Rigid Roof Tile Wind Load Analysis

Subject: "S" 80 Clay Roof Tile with Foam Tile Adhesive

Report 84047.01-122-34

Rendered to:

CLAYMEX BRICK & TILE CO.
2224 Del Rio Hwy, P.O. Box 3398
Eagle Pass, Texas 78852

Prepared by:

John H. Waskow, P.E.
Brady W. McNaughton

Architectural Testing, Inc.
130 Derry Court
York, Pennsylvania 17406

June 19, 2008

STATE OF TEXAS
JOHN H. WASKOW
78232
REGISTERED PROFESSIONAL ENGINEER

John H. Waskow P.E.
Digitally Signed by: John H. Waskow

John H. Waskow, P.E.
Director – Regional Operations - Texas
2008.06.30 12:51:11 -05'00'

Brady W. McNaughton
Digitally Signed by: Brady W. McNaughton

Brady W. McNaughton

Scope

Architectural Testing, Inc. was contracted by Claymex Brick & Tile Co. to determine the wind load capacities for their "S" 80 clay roof tiles secured with an expanding foam tile adhesive. The methods of the 2006 International Building Code were employed to establish the allowable wind loads on the tiles. The allowable wind loads are compared to the results of performance testing of Claymex "S" 80 clay roof tiles (Architectural Testing, Inc. Report 78967.01-801-44).

References utilized for this project include:

2006 International Building Code. International Code Council, Inc., 2006.

ASCE 7-05 Minimum Design Loads for Buildings and Other Structures. American Society of Civil Engineers, 2005.

Performance Test Report: *CLAYMEX "S" 80 Clay Roof Tile*. Test Report No. 78967.01-801-44, Architectural Testing, Inc., Revised 06/30/08.

Analyses

Wind Load on Rigid Tile

The methods of ASCE 7-05 Chapter 6 and the 2006 International Building Code Equation 16-35 are used to establish the wind pressures and aerodynamic uplift moment on the rigid roof tile for the following various site conditions:

Basic Wind Speeds:	110 MPH, 120 MPH, 130 MPH (3-second gust)
Project Exposure:	B or C
Project Importance:	1.0
Directionality Factor:	$K_d = 0.85$
Mean Roof Heights:	15 ft, 30 ft, 40 ft
Roof Types:	Gable ($\theta \leq 7°$), Gable/Hip ($7° < \theta \leq 27°$), Gable ($27° < \theta \leq 45°$), Hip ($\theta \leq 25°$)

Calculations of the aerodynamic uplift moments for the various site conditions are presented on Page 4 and Page 5 with a sample calculation on Page 6. Roof zones are as defined in the figure on Page 7.

Installation

As reported in Architectural Testing, Inc. Test Report 78967.01-801-44, Claymex "S" 80 style clay roof tiles are installed to bitumen type self-adhesive roof underlayment. Underlayment is applied with a 10" overlay and secured with 1" ring shank button cap nails at 12" on center. Clay tiles are then adhered to the underlayment at three places with Dow Tile Bond™ one part expanding foam adhesive. A 1-1/2" wide x 1" deep x 6" long pad of foam located at the head of the tile secures the tile to the underlayment, a 1-1/2" wide x 1" deep x 4" long pad of foam located at the nose of the tile secures the tile to the previous course, and a 1-1/2" wide x 1" deep x 4" long pad of foam located near the nose of the tile at the exposed side secures the tile to the adjacent course.

Comparison to Test Results

The Claymex "S" 80 style clay roof tile was tested to SSTD 11-99 as reported in Architectural Testing, Inc. Test Report No. 78967.01-801-44. Here, the allowable overturning moment for the tile is established. The allowable overturning moments are compared to the calculated aerodynamic uplift moment. If the allowable overturning moment exceeds the calculated aerodynamic uplift moment, the tile and its associated installation technique are deemed acceptable. Results for acceptable installations are summarized in the following table.

