

**PERIMETER FLASHING**

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## 1.0 SCOPE

This data sheet deals primarily with wind uplift forces on the perimeter of industrial, commercial and institutional buildings, and includes appropriate construction flashing details. Roofs considered in this standard are basically flat or slightly sloped, are not limited to any particular type of material, and are limited to Class 1-60, Class 1-75 and Class 1-90 wind rated designs.

The objective is to provide some guidelines to assist in detailing perimeter flashing assemblies.

### 1.1 Changes

September 2000. This revision of the document has been reorganized to provide a consistent format.

## 2.0 LOSS PREVENTION RECOMMENDATIONS

### 2.1 Introduction

#### 2.1.1 General

Two classes of roof coverings are currently in use: the built-up roof (BUR) covering and the single-ply membrane (SPM). Details appropriate to the BUR covering are included under "BUR Flashing Details"; those appropriate for the SPM are under "SPM Flashing Details."

The basic difference in flashing in the BUR and SPM is in the methods used to terminate these coverings at the building perimeter.

The majority of roof covering failures resulting from windstorm involve improperly designed or constructed perimeter flashings. A study of 145 FM Global losses involving BUR showed that 85 (59%) occurred because the perimeter failed. Damage occurred at the edge of the roof in 29 additional cases, with no specific mention in the loss report of flashing failure. However, poorly secured insulation or roof covering is subject to damage even when perimeter flashing is properly designed and constructed. Since most windstorms are accompanied by rain, contents are immediately vulnerable to damage due to leakage resulting from perimeter flashing and/or roof covering securement failure.

Perimeter flashing failures occur when wind suction or pressure exerts forces beyond the resistance strength of the metal flashing fascia and/or wood nailer cant strip assembly. When the lower edge of the fascia is not secured by a hook strip, the flashing can be bent outward and upward, exposing more of its area to the wind. Resulting prying action and uplift forces may rip off the metal and/or the wood nailer cant strip assembly. The roof covering is then vulnerable and may be easily peeled back, leaving the insulation and deck unprotected. In some cases, steel deck panels along the perimeter have been blown off (see Data Sheet 1-28, *Wind Loads to Roof Systems and Roof Deck Securement*).

Ribbed steel deck is commonly used today for the structural roof. If the edge flashing is bent outward, wind can enter the ribs of the deck. Pressures are thus created on the underside of the roof covering, which add to the suction caused by the wind blowing over the top of the roof.

Wind forces acting on a perimeter flashing assembly can vary greatly, depending on the building height, geographical location and ground roughness. For additional information, see the discussion and velocity pressure tables in Data Sheet 1-28.

Upward forces on perimeter flashing may be estimated for design purposes by multiplying the velocity pressures (Data Sheet 1-7, *Wind Forces on Buildings and Other Structures*, or Data Sheet 1-28, *Wind Loads to Roof Systems and Roof Deck Securement*) by the pressure coefficients, -2.0 at the roof perimeter strip and -3.0 at roof corners (Data Sheet 1-7). Outward forces on perimeter flashing may be estimated for design purposes by utilizing the above-mentioned velocity pressures directly from Data Sheet 1-7 or Data Sheet 1-28.

Uplift forces at building corners when the wind blows along the roof diagonal are higher than in other areas. Stronger securement is therefore needed at corners (Recommendation Nos. 2.2.4 and 2.2.8).

All recommended details shown in Figures 1 through 18 are applicable where estimated roof field area velocity pressures do not exceed 45 lb/ft<sup>2</sup> (2.15 kPa) or is Class 1-60, 1-75 and 1-90. However, additional fastening is needed for certain parts of the flashing assembly where these pressures are in the range of 30 to 45 lb/ft<sup>2</sup> (1.44 to 2.15 kPa) or is Class 1-75 and 1-90. Special design assemblies are needed where estimated roof field

area velocity pressures exceed 45 lb/ft<sup>2</sup> (2.15 kPa), or is greater than Class 1-90 and are not included in this data sheet (see Recommendation No. 2.2.13). Factory Mutual Research Approved (see Appendix A for definition) perimeter flashing systems can be used wherever the application of such a system does not exceed the Approved wind rating of that particular system.

### 2.1.2 Examples of Good Design

Examples of good design are illustrated in Figures 1 through 18.

**Note:** On new construction, it is advisable that this data sheet be used in conjunction with the roofing specifications. The details and recommendations are intended as a guide to prevent perimeter flashing blow-offs.

Differential movement between the building roof and wall can introduce stresses other than by wind into the flashing components. Such movement should be carefully considered by the architect or engineer responsible for the building design.

Metal sections used for perimeter flashing are usually 8-10 ft (2.44-3.05 m) long. A space is left between sections to allow for expansion of the metal. The joint is closed with a cover plate of the same metal. Caulking is advised between the surfaces to minimize leakage.

### 2.1.3 BUR Flashing Details

#### 2.1.3.1 Water Penetration Through Flashing Fasteners

The general practice in the past has been to fasten the roof edge flashing through the metal, roofing and flashing felts on the inside slope of a roof edge cant. The fasteners are then stripped in with two narrow strips of felt using hot asphalt. Over the years these strip-in felts deteriorate and the fastener holes may enlarge because of the expansion and contraction of the metal. Water may penetrate the holes and seep under the roof covering. This will result in wet roof insulation, roof blisters and leaks within the building. One solution is to avoid fasteners in the sloping cant where estimated roof field area velocity pressures are  $\leq 30$  lb/ft<sup>2</sup> (1.44 kPa) or is Class 1-60. Also minimize the use of these fasteners where estimated roof field area velocity pressures are in the range of 30 to 45 lb/ft<sup>2</sup> (1.44 to 2.15 kPa), or is Class 1-75 and Class 1-90 where it is necessary to add a screw and washer through the center of each section and the joint cover in the sloping cant (Detail A). Elimination of the fasteners, however, will permit cantilever action over the "X" distance from upward forces, so it will be necessary to select metal thickness in accordance with Table 1.

#### 2.1.3.2 Masonry Wall — With Roof Edge Cant or Low Parapet

Figures 1 through 4 show recommended details. In Figures 1 and 2, the bottom nailer may be anchored by placing the bolts at the necessary depth in the block cores or air space and then tightly filling the cores to the depth of the bolt with concrete (see Recommendation Nos. 2.2.3 and 2.2.4). In Figures 3 and 4, the nailer above the wall can be secured by steel rods, either with a nut embedded into the cavity with mortar, or welded to a steel angle that is embedded into the concrete beam. The inner bottom nailer can be screwed directly to the steel deck. A hook strip is needed for all fascia heights due to minimal fastening on the sloping surface (Detail A).

See Section 2.2 for recommendations for anchoring the following components:

Wood nailers to masonry (Recommendation Nos. 2.2.3, 2.2.4 and 2.2.5).

Wood to steel (Recommendation Nos. 2.2.5, 2.2.6 and 2.2.7).

Wood to wood (Recommendation No. 2.2.8).

Hook strips, metal fascia and cant flashing to wood (Recommendation Nos. 2.2.9 and 2.2.10).

Metal coping to metal (Recommendation No. 2.2.11).

Metal counterflashing (Recommendation Nos. 2.2.11 and 2.2.12).

After the "L" and "X" distances are established (see Fig. 2), the minimum metal thickness for the flashing assembly can be selected from Table 1. When the "L" or "X" distances are not shown, as in Figure 11, metal thicknesses and fastener spacing should be in accordance with the Section 2.1.3.6, *Metal Gravel Guard and Fascia*.

