DIPARTIMENTO DI INGEGNERIA
STRUTTURALE E GEOTECNICA

SAPIENZA
UNIVERSITÀ DI ROMA

AVVISO DI SEMINARIO
(Ciclo degli assegnisti di ricerca)

Il giorno **12 settembre 2014,** presso la sala riunioni del Dipartimento, area Strutture, via Eudossiana 18, gli assegnisti di ricerca interverranno sui propri argomenti di studio:

10.30
Andrea Arena
Nonlinear aeroelasticity of slender structures via geometrically exact structural models

11.00
Luca Masini
Seismic behaviour of geosynthetic-reinforced earth retaining structures

Nel seguito sono riportati i relativi sommari.

Gli interessati sono invitati a partecipare.

Roma, 4 settembre 2014

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NONLINEAR AEROELASTICITY OF SLENDER STRUCTURES VIA GEOMETRICALLY EXACT STRUCTURAL MODELS

Andrea Arena

Wind-induced vibrations are a major concern for designers of slender structures in different engineering contexts, such as aeronautic or civil. There is a need to enhance the structural design technology, through improved computational capabilities, a critical step for a better understanding of fluid-flow physics that induce vibrations and fluid-structure dynamics of flexible structures. The design of highly flexible aircraft wings and bridges with spans significantly longer than those existing today is quite challenging. To refine the computational tools required for such flexible structures, a multi-disciplinary research effort, devoted to the advanced modeling of super-long-span suspension bridges and high-altitude long-endurance (HALE) wings, is proposed. Fully nonlinear structural models parameterized by one single space coordinate are proposed to describe the overall three-dimensional motion. The nonlinear equations of motion are obtained via a direct Lagrangian formulation and the kinematics feature the finite displacements and the flexural and torsional finite rotations of the cross sections. The strain-displacement relationships for the generalized strain parameters retain the full geometric nonlinearities. The nonlinear aerodynamic features of the cross sections characterizing these structures are investigated by using state-of-the-art computational methods. For what concerns the description of the nonlinear aerodynamics of sharped-edge boxed sections, typical of suspension bridges decks, computational fluid dynamics (CFD) tools are used to develop computationally efficient unsteady aerodynamic models taking into account for viscous effects, including flow separation and boundary layer thickening, treated using Reduced-Order Models (ROMs). Frequency-domain representations of the aerodynamic loads in terms of flutter derivatives are obtained and their counterpart in the time-domain is proposed by using an indicial representation.

As a result, a fully nonlinear coupled fluid-structure model for suspension bridges and HALE wings is assembled to study the nonlinear static and dynamic behavior thus addressing problems of static aeroelastic stability, such as torsional divergence, and dynamic aeroelastic instabilities, such as flutter and post-flutter. The developed geometrically exact formulation lends itself naturally to parametric studies about the sensitivity of the static and dynamic limit states with respect to variations of the characteristic structural parameters. In addition, studies addressing the dynamic response of suspension bridges under time- and space-dependent loading conditions due to time- and space-wise distributed gust excitations as well as the study of the effects on the critical flutter condition of spatial nonuniform wind distributions are performed. Finally, the post-flutter behavior is studied by using a continuation method to highlight the post-critical bifurcation scenarios and emphasize the complex nonlinear response of slender self-excited structures.

SEISMIC BEHAVIOUR OF GEOSYNTHETIC-REINFORCED EARTH RETAINING STRUCTURES

Luca Masini

A number of field observations have shown a generally good performance of geosynthetic-reinforced earth retaining structures subjected to severe ground motion, and this finding is consistent with observations resulting from shaking table experiments on model reinforced-earth structures. Intuitively, this satisfactory behaviour can be ascribed to the possibility that these structures contribute to energy dissipation through the development of internal plastic mechanisms, and posses an overall ductile behaviour deriving from the large deformation that can be accommodated by the soil-reinforcement system.

In this seminar some aspects of the seismic behaviour of geosynthetic-reinforced earth retaining structures will be discussed, by providing an appreciation of their performance under a severe seismic loading.

For design purposes, it is postulated that during strong ground motion the main source of energy dissipation derives from the transient activation of plastic mechanisms within the soil mass: these mechanisms can be global, local, or a combination of the two.

Pseudo-static solutions based on limit analysis were used to design three retaining structures having a similar overall seismic resistance, expressed by their critical seismic coefficient, but activating different − global, local, or combined − plastic mechanisms. Pseudo-static analyses were repeated by uniformly accelerating a finite-difference model of the reinforced-earth structure, to compare the plastic mechanisms forming under critical conditions with those assumed in the limit analysis-based design. The seismic performance of the different retaining structures was then evaluated through a series of dynamic analyses in which acceleration time-histories were imposed to the bottom boundary of the same numerical models used for the pseudo-static analyses. The results of the dynamic analyses evidenced that, besides the prevailing plastic mechanism selected at the design stage, during strong motion there is always a local contribution to the dissipation of energy, evidenced by the attainment of the available strength in different portions of the soil-reinforcement system. The seismic performance of the different retaining structures, as evaluated with the dynamic analyses, can be used to guide the engineer to the choice of the most efficient criterion for the seismic design of similar structures.