

**RESISTANCE TESTS CONDUCTED
ON MORTARLESS "NOVABRIK" BRICKS**

CRIQ File 670-PE17988

Technical Report

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MONTREAL, MAY 10, 1996

The tests were performed from April 10 to April 25, 1996 at CRIQ testing facilities in Montréal. The samples were received at CRIQ on April 10, 1996 and were disposed on May 6, 1996.

The following persons were involved in the project

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- Jean-Pierre Gagné, P. Eng.
- Michel Poulin, Technician
- Sébastien Pelletier, Technician
- Daniel Carrier, Technician

No specific tolerance applies to the data reported herein

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Total number of pages: 24 including 12 pages in appendices.

The results presented in this report refer only to the products described in this report.

The equipment and instrumentation used during this test were verified and/or calibrated. The calibration certificates are retraceable to the National Research Council of Canada (NRC) and/or to the American National Institute of Standards and Technology (NIST) standards and can be provided on request.

CRIQ is registered ISO 9001, certificate no. 167-0075-18. Tests department is also accredited by the National Council of Canada, certificate no. 138.

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1. MANDATE

Upon request by ALBA Inc. and the firm BPR Ingénieurs-conseils, the CRIQ (Quebec's industrial research centre) conducted resistance tests on various configurations of framing covered with the new mortarless brick called "Novabrik." The tests consisted of:

- bending tests on 2 in. x 4 in. stud wall sections;
- wind suction test on brick;
- shear test on brick attachments installed on a roof truss.

The testing parameters were defined by the firm BPR Ingénieurs-conseils. These parameters are described in the Appendix. However, certain test conditions have been adapted and modified. These changes are described in this report.

2. BENDING TESTS ON WALL SECTIONS

2.1 Description of samples

Three samples were prepared for these tests. These samples were given the identification numbers E005796-4, E005796-5 and E005796-6.

The three sample walls were 8 ft. high by 48 in. wide. They contained 2 in. x 4 in. studs spaced 16 in. apart and linked by a girt at mid-height. The walls were installed on a base that featured joists and flashing identical to a section of floor. The studs were MSR 2100f-1.8E quality and homogeneously resistant. The samples were built according to the diagram in Figure 15 attached, except for Sample E005796-4. Detailed information on the materials in each sample is shown in the shaded areas of Table 2.1.

Table 2.1
Materials Installed on Samples

Sample	Fibreboard	Rigid insulation 2 in.	Fillers 1 in. x 3 in.	"Novabrik" bricks
E005796-4				
E005796-5				
E005796-6				

The laths were installed on the rigid insulation relative to each stud using 4-in.-long no. 10 wood screws. A horizontal lath was screwed to the base of the wall to enable installation of a steel "starter" for attaching the first row of bricks.

2.2 Methodology and test set-up

The test set-up is illustrated in Figure 2.1. The wall sample was blocked by two beams, one at the base and one at the top. Rectangular tubes measuring 3 in. x 2 in. x 4 ft. wide were installed on these beams. They were used as a contact surface with the sample along their 3-in. side. The vertical distance between the centres of two tubes was 88 inches. On the other side of the wall, the bending force was applied at mid-height (at the centre of the two beams) by a hydraulic jack powered by a manual pump. The contact surface used to push on the wall was a steel tube measuring 3 in. x 3 in. x 4 ft. wide, covered with a strip of fibreboard.

Two dial gauges were installed beside the supports, at each end of the sample, to measure the application of the pressure. Gauge D1 was placed at the left side of the sample, and Gauge D2 was installed on the right side, as shown in Figure 2.1.



Figure 2.1 Test set-up for bending tests

2.3 Results obtained

On samples E005796-4 and E005796-6, the bending force was applied to the stud-wall side. For Sample E005796-5, the bending force was applied on the brick side. The results are shown in tables 2.2 to 2.4.

For the three samples, note that the values of the displacement measured are relatively similar. This indicates a good homogeneity of bending resistance in the studs used to build the samples. The force was applied until the studs ruptured. For their protection, the dial gauges were removed at the first signs of rupture. For all samples, the stud tension fibres revealed ruptures in a zone situated within approximately 10 in. of the application of the bending force, at the moment where bending moment is at its maximum.

Table 2.2
 Sample E005796-4
 Bending Force Applied to Stud-Wall Side

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)
500	0.124	0.153
1 000	0.322	0.329
1500	0.530	0.515
2 000	0.740	0.708
4 275 (maximum force)	Not available	Not available

Table 2.3
 Sample E005796-6
 Bending Force Applied to Stud-Wall Side

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)
1 000	0.225	0.338
2 000	0.540	0.782
3 000	0.890	1.155
3 500	1.058	1.342
4 000	1.240	1.531
5 806 (maximum force)	Not available	Not available

Table 2.4
 Sample E005796-5
 Bending Force Applied to Brick Side

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)
1 000	0.212	0.190
2 000	0.537	0.559
3 000	0.872	0.885
3 500	1.045	1.062
4 000	1.253	1.253
5 892 (maximum force)	Not available	Not available

3. WIND SUCTION TEST ON BRICK

3.1 Description of sample

One sample was prepared for this test, and given the identification number E005796-3.

