

Pella Corporation

102 Main Street
Pella, Iowa 50219

PROJECT:

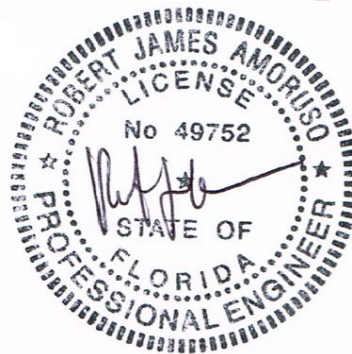
***MULLION CALCULATIONS
FOR VERTICAL AND HORIZONTAL MULLION***

SERIES: 4.0" Wood Spread Mull for Doors
with Transoms and/or Sidelights, 4" x 4-3/8" Wood Mullion

PROJECT NO.: 423-1101

REPORT NO.: 0504-7

DATE: 2/2/2024



Digitally
signed by
Robert J
Amoruso
Date:
2024.02.06
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PTC PRODUCT DESIGN GROUP, LLC

P.O. Box 520775, Suite C25
Longwood, Florida 32752

Client: Pella Corporation
Project #: 423-1101
Report #: 0504-7
Prepared by: RJA
Date: 2/2/2024
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SCOPE PTC, PRODUCT DESIGN GROUP was contracted by Pella Corporation to perform engineering evaluations of various mulled door & window combinations. This report will be based on using the combined properties of the 4.0" x 4-3/8" wood spread mull and the weakest wood frame (Casement Window and or in-swing Door) jambs as demonstrated in the section property section of this report, by evaluation of possible groupings of mullions based on section property comparisons in accordance with the AAMA 450-06/09/10. Structural analysis of the mullions is based on the current edition of the Florida Building Code – Building and Residential Volumes, Chapter 17 and Chapter 6 respectively using the product grouping method and tributary loading of AAMA 450.

PRODUCT APPLICABILITY: This report is applicable to the following Pella Corporation product lines and types only.

1. Product Lines

- a. Reserve Series, exterior clad and wood.
- b. Lifestyle Series with HGP, exterior clad
- c. Lifestyle Series without HGP, exterior clad
- d. Direct Set Aluminum Clad Wood Fixed Windows
- e. Pella Entry Systems, exterior clad and wood

2. Product Types

- a. Casement
- b. Awning
- c. Picture
- d. Direct Set Geometric and Radius
- e. Sliding Patio Door
- f. In-swing Patio Door
- g. Out-swing Patio Door
- h. In-swing Entry Door
- i. Out-swing Entry Door

3. Product Materials

- a. Extruded aluminum for aluminum portions of door and window frames.
- b. Pine for wood portions of mullion member and door and window frames.

The tributary areas are identified and calculated. These results are used to calculate the maximum pressure that the product can withstand without exceeding the allowable stresses or deflection. The minimum of these results is selected and defined as the design pressure for the product. Mullion stress and deflection is calculated using the AAMA 450 load distribution method.

For each mullion configuration, spreadsheet programs are used to calculate the apparent EI and equivalent I, a design pressure verification using equivalent I, and alternate spans from the design pressure calculation.



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ANALYSIS METHODOLOGY:

The following methodology was used to develop the Load width span tables presented in this report.

1. Determine the allowable design pressure (D.P.) based on the actual shear stress, bending stress, deflection and mullion reactions as compared to their respect design allowables choosing the worst case.
- 2.. Worst case section properties determined by a comparison of the individual component sections of the applicable products, the cross sections exhibiting the lowest Moment of Inertia (I) and section Modulus (Z) will be used. Area as it is related to shear stress does not govern design so it is not a deciding factor of the worst case section.
3. Using a ratio of the wood mull and window jambs Modulus of Elasticity (E) compute the overall apparent section properties of the worst case cross section.
4. Use the properties determined above in determining the load width/span tables.
5. Analysis based on:
 - a. Horizontal Shear Stress = P/A (psi)
 - b. Bending Stress = $M/I = M/Z$ (psi)
 - i. M = bending moment and is equal to M/Kf
 - ii. Kf is moment coefficient based on trapezoidal load distribution.
 - c. Deflection = $WL^3 / KdEI$
 - i. Kd is deflection coefficient based on trapezoidal distribution.
 - ii. W is load on mullion in Lbs. = wL where w is distributed load in Lbs/in and L in mullion span inches.
 - d. Mullion End Load Reactions
 - i. Based on trapezoidal load on mullion resolved into total load distributed to each end of mullion equally.
6. Load Width/Span Tables based on:
 - a. Solving for the allowable design pressure (D.P.) considering various window sizes and mullion spans.



