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Seismic force reduction coefficient for equivalent static design of chevron-braced steel frames

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1. Introduction

According to the Japanese seismic code, the seismic force reduction coefficient (Ds) for chevron-braced frames varies between 0.25 and 0.5, which allows for the trade-off between the strength and ductility. This value is determined according to the type of column and beam, the slenderness ratio (λ) and the participation ratio (β) of braces. However, when taking the strength of chevron braces as the sum of the yielding strength of the tensile brace and the ultimate strength of the compressive brace, it is found that the calculated strength trends to be constant regardless of the slenderness ratio, especially when ranging from 60 to 140, the usual values for braces, so that it is feasible to simplify the selection procedure of the seismic force reduction coefficient factor Ds.

2. Model-based study

In this study, the above deduction is examined by model-based studies using three-story structures and six-story structures, each with different Ds, β and λ. These structures are designed following the typical Japanese design procedure, with the approximated ultimate strength of braces in compression as 0.3 times the yielding strength of brace in tension. 20 ground motions recorded with the exceedance of 10% over 50 years are employed for time history analyses.

3. ESDOF model and time history analysis

To reduce uncertainties in the seismic response analyses, an equivalent model with a single degree of freedom (ESDOF) is simplified from each three-story structure by assuming the first vibration mode domination, equal stiffness and strength. The ESDOF model is validated by comparing the roof drift angle with that of the corresponding three-story structure, as shown in Fig.1. The results obtained from the time history analyses are compared with the referenced pure frame with the same Ds value. It is found that the braced frame largely has the smaller deformation than the referenced frame regardless of β and λ, so that it is possible to adopt the same Ds for braced frames as that for pure frames. This conclusion is further demonstrated by the time history analyses using six-story braced frames, as shown in Fig.2.

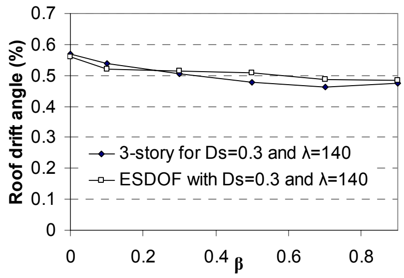

Fig.1. Roof drift angles of 3-story models and ESDOF

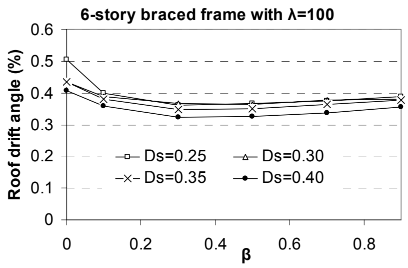

Fig.2. Roof drift angles of 6-story braced frame

4. Conlcusions

(1) The ESDOF model is reliable to represent the basic design parameters concerned in this study.

(2) It is possible to use the same seismic force reduction factor for the braced frames as the referenced pure frames.