The sample was a wall 8 ft. high by 48 in. wide, built with 2 in. x 6 in. studs spaced 16 in. apart. The wall was installed on a base that contained joists and flashing identical to a section of floor. The studs were "STUD" quality. The sample was built as shown in the diagram in Figure 15 (see Appendix), with 2-in. rigid insulation.

3.2 Methodology and test set-up

The wall sample was installed on the test set-up described in Section 2.2, except that the force applied was modified. Figure 3.1 illustrates the set-up. To simulate wind suction on brick, four sheets of ½ -in. plywood measuring 12 in. wide by 15 in. high covered with fibreboard were used to apply force from behind the bricks. The plywood covered an area of 32 in. high by 28 in. wide, with 4 in. of space between those on the right and those on the left, and 2 in. between those on top and those on the bottom.

The plywood was mounted on a rigid frame fitted with swivel joints to contour the deformation of the brick during the thrust. The force, applied by a hydraulic jack on the frame, was uniformly distributed over the four sheets of plywood (thrust boards). The fibreboard in the sample and the rigid insulation were cut to fit the plywood.

Two dial gauges were installed next to the support beams. The Gauge D1 was placed at the centre of the upper-right plywood sheet, and Gauge D2 was installed at the centre of the lower-left plywood sheet (see Figure 3.2).