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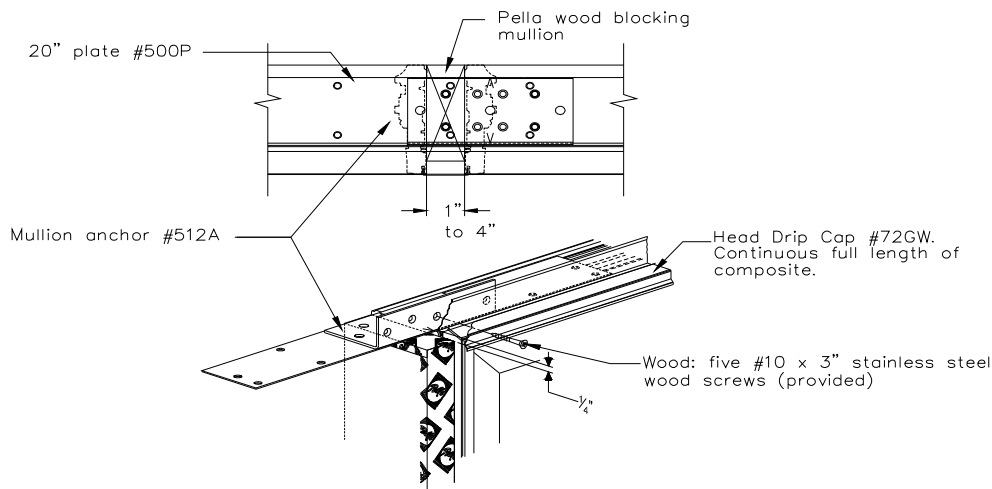
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MULLION END ANCHORAGE:

1. Calculated performance is based on the following:
Mullions anchor plates
 - a. 512-A Wood mullion anchor clip. (316 stainless steel)
 - b. 5071 installation type clip (A-653 Hot dipped Galvanized steel)
 - c. 500 P steel plate and through frame alternate end anchorage.

MULLION ATTACHMENT:

2. a. **Mullion End Clip 512-A (Fin mull anchor clip)**
 - i. The end clip is secured to each end of wood spread mullion using eight #10 x 5/8" wood screws, below, and requires a minimum of 1-1/2" wood buck thickness, (See Detail A).
 - ii. For 20" plate attachment to both main frame members use seven (7) #6 x 5/8" stainless steel screws.
 - iii. For clip attachment to wood frame substrates use five (5) #10 x 2" long or longer wood screws per clip leg into the installation bucking or frame with a minimum of 1 1/2" embedment into substrate and maintaining at least 3/4" minimum edge distance is required based on the analysis used in this report for development of the load width and span.



Mullion End Clip 512-A (Fin mull anchor clip)
Detail A



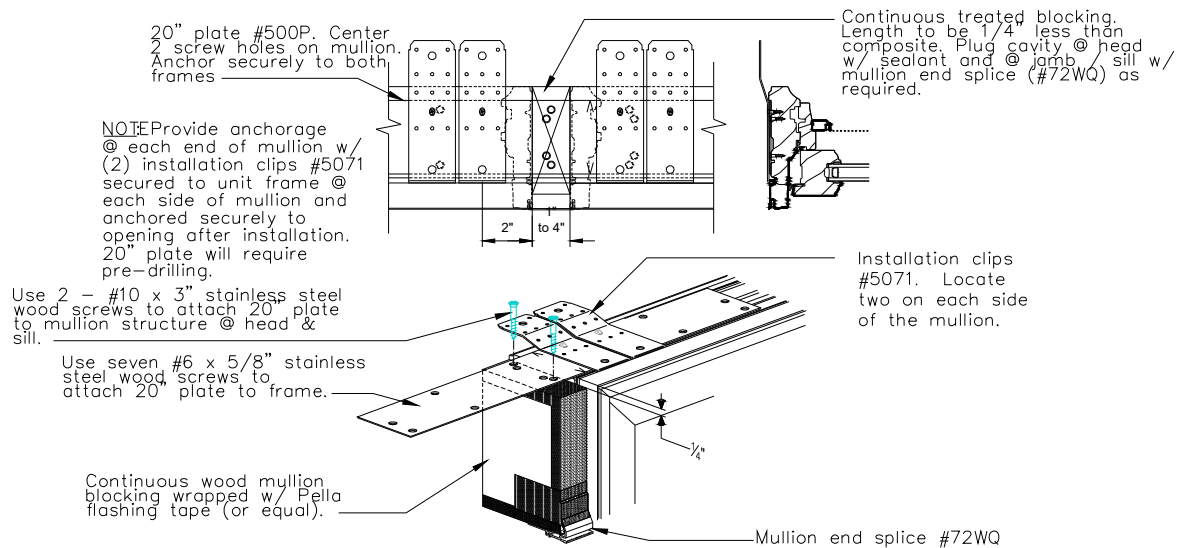
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f. Mullion End Clip 5071

- i. The end clips are secured to each end of wood mullion using a 20" steel plate #500P installed directly over mullion to secure both frames then install two (2) 5071 mull clips two at each side of the mullion, (See Detail B)
- ii. For 20" plate attachment to both main frame members use seven (7) #6 x 5/8" stainless steel screws.
- iii. For clip attachment to wood frame substrates use a total of four (4) #10 x 2" long or longer wood screws one per each clip leg into the installation bucking or frame with a minimum of 1 1/2" embedment into substrate and maintaining at least 3/4" minimum edge distance, for clip attachment to frames through plate use two (2) #5/8" stainless steel screws per each clip is required based on the analysis used in this report for development of the load width span.
- iv. For clip attachment to CMU or concrete substrates use a total of four (4) 3/16" dia. masonry anchors one (1) per each clip leg into the installation bucking or frame with a minimum of 1 1/4" embedment into substrate and maintaining at least 2 5/8" minimum edge distance each clip anchor hole spacing must be located at least on 2 1/4" spacing between anchors, for clip attachment to frames through plate use two (2) 10 x # 5/8" stainless steel screws per each individual clip is required based on the analysis of this report for development of the load width span.