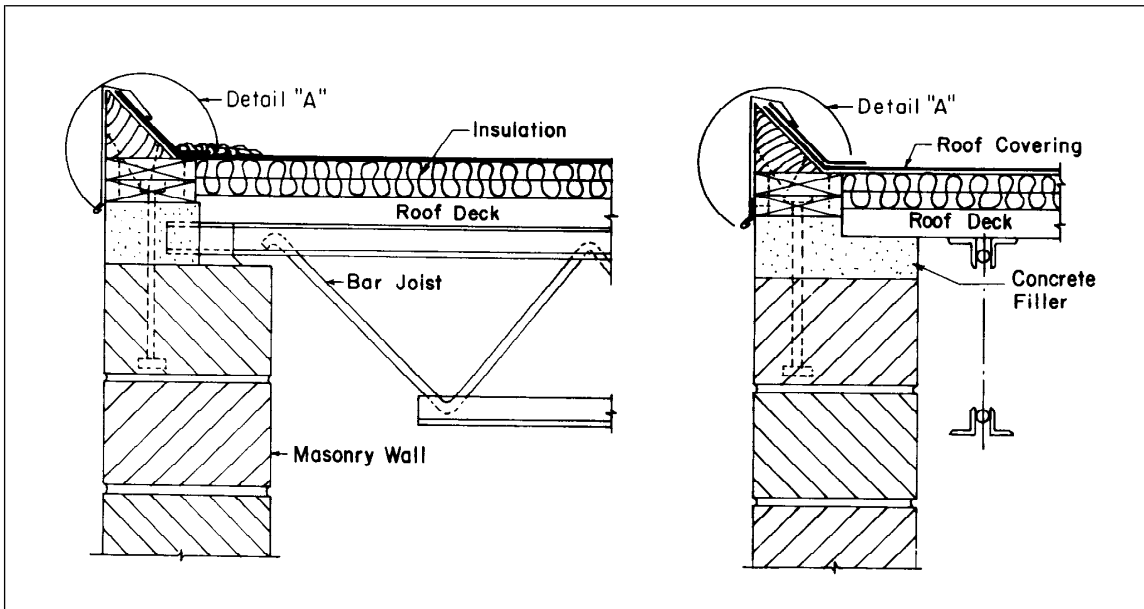


Fig. 1. Perimeter edge flashing detail with roof edge cant.

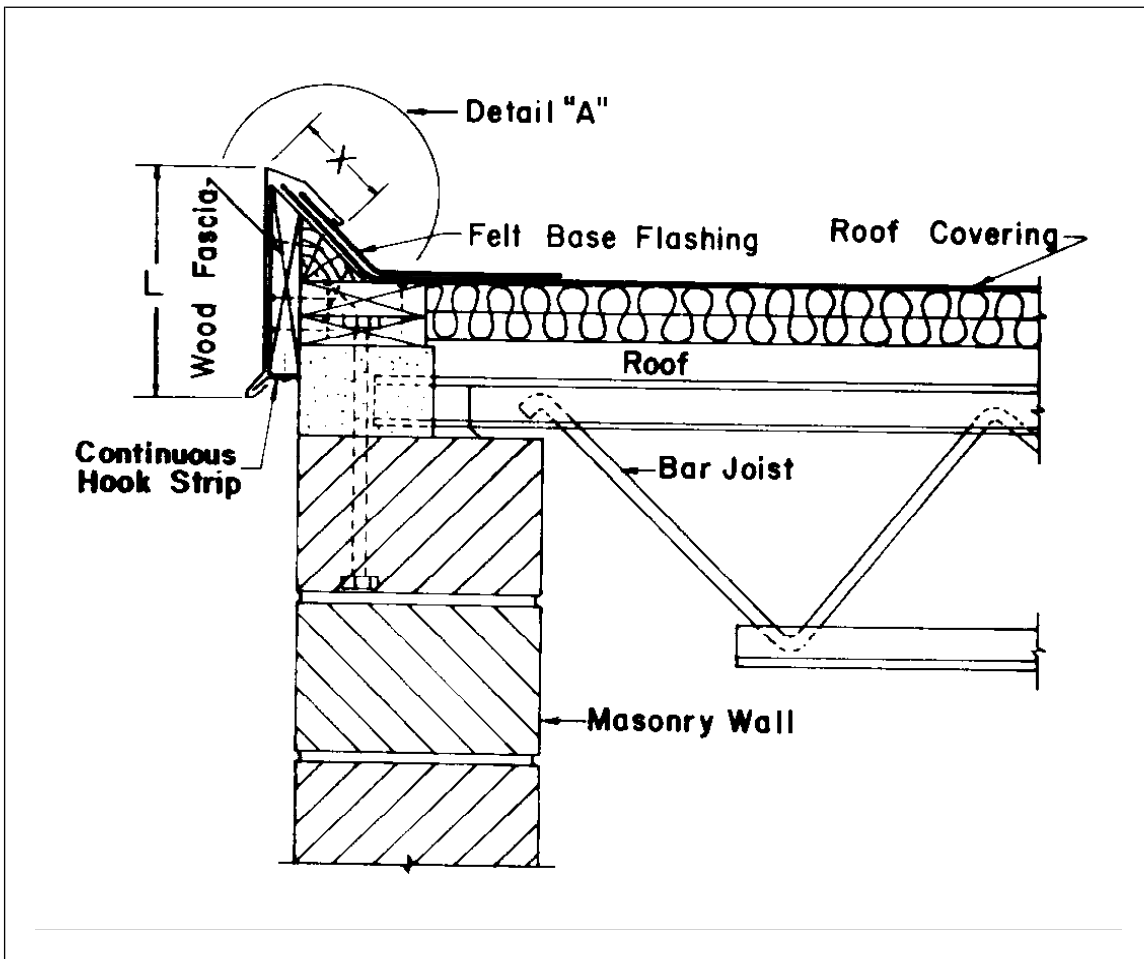


Fig. 2. With roof edge cant.

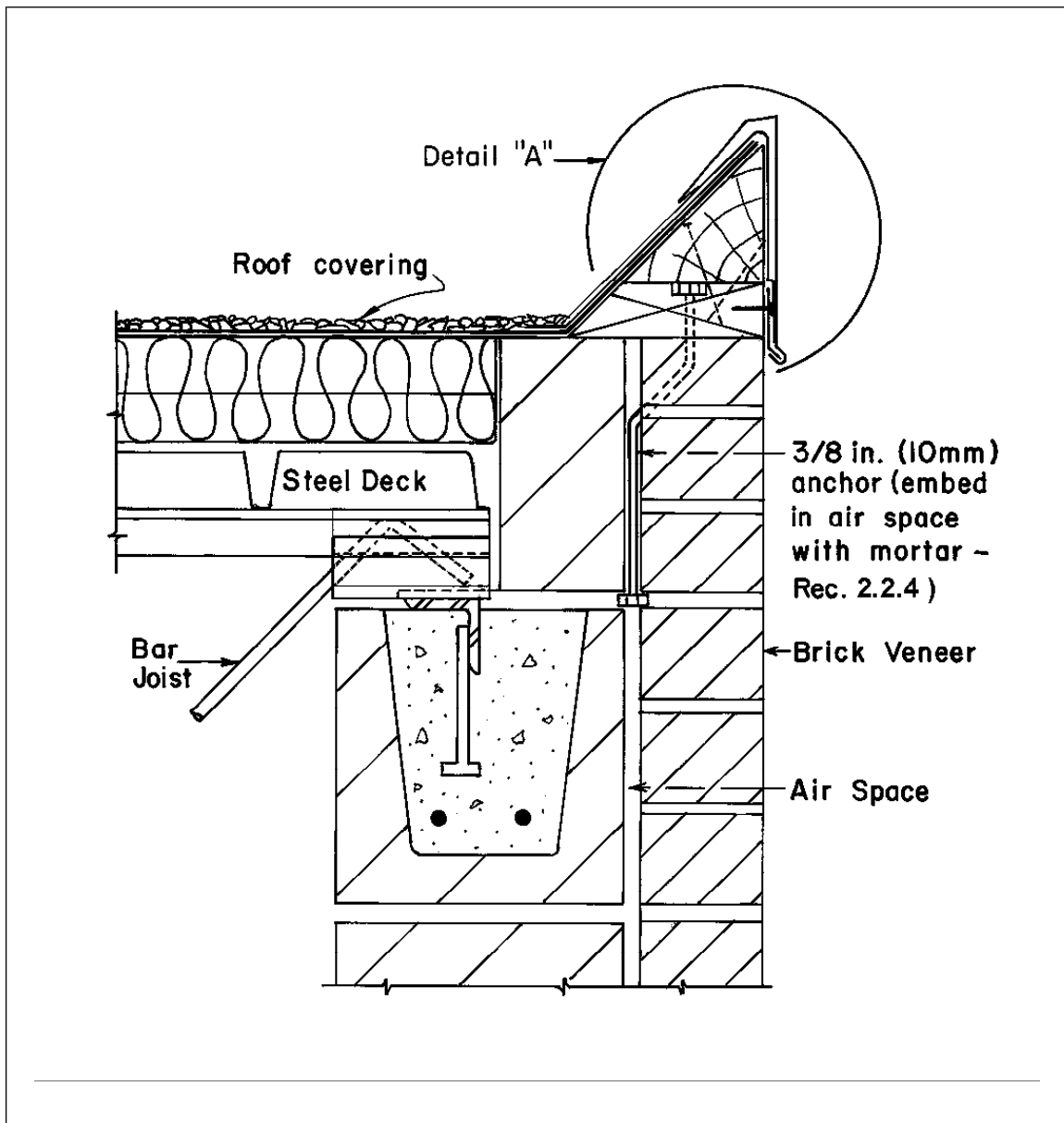


Fig. 3. With roof edge cant.

