

## PERF007 - Building of civil engineer under seismic request

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### Summary:

The objective of this CAS-test is to measure the performances of nonlinear dynamics.

Two modelings mixing DKTG and POU\_D\_EM carried out are the following ones:

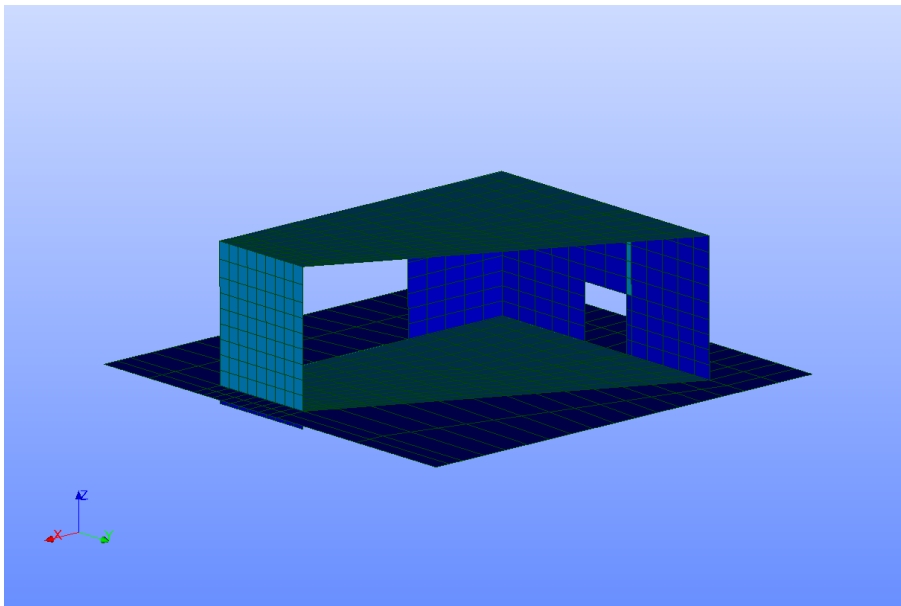
- Modeling a: 9060 degrees of freedom .
- Modeling b: 19272 degrees of freedom

## 1 Problem of reference

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### 1.1 Geometry

The geometry of the test represents a simplified building comprising three veils, a floor, a sole and a foundation raft. Moreover part of the ground is represented. The elements of civil engineer have a thickness of  $0,1m$  while the foundation raft and the sole have a thickness respectively of  $0.5m$  and of  $0.35m$ . The post has a rectangular section of  $0.2 \times 0.2m$  and the beam has a section of  $0.15 \times 0.325m$ .



### 1.2 Properties of material

Various materials were used. The veils and the floors are modelled with the reinforced concrete law GLRC\_DM :

- $E_M = 3E10$
- $\nu_M = 0,2$
- $E_F = 3,324E10$
- $\gamma_T = 0,0035$
- $\gamma_F = 0,0749$
- $\nu_{YT} = 1,85E5$
- $\nu_{YF} = 3880$

The foundation raft is out of concrete. An elastic behavior was considered:

- $E = 3E10$
- $\nu = 0,2$

The beam is out of concrete. An elastic behavior was considered:

- $E = 3E10$

The post is out of reinforced concrete and is modelled by an elastic beam multifibre. Fibres are out of concrete:

- $E = 3E10$

and others out of steel:

- $E = 2E11$
- $\nu = 0$

## 1.3 Boundary conditions and loadings

After a stage of setting under actual weight, the loading corresponds to a one duration earthquake of 1s and of amplitude 0,2g . The building is embedded on the level of the group of nodes *CDG* and the foundation raft has a rigid movement of body.

## 2 Reference solution

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### 2.1 Method of calculating

The result of reference (following displacement  $dx$  with  $t=0,5s$  at the point *AI* ) was obtained by considering that of modeling *B* .

