Numerical Assessment of Seismic Performance of Super High-rise RC Buildings with Buckling Restrained Braces

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Summary

In this paper, the passive control effect of BRBs in RC buildings subjected to earthquake ground motions is investigated by nonlinear time history analysis. In one model, the RC frame was braced by BRBs in each story (each model) and in the other one, each BRB spans over two stories (over model). As a result of the analysis, the over model exhibited almost the same passive control effect as compared to the 'each model', although the number of BRBs was significantly reduced and the RC beams in the braced span were abandoned.

Keywords: Super high-rise RC buildings, Buckling restrained braces, Seismic response analysis, Finite element analysis, Passive control effect

1. Introduction

The authors suggested a continuously buckling restrained braced frame (CBRBF) system in which the BRBs are arranged in the form of a Warren truss[1]. The BRBs in the adjacent stories share the same gusset plate, which is fastened to the concrete beam-to-column joint by prestressing bolts and is kept by a pair of RC corbels that project from the column surface. In such a manner, the prestressing bolts are mainly responsible to resist the horizontal force while the RC corbels the vertical one. The corresponding BRB connection details in the CBRBF system have been confirmed effective through cyclic loading test and FE analysis of RC subassemblies with BRBs. However, the subassemblage tests and corresponding analysis did not provide insight into the dynamic behavior of the whole building. In this paper, the passive control effect of BRBs in super high-rise RC buildings subjected to earthquake ground motions is investigated by nonlinear time history analysis.

2. Numerical Model and Analysis Result

The analysis parameters are shown in Table 1.The parameter of the analysis was the configuration of the BRBs. Two kinds of passive controlled building models were examined. In one model, the RC frame was braced by BRBs in each story (‘each model’) and in the other one, each BRB spans over two stories (‘over model’) (Fig.1). Describe below plan of over model. In BRB connection authors have proposed[1] central core part around the beam members can be changed to minor steel beam. It can be installed BRB the same yield strength in the upper and lower stories, the beam corresponding to the zero force member of the truss is because it can be a member of only supporting a long-term load. In this analysis, the beam around central core part was modeling H-section steel at both ends pin support. The story drift of two stories in the ‘over model’, it is considered the BRB deforms about twice than the ‘each model’. Further by modeling the beam members around central core part in the minor members, increase the deformation of the BRB, it is considered to be able to function effectively the BRB (Fig. 2). In order to process the varying axial force of column due to installation of BRB, around the core part was constituted by strong RC frame. In both model, the connection of the RC frame and BRB was rigid joint.

Table 1: Analysis parameters

Model	reference	each	Over
BRB	No	each story	over two stories
Slab of core part	Yes	No (wellhole)	
Column around core part	normal frame		strong frame
Beam around core part	normal frame		steel beam
natural period [s]	2.92	2.77	2.77

Fig. 1: BRB installation details of ‘over model’

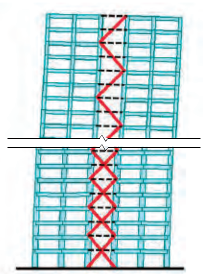

Fig. 2: Pattern diagram

By comparing the maximum story drift ratio of the reference model with the braced ones, the effect of passive control was confirmed for both the ‘each model’ and the ‘over model’. In addition, the ‘over model’ exhibited almost the same passive control effect as compared to the ‘each story model’, although the number of BRBs was significantly reduced and the RC beams in the braced span were abandoned.

From the results of the plasticity rate of the beam μ_r, deformation could be decreased by 42% in the ‘over model’ than that in the reference model. Therefore, the damage of the RC frame could be decreased. In addition, ‘over model’ has a greater deformation reduction effect than the setting form usually used like ‘each model’.

From the results of the plasticity rate of the BRBs μ_{BRB}, BRBs of ‘each model’ has not been yielded. Focusing on the energy dissipation, the ‘each model’s energy dissipation is 49kNm, the ‘over model’ model is 481kNm. The ‘over model’ represents the energy dissipation of the two stories, it is 240kNm to be considered as a half to contribute to one story, and is performed five times the energy dissipation of the ‘each model’. BRB is deformed about twice in the ‘over model’, compared to the ‘each model’ by the story drift of the two stories. Thus, in the ‘over model’, it is possible to increase the deformation of the BRB, it is considered to have been able to function effectively.

3. Conclusions

As a result of the analysis, the over model exhibited almost the same passive control effect as compared to the 'each model', although the number of BRBs was significantly reduced and the RC beams in the braced span were abandoned.

References

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