Nut And Bolt Face Washers Are Not Required With Turnasure Direct Tension Indicators

Andrews Fasteners stock Turnasure Direct Tension Indicators.

Turnasure literature states that Nut Face and Bolt Face Washers are not required when using their Direct Tension Indicators.

Turnasure have worked with the European Standards Agency in developing a European Standard for Direct Tension Indicators.

Within the new standard it states that Direct Tension Indicators can be used without using Nut and Bolt Face Washers.

BS 7644 has been replaced by BS EN 14399 Part Nine (System HR or HV – Direct Tension indicators for bolt and nut assemblies). The new standard for Direct Tension Indicators states –

1. Scope (page 6)

'…The direct tension indicator can be used alone or with bolt face washers or nut face washers ...'

The Turnasure report attached was used to show that Nut/Bolt Face Washers are not required when using Turnasure Direct Tension Indicators.

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Modified Rotational Capacity Testing of Structural Fastener Assemblies
EN 14399-1

Test Program —

Preload Testing of Structural Fastener Assemblies with Compressible-Washer-Type Direct Tension Indicators (DTIs).

1. Scope

1.1 This test series covers the application of an existing test method to structural bolt assemblies which include compressible-washer-type direct tension indicators (DTIs).

1.2 This test series evaluates structural bolt assemblies in configurations with and without DTIs.

1.3 This test series covers metric Class 8 structural nut, bolt, and washer assemblies for preloaded connections. The structural bolts, nuts, and washers which were used met British Standard 4395 M24 8.8, and were supplied by a distributor in the UK. The DTIs were manufactured to BS 7644 Part 1, and were manufactured by TurnaSure of the USA.

1.4 This test series was conducted in reference to Resolution 5 of CEN/TC 185 WG 6, and followed the test procedure outlined by Cooper & Turner Ltd in a memorandum dated 6 June, 2006.

1.5 This test series was conducted using a computer-controlled *hydraulic* bolt tension calibrator which electronically recorded bolt tensions continuously during tightening operations. (Note: The data gathered during this test program may be compared to that collected in 'solid state' testing devices such as those used in Germany, France, and the UK.)

1.6 This test series includes tests done without the use of nut faced washers – even when DTIs were installed directly under the nut, which was the element turned.

2. Test Parameters

2.1 All tests were performed on September 8th, 2006 at the Skidmore-Wilhelm Manufacturing Company in Cleveland, Ohio, USA.[1] All tests were conducted using an HT-4000 automated bolt calibration tester. The HT-4000 used in the test series is programmable, and a customized program was used to control the equipment during the tests series. The test equipment and data collection program were operated by John Biel, an Engineer employed by Skidmore-Wilhelm. Serving as an independent witness to the test series was Mr. Jeffrey Hehn of Tensile Testing Metallurgical Laboratory of Cleveland, Ohio, USA.

2.2 The tests were conducted at an ambient temperature of between 72 deg and 76 deg F.

2.3 Feeler gages of sizes 0.400 mm, 0.250 mm, and 0.125 mm were used to quantify residual gaps between DTI protrusions at various stages during the test series.

2.4 The lot number of the DTIs which were evaluated is TurnaSure Lot Number 2488A9 corresponding to the M24 nominal diameter.

2.5 A total of five samples for each test condition (test series) were evaluated during the test program.

[1] Full reference to test facility is Skidmore-Wilhelm Manufacturing Company, 442 South Green Road, Cleveland, Ohio 44121. (216) 481-4774.

3. Test Results

3.1 **Test Condition 1 —** The first series of tests were performed on 5 samples of M24 structural bolts, nuts, and nut-face washers without the use of DTIs.

