TEST REPORT

Button Fix Ltd – Bespoke Clip Testing

CTE-REP-1186

Issue: 1

Date: 01/12/2025

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Issue No	Author	Date	Remarks
1	Krzysztof Lipinski	01/12/2025	1st Issue

DISTRIBUTION LIST

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EXECUTIVE SUMMARY OF RESULTS

(%) Denotes Co-Efficient of Variation

Pull Off Results Summary

Material ID	Test Standard	Condition	Max Load (N)	Max Displacement (mm)
Push-on	Based on AS-22-589-AMRC-RP-231018A	Unaged Tested at RT	545.13 (6.01%)	2.73 (11.91%)
Drop Down			2232.87 (6.92%)	5.12 (16.71%)

Shear Results Summary

Material ID	Test Standard	Condition	Max Load (N)	Max Displacement (mm)
Push-on	Based on AS-22-589-AMRC-RP-231018A	Unaged Tested at RT	4496.24 (4.59%)	7.45 (19.81%)
Drop Down			4986.56 (1.95%)	8.53 (24.95%)

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

This report details the testing of Type 2 COMPACT fastener test assemblies utilising both the push-on and drop-down mounting clips.

The results reported herein only pertain to the materials and specimens tested and no opinion is expressed or implied by CTE as to the suitability of these materials for any particular purpose. Any opinions or interpretations expressed in this report are outside the scope of CTE's UKAS accreditation. Any opinions of CTE in this report have been highlighted in *italics*.

2 DOCUMENTATION & ABBREVIATIONS

2.1 Documentation

BS EN ISO/IEC 17025:2017 General Requirements for the competence of testing and **calibration laboratories**

ISO 7500-1:2018 Metallic materials — Calibration and verification of static uniaxial testing machines Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system

ASTM E4:2024 - Standard Practices for Force Calibration and Verification of Testing Machines

AS-22-589-AMRC-RP-231018A – Button Fix Fastener Testing

CTE-WO-9011- Button Fix - Bespoke Clip Testing - Test Results Spreadsheet Issue 3

2.2 Abbreviations

CoV – Coefficient of Variation
CTE – Composite Test & Evaluation Ltd

3 ACCREDITATION

CTE is a UKAS accredited test laboratory (No. 7583) accredited to BS EN ISO IEC 17025:2017. Our current scope of accreditation doesn't include method detailed in this report.

All non-accredited testing reported herein has been performed to the same level of diligence and professionalism as the tests that are covered under our current scope of accreditation.

4 UNCERTAINTY OF MEASUREMENT

The expanded measurement of uncertainty is less than ±1% on static tests. The reported uncertainty is multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. Uncertainty of measurement follows CTE internal procedure CTE-PI-7.6. Please contact CTE for further information on uncertainty of measurement.

5 MATERIALS

Six of Drop Down and Six of Push-on Type 2 COMPACT test assemblies were provided for testing as part of this test program as detailed below:

Table 1 – Materials Supplied for Testing

Material ID	Abbreviation	Material	Number of Specimens
Push-on	PO	Push-on Type 2 COMPACT test assemblies	6
Drop Down	DD	Drop Down Type 2 COMPACT test assemblies	6

Note: Abbreviations are used in the specimen Identification

6 SPECIMEN MANUFACTURE

6.1 Test Specimen Manufacture

A single 10mm diameter hole was drilled in the centre of each pull-out specimen to attach the test fixture. For shear specimens, six 10mm diameter holes were drilled for the same purpose. Otherwise, the specimens were tested in their original condition.

7 TEST PROGRAMME

7.1 Mechanical Test Equipment

7.1.1 Static Mechanical Testing

CTE performed all static mechanical testing using the test machines and load cells listed below, all load cells have been calibrated to ISO 7500-1 and ASTM E4.

Table 2 – Test Machine Details

Test Machine	Load Cell Range	Serial No.	Calibration Expiry Date
Shimadzu AGS-X Plus	0±100kN	M406901	24th Sept 2026

7.2 Test Conditions

All testing was performed at room temperature (RT) which is defined as 23±3°C and Max 60%RH. This is a deviation from the conditions recommended in ISO and ASTM Standards which typically call for test conditions of 23±2°C and 50±10%RH. It is CTE's technical opinion that testing at the increased temperature range and humidity's below 40%RH has no bearing on the results and therefore we do not define a lower humidity limit.

7.3 Static Mechanical Test Methods

The following static tests were performed as required by the Test Plan. All testing was performed in accordance with relevant methods detailed below. During testing the load and crosshead displacement was recorded continuously throughout the test. Videos of the testing were recorded and can be provided separately upon request.

7.3.1 Pull Off Test

All testing was conducted utilizing equipment and methodologies consistent with those specified in AS-22-589-AMRC-RP-231018A.

Testing was performed at a constant crosshead speed of 0.25mm/min.

The recorded parameters consist of maximum load and displacement values. Furthermore, both the load and extension at the point of first failure have also been documented. The First Failure Load is the maximum force recorded on the load-displacement curve before the first discontinuous load drop. It signifies the limit of elastic performance or the initiation of structural compromise, representing the load level at which the specimen incurs its first permanent, non-recoverable damage. It is more conservative estimation of the material strength.

