



Applications Laboratory Testing Report

**Performance Evaluation of DELTA PT® 40 in
P9-30FG K141 Test Bosses**



Project Number: 12025

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Introduction

The ATF, Inc. Applications Lab, on behalf of Asahi Kasei, initiated project number 12025 to evaluate the performance of a DELTA PT[®] in plastic P9-30FG K141 test bosses. Drive and strip torque tests were conducted to determine tightening torques. Pull-out tests were conducted to determine maximum axial loading of the joints. Repeat assembly tests were performed to evaluate the long term performance of the joint after several installations. Clamp load tests were conducted to determine retention of clamp load.

Testing Summary

Screws

DELTA 40 X 19 TORX[®] ROUND WASHER HEAD – DELTA PT[®] THREAD

- Size: 4.00 mm diameter; 18.00 mm length
- Head Style: Round Washer Head
- Drive Style: TORX[®]
- Material: 1022 Steel, Neutral hardened to RC 33-39



Application

P9-30FG K141 Plastic

- Thread Engagement: 8.00 mm



Tests Conducted

- Drive Torque
- Strip Torque
- Pull-out
- Repeat Assembly
- Clamp Load

Procedure

TEST PREPARATION

To ensure accuracy, a random sample of fasteners were selected for measurement. The pertinent dimensions of the fasteners include the major thread diameter, overall length and head diameter. Likewise, the application piece bosses were measured to ensure stability for testing. The pertinent boss dimensions include hole diameter and hole depth. All dimensional data can be found in Appendix A.

DRIVE & STRIP TORQUE

Driving torque and stripping torque are important in determining a joint's safety of assembly. Drive and strip torque testing is conducted by driving the fasteners into the pilot holes of each boss with an Atlas Copco electric driver, turning at a free speed of 600 rpm, until the joint fails. The torque is measured continuously throughout the driving process. The measuring apparatus consists of an Atlas Copco Tensor S4/S7 running ToolsTalk PF3000 for data acquisition. The software then collects and translates signals from the transducer into a torque vs. time graph. This graph is interpreted to determine the precise maximum driving and stripping torque.

TIGHTENING TORQUE

The tightening torque is the torque at which it is recommended the application be assembled. The tightening torque should be sufficiently high so as to fully drive the screw and generate clamp load, yet low enough to avoid stripping and long term boss damage. An adequate safety factor to compensate for the repeat accuracy of the driver system must also be considered.

The tightening torque values can be determined through the use of two different methods. The first method gives tightening torque values determined by the arithmetic mean between the statistical maximum driving torque and the statistical minimum stripping torque. The second method gives the result of the tightening torque according to the Bayer recommendation. When there is a sufficient window between maximum driving and minimum stripping torque, the Bayer recommendation is preferred as this places the tightening torque in the first third of the tightening torque range. This is better for long term stability of the screw/boss joint in thermoplastic materials.

Drive and Strip Torque Explanation

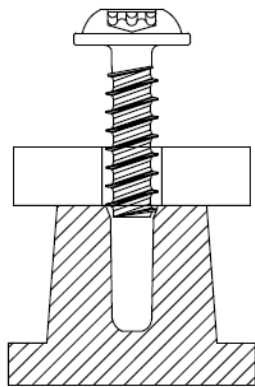
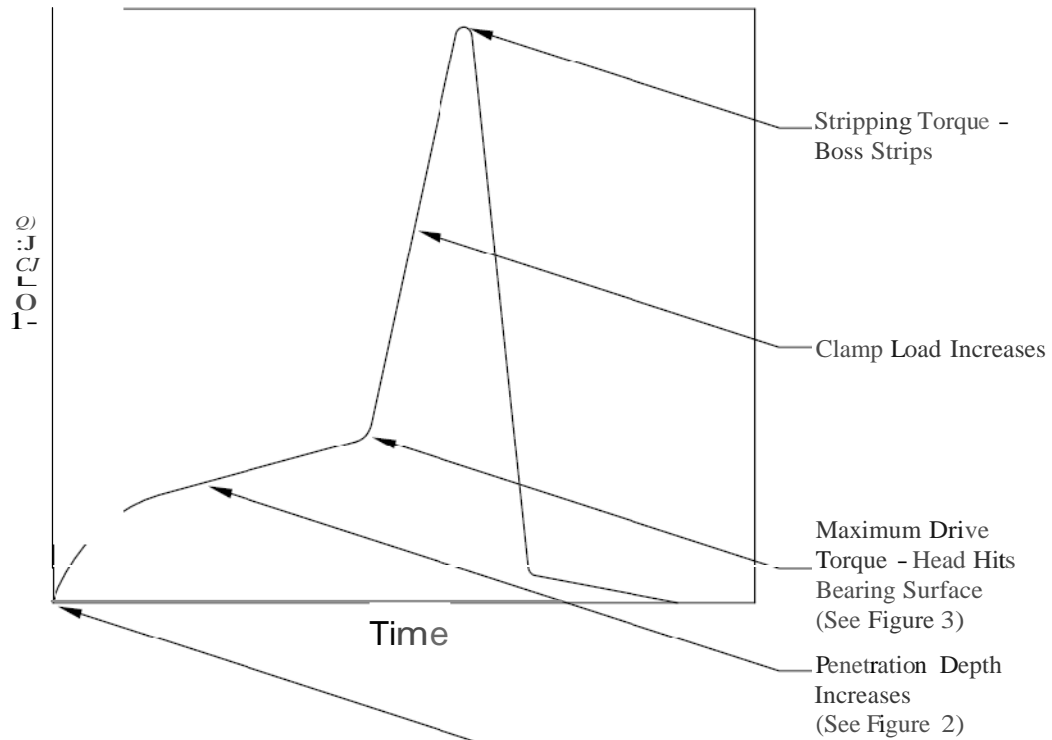


