Adjustable Gutter Bracket Tests

Report for Apex Building Products Pty Ltd

Project Number **SSL-10076**

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EXECUTIVE SUMMARY

The Smart Structures Laboratory (SSL) at Swinburne University of Technology (SUT) is commissioned by Apex Building Products Pty Ltd to carry out compression tests to evaluate the load bearing capacity of adjustable gutter brackets. All the test specimens are supplied by Apex for testing. The scope of the work is limited to:

i. Development of an appropriate testing setup to satisfy the loading and boundary conditions nominated by Apex;

ii. Conducting the tests;

iii. Providing a brief document reporting the test results.

Contents

1 INTRODUCTION

The Smart Structures Laboratory (SSL) at Swinburne University of Technology (SUT) was commissioned by Apex Building Products Pty Ltd to carry out testing on adjustable gutter brackets widely used on commercial buildings and factories. The bracket specimens were provided by Apex in three different sizes from 250 mm to 1000 mm wide. Each bracket, as shown in Figure 1, consists of two (inner and outer) sliding parts with pre-drilled straps. Pre-drilled holes are useful for easy installations. This configuration provides adjustable width depending on the application.

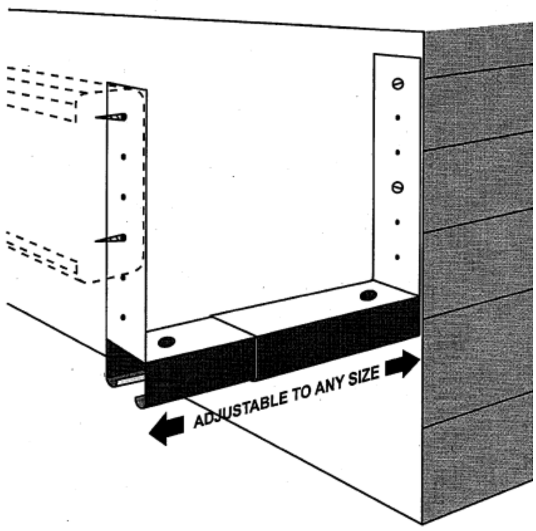

Figure 1. Schematic view of adjustable gutter brackets

The purpose of the tests was to evaluate the load bearing capacity for each type of provided brackets. For this purpose, an MTS 250 kN Dynamic Test Machine was used to conduct the experiments.

2 TEST SETUP

There were three different sizes of brackets:

Size 1: 250 mm – 400 mm wide

Size 2: 400 mm – 650 mm wide

Size 3: 650 mm – 1000 mm wide

A customised adjustable fixture was designed and manufactured at SSL to fit all bracket sizes as shown in Figure 2. This fixture has two vertical sliding parts which can be adjusted to fit the specimen width. The sliding parts were made from parallel flange channel (PFC) to give enough strength and space to secure bracket between them by using appropriate fasteners (bolt and nut).

Figure 2. Test fixture and setup schematic

In order to produce a uniform distributed load over the bracket, to simulate the weight of gutter, PFC was considered, because it is stiffer than the specimens and would distribute the load evenly on top of the bracket. Thus, various lengths for different width of bracket sizes were cut from 75 PFC. This size of PFC also helps to prevent any accidental slippage from brackets without interference with the loading distribution (as it has a clearance gap on either side when it sits over the bracket). A complete assembly of brackets and fixture is shown in Figure 3.

