Arnaud Deraemaeker (arnaud.deraemaeker@ulb.be)
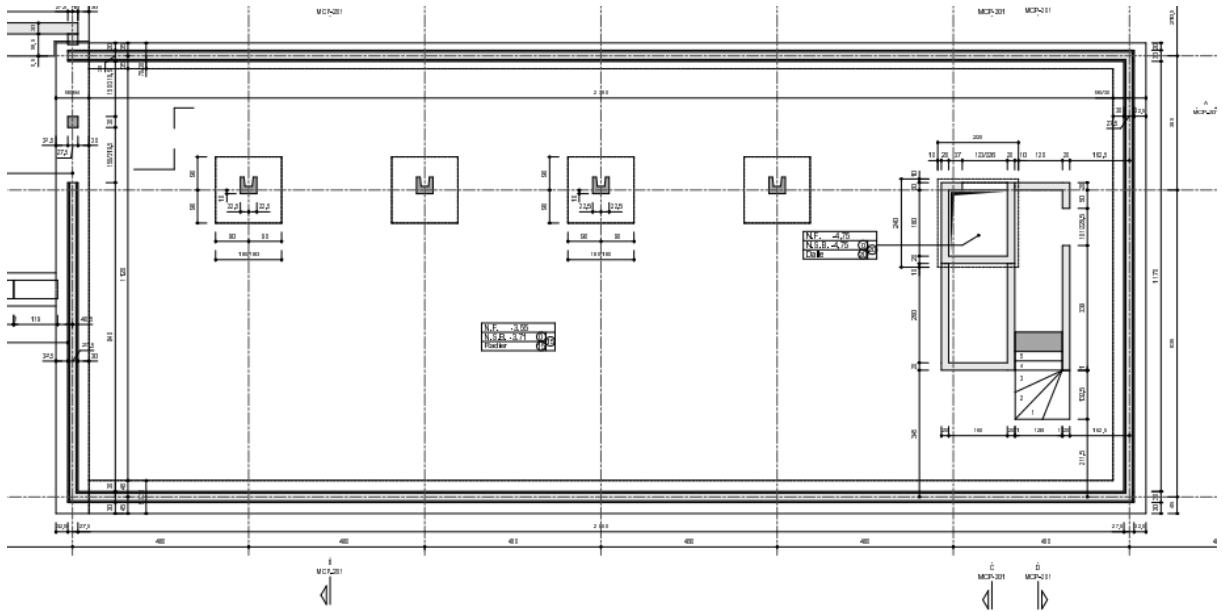
Yves Duchêne (yduchene@greisch.com)

