Answer on Question #74534-Engineering-Mechanical Engineering

A pile driver hammer of mass 272 kg falls freely through a distance of 4.2 m to strike a pile of mass 516 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.

Solution

The velocity of the pile driver of mass m = 272 kg just before it hits the pile after falling a height h is given by law of conservation of energy as

Gain in kinetic energy = loss in potential energy

$$\frac{mv^2}{2} = mgh$$

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

Velocity of the pile of mass M and the driver m just after the impact is given by law of conservation of linear momentum as

Momentum after impact = momentum before impact

$$(M+m)v' = mv$$

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

As the pile and driver moves simultaneously after impact against the resistance force of earth in moving by x before coming to rest, according to work energy rule

Work done against retarding force F = Loss in PE + loss in KE

$$Fx = (M+m)gx + \frac{1}{2}(M+m)v'^2$$

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

$$F = (M+m)g + \frac{m^2gh}{2(M+m)x} = (516+272)9.8 + \frac{272^2(9.8)4.2}{2(516+272)0.075} = 33485\ N.$$