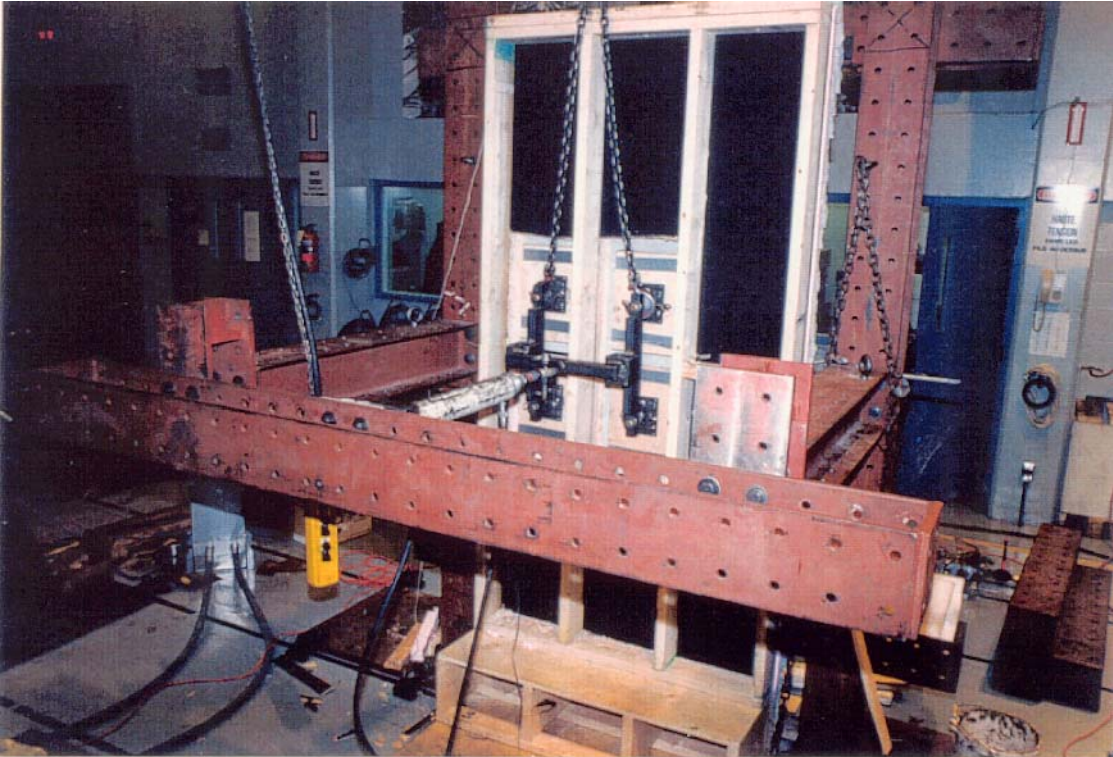


Figure 3.1 Test set-up for suction test

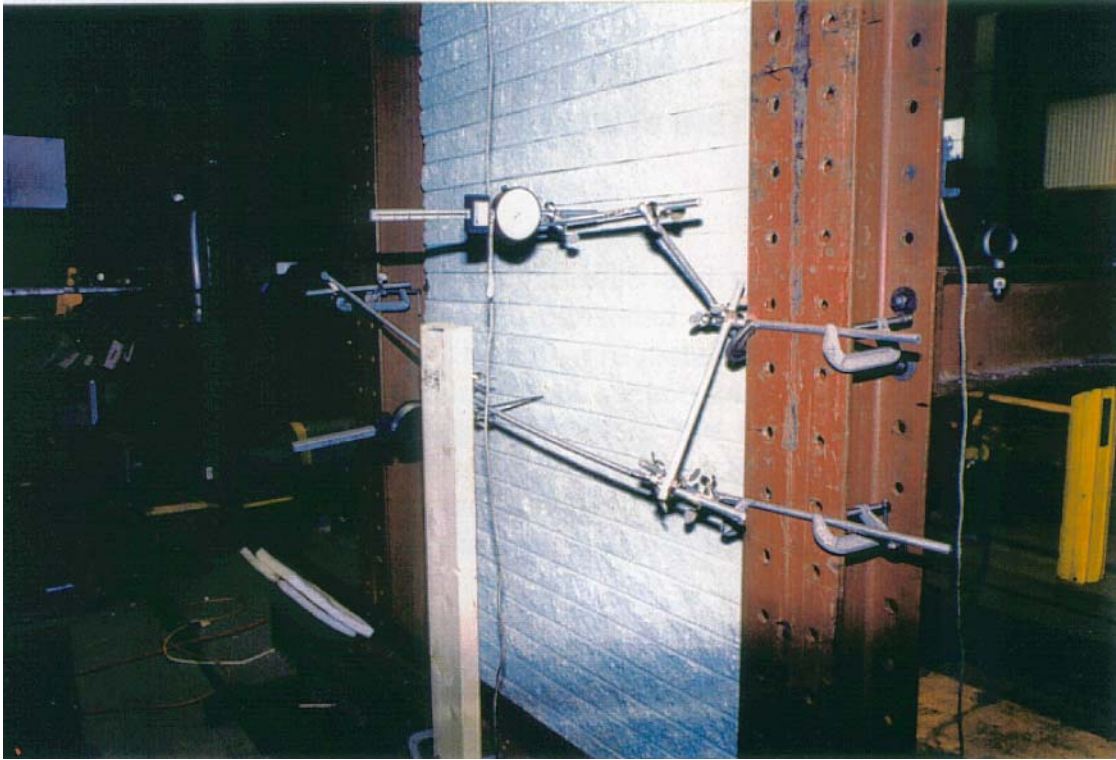


Figure 3.2 Positions of dial gauges

3.3 Results obtained

The results are shown in Table 3.1. Note that the values of the displacements measured are relatively similar. This indicates a good distribution of the force over the thrust boards. The force was applied until one of the brick attachments detached or ruptured. For their protection, the dial gauges were removed at the first signs of rupture. When the maximum force of 1,485 lb. was reached, corresponding to a pressure of 2.06 psi under each of the plywood sheets, the screws that held the laths on the studs were forced out of the studs.

Table 3.1
Sample E005796-3
Force Applied behind the bricks

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)
200	0.020	0.025
300	0.046	0.050
400	0.079	0.077
500	0.105	0.105
600	0.131	0.128
700	0.156	0.155
800	0.184	0.178
900	0.216	0.205
1,485 (maximum force)	Not available	Not available

4. SHEAR TEST ON BRICK ATTACHMENTS INSTALLED ON A ROOF TRUSS

4.1 Description of sample

One sample was prepared for this test, and was assigned the identification number E005796-7. The sample consisted of a roof truss 8 ft. high by 29 ft. wide, upon which "Novabrik" bricks were installed. Figures 4.1 and 4.2 illustrate the sample under construction. A roof section 24 in. wide was built to reproduce a standard roof truss installation. Before the bricks were installed, strips of plywood and laths were installed according to Sketch No. 1 (see Appendix). A steel "starter" was used to install the first row of bricks. The bricks were then screwed onto the laths every four rows with 2 1/2-in. long no. 8 screws.

The bricks were installed over the entire truss, up to a height of 77 in. so as to obtain a width of 91 in. and a height of 22.5 in. without bricks at the top of the truss, to apply the vertical shear force.

