WP4: SITE EFFECTS

First Symposium

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SUMMARY

1. **The big picture of the available approaches to account for site effects**

2. **The WP4 work program at a glance**

- SIGMA 1 has issued a guide to account for site effects

- Makes the synthesis of the outcomes of different projects (CASHIMA, INTERPACIFIC, NERA, PRENOLIN, E2VP)

- It presents different approaches, from the simplest to the most sophisticated.
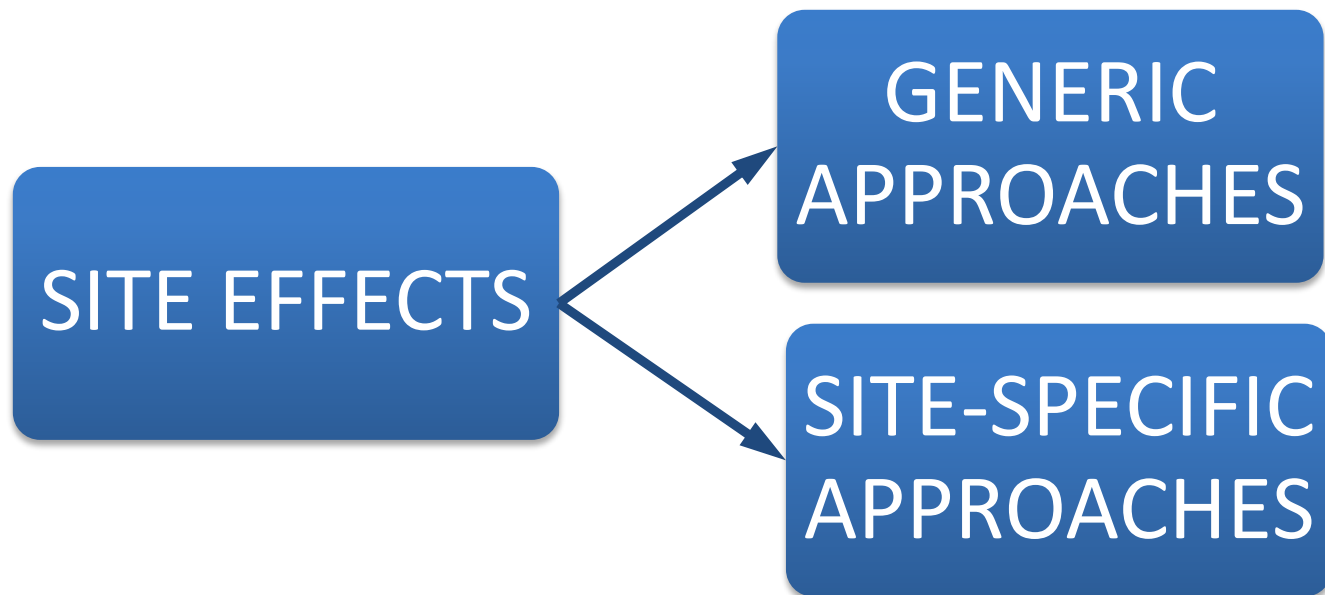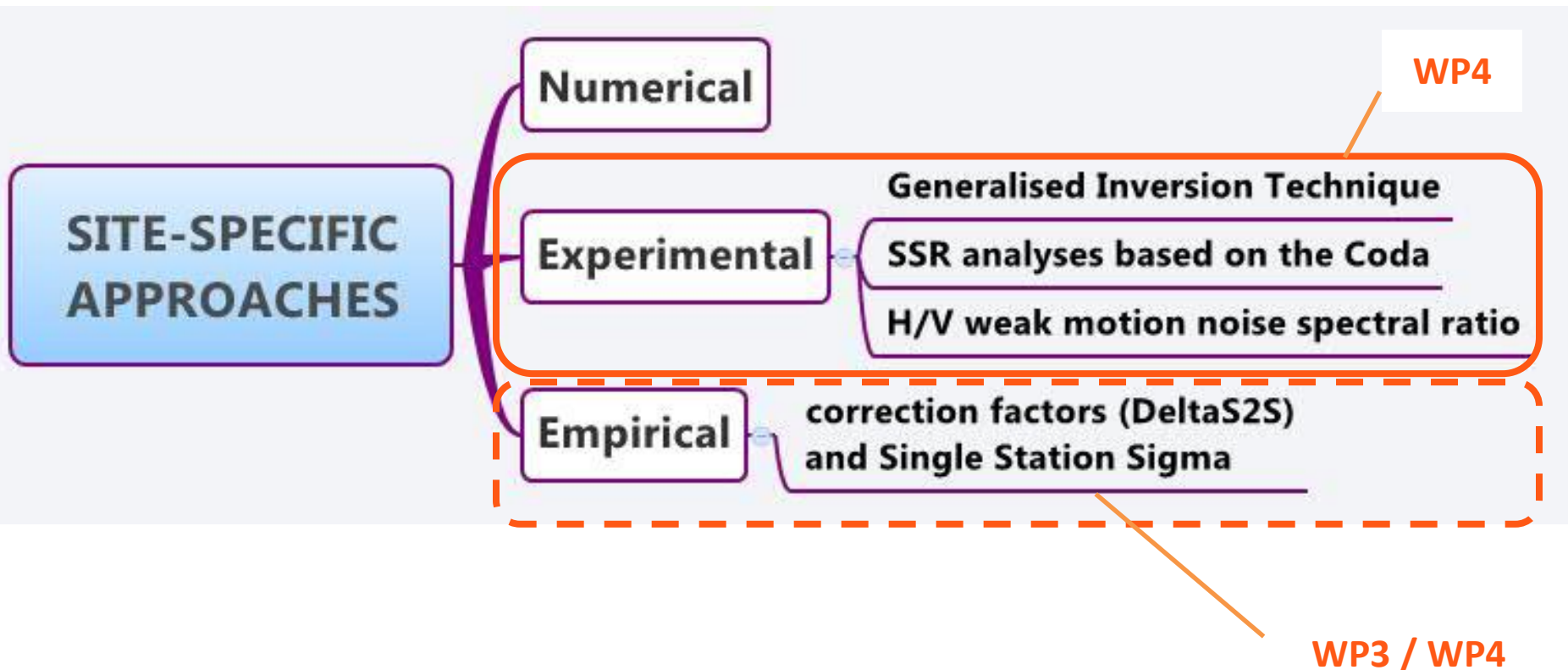
GENERIC APPROACHES

