Appendix E: Precast R-Value Calculations

THERMOMASS®
BUILDING INSULATION SYSTEMS
By Composite Technologies Corporation

1000 Technology Drive
P.O. Box 950
Boone, IA 50036

The next analysis that was performed was the **Steady State Isothermal Analysis Method #1:**

Using a series-parallel method of calculation, Isothermal Analysis predicts the effects of irregular sized and spaced penetrations through an insulation layer. Individually, steel or concrete have significant effects on the insulation layer and can be predicted with this analysis method.

The Isothermal Analysis by itself has been proven a bit aggressive when figuring the effects of solid concrete sections and therefore has been tempered with U-Value average to account for the restricted conduction zones affected by solid concrete.

The steady state thermal analysis shows the total isothermal R-value for the wall, with the ability to factor in thermal breaks such as metal ties or solid concrete sections.

You will notice in the findings shown in the Isothermal Analysis that the THERMOMASS wall panel has a material R-Value of **R-11.49**. The Isothermal Analysis shows **.90%** thermal loss in this wall panel with the use of fiber composite connectors. The overall material R-Value of the THERMOMASS wall consists of an **R-11.39**.

The competing wall system which consists of 2X4 steel studs (16" oc), 2" XPS insulation, full exterior brick w/ brick ties connected back to the steel studs. Due to the thermal conductivity of the brick ties this assumed R-11.66 wall actually performs at an **R-7.76** (33% reduction).

Steady-State Thermal Analysis by Modified Isothermal Analysis Method

Study Provided For:

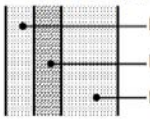
Penta Career Center - Perrysburg, OH

3"/2"/5" TM vs. 2x4 steel stud 2"XPS & brick (pt 1)

DESIGN INFORMATION FOR WALL PANELS

SYSTEM CRITERIA	THERMOMASS® SPEC.		PANEL DESIGN #2	
Insulation Type	EXTRUDED		EXTRUDED	
Connector Type	FIBER-COMP		BRICK TIE	
Connector Conductivity	6.9		365.0	
Connector Area	13.50 in²		15.12 in²	
Net Wall Area	43,200 in²	300.00 ft²	43,200 in²	300.00 ft²
Insulation Conductivity	0.20		0.20	
Concrete Conductivity	12.50		12.50	
Solid Concrete Area	0.00 in²		0.00 in²	
R-value of Air Film Coefficients	0.85		0.85	

WALL CONFIGURATION:



	THERMOMASS® SPEC. LAYERS	THERMOMASS® SPEC. COVER:	PANEL DESIGN #2 LAYERS	PANEL DESIGN #2 COVER:
Ext. Conc. Wythe:	3.00 in.	1.00 in.	10.00 in.	5.00 in.
Insulation:	2.00 in.		2.00 in.	
Int. Conc. Wythe:	5.00 in.	3.00 in.	0.10 in.	0.10 in.

ASSUMPTIONS: All values for extruded insulation based on ASTM C-578 specifications for Type IV - extruded polystyrene insulation @ base temperature of 75°F. -Part 1 of 2 - Value for brick veneer calculated to equal 10 inches of concrete.

This Modified "Isothermal Planes" Method combines Series-Parallel Path Analysis, ASHRAE Handbook - 2001 Fundamentals, Chapter 23 and U-value Average Analysis as validated through CTC/DOE Thermal Study 1999.

CALCULATED RESULTS SUMMARY

	THERMOMASS® SPEC. R-VALUE		THERMOMASS® SPEC. LOSS	PANEL DESIGN #2 R-VALUE			PANEL DESIGN #2 % of LOSS	
	Assumed	Isothermal	%	Assumed	Isothermal	Modified	To Iso.	To Mod.
1.00 in.	6.49	6.44	0.80%	6.66	4.71	4.71	29.32%	29.32%
1.50 in.	8.99	8.91	0.86%	9.16	6.23	6.23	31.95%	31.95%
2.00 in.	**11.49**	**11.39**	**0.90%**	**11.66**	7.76	**7.76**	33.46%	**33.46%**
3.00 in.	16.49	16.33	0.94%	16.66	10.81	10.81	35.11%	35.11%
4.00 in.	21.49	21.28	0.96%	21.66	13.86	13.86	36.00%	36.00%
5.00 in.	26.49	26.23	0.98%	26.66	16.91	16.91	36.56%	36.56%
6.00 in.	31.49	31.18	0.99%	31.66	19.96	19.96	36.94%	36.94%
7.00 in.	36.49	36.13	0.99%	36.66	23.02	23.02	37.21%	37.21%
8.00 in.	41.49	41.08	1.00%	41.66	26.07	26.07	37.42%	37.42%

