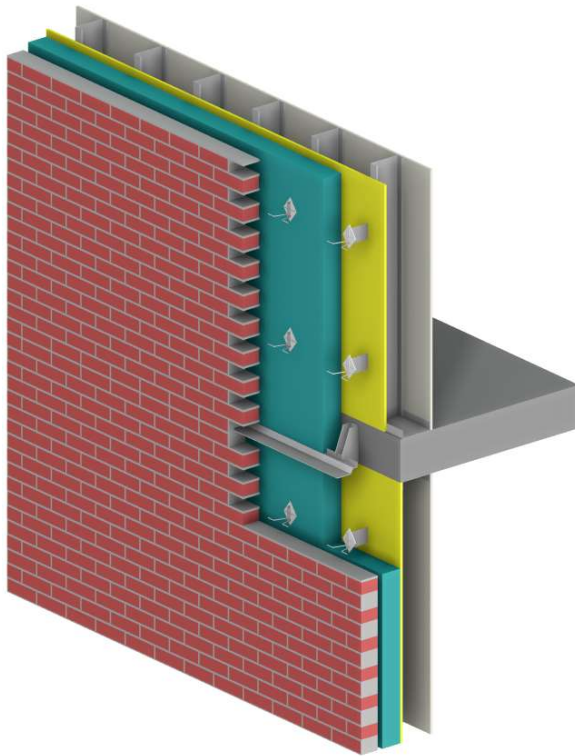


IG Masonry Titan MAX 7.5 Shelf Angle System Thermal Analysis



Presented to:

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APPENDIX A: MODELLING PARAMETERS AND ASSUMPTIONS

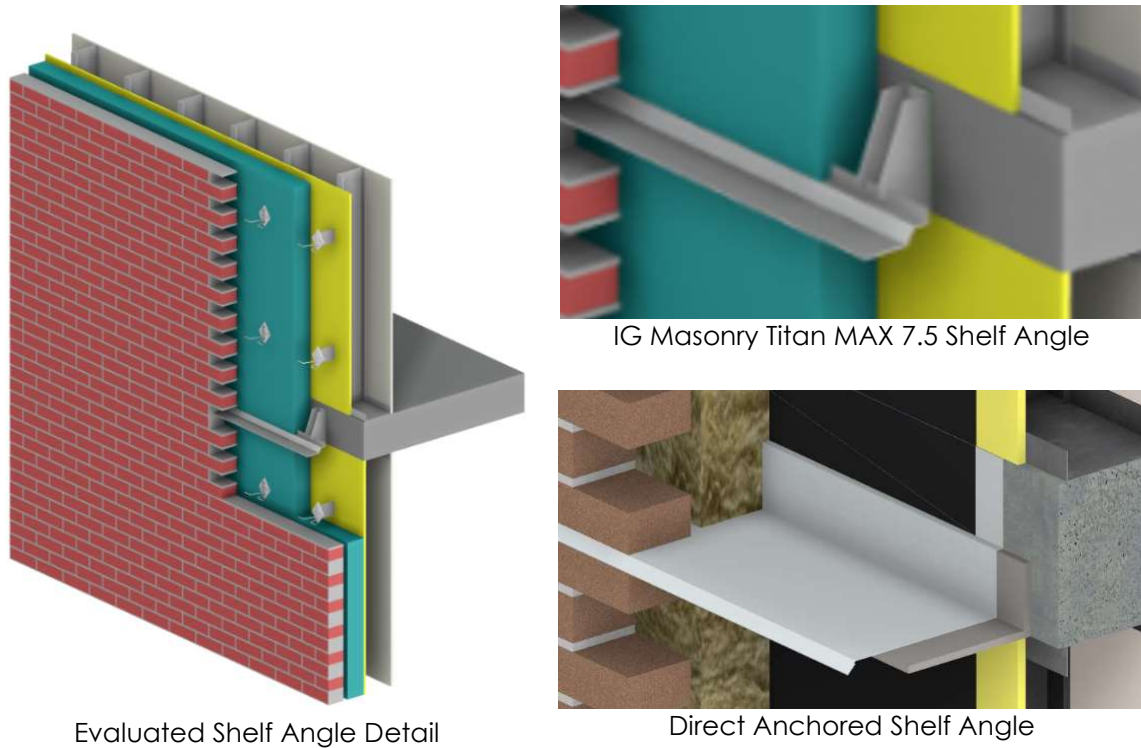
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1. INTRODUCTION

Morrison Hershfield (MH) has been commissioned by IG Masonry Support (IG Masonry) to evaluate the thermal performance of the IG Masonry Titan MAX 7.5 Shelf Angle System at intermediate floor detail for exterior insulated steel-frame wall assemblies with brick veneer with two exterior insulation types. This report is a summary of the analysis.

