The Testing of Kingspan K17 Timber Framed Bracing Elements

Introduction

In March 2025, a series of tests were undertaken to assess the performance of Kingspan K17 bracing elements. The bracing elements are lined on one side with nominally 35 mm thick K17. The K17 lining comprises of 25 mm thick phenolic foam laminated to the back face of 10 mm thick GIB® Standard.

Testing and evaluation was carried out in accordance with the procedures given in Shelton (2010).

Test Panels

Two different hold-down arrangements were tested:-

(i) Panels with GIB HandiBrac® hold-downs,
(ii) Panels held down in accordance with NZS3604:2011 with 3/3.15 mm diameter by 90 mm gun nails at 300 mm centres.

Three different panels lengths were investigated, 400, 600 and 1200 mm long panels. Details of the test panels are shown in Figure 1. All timber used in the construction of the panels was 90 by 45 mm kiln dried, SG 8 *Pinus radiata.*

The K17 lining was fastened to the framing with 51 mm long by 7 gauge GIB® Grabber high thread drywall screws spaced at 75 mm centres. In the corners of the panels the fastener spacing for the lining was decreased to 50 mm centres as detailed Figure 1. In tests with hold-downs, the edge studs were connected to the bottom plate with GIB Handibracs®.

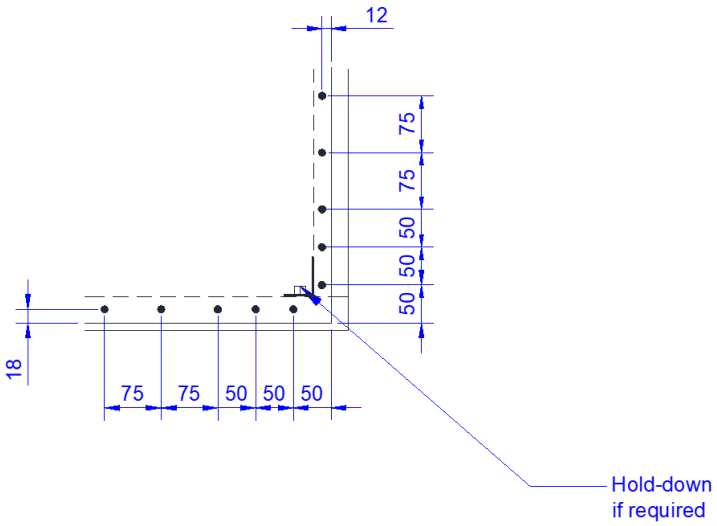


Figure 1
Details of Corner Fastener Pattern for K17 Lining

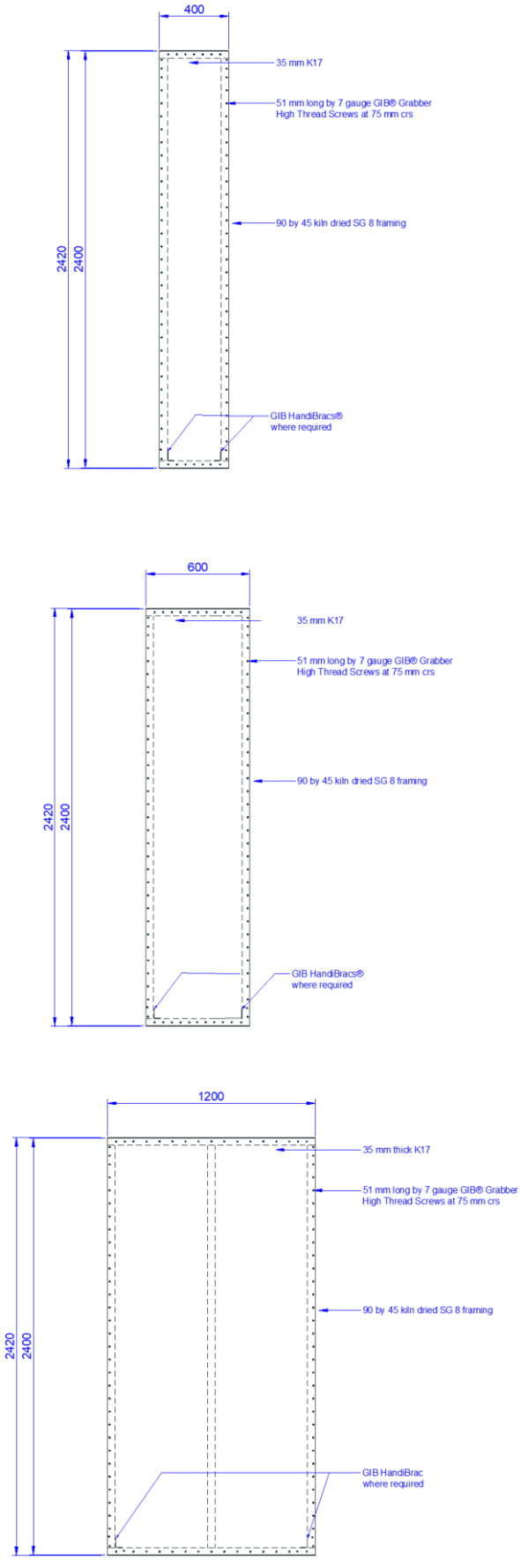


Figure 2
Details of Test Panels

Test Arrangement

All testing was undertaken using the bracing test frame, located at Winstone Wallboards Ltd, Penrose. Details of the test arrangement are shown in Figure 3. The load was applied to the top of the panel with a 5 tonne double acting hydraulic ram. The ram was actuated by a hydraulic power unit via a proportional valve. The proportional valve was controlled by a programmable logic controller, PLC, interfaced to a Windows XP computer. The displacement at the top of the frame was measured with a linear voltage differential transformer, LVDT. The computer was used to monitor the load and displacement and to control the displacement at the top of the panel.

Restraint blocks were placed at each end of the panel. These blocks were as specified by Shelton (2010) with 3/100 mm long by 4.0 mm diameter nails used to attach each block to the edge of the panel. Two lateral restraints were used to prevent out of plane movement at each end the top of the panel. In the tests with hold-downs, each edge stud was attached to the bottom plate with a GIB Handibrac®. The GIB HandiBracs® were bolted attached to the test frame with 12 mm diameter threaded rods. In the tests with no specific hold-downs, the panels were fastened to the subfloor timber and Strandboard with 3/90 mm long gun nails place at 600 mm centres.

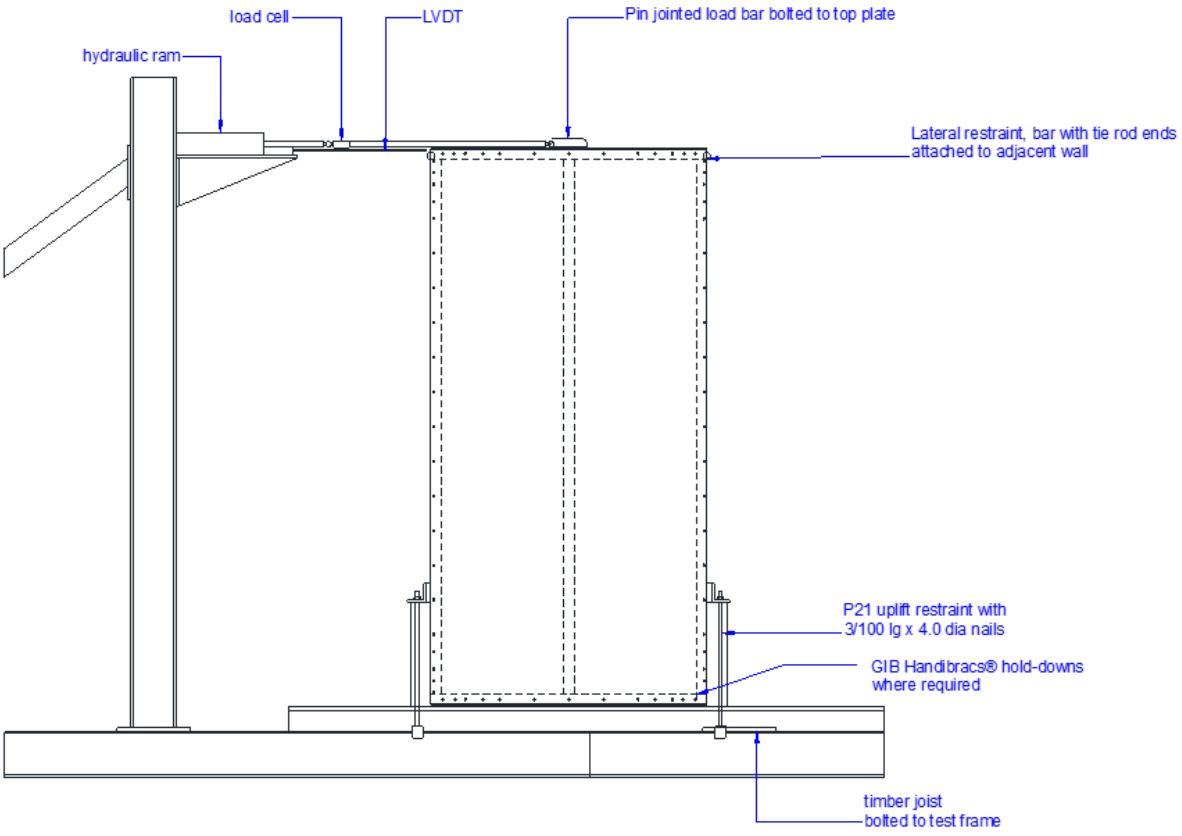


Figure 3
Details of Test Arrangement

The tests were displacement controlled. The element was subjected to three cycles to ±9 mm followed three cycles to ±15, ±22, ±29, and ±36 and then a further cycle to ±43 mm.