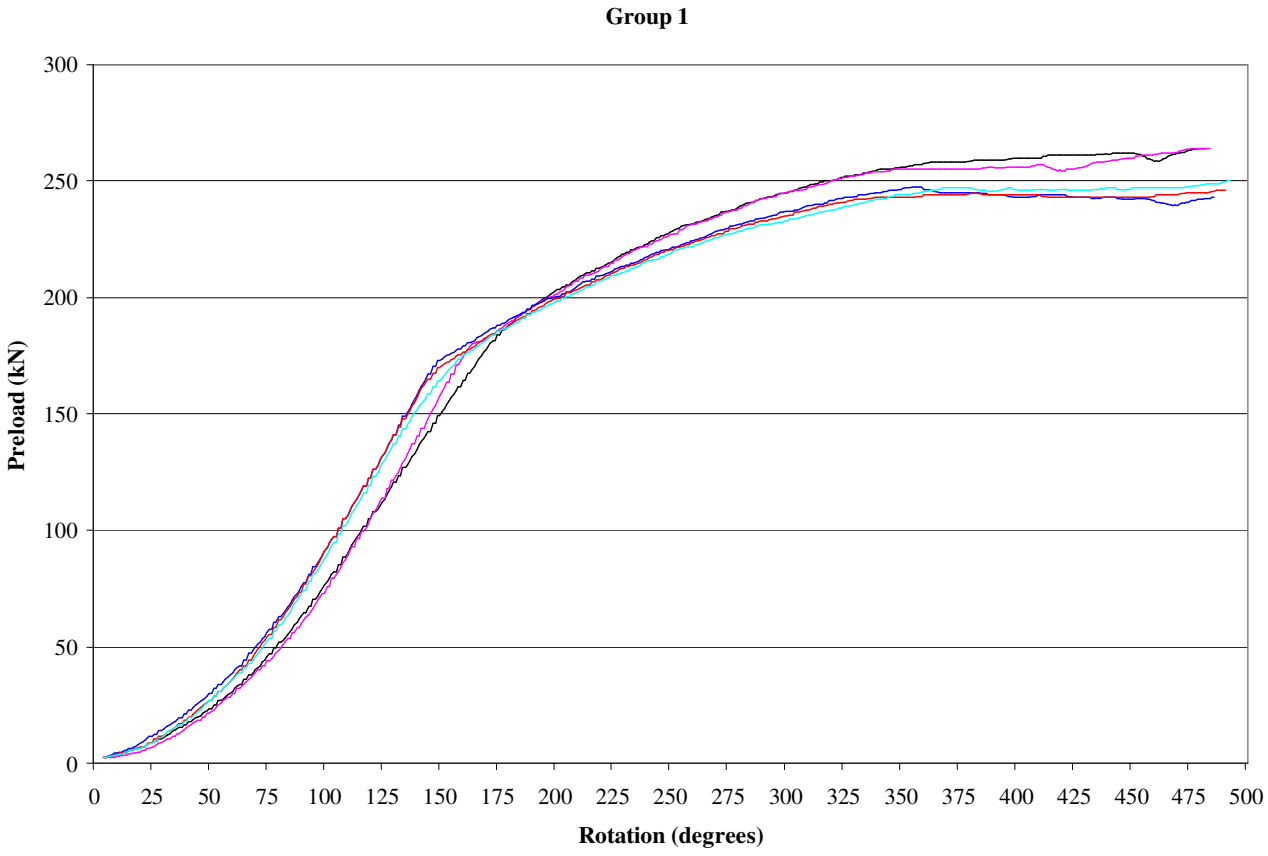
3.1.1 The following table of data summarizes the results for the first test condition.

Group 1

Nr	Θpi	$\Theta 1i$	Fbi max	$\Theta 2i$	Fbi $\Theta 2i$
1	207	478*	264*	478*	264*
2	211	355	248	482	243
3	208	480*	264*	480*	264*
4	218	489*	250*	489*	250*
5	216	487*	246*	487*	246*

Group 1 = Bolt, nut, nut-face washer, without DTI, continuous tightening.
Note: Asterisks (*) indicate that peak bolt preload coincided with maximum angle at end of test.
The end of test was preset at 270 degrees rotation beyond attainment of minimum preload.

3.1.2 The following graph depicts the relationship between the angle of rotation and the preload attained during the testing of each sample in Group.



3.2 **Test Condition 2 —** The second series of tests were performed on 5 samples of M24 structural bolts, nuts, and nut-face washers with DTIs.

3.2.1 The following table of data summarizes the number of applicable feeler gage 'entries' which were recorded at the corresponding levels of preload, starting at 207kN for test condition 2, identified at 'Group 2'.

3.2.2 In order to collect the data recorded in the table below, the following procedure was followed: Feeler gage inspections continued at 10kN increments starting from 207kN until the requirements of the manufacturer's installation criteria were satisfied. As the test configuration was such that the DTIs were installed under the nut end of the connection, and this end was used for tightening, the applicable feeler gage for use in the steelwork would have been the 0.125mm.