### 2.2 Results of reference

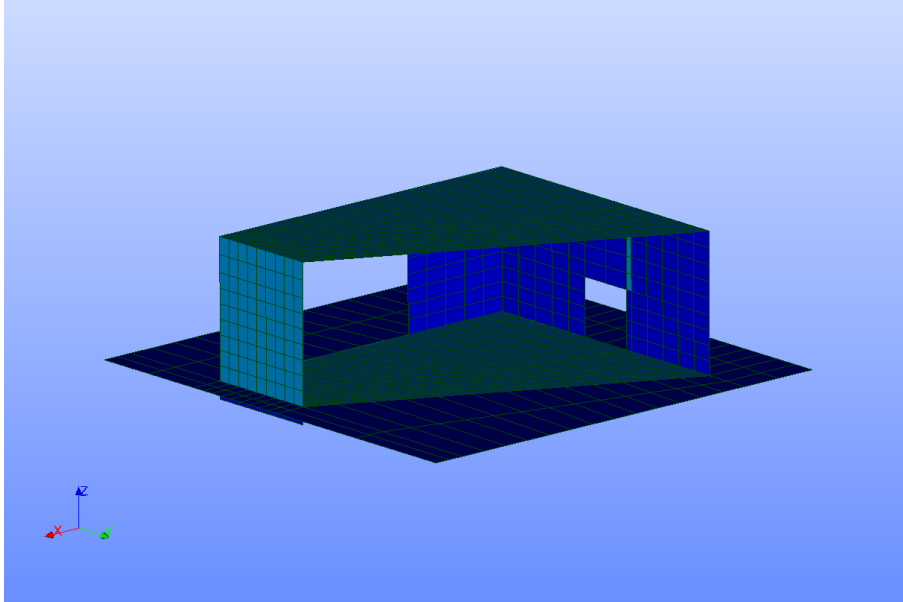
Following displacement  $dx$  at the moment  $t=0,5s$  is worth  $1.9531E-02mm$  .

### 2.3 Uncertainties

Digital solution

## 3 Modeling A

### 3.1 Characteristics of modeling A



The grid consists of:

- 6 POU\_D\_EM
- 13 POU\_D\_T
- 494 DKTG
- 299 DKT

The linear system to solve contains 4830 nodes of which:

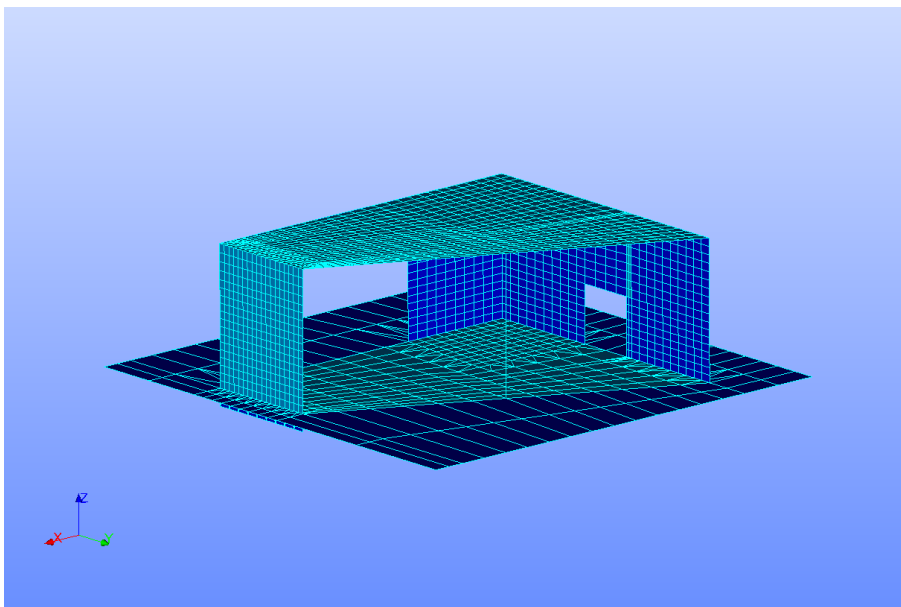
- 846 nodes carrying of the physical degrees of freedom
- 3984 nodes carrying of the degrees of freedom of Lagrange

### 3.2 Results

| Size                        | Reference       | Tolerance (%) |
|-----------------------------|-----------------|---------------|
| $DX$ with $t=0,5 s$ in $AI$ | $1.9531E-02 mm$ | 2.12          |

## 4 Modeling B

### 4.1 Characteristics of modeling B



The grid consists of:

- 6 POU\_D\_EM
- 26 POU\_D\_T
- 1927 DKTG
- 486 DKT

The linear system to solve contains 4830 nodes of which:

- 2342 nodes carrying of the physical degrees of freedom
- 5220 nodes carrying of the degrees of freedom of Lagrange

### 4.2 Results

| Size                        | Reference       | Tolerance (%) |
|-----------------------------|-----------------|---------------|
| $DX$ with $t=0,5 s$ in $AI$ | $1.9531E-02 mm$ | $1e-4$        |