Two scenarios with the IG Masonry Titan MAX 7.5 Shelf Angle System were evaluated and compared to the thermal performance of similar previously evaluated details with a direct anchored shelf angle, similar to Detail 5.2.33 in the Building Envelope Thermal Bridging Guide v1.6¹. The evaluated shelf angle details are shown in Figures 1.1 and 1.2, while the evaluated scenario descriptions are listed in Table 1.1.



| Wall Assembly | Intermediate Floor |
|---|--|
| <ul style="list-style-type: none"> • Standard clay brick masonry • 1" (25 mm) air space • 4" (102 mm) exterior insulation (varies) • Steel brick ties at 16" (406 mm) o.c. horizontally and 24" (610 mm) o.c. vertically, connected to web of steel studs • 1/2" (13 mm) gypsum sheathing • 6" (152 mm) steel studs at 16" (406 mm) o.c. with no insulation in the stud cavity • 1/2" (13 mm) gypsum drywall | <ul style="list-style-type: none"> • 8 inch (203 mm) intermediate concrete floor <p><i>IG Masonry Titan MAX 7.5 Shelf Angle System:</i></p> <ul style="list-style-type: none"> • Stainless steel brackets with 5/64" (2 mm) Mica shim mounted to slab with 1/2" (12 mm) Ø, 5" (127 mm) long stainless steel anchor bolt, spaced 24" (610 mm) o.c. • Stainless steel shelf angle, embedded in mortar <p><i>Direct Anchored Shelf Angle:</i></p> <ul style="list-style-type: none"> • Steel shelf angle with galvanized steel flashing |

Figure 1.1 Evaluated Shelf Angle Detail Geometry

¹ <https://www.bchydro.com/thermalguide>

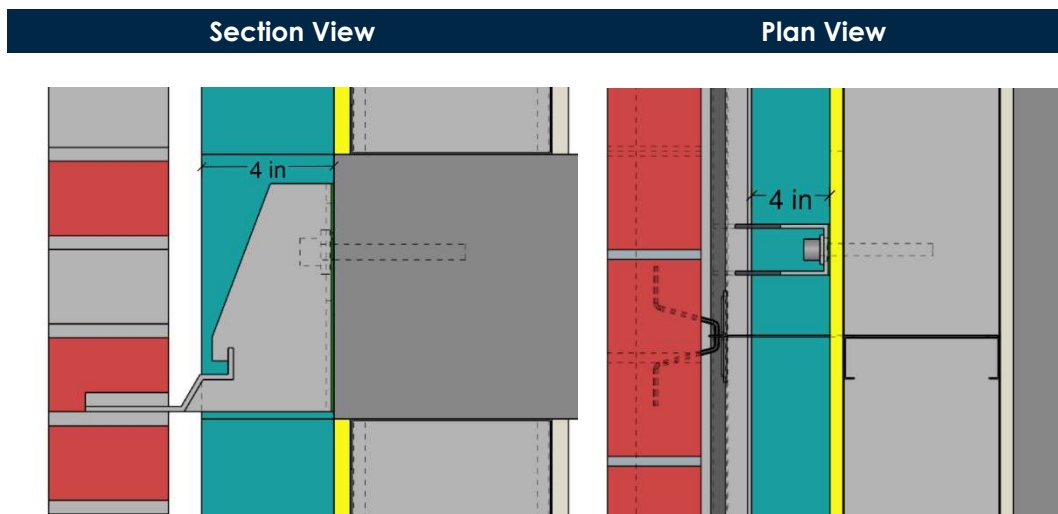


Figure 1.2: Evaluated IG Masonry Titan MAX 7.5 Shelf Angle Configuration

Table 1.1: Evaluated Intermediate Floor Shelf Angle Detail Scenarios

| Shelf Angle | Exterior Wall Type | Stud Spacing inch (mm) | Brick Tie Spacing inch (mm) | Exterior Insulation | | |
|--|--|---------------------------|--|--------------------------|------------------------|---|
| | | | | Type | Thickness inch (mm) | Nominal R-value |
| Titan MAX 7.5 Shelf Angle with Brackets at 24 inch (610 mm) o.c. | Exterior Insulated Steel-Frame Wall with Brick Veneer Wall | 16 (406) | Horizontal: 16 (406) Vertical: 24 (610) | Mineral Wool, Spray Foam | 4 (102) | R-16.8 (2.96 RSI), R-24.0 (4.23 RSI) |
| Direct Anchored Steel Shelf Angle | Exterior Insulated Steel-Frame Wall with Brick Veneer Wall | 16 (406) | Horizontal: 16 (406) Vertical: 24 (610) | Mineral Wool, Spray Foam | 4 (102) | R-16.8 (2.96 RSI), R-24.0 (4.23 RSI) |

2. MODELLING PROCEDURES

The thermal performance of the exterior insulated steel-frame wall at intermediate floor details with shelf angles were evaluated by 3D thermal simulations using the NX and SimCenter 3D software package from Siemens, which is a general-purpose computer aided design (CAD) and finite element analysis (FEA) package. The thermal solver and modelling procedures utilized for this study were extensively calibrated and validated to within +/- 5% of hotbox testing for *ASHRAE Research Project 1365-RP Thermal Performance of Building Envelope Details for Mid- and High-Rise Construction and for the Building Envelope Thermal Bridging Guide*² and conform to the CSA Z5010 standard for thermal simulations of opaque building envelope assemblies.

The thermal analysis utilized steady-state conditions, published thermal properties of materials and information provided by IG Masonry. Additional assumptions for the thermal analysis are listed in Appendix A. Further assembly information, including dimensions and materials are given in Appendix B.

The analysis presented in this report is limited to the thermal performance of the evaluated wall assemblies. Other requirements related to the structural integrity, code and life safety, air, vapour, and moisture control are to be verified by a design professional.