Observation and Results

400 mm Long K17-N Panels

Three tests were undertaken, and the panels all behaved in a similar manner. Significant movement of the K17 lining relative to the framing was observed during testing. Considerable bending of the panels and separation of the studs from the bottom plate was also observed during testing. Upon completion of testing, slotting of the back of the K17 linings around the fasteners was observed.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 1. Detailed load displacement behaviour is given in Appendix A.

Table 1
Summary of Load Displacement Behaviour of 400 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	0.63	1.09	1.23	36.0	8.21	1.13
	-ve	0.63	1.79	1.10	36.0		1.07
2	+ve	0.60	2.09	1.25	36.0	8.57	1.20
	-ve	0.67	2.24	1.13	36.0		1.04
3	+ve	0.68	1.94	1.29	36.0	8.21	1.23
	-ve	0.72	3.17	1.26	36.0		1.02
Average		0.66	2.05	1.21	36.0	8.33	1.12

The load and displacement values given in Table 1 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 22.4 bracing units (56 bracing units per metre) for earthquake loads and 22.2 bracing units (56 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix B. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations.

600 mm Long K17-N Panels

Three tests were undertaken, and the panels all behaved in a similar manner. Similar to the 400 mm long panels, significant movement to the K17 lining relative to the framing and bending of the panels was observed during testing. Upon completion of testing, slotting of the back of the K17 linings was observed.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 2. Detailed load displacement behaviour is given in Appendix C.

Table 2
Summary of Load Displacement Behaviour of 600 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	1.06	2.28	2.06	36.0	8.16	1.89
	-ve	1.21	3.65	2.05	36.0		1.86
2	+ve	1.10	1.50	1.89	36.0	7.18	1.70
	-ve	1.23	2.92	1.92	36.0		1.70
3	+ve	1.27	1.99	2.20	36.0	7.18	1.95
	-ve	1.29	3.14	2.05	36.0		1.92
Average		1.19	2.58	2.03	36.0	7.51	1.84

The load and displacement values given in Table 2 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 36.8 bracing units (64 bracing units per metre) for earthquake loads and 40.4 bracing units (67 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix D. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations.

1200 mm Long K17-N Panels

Three tests were undertaken, and the panels all behaved in a similar manner. Similar to the 300 and 400 mm long panels significant movement of the K17 lining relative to the framing was observed. Also observed during testing was significant irrecoverable deformation at the end of the serviceability cycling.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 3. Detailed load displacement behaviour is given in Appendix E.

Table 3
Summary of Load Displacement Behaviour of 1200 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	2.63	4.65	4.46	36.0	6.22	3.69
	-ve	2.71	5.22	4.16	36.0		3.72
2	+ve	2.72	4.53	4.54	36.0	6.33	3.85
	-ve	2.85	5.13	4.66	36.0		4.26
3	+ve	3.29	4.07	5.74	36.0	6.30	4.00
	-ve	2.65	5.48	4.88	36.0		3.75
Average		2.81	4.85	4.74	36.0	6.28	3.88

The load and displacement values given in Table 3 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 77.6 bracing units (66 bracing units per metre) for earthquake loads and 75 bracing units (63 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix F. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations. The degree of irrecoverable deformation after the serviceability cycles limited the wind serviceability resistance value.

400 mm Long K17-H Panels

Three tests were undertaken, and the panels all braved in a similar manner. As with K17-N panels considerable movement of the K17 lining relative to the framing and bending of the panels was observed during testing.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 4. Detailed load displacement behaviour is given in Appendix G.

Table 4
Summary of Load Displacement Behaviour of 400 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	0.68	2.47	1.60	36.0	11.51	1.40
	-ve	0.81	2.34	1.48	36.0		1.31
2	+ve	0.64	2.09	1.48	36.0	11.09	1.30
	-ve	0.75	2.21	1.47	36.0		1.31
3	+ve	0.66	1.87	1.45	36.0	9.10	1.30
	-ve	0.68	3.32	1.29	36.0		1.19
Average		0.70	2.38	1.46	36.0	10.57	1.30

The load and displacement values given in Table 4 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 22.4 bracing units (56 bracing units per metre) for earthquake loads and 23.8 bracing units (60 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix H. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations.

600 mm Long K17-H Panels

Three tests were undertaken, and the panels all braved in a similar manner. Considerable movement of the K17 lining relative to the framing was observed during testing. Also was observed was bending of frame during testing.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 5. Detailed load displacement behaviour is given in Appendix I.

Table 5
Summary of Load Displacement Behaviour of 600 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	1.38	2.83	2.55	36.0	7.92	2.25
	-ve	1.09	3.60	2.26	36.0		1.93
2	+ve	1.27	2.52	2.54	36.0	8.80	2.18
	-ve	1.23	3.60	2.29	36.0		1.92
3	+ve	0.96	3.72	2.11	36.0	10.88	1.76
	-ve	1.20	2.52	2.18	36.0		1.89
Average		1.19	3.13	2.32	36.0	9.20	1.99

The load and displacement values given in Table 4 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 38.3 bracing units (64 bracing units per metre) for earthquake loads and 40.2 bracing units (67 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix J. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations.

1200 mm Long K17-H Panels

Three tests were undertaken, and the panels all braved in a similar manner. Considerable movement of the K17 lining relative to the framing was observed during testing. Also observed during testing, was significant irrecoverable deformation at the end of the serviceability cycling.

Details of the loads at the serviceability displacement of ±8 mm, the peak loads, and at a displacement of ±36 mm recorded on the first cycle to ±43 mm are given in Table 6. Detailed load displacement behaviour is given in Appendix K.

Table 6
Summary of Load Displacement Behaviour of 1200 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	3.38	4.87	5.17	36.0	6.21	4.19
	-ve	3.03	3.91	4.75	36.0		4.19
2	+ve	3.09	4.62	5.21	36.0	6.80	4.38
	-ve	3.18	3.97	5.08	36.0		4.32
3	+ve	3.31	3.11	5.74	36.0	6.30	4.89
	-ve	2.74	5.13	4.88	36.0		4.29
Average		3.12	4.17	5.14	36.0	6.44	4.38

The load and displacement values given in Table 4 were used to evaluate the bracing resistance in accordance with Shelton (2010). Bracing resistance values of 87.6 bracing units (73 bracing units per metre) for earthquake loads and 91.4 bracing units (76 bracing units per metre) for wind loads were calculated. Details of the bracing calculation are given in Appendix L. The earthquake bracing resistance values were governed by the strength requirements of the P21 evaluation method and the wind value was governed by serviceability considerations.

Summary

In all testing, the wind bracing resistance values of all panel length were controlled by serviceability considerations. The earthquake values of the panels were controlled by strength considerations. Significant movement of the K17 lining relative to the framing was observed in all tests.

A summary of the bracing resistance values is given in Table 7.

Table 7
Summary of bracing Results

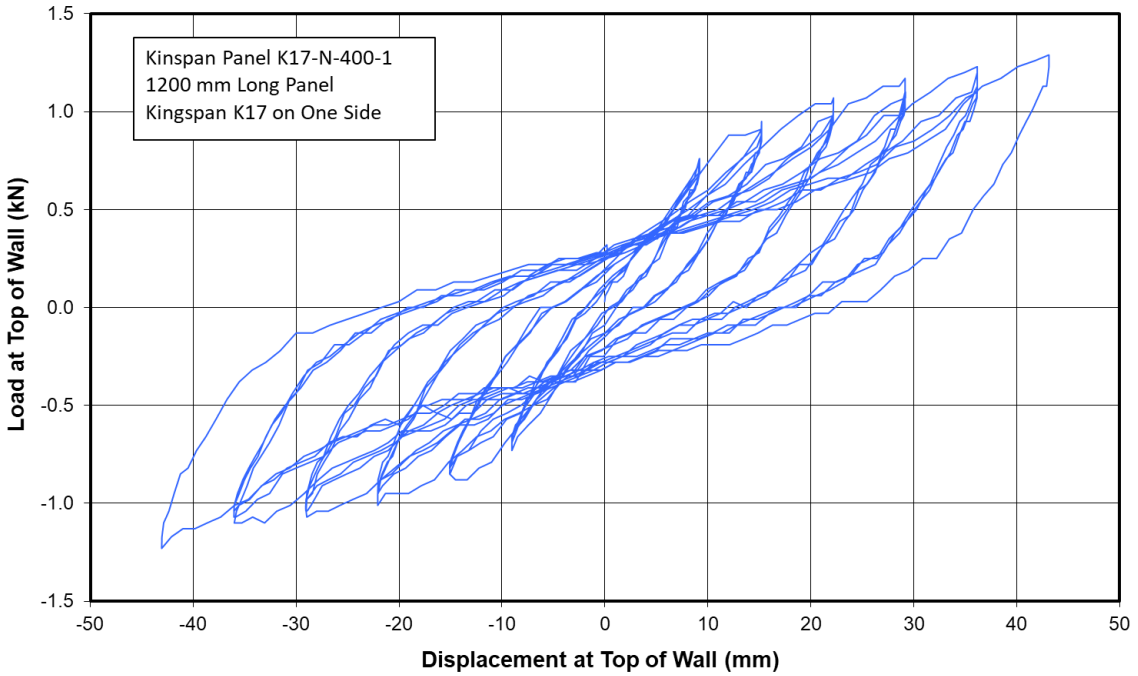
Panel	Panel Length (mm)	Hold-Downs	Bracing Resistance (BUs/m)	
			Wind	Earthquake
K17-N-400	400	No	56	56
K17-N-600	600	No	67	61
K17-N-1200	1200	No	62	65
K17-H-400	400	Yes	60	56
K17-H-600	600	Yes	67	64
K17-H-1200	1200	Yes	76	73

