Fire Protection

CANADIAN STEEL CONSTRUCTION COUNCIL

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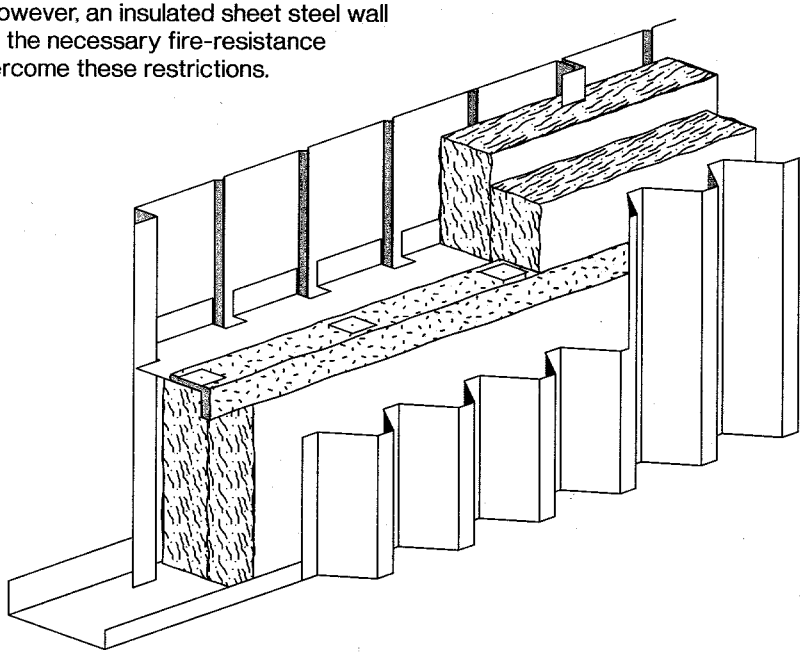
FIRE-RATED EXTERIOR SHEET STEEL WALLS

INTRODUCTION

Insulated sheet steel walls are frequently used on the exterior of commercial and industrial steel framed buildings. They have been found to be economical, aesthetically attractive, and amenable to the short construction duration inherent in such buildings.

Because economical sheet steel walls, until now, have not had recognized fire-resistance ratings, they have been restricted to exterior walls not subject to any Limiting Distance requirements specified by the National Building Code of Canada (NBCC). Exterior walls in close proximity to the Property Line or adjacent buildings (see NBCC Subsection 3.2.3) have traditionally been built in masonry block or concrete.

There is now, however, an insulated sheet steel wall that possesses the necessary fire-resistance ratings that overcome these restrictions.



CSCC

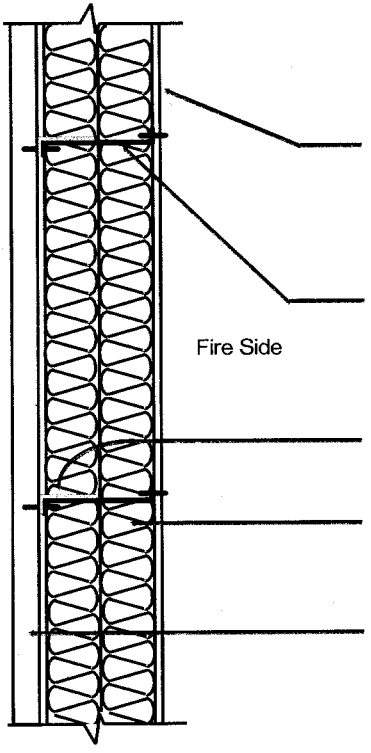
The Algoma Steel Corporation, Limited • Dofasco Inc. • Sidbec-Dosco Inc. • Stelco Inc.
Canadian Fasteners Institute • Canadian Institute of Steel Construction • Canadian Sheet Steel Building Institute
Canadian Steel Service Centre Institute • Corrugated Steel Pipe Institute • Canadian Welding Bureau (Associate Member)

92/05

CSCC/CSSBI/NRC RESEARCH PROGRAM

In response to Designers' needs for an alternative, the Canadian Steel Construction Council (CSCC), the Canadian Sheet Steel Building Institute (CSSBI), and the National Fire Laboratory of the Institute for Research in Construction, National Research Council of Canada (NRC) set up a joint research project, with the intent of developing an integrated **fire-rated** non load-bearing insulated sheet steel wall assembly.

