NRC·CNRC Construction

Cladding Deflection Evaluation for Wayne Building Products Lux Panel

Travis Moore and Michael Nicholls

A Report for:

Wayne Building Products Inc. Edmonton

12603 – 123 Street

Edmonton AB.
T51 0H9

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Cladding Deflection Evaluation for Wayne Building Products Lux Panel
Final Client Report

Author

Mr. Travis Moore, Technical Officer

Author Mr. Michael Nicholls, Technical Officer

Approved

Richard Tremblay
A/ Program Leader
Building Regulations for Market Access, NRC Construction

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Executive summary

This report details the cladding deflection evaluation completed for the Wayne Building Products Inc. Lux panel, conducted by NRC Canada. The evaluation consists of subjecting the client constructed 2.44m x 2.44m cladding assembly to a cladding deflection test protocol consisting of static pressures of positive and negative 0.5kPa, dynamic cyclic pressures of positive and negative pressures of 1555 Pa, and one time gust pressures of positive and negative 2321 Pa. The test protocol was conducted in the NRC wind load aging test apparatus. The specific test protocol was derived from the CCMC Wind loading protocol from *CCMC Technical Guide Master Format 01 46 45.01, for Evaluation of "Lap Siding/Panel Siding"*. Deflections of the cladding, studs and OSB sheathing board were monitored throughout the test to determine the net deflection of the cladding itself when subjected to the loading protocol described. At the conclusion of the testing the wall specimen was visually inspected for damage to the cladding, cladding fasteners, stud and OSB sheathing. Through both before and after measurements and visual inspection, it was determined that no permanent deflection or visually apparent degradation was observed in the cladding.

Contents

List of Figures

List of Tables

Final Client Report
Cladding Deflection Assessment for Wayne Building Products Lux Panel

Authored by
Travis Moore and Michael Nicholls

1 Purpose

The purpose of the wind load testing will is to provide information that will serve as a performance indicator for Wayne Building Products Inc. Lux panels and demonstrate the ability of these panels to withstand simulated cladding wind loads up to and including loads as might be found on the exterior of an 18 storey building in Alberta, Canada.

2 Approach

The test evaluation was conducted in accordance with ASTM E330[1], Procedure B, to the loading protocol as provided in the *CCMC Technical Guide* [2] and in the section entitled: "Wind Loading protocol". The pressure levels at which the panels were tested in this evaluation were determined based on information provided by the client for a 51.25 m tall building located in Calgary, Alberta (provided in Appendix A), and load levels specified from the CCMC technical guide[1].

2.1 Specimen construction

The specimen used in the evaluation was constructed by the client and shipped to NRC; it was received on January 5, 2016. It measured 2.44m by 2.44m (8-ft. x 8-ft.) and consisted of non-load bearing steel studs spaced at 400 mm (16-in.) on center, with OSB as the sheathing board. The OSB sheathing was butt jointed at the vertical centre of the wall (1.22 m, 4-ft.). The specimen is shown in Figure 1.

Figure 1: Photos of cladding deflection test specimen showing exterior (left) and interior (right)

[1] ASTM E330 ASTM E330 / E330M-14, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference, ASTM International, West Conshohocken, PA, 2014.
[2] CCMC Technical Guide Master Format 01 46 45.01, for Evaluation of "Lap Siding/Panel Siding"

2.2 Test apparatus

2.2.1 Wind load apparatus

The NRC Wind load apparatus (Figure 2) consists of a steel chamber to which a 2.44 m x 2.44 m (8-ft. x 8-ft.) specimen is installed. A pressure actuator is used to impart the desired static and dynamic pressures to the test chamber and across the test specimen. The actuator and chamber are capable of supplying static and dynamic loads up to ±3kPa.

The conditioning protocol is discussed in section *1.4 of the Wind Load Cladding Deflection Protocol.* The pressure acting on the cladding and deflections arising from the loads was monitored during testing and stored in a data acquisition system (DAQ) affixed to the actuator.

