FAT5 EXERCISE: SIMPLIFIED FATIGUE CHECK

Data

Let us consider a steel-concrete composite bridge with 3 spans, 60 m + 80 m + 60 m (i.e. with a total length of 200 m), see Figure 1. The cross-section is a twin-girder as shown in Figure 2 (showing ½ typical span section and ½ typical support section). Eurocodes are used in this exercise and the bridge must be checked for fatigue. It is a two lane bidirectionnal overpass bridge that serves to acccess the highway, category 1 traffic will circulate on it (2 million heavy vehicles per year and per direction). For the purpose of this exercise, we will only check details located in the 3 sections represented in Figure 1.

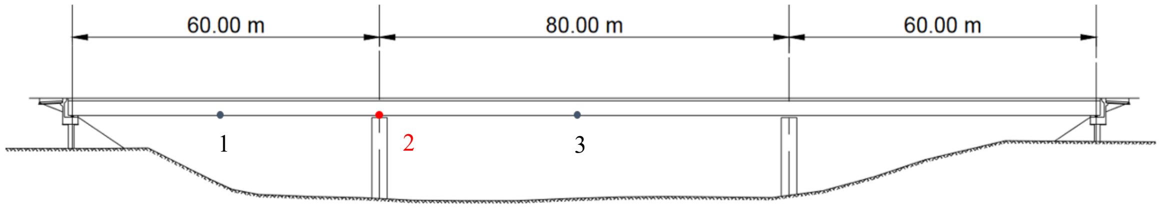

Figure 1: longitudinal profile of the road bridge

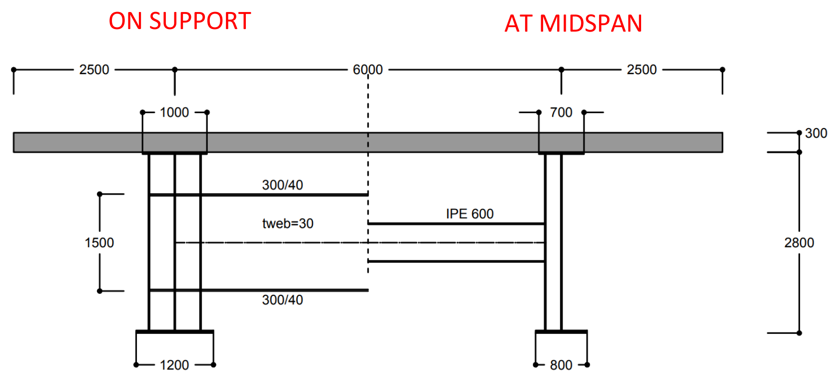

Figure 2: Typical cross-section

The elastic section modulus (lower flange) of this mixed section are as follows: in span $W_{b,0,inf,span} = 1.37 \cdot 10^8$ mm^3 and on support $W_{b,0,inf,support} = 4.52 \cdot 10^8$ mm^3. The positioning of the traffic lanes and the admitted transverse distribution line are given in Figure 3.

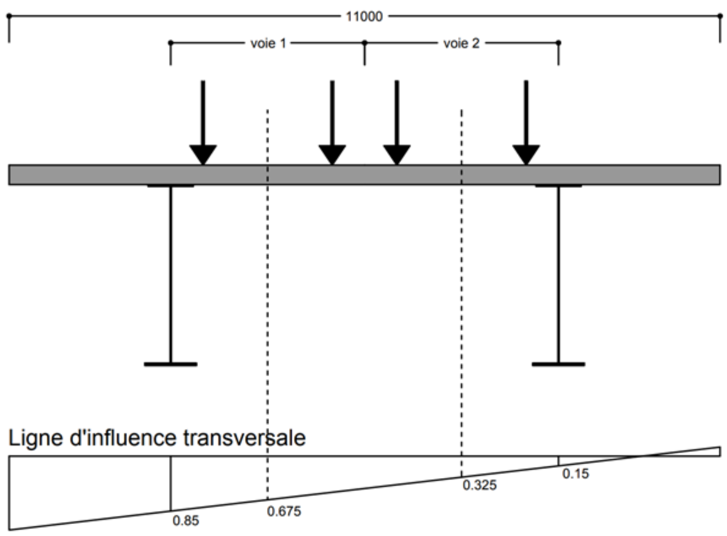

Figure 3: Lane Positioning and admitted transverse distribution line for the left beam

The transverse distribution line allows to compute the part of each lane load (lane 1, lane 2) that will be carried by each beam in bending.

The details subject to verification are shown in Figure 4. For sections 1 and 3 (mid-span), we will check the welded attachment of the vertical stiffener on the lower flange. For section 2 (on support), this time it will be the welded attachment of the T-stiffener on the lower flange.

