MODULE – 5
Machine Foundations
Design steps using Tschebotarioff’s “reduced natural frequency” method

1. Given
2. Assume the value of $\omega_n$ or $f_n$

   Depending on under tuned or over tuned case, assume $\omega_n$

3. Size of machine base plate is determined (Minimum all-round clearance of 150 mm must be provided.) get $A$

4. Assume depth of the block foundation.

5. Find out the total weight $W = W_f + W_s$

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Design steps using Tschebotarioff’s “reduced natural frequency” method (contd.)

6. Compute $q_0 = \frac{W}{A}$

7. Calculate $f_{nr} = f_n \sqrt{q_0}$

8. Use Tschebotarioff’s design chart. Find out $A$ corresponding to calculated $f_{nr}$

9. Check $A$ with previous calculation

   $A$ required < $A$ provided (Hence ok)

   * note: displacement criteria is not mentioned
Tschebotarioff’s Design Chart

\[ f_n = \frac{1}{2\pi} \sqrt{\frac{KA}{m+m_s}} \]

where,
- \( K \) = dynamic modulus of subgrade reaction (lb/ft²)
- \( A \) = area of the base of the foundation (ft²)
- \( m \) = mass of the foundation block + machine
- \( m_s \) = mass of the soil

so,

\[ f_n = \frac{1}{2\pi} \sqrt{\frac{A}{W}} \frac{1}{2\pi} \sqrt{\frac{K}{m+m_s}} = \frac{1}{2\pi} \sqrt{\frac{A}{W}} \frac{1}{2\pi} \sqrt{\frac{mg}{m+m_s}} = \frac{1}{2\pi} \sqrt{\frac{A}{W}} \frac{1}{2\pi} \sqrt{\frac{K}{1+\left(m_s/m\right)}} = \frac{1}{2\pi} \sqrt{\frac{A}{W}} \frac{1}{2\pi} \sqrt{\frac{K}{1+\left(m_s/m\right)}} \]

\[ where, \; q_0 = \frac{W}{A} = contact \; pressure \]
Design of a Machine foundations as per Tschebotarioff’s “Reduced Natural Frequency”

Example Problem:

Design a block foundation for a machine of weight \( W_m = 0.5 \text{ ton} \) with minimum area of base plate as 45cm x 60cm. Operating frequency of the machine is \( f = 1500 \text{ rpm} \). Use Tschebotarioff’s reduced natural frequency method to obtain the size of the block foundation resting on 3 different soils, with the values of \( G \) as,

1. \( G = 50 \text{ kg/cm}^2 \) (\( = \text{tsf} \))
2. \( G = 100 \text{ kg/cm}^2 \)
3. \( G = 200 \text{ kg/cm}^2 \)

Take Poisson’s ratio for all soils = 0.25
Design of Machine Foundations as per IS:2974 (Part-1)-1969 (contd.)

**Vibration criteria:**

It is expected to have a foundation which is having natural frequency much higher or lower than the operating frequency of the machine.

**UNDER TUNED** → \( \frac{\omega}{\omega_n} \leq 0.5 \) for important machine

\( \leq 0.6 \) for less important machine

**OVER TUNED** → \( \frac{\omega}{\omega_n} \geq 2 \) for important machine

\( \geq 1.5 \) for less important machine