5.5 SEISMIC HAZARD

Seismic hazard is defined as a natural phenomenon such as ground shaking, fault rupture, or soil liquefaction that is formed by an earthquake.

The term seismic hazard in engineering practice can refer specifically to strong ground motions produced by earthquakes that could affect engineered structures. Seismic hazards are very severe and damaging, which depend on the magnitude of the earthquake, local site conditions and the response of the system of interest (For example, dams, buildings, powerplants).

Seismic hazard analysis

Seismic hazard analysis often refers to the estimation of earthquake induced ground motions having specific probabilities over a given time period.

In simple, Seismic hazard analysis refers to the estimation of some measure of the strong earthquake ground motions expected to occur at a selected site.

Importance of seismic hazard analysis

(i)The seismic hazard analysis is important for earthquake resistant design of a new structure such as dams, nuclear power plants, high rise buildings, long-span bridges, etc. at that site.

(ii)The seismic hazard analyses also important in estimating the safety of existing structures .

Types of seismic hazard analysis

There are two basic methods for seismic hazard analysis, viz., (a) Deterministic Seismic Hazard Analysis (DSHA) (b) Probabilistic Seismic Hazard Analysis (PSHA)

(a) Deterministic Seismic Hazard Analysis (DSHA)

In Deterministic Seismic Hazard Analysis (DSHA) approach, the strong-motion parameters are estimated for the maximum credible earthquake, assumed to occur at the closest possible distance from the site of interest, without considering the likelihood of its occurrence during a specified exposure period.

Description

The deterministic seismic hazard analysis method uses geology and seismicity to identify earthquake sources and interpret the strongest each source is capable of producing regardless of time.

The main Objective is to identify the largest earthquake that appears along a recognized fault as a result of known (or) presumed tectonic activity.

Deterministic seismic hazard analysis usually requires four separate steps that are illustrated in Fig. 5.5.1

Step 1 Identification of earthquake sources

Identify and characterize (geometry and maximum magnitude) all earthquake sources capable of generating significant shaking at the Site.

Step 2 Calculation of source-to-site parameters

Calculate the appropriate source-to-site distance parameter such as R_1, R_2, and R_3 for each source identified in Step 1.

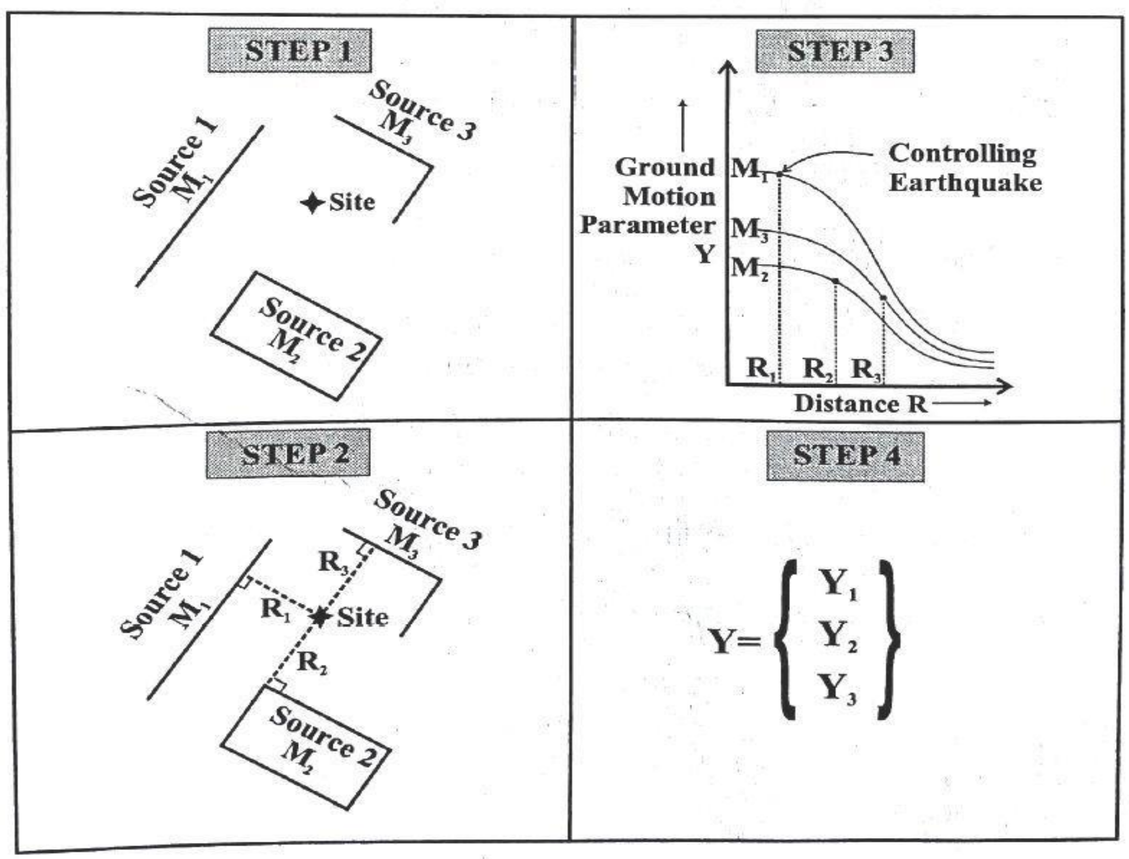

Fig:5.5.1- Deterministic seismic hazard analysis

Step 3 Determination of ground motion parameters

Select the controlling earthquake, i.e, the ground motion parameter (Y) at the attenuation model appropriate for the region.

Step 4 Estimation of seismic hazard

Define the hazard at the site based on the controlling earthquake. The hazard at the site can be expressed in terms of maximum spectral ordinates, maximum ground displacement, and so on.