9:45 PM, 12/30/2008

THERMOMASS®
BUILDING INSULATION SYSTEMS
By Composite Technologies Corporation

1000 Technology Drive
P.O. Box 950
Boone, IA 50036

Performance Mass Analysis:

A precast concrete sandwich wall panel system constructed with The THERMOMASS Insulation System maximizes the thermal mass effect of concrete, thereby reducing the heating and cooling loads and providing an R-Value greater than what can be expected by the material alone (R-11.49) or by which code requires.

When utilizing climate data for Perrysburg, OH the proposed 3-in exterior concrete / 2-in extruded polystyrene insulation / 5-in interior concrete THERMOMASS Wall Panel performs at **R-20.64**.

This is determined by taking into account climate data, building orientation, occupancy type, and facility type. ASHRAE/IESNA Standard 90.1-1989: System Performance Criteria is the standard calculation used.

This criteria determines the R-Value performance and the heating and cooling load adjustments for the effects of concrete mass within the building envelope. The results of the analysis are detailed in image to the right.

ASHRAE 90.1-2001 Compliant Building Envelope Performance Study

Study Provided For:

Penta Career Center - Perrysburg, OH

3"/2"/5" THERMOMASS - Edge to edge XPS insulation

SYSTEM PERFORMANCE CRITERIA | **MASS ANALYSIS 1.2**

The result of the balanced equation comparison of the designed, high-mass concrete wall to the similarly designed, non-mass wall is a relationship of energy performance in Btu's to R-value. Note: The material wall R-value is not altered by the dynamics of the building and the climate. The performance value represented below is a portrayal of energy consumption as a function of insulation performance.

PERFORMANCE STUDY SUMMARY

THERMOMASS BUILDING

	North	East	South	West
COOLING LOAD FOR DESIGNED WALL				
WCc	3.003577	2.946804	3.344073	2.766502
WCt	12.060956			
Btu Consumption	12,060,956			
HEATING LOAD FOR DESIGNED WALL				
WCh	4.397850	4.244893	3.820091	4.215030
WCt	16.677863			
Btu Consumption	16,677,863			
TOTAL ESTIMATED LOAD				
WCt	28.739			
Btu Consumption	28,738,819			

Note I: Btu's consumed equals 1,000,000 x Wall Criteria (WC)
Note II: A negative sum of the Wall Criteria results in a zero value for final calculation

STEADY-STATE WALL R-value:	STEADY-STATE WALL U-value:	WALL HEAT CAPACITY
11.49	0.087	20.00

LOW-MASS BUILDING

	North	East	South	West
COOLING LOAD FOR DESIGNED WALL				
WCc	3.587098	3.498771	3.994383	3.467419
WCt	14.547671			
Btu Consumption	14,547,671			
HEATING LOAD FOR DESIGNED WALL				
WCh	3.708222	3.572308	3.333991	3.576626
WCt	14.191148			
Btu Consumption	14,191,148			
TOTAL ESTIMATED LOAD				
WCt	28.739			
Btu Consumption	28,738,819			

Note I: Btu's consumed equals 1,000,000 x Wall Criteria (WC)
Note II: A negative sum of the Wall Criteria results in a zero value for final calculation

STEADY-STATE WALL R-value:	STEADY-STATE WALL U-value:	WALL HEAT CAPACITY
20.64	0.05	1.00

THIS THERMAL MASS, ANALYTICAL COMPARISON RESULTS IN THE THERMOMASS WALL BEHAVING AS A WALL WITH A MATERIAL R-VALUE OF:	**20.64**