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"Go SI"

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The feature article in the November issue of Foundation Drilling reported that in 1999 one quarter of the state-administered highway construction programme will not be in metric units. Indeed, the conversion to the SI-system of units progresses rather slowly. It would appear that full implementation is still more than a few years off. For reference, it is now a good number of years since Canada went SI and those who today find the conversion unnecessary and difficult are very few.

The advantage of using the SI-system is immediately apparent in an analysis that applies combined units—SI really does make the life of an engineer easier. The SI-system is superior to both the English System of units (also called the Imperial System of units, or the US customary units) and to its predecessors, the old metric systems called cgs and MKSA (with which I grew up). This notwithstanding that a few SI units are so precise or have so many zeros or decimals that they become awkward for everyday use in contrast to the English units. For example, for most everyday human endeavors, an inch is about as small a unit we can appreciate or the accuracy of a settlement prediction (at best), while the SI equivalent of 25 mm implies too great a precision. Similarly, a 2 tsf stress from a footing is a suitable reference value in the English system, as is 1 ksi for the stress on a small area of a structural unit, e. g., concrete. We do not have quite the same appreciation of 200 KPa, or 7 MPa, respectively. However, the SI units become as easy to relate to once we have used the system for a while.

In our conversion to the SI-system, we must take care not to fall into the same haphazard use of units as prevalent in the English system. We cannot and must not pick and choose amongst the units per our own preference. One advantage of the SI-system is precisely its rigidity and clarity, although it comes at a small price. For example, there are people with a metric (cgs or MKSA) background, who believe that the conversion is completed by merely replacing kg/cm^2 with the "bar" unit, which means that 1 bar is equal to 100 KPa. A bar is very close the unit at "at", which stands for atmospheric pressure and is equal to 101.325 KPa. Working with boilers and the like, ratio to atmospheric pressure is of interest, of course, but the SI-system is supposed to have universal application and should so be kept. Moreover, a few cannot for some reason bring themselves to accept the MPa, and express unit stress in the abominable unit of N/mm^2. The N/mm^2 violates the rule that in the SI-system a prefix is only to be applied to the remunerator, the denominator is always to be kept at its base value. Expressing density in units of g/cm^3 is almost as bad; density must be expressed in kg/m^3. It becomes worse when confusing density and unit weight; unit weight is density times gravity and must be expressed in force per unit area, N/m^3.

SI-units for engineering distances are expressed in metre and millimetre, the centimetre should not be used. For example, a 60 feet long, 24-inch pipe has a diameter of 610 mm not 61 cm and its length is 18.3 m. Remember to make soft conversion, that is, avoid making the converted values too precise.

A rule, which, if adhered to, provides an advantage of the SI system, often forgotten when discussing the pros and cons of the SI system, is that, in the SI system, formulae require input in the base units, which are N (newton) for load, Pa (pascal) for stress, m (metre) for length, etc. For example, a stress that

typically has a value of 5,000 KPa or 5 MPa must always be input in a formula as the numeral 5,000,000 or $5 \cdot 10^6$, not as 5,000 or 5. Similarly, a unit weight value is always to be input in any formula as N/m^3. We usually express unit weight in units of KN/m^3, that is, a unit weight of 19 KN/m^3 is to be input as 19,000. A multiplier is a numeral and is to be input with its numeric value along with the datum. This eliminates the necessity of always indicate what units to use in a formula and avoids errors associated with guessing, now common for many of the old formulae. For example, to use the Engineering News formula one must know that the hammer height-of-fall is in feet and the pile penetration is in inches. (Nota Bene, the use of the Engineering News formula to illustrate a point should not be taken to mean that the formula would be of any real other pertinence to the profession).

Not too infrequently, mistakes can be found in codes and manuals converting the old to the new. For example, the formula for determining the E-modulus of concrete from the concrete cylinder strength; $E = 5 \cdot 10^6 \sqrt{(f_c)}$. Both the E-modulus and the concrete strength are to be expressed in base units, that is N/m^2 or Pa. Unfortunately, the formula appears as $E = 5{,}000\sqrt{(f_c)}$ in some manuals, which looks simpler, but the latter formula requires the input of strength in KPa to obtain the modulus in MPa, which is a violation of the simple, but strict, SI-rule of only using base units in formulae. This rule is not so easy to pick up by users new to the SI-system.

The unit symbols are capitalized, but not the spelled-out unit names. That is, write 1 N and 1 Pa, but 1 newton and 1 pascal. Moreover, neither the names nor the units take plural ending. For example, 5 N and 5 newton, and 491 Pa and 491 pascal. My own additional preferred rule is when spelling out 1 m or 987 m, I write 1 metre and 987 metre. To me, the word meter is a measuring device, not a distance.

Another annoying English units left over is to write the units for second as sec. The unit symbol is s, please. And although the time span of an hour is not an SI-unit, write its units as h, not hr. Finally, do not place a period after an SI-unit; the unit is a symbol not an abbreviation.

Sure, the SI-system is not perfect. It was put together by minds that sometimes were too tied to old conventions. For example, in reference to the principle that all increasing multiples are to be expressed in upper case letters, e. g. M for 1,000,000 (mega), and diminishing multipliers are to be expressed in lower case letter, e. g. m for 0.001 (milli), when the SI Committee came to the multiplier for 1,000 (kilo), it regrettably allowed the use of lower case, writing km instead of Km for kilometre, for example. Moreover, as the base unit for mass is the kilogramme, not the gramme, it is a pity that the committee did not rename the base unit to, say, “ram” (somewhere, someplace, there must have been a scientist, say one Herr Doctor Adolphus Ram that could be so honored). Then, the tonne would be a KR. Well, we cannot win them all.

We may or may not approve of the shift to the SI-system of units. However, the clock cannot be turned back. Eventually, we will all go SI, become at ease with the SI units, and have it as our natural primary reference. We will then consider the English system of units to be the illogical and clumsy system it indeed is. I am saying “we” because my personal set of references to key values is still in English units—the personal conversion does no go fast. It will be a while after the full conversion before everyone is fully adept and we all can reap the benefits of having gone SI.