3.2.3 The manufacturer's instructions state that tightening should continue until the applicable feeler gage is refused in *'more than half'* of the gap locations between protrusions. As there are 6 potential locations on an M24 size, the test was stopped at the point where there were 4 or more 'refusals' of the applicable feeler gage.

Group 2

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
207kN	0.400mm	4	3	2	2	3
	0.250mm	6	6	6	5	6
	0.125mm	6	6	6	6	6
217kN	0.400mm	0	0	2	0	2
	0.250mm	5	4	4	3	4
	0.125mm	6	6	6	5	6
227kN	0.400mm	0	0	0	0	0
	0.250mm	2	2	2	2	3
	0.125mm	6	5	6	4	6
237kN	0.400mm	0	0	0	0	0
	0.250mm	0	0	0	0	1
	0.125mm	3	4	4	3	4
247kN	0.400mm	0	0	0	0	0
	0.250mm	0	0	0	0	0
	0.125mm	0	0	1	2	2
257kN	0.400mm	---	---	---	---	---
	0.250mm	---	---	---	---	---
	0.125mm	---	---	---	---	---

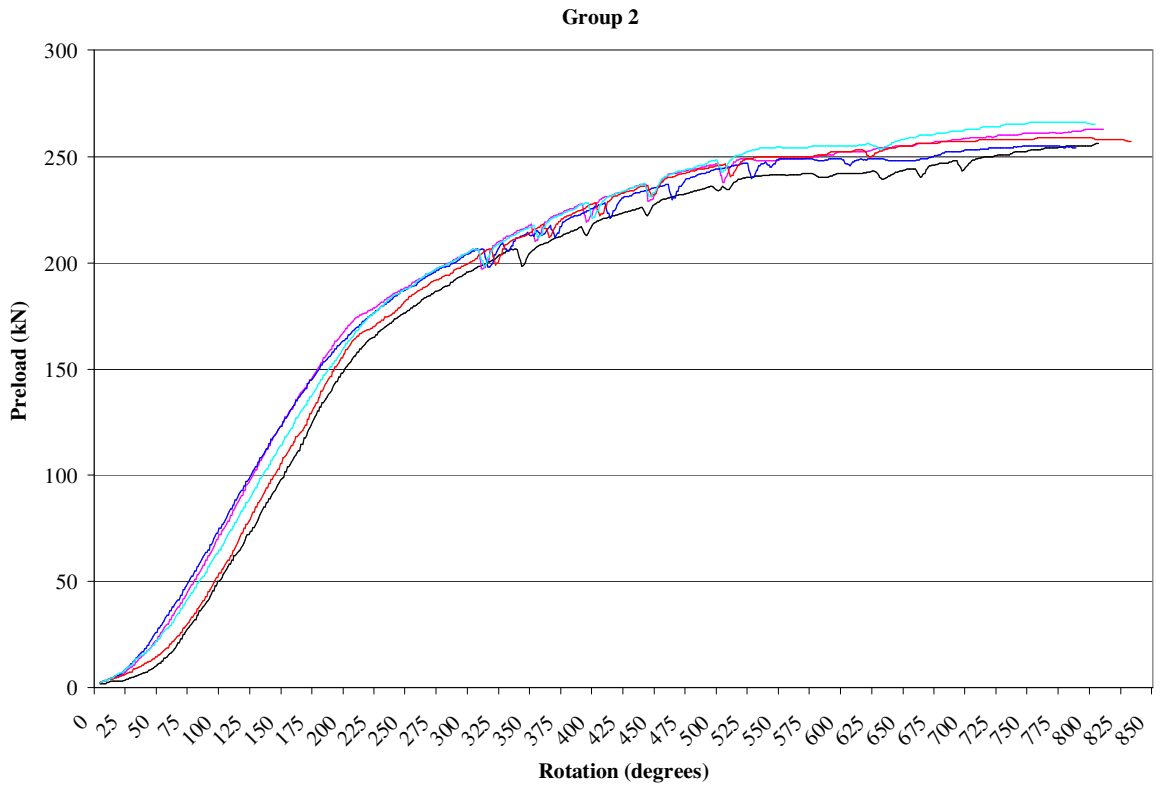
* Nut-face hardened washers were used during these tests.

