KTECT201611-001
Rev 1.0
01 Dec 2016

Thermal Simulation of KTECT SBS and Conventional Wood Framed Wall

Prepared for:

W. Crozier
Ktect Canada SBS Inc
475 Concession Rd 8
Westport, Ontario
K0G 1X0

By:

MAYA Heat Transfer Technologies Limited
4999 Ste. Catherine St. West, Suite 400
Montreal, Quebec
H3Z 1T3
(514) 369-5706

(This page intentionally left blank)

Thermal Simulation of KTECT SBS and Conventional Wood Framed Wall

Prepared By: C. J. Pye

Christopher J. Pye, Ph.D., Vice president

1 Dec 2016

Date

Revision History

Revision	Date	Changes
0.0	23 Nov 2016	Draft
1.0	1 Dec 2016	Initial Release
1.1	1 Dec 2016	Corrected KTECT related information

TABLE OF CONTENTS

TABLE OF FIGURES

1. INTRODUCTION

1.1 Background

KTECT Canada SBS Inc (KTECT) is bringing to the marketplace an innovative construction technology that aims to improve the thermal performance of exterior walls in a building. The goal is to minimize heat transfer between the interior and exterior of the building and thereby reduce heating costs during cold weather and, inversely, reduce cooling costs during warm weather.

Conventional N. American construction uses a structural frame of wooden studs with headers top and bottom to provide anchoring for the studs. The spaces between the studs are filled with a thermal insulation system that minimizes heat transfer. However, the studs themselves provide a continuous path between inner and outer surface of the stud wall. This, parasitic, thermal path is usually referred to as bridging. The impact of the bridging can be reduced with a layer of continuous insulation on the outside of the wall.

The KTECT system uses paired steel studs that are embedded in foam insulation. No stud embedded in the exterior of the wall is connected in any way to the stud embedded in the interior of the wall, the goal being to reduce the bridging that occurs in a traditional wood stud wall.

1.2 Scope

This report presents analysis of both the traditional stud and KTECT wall systems to determine their thermal performance. A detailed finite element model of each was created, appropriate boundary conditions applied and the models solved.

The heat transfer from interior to exterior was determined under winter conditions and the performance of each building system determined.

2. MATERIAL PROPERTIES

To determine the heat flow within each construction system it is necessary to know the thermal conductivities of the materials used. The values used in the model, together with the source of the value, are presented in Table 1.

Table 1 – Material Properties

Material	Where used	Thermal Conductivity ($Wm^{-1}K^{-1}$)	Source
Gypsum Board	Interior of both walls	0.16	Ref [1]
Blown in Cellulose	Cavity of stud wall	0.03575	Ref [1]
Pine	Traditional stud wall framing	0.0926	Ref [1]
Rigid Foam	Exterior of stud wall	0.03625	Ref [1]
Cement Board	Siding of conventional construction	0.245	Ref [1]
Steel	Screws, nails, steel studs	43	Ref [4]
Neopor Rigid Foam	KTECT foam insulation	0.0301	Ref [2]
Stucco	Exterior of KTECT wall	0.72	Ref [3]

3. PART DESCRIPTION

3.1 Stud Wall Model

A 48” x 48” section of the wall was modelled. The studs were nominal 2”x6” with a bottom plate of the same size. The model represents a half height section of a 96” high wall with top and bottom plates. The 48” length starts in the centre of a stud and includes two full and two half studs. The interior surface is covered with ½” (12.7mm) drywall, the outside with 1.5” (38.1mm) of rigid foam and 3/8” cement board. The cavity between the interior and exterior walls is filled with 5.5” (139.7mm) of blown in cellulose.

