

2. Torque Investigation

To determine the rotational torque characteristics of each variation of the High Torque Fastener Systems formed helix and mating fastener.

Test Procedure

As shown in figure 1 below, a 40mm square plate with the High Torque helix formed in the centre was clamped horizontally in a vice; a washer (minimum thickness matching the sample plate) was inserted onto the fastener, prior to the fastener being engaged into the sample plate, stopping the head of the fastener from coming into contact with the rear of the square plate during the test.

The matching fastener (heat treated to grade 8.8) was engaged into the formed helix and tightened using a proto-dial torque wrench equipped with slave pointer to record the maximum torque level when tightened. In each batch of samples tested, the maximum torque reached was recorded, with 50 samples tested for each size.

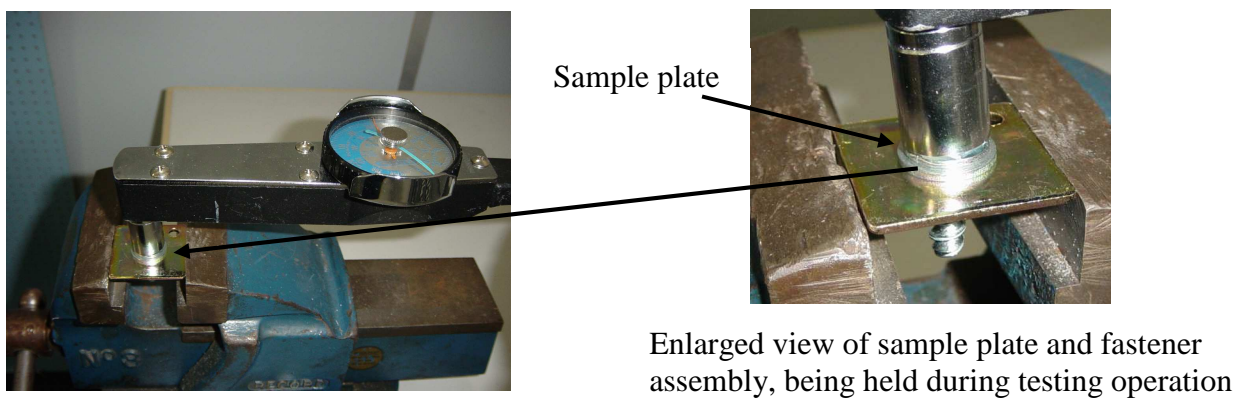


Figure 1 Destructive tightening torque setup

Results

Thickness	Diameter	Newton / Meters (Nm)				Lbs ft				Lbs in			
		Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
0.7 / 0.8	3.5	1.9	2.4	2.16	0.15	1.4	1.77	1.60	0.11	16.82	21.24	19.15	1.32
	4	2.2	3	2.53	0.17	1.62	2.21	1.86	0.12	19.47	26.55	22.36	1.46
	5	2.4	3.4	2.94	0.24	1.77	2.51	2.17	0.18	21.24	30.09	26.06	2.15
	6	3.8	6.2	4.43	0.46	2.80	4.57	3.27	0.34	33.63	54.87	39.23	4.10
0.9 / 1.0	4	2.5	3.4	2.93	0.25	1.84	2.51	2.16	0.19	22.13	30.09	25.93	2.25
	5	3	4.6	3.91	0.29	2.21	3.39	2.88	0.21	26.55	40.71	34.59	2.58
	6	6.1	8.2	7.10	0.4	4.5	6.05	5.24	0.30	53.99	72.58	62.84	3.54
	8	8.9	10.2	9.68	0.26	6.56	7.52	7.14	0.19	76.77	90.28	85.71	2.26
1.1 / 1.2	6	4.5	6.2	5.60	0.34	3.32	4.57	4.13	0.25	39.83	54.87	49.53	2.99
1.5 / 1.6	6	8.75	11.5	10	0.71	6.45	8.48	7.43	0.52	77.44	101.78	89.22	6.27
	8	15	19.5	16.95	0.90	11.06	14.38	12.50	0.67	132.76	172.59	150.02	8.01
1.9 / 2.0	8	25.5	29	27.46	0.71	18.81	21.39	20.25	0.52	225.69	256.67	243.02	6.29
	10	38	39	38.62	0.46	28.03	28.76	28.48	0.34	336.33	345.18	341.82	4.10

Table 1 Torque to failure results

Table 1 summarises all the destructive tightening torque results for the sizes tested. In all cases the mode of failure was the deformation of the plate "helix" as the material was pulled inwards by the tightening of the fastener.

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Table 2 shows the standard deviation for all 50 samples tested for each size. The standard deviation is a useful value; because we can then say that statistically, there is a 99.7% probability of the failure occurring within 3 standard deviations of the mean value i.e. 99.7% probability of failure occurring within the range, mean $\pm 3\sigma$.

Thickness	Diameter	Mean $\pm 3\sigma$ (Nm)
0.7 / 0.8	3.5	2.16 \pm 0.45
	4	2.53 \pm 0.51
	5	2.94 \pm 0.72
	6	4.43 \pm 1.38
0.9 / 1.0	4	2.93 \pm 0.75
	5	3.91 \pm 0.97
	6	7.10 \pm 1.20
	8	9.68 \pm 0.78
1.1 / 1.2	6	5.60 \pm 1.02
1.5 / 1.6	6	10 \pm 2.13
	8	16.9 \pm 2.7
1.9 / 2.0	8	27.5 \pm 2.13
	10	38.6 \pm 1.38

Table 2 Destructive torque probability table

Conclusions

When compared to existing fastening designs which incorporate a single thread engagement (SMS – sheet metal screws etc.), the characteristics of High Torque Fastener Systems design has major benefits.

The controlled forming operation of High Torque Fastener Systems helix allows the formed sheet material to accurately match the profile of the core of the fastener giving improved engagement properties between the two halves of the assembly (sheet material and fastener), resulting in higher than expected torque values.