Detail B
Mullion End Clip 5071



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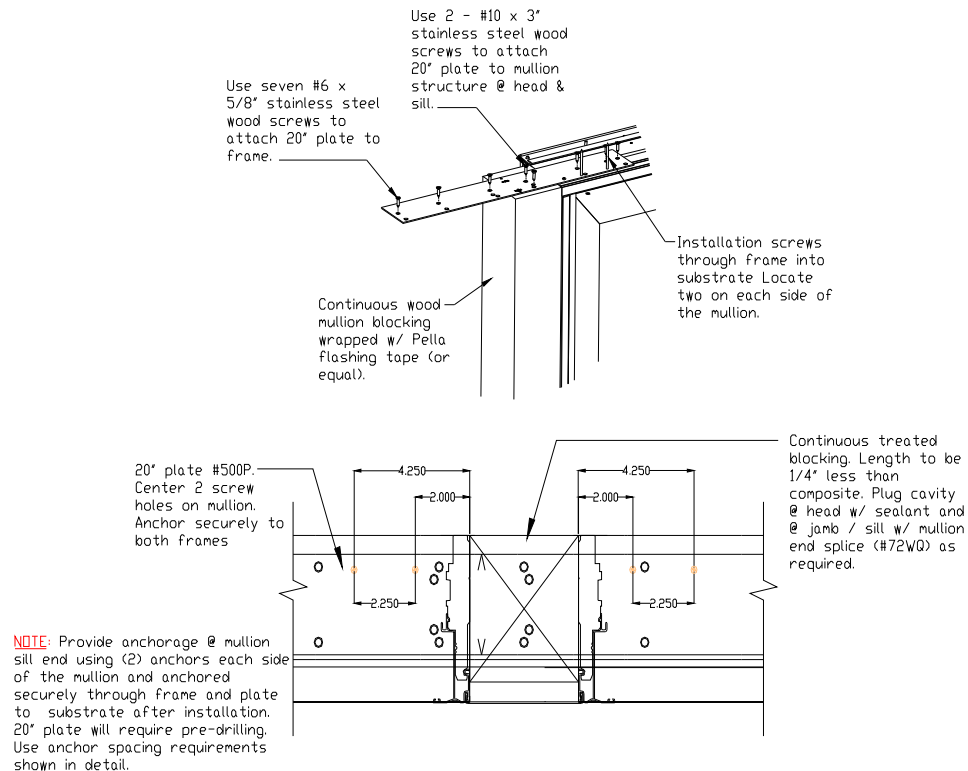
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- g. **Alternate, Through 500 P steel plate and main frame at mullion sill end.**
- i. For 20" plate attachment to both main frame members use seven (7) #6 x 5/8" stainless steel wood screws and two (2) #10 x 3" stainless steel wood screws to attach the 500 P plate directly to mullion structure at sill end (See detail C).
 - ii. For anchor attachment to wood frame substrates use a total of four (4) #10 x 2" long or longer wood screws located 2" and 4-1/4" from each mullion end into the installation bucking or frame with a minimum embedment of 1-1/2" and maintaining at least 3/4" minimum edge distances is required based on the analysis used on this report for the development of the load width and span tables.
 - iii. For anchor attachment to cmu or concrete substrates use a total of four (4) 3/16" diam. Masonry anchors located 2" and 4-1/4" from each mullion end into the installation bucking or frame with a minimum embedment of 1-1/4" and maintaining at least 2-5/8" minimum edge distances is required based on the analysis used on this report for the development of the load width and span tables.

Detail C

Through frame type anchorage





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REFERENCED DOCUMENTS:

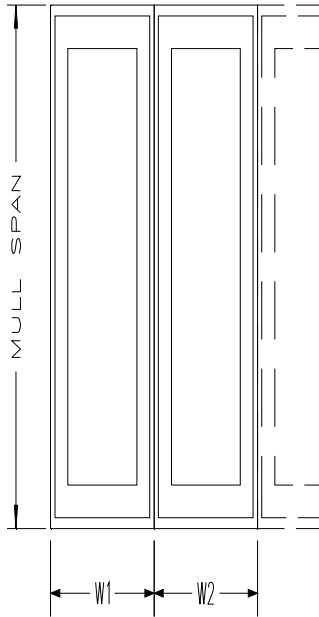
1. AAMA 450-06/09/10
2. Florida Building Code
 - a. Current Edition of the Florida Building Code (FBC), Building Volume
 - i. Chapter 17 - Mullions
 - b. Current Edition of the Florida Building Code (FBC), Residential volume
 - i. Chapter 6 - Mullions



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$$\text{LOAD WIDTH} = \frac{W1 + W2}{2}$$

THIS CHART APPLIES TO MULTIPLE WIDE 1 HIGH, VERTICALLY.