Figure 1

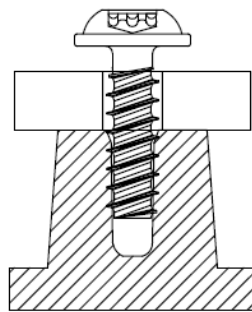


Figure 2

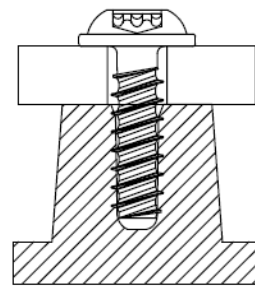


Figure 3

Figure 1: Drive and Strip Torque Explanation

PULL OUT

Pull out testing is used to evaluate the axial strength of a screw joint. Figure 2 illustrates the set up for this series of testing. This set up was placed in a United Tensile Tester Unit LCH-30 and subjected to an axial tensile load until the boss failed. The maximum force exerted on the joint was recorded.

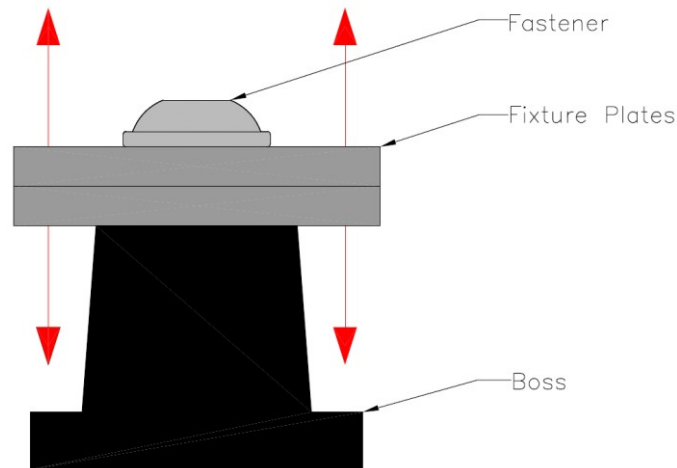


Figure 2: Pull-Out Fixture

BREAK-LOOSE TORQUE

Break-loose torque is conducted by driving the fasteners out of the pilot holes of each boss with an Atlas Copco electric driver, turning at a free speed of 100 rpm, until the fastener is no longer seated. The torque is measured continuously throughout the removal process. The measuring apparatus consists of an Atlas Copco Tensor S4/S7 running ToolsTalk PF3000 for data acquisition. The software then collects and translates signals from the transducer into a torque vs. time graph. This graph is interpreted to determine the precise maximum break-loose torque.

REPEAT ASSEMBLY

Repeat assembly testing is conducted to evaluate the performance of the fasteners after being serviced multiple times. Each fastener is driven into the test boss using an Atlas Copco electric driver, turning at a free speed of 600 RPM. The fastener is tightened to the tightening torque ten times. The Break-loose torque is measured on the first, fifth and tenth assemblies. On the eleventh assembly the fastener is driven until the joint fails due to stripping.

CLAMP LOAD

Clamp load testing is used to evaluate the long term performance of a screw joint. When any kind of stress is placed upon plastic, the plastic responds by relaxing and/or creeping, to relieve the stress. Measuring the loss of clamp load of a joint gives the long term stability and resistance to loosening.

The load is measured continually throughout the relaxing process by a RS-Technologies load cell. The measuring apparatus consists of a Fluke NetDAQ 2645A and a Compaq 686 desktop running Trend Link software. The software collects the signals from the load cell and a graph is created displaying load vs. time. The graph is then interpreted to give the trend of the clamp load. Temperature variation, when needed, occurs in a Tenney Environmental Chamber and is controlled using LinkTenn32 Environmental control software.

P9-30FG-K141

Torque testing

Sample #	Drive Torque [Nm]	Stripping Torque [Nm]	Strip to Drive Ratio
1	0.46	2.38	5.17
2	0.50	2.44	4.88
3	0.47	2.31	4.91
4	0.50	2.47	4.94
5	0.45	2.41	5.36
6	0.48	2.36	4.92
7	0.47	2.30	4.89
8	0.46	2.39	5.20
9	0.44	2.36	5.36
10	0.47	2.46	5.23
Average	0.47	2.39	5.09
3 Maximum	0.53	2.56	5.68
3 Minimum	0.41	2.21	4.50
St. Deviation	0.02	0.06	0.20

$T_t = 0.5 * (T_{dmax} + T_{smin})$
Tt= 1.37

Repeat Assembly Testing

	Sample	Repeat Number		
		1	5	10
Breakloose torque	1	1.17	0.99	0.95
% Retention			85%	81%
Breakloose torque	2	1.1	1.05	1.03
% Retention			95%	94%
Breakloose torque	3	1.18	1.05	0.99
% Retention			89%	84%
Breakloose torque	4	1.09	0.98	0.96
% Retention			90%	88%
Breakloose torque	5	1.13	1.07	1.01
% Retention			95%	89%

Pull-out testing

Sample #	Pull-out Force [kN]
1	2.36
2	2.35
3	2.33
4	2.43
5	2.24
Average	2.34
	2.53
	2.16
St. Deviation	0.06

Clamp load testing

Sample #	Load [N]
1	1130
2	1060
3	948
4	1015
5	997
Average	1030
	1215
	845
St. Deviation	62