue 11, November 2007, Pages 3094-3105*

[2] Maddah, Nariman, Fatigue Life Assessment of Roadway Bridges with Actual Traffic Loads, EPFL thesis n° 5575, Lausanne, 2013