The aim of this feature is to share up-dates, design tips and answers to queries. The Steel Construction Institute provides items which, it is hoped, will prove useful to the industry.

AD 268

Bolt Lengths – Table 3, BS 5950-2: 2001

Following the publication of AD 263 concerning the limitations of bolt grades in BS 5950-1 and Eurocode 3, we have received several questions regarding Clause 4.3.1 and Table 3 to BS 5950-2: 2001. This Advisory Desk note addresses questions about two issues. The first is the length of the bolt protrusion beyond the nut and the second is the number of threads in the "stressed length". Figure 1 gives the definition of various lengths referred to in this AD.

Bolt protrusion

The first line of Clause 4.3.1 states "All bolt shanks shall protrude beyond the end of the nut by at least one thread pitch after tightening." This is a simple and enforceable rule for all bolts which is relatively easy to check even on site. It results in full thread engagement between the nut and shank, thereby ensuring that any tension in the shank is transferred to the nut. The minimum theoretical bolt length should be calculated on this basis, allowing for the thickness of the nut, washer, grip and bolt protrusion.

The note under the first sentence adds the advice that a bolt length calculated with "at least one further full thread pitch in addition to the theoretical length required will normally ensure adequate allowance for tolerances." The grip length (the sum of the ply thickness) can vary due to the rolling tolerances of the plies and paint thickness, and the bolt also has manufacturing tolerances; however one additional full thread pitch on top of the theoretical bolt length will usually suffice. This is the same as the old rule of thumb in steelwork that "a bolt should have two full threads beyond the nut", one for thread engagement and one for tolerances. However, the designer should give further consideration to particular cases where greater than normal tolerances need to be accommodated. One example is where the paint coatings are unexpectedly thick. Another is where galvanizing is also unexpectedly thick on the faces of the plies, as can occur with Silicon rich steel.

Threads under the nut

Table 3 gives minimum lengths (in addition to the thread run-out) of the "threaded portion in the stressed length", "b" in Fig. 1, in terms of a number of thread pitches, for the various bolt grades and loading conditions. The reason for this requirement is related to ductility.

In general, the higher the bolt grade the less ductile the bolt, as can be seen from the minimum ductility requirements for bolts materials given in Table 3, EN ISO 898-1: 1999. In addition, the length of the threaded portion in the stressed length has been shown to influence considerably the ductility of the bolt (fig. 1). Table 3, BS 5950-2: 2001 reflects this by specifying longer threaded portions in the stressed length for higher grade bolts and higher tension loads: in other words, the minimum threaded portions in Table 3 are the means to ensure that bolts have sufficient ductility to be used safely in normal structural connections. Fully threaded bolts have greater ductility than short threaded ones and are preferable where maximum ductility of connections is required.

It can be seen that no provision has been made for Grade 12.9 and 14.9 bolts in Table 3, BS 5950-2: 2001. They are considered to have insufficient ductility to be used safely in normal structural connections, as explained in AD 263.

When specifying large diameter high-grade bolts in conjunction with short grip lengths, the designer should be careful because the minimum threaded portion required may exceed the grip length. Hence it is a good rule of thumb to maintain a minimum ply thickness in a joint greater than or equal to half the nominal bolt diameter used in the connection, where possible.

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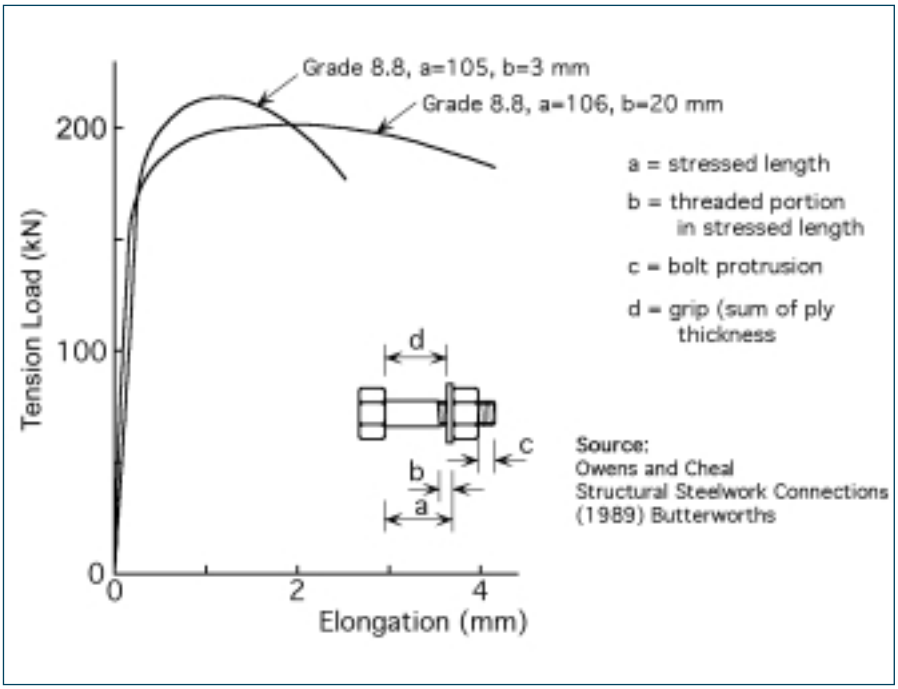

Fig. 1. Tensile behaviour of bolts.

Type of bolts	Grade 4.6	Grade 8.8[a]	Grade 10.9[b]
Non-preloaded in shear only	1	1	1
Non-preloaded otherwise	1	1	5
Preloaded	-	3	5

[a] Including general grade bolts to BS 4395-1
[b] Including higher grade bolts to BS 4395-2

Fig. 2. BS 5950-2: 2001 Table 3 – Clear Threads

Nominal bolt diameter	M12	M16	M20	M22	M24	M27	M30	M33	M36
Pitch (mm)	1.75	2.00	2.50	2.50	3.00	3.00	3.50	3.50	4.00

Fig. 3. The coarse pitch of screw threads for the normal range of ISO metric structural bolts.