
Taking into account of execution quality, steel grade and post-welding treatment in Eurocode 3 Part 1-9

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Fatigue behaviour and thus the probability of failure of a structural detail subject to fatigue is mainly dependant on five parameters: stress range, geometry of the detail, initial imperfection size, material characteristics and environmental conditions. Eurocode 3 Part 1-9 (EN 1993-1-9) defines the resistance to cyclic loading in terms of the detail category $\Delta\sigma_C$ which is the numerical designation given to a particular detail for a given direction of stress fluctuation, in order to indicate which fatigue strength curve is applicable for the fatigue assessment.

Since fatigue behaviour is mainly influenced by stress range, and assuming imperfections are within tolerances, the probability of developing a fatigue crack with time is function of the fatigue utilisation grade (not explicit in EN 1993-1-9), which can be expressed as : $U = E_d/R_d = \gamma_{FF} \Delta\sigma_{E,2} / (\Delta\sigma_C / \gamma_{MF})$. For the same U, all details can be said to be equal in terms of failure probability and thus fabrication quality and controls should be a function of U. Nevertheless, in structural details where fatigue is preeminent, higher levels of fabrication quality and controls might be necessary to guarantee the design fatigue resistance of these details. Failure probability / consequences, and thus fabrication quality and controls, should also depend on the detail category.

Regarding the choice of not only execution quality (Execution Class in EN 1090-2), but also the influence of steel grade (existing detail categories in the standard, valid up to S460, are extended to S690 in EN 1993-1-12) and of post-welding treatment, nothing is explicitly recommended in EN 1993-1-9. An attempt to associate particular detail categories $\Delta\sigma_C$ to Execution and Consequence Classes recently failed to get the approval of all the national standardisation bodies within CEN.

Nevertheless, since 2009 there has been a working group within ECCS TC6 "Fatigue", narrowly associated with the CEN evolution group on EN 1993-1-9, with a task of extending the fatigue approach to take into account execution quality, different steel grades and post-welding treatment and including it in the next revision of the standard. The final stage in this process would be to define the actual fitness-for-purpose (ffp) criteria for particular details.