EC9 – Fatigue Curves

It has always struck me, as a practising engineer, that the various codes of practice we use are rather poorly written and produced. I remember an occasion, working in a busy design office, when a colleague jumped up with joy and exclaimed, 'got the bugger!' He'd been trying to understand part of one of the British Standards. 'Canon', he said, 'if they'd only put this diagram into the code then I'd have saved a day and a half of my time!'

This lack of clarity is, I'm afraid, typical of many of the British Standards and also extends to the Eurocodes. This technical note looks at how the fatigue data presented in the Eurocode, EC9, might be better presented.

The fatigue data in EC9 is presented in a manner aimed at simplifying the engineer's task in assessing the structural integrity of his/her design. The engineer used to conventional fatigue assessment needs to put all that knowledge on Goodman diagrams, mean stress corrections, etc., to the background when using EC3. All he/she needs to do is to identify the *detail category* from the table provided to identify the correct SN curve in figure 7.1 of EC9 and out pops the design stress required to avoid fatigue failure or to offer a given service life.

(3) For nominal stress spectra with stress ranges above and below the constant amplitude fatigue limit $\Delta\sigma_D$ the fatigue strength should be based on the extended fatigue strength curves as follows:

$$\Delta\sigma_R^m N_R = \Delta\sigma_C^m \, 2\times10^6 \quad \text{with } m = 3 \text{ for } N \le 5\times10^6$$
$$\Delta\sigma_R^m N_R = \Delta\sigma_D^m \, 5\times10^6 \quad \text{with } m = 5 \text{ for } 5\times10^6 \le N \le 10^8$$

$$\Delta\sigma_L = \left(\frac{5}{100}\right)^{1/5} \Delta\sigma_D = 0{,}549\Delta\sigma_D \quad \textbf{is the cut off limit, see}$$

Figure 7.1.

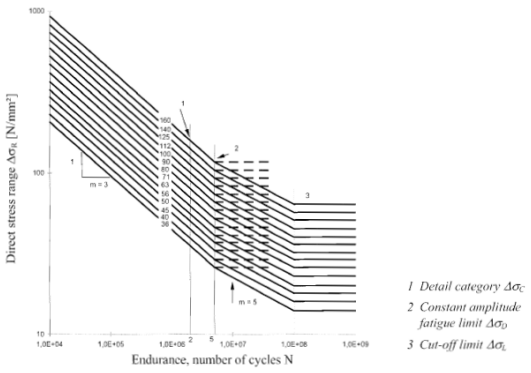
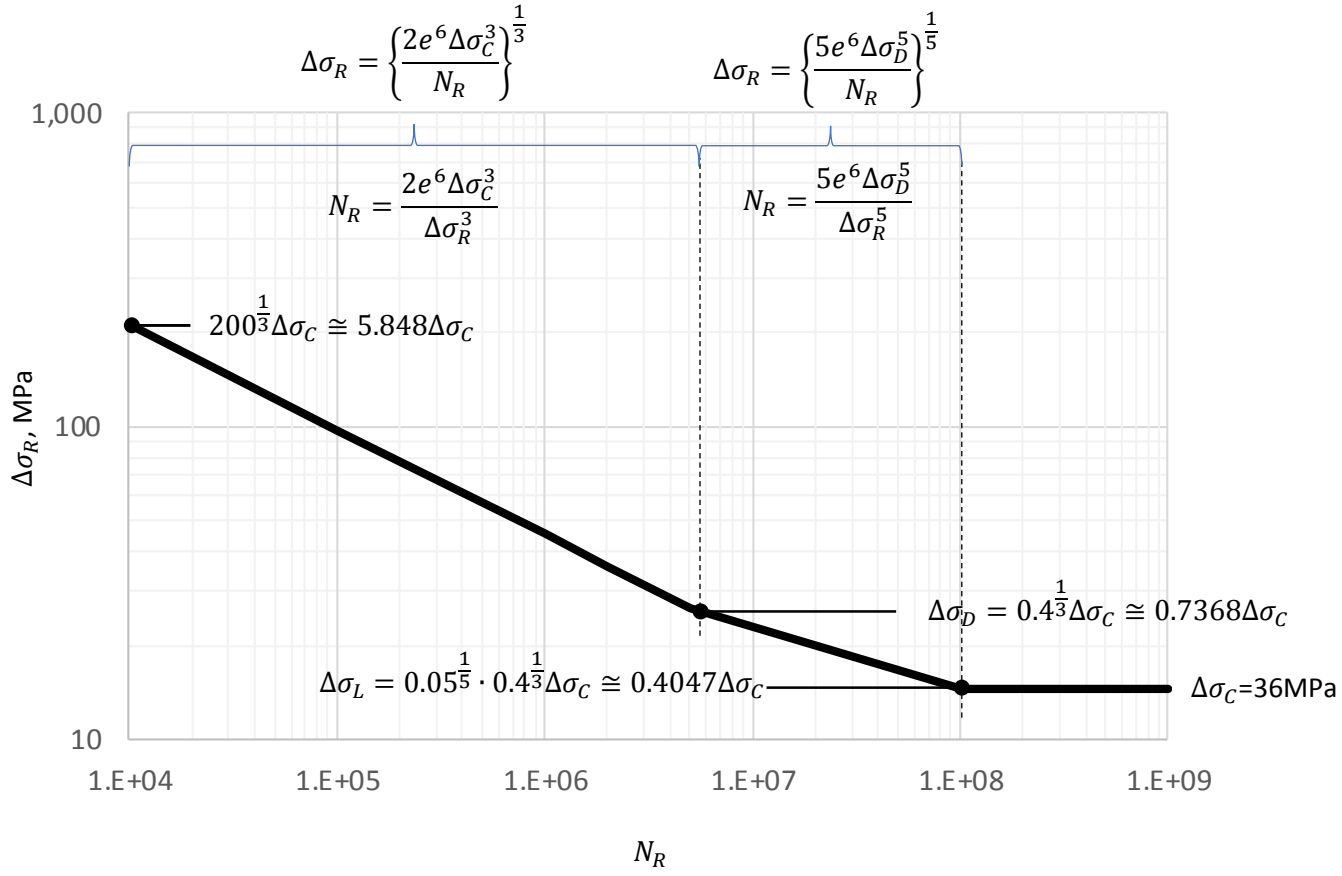


Figure 7.1: Fatigue strength curves for direct stress ranges


$\Delta\sigma_R = \left\{\frac{2e^6\Delta\sigma_C^3}{N_R}\right\}^{\frac{1}{3}}$
$\Delta\sigma_R = \left\{\frac{5e^6\Delta\sigma_D^5}{N_R}\right\}^{\frac{1}{5}}$
1,000
$N_R = \frac{2e^6\Delta\sigma_C^3}{\Delta\sigma_R^3}$
$N_R = \frac{5e^6\Delta\sigma_D^5}{\Delta\sigma_R^5}$
$200^{\frac{1}{3}}\Delta\sigma_C \cong 5.848\Delta\sigma_C$
$\Delta\sigma_R$, MPa
100
$\Delta\sigma_D = 0.4^{\frac{1}{3}}\Delta\sigma_C \cong 0.7368\Delta\sigma_C$
$\Delta\sigma_L = 0.05^{\frac{1}{5}} \cdot 0.4^{\frac{1}{3}}\Delta\sigma_C \cong 0.4047\Delta\sigma_C$
$\Delta\sigma_C$=36MPa
10
1.E+04
1.E+05
1.E+06
1.E+07
1.E+08
1.E+09
N_R