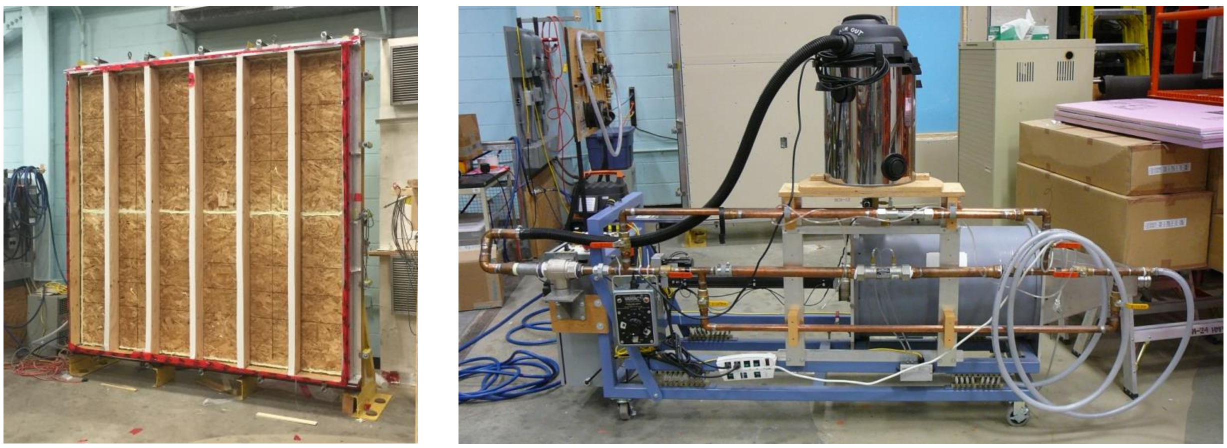

Figure 2: NRC Wind Load Aging apparatus – chamber (left) and actuator (right).

2.2.2 Instrumentation

Pressure sensors — Pressure was monitored to the chamber using two pressure sensors of different scale: (i) the first sensor (*MKS Baratron 225A ±5in H_2O*) measured pressures from 0 Pa to ±1500 Pa (±0.02%); (ii) the second sensor (*MKS Baratron 226A 100 Torr)* was used to monitor pressures from 0 Pa to ±13 kPa (±0.02%). The use of two sensors allowed for monitoring of pressure for the static testing (±500Pa), and also for the dynamic and cyclic pressure conditions (±2321Pa) to a reasonable resolution.

Cladding deflection — The cladding deflection was monitored using a laser distance measuring device *(Keyence LD-70)*, accurate to ±0.01mm. The stud deflection and sheathing board deflection were measured using linear potentiometers (*Penny and Giles HLP190*) also accurate to ±0.01mm.

As shown in Figure 3, the cladding deflections were measured in the centre of the cladding profile located in the centre of the stud cavity, and at the closest corresponding right and left stud location to the centre stud cavity cladding location. Due to the horizontal joint in the sheathing board, cladding deflections were measured at 101.6 mm (4-in.) above the joint. The deflection of the sheathing board at the center of the cladding profile, and deflections of the steel stud to the right and left of the center cladding profile were measured. To ensure that the maximum deflections for the test specimen (cladding, sheathing board, and studs) were captured during the test, locations for taking deflection measurements were selected as those farthest from the perimeter where the specimen was attached to the rigid test chamber.