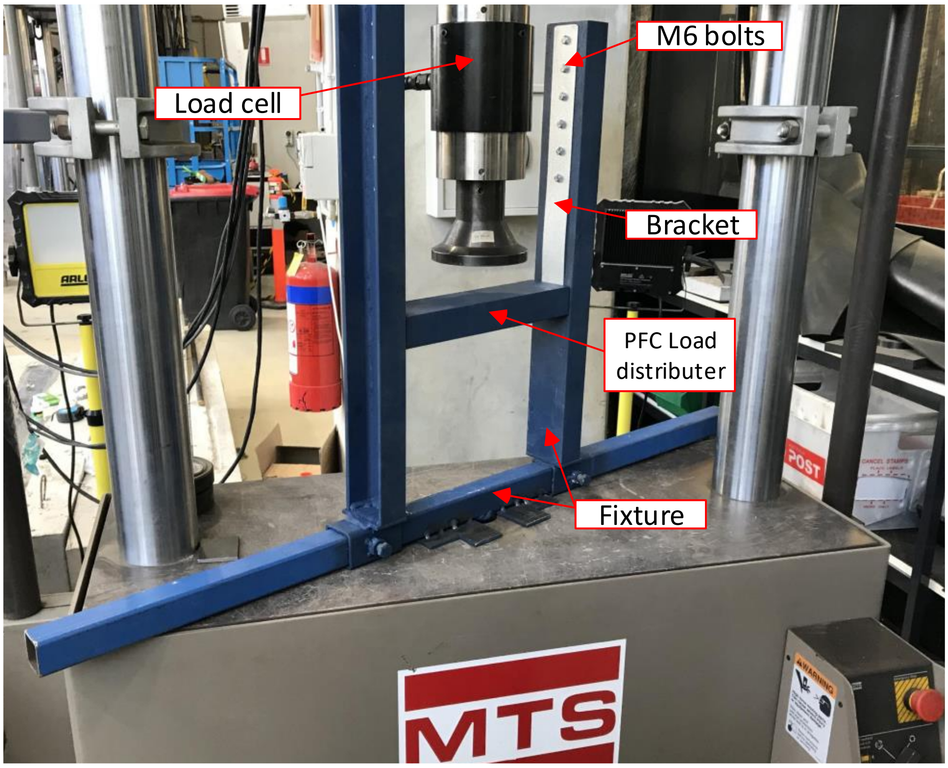

Figure 3. Detailed test setup on MTS 250 kN Dynamic Test Machine

3 TEST PROCEDURE

Three different sizes of brackets, as shown in Figure 4, were tested at the Smart Structures Laboratory. Each bracket was connected to the fabricated fixture using M6 bolts and nuts.

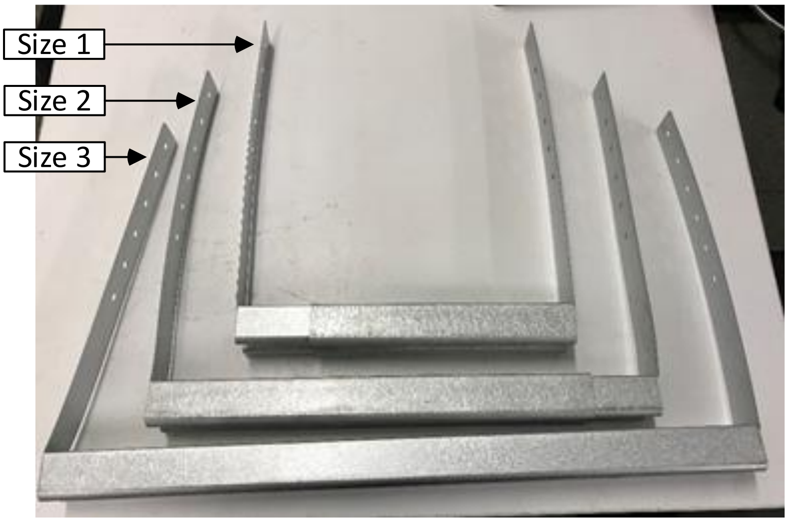

Figure 4. Adjustable Gutter Bracket sizes

For each bracket size, two tests were considered, one when the bracket is fully closed and the other one when the bracket is fully open. By considering three repeat tests for each case, a total number of 18 tests were conducted.