References

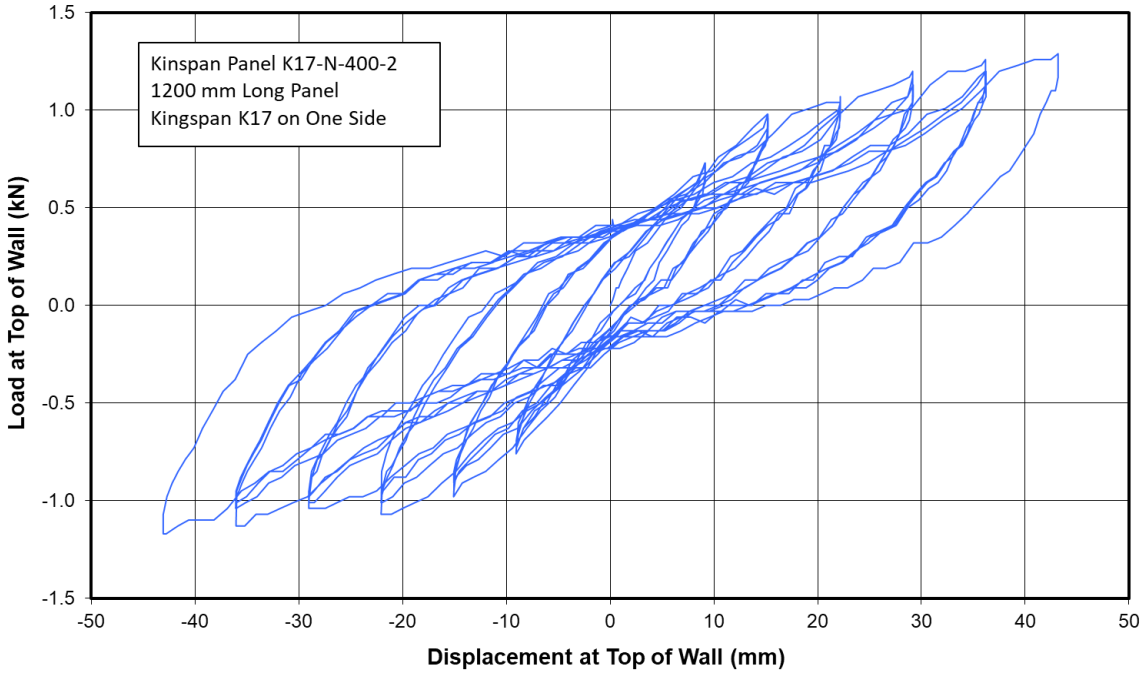
Shelton R., 2010, “P21 (2010) A wall bracing test and evaluation procedure”, BRANZ Technical Report, Judgeford, 2010.

Richard Hunt
March 2025

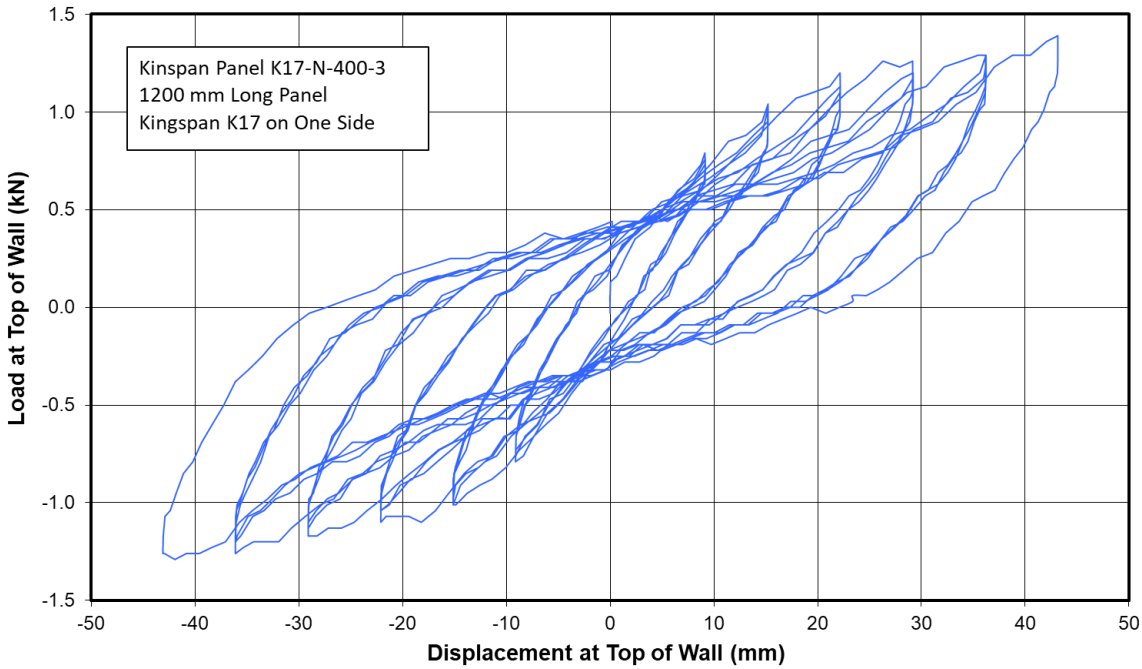
Appendix A –Details of Load-Displacement Behaviour Resistance of 400 mm Long K17-N Panels



KN17-N-400-1 Load-Displacement Behaviour



KN17-N-400-2 Load-Displacement Behaviour



KN17-N-400-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-N-400-1	7.71
KN17-N-400-2	7.91
KN17-N-400-3	8.10

Appendix B –Determination of Bracing Resistance of 400 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	0.63	1.09	1.23	36.0	8.21	1.13
	-ve	0.63	1.79	1.10			1.07
2	+ve	0.60	2.09	1.25	36.0	8.57	1.20
	-ve	0.67	2.24	1.13			1.04
3	+ve	0.68	1.94	1.29	36.0	8.21	1.23
	-ve	0.72	3.17	1.26			1.02
Average		S = 0.66	C = 2.05	P = 1.21	Y = 36.0	d = 8.33	R = 1.12

k_1 = 1.4 – C/8
= 1.4 – 2.057/8
= 1.00

F = k_1 x S
= 1.00 x 0.66
= 0.66

μ = Y/d
= 36.0/8.33
= 4.32

Therefore, from Shelton (2010)

k_4 = 1.00

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 1.0 x 1.12	or	20 x 1.2/0.55 x 0.66
22.4 BUs	or	27.4 BUs

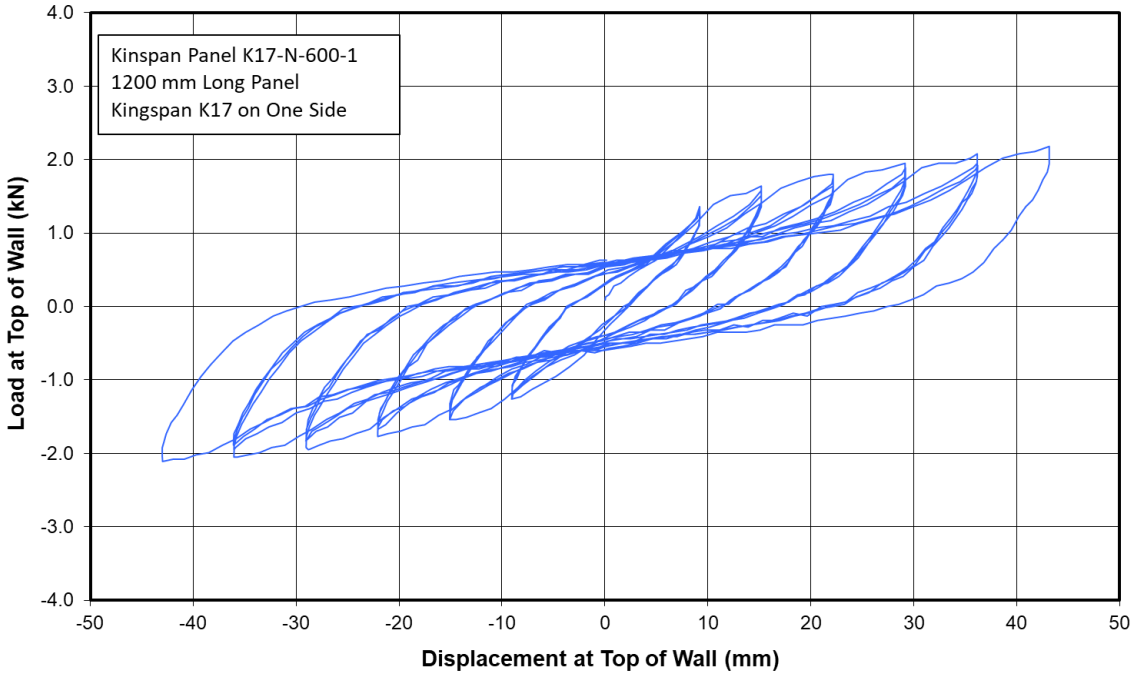
Therefore, Bracing Resistance Earthquake = 22.4 BUs for 0.4 m Panel or 56 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