Group 2

Nr	*Θpi*	*Θ1i*	Fbi max	*Θ2i*	*Fbi Θ2i*
1	338	803*	256*	803*	256*
2	311	739	255	785	254
3	303	807*	263*	807*	263*
4	303	749	266	800	265
5	317	755	259	829	257

Note: Asterisks (*) indicate that peak bolt preload coincided with maximum angle at end of test. The end of test was preset as 450 degrees rotation beyond attainment of minimum preload for samples 1 & 2, was increased to 490 degrees for sample 3 & 4, and 500 degrees for sample 5.

3.2.4 The following graph depicts the relationship between the angle of rotation and the preload attained during the testing of each sample in Group 2.



3.3 **Test Condition 3 —** The third series of tests were performed on 5 samples of M24 structural bolts, nuts, direct tension indicators and nut face washers, continuous tightening.

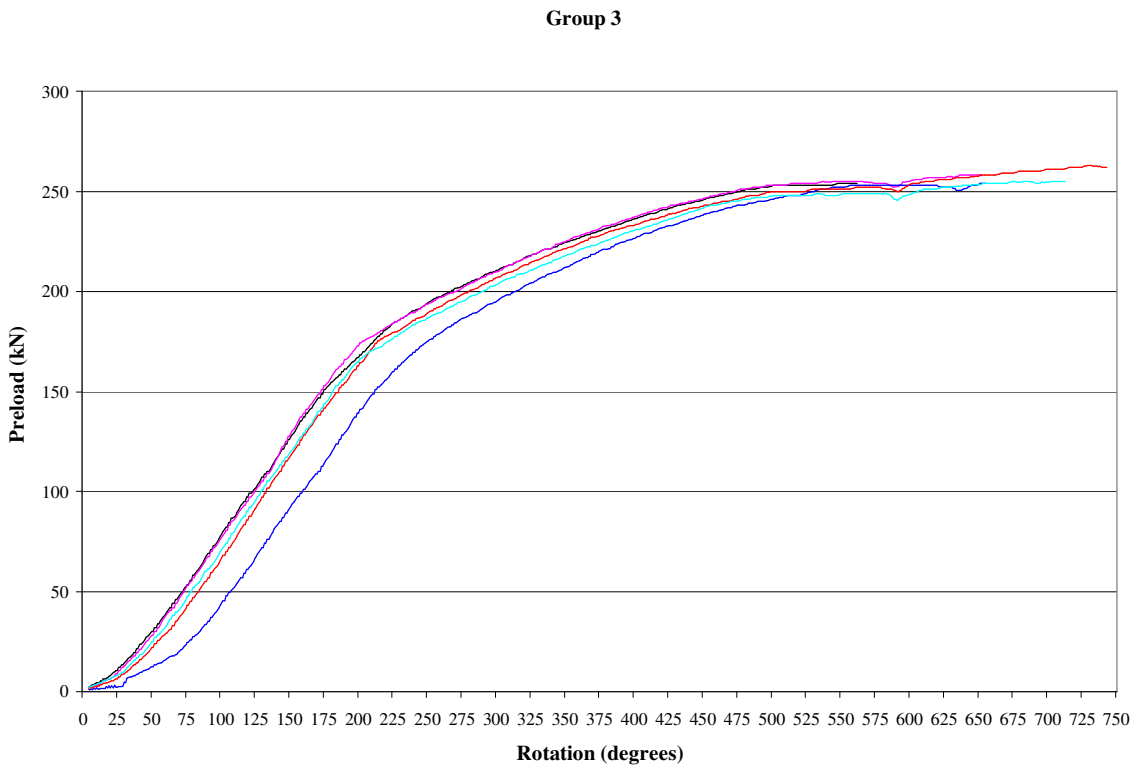
3.3.1 The following table of data summarizes the results for the third test condition.

Group 3

Nr	*Θpi*	*Θ1i*	Fbi max	*Θ2i*	*Fbi Θ2i*
1	287	558*	254*	558*	254*
2	330	651*	254*	651*	254*
3	287	649*	258*	649*	258*
4	308	709*	255*	709*	255*
5	298	726	263	739	262

Note: Asterisks (*) indicate that peak bolt preload coincided with maximum angle at end of test. The end of test was preset as 270 degrees rotation beyond attainment of minimum preload for sample 1, was increased to 320 degrees for sample 2, to 360 degrees for sample 3, 400 degrees for sample 4, and 440 degrees for sample 5.

3.3.2 The following graph depicts the relationship between the angle of rotation and the preload attained during the testing of each sample in Group 3.



3.4 **Test Condition 4 —** The fourth series of tests were performed on 5 samples of M24 structural bolts, nuts, and DTIs. No washers were used, and the nuts were turned directly against the protrusions on the DTIs.