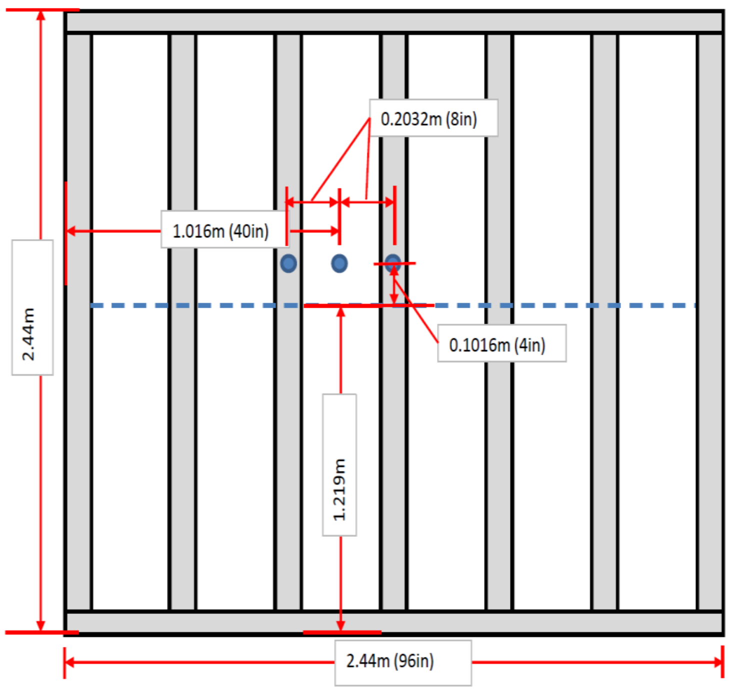

Figure 3: Displacement sensor locations.

2.3 Wind load cladding deflection test protocol

The wind load cladding deflection test protocol was conducted in accordance with ASTM E330 Procedure B[1] to wind loads calculated from information provided by the client (Appendix A) and load tables provided in the § on the Wind Load Resistance protocol of the *CCMC Technical Guide*[2]. The wind load aging protocol as well as the pressure levels tested are described in Figure 4 and Table 1. To be considered a pass, the cladding must be capable of resisting the positive and negative forces generated by the design wind loads without any fracture or permanent deterioration of the surfaces resulting from such design loads.

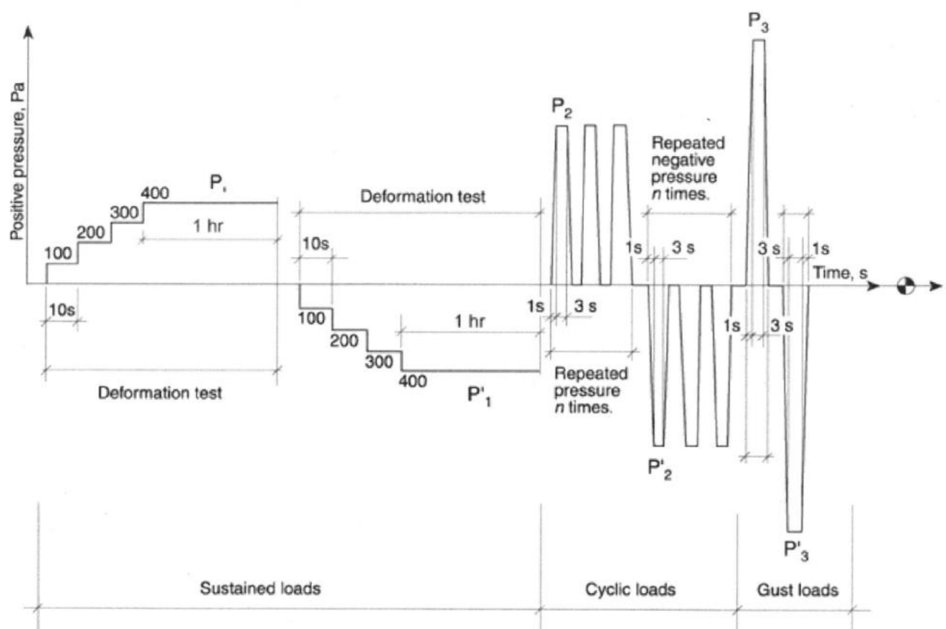

Figure 4: Wind Load Profile

Table 1: Wind load pressure levels for a 51.275m high building

	Step	Static Pressure (Pa)	Duration
Phase I - Static Sustained Loads @ P1 = Q_{50} = 0.5 kPa	1	0	10s
	2	100	10s
	3	200	10s
	4	300	10s
	5	400	10s
	6 (+P1)	500	1 hr
	7	0	10s
	8	-100	10s
	9	-200	10s
	10	-300	10s
	11	-400	10s
	12 (-P1)	-500	1 hr
Phase II - Cyclic Pressure Fluctuations	P2	± 1555	From 0 Pa to P2 in 1s, hold P2 for 3s, reduce to 0 Pa in 1s, repeat 2000 cycles (+ve 1000, and –ve 1000)
Phase III - Gust Loading	P3	± 2321	From 0 Pa to P2 in 1s, hold P2 for 3s, reduce to 0 Pa in 1s, repeat 2 cycles (one +ve, -ve gust)