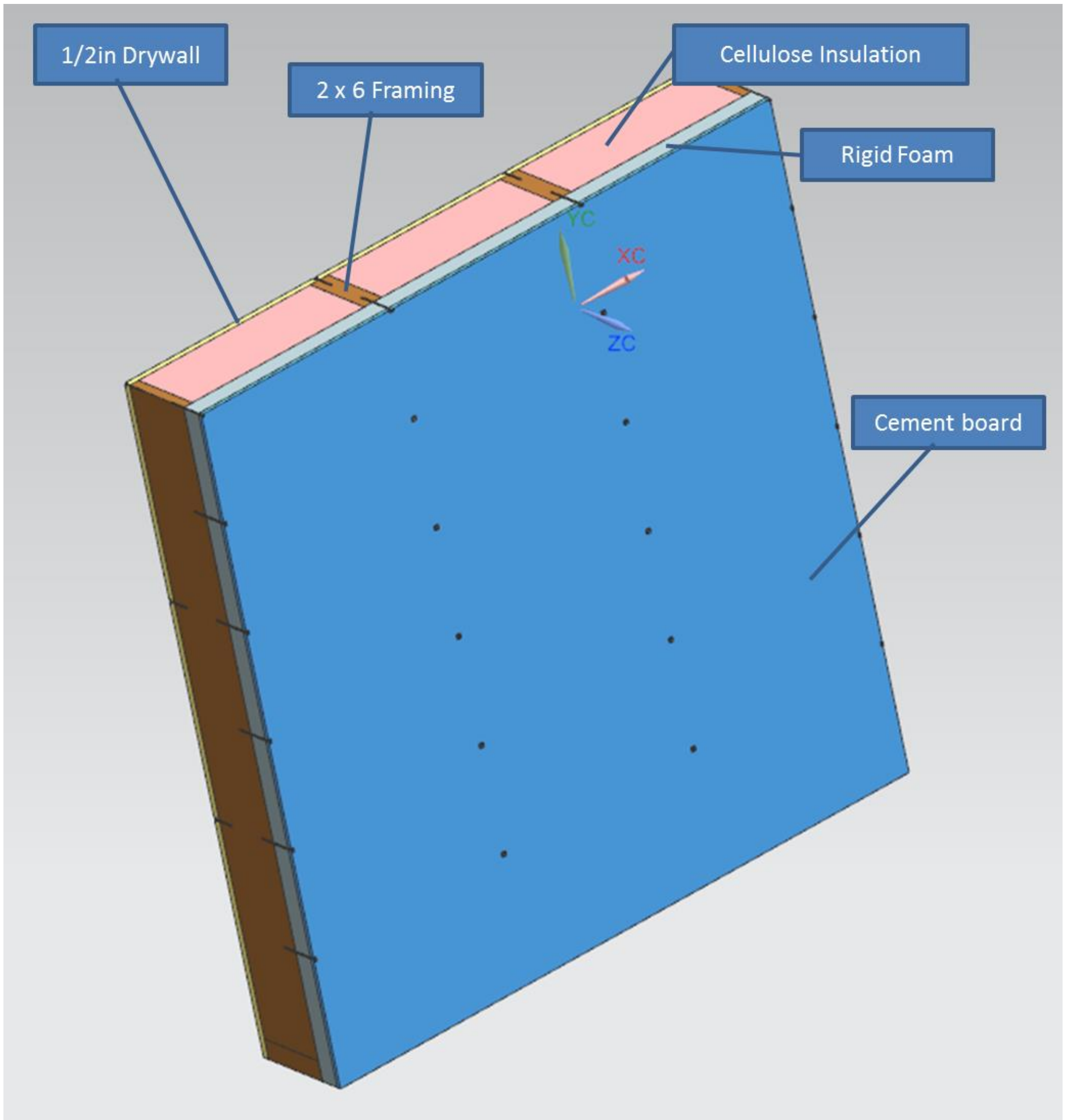

Figure 1: Wood Framed Wall

3.2 KTECT Wall Model

The KTECT wall model was also a 48” x 48” part of a wall running from metal stud centre to centre. It included the two pieces of steel angle that form the baseplate. The interior surface is covered with 0.5” (12.7mm) drywall and the exterior surfaces has 1.5” (38.1mm) of rigid foam plus 7/8” (22.2mm) of stucco. The heads of the fasteners are 3/8” (9.5mm) under the surface of the stucco.