### 2.1.3.3 Masonry Wall With High Parapet

Figure 5 outlines flashing details for masonry wall with high parapet, or where a low roof meets the wall of a building with a higher roof. The wood nailer can be attached directly to the deck with fasteners, according to Recommendation Nos. 2.2.6 and 2.2.7. The cant strip is then secured in accordance with Recommendation No. 2.2.8.

The roofing membrane and base flashing should be applied in accordance with the roofing manufacturer's specifications, and secured at the top edge with masonry nails. The top edge of felt base flashing should be sealed with plastic cement.

The metal counterflashing should be slipped under the counterflashing insert and over the felt base flashing. The metal is then secured with masonry anchors\* at 3 ft (914 mm) spacing. Metal thickness should be 24 gauge (0.61 mm) galvanized iron, 24 gauge (0.61 mm) stainless steel, 20 oz. (0.69 mm) copper or 0.040

in. (1.02 mm) aluminum in maximum 10 ft (3.05 m) lengths. The "L" dimension should not exceed the dimensions shown for those gauges (Table 1). For attachment of the metal, first drill holes into which the anchors are inserted. Resistance is provided by expansion sleeves or threads on the anchor.

**\*Note:** Plastic parts used in masonry anchors are not recommended.

The sections are joined by "S" slips blind nailed at the joints to minimize stresses due to expansion or contraction (Figs. 4 and 5, Detail B). The thickness of the metal should be in accordance with Table 1.

A reglet approximately 1 in. (25 mm) deep also may be cut into the wall. The reglet is primed and filled with a high grade caulking compound. The counterflashing is then inserted into the reglet and secured with masonry anchors 3 ft (914 mm) on center. Use "S" slips at laps.

When the parapet is too low for an insert or reglet on the vertical surface, the wall top can be covered with a metal coping. (Fig. 17.)

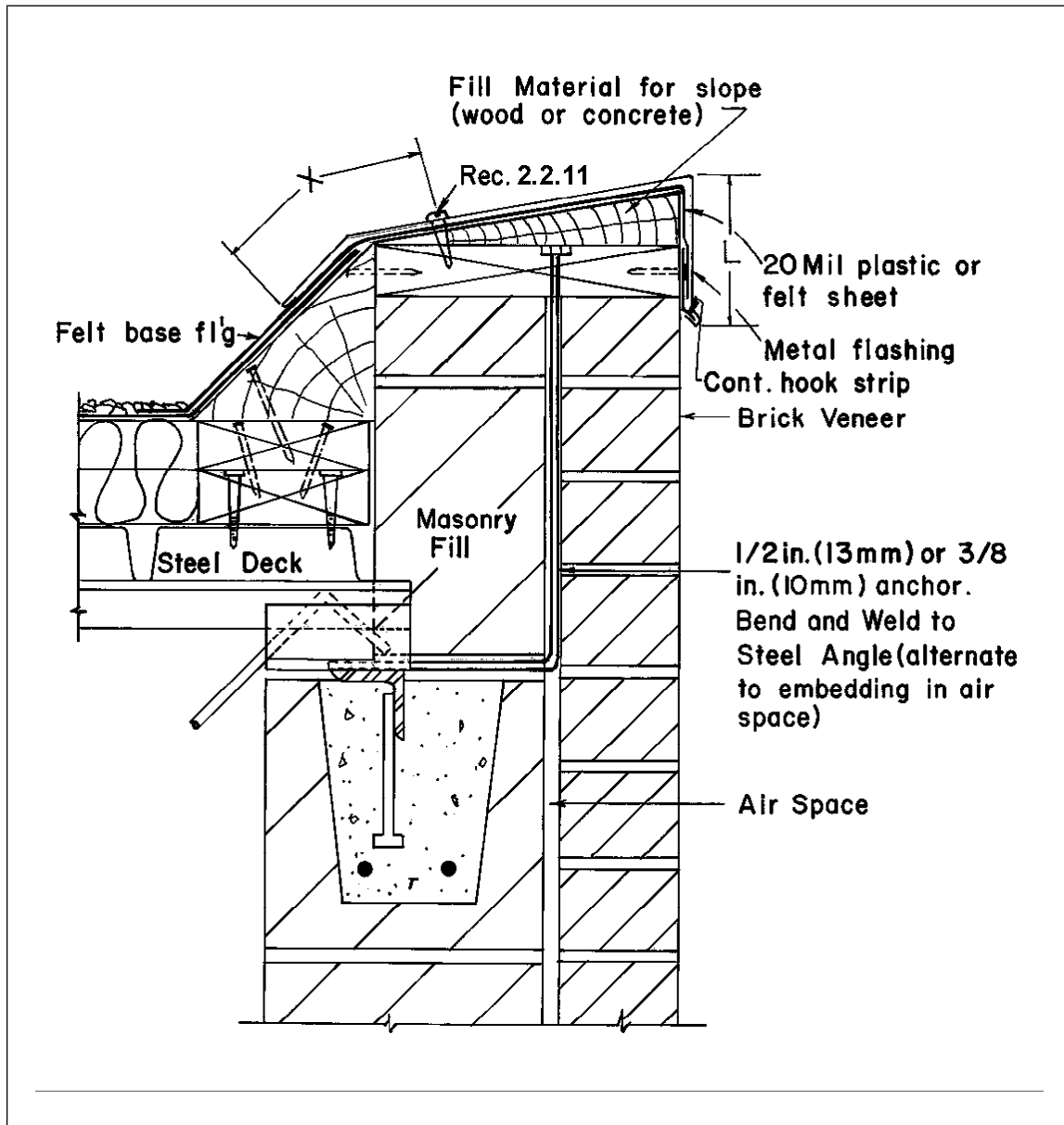


Fig. 4. With low parapet.