Advantages

The advantages of the deterministic seismic hazard analysis procedure are as follows.

1) It is simple to apply.
2) It yields conservative results for well-defined tectonic feature (e. g. line sources).
3) Largest Earthquake shall be easily analyzed using this method.

Disadvantages

The disadvantages of this type of analysis are as follows

1) It is difficult to apply this analysis for distributed sources close to the site where the source-to site distance is difficult to establish.
2) It provides no information on the controlling earthquake occurring at the site of interest.
3) It provides no information on the level of shaking a structure.

(b) Probabilistic Seismic Hazard Analysis (PSHA)

The Probabilistic (an ensemble of earthquakes) Seismic Hazard Analysis (PSHA) involves integrating the effects of all the earthquakes expected to occur at different locations during a specified life period, with the associated uncertainties and randomness.

Description

The application of the probabilistic seismic hazard analysis usually requires four steps, illustrated in Fig.5.5.2

Step 1 Identification of the seism genic sources

For a given site, geographic zones representing seism tectonic sources are drawn. For each zone, it is assumed that the probability of earthquake occurrence is the same for the entire surface area (a seism genic source). Thus, we have to identify the earthquake sources.

Step 2 Determination of seismicity

For each source, a magnitude-recurrence relation of the type log N = A –bM is defined for various distances say R_1, R_2 and R_3. Historical seismicity is used to establish the parameters of this relation. A maximum (cut-off) magnitude M_{max} is also defined for each source.

Step 3 Determination of attenuation

An attenuation relation is determined between each source and a given site. Often the same attenuation relation is used for the entire region.

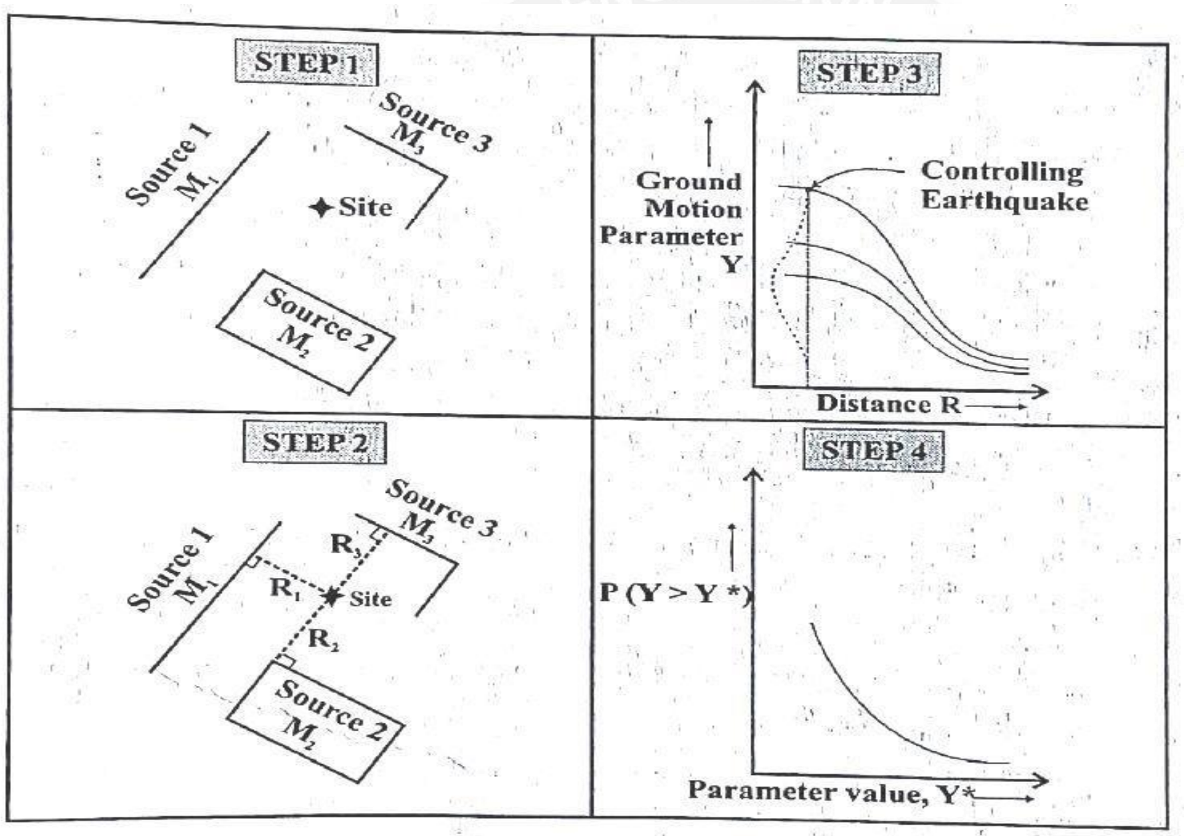

Fig.5.5.2- Probabilistic Seismic Hazard Analysis

Step 4 Calculation of the hazard curve for the site

The attenuation relations are combined with the magnitude-recurrence relations to calculate the annual number of earthquakes exceeding a chosen ground motion level at any given site (i.e. the recurrence rate). The total recurrence rate at the site from all sources is obtained by adding up the recurrence rates from each source.

The four steps above are then repeated on a grid for each given site in a region. Contour lines are then plotted for the chosen seismic parameter. These contour lines, based on the same annual probability of exceedance, creating a seismic hazard map for the region.

1) The probabilistic seismic hazard analysis procedure (PSHA) provides a systematic frame work for the treatment of uncertainty.

2) Two types of uncertainties need to be considered in the development of seismic hazard maps viz.,

(i) Uncertainty due to the randomness of the model parameters and

(ii) Epistemic uncertainty due to uncertainty in the knowledge of the model parameters.