7.3.2 Shear Test

All testing was conducted utilizing equipment and methodologies consistent with those specified in AS-22-589-AMRC-RP-231018A.

Testing was performed at a constant crosshead speed of 0.25mm/min

The recorded parameters consist of maximum load and displacement values. Furthermore, both the load and extension at the point of first failure have also been documented. The First Failure Load is the maximum force recorded on the load-displacement curve before the first discontinuous load drop. It signifies the limit of elastic performance or the initiation of structural compromise, representing the load level at which the specimen incurs its first permanent, non-recoverable damage. It is more conservative estimation of the material strength.

The initial test was carried out on a setup lacking sufficient stiffness. Following this, the setup was modified to resolve the issue. The specimen used in the first test was then retested with the improved setup.

8 DISCUSSION

- Graphical representations of the test results can be found in the figures of Appendix A.
- Tables of individual test results can be found in tables of Appendix B.
- Examples of the failure modes observed can be found in Appendix C.
- Photographs of the test setups can be found in Appendix D.

8.1 Pull Off Test

Tables B1 and B2 present the pull-off results obtained from push-on and drop-down specimens, respectively. Graphical representations of these results are provided in Figure A1. Figures A3 and A4 illustrate the load-displacement curves for the push-on and drop-down specimens. Examples of observed failure modes are shown in Figures C1 and C2, with the test setup depicted in Figure D1.

Push-on specimens achieved an average maximum load of 545.13N, accompanied by a moderate coefficient of variation (CoV) of 6.01%. The average displacement at this load was recorded as 2.73mm, with a higher CoV of 11.91%. Importantly, no load drop occurred prior to reaching the maximum load.

Drop-down specimens exhibited an average maximum load of 2232.87N, with a moderate CoV of 6.92%. The corresponding displacement averaged 5.12mm, reflecting an increased CoV of 16.71%. For specimens DD-POUR-A-2 and DD-POUR-A-3, inflection points—potentially associated with initial failure—were identified. The average load at first failure for this group was 2149.89N, with a CoV of 6.08%, occurring at an extension of 4.70mm and a CoV of 14.19%. However, neither specimen DD-POUR-A-2 nor DD-POUR-A-3 exhibited a clear load drop; for DD-POUR-A-2, there is even less evidence of such an event.

Regardless of how the inflection points on the load-displacement graphs for drop-down specimens are interpreted, these specimens required substantially greater pull-off force for unclipping. It is also noteworthy that most specimens did not exhibit visible damage. The exception was specimen DD-POUR-A-3, in which one of the battens cracked during testing, depicted in Figure C3. This observation suggests that the interface between the grain structure of the wooden batten and the screw may be a significant source of variability in test outcomes.

8.2 Shear Test

Tables B3 and B4 present the shear results obtained from push-on and drop-down specimens, respectively, with graphical data illustrated in Figure A2. Figures A5 and A6 display the load-displacement curves for the push-on and drop-down tests. Representative failure modes are depicted in Figures C4 and C5, while Figures D2 and D3 show the initial and modified test setups, respectively.

The average maximum shear load recorded for push-on specimens was 4496.24N, accompanied by a satisfactory coefficient of variation (CoV) of 4.59%. The corresponding displacement at this load was 7.45 mm, although the CoV was relatively high at 19.81%. It should be noted that the average does not include results from tests conducted using the initial setup, as these yielded significantly lower values that may not accurately represent the material's performance. No visible damage was observed in these initial tests; consequently, the specimen was reassembled and retested, resulting in higher maximum loads consistent with other specimens. Notably, specimen PO-SHUR-A-3 exhibited a significant load drop prior to reaching the ultimate load. Considering this, the average load at first failure was 4400.73N with a low CoV of 1.62%, occurring at a displacement of 6.29mm and a CoV of 17.03%. Post-test examinations revealed that all screws securing the batten were angled, likely due to either screw bending or movement within the batten. This again point to screw batten interface as source of variation.

Drop-down specimens demonstrated a maximum load of 4986.56N with a low CoV of 1.95% at a displacement of 8.53mm, albeit with a high CoV of 24.95%. Specimen DD-SHUR-A-3 showed a clear

load drop before achieving maximum load, with multiple drops observed overall. Subsequent inspection indicated that one screw may have been pulled out of the batten, accounting for the load drops detected. The image of it can be found in Figure C6. Adjusting for this result, the load at first failure was 4706.93N with a moderate CoV of 8.75%, corresponding to a displacement of 6.89mm with a CoV of 11.96%. Failure in this batch was attributed to fixing cracking, which was destructive to the fixing itself. It was also noted that, similar to the push-on specimens, the screws in the drop-down specimens were found to be angled.

Comparison of the results for push-on and drop-down specimens indicates that the latter exhibit noticeably higher ultimate strength. However, the difference is less pronounced than that observed in the pull-off tests.

