

# WP6 : NEEDS FOR ENGINEERS

First Symposium

November 28th, 2017

# Why a WP focusing on engineers' needs?

- Every improvement in our understanding of earthquake mechanics and earthquake hazards shall keep in mind the fact that civil engineers shall be able to use these.
- The importance of R&D in seismicity lies in its ability to improve : the protection for our population, the safety for our facilities.
- So, the interface between seismologists and civil engineers/ mechanics shall be given a fair importance.

- PSHA is increasingly used as a complement to DSHA, and may tend to replace it;
- Methodology and adapted tools for structural studies at industrial level must still be developed and promoted:
  - Deaggregation & conditionnal spectra : CS/CMS?
  - Selection of time histories?
  - Intensity indicators?
  - Which representation for the seismic motion : Response Spectrum, PSD, FAS, ...?

# SUMMARY

## 1. Scope of WP6

## 2. Program of WP6

- a. Conditional spectra
- b. Ground Motions Parameters
- c. Selection of time histories

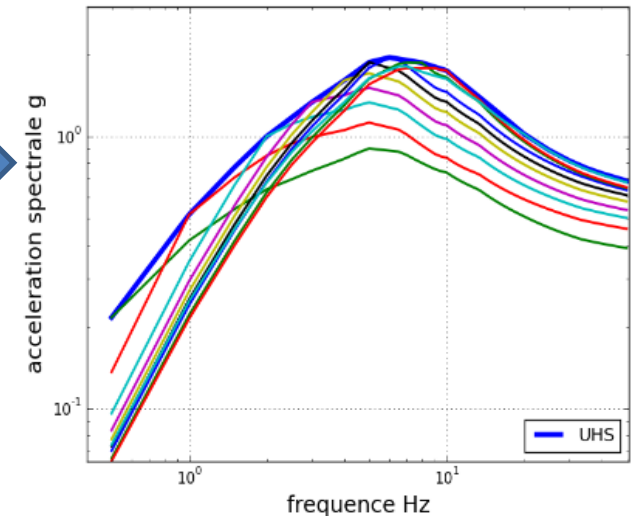
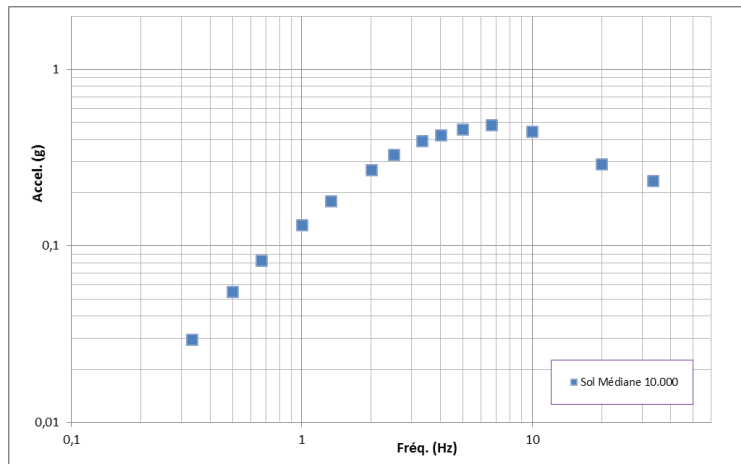
## 3. Conclusion

WP6 will focus on four main aspects :

- Methodology for the use of PSHA outputs in engineering studies
- Ground Motions Parameters
- Selection of time histories
- Towards a better representation of the seismic motions than response spectra

For a structure engineer, the easy way is to consider the envelop UHS as a direct input for their studies.

Now, if you tell them that a UHS is a collection of points from various earthquakes and that it is legitimate to consider them one by one ...



- There is a need to specify the methods to define the CMS:
  - What are the needed data?
  - What are the associated data to the CMS?
  - How to derive Ground Motions Parameters to these CMS?
- Use of CMS increase the amount of work => what are the advantages? In terms of damages to structures and systems?
- Need to quantify the average potential gain from using CMS instead of the envelop UHS, and to take into account the way we should consider the results!

- Expected deliverables :
  - WP6.1.A. Guide for generating CMS from a PSHA and on the associated use of the results for nuclear facilities;
  - WP6.1.B. Some examples of the interest of using CMS instead of the UHS envelop : pros & cons.
  - WP6.1.C. Document to help seismologist and structural engineers defining the needed output (to be fulfilled at the beginning of the PSHA).



