# FIELD INVESTIGATION
# OF
# BRICK VENEER/STEEL STUD
# WALL SYSTEMS

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SUBMITTED BY: SUTER KELLER INC
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NOVEMBER 30, 1989

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Canada Mortgage and Housing Corporation, the Federal Government's housing agency, is responsible for administering the National Housing Act.

This legislation is designed to aid in the improvement of housing and living in Canada. As a result, the Corporation has interests in all aspects of housing and urban growth and development.

Under Part V of this Act, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research. CMHC therefore has a statutory responsibility to make widely available, information which may be useful in the improvement of housing and living conditions.

This publication is one of the many items of information published by CMHC with the assistance of federal funds.

## DISCLAIMER

This study was conducted by Suter Keller Inc for Canada Mortgage and Housing Corporation under Part V of the National Housing Act. The analysis, interpretations and recommendations are those of the consultants and do not necessarily reflect the views of Canada Mortgage and Housing Corporation or those divisions of the Corporation that assisted in the study and its publication.

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# FIELD INVESTIGATION OF BRICK VENEER/STEEL STUD WALL SYSTEMS

## ABSTRACT

The brick veneer/steel stud wall system has become very popular as an exterior wall system in North America during the past 15 years. However, the rapid adoption of this wall system by the building industry preceded the development of adequate design and construction standards. In view of this situation great concern has been voiced by design professionals, contractors and building owners over the longterm serviceability and safety of the system. In order to address these concerns, the Canada Mortgage and Housing Corporation, a federal agency, commissioned a field investigation of the brick veneer/steel stud wall system across Canada as part of an extensive research program.

As part of this field survey, a number of buildings in different climatic regions across Canada and after several years in service were investigated in detail. This report summarizes the findings of this field study on the in-situ performance of the brick veneer/steel stud wall system under different service conditions.

## 1. INTRODUCTION

In response to industry concerns expressed about the design, construction practices and in-service performance of the brick veneer/steel stud (BV/SS) wall system, Canada Mortgage and Housing Corporation commissioned a nation-wide field investigation as part of an extensive research program.

A total of 8 buildings in 4 cities were investigated. Two buildings each were selected in the following locations:

- St. John's, Newfoundland
- Montreal, Quebec
- Toronto, Ontario
- Calgary, Alberta

The particulars about each building are summarized in Table 1.

Table 1 Building Particulars

| Building No. | Location | Age Yrs | No. of Storeys | Structural System |
|---|---|---|---|---|
| 1 | St. John's | 8 | 7 | Prestressed Concrete |
| 2 | St. John's | 6 | 6 | Slabs, Steel Columns |
| 3 | Montreal | 9 | 8 | Steel Frame/R.C. Slabs |
| 4 | Montreal | 4 | 6 | Reinforced Concrete |
| 5 | Toronto | 8 | 9 | Reinforced Concrete |
| 6 | Toronto | 11 | 7 | Reinforced Concrete |
| 7 | Calgary | 9 | 11 | Prestressed Concrete |
| 8 | Calgary | 9 | 17 | Slabs, Concrete Columns |

The investigation locations were chosen to include three distinctly different climatic regions in the most populated areas of Canada. The Atlantic Region with its high winds and driving rain conditions is considered the most severe. This is followed by the Great Lakes - St. Lawrence Region which includes the two largest urban centres of Canada, Toronto and Montreal. The climate is still relatively severe with a large number of freeze thaw cycles and its proximity to the Great Lakes. The Western Prairie Region essentially has continental climate with hot and dry summers and dry and cool winters. Fig. 1 shows the climatic regions of Canada and the investigation locations.

## 2. FIELD INVESTIGATION

The investigation consisted firstly of a visual examination of the brick veneer, secondly of a detailed inspection of the exterior wall system in a number of locations through inspection openings from the interior and thirdly of a

Fig. 1 Climatic Regions of Canada

thermographic survey. Samples of mortar and metal components such as studs, tracks and screws were removed for laboratory analysis. Based on the metallurgical assessment remaining life predictions were made of the stud wall components and brick ties.

