NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF CIVIL ENGINEERING

GUEST LECTURE

THURSDAY, JUNE 25, 2026, 11:00 – 11:45, New PC Lab, School of Civil Engineering, NTUA

Direct-Method-Based Shakedown Analysis in a Multiscale Context Structural Assessment and Optimization under Alternating Loads

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Structures subjected to cyclic loading may experience elastic shakedown behavior, where plastic deformation occurs only during the initial loading cycles and subsequent responses remain purely elastic. To address this phenomenon, scholars such as Melan and Koiter have developed theory and direct methods that avoid tracking the loading process and determine the shakedown limit by constructing and solving optimization problems, while Dang Van established an equivalence between fatigue limits and multiscale shakedown, based on which he proposed the well-known fatigue criterion. Although the shakedown limit effectively characterizes the structural capacity under cyclic loads and the direct method benefits from load-path independence, the complexity associated with solving large-scale optimization problems and the lack of sufficient experimental validation have limited its widespread adoption in structural analysis and optimization. Recent advancements in numerical algorithms and computer hardware, along with experimental technologies such as Digital Image Correlation (DIC), have gradually enabled shakedown analysis and experimental validation for large-scale engineering structures. Therefore, in this presentation it will be elaborated how to predict fatigue limits of random heterogeneous material and the failure probabilities of structures made by it through establishing a multiscale direct-method-based framework in accordance to Dang Van's theory. Meanwhile, recent research advancements we achieved in the field of shakedown analysis of structures, including shakedown of thin-walled structures, shakedown-oriented topology optimization, and shakedown experiments will be introduced as well. Finally, the potential feasibility of employing shakedown theory in the lightweight design of reusable spacecraft structures will be discussed.

Dr. Geng Chen is a Professor at Beijing Jiaotong University in China. He received his M.Sc. and Ph.D. degrees in Mechanical Engineering from RWTH Aachen University, Germany. His research interests include limit and shakedown analysis, integrated material–structure design, and AI-assisted computational and monitoring system for railway and aerospace structures. He has published more than 50 SCI-indexed journal papers and led over ten national and ministerial-level research projects, including projects funded by the National Natural Science Foundation of China and the National Key R&D Program of China. Before returning to China in 2019, he conducted industry-sponsored research in Germany with companies such as Hilti and Saint-Gobain, and worked at IAV GmbH on engine data analysis and calibration tools for Volkswagen platforms.