APPENDIX A – GRAPHICAL REPRESENTATIONS

Figure A1 –Pull Off Strength

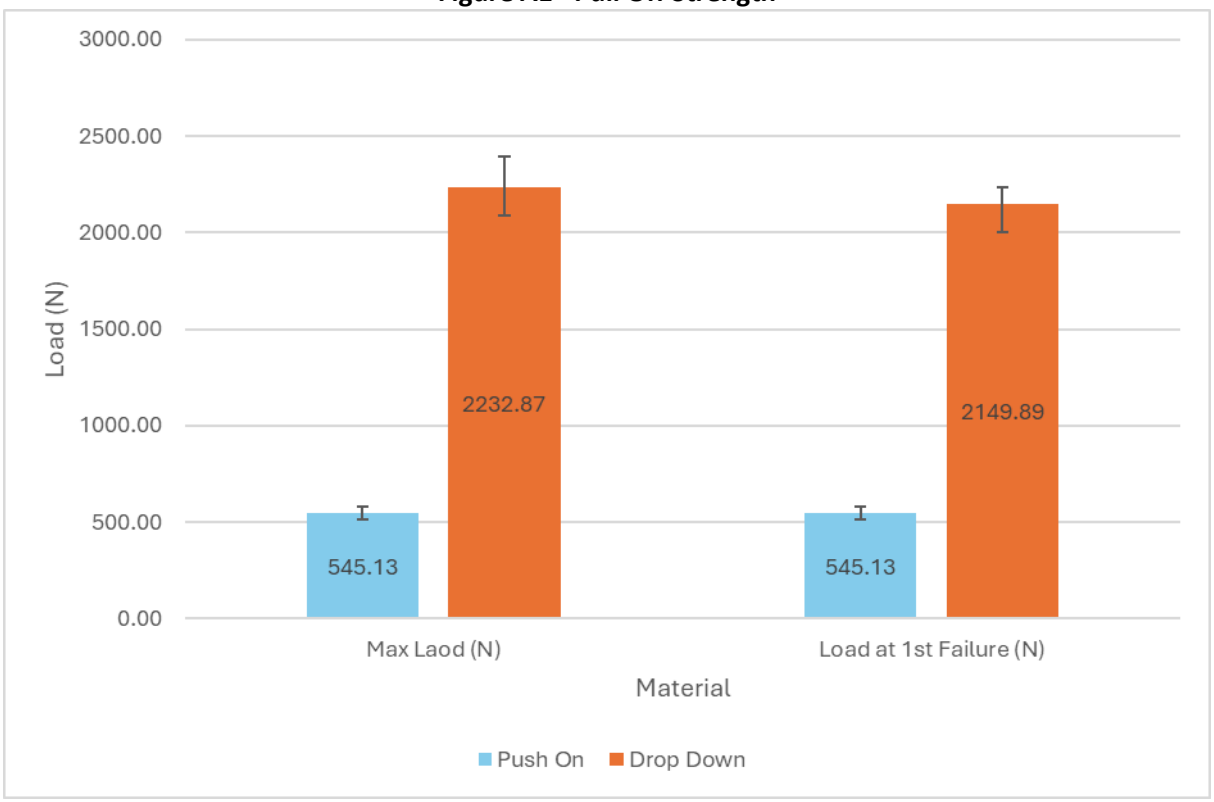


Figure A2 – Shear Test

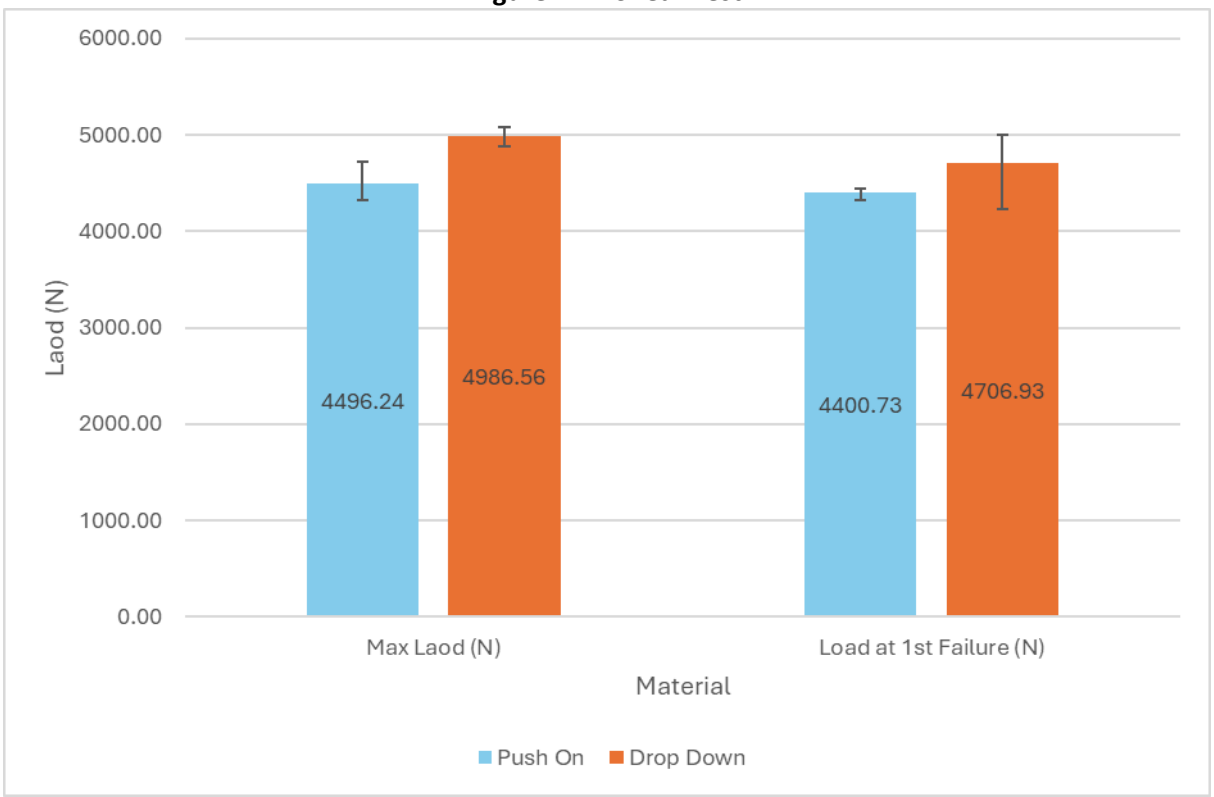