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (ALL TABLES).

DOORS MAY BE INTERMIXED WITH COMBINATIONS OF ANY DOOR OR DOOR SIDELITE TYPES, (ALL TABLES).

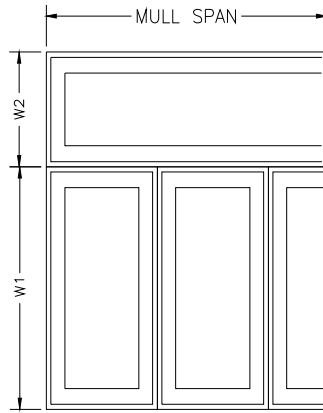
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* Use this table for intermediate 2-way vertical door to door mullions.

* For anchor clip attachment to substrates, see notes on sheets 4 & 5 on this report.

* where installation applications do not permit the use of clip type 5071 an alternate through frames mullion anchorage may be substituted see detail C on sheets 6 of this report.

MULLION TABLE 1							
DOOR TO DOOR							
(VERTICAL SPAN—4.0" Wood Spread Mull)							
MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
60	30	85	85	96	30	85	85
	36	85	85		36	78	81
	42	85	85		42	69	72
	48	85	85		48	63	66
	54	85	85		54	59	61
	60	85	85		60	55	57
66	30	85	85	102	30	84	85
	36	85	85		36	72	75
	42	85	85		42	64	67
	48	85	85		48	58	61
	54	85	85		54	54	56
	60	85	85		60	51	53
72	30	85	85	108	30	78	81
	36	85	85		36	68	70
	42	85	85		42	60	62
	48	85	85		48	54	56
	54	85	85		54	50	50
	60	85	85		60	47	47
78	30	85	85	114	30	72	72
	36	85	85		36	61	61
	42	85	85		42	53	53
	48	84	85		48	47	47
	54	79	82		54	42	42
	60	76	79		60	39	39
84	30	85	85	120	30	61	61
	36	85	85		36	52	52
	42	83	85		42	45	45
	48	76	79		48	40	40
	54	71	74		54	36	36
	60	68	70		60	33	33
90	30	85	85				
	36	84	85				
	42	76	78				
	48	69	72				
	54	64	67				
	60	61	63				



$$\text{LOAD WIDTH} = \frac{W1 + W2}{2}$$

THIS CHART APPLIES TO ("T") 3-WAY MULLS.

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (ALL TABLES).

DOORS MAY BE INTERMIXED WITH COMBINATIONS OF CASEMENT, AWNING, PICTURE, IN-SASH AND DIRECT SET GEOMETRIC OR RADIUS, (ALL TABLES).

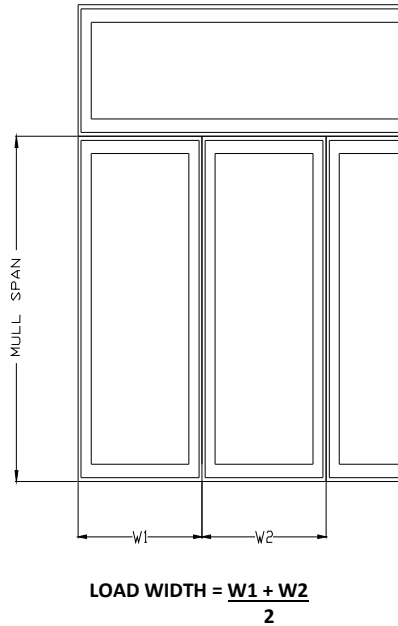
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* For anchor clip attachment to substrates, see notes on sheets 4 & 5 on this report.

*Table 2A is to be used for the horizontal mullion that goes through the 3-way frame intersection, which is the structural through-mull, use table 1 & 3 for the remaining, intermediate 2-way mullions.

* where installation applications do not permit the use of clip type 5071 an alternate through frame mullion anchorage may be substituted see detail C on sheet 6 of this report.

