



Application of the Equivalent Static Analysis procedure for the seismic design of buildings with added viscous dampers

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Abstract

Most of the actual seismic design procedures for structures equipped with viscous dampers requires the development of non-linear time-history analyses, which, even though of quite common use among the researchers, still represent a challenge for professional engineers. The paper describes a simple Equivalent Static Analysis procedure for the seismic design of building structures equipped with added viscous damper. The procedure, which is based on the fundamentals of the dynamics of multi-storey frame structures with added viscous dampers, is aimed at estimating the maximum forces in the viscous dampers as well as the peak internal actions in the structural members. The simplified procedure is applied for the design of a 3-storey reference steel frame analysed by other researchers.

Keywords: viscous dampers, design procedure, equivalent static analyses.

1 Introduction

For many years, the seismic design of buildings has been carried out essentially with the method of equivalent static forces. Nowadays it is still widely used by professional engineers to check and validate the output of more sophisticated analyses, such as non-linear time history analyses.

For buildings equipped with dissipative devices, the ASCE 7 (2005) contains linear and non-linear procedures for design and analysis of building with added viscous dampers. The procedures of the ASCE 7 (2005) can be applied to all types of damping systems and has been successfully validated also with reference to yielding structures (MCEER report).

Alternative approaches leading to practical design procedures for the sizing of viscous dampers have been proposed in the last years: (i) Lopez-Garcia (2001) developed a simple algorithm for optimal

damper configuration (placement and properties) in MDOF structures, assuming a constant inter-storey height and a straight-line first modal shape; (ii) Christopoulos and Filiatrault (2006) suggested a design approach for estimating the damping coefficients of added viscous dampers consisting in a trial and error procedure; (iii) Silvestri et al. (2010) proposed a direct design approach, referred to as the “five-step procedure”.

In the present work, starting from basic considerations of structural dynamics, an Equivalent Static Analysis (ESA) procedure for structures equipped with added viscous dampers is presented. The ESA method does not require the use of a computer software and is targeted to professional engineers as a tool for a fast preliminary structural design and/or to check the results (in terms of order of magnitude) of more sophisticated design procedures, such as those