Figure A3 – Push-on Fixing Pull Off Graphs

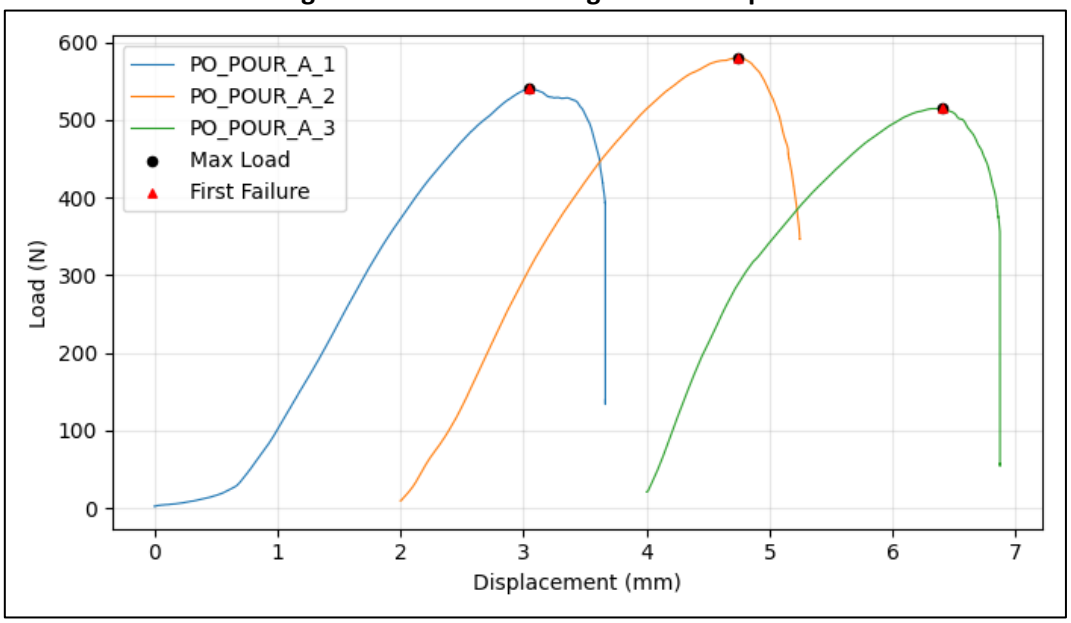


Figure A4 – Drop Down Fixing Pull Off Graphs

