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If You Can't Buy U.S. Structural Bolts

We've Got It Easy Here

Things are pretty well defined and cozy over here in North America when it comes to buying structural bolts. It's ASTM A325 or A490 most of the time. They're big, strong, well proportioned bolts (made to the heavy hex ANSI B18.2.1 dimensions) which when made and certified correctly, will satisfy the most demanding design applications.Their compatible nuts are covered by ASTM A563 or A194, made deep enough to cause the bolt to break before the nut strips, and their out/out dimensions match the bolt head, which is convenient for assembly. Thread fit is controlled, and all these specifications come in both Imperial and Metric. Much less readily available from stock are A307, A354, or A449 bolts, but when these must be used the product specification are available and suitable conservative design rules can at least be assembled. Distributor inventory positions vary widely, but a determined purchaser can usually supply a project if they shop around and/or maintain a close, long-term buying relationship with a good structural bolt distributor.

But what do you do when you have to design connections or purchase structural bolts, which are not made to these specifications? Let's say you have designed or are about to purchase bolts for a power plant or other similar structural steel project in Thailand, Indonesia, or China. What do you do?

THREAD COMPARISON BETWEEN ASTM AND BS4395 SPECIFICATIONS

BOLT DIA	A325 & A490 LENGTH	A325 & A490 THREAD	BS4395 PTI LENGTH	BS4395 PTI THREAD	BS4395 PT2 LENGTH	BS4395 PT2 THREAD
MI6	<100	31	<I25	38	<I25	44
	>I00	38	>125<200	44	>125<200	50
			>200	57	>200	62
M20	<100	36	<I25	46	<I25	52
	>I00	43	>125<200	52	>125<200	58
			>200	65	>200	70
M22	<100	38	<I25	50	<125	56
	>I00	45	>125<200	56	>125<200	62
			>200	69	>200	74
M24	<I00	41	<125	54	<I25	60
	>I00	48	>125<200	60	>125<200	66
			>200	73	>200	78
M27	<100	44	<125	60	<I25	60
	>100	51	> 125<200	66	>125<200	72
			>200	79	>200	84
M30	<100	49	<I25	66	<125	72
	>I00	56	>I25~200	72	~125<200	78
			>200	85	>200	90
M33	N/A		N/A		<I25	78
	N/A		N/A		>125<200	84
					>200	96
M36	<100	56	<I25	78	NIA	
	>100	63	>125<200	84	N/A	
			>200	97	N/A	

But Elsewhere, Watch Out!

1. First, try to get bolts made to the ASTM (M) specifications.

Firstly, there are many bolt producers in the far parts of the world which will make bolts to the North American ASTM specifications, your best bet might be to try for those first. Stock positions in Imperial sizes will be non-existent, however, so be sure of your bolt list before you commission the order, and be sure to give the bolt producer at last 60 days to make all the bolts. Insist on correct quality certifications of course. If you are going metric, and that's the logical way to go over there, these A325M and A490M specs are still a good bet for producers in the Far East.

2. Next, try British Bolt Specifications.

Failing availability of these, try for the British type of high strength friction grip (HSFG) bolt sets made to either BS 4395 Pt. 1 (General Grade) or Pt.2 (Higher Grade). These are heavy hex structural bolt sets much like our A325 and proportioned so that the unthreaded bolt shank takes

the ultimate connection forces in shank bearing against the edge of the hole. It used to be that the bolts were commonly used in Britain, and the British consultants and contractors who designed and built much of the Far East brought their preference for these bolts in preloaded connections with them when they extended the Empire. They also brought load indicating washers (then called LIWs, now called DTIs) with them.These British specifications conveniently include bolt, nut, and washer, will not strip before breaking, and are available only in metric sizes. (Let's all remember, metric is good. Metric is good. Repeat this every day.) Thread lengths are different, though (See Table 1). So you can order BS4395 (metric) bolts either from the UK for delivery to your project, or manufactured by bolt makers in the Far East.

