Progetto DPC-ReLUIS 2022-2024 WP 6

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

WP6 – Task 6.1,6.3,6.4: Integration of satellite and on-site data for structural monitoring

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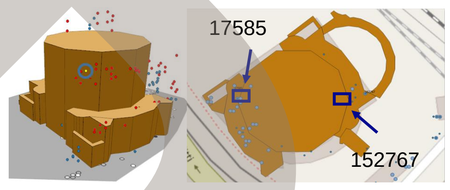
Temple of Minerva in Rome [1]

Urban context



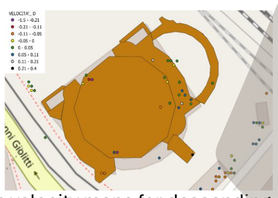
Selected point with max annual velocity

PS	Max velocity [cm/y]	Coherence
17585	0.0816	0,553
152767	0.0618	0,638

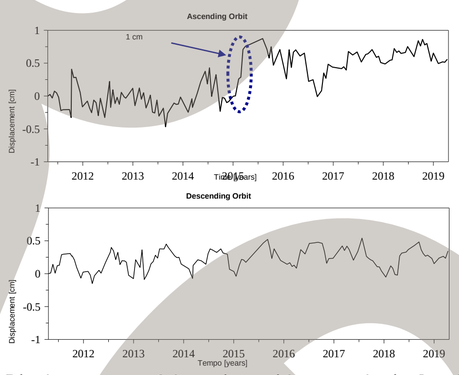
Table with points of max annual velocity

- DInSAR analysis, and mean annual displacement and velocity assessments
- Realization of FEM model validated by on-site monitoring (accelerometer acquisitions)
- Trend analysis of the displacements of Persistent Scatterers (PSs) with maximum annual velocity for the ascending and descending orbits
- Identification in ascending orbit of an irregular trend with a permanent displacement in 2015, for event independent of seasonal thermal variations
- FEM model updating: numerical analysis of the base failure that reports damages consistent with reality

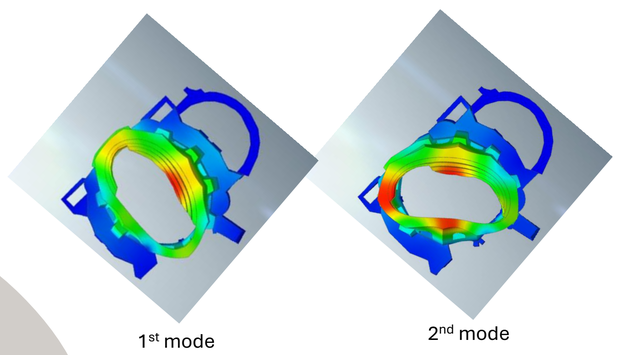
Mean velocity maps for ascending orbit



Mean velocity maps for descending orbit



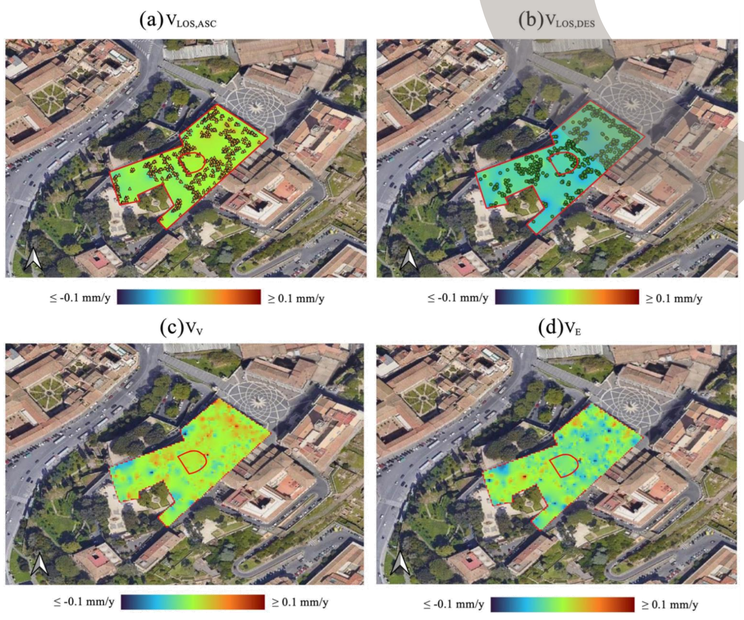
Displacements of the points with max velocity [cm/y]



