NRC·CNRC CONSTRUCTION

Acoustic Testing of Skyfold Prisma with Glass Panels

Author: Pascal Beaulieu
Report Number: A1-021085.2
Report Date: 13 September 2022
Contract Number: A-0039125
Agreement Date: 02 March 2022

National Research Council Canada
Conseil national de recherches Canada

Canada

Acoustic Testing of Skyfold Prisma with Glass Panels

Author

Beaulieu, Pascal
Digitally signed by Beaulieu, Pascal
Date: 2022.11.10 09:53:17 -05'00'

Pascal Beaulieu, Technical Officer

Approved

Gover, Bradford
Digitally signed by Gover, Bradford
DN: cn=Gover, Bradford, c=CA, o=GC, ou=NRC-CNRC, email=brad.gover@canada.ca
Date: 2023.01.13 14:51:36 -05'00'

Bradford Gover, Ph.D.
Director, Research and Development
Building Envelope and Materials,
Intelligent Building Operations
NRC Construction Research Centre

Report No: A1-021085.2
Report Date: 13 September 2022
Contract No: A-0039125
Agreement date: 02 March 2022
Program: Building Envelope & Materials (BEM)

4 Pages
Copy 1 of 3

This page was intentionally left blank

Client	Skyfold Inc 325 Avenue Lee, Montreal, Quebec, H9X3S3
Specimen	**Skyfold Prisma – 1x3 Double Glass Panels** • Laminated tempered glass panels, each 12.5 mm thick **Lifting Mechanism** • Telescoping arms • Beams • Trim • Seals
Specimen ID	A1-021085-05W

Specimen Description

The size of the 2.44 m x 3.66 m NRC facility test opening was reduced to accommodate the specimen by constructing a filler element as follows: The test opening was lined with a layer of sill gasket. A header consisting of a steel beam measuring 77 mm x 305 mm x 3667 mm covered on both sides with 2 layers of plywood with dimensions of 19 mm x 305 mm x 3667 mm and 6 layers of CGC SHEETROCK gypsum panels with dimensions of 16 mm x 305 mm x 3667 mm was constructed. The header housed the motor and other operable parts of the lifting mechanism. The header assembly was supported at each end by 39 mm x 89 mm wood studs 2439 mm long and spaced 89 mm apart and fastened to the test frame using Type S screws 51 mm long spaced every 200 mm on centre. The space between the studs, which measured 39 mm x 89 mm, was filled with fiberglass insulation and the supports were then enclosed with 3 layers of 13 mm CGC SHEETROCK gypsum board on the face and sides. The supports had a finished measurement of 76 mm deep x 380 mm wide and 2362 mm high. Two layers of CGC Type X gypsum board each measuring 13 mm x 189 mm x 3581 mm and 16 mm x 189 mm x 3581 mm were placed on the bottom portion of the test frame. Exposed joints between pieces of gypsum board were caulked and covered with metal foil tape.

The Skyfold Prisma operable partition was installed by the client. It consisted of 6 single laminated glass panels; each factory mounted in aluminum frames which were fixed to two lifting mechanisms that were supported from the top. The panels and lifting mechanisms raised and lowered in a telescoping manner for operation. The framed panels measured 721 mm high x 3310 mm wide. The partition was made up of three sections of different thickness, 150mm, 230mm and 308mm (~6”, ~9”, and ~12”) (outer face of frame to outer face of frame). The overall dimensions of the partition were 2172 mm high x 3508 mm wide.

The client reported that each single laminated glass panel was constructed as follows: tempered glass + film + tempered glass. The laminated glass panels, without frames, measured 697mm x 3226 mm x 12.5mm (27.4375” x 127” x ½”) and weighed ~62 kgs (~136 lbs). The mass of each framed glass panel was 78.6 kg. The total mass of all 6 glass panels was 471.6 kg. The total mass of the lifting mechanisms including floor bar, and side seals was 83.9 kg. The total mass of the specimen was 555.5 kg.

The client reported the highlights of the specimen as follows: Various cover plates, gaskets, foam tapes, and bulb seals act as acoustic seals between panels, lifting mechanisms and the perimeter construction elements.

