

Pella Corporation

102 Main Street
Pella, Iowa 50219

PROJECT:

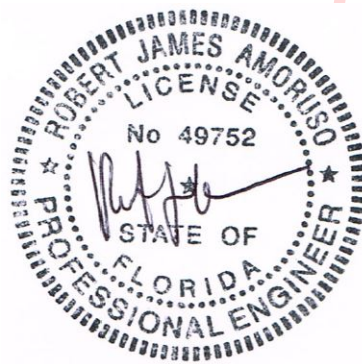
***MULLION CALCULATIONS
FOR VERTICAL AND HORIZONTAL MULLION***

SERIES: 1.5" Wood Spread Mull for Doors
with Transoms and/or Sidelights, 1-1/2" x 4-3/8" Wood Mullion

PROJECT NO.: 423-1101

REPORT NO.: 0501-5

DATE: 2/4/2024



Digitally signed
by Robert J
Amoruso
Date:
2024.02.06
16:17:07 -05'00'

Prepared by:

PTC, PRODUCT DESIGN GROUP

P.O. Box 520775

Longwood, Florida 32752

Phone: (321) 690-1788

Fax: (321-) 690-1789

Evaluated By:

ROBERT J. AMORUSO, P.E.

FL. NO. 49752

F.B.P.E. CERTIFICATE OF AUTHORIZATION NO. 25935



PTC PRODUCT DESIGN GROUP, LLC

P.O. Box 520775
Longwood, Florida 32752

Client: Pella Corporation
Project #: 423-1101
Report #: 0501-5
Prepared by: RJA
Date: 2/4/2024
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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 1-1/2" 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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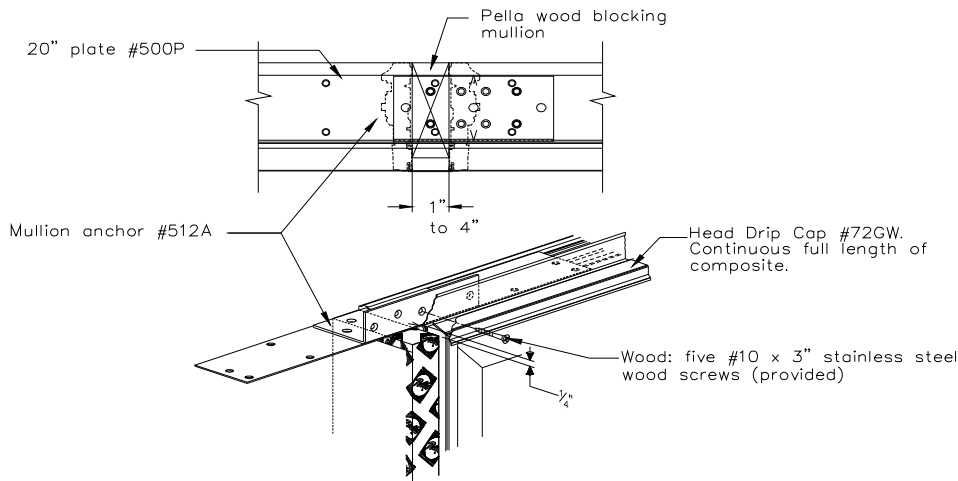
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MULLION END ANCHORAGE:

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 ATTACHEMENT:

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 frame 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**



