PAKISTAN
WATER & POWER DEVELOPMENT AUTHORITY

KOHALA HYDROPOWER PROJECT

SEISMIC HAZARD ANALYSIS

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1. GENERAL

As per international practice and guidelines for seismic hazard evaluation and seismic hazard mapping, probabilistic seismic hazard assessment (PSHA) procedure as well as deterministic seismic hazard assessment was employed for seismic hazard analysis.

Seismic Hazard Analysis involves the quantitative estimation of ground motion characteristics at a particular site and conducted by probabilistic or/and deterministic methods. In recent years a good deal of work has been carried out throughout the world to study the seismicity of various areas to estimate the earthquake hazard potential for establishing design criteria for the construction of massive structures like dams, high rise buildings etc. Probabilistic techniques for estimation of seismic risk can be used when ample seismic data is available but in case when earthquake data is small, in spite of the presence of the number of active fault, the probabilistic estimates cannot normally be expected to yield realistic results. In such cases, a technique known as paleoseismic analysis is employed. This involves estimation of source parameters and earthquake magnitude potential of a seismogenic zones/structure by carefully studying geotectonic facts such as surface faulting, offsets and deformations etc. present in the area of interest. The geological and geotechnical information when combined with historical and instrumentally recorded seismological data, the analysis would lead to a better understanding and a more reliable assessment of hazard in the region.

2. PROBABILISTIC SEISMIC HAZARD ANALYSIS

It is based on probability by modeling and analyzing the level of ground motion parameters regarding its exceedance during a specified time interval. Analytical methods to determine the seismic hazard at the site of an engineering project were developed by Cornell (1968, 1971) and Esteva (1969) and have been applied by various workers. It requires the following:

- The identification and characterization of all potential sources of seismic activity that could produce significant ground motions at the site of interest. These sources are identified on the basis of geologic, tectonic, historical and instrumental evidence. It allows and quantifies the uncertainties in the size, location and rate of recurrence and effects of earthquakes to be explicitly considered in the evaluation of seismic hazard.
- The Gutenberg–Richter recurrence law, which assumes an exponential distribution of magnitude, is commonly used with modification to account for minimum and maximum magnitudes.
- Predictive relationships, where the level of shaking produced by an earthquake of a given size occurring at a given source to site distance are determined.
- The probabilities of exceedance of estimated ground motion over the lifetime of the structure.

2.1 Identification and Characterization Earthquake Sources

All earthquakes sources that are capable of producing significant ground motion at the site are identified and characterized. Source characterization includes definition of each source's geometry (the source zone/fault), earthquake potential of each source and its probability distribution of potential rupture locations within source and earthquake distribution with time. Each of these characteristics involves some degrees of uncertainties such as spatial uncertainty and size uncertainty. The sources that are identified in the project area are shown in Figure 1.

2.2 Recurrence Relationship

A general equation that described earthquake recurrence may be expressed as follows:

$$N(M) = f(M, t) \qquad (1)$$

Where N (M) is the number of earthquakes with magnitude equal to or greater than M and t is time period. The simplest form of equation (1) that has been used in most engineering applications is the well known Richter's law which states that the cumulated number of earthquakes occurred in a given period of time can be approximated by the relationship

$$\text{Log } N(M) = a - b M \qquad (2)$$

Equation (2) assumes spatial and temporal independence of all earthquakes, i.e. it has the properties of a Poisson model. The coefficients 'a' and 'b' can be derived from