ENERGY MASS WALL

True R-value Verses modified R-value

R. Gary Black[1] October 29, 2012

Integrated Structures, Inc. claim that the EM wall system has a true R-100 insulation rating is supported by the following industry data, comparison and analysis of industry experts.

The true R-value of an assembly is found by the direct addition of the sub components. In an insulated concrete wall, whether an Insulated Concrete Form (ICF) with insulation surrounding a concrete core, or a panelized system with concrete surrounding an insulated core, the true R-value will be that of the insulation material. This occurs because the R-value of the insulation (4.00/inch for beadboard, 5.00/inch for polystyrene, 7.00-8.00/inch for polyurethane) is fifty to one hundred times that of the concrete whose R-value is only 0.08/inch.

To increase the apparent R-value of certain assemblies – those incorporating concrete and insulation, manufacturers have coined the notion of TMO -- "thermal mass optimization" or TME – "thermal mass effect." This notion attempts to take into account the thermal inertia of a heavy material like concrete, brick or stone and assign an "equivalent R-value" to it.

For this reason, Tom Stecker, president of composite technologies corporation (CTC), the manufacturer and distributer of Thermomass Building systems can state; "an R-value of 30 is possible with as little as two-inches of insulation using the mass effect of the concrete sandwich wall." [2] In reality, the kind of result he is referring to would not be transferable to real building situations. [3] The calculation would have to be based on some theoretical condition (inside average temperatures, outside average temperatures, day/night diurnal temperature swings, etc.) *specifically tailored* to maximize the TME. A calculation of the true R-value based on the subassemblies leaves no doubt. It results from 2" of extruded polystyrene produced by Dow Chemical under the trade-marked name "Styrofoam." According to Dow's published literature, this value is R-10.[4]

Simply stated, the Energy Mass wall has a true R-value of 100. An EM wall for a 50,000 square foot warehouse will contain nearly three million pounds of thermal mass, producing a colossal TME. To reduce confusion and ambiguity, we prefer to discount this effect in determining the wall's R-value and instead use the time honored industry standards.

In a one on one comparison, the EM wall's R-value is **ten times** that of the example quoted above.

EM wall's unparalleled energy performance is in part, the result of its true R-value.

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[1] Professor of Architecture, University of California, Berkeley; President, Integrated Structures, Inc.

[2] See attached article from DCD, page 2.

[3] See attached Thermomass analysis predicting only R-20.64 for a career center in Perrysburg, OH.

[4] See attached table of R-values from Dow; (a stead state TME will give the same result).

FOOT NOTE 2

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THERMOMASS® Sandwich Tilt-Up Wall Panels are Natural Fit for New Prison

Long recognized as a durable, fast and economical building solution, the selection of site cast Tilt-Up for prisons is a growing trend. With concern for safety, security, maintenance and energy efficiency always at the forefront, owners of today's correctional facilities are turning to insulated site cast Tilt-Up wall panels to meet these needs. Innovative Tilt-Up contractors are collaborating together with sandwich wall insulation system suppliers to target this market. A recent penitentiary and prison project in Tucson, Ariz. demonstrates the success of sandwich panel Tilt-Up in addressing a prison owner's needs in a timely and cost-effective manner.

Why Sandwich Wall Tilt-Up?

Since 1984, Composite Technologies Corporation (CTC) - the manufacturer and distributor for the **Thermomass® Building Insulation System**, has been active in the correctional facilities market. The Thermomass® system is a patented continuous fiber composite connector that is used to structurally tie two layers of concrete together through predrilled, prefabricated, extruded Dow® brand insulation products. Known for its energy efficiency, this system was a natural fit for the prison marketplace.

"Since most correctional institutions are government-owned entities, they must be concerned with not only securing the resources to construct the facility, but also having the funds to operate it," said Tom Stecker, President of CTC. "As such, energy

efficient structures are a must in this industry."

"Performance" of the exterior concrete walls is the key element of success for Tilt- Up as an efficient insulating option. Concrete that is located adjacent to controlled interior spaces dampens the temperature swing that is normally experienced as daily temperatures rise and fall. This dampening effect can result in substantial energy savings due to reduced HVAC capacity. Essentially, the mechanical systems don't have to work as hard to control the temperature. The same quantity of energy may need to be removed or added, but it is done so over a longer period of time. In the cooling mode, thermal mass reduces temperature swings by storing energy during the build-up phase, typically afternoons, and then releases energy during cooler periods, such as evenings. This 'thermal mass effect' is more pronounced in temperature zones where it gets too hot during the day, yet cools down nicely at night. In the heating mode, the walls store energy from the building's heating system and release it back into the space.

The large, Tilt-Up concrete panels also add to the energy efficiency of a Tilt-Up structure since the panel size reduces the number of joints between panels, which in turn reduces air infiltration or leakage into and out of the building. Air infiltration is a large source of heat loss.

The **Thermomass® Building System** has proven to reduce a facility's energy costs by as much as 50 percent or more. Thermal testing programs, commissioned by CTC and conducted through Oak Ridge National Laboratory and Construction Technologies Laboratory, provide the necessary data to validate that Tilt-Up sandwich panels, when constructed with a complete separation between concrete layers, develop significantly higher thermal performances than traditional methods of construction and other sandwich systems that use metal connectors or solid sections of concrete to tie the concrete layers together. According to Stecker, an R value of 30 is possible with as little as two-inches of insulation using the mass effect of the concrete sandwich wall. Load bearing Tilt-Up sandwich panels eliminate the need for redundant structural steel around the perimeter of the facility. Additionally, the Tilt-Up sandwich

panels with integral insulation can eliminate the need for additional interior and exterior finishes, which also c ntributes to lowering the overall cost of the project.