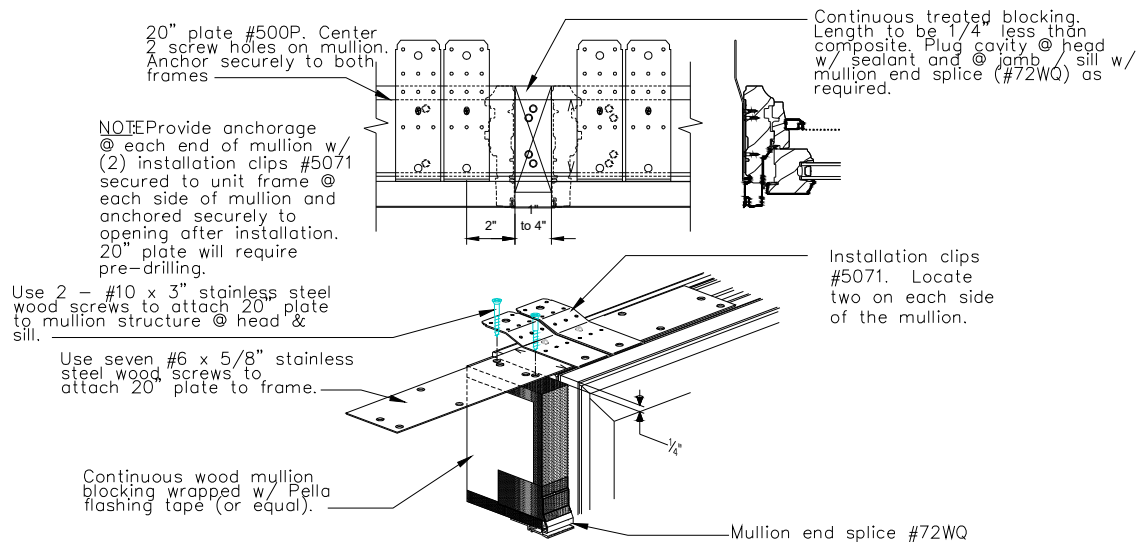
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f. Mullion End Clip 5071

- 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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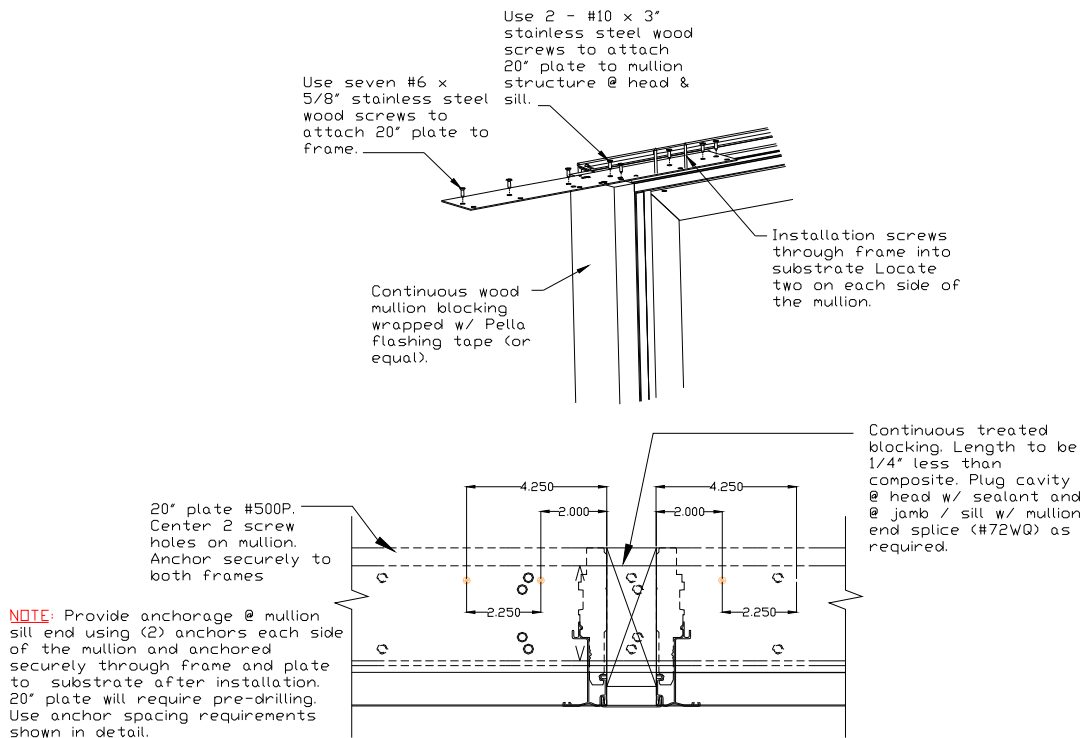
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g. Alternate, Through 500 P steel plate and main frame at mullion sill end.