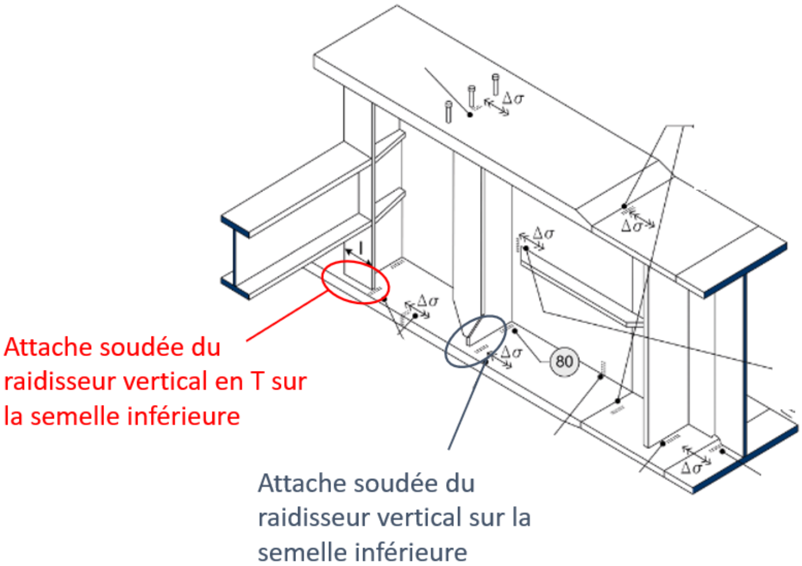

Figure 4: Figure showing the details to check for fatigue (function of the section)

Given the span, the FLM3 fatigue load model can be simplified to a single axle with a weight corresponding to that of the model, i.e. $Q_{fat} = 4*120 = 480$ kN. The lines of influence for the 3 sections are given in Figure 5 (you can also recompute them using any FE software on the market).

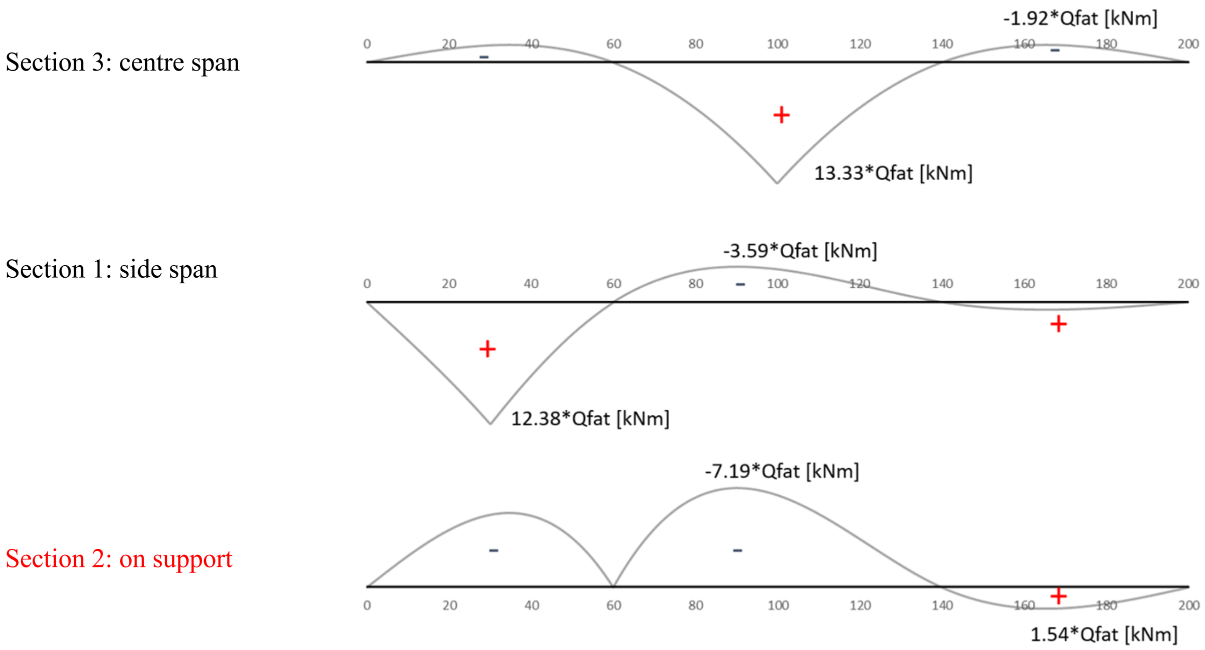

Figure 5: Lines of influence

Questions

1 Determine the resulting equivalent damage factor lambda λ (i.e. using the partial factors λ_i and λ_{max}) for the following cases:

a. For each span and support regions, the resulting λ under the action of a bending moment.

b. And what is the value of the resulting λ for a longitudinal weld located in the beam web and in the side span?

2. Determine stress differences $\Delta\sigma$ in the three sections to be checked.
3. Perform the fatigue check of the relevant detail in each of the three sections; propose a solution if one does not comply.