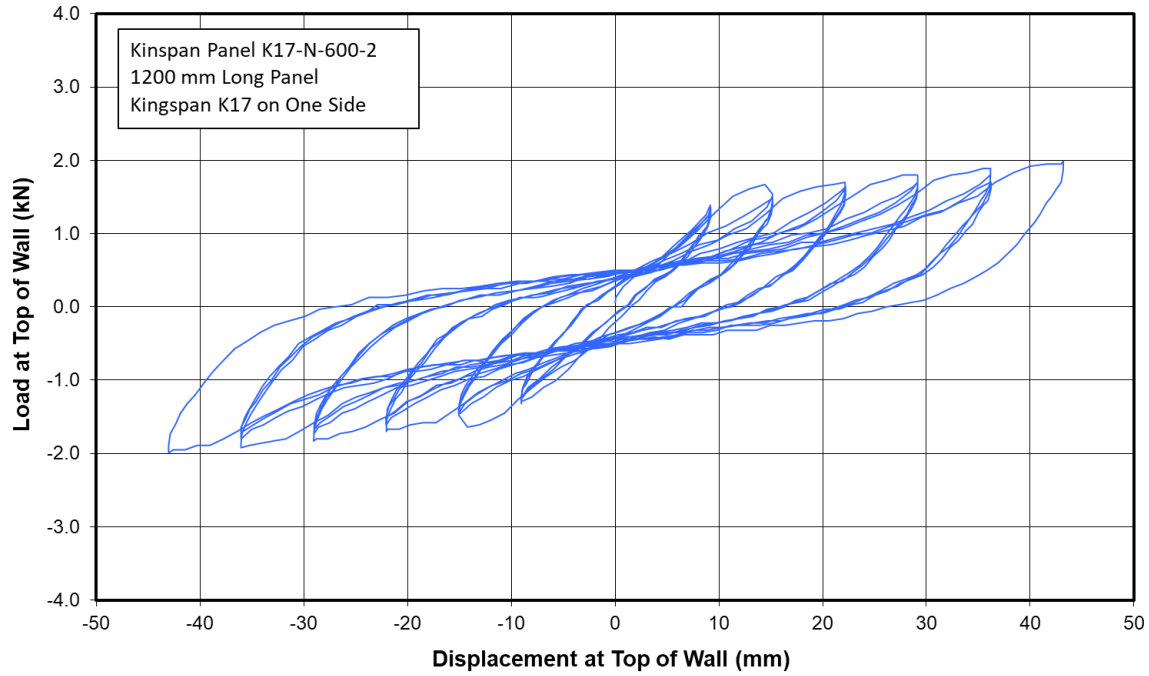
20 x P	or	20 x 1.20/0.71 x F
20 x 1.21	or	20 x 1.20/0.71 x 0.66
24.2 BUs	or	22.2 BUs

Therefore, Bracing Resistance Wind = 22.2 BUs for 0.4 m Panel or 56 BUs/m

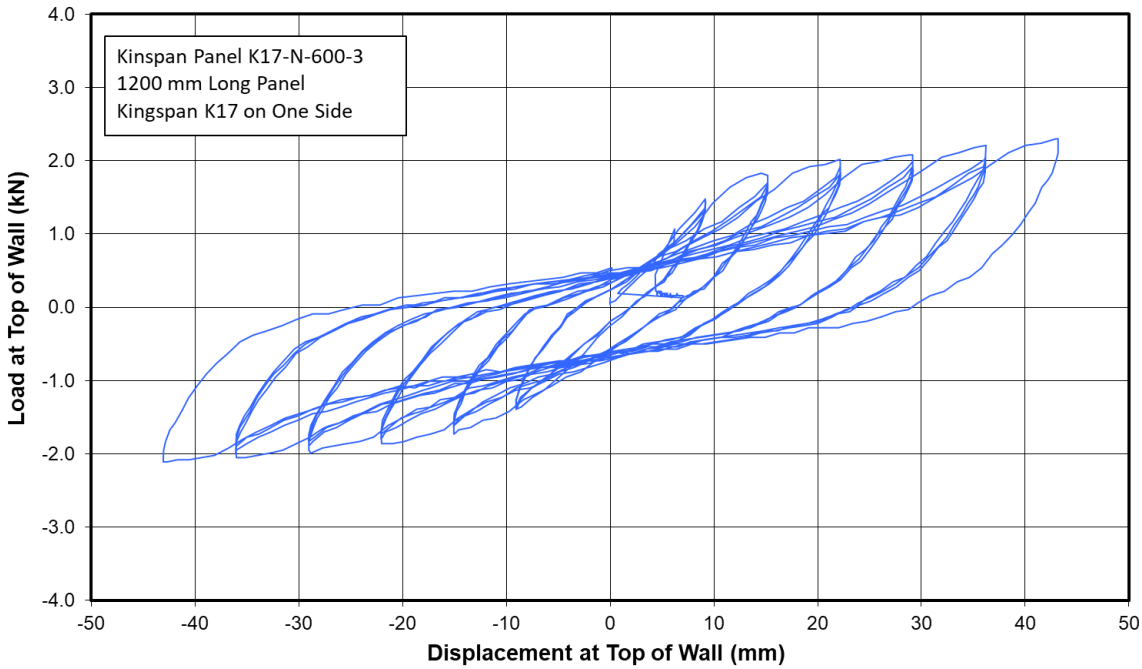
Appendix C –Details of Load-Displacement Behaviour Resistance of 600 mm Long K17-N Panels



KN17-N-600-1 Load-Displacement Behaviour



KN17-N-600-2 Load-Displacement Behaviour



KN17-N-600-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-N-600-1	8.01
KN17-N-600-2	7.55
KN17-N-600-3	8.33

Appendix D –Determination of Bracing Resistance of 600 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	1.06	2.28	2.06	36.0	8.16	1.89
	-ve	1.21	3.65	2.05			1.86
2	+ve	1.10	1.50	1.89	36.0	7.18	1.70
	-ve	1.23	2.92	1.92			1.70
3	+ve	1.27	1.99	2.20	36.0	7.18	1.95
	-ve	1.29	3.14	2.05			1.92
Average		S = 1.19	C = 2.58	P = 2.03	Y = 36.0	d = 7.51	R = 1.84

k_1 = 1.4 – C/8
= 1.4 – 2.58/8
= 1.00

F = k_1 x S
= 1.00 x 1.19
= 1.19

μ = Y/d
= 36.0/7.51
= 4.80

Therefore, from Shelton (2010)

k_4 = 1.00

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 1.0 x 1.84	or	20 x 1.2/0.55 x 1.19
36.8 BUs	or	49.8 BUs

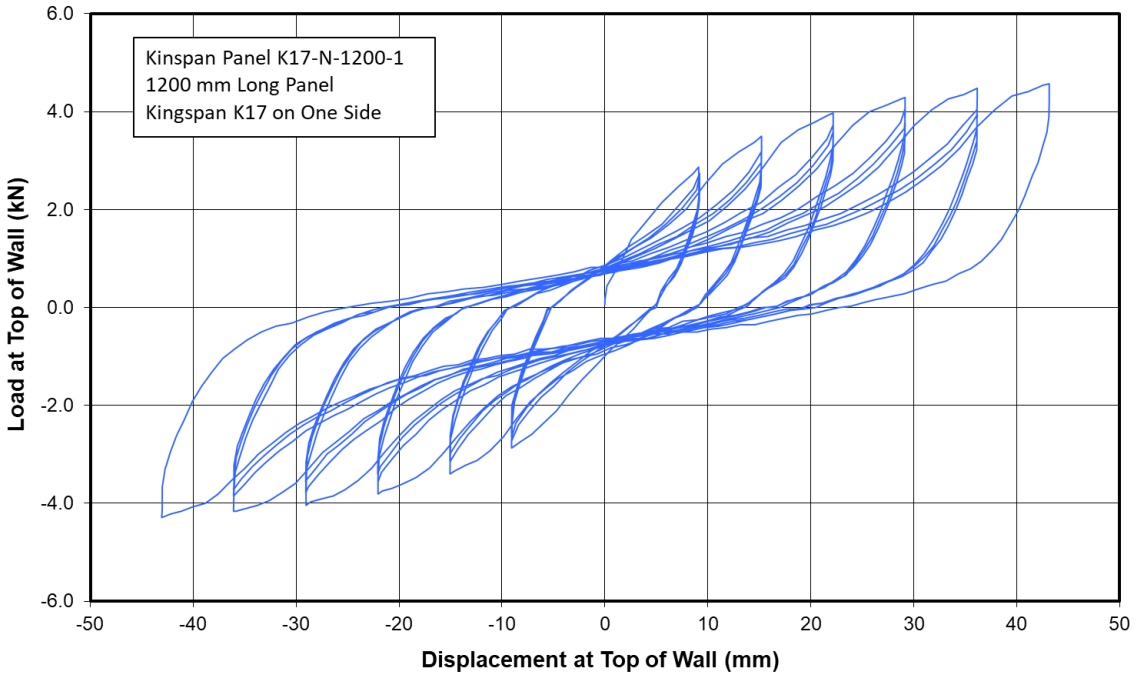
Therefore, Bracing Resistance Earthquake = 36.8 BUs for 0.6 m Panel or 61 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