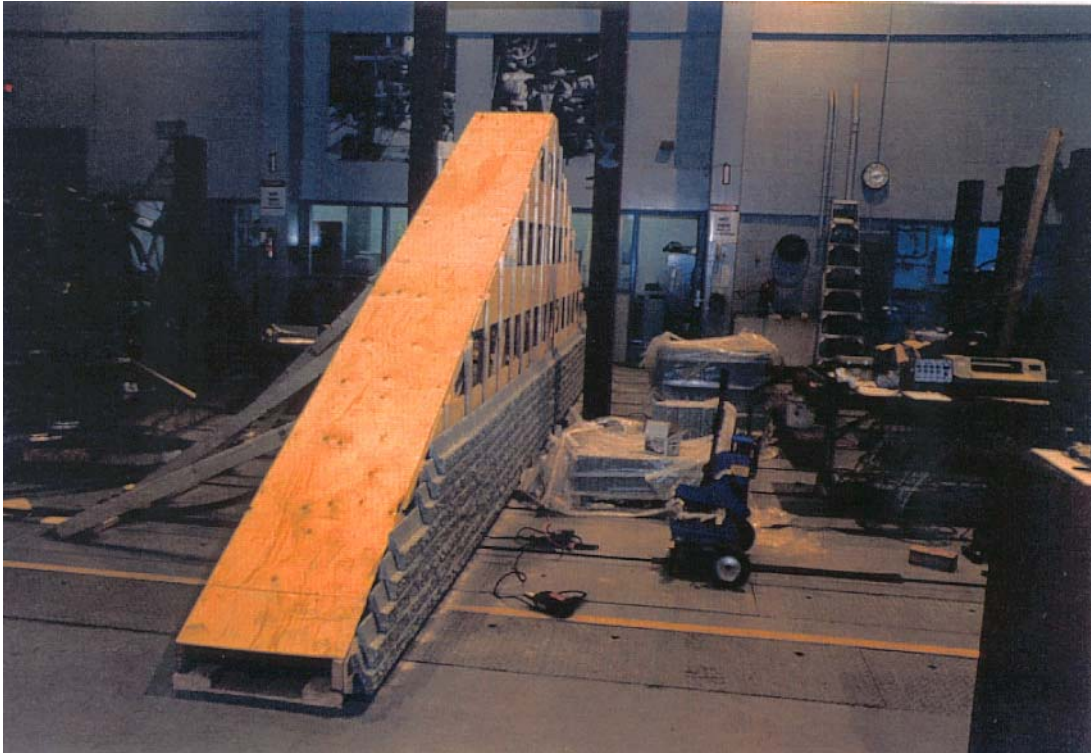


Figure 4.1 Sample under construction

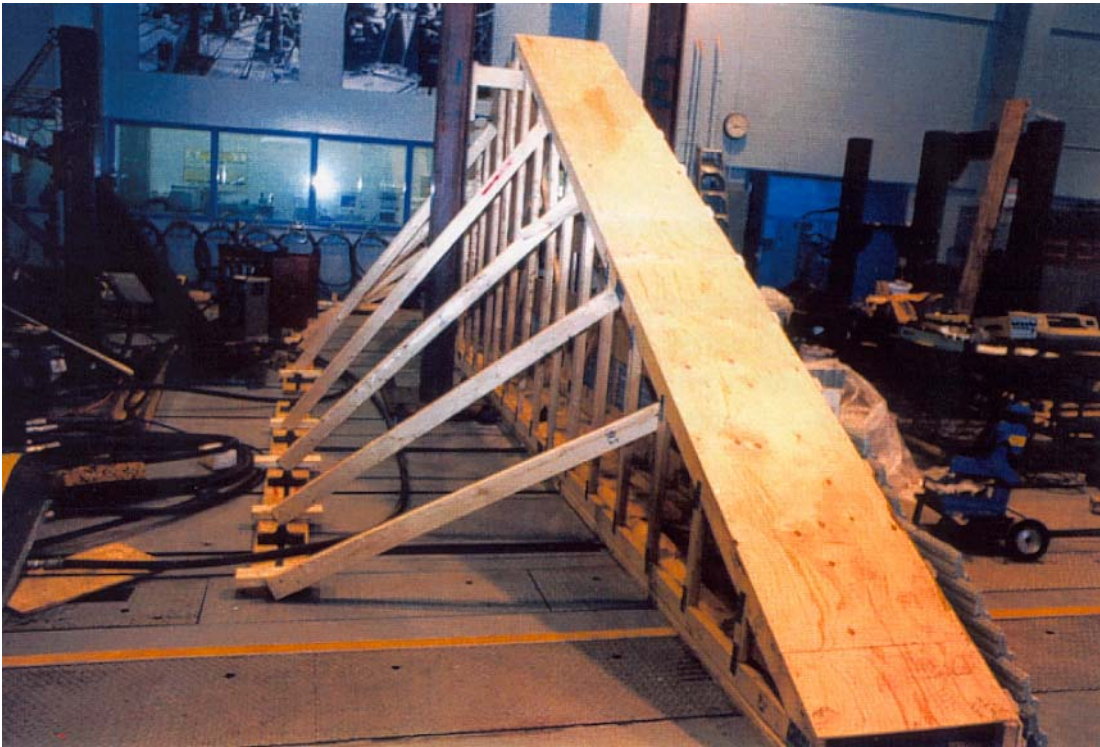


Figure 4.2 Sample under construction

Two sheets of 1/2 in. plywood 6 ft. high by 24 in. wide (1/2 in. thick) were screwed opposite each other on the central chords of the two trusses used to build the sample (vertical chord situated at the centre of each roof truss). This change was made upon request by ALBA Inc. and BPR Ingénieurs-conseils after a lack of rigidity was noted at the centre of the sample.