You'll find that the two major structural bolt makers in the UK prefer to make bolt sets to the BS4395 specification. For their home market, though, their use has recently declined, supplanted by cheap offshore-produced, lower quality bolts with quite different properties and thread dimensions. The norm now in the UK itself is for steelwork other than bridges and heavy frames to be assembled using bolts made to a hybrid specification stuck together from BS 4190 for dimensions, the short thread length option of only 1.5 x diameter, with BS 3692 Grade 8.8 mechanical properties.These bolts are not intended to be tensioned other than by what the British call a "podger spanner." They are also used in the fully threaded form (called a "set screw") resembling a DIN 933 bolt. Because these bolts take the ultimate shear loads of the connections in threaded shank bearing, they build their structures with many more bolts in the connections that would be required if they used BS4395 bolts. How one is supposed to order these bolts is beyond me. What does one call it? "Give me a pseudo BS4190 or a BS 419O/BS 3692 bolt please!" Incidentally, BS 3692 itself is a precision bolt specification with grades offered from 4.6 all the way up to the stratospheric grade 14.9, which thankfully, is no longer made, but it includes grades 8.8 and 10.9 which resemble the strength levels of our A325 and A490. BS 3692 does include lot control provisions, requires quenching and tempering, specifies tight tolerances on dimensions, but alas bolt sets made to this specification will strip during preloading because the nuts listed are shallow and not of the heavy hex form. A preloaded BS 3692 or "pseudo BS 4190" is therefore not anticipated. If it were me doing the bolt specifying, I'd stay far, far away from these bolts!

3. Next, if that doesn't work, DON'T try the European Specifications.

But now your supplier(s) tell you that they can't make or obtain any of the above, so what do you do? Do you lean towards the European prestandard EN 780, 781, or 782 series? Although mentioned as far back as June, 1995 in the draft version of the European steel structures design guide (ENV 1090-1), these specifications actually have not yet been issued. Does one revert to the (EN 2) 4014, 4016, 4017, 4018, 4032, 4033, 4034 specifications (equivalent to IS0 specs of the same numbers)? These specifications, although officially issued, have never been brought into use by bolt makers (to my knowledge), so that doesn't sound like the right path either.

You could specify IS0 7411 or its shorter thread cousin IS0 7412, but these are very rarely made. The favorite in Germany is DIN 6914 which is a heavy hex bolt, but the associated nut (DIN 6915) is shallow, so watch out when tightening. And, like a lot of French things, the French specification NF E27-711 is never seen outside of France.

4. Instead, go right to JIS.

What you may have to accept is bolts and nuts made to the Japanese Industrial Standard (JIS) B1186. This is a thoroughly thought-through and well used and tested metric specification (Let's all remember, metric is good. Metric is good. Repeat this every day.) which includes bolt, nut and washer, several strength grades, and includes such advanced features as allowable torque coefficients (WOW!). Allowable torque coefficients are a much more direct way of specifying the same thing as ASTM A325's "rotational capacity" capability. (I know what a "torque coefficient" is, but what is "rotational capacity?") JIS B1186 covers bolts up to M30, which isn't as big as the A325M maximum diameter of M36, but not bad. Any bolt over M30 is a brute to tighten anyway. The usual strength made is grade F1OT (the nut is grade F1O), and it is widely made throughout the Far East in both normal hex head form and (to M24 only, I believe) in "tor-shear" or "TC" form. An M22 F1OT bolt with an F1O nut and an F35 washer in **a** set (they must be made and certified as a set) has a tensile strength 20% higher than our A325M (297 kN vs. 251 kN), but 6% lower than our A490M (297 kN vs. 316 kN), DTIs are made to suit these F1OT sets and used frequently when the F1OT set is used in the hex head form. This is sometimes because of installer/designer preference, but even more importantly, note that there is no universally acceptable turn-of-nut procedure for metric threaded bolts like there is for Imperial, so for metric bolts compressible washers or DTIs are just what the doctor ordered.