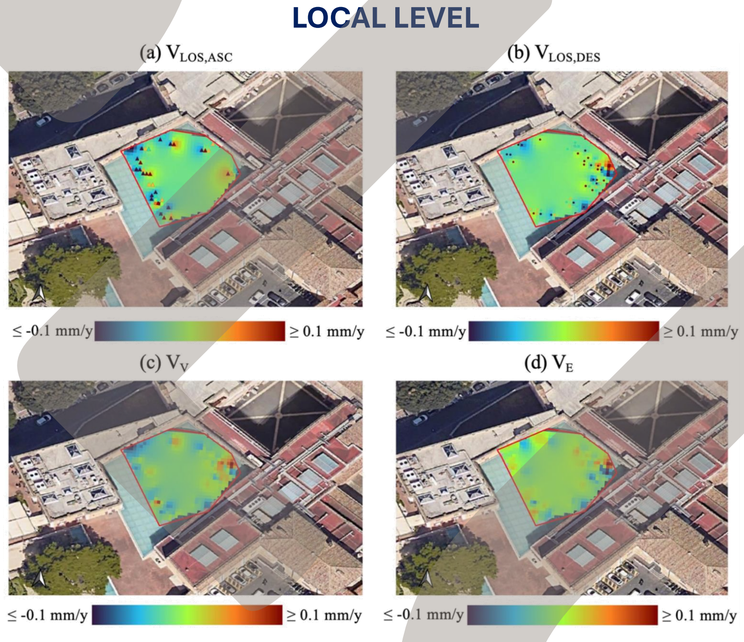
1st and 2nd vibration mode of the temple.

Marcus Aurelius Exedra Hall (Capitoline Museum) [2]

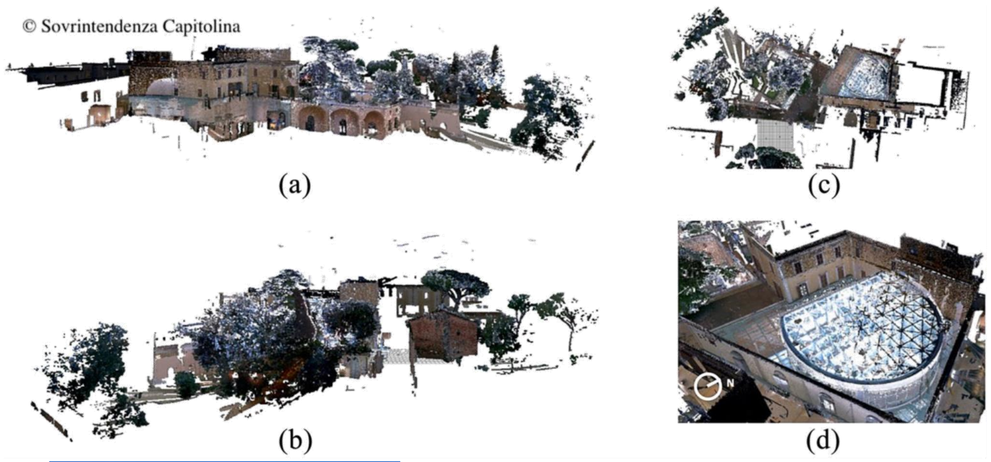
GLOBAL LEVEL

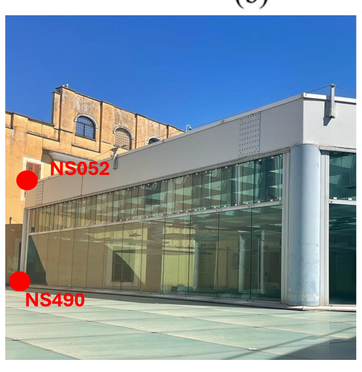


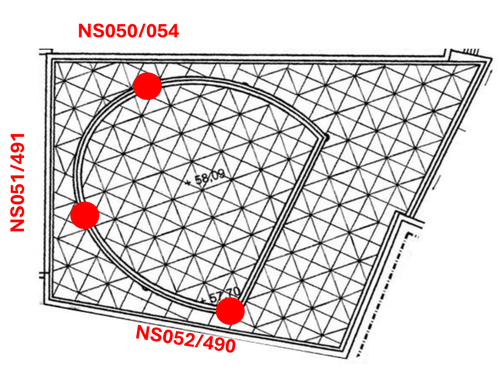
LOCAL LEVEL

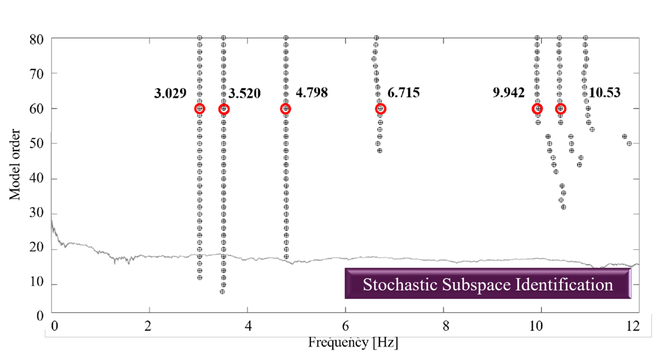


- DInSAR analysis and displacement assessment (from global to local level)
- BIM As Design derived from the technical drawings
- On-site measurements: TLS survey and point cloud model
- BIM As Built derived from the 3D point cloud
- By superimposing the BIM As Design and the point cloud model, differences between the desired and actual configurations can be highlighted. Such differences are the sum of errors in the realization and possible deformation that occurred after construction, which cannot be separated by only one measurement on-site.
- Assessment of the deformation trend obtained from satellite data analysis
- Evaluation of the differential shift observed by overlaying the point cloud and BIM As Design.
- Short-term dynamic test
- FEM model updating