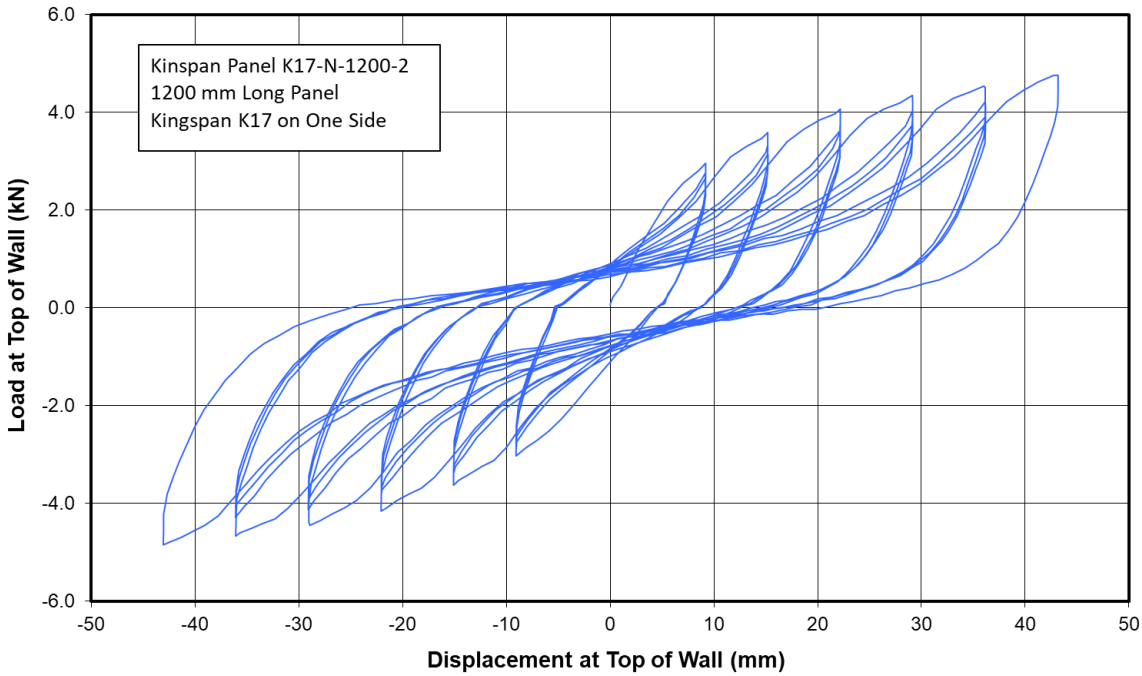
20 x P	or	20 x 1.20/0.71 x F
20 x 2.03	or	20 x 1.20/0.71 x 1.19
40.6 BUs	or	40.4 BUs

Therefore, Bracing Resistance Wind = 40.4 BUs for 0.6 m Panel or 67 BUs/m

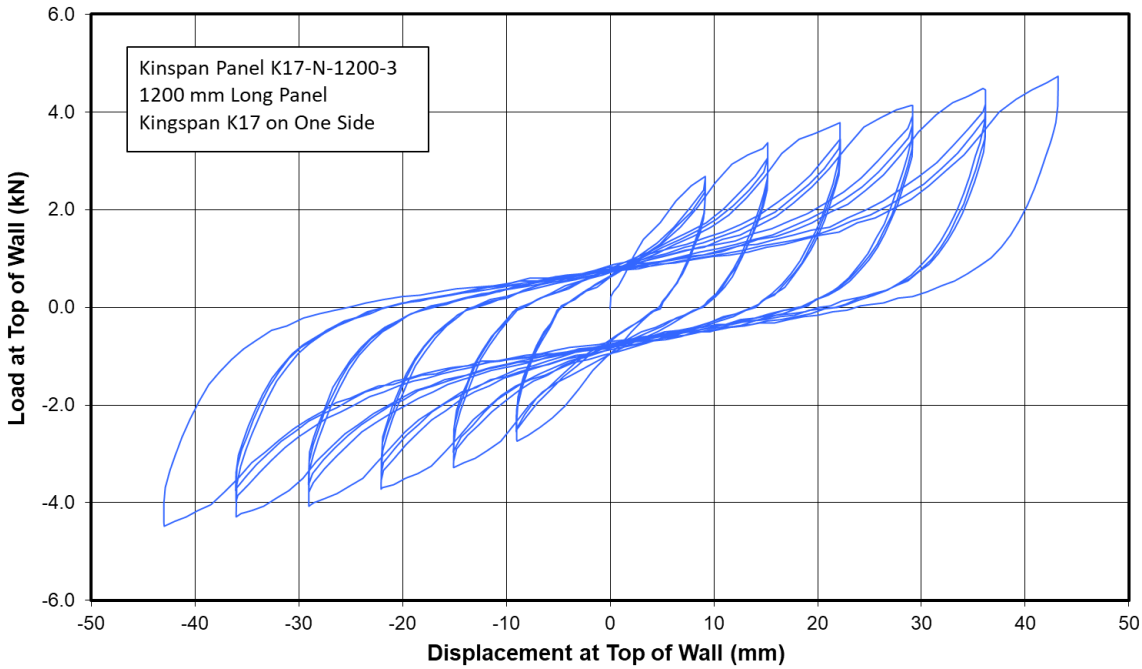
Appendix E –Details of Load-Displacement Behaviour Resistance of 1200 mm Long K17-N Panels



KN17-N-1200-1 Load-Displacement Behaviour



KN17-N-1200-2 Load-Displacement Behaviour



KN17-N-1200-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-N-1200-1	7.95
KN17-N-1200-2	8.19
KN17-N-1200-3	8.10

Appendix F –Determination of Bracing Resistance of 1200 mm Long K17-N Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	2.63	4.65	4.46	36.0	6.22	3.69
	-ve	2.71	5.22	4.16			3.72
2	+ve	2.72	4.53	4.54	36.0	6.33	3.85
	-ve	2.85	5.13	4.66			4.26
3	+ve	3.29	4.07	5.74	36.0	6.30	4.00
	-ve	2.65	5.48	4.88			3.75
Average		S = 2.81	C = 4.85	P = 4.74	Y = 36.0	d = 6.28	R = 3.88

k_1 = 1.4 – C/8
= 1.4 – 4.85/8
= 0.79

F = k_1 x S
= 0.79 x 2.81
= 2.22

μ = Y/d
= 36.0/6.28
= 5.73

Therefore, from Shelton (2010)

k_4 = 1.00

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 1.0 x 3.88	or	20 x 1.2/0.55 x 2.22
77.6 BUs	or	92.4 BUs

