



Energy Technologies Area

Technical Note:

MODELING SPANDREL SYSTEMS FOR NFRC RATINGS

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September 20, 2010. Revised July 28, 2020

INTRODUCTION:

Spandrel systems represent an important segment of non-residential fenestration market and up until now, there was no sanctioned procedure how are these products modeled for thermal and solar-optical performance. This document presents a method, by which spandrel systems can be modeled and NFRC certified. The whole product performance calculation, presented later in this document, references a still un-approved proposal for rating size and configuration of the curtain wall with spandrel system.

MODELING PROCEDURE:

Modeling of spandrel systems is done in a similar fashion as standard glazing infill, thus relying on “center of glazing” procedure for determining thermal and solar optical performance of clear area of the spandrel system (i.e., area of the spandrel system excluding framing and 2.5 in. of edge area, also known as “Spandrel Panel”). Layers that make clear area of the spandrel panel are modeled using ISO 15099 algorithms, with the exception of solid layers that are in contact with each other (e.g., insulation in contact with opaque panel, etc.). Such layers are modeled by inserting very thin layer (0.001 mm) of fictitious gas that has very high conductivity (i.e., 9999 W/(m²·K)) between the two solid layers. Optical properties of opaque layers shall be either measured or default values (T=0, R=0.5, A=0.5) should be used. It is recommended to use default optical values for spandrel systems that incorporate insulation, where absorptance of the layer does not make significant difference. In addition to optical properties, conductivity and emissivity of opaque layers shall be specified using NFRC 101.

Proposed Modeling Steps in THERM and WINDOW:

- WINDOW:
 - Create opaque layers in WINDOW 6 glazing layer library, as needed using conductivities, emissivities, and absorptivities (front and back) from NFRC 101. Transmittance shall be set to 0. Default absorptivity of 0.5 shall be used for spandrel systems that incorporate insulation.
 - Create fictitious gas in gas library screen with the conductivity of 9999 W/(m²·K).
 - Create clear portion of the spandrel system in glazing system library and set number of glazing layers to the total number of solid layers. Select appropriate entry from the glazing layer library for each solid layer. When solid layers are in contact with each other, separate them by a layer of fictitious gas, 0.001 mm wide, otherwise use actual gap width between solid layers and actual gas fill.
 - Select NFRC 100-2002 boundary conditions
 - Run simulation
- THERM:
 - Prepare model of the frame cross-section
 - Insert spandrel system, created above into the frame cross-section and make necessary edits to the spandrel panel to fit with the frame cross-section, as per drawings
 - Apply boundary conditions and U-factor tags

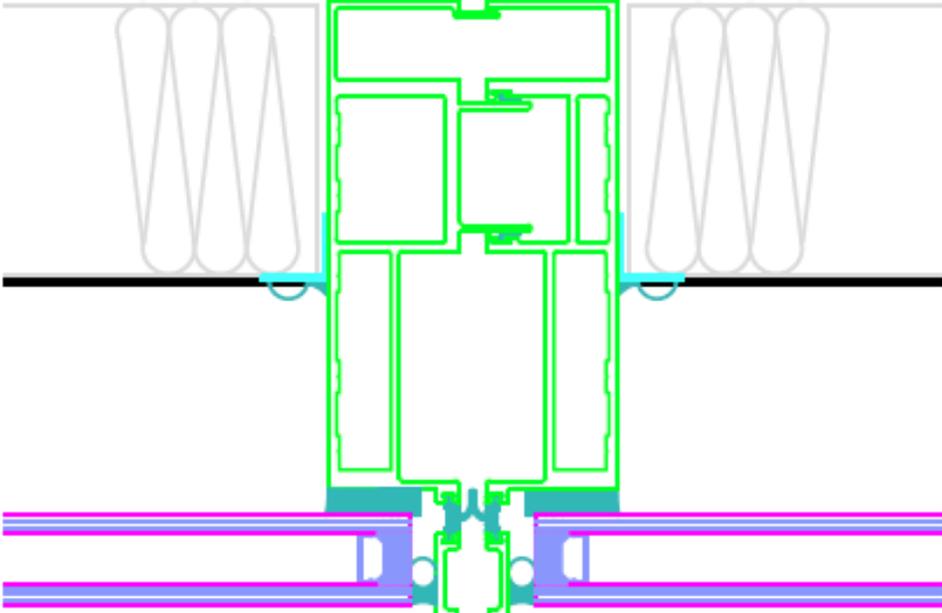
- Run simulation
- WINDOW:
 - Import frame cross-sections generated above
 - In whole product library, select “custom dual vision with vertical mullion” product type.
 - Set width to 2000 mm and set height to 900 mm
 - Attach appropriate frame library entries to each frame member
 - Select spandrel panel for infill