3.4.1 The following two tables of data summarize the results for the third test condition.

Group 4

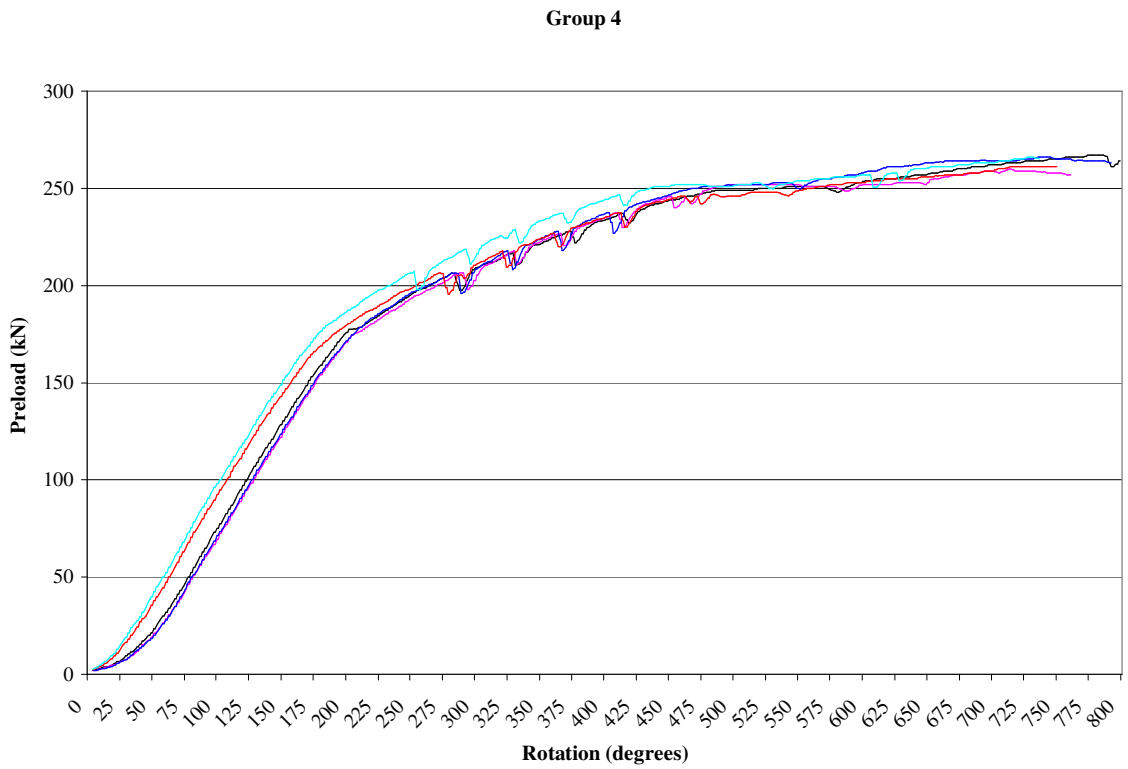
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
207kN	0.400mm	1	1	1	3	2
(0.010")	0.250mm	6	6	6	5	6
(0.005")	0.125mm	6	6	6	6	6
217kN	0.400mm	0	0	2	0	0
	0.250mm	2	3	4	4	3
(0.005")	0.125mm	6	6	6	6	6
227kN	0.400mm	0	0	0	0	0
	0.250mm	0	0	3	3	3
(0.005")	0.125mm	3	6	5	4	4
237kN	0.400mm	0	0	0	0	0
	0.250mm	0	0	2	0	1
(0.005")	0.125mm	2	1	4	4	3
247kN	0.400mm	--	--	0	0	0
	0.250mm	--	--	0	0	0
	0.125mm	--	--	2	3	1
257kN	0.400mm	---	---	---	0	---
	0.250mm	---	---	---	0	---
	0.125mm	---	---	---	0	---

* Nut-face hardened washers were NOT used during these tests.

Group 4

Nr	*Θpi*	*Θ1i*	Fbi max	*Θ2i*	*Fbi Θ2i*
1	281	772	267	795	264
2	281	733	266	788	263
3	288	691	259	757	257
4	250	725	266	733	265
5	272	711	261	746	261

3.4.2 The following graph depicts the relationship between the angle of rotation and the preload attained during the testing of each sample in Group 4.



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