Critical aspects in designing earthquake-resistant dual systems

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Summary

A simple scheme of dual system is designed for different seismicity levels according to Italian and European standard codes. Some critical aspects on the application of the capacity design rules are evidenced. Nonlinear analyses are carried out for evaluating the actual lateral behavior, showing that the actual structural performance can significantly differ from that assumed at design level. The constructive detailing prescriptions appear to be not calibrated on the design performances and local ductility demand expected in dual systems. This can lead to over-strengthening the structure, without reference to the design assumptions, the actual site hazard, the standard safety levels.

Keywords: Dual systems; capacity design; seismic performance; detailing; Italian code; Eurocode.

1. Introduction

Dual systems, coupling ductile frames and shear walls, are very effective earthquake-resistant systems [1], optimizing the elastic and post-elastic performance of the constructions: the shear walls offer the stiffness for containing the lateral deformations, the plastic hinges of the frames give the suitable ductility in post-elastic range. In spite of their effectiveness, the capacity and strength evaluation of these systems, including components with very different behavioural characteristics, require further studies [2]. Usual design methods, conceived for framed structures, reveal some critical aspects, when applied to dual systems. In these systems the force distribution at the frame joints, derived by using linear analyses with reduced design spectra, can not correspond to the one assumed for framed structures. Moreover, both the walls and the elements of the framed portion shall be designed with the same detailing prescriptions of the ductile frame systems. Due to the high efficiency of the dual systems this can lead to overestimate the capacity of the designed system. With the aim of investigating these aspects, a simple model of dual system has been designed according to standard codes and nonlinear analyses have been then carried out on it.

2. Sample structure

2.1 Dimensions and properties

The sample structure, used for the evaluations, is a 2-bays 8-stories r/c frame coupled with a wall (Fig. 1). The plane structure is hypothesized to be the transversal earthquake resistant system located in a building with a longitudinal repeated span of 5,50 m. All the beams have dimensions 300×500m, all the columns have rectangular section 500×800 mm, the wall has dimension 200×2100mm. The following load values, and the consequent masses, have been adopted. Member dead load = 25 kN/m^3; floor dead and permanent loads: $g_{k,s}$= 5.0 KN/m^2; floor live loads: $q_{k,s}$ = 2,0 KN/m^2 at the intermediate floors and $q_{k,s}$ =1,5 KN/m^2 at the roof level.

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