Proposed Modeling Steps in THERM and CMAST:

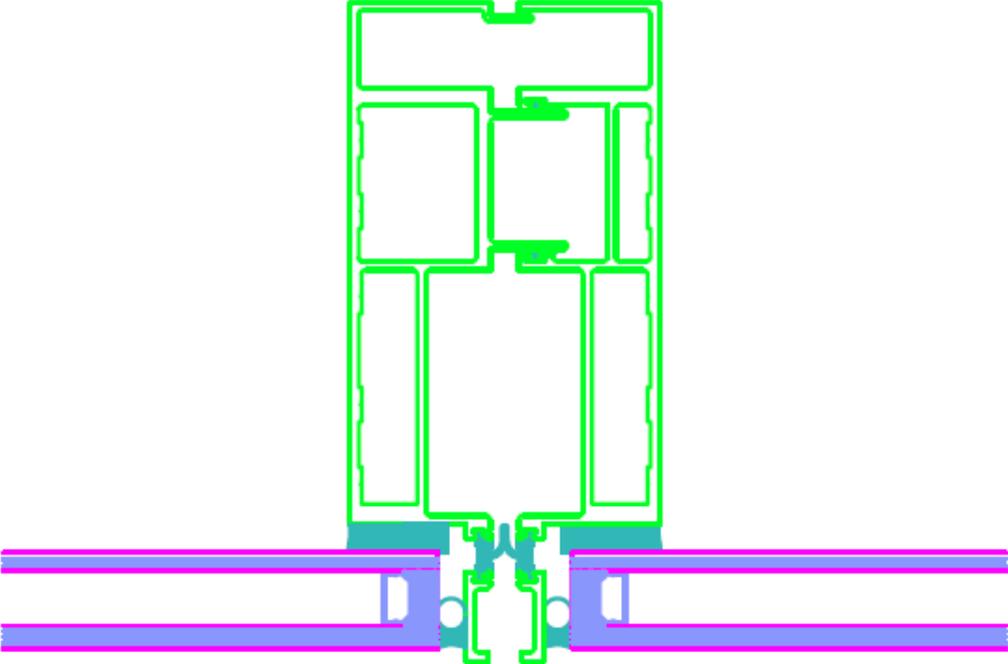
- THERM:
 - Prepare model of the frame cross-section
 - Insert CMA glazing system
 - Apply boundary conditions
 - Run simulation
- CMAST:
 - Create opaque layers in glazing component library, as needed using conductivities, emissivities, and absorptivities (front and back) from NFRC 101. Transmittance shall be set to 0. Default absorptivity of 0.5 shall be used for spandrel systems that incorporate insulation.
 - Create clear portion of the spandrel system (spandrel panel) in glazing assembly detailed screen and set number of glazing layers to the total number of solid layers. Select appropriate entry from the glazing layer library for each solid layer. When solid layers are in contact with each other, separate them by a layer of fictitious gas, 0.001 mm wide, otherwise use actual gap width between solid layers and actual gas fill. Prepare clear vision glazing system portion (without spandrel system) in WINDOW 6
 - Select NFRC 100-2002 boundary conditions
 - Run simulation
 - Create spacer system in spacer edge-seal assembly detailed screen, if there is one present
 - In frame assembly, select curtain wall product type
 - Set width to 2000 mm and height to 900 mm
 - Assign frame component to each frame member
 - Assign spandrel panel to the infill area
 - Assign spacer system to the infill area, if there is any
 - Run simulation

EXAMPLE:

Curtain Wall with Spandrel System (Example from Benson Industries):



Curtain Wall with Glazing:



Glazing System Model of the Clear Area of Spandrel System (Spandrel Panel):

ID #: Name:
 # Layers: Tilt: ° IG Height: mm
 Environmental Conditions: IG Width: mm
 Comment:
 Overall thickness: mm Mode: Model Deflection

	ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
▼	Glass 1 ▶▶	5279 SB60 Clear-8.PPG	#	7.9	<input type="checkbox"/>	0.373	0.228	0.455	0.781	0.058	0.049	0.000	0.842	0.035	1.000
	Gap 1 ▶▶	1 Air		20.1											
▼	Glass 2 ▶▶	103 CLEAR_6.DAT	#	5.7	<input type="checkbox"/>	0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000
	Gap 2 ▶▶	1 Air		89.9											
▼	Glass 3 ▶▶	20001 Steel Plate - Painted		1.0	<input type="checkbox"/>	0.000	0.100	0.100	0.000	0.100	0.100	0.000	0.900	0.900	62.000
	Gap 3 ▶▶	1 Air		2.0											
▼	Glass 4 ▶▶	20002 Fiberglass Batt Insulator		101.4	<input type="checkbox"/>	0.000	0.100	0.100	0.000	0.100	0.100	0.000	0.900	0.900	0.036

Center of Glass Results | Temperature Data | Optical Data | Angular Data | Color Properties | Radiance Results

Ufactor	SC	SHGC	Rel. Ht. Gain	Tvis	Keff	Layer 1 Keff	Gap 1 Keff	Layer 2
W/m2-K			W/m2		W/m-K	W/m-K	W/m-K	W/m
0.253	0.056	0.049	37.6	0.000	0.1259	0.0000	0.0314	0.00

Glazing System Model of the Glazing Only Section (Curtain Wall):

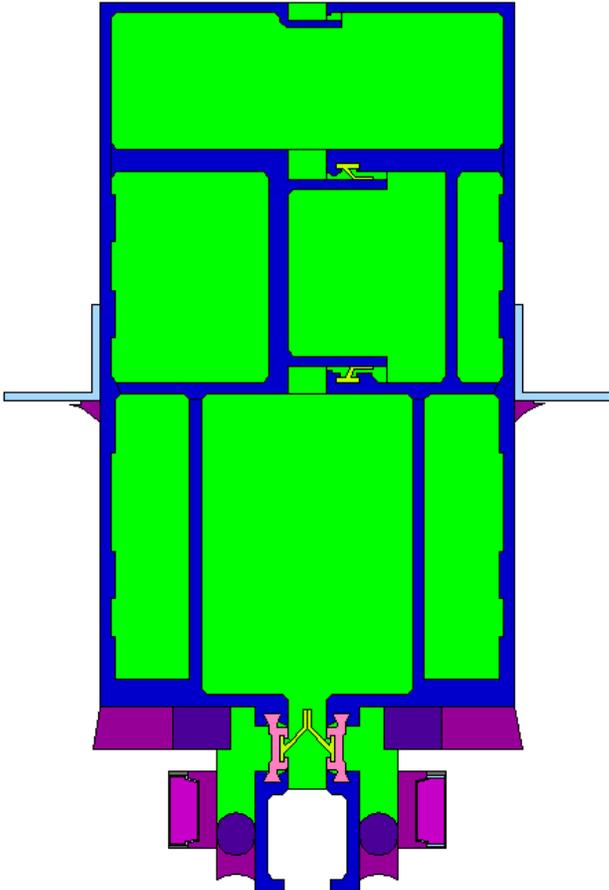
ID #: Name:
 # Layers: Tilt: ° IG Height: mm
 Environmental Conditions: IG Width: mm
 Comment:
 Overall thickness: mm Mode: Model Deflection

	ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
▼	Glass 1 ▶▶	5279 SB60 Clear-8.PPG	#	7.9	<input type="checkbox"/>	0.373	0.228	0.455	0.781	0.058	0.049	0.000	0.842	0.035	1.000
	Gap 1 ▶▶	1 Air		20.1											
▼	Glass 2 ▶▶	103 CLEAR_6.DAT	#	5.7	<input type="checkbox"/>	0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000

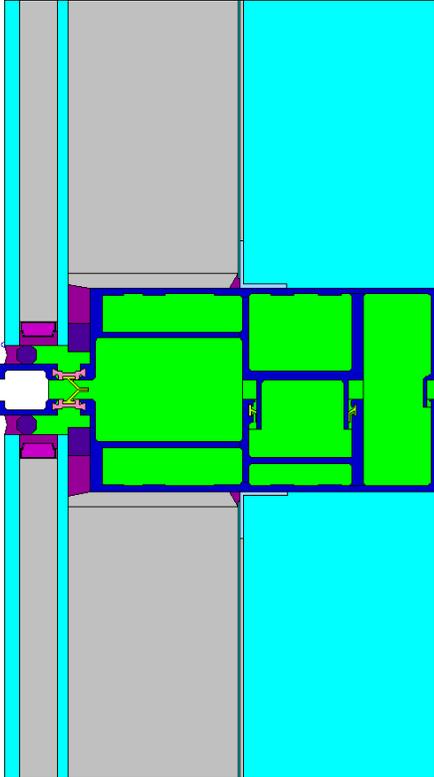
Center of Glass Results | Temperature Data | Optical Data | Angular Data | Color Properties | Radiance Results

