INSTALLATION GUIDE
FOR
REPLACEMENT WINDOWS

PREPARED FOR:

Buildings Group
The CANMET Energy Technology Centre (CETC)
Energy Technology Branch, Energy Sector
Department of Natural Resources Canada
Ottawa, Ontario, K1A 0E4
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IMPORTANT NOTICE

The intent of this technical guide on windows installation is to help assure integrity and durability of replacement windows in building envelopes. The technical requirements put forward in this manual should be considered as complementary to window manufacturer's instructions. In case of contradiction, comply with the manufacturers' instructions and local building codes.

FOREWORD

Once the decision is made to replace existing windows, many possibilities exist, regarding namely:

- Frame material (frame and sashes);
    - Wood
    - PVC
    - Aluminum
    - Other

- Glazing type;
    - Double glazing
    - Factory sealed unit
        - With or without low emissivity coatings
        - Air or inert gas filled space

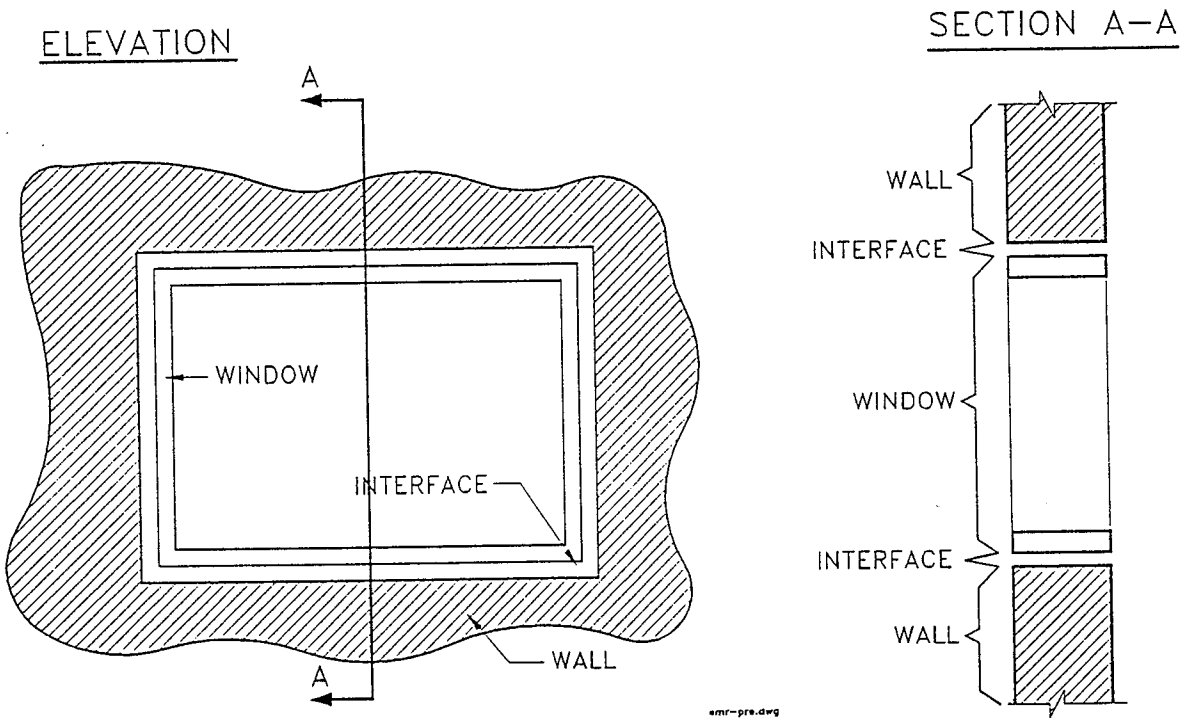
- Window type;
    - Horizontal sliding
    - Vertical sliding
    - Casement
    - Awning
    - Tilt-and-turn
    - Fixed
    - Composite
    - Combination

- Installation method;

This document will deal specifically with installation method, considering frame materials and type of replacement window. The type of glazing will not affect the method of installation in any way.

The windows covered in this manual must conform with the prescriptive and performance requirements of the National Canadian Window Std. (CAN/CSA-A440-M90) for shop assembled windows.

All of the operations involved in window replacement must result in the proper integration of the new window into the existing wall, while complying with building science requirements. Therefore, the "window system" must be integrated in the "wall system" in such a way that both system maintains their respective qualities.



The integration of the window into the wall requires consideration for the "interface system", with the following basic function:

- Ensure a structural tie between the "window system" and the "wall system", while following these principles:
    - Reduce or eliminate any downward load transfer to the top cross member (frame head).
    - Permit differential movement between both systems, in the same plane as the window.
    - Maintain forced entry (burglary) resistance of the "window system"
- Ensure continuity of air-barrier
- Shelter the window from weather conditions (rain and snow)
- Restrict vapour diffusion
- Reduce the risk of condensation and thermal heat loss
- Maintain satisfactory performance throughout service life (durability)
- Maintain ease of operation
- Prevent insect entry
- Limit sound transmission
- Be aesthetically acceptable and blend in with surroundings
- Be cost effective

In order to facilitate comprehension, this manual is sub-divided into several chapters, which follow the sequence of the various steps involved in window replacement. Each chapter takes into consideration the functions or requirements mentioned above to ensure the integration of the window to the wall. The flow chart illustrated on the following page illustrates the decision making process involved in window replacement.

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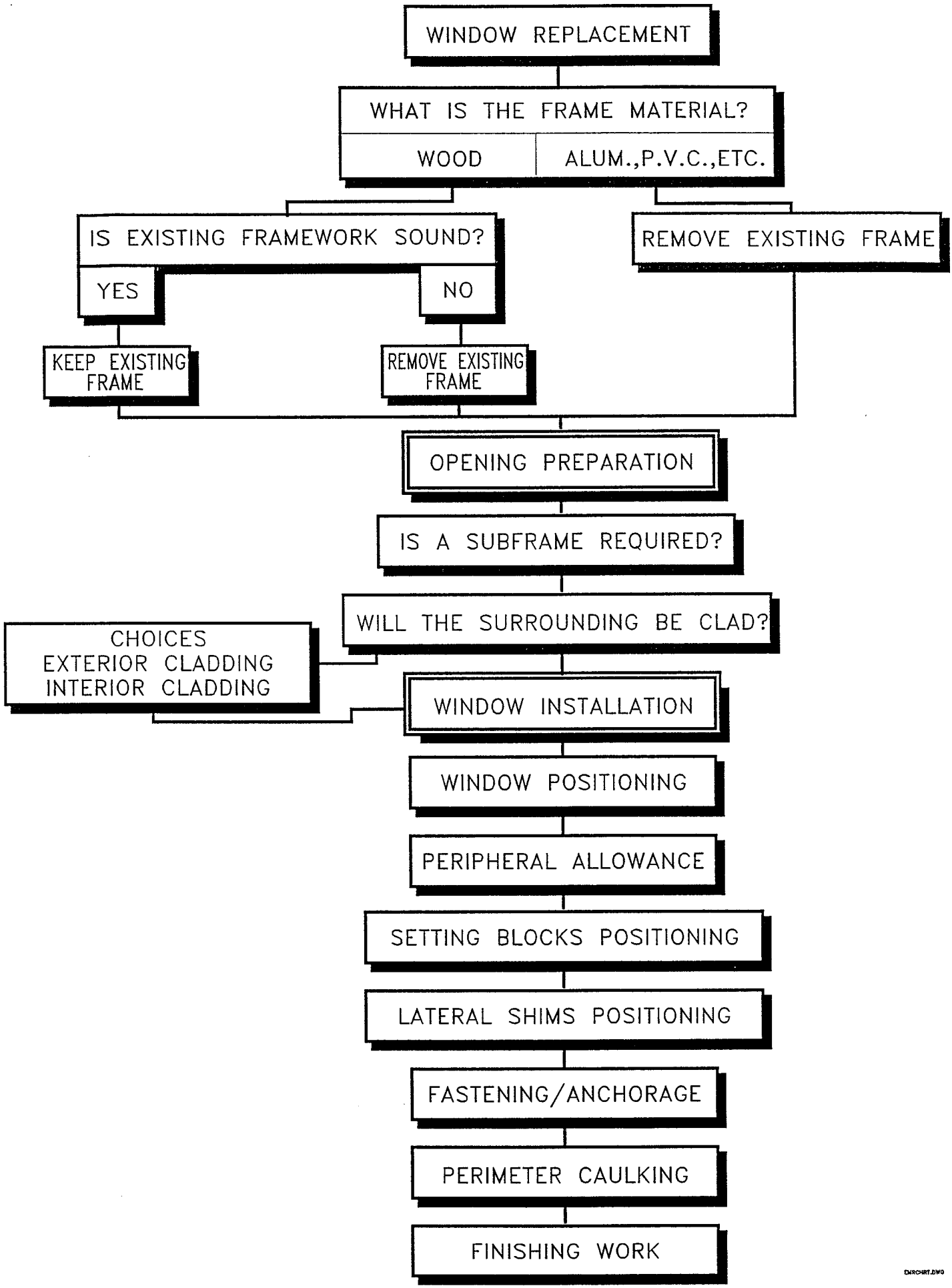
WINDOW REPLACEMENT
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CHAPTER 1
EXISTING FRAMEWORK

1.1 INTRODUCTION

Prior to replacing an existing window frame, it is necessary to establish its type and condition, in order to determine whether to preserve or dispose of the existing one.

This chapter discusses the different steps to take, according to frame type and condition.

The frame covered in this manual and currently in use in Canada, are: wood, aluminum and steel.

1.2 WOOD FRAME

Wood frames are found in almost every older home and the majority of more recently built dwellings. The deterioration of wood frames is mostly due to decaying of components. The deterioration of wood work caused by water results from:

- Exposure to wind driven rain and water run-off.
- Poor sealant condition between exterior wall cladding and frame, which can be an infiltration source.
- Lack of maintenance of components and poor condition of paint or varnish on frame.
- Poor condition of sill components with regards to water evacuation from condensation within the window system or rain.
- Poor design or installation of support members, not allowing effective water evacuation.
- Finally, internal causes, such as surface condensation and moist air exfiltration, when façade is downwind.

Deterioration affects primarily the frame is lower components (sill and cross members). However, it is possible that window head components decay when water penetrates behind the wall cladding above when the flashing detail is deficient (punctures or rips, absence of flashing).

1.1.2 HOW TO VERIFY WOOD CONDITION

There are many ways which can be used to check this condition:

- Poking the wood with a punch or a knife while trying to lift the wood where it is covered by a cladding.
- Driving a nail and attempting to remove it.
- Drilling in a screw and attempting to remove it.

When the pull out resistance is minimal and the wood is friable, decay is serious and framework should be replaced.

1.2.2. FRAME PRESERVATION OR REPLACEMENT

When the wood is judged to be sound, it is preferable to leave it in place. This results in the following advantages:

- Lower cost for window replacement.
- Provides an additional thermal separation between window frame and the rough opening.
- Eliminates the necessity to replace mouldings or other expensive finishing components.

1.3 ALUMINUM OR STEEL FRAME

Even though these materials are durable and rarely show any deterioration, they still should be replaced:

Preserving frames may result in:

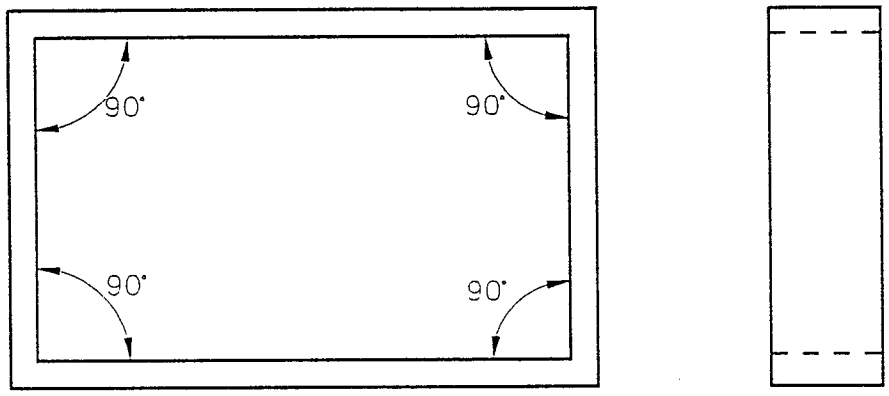
- Prohibitive cladding costs
- Low thermal resistance
- Exaggerated reduction of the new window area
- Poor aesthetic appearance.

CHAPTER 2

ROUGH OPENING PREPARATION

2.1 INTRODUCTION

The frames of shop-assembled windows consist of members that are straight and square. All corners have an angle of exactly 90° thus forming a rectangle.



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Ideally, the size of the opening to receive the replacement window should be slightly larger, and should also be straight, plumb and square.

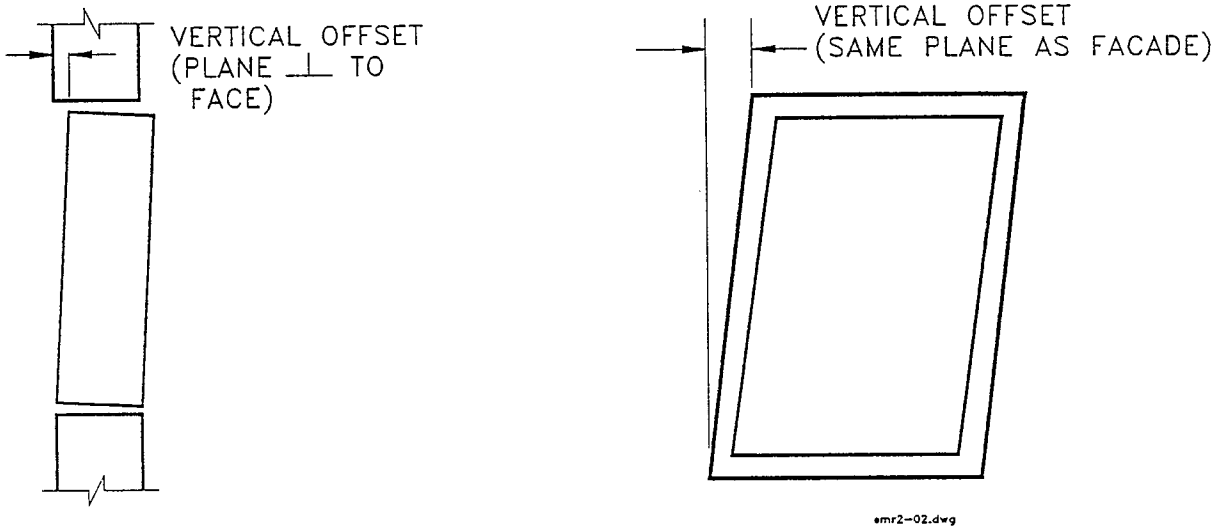
Before establishing the dimensions of the replacement windows, the opening should be closely examined to determine what modifications or improvements can be implemented, and what replacement method should be used.

This chapter describes the observations and corresponding actions to be taken before the subframe or window is installed.

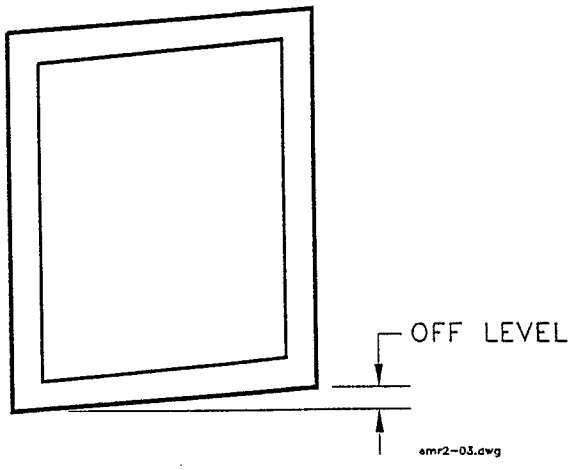
2.2 PREPARATION OF EXISTING WOOD FRAME

When the existing wood frame is intended to be preserved, one or more of the following conditions may exist:

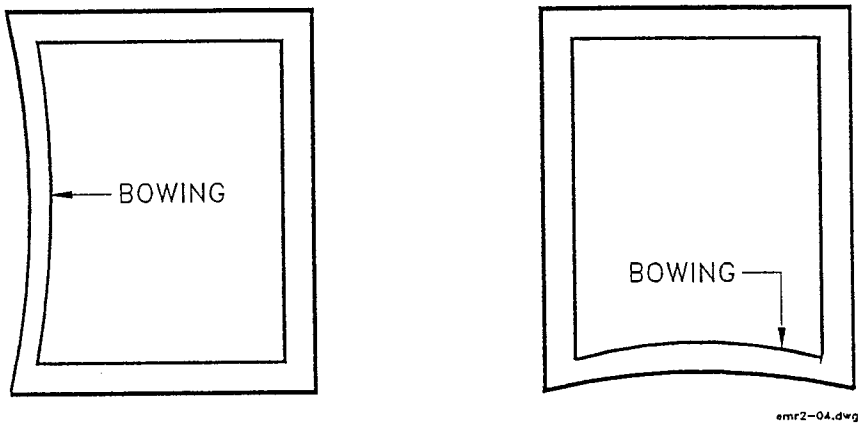
a) vertical offset of jambs;



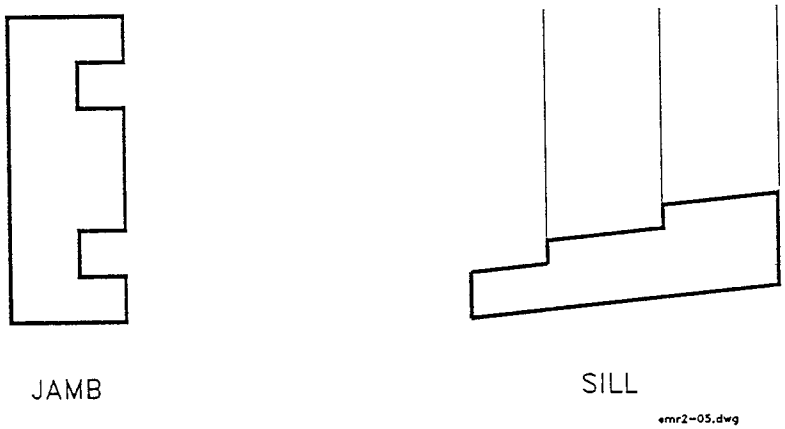
b) upper and lower cross members off level;



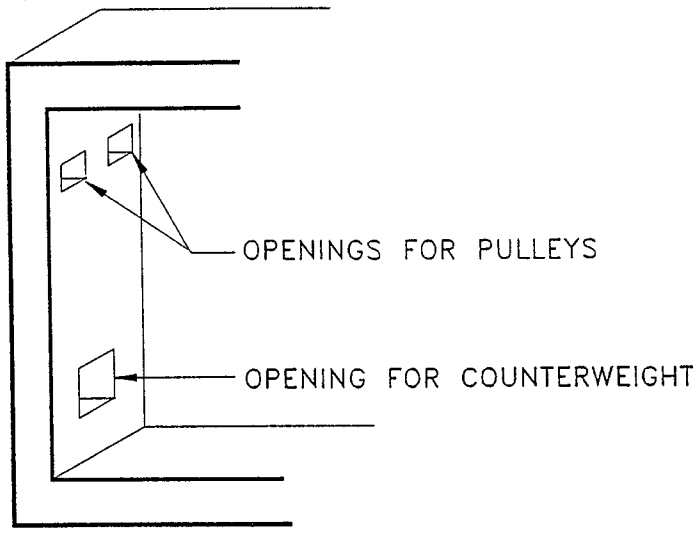
c) one or several members is or are curved or warped;



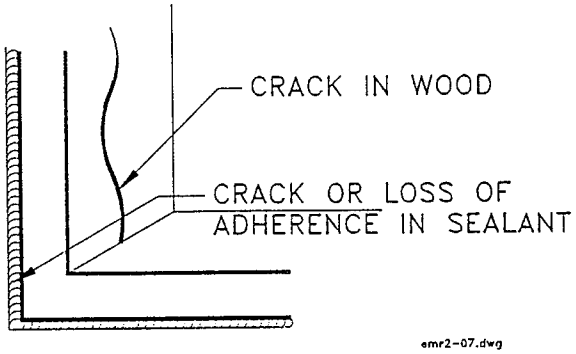
d) the cross sectional profile of members is grooved in one or several locations;



e) there is one or several openings in the frame components;



f) wood is split or sealant has failed at one or several junctions;



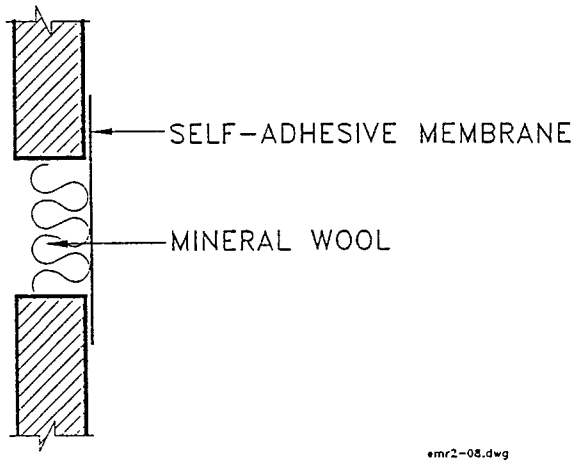
g) frame strength is poor or unsound.

2.2.1 REMEDIAL ACTION

A) When vertical or horizontal offset is equal to or inferior to 3 mm, and that members are straight:

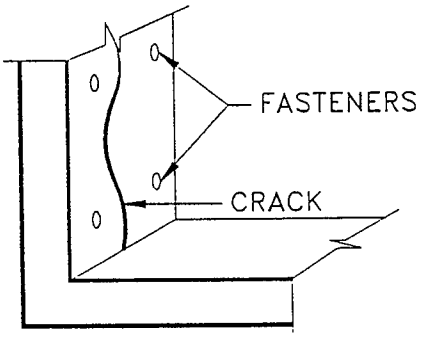
Option 1: - Seal all cracks (int. and ext.), between rough opening and existing window frame, as well as cracks within frame materials.

- Pack all openings in frame members with mineral wool, and seal with self-adhesive elastomeric membrane, in one piece. Membranes such as "Bituthene", "blueskin" or equivalent are acceptable.

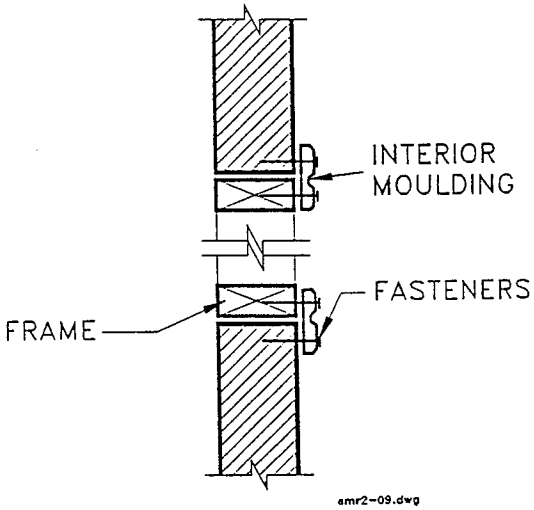


- Ensure strength and rigidity of the interface between the window frame and the rough opening, with adequate fasteners (nails, screws, etc.). If necessary, strengthen or reinforce the lintel and sill of the existing frame.

Strengthening of cracked members

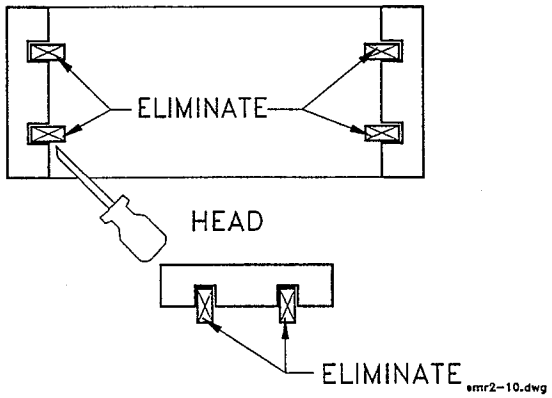


Fastening of window frame to rough opening using interior mouldings

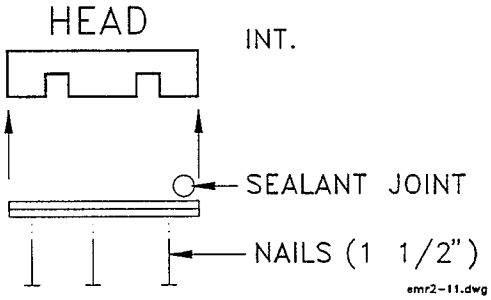


THE EXISTING FRAME IS READY FOR CLADDING OR TO RECEIVE A REPLACEMENT WINDOW

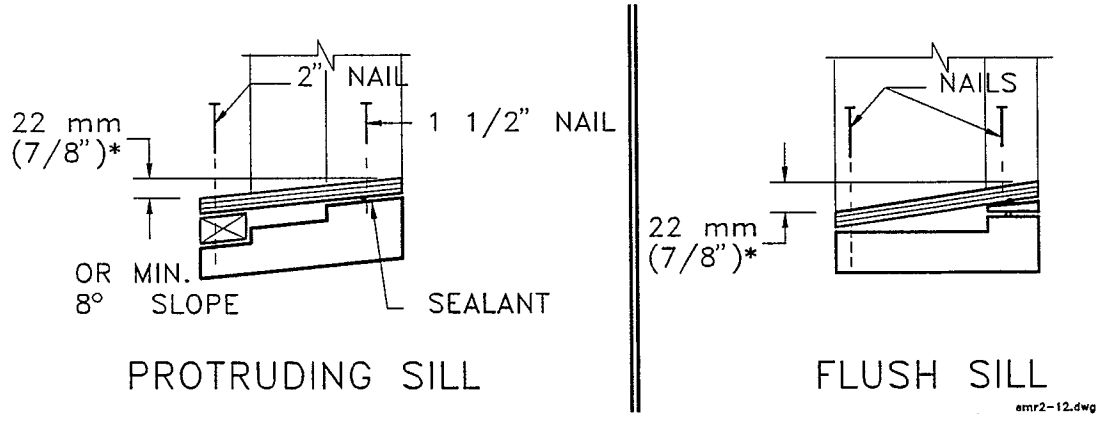
Option 2: - Remove protruding rails or mouldings to provide a flat surface, such that a strip of plywood can be uniformly supported.



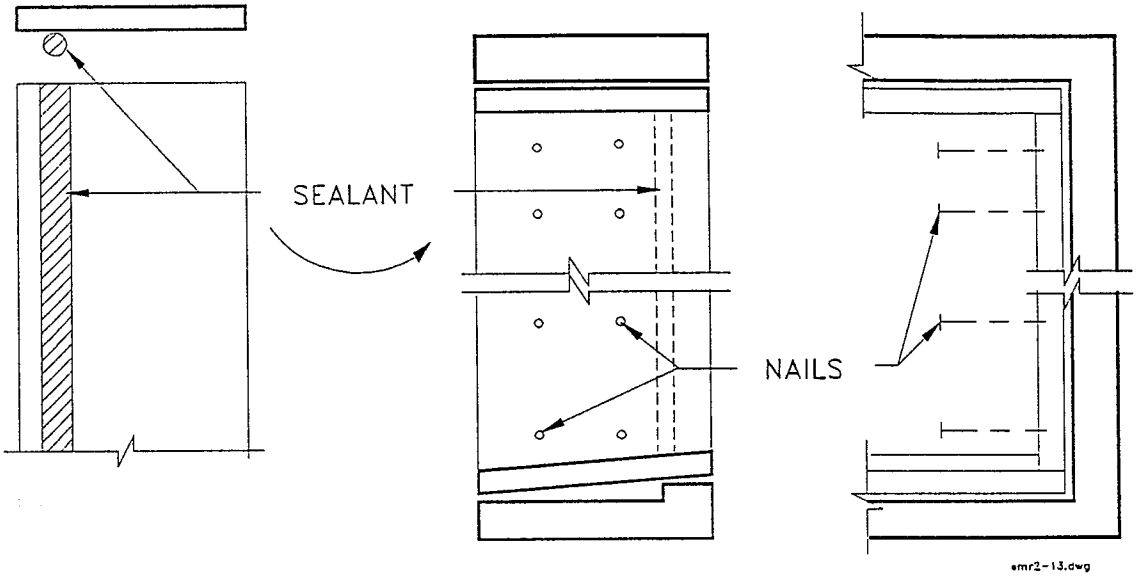
- Cut a strip of 1/4" plywood, to fit existing head's width and depth of openings. Apply a bead of caulking (air tightness) on the interior side, at the head, and fasten the plywood strip into place with 1 1/2" finishing nails.



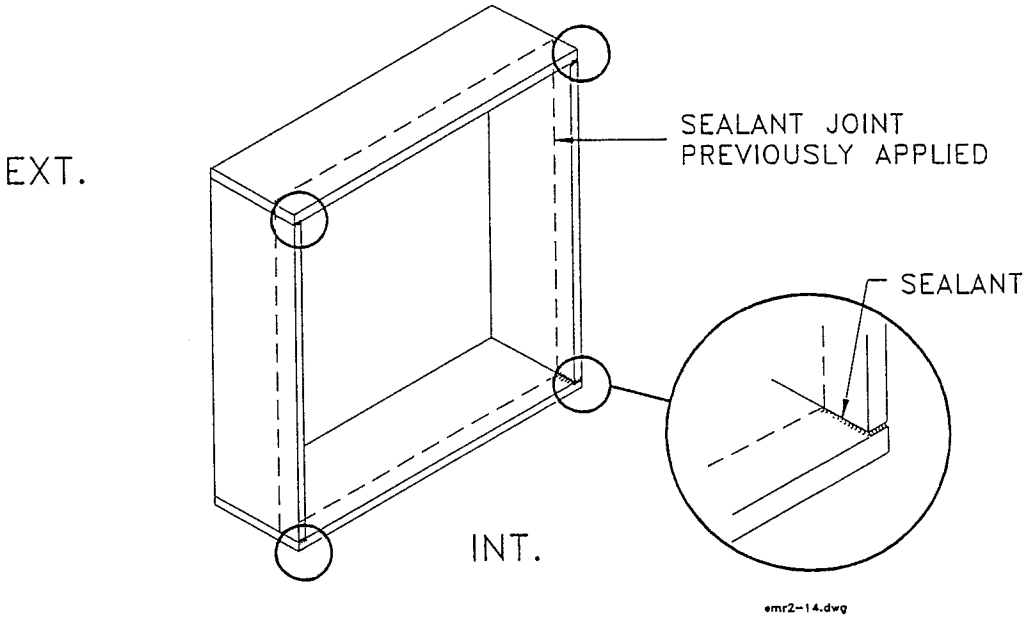
- Cut a strip of 1/2" plywood, to cover existing sill's width and depth. When necessary, insert longitudinal shim to ensure a minimum 8° slope toward the exterior. Apply a bead of caulking on interior side.