4.2 Methodology and test set-up

A mechanical arch was installed above the sample to allow a hydraulic jack to be suspended over the centre of the truss, above the rows of bricks. The vertical shear force was applied over the entire width (91 in.) of the last row of bricks by means of a steel surface measuring 3 in. wide by 91 in. long. This surface was covered with a layer of fibreboard. A row of half-bricks was laid on the side of the last row of bricks to increase the contact surface during application of the force.

A cable sensor (D1), was installed on the hydraulic jack to measure the vertical displacement of the beam that applied the force. Two dial gauges were positioned opposite each other at the centre of the sample, at a height of 50 in. up the side of the brick (D2) and on a lath inside the roof section (D3).

A 10,000-lb. load cell was installed on the hydraulic jack for the first test. It was replaced by a 25,000-lb. load cell for the second test.

4.3 Results obtained

Two tests were conducted on the sample. During the first test, the capacity limits (10,000 lb.) of the load cell used did not enable any component's rupture or detachment point to be reached. A second test was then conducted, using a 25,000-lb. load cell. Tables 4.1 and 4.2 show the results of these tests.

The rupture mode observed consists of fragile fractures of the bricks themselves, mainly in the four upper rows of bricks, just below the bar that applied the force. In addition, certain screws were torn from the laths. Figure 4.3 illustrates the condition of the truss and the bricks after the test.



Figure 4.3 Condition of sample after shear test

Table 4.1
 Sample E005796-7 Test number 1
 Vertical Shear Force Applied Above Last Row of the Bricks

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)	Displacement D3 (in)
1 000	0.122	0.015	0.008
1 500	0.152	0.024	0.017
2 000	0.186	0.030	0.028
2 500	0.224	0.038	0.038
3 000	0.254	0.050	0.055
3 500	0.288	0.062	0.065
4 000	0.320	0.076	0.075
4 500	0.356	0.099	0.085
5 000	0.387	0.122	0.100
5 500	0.420	0.140	0.113
6 000	0.457	0.157	0.130
6 500	0.551	0.204	0.180
7 000	0.601	Not available	Not available
7 500	0.626	Not available	Not available
8 000	0.655	Not available	Not available
8 500	0.690	Not available	Not available
9 000	0.717	Not available	Not available
9 500	0.736	Not available	Not available
10 000	0.771	Not available	Not available

Table 4.2
Sample E005796-7 Test number 2
Vertical Shear Force Applied Above Last Row of the Bricks

Force (lbf)	Displacement D1 (in)	Displacement D2 (in)	Displacement D3 (in)
2 500	0.113	0.050	0.047
3 000	0.130	0.060	0.051
4 000	0.169	0.082	0.071
5 000	0.200	0.105	0.099
6 000	0.266	0.126	0.119
7 000	0.255	0.150	0.139
8 000	0.286	0.172	0.153
9 000	0.309	0.187	0.167
10 000	0.322	0.202	0.180
11 000	0.358	0.221	0.201
12 000	0.383	0.241	0.220
13 000	0.426	Not available	Not available
14 207 (maximum force)	0.482	Not available	Not available

5. INSTRUMENTS USED

The following instruments were used during testing:

- Signal conditioner, Vishay, model 2160, s/n 5284.
- Signal conditioner, Vishay, model 2160, s/n 24474.
- Variable resistor, J.J.Lloyd, model R41, s/n 1-86.
- Load cell, Lebow, model 3124-20K, s/n 420.
- Load cell, Lebow, model 3124-10K, s/n 430.
- Load cell, Lebow, model 3124-25K, s/n 4134.
- Cable potentiometer, Celesco, model PT101-0010-111-5110, s/n A79103.
- Two 6 in. dial extensometers, Starett, s/n Q-155-149 and Q-155-150.
- Multimeters Fluke, model 8060A, s/n 4155239 and 6535192.
- Data acquisition system, Global Lab, model DT2829, s/n 08616.

6. CONCLUSION

Three types of tests were conducted. The five samples evaluated in this report were built at the CRIQ, and four of the samples were covered with "Novabrik" bricks provided by ALBA Inc. The samples were built according to recommendations from BPR Ingénieurs-conseils Inc., ALBA Inc. and CRIQ representatives.

The following tests were conducted:

- bending tests on three wall sections of 2 in. x 4 in. stud walls;
- wind suction test on brick on one wall section;
- shear test on brick attachments on a roof truss installed in a standard manner in a roof section.

Regarding the bending tests on wall sections, one can observe an average increase in bending rigidity of 35% on the samples covered with "Novabrik" bricks, 2-in. rigid insulation and laths. This comparison was based on a test conducted on sample E005796-4, which was covered with a piece of fibreboard only.

The test conducted to simulate the effect of wind suction on the brick demonstrated that a pressure of 2.06 psi, applied behind the brick to an area of around 869 sq. in. was necessary to cause the screws that held the laths on the studs to detach.

The shear test on brick attachments installed on a roof truss revealed that a force of 14,207 lb., applied under the conditions described in Section 4, was required to cause the upper bricks to rupture.