Ufactor	SC	SHGC	Rel. Ht. Gain	Tvis	Keff	Layer 1 Keff	Gap 1 Keff	Layer :
W/m2-K			W/m2		W/m-K	W/m-K	W/m-K	W/r
1.748	0.429	0.374	280	0.693	0.0522	0.0000	0.0522	0.00

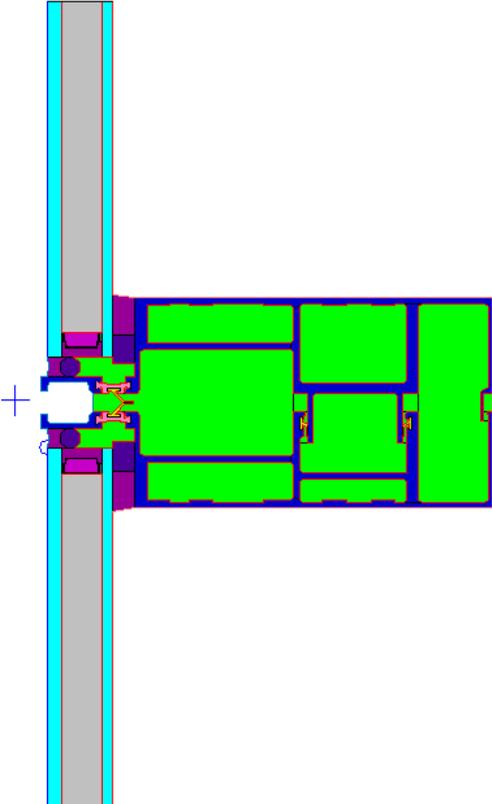
THERM Model of Frame Cross-Section in Spandrel System:



THERM Model of Frame Cross-Section with Spandrel System Inserted (Meeting Rail):



THERM Model of Frame Cross-Section with Glazing Only Inserted (Meeting Rail):



Whole Product Performance (Section with Spandrel System):

List

Calc (F9)

New

Copy

Delete

Save

Report

Dividers

Dividers

Display mode:
Normal

SHGC/VT Detail

CR Detail

ID # 1

Name D3-12

Mode Design

Type Horizontal Slider, custom >>

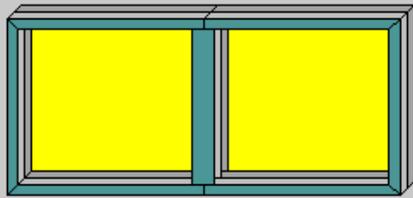
Width 2000 mm

Height 900 mm

Area 1.800 m2

Tilt 90

Environmental Conditions
NFRC 100-2001



Total Window Results

U-factor 1.167 W/m2-K

SHGC 0.045

VT 0.000

CR N/A

Click on a component to display characteristics below

Whole Product Performance (Section with Glazing Only):

List

Calc (F9)

New

Copy

Delete

Save

Report

Dividers

Dividers

Display mode:
Normal

SHGC/VT Detail

CR Detail

ID # 2

Name D3-12 G

Mode Design

Type Horizontal Slider, custom >>

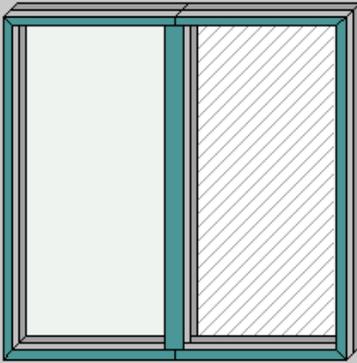
Width 2000 mm

Height 2000 mm

Area 4.000 m2

Tilt 90

Environmental Conditions
NFRC 100-2001



Total Window Results

U-factor 2.351 W/m2-K

SHGC 0.321

VT 0.581

CR N/A

Click on a component to display characteristics below

Glazing System

Name Glazing Only D3-12 >>

ID	11	Ucenter	1.719 W/m2-K
Nlayers	2	SC	0.429
Area	1.340 m2	SHGC	0.373
Edge area	0.336 m2	Vtc	0.693