3 Test results

As previously described in the section on *Instrumentation*, cladding deflection was determined at the centre of the stud cavity, and at the stud. The net cladding deflection was determined at each location (centre of stud cavity and stud) by subtracting the deflection of the stud and sheathing board from the total wall deflection.

During the portion of the test where negative cyclic loads acted on the test specimen, the steel studs on one side of the specimen buckled in their center height at approximately -800 Pa pressure. To complete the cladding deflection test, these studs were thereafter reinforced with plywood horizontal strapping. As the purpose of this evaluation was determining cladding deflection under loads, and not deflections of the test specimen, no assumptions are made regarding the performance of this wall configuration under field loading conditions. However, care should be taken to ensure that the steel stud gauge is properly selected for the expected wind loads in a full scale wall design. Photos of the buckled steel studs and plywood strapping that were used in the test are shown in Appendix B. Through visual observation the buckled studs did not have any effect on the cladding.

The cladding deflection at the stud locations was averaged and the deflection results for Phase 1 (static) load profile are presented in Table 2.

Table 2: Phase I Cladding Deflections

Applied Pressure (Pa)	Deflection of Cladding at Stud (mm)	Deflection of Cladding at Centre Stud Cavity (mm)
0	0	0
100	0.15	0.17
200	0.3	0.34
300	0.45	0.51
400	0.6	0.68
500	0.75	0.85
-100	-0.28	-0.32
-200	-0.56	-0.64
-300	-0.84	-0.96
-400	-1.12	-1.28
-500	-1.4	-1.6

The loading profile for the Phase 2 (Cyclic) load profiles is shown in Figures 5 and 6. These figures show the profiles of the net cladding deflection during an average positive and negative cycle. The deflection profile was determined from data gathered during numerous snapshots during the cycle. The maximum deflection measured during these cycles is presented in Table 3.