This program comprised a number of small-scale and full-scale fire tests in NRC's furnaces. The resulting exterior wall assembly has been assigned a **one-hour fire-resistance rating**, based on CAN/ULC-S101-M89 - "Standard Methods of Fire Endurance Tests of Building Construction and Materials". IRC Internal Report *Fire Resistance Tests of Exterior Sheet Steel Walls Insulated With 152 mm Thick, 96 kg/m³ Density, Mineral Wool Insulation*, by Martin Chabot, details the results of the actual fire tests. The full constructional and material details are given in Underwriters Laboratories of Canada (ULC) "List of Equipment and Materials - Volume 3 - Fire Resistance Ratings", under Design No. W605, but the following describes the salient details.



Vertical Section

INSULATED SHEET STEEL WALL ASSEMBLY

Fire-Resistance Rating - 1 h

Steel liner: Panels fabricated from minimum 0.61 mm thick sheet steel, fastened to flashing channels by 19 mm long sheet metal screws spaced maximum 305 mm on centre. Side lap joints sealed with factory- applied caulking and secured with 19 mm long sheet metal screws maximum 305 mm on centre.

Z-bar sub-girt: Minimum 152 mm wide x 1.22 mm thick sheet steel Z-bars with 25 mm and 38 mm flanges, maximum 1525 mm on centre, fastened to steel liner by 19 mm long sheet metal screws spaced maximum 250 mm on centre.

Ceramic fibre strip: 128 kg/m³ density, mimimum 100 mm wide x 13 mm thick strips, attached to Z-bar sub-girt with stick pins spaced 250 mm on centre.

Mineral wool batts: 96 kg/m³ Nominal density, processed from rock and slag, supplied in 76 mm thick sheets 610 mm x 1220 mm. Two layers installed with vertical and horizontal joints staggered.

Exterior cladding: Corrugated prepainted sheet steel panels, to various profiles and widths. Panels minimum 0.46 mm thick, fastened to Z-bar sub-girts by 19 mm long sheet metal screws maximum 305 mm on centre. Lap joints of adjacent panels fastened by 19 mm long sheet metal screws maximum 405 mm on centre.

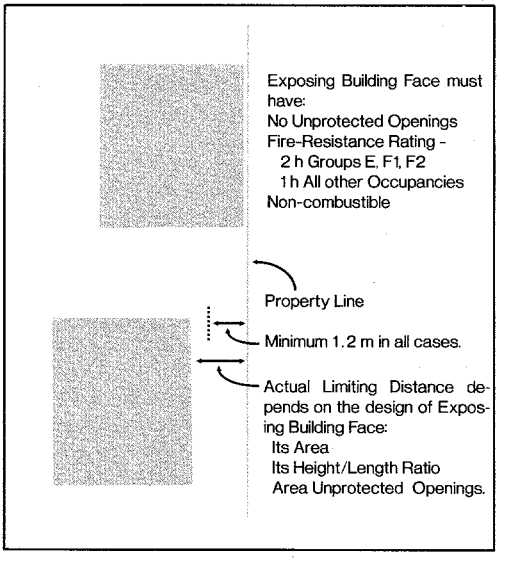
SPATIAL SEPARATION REQUIREMENTS OF NBCC

The NBCC requires that no building shall put an adjacent building at risk due to a fire. This is achieved by requiring a minimum separation between buildings, or by limiting the area of unprotected openings in walls between buildings. This is all set out in two Tables - Table 3.2.3.A for Groups A, B, C, D and Group F Division 3 Occupancies; and Table 3.2.3.B for Group E and Group F Divisions 1 and 2 Occupancies.

These Tables may be used in either of two ways. For any given exterior wall (called **the exposing building face**), (a) the required Limiting Distance may be calculated according to the area of unprotected openings; or (b) the area of unprotected openings may be restricted according to the available Limiting Distance. The actual Spatial Separation requirements are governed by two situations:

(1) If the exposing building face of a building has **no unprotected openings**, it may be located right **on** the Property Line,* provided it has a fire-resistance rating. This rating is **2 h** for Groups E, F1 and F2 Occupancies, and **1 h** for all other Occupancies (NBCC 3.2.3.7).

(2) If there **are** any unprotected openings, then the wall must be **set back** from the Property Line. The minimum set-back distance is **1.2 m**, but this increases as the size of the wall and the amount of unprotected openings increase. The construction and fire-resistance rating (if required) of the exposing building face depend on the amount of unprotected openings permitted by Tables 3.2.3.A and 3.2.3.B for any given wall (NBCC 3.2.3.7).