2 <https://www.bchydro.com/thermalguide>

3. THERMAL RESULTS

The U-values, effective R-values, and linear transmittances for the evaluated IG Masonry Titan MAX 7.5 Shelf Angle system and the previously evaluated direct anchor configurations are shown below in Table 3.1. Temperature profiles for the configurations are provided in Appendix C.

Table 3.1: Evaluated Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Brick Veneer and IG Masonry Titan MAX 7.5 Shelf Angle and Direct Anchor Details

| Shelf Angle Support System | Exterior Insulation | | | Clear Field | | Overall Detail | | Intermediate Floor Linear Transmittance Ψ Btu/h ft ² °F (W/m ² K) |
|----------------------------|---------------------|------------------------|--|--|---|---|---|---|
| | Type | Thickness inch (mm) | Nominal R-Value ft ² ·hr·°F/Btu (m ² ·°K/W) | U-Value Btu/h ft ² °F (W/m ² ·°K) | R-Value h·ft ² ·°F/Btu (m ² ·°K/W) | U-Value Btu/h·ft ² ·°F (W/m ² ·°K) | R-Value h·ft ² ·°F/Btu (m ² ·°K/W) | |
| IG Titan MAX 7.5 | Mineral Wool | 4 (102) | R-16.8 (2.96 RSI) | 0.062 (0.353) | R-16.1 (2.84 RSI) | 0.066 (0.376) | R-15.1 (2.66 RSI) | 0.036 (0.062) |
| IG Titan MAX 7.5 | Spray Foam | 4 (102) | R-24.0 (4.23 RSI) | 0.051 (0.287) | R-19.8 (3.49 RSI) | 0.055 (0.310) | R-18.3 (3.23 RSI) | 0.035 (0.061) |
| Direct Anchor | Mineral Wool | 4 (102) | R-16.8 (2.96 RSI) | 0.062 (0.353) | R-16.1 (2.84 RSI) | 0.093 (0.525) | R-10.8 (1.90 RSI) | 0.337 (0.583) |
| Direct Anchor | Spray Foam | 4 (102) | R-24.0 (4.23 RSI) | 0.051 (0.287) | R-19.8 (3.49 RSI) | 0.082 (0.466) | R-12.2 (2.15 RSI) | 0.351 (0.608) |

We believe that this report meets your objectives for evaluating the thermal performance for the IG Masonry Titan Max 7.5 Shelf Angle System. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

Morrison Hershfield Limited



Mohammad Azimi, E.I.T, B.Sc, MEng
Building Science Consultant

Ivan Lee, P.Eng., M.A.Sc.
Building Science Engineer

APPENDIX A

Modelling Parameters and Assumptions

A1. GENERAL MODELLING APPROACH

For this report, a steady-state conduction model was used. The following parameters were also assumed:

- Material properties were taken from information provided by IG Masonry Support and ASHRAE Handbook – Fundamentals for common materials.
- Large enclosed air spaces, such as stud cavities, were simulated with an equivalent thermal conductivity of the air that includes the impacts of convection and radiation within the enclosure. Calculations for this equivalent conductivity were based on Table 6 of CSA Z5010 and Chapter 26 of 2017 ASHRAE Handbook - Fundamentals
- Interior/exterior air films were taken from Table 8 of CSA Z5010:21 which are similar to Table 10, p. 26.21 of 2017 ASHRAE Handbook – Fundamentals depending on surface orientation. The exterior air films were based on an exterior wind speed of 15 mph.
- Contact resistances between materials were modelled following Table 5 of CSA Z5010 depending on the materials and interfaces.
- Insulation and other components were considered tight to adjacent interfaces.
- The clear field transmittances included in this analysis include uniform thermal bridges such as studs, clips, and girts.

A2. TEMPERATURE INDEX

The wall assemblies were evaluated over a temperature index. The temperature index is the ratio of the surface temperature relative to the interior and exterior temperatures. The temperature index has a value between 0 and 1, where 0 is the exterior temperature and 1 is the interior temperature. If T_i is known, Equation 1 can be rearranged for $T_{surface}$. This arrangement allows the modelled surface temperatures to be applicable to any climate.

$$T_i = \frac{T_{surface} - T_{outside}}{T_{inside} - T_{outside}} \quad \text{EQ 1}$$

Note: These indices shown in the temperature profiles for this analysis are for general information only and are **not** intended to predict in-service surface temperatures subject to transient conditions, variable heating systems, and/or interior obstructions that restrict heating of the assembly. For full limitations of this modeling approach, see ASHRAE 1365-RP.

