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Major Parameters Affect the Non-Liner Response of Structure Under Near-Fault Earthquakes

Ali A. Muhsin [a*], Hussam K. Risan [a]

[a] *Civil Engineering Department, Al-Nahrain University, Baghdad, 10072, Iraq.*

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Abstract

Near-fault ground motion can be identified by the presence of a predominant long duration pulse in the velocity traces mainly due to directivity effect. This pulse exposes the structure to high input energy at the beginning of the earthquake which leads to a higher response in comparison with the ordinary ground motions. This paper investigates 79 earthquake records with different properties to achieve three goals: the first aim is to compare between the linear and nonlinear response of SDOF systems under near-fault and far-fault earthquakes. While the second objective is to examine the parameters that control the characteristics of near-fault earthquakes. Two factors have been studied which is PGV/PGA ratio and pulse period. Finally, the seismic code provisions related to the near-fault earthquakes were evaluated in term of the elastic acceleration response spectrum, the evaluation is adopted for American Society of Civil Engineers code ASCE 7 and Uniform Building Code UBC. The results lead to the following conclusions: with respect to a specific PGA, the near-fault earthquake imposed higher response in comparison with far-field earthquakes. The near-fault earthquakes become severe as the PGV/PGA and pulse period increase. The interested seismic codes can cover the actual behavior based on the average response of a certain amount of data, while it may become non-conservative relative to an individual record.

Keywords: Near-Fault Earthquake; Pulse Period; PGV/PGA; Strength Reduction Factor; Response Spectrum.

1. Introduction

Near-field earthquake identified by limited frequency and high amplitude pulse with a long duration that may or may not appear in the acceleration time history but it is significantly obvious in the velocity traces. This kind of ground motions put the structures under high input energy at the starting of earthquake due to the effect of two phenomena called directivity effect and fling step effect. The directivity effect occurs when the fault rapture travels toward the site at a velocity very close to the shear wave velocity. This will expose the structures to high amplitude with long duration pulse that extremely affects the structural response. Conversely, the backward directivity effect happens when the fault spread apart from the site, such effect can produce a long duration ground motion traces with small amplitude [1]. On the other hand, the fling step effect takes place when the two sides of the fault moved relative to each other. This movement happened in a manner that causes permanent displacement on the tectonic plate which leads to one side pulse in the velocity time history and step pulse in the displacement traces [2].

Due to the special properties of the near-fault earthquakes, it deserves a deeper discussion to clarify all the mysterious points related to this phenomenon. Many conclusions regard the structural response under near-fault earthquakes have been discussed in previous attempts. Chopra and Chintanapakdee (2001) diagnosed the changes in the spectral regions

* Corresponding author: aliabdulwahid80@gmail.com

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