UNIVERSITÀ DEGLI STUDI FIRENZE
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DIPARTIMENTO DI INGEGNERIA CIVILE E AMBIENTALE

Extreme actions on monumental buildings: Notre Dame and some other case studies

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Venerdì 31 maggio 2019

Ore 14,30

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The safeguard of the built cultural heritage is today concerned with two new types of extreme events: extreme wind storms and explosions that can take place in war conflicts or terrorist attacks. That is why it is today interesting to investigate by mechanical models and numerical simulations the response of monumental buildings and artefacts to extreme events like a blast or a severe wind storm. In the talk, we show some recent studies done in this field: we start proposing a study about the wind strength of a Gothic Cathedral, Notre Dame of Paris; this study proposes a new incremental approach, determining the ultimate wind load as the one able to produce unbounded displacements in the structures. We show also how much the recent fire that destroyed a part of Notre Dame has reduced, in the present state, the wind strength of the Cathedral. Then, we propose a study about the blast effects inside a monumental structure, the Pantheon of Rome; by using a Coupled Euler Lagrange approach for describing the blast phenomenon in the air and the fluid-structure interaction, we show the importance of the reflected shock-wave pattern, determined by the geometry of the structure, to evaluate its structural collapse under the blast actions. Both the previous studies are done using a nonlinear mechanical model for the structure, modeled as a damageable continuum. Finally, we show two some more recent, and still going on, researches; the first one, concerns the modeling of structures submitted to a blast using a discrete element model. The second is about the effects of a blast on artefacts likes statues in a museum: adapting to blast actions, in a simplified context, the classical rocking-sliding analysis of a rigid block, we show what are the critical situations for the preservation of such artifacts against explosions.

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