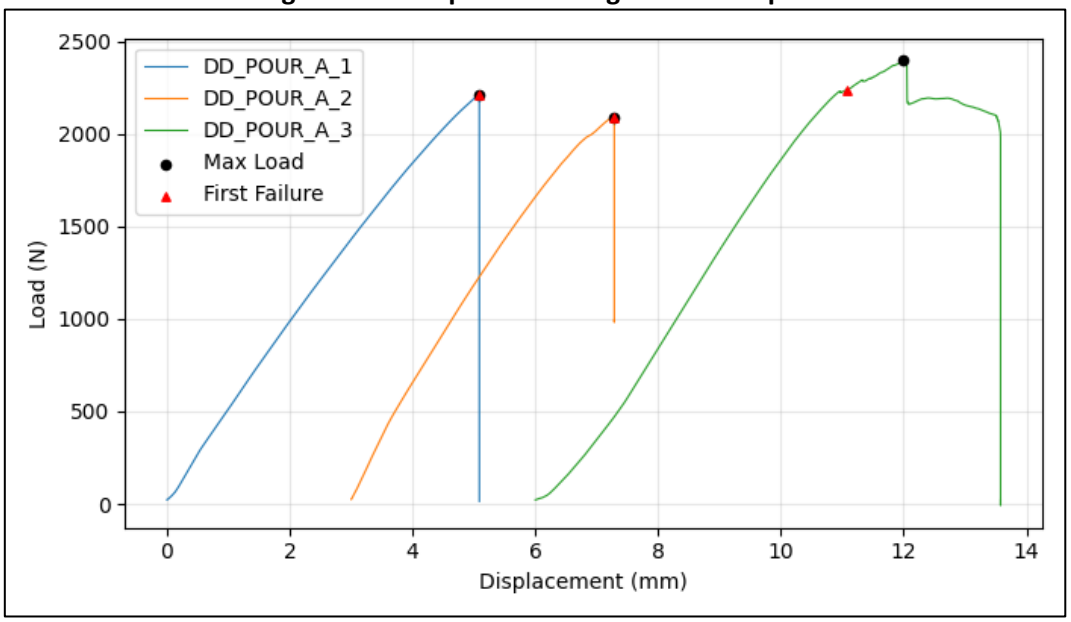


Figure A5 – Push-on Fixing Shear Graphs

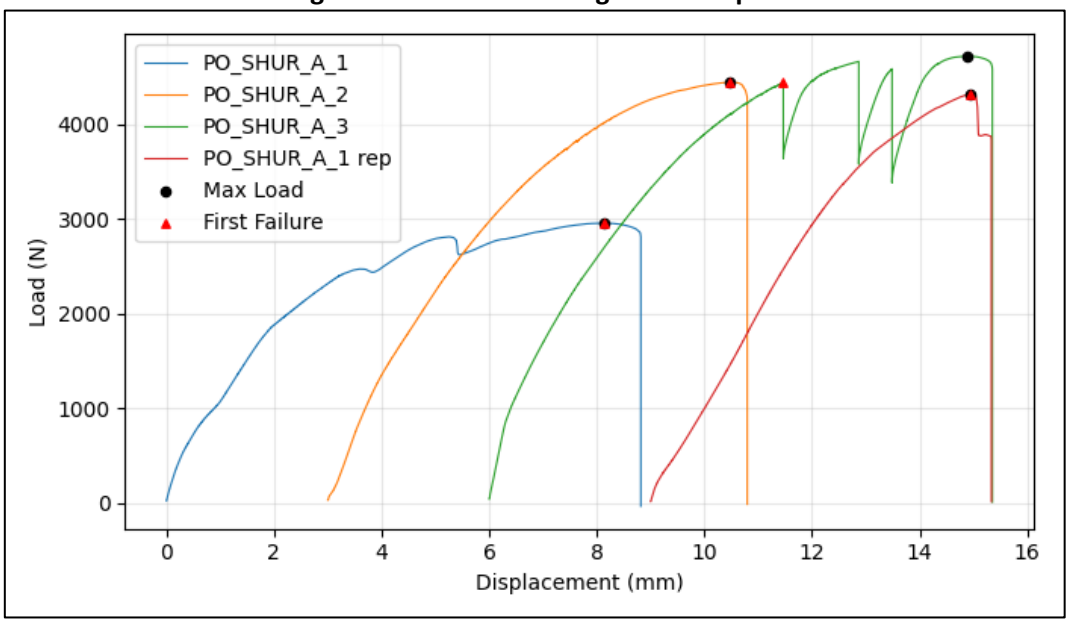
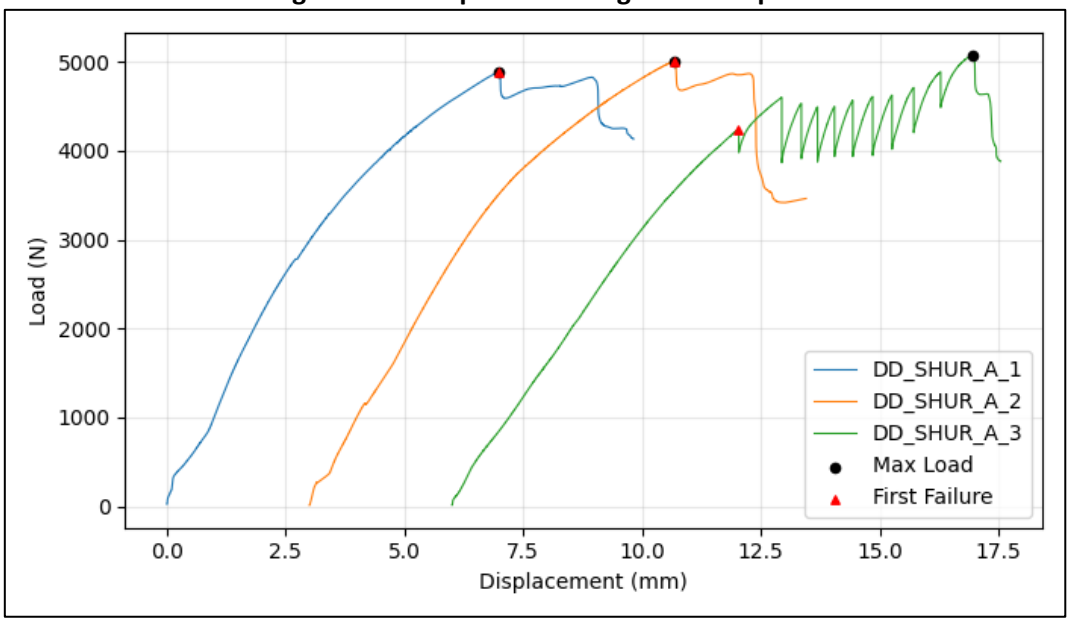