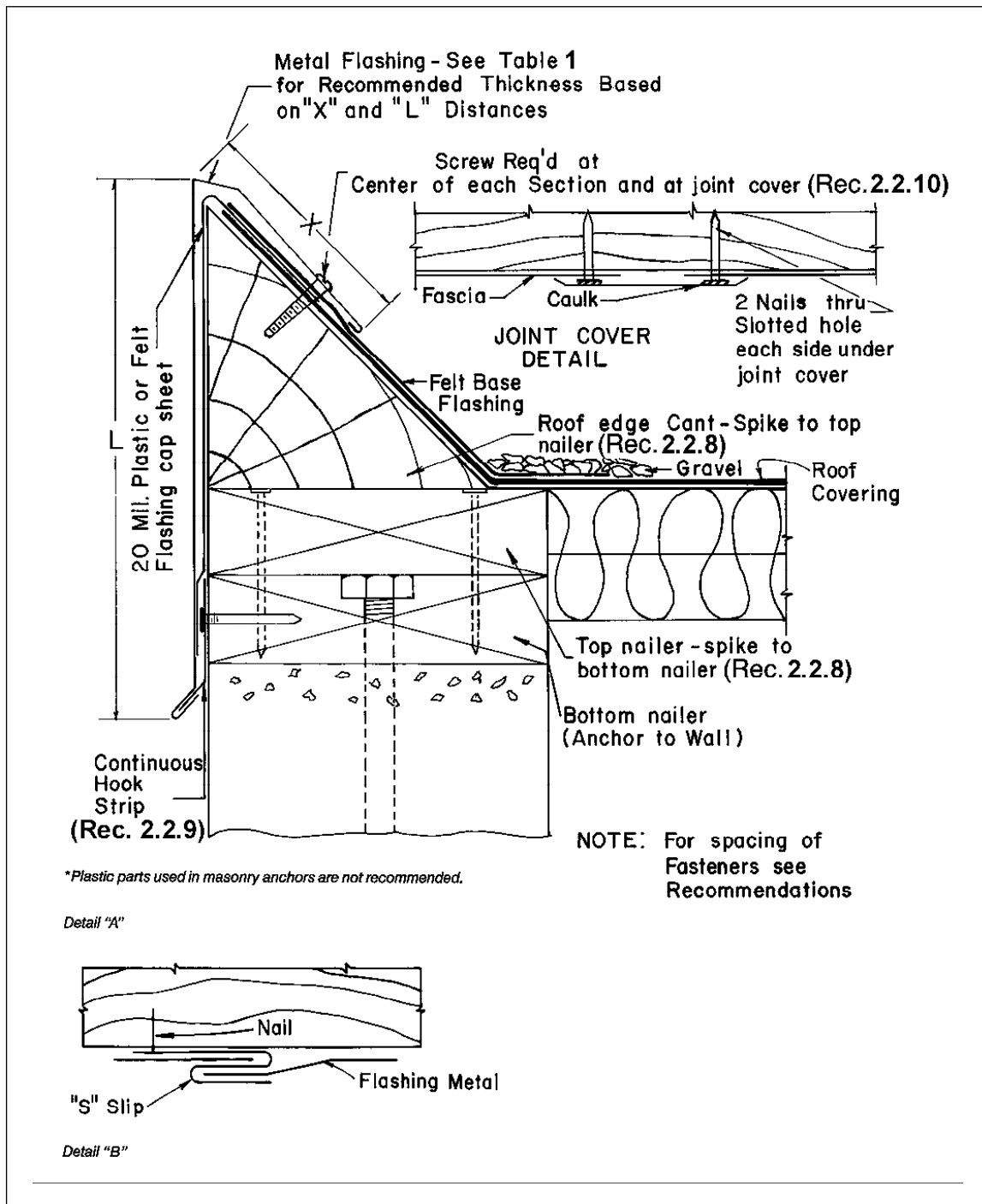


Fig. 4. Continued.

Table 1. Maximum Recommended "L" & "X" Dimensions and Metal Thicknesses for Roof Edge Flashing & Hook Strip.  
 Note: Not applicable for metal gravel guard and fascia — Fig. 11 (See text).

Type of Metal	Maximum "L" Dimension							Hook Strip		Maximum "X" Dimension						
	Velocity Pressure (pounds per square foot)															
	Class 1-60				Class 1-75 and 1-90					Class 1-60				Class 1-75 and 1-90		
	10-20		21-30		31-45					10-20		21-30		31-45		
Galv. Iron or Soft Stainless Steel	(0.48-0.95 kPa)		(1.0-1.44 kPa)		(1.48-2.15 kPa)					(1.48-0.95 kPa)		(1.0-1.44 kPa)		(1.48-2.15 kPa)		
	Ga.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	Ga.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
	26	(0.45)	6	(150)	6	(150)	4	(100)	24	(0.61)	3	(75)	2½	(65)	use thicker metal	
	24	(0.61)	8	(200)	8	(200)	6	(150)	22	(0.76)	4	(100)	3	(75)	3	(75)
	22	(0.76)	10	(250)	10	(250)	8	(200)	20	(0.91)	4	(100)	4	(100)	3½	(88)
	20	(0.91)	12	(300)	12	(300)	10	(250)	18	(1.06)	5	(130)	4½	(115)	4	(100)
Aluminum**																
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
	0.040	(1.02)	6	(150)	6	(150)	4	(100)	0.050	(1.27)	4	(100)	3	(75)	2½	(65)
	0.050	(1.27)	8	(200)	8	(200)	6	(150)	0.060	(1.62)	4½	(115)	4	(100)	3	(75)
	0.060	(1.62)	10	(250)	10	(250)	8	(200)	0.070	(1.78)	5	(130)	4½	(115)	3½	(88)
	0.070	(1.78)					10	(250)	0.080	(1.93)	5½	(140)	5	(130)	4	(100)
Copper																
	oz	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	oz	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
	16	(0.55)	8	(200)	6	(150)	4	(100)	20	(0.69)	3½	(88)	3	(75)	2½	(65)
	20	(0.69)	10	(250)	8	(200)	6	(150)	24	(0.82)	4	(100)	3½	(88)	3	(75)
	24	(0.82)			10	(250)	8	(200)	32	(1.10)	4½	(115)	4	(100)	3½	(88)
	32	(1.10)					10	(250)	48	(1.64)	5½	(130)	5	(130)	4	(100)

NOTES:

\*1. Additional fasteners are required near top of cant. One screw with washer at center of each section of fascia and one through joint cover. See Detail "A".

\*\*2. Temper "O" aluminum, although easily formed, has a low bending strength. High tempers are advised when using aluminum.

### 2.1.3.4 Panel Wall — With Roof Edge Cant or Low Parapet

As in the case of masonry wall, adequate anchorage of nailers is very important. The nailers can sometimes be extended to the outer face of the wall (Fig. 6). If the wall is farther away, the nailers can extend only to the inner face of the wall (Figs. 7 and 8). When the wall is thick, the metal can be sloped over its top, forming a low parapet. When joist spacings are wide, it is good practice to weld a steel angle (for nailer support) to the building framing (Fig. 9).

Blocking, or several thicknesses of wood may be necessary so that the top of the nailer will be level with the top of the roof insulation or top of the deck (if no insulation is used).

Fastening the wood nailer to steel deck that overhangs the supporting beam is not recommended unless the outer extremity of the deck or nailer is secured from vertical deflection by attachment to the roof joists or wall (see Recommendation Nos. 2.2.6 and 2.2.7).

When a nailer is fastened directly to the deck or bar joists, the maximum advisable unsupported overhang is 2 in. (50 mm). Use of a 1-½ by 7-½ in. (38 by 190 mm) nailer is recommended because it will be wide enough to allow for the installation of two rows of fasteners into the deck.

When the wall is constructed of precast concrete, bolts are usually cast in the top edge of the wall to anchor the nailer. The threaded bolt is projected upward sufficient distance so that the tops of the nuts and bolts are even with the top of the nailer. It is necessary to countersink the nut into the wood.

When the roof is a heavy, poured-concrete slab, it may be cantilevered to the wall edge without beam support. The nailer may then be bolted directly to the concrete.

When the walls of the building are ribbed, an insulated metal closure normally is provided behind the hook strip. This also prevents wind from getting behind the metal fascia and bending it outward.