The tests included in this project were conducted according to the plans and specifications proposed by BPR Ingénieurs-conseils (see Appendix).

The results of these tests have been sent to BPR for further analysis.

APPENDIX

Testing protocol proposed by BPR Ingénieurs-conseils

ALBA PRODUCTS INC.

NOVABRIK BRICKS

REFERENCE: S95-0023

NOVABRIK BRICK BY ALBA-REQUIRED STRUCTURAL TESTS

Name of test

2. Effect of rigidity of brick on bending resistance of 2 in. x 4 in. and 2 in. x 6 in. studs.

Test objective

To verify whether the bending resistance of a wall built with 2 in. x 4 in. and 2 in. x 6 in. studs is increased if a brick veneer is added.

Description of set-up

Build one (1) wall section 4 ft. wide x 8 ft. high, with 2 in. x 4 in. studs @ 16 in. and 2 in. x 6 in. studs @ 16 in. Connect the studs by a girt at mid-height. The wood will be of MSR 2100f-1.8E quality, with known homogeneous resistance between pieces. Make a second wall section by adding a veneer of Novabrik bricks installed as indicated in Figure 15 of the Novabrik installation guide.

Methodology

Apply a horizontal force at the centre of the span of each stud until the studs rupture. Conduct the same procedure on the brick until the studs rupture. The deflections of the studs must be measured for each set-up.

Results to present

Present the rupture force data for each of the two (2) set-ups and provide a displacement curve according to the force applied at the stud centre.

Québec City, February 27, 1996

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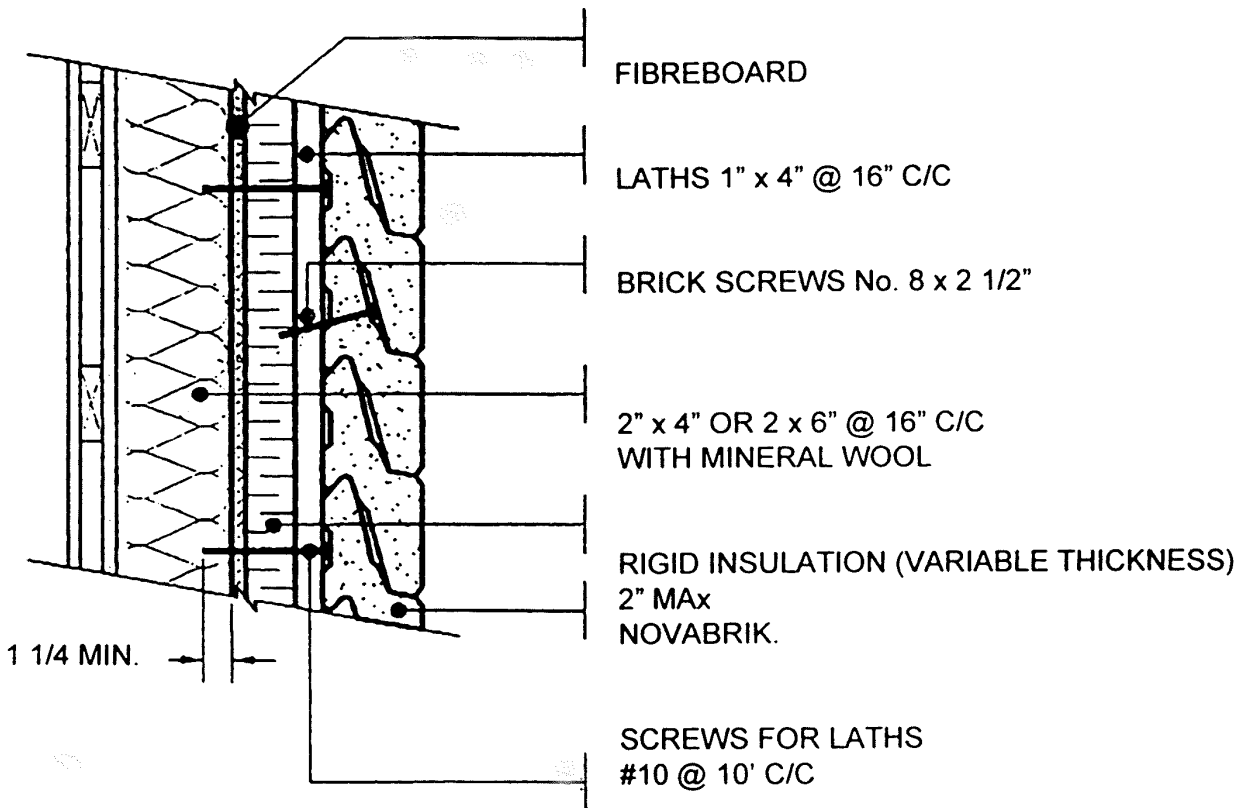


FIGURE #15

WALL WITH EXTERIOR INSULATION

ALBA PRODUCTS INC.

