DAMAGE OF STEEL BUILDINGS AND SEISMIC INPUT IN THE HYOGOKEN-NANBU EARTHQUAKE

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ABSTRACT

The Hyogoken-nanbu Earthquake occurred just one year after the Northridge Earthquake in California. In these two earthquakes, steel buildings showed a same collapse mode in which the fracture of members and connections was predominant. Although details of mechanisms in fracture are different between two earthquakes, it is strongly recognized that to prepare sound measures to meet fractural modes of failure is essentially necessary for the seismic design of steel buildings. In this paper, damage in Hyogoken-nanbu Earthquake is overviewed, and the effectiveness of the current design practice and problems to be solved are discussed in relation to the intensity of the seismic input.

Conclusion is summarized as follows.

1) Damage of steel buildings is divided into two; One is ascribed to the lack of considerations in design and fabrication work, the other being reasonable in the light of severity of ground motions.

2) The former was mainly found in the premature failure of welded connections due to defects in welding and dismissed several factors of stress concentration.

3) The later was typically seen in the fractural mode of failure in the beam ends of the moment frames in sharp contrast with the fractural mode of the column ends found in the Northridge earthquake.

4) The seismic resistibility of steel moment frames designed by the current practice was investigated considering the balance of the seismic input and the energy absorption capacity of structures;

4.1 Provided that beams develop the strength which corresponds to the normal strength of material, the current design method can meet to the seismic input of the Hyogoken-nanbu earthquake which is considerably greater than that of the design earthquake.

4.2 In order to properly estimate the reserve of resistance of frames, the influence of composite action between the beams and the concrete slab and the stress concentration on the deformation capacity of beams must be fully taken into account.

4.3 The allowable stress design approach introduced to secure the minimum level of seismic resistance is very effective to keep the reserve of strength of buildings.

5) The fractural mode of failure is of decisive importance to the seismic design of steel buildings. The possibility of brittle fracture of heavy section members, the relationship between details of welding and the breaking strength, and the required performance of column bases must be thoroughly investigated.