EVALUATION OF THE

STONETILE SYSTEM

FOR STEEL STUD WALL

APPLICATIONS

Prepared For:
Stonetile (Canada) Ltd.
2312 - 14A Street S.W.
Calgary, AB T2T 3X1

Prepared By:
AGRA Earth & Environmental Limited
221 - 16 Street SE
Calgary, AB T3E 6J5
Phone: (403) 248-4331
FAX: (403) 569-0737

R. Smith, P. Eng.

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AGRA Earth & Environmental

1.0 INTRODUCTION

AGRA Earth & Environmental Limited (AEE) was retained by Stonetile (Canada) Ltd. to conduct a test program to evaluate the "Pull-Off" and "Shear" strength of the "Stonetile" cladding system placed over a prototype steel stud and 'Z' bar wall system. The pull off testing was conducted to evaluate the effects of wind suction on the tiles and the adequacy of the attachment method. The shear testing was conducted to evaluate the ability of the proposed steel stud and 'Z' bar system to support the Stonetile system. Drawing #1, contained in Appendix 'A', illustrates the proposed wall system.

2.0 DESCRIPTION OF THE "STONETILE" SYSTEM

The "Stonetile" system consists of concrete tiles with embedded steel inserts on the back side which are fastened to the substrate. Detailed drawings and a complete description of the "Stonetile" are published in previous AEE evaluation reports and are available from Stonetile (Canada) ltd.

3.0 TESTING

3.1 TEST SAMPLES

Three 1 meter x 1 meter test samples were constructed by Stonetile (Canada) Ltd. for testing 52purposes. The wall design is shown in Diagram #1 and consists of standard 2x4 steel stud framed wall (500 mm o.c.) with 16 mm (5/8") gypsum board on the exterior. The drywall was covered with a 'peel and stick' air barrier. A series of horizontal 22 gauge 'Z' bar channels were installed every 300 mm (12") and were separated by 300 mm wide x 50 mm thick (12" x 2") sections of extruded polystyrene insulation (XPS). On each 1 meter x 1 meter test sample, three standard 300 mm x 450 mm Stonetile tiles were installed, as shown in Diagram #2, and attached with #6 'waferhead Tek screws'.

3.2 TEST PROCEDURES

3.2.1 Pull-Off Test

The top tile on each test sample was selected for pull-off testing. Two layers of 3/4" plywood, containing 4 vertical bolts, were bonded to the surface on each selected tile. An aluminum I-beam was attached to the bolts and connected to a hydraulic pump, ram, and load cell assembly. Diagram #3 illustrates the test setup. The panel was restrained at the edges and an increasing load was applied until the anchor bar prongs pulled past the tile below. The load and deflection data was recorded using a computer data acquisition system.
The panel was restrained in a vertical position and an increasing load was applied, via a hydraulic ram and load cell assembly, in a downward direction parallel to the tile surface. The load and deflection on the 'Z' bar was recorded to a maximum of 2230 N (500 lbs) using a computer based data acquisition system.

3.2.2 Shear Test

One lower tile on each sample was selected for testing. Two layers of 3/4" plywood were bonded to the surface on each selected tile, and two "J" hooks were screwed to the plywood such that the hooks hung over the bottom of the tile. Diagram #4 illustrates the test setup.

4.0 TEST RESULTS

4.1 PULL-OFF TEST

The test data obtained is shown in Table #1. Graphical representations of the data for each test are shown in Figures #1 - #3. Appendix 'A'. It should be noted that the maximum load represents the load at which the bottom prongs deflected and pulled past the tile below. The screw anchor connections at the top of the tile hangers did not fail and only minor deflection of the top of the tile hanger bars was observed.

Table #1

Pull-Off Test Data

Test Number	Pull Off Load (N)	Tile Area (M^2)	Pull-Off Pressure (kPa)
1	715	0.135	5.3
2	941	0.135	7.0
3	822	0.135	6.1

4.2 SHEAR TEST

Graphical representations of the data for each test are shown in Figures #4 - #6, Appendix 'A'. Observations of the system deflection indicated the deflections under maximum load were small (approx. 25 mm) with the majority of the deflection occurring in the 'Z' bar. It should be noted that the position of the XPS insulation between each 'Z' bar row provided additional support and resistance to deflection.

5.0 ANALYSIS OF DATA

5.1 PULL-OFF TEST

For comparison purposes, the maximum anticipated negative wind load pressure (suction) was calculated for various centres in Canada. The calculation was performed in accordance with subsection 4.1.8., 'Live Loads Due to Wind', of the 1995 National Building Code (95 NBC). Table #2 illustrates this calculation and presents the maximum anticipated cladding suction pressure for various centres in Canada. Please note that, in order to illustrate the 'worst case scenario', maximum coefficient values were selected. Additional positive pressures from behind the panel system were not taken into account as previous testing indicates that pressure equalization across the tile occurs quickly and therefore the force would be negligible.