A3. BOUNDARY CONDITIONS

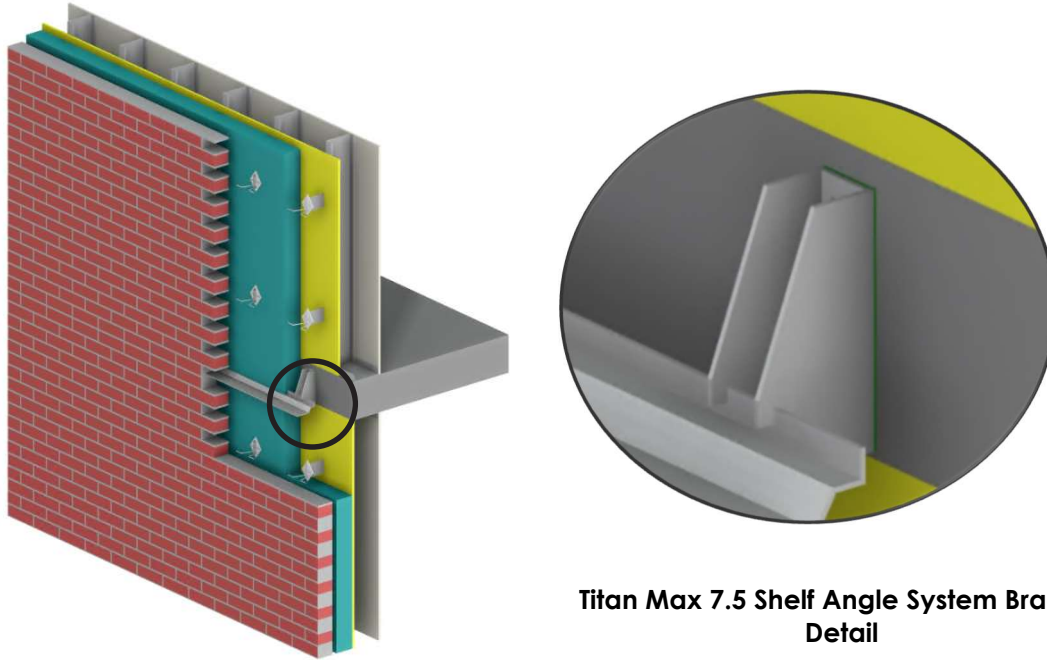
Table A1: Boundary Conditions

| Boundary Location | Heat Transfer Coefficient BTU/h ft ² °F (W/m ² K) |
|---|--|
| Exterior Wall Surfaces with Generic Cladding | 1.5 (8.3) |
| Interior Vertical Surfaces | 1.5 (8.3) |

APPENDIX B

Material Properties

B1. EXTERIOR INSULATED STEEL-FRAME WALL WITH TITAN MAX 7.5 SHELF ANGLE SUPPORT SYSTEM WITH BRICK VENEER WALL ASSEMBLY



Titan Max 7.5 Shelf Angle System Bracket Detail

| Component | Material | Thickness inch (mm) | Thermal Conductivity Btu-in/ft ² hr°F (W/mK) | Nominal Resistance ft ² hr °F / Btu (m ² K/W) |
|------------------------------|------------------|------------------------|--|---|
| Wall Assembly | | | | |
| Interior Film | - | - | - | R-0.6 to R-0.9 (0.11 RSI to 0.16 RSI) ¹ |
| Gypsum Board | Gypsum | 1/2 (13) | 1.1 (0.16) | R-0.5 (0.08 RSI) |
| Stud Cavity | Air | 6 (152) | - | R-0.9 (0.16 RSI) ² |
| Studs | Galvanized Steel | 20 ga. | 430 (62) | |
| Track | Galvanized Steel | 20 ga. | 430 (62) | - |
| Exterior Sheathing | Gypsum | 1/2 (13) | 1.1 (0.16) | R-0.5 (0.08 RSI) |
| Brick Tie Insulation Support | Polyethylene | - | 2.91 (0.42) | - |
| Brick Tie Wire | Steel | - | 430 (62) | |
| Exterior Insulation | Varies | 4 (102) | Varies | R-16.8 to R-24 (2.96 to 4.23 RSI) |
| Rainscreen Cavity | Air | 1 (25.4) | - | R-0.4 (0.07 RSI) |
| Brick | Clay Brick | 3 5/8 (92.1) | 5.41 (0.78) | - |
| Mortar | Cement Mortar | - | 3.47 (0.50) | - |
| Exterior Film | - | - | - | R-0.7 (0.12 RSI) ¹ |

| Intermediate Floor | | | | |
|---|---------------------------------|------------|-------------|---|
| Slab | Concrete | - | 12.5 (1.80) | - |
| IG Masonry Titan MAX 7.5 Shelf Angle System | | | | |
| Shelf Angle Shim | Mica | 5/64 (2) | 1.73 (0.25) | - |
| Shelf Angle Bracket | Stainless Steel | - | 118 (17) | - |
| Lock Washer | Stainless Steel | - | 118 (17) | - |
| Anchor Bolt | Stainless Steel | 1/2 (12) Ø | 118 (17) | - |
| Shelf Angle | Stainless Steel | - | 118 (17) | - |
| Direct Anchored Shelf Angle | | | | |
| Anchor Plates | Steel | - | 347 (50) | - |
| Shelf Angle | Steel | - | 347 (50) | - |
| Flashing | Galvanized Steel | 20 ga. | 430 (62) | - |
| Thermal Pad | Fiberglass-Reinforced Composite | - | 1.8 (0.26) | - |
| Anchor Bolt | Steel | 5/8 (16) Ø | 347 (50) | - |

¹The thermal resistance of interior and exterior films were determined according to Table 8 of CSA Z5010:2021 and Table 10 of Chapter 26 of 2017 ASHRAE Handbook - Fundamentals

²The thermal conductivities of the air spaces were determined according to Table 6 of CSA Z5010:2021 and Table 3 of Chapter 26 of 2017 ASHRAE Handbook - Fundamentals

APPENDIX C

Simulated Temperature Profiles

The simulated temperature profiles of intermediate floor details with exterior insulated steel-frame wall assemblies with brick veneer and IG Masonry Titan MAX 7.5 shelf angle system with brackets at 24 inch (610 mm) spacing, and direct anchored shelf angles are shown below. These figures illustrate a typical temperature distribution for the 4 inch (102 mm) exterior insulation with steel brick tie anchors at 16 inches (406 mm) o.c. horizontal and 24 inches (610 mm) o.c. vertical spacing. The profiles are presented as a temperature index (between 0 and 1). See Appendix A2 for more information.