MULLION TABLE 2A											
DOOR TO WINDOW											
(HORIZONTAL SPAN—4.0" WOOD SPREAD MULLION FOR WINDOW UNITS)											
MULL SPAN (in.)	LOAD WIDTH (in.)	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN (in.)	LOAD WIDTH (in.)	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN (in.)	LOAD WIDTH (in.)	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
48	30	85	85	84	30	78	81	120	30	42	44
	36	85	85		36	74	77		36	40	42
	42	85	85		42	83	85		42	39	40
	48	85	85		48	76	79		48	37	38
	54	85	85		54	70	73		54	36	36
	60	85	85		60	66	68		60	33	33
	66	85	85		66	62	65		66	31	31
	72	85	85		72	59	62		72	29	29
54	30	85	85	90	30	69	72				
	36	85	85		36	66	68				
	42	85	85		42	63	65				
	48	85	85		48	69	72				
	54	85	85		54	64	66				
	60	85	85		60	60	62				
	66	85	85		66	57	59				
	72	85	85		72	54	56				
60	30	85	85	96	30	62	64				
	36	85	85		36	59	61				
	42	85	85		42	56	59				
	48	85	85		48	63	66				
	54	85	85		54	59	61				
	60	85	85		60	55	57				
	66	85	85		66	52	54				
	72	85	85		72	49	51				
66	30	85	85	102	30	56	58				
	36	85	85		36	53	55				
	42	85	85		42	51	53				
	48	85	85		48	49	51				
	54	85	85		54	54	56				
	60	85	85		60	50	52				
	66	85	85		66	47	49				
	72	85	85		72	45	47				
72	30	85	85	108	30	51	53				
	36	85	85		36	48	50				
	42	85	85		42	46	48				
	48	85	85		48	44	46				
	54	85	85		54	50	50				
	60	82	85		60	47	47				
	66	78	81		66	43	43				
	72	75	78		72	41	41				
78	30	85	85	114	30	46	48				
	36	84	85		36	44	46				
	42	85	85		42	42	44				
	48	84	85		48	40	42				
	54	78	81		54	39	41				
	60	73	76		60	39	39				
	66	69	72		66	36	36				
	72	66	69		72	34	34				



THIS CHART APPLIES TO ("T") 3-WAY MULLS.

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (ALL TABLES).

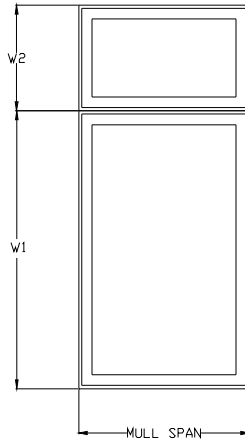
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* For anchor clip attachment to substrates, see notes on sheets 4 & 5 on this report.

*Table 2B is to be used for the vertical mullion that frames into the 3-way frame intersection, at the horizontal which is the structural through mull on table 2A.

MULLION TABLE 2B							
DOOR TO DOOR							
(VERTICAL SPAN—4.0" Wood Spread Mull)							
MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
60	30	85	85	96	30	85	85
	36	85	85		36	78	81
	42	85	85		42	69	72
	48	85	85		48	63	66
	54	85	85		54	59	61
	60	85	85		60	55	57
66	30	85	85	102	30	84	85
	36	85	85		36	72	75
	42	85	85		42	64	67
	48	85	85		48	58	61
	54	85	85		54	54	56
	60	85	85		60	51	53
72	30	85	85	108	30	78	81
	36	85	85		36	68	70
	42	85	85		42	60	62
	48	85	85		48	54	56
	54	85	85		54	50	50
	60	85	85		60	47	47
78	30	85	85	114	30	72	72
	36	85	85		36	61	61
	42	85	85		42	53	53
	48	84	85		48	47	47
	54	79	82		54	42	42
	60	76	79		60	39	39
84	30	85	85	120	30	61	61
	36	85	85		36	52	52
	42	83	85		42	45	45
	48	76	79		48	40	40
	54	71	74		54	36	36
	60	68	70		60	33	33
90	30	85	85				
	36	84	85				
	42	76	78				
	48	69	72				
	54	64	67				
	60	61	63				

* where installation applications do not permit the use of clip type 5071 an alternate through frame mullion anchorage may be substituted see detail C on sheet 6 of this report.



$$\text{LOAD WIDTH} = \frac{W1 + W2}{2}$$

THIS CHART APPLIES TO 1 WIDE 1 HIGH, HORIZONTALLY

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (ALL TABLES).

DOORS MAY BE INTERMIXED WITH COMBINATIONS OF CASEMENT, AWNING, PICTURE, IN-SASH AND DIRECT SET GEOMETRIC OR RADIUS, (ALL TABLES).

ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* For anchor clip attachment to substrates, see notes on sheets 4 & 5 on this report.

*Table 3 is to be used for the horizontal mullion that goes through the 2-way frame intersection, which is the structural through-mull, use table 1 for the remaining, intermediate 2-way mullions.

* Use this table for intermediate 2-way horizontal door to window mullions.

* where installation applications do not permit the use of clip type 5071 an alternate through frame mullion anchorage may be substituted see detail C on sheet 6 of this report.

