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Seismic Performance of Two Story Steel Building Using Shape Memory Alloys (SMAs) Bars

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Abstract

Shape Memory Alloys (SMA) is type of smart materials that have ability to undergo large deformation and return back to their undeformed shape through heating (shape memory effect) or removal of load (superelastic effect). This unique ability is useful to enhance behavior of structure and seismic resistance. In this paper, superelasticity (SE) effect of NiTi alloys is used to improve the structural characteristics of steel building. The finite element analysis of steel building is done using ABAQUS v.2017. In order to compare the structural behavior of the steel building equipped with Shape Memory Alloy bars at beam-column connection, three steel building was modeled with a different combination of high strength steel bars and SMA bars. The steel building was checked for time history analysis by using Vrancea 1977 earthquake data. In order to estimate the recentring ability, residual of roof displacement and energy dissipation. The steel building equipped with SMA bars shows 82.7%, 152.72% recovery in residual roof displacement for steel building equipped with 50 % SMA bars and 50% HS steel bars and steel building equipped with 100% SMA bars respectively, and moderate energy dissipation. In general, the frame equipped with 50% superelastic SMA bars and 50% HS steel bars provided better seismic performance.

Keywords: Beam-Column Connection, Smart Materials, Shape Memory Alloys, Bars, Recentering Ability.

1. Introduction

High residual deformations and brittle fracture of conventional moment resisting frame that incorporating welded beam-column connection after earthquake action, thus a new system of structural steel which was the ability of recentring and energy dissipation is required in order to address such problems. Lately, the application of smart material (shape memory alloys SMA), particularly with nickel-titanium (NiTi) has attracted a lot of attention in the society of researchers of civil engineering. SMAs are a type of alloys that show a unique feature to undergo large deformations and return back to undeformed shape through either heating known as the shape memory effect (SME), or by removing the load that causes the deformations known as the superelastic effect (SE). Owing to these extraordinary properties, SMA materials have already been effectively used in projects of civil engineering [1].

Dolce et al. suggested and tested the three types of (SMA) Nitinol wire-based devices: supplemental recentering device (SRCD), recentering device (RCD), non recentering device (NRD), the use of SMA and SRDC isolation devices in structure [2]. Ocel et al. perform the H shaped beam to H shaped column connections by using SMA bars as moment transferred element with diameter 35 mm. upon heating the SMAs bars above the transformation temperature, results showed stable and repeatable hysteretic behavior [3]. Penar study the behavior of beam-column connection with SMA tendons in the austenite phase. The tendons with a diameter of 19.05 mm. the tendon was machined into a shape of a

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