

FAT1 EXERCISE: S-N CURVES

1. Data

The fatigue behaviour of metal parts can be described using curves between the number of cycles – stress differences, or S-N curves, see Fig. 1.

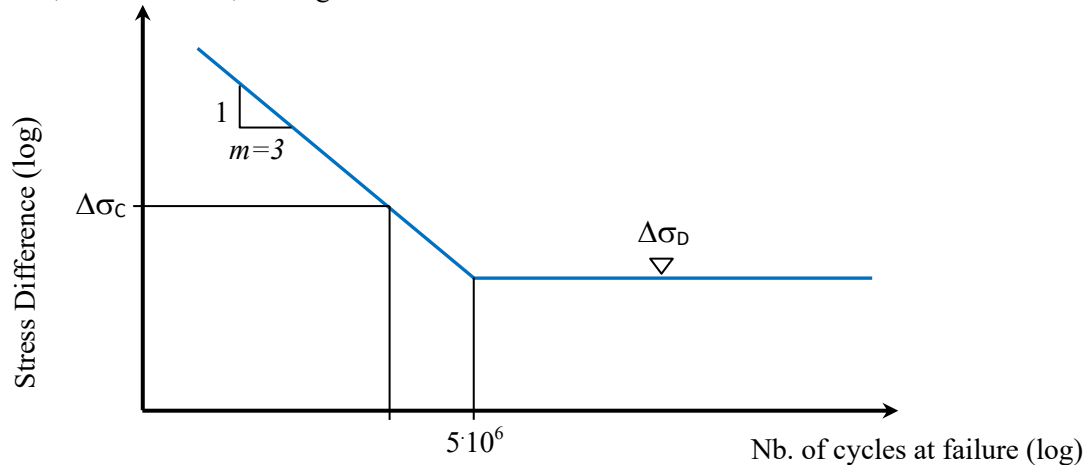


Figure 1: S-N curve

Questions

- 1.1. How many cycles does a detail category have?
- 1.2. Express the stress difference $\Delta\sigma_D$ as a function of $\Delta\sigma_C$.
- 1.3. For a detail with a constant $C = 1.46 \cdot 10^{12}$, determine the detail category and the stress difference corresponding to 100'000 cycles.
- 1.4. What is the service life for the following case ? Detail category 100, cycles between the following min. and max. stresses: $\sigma_{Ed,min} = -30$ MPa, $\sigma_{Ed,max} = 40$ MPa

2. Multiple choice questions

Answer the following questions:

- 2.1 To what other problem is the solution of the problem of crack instability analogous?
 - A) Solution to the problem of slope stability in geotechnics
 - B) Solution to the buckling problem
 - C) Solution to the problem of progressive collapse
 - D) The problem of exponential degrowth.
- 2.2 For each detail, a portion of the cycles corresponds to the initiation of cracks and another to the propagation. Put the following proposals for different details in the order from the one with the highest portion of initiation cycles to the one with the lowest
 - A) High-quality welded joints
 - B) Drilled holes
 - C) Mechanical parts
 - D) Standard welded joints

2.3 What are the common parameters for the solutions of the problem of crack instability and buckling? (several answers possible)

- A) Imperfections
- B) Scale effects
- C) Residual stresses
- D) Stress concentrations.

3. Group small project : search and discuss a fatigue fracture

This exercise counts for 10% of the final grade.

Data

Look for and explain a case of fatigue damage, or failure, preferably of a bridge. There are two options to choose from:

- A. Find yourself in the literature an example of failure within a structure or of a structure (use the search engines BEAST, SCOPUS, etc. and not just Google). There could be recent cases I am not aware of. For your info. among the scientific journals that contain failure cases, there is:
 - Structural Safety,
 - Journal of performance of constructed facilities,
 - Engineering Failure Analysis.
- B. Choose a case from the list of bridges given on the Moodle. This list also contains some indications where to start your research (link, article, etc.). Please organize yourselves so that there are not two groups dealing with the same case.

Requested

Summarize (title page plus three to four A4 pages), in French or English, in your own words (not simply by copy/paste), your understanding of the problem: the structure involved, the circumstances of the failure as well as the main parameters responsible for this failure. Don't forget to put the references used. Upload your work to Moodle (as shown below).

Conditions:

- The exercise is **carried out in groups of 2 people**.
- Deadline : **see on Moodle**.
- Form of the assignment: **1 person (from the group)** uploads the file in pdf format to Moodle using the following name format:

Option_name1_surname1_name2_surname2_FAT1.pdf

Under **Option**, specify A or B.

- Don't forget to write your first and last names on the title page of your submission, as well as the date, the course number (and not only in the filename), thank you.