CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

4.1 Summary

The modification of existing floor structures to prevent annoying floor vibrations due to rhythmic exercise is both difficult and expensive. The concept of a "floating" concrete floor is an acceptable method of eliminating most of the forces transmitted to a supporting floor system.

The floor system arrangement developed in this research was a concrete slab mounted on pneumatic air springs individually connected to an external air reservoir. The most effective configuration of the air springs in terms of isolation of forces due to jumping was achieved by removing the air control valve assembly installed on each air storage tank.

The most favorable vibration properties were measured for this no valve configuration. The measured natural frequency of 1.0625 hz was the lowest of the three valve configurations and is well below the frequency range of 1.5 hz to 3.0 hz of typical aerobics exercises. Therefore, experiencing a resonance condition is unlikely.

The lowest peak accelerations due to jumping at various frequencies were recorded when no valves were used. The predicted first harmonic peak acceleration of 9 %g for four participants was slightly above the recommended acceleration limit of 4 - 7 %g for a floor used exclusively for rhythmic activity. The measured first harmonic peak accelerations of 2 %g due to one person jumping were within the recommended limit of 1.5 - 2.5 %g for a floor of combined occupancy, such as, aerobics and weightlifting.

Removing the air control valves was also the best arrangement for measured force transmission. At the first harmonic, the average measured transmissibility of the four jumping frequencies was 30 %, which was considerably lower than the average values of 84 % for the open valve configuration and 98 % for the closed valve configuration. At the second and third harmonics, the average measured force transmission values were all approximately 13 % for each valve configuration, which results in an 87% reduction in the second and third harmonic forces transmitted to the supporting floor system.

The acceptability evaluations indicate that the open and no valve configurations were acceptable for use as an aerobics exercise floor. When the participants were jumping simultaneously, the floor vibrations were within acceptable levels and there was sufficient damping in the system to prevent the participants from feeling "seasick" after the jumping exercises stopped.

4.2 Conclusions

The "floating" floor concept is an effective method of controlling transmitted forces induced by rhythmic exercises. After addressing some of the feasibility issues discussed in the following section, a "floating" floor could be installed and used effectively.

The corner and side rotating modes of oscillation would be less of a problem in a continuous span floor system, where the adjacent spans would restrict rotating oscillation of the corners and sides of the floor panels.

The additional weight of the "floating" floor on the supporting floor system may be compensated by the decrease in live load due to an aerobics class. The weight distribution suggested by Allen (1990b) of 4.2 psf (0.2 kPa) for adequate space for movement during aerobics exercises without interfering with another person or wall may be increased to approximately 10 psf as a maximum loading condition. This value is much smaller than the design live load of 70 psf for most commercial buildings. The weight of the test floor slab of approximately 69 psf could be reduced by utilizing a thinner slab or utilizing an alternative floor design, as described in the following section but this may increase the "floating" floor acceleration levels.

4.3 Recommendations for Further Research

It is recommended that further research be performed using the "floating" floor concept. Stability and feasibility of an actual installation of the "floating" floor system are the most significant areas to be addressed.

The lateral stability of the floor system was one of the largest problems encountered with the prototype floor system. Large restraining forces were required to maintain the stability of the floor slab on the pneumatic air springs.

Several possible restraint methods exist for an installed floor system. If an installed full size floor filled an entire room, the lateral restraints could be integrated with the walls or columns of the room. Another restraint concept involves the use of rollers or bumpers at the edges of the slab restrained by a vertical member. The problem of lateral stability is a critical area in the design of an actual floor system and further research should be conducted in this area.

The feasible design of a full size "floating" floor system is the second significant area for further research. The "floating" floor concept has been proven to be effective. The best design in terms of constructability and durability needs to be determined.

To reduce the amplitudes of the rotating modes of oscillation, the majority of the floor mass should be located over the air springs. A possible solution involves a redesign of the floor system by placing concrete or steel beams between each of the air springs and building a light-weight wooden floor to span between the beams. In the same manner, the overall weight of the floor system could be reduced to comply with the building design live loads.

Additional consideration should be given to the point loading caused by the air springs on the supporting floor system. The location of the air springs for an actual installation would vary for each installation due to the geometry of the supporting floor structure.

Finally, the shock absorbency of the floor to the participants should be integrated into the design of the floor system. The concrete surface provides no cushioning to the participants. Therefore, if an actual floor is installed for aerobics, a shock absorbing floor covering or secondary cushioning floor system should be installed.