

DTI's Technical Report #30

Comparison of tightening methods for high strength bolts.

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Introduction

Customer response suggested that many users of high strength bolting systems believe that there is a time-saving factor in the use of Coronet Load Indicators.

Cooper & Turner decided to establish whether this had any validity and this reports sets down the method and results of a series of controlled tests carried out with the co-operation of the British Steel Corporation during August, 1970. The time study was undertaken by P.A. Management Consultants Ltd., Product Research & Development Department, and the tests were supervised by W.S. Atkins & Partners, Consulting Engineers.

Summary

Three basic systems of bolting were compared: (1) The torque or calibrated wrench method:

(2) The Turn-of-Nut method: (3) The Coronet Load Indicator method.

Timings were made of each step. A minimum time saving of 13% was shown by the Coronet Load Indicator method compared with the other two systems. This savings was increased to 33% with the omission of initial spud wrench tightening.

Procedure

A test piece as shown in Fig. 1 was prepared, into which could be inserted 72 – ¼" dia. Bolts through 13/16" dia. holes. The plate was divided into three equal areas of 24 holes and all three systems were used during any one particular sequence. For each sequence the separate elements of preliminary tightening, final tightening and checking were completed for all the systems before passing on to the next element. In order to minimize the effects of operator fatigue or familiarity, which might slow down or quicken the tightening times, the positions of each group were cycled and tightening was always carried out starting from the same side and proceeding in the same order.

The tightening technique for each system was as follows:

1) Torque or Calibrated Wrench method

- (a) All bolts were inserted by hand and nuts snugged with a spud wrench.
- (b) The pneumatic impact wrench was calibrated by use of a load cell to

cut out when a bolt tension 10% higher than the minimum specified was achieved.

- (c) The bolts were tightened with the calibrated impact wrench.
- (d) A normal torque wrench was calibrated in the load cell to indicate a torque 5% above that necessary to obtain the minimum tension.
- (e) The manual torque wrench was used for inspection testing of the tightened bolts.

2) Turn-of-Nut Method

- (a) All bolts were inserted by hand and nuts snugged with a spud wrench.
- (b) The nuts were checked for adequate preliminary tightening and the necessary mark made on the nut and protruding thread with a chisel.
- (c) The bolts were tightened to half turn of the nut using the pneumatic impact wrench.
- (d) The marks were visually inspected to ensure the required rotation of the nut.

3) Coronet Load Indicator method

- (a) The Coronet Load Indicators were placed under the heads of the bolts and the bolts were inserted by hand. Nuts were then snugged with a spud wrench.
- (b) The bolts were tightened to the required 0.015" average Indicator gap using the pneumatic impact wrench.
- (c) The gap was checked.

The tests were repeated five times and the results are shown in appendix 1. Tests 1 to 3 follow precisely the methods described above. In practice there will be occasions where the plies are sufficiently well drawn together by fitting-up bolts to make preliminary tightening with a spud wrench unnecessary in the torque control and Coronet Load Indicator methods: tests 4 and 5 were therefore carried out with the spud wrench tightening eliminated from these methods. An impact wrench was used for the Turn-of-Nut initial tightening.

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Results

Average results for each test series were as follows: Key: **T** – torque (calibrated wrench) **N** – turn-of-nut **C** – Coronet (Time is in minutes per 24 bolts)

	Tests 1–3			Tests 4–5		
	T	N	C	T	N	C
Hand place & hand tighten	6.25	6.70	6.52	–	–	–
Hand place only	–	–	–	3.56	3.58	4.86
Spud tighten	2.39	3.02	3.22	–	5.37	–
Final tighten	6.75	6.52	5.32	13.49	5.14	3.99
Inspect	9.17	2.24	1.22	8.11	1.69	1.65
Total	25.10	18.78	16.28	25.26	15.78	10.50

It will be appreciated that the testing was carried out in ideal shop conditions and these figures may not be achievable on site. However, the comparison of the results will in no way be affected by this consideration. It will be seen that the Coronet Load indicator method was the quickest of the three methods, both with or without initial spud wrench tightening, the comparison being:

Time saved by Coronet Load Indicator:

Compared with	Tests 1 – 3	Tests 4 – 5
Turn-of-Nut	13%	33%
Torque Control	35%	58%

Appendix 1 – Individual test results Key: **T** – torque (calibrated wrench) **N** – turn-of-nut **C** – Coronet

TEST #	Place Bolts by Hand			Spud Tighten			Final Tighten			Inspect		
	T	N	C	T	N	C	T	N	C	T	N	C
1	7.31	8.01	7.66	2.93	3.64	3.93	8.19	7.81	5.18	6.82	3.07	1.28
2	5.87	6.69	6.28	2.23	2.56	2.56	6.90	6.07	5.67	9.47	2.27	1.44
3	5.69	6.23	5.60	2.03	2.88	3.19	5.02	5.70	5.11	12.73	1.39	.93
Average	6.25	6.70	6.52	2.39	3.02	3.19	6.75	6.52	5.32	9.17	2.24	1.22
4	3.79	3.14	5.17	–	4.63	–	12.00	5.08	4.46	9.39	1.59	.96
5	3.32	4.01	4.54	–	6.10	–	14.98	5.20	3.52	6.83	1.80	2.34
Average	3.56	3.58	4.86	–	5.36	–	13.49	5.14	3.99	8.11	1.69	1.65

TEST #	TOTAL TIME (Times are minutes per 24 Bolts)		
	T	N	C
1	25.25	22.53	18.05
2	24.47	17.59	15.95
3	25.47	16.20	14.83
Average	25.10	18.78	16.28
4	25.18	14.44	10.59
5	25.13	17.11	10.40
Average	25.26	15.78	10.50

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Fig. 1
Test Piece