Proprietary details of the specimen are withheld from this report at the request of the client.

Figure 1: Wall Specimen

Specimen Properties

Element		Actual thickness (mm)	Mass (Kg)	Mass/length, area or volume
Skyfold Prisma 1X3 Double	Each glass panel: Laminated tempered glass panels	12.5	62	27.6 kg/m^2
	Lifting mechanism: Telescoping arms, beams, trim and seals	127	83.9	
Total		127	555.5	62.3 kg/m^2

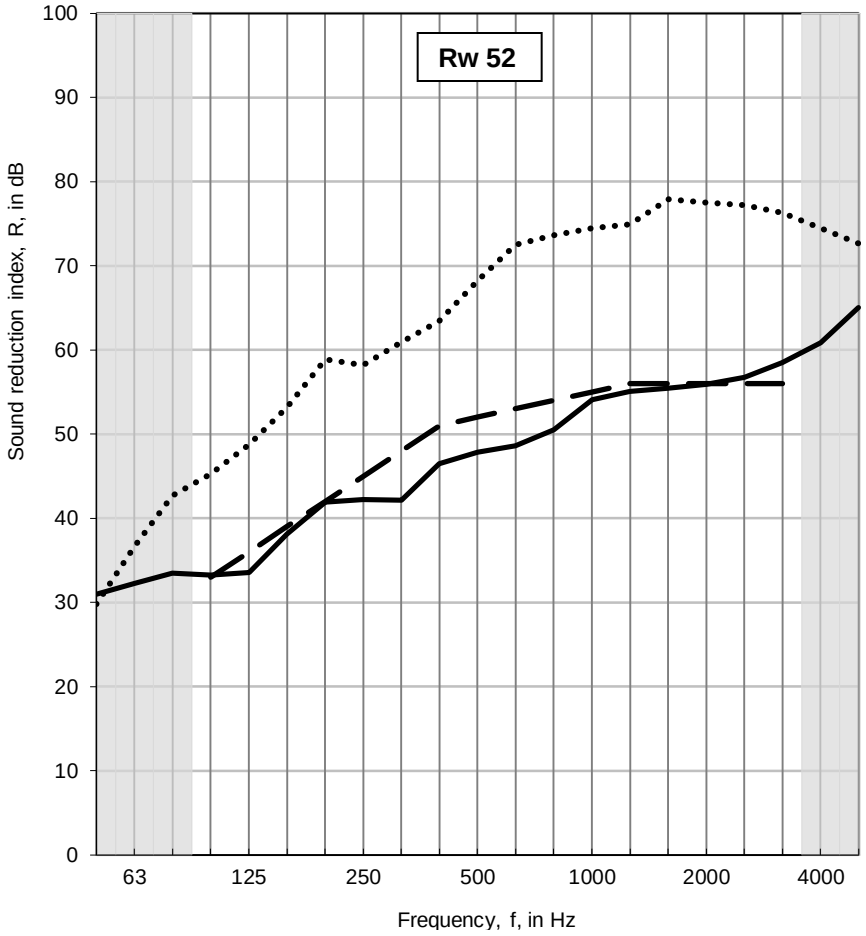
Airborne sound transmission loss measurements were conducted in accordance with the requirements of ISO 10140-2, "Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation"

Client:	Skyfold Inc.	**Test ID:**	TLA-22-206
Specimen ID:	A1-021085-05W	**Date of Test:**	2022-08-05
Large Room Volume:	255.6 m³	**Area S of test specimen:**	8.92 m²
Small Room Volume:	140.5 m³	**Mass per unit area:**	62.2 kg/m²

Room	**Air temperature, °C**	**Humidity, %**
Large	22.0 to 22.1	64.5 to 64.7
Small	22.4 to 22.4	68.2 to 68.3

For a further description of the test specimen and mounting conditions see text pages before.
The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen.

f (Hz)	**R (dB)**
50	31.0
63	32.2
80	33.5
100	33.3
125	33.5
160	38.1
200	41.9
250	42.2
315	42.1
400	46.5
500	47.9
630	48.6
800	50.5
1000	54.1
1250	55.0
1600	55.5
2000	55.9
2500	56.8
3150	58.5
4000	60.9
5000	65.0



In the graph: The solid line is the sound reduction index, R, for this specimen. The dashed line is the curve of reference values fitted to the measured values according to ISO 717-1. The dotted line is 15 dB below the flanking limit established for this facility. Shaded values are not accounted for the single number rating, R_W, according to ISO 717-1.