NOVABRIK BRICKS

REFERENCE: S95-0023

NOVABRIK BRICK BY ALBA-REQUIRED STRUCTURAL TESTS

Name of test

3. Effect of wind suction on brick attachments.

Test objective

To determine the traction resistance of Novabrik brick attachments under wind suction, as recommended by the National Building Code of Canada.

Description of set-up

Build one (1) wall section 4' wide x 8' high, with 2" x 6" studs @ 16" c/c SPF No.1/No. 2. Install the brick veneer as shown in Figure 15 of the Novabrik installation guide.

Methodology

Apply a uniform suction force to the brick until the attachments detach. Measure the displacement of the brick veneer in relation to the force applied.

Results to present

Present the rupture force data for the brick attachments as well as the displacement curve according to the suction applied.

Québec City, February 27, 1996

ALBA PRODUCTS INC.

NOVABRIK BRICKS

REFERENCE: S95-0023

NOVABRIK BRICK BY ALBA-REQUIRED STRUCTURAL TESTS

Name of test

1. Attachment of brick to lateral facades (gables)

Test objective

To verify the resistance to shearing of brick attachments on lateral facades (gables).

Description of set-up

Use a roof truss 30' long by 8' high, upon which sheets of plywood 1/2" by 12" wide are installed at 24" c/c. On the lower chord of the truss, attach a continuous strip of plywood 1/2" by 6" wide. Screw the 1" x 3" laths vertical @ 16" c/c onto the horizontal sheets of plywood. Attach the brick to the laths, as described in Figure 15 of the Novabrik installation guide. The wood used for the test will be SPF Not/No. 2 quality and the plywood will be Canadian softwood.

Methodology

Apply a concentrated force to five (5) points on the upper row of bricks at a rate of 2,000 lbs total/minute until one of the assemblage components ruptures. Measure the displacement of the brick in relation to the roof truss under various degrees of force.

Results to present

Present the capacity limit of the assemblage (upon rupture) as well as the displacement curve in relation to the force applied. This will indicate the force that can be applied to the assemblage before apparent deformations occur.