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GMPE with proxies gives Ground Motion at surface included site effects.

potentially, further corrected with Site Amplification Prediction Equation (SAPE)
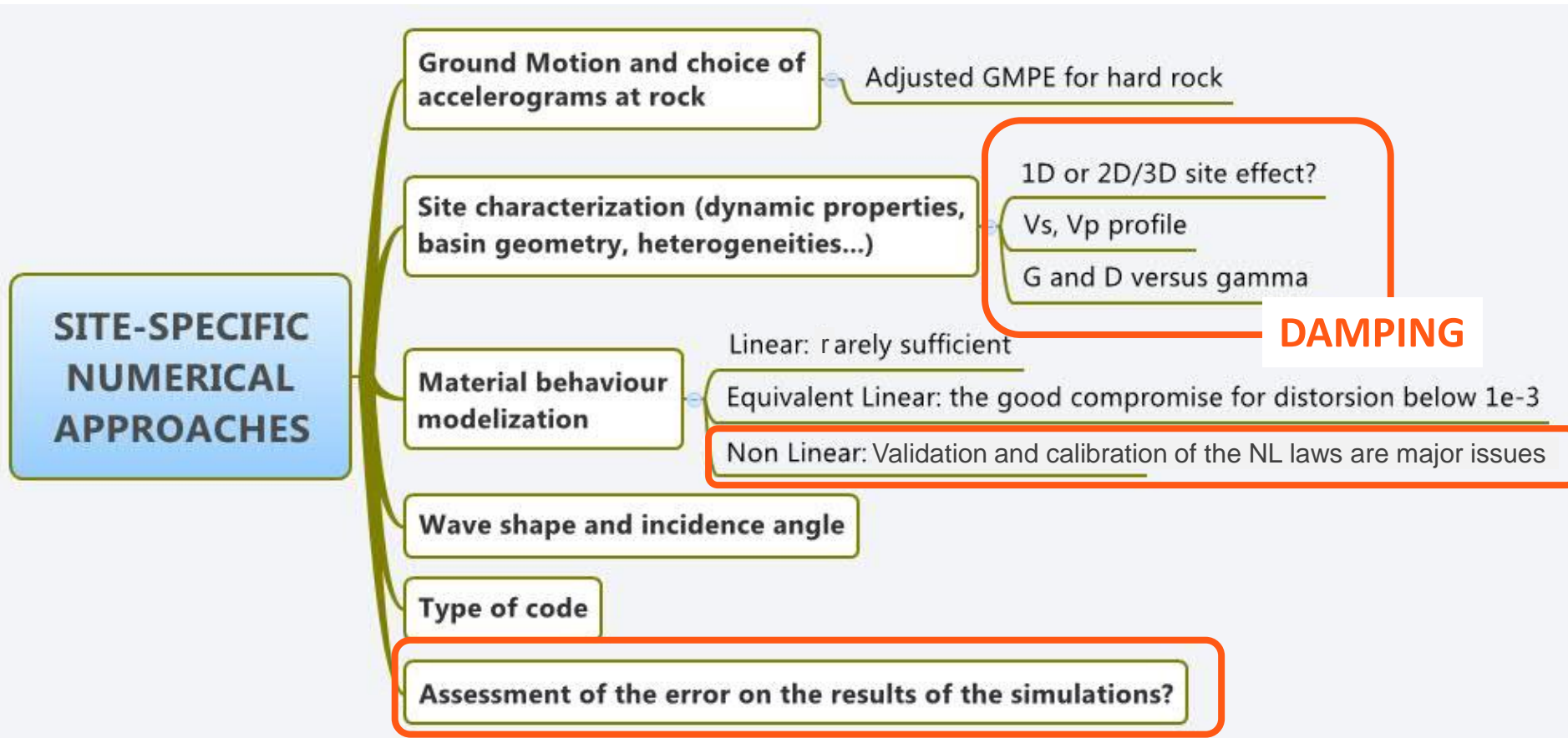
GMPE gives Ground Motion at rock + Amplification Function based on seismic norms or simplified methods.