- Cut two strips of 1/4" plywood to cover the two jambs. Apply a bead of caulking on the interior side.



- Seal all four corners in order to ensure continuity of air-barrier with existing frame.



THE EXISTING FRAME IS READY TO RECEIVE CLADDING

B) When vertical or horizontal offset is greater than 3 mm and/or that members are warped, it is advisable to install a subframe within the existing opening.

The subframe provides the following:

- Converts the existing opening into a plumbs and square shape, so as to receive the new window and create a uniform peripheral joint.
- Make the assembly "existing frame + subframe" aesthetically adequate by reducing dimensional differences.

Regarding aesthetics, sketches on the following pages show the visual effect created by the "existing frame vs subframe" assembly, for two different solutions. Aesthetically, solution # 2 is preferable. The vertical or horizontal offset relative to the length of the member must be considered before making a definite choice. A 15 mm offset for an opening width "W" of 1000 mm (example shown) will not have the same visual effect as it would for 1500 mm wide opening.

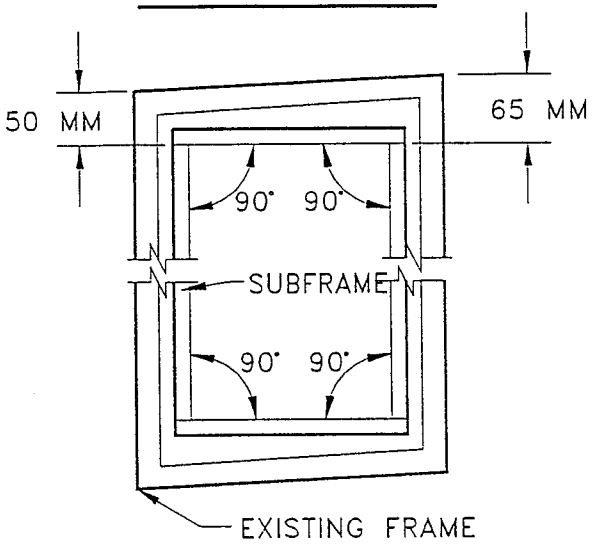
- Recommendation

  The following table provides the suggested minimal height (H_{MIN}) relative to member length (L) and height variation (δH)

MEMBER LENGTH (L)	**MINIMAL HEIGTH (H_{MIN}) mm**			
mm	**δH = 5 mm**	**δH = 10 mm**	**δH = 15 mm**	**δH = 20 mm**
500	65	90	125	150
1000	50	75	90	100
1500	25	35	45	50
2000	20	30	40	50

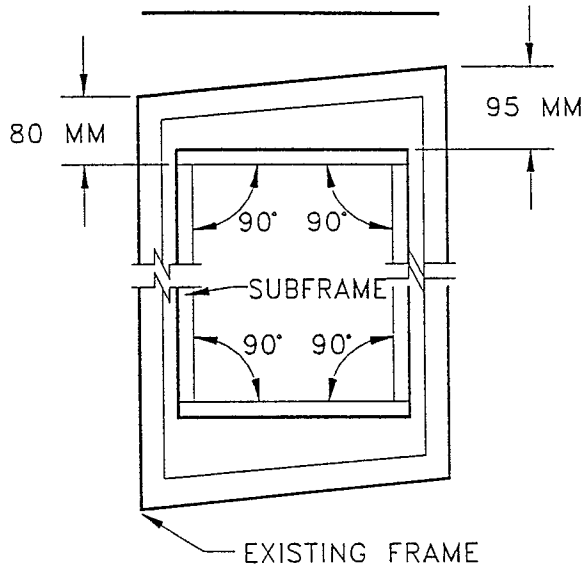
$\delta H = H_{MAX} - H_{MIN}$

SOLUTION 1



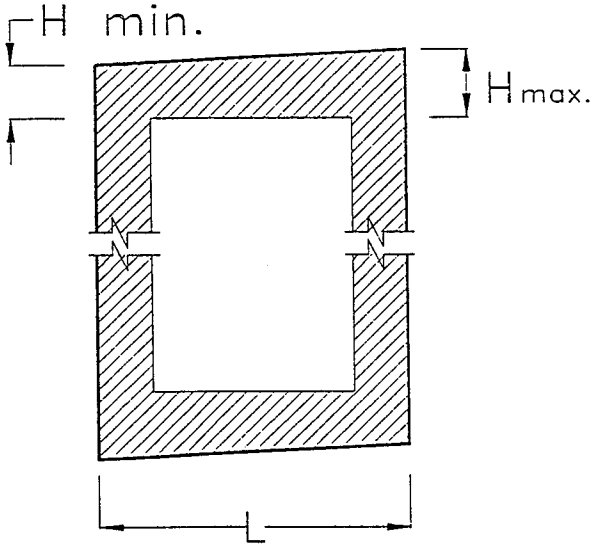
$$\text{VARIATION} = \frac{15}{50} = 30\%$$

SOLUTION 2

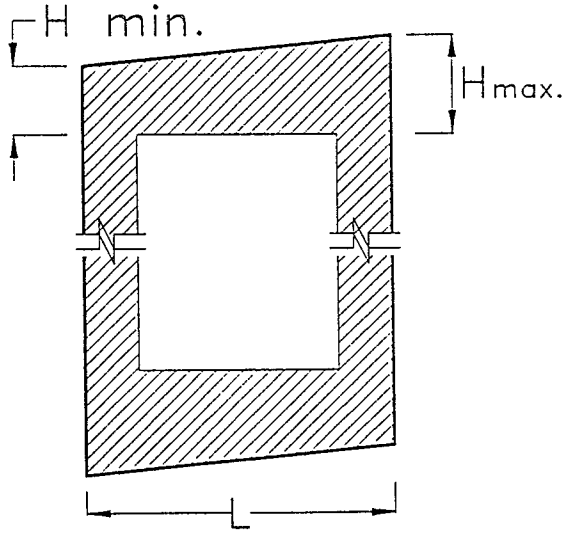


$$\text{VARIATION} = \frac{15}{80} = 18.7\%$$

SOLUTION 1 AFTER COVERING



SOLUTION 2 AFTER COVERING



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2.3 REPLACEMENT OF EXISTING FRAME

When the existing frame (wood, aluminum, steel) is removed, together with exterior and interior mouldings, the rough openings must be carefully examined (opening shape, noticeable visual deterioration) before establishing a replacement strategy.

2.3.1 CONDITION OF ROUGH OPENING

The visual inspection of the rough opening includes verifying aspects that will ensure durability of the replacement window and, if present, the subframe.

Important aspects are:

- Strength and rigidity
- Deterioration

2.3.1.1 STRENGTH AND RIGIDITY

The existing wall rough opening must be solid and rigid enough to withstand the loads occasionally applied to the window (wind, person leaning on the sill, etc.) and permanent loads (window weight), without causing excessive deflection (L/360).

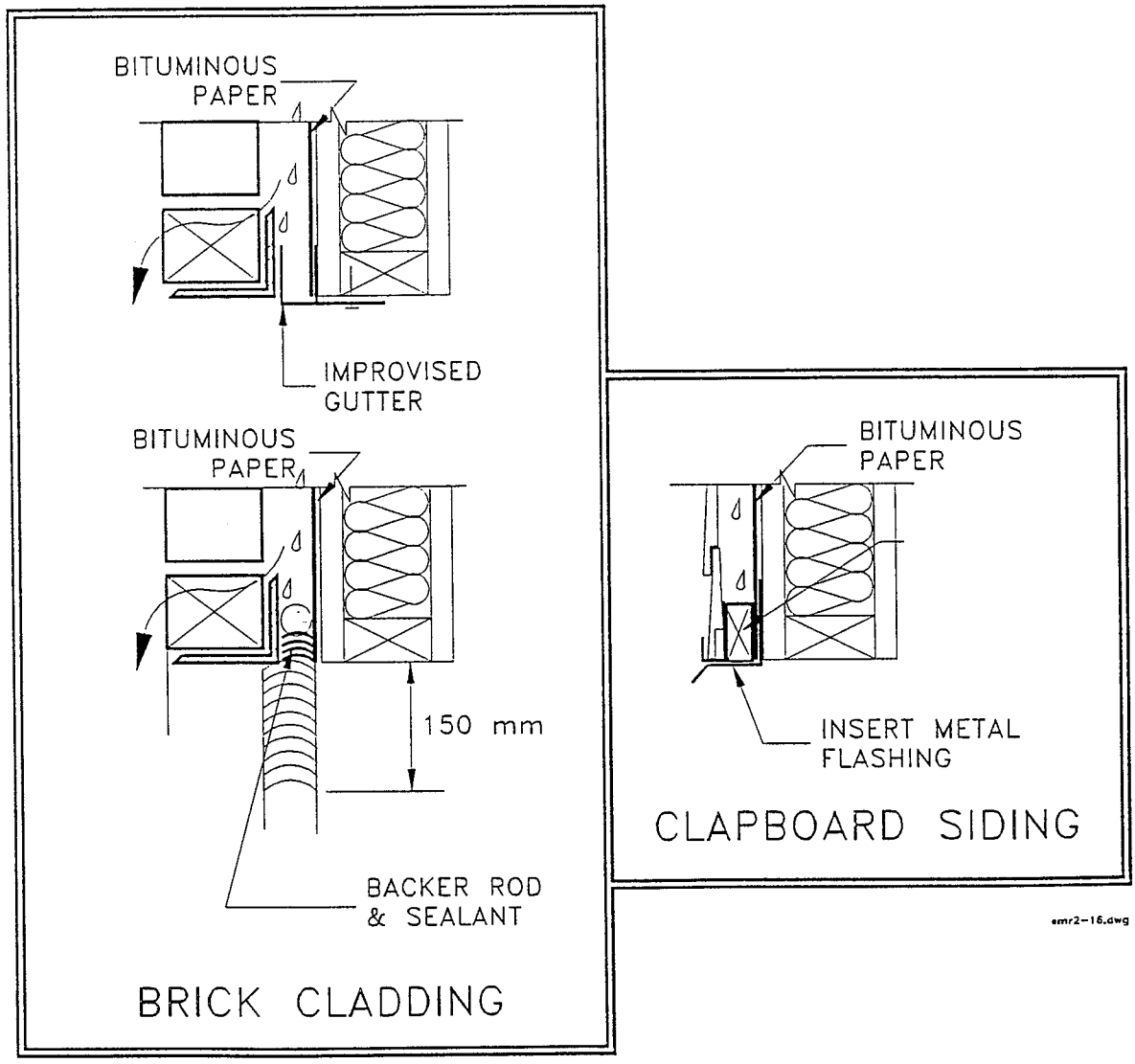
It is the installer's responsibility to make sure that the components which will be supporting the loads are solid and rigid. In cases where reinforcement is required or where some components require additional fastening, the installer shall provide it. It is critical that the existing lintel be able to support all vertical loads without imposing loads to the subframe or replacement window.

2.3.1.2 DETERIORATION

When it is obvious that there is water penetration through the exterior wall cladding above the windows, the installer should notify the

owner so that appropriate corrective measures are under taken. If the wall construction includes an air space behind the exterior cladding and it is observed that flashing above the window is non-existant, the contractor shall provide an improvised gutter (see sketch), which will exceed the visible vertical edges on both sides, by 75 mm. Alternatively, a backer rod and flexible caulking could be applied along the entire width of the opening, and turning down for 150 mm on each side of visible vertical edges.

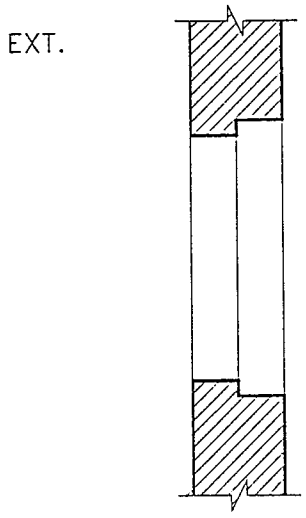
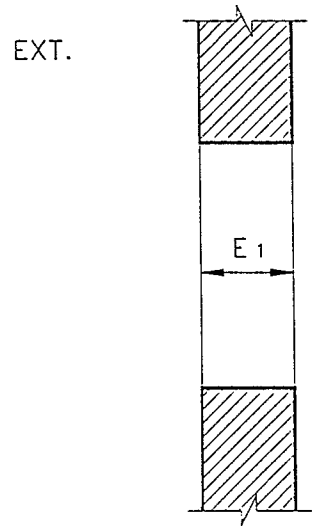
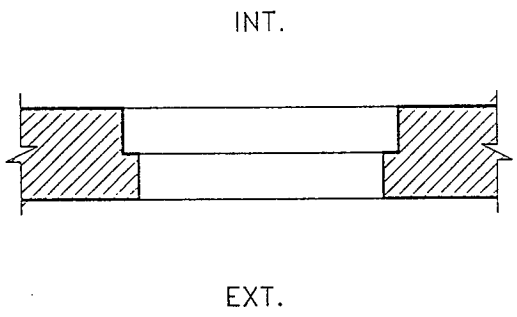
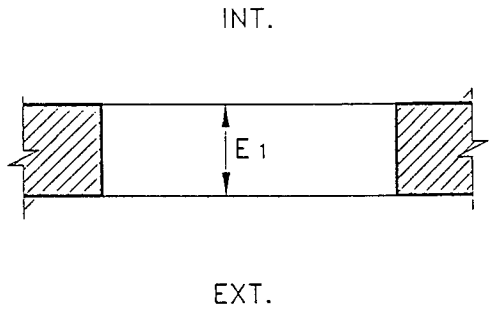
If the exterior cladding consists of horizontal siding (P.V.C. or aluminum) and no provision for water shedding from the window head exists, a flashing trim should be installed along the full width (see sketch).



2.3.2 OPENING SHAPE

Regardless of the shape of the existing opening, there is one common point to all replacement windows: they consist of straight members, forming a four-sided polygon with 90° angles between adjacent sides, i.e. a square box. This box will have to fit into the opening and satisfy all desirable performance requirements.

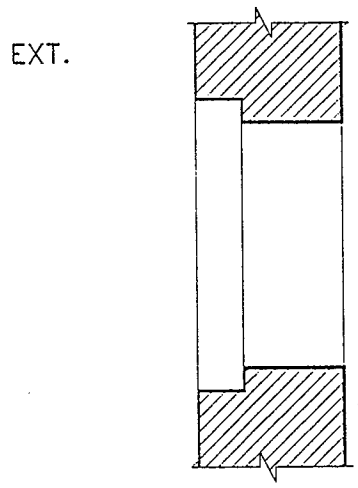
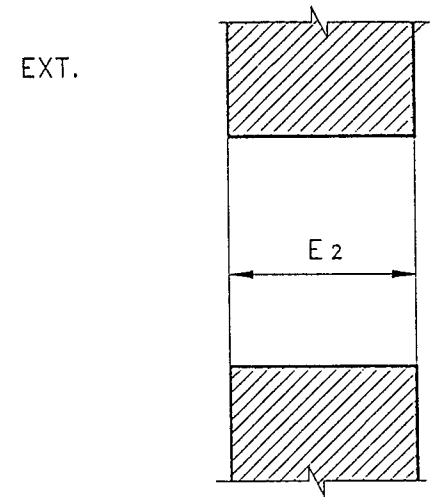
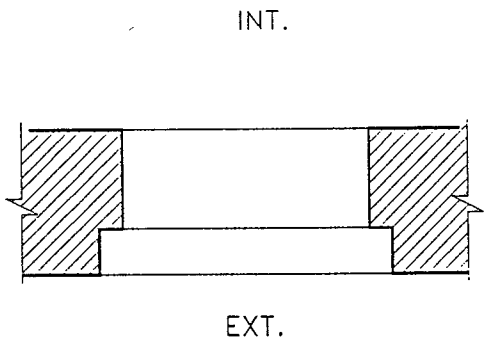
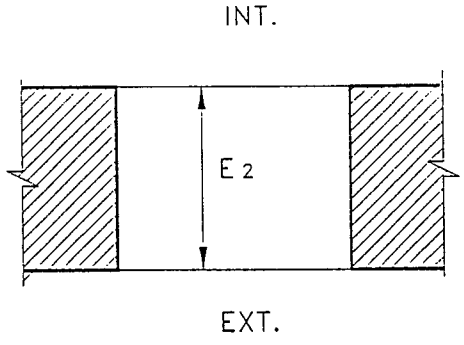
The shape and geometry of existing openings is usually related to the building's age and the framework used at that time. The following sketches illustrate some opening geometries.

VERTICAL SECTION	VERTICAL SECTION
	
HORIZONTAL SECTION	**HORIZONTAL SECTION**
	
GEOMETRY A	**GEOMETRY B**

← EUROPE → ← NORTH AMERICAN →

TYPICAL HORIZONTAL AND VERTICAL SECTIONS OF WALL FRAME

Note: Geometry B and D are identical but of different depth.

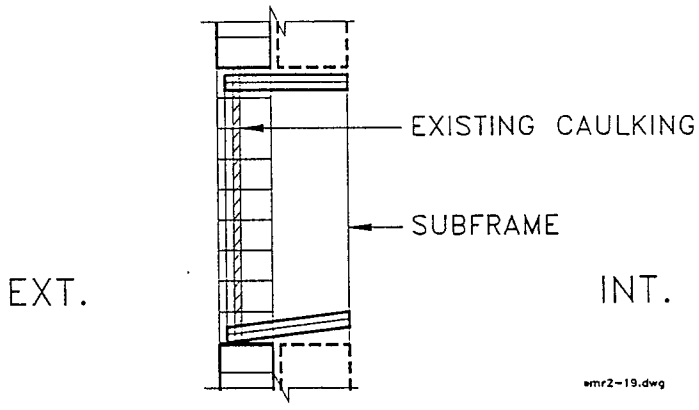
VERTICAL SECTION	VERTICAL SECTION
	
HORIZONTAL SECTION	**HORIZONTAL SECTION**
	
GEOMETRY C	**GEOMETRY D**

← EUROPE → ← CANADA →

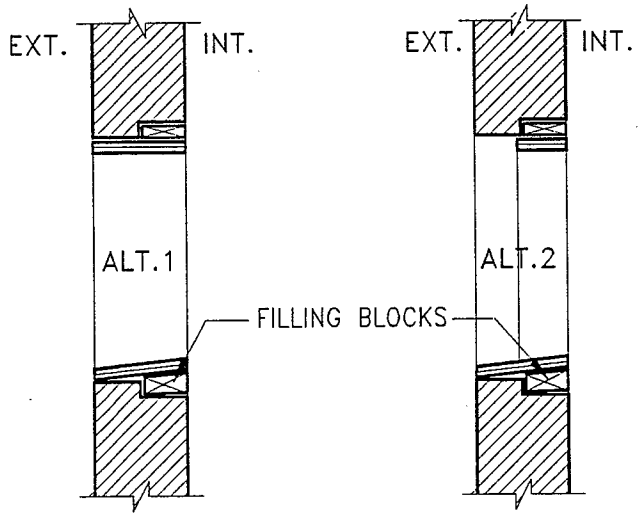
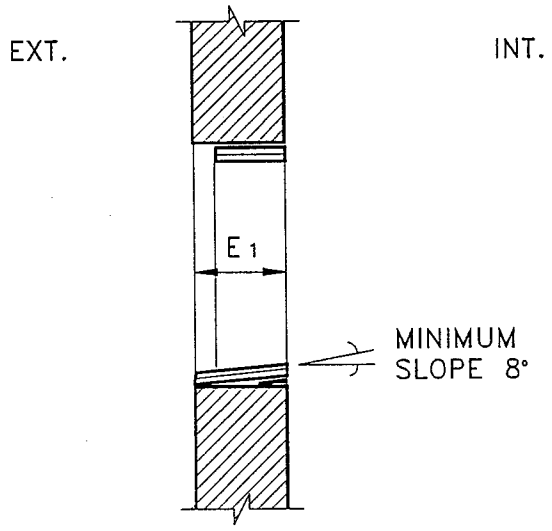
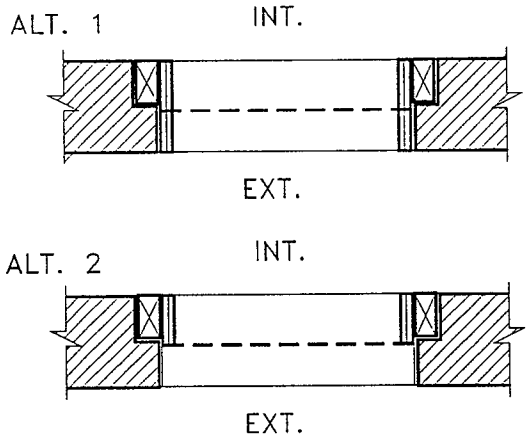
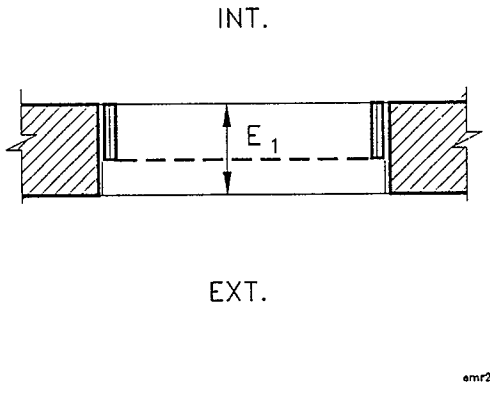
Despite the large variety of shapes possible and the various wall compositions (with or without weepholes, with varying thermal resistances), one solution applicable to all types of framework stands out, namely using a subframe which will provide for the connection between the rough opening and the window.

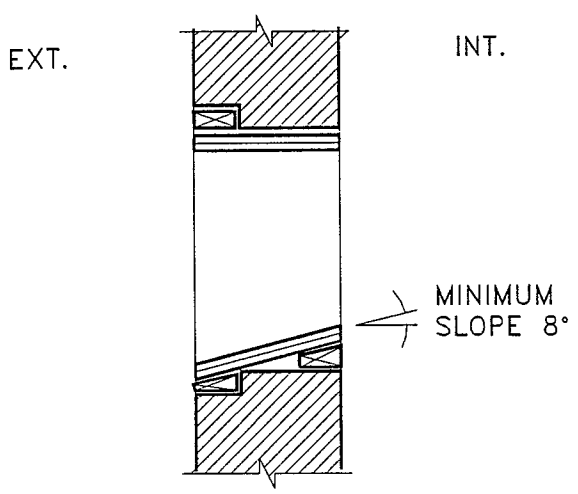
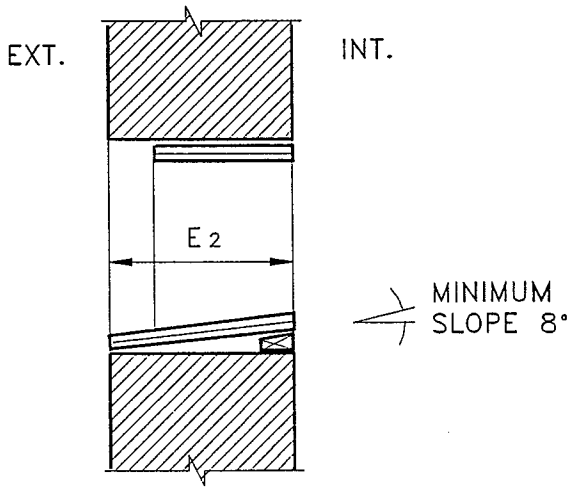
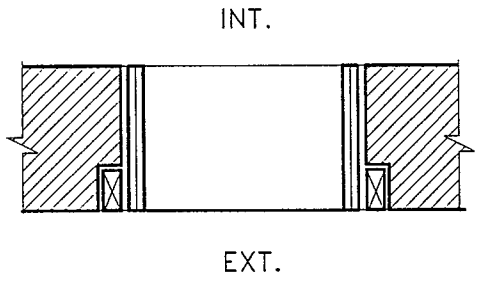
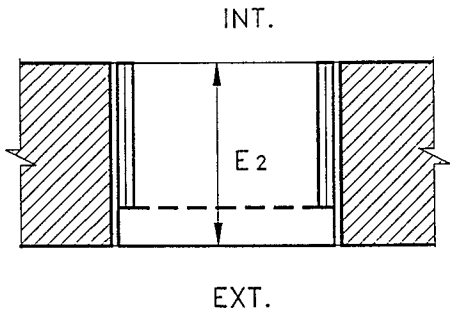
This solution offers several advantages:

- Applies to all types of framework.
- Provides some thermal resistance between the rough opening and the window.
- Eliminates or reduces the influence or cold air convection within the wall cavity surrounding the windows which tends to lower window frame temperatures. This results in improved condensation resistance for the replacement window.
- Permits the positioning of the replacement window closer to the heated side, thus also enhancing the condensation resistance of interior surfaces.
- Provides flat or planar surfaces required for installation of interior (gypsum board, aluminum or vinyl cladding, mouldings, etc.) and exterior finishes (cladding, moulding, etc.).
- Continuity, rigidity and strength of assembly.
- Covers up residues on exterior surfaces (old caulking, etc.).



The following sketches illustrate the installation of a subframe in the existing wall frame for the previously described shapes and geometries, A, B, C and D.

VERTICAL SECTION	VERTICAL SECTION
	
HORIZONTAL SECTION	**HORIZONTAL SECTION**
	
GEOMETRY A	**GEOMETRY B**

VERTICAL SECTION	VERTICAL SECTION
	
HORIZONTAL SECTION	**HORIZONTAL SECTION**
	
GEOMETRY C	**GEOMETRY D**

- Recommendations

  - Except for wood frames of replacement windows, which may be inserted directly in the existing rough opening, other frames (P.V.C., aluminum) should use a subframe.

CHAPTER 3

CONSTRUCTION AND INSTALLATION OF A SUBFRAME

3.1 INTRODUCTION

Regardless of the framing material of the new window and the wall opening, it is preferable to use a subframe.

This chapter describes:

a) Types of subframes that may be used, as well as the type and thickness of acceptable materials.

b) Installation of the subframe over an existing window frame or in the rough opening.

3.2 TYPES OF SUBFRAMES

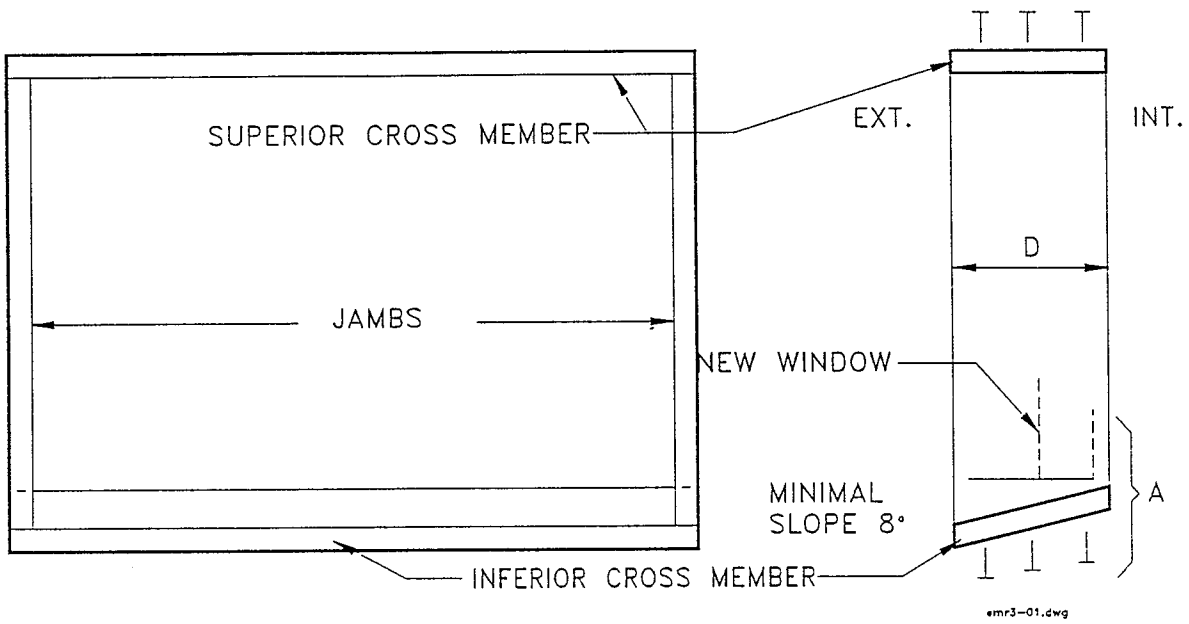
Two types of subframes may be used:

1) Subframe with constant depth along the entire perimeter.
2) Subframe with protruding inferior cross-member.

3.2.1 CONSTANT DEPTH SUBFRAME

This type of subframe is usually appropriate for more recent residential buildings.