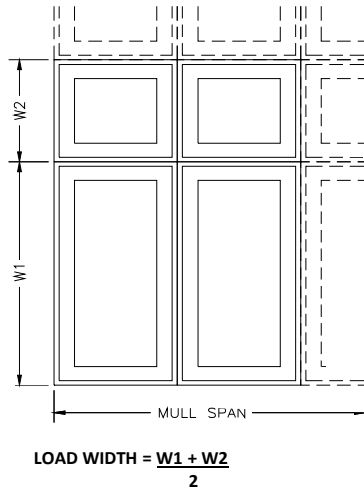
MULLION TABLE 3											
DOOR TO WINDOW											
(HORIZONTAL SPAN—4.0" WOOD SPREAD MULLION FOR WINDOW UNITS)											
MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
30	30	85	85	60	30	85	85	90	30	85	85
	36	85	85		36	85	85		36	84	85
	42	85	85		42	85	85		42	76	78
	48	85	85		48	85	85		48	69	72
	54	85	85		54	85	85		54	64	67
	60	85	85		60	85	85		60	61	63
	66	85	85		66	85	85		66	58	60
36	72	85	85	66	72	85	85	96	72	56	58
	30	85	85		30	85	85		30	85	85
	36	85	85		36	85	85		36	78	81
	42	85	85		42	85	85		42	69	72
	48	85	85		48	85	85		48	63	66
	54	85	85		54	85	85		54	59	61
	60	85	85		60	85	85		60	55	57
42	66	85	85	72	66	85	85		66	53	55
	72	85	85		72	85	85		72	51	53
	30	85	85		30	85	85				
	36	85	85		36	85	85				
	42	85	85		42	85	85				
	48	85	85		48	85	85				
	54	85	85		54	85	85				
48	60	85	85	78	60	85	85				
	66	85	85		66	85	85				
	72	85	85		72	84	85				
	30	85	85		30	85	85				
	36	85	85		36	85	85				
	42	85	85		42	85	85				
	48	85	85		48	84	85				
54	54	85	85	84	54	79	82				
	60	85	85		60	76	79				
	66	85	85		66	74	76				
	72	85	85		72	72	75				
	30	85	85		30	85	85				
	36	85	85		36	85	85				
	42	85	85		42	83	85				
	48	85	85		48	76	79				
	54	85	85		54	71	74				
	60	85	85		60	68	70				
	66	85	85		66	65	67				
	72	85	85		72	63	66				



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THIS CHART APPLIES TO 4-WAY INTERSECTING WHERE THE HORIZONTAL MULLION RUNS THROUGH FULL LENGTH.

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (ALL TABLES).

DOORS MAY BE INTERMIXED WITH COMBINATIONS OF CASEMENT, AWNING, PICTURE, IN-SASH AND DIRECT SET GEOMETRIC OR RADIUS, (ALL TABLES).

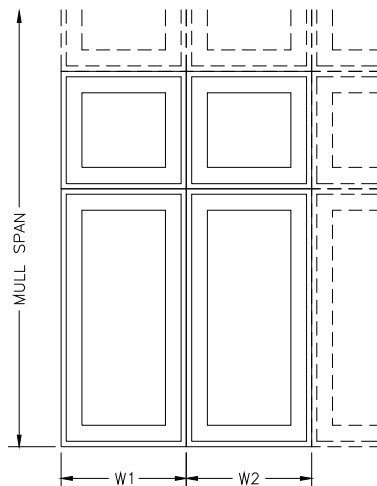
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* For anchor clip attachment to substrates, see sheets 4 & 5 on this report.

*Table 4 is to be used for the mullion that goes through the 4-way frame intersection, which is the structural thru-mull.
Use Table 1 & 3 for the remaining, intermediate 2- way mullions.

* where installation applications do not permit the use of clip type 5071 an alternate through frame mullion anchorage may be substituted see detail C on sheet 6 of this report.

MULLION TABLE 4							
DOOR TO WINDOW							
(4- WAY THROUGH HORIZONTAL TALL SPAN) - 4.0" Wood Spread Mull							
MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
60	30	85	85	84	30	78	81
	36	85	85		36	74	77
	42	85	85		42	65	65
	48	85	85		48	56	56
	54	85	85		54	49	49
	60	85	85		60	44	44
	66	85	85		66	40	40
	72	85	85		72	36	36
66	30	85	85	90	30	69	72
	36	85	85		36	63	63
	42	85	85		42	53	53
	48	85	85		48	46	46
	54	85	85		54	40	40
	60	85	85		60	36	36
	66	81	81		66	33	33
	72	74	74		72	30	30
68	30	85	85	96	30	62	64
	36	85	85		36	52	52
	42	85	85		42	44	44
	48	85	85		48	38	38
	54	85	85		54	34	34
	60	82	82		60	30	30
	66	74	74		66	27	27
	72	68	68		72	25	25
72	30	85	85				
	36	85	85				
	42	85	85				
	48	85	85				
	54	78	78				
	60	69	69				
	66	63	63				
	72	57	57				
78	30	85	85				
	36	84	85				
	42	81	81				
	48	70	70				
	54	61	61				
	60	55	55				
	66	50	50				
	72	45	45				



$$\text{LOAD WIDTH} = \frac{W1 + W2}{2}$$

THIS CHART APPLIES TO 4-WAY INTERSECTING WHERE THE VERTICAL MULLION RUNS THROUGH FULL LENGTH.

LOAD WIDTH MUST BE CALCULATED USING LARGEST ADJACENT (SIDE BY SIDE) DOOR HEIGHTS OR WIDTHS.

MULL SPANS ARE RESTRICTED BY THE LONGEST SPAN, (All TABLES).

WINDOWS MAY BE INTERMIXED COMBINATIONS OF CASEMENT, AWNING, PICTURE, IN-SASH AND DIRECT SET GEOMETRIC OR RADIUS . (ALL TABLES).

ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDULE DOOR UNIT.

* For anchor clip attachment to substrates, see sheets 4 & 5 on this report.