Sessions 3 – 4 : Parasismic verification of a building according to Eurocode 8

Make the seismic verification of the building of the sport center located in Liege according to the Eurocode EN 1998-1
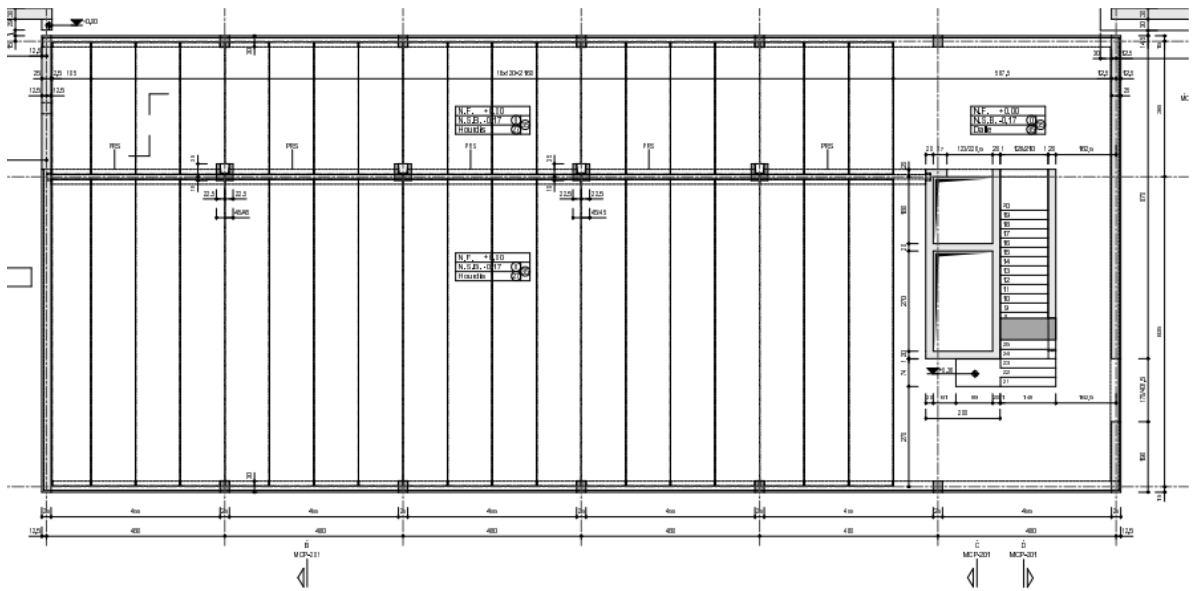
The building characteristics are:

- Rectangular building of dimensions 45 X 15 m

- 1 ground level + 1 level and an underground level ➔ 3 levels

- Columns and central nucleus in concrete. All the other walls are in masonry except the underground walls which are in concrete

- The slabs are in concrete

- The building is located in Liege with a soil class C according to EN 1998-1

- The building is an office building with meeting rooms

- Concrete is C 30/37 with an instantaneous non cracked Young's modulus of 35 000 N/mm²

- The dead masses of the floor are 600 kg/m² and 500 kg/m² for the roof

- The live loads are 500 kg/m²

- The vertical component of the earthquake is not taken into account
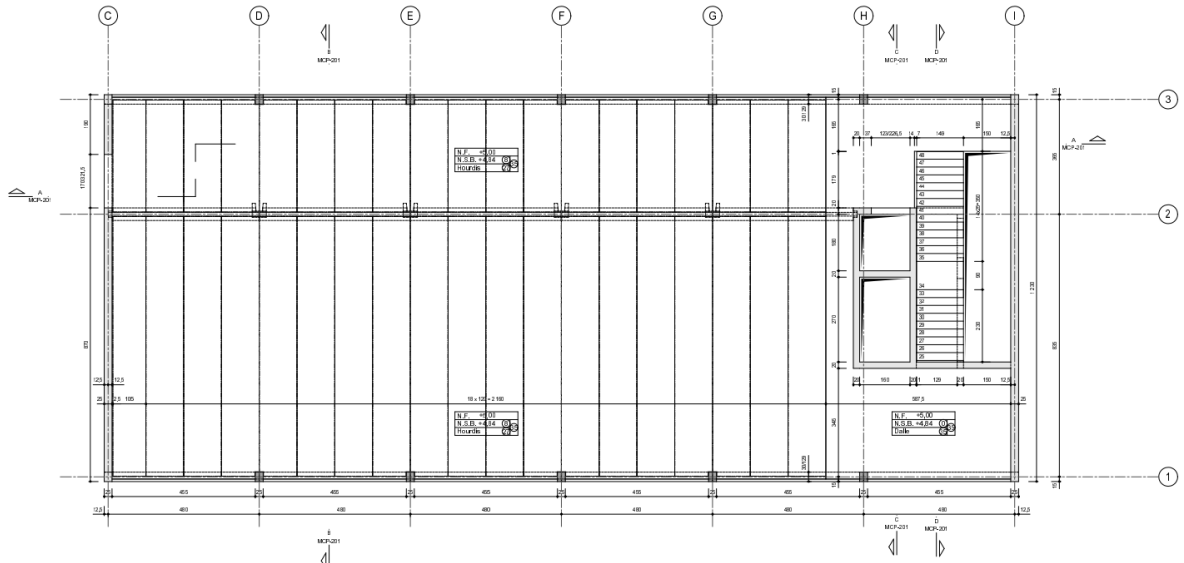
- The behaviour q factor is taken equal to 1.5

