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Hybrid on-line test on simulation of steel moment-frames subjected to extremely large ground motions

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1. Introduction

The on-line test system used here, Peer-to-Peer (P2P) Internet online hybrid test system, is one of the appealing systems developed recently for simulation of earthquake responses of structures. It has been demonstrated to be valid and capable of handling multiple numerical nonlinear substructures. However, the feasibility to accommodate multiple tested substructures is not made clear. Furthermore, if the tested substructures involve significant deterioration, stability of the system should be examined as well.

2. Target structure and tested substructure

When a moment frame is subjected to extremely large earthquakes, plastic hinges take place not only at beam ends but also at the column bases where significant strength deterioration might occur. In this study, the two column bases of a one-bay four-story frame are taken as the tested parts, while the superstructure is analyzed by ABAQUS, as shown in Fig.1. The three substructures are distributed to three different locations and connected through Internet. The plastic rotations of the two column bases are treated as the boundary deformations.

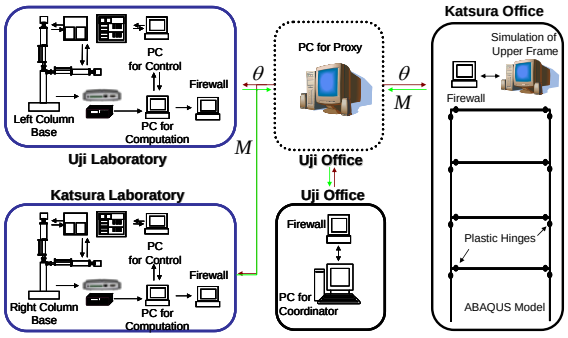

Fig.1. Distributed test system

The tested substructures are the plastic hinges at the column bases, which are reproduced by cantilever columns shown in Fig.1. The boundary rotation is controlled by the horizontal displacement at the top of the cantilever column. The varying axial force obtained from the numerical substructure is applied at the top end.

3. Test results

The system ran well without any malfunction and the concurrent implementation of the two tested substructures was successful. 10-second simulation took about 8 hours. In this study, the fault normal ground motion recorded at Takatori in 1995 was adopted and enlarged by 1.5 times. Under this extremely large earthquake, the deformation of the column bases reaches 0.1 rad, and significant deterioration was observed, as shown in Fig.2.

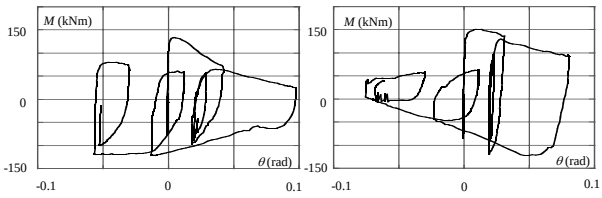

Fig.2 (a) Right column base (b) left column base

4. Conclusions

Major findings are as follows:

(1) The proposed P2P system can handle multiple tested substructures.

(2) The P2P system is stable even when significant deterioration occurs in the tested substructures.