Figure A6 – Drop Down Fixing Shear Graphs



APPENDIX B – RESULTS TABLES

Table B1 –Push-on Fixing Pull Off Results

CTE Specimen ID	Load at 1st Failure (N) (1st Load Drop)	Max Load (N)	Displacement 1st Failure (mm) (1st Load Drop)	Max Displacement (mm)	Failure Mode	Notes
PO-POUR-A-1	540.40	540.40	3.05	3.05	Unclip	
PO-POUR-A-2	579.99	579.99	2.74	2.74	Unclip	
PO-POUR-A-3	515.00	515.00	2.40	2.40	Unclip	
Average	**545.13**	**545.13**	**2.73**	**2.73**	**Date**	**07/11/2025**
St. Dev.	**32.75**	**32.75**	**0.33**	**0.33**	**Temp**	**22.0 °C**
C of V (%)	**6.01**	**6.01**	**11.91**	**11.91**	**Humidity**	**52.5 %RH**
Min	**515.00**	**515.00**	**2.40**	**2.40**	**Test Speed**	**0.25 mm/min**
Max	**579.99**	**579.99**	**3.05**	**3.05**	**Operator**	**K Lipinski**
+ve	**34.86**	**34.86**	**0.32**	**0.32**	**Test Machine**	**Shimadzu 100kN A**
-ve	**30.13**	**30.13**	**0.33**	**0.33**	**Filename:**	**CTE38253**

Table B2 –Drop Down Fixing Pull Off Results

CTE Specimen ID	Load at 1st Failure (N) (1st Load Drop)	Max Load (N)	Displacement 1st Failure (mm) (1st Load Drop)	Max Displacement (mm)	Failure Mode	Notes
DD-POUR-A-1	2213.61	2213.61	5.09	5.09	Unclip	
DD-POUR-A-2	1999.55	2088.99	3.93	4.28	Unclip	
DD-POUR-A-3	2236.51	2396.01	5.08	5.99	Unclip + Batten Crack	
Average	**2149.89**	**2232.87**	**4.70**	**5.12**	**Date**	**07/11/2025**
St. Dev.	**130.70**	**154.41**	**0.67**	**0.86**	**Temp**	**22.2 °C**
C of V (%)	**6.08**	**6.92**	**14.19**	**16.71**	**Humidity**	**55.2 %RH**
Min	**1999.55**	**2088.99**	**3.93**	**4.28**	**Test Speed**	**0.25 mm/min**
Max	**2236.51**	**2396.01**	**5.09**	**5.99**	**Operator**	**K Lipinski**
+ve	**86.62**	**163.14**	**0.39**	**0.87**	**Test Machine**	**Shimadzu 100kN A**
-ve	**150.34**	**143.88**	**0.77**	**0.84**	**Filename:**	**CTE38254**

Table B3 –Push-on Fixing Shear Results

CTE Specimen ID	Load at 1st Failure (N) (1st Load Drop)	Max Load (N)	Displacement 1st Failure (mm) (1st Load Drop)	Max Displacement (mm)	Failure Mode	Notes
PO-SHUR-A-1	*2958.043	*2958.043	*8.15	*8.15	Unclip	Insufficient Setup Stiffness
PO-SHUR-A-2	4447.65	4447.65	7.49	7.49	Unclip + Bend Screw	
PO-SHUR-A-3	4435.94	4722.48	5.43	8.90	Unclip + Bend Screw	
PO-SHUR-A-1 Repeated	4318.59	4318.59	5.95	5.95	Unclip + Bend Screw	
Average	**4400.73**	**4496.24**	**6.29**	**7.45**	**Date**	**11/11/2025**
St. Dev.	**71.37**	**206.29**	**1.07**	**1.48**	**Temp**	**20.8 °C**
C of V (%)	**1.62**	**4.59**	**17.03**	**19.81**	**Humidity**	**54.7 %RH**
Min	**4318.59**	**4318.59**	**5.43**	**5.95**	**Test Speed**	**0.25 mm/min**
Max	**4447.65**	**4722.48**	**7.49**	**8.90**	**Operator**	**K Lipinski**
+ve	**46.93**	**226.24**	**1.20**	**1.45**	**Test Machine**	**Shimadzu 100kN A**
-ve	**82.14**	**177.65**	**0.86**	**1.50**	**Filename:**	**CTE38255**