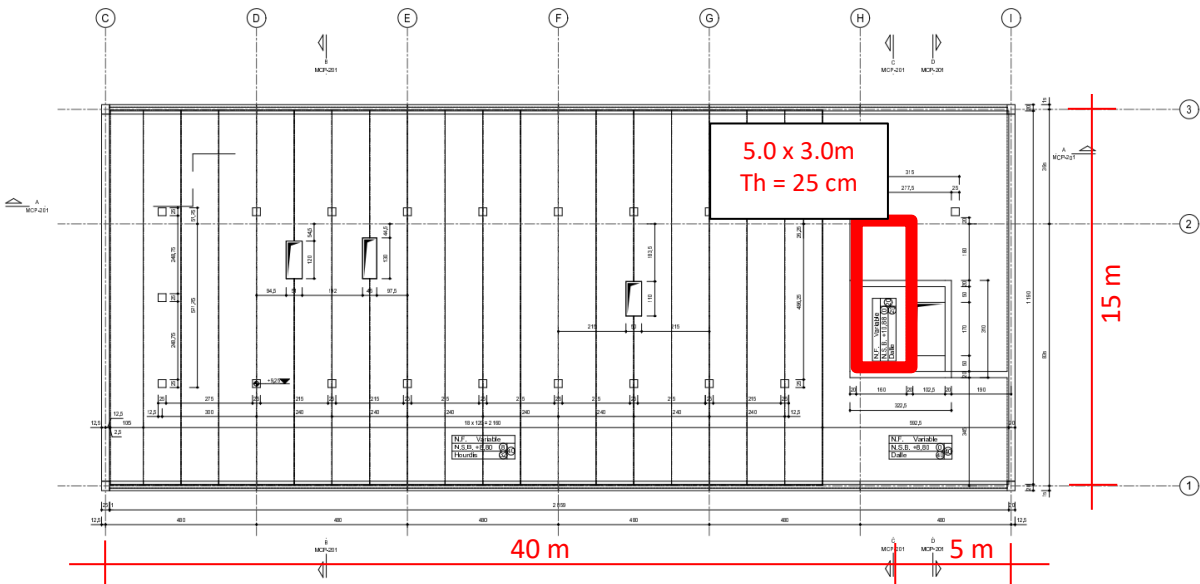Views of the building are given in the next figures:
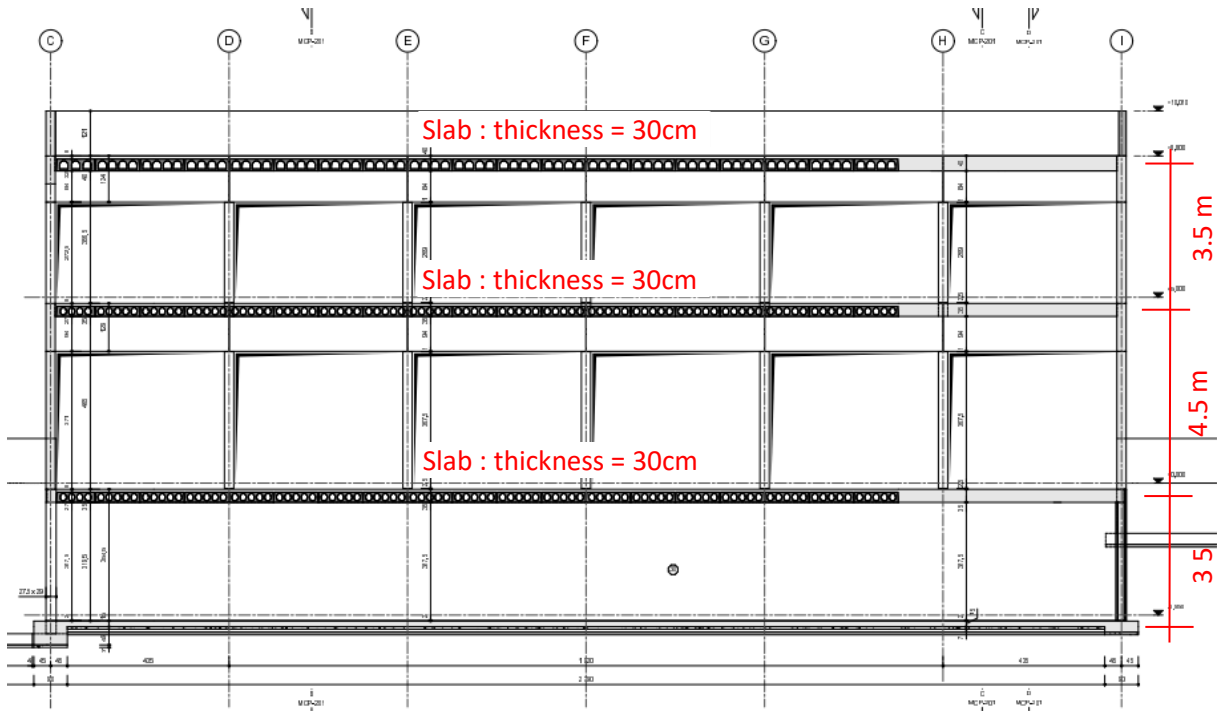
Plane view – underground