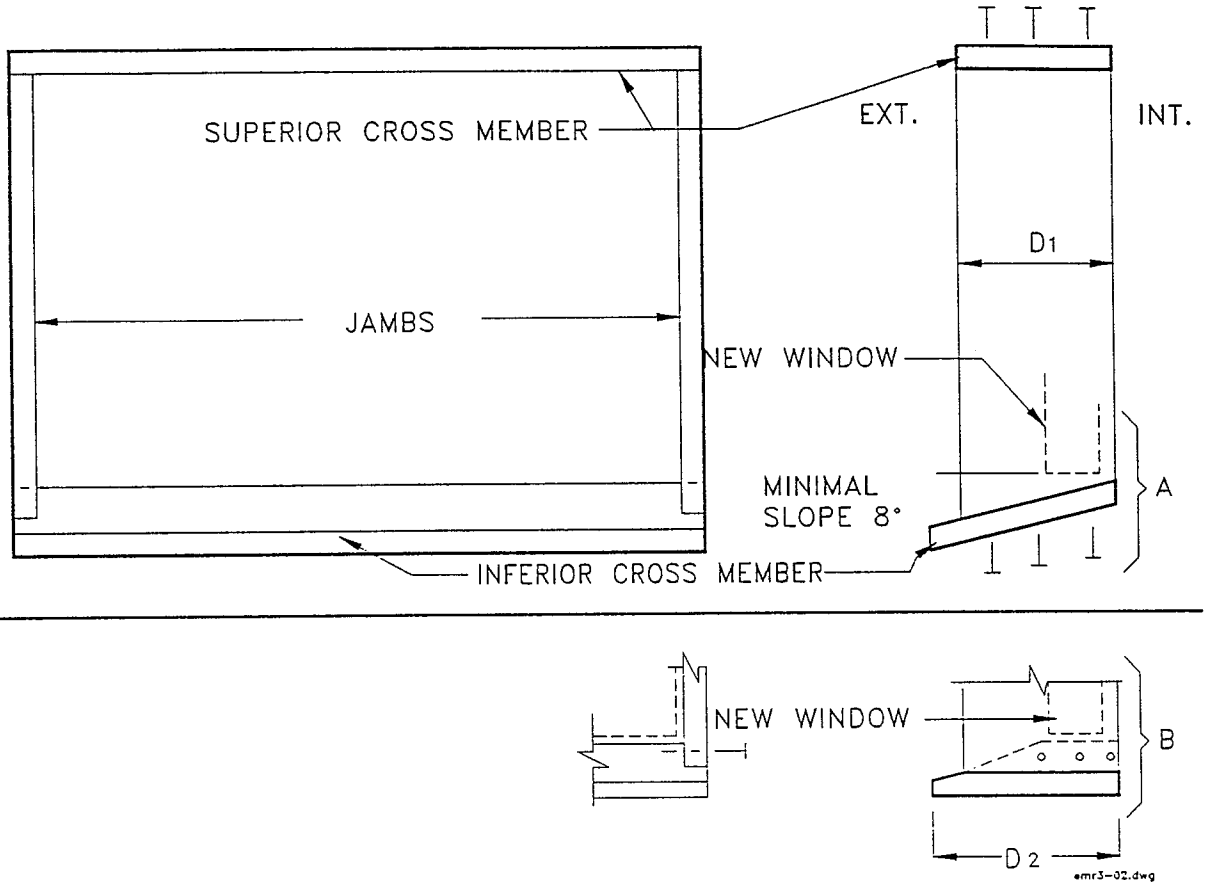
It is characterized by the constant depth (D) of all its members (see sketch). It may be fabricated in the shop or on site. the inferior cross member must have a slope of at least 8° towards the exterior for the exposed portion (the concealed area may be horizontal).



3.2.2. SUBFRAME WITH PROTRUDING INFERIOR CROSS MEMBER

This type of subframe is more appropriate for older residential buildings, i.e. the wall construction consists of cut stone or when the total wall thickness exceeds 300 mm.

It is characterized by a constant depth for both jambs and the head cross member (D1), while the inferior cross-member (D2) exceeds the jambs on the exterior side (see sketch). The exposed portion must also have a slope of at least 8° towards the exterior. Similar to the constant depth subframe, the concealed portion of the inferior cross member can be horizontal.



3.3 TYPE AND THICKNESS OF MATERIALS

Materials used must have the following characteristics:

- Rigid, to ensure flat surfaces and to minimize the number of anchoring points;
- resistant, in order withstand the occasional (wind) and permanent (weight) loads;
- low thermal conductance, to reduce the effect of the adjacent walls on the window's thermal performance;
- low air permeance, to eliminate the effect of air circulation within the wall cavity on the window's thermal performance;
- durable, in order to maintain desired qualities throughout the replacement window's service life;
- easy to handle and cost effective.

Wood is one of the materials which conforms to the above noted requirements. However, in order to meet the rigidity and surface flatness requirements, wood species or composites should be selected such that minimal filling and anchoring is required for the specified thickness.

The following table provides the minimal thicknesses required for subframe members, according to its depth and the type of material used. When plywood is to be used, the interior and exterior exposed surfaces should be covered with a cladding material. In addition, when pine is to be used and not covered, it must be treated with a preservative conforming to CAN/CSA-A440-M90 requirements.

SUBFRAME MINIMUM THICKNESS

TYPE OF MATERIAL	THICKNESS (mm)	
	DEPTH ≤ 300 mm	DEPTH > 300 mm
Pine*	19	31
Plywood**	18	31

* Pine shall be oven-dried/and knots must be sound

** Quality ?

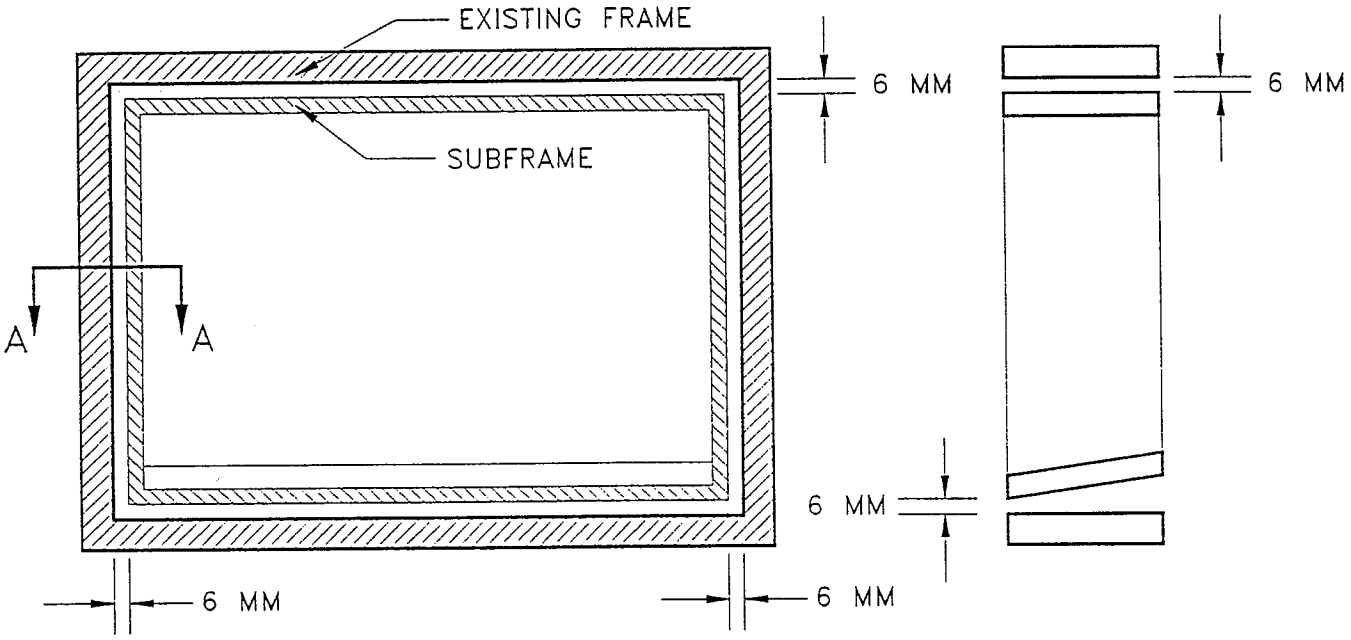
3.4 INSTALLATION OF A SUBFRAME OVER AN EXISTING FRAME

3.4.1 EXTERIOR DIMENSIONS

Taking into account the aesthetical considerations discussed in Chapter 2, the dimensions of the existing frame and warping of members, it is possible to determine the exterior dimensions of the subframe.

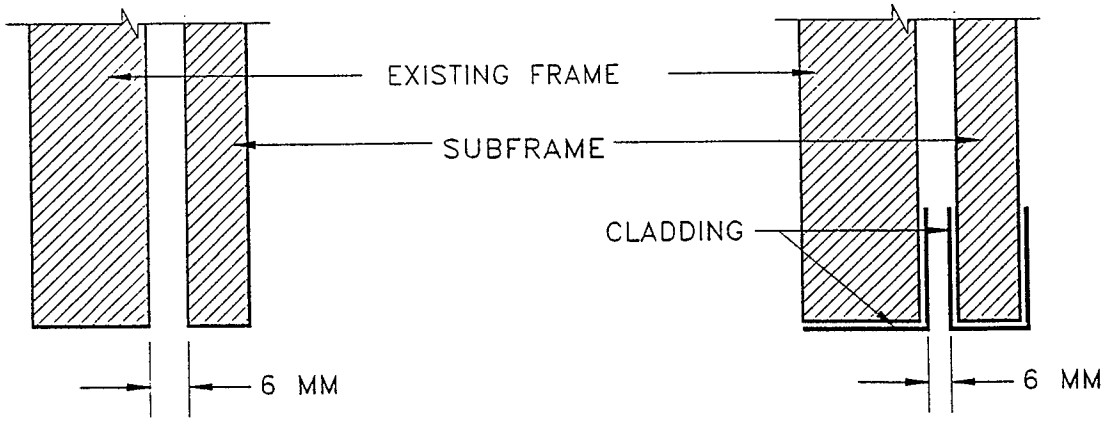
The only missing variable is the required peripheral allowance that must be maintained between the subframe and the existing frame. When the components of both the subframe and existing frame are wood, the minimal peripheral allowance should be 6 mm. This allowance must take into consideration the cladding of both the subframe and the existing frame. The next sketch illustrates the principles stated.

PERIPHERAL ALLOWANCE



SECTION "A–A"
WITHOUT CLADDING

SECTION "A–A"
WITH INDEPENDENT CLADDING



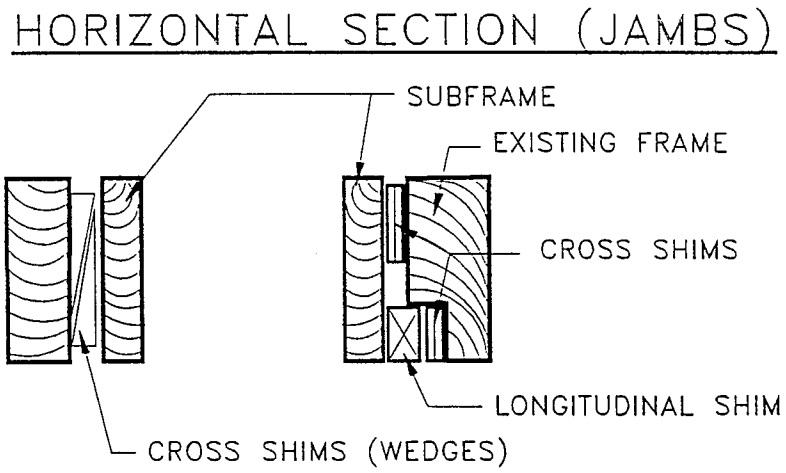
3.4.2 INSTALLATION

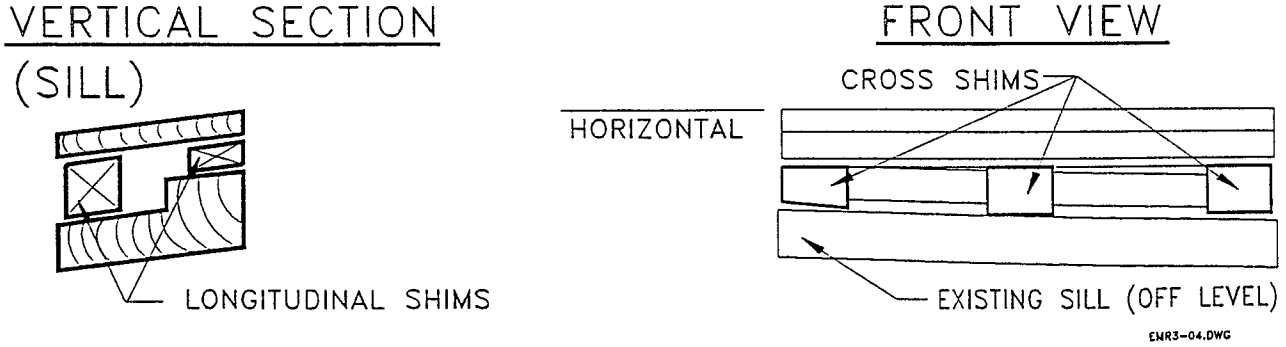
The installation of the subframe in the existing opening must:

- ensure that the required peripheral allowance is maintained;
- ensure straightness of subframe members;
- ensure that subframe members are true, square and plumb in the glazing plane;
- ensure that the supporting surface is level in the glazing plane;
- ensure strength and rigidity of the subframe assembly vs existing frame;
- permit the continuous seal of exterior and interior perimeter interfaces (after installation).

3.4.2.1 POSITIONING OF THE SUBFRAME

The positioning of the subframe may be achieved using wood shims (cedar shakes, plywood, oven-dried pine) or plastic shims (european method). The shims can be positioned parallel or perpendicular to the subframe members, depending on the peripheral allowance.

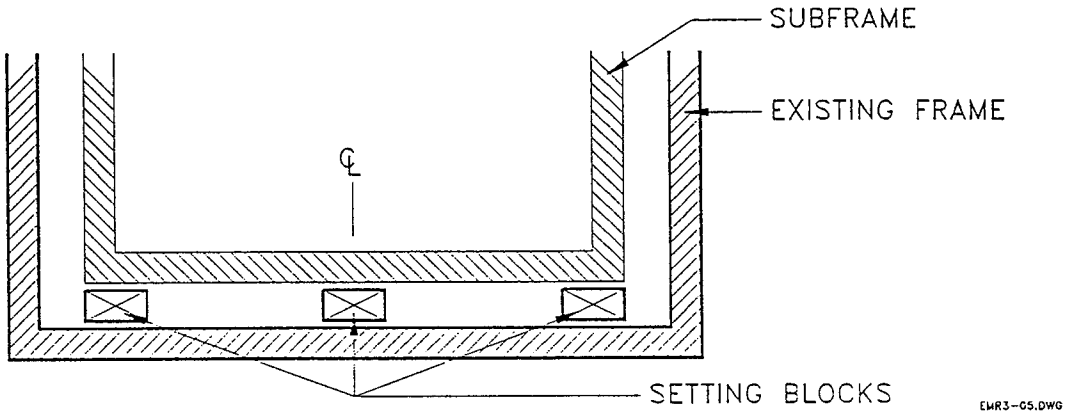




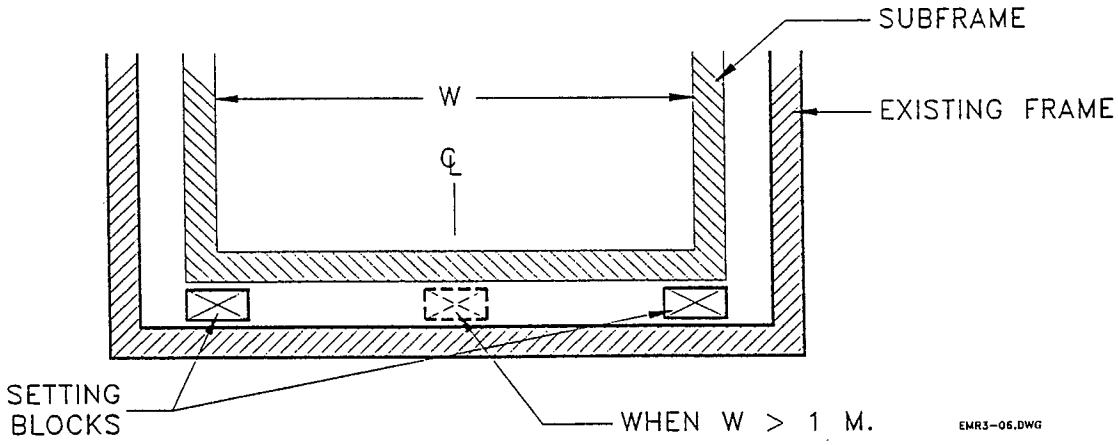
A) SETTING BLOCKS

The positioning of setting blocks depends on the type of replacement window. Ideally, the setting blocks are positioned where vertical loads will be transferred (window weight, or person leaning on the sill).

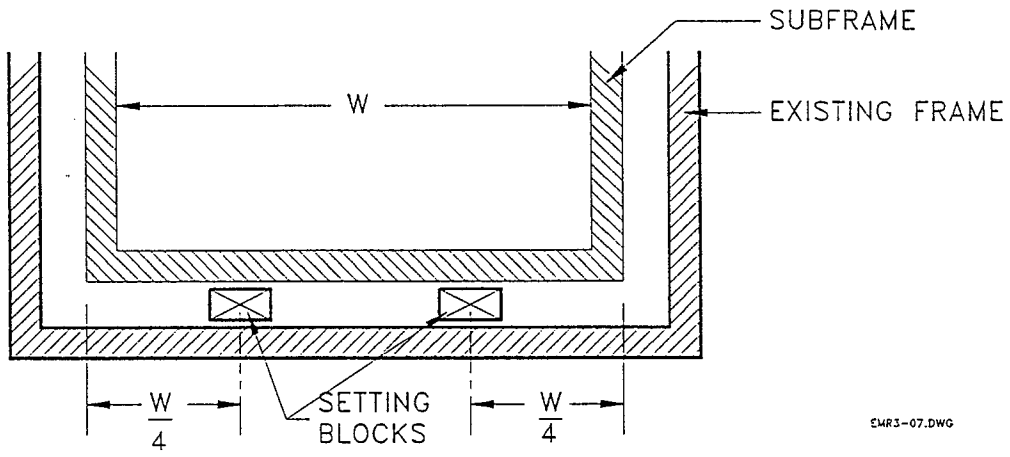
a) HORIZONTAL SLIDING WINDOW



b) VERTICAL SLIDING (DOUBLE HUNG), CASEMENT, AWNING AND TILT-TURN WINDOWS



c) FIXED WINDOW



NOTE:

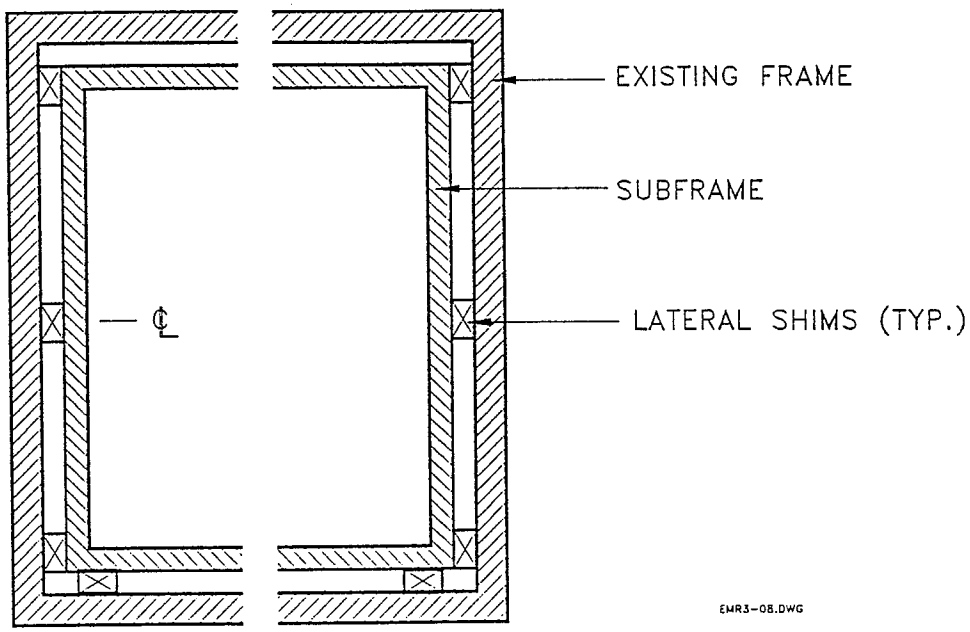
When the replacement window sill is pre-drilled in the shop, the setting blocks should be located beneath these holes.

B) LATERAL SHIMS

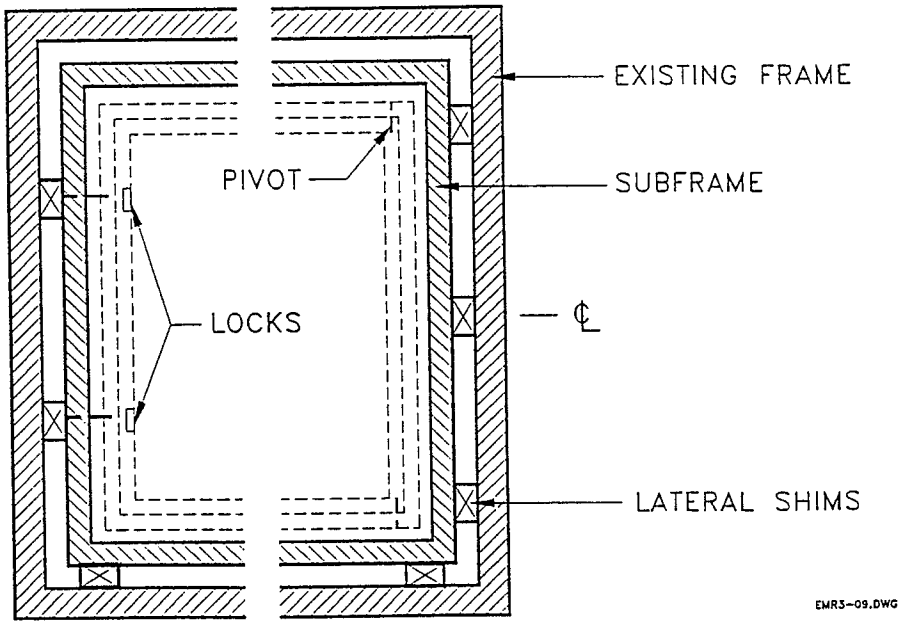
The locations of lateral shims depends on the rigidity of the subframe jambs, and the position of locking and moving elements of the replacement window. Lateral shims should be located in such a manner to minimize subframe movement relative of the existing frame, and to maintain rigidity and straightness of the subframe after it is fastened.

The following sketches show the locations and the minimum number of shims required according to window type.

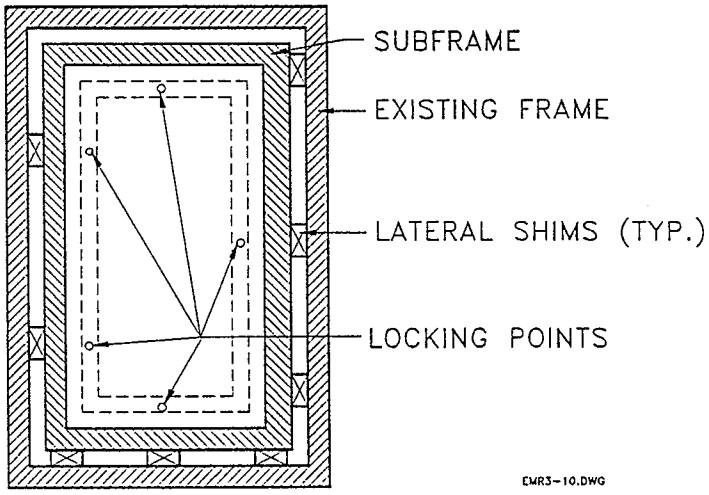
a) HORIZONTAL AND VERTICAL SLIDING WINDOWS



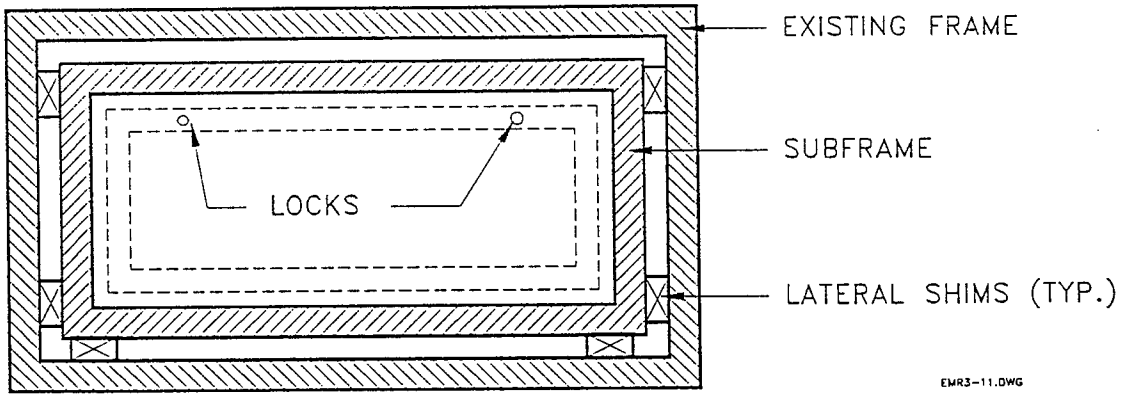
b) CASEMENT WINDOW



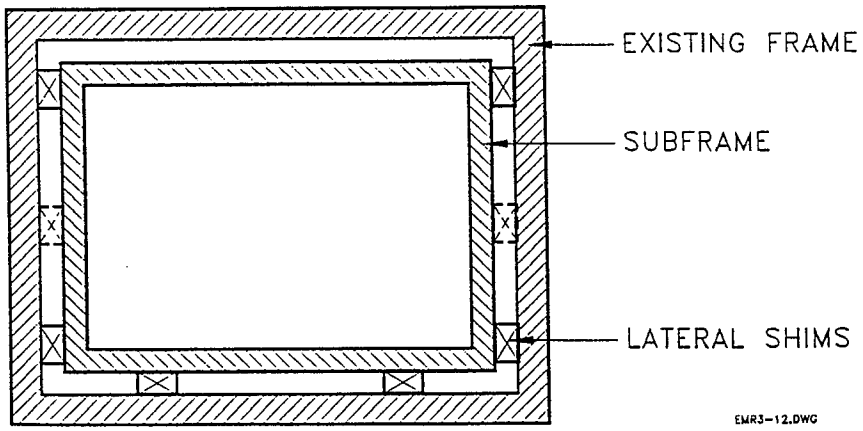
c) TILT-TURN WINDOW



d) AWNING WINDOW



e) FIXED WINDOW



NOTE:

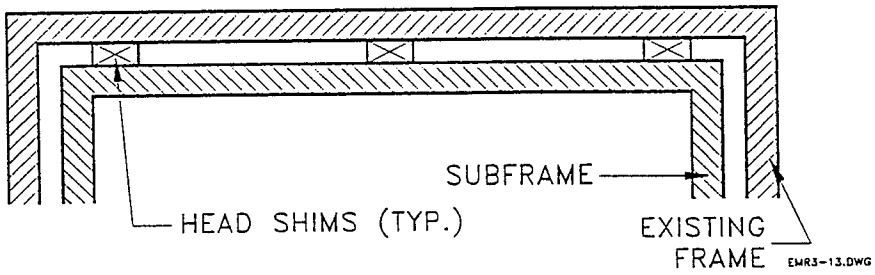
When replacement window jambs are pre-drilled in the shop, lateral shims should be aligned with these holes.

C) SHIMS ABOVE THE TOP SUBFRAME CROSS-MEMBERS (HEAD)

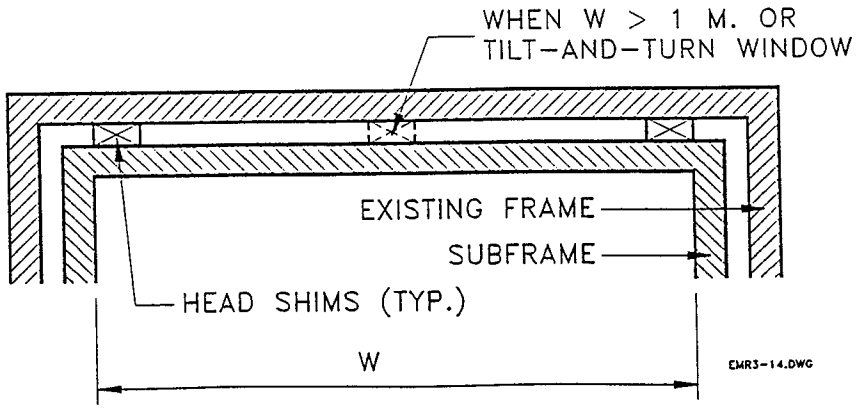
Locations of head shims depend on subframe member rigidity, location of locking devices and the fastening points of the replacement window. Head shims should be located in such a way to minimize subframe movement relative to the existing frame, and to maintain rigidity and straightness of the subframe after it has been fastened.

The following sketches show the locations and the minimum number of head shims to be used according to the window type.