- 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:

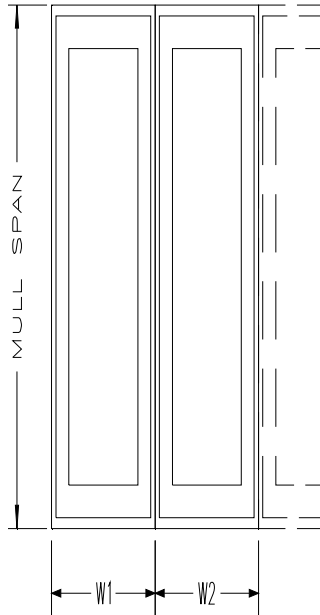
1. AAMA 450-06/09/10
2. Florida Building Code
 - a. Current Edition of the Florida Building Code (FBC), Building Volume
 - i. Chapter 17 - Mullions
 - b. Current Edition of the Florida Building Code (FBC), Residential volume
 - i. Chapter 6 - Mullions



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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).

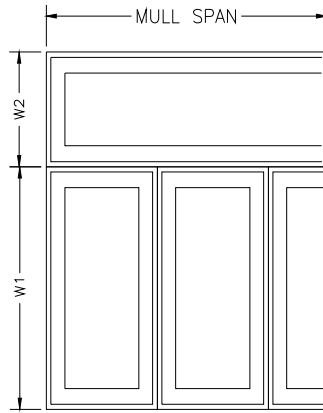
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL
BE CONTROLLED BY THE LESSER OF MULLION OR THE
INDIVIDUAL DOOR UNIT.

* 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—1.5" 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	65	65
	36	85	85		36	55	55
	42	85	85		42	48	48
	48	85	85		48	43	43
	54	85	85		54	39	39
	60	85	85		60	36	36
66	30	85	85	102	30	58	58
	36	85	85		36	49	49
	42	85	85		42	42	42
	48	85	85		48	38	38
	54	85	85		54	34	34
	60	85	85		60	32	32
72	30	85	85	108	30	48	48
	36	85	85		36	41	41
	42	85	85		42	36	36
	48	82	82		48	32	32
	54	77	77		54	29	29
	60	73	73		60	27	27
78	30	85	85	114	30	41	41
	36	85	85		36	35	35
	42	76	76		42	30	30
	48	68	68		48	27	27
	54	63	63		54	24	24
	60	59	59		60	22	22
84	30	85	85	120	30	35	35
	36	73	73		36	30	30
	42	64	64		42	26	26
	48	58	58		48	23	23
	54	53	53		54	21	21
	60	50	50		60	19	19
90	30	74	74				
	36	63	63				
	42	55	55				
	48	50	50				
	54	45	45				
	60	42	42				



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

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).

