Structural Hollow Sections are being used more and more in structural applications as they have proven to be aesthetically pleasing and very efficient profiles. This has resulted in an increase in demand for structural tube. This includes both direct off mill and ‘drawn’ sizes.

Typically tube is used in applications where the member is subject to compression or part of a frame that may be subjected to both compression and tension depending on load direction. In some cases it may be used in application where the member is subjected to biaxial bending. This typically results in lighter more efficient structures.

Other benefits include ease of erection as they are typically lighter and the increased stiffness makes it possible to fabricate longer sections. Tubular structures also create aesthetically pleasing buildings.

One common denominator regardless of production processes used is the structural behavior of the tube. As with other steel structural members the performance of the tube is dependent on the class of member, typically regarded as stocky or slender. Class 1 and 2 are regarded as stocky. Class 4 members are slender and should be avoided especially where the member is to be used as a structural element. One must bear in mind that Class 4 members are not structurally efficient as they will fail before the stress in the steel reaches its yield strength. In this case it is recommended that one rather chooses a ‘stockier’ size which may be smaller but more efficient. This would include Class 3 members.

Another interesting aspect of Class 4 members is that the higher the D/t or B/t ratios (depth or width divided by the thickness ratios) are the more difficult they are to manufacture. The difficulty will also increase, for the same ratios, the higher yield stress steel is as this ratio is inversely proportional to the square root of the yield stress in the case of Square or Rectangular tubes.
Rectangular Hollow Sections; and inversely proportional to the yield stress in the case of Circular Hollow Sections. This correlates to the theory that thin plate or tube will elastically deform before reaching the yield stress, which may in the end result in severe deformation and in many cases results in failure of the member before it has reached its yield stress.

When Class 4 members are used, the complex theoretical resistance of the member will need to be calculated from first principles in order to avoid unwanted failures.

Drawn tube is often needed especially for sizes that are unique, too large for, or where volumes do not permit efficient direct of mill rolling. By definition, Drawn (tube) Hollow Sections are Circular (CHS), Square (SHS) or Rectangular (RHS) profiles that are converted ‘off line’ from a circular ‘mother tube’. In this instance ‘line’ refers to tube manufacturing mill in which the final (by size) product is made on a continuous tube production line. Simply described, the process would entail taking a previously formed (circular) hollow section and alter its shape, preferably without reducing its diameter, into a square or rectangle which has the same perimeter as the mother tube.

The drawing process can also be used for circular sections to be drawn down into non-standard diameters through dies. The cost of rolls used to convert the tube is often low as typically they can be used to manufacture a range of different sizes, so the costs associated with changing an on line mill set up to a new profile can thus be avoided, which is especially desirable when only small quantities are required.

One of the biggest advantages of drawn tube is more than one size can be made from the Circular Hollow Sections input. In other words, the width and height of the profile can be varied for the same input mother tube, for example A 219.1 diameter circular hollow section can be converted to a RHS 250 x 100, RHS 200 x 150 or to a SHS 175. When producing tubes on an online mill, minimum order quantity is often based on the length of a strip of coil. To produce a drawn tube only the availability of the number of lengths of mother tube required is considered, hence small quantities can be made on a given ‘Turks head’ (the Turks head is the device used to draw down or reshape circular profiles) setting. The only limiting criterion is that the size of

![Figure 1: Example of tubes with too tight corner radii.](Image)

![Figure 2: Tubes with too large corner radii resulting in large and inconsistent corner radii. The simple and desirable solution is to specify the sizes that are a direct conversion, i.e. a size that does not need to be drawn before conversion.](Image)
Annealing (heating and slow cooling treatment) may be required when excessive work hardening has occurred in the drawing down process. This can however be expensive and should therefore be avoided where possible.

If a mother tube circumference is too small for perimeter of the drawn tube is used, it will result in a profile which has very rounded corner radii considerably in excess of the requirements of SANS 657 Part 1 (see Figure 2). In many of these cases a compounding problem may occur in that the four rounded corners are often unequal and may present aesthetic problems. A good example is a SHS 175 that is drawn from a CHS 219.1, if a 180 square is specified and product is drawn then the corners will be very rounded and in most cases will result in unequal corner radii.

Drawn tube manufacturing does not have a place where volumes required reach a critical mass which justifies these sizes to be made directly, and more efficiently, using on line mills. Some examples, to name a few, are SHS 120, SHS 150, RHS 160 x 80 and RHS 200 x 100.

The recommended (preferred) large square and rectangles sizes in graded steel (typically S355) are shown below. Smaller sizes, provided they are ‘standard’, will typically already be manufactured direct using on line mills. Consult the SAISC Steel Construction Handbook (The Red Book) or your friendly steel supplier or tube manufacturer if in doubt.

It is important for engineers to specify structurally efficient members avoiding Class 4 members. Drawn tube serves an important part of the market where non-standard sizes are required and/or when quantities are small. When specifying drawn sizes, where possible, ensure that you specify a size that does not require drawing down before conversion and is compatible with the mother tube standard sizes which will result in a finished product that will conform to the dimensions and standards called up in SANS 657 Part 1. The sizes listed in the latest Red Book will typically avoid many of the above pitfalls when specifying tube. For availability it is best discussed with your local merchant or tube mill.

For the record the mass per metre of drawn tubes will always be the mass per metre of the mother tube.

By sticking to these simple rules, the result will be a reduced cost and provide the end user with a better quality product.