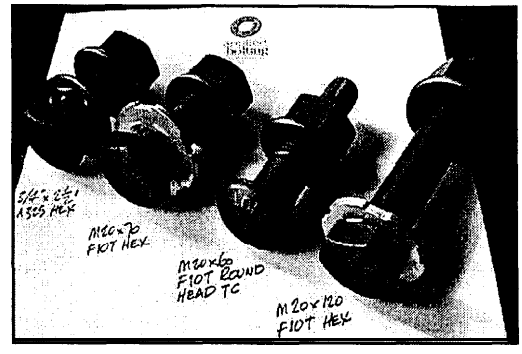

Figure 1: 34" A325 Bolts, M20 F10T Bolts

Figure 1 shows a 3/4" A325 hex head bolt, and three examples of M20 F1OT sets in both the hex head and round head TC forms. They look identical. Note the 3/4" Imperial nut and the M20 nuts are interchangeable on the bolts, but will not tighten correctly if mixed up. The DTIs shown on the 3/4" and the M20 bolts in Figure 1 will show whether the correct nut has been threaded on because it will not flatten correctly unless the nut fits the bolt thread correctly.

Figure 2 shows a 7/8" A325 hex head bolt, and an M22 F1 OT hex bolt set.They too look identical. Although the 7/8" and M22 diameters are almost identical, note that in the case of these F10 nuts anyway, the 7/8" nuts will not thread onto the M22 bolt, and vice-versa too. The thread pitches are radically different.That's why the usual rules for turn-of-nut don't work with metric bolts.

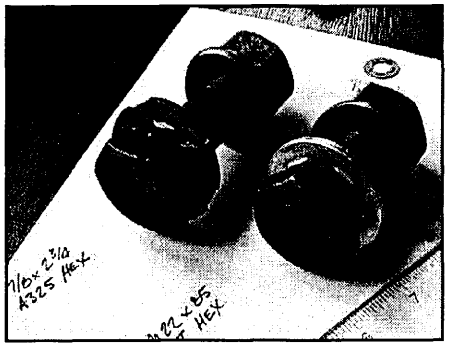

Figure 2: 7/8" & M22 Bolts

Figure 3 shows an assortment of correctly made 3/4", M20, M22, and 7/8" bolts in various forms. They look the same from a few feet away. This is why the bolts must be specified correctly and then carefully controlled on the site.

Summary

In conclusion, when you can't get the good old favorites A325 and A490 (M), go for BS4395 as a first choice, and if that doesn't fly, go straight to JIS B1186 and specify the type of bolt — that is, whether hex head or TC is to be used. Keeping to hex head will make the number of possible producers larger and therefore the prices more competitive, and will allow bolts right up to M30. Using DTIs to ASTM F959 for bolts that need full tensioning will produce the most consistent results even when the field skill level is questionable, even when the bolts are metric, and DTIs can check that oh-so-possible mixed hardware situation where M20 bolts are being used with 3/4" nuts, M22 with 7/8", M24 with 1", etc. Weird, wild stuff happens out there. Count on it. Head it off.

And remember — metric is good. Metric is good. Repeat this every day. **O**

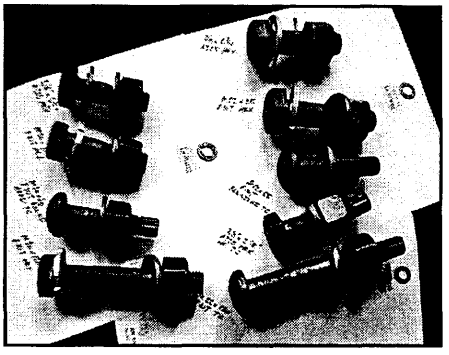

Fig. 3: Don't let this happen to you!