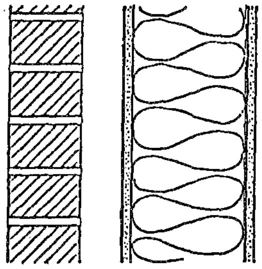
## 2.1 Exterior Wall Sections

The details of the exterior wall sections encountered in the survey are shown in Fig. 2. The illustrations clearly show that BV/SS wall construction practices greatly vary across the nation.

## 2.2 Exterior Inspection

The veneer of each building was carefully scanned with binoculars from the ground, and randomly inspected from

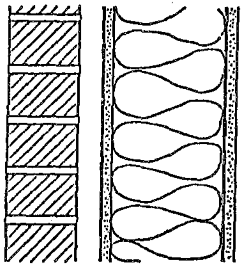
**BUILDING # 1 ( ST. JOHN'S )**



WALL SECTION

- 100mm BRICK MASONRY
- 55mm AIR SPACE
- BUILDING PAPER
- 13mm DRYWALL
- BATT INSUL. IN STUD SPACE
- 152mm STEEL STUD
- 13mm DRYWALL FOIL-BACKED

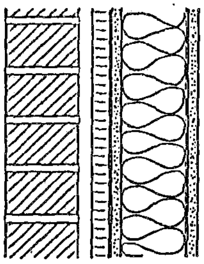
**BUILDING # 2 ( ST. JOHN'S )**



WALL SECTION

- 100mm BRICK MASONRY
- 30mm AIR SPACE
- BUILDING PAPER
- 13mm DRYWALL
- BATT INSUL. IN STUD SPACE
- 152mm STEEL STUD
- POLY. VAPOUR BARRIER
- 16mm DRYWALL

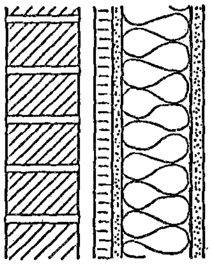
**BUILDING # 3 ( MONTREAL )**



WALL SECTION

- 100mm BRICK MASONRY
- 18mm AIR SPACE
- 25mm RIGID INSULATION
- BUILDING PAPER
- 13mm EXTERIOR DRYWALL
- BATT INSUL. IN STUD SPACE
- 92mm STEEL STUD
- POLY. VAPOUR BARRIER
- 13mm DRYWALL

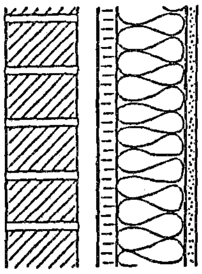
**BUILDING # 4 ( MONTREAL )**



WALL SECTION

- 100mm BRICK MASONRY
- 20mm AIR SPACE
- 25mm SEMI-RIGID INSULATION
- 13mm DRYWALL
- BATT INSUL. IN STUD SPACE
- 92mm STEEL STUD
- POLY. VAPOUR BARRIER
- 16mm DRYWALL

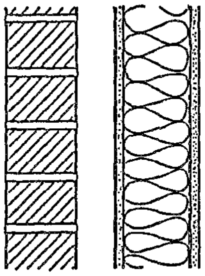
**BUILDING # 5 ( TORONTO )**



WALL SECTION

- 100mm BRICK MASONRY
- 25mm AIR SPACE
- BUILDING PAPER
- 25mm RIGID INSULATION
- BATT INSUL. IN STUD SPACE
- 92mm STEEL STUD
- POLY. VAPOUR BARRIER
- 13mm DRYWALL

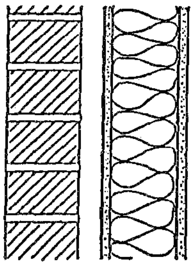
**BUILDING # 6 ( TORONTO )**



WALL SECTION

- 100mm BRICK MASONRY
- 50mm AIR SPACE
- BUILDING PAPER
- 11mm TENTEST
- BATT INSUL. IN STUD SPACE
- 89mm STEEL STUD
- POLY. VAPOUR BARRIER
- 13mm DRYWALL

