Seismic Resistant Design of Steel Structures

Design Project (Assignment #3) Due: 6/4/2018

Properly use the ETABS program to include the gravity load effects:

（1）Use the 475-year return period earthquake (DBE) acceleration response spectrum for the building site. Scale the spectrum to the level of the PGA=0.08g. Use this scaled spectrum in the dynamic response spectrum analysis of your building model. Choose the CQC combination rule to compute the responses. Compute the ratios, β_x and β_y, between the static base shears (obtained in Assignment #2) and the CQC base shears for X and Y directions, respectively. Scale the analytical results by multiplying all responses by β_x and β_y, for dynamic seismic load effects in X and Y directions, respectively.

（2）Assume the average steel weight of the gravity beams is 15 kg/m^2 and for girder is 30 kg/m^2 in each typical floor. Apply the dead loads and live loads transferred to the girders or columns of the lateral force resisting frame. You may want to consider create Load Case 1 for dead loads, Load Case 2 for the self-weight of the lateral force resisting frames. Load Case 3 for live load. Apply these load cases in the ETABS frame response analysis.

（3）There is no need to consider the accidental torsion in this exercise. After you have performed the static and dynamic frame response analyses using the load effects described in this and previous assignments, compute the demand-to-capacity ratios (DCRs) using the LRFD method and appropriate load factors. Note that you should apply the suitable live load reduction factors based on the tributary area of the members. Check the DCRs, change the structural frame member sizes as needed and make sure your design satisfies the code prescribed lateral drift limit of 0.005 radian under the static or dynamic seismic load effects. Report the average of the lateral resisting system weight. It can be computed by dividing the total frame weight (recorded in the ETABS analytical model) by the total floor area.

（4）Submit the analysis results. Indicate the frame member sizes on suitable frame elevations. Plot static and dynamic (before and after scaling) lateral force, story shear and overturning moment distributions along the building height in both two directions. Show the lateral displacements and the inter-story drifts under the static and dynamic (before and after scaling) loads. Clearly identify the responses associated with the static or the dynamic load effects in your plots. Show the governing DCRs of all frame members on frame elevations.

（5）Use the composite beam theory to design one typical gravity floor beam and one typical gravity girder in the typical office floor. Mark the metal deck direction, indicate the typical beam and girder sizes on the typical floor framing plan. Indicate the size and number of shear studs at the end of the beam or girder size descriptions. Compare your results with those designed by using ETABS.

（6）Investigate the total numbers of typical gravity beams and girders, then calculate and report the averaged steel weight of the gravity load carrying floor beams and girders combined in the typical floor.

（7）Apply suitable amplification factor on the inter-story displacement to account for the P-△ effects. Design the gravity columns for the ground story. Consider at least two load combinations.

（8）Add the average steel weight of the gravity beams, girders and columns to that of the lateral load resisting system. Report the averaged total weight of steel (kg/m^2) applied in the proposed building.

（9）Please keep a copy for your reference.