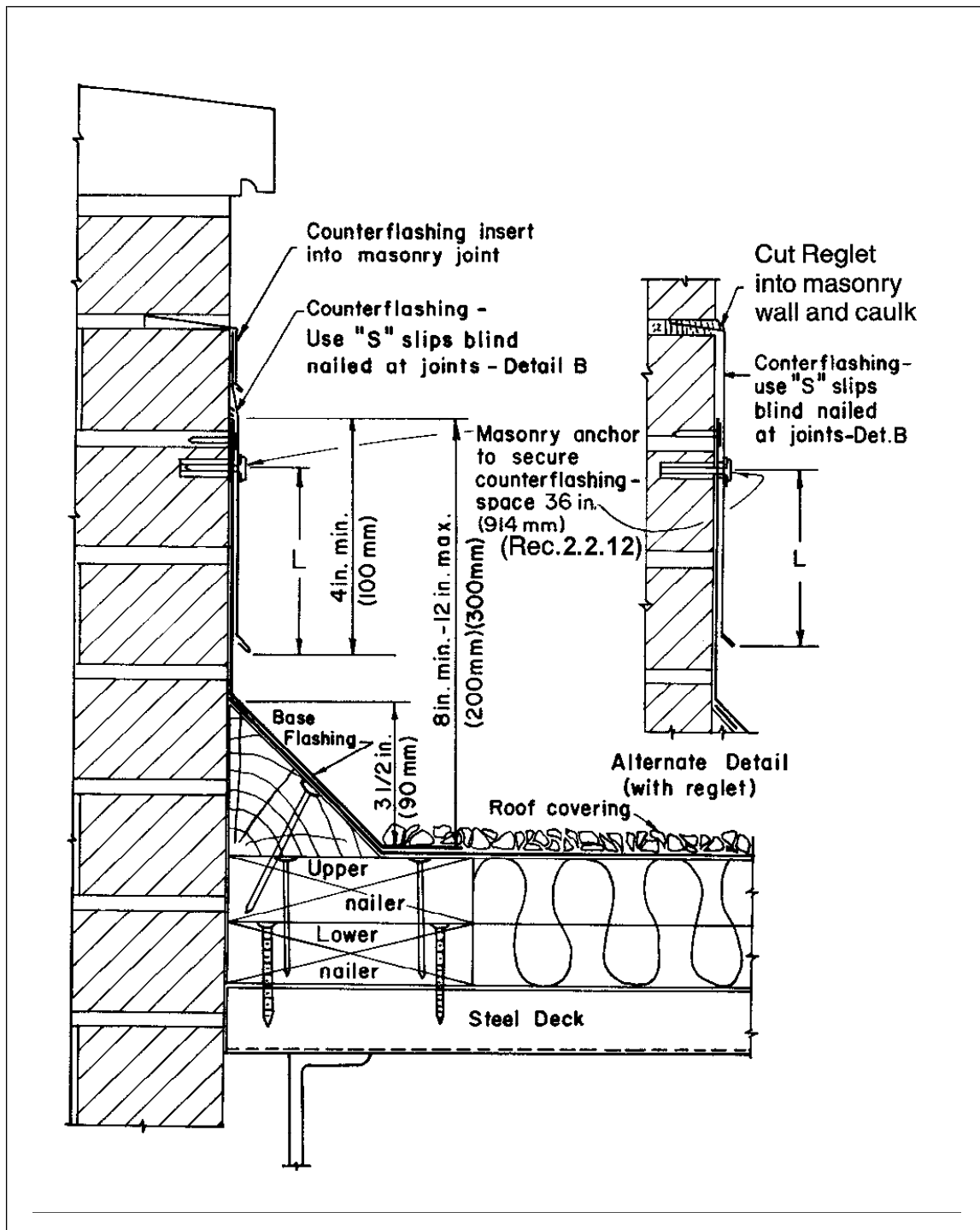


Fig. 5. With high parapet.

2.1.3.5 Panel Wall — With Parapet

Should the panel wall extend above the roof, forming a parapet, a good installation may be obtained by bolting a wood nailer to the inner face of the wall. The coping and combination counterflashing may be attached to this nailer and to the outer face of the wall. The bottom nailer may be attached directly to the steel deck, as the outside extremity is held from vertical deflection to the wood members above. A closure and hook strip

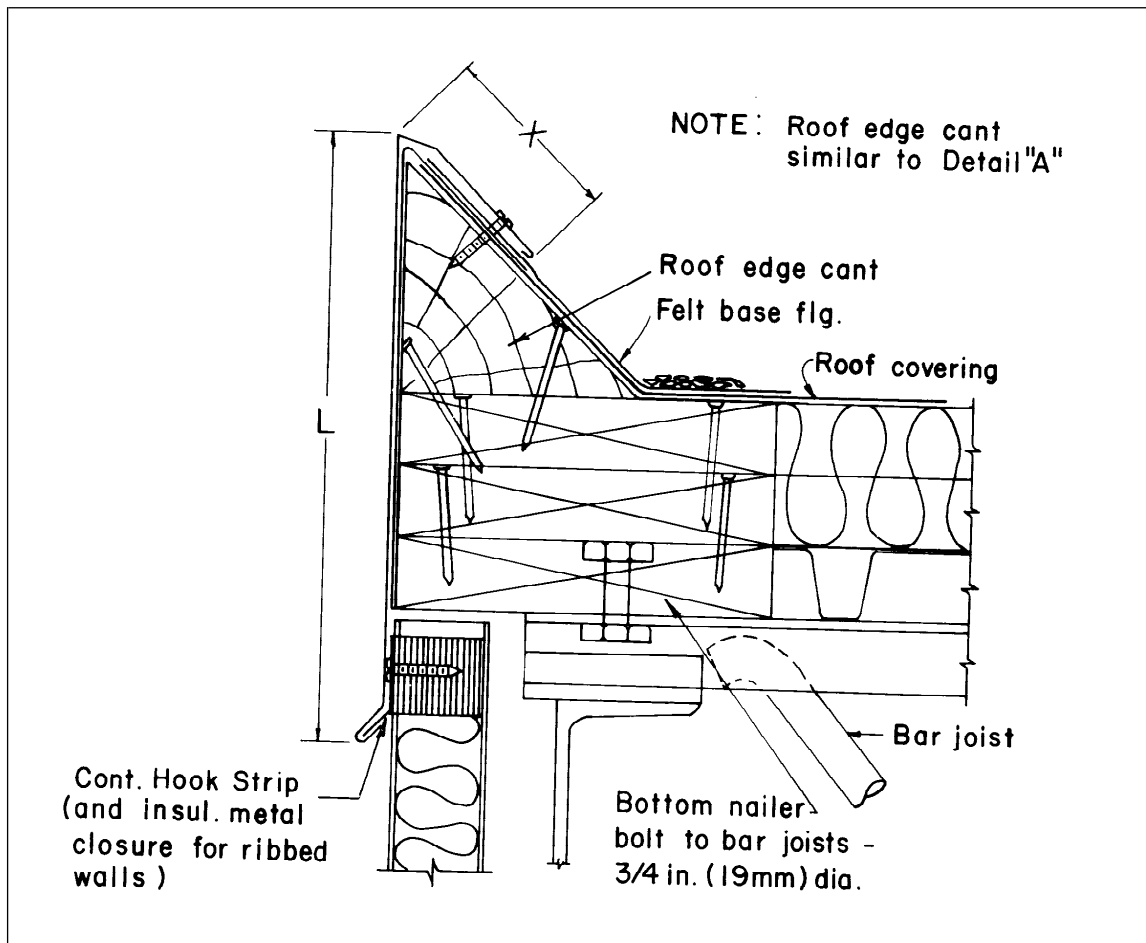


Fig. 6. With roof edge cant, nailer bolted to roof joists.

is provided on the outside. Walls to which flashing assemblies are attached should be independently supported by the building frame, and should not create a stress on the flashing assembly (Fig. 10).

When the fascia over an existing metal panel wall has no hook strip, and a loss has occurred, installation of a new hook strip under the metal may be difficult. Instead, the flashing can be fastened directly to the wall in accordance with the hook strip fastening given in Recommendation No. 2.2.9.

#### 2.1.3.6 Metal Gravel Guard and Fascia

Thermal expansion and contraction in heavy gauge metal can sometimes dislodge the fasteners in gravel guards. Therefore, gravel guards and hook strips should not be heavier than 24-26 gauge (0.61-0.45 mm) galvanized iron or stainless steel, 16-12 oz. (0.55-0.41 mm) copper or 0.040-0.30 in. (1.02-0.77 mm) aluminum in maximum 10 ft (3.05 m) lengths. Hook strips should be one gauge heavier than the fascia. Fasteners and spacing should be in accordance with Recommendation No. 2.2.9. The strip-in felts will likely require periodic maintenance. The gravel guard joints, which depend upon the plastic roofing cement to remain tight, are likely to break open at every second or third joint due to expansion and contraction of the metal. If tapered insulation is used to raise the edge out of the water line in the case of flat roofs, or if the roof slopes away from the roof edge, the problems are somewhat minimized, but still exist.

