Answer on Question #74721 -Engineering

A pile driver hammer of mass 272kg falls freely through a distance of 4.2m to strike a pile of mass 516kg and drives it 75mm into the ground. The hammer does not rebound when driving the pile. Determine average resistance of ground. (Use D' Alembert's principle and compare the principle of conservation of energy when solving the problem)

Solution:

Mass of pile driver hammer (m) = 272kg
Hammer falls freely through distance of (h) = 4.2m
Mass of pile (M) = 516kg
Distance travelled by pile along the ground (x) = 75mm

Velocity (v) of pile driver hammer acquired before striking the pile at ground is given by,

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

After hammer striking the pile both move together with new velocity (v'), from conservation of linear momentum we can write that,

Momentum before impact = Momentum after impact

$$mv = (m+M)v'$$
$$v' = \left(\frac{m}{m+M}\right)v$$

Pile and hammer moving after impact against the resistance force (F) of ground by x distance before coming to rest. According to work-energy theorem we can write that,

Work done by resisting force = loss in K.E + loss in P.E

$$F \times x = \frac{1}{2}\left((m+M)(v'^2)\right) + (m+M)gx$$

$$= \frac{1}{2x}\left((m+M)(v'^2)\right) + (m+M)g$$

$$= \frac{1}{2x}\left((m+M)\left(\left(\frac{m}{m+M}v\right)^2\right)\right) + (m+M)g$$

$$= \frac{1}{2x}\frac{(mv)^2}{m+M} + (m+M)g$$

$$= \frac{1}{2x}\frac{(m(\sqrt{2gh}))^2}{m+M} + (m+M)g$$

$$= \frac{1}{x}\frac{(m^2(gh))}{m+M} + (m+M)g$$

$$= \frac{1}{0.075}\frac{(272^2(9.81\times 4.2))}{272+516} + (272+516)9.81$$

$$= 51578.5 + 7730.28$$
$$= 59308.78\text{N}$$

Average resistance of ground is (F) **59308.78 N.**

Answer provided by Assignment Expert