SEISMIC DESIGN

J. D. Renard
Tractebel Energy Engineering, Avenue Ariane 7, B-1200 Brussels Belgium

Keywords: Bracing, Ductility, Epicenter, Fault, Hypocenter, Landslides, Tectonic plate, Tsunami

Contents

Summary

After a description of the physical properties of earthquakes and some definitions of seismology, different aspects of seismic engineering are presented such as the determination of the maximum seismicity to a site, the principles of the seismic design of structures, some related codes and regulations and the influence on lifelines and equipment. The most important factors which influence the seismic protection of structures are also outlined.

Other consequences of earthquakes such as tsunamis, landslides or soil liquefaction are also described to emphasize their catastrophic consequences if they have not been considered in the design.

1. Introduction

Earthquakes can affect to some degree the human communities. Vital installations such as water and electricity supplies must remain unaffected or rapidly reparable after such events. It is thus necessary to design the structures, equipment and lifelines for the average earthquake which is likely to occur on the site of the facility. It is also important to evaluate the level of the most severe earthquake that can affect such facilities without reducing their serviceability.

2. Earthquakes

An earthquake is the vibration of the surface of the earth due to the sudden relative motion of two or more adjacent tectonic plates (Newmark 1971, AIEA 1991). When one plate is freed and begins to slide against another (Figure 1), all the energy accumulated by contact is released.

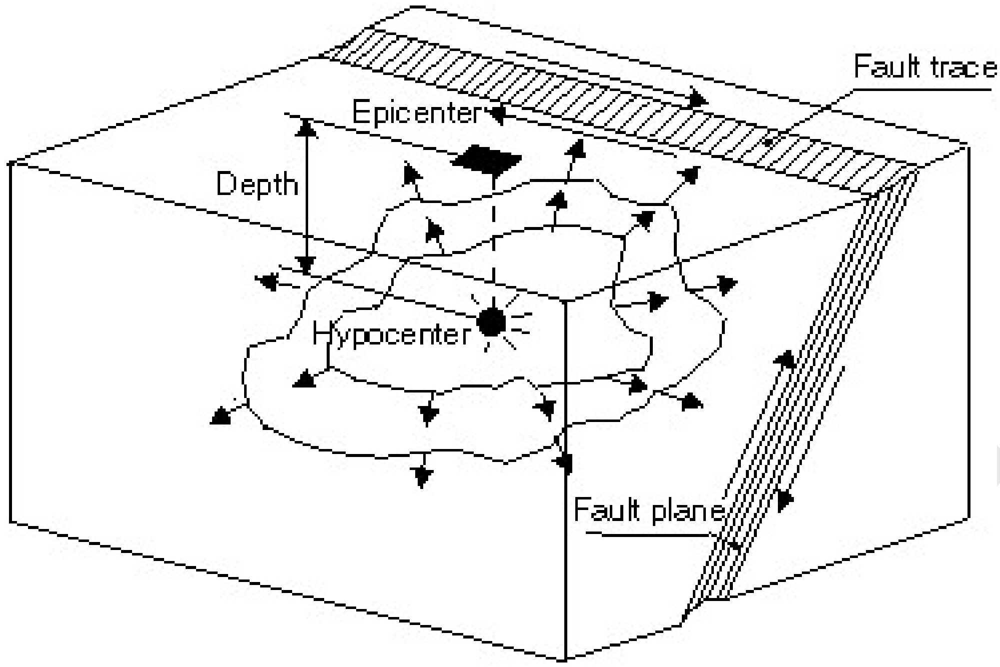

Figure 1. Mechanism of an earthquake at the epicenter.

The larger the energy accumulated and then released, the bigger is the corresponding earthquake. The surface along which the sliding occurs is called a fault. The zone of the fault where the sliding starts is located at a certain depth and is called the hypocenter. The point at the surface of the earth, just on the vertical of the hypocenter is called the epicenter. Often, this point corresponds to the most damaged zone during an earthquake.

The importance of an earthquake is categorized on two different types of scales:

- The Intensity scale under the name Mercalli modified (MM scale) and later on defined by Mendvedev, Sponheur and Karnik (MSK scale). Those scales have 12 levels: the highest level corresponds to the highest observable damage, a complete change of the landscape and the disappearance of all human works; the lowest level is only recorded by very sensitive devices. For the same earthquake, Intensities vary with the distance to the epicenter; the Intensity which characterizes an earthquake is the highest level reached during the earthquake in the most damaged area, near the epicenter.
- The Magnitude scale, defined by Richter. The Magnitude is the logarithm of the ratio of the maximum displacement measured at a certain distance on a standardized device to a conventional displacement taken as reference. The Magnitude level is related to the energy released by the earthquake and is independent of the location of the measurement.