C1. EXTERIOR INSULATED STEEL-FRAME WALLS WITH TITAN MAX 7.5 SHELF ANGLE SUPPORT SYSTEM

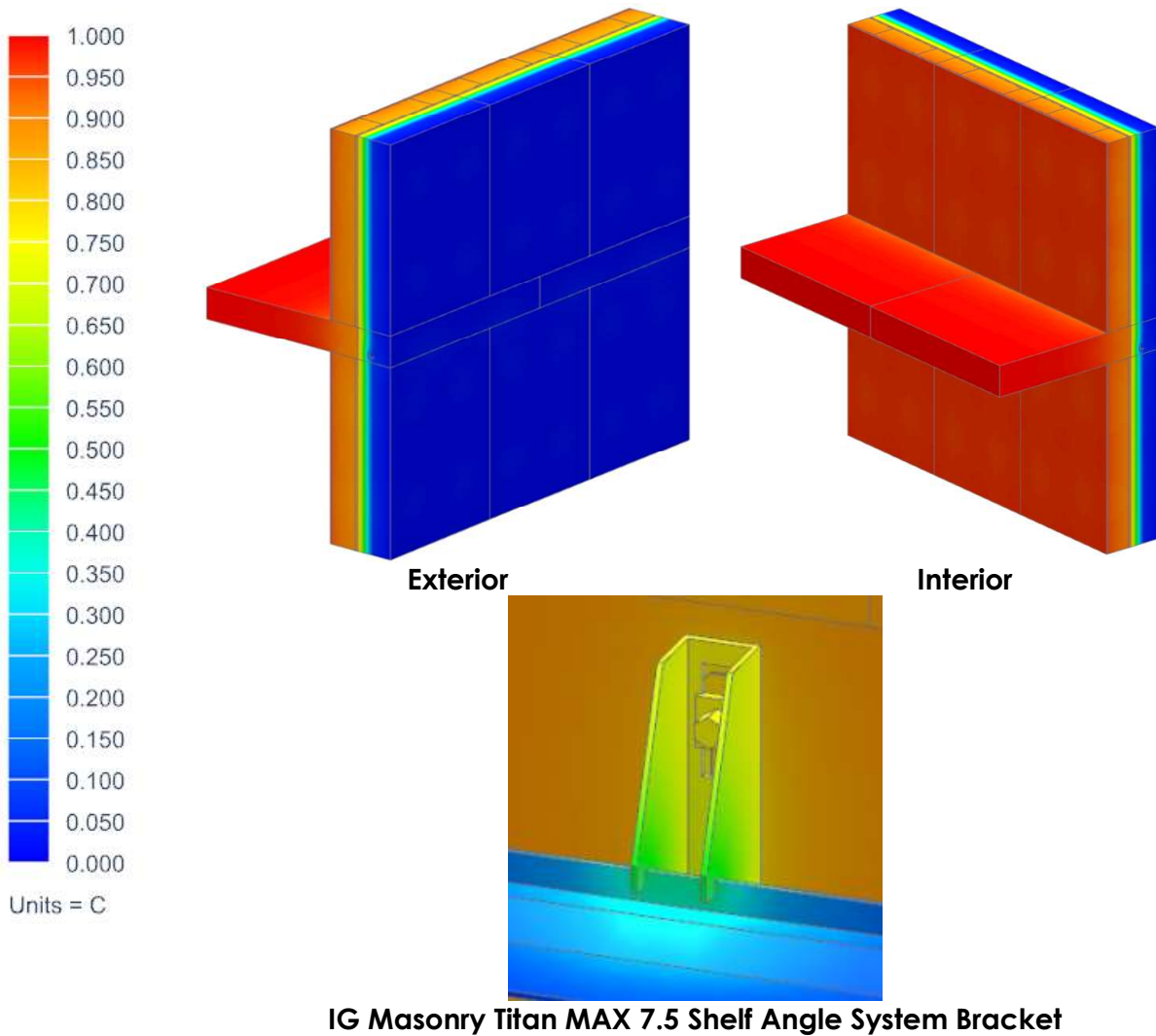


Figure C1: Simulated Temperature Profile of Exterior Insulated Steel-Frame Wall Assembly with Brick Veneer and IG Masonry Titan MAX 7.5 Shelf Angle System Intermediate Floor Detail with Mineral Wool Insulation (R-16.8)

