An Introduction to Geotechnical Engineering

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Some useful relationships of these prefixes are:

1 kilonewton, kN	= 10^3 newton	= 1000 N	
1 meganewton, MN	= 10^6 newton	= 10^3 kN = 1000 kN	
1 figanewton, FN	= 10^8 newton	= 10^5 kN = 10^2 MN	= 100 MN
1 giganewton, GN	= 10^9 newton	= 10^6 kN = 10^3 MN	= 1000 MN
3 giganewtons	= 30 figanewtons	= 1 boxafiganewtons*	
14.4 giganewtons	= 1 grossafiganewtons		

*This unit is only a constant prior to opening the box.

The correct unit to express the *weight* of an object is the newton since the weight is the gravitational force that causes a downward acceleration of the object. Or, weight W equals Mg, where M is the mass of the object and g is the acceleration due to gravity. You will recall that the acceleration due to gravity varies with latitude and elevation and, in fact, SI recommends that weight be avoided and that mass be used instead. If weight must be used, it is suggested that the location and gravitational acceleration also be stated. However, for most ordinary engineering purposes, the difference in acceleration (about 0.5%) can be neglected, and as long as we express the weight in newtons, the units will be consistent.

Another problem with weight is that it is commonly used when we really mean the mass of an object. For example, in the laboratory when we "weigh" an object on a laboratory balance, we really are comparing two masses, the mass of the unknown object with objects of known mass. Even scales or balances which displace linear springs are calibrated by using objects of known mass.

Further ambiguity occurs, of course, because common units of mass such as the pound or kilogram are often used in engineering practice as a unit of force. If pound is used as a unit of force, then depending on the resulting accelerations, different mass units are defined. For example, if a 1 lb-force causes an acceleration of 1 ft/s^2, then the mass is 1 lb-force$\cdot s^2/ft$, which is called a *slug*. In other words, 1 lb-force = 1 slug $\times$ 1 ft/s^2. Using slugs as units of mass avoids the confusion with pounds-mass, and this unit has been commonly used in aerodynamics and fluid mechanics.

If we wanted to use instead a pound-mass system, we could define a unit of force called the *poundal*, where 1 poundal = 1 lbm $\times$ 1 ft/s^2. Poundals are apparently used only in physics books.

EXAMPLE A.1

Given:

A force of 1 lb acts on an object weighing 1 lb.