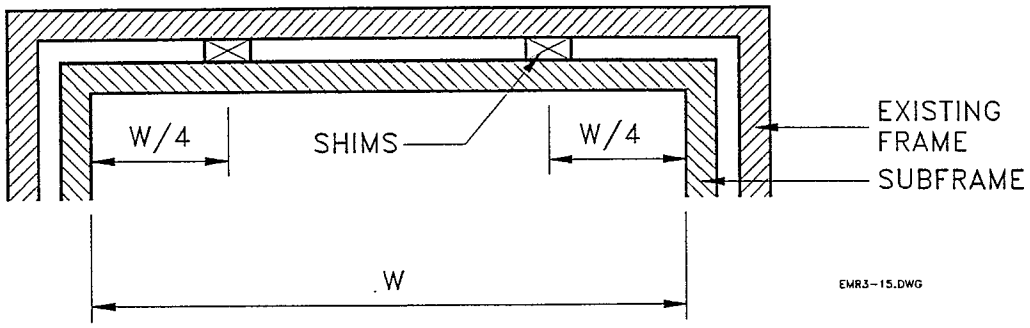
a) HORIZONTAL SLIDING WINDOW



b) VERTICAL SLIDING AND CASEMENT WINDOW



c) AWNING AND FIXED WINDOW



NOTE:

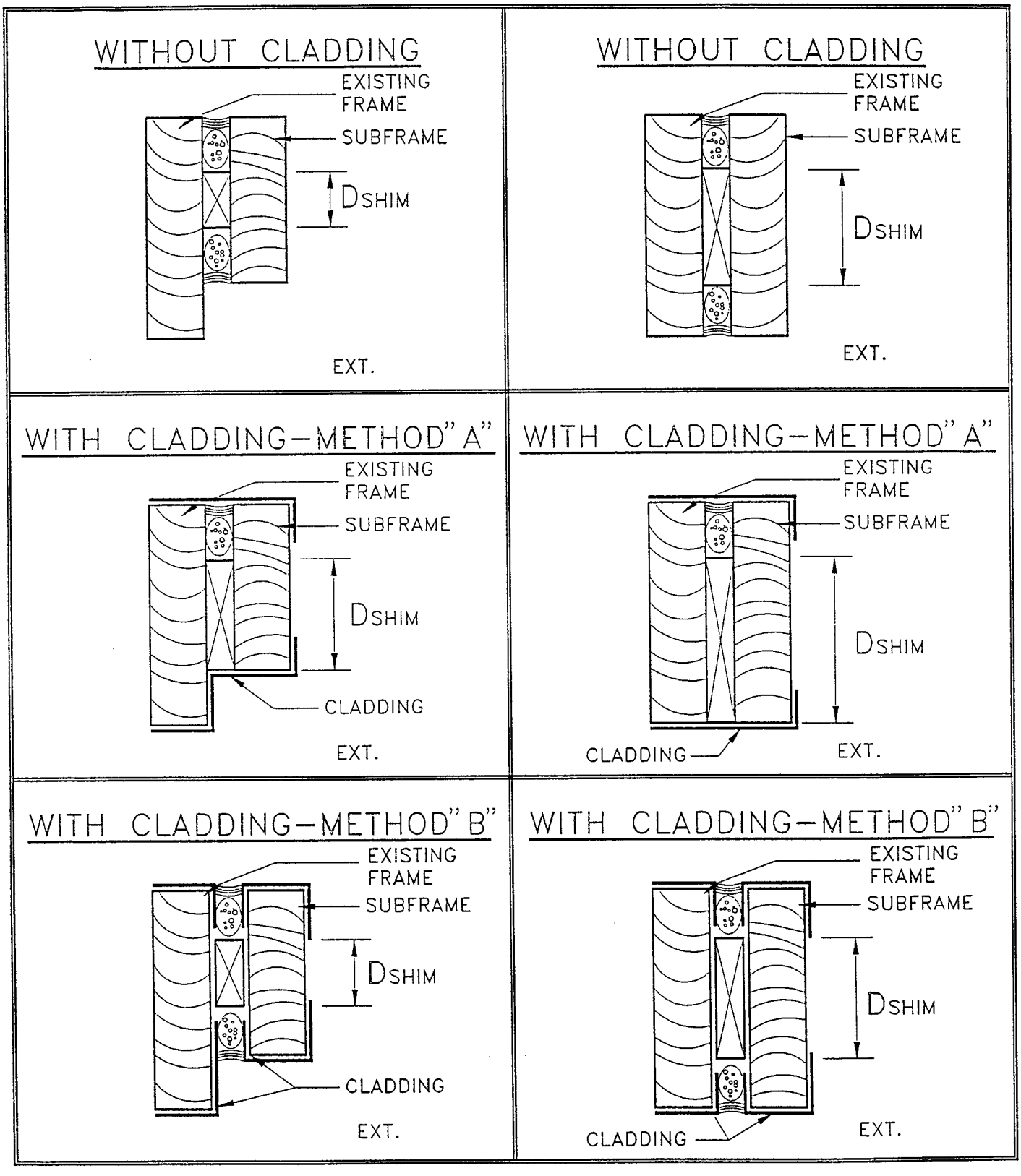
When the replacement window head is pre-drilled in the shop, head shims should be aligned with these holes.

3.4.2.2 DEPTH OF SHIMS

Depth of shims is based on the following considerations:

- whether or not the exposed exterior surfaces are clad;
- whether or not the exposed interior surfaces are clad;
- caulking of interior junction between the subframe and the existing frame, to provide air and watertightness.

Given the numerous cladding and caulking techniques, this section will be limited to showing the effect of these techniques on the depth of the shims.

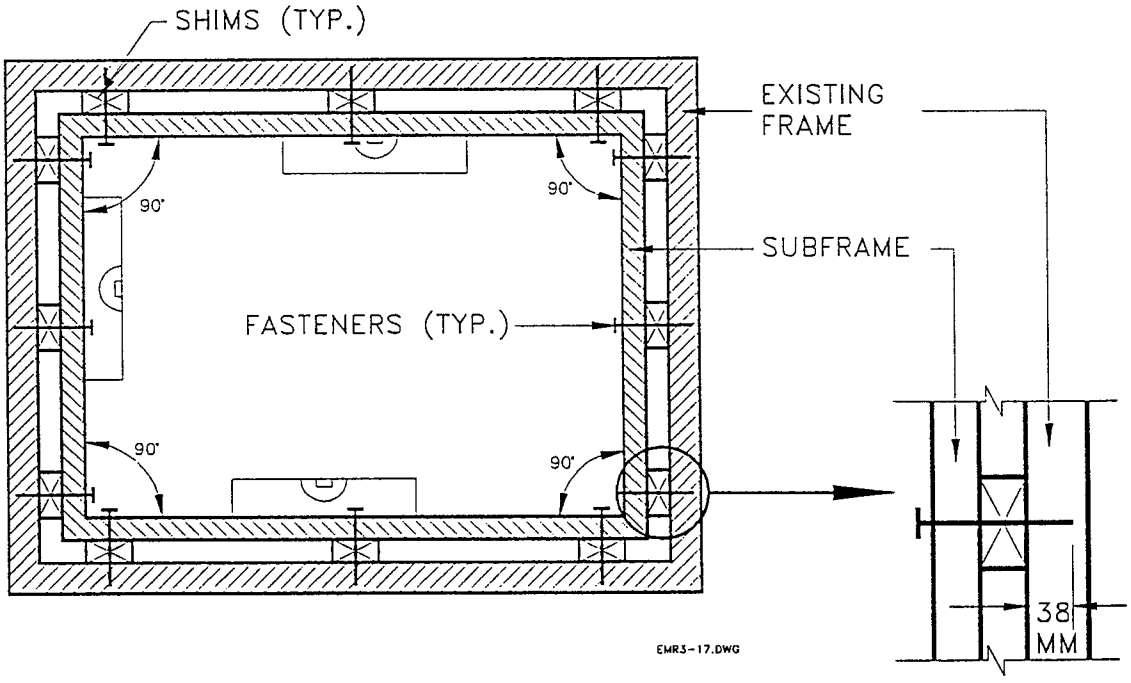


Method "A" required less caulking, but more cladding work.

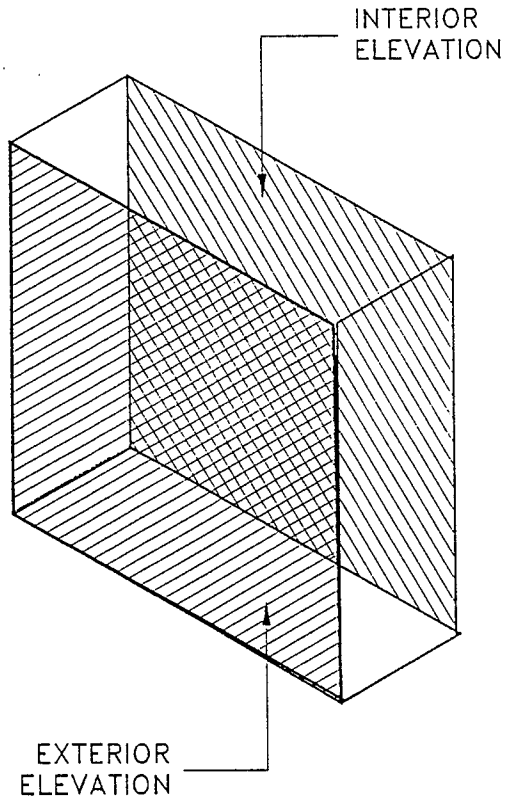
3.4.2.3 SUBFRAME ANCHORAGE

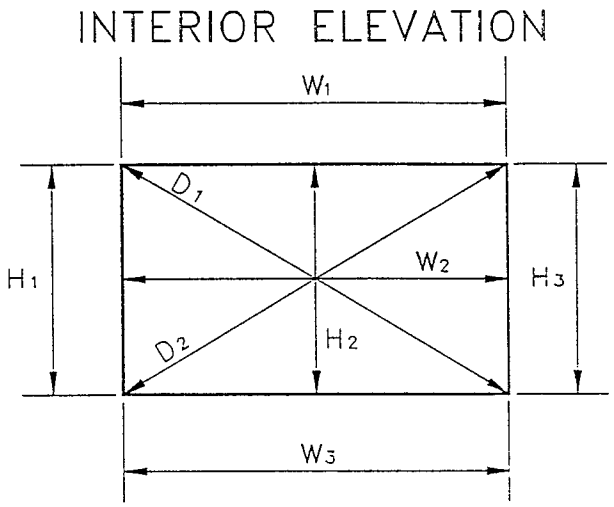
After having verified straightness and squareness of members and the vertical and horizontal offsets, the subframe may be fastened to the existing frame, using either nails or screws. The fasteners must penetrate the existing frame by at least 38 mm (1 1/2").

The following sketch illustrates subframe fastening for a horizontal sliding window.



Once the subframe is anchored, the applicable tolerances for the dimensions illustrated in the following sketch must conform to requirements of Table 1.





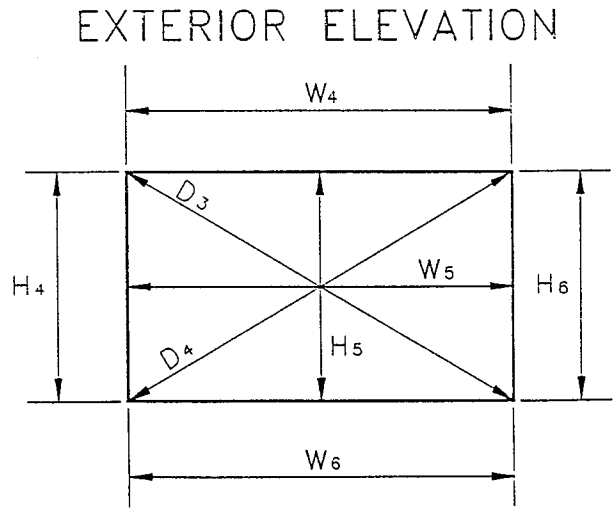


TABLE 1: DIMENSIONAL TOLERANCES APPLICABLE TO THE SUBFRAME

MEASURED DIFFERENCE	TOLERANCE (± mm)			
	MEASURED DISTANCE			
	1 m	2 m	3 m	4 m
$D_1 - D_2$	2	3	4	5
$D_3 - D_4$	2	3	4	5
$H_1 - H_2$	1	2	2	3
$H_1 - H_3$	1	1	1	1
$L_1 - L_2$	1	2	2	3
$L_1 - L_3$	1	1	1	1
$L_1 - L_4$	1	1	1	1
$L_1 - L_5$	1	2	2	3
$L_1 - L_6$	1	1	1	1
$H_4 - H_5$	1	2	2	3
$H_4 - H_6$	1	2	2	3
Vertical offset	2	3	4	4
Horizontal offset	2	2	3	3

3.4.2.4 OTHER STEPS

In the case where the next step consists of cladding the "subframe vs existing frame" assembly (method A), the following actions must be taken:

- Fill and pack the space between the subframe and the existing frame with mineral wool insulation, to reduce thermal losses.

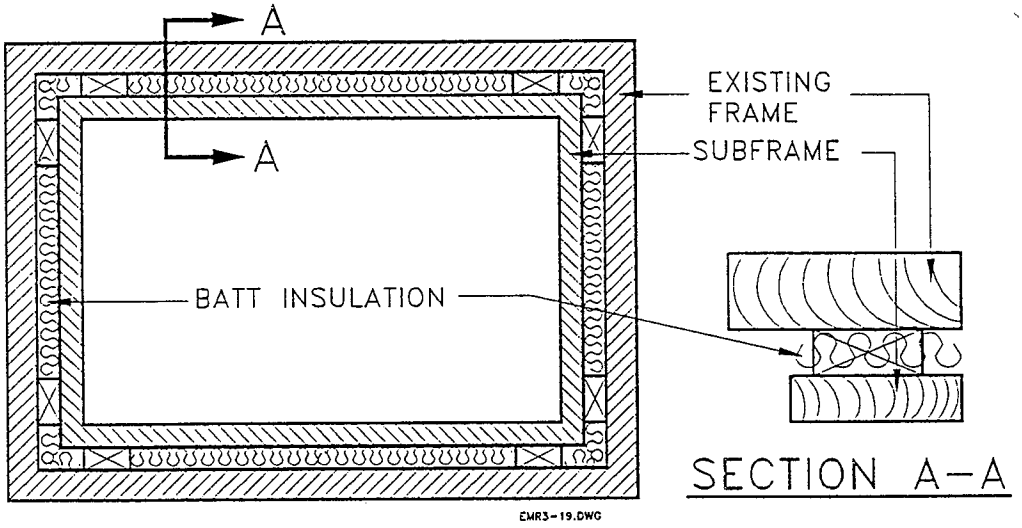
- Insert a backer rod on the interior side, ensuring a compression of approximately 30%. Caulk the junction with an appropriate sealant (see Chapter 8).

Note:

When the peripheral joint is too large (> 25 mm), use a self-adhesive elastomeric membrane, to ensure airtightness of the interior junction.

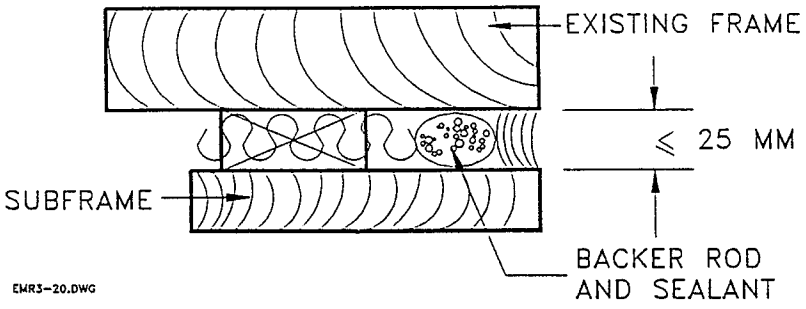
- Seal meeting edges of the subframe members. The following sketches illustrate these steps.

a) INSULATION OF SUBFRAME VS FRAME JUNCTION

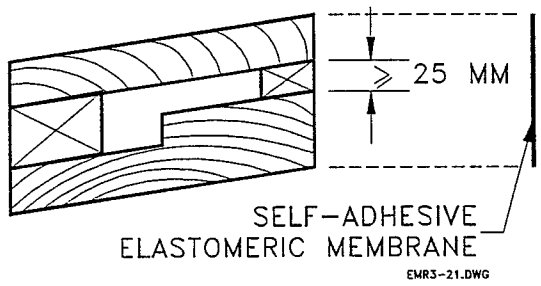


b) INTERIOR CAULKING

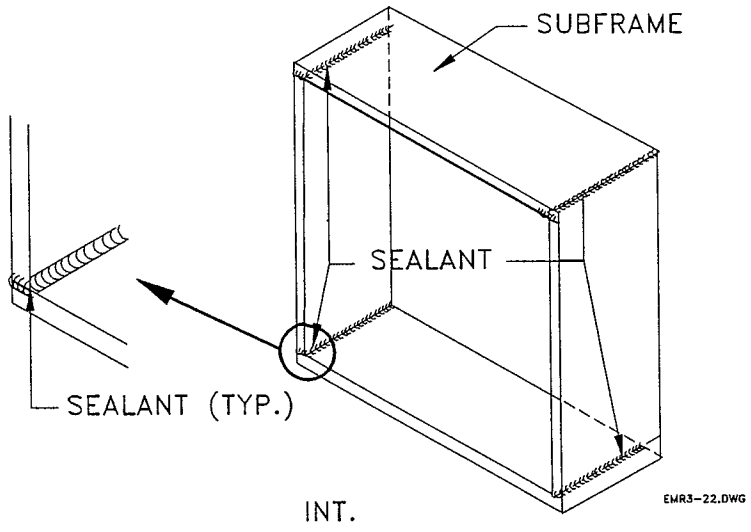
A) PERIPHERAL JOINT ≤ 25 mm



B) PERIPHERAL JOINT > 25 mm



c) CAULKING OF SUBFRAME MEMBERS MEETING EDGES



THE "SUBFRAME VS EXISTING FRAME" ASSEMBLY IS NOW READY FOR CLADDING OR FOR REPLACEMENT WINDOW INSTALLATION

CHAPTER 4

CLADDING OF EXISTING FRAME AND/OR SUBFRAME

4.1 INTRODUCTION

Generally, cladding is installed over frames (with or without a subframe) to reduce maintenance costs and/or improve the appearance of the opening.

Available materials for this purpose are:

- Prefinished aluminum sheets (anodized or shop painted)
- Prefinished aluminum extrusions (anodized or shop painted)
- PVC extrusions

The chosen material must meet the requirements of CAN/CSA A440-M90 Standard, for the intended application. The minimum allowable thicknesses are shown in the following Table.

MINIMUM THICKNESS OF CLADDING

MATERIAL	MINIMUM THICKNESS (mm)
Aluminum	
Extrusion	1.00
Sheet	0.55
Vinyl	
Extrusion	0.85
Film	?

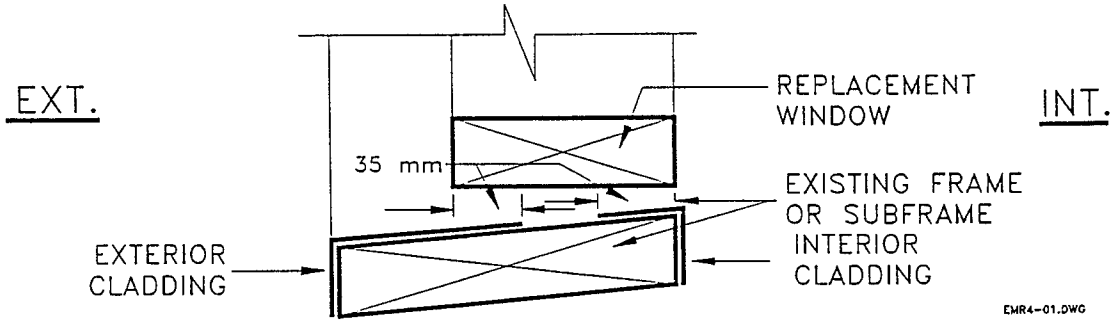
Exterior cladding material and assembly design must:

- Ensure watertightness (rain or run-off)
- Accommodate differential movements between the cladding material and the support material (or substrate).
- Blend in with the replacement window color to meet aesthetic requirements.
- Be easy to maintain.
- Avoid forming thermal bridges with the interior side of the opening.

On the other hand, the interior cladding material is only concerned with appearance and maintenance requirements.

4.2 PREPARATION

- Before installing the cladding, the old caulking between the existing window frame and the wall must be removed.
- Surfaces not to be covered by the cladding should be cleaned before cladding installation.
- Surfaces to be covered must be flat and edges straight.
- Support under exposed edges must be continuous.
- Exterior and interior cladding must extend so that the replacement window frame overlaps both sections by at least 35 mm.

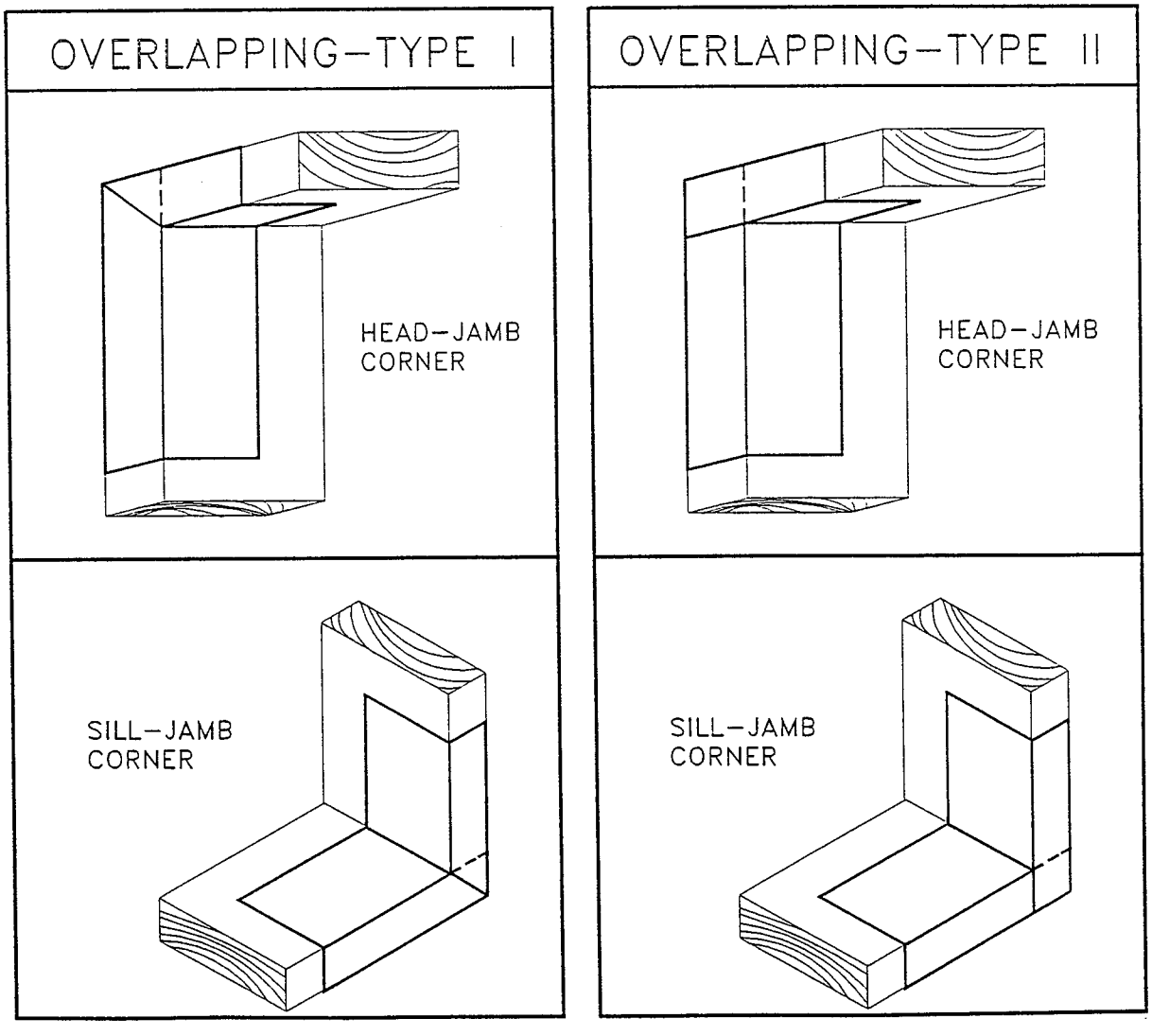


4.3 CLADDING OF EXISTING FRAME, WHEN WIDTH OF SILL, JAMBS AND HEAD ARE IDENTICAL

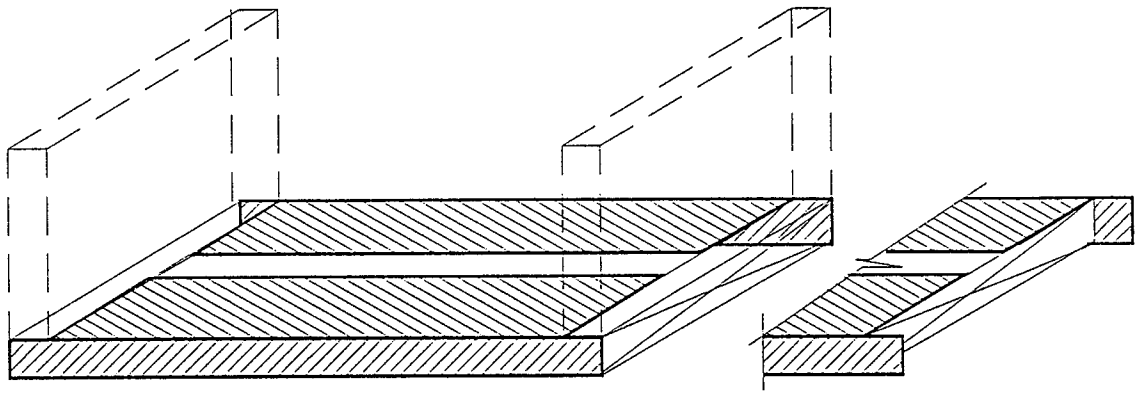
When installing interior and exterior cladding, it is important to follow the following sequence (see sketch).

1. Clad sill (support)
2. Clad jambs
3. Clad head

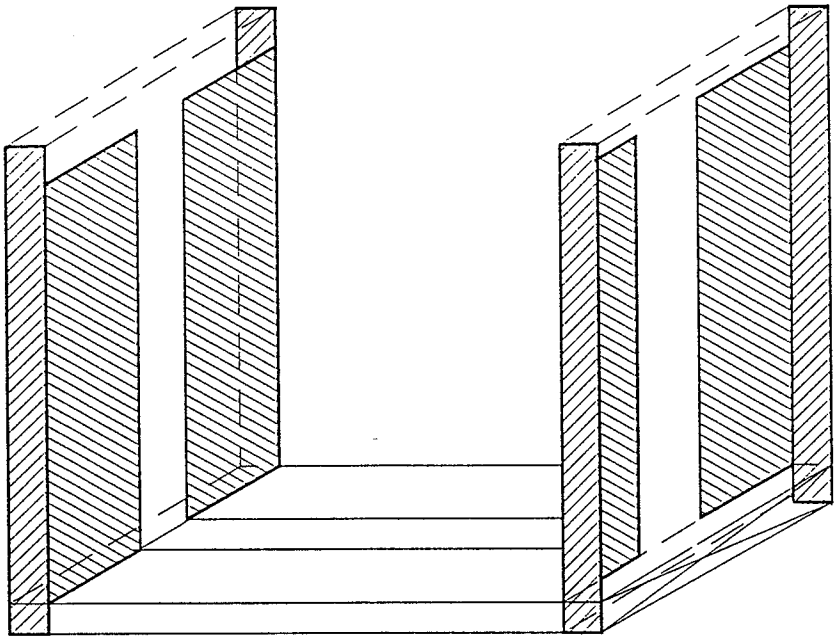
At the bottom and top corners of the exterior cladding, it is essential to avoid water infiltration. Two types of lap joints are acceptable. Both techniques are illustrated in the following sketches.



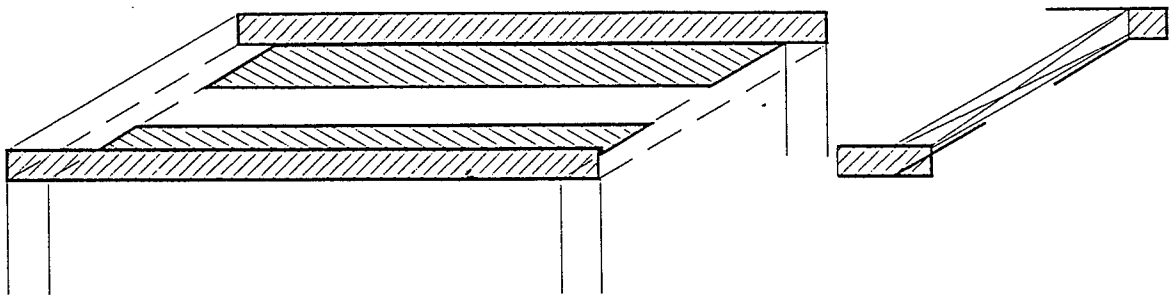
CLADDING OF EXISTING FRAME



(1) SILL CLADDING



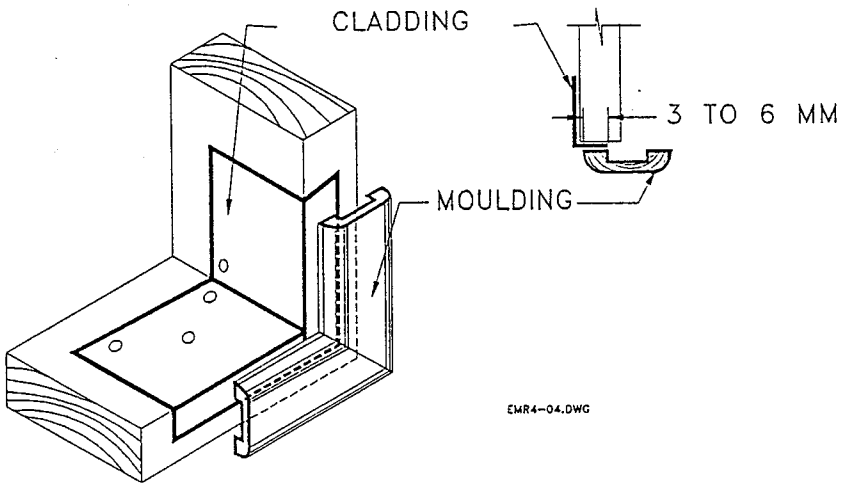
(2) JAMB CLADDING



(3) HEAD CLADDING

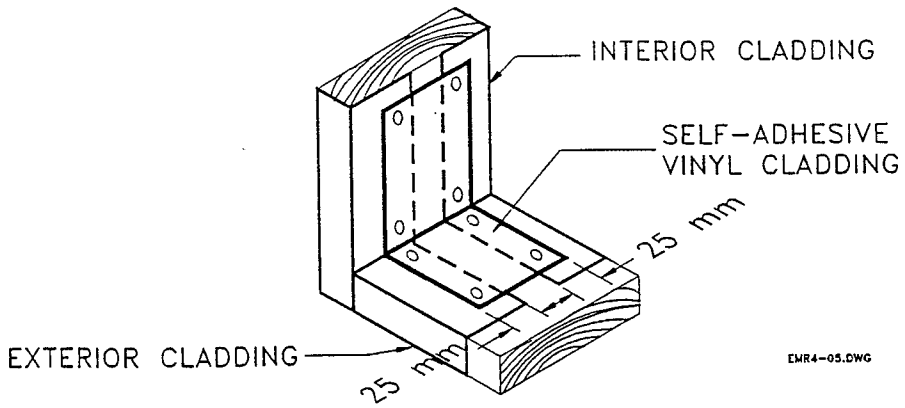
EMR4-03.DWG

- For interior cladding, slightly lift existing woodwork and slide the cladding behind it (lapping of 3 to 6 mm is sufficient). (See next sketch).



