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An Investigation on DDBD Approach of Near-Fault RC Frame, RC Wall-Frame and Steel Braced RC Frame Systems

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Abstract

Direct Displacement Based Design (DDBD) is one of the novel approaches for structural design of reinforced concrete frame systems. In this study, DDBD approach is investigated for single moment-resisting reinforced concrete frame, dual reinforced concrete wall-frame and dual steel braced reinforced concrete frame systems. In this methodology, first the displacement profile is calculated, following which the equivalent single degree of freedom system is modeled considering the damping characteristics of each member. Then, having calculated the effective period and secant stiffness of the structure, the base shear is obtained based on which the design process can be carried out. For each system three frames are designed using Direct Displacement Based Design approach. The frames are then analyzed using nonlinear time-history analysis with 7 near-field earthquake accelerograms. In order to reach an understanding of response of the three systems designed using Direct Displacement Based Design, damage index is investigated through lateral drift profile of the models. Compatibility of the above mentioned systems with Direct Displacement Based Design approach is also studied via comparison of the nonlinear time-history analysis results. The results of the analyses indicate efficiency of the DDBD approach for different reinforced concrete structural systems located in near-field regions.

Keywords: Direct Displacement Based Design, RC frame systems, Time-history analysis, Near-field accelerograms.

1. INTRODUCTION

In recent years, there has been a great tendency toward performance-based seismic design of structures. Therefore, various methods have been developed namely Capacity Spectrum Method [1], the N-2 Method [2], and Direct Displacement-Based Design method. A new performance-based seismic design procedure called the Direct Displacement-Based Design (DDBD) proposed by Priestley [3] has recently received notable acceptance among researchers. It seems that the methods could be a rational alternative to traditional erroneous force-based seismic design of structures. The method defines the design performance level of the structure in terms of displacement limits. Therefore, displacement is the key parameter of the design method.

Near-Fault ground motions, on the other hand, impose severe seismic demands on structures in terms of displacement and ductility due to the effects of both directivity and fling step pulses. Indeed long-period pulses, and high frequency content of motions in the near-fault zone can excite both short and long period structures quite well. Previous studies [4] have proved the importance of the above mentioned demands on the response of near-fault structures. Many studies [5] have also showed that current force-based seismic design procedures are not appropriate for the design of near-fault structures and more efficient methods are needed.

Due to the importance of severe pulse-type displacement demands on near-fault structures, on one hand, and the key role of displacement in DDBD procedure, on the other, it is argued that the method would be appropriate for seismic design of near-fault type structures.

In this study, DDBD approach is investigated for single moment-resisting reinforced concrete frame, dual reinforced concrete wall-frame and dual steel braced reinforced concrete frame systems.