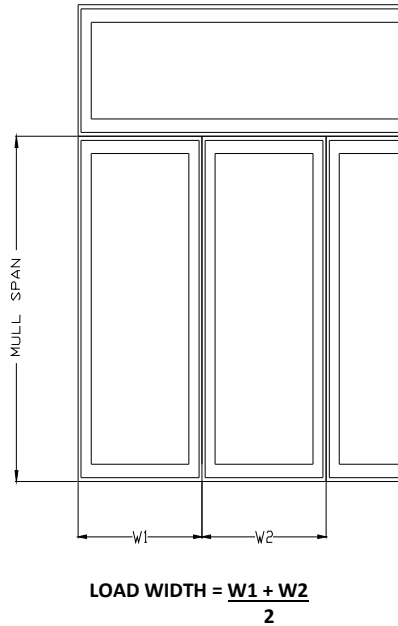
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* 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—1.5" 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	32	32
	36	85	85		36	71	71		36	28	28
	42	85	85		42	62	62		42	24	24
	48	85	85		48	55	55		48	22	22
	54	85	85		54	50	50		54	20	20
	60	85	85		60	46	46		60	18	18
	66	85	85		66	43	43		66	17	17
	72	85	85		72	40	40		72	16	16
54	30	85	85	90	30	69	72				
	36	85	85		36	61	61				
	42	85	85		42	53	53				
	48	85	85		48	48	48				
	54	85	85		54	43	43				
	60	85	85		60	40	40				
	66	85	85		66	37	37				
	72	85	85		72	34	34				
60	30	85	85	96	30	62	63				
	36	85	85		36	53	53				
	42	85	85		42	47	47				
	48	85	85		48	42	42				
	54	85	85		54	38	38				
	60	85	85		60	34	34				
	66	85	85		66	32	32				
	72	85	85		72	30	30				
66	30	85	85	102	30	54	54				
	36	85	85		36	46	46				
	42	85	85		42	40	40				
	48	85	85		48	36	36				
	54	85	85		54	33	33				
	60	80	80		60	30	30				
	66	75	75		66	28	28				
	72	70	70		72	26	26				
72	30	85	85	108	30	45	45				
	36	85	85		36	38	38				
	42	85	85		42	34	34				
	48	78	78		48	30	30				
	54	71	71		54	28	28				
	60	65	65		60	25	25				
	66	61	61		66	24	24				
	72	57	57		72	22	22				
78	30	85	85	114	30	38	38				
	36	83	83		36	32	32				
	42	73	73		42	28	28				
	48	65	65		48	25	25				
	54	59	59		54	23	23				
	60	55	55		60	21	21				
	66	51	51		66	20	20				
	72	48	48		72	19	19				



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).

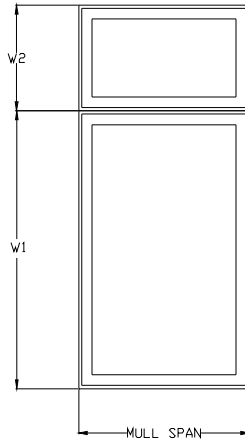
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* 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—1.5" 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	65	65
	36	85	85		36	55	55
	42	85	85		42	48	48
	48	85	85		48	43	43
	54	85	85		54	39	39
	60	85	85		60	36	36
66	30	85	85	102	30	58	58
	36	85	85		36	49	49
	42	85	85		42	42	42
	48	85	85		48	38	38
	54	85	85		54	34	34
	60	85	85		60	32	32
72	30	85	85	108	30	48	48
	36	85	85		36	41	41
	42	85	85		42	36	36
	48	82	82		48	32	32
	54	77	77		54	29	29
	60	73	73		60	27	27
78	30	85	85	114	30	41	41
	36	85	85		36	35	35
	42	76	76		42	30	30
	48	68	68		48	27	27
	54	63	63		54	24	24
	60	59	59		60	22	22
84	30	85	85	120	30	35	35
	36	73	73		36	30	30
	42	64	64		42	26	26
	48	58	58		48	23	23
	54	53	53		54	21	21
	60	50	50		60	19	19
90	30	74	74				
	36	63	63				
	42	55	55				
	48	50	50				
	54	45	45				
	60	42	42				