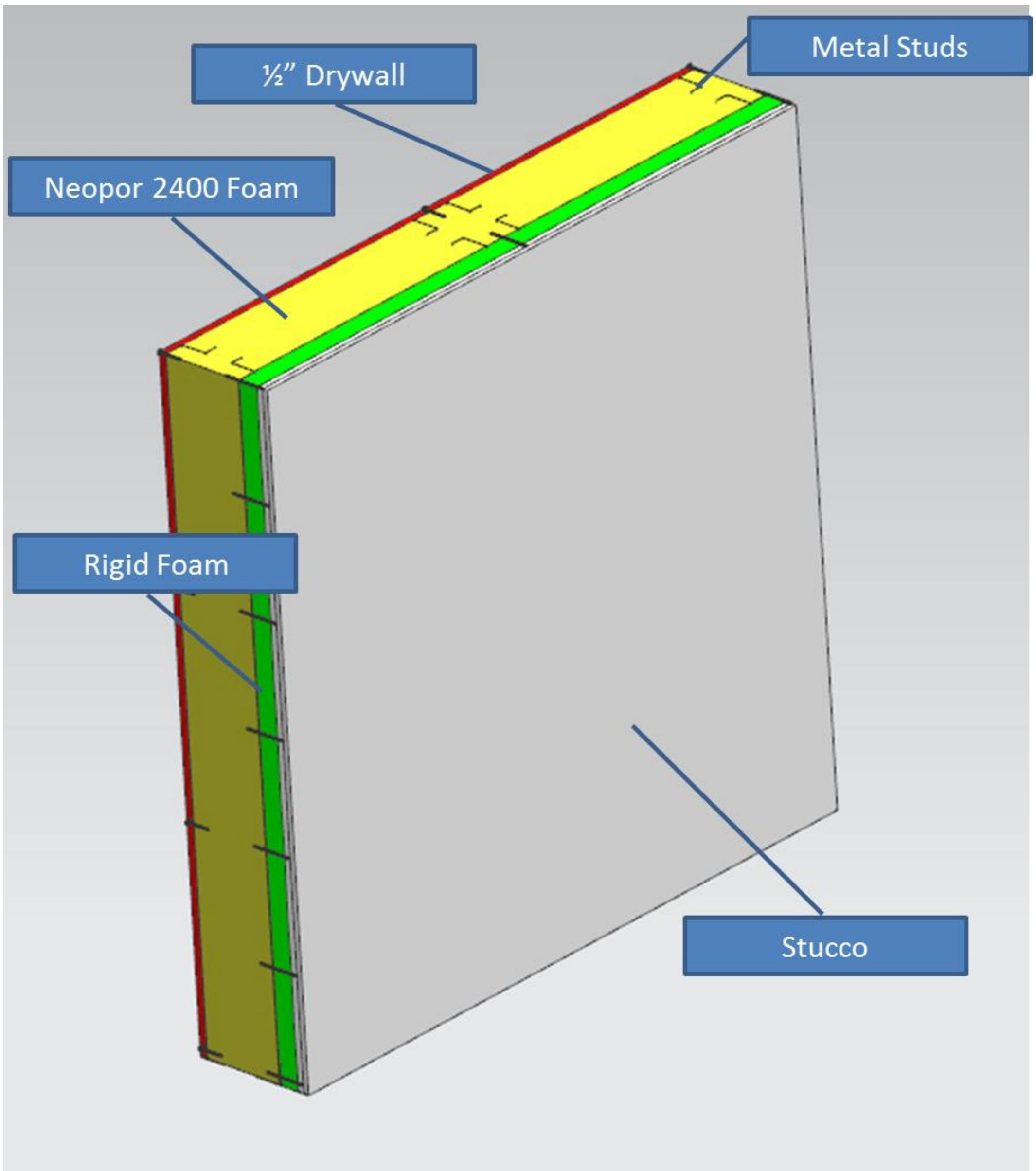

Figure 2: KTECT Wall System

4. METHODOLOGY AND ASSUMPTIONS

4.1 Approach

The wall 3-D geometry was used to create a finite element mesh for each component and the appropriate materials assigned.

The models were meshed and solved with NX Thermal from Siemens Product Lifecycle Management. NX thermal is a high end solver developed by MAYA HTT Ltd and used across a broad range of industries including aerospace, consumer electronics, manufacturing and detailed building analysis.

4.2 Assumptions

In both models the fasteners were modelled as having a square section with the same cross sectional area as the appropriate round screw. This allowed for a fewer elements around the corresponding holes.