Table 1: Test specifications

Test No	Test label	Bracket size	Bracket width (mm)	No of bolts used per strap	Bolt location in strap holes
1	T01_G1_L290	1	290	6	All
2	T04_G1_L290	1	290	3	Bottom 3
3	T05_G1_L290	1	290	3	Top 3
4	T06_G1_L400	1	400	3	Top 3
5	T07_G1_L400	1	400	3	Top 3
6	T08_G1_L400	1	400	3	Top 3
7	T09_G2_L400	2	400	3	Top 3
8	T10_G2_L400	2	400	3	Top 3
9	T11_G2_L400	2	400	3	Top 3
10	T12_G2_L650	2	650	3	Top 3
11	T13_G2_L650	2	650	3	Top 3
12	T14_G2_L650	2	650	3	Top 3
13	T15_G3_L670	3	670	3	Top 3
14	T16_G3_L670	3	670	3	Top 3
15	T17_G3_L670	3	670	3	Top 3
16	T18_G3_L1000	3	1000	3	Top 3
17	T19_G3_L1000	3	1000	3	Top 3
18	T20_G3_L1000	3	1000	3	Top 3

MTS Basic TestWare Application was utilised to apply displacement control loading. The loading rate was set to 3 mm/min. The data including the deflection and force was recorded at the rate of 10 Hertz by a Data Acquisition System (DAQ).

4 TEST RESULTS

The results obtained from the tests are tabulated in Table 2. The peak load shows the maximum recorded force for each test whilst the average capacity represents the average of three repeat tests for each case. It is worth noting that the weight of the load distributers from 75 PFC used for testing is negligible (5.92 kg/m) compared to the average capacity of gutter bracket, so it is not included in calculations.

Table 2: Test results summary

Test No	Bracket size	Specimen label	Peak load (kN)	Average capacity (kN)	Difference compared to average	Failure mode
1	Size 1	T01_G1_L290	13.3	13.6	-2.2%	Hole break
2		T04_G1_L290	13.2		-2.9%	Hole break
3		T05_G1_L290	14.3		5.1%	Hole break
4		T06_G1_L400	10.6	10.4	1.9%	Hole break
5		T07_G1_L400	10.3		-1.0%	Rivet shear
6		T08_G1_L400	10.4		0.0%	Rivet shear
7	Size 2	T09_G2_L400	12.9	12.0	7.5%	Combined
8		T10_G2_L400	11.9		-0.8%	Rivet shear
9		T11_G2_L400	11.1		-7.5%	Rivet shear
10		T12_G2_L650	12.7	13.0	-2.3%	Rivet shear
11		T13_G2_L650	13.0		0.0%	Rivet shear
12		T14_G2_L650	13.3		2.3%	Rivet shear
13	Size 3	T21_G3_L670	10.0	10.2	-2.0%	Rivet shear
14		T22_G3_L670	9.54		-6.5%	Rivet shear
15		T23_G3_L670	11.0		7.8%	Rivet shear
16		T18_G3_L1000	10.7	10.8	-0.9%	Rivet shear
17		T19_G3_L1000	10.7		-0.9%	Rivet shear
18		T20_G3_L1000	10.9		0.9%	Rivet shear

Test results showed that there are three different mechanism of failure for the tested adjustable gutter brackets i.e. shear failure at riveted joint (Figure 5a), break at two holes (Figure 5b), and combination of these modes (Figure 5c). The relevant failure mechanism for each test is also reported in Table 2.

