Advanced Analysis to evaluate GEO-Hazards in Cinque Terre, Italy
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THE SITE

GEO-HAZARD

The area is affected by different GEO-Hazards connected to each other:
- Landslides (analysis performed on deep-seated landslide and rockfall)
- Floods (e.g. 2011 event)
- Earthquakes

MODELING

3D Rockfall modeling - HYSTONE

- 3D simulation of free fall, impact and rolling of blocks on a DEM-driven topography
- Kinematic and hybrid (mixed kinematic-dynamic) approach
- Impact on structures
- Input and output data in ArcGIS
- Multi-scale analysis capability

For the case study, different volumes along the cliff based on kinematic analysis ⇒ 11 domains have been identified.

GEOLOGIC SETTING

Regional Geologic Setting
The complex geologic history of the region is punctuated by several major tectonic transitions:
- Deposition of Ligurian deep marine sediments along the European Conca-Sardina massif that marked the northern boundary of the Tethys Ocean (Jurassic to Paleocene);
- Transition from a passive margin to an actively subducting plate boundary, with associated deposition of Sub-Ligurian sedimentary rocks (Paleocene–early Miocene);
- The thick sequence of sediments deposited on the Adria passive plate margin (located across the then-narrowing Tethys Ocean from the Ligurian rocks) are involved in the Adria-Europe continental collision (Miocene to Present).

Structural Geology
All three major tectonic divisions in the Cinque Terre area are components of the Northern Apennines fold-and-thrust belt. The rocks exposed along the Cinque Terre cliffs are highly deformed as a result of the Adria-Europe continental collision. During the Late Miocene continental plate collision, Ligurian and Sub-Ligurian rocks deposed on the European Plate smashed into Tuscian sediments deposited on the Adria Plate. Ligurian and Sub-Ligurian rocks were deformed during the initial phases of the collision and were then overthrusted over the Tuscan units. The La Spezia field is an expression of the compressive forces that were invoked in the building of the Northern Apennines.

MODELING

Deep-seated landslide modeling - Midas GTS NX

FEM analysis with Midas GTS NX ⇒ Static SRM construction stage with space-variable parameters based on field survey

- Easy management of solid geometry
- Hybrid mesh (tetra-hexa)
- Multiple analysis cases
- High control of constraints
- Surface penetration from contour lines
- Different computable failure criteria

CONCLUSIONS

Deep-Seated Landslide Campiglia
1) Comparable deformations between on-field and model results
2) Different type of landslides based on rock mass characteristics:
   - NW sector ⇒ characterized by good rock mass properties ⇒ rockfall
   - SE sector ⇒ characterized by weak rock ⇒ shallow landslide (both rotational and translational landslide)
3) viscous analysis (in progress) with possibility to use PS-InSAR displacement to calibrate and/or validate the model