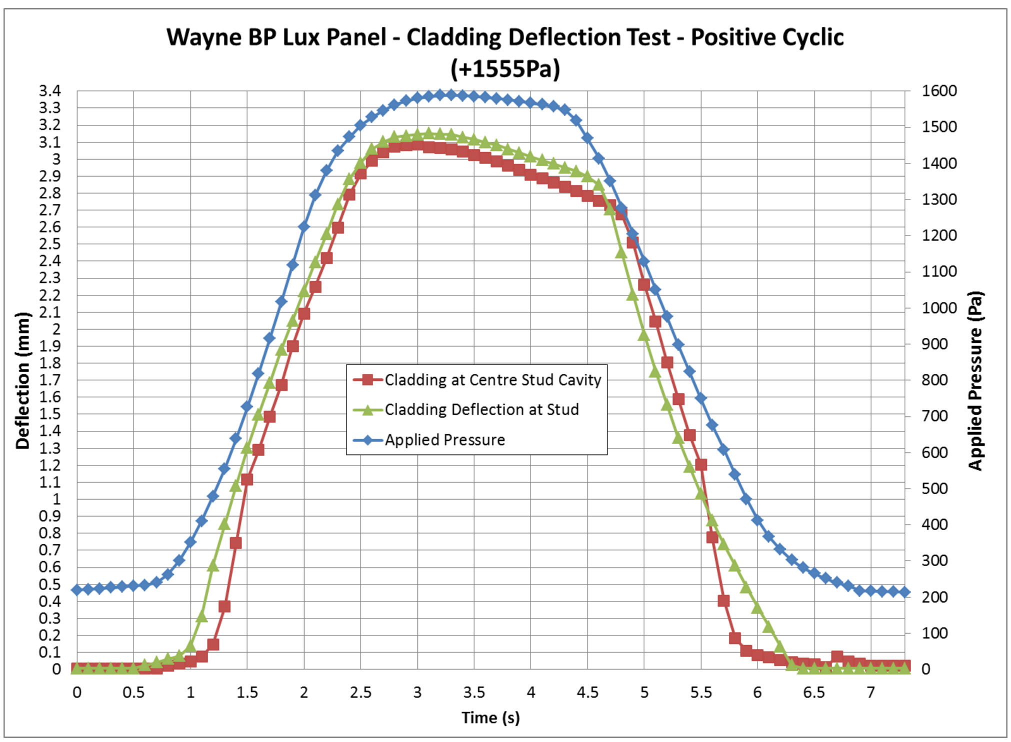

Figure 5: Representative cladding deflection test results during the positive cyclic applied pressure.

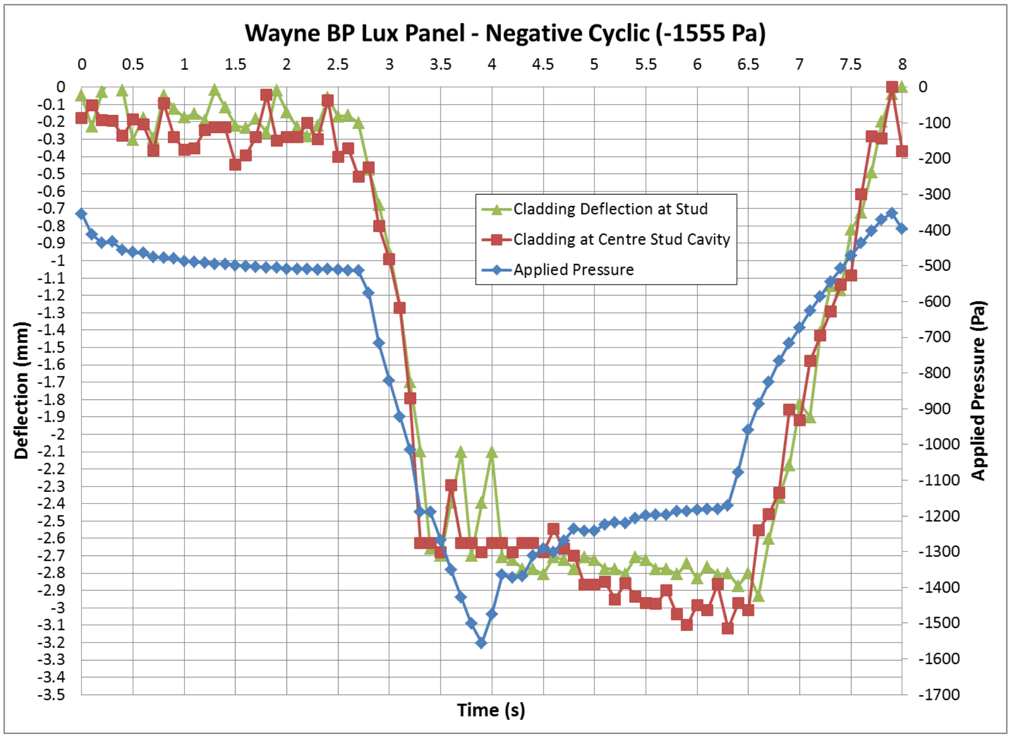

Figure 6: Representative cladding deflection test results during the negative cyclic applied pressure.

Cladding deflection profile during the Phase III loading protocol is shown in Figure 7 and 8 for the positive and negative loading protocols. The maximum deflection during the test is given in Table 3.