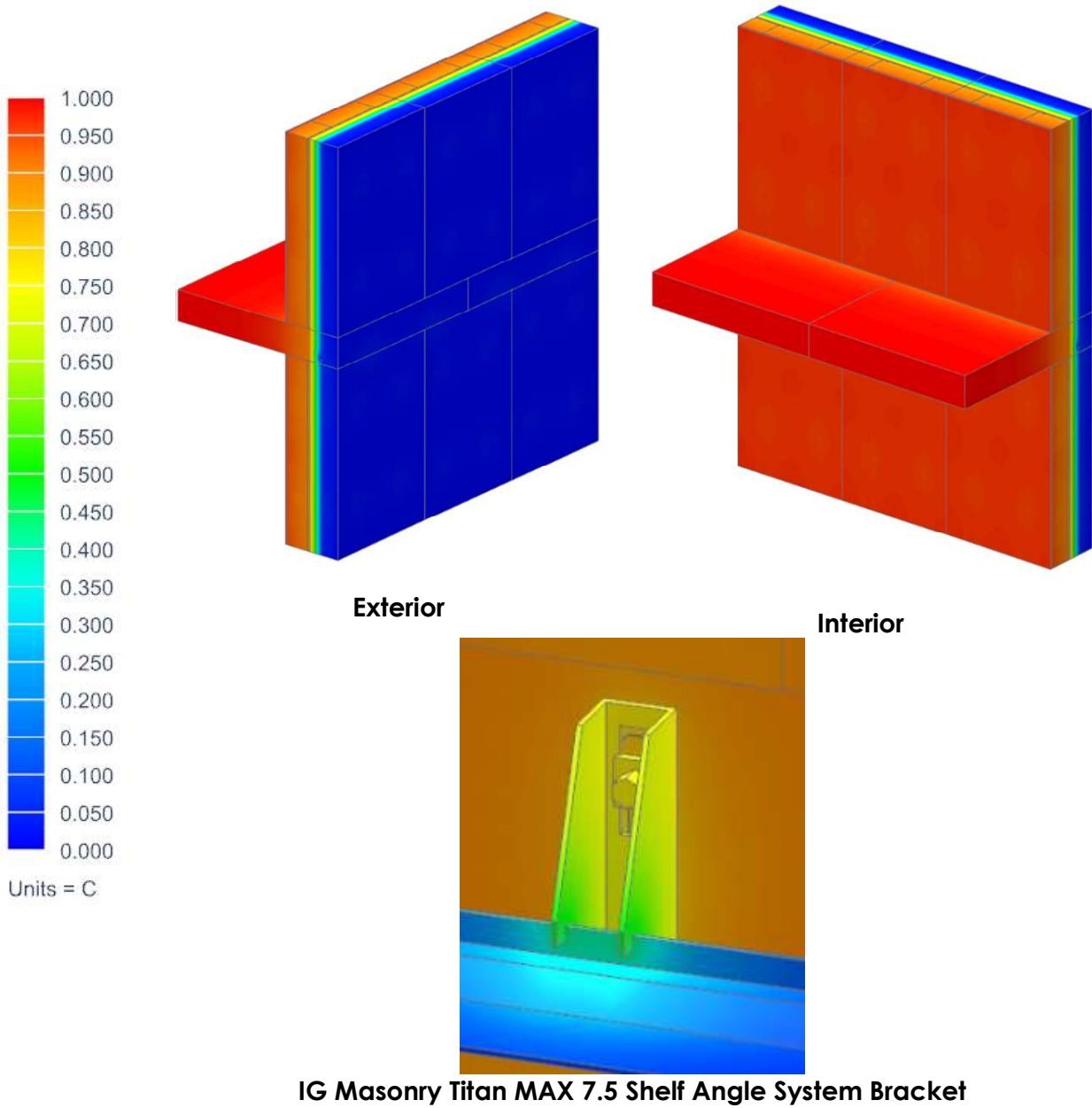


Figure C2: Simulated Temperature Profile of Exterior Insulated Steel-Frame Wall Assembly with Brick Veneer and IG Masonry Titan MAX 7.5 Shelf Angle System Intermediate Floor Detail with Spray Foam Insulation (R-24)

C2. EXTERIOR INSULATED STEEL-FRAME WALLS WITH DIRECT ANCHORED SHELF ANGLE

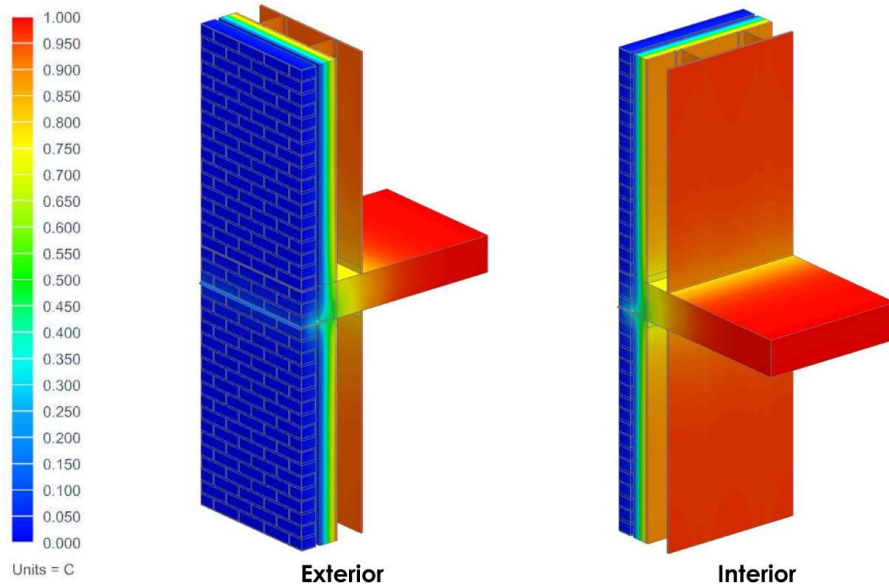


Figure C3: Simulated Temperature Profile of Exterior Insulated Steel-Frame Wall Assembly with Brick Veneer and Direct Anchored 5 Shelf Angle Intermediate Floor Detail with Mineral Wool Insulation (R-16.8)