Table 1 Acceptable Installations

Roof Type	Exposure	Wind Velocity (mph)	Mean Roof Height (ft)
Gable ($\theta \leq 7°$)	B	110	≤40
		120	≤40
		130	≤40
	C	110	≤40
		120	≤40
		130	≤30
Gable/Hip ($7° < \theta \leq 27°$)	B or C	110	≤40
		120	≤40
		130	≤40
Gable ($27° < \theta \leq 45°$)	B or C	110	≤40
		120	≤40
		130	≤40
Hip ($\theta \leq 25°$)	B or C	110	≤40
		120	≤40
		130	≤40

Note: Installation in any area other than those specified in the table may result in an aerodynamic uplift moment greater than that of the tested roof tiles.

Rigid Tile Uplift Resistance

2003 International Building Code 1609.7.3

Manufacturer: Claymex
Style: Spanish Roof Tile
Material: Clay

Test Report: 78967.01-801-44
Fastener: Expanding Foam Roof Tile Adhesive
Fastener Location: Head of the tile to the batton, nose of the tile to the previous course, nose of the previous course at the exposed edge
Deck: 7/16 OSB with bitumin type self adhesive underlayment secured with 1" ring shank button cap nails at 12" oc
Allowable Overturning Moment: 57.5 ft-lb

Exposed Width of Tile (b): 0.958 ft
Lift Coefficient (C_L): 0.2 (0.2 or determined by test)
Length of Tile (L): 1.656 ft
Moment Arm (L_a): 1.258 ft

Roof Type: Gable $\theta \leq 7°$
GC_p: -2.80 (Roof Zone 3)
Exposure: B

h (ft)	K_z
15	0.70
30	0.70
40	0.76

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	18.4	21.9	25.7	18.4	22.0	25.8	20.0	23.8	28.0
M_o (ft-lb)	28.0	33.3	39.1	28.0	33.3	39.1	30.4	36.2	42.4
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Roof Type: Gable/Hip $7° < \theta \leq 27°$
GC_p: -2.60 (Roof Zone 3)
Exposure: B

h (ft)	K_z
15	0.70
30	0.70
40	0.76

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	18.4	21.9	25.7	18.4	22.0	25.8	20.0	23.8	28.0
M_o (ft-lb)	26.5	31.5	37.0	26.5	31.6	37.0	28.8	34.3	40.2
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Roof Type: Gable $27° < \theta \leq 45°$
GC_p: -1.20 (Roof Zone 3)
Exposure: B

h (ft)	K_z
15	0.70
30	0.70
40	0.76

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	18.4	21.9	25.7	18.4	22.0	25.8	20.0	23.8	28.0
M_o (ft-lb)	16.2	19.3	22.6	16.2	19.3	22.6	17.6	20.9	24.6
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Roof Type: Hip $\theta \leq 25°$
GC_p: -1.70 (Roof Zone 2)
Exposure: B

h (ft)	K_z
15	0.70
30	0.70
40	0.76

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	18.4	21.9	25.7	18.4	22.0	25.8	20.0	23.8	28.0
M_o (ft-lb)	19.9	23.6	27.8	19.9	23.7	27.8	21.6	25.7	30.2
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: $q_h = 0.00256V^2K_dK_zK_zI$ where $K_d = 0.85$, $K_t = 1.00$ and $I = 1.00$

Rigid Tile Uplift Resistance

2003 International Building Code 1609.7.3

Manufacturer: Claymex
Style: Spanish Roof Tile
Material: Clay

Test Report: 78967.01-801-44
Fastener: Expanding Foam Roof Tile Adhesive
Fastener Location: Head of the tile to the batton, nose of the tile to the previous course, nose of the previous course at the exposed edge
Deck: 7/16 OSB with bitumin type self adhesive underlayment secured with 1" ring shank button cap nails at 12" OC
Allowable Overturning Moment: 57.5 ft-lb