*Table 5 is to be used for the mullion that goes through the 4-way frame intersection, which is the structural thru-mull.
Use Table 1 & 3 for the remaining, intermediate 2- way mullions.

* where installation applications do not permit the use of clip type 5071 an alternate through frame mullion anchorage may be substituted
see detail C on sheet 6 of this report.

MULLION TABLE 5							
DOOR TO WINDOW							
(4- WAY THROUGH VERTICAL SPAN) - 4.0" Wood Spread Mull							
MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)	MULL SPAN	LOAD WIDTH	CLIP TYPE 512A (PSF)	CLIP TYPE 5071 (PSF)
60	30	85	85	102	30	84	85
	36	85	85		36	72	75
	42	85	85		42	64	64
	48	85	85		48	56	56
66	30	85	85	108	30	77	77
	36	85	85		36	65	65
	42	85	85		42	56	56
	48	85	85		48	50	50
72	30	85	85	114	30	65	65
	36	85	85		36	55	55
	42	85	85		42	48	48
	48	85	85		48	42	42
78	30	85	85	120	30	56	56
	36	85	85		36	47	47
	42	85	85		42	41	41
	48	84	85		48	36	36
84	30	85	85	126	30	48	48
	36	85	85		36	40	40
	42	83	85		42	35	35
	48	76	79		48	31	31
90	30	85	85	132	30	42	42
	36	84	85		36	35	35
	42	76	78		42	30	30
	48	69	72		48	27	27
96	30	85	85	138	30	36	36
	36	78	81		36	31	31
	42	69	72		42	26	26
	48	63	63		48	23	23
				144	30	32	32
					36	27	27
					42	23	23
					48	20	20



PTC PRODUCT DESIGN GROUP, LLC

P.O. Box 520775, Suite C25
Longwood, Florida 32752

Client: Pella Corporation
Project #: 423-1101
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Prepared by: RJA
Date: 2/2/2024
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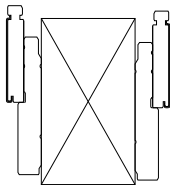
Product Grouping:

1. Reserve and Lifestyle Series Clad combination assemblies with 4.0" wood spread mullion in intermixed configurations of casement, Awning, Picture, In-sash or Direct set Geometric or Radius.
2. Product type grouping: operable vs. fixed window load distribution was considered in the determination of the theoretical stress and deflection analysis due to mullion bending load and how concentrated loads produce higher bending stresses and deflections.

Section Property Grouping:

1. The casement and or inswing door jamb type frame components combined with the 4.0" wood spread mullion produce the lowest overall combined composite section properties. The jambs, stops and wood mullion act as one member.
2. The illustration below shows the individual component section properties for the casement window and in-swing door jamb and stop.
3. The intermixed combinations of Casement, Awning, Picture, In-Sash, and Direct Set geometric or Radius were examined, the combined section properties calculated using AutoCad (independent of material stiffnesses), and based on comparison of these section properties the combination of units that produce the weakest section determined. This section, combined with the wood mullion was used in the analysis.

MULLIONS COMPOSITE SECTION PROPERTIES

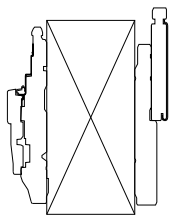


Door to Door

In-swing door jamb with 4.0" wood spread Mullion used in door to door mull analysis is shown at left. Only the wood jamb, wood side stop combined with the 4.0" wood spread mullion is used in the calculation of section properties. The wood and mull covers are not considered.

The combined section properties for the above, considering the material differences were found to be the following.

I =	40.871 in ⁴	(In terms of wood)
S =	18.484 in ³	
A =	27.046 in ²	



Door to Window

In-swing door jamb with casement jamb and 4.0" wood spread Mullion used in door to window mull analysis is shown at left. Only the wood jambs, wood side stops combined with the 4.0" wood spread mullion is used in the calculation of section properties. The wood and mull covers are not considered.

The combined section properties for the above, considering the material differences were found to be the following.

I =	38.492 in ⁴	(In terms of wood)
S =	17.664 in ³	
A =	26.614 in ²	

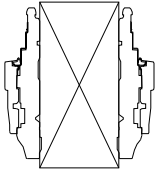


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MULLIONS COMPOSITE SECTION PROPERTIES



Window to Window

Casement with 4.0" wood spread Mullion used in analysis is shown at left. Only the wood jamb, wood side stop combined with the 4.0" wood spread mullion is used in the calculation of section properties. The wood mull covers are not considered.

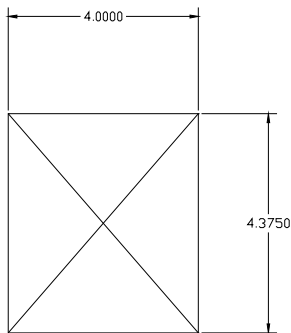
The combined section properties for the above, considering the material differences were found to be the following.

I =	36.113 in ⁴
S =	16.844 in ³
A =	26.182 in ²

(In terms of wood)

The individual wood jamb, wood side stop and 4.0" wood spread mullion section properties used to determine the combined section properties are given on the following pages.