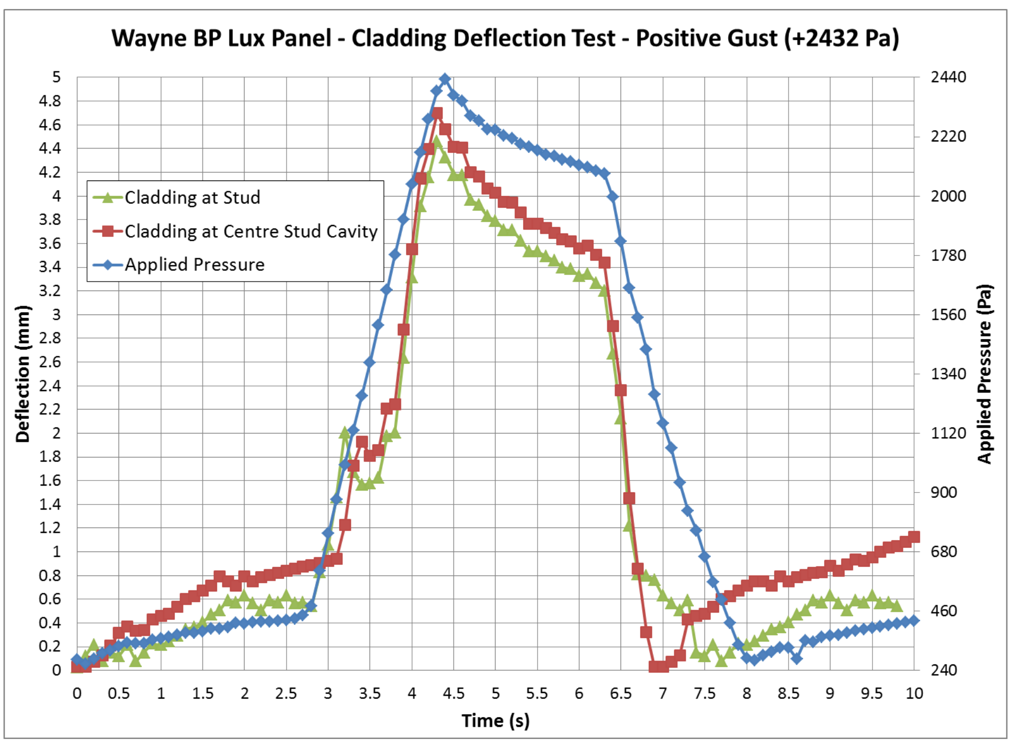

Figure 7: Representative cladding deflection profile during a positive gust loading