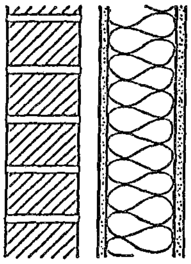
**BUILDING # 7 ( CALGARY )**



WALL SECTION

- 100mm BRICK MASONRY
- 30mm AIR SPACE
- BUILDING PAPER
- 11mm DRYWALL
- BATT INSUL. IN STUD SPACE
- 89mm STEEL STUD
- POLY. VAPOUR BARRIER
- 13mm DRYWALL

**BUILDING # 8 ( CALGARY )**



WALL SECTION

- 100mm BRICK MASONRY
- 25mm AIR SPACE
- BUILDING PAPER
- 11mm DRYWALL
- BATT INSUL. IN STUD SPACE
- 89mm STEEL STUD
- POLY. VAPOUR BARRIER
- 13mm DRYWALL

Fig. 2 Exterior wall details

balconies and through windows at re-entrant building corners.

Deficiencies such as cracking, spalling and efflorescence staining were recorded.

Deficiencies typically included:

- spalling at shelf angle locations
- spalling due to freeze/thaw action
- cracking at corners
- cracking between openings
- cracking due to poor detailing and construction practices such as discontinuous shelf angles and rowlock sills or copings.

## 2.3 Interior Inspection

Detailed interior inspections of the exterior wall assembly were typically carried out in four locations. The inspection openings were generally 600 mm wide from floor to ceiling to fully expose all exterior wall components.

The information typically recorded during the interior inspections included:

- type and condition of brick ties
- size, spacing and anchorage of studs
- size and anchorage of top and bottom tracks
- type of bridging
- vertical movement capability of studs
- type and location of insulation
- type of moisture barrier
- condition of drywall
- size and condition of cavity
- brick veneer workmanship.

## 2.4 Thermographic Survey

A thermographic study of the exterior walls was carried out to identify locations of air leakage, condensation and rain penetration. The thermographic survey generally followed the site documentation work by about one month.

# 3. SURVEY FINDINGS

## 3.1 Brick Veneer

The condition of the brick veneers ranged from satisfactory to poor in some buildings. Typical examples of distress are depicted in Figs. 3 to 6. Masonry workmanship for the 8 buildings was considered average for residential

Fig. 3 Freeze/thaw damage at soldier course

Fig. 4 Vertical cracking due to unintentional load transfer at balcony

Fig. 5 Spalling of brick units at shelf angle location due to lack of a "soft" joint

Fig. 6 Cracking of masonry due to poor detailing at balcony slab locations

Fig. 7 Extensive mortar protrusions and poorly filled head joints.

Fig. 8 Extensive mortar droppings at floor levels

construction. Poorly filled head joints, excessive mortar protrusions into the cavity and extensive mortar droppings on brick ties and at the flashing levels were frequently encountered. Examples are shown in Figs. 7 and 8.

The cavity size varied from a low of 6 mm to a maximum of 64 mm. In general the cavity size was considered to be inadequate to permit proper venting, especially in view of the frequent presence of heavy mortar droppings in the cavity. Table 2 gives an overview of the recorded cavity size and condition of the cavity space.

It is emphasized here that the types of deficiencies observed were found to be common to other backup wall systems and no correlation could be drawn to the use of the steel stud backup system.

Table 2 Cavity Size and Condition

| Building No. | Cavity Size (mm) | Mortar Droppings |
|---|---|---|
| 1 | 50 - 64 | extensive |
| 2 | 19 - 38 | moderate |
| 3 | 6 - 32 | moderate |
| 4 | 13 - 32 | extensive |
| 5 | 20 - 30 | extensive |
| 6 | 45 - 55 | moderate |
| 7 | 13 - 50 | extensive |
| 8 | 20 - 30 | extensive |

## 3.2 Brick Ties

Over 60% of the buildings investigated utilize strip ties to fasten the brick veneer to the steel stud wall. The remainder used adjustable type ties directly screwed onto the stud flange. The strip tie installation was generally poor with ties being frequently bent up or down to suit the installation as shown typically in Fig. 9.