Gravel guards normally are installed in lengths of 8 to 10 ft (2.44 to 3.05 m). They are lapped a minimum of 2 in. (51 mm) at their joints. A full bead of plastic roofing cement is between the lap or space ends and a 4 in. (102 mm) wide cover plate. The roof flange (horizontal part) is set over all of the roofing felts in a solid troweled coat of plastic roofing cement and nailed 1 in. (25 mm) from the back edge at 4 in. (102 mm) spacing. The flange edge and nail heads are sealed by stripping in with two layers of felt set in hot roofing bitumen. The first 6 in. (152 mm) wide strip should extend onto the gravel guard flange 3 in. (76 mm), overlapping

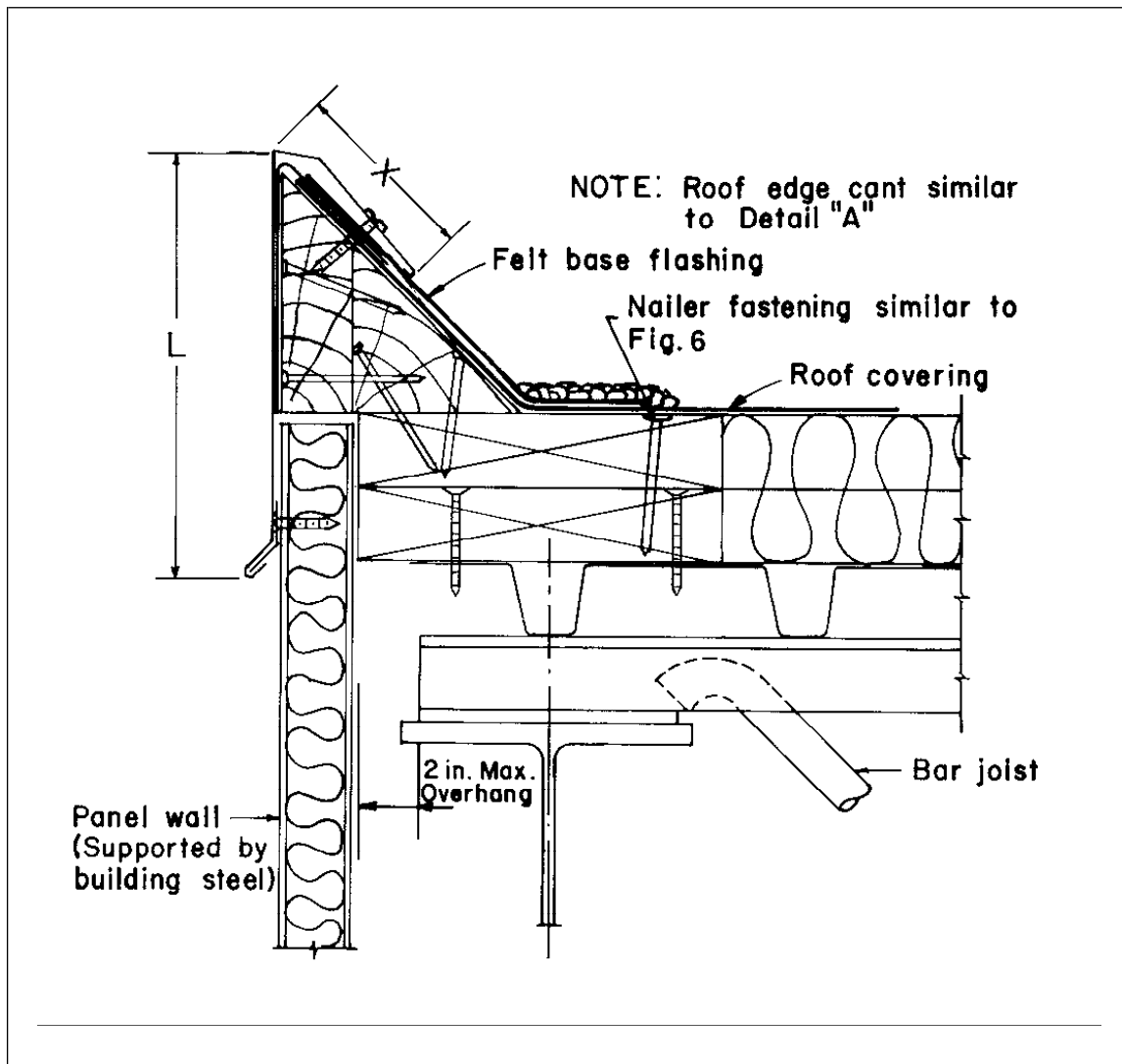


Fig. 7. With roof edge cant, nailer bolted to roof.

the nail heads 2 in. (51 mm), and over the roofing felts 3 in. (76 mm). A second strip 9 in. (229 mm) wide is extended onto the gravel guard flange to the gravel stop at least 4 in. (102 mm) and over the roofing felts a minimum of 4 in. (102 mm). It is important that the second layer have a good overlap on the metal flange beyond the first layer (Fig. 11).

#### 2.1.3.7 Metal Gutter

Wind uplift forces on a gutter at the eave of a building can be much greater than the gutter weight. Wind has removed a considerable number of weakly attached gutters.

Gutter-blow-off can be prevented by placing metal straps around the gutter exterior at intervals of 10 ft (3.05 m), and securely anchoring the straps to the roof and wall (Fig. 12). Nails and strip-in felts can be installed in accordance with Section 2.1.3.6, *Metal Gravel Guard and Fascia*.

Metal gutters need expansion joints at approximately 30 ft (9.14 m) intervals.

#### 2.1.3.8 Overflow Scuppers

Wood cant strips 5-½ in. (140 mm) high (or parapet walls) are desirable to minimize accumulated water along the edge from seeping under the roof covering where it terminates on the cant. However, if the roof

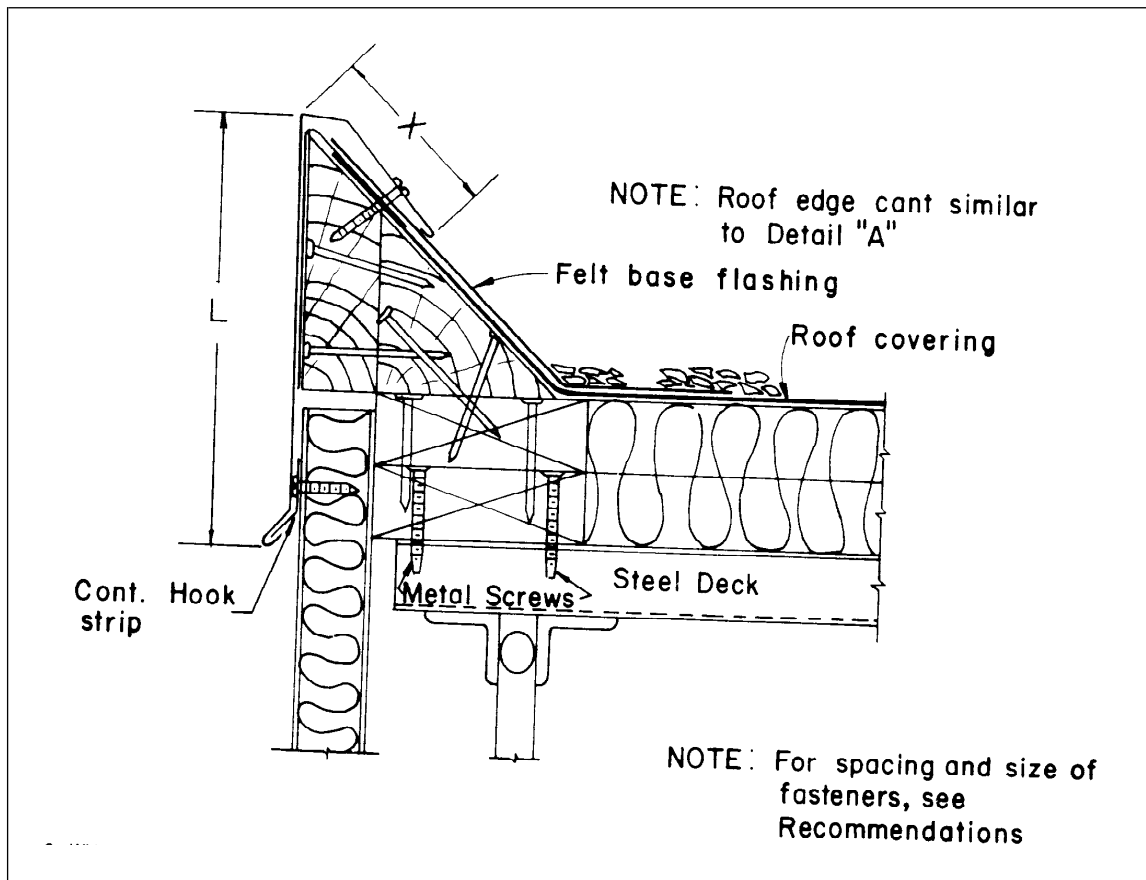


Fig. 8. With roof edge cant, nailer screwed to deck.

drains become plugged or do not exist, the weight of water buildup can be up to 30 lb/ft<sup>2</sup> (1.44 kPa) at the roof edge and higher toward the interior. It is not advisable to allow that much water to stand on the roof, as it may lead to collapse.

