Customer: Best customer – Project reference: Building of the Century
Executed by Vincent Juhel Ouaip, on Friday, 22 March 2019.
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Global data

Building address: 21 Rue Général Bérenger, 06800 Cagnes-sur-Mer, France
Altitude: 19 m Gravity: 9.805 N/kg
Eurocodes standards :

- *basis : EN 1990 (03/2003) + FR NA (12/2011)*
  (Consequences class CC2 = Medium consequence for loss of human life, economic, social or enviromnental consequences considerable.)
- *snow loads : EN 1991-1-3 (07/2003) + FR NA (05/2007)*
- *wind actions : EN 1991-1-4 (2005) + FR NA (03/2008)*
- *seismic actions : EN 1998-1 (12/2004) + FR NA (12/2013)*

Seism

Seism standard

The standard *EN 1998-1 (12/2004)* and its national annex *FR NA (12/2013)* define the design rules and design methods for seismic actions on buildings.

Legislative texts about seism

- Zoning: *Art. D563-8-1, Décret N°2010-1255 (22/10/2010)*
  - The construction is located at Cagnes-sur-Mer in a average seismicity zone (zone 4).
- Classification: *Art. 2, Arrêté du 22/10/2010 modifié par Art.1, Arrêté du 15/09/2014*

Reference peak ground acceleration

The intensity of the acceleration a_{gr} is function of the seismic zone. Its value of 1.6 m/s² is specified in Art. 4, Arrêté du 22/10/2010 modifié par Art.1, Arrêté du 15/09/2014.

Use for importance classification:

The building's use is of type "establishment open to the public of 5th category" (Public establishment classification according to *Article R*123-19 du code de la construction et de l'habitation*)
According to Art. 2, Arrêté du 22/10/2010 modifié par Art.1, Arrêté du 15/09/2014, the importance category associated to seism is II.

Importance factor of the building

The factor γ_I is function of the importance category of the building. Its value of 1 is specified in Art. 2 §III, Arrêté du 22/10/2010 modified by Art.1, Arrêté du 15/09/2014.

Ground type

The ground of construction is of type "C" :
Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres

Horizontal design acceleration for a ground of type "C"

The ground acceleration intensity is calculated as follows:
$a_g S = (a_{gr} \cdot \gamma_I) \cdot S$ *(NF EN 1998-1 §3.2.2.2(1))*
$a_g S = (1.6 \cdot 1.0) \cdot 1.5$
$a_g S = 2.400$ m/s²

Paraseismic checking

A building located in seismic zone 4 and belonging to the important class II requires the mandatory application of the Eurocode 8.

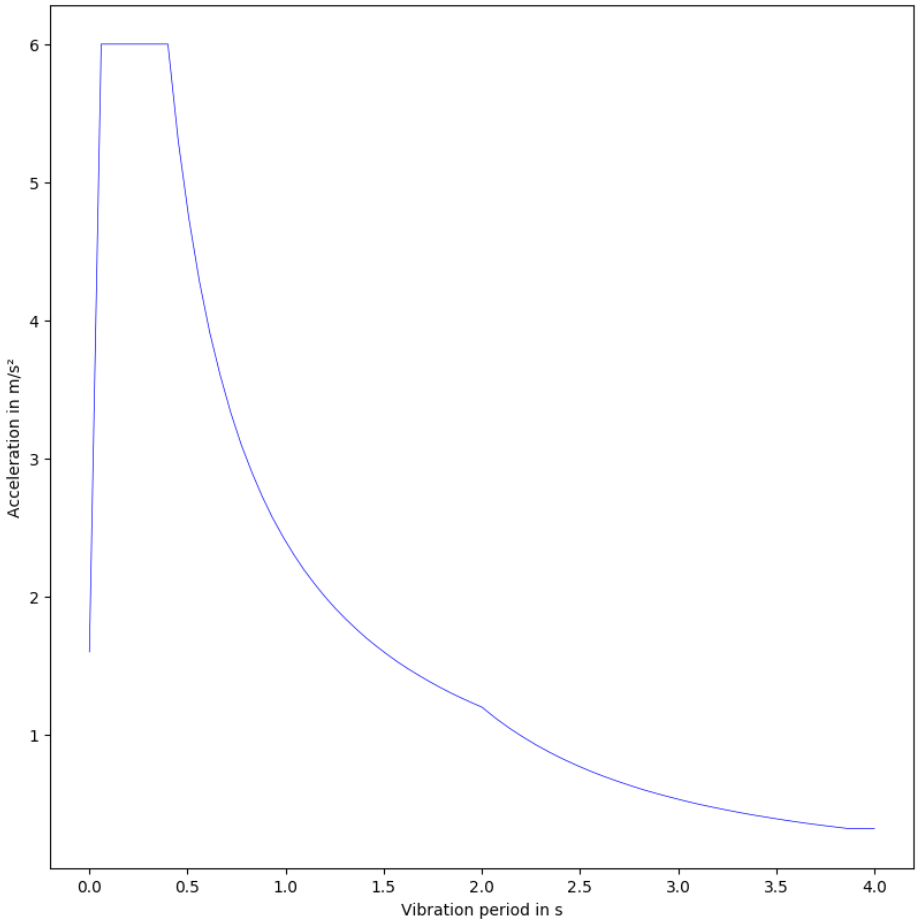
Horizontal design spectrum for elastic analysis