INTERIOR CLADDING - FINISHING

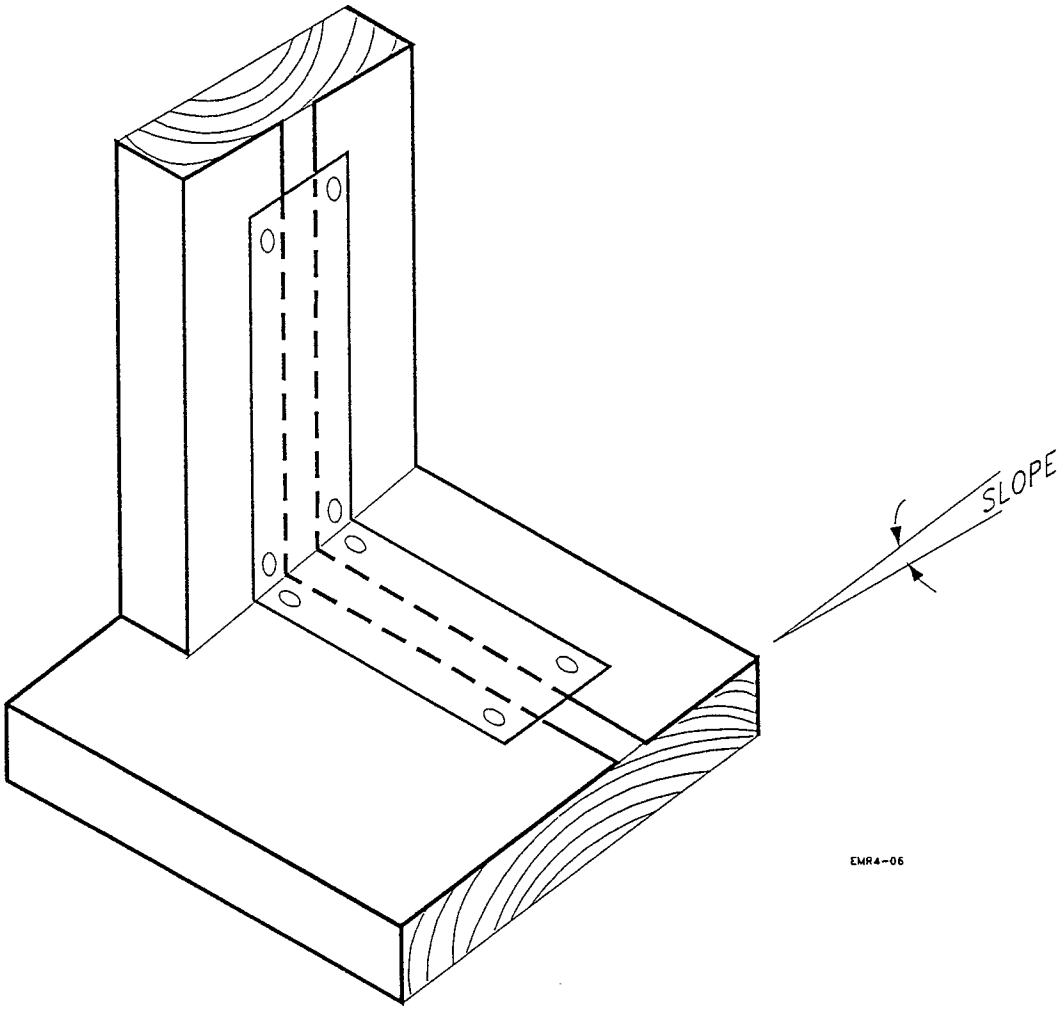
- Fasten the cladding strips at strategic locations to ensure proper securement and flat surfaces. Nails or staples must be of aluminum, galvanized or cadmium steel.
- Apply a self adhesive vinyl strip, making sure that interior and exterior cladding strips are covered by 25 mm (the vinyl strips should not be visible after the replacement window is installed).



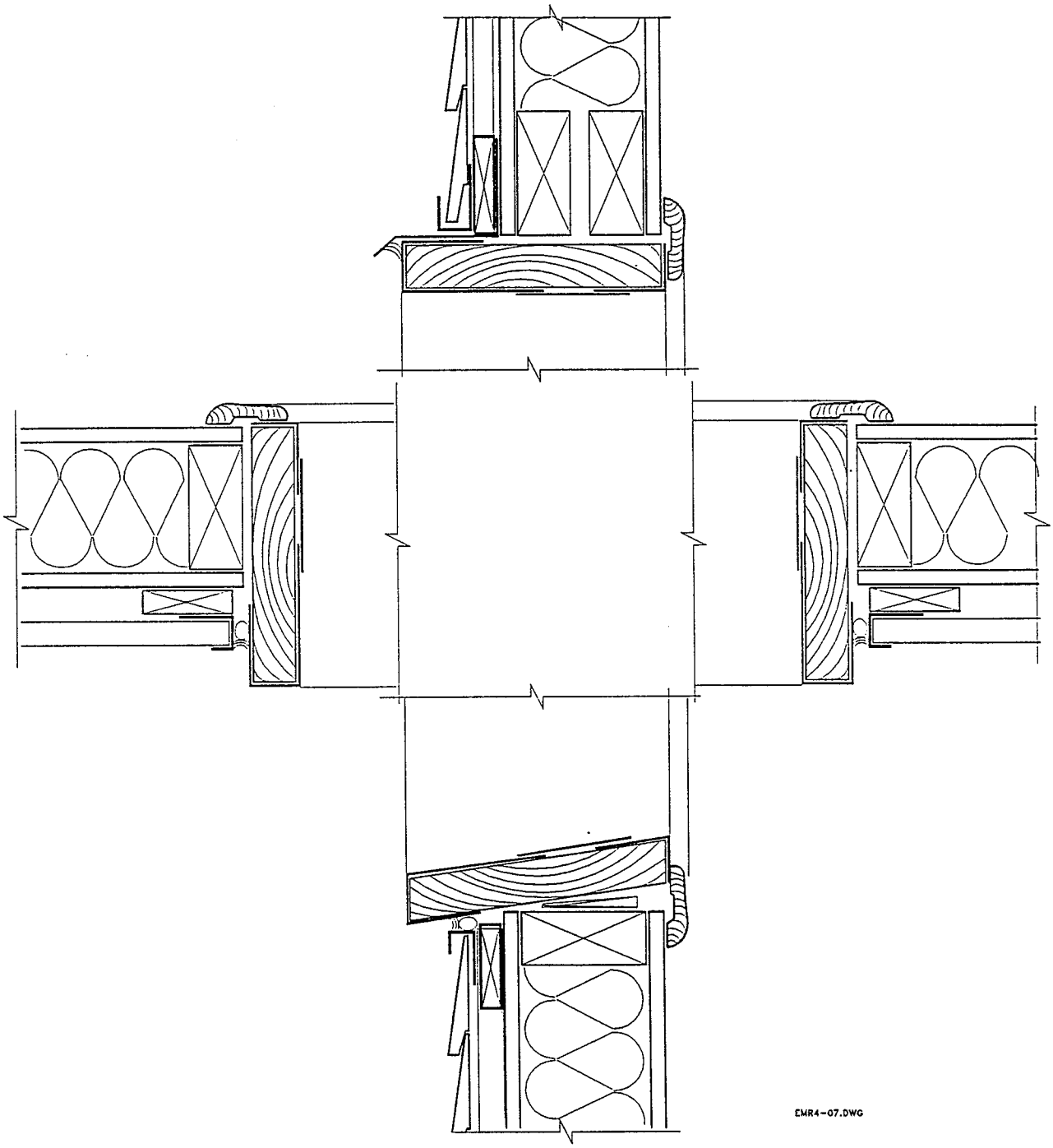
- The existing opening is then ready for caulking application at all corners and/or at perimeter of existing frame, at the junction with rough opening.

4.4 CLADDING OF EXISTING FRAME WITH PROTRUDING SILL\

With the exception of the exterior portion of the sill, the steps are identical to the previous section. The next sketch illustrates this condition.

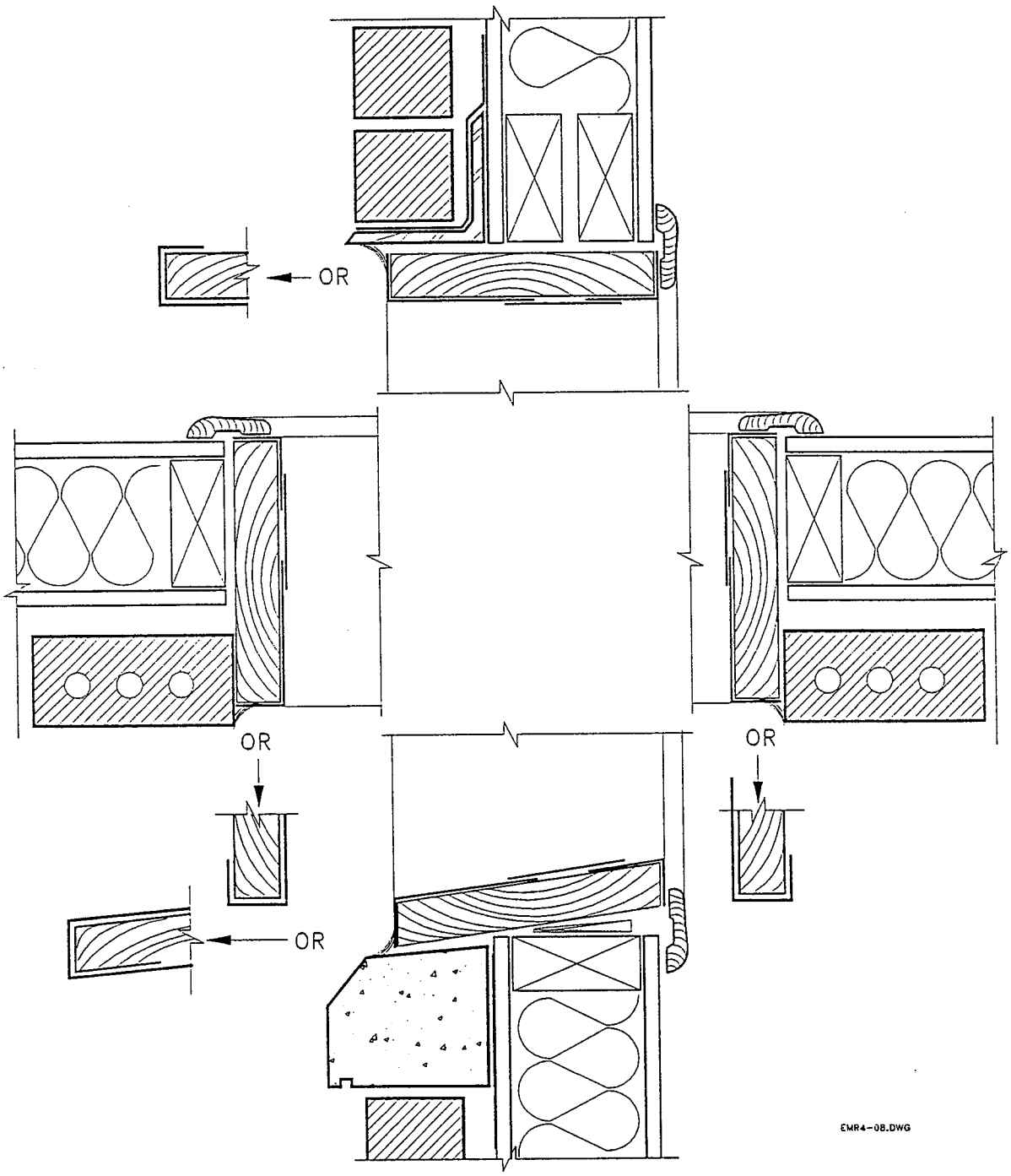


EXTERIOR CLADDING - LAP SIDING



THE SUBFRAME OR THE ROUGH OPENING IS READY FOR WINDOW INSTALLATION

EXTERIOR CLADDING - BRICK



THE SUBFRAME OR THE ROUGH OPENING IS READY FOR WINDOW INSTALLATION

CHAPTER 5

WINDOW INSTALLATION

5.1 INTRODUCTION

Before proceeding to describe, in detail, the installation of a window in a building envelope, it is imperative that the installer fully understands the various basic functions performed by the interface system between the window and the wall.

The "wall vs window" interface must perform the following functions:

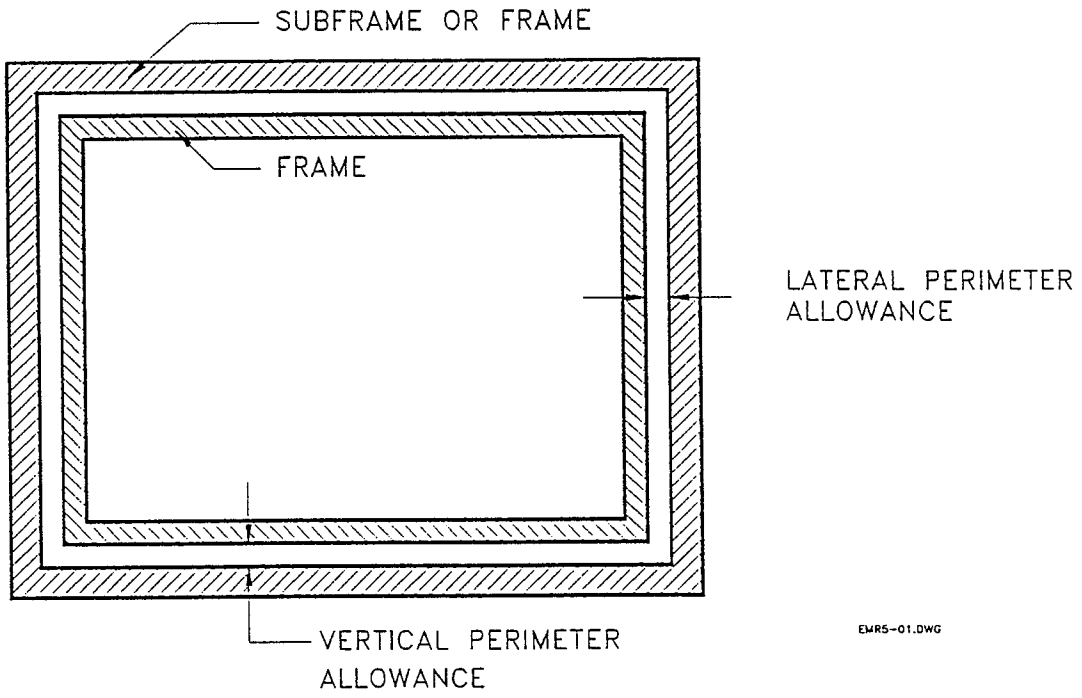
a) Ensure structural integrity of the window.
b) Ensure airtightness of the window's interior perimeter.
c) Ensure watertightness of the window's exterior perimeter.
d) Provide for continuity of thermal insulation between window and wall.
e) Limit vapour diffusion from interior side to the cavity.
f) Minimize superficial condensation on window's interior surfaces
g) Allow differential movements along the glazing plane between the window frame and the opening.
h) Maintain or improve the window's performance qualities (ex.: resistance to forced entry, air infiltration, resistance to wind loads, etc...).

5.2 SELECTION OF WINDOW SIZE

The size of replacement windows will be governed by the following parameters:

- Dimensions (height and width) of the opening (subframe)
- Window frame material (wood, PVC, aluminum)
- Type of caulking compound.

Establishing the exterior dimensions of the window frame must also take into account an allowance for the peripheral joint (chapter 3), which is governed by anchorage type and technique. A peripheral allowance is necessary to accommodate differential movements between the window and wall systems, and to allow the caulking product to stretch or compress without causing cohesive or adhesive failure.

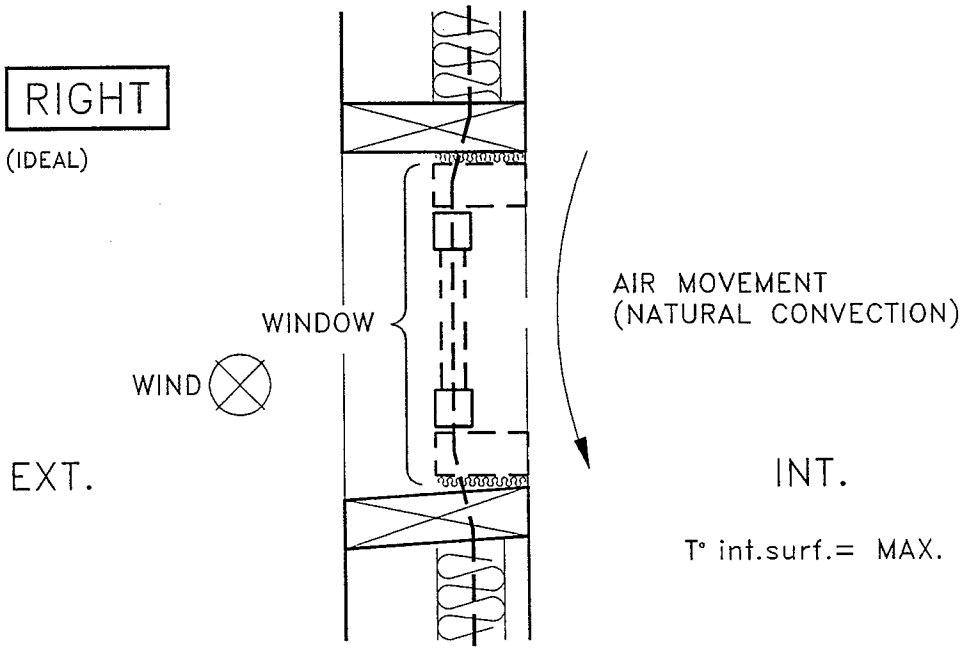


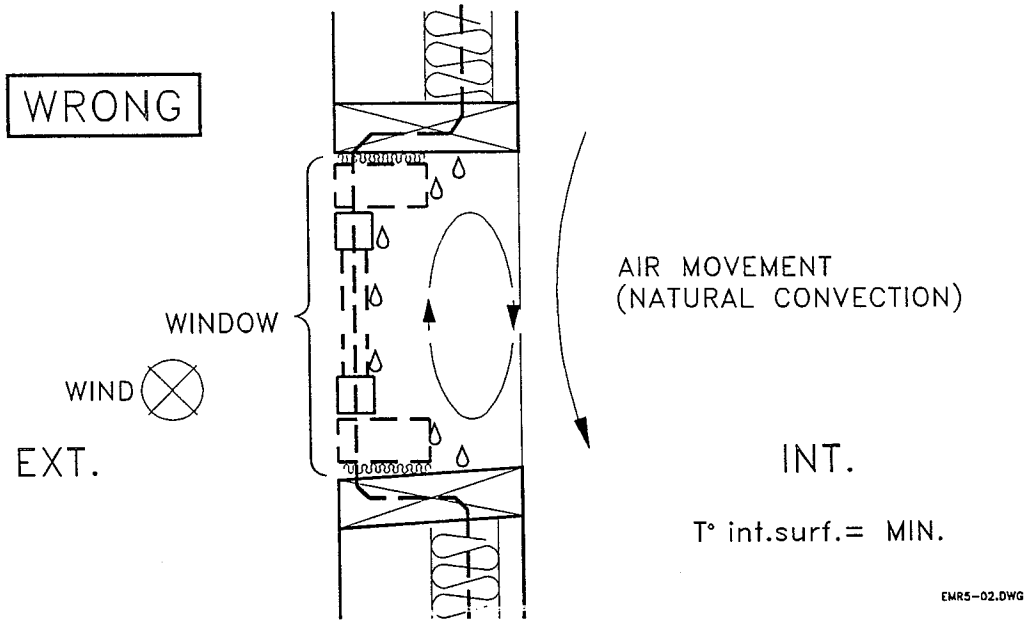
The peripheral joint provides a transition volume between the subframe and the window frame to ensure a proper interface between the two systems. The design of this interface is discussed in the following section.

5.3 POSITIONING OF THE WINDOW IN THE OPENING

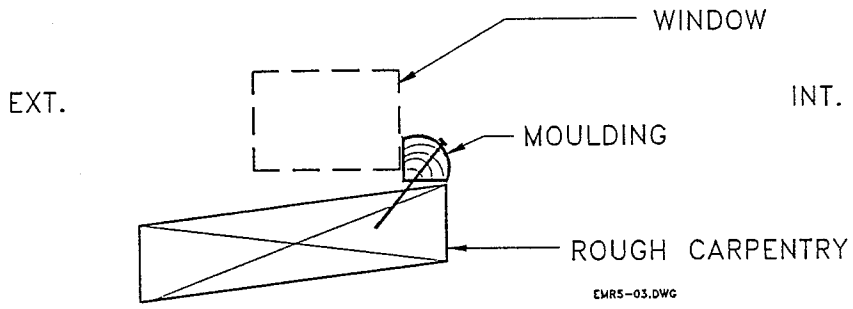
Ideally, the window should be installed as close as possible to the vertical plane of the interior finishes. This location provides improved resistance to surface condensation, and ensures that the thermal insulation within the adjacent walls reduce thermal heat loss in the window frame.

POSITIONING OF THE WINDOW IN WALL





The window frame may be moved slightly outward without significantly affecting the thermal performance of the window. However, this outward positioning should be kept to a strict minimum (ex. installation of finishing moulding).



5.4 WINDOW SHIMMING

Three types of shims are commonly used between the window and the subframe: setting blocks, lateral shims, and in some cases, head shims.

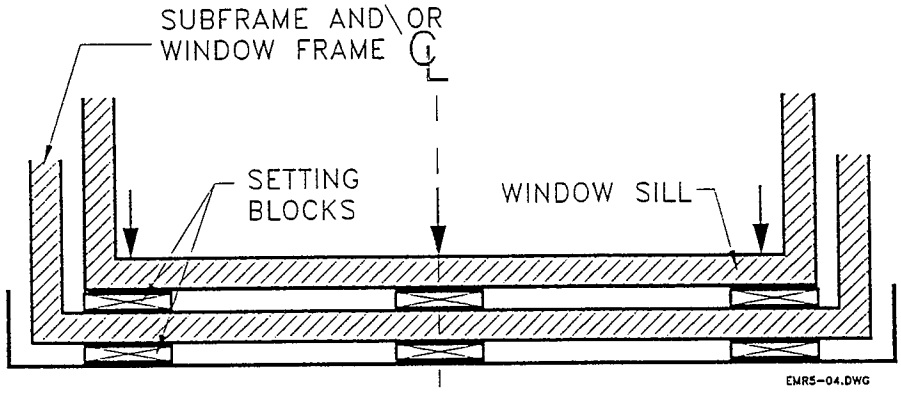
The location of these shims will depend on window type, frame material and location of fasteners.

Shim material should be hard enough to withstand the loads applied to the window throughout its service life; without permanent deformation, be a good thermal separator and permit fastening (window or subframe) through it.

5.4.1 SETTING BLOCKS

The lower cross-member of the window frame (sill) must remain horizontal when vertical loads are applied. These loads include the window's own dead weight and all other vertical loads that may be applied during the window's service life (ex.: person leaning on the sill). The number and location of the setting blocks are determined in such a manner so as to minimize the sill deformation when the loads are applied. Positioning of setting blocks should be identical to what was prescribed for the subframe (see section 3.4.2.1 A), page 26). These shims allow the sill to be installed level, and are sometimes used to anchor this member.

EXAMPLE: HORIZONTAL SLIDING WINDOW



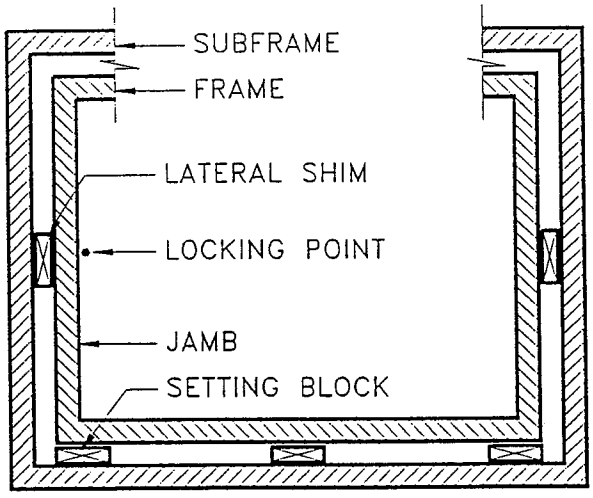
5.4.2 LATERAL SHIMS

Lateral shims are used to provide the following:

- Assure that jambs are vertical and straight at installation.
- Restraint against movement (relative to the sash) to maintain the window's resistance to forced entry and wind loads.
- Fastening of the window frame jambs to the subframe.

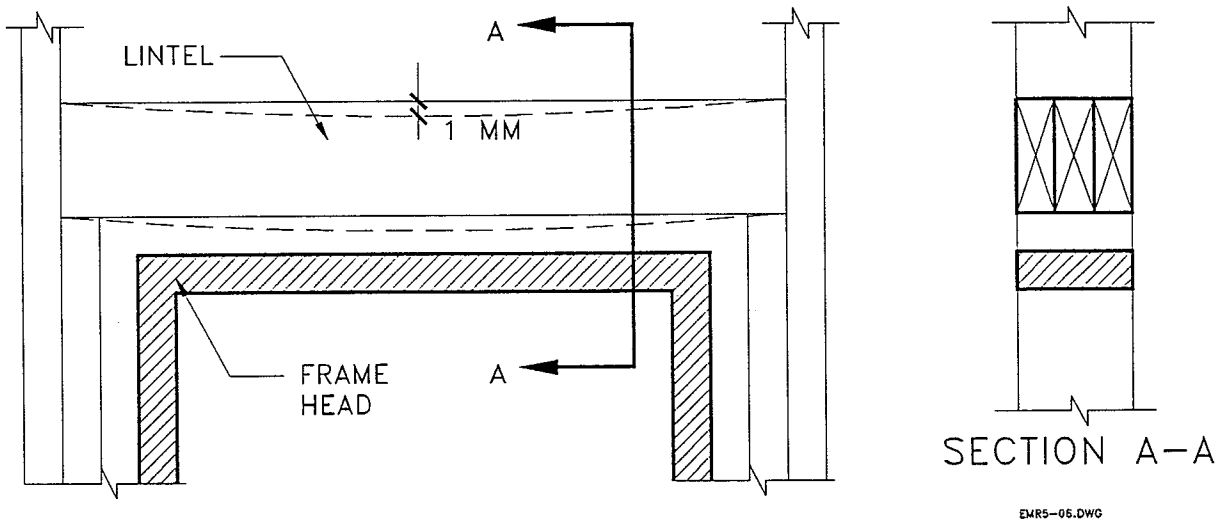
Note: Positioning of these shims must allow for differential movement between the window frame and the opening, without causing excessive stresses (ex.: rupture at corners).

EXAMPLE: HORIZONTAL SLIDING WINDOW

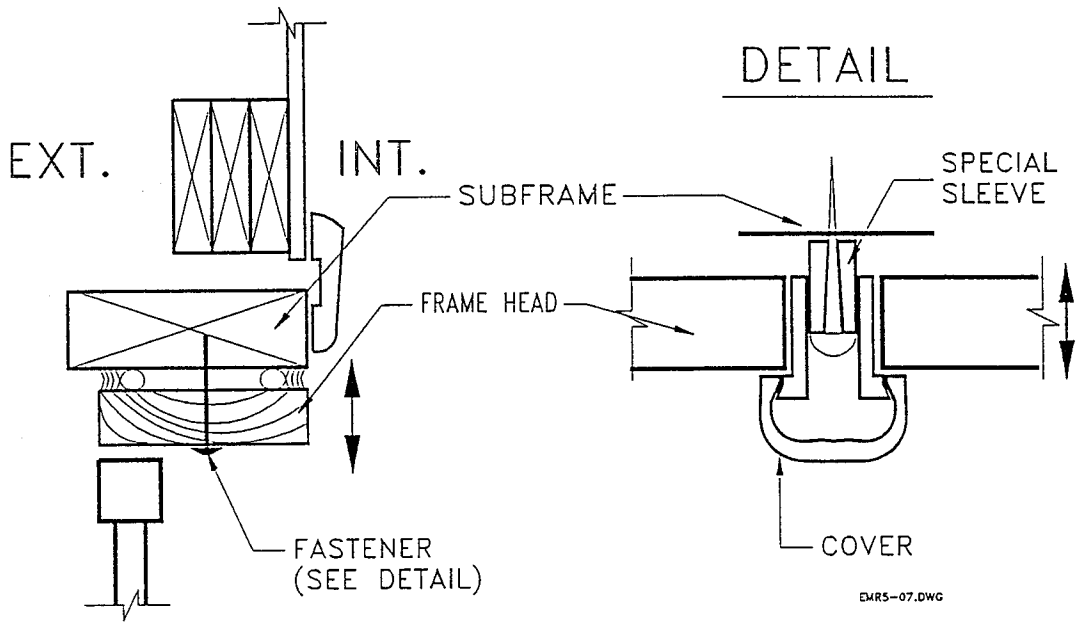


5.4.3 HEAD SHIMS

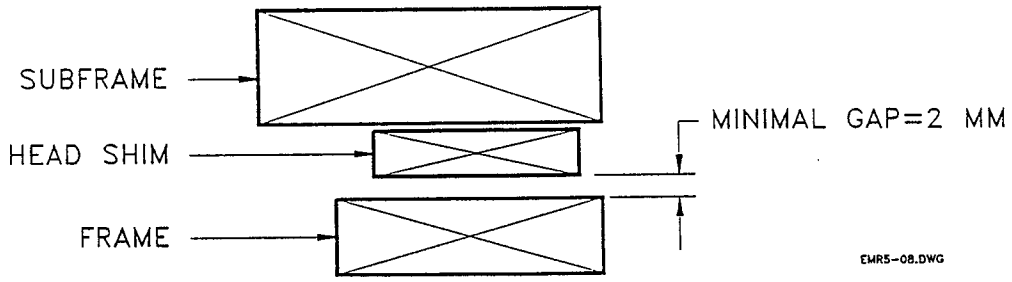
The window head is not normally designed to withstand vertical loads. Therefore, any transfer of downward vertical loads will result in bowing of the upper cross-member, possibly being transferred to the glazing and/or to the operable sash(es). Such load transfer will affect the ease of operation or may impose stresses on the glazing. Consequently, vertical loads from above the window should be transmitted to lintels or other structural elements which will deflect within acceptable limits ($\leq$ 1 mm).



In order to minimize the transfer of vertical loads from the lintel to the window head when a differential movement occurs (expansion or contraction), the caulking joint at the head must be easily compressible. This can be achieved by using a sealant with a low modulus of elasticity. The anchoring points at the window head should, as much as possible, permit vertical movement of the upper cross member, while keeping to a minimum the vertical load transmitted to the window head (see design on next sketch, not available at this time).



However, for large spans where the rigidity against torsion of the member vs sealant junction is low, it may be possible to insert a head shim to limit rotation of the frame head. It is important in any case to provide an allowance of 2 mm between the shim and any of the adjacent frame members. With the exception of the above noted case and where the resistance to forced entry may be affected, head shims should be avoided between the window frame and the subframe (or wall frame).



