SECTION 5

DISCUSSION OF TEST RESULTS AND RECOMMENDATIONS

Generally speaking, test results show that there is a trade off in the system response between the relative displacement and the maximum acceleration. Typically, a smaller relative displacement is accompanied by a larger maximum acceleration. The reverse of this also holds true.

5.1 June 1991 Test

For the IBM 9370 mainframe system, the test results show that, for the IBM2 input simulation runs, the fixed base case gives the overall best results. The maximum acceleration values in this case are all below 2.5 g's while the relative displacement is zero.

The results from the Bellcore input simulation runs for the IBM 9370 mainframe system show that the locked casters case gives the overall best results. Here the maximum acceleration values are all below 2.0 g's and the relative displacement is 2.75 in.

The results from Taft RC-7 input simulation runs for the IBM 9370 mainframe system show that the *D* VE dampers, 4-Hz wire ropes, and the fixed base cases all give similar acceptable results. The maximum acceleration values for all three cases are below 1.5 g's, and the relative displacements are all between zero and 0.75 in.

Similar observations can be made for the El Centro RC-7 input simulation runs. The maximum acceleration values for all three cases are below 1.5 g's, and the relative displacements are all between zero and 2.50 in.

For the IBM 9371 mainframe system, the results show that, for the IBM2 input simulation runs, the bolted-to-slab case gives the overall best results. The maximum acceleration values in this case are all below 3.0 g's with no relative displacements.

The results from the Bellcore input simulation runs for the IBM 9371 mainframe system show that the bolted-to-slab case also gives the overall best results with all maximum acceleration values below 2.0 g's.

The results from Taft RC-7 input simulation runs for the IBM 9371 mainframe system show that *E* VE dampers give the best results. The maximum acceleration values are all below 0.8 g's, and the relative displacement is 1.5 n. However, from El Centro RC-7 input simulation runs, the bolted-to-slab case provides the best result with all maximum acceleration values below 1.8 g's with no relative displacements.

The conclusion that can be drawn from these results is that the fixed-base and locked-caster installation methods appear to be a good low cost solution for anchoring mainframe computer systems to raised floors.

5.2 August 1991 Test

For the IBM 9221 mainframe system, the results show that, for the IBM2 input simulation runs, the VE dampers, case 3, gives the overall best results. The maximum acceleration values are all below 3.0 g's and the relative displacement is 4.75 inches. The same conclusion can be drawn from the El Centro RC-7 input simulation results where the maximum acceleration values for this input are all below 1.5 g's and the relative displacement is 1.0 inch.

The conclusion that can be drawn from these results is that, overall, the viscoelastic damper device provides sufficient stiffness and damping characteristics to offer a good solution for anchoring the IBM 9221 mainframe computer system to the raised floor.

5.3 June 1992 Test

For the Frame 8 system, the results show that toggle bars appear to satisfy the dual requirements, i.e., a small relative displacement and a small maximum acceleration. The bushings which seem to work best are the 80-durometer ones.

For the Endicott Frame, the results show that toggle bars are promising, but the response is much improved if they are used with the NTT levelers. The trade off here between the displacement and the acceleration seems to hold true for all the runs except Bellcore. For this simulation run, the response shows a small relative displacement and a small maximum acceleration for the NTT levelers with the toggle bars. Again, the 80-durometer bushings seems to work best here.

For the Frame 1 system, the results are not as clear cut. Here the 5/32-in wire cables performed well for the El Centro RC-7 simulation runs. For the IBM1 and Bellcore simulation runs, the toggle bars with the 80-durometer bushings worked well. Finally, for the IBM2 simulation runs, the NTT levelers with toggle bars and aluminum bushings appear to perform the best. Therefore, it appears levelers could help the response of the system.

The conclusion that can be drawn from these results is that a restraint system consisting of toggle bars with 80-durometer bushings appear to be a good low cost solution for anchoring mainframe computer systems to a raised floor. To possibly improve this response in terms of relative displacement and maximum acceleration, NTT levelers with toggle bars and 80-durometer bushings could be used. This method of anchoring will also provide good results, but at a much higher cost.

An assessment of the overall test results indicates that there is a need to formulate installation procedures for computers and data processing equipment according to their dynamic behavior in a seismic environment. It is clear that an optimum restraint system is one which provides, on the one hand, sufficient stiffness to limit lateral displacement of the computer system within acceptable range and, on the other hand, sufficient damping or energy dissipation capacity to minimize its absolute acceleration. The amount of stiffness and damping of the restraint system required is, in turn, a function of the system characteristics, its location in the structure, the structural characteristics, soil conditions, and seismic conditions at the site. Sufficient knowledge currently exists on the dynamics of these types of systems under conditioning specified above, and this knowledge base can be utilized in the formulation of realistic installation guidelines and in the development of efficient restraint systems.

SECTION 6

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