CLOSURE TO DISCUSSION BY A. SRIDHARAN OF "DESIGN OF ANTENNA TOWER FOUNDATIONS"

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Laboratory model tests performed by Mr. Sridharan indicate that as the depth of the foundation increases, the natural frequency of the foundation-soil system decreases. Data obtained from tests performed on a 12 in. by 12 in. footing resting on dry sand and vibrating in a vertical mode are presented by the writer which clearly show that natural frequency is a function of foundation embedment.

The ratio of depth to the diameter of the mat in Example 2 is 0.192, which corresponds to a depth of 2.3 inches in Mr. Sridharan's tests, for which he found that the natural frequency was about 2 per cent less than that of an equivalent surface footing. The author believes that such a small difference would not merit consideration in an actual design problem. In addition, the soil conditions in Example 2 are quite different from those in the model tests. The mat in that example rests on the surface of a deposit of very stiff clay which is overlain by very loose sand. The author believes that in such a situation, the influence of foundation embedment would be considerably less than if all of the soil involved were sand having a uniform relative density. Relationships such as those presented by Mr. Sridharan should be considered when designing a deeply embedded mat or footing. Embedment is particularly significant when the top of the foundation is below the ground surface, in which case the overlying soil acts as part of the vibrating foundation.

Mr. Sridharan questions the reliability of a design based on relationships derived on the assumption that a rigid base-elastic foundation contact exists between the footing or mat and the underlying soil. The author realizes that such an assumption leads to computed natural frequencies which are greater than those based on theory in which either a parabolic or a linear distribution of contact stress is assumed for the static case. However, when foundations rest on very stiff cohesive soils, such as in Example 2, the author believes

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that the rigid base assumption is reasonable. He agrees that this point is open to question, and feels that it can only be resolved by studying performances of large-scale models and prototype structures.

Mr. Sridharan is correct in his contention that the natural frequency can be increased by increasing the diameter of the foundation. The author believes, however, that this is often an inefficient means of achieving such an increase. For example, if the diameter of the mat in Example 2 were increased from 52 ft. to 60 ft., as the writer suggests, the value of "b" would be 1.015 and the frequency factor, $a_o \approx 1.37$, for $\nu = 0$. The computed natural frequency, $\bar{f}_r$, would be:

$$\bar{f}_r = \frac{1.37}{1.10} \times \frac{26}{30} \times 5.04 = 5.44 \text{ cps} < 5.82 \text{ cps}$$

In order to raise the computed natural frequency of the system to 5.82 cps, a mat with a diameter of approximately 70 ft. would be needed. Such a mat would have a volume that was approximately 80 per cent greater than that needed for one of equal thickness and 52 ft. in diameter.

The relationship:

$$\frac{\bar{f}_r\ (\nu_1)}{\bar{f}_r\ (\nu_2)} = \sqrt{\frac{1 - \nu_2}{1 - \nu_1}}$$

used by the author to account for the influence of Poisson's ratio on natural frequency is based on theory for the natural frequency of an oscillator having a rigid base, vibrating in a rocking mode while resting on an elastic but weightless half space (Richart, 1960). If this oscillator had a circular base, the natural frequency of the system would be:

$$\bar{f}_r = \frac{1}{2\pi} \sqrt{\frac{d^3\, G}{3\ (1 - \nu)\ I_o}}$$

Therefore,

$$\bar{f}_r = F\ [\sqrt{1/(1 - \nu)}]$$