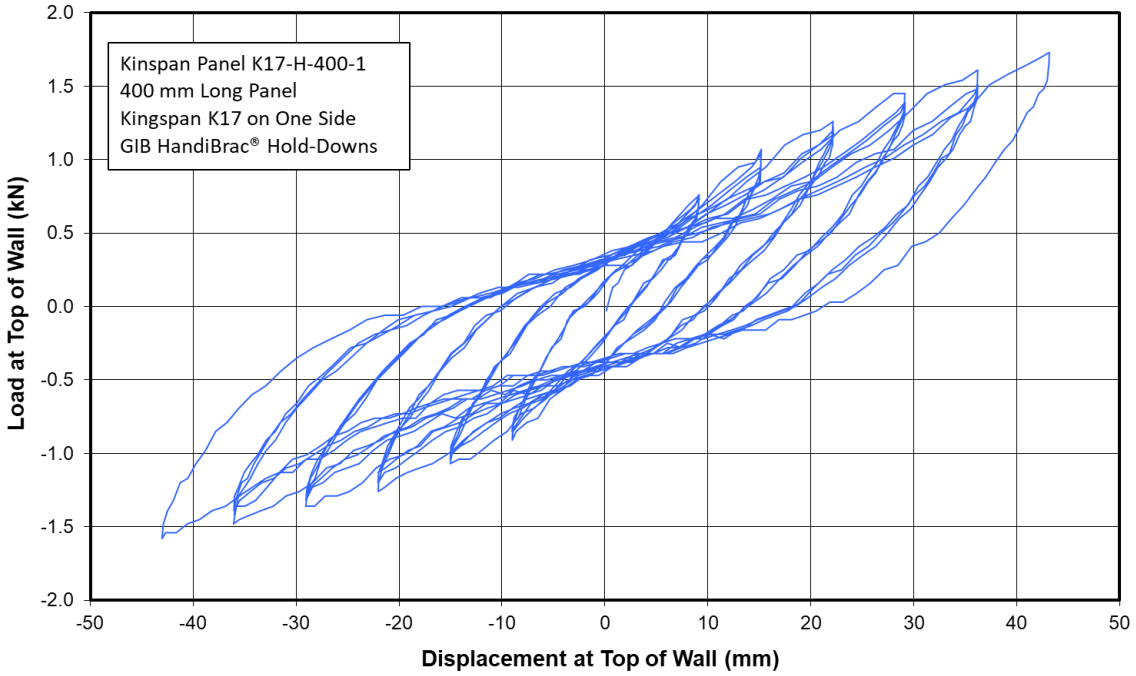
Therefore, Bracing Resistance Earthquake = 77.6 BUs for 1.2 m Panel or 66 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

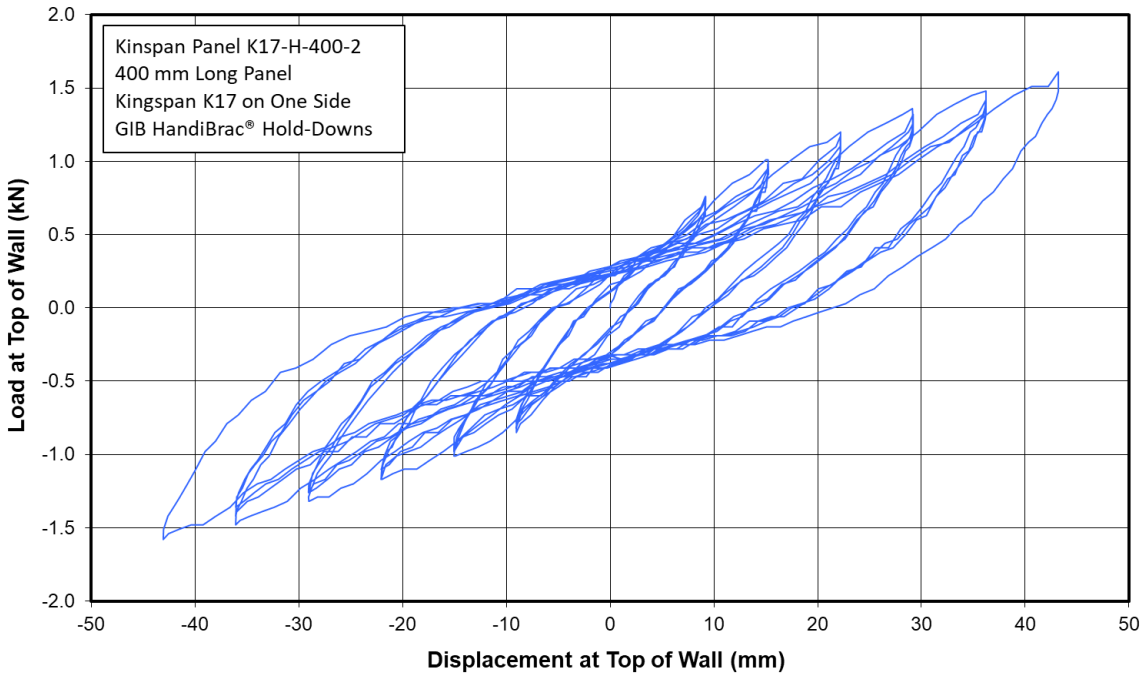
20 x P	or	20 x 1.20/0.71 x F
20 x 4.74	or	20 x 1.20/0.71 x 2.22
94.8 BUs	or	75.0 BUs

Therefore, Bracing Resistance Wind = 75.0 BUs for 1.2 m Panel or 63 BUs/m

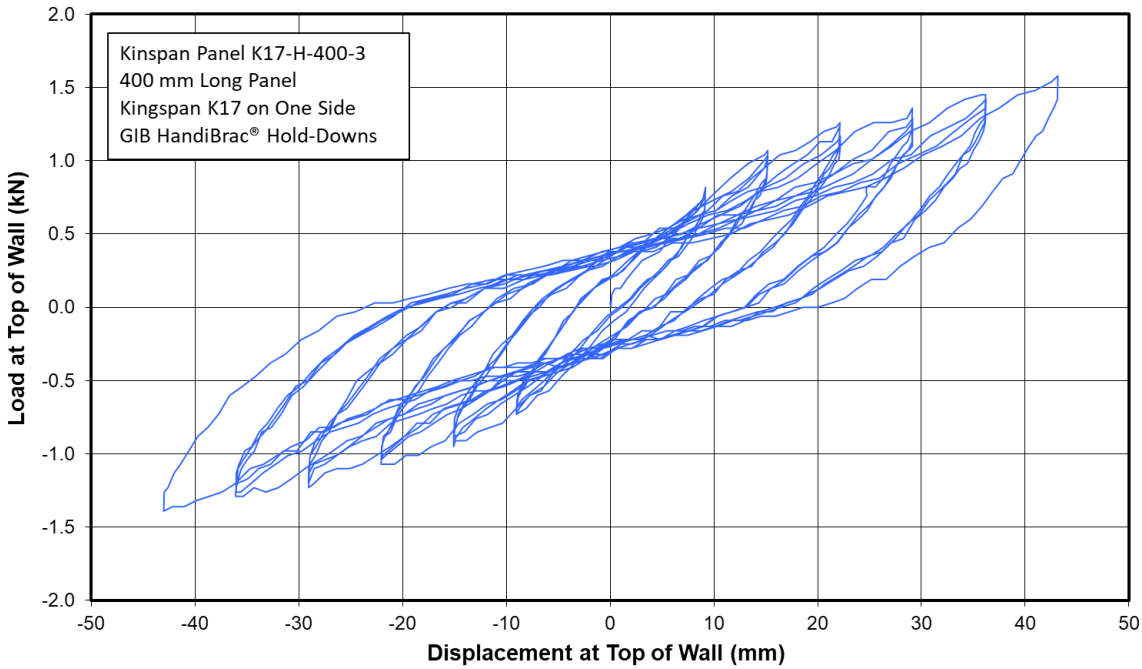
Appendix G –Details of Load-Displacement Behaviour Resistance of 400 mm Long K17-H Panels



KN17-H-400-1 Load-Displacement Behaviour



KN17-H-400-2 Load-Displacement Behaviour



KN17-H-400-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-H-400-1	7.71
KN17-H-400-2	7.91
KN17-H-400-3	8.10

Appendix H –Determination of Bracing Resistance of 400 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	0.68	2.47	1.60	36.0	11.51	1.40
	-ve	0.81	2.34	1.48			1.31
2	+ve	0.64	2.09	1.48	36.0	11.09	1.30
	-ve	0.75	2.21	1.47			1.31
3	+ve	0.66	1.87	1.45	36.0	9.10	1.30
	-ve	0.68	3.32	1.29			1.19
Average		*S = 0.70*	*C* = 2.38	*P* = 1.46	*Y* = 36.0	*d* = 10.57	*R = 1.30*

k_1 = 1.4 – C/8
= 1.4 – 2.38/8
= 1.0

F = k_1 x S
= 1.0 x 0.70
= 0.70

μ = Y/d
= 36.0/10.57
= 3.41

Therefore, from Shelton (2010)

k_4 = 0.86

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 0.86 x 1.30	or	20 x 1.2/0.55 x 0.70
22.4 BUs	or	29.4 BUs