Beyond energy efficiency, security and maintenance are also crucial considerations for correctional facility owners. For example, according to Stecker, it is common for prisoners to pick at the joints in a masonry wall - placing a tremendous maintenance burden on prison facility managers. With minimal joints, Tilt-Up is an obvious solution. Further, with growing concerns about indoor air quality and mold, moisture concerns are paramount. Correctional institutions must address this issue head-on and seek building systems that have a long-term reputation to standing up to moisture. Tilt-Up panels that utilize the Thermomass® system can eliminate moisture penetration throughout the panel, as well as condensation on the inside of the wall. The system prevents cold spots on the wall, which eliminates condensation on the walls.

Another benefit that the Tilt-Up system affords correctional institution is speed. Many of these projects have fasttrack schedules and Tilt-Up has proven performance in meeting tight schedules cost-effectively.

Wendy Ward, Vice President of Constructive Communication, a public relations firm specializing in the design and construction industry, serves as a marketing consultant to the Tilt-Up Concrete Association. For more information about the growing tilt-up method, visit **www.tilt-up.org**. Ward can be reached at **wward@constructivecommunication.com**.

FOOTNOTE 3

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

LOW-MASS BUILDING

	North	East	South	West
COOLING LOAD FOR DESIGNED WALL				
WCc	3.587038	3.198771	3.991383	3.467119
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

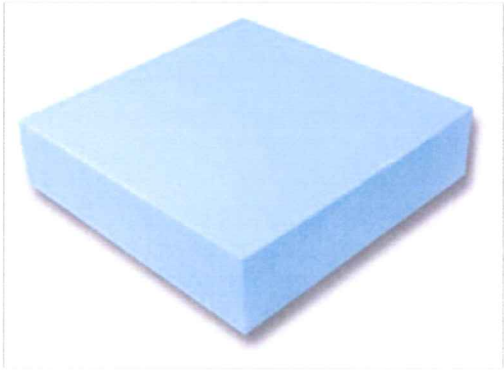
STEADY-STATE WALL R-value:	20.64
STEADY-STATE WALL U-value:	0.05
WALL HEAT CAPACITY	1.00

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

FOOTNOTE 4.

Building Solutions

NORTH AMERICA – STYROFOAM™ BRAND SQUARE EDGE INSULATION



OAM™ Brand Square Edge Insulation Extruded Polystyrene is a Type IV product
are edges on four sides to help ensure energy efficiency and minimize on-site
id waste. It offers superior water resistance, long-term thermal performance and
pressive strength in a wide range of residential and commercial construction
ons.

Code Compliance

s with ASTM C578 Type IV. Meets IBC/IRC requirements for foam plastic
n. See ESR-2142, BOCA-ES RR 21-02. UL Classified, see Classification
e D369. Calif. Std. Reg. # CA T064. Florida Building Code FL 3835.

OAM™ Brand Square Edge Insulation CAD Details

nformation

OAM™ Brand Square Edge Insulation Product Information (66KB PDF)
aces – Installing STYROFOAM Square Edge, STYROFOAM SCOREBOARD™ or STYROFOAM Tongue & Groove Insulation
Basement Wall – Installing STYROFOAM™ PERIMATE™, Square Edge, SCOREBOARD™, Tongue & Groove or BLUECOR
asement Wall (Even Wall w/Drywall Finish) – Installing STYROFOAM™ Tongue & Groove, SCOREBOARD™ or Square Edge
asement Wall (Foam and Stud Wall Framing) – Installing STYROFOAM™ Square Edge, Tongue & Groove, SCOREBOARD™,
IFF-R™, or TUFF-R
er Studs – Installing STYROFOAM™ Residential Sheathing, Tongue & Groove, Square Edge, DURAMATE™ Plus, TUFF-R™,
IFF-R™ or THERMAX™ for use as a Water-Resistive Barrier
on Procedures for THERMAX™ or STYROFOAM™ Brand Rigid Insulation – Closed Crawl Space (414KB PDF)
OAM™ Extruded Polystyrene Foam Insulation – 50 Year Thermal Limited Warranty (206KB PDF)
OAM™ Extruded Polystyrene Foam Insulation – 30 Year Thermal Limited Warranty (202KB PDF)
OAM™ Extruded Polystyrene Foam Insulation – 15 Year Thermal Limited Warranty (201KB PDF)

OAM™ Brand Square Edge Insulation has square edges to help ensure energy efficiency and minimize on-site cutting and
a wide range of residential and commercial construction applications.

l Board Thickness[1], in	R-Value[2]	Board Size, ft	Edge Treatment	Min Compressive Strength[3], psi
	3.8	2 x 8 / 4 x 8	Square Edge	25
	5.0	2 x 8 / 4 x 8	Square Edge	25
	7.5	2 x 8 / 4 x 8	Square Edge	25
	10.0	2 x 8 / 4 x 8	Square Edge	25
	12.5	2 x 8 / 4 x 8	Square Edge	25
	15	2 x 8 / 4 x 8	Square Edge	25

ll product sizes are available in all regions.

ans resistance to heat flow. The higher the R-value, the greater the insulating power. R-values are expressed in $ft^2 \cdot h \cdot °F/Btu$.
determined by ASTM C518.

al compressive strength is measured at 10% deformation (5% for STYROFOAM™ Brand PLAZAMATE™ Insulation and for
OAM™ Brand HIGHLOAD 40, 60 and 100 Insulation products) or at yield, whichever occurs first. Since STYROFOAM™ Brand
l Polystyrene and Dow polyisocyanurate insulation products are visco-elastic materials, adequate design safety factors should
to prevent long-term creep. For static loads, 3:1 is suggested. For dynamic loads, 5:1 is suggested.