The depth of water can be significantly reduced by setting metal-lined overflow scuppers at intervals in the cant strip. The bottom of the scupper should be at an elevation such that only a minimal amount of water will stand on the roof at its lowest point (see Recommendation No. 2.2.14 and Data Sheet 1-54, *Roof Loads for New Construction*).

Flanges of gutters and scuppers are set in a bed of roofing cement to level them and to prevent water from seeping through the joints into the wall below.

#### 2.1.3.9 Roof Penetration

Openings are necessary in the structural roof and covering wherever pipes, vents, structural members, curbs, etc. pass through. The National Roofing Contractors Association publishes standard flashing details that are generally appropriate. Roof penetrations have not been an appreciable factor in roof wind losses, but should be evaluated for their long-range watertightness.

#### 2.1.4 SPM Flashing Details

##### 2.1.4.1 General

See Data Sheet 1-29, *Above-Deck Roof Components* for single-ply secured membranes and ballasted membranes.

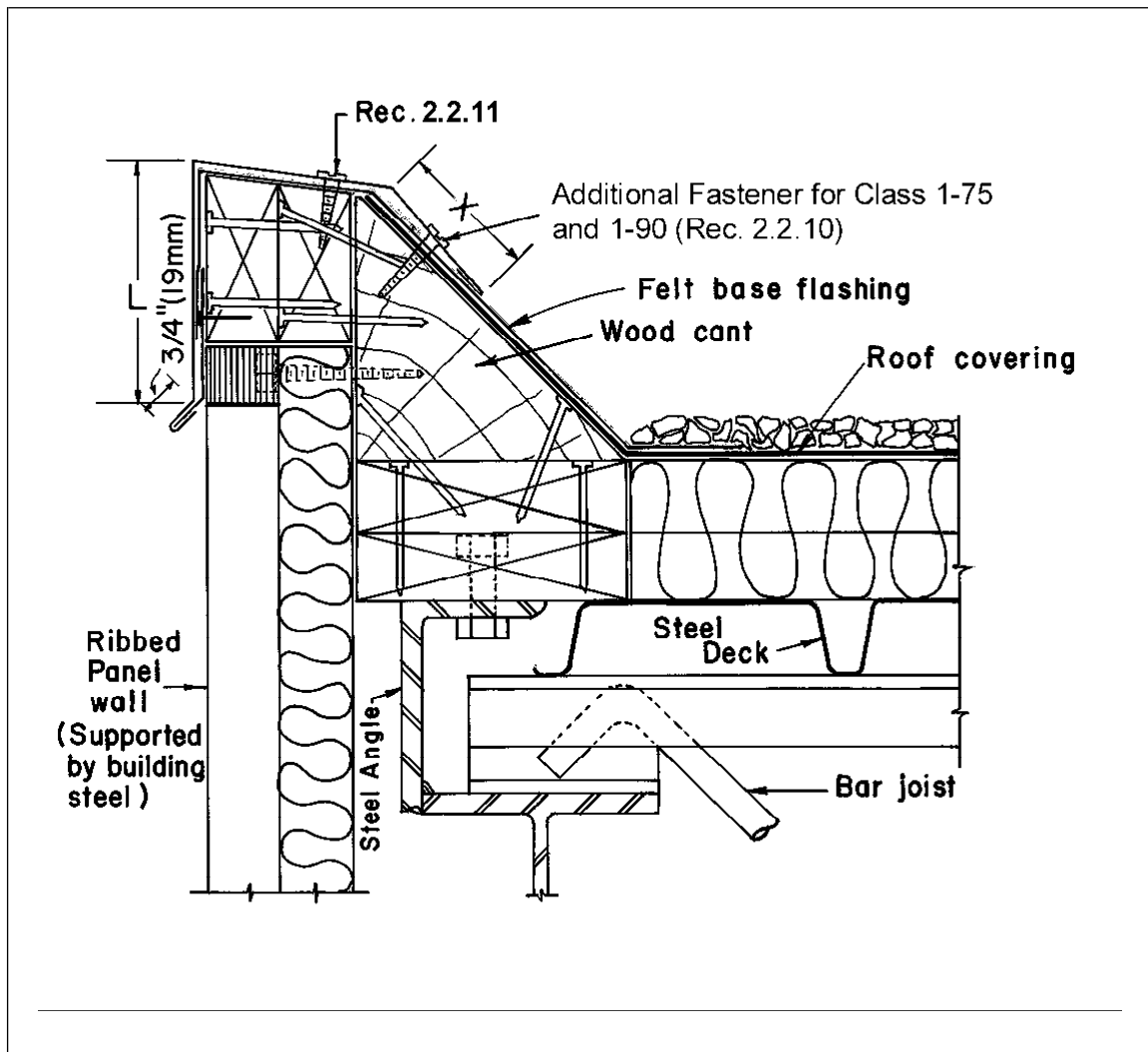


Fig. 9. With low parapet, nailer bolted to steel angle.

Wind forces acting on a particular perimeter flashing assembly are not significantly influenced by the type of covering. Therefore, anchorages of nailers, cant strips, hook strips, etc. and metal thicknesses can be in accordance with the *BUR Flashing Details* discussed previously.

#### 2.1.4.2 Membrane Terminations

It is necessary that the membrane be continuous across the junction between the wall and roof, otherwise water will enter the building. When the roof edge has a gravel guard, the membrane, if flexible, can be extended down over the nailers and fastened [Fig. 13 (a)]. If not flexible, it can be stopped at the outside edge of the nailer [Fig. 13 (b)]. When a wood cant strip is present, the membrane can be stopped at the cant and fastened at the nailer. A strip of membrane or flashing, as appropriate, can be adhered to the cant and membrane to seal. Caulking the joints may be needed, as specified by the membrane manufacturer (Fig. 14).

Membranes should not be bent at 90° or even 45° unless authorized by the manufacturer. With certain membranes, there is a possibility that leaks may develop at the bend. The manufacturer may require that the membrane be flat, with specified flashing material utilized at bends.

For certain membranes, it may be difficult to seal directly to the metal at the job site. The membrane manufacturer can supply a factory-assembled laminate of the membrane material on the metal for use in such cases (see Fig. 18).

