STRUCTURAL RESPONSE OF UPGRADED FLAT SLAB

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In Beck (1980) analytical analyses were performed on "as built" slabs-over-basement areas to determine if the slabs had the potential to be upgraded to resist blast overpressures of between 30 and 50 psi resulting from a 1-Mt nuclear explosion. These analyses were performed with the assumption that the upgrading support system was "adequate" to develop the full upgrading potential of the slab. Specifically, rigid intermediate support columns and beams were assumed as outlined in various upgrading schemes. This study was not charged with developing recommendations for upgrading schemes, it was limited in scope to determining whether the slabs could be upgraded to usable values. The study predicted that 18% of the NSS buildings evaluated could be upgraded to withstand overpressures in the desired overpressure range. Therefore, with "adequate" support, many NSS buildings could potentially be upgraded to the standards desired by FEMA. However, the assumption of rigid supports gives an upper bound on the upgrading strength potential of a system, and it does not predict the actual strength of the upgraded system with real (non-rigid) supports.

In many real upgraded situations one would not find supports that would meet the required rigidity standards to produce the upper limits of the floor system's upgraded potential strength. Therefore, a dynamic-single-degree-of-freedom (DSDOF) analytical model previously developed for FEMA (Wiehle 1973) was modified (Beck 1982) so that a wooden post (non-rigid support) upgraded flat slab could be analyzed for response to a blast type of loading. After being modified the analytical model was compared with the results of an experiment performed at the US Army Waterways Engineer Experiment Station (WES) (Woodson 1981). The analytical model, as originally constructed, over-predicted the strength of the upgraded WES test structure (Beck 1982). The original predictions were based on assuming design properties for the strength of the wooden columns. Inspection of the WES test data revealed that the columns were considerably less stiff than normally used design strength parameters would predict, notably the modulus of elasticity was over-estimated by a factor of about four. As a second attempt to predict the strength of the upgraded structure, the observed values of the column load-deflection function were then used in the analytical model. This new set of calculated deflections faithfully predicted the response of the upgraded floor system. This experience has shown that there is a potentially serious problem of simply using design calculations for evaluating the strength of a floor system for upgrading.

This work indicates that not only must element ultimate strengths be considered in upgrading structural systems, but also the relative stiffnesses of the members must be considered. Currently, this is not done, and strength predictions based on not looking at the "true" relative stiffness of the upgraded system can result in one over-predicting the strength of the upgraded system by a factor of between 2 and 8 times greater than that of the actual system. This can, therefore, be of considerable interest when considering the upgrading potential of a structural system.

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