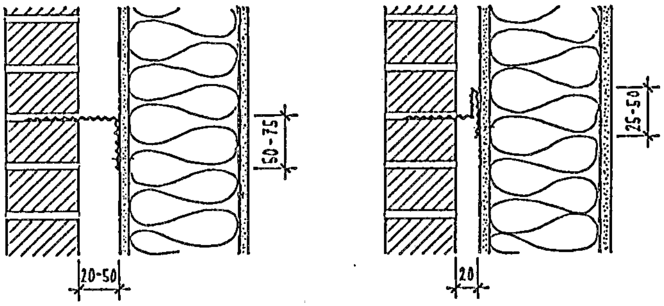


Fig. 9 Frequent strip tie installation

The condition of the brick ties varied from building to building. Strip ties generally showed corrosion at the brick/cavity interface or where in contact with mortar, i.e. if covered with mortar droppings as seen typically in Fig. 10. Adjustable ties were generally in satisfactory condition but corrosion was also evident in some instances especially at the brick/mortar interface.

## 3.3 Mortar

Mortar samples were removed from several buildings and analyzed for chloride contents. Table 3 shows a summary of percent chloride by weight of cement for the samples analyzed.

Table 3 Mortar Sample Chloride Analysis

| Building No. | Sample No. | % Chloride by Weight of Cement |
|---|---|---|
| 3 | 7 | 1.10* |
| | 8 | 0.58* |
| 4 | 5 | 0.05 |
| | 6 | 0.14 |
| 5 | 1 | 0.77* |
| | 2 | 0.05 |
| 6 | 3 | 0.03 |
| | 4 | 0.04 |
| 7 | 9 | 0.26* |
| | 10 | 0.29* |
| 8 | 11 | 1.63* |
| | 12 | 0.02 |

* Exceeds ACI published threshold limit for acid-soluble chloride of 0.20% above which corrosion of steel occurs

The test results indicate that in 4 out of 6 buildings sampled the chloride content in the mortar exceeds the ACI published threshold level of 0.20% by weight of cement above which corrosion of steel occurs. In four cases the threshold limit was exceeded by a factor of 3 to 8. It is assumed that the chlorides were added as accelerators during construction. Our findings therefore indicate that this practice is still widely used.

Fig. 10 Showing corroded strip tie after removal of mortar droppings

### 3.4 Stud Wall System

Stud sizes varied from 150 mm 20 ga. to 89 mm 26 ga. interior type stud with spacings of mostly 400 mm as summarized in Table 4.

Table 4 Stud Sizes and Spacings

| Building No. | Location | Size (mm) | Thickness Without Coating (mm) | Gauge | Spacing (mm) |
|---|---|---|---|---|---|
| 1 | St. John's | 150 | 0.876 | 21 | 609 |
| 2 | St. John's | 150 | 0.965 | 20 | 406 |
| 3 | Montreal | 92 | 0.914 | 20 | 406 |
| 4 | Montreal | 92 | 0.907 | 22 | 406 |
| 5 | Toronto | 92 | 1.130 | 19 | 406 |
| 6 | Toronto | 89 | 0.478 | 26 | 406 |
| 7 | Calgary | 89 | 0.457 | 26 | 406 |
| 8 | Calgary | 89 | 0.445 | 26 | 406 |

Top and bottom tracks were generally of the same size as the studs with flanges of equal size. Table 5 gives a summary of the top and bottom tracks found in the investigation. In all cases top and bottom tracks were attached to the structure by power actuated fasteners at 600 to 900 mm spacing.