5.5 ANCHORING OF WINDOW FRAME

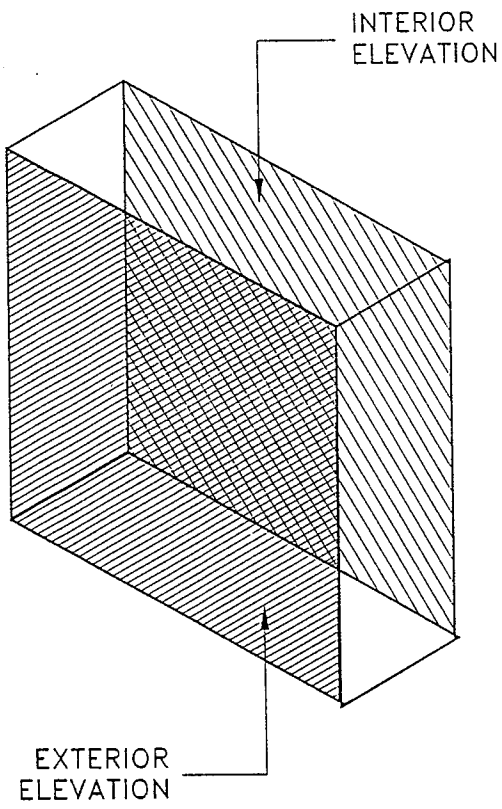
.1 DESIGN

The anchoring system must:

- Allow for transfer of wind loads (positive or negative) to the subframe or wall frame.
- Resist structural stress without permanent deformation and without affecting weathertightness at the "window vs subframe" interface.
- Allow for differential movement (expansion or contraction) of window frame with regards to the subframe in the glazing plane, without affecting the weathertighness at the "window vs subframe " interface, without deforming or damaging components, and without affecting window performance (ex. air infiltration, resistance to water penetration, ease of operation, etc.).
- Maintain resistance to forced entry of original product.

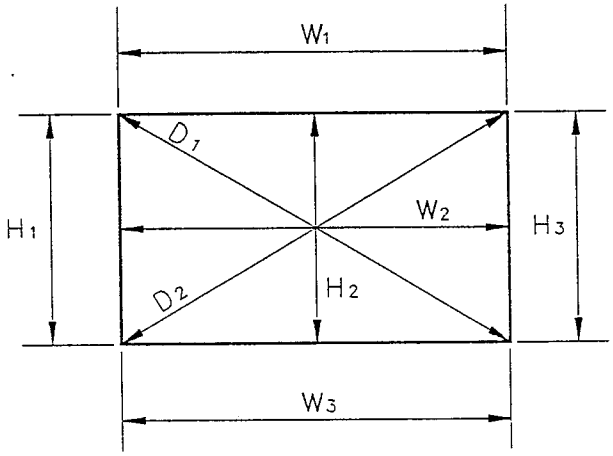
Note:

After anchoring the window frame, the applicable tolerances for the various opening dimensions given in the following sketch must conform to the limits provided in Table 2.



EMR5-09.DWG

INTERIOR ELEVATION



EXTERIOR ELEVATION

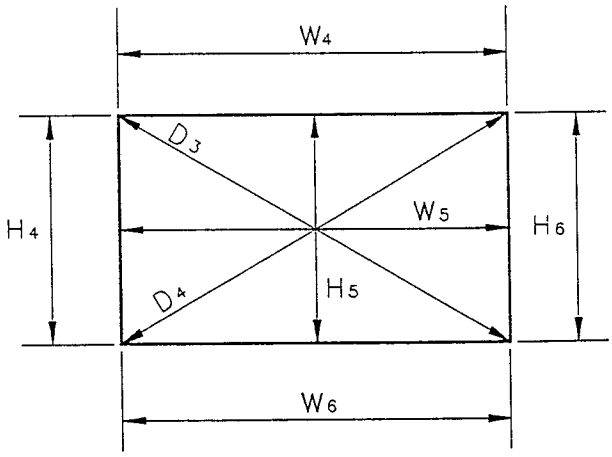


TABLE 2: APPLICABLE TOLERANCES OF WINDOW FRAME DIMENSIONS

MEASURED DIFFERENCE	TOLERANCE (± mm)			
	MEASURED DISTANCE			
	1 m	2 m	3 m	4 m
$D_1 - D_2$	2	3	3	4
$D_3 - D_4$	2	3	3	4
$H_1 - H_2$	1	1	2	2
$H_1 - H_3$	1	1	1	1
$L_1 - L_2$	1	1	2	2
$L_1 - L_3$	1	1	1	1
$L_4 - L_5$	1	1	2	2
$L_4 - L_6$	1	1	1	1
$H_4 - H_5$	1	1	2	2
$H_4 - H_6$	1	1	1	1
Vertical offset	2	2	3	3
Horizontal offset	1	2	2	3

Except for specific cases, fasteners should be located:

- in proximity to axis of rotation;
- close to locking points (locks, stoppers, etc.);
- through the frame's setting blocks;
- at even spaces along the jambs (B), providing that the specified minimum distance (A) from extremities are respected;
- at frame head when necessary.

.2 ALLOWANCE FOR DIFFERENTIAL MOVEMENTS

In order to minimize differential movement of the window frame relative to the subframe, it is necessary to locate a reference anchoring point (point "R"), relative to which all anchoring points allow for movement. This reference point ("R") usually is located at the mid-point of the window sill except for casement and tilt-turn windows. In order to ensure proper securement of the reference anchor, it should have a rigidity equal to double that of the other anchors. This may be achieved by driving in two screws at point "R" and only one at the other points, or by installing at point "R" one screw that is twice as rigid as the screws used at the other points. The double-headed arrows in the following sketches indicate the differential movement axis relative to point "R".

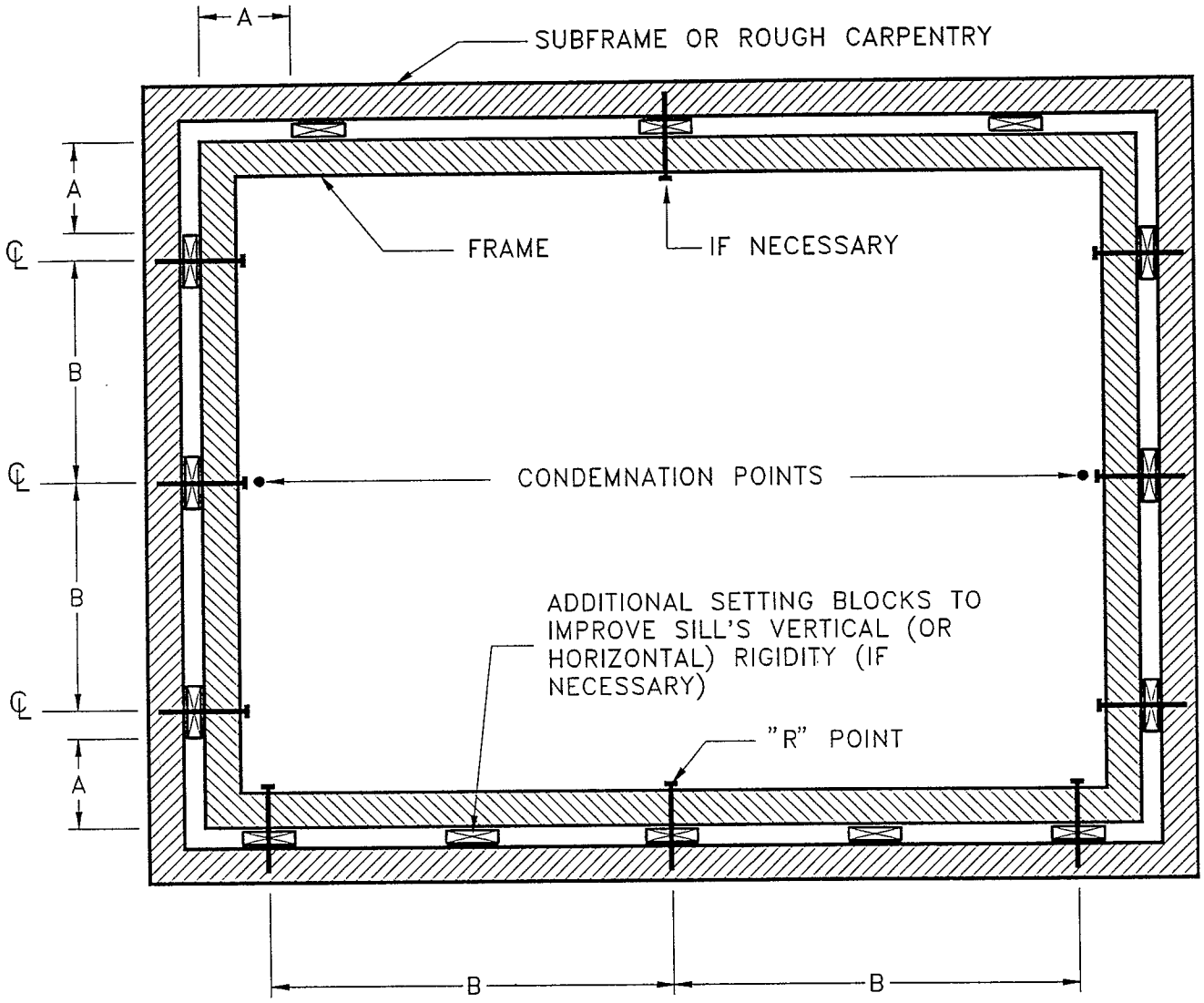
In order to provide for differential movement within the window plane, without causing excessive stress at frame corners, lateral and head shims should be located at a minimum distance (A) from the exterior corner of the window frame. This minimum distance will vary depending on the thermal expansion coefficient of the framing material. Materials with a higher coefficient thermal expansion will require a greater distance "A". In addition, when the frame is dark-coloured, add 20 mm to account for higher solar absorption and the increased expansion.

The distance between sill and jambs anchors must ensure that members remain straight under loading (wind, forced entry, person leaning). Thus distance "B" will depend on member rigidity.

The following sketches indicate shims and anchors location according to window type. Dimensions "A" and "B" are representative of normal size window (height $\leq$ 1.6 m, width $\leq$ 1.6 m). For larger windows, consult with window manufacturer.

ANCHORING

SLIDING WINDOW



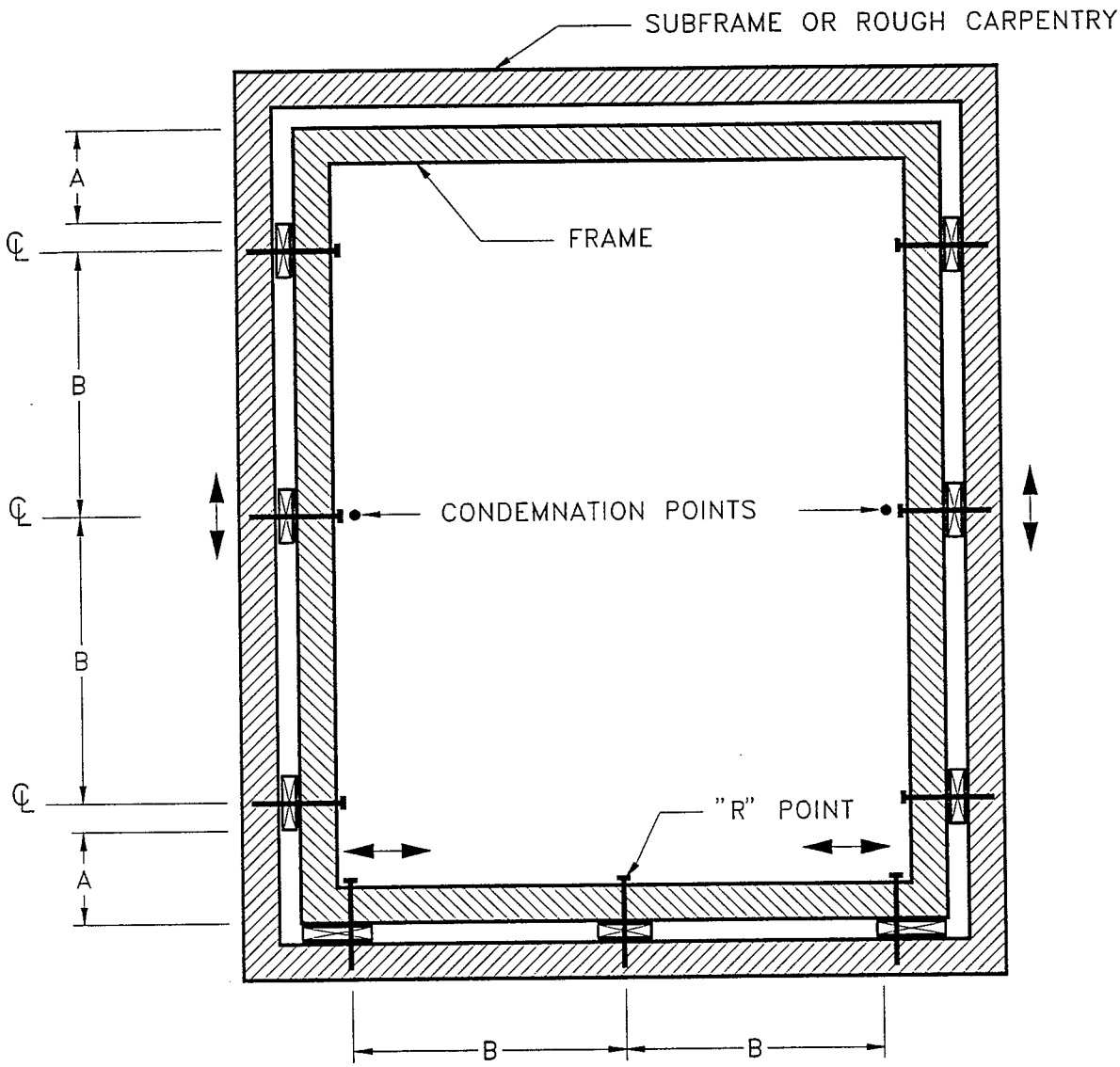
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-10.DWG

ANCHORING

VERTICAL SLIDING WINDOW

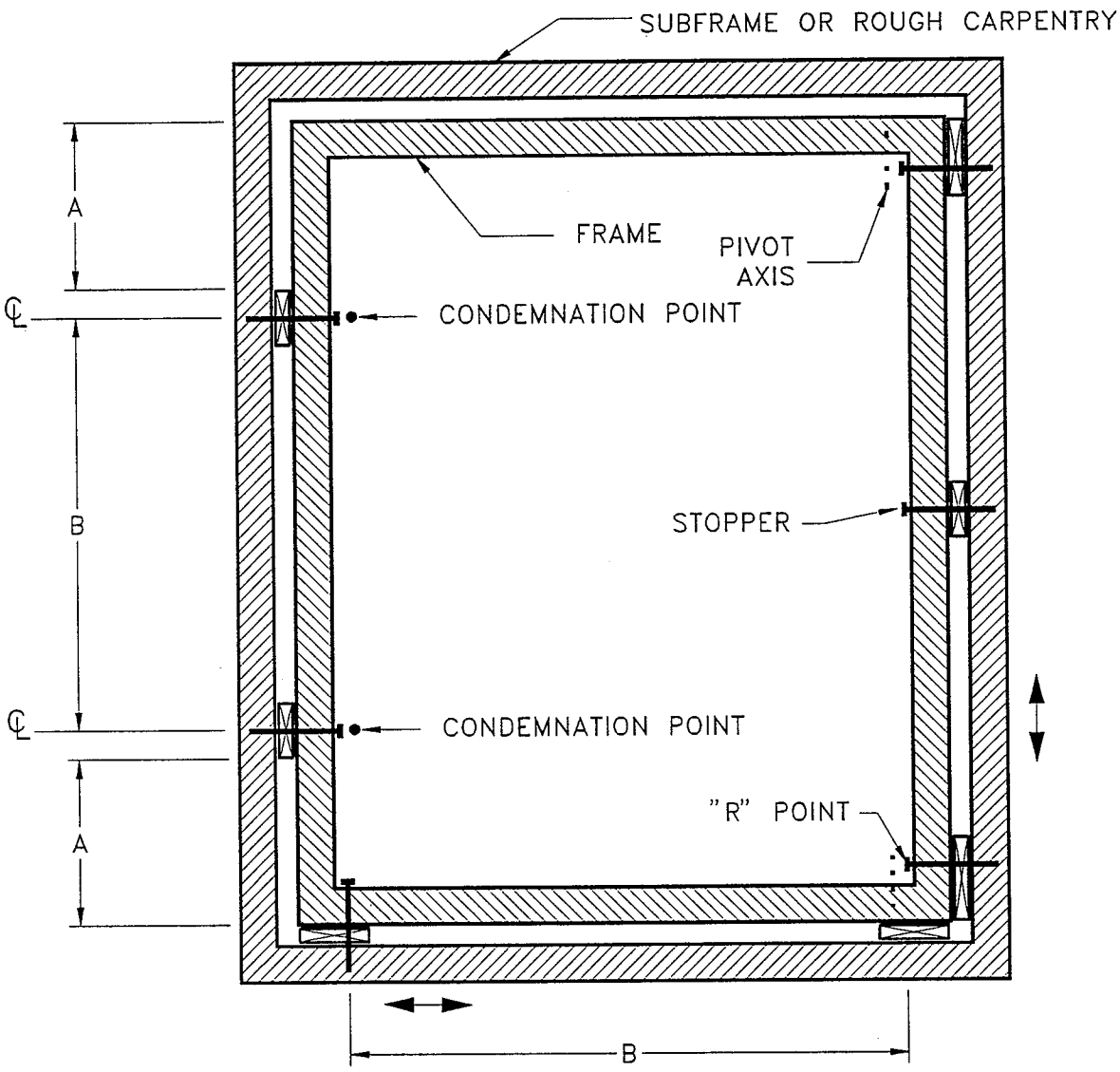


FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-11.DWG

ANCHORING
CASEMENT WINDOW

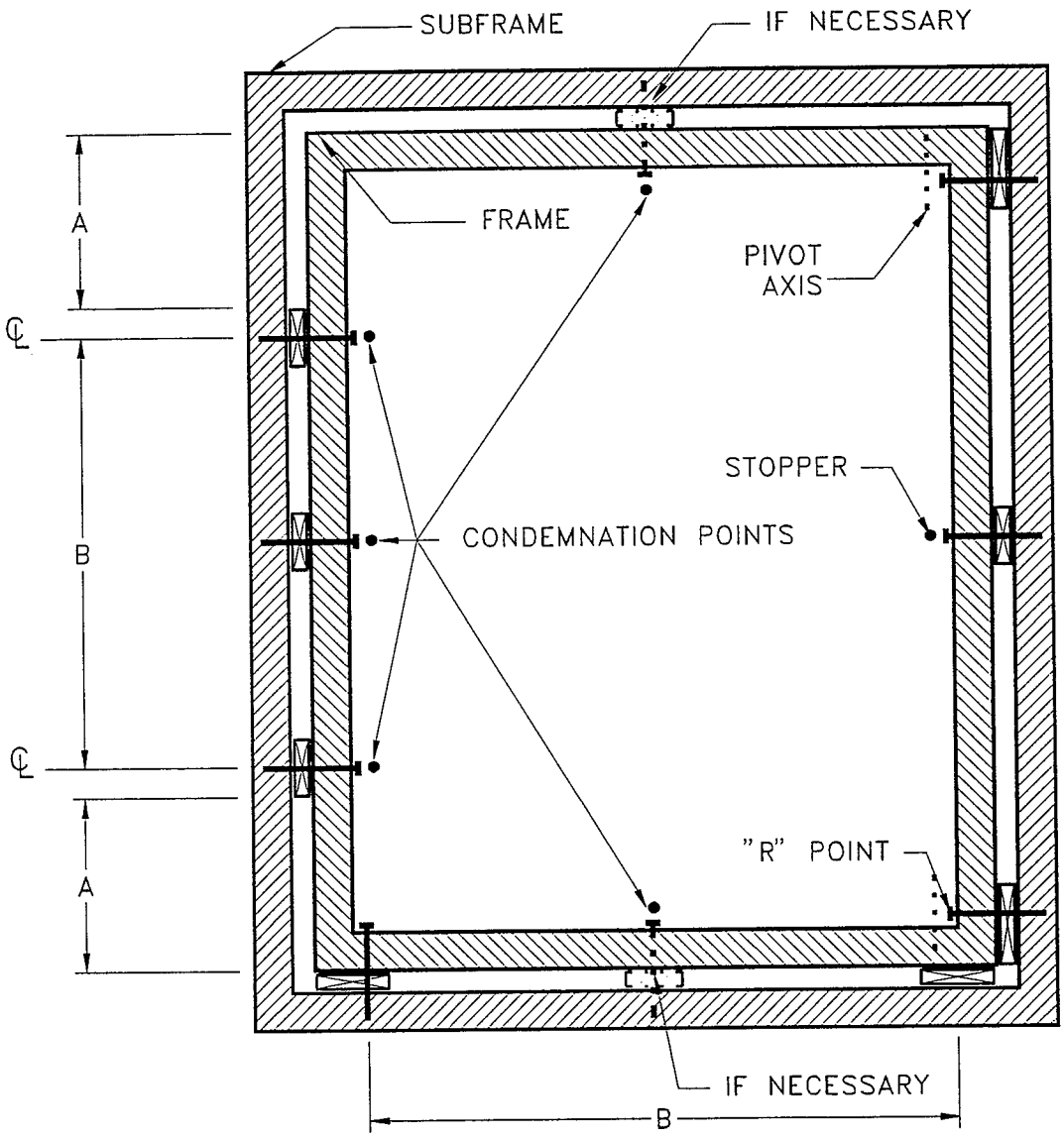


FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-12.DWG

ANCHORING
TILT–AND–TURN WINDOW



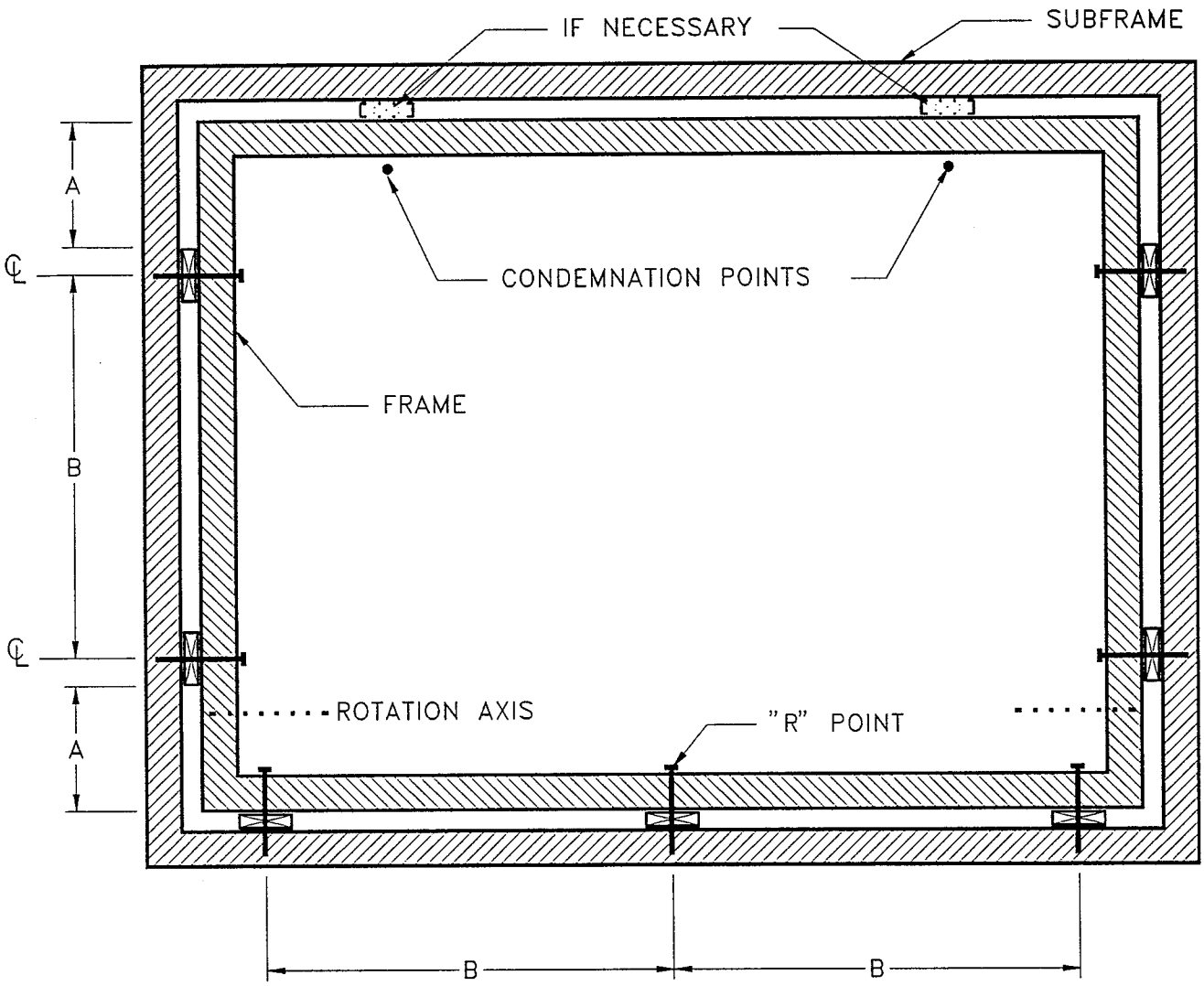
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5–13.DWG

ANCHORING

AWNING WINDOW



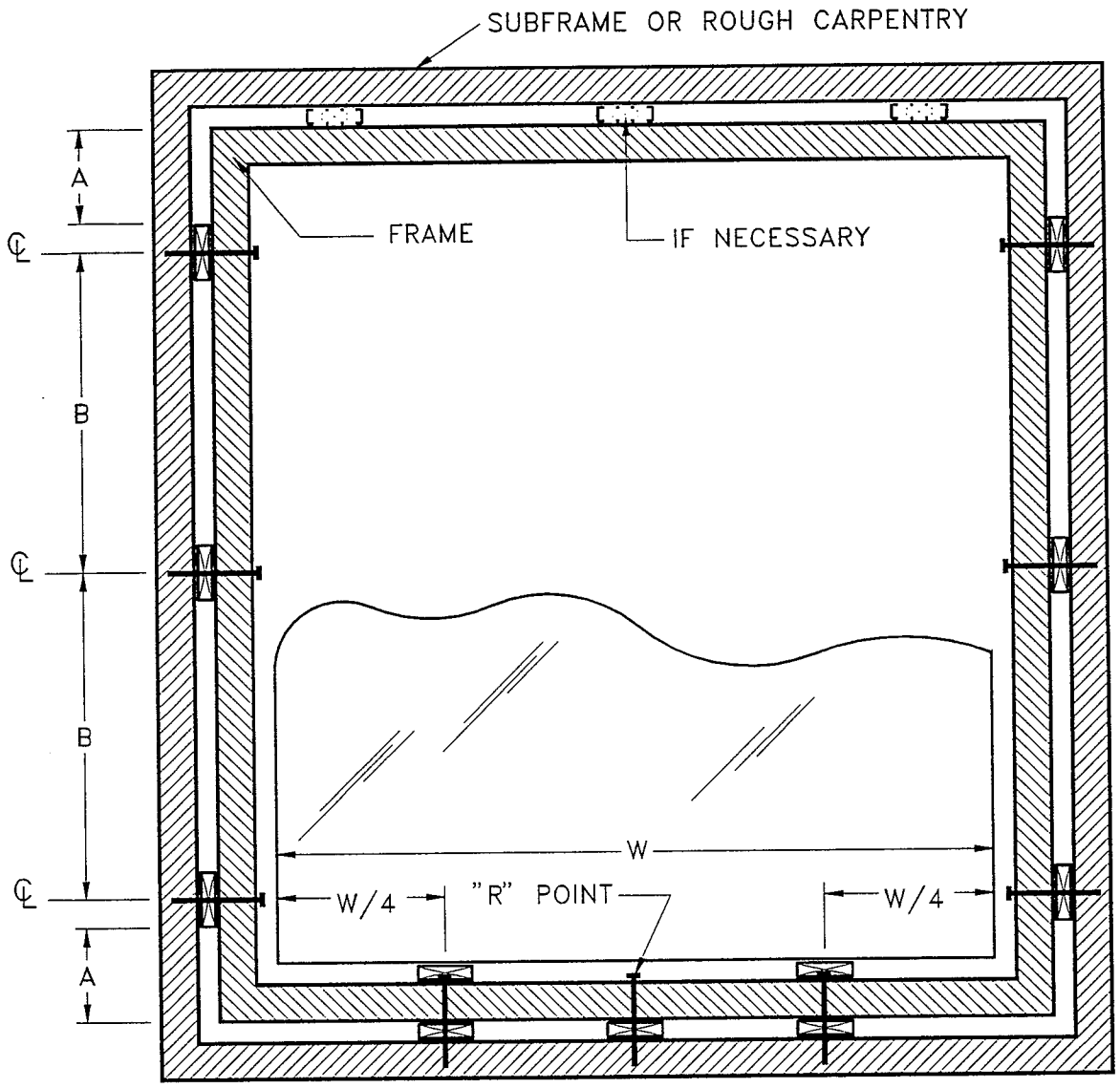
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-14.DWG