In the table: Values marked "≥" are to be taken as limits of measurement and the reported values provide an estimate of the lower limit of R. Values marked "*" indicate that the measured background level was 6 dB or less below the combined receiving room level and background level.

Rating according to ISO 717-1:

R_w (C;C_{tr}) = 52 (-2;-6) dB $C_{50\text{-}5000}$ = -2 dB; $C_{tr,50\text{-}5000}$ = -6 dB

Evaluation based on laboratory measurement results obtained by an engineering method

Appendix A - ISO 10140-2 Airborne Sound Transmission Loss Measurement Procedure

Facility and Equipment: The NRC Construction Wall Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the large and small rooms) with a moveable test frame between the two rooms. The large room has an approximate volume of 255 m^3 while the small room has an approximate volume of 140 m^3. The rooms of the acoustic wall test facility fulfill the requirements of ISO 10140-5. The movable frame is made from hollow steel beams filled with concrete, which conforms to the intent but not the specific wording of ISO 10140-5. In each room, a calibrated Brüel&Kjaer condenser microphone (type 4166 or 4165) with preamplifier is moved under computer control to nine positions, and measurements are made in both rooms using a National Instrument NI-4472 system installed in a computer. Each room has four loudspeakers driven by separate amplifiers and noise sources. To increase diffusivity of the sound field, there are fixed diffusing panels in each room.

Test Procedure: Airborne sound transmission measurements were conducted in accordance with the requirements of ISO 10140-2, "Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurements of airborne sound insulation". Airborne sound reduction index was measured in the forward (receiving room is the large room) and reverse (receiving room is the small room) directions. Results presented in this report are the average of the tests in these two directions. In each case, sound reduction index values were calculated from the average sound pressure levels of both the source and receiving rooms and the average reverberation times of the receiving room. One-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to get the average sound pressure level in each room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room; these reverberation times were averaged to get the average reverberation times for each room. Information on the flanking limit of the facility and reference specimen test results are available on request.

Significance of Test Results: ISO 10140-2 requires measurements in one-third octave bands in the frequency range between 100 Hz and 5000 Hz. Within this range, reproducibility has been assessed by inter-laboratory round robin studies. The standard recommends making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the 100 Hz to 5000 Hz range has not been established, and is expected to depend on laboratory-specific factors.

Weighted Sound Reduction Index (R_W) and Spectrum Adaptation Terms (C, C_{tr}): The Weighted Sound Reduction Index and Spectrum Adaptation Terms were determined in accordance with ISO 717-1:2020, "Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation". The Weighted Sound Reduction Index (R_W) is a single-number rating scheme intended to rate the acoustical performance of a partition element separating offices or dwellings. The higher the value of the rating, the better the performance. The Spectrum Adaptation Terms (C, C_{tr}) are values to be added to the single-number rating and intended to correlate with subjective impressions of the sound insulation provided against sounds with different spectra. Two sound spectra are defined in ISO 717-1:2020. Spectrum Adaptation Term C is intended for sources like pink noise, such as living activities (talking, music, radio, TV, children playing), railway traffic at medium and high speed, highway road traffic (> 80 km/h), jet aircraft at short distance, or factories emitting mainly medium and high frequency noise. Spectrum Adaptation Term C_{tr} is intend for urban road traffic noise, but it is also suitable for other noise sources, such as railway traffic at low speed, propeller driven aircraft, jet aircraft at large distance, disco music, or factories emitting mainly low and medium frequency noise. The ratings above are of limited use in applications involving noise spectra that differ markedly from those referred to above (for example, heavy machinery, power transformers,..). Generally, in such applications it is preferable to consider the source levels and insulation requirements for each frequency band.

In-Situ Performance: The ratings obtained by this standard test method tend to represent an upper limit of what might be measured in a field test, due to structure-borne sound transmission ("flanking") and construction deficiencies in actual buildings.