Table 5 Top and Bottom Tracks

| Building No. | Top and Bottom Track | Track Thickness |
|---|---|---|
| 1 | 30 ⌈150⌉ | 19 ga. (1.080 mm) |
| 2 | 30 ⌈150⌉ | 19 ga. (1.080 mm) |
| 3 | 32 ⌈150⌉ | 20 ga. (0.902 mm) |
| 4 | 25 ⌈92⌉* | 20 ga. (0.978 mm) |
| 5 | 25 ⌈92⌉ | -- -- |
| 6 | 26 ⌈89⌉ | -- -- |
| 7 | 29 ⌈89⌉ | 26 ga. (0.445 mm) |
| 8 | 29 ⌈89⌉ | 27 ga. (0.416 mm) |

* Top track flange = 44 mm

Bridging or bracing between studs has not been used in general. One building utilized through-the-stud channel bridging but a positive connection had been omitted. Another building used 60 mm wide, 1.17 mm (18 ga.) galvanized strapping on the exterior face of studs at mid-height of the wall.

Vertical movement capability was not provided in any of the buildings investigated, although one building had neither top nor bottom connections and another building had only bottom connections. In all cases top and bottom connections consisted of one drywall screw attached at the inner stud flange.

The presence of double studs at window openings was also reviewed. The findings are summarized in Table 6.

Table 6 Window Stud Framing Details

| Building No. | Vertical Studs at Windows |
|---|---|
| 1 | single stud |
| 2 | double stud |
| 3 | single stud |
| 4 | double stud |
| 5 | double stud |
| 6 | single stud |
| 7 | single stud |
| 8 | single stud |

The findings indicate that more than half of the buildings investigated use single studs at wall openings.

In general, steel studs were found to be in satisfactory condition. Only traces of corrosion were noticed in some cases except for one building in St. John's where the studs on some walls exhibited considerable corrosion. There were however cases where the bottom tracks exhibited extensive corrosion in the investigation areas. An example of bottom track deterioration is shown in Fig. 11.

Pertaining to insulation, all buildings had glass fibre batt insulation within the stud space. The buildings in Montreal in addition had 25 mm rigid or semi-rigid insulation on the exterior together with 13 mm exterior drywall. One Toronto building also used an additional 25 mm rigid insulation on the exterior of the studs but without exterior drywall.

The vapour barrier in all but one case consisted of polyethylene sheeting placed on the warm side of the insulation. One building used foil-backed drywall. The moisture barrier consisted of building paper. One building did not have a moisture barrier. Table 7 summarizes the information on vapour and moisture barriers used.

The condition of the drywall was reviewed for the presence of moisture, mould or evidence of moisture staining. Our review indicates that in one building all wall components from the brick through to the interior drywall were wet or moist on one elevation. Since the drywall on the weather side of the building exhibited surface mould, it is concluded that wet conditions occur frequently. In another building moisture was found on the exterior drywall, but in general drywall was found to be dry at the time of the investigation.

Fig. 11 Bottom track corrosion as seen in St. John's, Toronto and Calgary

Table 7 Moisture Barrier and Vapour Barrier

| Building No. | Moisture Barrier | Vapour Barrier |
|---|---|---|
| 1 | building paper | foil-backed drywall |
| 2 | building paper | polyethylene ( - ) |
| 3 | building paper | polyethylene ( 6 mil) |
| 4 | none | polyethylene (10 mil) |
| 5 | building paper | polyethylene ( 6 mil) |
| 6 | building paper | polyethylene ( 4 mil) |
| 7 | building paper | polyethylene ( 2 mil) |
| 8 | building paper | polyethylene ( 2 mil) |

Shadowing of studs on the interior was observed in 5 buildings. This condition occurred primarily in buildings which did not use additional insulation on the exterior face of the stud, except for one case where shadowing also occurred in spite of the presence of exterior insulation but where no exterior drywall had been used. The two buildings which used both exterior drywall and exterior insulation did not exhibit shadowing of steel studs on the interior finishes.

