

1. Pull-Out Load

To determine the pull out load that the High Torque Fastener Systems product can withstand.

Test Procedure

Various size sample plates and fasteners were tested using the Hounsfield tensile testing machine and a custom-designed holding jig. As shown below (Figure 1) a 40mm square sample plate was inserted into the retaining block and held in position via the retaining plate, the corresponding fastener for the sample plate was inserted into the holder and held in position.

The assembly was inserted into the Hounsfield testing machine and held in position via retaining pins; force was applied along the centre axis of the fastener until the fastener or formed helix deformed, with the results recorded. 50 samples were tested for each size variation.

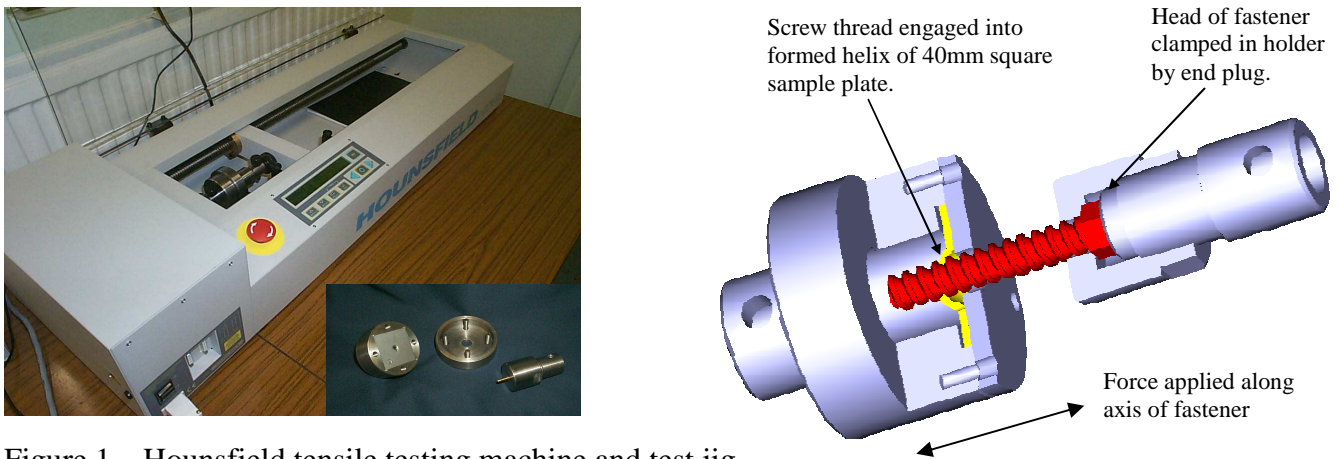


Figure 1 – Hounsfield tensile testing machine and test jig.

Results

Thickness	Diameter	Newtons				Lbs Force			
		Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
0.5 / 0.6	3	420	513	455	23.1	94	115	102	5.2
0.7 / 0.8	4	827	1112	933	54.5	186	250	210	12.3
	5	1017	1121	1075	21.5	229	252	242	4.8
	6	983	1277	1078	48.8	221	287	242	10.9
0.9 / 1.0	4	1000	1166	1100	35	225	262	247	7.9
	5	1491	1804	1647	63.4	335	406	370	14.3
	6	2108	2182	2134	19.3	474	491	480	4.3
	8	3124	3356	3232	55.8	702	754	709	12.5
1.1 / 1.2	5	1899	2323	2193	87.2	427	522	493	19.6
	6	3012	3362	3156	85.9	677	756	709	19.3
1.5 / 1.6	6	3860	5218	4503	300	868	1173	1012	67
	8	4659	7094	6141	590	1047	1595	1381	132.7
1.9 / 2.0	8	9057	10015	9648	240	2036	2251	2168	54
	10	13509	13952	13750	117	3037	3137	3091	26.4

Table 1 Pull Out test results

Table 1 summarises the pull out load results with the force measured in both Newton's and Pounds Force.

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Table 2 below shows the standard deviation for all 50 samples tested for each size. The standard deviation is a useful value; because we can say that statistically, there is a 99.7% probability of the pull-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 $\pm 3\sigma$ (Newtons)
0.5 / 0.6	3	455 \pm 69
0.7 / 0.8	4	933 \pm 164
	5	1075 \pm 64
	6	1078 \pm 147
0.9 / 1.0	4	1100 \pm 104
	5	1647 \pm 190
	6	2134 \pm 58
	8	3232 \pm 167
1.1 / 1.2	5	2193 \pm 261
	6	3156 \pm 258
1.5 / 1.6	6	4503 \pm 900
	8	6141 \pm 1770
1.9 / 2.0	8	9648 \pm 720
	10	13750 \pm 351

Table 2 Pull-Out probability

The failure mode in all cases appeared to be the deformation of the helical form in the plate at the point of contact with the screw thread. It was noted that the load would rise until the initial point of failure, which was accompanied by a sudden drop in load as the screw thread pulled free of the plate.

However, for some sizes the load would again rise as the thread of the fastener made a second point of contact with the formed helix in the sample plate until, once again, the screw thread pulled clear. Clearly it is this first failure point for which the loads above have been reported, since it is considered that this point constitutes failure.

Conclusions

During testing it was noted that the amount of force required to pull the fastener through the formed helix was higher than expected. This investigation into has concluded that with the varying amount of material that is displaced from the external to internal points of the helix causes the force to be dissipated at varying degrees around its parameter giving a larger supporting area. Unlike conventional nut inserts where the supporting material is spread evenly around the fastener axis resulting in a substantially reduced supporting area.