DIRECT DISPLACEMENT-BASED DESIGN OF SPECIAL COMPOSITE RC SHEAR WALLS WITH STEEL BOUNDARY ELEMENTS

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Direct Displacement-Based Design (DDBD) is a performance-based seismic design method that has been proposed and well developed over the past two decades remarkably by Priestley and his co-workers (Priestley et al., 2007) for designing RC frame structures, shear walls and bridges. In this method, the behavior of a multi-degree-of-freedom (MDOF) system is approximated by an equivalent single-degree, f-freedom (SDOF) substitute structure. The SDOF structure has an equivalent secant stiffness at maximum displacement response with an equivalent viscous damping. Knowing the target design displacement and corresponding ductility, the effective stiffness of the SDOF structure at peak response and then the design base shear is determined and distributed along the MDOF structure height.

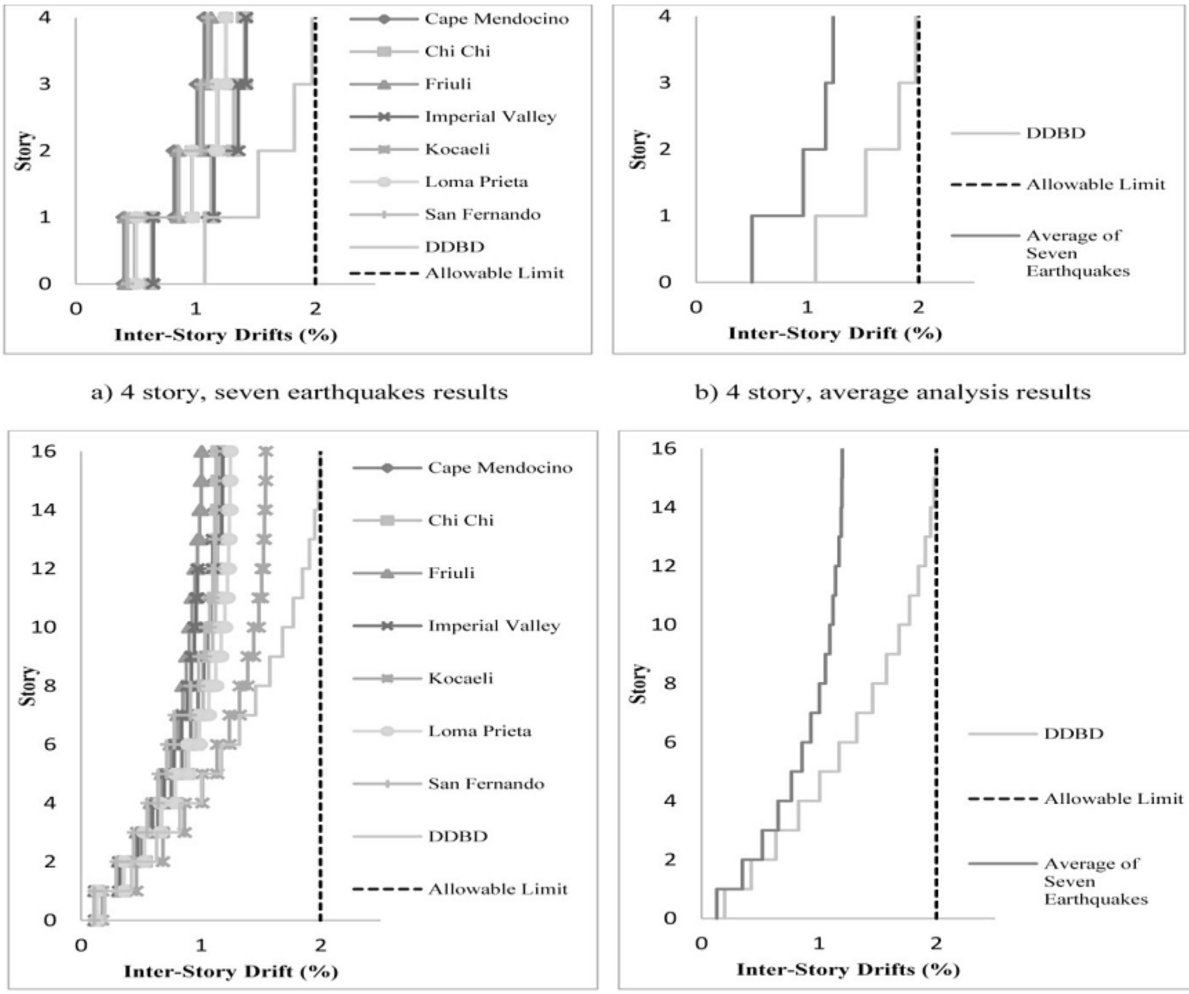
Special composite RC shear wall (CRCSW) with steel boundary elements is a kind of lateral force resisting structural systems which is used in earthquake-prone regions. Due to their high ductility and energy dissipation, CRCSWs have been widely used in recent years by practitioner engineers. However, there are few studies in the literature on the seismic design of such walls.

Although there are many studies in the literature on the DDBD of RC structures, however, no study can be found on DDBD of CRCSWs. Therefore, the aim of present study is to evaluate the ability of DDBD method for designing EBFs CRCSWs. To this end, four special composite reinforced concrete shear walls with steel boundary elements of 4, 8, 12 and 16-story numbers were designed using the DDBD method for target drift of 2%.

To investigate the seismic behavior of designed CRCSWs, it is necessary to model the nonlinear cyclic behavior of such walls properly. In this regard, a finite-element macro-model was developed and utilized in this study to simulate the nonlinear behavior of a CRCSW tested under cyclic loading at the Politehnica University of Timisoara in Romania by Dan et al. (2011) using SeismoStruct software. The analyses showed a good correlation between the numerical and experimental results and hence validated the use of developed model to simulate nonlinear behavior of CRCSWs.

After validating the finite-element macro-model, the seismic behavior of the four CRCSWs was studied using nonlinear time-history dynamic analyses. Frames were modeled using SeismoStruct software as two dimensional systems. This software is capable of performing nonlinear dynamic and static analyses with advanced distributed plasticity model for elements. Distributed plasticity fiber based model is used to describe material nonlinearity of the framing members. Seven suitable horizontal earthquake records were selected from the PEER NGA Database. Dynamic analyses were performed for the mentioned walls using the selected earthquake records.

The earthquake records were scaled using the method given in IS-2800 so that their average not to fall below the target design spectrum for the code specified range of periods.



a) 4 story, seven earthquakes results

b) 4 story, average analysis results

c) 16 story, seven earthquakes results

d) 16 story, average analysis results

Figure 1. Comparison of the design inter-story drift profiles with the results of nonlinear time-history analyses for the studied CRCSWs with (a,b) 4 stories and (c,d) 16 stories

Profiles of the inter-story drifts of the studied 4- and 16-story walls have been shown in Figure 1. These results indicate that the DDBD method can be used to design CRCSWs safely in seismic regions with predicted behavior.

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