Improving the dynamic performance of a floor system

Both the Murray Allen analysis and the FE modelling suggest that Mode 1 may give rise to an acceleration in excess of 0.5% of gravity – and is thus considered unacceptable for an office space. To decide the best way for the designer to improve the dynamic performance of the floor it is necessary to again consider equations 16 and 10:

$$a_{max} = \frac{1}{2\beta} x \frac{580e^{-0.35fn}}{M_{e.involvedinmotion}} \qquad (16)$$

And $$\Omega = \sqrt{\frac{K}{M_{e.fora\sin glebeam}}} \quad \text{Radians/second} \qquad (10)$$

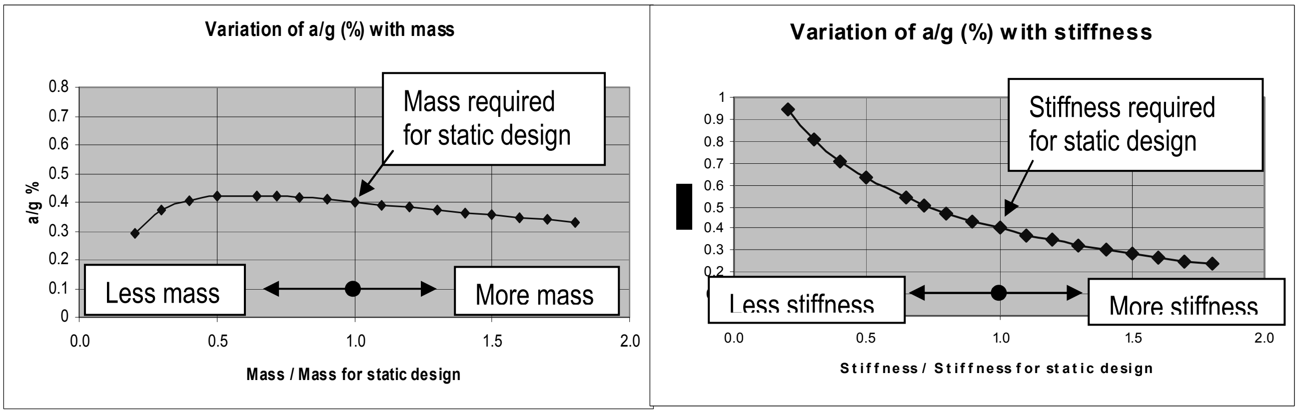
For a single degree of freedom system, the M_e in the two equations are the same. For a slab system they are significantly different with M_e in equation 16 being the effective mass of the total weight W involved in the natural frequency mode while M_e in equation 10 is simply the (effective) tributary mass supported by a single beam. As illustrated in the main calculations $M_{e.involved\ in\ motion}$ = 4.5 x $M_{e.for\ a\ single\ beam}$. Without going through all the mathematics in detail, with M_e = the effective tributory mass for a single beam then equations 10 and 16 may be combined to give:

$$a_{max} = \frac{1}{2\beta} x \frac{580e^{-0.35x\sqrt{K/Me}}}{4.5xM_e}$$

Or $$a_{max} = \frac{1}{2\beta} x \frac{580e^{-0.35x\sqrt{\kappa Kstatic/\mu Me.static}}}{4.5x\mu M_{e.static}} \qquad (19)$$

Where M_e = μ x $M_{e.static}$ With $M_{e.static}$ = the effective tributory mass to satisfy static requirements
And K = κ x K_{static} With K_{static} = the stiffness required to satisfy static requirments

The acceleration predicted by equation 19 can then be plotted for values of μ and κ varying from 0.2 to 2.0 as illustrated in graph 2.



Variation of a/g with mass

Variation of a/g with stiffness

Graph 2 Illustration of the variation in acceleration with mass and stiffness

Graph 2 illustrates that simply adding mass to the floor (without altering the stiffness) has a very minor effect on the maximum acceleration. Doubling the floor mass produces a reduction in acceleration from 0.4 to 0.3% of gravity. Increasing the stiffness on the other hand produces more significant changes in acceleration with a doubling in stiffness reducing the acceleration from 0.4 to 0.2% of gravity.

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Table of contents