Table B4 –Push-on Fixing Shear Results

CTE Specimen ID	Load at 1st Failure (N) (1st Load Drop)	Max Load (N)	Displacement 1st Failure (mm) (1st Load Drop)	Max Displacement (kN)	Failure Mode	Notes
DD-SHUR-A-1	4882.46	4882.46	6.98	6.98	Fixing Failure	
DD-SHUR-A-2	5001.78	5001.78	7.66	7.66	Fixing Failure	
DD-SHUR-A-3	4236.56	5075.42	6.02	10.96	Fixing Failure + Screw Pull Out	
Average	**4706.93**	**4986.56**	**6.89**	**8.53**	**Date**	**11/11/2025**
St. Dev.	**411.71**	**97.38**	**0.82**	**2.13**	**Temp**	**24.3 °C**
C of V (%)	**8.75**	**1.95**	**11.96**	**24.95**	**Humidity**	**49.8 %RH**
Min	**4236.56**	**4882.46**	**6.02**	**6.98**	**Test Speed**	**0.25 mm/min**
Max	**5001.78**	**5075.42**	**7.66**	**10.96**	**Operator**	**K Lipinski**
+ve	**294.85**	**88.87**	**0.77**	**2.43**	**Test Machine**	**Shimadzu 100kN A**
-ve	**470.38**	**104.09**	**0.87**	**1.55**	**Filename:**	**CTE38256**

