Q- A pile driver of mass 273 KG is allowed to fall through a height of 4 m on a 667 kg steel pile to drive it into the ground. Each impact drives the pile into the ground by 109mm. Assume that the pile driver remains in contact with the pile after impact, calculate the average retarding force on the pile after contact.

The velocity of the pile driver of mass m = 273 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

Or $\frac{1}{2}mv^2 = mgh$

Or $v = \sqrt{2gh}$ ---------- (1)

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

Or $(M+m)v_1 = M*0 + mv$

Or $v_1 = \frac{mv}{(M+m)}$ ---------- (2)

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

Or $F*x = (M+m)gx + \frac{1}{2}(M+m)v_1^2$

Or $F*x = (M+m)gx + \frac{1}{2}(M+m)\left(\frac{mv}{M+m}\right)^2$ -------- using eq (2)

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

Or $F = (M+m)g + \frac{m^2gh}{(M+m)x}$ -------- using eq (1)

Or $F = (667+273)*9.8 + \frac{273^2*9.8*4}{(667+273)*0.109} = 9212 + 28514 = 37726\ N$