All components were connected with a heat transfer coefficient of 1000 $Wm^{-2}K^{-1}$. This was considered large enough to effectively model perfect contact. In practice the connections will provide less of a thermal path. This assumption is conservative in that it leads to the walls insulation properties being slightly underestimated.

4.3 Model Description

4.3.1 Mesh

The details of the meshes used in each model are given in Table 2 and shown in Figure 3 and Figure 4.

Table 2: Model Summary

	Wood Frame Wall Model	KTECT Wall Model
Number of Elements	556709	993020
Number of Nodes	142299	274066

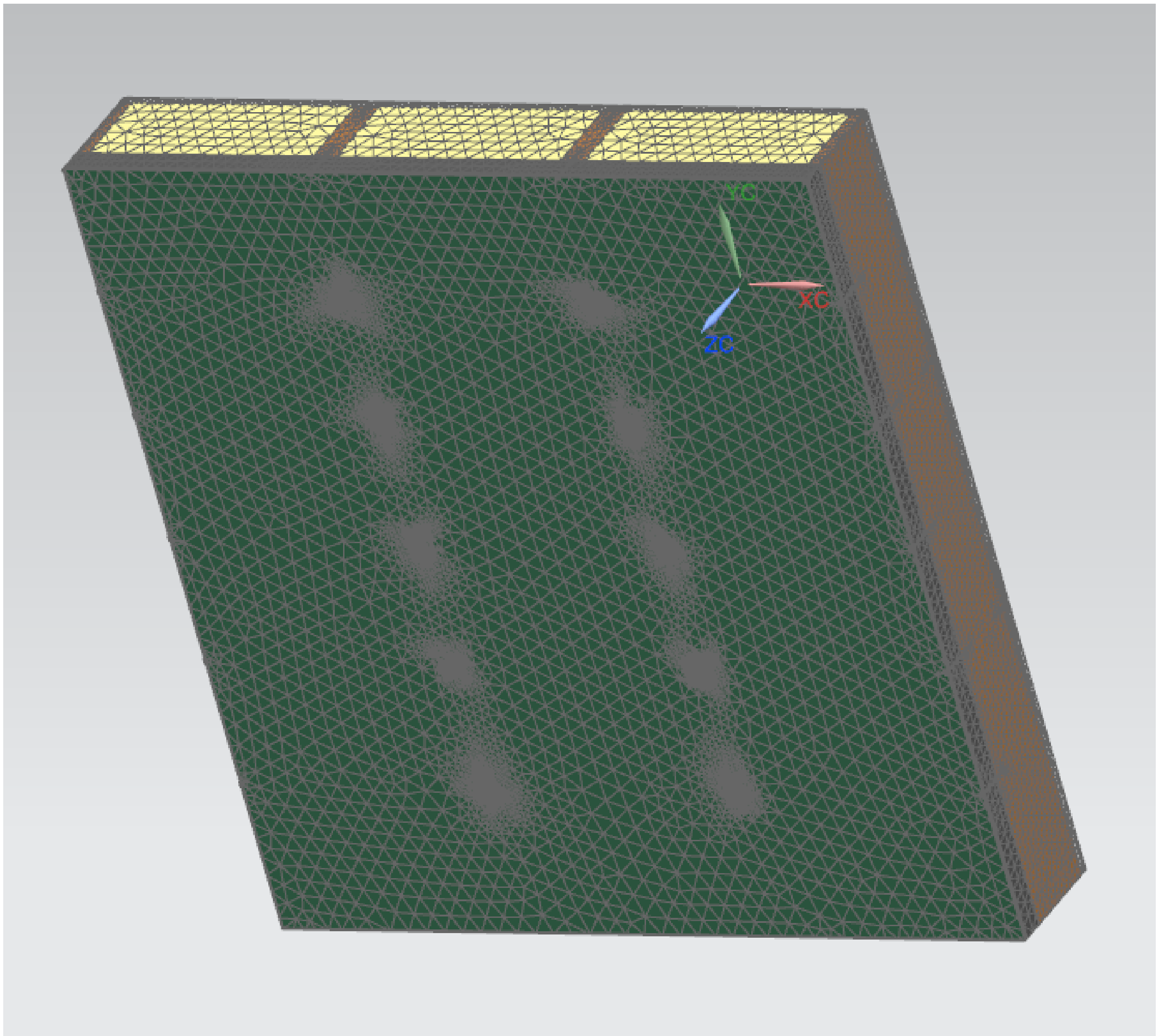

Figure 3: Wood Framed Wall Model

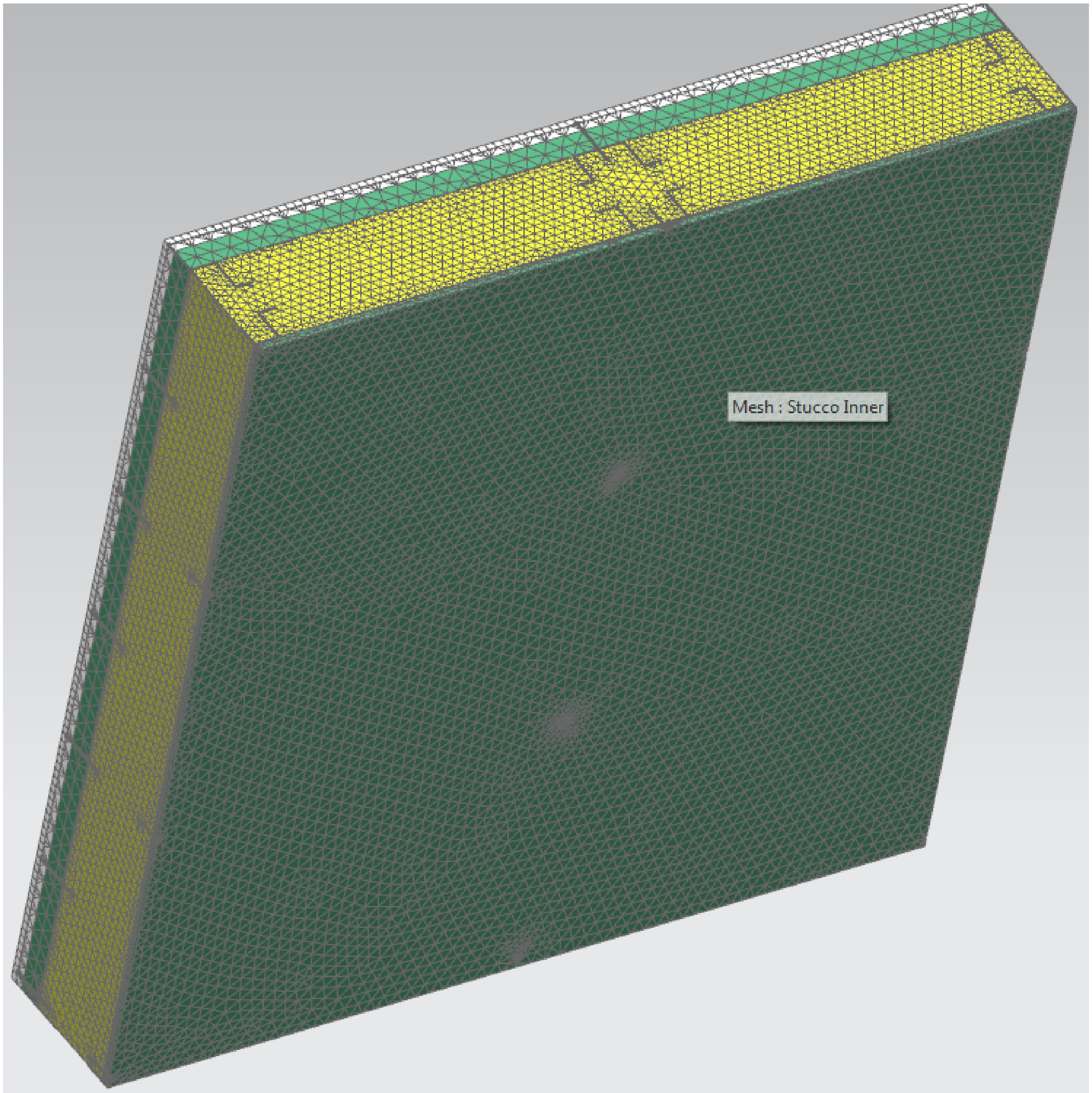

Figure 4: KTECT Wall Model

4.3.2 Boundary Conditions

Interior and exterior surfaces were assigned radiation and convective boundary conditions. For the interior surface the boundary conditions temperature was 20ºC, for the exterior surfaces the boundary condition temperature was -10ºC, representing a typical Canadian winter day.

