Fatigue analyses of buildings with viscoelastic dampers

Alessandro Palmeri\textsuperscript{a,}* , Francesco Ricciardelli\textsuperscript{b}

\textsuperscript{a}Department of Civil Engineering, University of Messina. Vill. Sant’Agata 98166, Messina, Italy
\textsuperscript{b}Department of Mechanics and Materials, University of Reggio Calabria. Feo di Vito 89060, Reggio Calabria, Italy

Available online 13 February 2006

Abstract

Viscoelastic damping devices are effective in mitigating the buffeting response of medium- to high-rise buildings. Their use has the effect of limiting displacements and accelerations, as well as of reducing number and amplitude of fatigue cycles. The structural behaviour, however, is somehow modified, and a standard Kelvin–Voigt model proves to be inaccurate in predicting the dynamic response. For an accurate analysis, in fact, a model able to account for the viscoelastic memory is needed. In this paper, the problem of estimating the fatigue life of structural components of tall buildings provided with viscoelastic dampers is dealt with. A dynamic model of the building in the modal space is established, able to account for the viscoelastic memory, as opposed to the classical modal strain energy method. A cycle counting procedure is then summarised, based on the separation of the dynamic response of the building into a quasi-static and a resonant part. The fatigue life is then evaluated using the well-known Palmgren–Miner rule. An application to a 15-storey building is included, aimed at quantifying the inaccuracies arising when the memory effect is neglected.

\( \copyright \) 2006 Elsevier Ltd. All rights reserved.

Keywords: Tall buildings; Viscoelastic dampers; Modal analysis; Modal strain energy (MSE) method; Gust buffeting; Cycle counting; Fatigue damage

1. Introduction

Fatigue life is one of the relevant parameters in the design of wind-exposed structures. As an example, long-span bridges that have performed well in wind for decades, both from...