The Sheet Steel Wall Assembly described in this Bulletin has a 1 h fire-resistance rating and is of non-combustible construction. It may therefore be used in any situation where these attributes are required, including (in buildings governed by Table 3.2.3.A) walls situated on the Property Line that have no unprotected openings.

Equivalent two-hour rated wall

Sometimes, in buildings governed by Table 3.2.3.B, a 2 h wall is required. This Sheet Steel wall assembly meets all the requirements of a 2 h fire test, with the exception that it exceeds the **temperature rise criteria** on the unexposed (non-fire) surface, as set out in the test standard (CAN/ULC-S101-M89). The NBCC recognizes this situation by **waiving** the temperature rise criteria, as long as a **correction factor** is applied to the wall (NBCC 3.1.7.2).

This correction factor (defined as the equivalent opening factor) is calculated by translating the actual temperature reached in the fire test at the 2 h point to an **equivalent area of unprotected opening**. Of course, once unprotected openings are introduced (whether actual or equivalent), the wall can no longer be located on the Property Line, but must be 1.2 m or more from it (NBCC Table 3.2.3.B).

In the case of the sheet steel wall assembly, the correction factor is 1.6% of the total rated wall area (i.e. exclusive of actual unprotected openings), calculated in accordance with a formula shown in NBCC 3.2.3.12 (see Page 4).

* See NBCC Subsection 1.1.3 *Definitions of Words and Phrases* - "Limiting Distance" - for all situations that may be governed by Limiting Distance requirements.

EXAMPLE CALCULATIONS

The following example shows how this information may be put to practical use.

Consider a Group E (Mercantile) Occupancy building (typically an enclosed shopping centre), which is to be clad with the 1 h rated sheet steel wall assembly described in this Bulletin. Note that, as this is a Group E building, a 2 h wall is required (NBCC 3.2.3.7.), but as described earlier, the 1 h ULC-listed sheet steel wall can be used if correction is made by adding an equivalent area of unprotected openings.

The design parameters of the exposing building face are as follows:

Where the 1.6% Correction Factor Comes From:

An **equivalent opening factor**, F_{EO}, is calculated for the wall at the given fire-resistance period according to this formula given in Article 3.2.3.12. of NBCC:

$F_{EO} = (T_u + 273)^4 / (T_e + 273)^4$, where:

T_u = average temperature reached on the unexposed wall surface at the time the required fire-resistance rating is reached under test conditions;

T_e = 892 °C for a fire-resistance rating of 45 min
927 °C for a fire-resistance rating of 1 hour
1010 °C for a fire-resistance rating of 2 hours.

The average temperature (T_u) of the unexposed surface of the sheet steel wall at 2 h in the fire test was 185 °C, giving an F_{EO} value of 0.016 or 1.6%.

Length:		88.0 m
Height:		8.0 m
Length/Height Ratio:	88.0 ÷ 8.0 m =	11 : 1
Total Gross Area:	88.0 x 8.0 m =	704 m²
Actual Area of Unprotected Openings (4 Entrances each 6 m x 2 m):	4 x 6.0 x 2.0 m =	48 m²
Net Area of 1 h rated wall (i.e. excluding openings):	704 m² - 48 m² =	656 m²

From the above information, two calculations need to be performed:

(1) Total area of Unprotected Openings		
To the actual area of unprotected openings, an equivalent area must be added as previously noted (NBCC 3.1.7.2), using the equivalent opening factor of 1.6%:	656 m² x 1.6% =	10.5 m²
Therefore, total area of unprotected openings (actual + equivalent) =	48 m² + 10.5 m² =	58.5 m²
Area of unprotected openings (% of the exposing building face):	58.5 m² ÷ 704 m² =	8.3%

(2) Required Limiting Distance	
Referring to NBCC Table 3.2.3.B: For a building with an Exposing Building Face that has:	
Maximum Area =	1 000 m²
L/H Ratio	> 10 : 1
Area Unprotected Openings =	8.3%
The required Limiting Distance =	**7 m**

Note that, as the (permitted) area of unprotected openings for this wall situated 7 m from the Property Line is 9% (Table 3.2.3.B), the construction of the wall (with the exception of the 2 h rating) must be as specified in NBCC 3.2.3.7.(2)(a).

CONCLUSION

The fire-rated sheet steel wall described in this Bulletin is a ULC- listed Design, using primarily generic materials. It offers designers flexibilty in the design of steel clad walls that was previously unavailable to them. Future developments will expand the range of materials that can be used.