EVALUATION OF DIRECT-DISPLACEMENT BASED SEISMIC DESIGN METHOD FOR EBFs

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Recent research in the field of earthquake engineering has seen the development of number of different displacement-based seismic design (DBD) methods. Such methods aim to overcome limitations with the force-based design methods incorporated in current codes. The most developed DBD method currently available is the Direct DBD approach, described and investigated in a text by Priestley et al. (2007).

While the guidelines in the DDBD code have been relatively well tasted for RC structures, further verification and development is required for steel frame systems. There is just one comprehensive study can be found on DDBD of eccentrically braced frames (EBFs) which has been published recently by Sullivan (2013). The study presented by Sullivan (2013), has been focused of DDBD of EBFs with short (shear) link beams. Therefore, the aim of present study is to evaluate the ability of DDBD method for designing EBFs with intermediate and long link beams. To this end, three five-storey EBFs with short, intermediate and long link beams designed using the DDBD method proposed by Sullivan (2013). Figure 1 shows the case study EBF structures selected for examination in this paper.

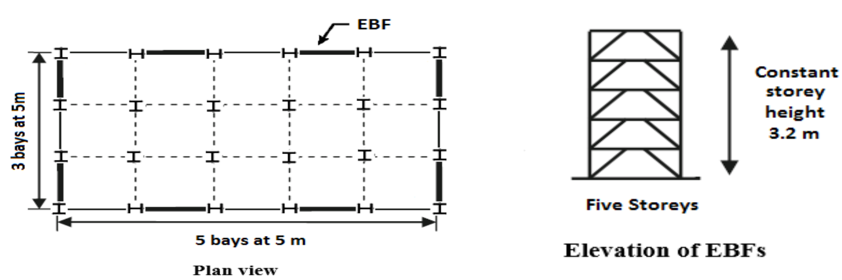

Figure 1. Illustration of the case study EBF structures

To survey the designed frames seismic behavior and also model their nonlinear behavior in structural analyses, it is necessary to model the nonlinear cyclic behavior of link beams properly. In this regard, the macro-model developed and proposed by Richards (2004) was utilized in this study to simulate the nonlinear behavior of some link beams tested at the University of Texas at Austin by Arce (2002) using OpenSees software. The analyses showed a good correlation between the numerical and experimental results and hence validated the use of Richards' model to simulate the nonlinear behavior of link beams in a finite-element macro-model.

Therfore, the nonlinear-seismic demands of EBFs are investigated in this paper. To this end, seismic behavior of the three EBFs was studied using nonlinear time-history dynamic analyses. Frames were modeled using OpenSees software as two dimensional systems. OpenSees software is an object-orieted framework for finite element analysis. Distributed plasticity fiber based model is used to describe material nonlinearity of the framing members. Fourteen suitable horizontal earthquake records were selected from the PEER NGA Database. Dynamic analyses were performed for the mentioned frames using the selected earthquake records. The earthquake records were scaled using the method given in ASCE-7 so that their average not to fall below the target design spectrum for the code specified range of periods.

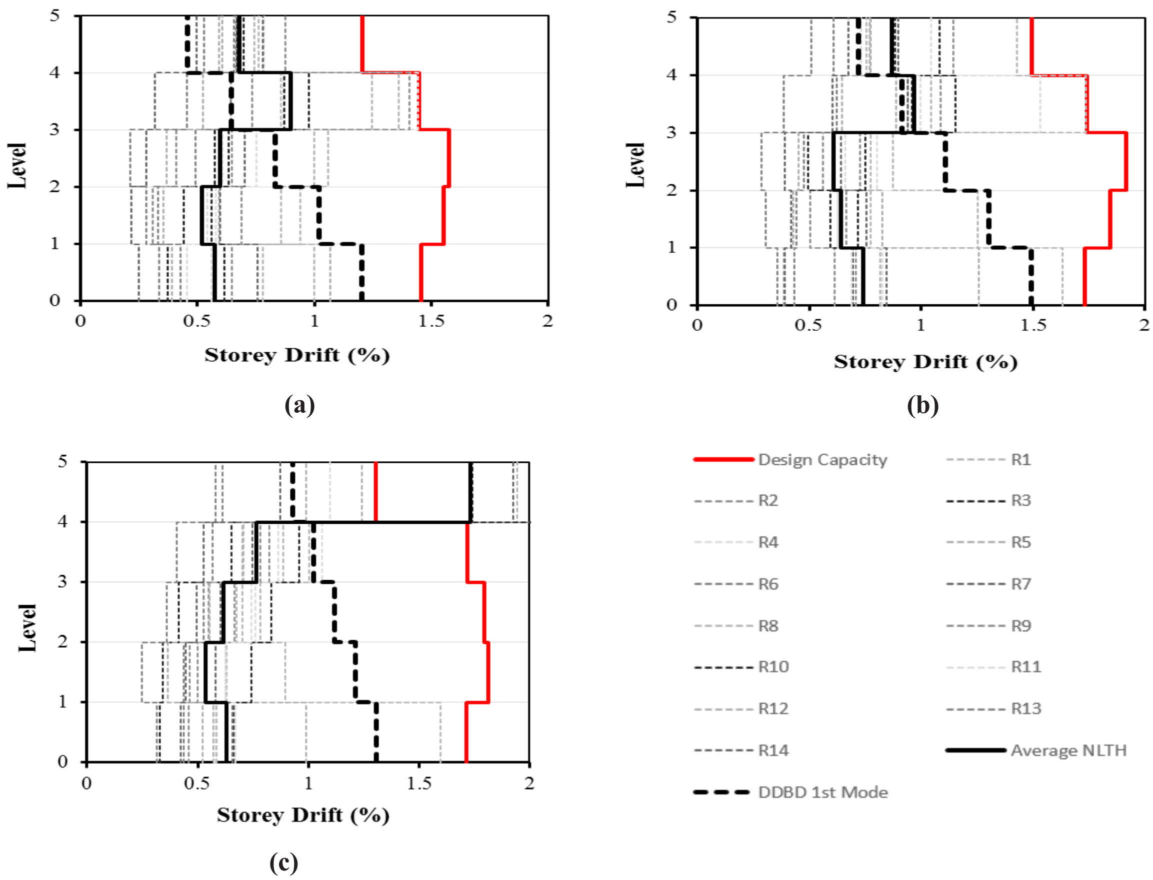

Figure 2. Comparison of the design inter-storey drift profiles with the results of nonlinear time-history analyses for the 5-storey EBF with (a) short link, (b) intermediate link and (c) long link

The storey drifts recorded in the NLTH analyses indicate that the DDBD can provide accurate control of deformations and therefore damage, but that further research is required to develop and test the DDBD methods for EBF systems.

REFERENCES

Arce G (2002) Impact of higher strength steels on local buckling and overstrength of links in eccentrically braced frames, MSc thesis, Univ. of Texas at Austin, Austin , Tex, USA

Priestley MJN, Calvi GM and Kowalsky MJ (2007) Displacement-based Seismic Design of Structures, IUSS Press, Pavia, Italy

Sullivan TJ (2013) Direct displacement-based seismic design of steel eccentrically braced frame structures, Bull Earthquake Eng., 11(6): 2197-2231