The convection coefficient was calculated using the NX Thermal built in function.

For radiation, interior and exterior surfaces were assigned an emissivity of 0.85, typical of a painted surface.

5. RESULTS

The overall heat flow from the interior to the exterior was used to calculate the performance of each wall type. The results are presented as R-values in Table 3.

Table 3 Overall Wall Performance

System	Area (m^2)	Heat Loss (W)	Rsi	R Value
Wood framed wall	1.49	14.3	3.12	17.7
KTECT wall	1.49	7.55	5.75	32.7

The KTECT wall shows an 88% increase in R-Value over the wood framed wall.

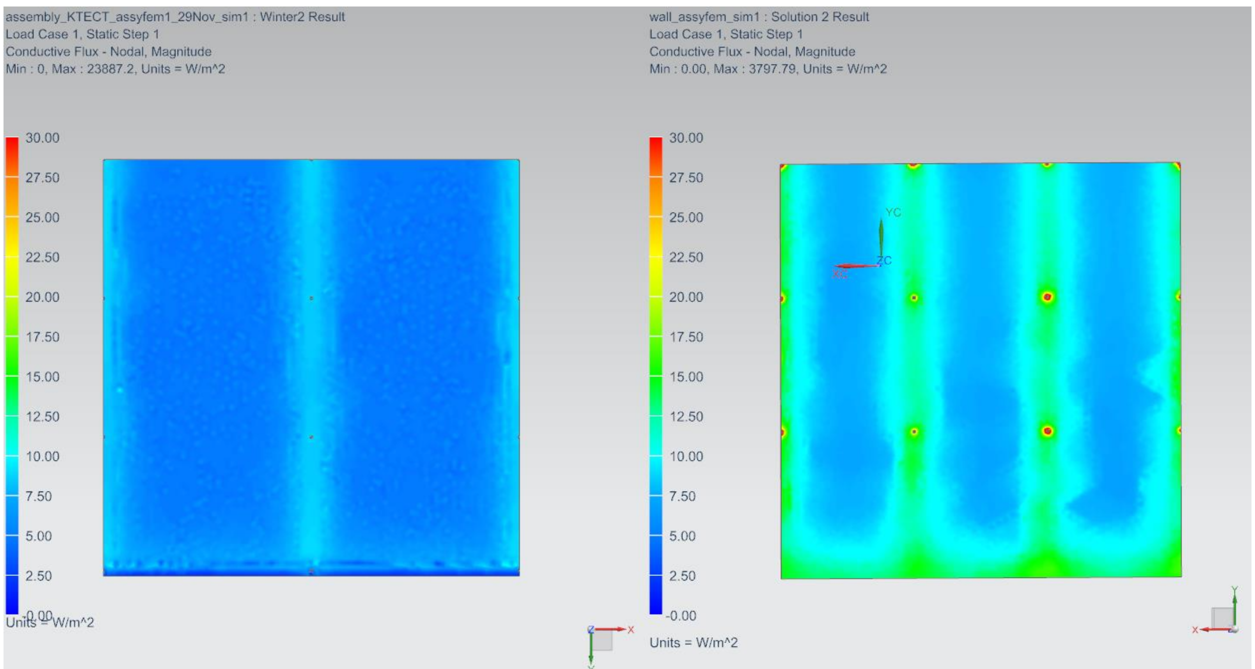

Figure 5 Interior Surface Heat Flux (KTECT on Left)

Figure 5 shows the heat flux into the interior wall surface. This represents the heat flow into the wall from the warm room, expressed on a per unit area basis. A high value indicates a higher heat loss. The local heat loss due to the bridging created by the wood framing can be clearly seen in the right hand part of the figure. For the KTECT system there is increased heat loss in the region of the metal studs but the lack of complete bridging (the metal studs on either side do not meet) the heat flux is considerably lower than for the wood framed wall.