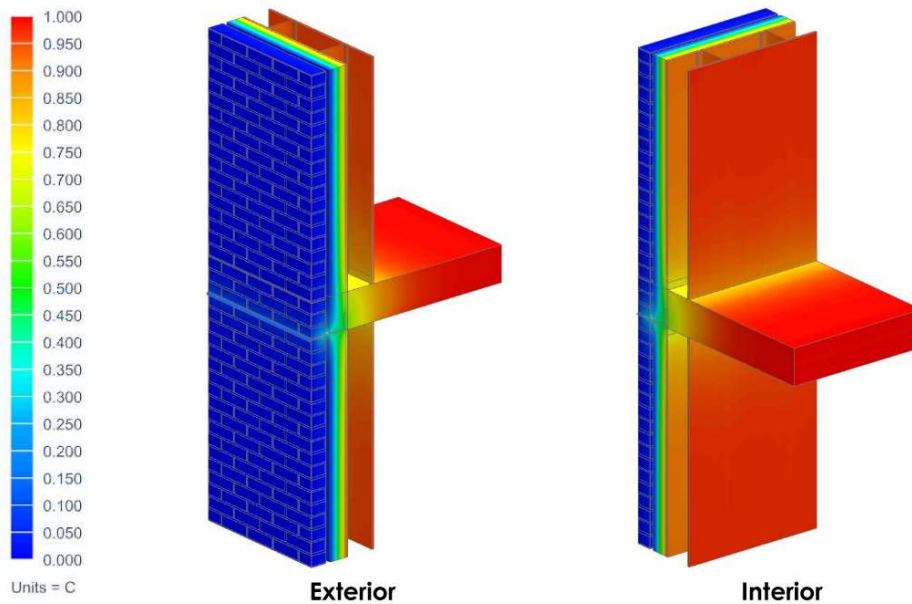
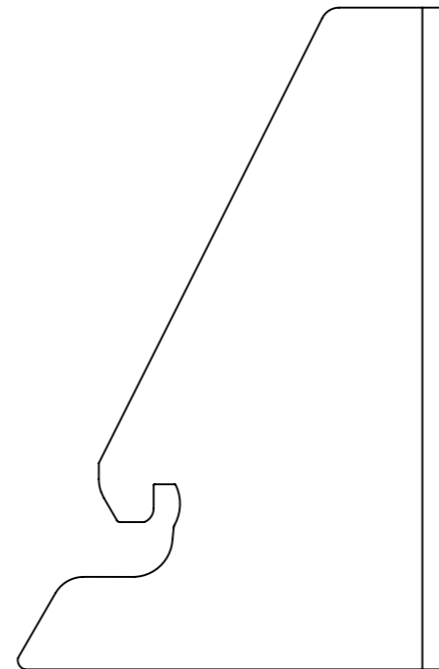
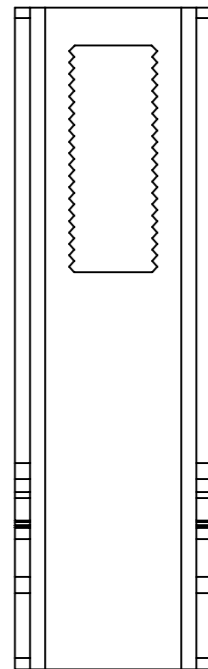
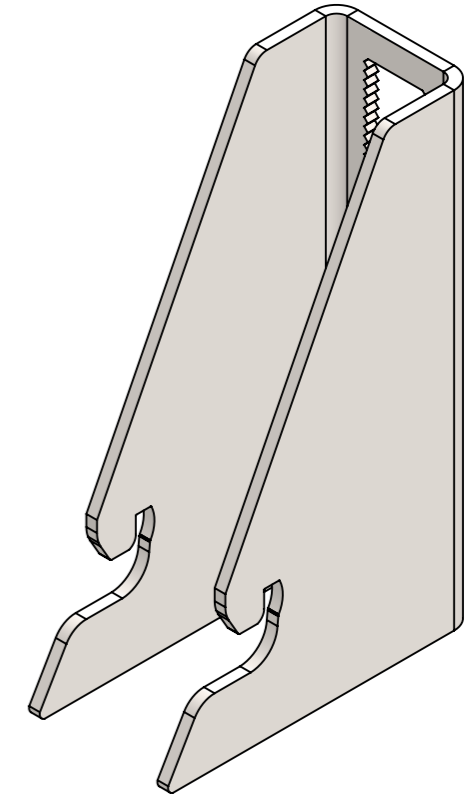
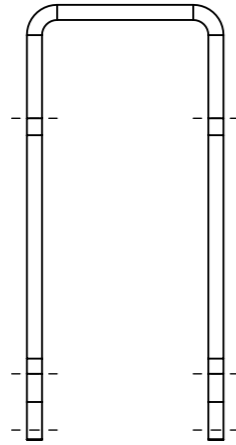
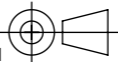


Figure C4: Simulated Temperature Profile of Exterior Insulated Steel-Frame Wall Assembly with Brick Veneer and Direct Anchored Shelf Angle Intermediate Floor Detail with Spray Foam Insulation (R-24)

