A Matlab-Based Educational Tool for the Seismic Design of Flexibly Supported RC Buildings

E. I. KATSANOS, O. N. TASKARI, A. G. SEXTOS

Department of Civil Engineering, Aristotle University Thessaloniki, Thessaloniki, Greece

Received 2 March 2011; accepted 10 July 2011

ABSTRACT: This article presents a Matlab-based educational software developed at Aristotle University of Thessaloniki in Greece, in order to familiarize students and young engineers with fundamental concepts of structural dynamics and, in particular, soil–structure interaction problems. This user-friendly educational tool aims to assist the students in comprehending the nature of this complex phenomenon and the role played by the physical parameters involved, while increasing their awareness of the potential impact of neglecting soil flexibility during seismic design of reinforced concrete (RC) buildings. This software is also used as a case study for teaching the development of civil engineering-oriented applications in Matlab within a course where all the relevant material is provided online. Two demonstration examples are comparatively assessed to illustrate the applicability of the software and justify the necessity of its implementation in class, while the integration of the software in the curriculum as well as students' feedback is also discussed. Comput Appl Eng Educ; View this article online at wileyonlinelibrary.com/journal/cae; DOI 10.1002/cae.20568

Keywords: educational software; earthquake engineering; structural dynamics; earthquake loading; response spectra; soil–structure interaction

INTRODUCTION

The way in which the response of a structure, its foundation, the surrounding soil, and the characteristics of an incoming earthquake input motion are coupled during a strong seismic event is an extensively complex physical problem of major practical interest in civil engineering. It is nowadays widely accepted [1–3] that the ''soil–structure interaction'' (SSI) may significantly modify the dynamic characteristics of a structural system leading to a completely different (elastic or inelastic) dynamic behavior compared with the one expected when considering fixed support conditions. The reason is that the foundation of a structure is never completely rigid, as it is typically supported on compliant soil formations. Moreover, the foundation dissipates energy and interacts with the surrounding soil and the superstructure, so it filters the incoming seismic wavefield (a phenomenon called kinematic interaction) while at the same time it is also subjected to inertial forces indirectly generated by the vibration of the superstructure (inertial interaction) [4,5]. The overall SSI problem is complex and its beneficial or detrimental effect on the seismic response of a reinforced concrete (RC) building depends on a series of parameters such as [6] the intensity of strong ground motion, the dominant wavelengths, the angle of incidence of the seismic waves, the stromatography, the stiffness, and damping of the supporting soil, as well as the size, geometry, stiffness, slenderness, and the dynamic characteristics of the structure.

Consequently, the particular phenomenon cannot be easily ignored in advance during seismic design of buildings, neither it is easy to predict whether its thorough consideration will eventually lead to more critical or favorable structural response [7], and this is especially pronounced in buildings supported on soft soils or having specific structural characteristics. To this end, various methods have been proposed by researchers during the last four decades aiming to investigate the role and importance of SSI. The most common approach for considering the above phenomenon in a practical, yet acceptably rigorous way, is to uncouple the problem into its kinematic and inertial component, that is, by modifying the incoming earthquake wavefield based on the stiffness of the foundation, then replacing the foundation and the surrounding soil subsystem with appropriate springs and dashpots to account for the (frequency dependent)

Correspondence to A. G. Sextos (asextos@civil.auth.gr).