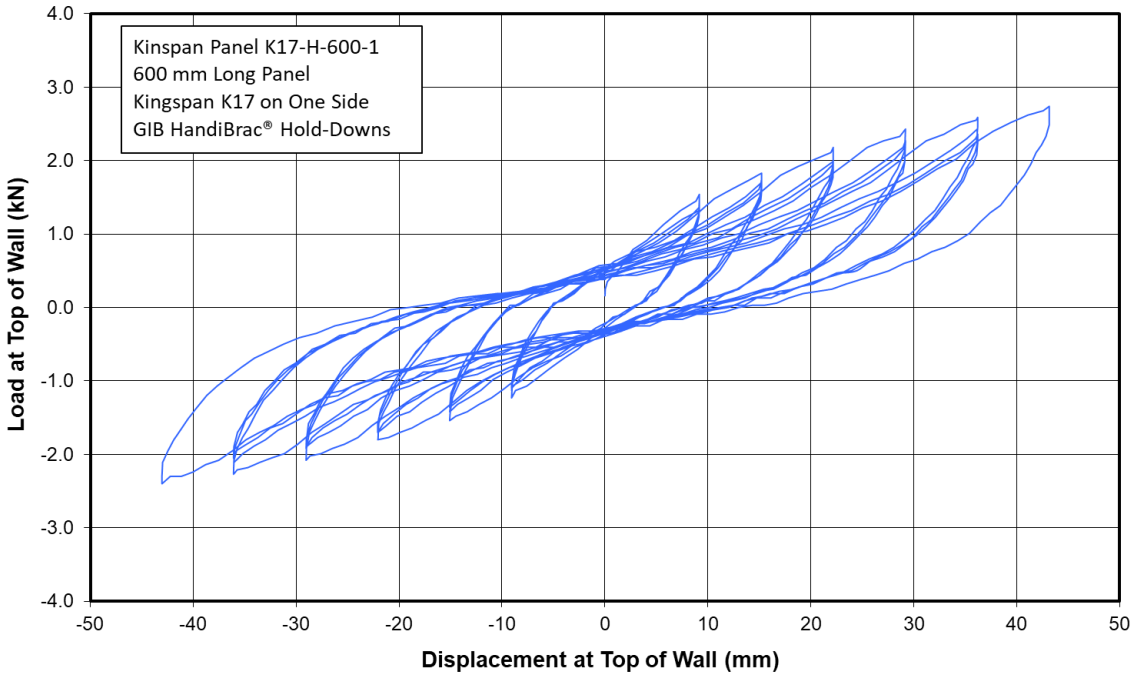
Therefore, Bracing Resistance Earthquake = 22.4 BUs for 0.4 m Panel or 56 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

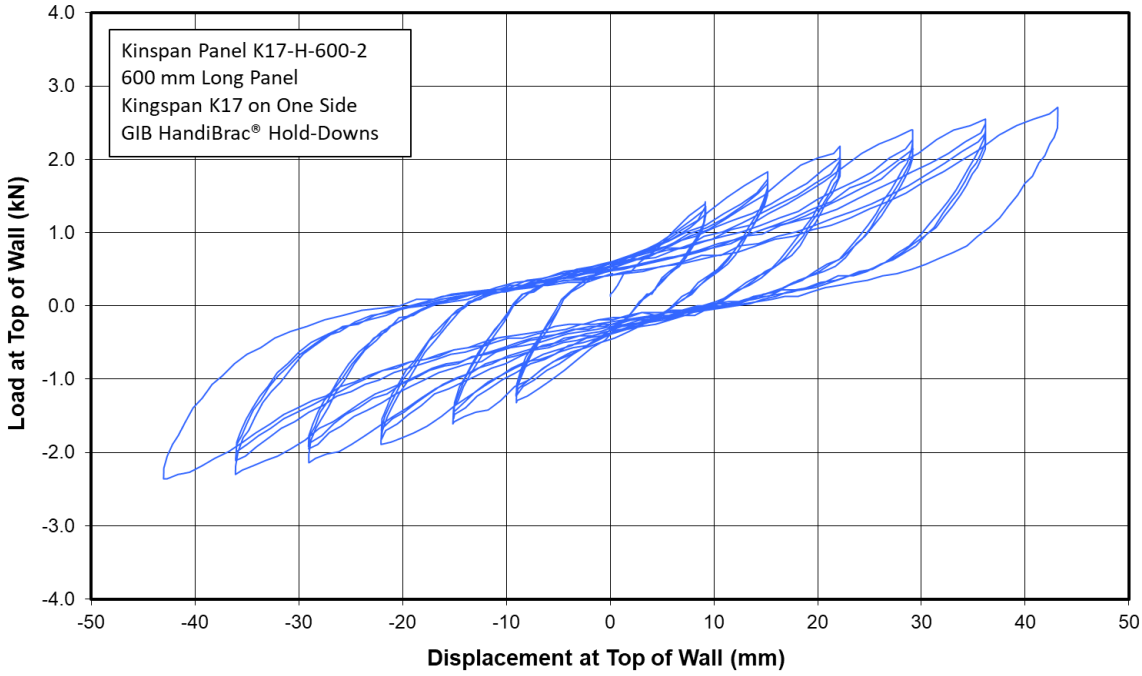
20 x P	or	20 x 1.20/0.71 x F
20 x 1.46	or	20 x 1.20/0.71 x 0.70
29.2 BUs	or	23.8 BUs

Therefore, Bracing Resistance Wind = 23.8 BUs for 0.4 m Panel or 60 BUs/m

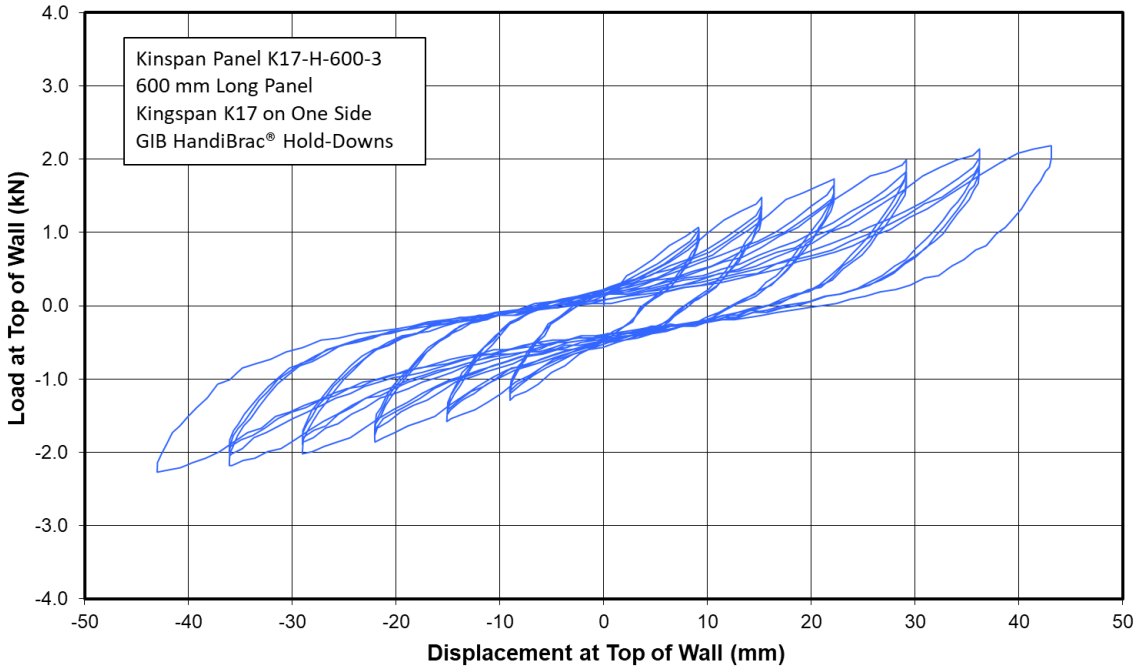
Appendix I –Details of Load-Displacement Behaviour Resistance of 600 mm Long K17-H Panels



KN17-H-600-1 Load-Displacement Behaviour



KN17-H-600-2 Load-Displacement Behaviour



KN17-H-600-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-H-600-1	8.01
KN17-H-600-2	7.55
KN17-H-600-3	8.33

Appendix J –Determination of Bracing Resistance of 600 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	1.38	2.83	2.55	36.0	7.92	2.25
	-ve	1.09	3.60	2.26			1.93
2	+ve	1.27	2.52	2.54	36.0	8.80	2.18
	-ve	1.23	3.60	2.29			1.92
3	+ve	0.96	3.72	2.11	36.0	10.88	1.76
	-ve	1.20	2.52	2.18			1.89
Average		S = 1.19	C = 3.13	P = 2.32	Y = 36.0	d = 9.20	R = 1.99

k_1 = 1.4 – C/8
= 1.4 – 3.13/8
= 1.0

F = k_1 x S
= 1.0 x 1.19
= 1.19

μ = Y/d
= 36.0/9.20
= 3.91

Therefore, from Shelton (2010)

k_4 = 0.96

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 0.96 x 1.99	or	20 x 1.2/0.55 x 1.19
38.3 BUs	or	49.5 BUs