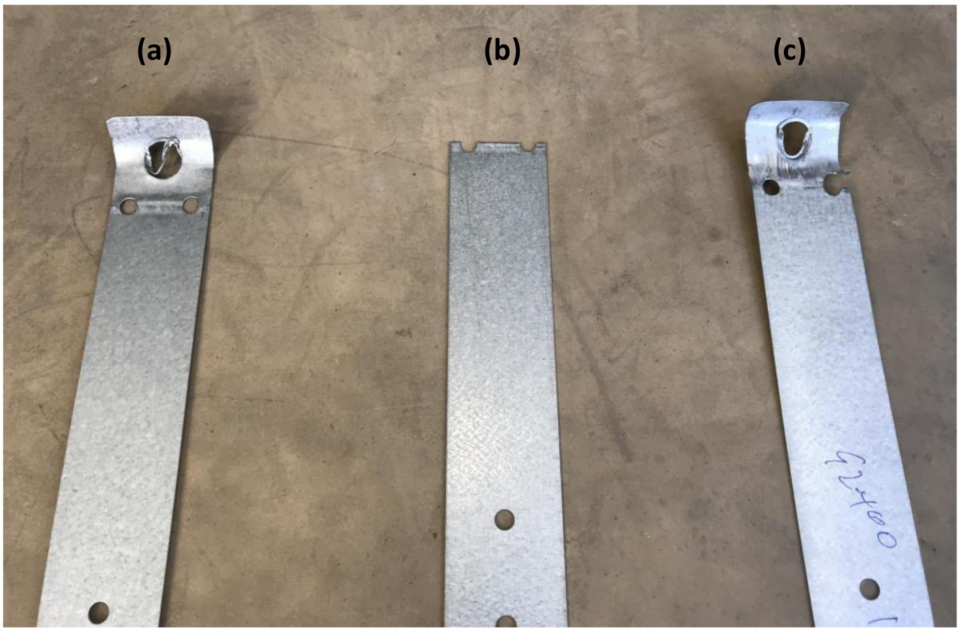

Figure 5. Bracket failure mechanisms

The images shown in Figure 6 demonstrate that the majority of brackets failed on the side where the strap is joined to the outer sliding sleeve (detailed image on the left). However, the interface of the strap to the inner sliding sleeve ripped both edges of the bracket (detailed image on the right) as highlighted in yellow circle.

Figure 6. Detailed failure of brackets

It is also observed that a minimum of three fasteners on each bracket strap is required, otherwise, the holes become distorted as shown in Figure 7.

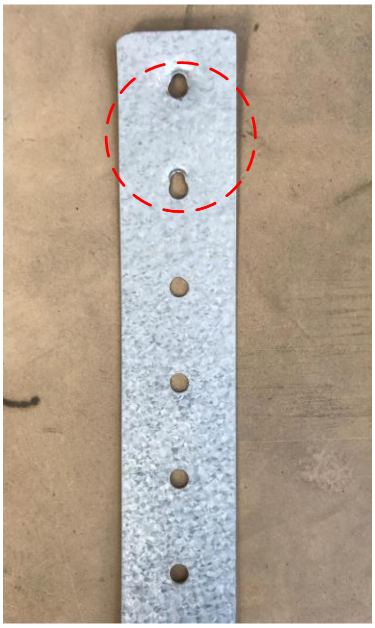

Figure 7. Bearing distortion of strap's holes if only 2 holes out of 6 is fastened

It might also be a point of interest to see the force versus deflection curves for each test. So, the recorded data is plotted in Figure 8 to Figure 10.