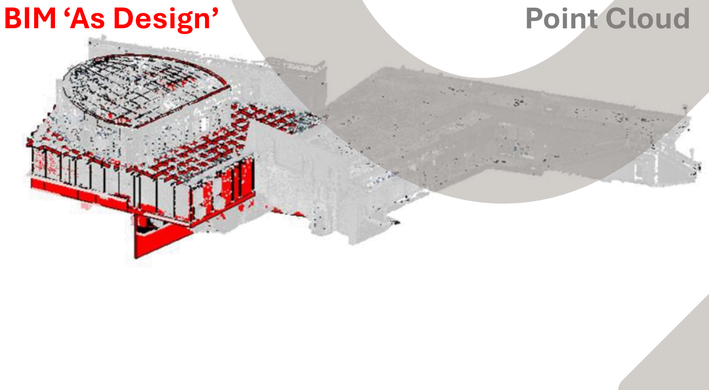




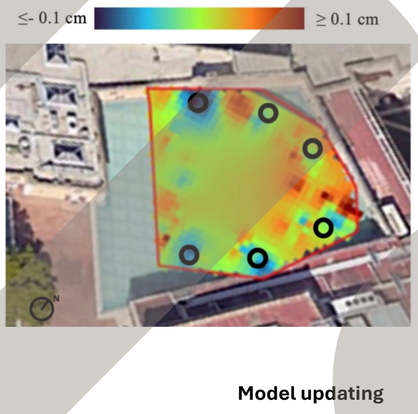


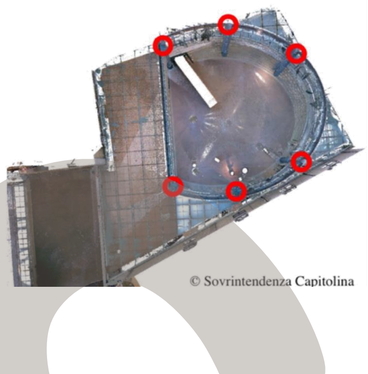


BIM 'As Design'

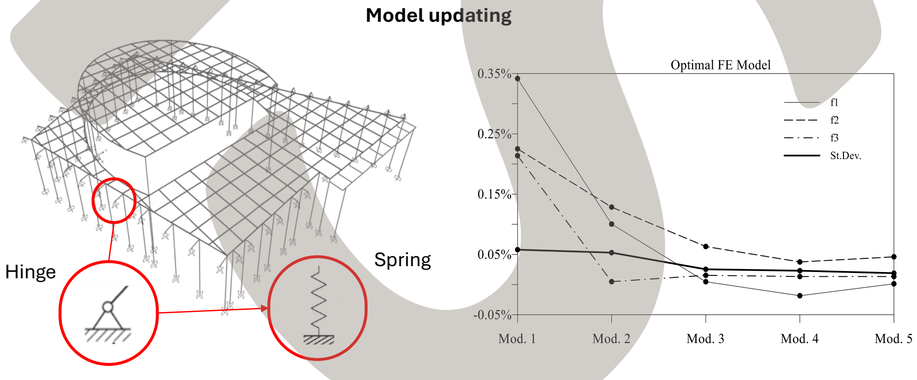


Point Cloud





Model updating



Conclusions

It is advisable to perform periodic terrestrial laser scans to observe a deformation trend comparable to the satellite data. These scans would provide high-resolution, accurate representations of the structure over time, allowing for a more detailed analysis of any changes. By integrating this ground-based data with satellite observations, our understanding of structural behavior would be enhanced, improving monitoring capabilities and ultimately leading to more effective maintenance strategies and informed decision-making processes.

1. Sabbà, M. F., Lerna, M., Diaferio, M., & Foti, D. (2021). Satellite Data for Structural Monitoring of Historical Building: The Temple of Minerva Medica in Rome. *WSEAS Transactions on Environment and Development*, *17*, 1284-1289 10.37394/232015.2021.17.117
2. De Iuliis, M., Crognale, M., Potenza, F. et al. (2024). On the combined use of satellite and on-site information for monitoring anomalous trends in structures within cultural heritage sites. *J Civil Struct Health Monit,* 14, 1173–1190 https://doi.org/10.1007/s13349-024-00780-2