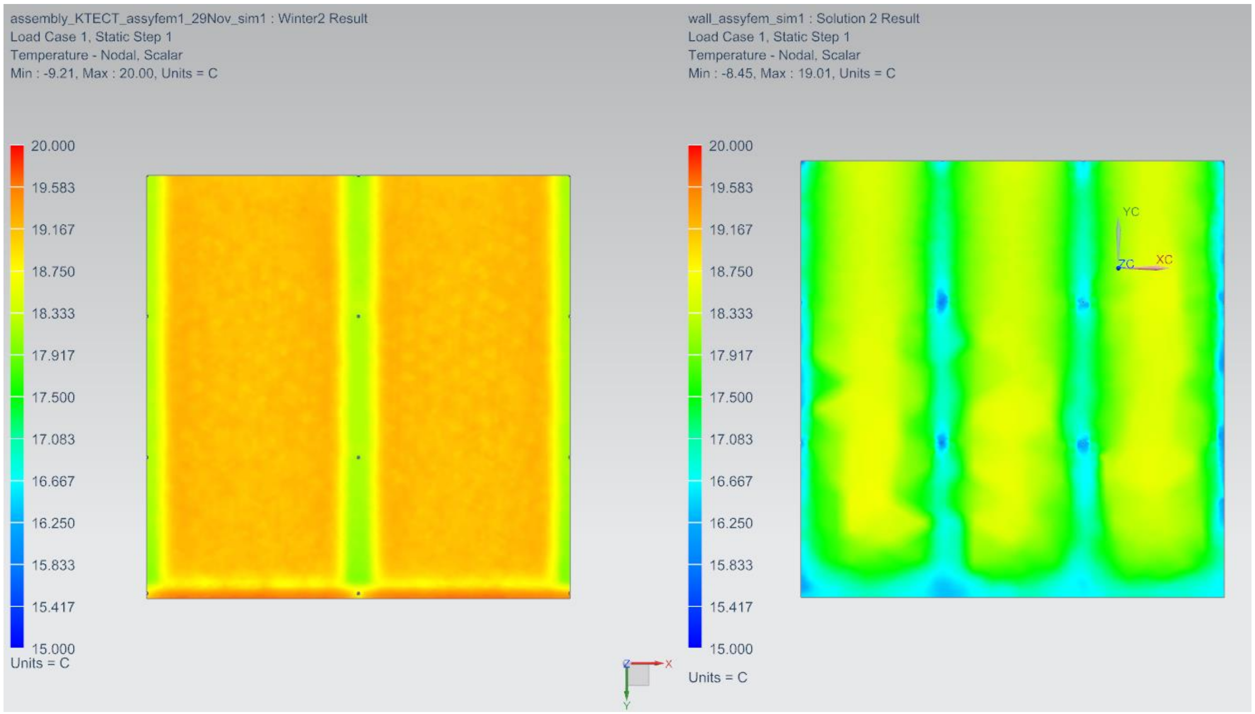

Figure 6 Interior Surface Temperatures (ºC)

Figure 6 shows the temperatures of the interior wall for both construction methods. A higher temperature implies a lower heat loss at that point. The KTECT wall is warmer than the wood framed wall.

6. CONCLUSIONS

The overall R-value of the KTECT wall is almost twice that of the wood framed wall. The wood framed wall chosen as a reference includes continuous layer of foam on the exterior side of the framing to reduce the impact of the bridging created by the wood framing. In spite of this, the wood frame wall still exhibits almost twice the heat loss of the KTECT wall.