Moisture conditions within the exterior wall assembly varied from location to location depending on prevailing weather conditions. Relative humidity in the cavity was generally above 50% with values as high as 82%. Where rain had occurred just a few days prior to the inspection, the inner face of the brick veneer and the brick ties were found to be wet.

## 3.5 Metallurgical Examination

Metal components such as studs, tracks, and brick ties were examined in detail to determine material thickness, corrosion protection coatings and extent of corrosion. Based on this metallurgical assessment remaining life predictions were made. Table 8 provides a summary of the findings.

As seen from Table 8, there is a wide contrast in the remaining life predictions of the metal specimens. While many of them show no degradation, some of them are extensively corroded. Electrolytically applied zinc coatings appear to show better resistance to corrosion than the hot dipped systems, in spite of a thinner coating. Hot dipped zinc coatings range between 0.001 to 0.002 in. (0.025-0.051 mm). If the amount of zinc coating is compared to

Table 8 Metallurgical Examination of Metal Components

| Building No. | Age | Metal Component | Thickness (mm) | Gauge (MSG) | Coating Type | Coating Thickness (mm) | Estimated Remaining Life |
|---|---|---|---|---|---|---|---|
| 1 | 8 | stud | 0.876 | 21 | HD | 0.033 | <5 |
| | | strip tie | 0.635 | 24 | HD | 0.036 | <2-5 |
| 2 | 6 | stud | 0.965 | 20 | HD | 0.031 | >10 |
| 3 | 9 | stud | 0.914 | 20 | HD | 0.028 | >10 |
| | | strip tie | 0.305 | 30 | HD | 0.028 | >5 |
| 4 | 4 | stud | 0.907 | 21 | HD | 0.041 | >10 |
| | | strip tie | 0.914 | 20 | HD | 0.031 | <5 |
| 5 | 8 | stud | 1.130 | 19 | HD | 0.020 | >10 |
| | | adj. tie | 4.750 | -- | EG | 0.013 | >5 |
| 6 | 11 | stud | 0.495 | 26 | EG | 0.010 | >10 |
| | | adj. tie | 0.775 | -- | EG | 0.013 | >5 |
| 7 | 9 | stud | 0.445 | 26 | EG | 0.010 | >10 |
| | | strip tie | 0.330 | 30 | HD | 0.031 | <2 |
| 8 | 9 | stud | 0.445 | 26 | EG | 0.010 | >10 |
| | | strip tie | 0.356 | 29 | HD | 0.036 | <2 |

