

Answer on Question#36986, Engineering, Other

Question

A piledriver hammer of mass 150 kg falls freely through a distance of 5 m to strike a pile of mass 400 kg and drives it 75 mm into the ground. The hammer does not rebound when driving the pile. Determine the average resistance of the ground.

Answer

The law of conservation of energy:

$$T + U = \text{const}$$

where $T = \frac{mv^2}{2}$ - kinetic energy, m - mass of the body, v - speed

$U = mgh$ - potential energy, h is height

$$0 + mgh = \frac{mv_0^2}{2} + 0$$

$$v_0 = \sqrt{2gh}$$

The law of conservation of momentum:

$$m_h v_0 = Mv$$

where M is sum of hammer and pile masses, v – their speed after impact:

$$v = \frac{m_h v_0}{M}$$

The law of conservation of energy:

$$\Delta E = W$$

where ΔE – change of body's energy, W – work of force

Work for uniform force directed opposite displacement can be expressed by the following equation:

$$W = Fd \cos 180 = -Fd$$

where F is the force, d is the displacement.

Change of body's energy equals $-\frac{Mv^2}{2}$, therefore:

$$\frac{Mv^2}{2} = Fd$$

$$F = \frac{M \left(\frac{m_h v_0}{M} \right)^2}{2d} = \frac{2ghm_h^2}{2d(m_h + m_p)} = \frac{ghm_h^2}{d(m_h + m_p)} = 267545 \text{ N} \cong 270 \text{ kN}$$

Answer: 270 kN