Comparing the 95 NBC calculations to the obtained test data, the Stonetile cladding system satisfies the 95 NBC requirements for all the centres listed.

For further comparison, and using the 'worst case scenario' coefficients with a maximum suction pressure of 5.0 kPa, the Stonetile system would be acceptable for centres having a maximum hourly wind pressure up to 1.00 kPa. According to Appendix 'C' of the 95 NBC, the highest listed hourly wind pressure for any region in Canada is 0.79 kPa.

It should be noted that the maximum test load only related to the tile prongs pulling past the tile below. Neither the screws, tile hangers, or 'Z' bar showed any indications of significant or permanent damage during testing. This provides an extra level of safety with the system as the tiles should remain attached to the wall substrate even after a pull-off failure.

5.2 SHEAR TEST

The shear test was conducted to determine if the proposed steel stud and 'Z' bar system provided adequate strength to support the Stonetile tile system. As each tile is only supported by its anchor bars, only minimal 'tile-to-tile' loading would be expected. The shear load applied to the tile was approximately 25 times the weight of an individual tile. This high level of loading was performed to determine if and how the anchor system would fail. Inspection of the test samples indicated that all samples remained firmly attached to the 'Z' bar substrate and that insignificant deflection of the 'Z' bar and steel stud system would occur under normal tile loading. It should be noted that, inspection of the screw holes in the tile hangers and 'Z' bar found no evidence of deformation or deterioration.

6.0 CONCLUSIONS

From review of the test data and analysis, it can be concluded that the combination of the Stonetile system over the proposed steel stud and 'Z' bar mounting system, meet and exceed the live wind load requirements stated in the 1995 National Building Code. Further, the steel stud and 'Z' bar system provides more than adequate support against shear failure.

7.0 CLOSURE

AGRA Earth & Environmental Limited trusts this information meets your requirements. We thank you for the privilege of assisting you with this project and look forward to working with you in the future.

AGRA Earth & Environmental Limited

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Randy Smith, P.Eng.
Building Sciences and
Materials Testing Specialist
Materials Engineering Division

Reviewed by:

Kevin Spencer, P.Eng.

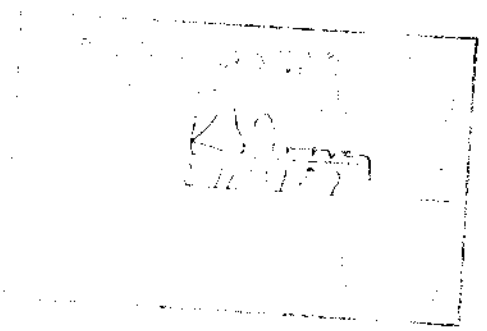

Table #2

Maximum Wind Induced Suction Pressure Levels on Cladding for Buildings Greater in Height Than Width (worst case scenario)

City	Hourly Wind Pressure (1/10) (kPa)	Exposure Coefficient C_e	Gust Coefficient C_g	External Pressure Coefficient C_p	Induced Pressure on Cladding (kPa)
Victoria	0.49	2.0	2.5	-1.0	-2.45
Vancouver	0.36	2.0	2.5	-1.0	-1.80
Calgary	0.40	2.0	2.5	-1.0	-2.00
Edmonton	0.32	2.0	2.5	-1.0	1.60
Saskatoon	0.36	2.0	2.5	-1.0	-1.80
Regina	0.34	2.0	2.5	-1.0	-1.70
Winnipeg	0.35	2.0	2.5	-1.0	-1.75
Thunderbay	0.30	2.0	2.5	1.0	1.50
Hamilton	0.36	2.0	2.5	-1.0	-1.80
Toronto	0.39	2.0	2.5	1.0	1.95
Ottawa	0.30	2.0	2.5	-1.0	-1.50
Quebec City	0.38	2.0	2.5	-1.0	-1.90
Montreal	0.32	2.0	2.5	-1.0	-1.60
Fredricton	0.30	2.0	2.5	1.0	-1.50
Halifax	0.40	2.0	2.5	-1.0	-2.00
Charlottetown	0.46	2.0	2.5	-1.0	-2.30
St. John's	0.60	2.0	2.5	-1.0	-3.00

Calculation: $P = q \times C_e \times C_g \times C_p$

where: P = Pressure exerted on cladding (Kpa)(negative value indicates suction)
q = Maximum hourly wind pressure (Kpa)(1995 NBC, Appendix 'C', 1/10)
C_e = Exposure Coefficient (maximum 2.0 for tall buildings)
C_g = Gust Coefficient (maximum 2.5 for cladding)