- Hazard curves and UHS are the standard output from a PSHA;
- Deaggregation should be systematically provided, for useful structural frequencies;
- However the availability of complementary data could be very interesting, related to the damage potential of the seismic events => Ground Motions Parameters : CAV, SMD, Arias intensity, Dmax, Vmax, ...

Not all of these indicators are necessary, but to have additional informations might be interesting :

- On the energy (CAV or  $I_{Arias}$ ) and SMD for the selection of time histories;
- For some specific structures. Examples : buried pipes (Vmax and Dmax).

Two kinds of information would be useful :

- The mean values and standard deviation for the main contributors of the deaggregation;
- The hazard curves of these indicators.

How to determine them ? =>Correlation coefficients between GMPs could allow to evaluate them, from the spectral acceleration by example

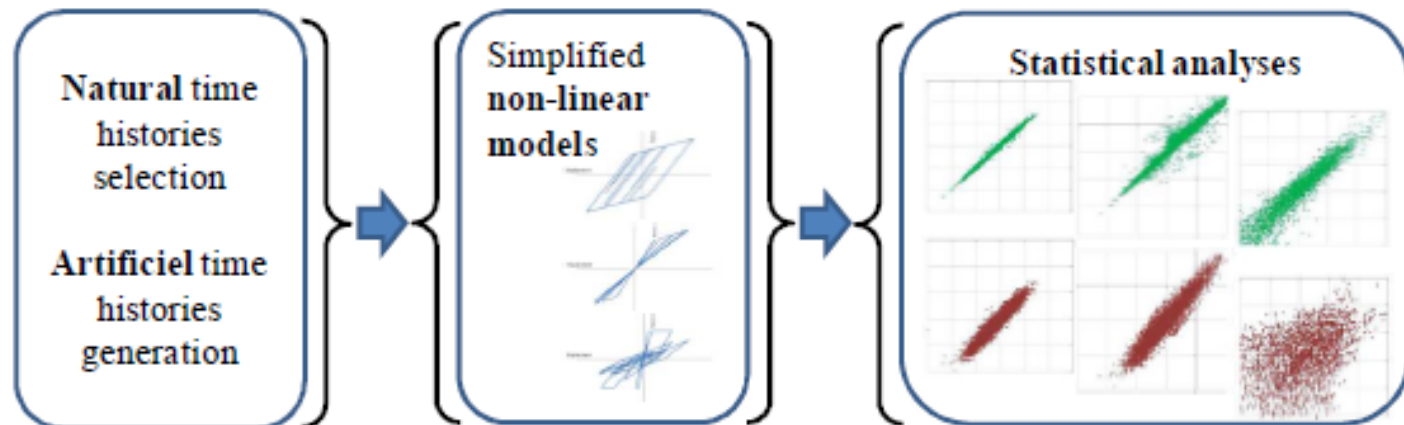
Expected deliverables :

WP6.2.A Development of correlation coefficient between the GMPs and several spectral accelerations

WP6.2.B Specific part for deliverable WP6.1.A concerning the GMPs

A recurrent discussion concerns the use of synthetic or natural time histories. Practice tends to favor one or the other, with a greater inclination towards natural time histories (modified or not).

However, we think there is a lack of objective comparison between both methods with regards to the damages to structures and facilities.



**Figure 7: Description of the process of comparing natural and artificial time histories**

Expected deliverables:

WP6.3.A Simple non-linear oscillators in Code-Aster (ex : Humbert 2014 et Viallet 2017) :

- Development;
- Use on Strong Motions Database;
- Evaluation of the relevance of criteria for the selection or generation of time histories.

➔ Tool for the assessment of the quality of sets of time histories.

- The general representation of the seismic motion by response spectrum was a good compromise when the computation cost was challenging;
- Now, it seems that using response spectrum is more a legacy and that others representation could be used through new methodologies :
  - Others representations : PSD, FAS or time histories
  - New methodologies : Random Vibrations Theory ...

### Proposed work:

- Discuss with WP3 and WP4 on the potential use or development of PSD or FAS GMPEs
- Compare on a study case the various possibilities to evaluate the dynamic behaviour of a structure:
  - TH on modal Basis
  - Modal-spectral
  - RVT
- Write a guideline on the use of RVT for the evaluation of the dynamic response of a structure : less conservatism, less work, better understanding, better confidence

- WP focusing on the interface between seismologists and structure engineers
- Several documents expected to establish practical methodologies for structural engineers to:
  - Define their need at the beginning of the PSHA;
  - Limit the conservatism when considering outputs from a PSHA => CMS;
  - Validate sets of accelerograms for their analysis
  - Propose an optimized methodology to evaluate the dynamic response of a structure



**THANK YOU**