Plane view – level 0

Plane view – level 1

5.0 x 3.0m
Th = 25 cm

15 m

40 m   5 m

Plane view – roof

Slab : thickness = 30cm

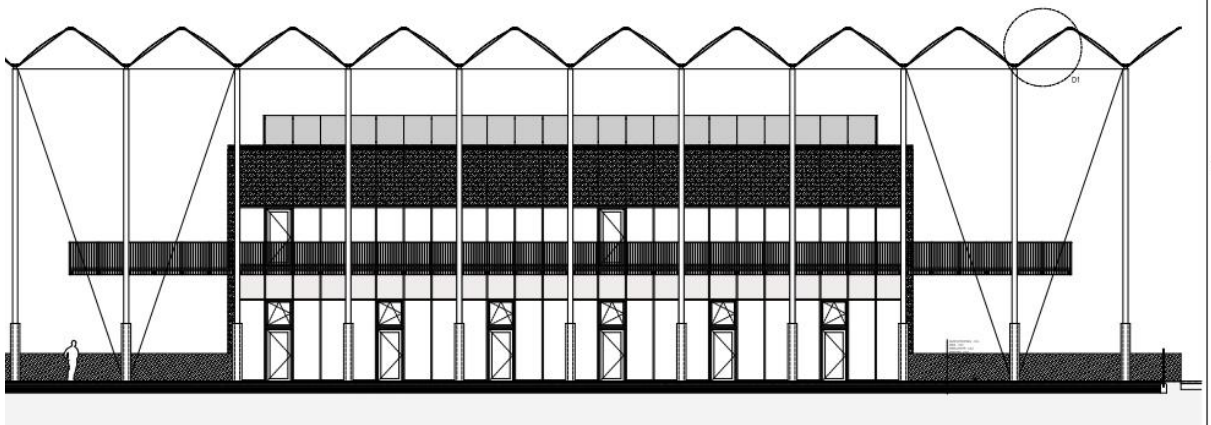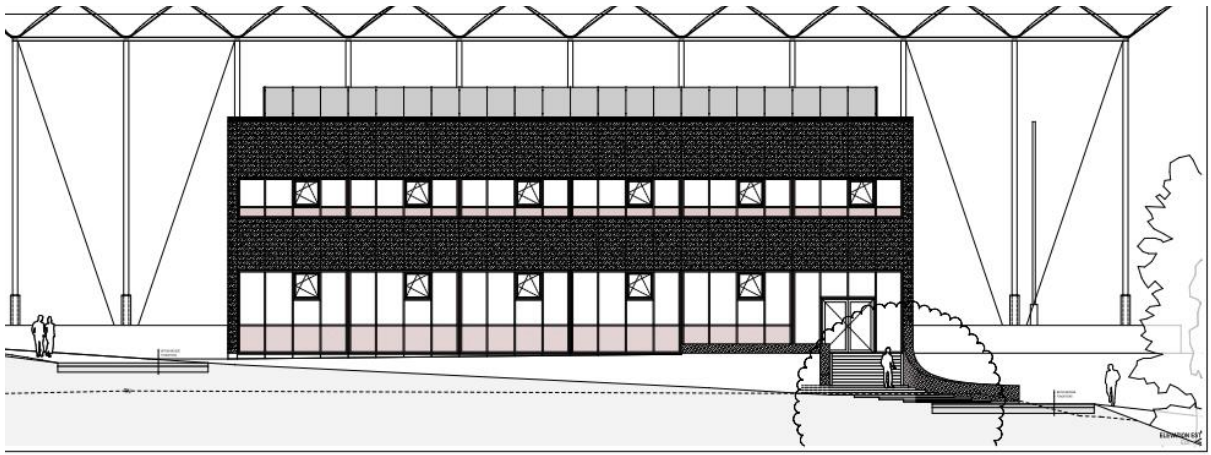Slab : thickness = 30cm
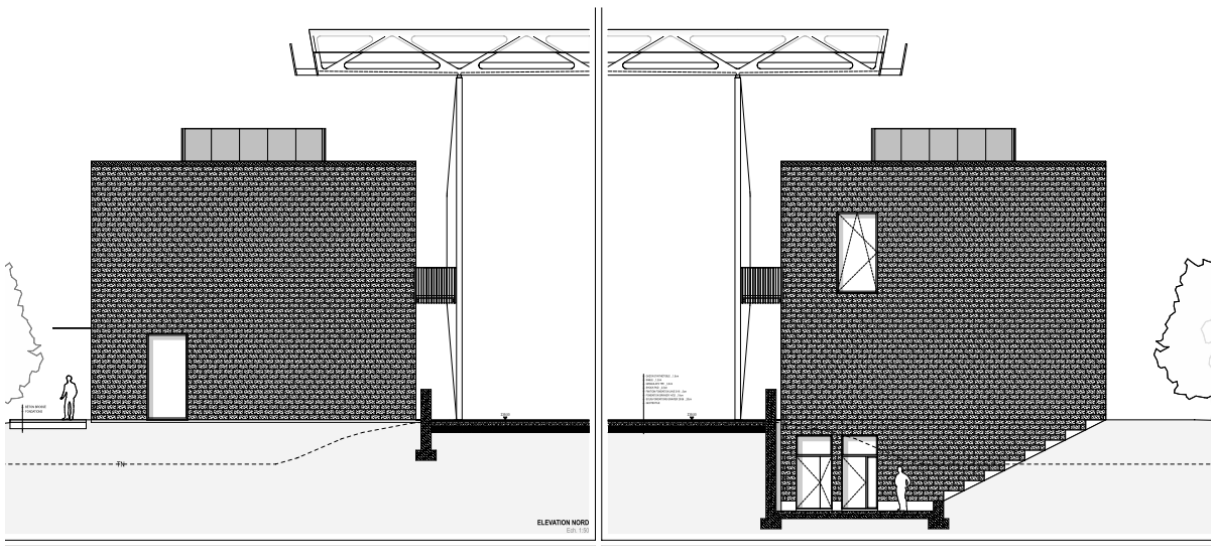
Slab : thickness = 30cm