The elastic analysis is performed using a horizontal design spectrum of Type 2 - modified by Art.4 Arrêté du 22/10/2010.
It provides the maximum acceleration of the structure anchored to the ground during an earthquake. With, according to EN 1998-1 §3.2.2.5:

- the parameters of the design spectrum, function of the ground type and the seismicity zone:
  - T is the vibration period of a linear single-degree-of-freedom system.
  - the lower limit of the period of the constant spectral acceleration branch : $T_B = 0.06$ s.

- the upper limit of the period of the constant spectral acceleration branch : $T_C = 0.4$ s.
- the value defining the beginning of the constant displacement response range of the spectrum : $T_D = 2$ s.
- the lower bound factor for the horizontal design spectrum : $\beta = 0.2$.
- the design ground acceleration, taking into account the lithologic effects of site that amplify the seismic movement depending on the nature of the basement : $a_g S = 2.40$ m/s^2.

* behavior factor to take into account the energy dissipation capacity of the structure : $q = 1$.
* $S_d(T)$ the horizontal design spectrum defined by the following expressions :
  - $0 \leq T \leq T_B : S_d(T) = a_g \cdot S \cdot \left[\frac{2}{3} + \frac{T}{T_B} \cdot \left(\frac{2.5}{q} - \frac{2}{3}\right)\right]$ *(EN 1998-1 equation 3.13)*
  - $T_B \leq T \leq T_C : S_d(T) = a_g \cdot S \cdot \frac{2.5}{q}$ *(EN 1998-1 equation 3.14)*
  - $T_C \leq T \leq T_D : S_d(T) = \max\left(a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_C}{T}\right], \beta \cdot a_g\right)$ *(EN 1998-1 equation 3.15)*
  - $T_D \leq T : S_d(T) = \max\left(a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_C \cdot T_D}{T^2}\right], \beta \cdot a_g\right)$ *(EN 1998-1 equation 3.16)*



<u>Design ground displacement</u>

The design ground displacement is evaluated to
$d_g = 0.025 \cdot a_g \cdot S \cdot T_C \cdot T_D$ *(EN 1998-1 equation 3.12)*

$d_g = 0.025 \cdot 1.6 \cdot 1.5 \cdot 0.4 \cdot 2.0$

$d_g = 4.8$ cm.

Vertical design acceleration

The intensity of the design acceleration of the ground in the vertical direction is calculated as :

$a_{vg} = a_g \cdot \left[\frac{A_{vg}}{A_g}\right]$ *(Art. 4 II c), Arrêté du 22/10/2010)*

$a_{vg} = 1.6 \cdot [0.9]$

$a_{vg} = 1.440$ m/s²

Vertical design spectrum for elastic analysis

The vertical design acceleration is less than 2.5m/s^2, its influence is not to be considered. *(EN 1998-1 §4.3.3.5.2)*