ANCHORING

FIXED WINDOW



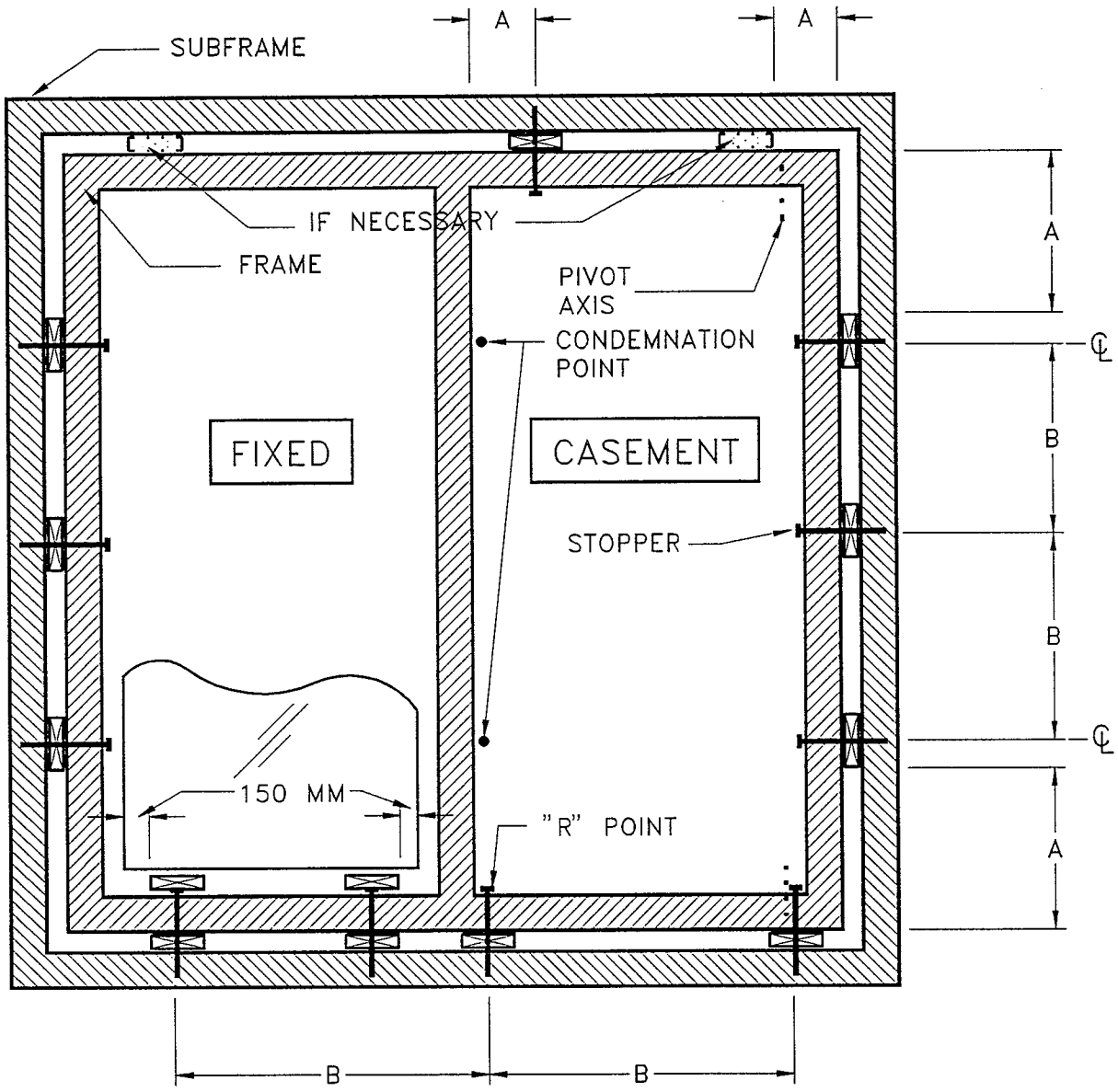
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-15.DWG

ANCHORING

COMPOSITE WINDOW: FIXED + CASEMENT



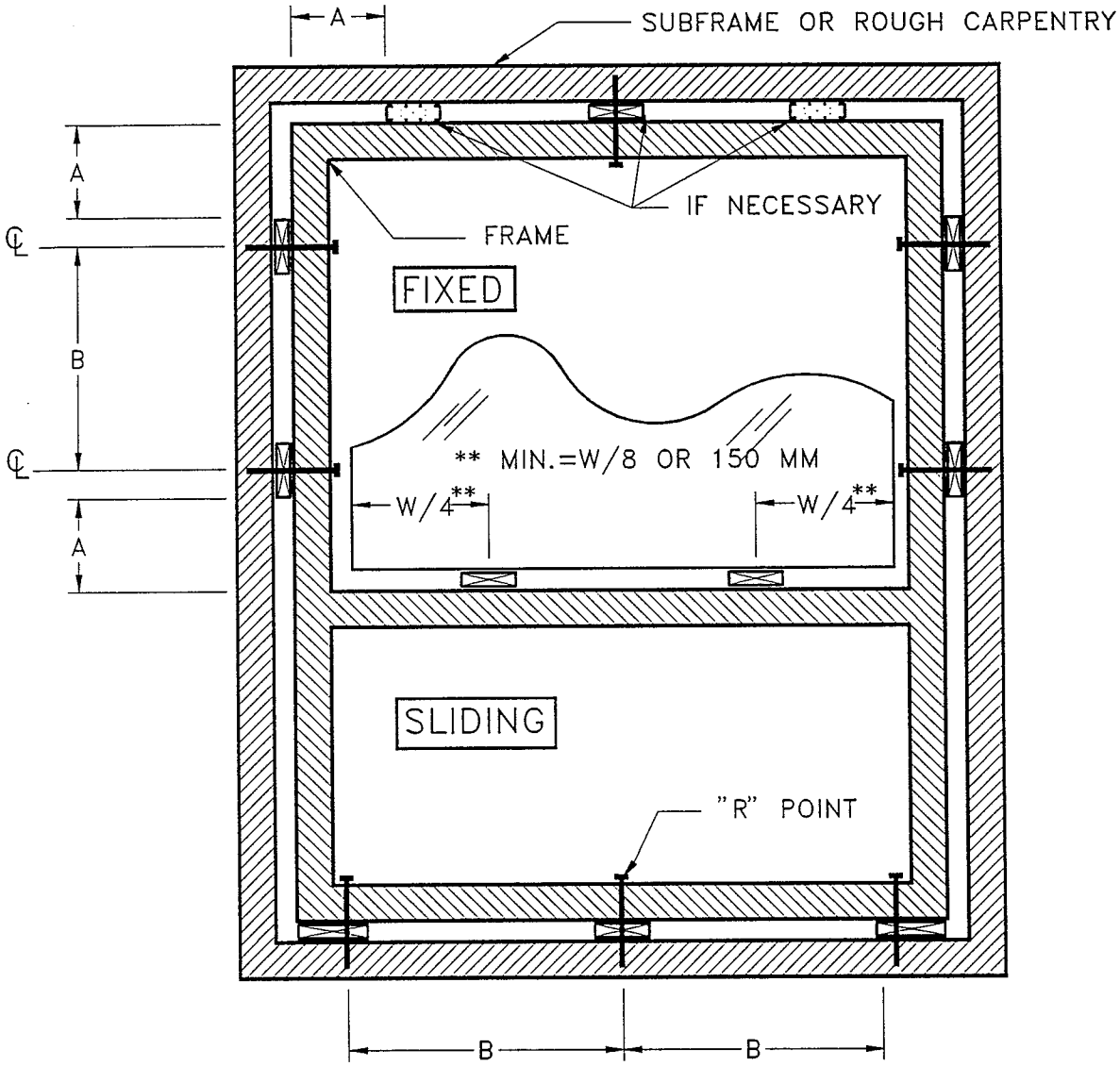
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-16.DWG

ANCHORING

COMPOSITE WINDOW: FIXED + HORIZONTAL SLIDING



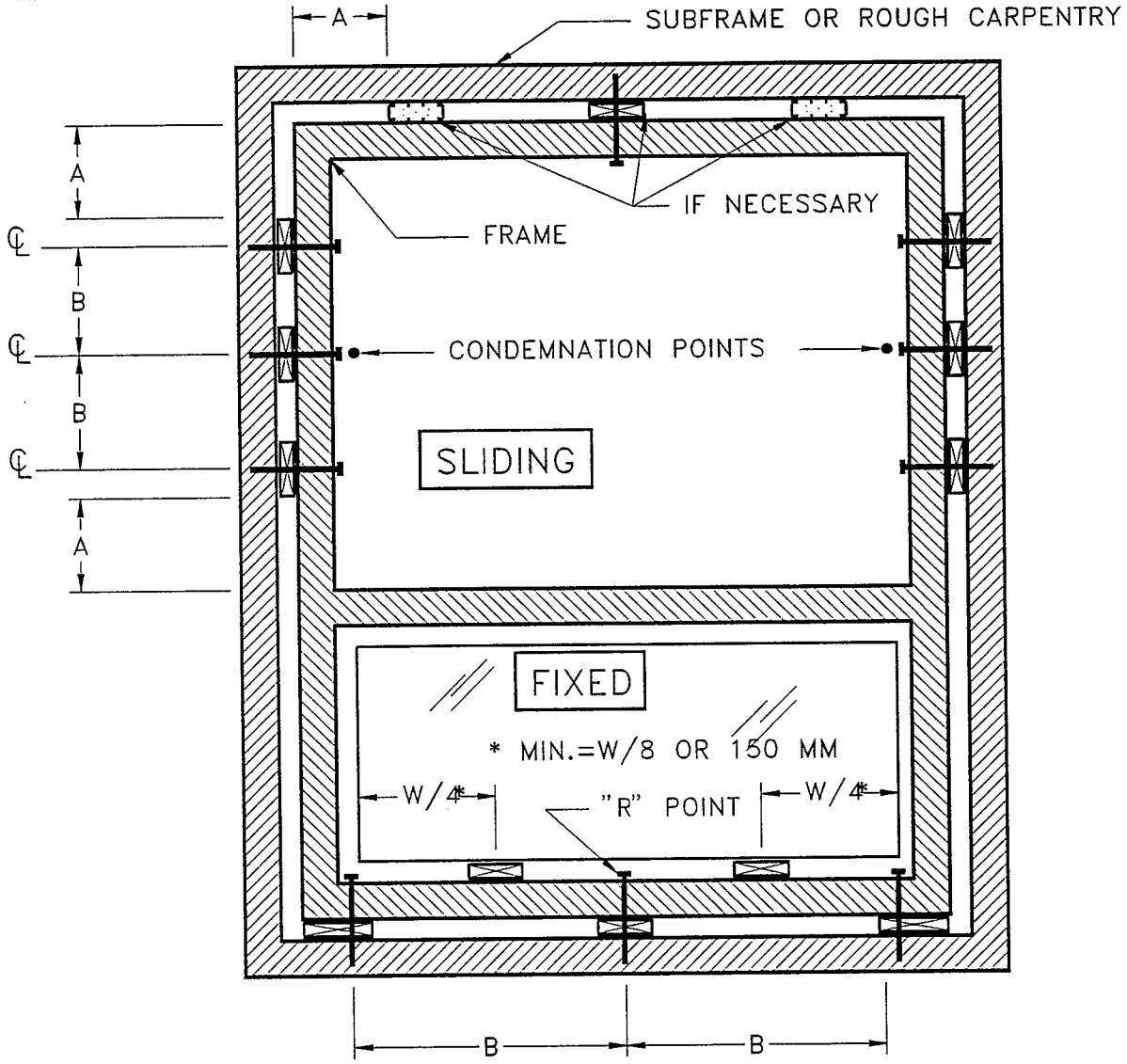
FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EMR5-17.DWG

ANCHORING

COMPOSITE WINDOW: FIXED + HORIZONTAL SLIDING



FRAME CONSTRUCTION	MINIMUM "A" DIST. (MM)*	MAXIMUM "B" DIST. (MM)
WOOD	50	800
ALUMINUM	150	800
P.V.C.	200	600

* WHEN EXTERIOR FINISH IS DARK COLOURED, ADD 20 MM TO ABOVE INDICATED "A" DISTANCE.

EWR5-18.DWG

5.6 GENERAL COMMENTS ON FASTENERS

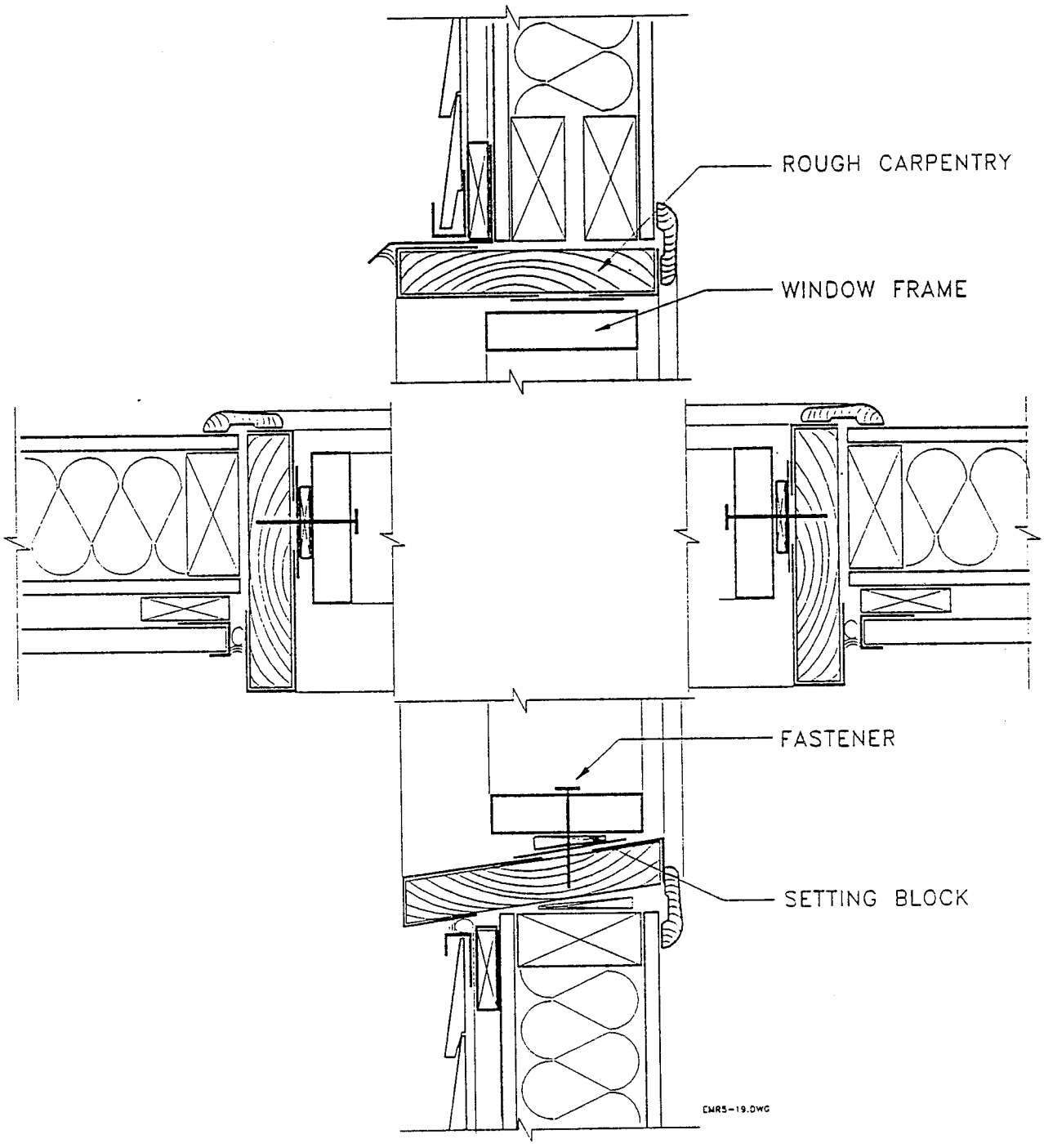
The nature or the treatment of fasteners must assure its integrity (physical and mechanical) for at least as long as the anticipated service life of other window frame components anchored to the rough opening.

Anchors and fasteners must be treated against corrosion in such a manner so as to provide durable protection.

Welding, screwing or any other process considered equivalent which fixed these components will be considered fastening. Selection of the type of fasteners will be dictated by the window manufacturer. The installer must conform to the manufacturer's instructions and recommendations regarding installation.

When the installation of a fastener perforates through a component where water could penetrate (ex.: window sill) and damage underlying components, the installer must assure its watertightness (sealant, compressible material, etc...).

EXTERIOR CLADDING - LAP SIDING

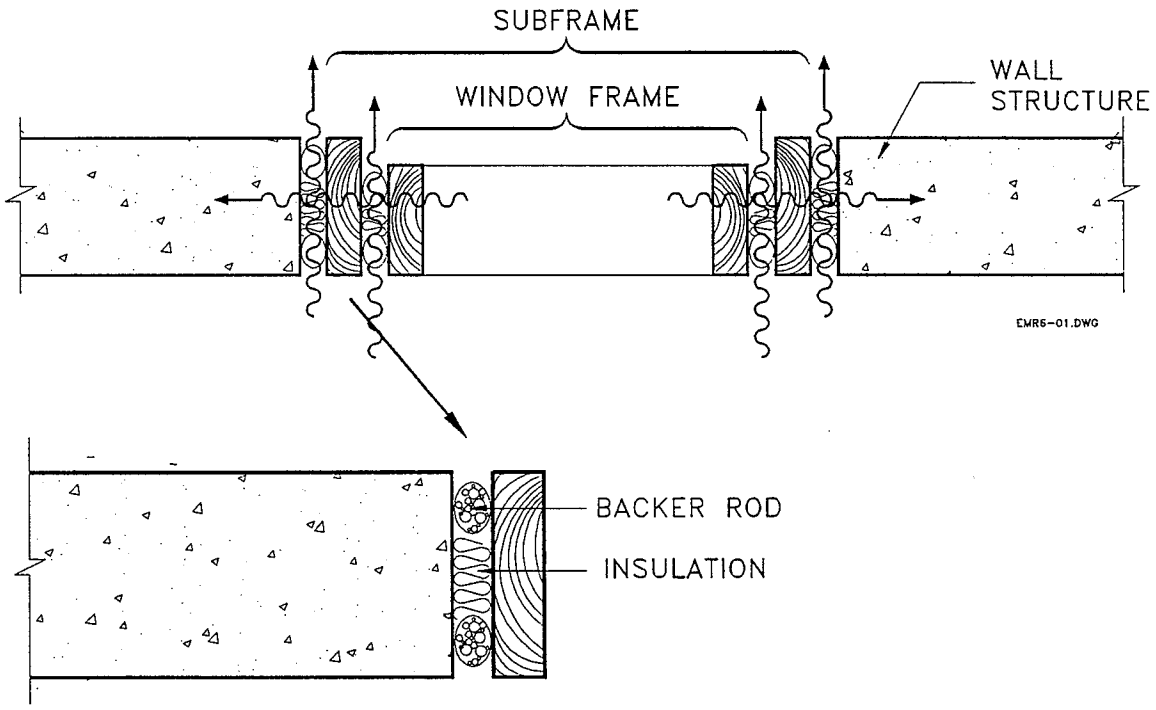


WINDOW FRAME IS READY FOR INSULATION AND CAULKING APPLICATION

CHAPTER 6

THERMAL INSULATION

In order to reduce the influence of the wall frame on the window's thermal performance, and to minimize heat loss through cracks between the window frame and the subframe or between the subframe and the rough opening, it is necessary to fill these gaps with insulating wool or foam.



When insulating wool is used, excessive compression of the material must be avoided, for the wool to retain its insulation properties.

The use of polyurethane foam may be problematic. Compatibility of the foam with adjacent materials must be ensured (subframe, rough opening, window frame and caulking compounds). In addition, deformation of frame members must be avoided during the curing period. Rigid polyurethane foam must be avoided when PVC or aluminum members are used. In fact, there will likely be cracking of the foam at the junction of these materials.

CHAPTER 7

PERIPHERAL ALLOWANCE BETWEEN WINDOW FRAME AND ROUGH OPENING (OR SUBFRAME)

The width of the perimeter joint between the window frame and the rough opening depends on the following parameters:

- Window frame material
- Frame dimensions (height and width)
- Colour of frame's exterior surface
- Chosen sealant

7.1 TYPE, DIMENSIONS AND COLOUR OF FRAME MATERIAL

Materials expand or contract at different rates (thermal expansion coefficient "α") as their temperature is raised or lowered. To measure this phenomenon, the linear expansion coefficient (α) is used, giving a length variation per unit length when the temperature changes by one degree. Table 3 provides the expansion coefficient "α" for most common materials.

TABLE 3: EXPANSION COEFFICIENT "α"

MATERIAL	"α" mm/mm/°C x 10^{-6}
Wood	3.8 to 6.5
Brick	5.6 to 6.3
Concrete	11.7
Steel	12
Aluminum	23.2
PVC	40 to 80

The expansion or contraction of a given material (ΔL) is the product of the expansion coefficient (α), length (L) or distance relative to reference point "R" and the temperature change of the material.

$$\Delta L = \alpha \times L \times \Delta T$$

Where:
- ΔL = Expansion (mm)
- α = Linear thermal expansion coefficient of material (mm/mm/°C x 10^{-6})
- L = Distance from calculation point to reference point "R" (mm)
- ΔT = Anticipated temperature change (°C)

In order to determine the differential movement between two adjacent points (C) of the frame relative to point "R" (see sketch page 72), it is necessary to assess the following conditions:

- Difference between window frame (F) and subframe (S) with regards to expansion coefficients ($\alpha_F - \alpha_S$).
- Horizontal (Lx) and vertical (Ly) distance from point "C" to point "R".
- The expected temperature variations to which the window frame (ΔT_F) and the subframe (ΔT_S) will be subjected, during the service life of the "frame-subframe" assembly. Considering that components of the "frame - subframe" assembly will be submitted to similar temperature changes (ΔT), the calculation of the differential movement between two adjacent points is given by the following expression:

$$\Delta L_X = (\alpha_F - \alpha_S) \times L_X \times \Delta T$$

$$\Delta L_Y = (\alpha_F - \alpha_S) \times L_Y \times \Delta T$$

The maximum temperature range to which the components will be submitted will depend on installation temperature, and the maximum and/or minimum temperatures of the area where the house is built.

The installation temperature should always be above 5°C (minimal temperature recommended for caulking application) but less than 30°C for all locations in Canada.

The coldest temperature after installation (winter) should be the winter design temperature for January (NBC - 2 1/2%) for the area in question, to which 2°C should be further subtracted (clear winter night).

In summary, the maximum temperature range to which the "frame - subframe" assembly will be submitted should be less than 60°C for most canadian areas.

The following sketch illustrates a typical window installed in a wood subframe (α = 3.8 x 10^{-6} mm/mm/°C). The window frame may be either wood, aluminum, or PVC. Table 4 gives the differential movement between two adjacent points (one on the window frame and one on the subframe), relative to reference point "R", for a temperature range of 60°C.

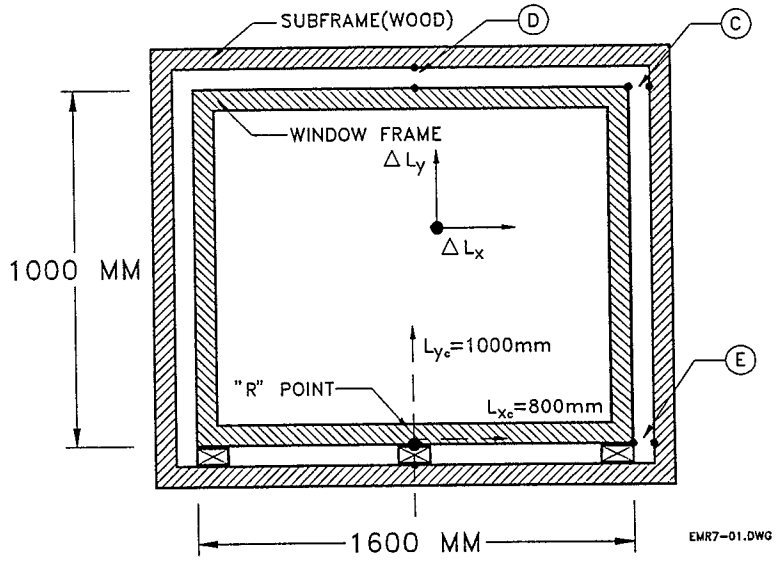


TABLE 4: ANTICIPATED MAXIMUM DIFFERENTIAL MOVEMENT OF POINT "C"

FRAME MATERIAL	ΔL_X	ΔL_Y
	mm	mm
Wood	0	0
Steel	0.38	0.48
Aluminum	0.96	1.2
PVC		
$\alpha = 40 \times 10^{-6}$	1.73	2.16
$\alpha = 80 \times 10^{-6}$	3.65	4.56

CONCLUSION

- The differential movement between components of the frame and the subframe are strongly influenced by frame material and by the distance between calculation point ("C") and the reference point ("R").

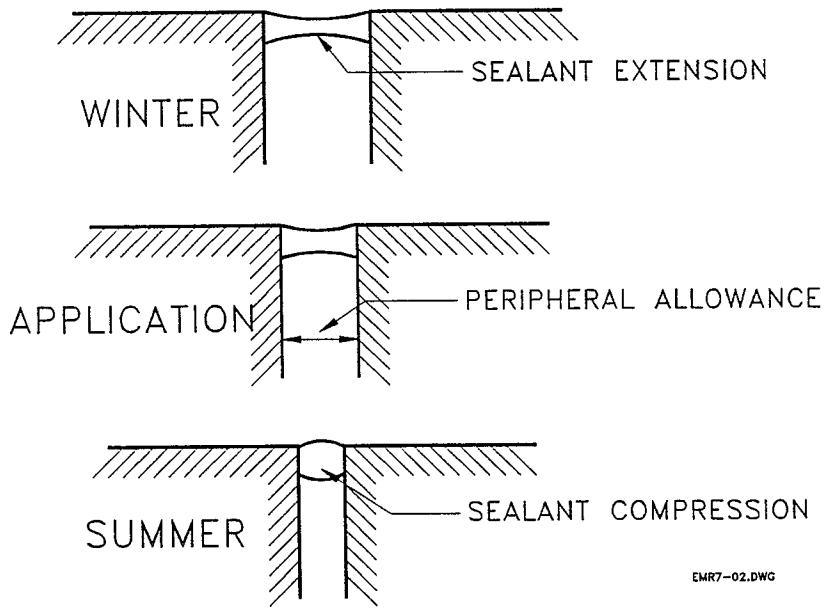
NOTE

When a frame member is reinforced with a material of a different nature, and that the member and reinforcement are interlocked, the calculation of assembly expansion or contraction must account for the modulus of rigidity (product of the modulus of elasticity (E) by the moment of inertia (1) of each component of the assembly). This occurs when PVC frame members are steel-reinforced. Consult with the manufacturer to obtain or calculate the differential movements sustained by these hybrid assemblies. Usually, differential movement of steel-reinforced PVC assemblies are much smaller than those associated with PVC alone.

7.2 TYPES OF CAULKING COMPOUNDS

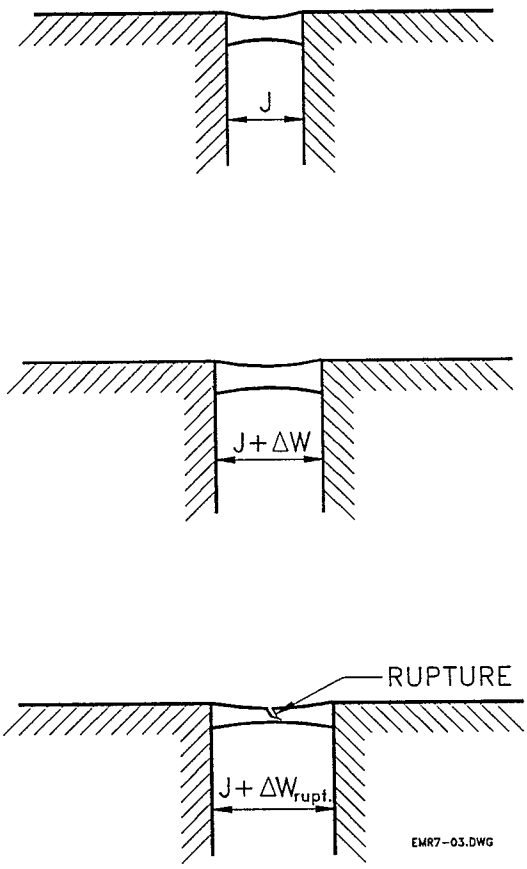
Water and airtightness products covered in this document are sealants. They are available in cartridges and applied by extrusion with a manual pump (caulking gun), after the window frame and other intermediary components, such as insulation and backer rods, have been installed.

The sealant has the function of permanently linking two adjacent components, to maintain water and airtightness of an interface while permitting differential movement between the two components.



One of the important characteristics for maintaining water and airtightness is the in-service allowable maximum elongation (E_{MAX}) under dimensional variations of the joined components. This characteristic will be governed primarily by caulking type.

The allowable maximum elongation (E_{MAX}) of a given product is expressed in percentage, by the absolute elongation coefficient at rupture (ΔL_{RUPT}), relative to joint width (J) at application.



$$E\ max.(\%) = \frac{\Delta w_{rupt.}}{G} \times 100$$

Given the wide variety of available products, this section will be limited to the calculation of the required perimeter joint for caulking products with admissible maximum elongations of 10%, 15%, 20%, 25%, 30%, 40% and 50%.

The required joint width (J) is obtained from the following equations:

$$J = \frac{\Delta L_{RUPT.} \times 100}{E_{MAX}}$$

where:

J = Joint width around frame (mm)

$\Delta L_{RUPT.}$ = Maximum differential movement (mm) along the vertical or horizontal axis, caused by a temperature range of 60°C.

E_{MAX} = Sealant's allowance maximum elongation (%)

7.3 CALCULATION OF MINIMUM PERIMETER JOINT (JOINT WIDTH "J")

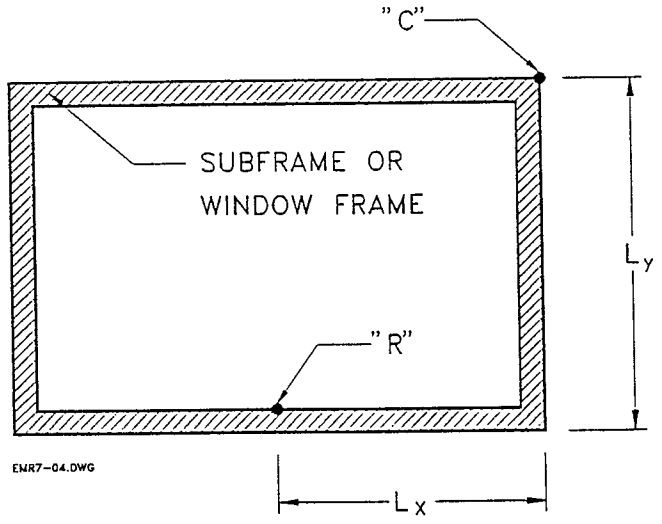
Tables 5, 6 and 7 give (wood rough opening, $\alpha = 3.8 \times 10^{-6}$mm/mm/°C) the minimal peripheral allowance between the window frame and the rough opening (or subframe), depending on the caulking type, the window frame's exterior dimensions and material (aluminum and PVC). The intent of the joint allowance is to prevent joint rupture (aluminum and PVC).

In the case of wood frames, there is little, if any, differential movement between the window frame and the rough opening. Therefore, theoretically there is no need for an allowance. However, to provide for the various tolerances (vertical and horizontal offsets, bowed members, etc.) that may exist, a minimal peripheral allowance of 6 mm should be maintained around the window frame.

