11. Let tension in string be T, then by Newton's second law, if acceleration is f,
$Mg - T = Mf$ and $T - mg = mf \Rightarrow Mg - mg = (m = m)f \Rightarrow f = \left(\frac{m-m}{M+m}\right)g$
Speed of counterweight is not changed by impact of driver on pile so it has speed v just before driver is jerked into motion again, so if speed just after is V then by conservation of momentum
$(m + M)v = mv \Rightarrow v = \frac{mv}{m+M}$
Time from release to first impact $= \frac{v}{f} = \frac{(M+m)v}{(M-m)g}$
time between impact and driver moving again $= \frac{2v}{g}$
speed of driver is now $\frac{m^2v}{(m+M)^2}$ so time to next impact is $\frac{2m^2v}{(m+M)^2} \times \frac{(M+m)}{(M-m)g} = \frac{2m^2v}{(M+m)(M-m)g}$
total time between first and second impacts $= \frac{2v}{g} + \frac{2mv}{(M-m)g} = T_1$ say
and between second and third impacts $= \frac{2mv}{(M+m)g} + \frac{2m^2v}{(M+m)(M-m)g} = \left(\frac{m}{m+M}\right)T_1$
times between successive impacts thus form a G.P. with common ratio $\frac{m}{m+M}$
total time between impacts is thus $\left(\frac{2v}{g} + \frac{2mv}{(M-m)g}\right) \times \frac{1}{1-\frac{m}{m+M}} = \frac{2v(M+m)}{(M-m)g}$
so time from release to rest $= \frac{(M+m)v}{(M-m)g} + \frac{2v(M+m)}{(M-m)g} = \frac{3v(M+m)}{(M-m)g}$
i.e. three times the time from release to first impact
