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Wave-passage effect on responses of MDOF systems in near field earthquakes

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Abstract

In this article responses of seven story building excited by the horizontal component of fault-parallel (permanent) displacement and fault-normal pulses with different magnitudes and time lags are investigated. In the considered model each storey consist of a rigid beam connected to two axially rigid mass-less columns by linear rotational springs and dashpots. The system of coupled equations of motion has been solved by the fourth-order Runge-Kutta method **.**The drift responses show that time lag of input ground motion records has influence on structure responses. Because of the large initial velocity present in the ground motion near earthquake faults the story drifts quickly exceed the typical design levels and fault-normal pulses produce more intense drift demands relative to those for fault-parallel displacements and it must be noticed in near fault zone designs.

Keywords: near field earthquake, structure response, design, wave passage

1. INTRODUCTION

In the near field of large earthquakes, and especially close to surface faults, the strong ground motion can be dominated by the permanent displacements (typically parallel to the fault surface) and by large pulses (often perpendicular to the fault). Traces of these large displacements and pulses may not always be obvious in the processed records of the recorded motions because of band-pass filtering, designed to eliminate digitisation and processing noise [1].When the distances between the multiple support points are large (e.g., bridges, dams, tunnels, and long buildings), the effects of differential motions become important and should be considered in dynamic analyses. Spatial and temporal representations of strong earthquake motion required for such analyses have been investigated in numerous papers [2].Their consequences have been studied for the response of beams, bridges, simple models of three-dimensional structures, long buildings [3], and dams [4]. It was shown that the common response spectrum method for synchronous ground motion can be extended to be applicable for earthquake response analyses of extended structures experiencing differential in-plane and out-of-plane ground motion[5],[6]. Strong dependence of the R-factor on the magnitude of an earthquake for the response of a one-story system to in-plane motions close to an earthquake source was found [7],[8].
The purpose of this study is to investigate the variation of maximum linear drift in the seven-story buildings subjected to fault-normal pulses and fault-parallel displacements.

2. Dynamic model

Considered model is a seven-story building consisting of seven rigid beams with masses m_i, polar mass moments of inertia I_i, and length *L*, supported by fourteen rigid mass-less columns connected at two ends by circular springs Fig.1a. The mass-less columns are also connected at two ends by circular dashpots providing a fraction of critical damping. Rotation of the columns is assumed not to be small, which leads us to consider the geometric nonlinearity. The masses are acted upon by the acceleration of gravity, g, and are excited by differential ground motions at two piers. We define the parameters of the model as follows:
$k_{\phi_i} =$ Initial rotational stiffness of column springs of $i-th$ story;