Exposed Width of Tile (b): 0.958 ft
Lift Coefficient (C_L): 0.2 (0.2 or determined by test)
Length of Tile (L): 1.656 ft
Moment Arm (L_a): 1.258 ft

Roof Type: Gable $\theta \leq 7^\circ$
GC_p: -2.80 (Roof Zone 3)
Exposure: C

h (ft)	K_z
15	0.85
30	0.98
40	1.04

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	22.4	26.6	31.3	25.8	30.7	36.0	27.4	32.6	38.2
M_o (ft-lb)	33.9	40.4	47.4	39.1	46.6	54.7	41.5	49.4	58.0
OK?	YES	YES	YES	YES	YES	YES	YES	YES	NO

Roof Type: Gable/Hip $7^\circ < \theta \leq 27^\circ$
GC_p: -2.60 (Roof Zone 3)
Exposure: C

h (ft)	K_z
15	0.85
30	0.98
40	1.04

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	22.4	26.6	31.3	25.8	30.7	36.0	27.4	32.6	38.2
M_o (ft-lb)	32.2	38.3	44.9	37.1	44.1	51.8	39.3	46.8	55.0
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Roof Type: Gable $27^\circ < \theta \leq 45^\circ$
GC_p: -1.20 (Roof Zone 3)
Exposure: C

h (ft)	K_z
15	0.85
30	0.98
40	1.04

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	22.4	26.6	31.3	25.8	30.7	36.0	27.4	32.6	38.2
M_o (ft-lb)	19.7	23.4	27.4	22.7	27.0	31.6	24.0	28.6	33.6
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Roof Type: Hip $\theta \leq 25^\circ$
GC_p: -1.70 (Roof Zone 2)
Exposure: C

h (ft)	K_z
15	0.85
30	0.98
40	1.04

Mean Roof Height (ft)	15			30			40		
Wind Speed (MPH)	110	120	130	110	120	130	110	120	130
q_h (psf)	22.4	26.6	31.3	25.8	30.7	36.0	27.4	32.6	38.2
M_o (ft-lb)	24.1	28.7	33.7	27.8	33.1	38.8	29.5	35.1	41.2
OK?	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: $q_h = 0.00256V^2K_dK_tK_zI$ where $K_d = 0.85$, $K_t = 1.00$ and $I = 1.00$

Sample Calculation

Tile Info

Allowable Moment : 57.45 in lbs
Exposed Width : 11½" = 0.958 ft
Length of Tile : 19⅞" = 1.656 ft
Moment Arm : 0.76L = 1.258 ft

Site Info

V = 110 MPH
h = 40 ft
Roof 5:12 Gable (22°)
Exposure B
Roof Zone 3

$K_z = 0.76$ (Table 6-3)

$q_H = 0.00256\, V^2 K_z K_D K_r I$ (Eq 6-15)

