

Seismic Design: From Buildings to Cities

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1. Seismic design of buildings

Many studies have been carried out on a variety of earthquake resistant structures such as seismic isolated structures, strength oriented structures, passively controlled structures and ductile frame structures. Of these methods, the highest seismic performance is expected from seismic isolated structures. Structures can be designed to achieve the required performance within the limits of each of the above four structural methods, if the design earthquake ground motion can be defined.

2. Seismic design for city

Earthquake is a natural phenomenon. The largest problem in the seismic design of building structures is the uncertainty of future occurrence of ground motion where the building stands. When it will happen and how large it will be are totally unpredictable. The probability of occurrence of a large earthquake ground motion may be evaluated as negligible, and thus neglected in the design process on economic grounds. However, this would be a big gamble, because although the life of individual buildings may be 60 years, the life of a city may be longer than 1000 years. Individual buildings are components of a city. The seismic issues of a city cannot be solved if the seismic resistance of its individual buildings is determined only from the relationship between the life of a single building and the earthquake occurrence in this life span.

3. Level of seismic design and violation of private property rights

Nevertheless, criticism would arise from society if individual buildings were designed for the largest level of earthquake ground motion. However, if there had been no large earthquake in the period until the building was demolished after several 10s of years, the structures would have been wastefully over-designed. Actions to legally demand excessively high seismic performance are interpreted as a violation of Article 29 of the Constitution of Japan [property right].

4. Leaping improvement of seismic performance that does not increase cost

It is necessary to develop advanced technologies that provide a huge leap in seismic performance at the same cost as current construction methods. If the cost is not excessive, the rationale is put in place to seek no building damage against very rarely occurring large earthquake ground motions. Society could then not claim that the expenditure is wasted. As a result, safety of cities would become very high.

5. Research target

The focus of our studies is to pursue this huge leap in seismic performance. It is necessary to greatly improve seismic performance of cities by popularizing new technologies such as seismic isolated structures and passively controlled structures. The desired approach should be to promote building structures of higher seismic performance while maintaining generally the same cost rather than the approach of fixing the required seismic performance followed by seeking cost reduction.