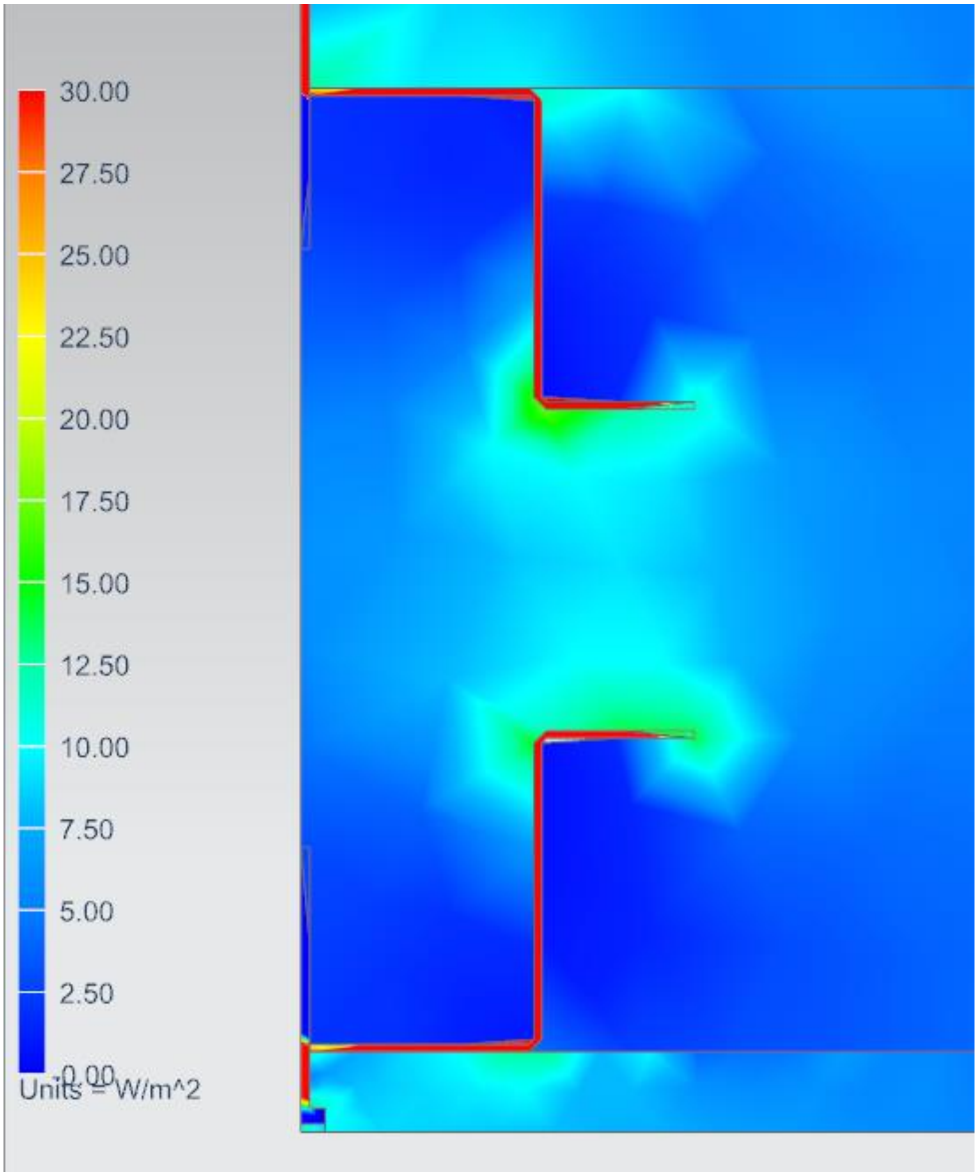

Figure 7: Conductive Heat Flux Through KTECT Wall

Figure 7 shows the conductive heat flux in the region of the end studs of the KTECT wall. A high value means greater energy flow per unit area. As expected there is a high heat flux through the high conductivity steel studs, however, the small cross section of the stud means that the actual energy flow is still small. Figure 7 also shows heat flux spreading from the interior surfaces on the stud into the insulation and flowing across the gap. This heat flow could be reduced by offsetting the studs so that they are not opposite each other in the wall.

7. REFERENCES

[1] Christensen, D., “Thermal Impact of Fasteners in High-Performance Wood Framed Walls” Presented at the Thermal Performance of the Exterior Envelopes of Whole Buildings XI International Conference, Clearwater Beach, Florida.

[2] ICC-ES Evaluation Report ESR-2784 “BASF NEOPOR EXPANDABLE POLYSTYRENE BEADS 2200, 2300 AND 2400 SERIES.”

[3] National Research Council, Canada, “Heat, air and moisture transport properties of three N. American stuccos.” NRCC-46790

[4] http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html.