Study on Selection Schemes of Blasted Columns of Buildings to Improve Efficiency and to Secure Safety during Demolition

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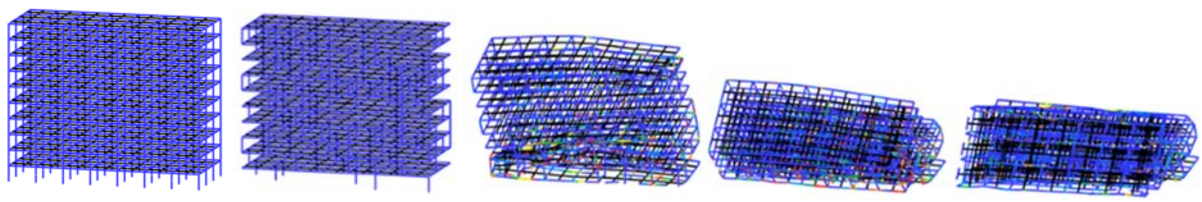
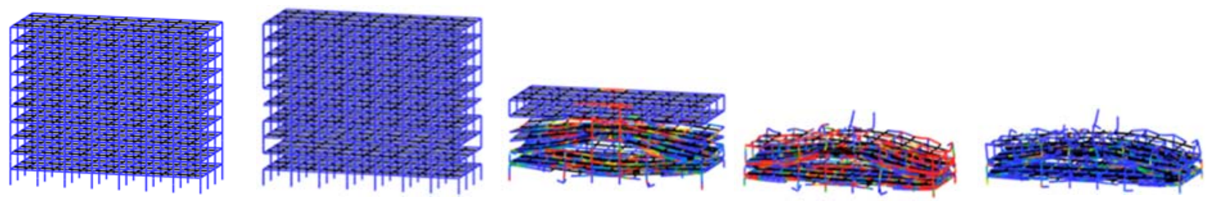
Strong demand for demolition of buildings increases due to the aging of buildings which were built during the period of high economic growth and the redevelopment of cities. At present, demolition using heavy equipment is mainly conducted in Japan; however, the demolition work will be prolonged and the cost will increase if the scale of the building becomes larger. A blast demolition technique is often used in Europe and the United States to solve the concerns of demolition using heavy equipment. The blast demolition techniques can avoid dangerous work at a higher place and can be completed at a relatively low cost in a short period. However, as demolition planning are mainly conducted based on proprietary technology of some vendors, the technique requires high levels of knowledge and experience in such occasion when selecting blasted columns. Furthermore, Japanese buildings are designed more strongly than in Europe and in the US, so the rules cannot be simply adapted. To ensure reliable and safe demolition, it is necessary to establish a quantitative selection scheme of blasted columns based upon criteria of dynamics.

In this study, a blast demolition planning tool of buildings based upon a parameter called the



(a) 0.9 s (before the 1st blast) (b) 1.0 s (1st blast) (c) 5.0 s (after the 1st blast) (d) 9.0 s (e) 30.0 s (final form)

Fig. 1 An example of blast demolition analysis (10-story, 7×3 span model, random selection of blasted columns)



(a) 0.9 s (before the 1st blast) (b) 3.9 s (before the 2nd blast) (c) 6.0 s (after the 2nd blast) (d) 6.9 s (e) 30.0 s (final form)

Fig. 2 An example of blast demolition analysis (10-story, 7×3 span model, selection of blasted columns with the largest variance of the key element index values at third floor) key element index [1], is developed. The index indicates the contribution of a column to the strength of the building and can be numerically evaluated; the higher the index value, the higher the contribution to the overall strength of the building. An Adaptively Shifted Integration (ASI) - Gauss code [2] is applied to blast demolition analyses of ten-story steel framed building models with different span numbers. Various selection schemes of blasted columns using the index were evaluated by comparing the efficiencies and levels of safety during demolition; namely, by comparing the relation between the number of blasted columns and the heights of remains after the demolition, and by the scattered distance of members after demolition. First, the blasted columns were selected randomly to derive a simple relation between the number of blasted columns and the heights of remains of buildings. The results indicated that there are similar tendencies in the relation regardless of the number of spans. However, some results deviated from the tendencies. In those cases, safety could not be secured because the buildings collapsed in the lateral direction (Fig. 1). Next, some selection schemes of blasted columns based upon the key element index values were applied to secure safety during demolition. The variances of key element index values were considered, in particular, to make a large difference in the distribution of the index values in each layer of the building. A difference in efficiencies of demolition appeared between each selection scheme. The efficiency deteriorated in most of the selection schemes as the number of spans increased. However, the efficiency maintained the same level when the columns with the largest variance of the key element index values at the first floor were selected as the blasted columns. As shown in Fig. 2, most of the cases using the variance of index values showed a collapse motion in vertical direction, and the scattered distances of structural members were significantly suppressed.

References

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[2] K.M. Lynn and D. Isobe: Finite Element Code for Impact Collapse Problems of Framed Structures, *International Journal for Numerical Methods in Engineering*, Vol. 69, No. 12, pp. 2538-2563, 2007.