* 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—1.5" 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	69	69
	36	85	85		36	85	85		36	58	58
	42	85	85		42	85	85		42	51	51
	48	85	85		48	85	85		48	46	46
	54	85	85		54	85	85		54	42	42
	60	85	85		60	85	85		60	39	39
	66	85	85		66	85	85		66	37	37
36	72	85	85	66	72	85	85	96	72	35	35
	30	85	85		30	85	85		30	60	60
	36	85	85		36	85	85		36	51	51
	42	85	85		42	85	85		42	44	44
	48	85	85		48	85	85		48	40	40
	54	85	85		54	85	85		54	36	36
	60	85	85		60	85	85		60	33	33
42	66	85	85	72	66	84	84		66	31	31
	72	85	85		72	84	84		72	30	30
	30	85	85		30	85	85				
	36	85	85		36	85	85				
	42	85	85		42	83	83				
	48	85	85		48	76	76				
	54	85	85		54	71	71				
48	60	85	85	78	60	67	67				
	66	85	85		66	65	65				
	72	85	85		72	65	65				
	30	85	85		30	85	85				
	36	85	85		36	79	79				
	42	85	85		42	70	70				
	48	85	85		48	63	63				
54	54	85	85	84	54	58	58				
	60	85	85		60	55	55				
	66	85	85		66	53	53				
	72	85	85		72	51	51				
	30	85	85		30	79	79				
	36	85	85		36	67	67				
	42	85	85		42	59	59				
	48	85	85		48	53	53				
	54	85	85		54	49	49				
	60	85	85		60	46	46				
	66	85	85		66	43	43				
	72	85	85		72	42	42				

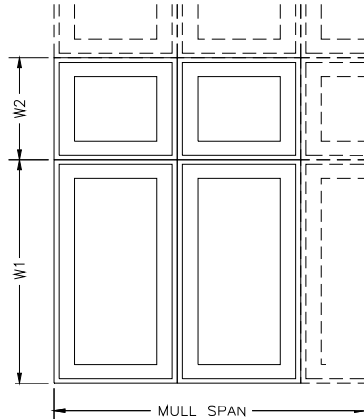


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$$\text{LOAD WIDTH} = \frac{W1 + W2}{2}$$

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).

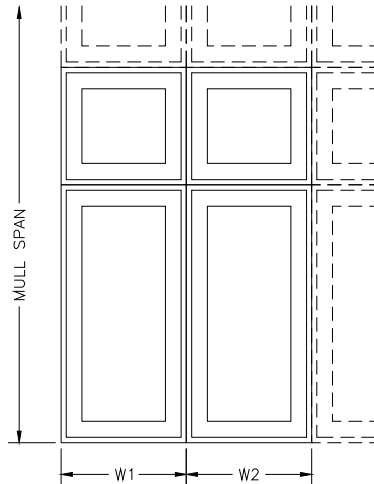
ALLOWABLE PRESSURES ON THE MULLED ASSEMBLY SHALL BE CONTROLLED BY THE LESSER OF MULLION OR THE INDIVIDUAL DOOR UNIT.

* 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) - 1.5" 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	51	51
	36	85	85		36	42	42
	42	85	85		42	36	36
	48	79	79		48	31	31
	54	70	70		54	27	27
	60	63	63		60	24	24
	66	57	57		66	22	22
	72	52	52		72	20	20
66	30	85	85	90	30	42	42
	36	85	85		36	35	35
	42	72	72		42	29	29
	48	62	62		48	25	25
	54	55	55		54	22	22
	60	49	49		60	20	20
	66	44	44		66	18	18
	72	40	40		72	16	16
68	30	85	85	96	30	35	35
	36	78	78		36	29	29
	42	66	66		42	24	24
	48	57	57		48	21	21
	54	50	50		54	18	18
	60	45	45		60	16	16
	66	41	41		66	15	15
	72	37	37		72	13	13
72	30	81	81				
	36	66	66				
	42	56	56				
	48	48	48				
	54	42	42				
	60	38	38				
	66	34	34				
	72	31	31				
78	30	64	64				
	36	52	52				
	42	44	44				
	48	38	38				
	54	34	34				
	60	30	30				
	66	27	27				
	72	25	25				