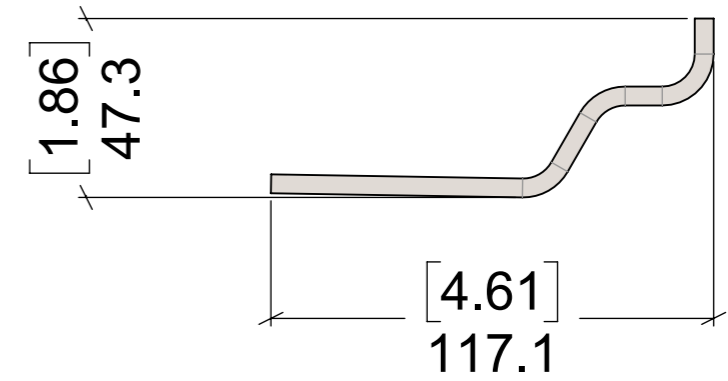
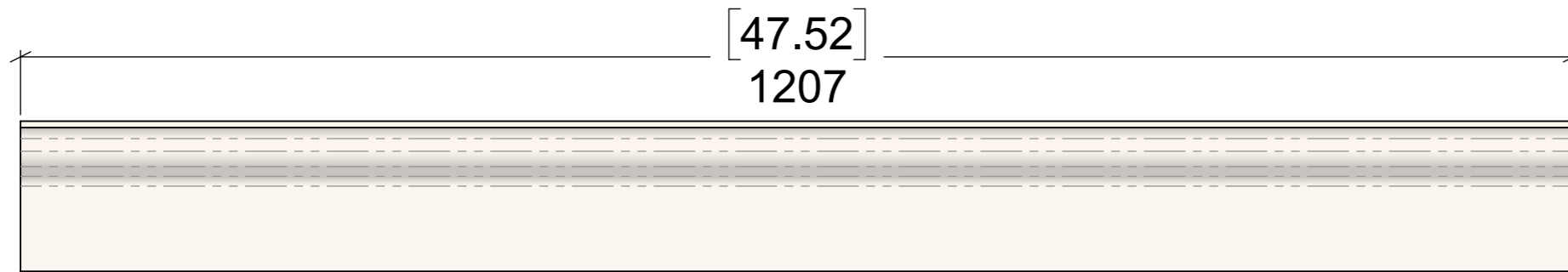
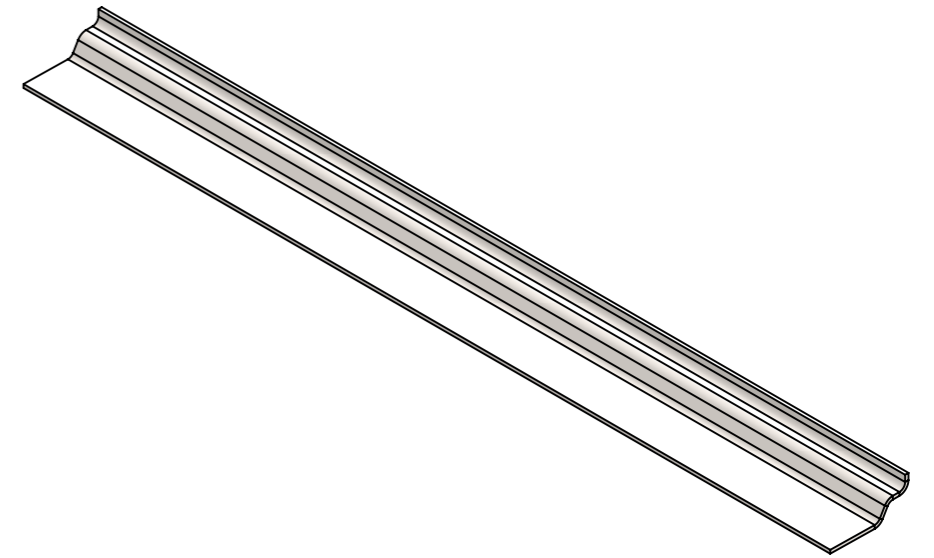
APPENDIX D

Detail Drawings

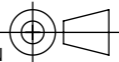


| | | | |
|--|--|----------------------------------|---|
| MATERIAL THICKNESS: 4 | DRG REF: T5-175 | SHEET: 1/1 | MATERIAL: STAINLESS 304 |
| WEIGHT: 0.99 KG | TOLERANCES ALL DIMS +/- 2mm UNO ALL ANGLES +/- 2 DEGREES UNO | DRAWN BY: MJ DATE: 22/03/2023 | MANU CHK: SS DATE: 27/03/2023 |
| THIRD ANGLE PROJECTION  | | A3 | SCALE U.N.O: 1:2 |
| | | | DETAILER CHK: - DATE: 22/03/2023 REV: A |





Titan Max

| | | | |
|--|--|----------------------------------|--|
| MATERIAL THICKNESS: 5 | DRG REF: TITAN 1207 5MM | SHEET: 1/1 | MATERIAL: STAINLESS 304 |
| WEIGHT: 6.85 KG | TOLERANCES ALL DIMS +/- 2mm UNO ALL ANGLES +/- 2 DEGREES UNO | DRAWN BY: EG DATE: 18/10/2023 | MANU CHK: SS DATE: 07/11/2022 |
| THIRD ANGLE PROJECTION  | | A3 | DETAILER CHK: EG DATE: 18/10/2023 REV: A |

