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DETERMINATION OF SOIL CONSTANTS FOR DESIGN OF MACHINE FOUNDATIONS

Shamsher Prakash[1] and D. C. Gupta[2]

Soil constants used in the design of machine foundations can be determined from a simple test on a model cement concrete block A block of size 1.5 m × 0 75 m × 0.7 m high with its base resting on the surface of the soil is excited beyond resonance by subjecting it to a sinusoidally varying force by means of a mechanical oscillator. The oscillator is mounted on the top surface of the block (Figure 1) and is subjected to vertical vibrations. The amplitude of vibrations at different frequencies of excitation are recorded. Coefficient of Elastic Uniform Compression, Cu, is then calculated by the formula

$$Cu = \frac{\omega_{nz}^2 \ m}{A} \ \text{tons/m}^3 \qquad (1)$$

where ω_{nz} = Resonant circular frequency, radians/sec.

m = mass of the block (oscillator+motor), tons. sec^2/m

A = Base area of the block, m^2

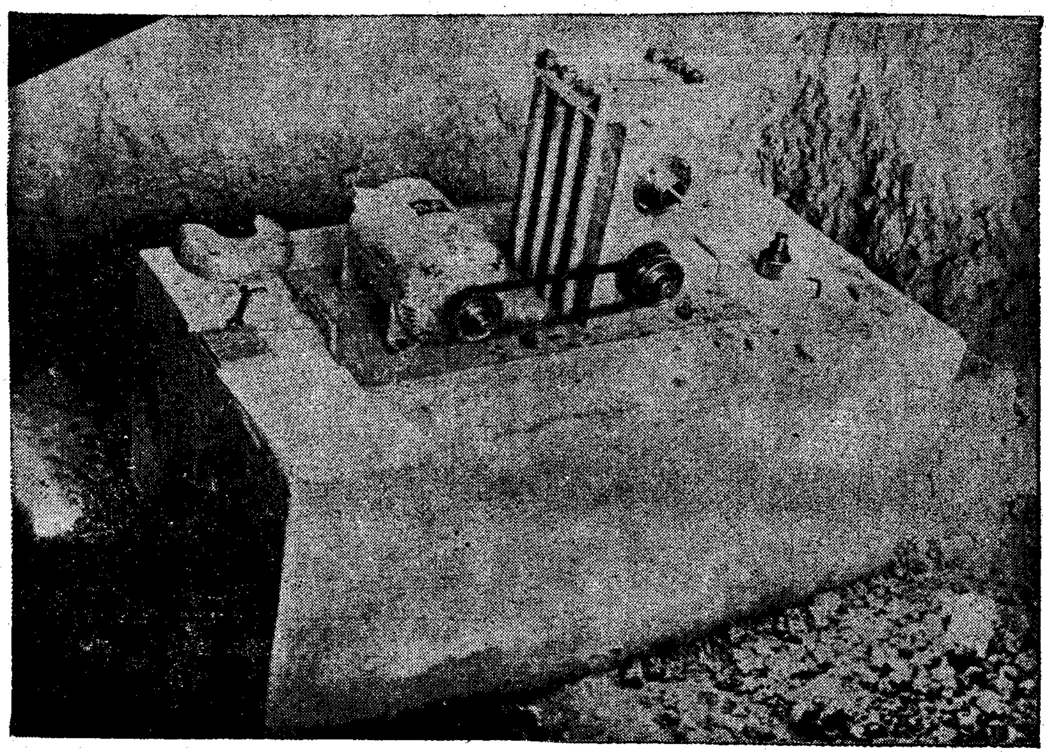

Fig. 1. Lazan Oscillator Mounted on Test Bloch

1. Professor of Soil Dynamics, School of Research and Training in Earthquake Engineering, University of Roorkee, U P. India.

2. Lecturer in Soil Dynamics, School of Research and Training in Earthquake Engineering, University of Roorkee, Roorkee, U.P. India.

However, it is relatively easy to excite the block to resonance in the longitudinal direction as the resonant frequency in this case is lower than that for vetical excitation. In case of longitudinal vibrations, the unbalanced force produced by the oscillator causes the foundation block to translate in the longitudinal direction as well as to have pitching about the transverse axis of the footing (Figure 2). The system thus constitutes a two degrees of freedom system having two natural frequencies. In practice, only the first natural frequency is generally achieved because of the limitations of the usually availalable equipment.

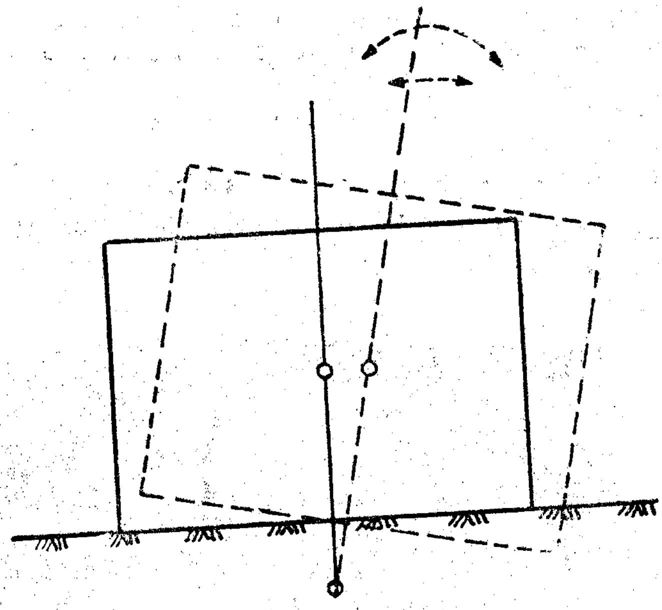

Fig. 2. The Block Vibrations in the First Mode-
Sliding and Pitching in the Same Direction

Figure 3 shows a typical plot of amplitude versus frequency of excitation for longitudinal vibrations of the block, vibrations being measured at the top of the block on its side and along the direction of vibration. Assuming the following relationship between coefficients of Elastic non-Uniform compression ($C_\varnothing$) and Uniform shear (C_τ)*

$$C\phi = 3.46 \ C_\tau \tag{2}$$

the following expression is obtained for the natural frequencies :—

$$\omega^2_{n_{1,2}} = \frac{1}{2\gamma}\left[\left(\frac{A}{m} + \frac{3.46\ I}{M_{mo}}\right) \pm \sqrt{\left(\frac{A}{m} + \frac{3.46\ I}{M_{mo}}\right)^2 - \frac{13.84\ .AI}{m\ M_{mo}}}\right] \times C_\tau \tag{3}$$

where I = Moment of Inertia of the base area w r.t. axis of rotation.

M_m = Mass M.I. of system about an axis passing through C.G. of the system.

M_{mo} = Mass M.I. of system about an axis passing through C.G. of the base.

$\gamma = M_m/M_{mo}$

Equation (3) for the block of above dimensions reduces to

$$\omega^2_{n_{1,2}} = 4.96\ C_\tau \text{ and }$$
$$= 22.35\ C_\tau \tag{4}$$

*Barkan, D. D., (1962) "Dynamics of Bases and Foundations", McGraw Hill Co., New York, N.Y. p-40.