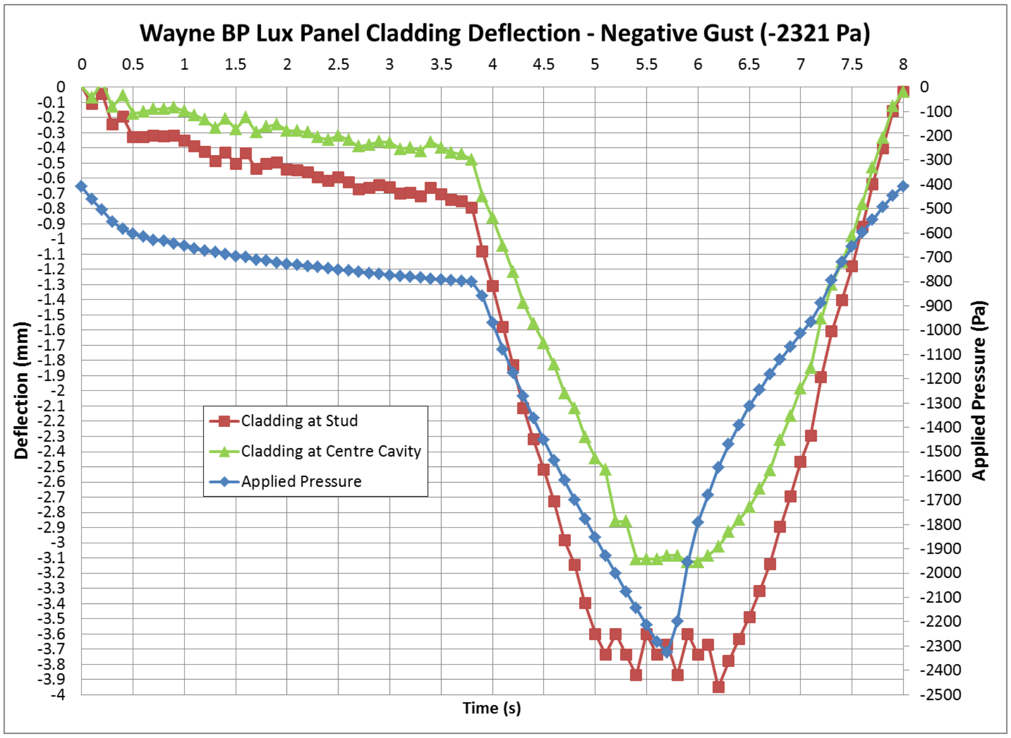

Figure 8: Representative cladding deflection profile during a negative gust loading

Table 3: Maximum pressure and deflections for Phases II and III

Pressure (Pa)	Cladding at Centre Cavity Deflection (mm)	Cladding at Stud Deflection (mm)
1588	3.09	3.15
-1556	-3.12	-2.93
2432	4.70	4.46
-2326	-3.13	-3.95

As provided in Table 3, a maximum cladding deflection of 4.7mm was measured during the positive gust cycle of +2432 Pa.

Visual observation before and after deflection testing indicated no permanent deflection or visually apparent degradation of the cladding.

4 Conclusion

The Wayne Building products Lux Panel cladding was subjected to a wind load cladding deflection test protocol, following that provided in ASTM E330[1]and a wind load aging protocol in accordance with that specified in the *CCMC Technical Guide*[2]*.* The pressure limits were determined from a combination of load information provided by the client for an Alberta location, as well as the levels specified in the *CCMC Technical Guide*[2] for a location with a building height of 51.25m and a Q_{50} of 0.5kPa, as provided by the client. The resulting cladding deflections were determined at centre of stud cavity and stud locations. Visual and measurement results of the cladding after testing showed that no permanent deterioration or fracture of the cladding occurred during testing. The measured deflection results showed that the maximum cladding deflection during testing was 4.70mm. It should be noted that although the cladding suffered no permanent deflection or visually apparent degradation during testing, this was not the case for the steel studs. During negative load testing the steel studs on one side of the specimen buckled at their center, and subsequently required support of horizontal plywood strapping to complete the cladding deflection testing.

Care should be taken when using this wall configuration in the field to ensure that the stud gauges are properly sized for the intended use.

Appendix A – Wind Load levels as provided by the Client for an Alberta Location

Centuria on Park

Cladding Desing wind loads

q 1/50 = 0.50 kPa
Category 2

Level	Height m	Ce	Wind kPa	Fact Wind kPa	Serv Wind kPa
Main	0	0.90	0.99	1.39	0.74
2	3.875	0.90	1.01	1.42	0.76
3	6.65	0.92	1.09	1.53	0.82
4	9.625	0.99	1.15	1.61	0.86
5	12.6	1.05	1.20	1.68	0.90
6	15.575	1.09	1.24	1.74	0.93
7	18.55	1.13	1.28	1.80	0.96
8	21.525	1.17	1.32	1.84	0.99
9	24.5	1.20	1.35	1.88	1.01
10	27.475	1.22	1.37	1.92	1.03
11	30.45	1.25	1.40	1.96	1.05
12	33.425	1.27	1.42	1.99	1.07
13	36.4	1.29	1.45	2.03	1.09
14	39.375	1.32	1.47	2.06	1.10
15	42.35	1.33	1.49	2.08	1.12
16	45.325	1.35	1.51	2.11	1.13
17	48.5	1.37	1.53	2.14	1.14
18	51.275	1.39	1.54	2.16	1.16
Roof	54.25	1.40	1.54	2.16	1.16

Loads indicates at levelx "x" are for cladding elements from level "x" to level "x+1"

Appendix B – Photos of Buckled studs and plywood strapping

Figure 9: Photo of one buckled stud. This occurred during the negative cycling at approximately -800Pa.

Figure 10: The buckled studs were straightened and reinforced with 3/4in plywood strapping so that the cladding deflection tests could be completed.