BRUFACE **Dynamics of Structures**

MA1 Civil Engineering **Academic year 2021-2022**

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Sessions 6 : Wind verification of a work of art: the Arc Majeur according Eurocode 1991-1-4

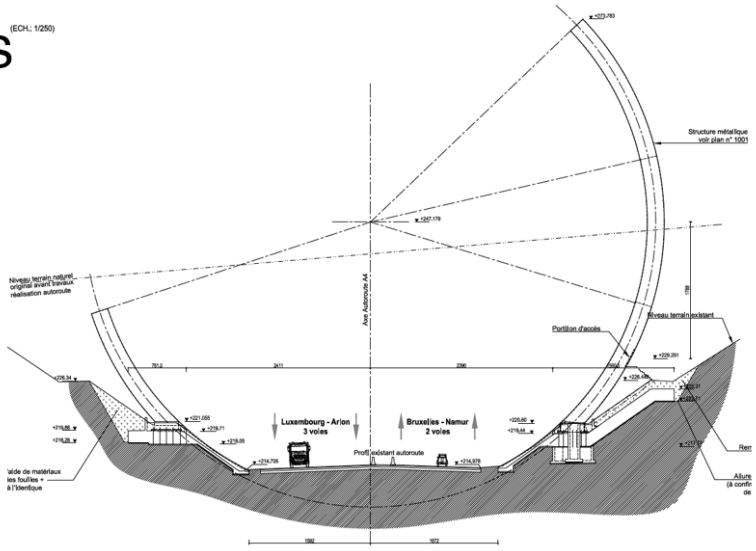
The Arc Majeur is a work of art built along the motorway E411 between Brussels and Luxembourg. It is constituted of 2 cantilever beams encircling the motorway. We ask you to define the wind loads and verify the wind vibrations of the tallest one.

The main dimensions are

Main dimensions (ECH.: 1/250)

- Angle of 205°
- Radius of 38,5m
- Height : 60m
- Square section 2,25m
- Corten Steel: thk of 20 mm, 30mm and 40mm

- Total mass 147 To + 37 To
- Foundations: 1200 To



The structure is an arc and is modelled as a cantilever beam. The height is 60m and the radius is equal to 38.5m. The shape of the section is a square hollow section 2,25 m x 2,25m. The thickness is 40mm for lower third, 30 mm for the middle part and 20 mm for the upper third.

To make the wind verification of the arc, we ask you to:

1. Calculate the wind characteristic at the top of the arc
    - Mean wind speed = 31 m/s
    - Turbulence intensity = 0.141
    - The peak wind speed = 43.7 m/s
    - The peak wind pressure = 1200 N/m²

    The wind characteristics are:

    Reference wind speed = Vb,0 = 23m/s

    Return period = 50 years

    Cdir = Cseasonal = C_0 = 1,0

    Terrain Category II ➔ z0 = 0.05 and zmin = 2m

    The force coefficient for a square section is taken equal to: Cf = 2,0

Results already given, do not calculate them

2. Vortex shedding stability (EN 1991-1-4: Annex E)
    - Calculate the critical wind speed to vortex shedding
    - Compare to the top mean speed
    - Compute the maximum displacement under vortex shedding according:
    - method 1 (EN 1991-1-4 E.1.5.2)
    - method 2 (EN 1991-1-4 E.1.5.3)
    - Compare both values
    - Design a Tuned Mass Damper (TMD) to divide the maximum displacement by 10:
        - Use Den Hartog formulation to optimise the TMD
        - Plot the Bode diagram of the 1 dof system
        - Compare with the 2 dof's (+TMD) system to optimise the dimensions of the TMD