For framing materials other than wood, a minimum peripheral joint of 6 mm should also be maintained to account for possible differences between the window frame and the subframe (or rough opening).

TABLE 5: MINIMUM PERIPHERAL ALLOWANCE (MM) FOR ALUMINUM FRAMES

MAXIMUM ALLOWABLE SEALANT ELONGATION (%)	MAXIMUM HORIZONTAL OR VERTICAL DISTANCE BETWEEN POINT "R" AND POINT "C" (mm)						
	600	800	1000	1200	1400	1600	1800
10	7	9	12	14	16	18	20
15	6	6	8	9	11	12	14
20	6	6	6	7	8	9	10
25	6	6	6	6	7	8	9
30	6	6	6	6	6	6	7
40 and over	6	6	6	6	6	6	6

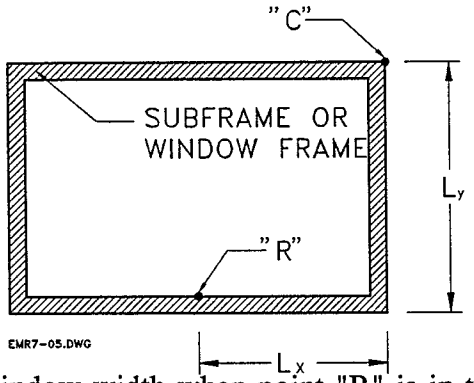


L_X = ½ of window width when point "R" is in the center of the sill

TABLE 6: MINIMUM PERIPHERAL ALLOWANCE (MM) FOR PVC FRAMES

α = 40 x 10^{-6} mm/mm/°C

MAXIMUM ALLOWABLE SEALANT ELONGATION (%)	MAXIMUM HORIZONTAL OR VERTICAL DISTANCE BETWEEN POINT "R" AND POINT "C" (mm)						
	600	800	1000	1200	1400	1600	1800
10	13	18	22	26	31	36	39
15	9	12	15	18	20	23	26
20	7	9	11	13	16	18	20
25	6	7	9	11	13	14	16
30	6	6	8	9	11	12	13
40	6	6	6	7	8	9	10
50	6	6	6	6	6	7	8

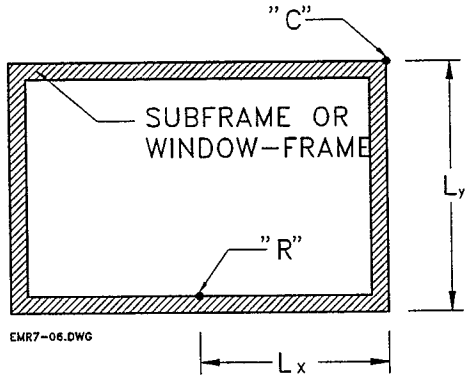


L_X = ½ of window width when point "R" is in the center of the sill

TABLE 7: MINIMAL PERIPHERAL ALLOWANCE (MM) FOR PVC FRAMES

$\alpha = 80 \times 10^{-6}$ mm/mm/°C

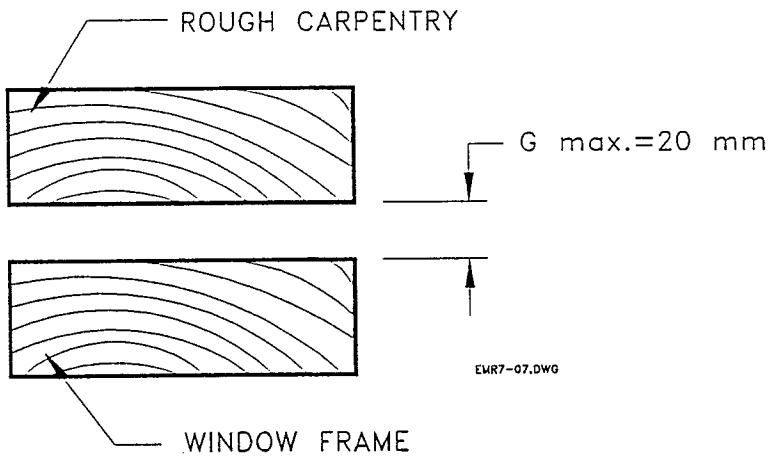
MAXIMUM ALLOWABLE SEALANT ELONGATION (%)	MAXIMUM HORIZONTAL OR VERTICAL DISTANCE BETWEEN POINT "R" AND POINT "C" (mm)						
	600	800	1000	1200	1400	1600	1800
10	28	37	46	55	64	73	82
15	19	25	31	37	43	49	55
20	14	19	23	28	32	37	41
25	11	15	19	22	26	30	33
30	10	13	16	19	22	25	28
40	7	10	12	14	16	19	21
50	6	8	10	11	13	15	17



L_X = ½ of window width when point "R" is in the center of the sill

7.4 ANALYSIS OF RESULTS FOR PERIMETER JOINT CALCULATION

For aesthetical reasons as well as sealant application practical requirements, and in order to maximize the transparent portion of the replacement window, it is imperative that the peripheral allowance between the window frame and the rough opening be set at 20 mm or less.



This limitation for the joint allowance with regards to windows with PVC members (without steel reinforcement) will require a sealant with an allowable maximum elongation (E_{MAX}) greater than 20% (see tables 6 and 7) for most applications. Furthermore, since the thermal expansion coefficient of PVC depends on the additives incorporated within the material, it becomes essential to establish this value prior to selecting the exterior dimensions of the window frame for a given application.

CHAPTER 8

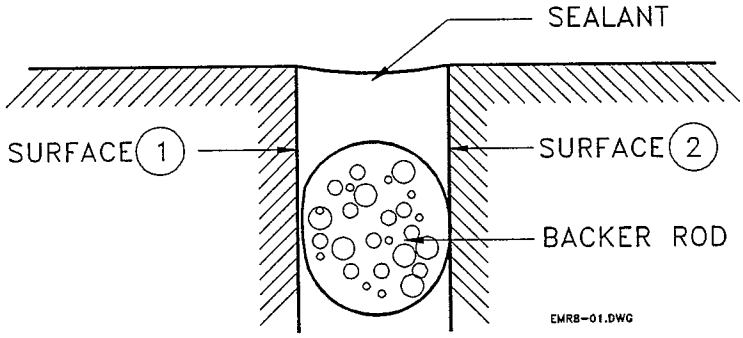
JOINT DESIGN AND SEALANT SELECTION

8.1 JOINT DESIGN

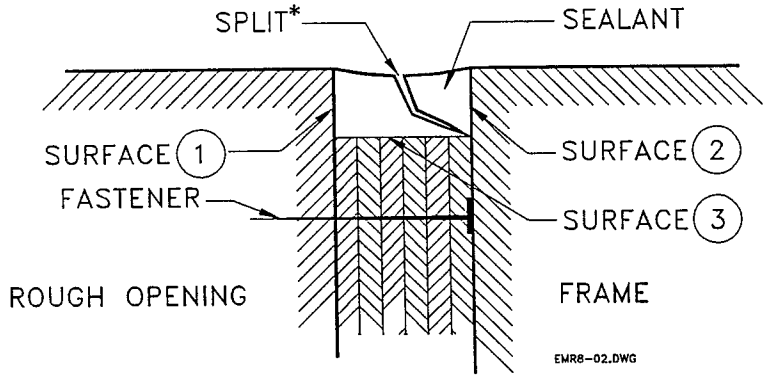
A) BOND BREAKER

Regardless of the type of sealant used for a given application, it is essential to avoid adherence of the sealant to any surface other than the two components to be joined. In order to achieve this, a filling material generically called "bond breaker" or backer rod is used . This backer rod permits adjustment for the joint depth and provides proper sealant profile. A proper joint profile (cross section) will be concave as shown below.

RIGHT

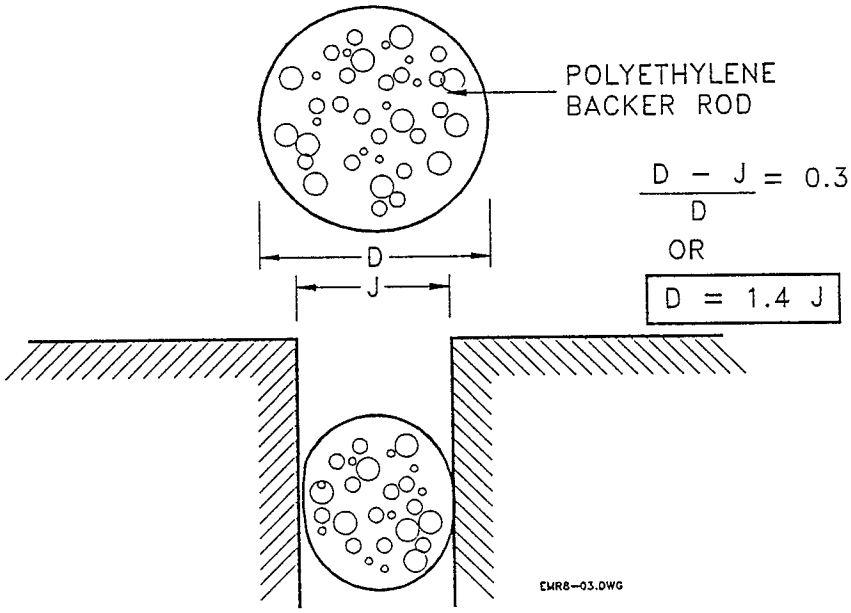


WRONG

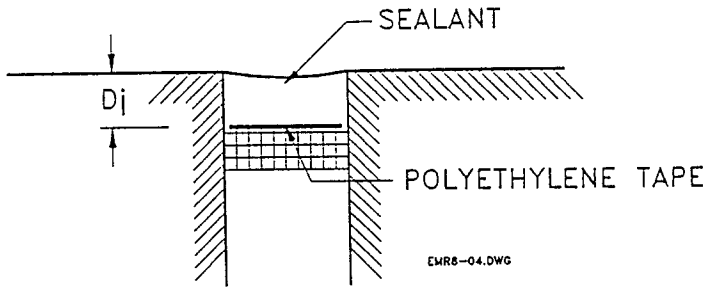


* When there is adherence between surfaces 2 and 3, and there is relative movement between the two surfaces, a sealant cohesive failure will occur, starting at the meeting point of both surfaces.

The bond breaker is usually a closed cell polyethylene foam rod, installed with a minimum initial compression between 25 and 35%.

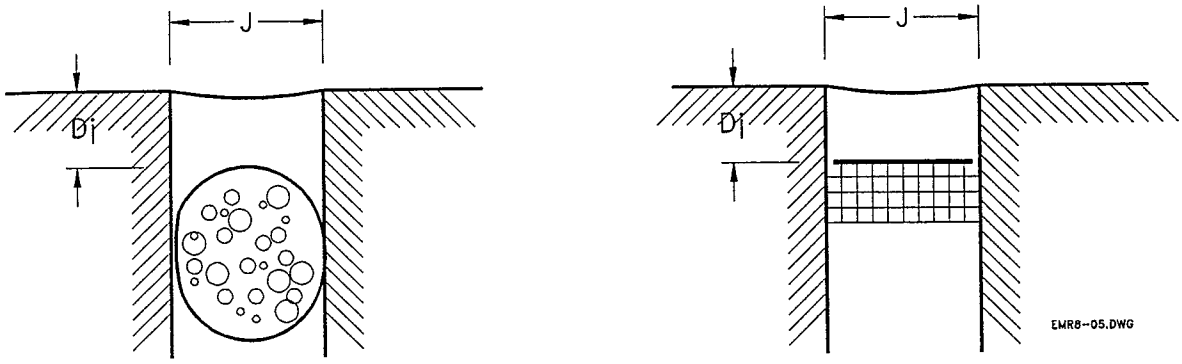


When joint depth (Dj) is not sufficient to permit the insertion of a foam rod, a bond breaker tape should be used to avoid three-sided adhesion of the sealant. Self-adhesive polyethylene tape is recommended for such applications.



B) JOINT DEPTH VS JOINT WIDTH RATIO

In order to minimize sealant waste, and to optimize sealant resistance (adherence and coherence), it is imperative to follow manufacturer's recommendations regarding minimum and maximum joint depth. Generally, the ratio of joint width (J) to joint depth (Dj) of the sealant is approximately 2 to 1. However, generally, joint depth should not be less than 3 mm and not more than 12 mm.



$$\frac{J}{Dj} \approx 2$$

$$Dj_{MIN.} = 3 \text{ mm}$$

$$Dj_{MAX} = 12 \text{ mm}$$

C) SURFACE PREPARATION

The joint surfaces intended to be sealed must be clean, dry and free of contaminants. Given the multitude of sealant types and substrates, it is recommended that a Manufacturer's technical representative or a specialist be contacted with regards to the use of solvents or primers required for joint cleaning.

It is imperative that primers be applied in strict conformance with the Manufacturers printed literature. In order to avoid messy sealant application or spills, the surfaces adjacent to the joint should be masked, preferably prior to any primer application.

It is important during material selection to check for compatibility between sealant and joining substrate to ensure proper adhesion and avoid staining.

D) SEALANT APPLICATION AND TOOLING

Most construction sealants can be applied directly from the cartridge, without any mixing. Manufacturers instructions should be followed closely for application temperatures and surface preparation.

Immediately after sealant application, it is recommended to tool the joint to ensure proper contact with joint surfaces and proper joint profile. For specific instructions, consult with manufacturer's specifications.

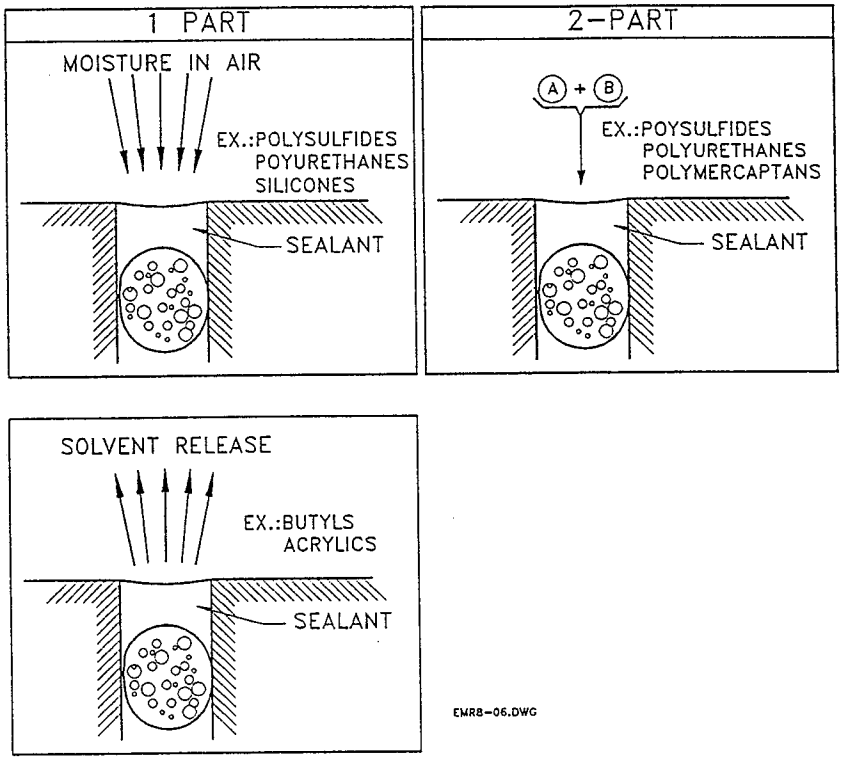
After tooling, immediately remove excess sealant and stains with the appropriate solvents, as work progresses.

8.2 SEALANT SELECTION

A) INTRODUCTION

The sealants discussed here are for the sole purpose of creating a permanent barrier against water, air, sound and dust infiltration.

They consist of an inert part (Asbestos, chalk, kaolin, talc...) and a bonding agent (oil, tar, synthetic elastomer). Nowadays, most sealants use synthetic elastomeric bonding agents. These agents polymerize or cure in the presence of moisture in the air, or by releasing a solvent when they are one part, or under the action of a polymerization agent (mixed on site) when they are two-part.



B) IMPORTANT SEALANT PROPERTIES

Among the many sealant properties to be reviewed during sealant selection, the most important are:

a) adherence to surface to be joined,
b) requirement for primer application,
c) impermeance to air and water vapour,
d) elasticity relative to service temperature,
e) tensile, compressive and shear strength,
f) allowable maximum elongation (E_{MAX}) in-service, under dimensional variations,
g) maximum elongation at rupture,
h) residual deformation after compression,
i) abrasive resistance,
j) resistance to weather extremes and chemical agents,
k) chemical compatibility with other materials,

l) toxicity, flammability, colour stability
m) available colours,
n) ease of repair/removal,
o) staining,
p) sagging,
q) specific weight loss after cure,
r) curing time (surface and in-depth),
s) ease of application
t) maximum and minimum application temperature,
u) shelf life,
v) paint adherence.

Although all of these properties are important, in this report only the most critical will be analyzed.

The most important is the sealant's capacity to withstand differential movements while keeping its elastic properties (E_{MAX}). After the installer or the manufacturer has made sure the product has the required movement capabilities, other properties such as adherence, air and water vapour permeance, cohesion, modulus of elasticity, residual deformation after compression and resistance to weather extremes should be considered.

In the case of high performance sealants, it is often necessary to apply primer to ensure proper adherence to surfaces.

Even though permeance to air and/or water vapour can vary greatly from one sealant type to the other, the resulting value is always very low, no matter what type of sealant is being used. Thus, the air infiltration or exfiltration through the joint should be negligible, if there is proper adherence to adjacent surfaces.

For the modulus of elasticity, it is better to use a sealant with as high an elasticity as possible (low modulus), to minimize the tensile and compressive stresses with in the sealant as well as on components substrate.

TABLE 9: PROPERTIES OF COMMON SEALANTS

TYPE OF SEALANT	LOW PERFORMANCE	
	Oil-based 1 part	Latex (acrylic) 1 part
Maximal range in %	±3	±5
Maximum joint width in mm.	12 to 18	12 to 18
Durability (years)	2 to 5	3 to 7
Service temperatures (°C)	-18 to 66	-17 to 71
Recommended application temperature (°C) (some products need to be heated at lower temperatures)	4 to 49	4 to 49
Drying time*, tack-free (hours)	6 to 12	½ to 1
Hardening period for intended performance* (days)	continuous	5
Shrinkage (%)	5	20
Hardness, new (1 to 6 months), shore "A" at 75°F		15 to 40
Hardness, aged (5 years), shore "A" at 75°F		30 to 50
Tensile strength at low temperature	very high	high
Required primer on substrate for proper adherence: masonry	no	no
metal	no	no
glass	no	no
Solvent required to clean substrate before application (attempt dry-cleaning fist)	mineral solvents	soapy water
Canadian applicable standards	CAN/CGSB-19.2-M87	CAN/CGSB-19.17M90

*Varies according to temperature and humidity levels - required time for formation of surface skin

TABLE 10: PROPERTIES OF COMMON SEALANTS

TYPE OF SEALANT	AVERAGE PERFORMANCE	
	Butyls (skin formation) 1 part	Acrylic (solvent release) 1 part
Maximal range in %	±7.5 to ±10	±7.5 to ±12.5
Maximum joint width in mm.	12 to 18	18
Durability (years)	5 to 10	5 to 20
Service temperatures (°C)	-29 to 82	-29 to 82
Recommended application temperature (°C) (some products need to be heated at lower temperatures)	4 to 49	-18*** to 49
Drying time*, tack-free (hours)	24	12 to 36
Hardening period for intended performance* (days)	continuous	14
Shrinkage (%)	20	12 to 15
Hardness, new (1 to 6 months), shore "A" at 75°F	10 to 40	25 to 50
Hardness, aged (5 years), shore "A" at 75°F	30 to 50	30 to 60
Tensile strength at low temperature	average to high	average to high
Required primer on substrate for proper adherence: masonry	no	no
metal	no	no
glass	no	no
Solvent required to clean substrate before application (attempt dry-cleaning fist)	mineral solvents	xylene, toluene
Canadian applicable standards	19-GP-14M	19-GP-5M

*Varies according to temperature and humidity levels - required time for formation of surface skin
***For application under 10°C, the products are usually heated; otherwise, they are applied between 4 and 49°C

TYPE OF SEALANT	HIGH PERFORMANCE				
	Polysulphide 1 part	Polysulphide 2 part	Polyurethane 1 part	Polyurethane 2 parts	Silicone 1 part
Maximal range in %	±20	±25	±25	±25	±25 (±40)**
Maximum joint width in mm	12 to 25	18	12 to 36	50	30
Durability (years)	10 to 20	10 to 20	10 to 20	10 to 20	10 to 25
Service temperature (°C)	-40 to 82	-40 to 82	-40 to 82	-40 to 82	-54 to 177
Recommended application temperatures (°C) (some products need to be heated at lower temperatures)	4 to 49	4 to 49	4 to 49	4 to 49	-29 to 71
Drying time*, tack-free (hours)	12 to 24	24 to 48	12 to 48	24 to 48	15 min to 1 h
Hardening period for intended performance* (days)	30 to 45	7	8 to 14	3 to 5	5 to 14
Shrinkage (%)	8 to 12	0 to 10	nul to 5	nul to 5	nul to 5
Hardness, new (1 to 6 months), shore "A" at 75°F	20 to 45	20 to 45	20 to 45	20 to 45	15 to 45
Hardness, aged (5 years), shore "A" at 75°F	25 to 55	20 to 55	20 to 55	20 to 55	15 to 45
Tensile strength at low temperature	low to high	low to high	low to high	low to high	low
Required primer on substrate for proper adherence:					
masonry	yes	yes	no	maybe	maybe
metal	maybe	maybe	no	maybe	maybe
glass	maybe	maybe	no	maybe	no
Solvent required to clean substrate before application (attempt dry-cleaning first)	xylene, toluene	xylene, toluene	xylene, toluene	xylene, toluene	xylene, toluene, butanone
Canadian applicable standards	CAN/CGSB-19.13-M87	CAN/CGSB-13.24-M90	CAN/CGSB=19.13-M87	CAN/CGSB-19.24-M90	CAN/CGSB-19.13-M87

*Varies according to temperate and humidity levels - required time for formation of surface skin
**Maximum allowance (between brackets) is for products with a low modulus of elasticity. Some products have an even greater tolerance.

D) APPLICABLE STANDARDS

The selected sealant must comply with one of the following Standards:

CGSB-19-GP-5M: Sealing compound, one component, acrylic base, solvent curing.

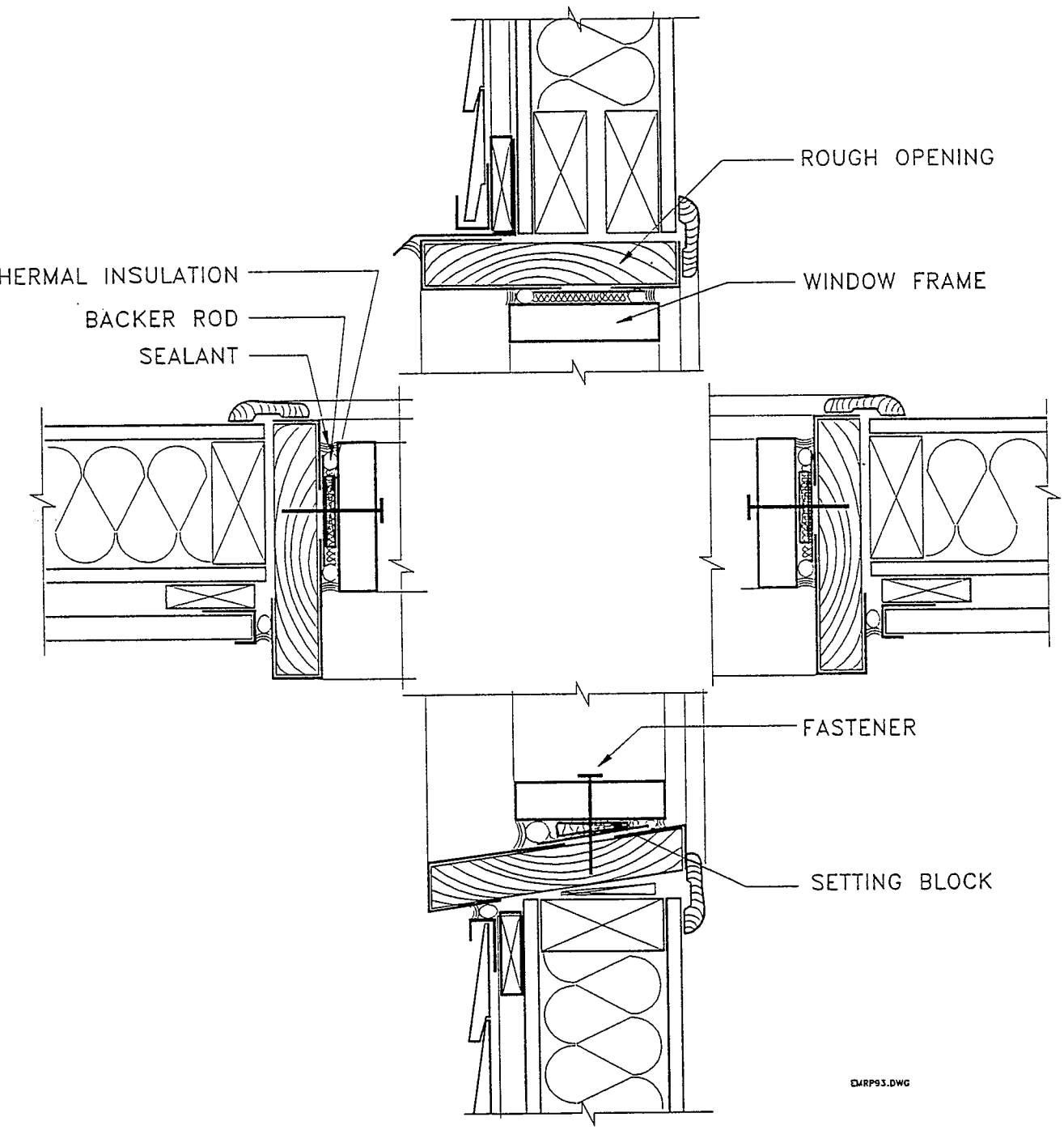
CAN/CGSB-19.13: Sealing compound, one component, elastomeric, chemical curing.

CGSB-19-GP-14M: Sealing compound, one component, butyl-polyisobutylene, polymer base, solvent curing.

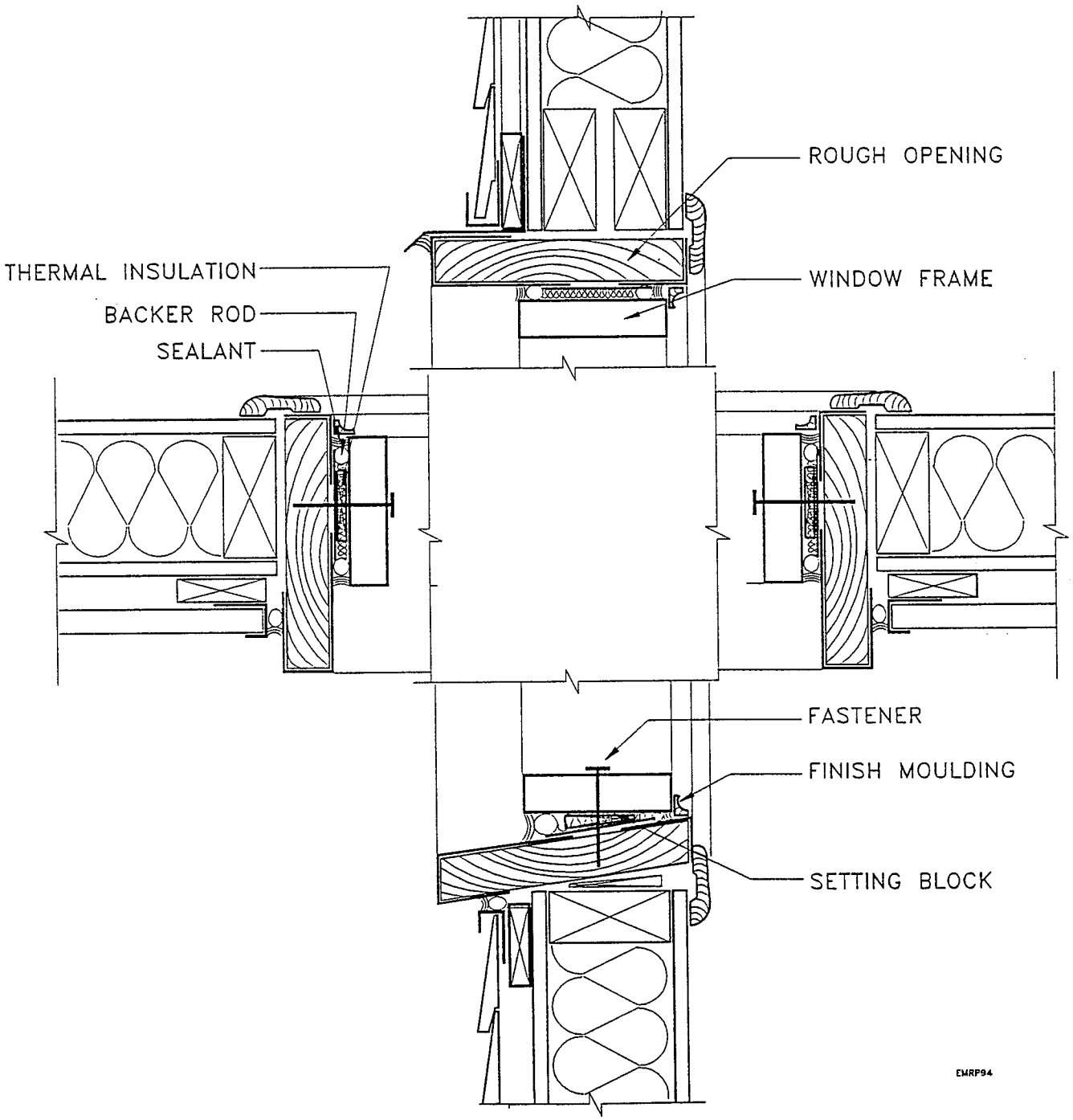
CAN/CGSB-19.17: Sealing compound, one component, acrylic resins extrusion base.

CAN/CGSB-19.18: Sealing compound, one component, silicone base, solvent curing.

CAN/CGSB-19.24: Multi-component, chemical curing sealing compound.



INTERIOR FINISHING MOULDINGS CAN NOW BE INSTALLED



THE INSTALLATION IS COMPLETE

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