APPENDIX C – FAILURE MODES

Figure C1 – Push-on Fixing Pull Off Failure Modes Example

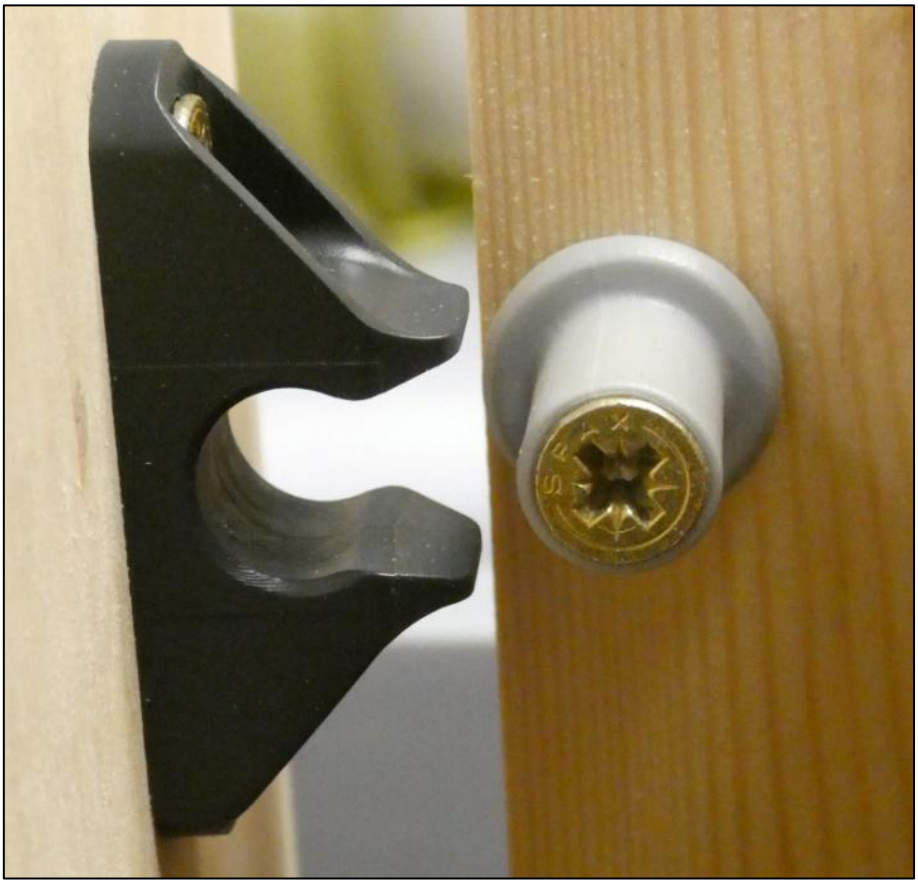


Figure C2 –Drop Down Fixing Pull Off Failure Modes Example

Figure C3 –Drop Down Fixing Pull Off Cracked Batten

Figure C4 – Push-on Fixing Shear Failure Modes Example

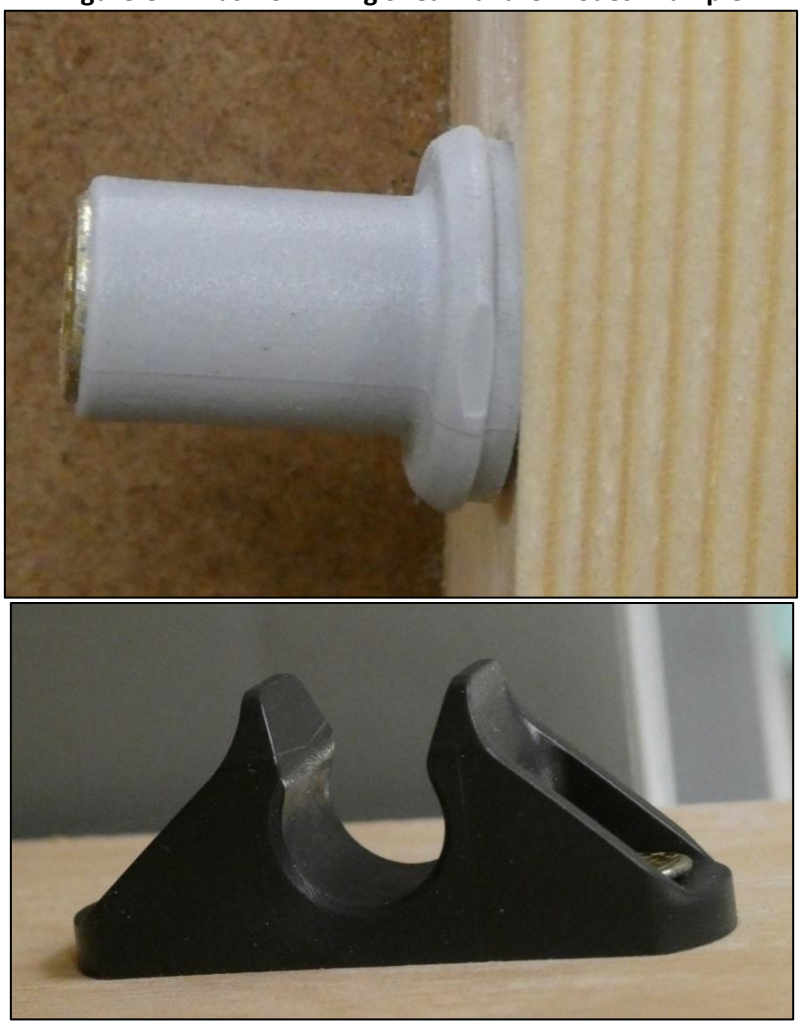


Figure C5 –Drop Down Fixing Shear Failure Modes Example

Figure C6 –Drop Down Fixing Shear Failure Mode Pulled Out Screw

APPENDIX D – TEST SETUP IMAGES

Figure D1 – Pull Off Test Setup

Figure D2 –Shear Initial Test Setup

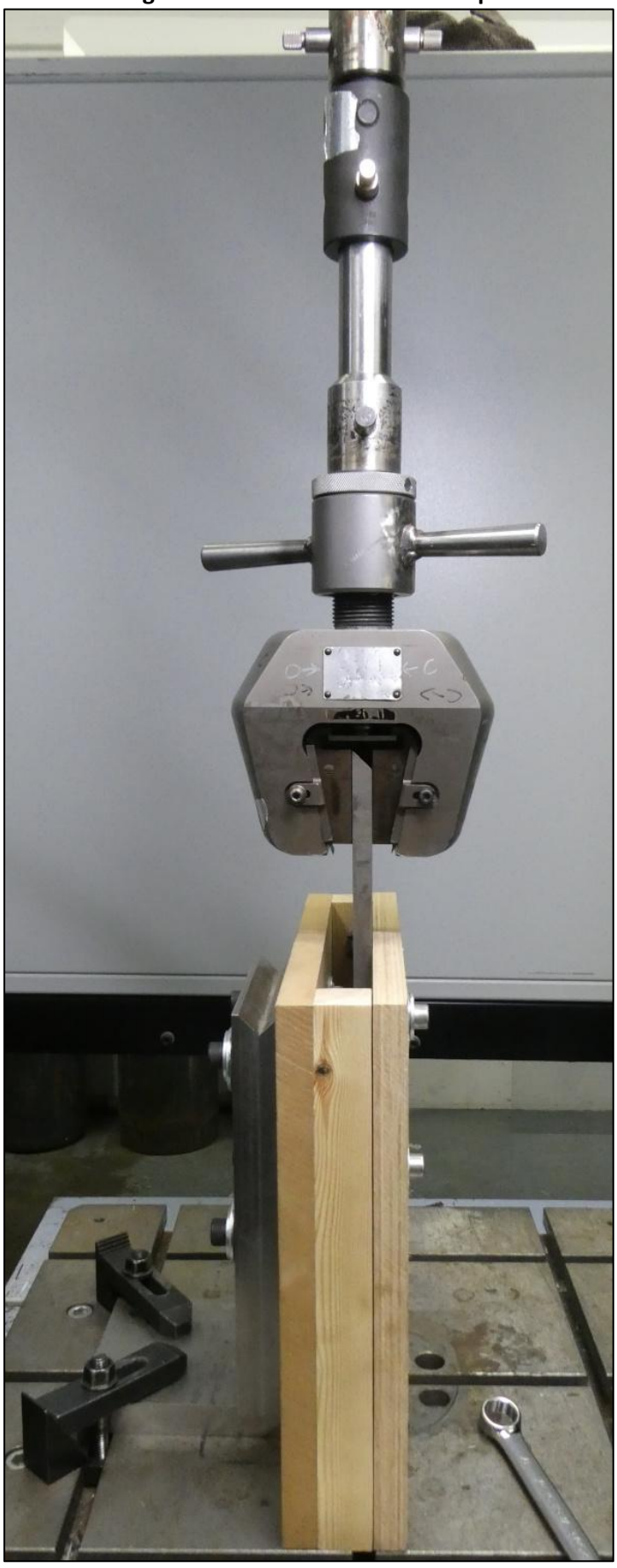


Figure D3 –Shear Modified Test Setup