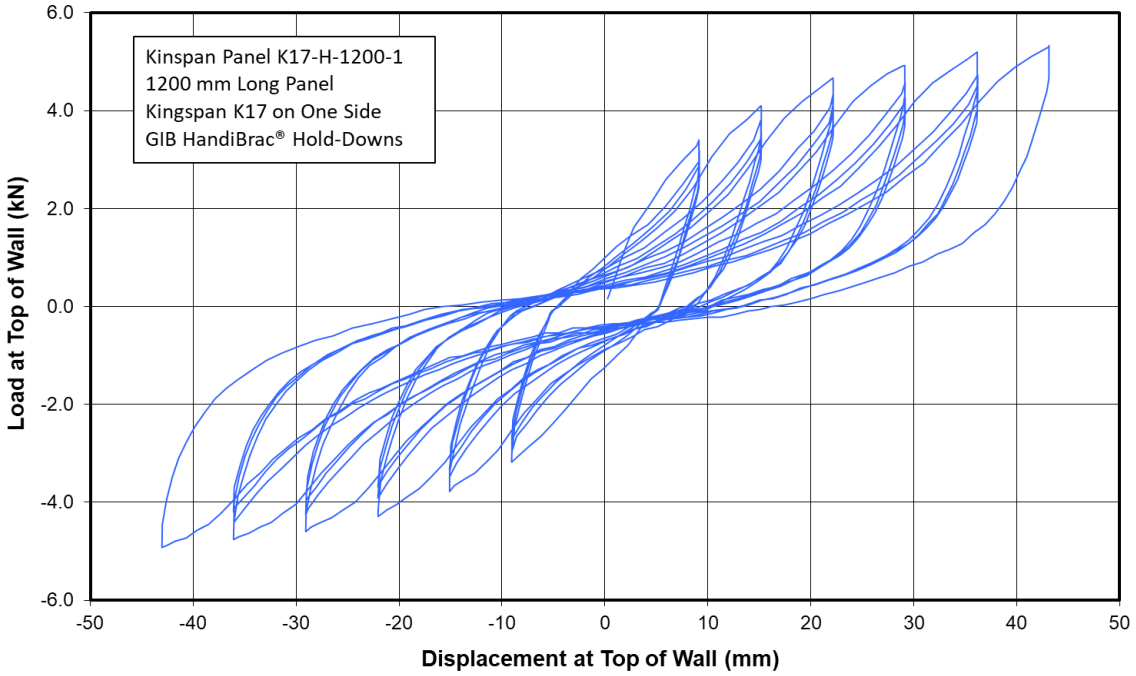
Therefore, Bracing Resistance Earthquake = 38.3 BUs for 0.6 m Panel or 64 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

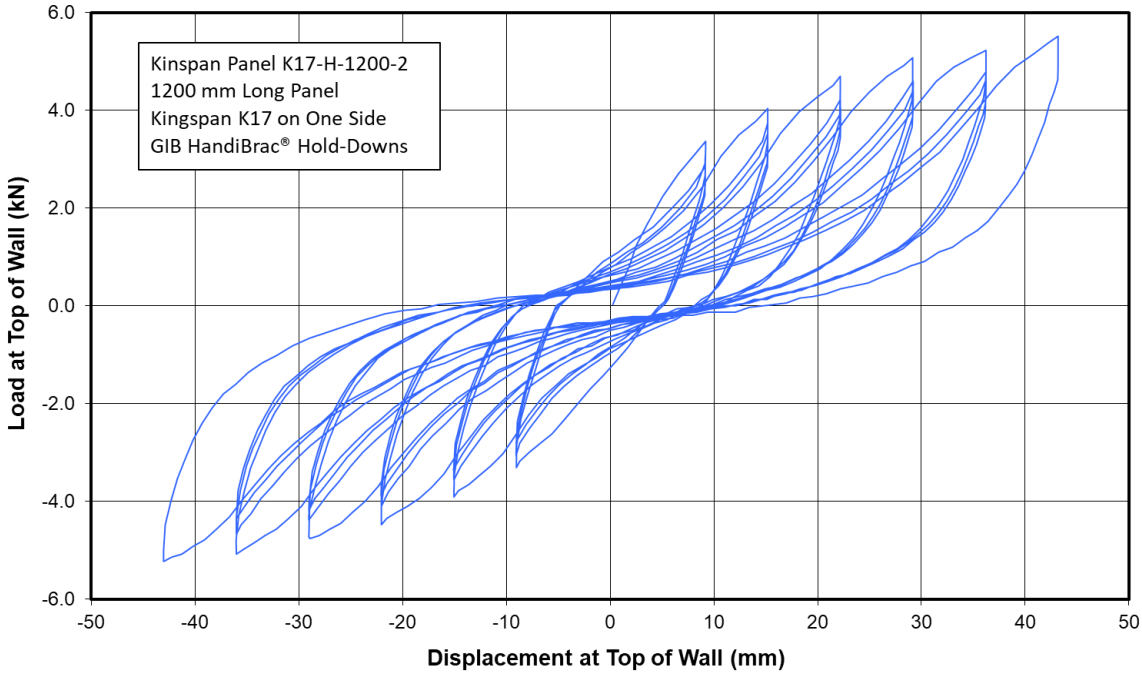
20 x P	or	20 x 1.20/0.71 x F
20 x 2.32	or	20 x 1.20/0.71 x 1.19
46.4 BUs	or	40.2 BUs

Therefore, Bracing Resistance Wind = 40.2 BUs for 0.6 m Panel or 67 BUs/m

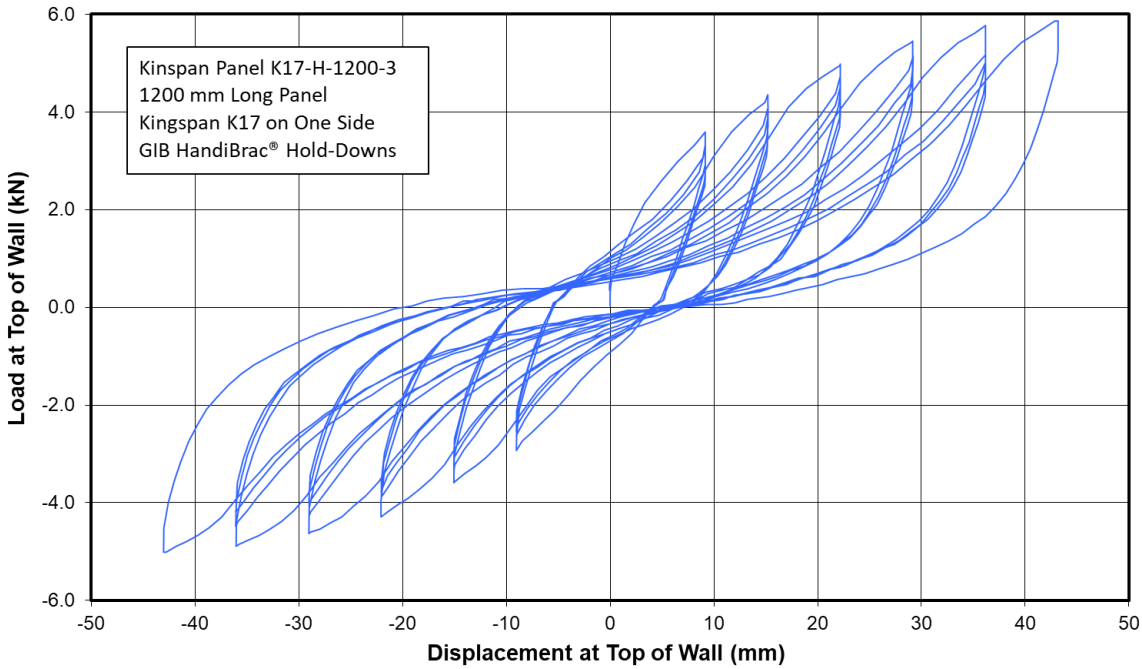
Appendix K –Details of Load-Displacement Behaviour Resistance of 1200 mm Long K17-H Panels



KN17-H-1200-1 Load-Displacement Behaviour



KN17-H-1200-2 Load-Displacement Behaviour



KN17-H-1200-3 Load-Displacement Behaviour

Panel	Lining Mass per Area (kg/m^2)
KN17-H-1200-1	8.09
KN17-H-1200-2	8.11
KN17-H-1200-3	7.96

Appendix H –Determination of Bracing Resistance of 1200 mm Long K17-H Panels

Test		Load at 8 mm Displacement (kN)	Residual Displacement after 8 mm Displacement (mm)	Peak Load (kN)	Displacement at Peak Load (mm)	Displacement at Peak Load/2 (mm)	Residual Load at Displacement of ±36 mm (kN)
1	+ve	3.38	4.87	5.17	36.0	6.21	4.19
	-ve	3.03	3.91	4.75			4.19
2	+ve	3.09	4.62	5.21	36.0	6.80	4.38
	-ve	3.18	3.97	5.08			4.32
3	+ve	3.31	3.11	5.74	36.0	6.30	4.89
	-ve	2.74	5.13	4.88			4.29
Average		S = 3.12	C = 4.17	P = 5.14	Y = 36.0	d = 6.44	R = 4.38

k_1 = 1.4 – C/8
= 1.4 – 4.17/8
= 0.87

F = k_1 x S
= 0.87 x 3.12
= 2.70

μ = Y/d
= 36.0/6.44
= 5.59

Therefore, from Shelton (2010)

k_4 = 1.00

Evaluation: Earthquake Performance
Bracing Resistance (EQ) is the lesser of

20 x k_4 x R	or	20 x 1.2 /0.55 x F
20 x 1.0 x 4.38	or	20 x 1.2/0.55 x 2.7
87.6 BUs	or	112.7 BUs

Therefore, Bracing Resistance Earthquake = 87.6 BUs for 1.2 m Panel or 73 BUs/m

Evaluation: Wind Performance
Bracing Resistance (EQ) is the lesser of

20 x P	or	20 x 1.20/0.71 x F
20 x 5.14	or	20 x 1.20/0.71 x 2.70
102.8 BUs	or	91.4 BUs

Therefore, Bracing Resistance Wind = 91.4 BUs for 1.2 m Panel or 76 BUs/m