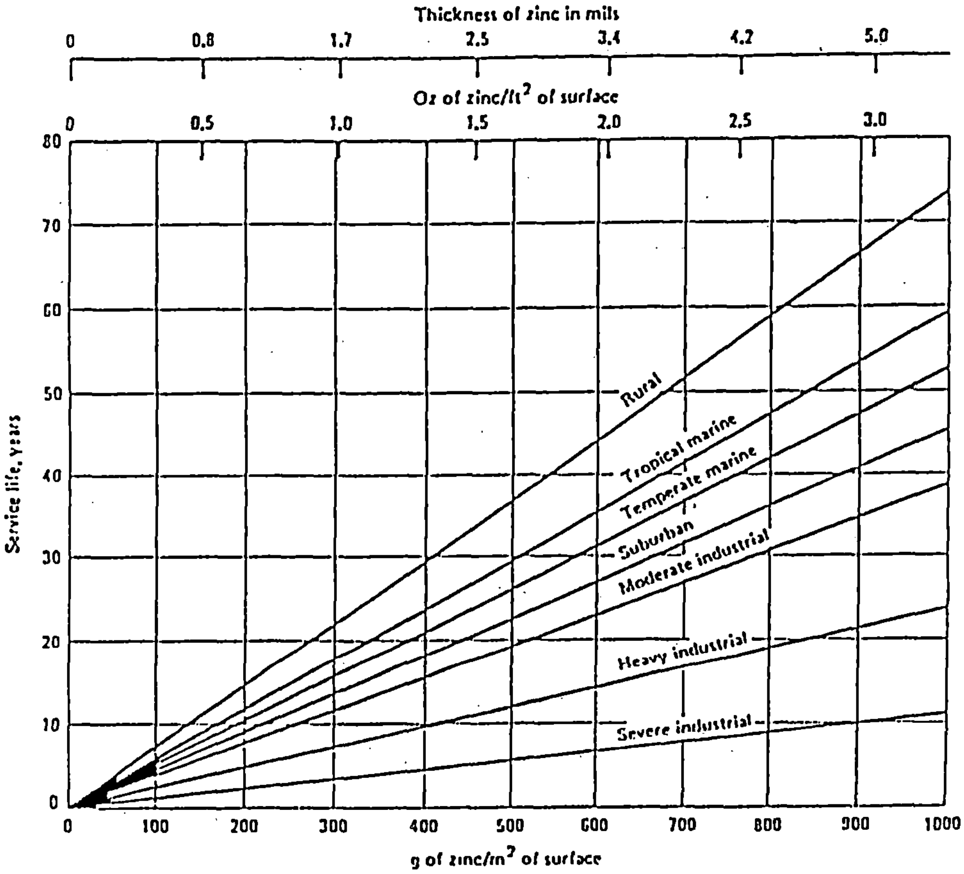
Corrosion Protection Type:

HD = Hot dipped
EG = Electro galvanized

Remaining Life:

>10 means excellent
>5 limited life say up to 15 years
<2 very poor condition

service life it appears that the coating thickness on the metal components tested are at the low end of the scale. Fig. 12 shows that for a coating thickness of 0.001 in. (0.025 mm) the underlying steel would be protected for about 15 years in a rural environment whereas an increase in coating thickness to 0.002 in (0.051 mm) or 0.003 in (0.076 mm) would increase the service life to say 30 years or 40 years, respectively. On the other hand, if the system is exposed to a more aggressive environment, a coating of 0.001 in. (0.025 mm) would protect the underlying steel for only a few years and a heavier coating would still only provide about 5 to 8 years of protection. This indicates the absolute need to stop the ingress of moisture or to improve the protection of vulnerable steel components.



Service life is measure in years to the appearance of first significant rusting.

Fig. 12 Effects of Amount of Zinc on Service Life of Galvanized Sheet (ASTM Handbook)

### 3.6 Thermographic Survey

Thermographic surveys were conducted on buildings in St. John's, Nfld., Toronto, Ont., and Calgary, Alta.

In all cases the thermographic surveys indicated that the building envelope was uniformly insulated and free of any significant air leakage or moisture retention at the time of the survey. Air movements across the building envelope were considered normal. The majority of the detected air leakage was associated with window/door framing details. The thermographic survey also indicated various degrees of thermal bridging at floor levels in all buildings. This condition occurred whether slab edge insulation was provided or not.

## 4. SUMMARY AND CONCLUSIONS

The findings of the field survey of 8 buildings in 4 cities across Canada are summarized as follows:

### 4.1 Steel Stud System

Steel studs are generally in satisfactory condition and exhibit little evidence of corrosion after a service life of 4 to 11 years except for one building in St. John's where the studs on some walls have an estimated remaining life of 5 years or less.

The survey indicated that steel stud construction is frequently substandard in the following ways:

- lack of bridging
- inadequate stud attachment
- lack of vertical movement capability
- use of thin gauge material which is not recommended today
- inadequate corrosion protection
- use of unprotected black metal screws.

Where corrosion has been noticed, bottom tracks were the first ones to be affected.

The metallurgical assessment indicated that the steel stud assembly is not generally protected effectively against exposure to moisture.

### 4.2 Brick Veneer

Brick veneer conditions were found to be generally satisfactory. Where brick veneer distress was observed, the type of distress typically is not related to the use of steel stud as a backup system but rather is associated with design, construction and maintenance issues.

