Latest Trends in Earthquake Resistant Construction

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Abstract -- Today Earthquake-resistant construction of structures has grown into a true field of engineering in which many exciting developments are possible in the future. Most of among these are:
(a)A complete probabilistic analysis and design approach
(b) Performance-based design code
(c) Multiple annual probability hazard maps for response spectral accelerations and peak ground accelerations with better properties of site soils, topography, near-field effects
(d) New structural systems and devices using on-traditional civil engineering materials and techniques
(e) New refined analytical tools for reliable prediction of structural response, including nonlinearity, strength and stiffness degradation due to cyclic loads, geometry effects and more importantly, effects of soil–structure interaction.

I. INTRODUCTION

When we see that there is an earthquake-related disaster in the news with pictures of collapsed buildings and other structures spread all over the place, then we think that earthquake-resistant construction of structures is still in the dark ages. Of course, the main objective of professionals engaged in the area of earthquake resistant design is to create various cost-effective design solutions to make structures less vulnerable to earthquakes, even large earthquakes. So we have to learn enough about building structures that will behave predictably and within acceptable damage limits during the earthquake. So today this field is very important for developing countries like India. Developments of new technologies and replacing new materials, which are not traditionally used in civil engineering structures, offer significant promise in reducing seismic risk. Some improvements have been made in our understanding of earthquakes and the response of structures. Advances in modeling ground motions development of more involved and complex analysis tools; larger and better quality database to predict ground motions; a shift towards probabilistic and reliability-based design approaches and a gradual replacement of descriptive codes by performance based design procedures are some of the significant changes in this field.

Seismic risk is a function of seismic activity and vulnerability of the built environment in a given area. Since the earthquake engineer has no control over the earthquake itself, mitigation of seismic risk means conceiving of structures which can safely resist and negotiate the actions of earthquake ground motions, preferably with minimum cost implications. Earthquake resistant construction and design involves developing the structural configuration, determining the size and shape of various elements, the materials of construction, and the method of fabrication. The 'modern 'design techniques were developed primarily during the last five decades, mostly in developed countries with active seismic regions such as the United States, Japan and New Zealand. However, it should be kept in mind that the traditional structures in earthquake-prone areas did include special construction features, which made them less vulnerable to earthquakes.

The violent vibration caused by the sudden movement of the tectonic plates in the earth's crust following the release of tremendous amount of heat is known as earthquake. In the diagram shown, the two tectonic plates which are in the earth's crust moves to and fro because of which an epicenter is created on the surface of earth. At this epicenter the intensity of that vibration is the maximum resulting in the release of seismic waves which moves in a way of making concentric circles and the intensity of vibrations gradually decreases. In spite of great advancement in science and technology, earthquake is one natural disaster which cannot be predicted

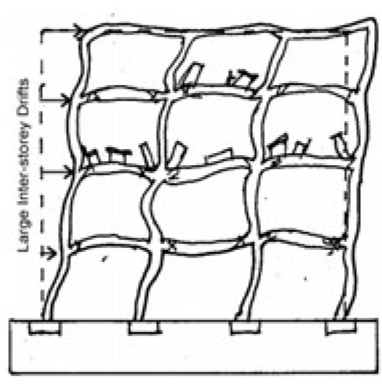
So the future of Earthquake resistant construction and Design is a function of the past performances of such designs. Fortunately, our past experience is rich with many centuries of construction (mostly trial-and-error) and at least a hundred years of systematic study of earthquake effects, of which the last fifty years led to earthquake resistant designs we know them now. Today, we understand to a great deal, how our built environment will respond to a wide range of earthquake motions. The challenges therefore are, to develop new techniques and to improve on the existing practices so that the performance of the structures is predictable and acceptable.

II. NEW STRUCTURAL SYSTEMS AND MATERIALS

A number of new systems and devices has been developed using non-conventional Civil engineering materials broadly for the following two reasons:
(a) to reduce the earthquake forces acting on a structure
(b) To absorb a part of the seismic energy released during the movement of the tectonic plates.

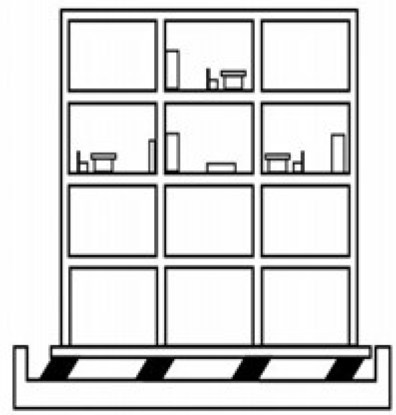
The following new techniques are being developed, evaluated and implemented to make the buildings to withstand the shaking and vibrations caused by earthquake.

A) Fixed base system:
In this system the conventional structures absorb energy through inelastic deformation in structural members. Using this system large inter-storey drifts cause structural and non-structural damages occur but loss of life and collapse of structure can be prevented.



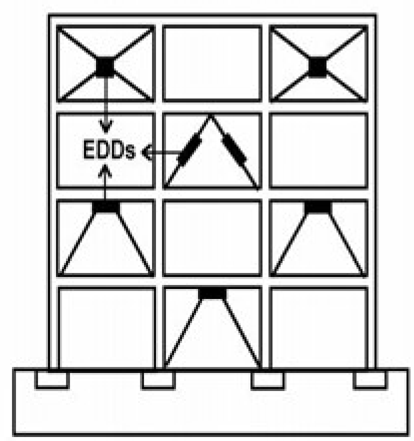
(a) Fixed-Base Systems:

B) Seismic isolation system:
In this system the structures are supported on isolators which decouple structures from damaging earthquake components and absorb seismic energy adding substantial damping.



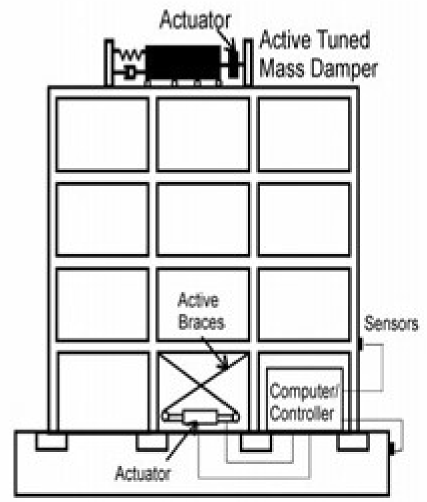
(b) Seismic Isolation Systems:

C) Energy dissipation system:
Energy dissipation devices absorb seismic energy thereby reducing the demand on primary structural members. Using this system the structural and non-structural is significantly reduced.



(c) Energy Dissipation Systems:

D) Active control system:
Lateral stiffness and dynamic properties of structures are adjusted during the earthquake to control its response. In this system complex control mechanism and elaborate hardware is required.



(d) Active Control Systems:

III. CONCLUSIONS

In the coming years, the field of Earthquake Resistant Designing of structures is most likely to witness the most reliable structure which could withstand the effect of earthquake in all kinds of zones. The development of new structural systems and devices will continue for base-isolation, passive energy dissipation and active control systems, along with the proliferation of non-traditional civil engineering materials and techniques.

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