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No. 301

TECHNICAL NOTE

NOT FOR PUBLICATION FOR INTERNAL USE

PREPARED BY N. B. Hutcheon CHECKED BY APPROVED BY

DATE 11 January 1960

PREPARED FOR CGSB Committee on Specifications 63-GP

SUBJECT Load Test Requirements for Aluminum Windows

Specifications are being prepared by the Canadian Government Specifications Board for aluminum windows. Those in preparation at the time of writing are in the 63-GP series, Nos. 1, 2 and 3, Windows, Aluminum, Vertical and Horizontal Sliding, for Heavy, Medium and Standard duty respectively. These specifications follow generally the corresponding specifications of the Aluminum Window Manufacturers Association in respect of performance requirements.

It was tentatively decided that the window sizes to be submitted for test according to the 63-GP specifications should be somewhat smaller than those called for in the AWMA specifications. This raises some interesting problems in establishing the appropriate criteria for the smaller window sizes which are considered in this Note.

The AWMA requirements for double hung and double sliding windows are given in Tables I and II. The moments of inertia of sections which, on the assumption of spans equal to the required minimum test size, are required to meet the relative and absolute limits of deflection have been calculated and are shown in the Tables.

Points to Note

1. Minimum sizes for load tests are greater than sizes required for the infiltration test for commercial and monumental double hung windows thus requiring submission of two sizes for test.

2. Windows larger than the size required as a minimum for the load test are required to meet the same limits.

$S = \frac{Plc}{4I}$ for stress in a simple beam

$D = \frac{Pl^3}{48EI}$ for deflection in a simple beam

For $\frac{D}{l}$ = constant, I must be proportional to l^2

For D = constant, I must be proportional to l^3

So larger windows must have increasingly greater sizes of sections as spans increase over the minimum tested.

3. For sizes over the minimum to be tested, which meet the deflection requirements,

$S = \frac{Plc}{4I}$

S will vary as $\frac{c}{l}$, or as $\frac{c}{l^2}$

c may increase but not in proportion to l

∴ S, the stress, will almost certainly decrease for increasing spans, over the test span, which meet the two deflection requirements. The requirements for absolute limit on deflection will govern.

4. By the same arguments as in 3, windows of lesser span than the test minimum might be greatly decreased in moment of inertia while still meeting the same values for the deflection requirements of the longer test span. The stress will almost certainly increase greatly, since c will not be decreased sufficiently. The requirement for relative deflection will govern.

5. Nothing in the AWMA specification positively relates the properties of sections to be used for smaller spans to the properties of the sections tested, except that:

(i) There is a reference to manufacturers largest standard size, of standard construction. It may be that in a standard series, all windows may be of the same section, regardless of span.

(ii) Under comments, p.24 Item General 2(b) it is noted that the maximum use of one size and type of window throughout the building will result in economies.

6. The load tests determine only the stiffness of the horizontal rails in double hung windows and the vertical members in horizontal sliding windows. There need be no other sash members to meet the load tests. One must question whether horizontal and vertical rails must or should be the same section throughout a building. This is all that is affected by the load tests.

7. The uniform load test if applied to a two-sash window with single lights in each sash will add nothing not already covered by the transverse load test. It will only have significance in the case of sash having more than one light, and in the case of windows of more than one sash in width (or height), so as to test sub-frame members. Window frames are not tested by the uniform load test.

8. Specification of a certain stiffness of sash rail does not guarantee a certain standard or weight of window generally.

9. It may be questioned whether windows will always be one sash wide; i.e. in the case of double hung monumental is it proposed that a sash will be 5' 6" wide? If so, what maximum widths are appropriate for Canada and what stiffness should sash rails have? Must they be determined by the section required for a 5' 6" wide sash?

10. The stiffness of sections specified in AWMA vary by four times from residential to commercial, and by an additional two times from commercial to monumental for double hung windows.

Horizontal sliding windows Class I are only about $\frac{1}{4}$ the stiffness of residential double hung rails, (for 2' 0" span compared to 3' span) and Class II window rails are about three times the stiffness of Class I, or slightly less stiff, on a 3' 6" span than residential double hung rails on a 3' 0" span.

There appears therefore to have been a selection of stiffness by AWMA on some systematic basis.

TABLE I

SUMMARY OF AWMA REQUIREMENTS

Loads and Deflections on Double Hung Aluminum Windows

Item	Residential	Commercial	Monumental
Load Test Size, min.	3' x 5'	4'6" x 7'6"	5'6" x 10'0"
Infiltration Test Size, abs.	3' x 5'	4' x 6'	4' x 6'
Horizontal rail load	20 lb.	30 lb.	40 lb.
Deflection, rel., max.	1:175	1:175	1:175
Moment of Inertia, min.	7.7×10^{-3}	31.8×10^{-3}	63.3×10^{-3}
Deflection, abs., max.	.219	.250	.312
Moment of Inertia, min.	8.9×10^{-3}	39.4×10^{-3}	77.0×10^{-3}
Vertical Load, hor. rail	20 lb.	30 lb.	40 lb.
Deflection, rel., max.	1:375	1:375	1:375
Moment of Inertia, min.	16.5×10^{-3}	68.2×10^{-3}	136×10^{-3}
Deflection, abs., max.	.094	.160	.188
Moment of Inertia, min.	20.7×10^{-3}	61.5×10^{-3}	128×10^{-3}
Uniform Load	10 psf	15 psf	15 psf
Deflection, rel., max.	1:175	1:175	1:175

TABLE II

SUMMARY OF AWMA REQUIREMENTS

Loads and Deflections on Horizontal Sliding Windows

Item	Residential Class I	Class II
Load Test Size, min.	4' x 2'	4'6" x 3'6"
Infiltration Test Size, abs.	4' x 2'	4'6" x 3'6"
Hor. Para. Load on vert. rail	10 lb.	10 lb.
Deflection, rel., max.	1:165	1:175
Moment of Inertia, min.	1.98×10^{-3}	6.45×10^{-3}
Deflection, abs., max.	.145	.240
Moment of Inertia, min.	1.98×10^{-3}	6.45×10^{-3}
Hor. Perp. load on vert. rail	10 lb.	10 lb.
Deflection, rel., max.	1:160	1:175
Moment of Inertia, min.	1.8×10^{-3}	6.45×10^{-3}
Deflection, abs., max.	.150	.240
Moment of Inertia, min.	1.9×10^{-3}	6.45×10^{-3}
Uniform Load	10 psf	10 psf
Deflection, rel., max.	1:175	1:175