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

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) - 1.5" 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	47	47
	36	85	85		36	39	39
	42	85	85		42	34	34
	48	85	85		48	29	29
66	30	85	85	108	30	40	40
	36	85	85		36	33	33
	42	80	80		42	29	29
	48	70	70		48	26	26
72	30	85	85	114	30	34	34
	36	79	79		36	28	28
	42	68	68		42	25	25
	48	59	59		48	22	22
78	30	81	81	120	30	29	29
	36	67	67		36	24	24
	42	58	58		42	21	21
	48	50	50		48	19	19
84	30	69	69	126	30	25	25
	36	58	58		36	21	21
	42	50	50		42	18	18
	48	43	43		48	16	16
90	30	61	61	132	30	21	21
	36	50	50		36	18	18
	42	43	43		42	16	16
	48	38	38		48	14	14
96	30	53	53	138	30	19	19
	36	44	44		36	16	16
	42	38	38		42	14	14
	48	33	33		48	12	12
				144	30	16	16
					36	14	14
					42	12	12
					48	11	11



PTC PRODUCT DESIGN GROUP, LLC

P.O. Box 520775
Longwood, Florida 32752

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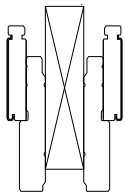
Product Grouping:

1. Reserve and Lifestyle Series Clad combination assemblies with 1.5" 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 1.5" 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

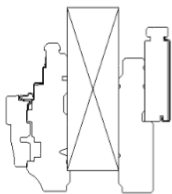


Door to Door

In-swing door jamb with 1.5" wood spread Mullion used in door to door mull analysis is shown at left. Only the wood jamb, wood side stop combined with the 1.5" 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 =	23.424 in ⁴	(In terms of wood)
S =	10.508 in ³	
A =	16.109 in ²	



Door to Window

In-swing door jamb with casement jamb and 1.5" wood spread Mullion used in door to window mull analysis is shown at left. Only the wood jambs, wood side stops combined with the 1.5" 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 =	21.045 in ⁴	(In terms of wood)
S =	9.688 in ³	
A =	15.678 in ²	

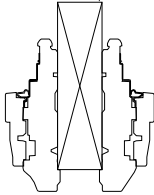


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MULLIONS COMPOSITE SECTION PROPERTIES



Window to Window

Casement with 1.5" wood spread Mullion used in analysis is shown at left. Only the wood jamb, wood side stop combined with the 1.5" wood spread mullion is used in the calculation of section properties. The wood mull covers are not considered.

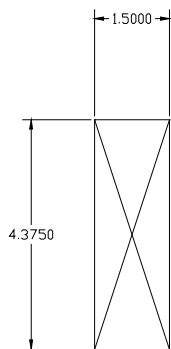
The combined section properties for the above, considering the material differences were found to be the following.

I =	18.666 in ⁴
S =	8.868 in ³
A =	15.245 in ²

(In terms of wood)

The individual wood jamb, wood side stop and 1.5" wood spread mullion section properties used to determine the combined section properties are given on the following pages.

**1.5" wood spread Mull (VT or HZ)
Mullion Only**



I_{xx} = 10.466
S_{xx} = 4.784
A = 6.563

----- REGIONS -----

Area: 6.5625
Perimeter: 11.7500
Bounding box: X: -0.7500 -- 0.7500
Y: -2.1875 -- 2.1875
Centroid: X: 0.0000
Y: 0.0000
Moments of inertia: X: 10.4675
Y: 1.2305
Product of inertia: XY: 0.0000
Radii of gyration: X: 1.2630
Y: 0.4330
Principal moments and X-Y directions about centroid:
I: 1.2305 along [0.0000 -1.0000]
J: 10.4675 along [1.0000 0.0000]



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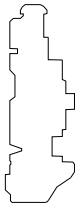
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Wood Side Stop (VT or HZ)



----- 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]

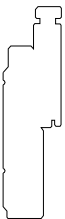
wood Jamb (VT or HZ)



----- 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 mulled 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