For $K_D = 0.85$ $K_r = 1.00$ $I = 1.00$

$q_H = (0.00256)(110)^2(0.76)(0.85) = 20.0$ psf

Overturning Moment

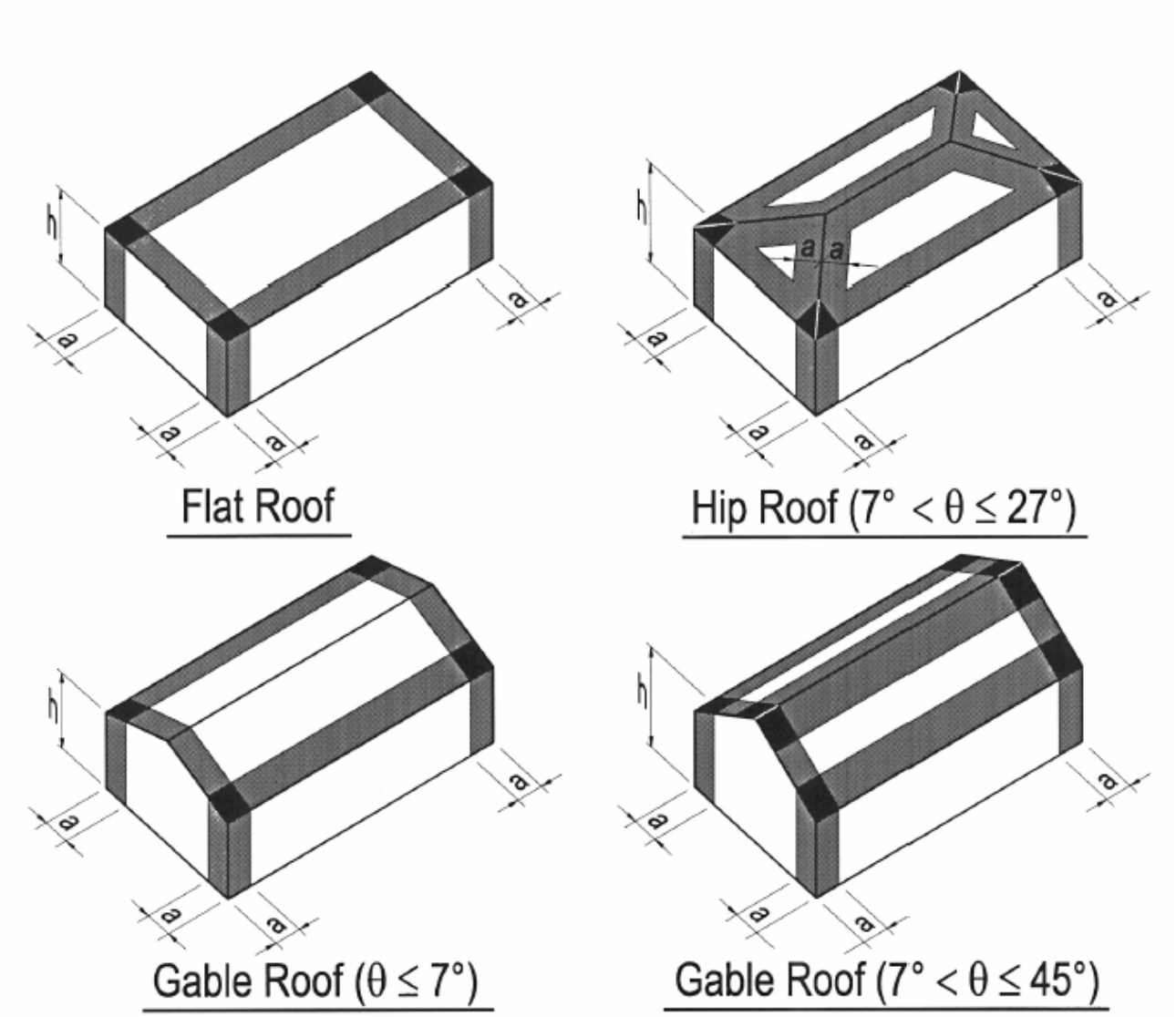
$C_L = 0.2$
$b = 0.958$ ft
$L = 1.656$ ft
$L_a = 1.258$ ft

$GC_p = -2.8$ (Fig 6-11B)

$M_A = q_H C_L L L_A b (1 - GC_p)$

$= (20.0)(0.2)(1.656)(1.258)(0.968)(1 - (-2.8))$

$= 30.3$ ft-lb $<$ 57.4 ft-lb OK



White = Zone 1; Gray = Zone 2; Black = Zone 3

Note: a = minimum of 0.4h or 0.1w where w is minimum plan dimension of building; a shall not be less than 3.0 ft.

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	06/19/08	N/A	Original report issue
1	06/30/08	1-3	Corrected product name to "S" 80
		3	Added foam manufacturer to Installation