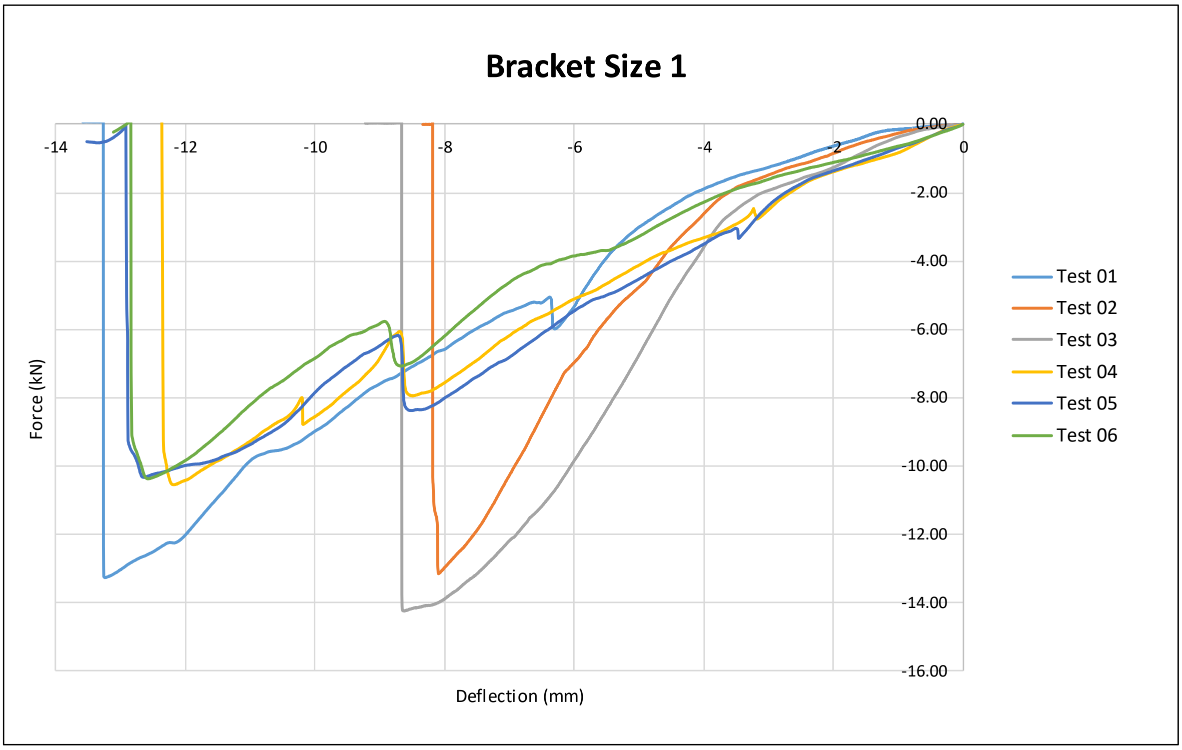

Figure 8. Force vs. Deflection curve for bracket size 1

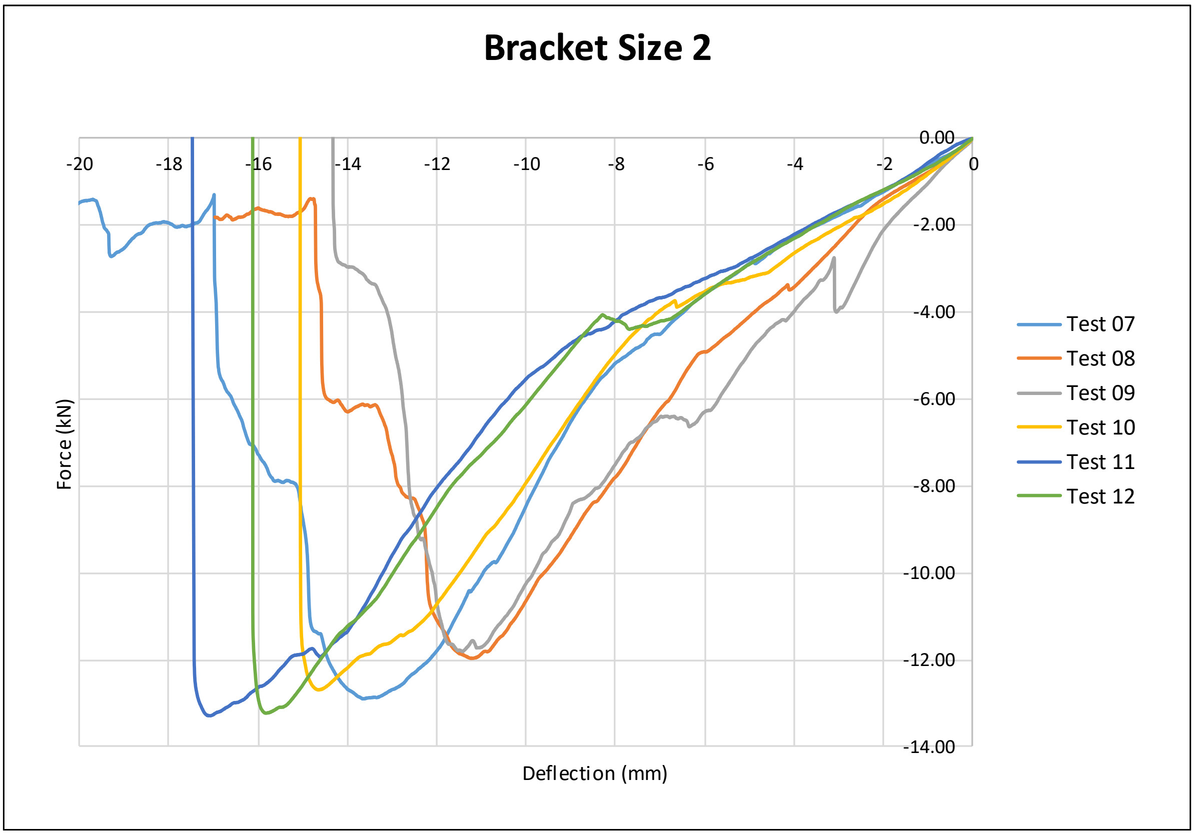

Figure 9. Force vs. Deflection curve for bracket size 2

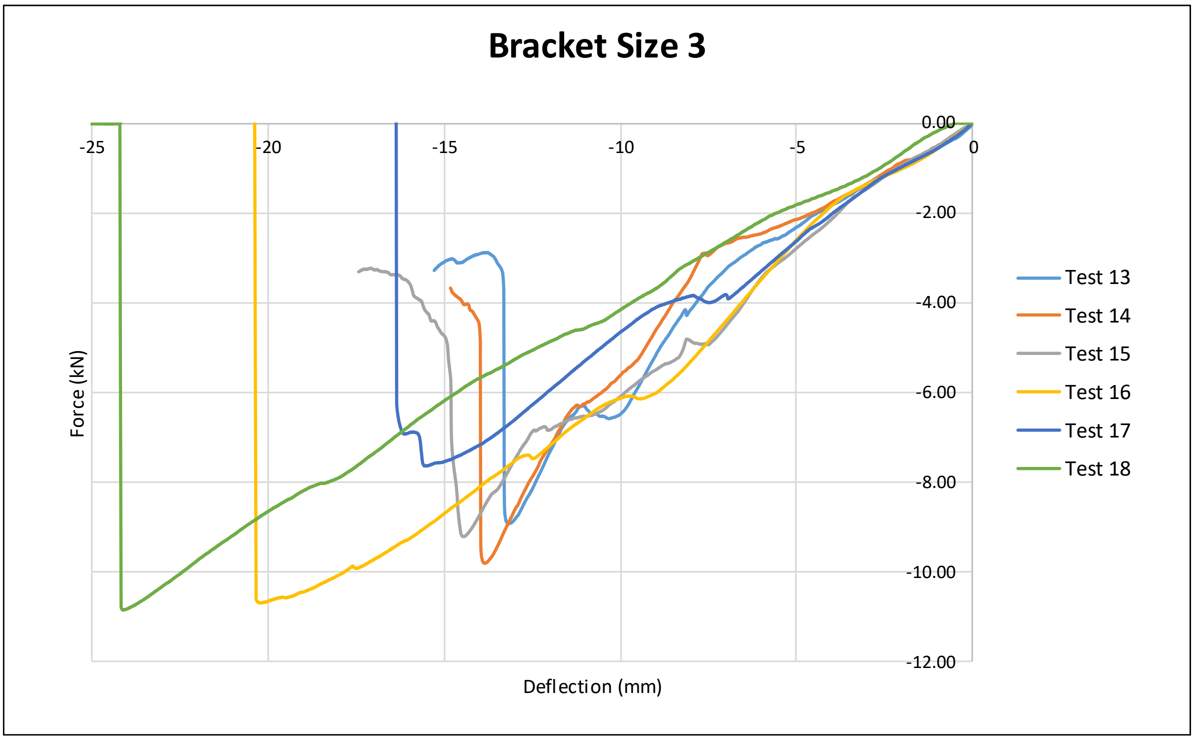

Figure 10. Force vs. Deflection curve for bracket size 3

5 CONCLUDING REMARKS

The results obtained in the tests are reasonably consistent. As expected, size 1 bracket (when it is fully retracted) has the maximum average loading capacity compared to the other bracket sizes. However, when it is at the maximum width opening, it shows less strength than that of the size 3 bracket.

According to the experiments, it is also demonstrated that the load capacity could be 7.5% less than the average calculated value for each case, so a reasonable safety factor is required to be considered for design calculations.

The results also showed that a minimum of three fasteners are required on each bracket's strap. According to the developed failure mechanisms in this test program, the strap interface and rivet quality could be improved in order to get higher capacities for the supplied adjustable gutter brackets.