3.5 m

4.5 m

3.5
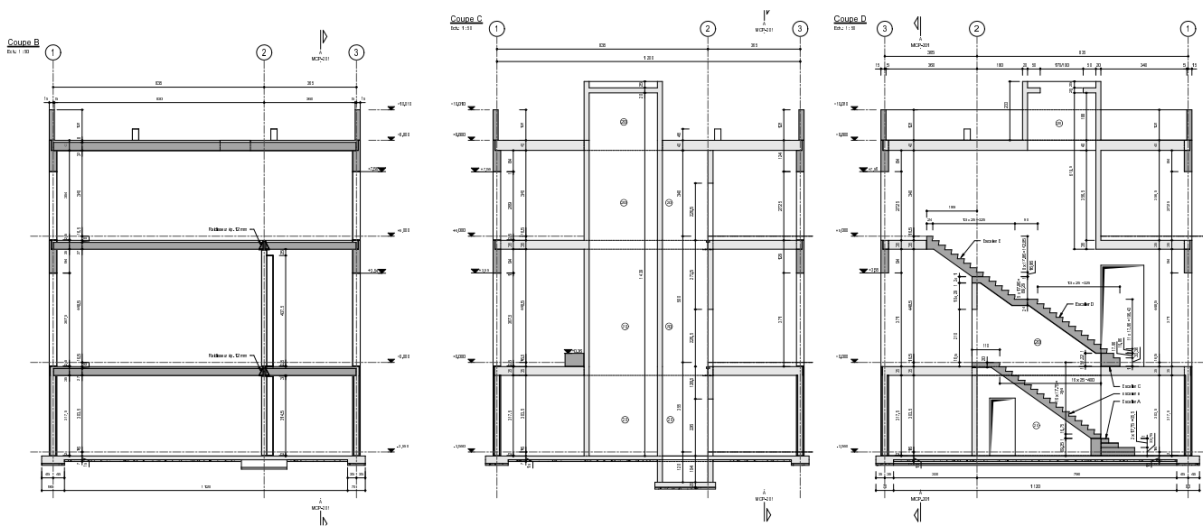
Elevation

Elevation

Façades

Façades

To make the parasismic verification of the building, we ask you to:

1. Establish the static scheme of the structure
    a. Simplify the structure to focus on the horizontal behavior of the structure to represent the dynamic behavior under earthquake. Use beam elements.
    b. Propose several (minimum 2) structure modifications to improve torsion behavior
    c. Make the next calculations (point 2 to 4) for the base solution and 2 variants
    d. Notation between lecture slides and Eurocode are different. So make a correspondence table between both notations.
2. Frequencies and eigen modes
    a. Make the modelization of the structure with MyFin. Use beam elements
    b. Compute the first eigen modes and draw the first important eigen modes
    c. Analyse the effects of the number of beams for the vertical columns, for the horizontal beams with MyFin
       For the Octave calculations, keep the simpler model
    d. Extract the stiffness and mass matrix of the system
    e. Import the matrices in Octave (Matlab)
    f. Compute the eigen modes and the frequencies
    g. Compare with the MyFin solution
3. Modal properties
    a. Compute the modal stiffness and modal mass of each mode
       Modes normalized with maximum nodal displacement equal to 1
    b. Compute the effective modal mass in both horizontal directions
    c. Compute the modal share ratio for both horizontal directions
4. Parasismic calculation
    a. Establish the design acceleration spectrum according to EN 1998-1
    b. Compute the response (displacements) of each mode in each direction
    c. Compute the maximum response in each direction (SSRS and CQC) of the building top
    d. Compute the support forces (by modes, SRSS and CQC)
    e. Combine the support forces in both horizontal directions
    f. Compare the maximum displacements (key points) and base reactions for the different variants