A Review on Earthquake Resistant Construction Techniques

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Abstract

Earthquakes are natural hazards under which disasters are mainly caused by damage to or collapse of buildings and other man-made structures. Experience has shown that for new construction, establishing earthquake resistant regulations and their implementation is the critical safeguard against earthquake-induced damage. As regards existing structures, it is necessary to evaluate and strengthen them before an earthquake based on evaluation criteria. Earthquake damage depends on many parameters, including earthquake ground motion characteristics (intensity, duration and frequency content of ground motion), soil characteristics (topography, geologic and soil conditions), building characteristics, and quality of construction, etc. Building design must be such as to ensure that the building has adequate strength, high ductility, and will remain as one integral unit, even while subjected to very large ground motions.

Keyword- Earthquakes Structure, Prevention , Technique

Introduction

Social and other factors are also important, such as density of population, time of day of the earthquake occurrence and community preparedness for the possibility of such an event. Up to now we could do little to diminish direct earthquake effects. However we can do much to reduce risks and thereby reduce disasters provided we design and build or strengthen the buildings so as to minimize losses based on the knowledge of the earthquake performance of different building types during an earthquake.

This research project will give a brief presentation about earthquake resistant design and the methodology about seismic evaluation and rehabilitation of existing structures. It also provides certain aspects of computer software modeling against seismic loads and shows the necessity of seismic upgrading in a steel moment-frame building. The seismic evaluation process consists of investigating if the structure meets the defined target structural performance levels. The main goal during earthquakes is to assure that building collapse doesn’t occur and the risk of death or injury to people is minimized and beyond that to satisfy post-earthquake performance level for defined range of of seismic hazards. Also seismic evaluation will determine which are the most vulnerable and weak components and deficiencies of a building during an expected earthquake. The seismic rehabilitation process aims to improve seismic performance and correct the deficiencies by increasing strength, stiffness or deformation capacity and improving connections. Thus, a proposed retrofit implementation can be said to be successful if it results an increase in strength and ductility capacity of the structure which is greater than the demands imposed by earthquakes. Performance-based design aims to utilize performance objectives to determine acceptable levels of damage for a given earthquake hazard for new buildings or upgrade of existing buildings. These performance objectives can be such as limiting story drift, minimizing component damage etc. This study shows how to model a building in computer software and analyze its seismic resistance with linear methods and propose concentrically braced frame rehabilitation in order to increase the drift capacity. It also describes how the linear analysis may be followed by the pushover analysis in order to estimate the seismic resistance of retrofitted structure. One of the most significant advantages of nonlinear pushover analysis beyond the linear analyses is the opportunity to evaluate damage. The pushover analysis can give valuable information about performance of building in expected future seismic events.

Literature Review

Base isolation (BI) system for buildings is introduced to decouple the building structure from potentially damaging induced by earthquake motion, preventing the building superstructures from absorbing the earthquake energy. The mechanism of the base isolator increases the natural period of the overall structure, and decreases its acceleration response to earthquake / seismic motion. A steel building with structural rubber bearing is introduced throughout this study. The study analysis performed to check for the adequacy of the base isolation against building lateral drift and inter-story drift as per allowance in National Building Code of Canada 2010(Ashtashil Bhambulkar et al.,2013,2014,2016,2019,2020). Two buildings were analyzed using the nonlinear time history response analysis using the dynamic MODAL analysis for fixed base (FB) building, and Isolated base (IB)building with rubber bearing. The analysis represents a case study for symmetric steel building to show the ultimate capacity of the selected structural bearing, and to make a comparison for the difference between the isolated base and the fixed base buildings. Initial results show that the presence of the structural rubber bearing reduces significantly the vertical displacement, moment and shear generated for the same mode

Methodology

Seismic codes are unique to a particular region or country. They take into account the local seismology, accepted level of seismic risk, building typologies, and materials and methods used in construction. Further, they are indicative of the level of progress a country has made in the field of earthquake engineering. The first formal seismic code in India, namely IS1893, was published in 1962. Today, the Bureau of Indian Standards (BIS) has the following seismic codes:

IS 1893 (Part I), 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision)

IS 4326, 1993, Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision)

IS 13827, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Earthen Buildings

IS 13828, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings

IS 13920, 1993, Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces

IS 1893

IS 1893 is the main code that provides the seismic zone map (Figure 1) and specifies seismic design force. This force depends on the mass and seismic coefficient of the structure; the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. For example, a building in Bhuj will have 2.25 times the seismic design force of an identical building in Bombay. Similarly, the seismic coefficient for a single-storey building may have 2.5 times that of a 15-storey building. (Ashtashil Bhambulkar et al., 2019)

Techniques Used In Single Storey

Horizontal Bands

Why are horizontal bands necessary in masonry buildings? Role of Horizontal Bands -Horizontal bands are the most important earthquake-resistant feature in masonry buildings. The bands are provided to hold a masonry building as a single unit by tying all the walls together, and are similar to a closed belt provided around cardboard boxes.

Lintel Bands

During earthquake shaking, the lintel band undergoes bending and pulling actions. To resist these actions, the construction of lintel band requires special attention. Bands can be made of wood (including bamboo splits) or of reinforced concrete (RC); the RC bands are the best.

Waste Tire Pads

This technique focuses on the experimental studies conducted on the development of low-cost seismic base isolation pads using scrap automobile tires. Seismic base isolation is a well-defined building protection system against earthquakes, on which numerous studies have been conducted.

Plinth Band

This study concentrates on development and testing of alternative free-of-charge isolators and pads made from scrap tires. On the other hand, the STPs would not require additional preparation for small bridges. The idea and investigation of using scrap tires and tinplates instead of conventional elastomeric pads is to have no-cost seismic isolation. Weight reduction, ease of handling, simple shear stiffness adjustment by changing the layer numbers, and positive environmental impact are complementary advantages.

Haunches

As we know joints are most vulnerable during e.q. & most of structures fails due to failure of joints. Thus by increasing strength of joints some resistance can be achieved. Strength of joints can be achieved by simply using high strength or fiber reinforced concrete. Or just by increasing section near joints or provide haunches. This might be work as a knot as in bamboo. And thus provide stiffness to the joint.

Hollow foundation-

As we all know Secondary & Love types of waves are most destructible among other earth quake waves. And the Secondary waves can't pass through water media. Thus by providing a hollow type raft foundation fully filled with water can be reducing some destructible effects of earth quake. It might be filled with some viscous fluid, worked as damper to reduce earth quake effects.

Techniques Used In Multi-Story

The conventional approach to earthquake resistant design of a building depends upon providing the building with the strength stiffness, and in elastic deformation capacity which is good enough to withstand a given level of an earthquake generated inertia forces. This is generally a accomplish through the selection of an appropriate structures configuration and the careful detailing of the structure member such as beam columns and shear walls and the connections between them and the adequate foundation for the structure. Among the most important advance technique of earthquake resistance design and construction are

1. Base isolation
2. Energy dissipation devices

Conclusion

- Technology is available to drastically mitigate the earthquake related disasters.
- This is confirmed by minimal damage generally without any loss of life when moderate to severe earthquake strikes developed countries, whereas even a moderate earthquake cause's huge devastation in developing countries as has been observed in recent earthquakes.
- The reason being that earthquake resistant measures are strictly followed in these countries where as such guidelines are miserably violated in developing countries.

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