H2020-MSCA-ITN-2018 – INSPIRE – "INNOVATIVE GROUND INTERFACE CONCEPTS FOR STRUCTURE PROTECTION"

A. TITLE OF THE PROJECT:

Development of a surface cloak/wave guide for seismic waves

B. RESEARCH TEAM

- Alessandro Marzani – DICAM
- Antonio Palermo - DICAM

C. DESCRIPTION OF THE RESEARCH ACTIVITIES

The goal of INSPIRE is to foster a new generation of highly qualified researchers and engineers able to implement novel soil-foundation-structure concepts for the efficient protection of structures from all ground induced hazards, including earthquakes and all other sources of low-frequency noise and vibration excitations (project website: https://sites.google.com/view/msca-inspire).

INSPIRE relies on recent innovative scientific and technological concepts, mainly developed within the broad concept of meta-materials – *natural or artificial materials or structures which exhibit extraordinary properties for inhibiting or conditioning wave propagation in all spatial directions over broad frequency bands*. General developments of meta-materials will be combined or enriched with novel absorption and isolation concepts (i.e. negative effective mass and stiffness moduli media, novel friction vibro-impact rocking motion based non-linear mechanisms) with the goal to overcome the limitations of the existing seismic and low-frequency isolation technologies and deliver highly-damped, low maintenance and easily implemented designs.

The so-called Early Stage Researcher (ESR) will mainly work on the development of a radically new concept, namely a cloack for surface elastic waves (Rayleigh, Love), aimed at protecting structures and infrastructures. In particular, by using appropriate conformal elastodynamics and homogenization techniques, the ESR will be in charge of designing a cloak based on spatially varying elastic parameters taking into account its practical implementation. The ESR will then have to verify the results with harmonic and time-domain numerical simulations using a finite difference or finite element software considering proper geometries of the cloack and the target buildings, as well as geometrical constraints given by the surrounding soil.

The work will practically require:

- to understand wave propagation in solid heterogeneous media including wave scattering, wave filtering, wave dispersion, wave conversion, waveguiding, frequency band gaps, wave energy loss;
- to develop analytical and finite element-based formulations to predict the elastic waves behaviour in heterogeneous media, considering geometrical periodicities and resonant inclusions (i.e. phononic and resonant metamaterials);
- to develop ideas and procedures to model the a cloack for surface waves as well as to guide its optimal design;
- to carry out an in-depth feasibility analysis of the cloack including lab and on-site experimental testing;
- to process data related to one-dimensional and multi-dimensional stationary and non-stationary signals (FFT, time-frequency analysis, spectral analysis, data statistics);
- to report and disseminate the research activities.

D. EXPECTED RESULTS

1. Ideation of a new concept of a cloak for surface guided waves.

2. Development of new numerical tools for non-linear transformation elasto-dynamics, taking into account arbitrary soil geometries.

E. MODALITIES

The ESR will perform the activities planned in close collaboration with the other members of the main research team.

The ESR will be employed with 32-month contract and enrolled as a PhD student at the University of Bologna. The contract may be renewed and/or extended according to the University of Bologna regulation concerning the MSCA research fellowships. The candidate will be expected to spend 9 Months at UNITN in Trento and 3 Months at TREVI group as part of secondment activities foreseen by the INSPIRE project.

The ESR advisor

Prof. Alessandro Marzani