2D/3D site effects are accounted for with the Aggravation Factor correction

SITE-SPECIFIC APPROACHES

SITE-SPECIFIC NUMERICAL APPROACHES

SIGMA 1 lesson learned: The largest epistemic uncertainty resides in the choice of the constitutive model (linear, equivalent linear or nonlinear) and of the associated parameters (decay curves)

LESSONS LEARNED FROM SIGMA1 PROJECT

Site response characterisation

• Investigations on the nonlinear behaviour of soils under cyclic loading are needed from both the experimental and numerical viewpoint to answer critical questions such as: is nonlinear behavior supported by experimental evidence? Beyond which threshold amplitude is it necessary to take it into account? What are the prerequisites and validation steps for a nonlinear constitutive model?

• The range of applicability of 2D geometric models for site response analyses must be ascertained;

• The spatial variability in soil characteristics needs to be considered in 2D site response evaluations;

• With the increasing number of available earthquake records, the selection of time histories for site response analyses should be guided in more detail;

• The evaluation of the vertical component of motion at the ground surface is an issue that deserves further investigation.

From OVERVIEW & LESSONS LEARNED FROM A PROBABILISTIC SEISMIC HAZARD ASSESSMENT FOR FRANCE AND ITALY

WP4 - Work Program at a glance

4.1 - Assessment of the 2D/3D empirical site effect based on actual records

4.2 - Improvement of simulation methods for nonlinear site response analyses

4.3 - Application guidelines for performing site response calculation

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WP4 - WORK PROGRAM AT A GLANCE

Main objective is to use actual records from existing monitoring networks and the RESORCE database, to:

- Identify stations likely to present 2D/3D effects

- Assess the contribution of the site term to the surface ground motion:

  – Working on proxies to identify sites as good candidates for 1D analysis

  – Plotting amplification function & f0 vs. various proxies to highlight configurations for which 2D/3D effects become significant.

  – Comparison with the GMPEs prediction, to identify the potential bias 2D/3D site effects may have on the GMPEs.

4.1 - Assessment of the 2D/3D empirical site effect based on actual records

- Obtain robust estimation of local soil amplification through the "SSR" approach

Known issues:

– Estimation of the site amplification function requires to **find a suitable reference (rock-site) station nearby**

⇒ Use of **Coda of EQ records** (instead of strong S wave phase) should allow to choose more distant reference station (e.g. national network stations)

– **Local amplification variability estimation**

⇒ The **seismic ambient vibration** methodology developed by V. Perron (PhD works within SIGMA-1 & Cashima), needs to be further optimized/tested.

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WP4 - Work Program at a Glance

Main objective is to review/improve the current (mostly physic-based) modelling strategies, in order to better assess the uncertainties and predictive capabilities of the models:

- Working on soil models:
  - Increasing the reliability of G&D-γ curves for engineering uses
  - Improving parameter calibration strategies, damping capabilities at low/high strains, etc.: providing guidelines for some existing well-known nonlinear constitutive models

- Working on modelling strategies with / without SSI effects to improve the agreement between nonlinear simulations and actual signals for specific sites

- Characterizing ground variability and model uncertainties (e.g. when few field data is available and in low seismicity areas)

4.2 - Improvement of simulation methods for nonlinear site response analyses

WP4 - WORK PROGRAM AT A GLANCE

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WP4 - WORK PROGRAM AT A GLANCE

Main objective is to produce a guideline for the engineer, to perform 1D and 2D (possibly 3D) site response analyses

- Physic-based modelling strategies and their limits of applicability
- How to account for the nonlinear behavior of soils
- How to account for the variability (spatial, parameters…)
- How to validate the model with actual records of instrumented sites?
- …

4.3 - Application guidelines for performing site response calculation

WP4 - CONCLUSIONS

- **This WP is linked to other WPs in SIGMA2 (e.g. WP3)**

- **This program is still**

  – A new contribution has been proposed very recently (last week)

  – Further discussions to occur in a near future

THANK YOU