To design or to check the resistance of structures against earthquakes, the maximum acceleration at the surface of the soil is the most suitable data. The values of the accelerations given for real earthquakes have been measured or have been deduced from the observed damages.

Time-histories of acceleration and displacement of most of the recent earthquakes have been recorded (Figure 2) and their response spectra have been calculated.

The response spectrum of an earthquake gives the maximum answer of a single degree of freedom oscillator submitted to the recorded time-history of this earthquake (Figure 3).

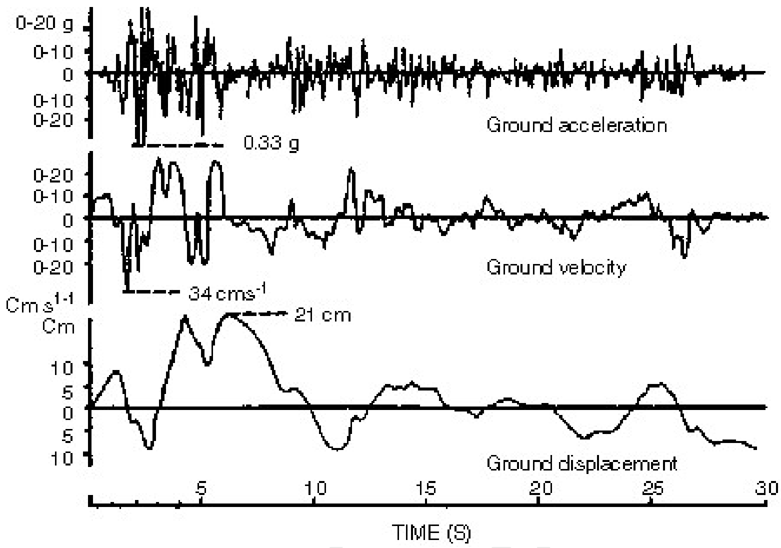

Figure 2. ElCentro earthquake (1940) ground motion: acceleration, velocity and displacements recorded in a north-south direction.

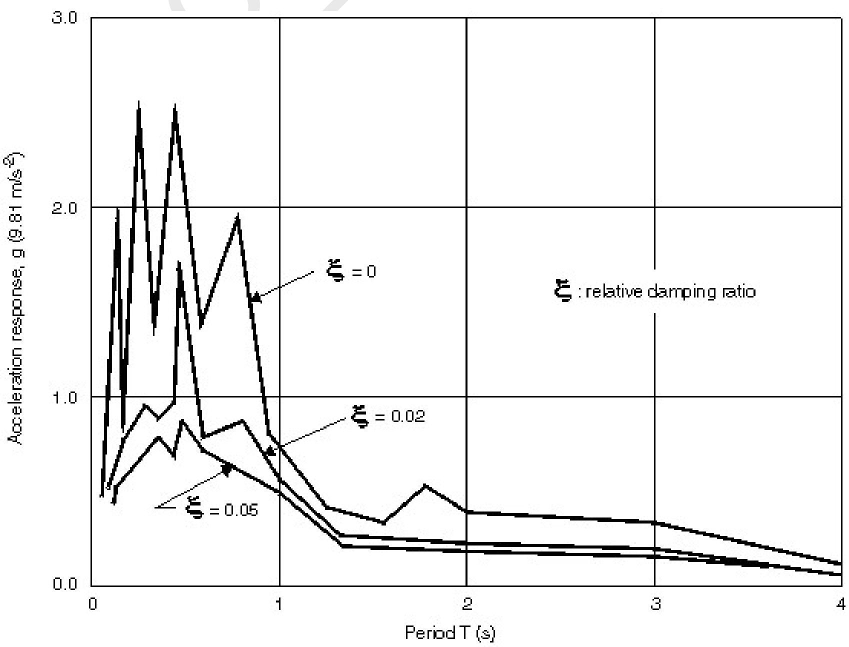

Figure 3. ElCentro earthquake (1940) ground motion: acceleration response spectra of the north-south component.

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Bibliography and Suggestions for further study

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