Mortar sample analyses indicated the frequent presence of excessive amounts of chlorides which shows that this practice was still widely used at the time of construction of these buildings.

Our visual observations and metallurgical analysis have shown that brick ties are often corroded and where strip ties have been used their service life appears to be significantly shortened regardless of climatic region. The problem of early deterioration of brick ties appears to be related primarily to the presence of chlorides in the water and the minimal amount of corrosion protection currently specified on brick ties. The problem is obviously aggravated by the frequent presence of moisture in the mortar joints and the cavity.

The cavity space typically was found to be too small and partially filled with mortar fins and mortar droppings at the bottom of the wall. This condition not only restricts the circulation of air in the cavity but the bridging of the air space by mortar fins and droppings provides potentially large paths for moisture movement across the cavity to the backup wall. In order to minimize bridging by mortar fins and improve drainage and air circulation in the cavity a minimum air space of 50 mm is recommended.

## 4.3 Building Science Issues

The Thermographic scan and our visual observations indicated that air leakage through the wall system was generally minimal except for isolated locations. This finding is significant since excessive air exfiltration could seriously compromise the long term performance of the backup wall system due to moisture deposition in the wall and associated corrosion of metal components.

While the thermographic scan indicated that insulation was generally uniformly placed in the backup wall, it is interesting to note that most buildings exhibited a certain amount of thermal bridging at floor slabs. This finding supports our initial observations of frequently poor detailing and construction practices of the BV/SS wall system at floor slab junctions.

## 4.4 General Conclusions

The buildings indicated in this survey were only between 4 and 11 years old and their long term performance record therefore has not yet been established. However, based on our investigation, it is concluded that the performance of the BV/SS exterior wall system is not as much affected by the severity of the climatic exposure conditions but rather by detailing and construction practices, and by the choice of materials. While only a limited number of buildings could be included in this project, the survey has identified the key vulnerabilities of the BV/SS wall system. The recognition of these vulnerabilities and the implementation of corrective design measures and improved construction practices will likely govern the long term acceptability of the BV/SS wall system as an economical building envelope component.

## 4.5 General Recommendations

A number of general recommendations are included here based on our key observations of potential vulnerabilities and areas of deterioration of the BV/SS wall system.

These recommendations are as follows:

- All efforts should be made to keep moisture out of the backup wall system. Evidence has shown that the key factor leading to deterioration is moisture, whatever its source.

- The use of ordinary (unprotected) dry wall screws to fasten stud wall components should not be allowed. Cadmium plated or galvanized screws should be specified instead.

- The practice of using ordinary strip ties to fasten the brick veneer should be discontinued. It is noted here that CSA Standard CAN3-A370-M84 (1) does not permit the use of standard corrugated strip ties to connect brick veneer in buildings exceeding 11 m (36 ft.) in height.

- Chloride additives and other corrosive agents in mortar should be banned in accordance with CSA Standard CAN3-A371-M84 (2) requirements.

- The cavity size should be increased to a minimum width of 50 mm (2 in.) to ensure a reasonable amount of air circulation in the cavity and to minimize potential bridging of the cavity by mortar fins and mortar droppings.

- All efforts should be made to keep the cavity clear and to ensure that weepholes at the bottom of the wall can function properly.

- Quality assurance by means of rigorous inspection of all building components of the BV/SS wall system during all construction stages will eliminate many deficiencies which were observed during the course of this field survey.

- Since all building materials deteriorate to some degree with time due to aging, weathering and other environmental effects, periodic post-construction inspections are recommended. The interval of inspection is dependent on past experience in a particular climatic region and the cladding's performance history.

## REFERENCES

1. Canadian Standards Association, CAN3-A370-M84, "Connectors for Masonry", CSA, Rexdale, 1980.

2. Canadian Standards Association, CAN3-A371-M84, "Masonry Construction for Buildings". CSA, Rexdale, 1984.