SPECTRAL ACCELERATION AMPLIFICATION EFFECTS ON THE PERFORMANCE POINT OF STEEL INDUSTRIAL STRUCTURES WITH OVERHEAD CRANES

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ABSTRACT

Due to development of the construction of industrial steel structures containing overhead cranes and by realizing that almost none of the aseismic codes in the world have any notification about special structures of this kind, the importance of studying the seismic behaviour of this kind of structures becomes evident.

In this research, the overall structural behaviour and Performance Point determination bases are briefly described. Later, 3 existing models of industrial steel structures with overhead cranes, which are previously analysed and designed by the author of this paper, are selected. Equivalent Linear Static Analyses and structural design of models are completed according to ASCE 7-10, AISE (Association of Iron and Steel Engineers) and SNIP II-6.02 Armenian Seismic Code, considering 4 soil categories of Rock (800<Vs<1200m/s), Dense Soil (360<Vs<800m/s), Loose Soil (180<Vs<360m/s) and Very Loose Soil (Vs<180) respectively, based on spectral acceleration of S_a=0.35g.

By performing a "Modal Pushover Analysis" on all estimated finite element models, the Capacity Curves of them are achieved. Later the Performance Point characteristics (base shear force and roof maximum displacements) of all models are computed according to FEMA 356 guideline recommendation, based on spectral acceleration range of 0.1g~1.0g for above mentioned soil types and using FEMA 356 pseudo acceleration spectrums. After completing the achieved information from modal pushover analysis, the diagrams for both base shear forces and displacements versus spectral acceleration are prepared and the final results are discussed.

Keywords: Industrial Steel Structures, Overhead Cranes, Modal Pushover Analysis, Performance Point, Capacity Curve

1. INTRODUCTION

Experiences of earthquakes illustrate that many types of structures behave nonlinearly during a severe earthquake. So a huge amount of input energy is mainly dissipated through the form of damping and hysteresis [1].

Therefore, the seismic behaviour analysis and accurate design of structures for severe earthquakes are mainly carried out using Nonlinear Time history Analysis method (NTHA). Due to development of design and construction of Industrial Steel Structures containing overhead cranes, indicating on the seismic behaviour and computation of the performance point of this kind of special structures are of much importance. It also should be noted that almost in all aseismic codes over the world, there is almost nothing stated about this kind of special structures. One of the main reasons could be the variety of the types, spans and crane capacities.

Due to the new concept of Performance Based Earthquake Engineering, this research is carried out to compute the performance point characteristics (base shear force and roof maximum displacement) of industrial steel structures containing overhead cranes, according to the amplification of spectral acceleration levels.

The finite element models are chosen so that they would demonstrate most probable structural and industrial characteristics of such buildings. The chosen variety of crane capacities are also the most popular ones which are frequently used in this kind of buildings.

According to related codes and regulations, the crane masses should be computed based on parked crane dead loads, without taking into account any vertical and horizontal weights. The parking position should be chosen the worst one possible and the crane masses should be distributed according to it. All mentioned cases are taken into account in numerical models of this research.