4.0" wood spread Mull (VT or HZ)
Mullion Only



I_{xx} = 27.913
S_{xx} = 12.760
A = 17.500

REGIONS	
Area:	17.5000
Perimeter:	16.7500
Bounding box:	X: -2.0000 -- 2.0000 Y: -2.1875 -- 2.1875
Centroid:	X: 0.0000 Y: 0.0000
Moments of inertia:	X: 27.9134 Y: 23.3333
Product of inertia:	XY: 0.0000
Radii of gyration:	X: 1.2630 Y: 1.1547
Principal moments and X-Y directions about centroid:	I: 23.3333 along [0.0000 1.0000] J: 27.9134 along [-1.0000 0.0000]



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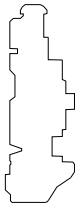
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Wood Side Stop (VT or HZ)



----- REGIONS -----
Area: 0.9721
Perimeter: 5.6195
Bounding box: X: -0.3265 -- 0.3715
Y: -1.0161 -- 0.9037
Centroid: X: 0.0000
Y: 0.0000
Moments of inertia: X: 0.2751
Y: 0.0293
Product of inertia: XY: 0.0319
Radii of gyration: X: 0.5320
Y: 0.1735
Principal moments and X-Y directions about centroid:
I: 0.0252 along [0.1265 0.9920]
J: 0.2792 along [-0.9920 0.1265]

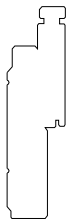
wood Jamb (VT or HZ)



----- REGIONS -----
Area: 3.3695
Perimeter: 11.4918
Bounding box: X: -0.5527 -- 0.6973
Y: -1.8257 -- 2.1593
Centroid: X: 0.0000
Y: 0.0000
Moments of inertia: X: 3.8249
Y: 0.2682
Product of inertia: XY: -0.0773
Radii of gyration: X: 1.0654
Y: 0.2821
Principal moments and X-Y directions about centroid:
I: 0.2665 along [0.0217 -0.9998]
J: 3.8266 along [0.9998 0.0217]

Wood Door Jamb and Stop (VT or HZ)

Composite Properties



----- REGIONS -----
Area: 4.7731
Perimeter: 12.3995
Bounding box: X: -0.6823 -- 0.7537
Y: -2.1853 -- 2.2637
Centroid: X: 0.0000
Y: 0.0000
Moments of inertia: X: 6.4792
Y: 0.7146
Product of inertia: XY: 0.9018
Radii of gyration: X: 1.1651
Y: 0.3869
Principal moments and X-Y directions about centroid:
I: 0.5768 along [0.1510 0.9885]
J: 6.6170 along [-0.9885 0.1510]

IXX = 6.4792
SXX = 2.862
A = 4.773



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SECTION PROPERTY COMPARISON CHART (VT. & HZ.)

Minimum of Compared Section Properties				
Brand	Product	Section	Exterior	MOI_Wood
Minimum of Compared Section Properties	Window Mullion Charts	All	Clad	4.1239
	Door Mullion Charts	All	Clad	6.4792
Reserve and Lifestyle Series	Clad Frame (Direct Set)	All	Clad	4.3409
Reserve Series	Casement	All	Wood	5.8819
	In-swing Patio Door	All	Wood	10.5581
	Out-swing Patio Door	All	Wood	8.7762
	Casement	All	Clad	4.1239
	In-swing Patio Door	All	Clad	6.4792
	Out-swing Patio Door	All	Clad	9.2629
	Sliding Patio Door	Jamb	Clad	6.5248
	Sliding Patio Door	Head	Clad	6.5248
Lifestyle Series with HGP	Casement	All	Clad	4.1239
	In-swing Patio Door	All	Clad	6.4792
	Sliding Patio Door	Jamb	Clad	6.5248
	Sliding Patio Door	Head	Clad	6.5248
Lifestyle Series w/o HGP	Casement	All	Clad	4.1239
	In-swing Patio Door	All	Clad	8.0055
	Sliding Patio Door	Jamb	Clad	7.5874
	Sliding Patio Door	Head	Clad	6.6263
Pella	In-swing Entry Door	All	Clad	6.7557
	Out-swing Entry Door	All	Clad	9.2338
	In-swing Entry Door	All	Wood	6.7557

MOE_Wood
(x10^6 psi)

Discussion:

- 1). Frame Section Properties above provided by Pella Corporation.
- 2). I_{xx} is moment of Inertia about axis of bending of the mullion configuration, Y_{max} is the maximum distance from "X" axis to outer fibers of the section in the "y" direction. Z_x is section modulus = I_{xx} / y_{max} . A is area.
- 3). The configuration with the lowest I and Z will envelope all other configurations. A is relatively the same for all, except the DS radius, therefore will not be deciding factor.
- 4). Based on the above comparison of sections the casement jamb and In-swing door jamb is the worst case.
- 5). Comparison above based on section properties of the combined sections without the wood mullion. Adding the wood mullion has the same affect on each combination. So the weakest combination without wood mullion will still be the weakest combination with reinforcement.



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THE FOLLOWING CONFIGURATIONS ARE EXAMPLES IN THIS REPORT

