Design elastic input energy spectra based on Iranian earthquakes

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Abstract: The goal of this paper is to propose input energy spectra applicable to seismic design of structures based on Iranian earthquakes. In terms of input energy, these spectra represent the load effects of a strong earthquake that a structure may encounter during its lifetime. For this purpose, from among 1800 existing earthquake records in Iran, 110 records were selected. By using these records and through dynamic response analyses, the design input energy spectra for four ground types, defined by the Iranian earthquake code of practice, have been derived.

Key words: absorbed energy, design input energy spectra, energy-based seismic design, Iranian earthquakes, strong motion.

Résumé : L'objectif de cet article est de proposer des spectres d'énergie induite applicables à la conception sismique de structures basée sur des séismes Iraniens. En termes d'énergie induite, ces spectres représentent les effets de charge d'un séisme fort qu'une structure pourrait subir au cours de sa durée de vie. À cet effet, parmi les 1800 enregistrements de séismes existants en Iran, 110 enregistrements ont été sélectionnés. En utilisant ces enregistrements et des analyses de réponse dynamique, les spectres d'énergie induite par conception, pour quatre types de sol, définis par le Code de la pratique des séismes Iranien, ont été dérivés.

Mots-clés : energie absorbée, spectres d'énergie induite en conception, conception sismique basée sur l'énergie, séismes Iraniens, mouvements forts.

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1. Introduction

In recent years, in seismic design methodologies, there has been much effort to propose design methods that deal with the definition of performance-based methods for the design of new structures and assessing the seismic capacity of existing structures. In this field of improvement of the reliability of the existing method of earthquake-resistant design of structures, the energy concept and the energy balance equation are effective tools for a comprehensive interpretation of the behavior observed during recent destructive strong ground motions. In this method, the energy criterion expresses that the structure collapses when it is demanded to dissipate energy through inelastic deformations, in an amount of larger than the structure is capable of absorbing.

Among various types of energy, researchers consider input energy, E_I, as a suitable parameter in seismic design, with the idea that this concept may improve the understanding of structural behavior. They found that E_I depends mainly on the total mass and fundamental period of the structure and it's scarcely influenced by other factors, such as structural ductility and hysteretic properties.

Input energy is a measure of the energy that an earthquake inputs to a structure during a ground motion. The input energy can be divided into three types of energy (kinetic energy, potential energy absorbed by the spring, and energy consumed by the damping mechanism), and at the end of ground motion, this energy is dissipated and absorbed through damping and hysteretic cyclic treatment of structures. This inelastic cyclic behavior causes damage in the structure and therefore the E_I demand can be assumed as a reliable tool to predict the seismic hazard and design.

In energy-based seismic design methods, the design criterion is constituted by the comparison of the energy absorption capacity of a structure (its seismic resistance) and earthquake input energy (the load effect of ground motion). To apply this method, it is necessary to derive the input energy spectrum corresponding to the strongest earthquake expected in the region, i.e., design input energy spectra. This research will propose design input energy spectra based on Iranian earthquakes. Iran is one of the highest seismic regions

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