Question: What is proper redundancy factor, ρ, for diaphragms designed in accordance with the 1997 UBC?

Subject: Redundancy Factor

Code Reference: 97UBC,

Answer:

It has been the position of the SEAOC State Seismology Committee that ρ for diaphragms may be taken as 1.0, except diaphragms that transfer forces between offset lateral force resisting systems per UBC Table 16-L, Item 4. However, there is not consensus on this issue.

One position is that the ρ factor for the entire lateral force resisting system should be the same. In other words, the ρ value calculated for the base shear in a particular direction should be applied up through the building structure, including to diaphragms.

An alternate position is that the ρ factor was created to reward redundancy in the vertical lateral force resisting elements and was not intended to apply to diaphragms. It is believed that increasing the diaphragm strength by application of the ρ factor may not be practical, and will not noticeably improve the seismic performance of the building.

Question: In the 1997 UBC, Sec. 1630.1 (page2-13). The redundancy factor, ρ for "Special Moment-Resisting Frames" (SMRF) is limited to a maximum value of 1.25. Is this also true for the "Special Truss Moment Frame" (STMF)? It is my contention that while the code does not expressly include the STMF, the intent is that it should be limited to Rho= 1.25, due to the similar nature of STMF and SMRF (i.e.: large drifts). Is this a correct interpretation, and is there any literature available to support this contention?

Subject: Redundancy Factor

Code Reference: 97UBC, 1630.1

Answer:

As written in the 1997 UBC, the 1.25 limitation is only permitted for SMRF systems.

This is a valid question for future code development. Code writers who included the 1.25 limitation were thinking primarily about conventional steel SMRF systems. The effects of the redundancy factor calculation on other types of moment frames, including STMF and concrete SMRF systems, should be systematically reviewed in the future.

Question: When calculating r_{max} and ρ for a two story wood frame structure, how is the factor applied? One interpretation is as follows: The value of r_i is calculated in each of the two principal directions of the lateral force resisting system for each story. The largest value of r_i, r_{max} is used to calculate the ρ factor for the entire structure. This seems too conservative.

Other engineers I have talked with calculate ρ as follows: The r_i is calculated in each principal direction at the appropriate story. The maximum r_i, r_{max} for the story is used to calculate ρ for that story. Thus a building may have multiple r_{max} and ρ for use with E. By definition E is the earthquake load on an element of the structure, and ρ is based on the maximum element-story shear ratio. Which method is correct?

Subject: Redundancy Factor

Code Reference: 97UBC, 1630.1

Answer:

Only one value of ρ should be determined, in each principal direction of the structure. The value of ρ is determined using the largest value of r_{max} determined for all stories over the lower 2/3 of the structure height. It is incorrect to use a different value of ρ at each story of a structure.