On the behavior of low-rise, irregular, dual structure

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Abstract

The Response modification factor R represents a number of structure behaviors including ductility, overstrength and the inherent redundancy. Thus, this factor is to be defined according to the type of lateral force resisting system. However, there are some complexities and/or uncertainties with regard to the codes related to the R factor in terms of height, form of irregularities and structural systems. In the present study, assuming a low-rise, vertically irregular structure with a heliport and a dual structural system, and applying a complete design, including a nonlinear finite element approach, pushover analysis, and implementation of different codes, an extensive investigation of the R factor has been conducted for different orientation of concrete core and/or irregularities in structure. It is expected that with the help of to this wide-ranging study, we can come up with an appropriate and reasonable understanding of the R factor in these types of structures.

Keywords: ***R-factor, Ductility, Inelastic Deformation, Irregularity, Shear Wall***

1-Introduction

Seismic design concentrates on safety of the occupants and economical considerations. However, it is impossible to guarantee complete life safety and no structural damage. In order to meet such objectives, structures need to be designed with adequate strength and stiffness to limit damages. In this regard, design forces are determined by using a response modification factor R to reduce the forces obtained by analysis, assuming a linear elastic response of the structure. The reduction factor (R) accounts for the reduced strength demand due to a number of effects, including energy dissipation and lengthening of the structural period as the structure becomes inelastic. Therefore, if suitable structural systems are selected and structures are detailed with appropriate levels of ductility, regularity, and continuity, elastic design of structures for reduced forces would be followed by acceptable performance. [1], [2]

A dual system consists of a space frame (columns and beams) that provides primary support for the gravity load and structural nonbearing walls or bracing for primary lateral load resistance; and therefore, the frame and shear walls (or braced frames) must resist lateral seismic force in accordance with their relative rigidities considering the interaction of the walls and the moment frames as a single system.

The configuration of structural elements can extensively affect its performance. Configuration can be divided into two levels, namely, plan configuration and vertical configuration. [3]

2-Review of the related literature

There have been a vast number of research studies conducted on different aspects of how R-factor may affect the general behavior of the structure. Damage demand and capacity parameters, which concentrate on demand parameters, limit states, ductility capacity, energy dissipating models, and damage models in elements and structures (Krawinkler, Nassar)[4]. In another study, Fajfar, Vidic & Fichinger have investigated on levels of structural damage and dissipated hysteretic energy [5]. Reinhorn, Kunnath & Mander have studied on damage control, which explains damage states, strength deterioration and seismic design targets [6]. A comparison between Variety of R-factor, force reduction factors, displacement amplification factor quantities which was conducted and investigated by Uang [7]. Extensive studies on nonlinear spectra's for design process and soil-structure interaction (Miranda) [8], specific investigations on relationships between damage to welded steel moment frames in connections of the structures and redundancy (Bonowitz et al., 1995). The potential effects of redundancy was also evaluated in the performance of 165 Chilean concrete buildings ranging from 6 to 23 stories in height (Klingner, 1991)[9]. Elsewhere the performance level and damage control was focused on in concrete structures by Ghosh (1991)