Québec City, February 27, 1996

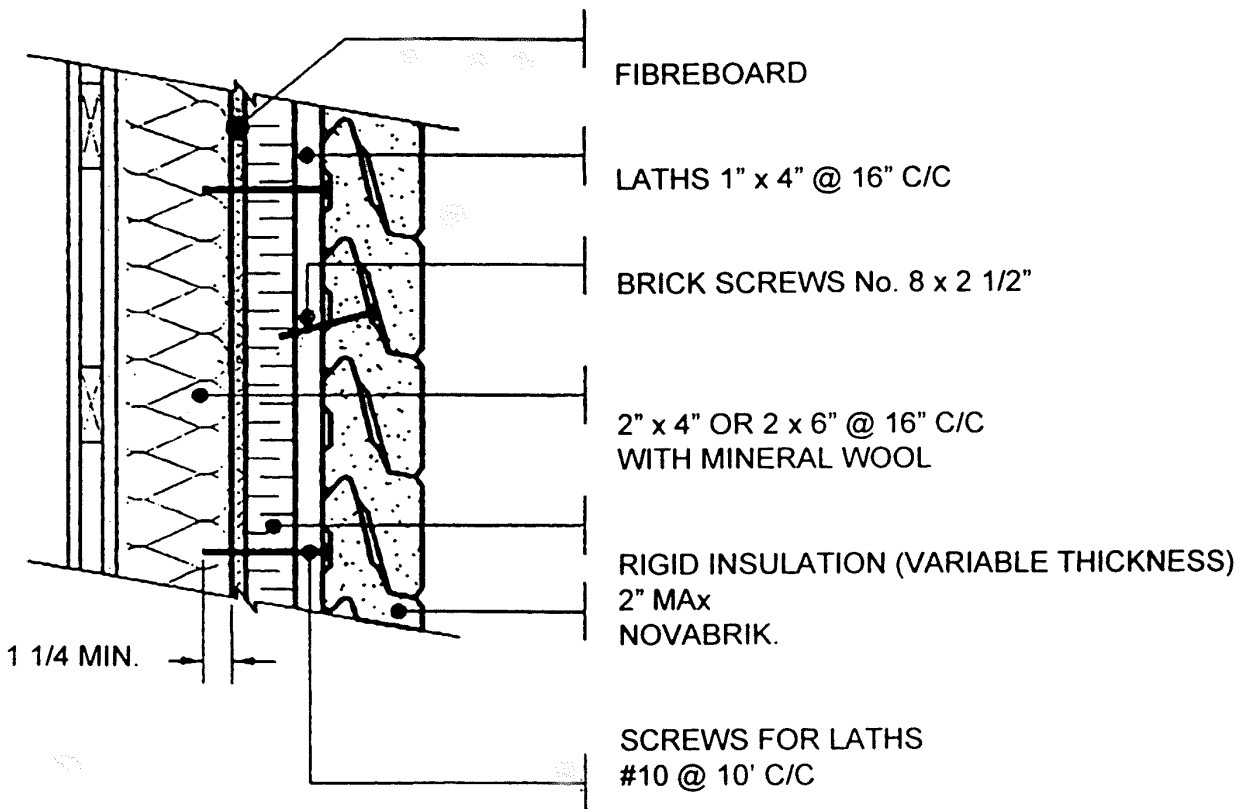
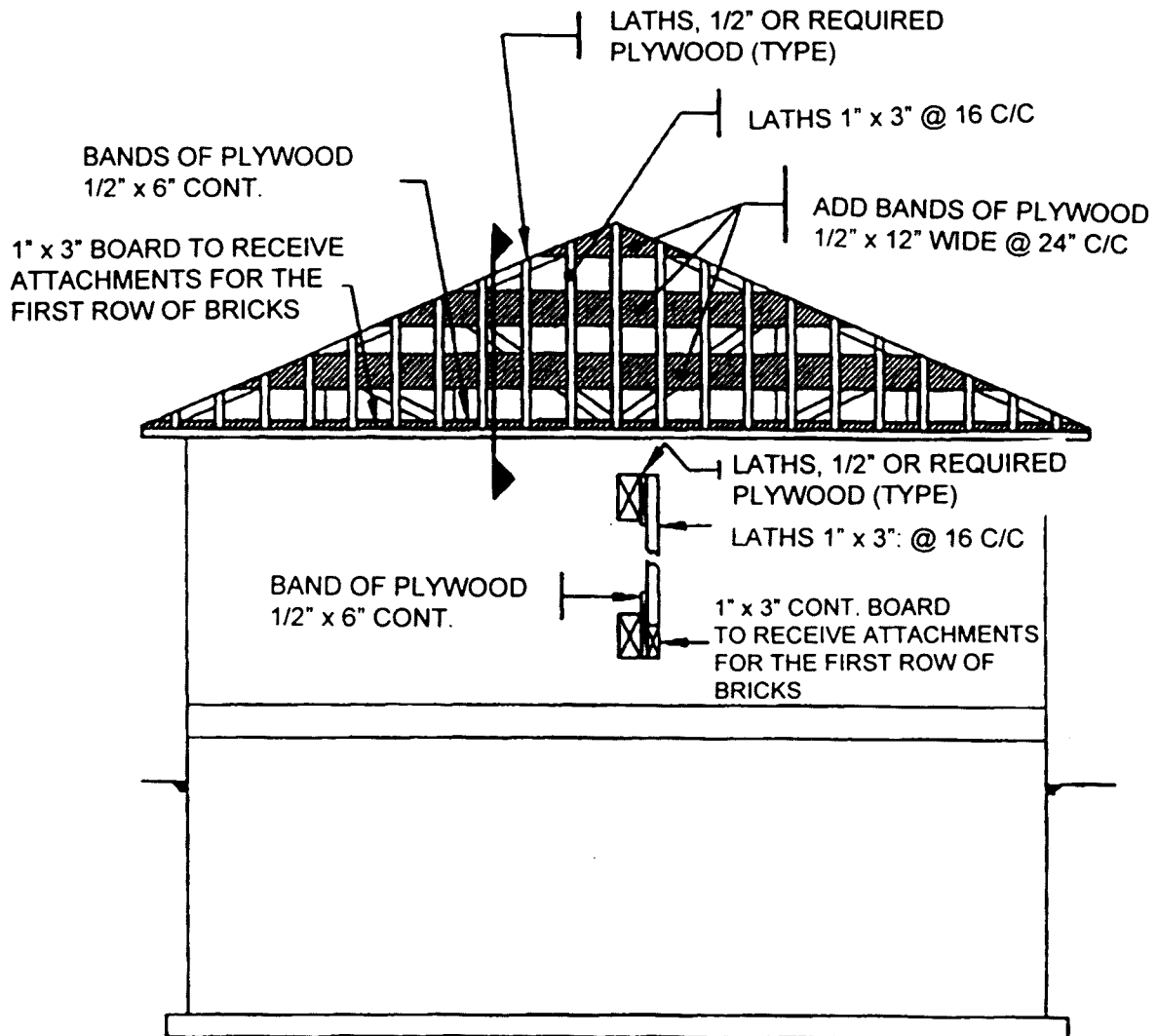


FIGURE #15

WALL WITH EXTERIOR INSULATION



NOTE : - REPLACE EXISTING FIBREBOARD WITH PLYWOOD. MINIMUM QUALITY OF PLYWOOD: SPF/NORTH (CANADIAN SOFTWOOD) EXTERIOR TYPE.

- THE VERTICAL CHORD OF THE TRUSS END MUST BE CONVERTED TO THE VERTICAL CHORD OF THE ADJACENT TRUSS BY A 1/2" PLYWOOD PANEL AT TWO-THIRDS OF ITS HEIGHT

REINFORCEMENT OF LATERAL FACADES