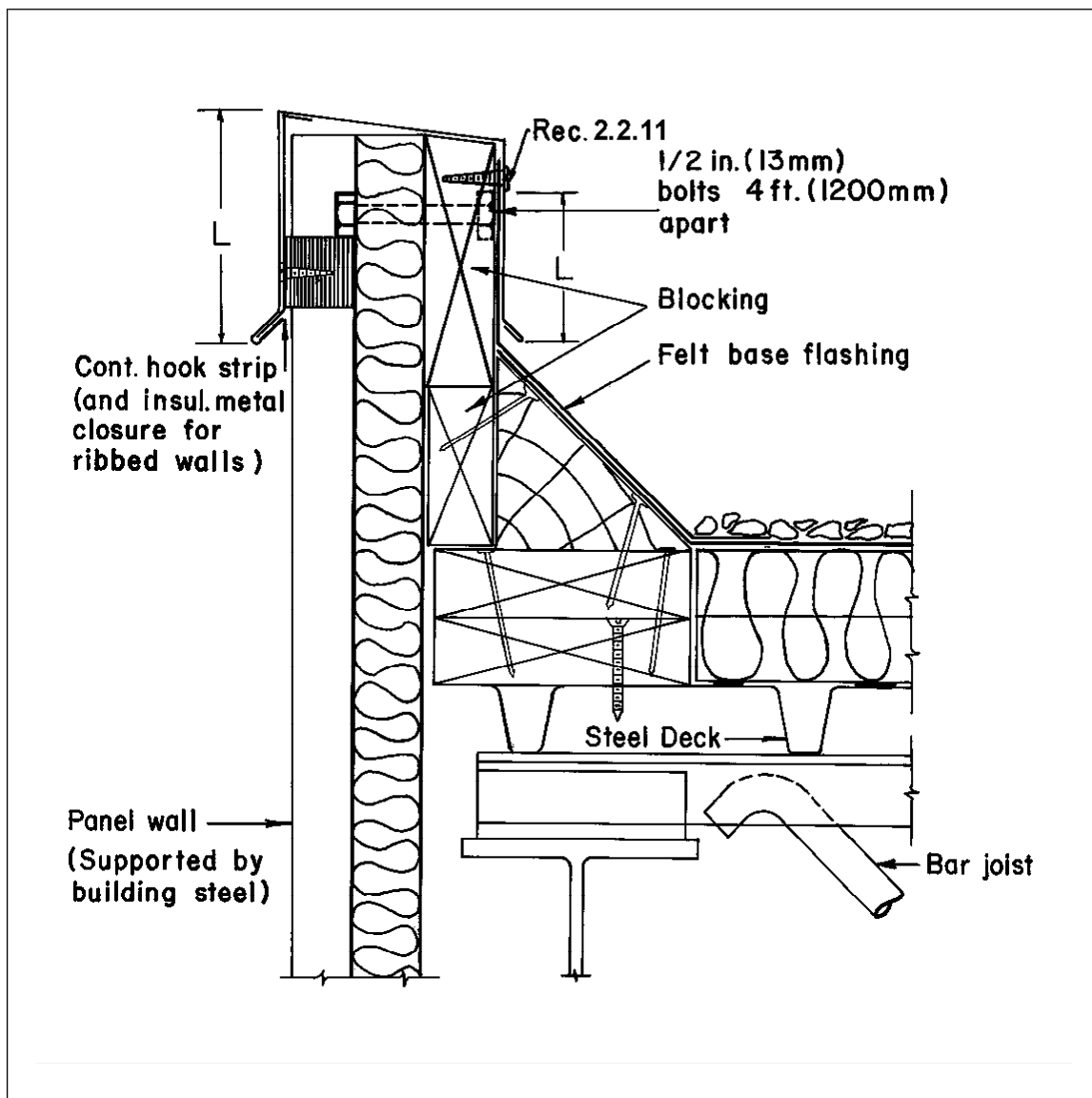


Fig. 10. With parapet.

### 2.1.4.3 Reglets

Reglets are notches that are built, cut or formed on the inside face of a masonry parapet wall to receive the upper termination of the metal counterflashing. The metal protects the membrane termination from the weather (Fig. 15).

A reglet having an upward slope is preferred, as the metal also can be sloped. This will prevent water from seeping in behind the metal and finding its way under the membrane. The space between the metal and upper surface of the reglet should be caulked with a specified, good quality caulking compound.

When the wall is concrete, the reglet can be constructed by use of a sheet metal form. An exception may exist when the wall is precast and relatively thin. In this case, the wall could be significantly weakened by forming or cutting a reglet. When the wall is masonry, the reglet can be made at a joint by raking out the mortar. The sheet metal should be sloped outward and, in masonry walls, the metal should have a 135° bend that will help to hold it in place after it is inserted.

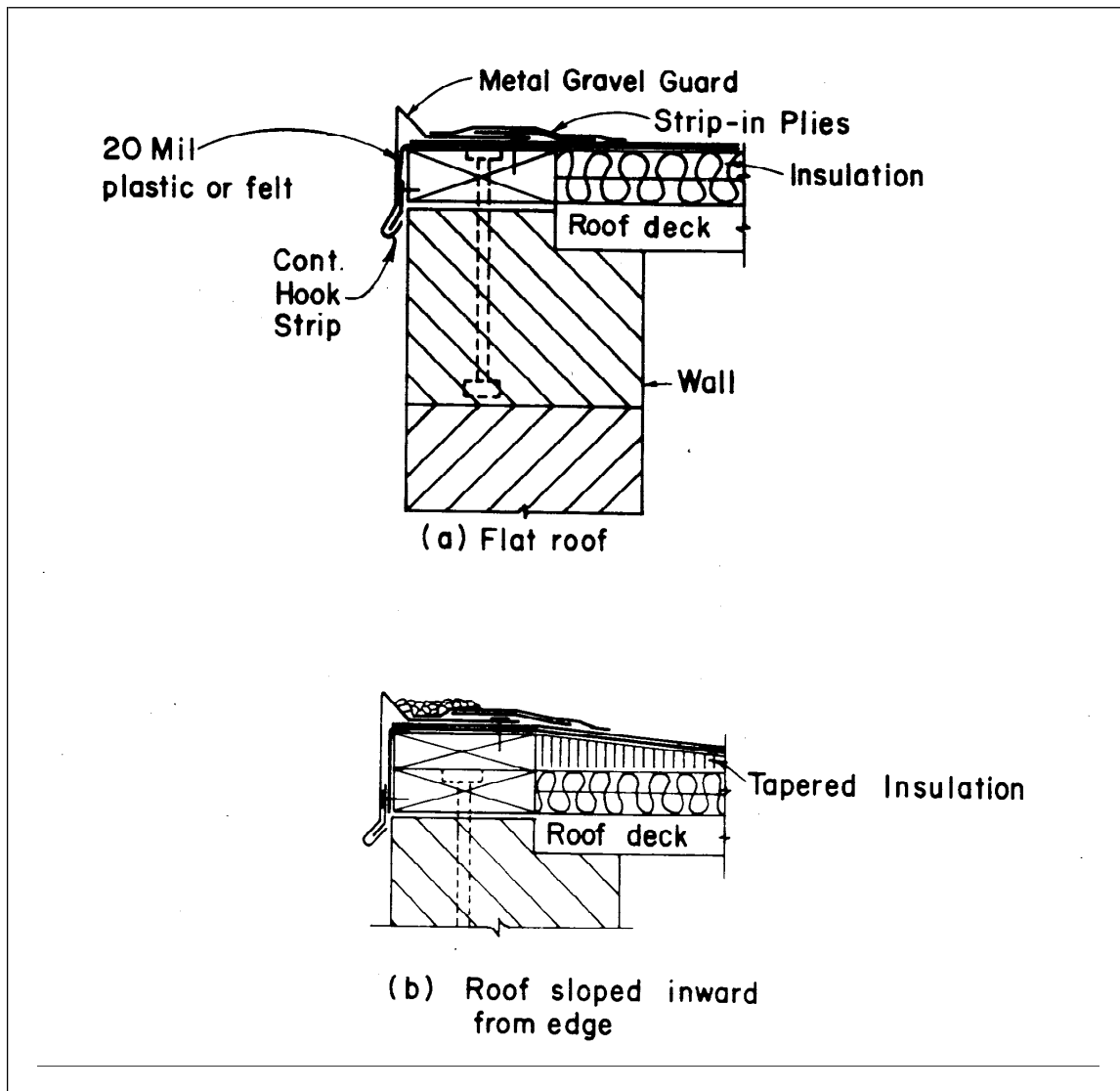


Fig. 11. Metal gravel guard and fascia.

When a concrete wall or parapet does not have a formed reglet, one can be cut using a concrete saw and chisel. This may be difficult, however, and there are other methods, such as: a) terminating the membrane at a point above the roof higher than the maximum expected rain or snow elevation and protecting it with a termination bar (Fig. 16), or b) fastening the membrane to the face of the parapet under the coping cap and adhering it to the wall by adhesives (Fig. 17). Caution should be used, however, because the distance a single-ply membrane or flashing can be run up a wall depends on variables such as membrane strength, adhesive type, wall roughness, etc. The safe distance is usually no more than several feet; however, it can be greater when several rows of reglets or termination bars are used.

#### 2.1.4.4 Termination Bars

When individual fasteners are used at the membrane termination, local stresses are introduced into the fabric around the fastener. This is due to the dead weight of the membrane, along with possible contraction forces in the membrane. Fasteners need to be spaced closely to prevent sagging.

The termination bar is a continuous metal bar that is attached to the wall with fasteners that penetrate the membrane. The bar tends to distribute forces in the membrane more evenly so fasteners need not be spaced

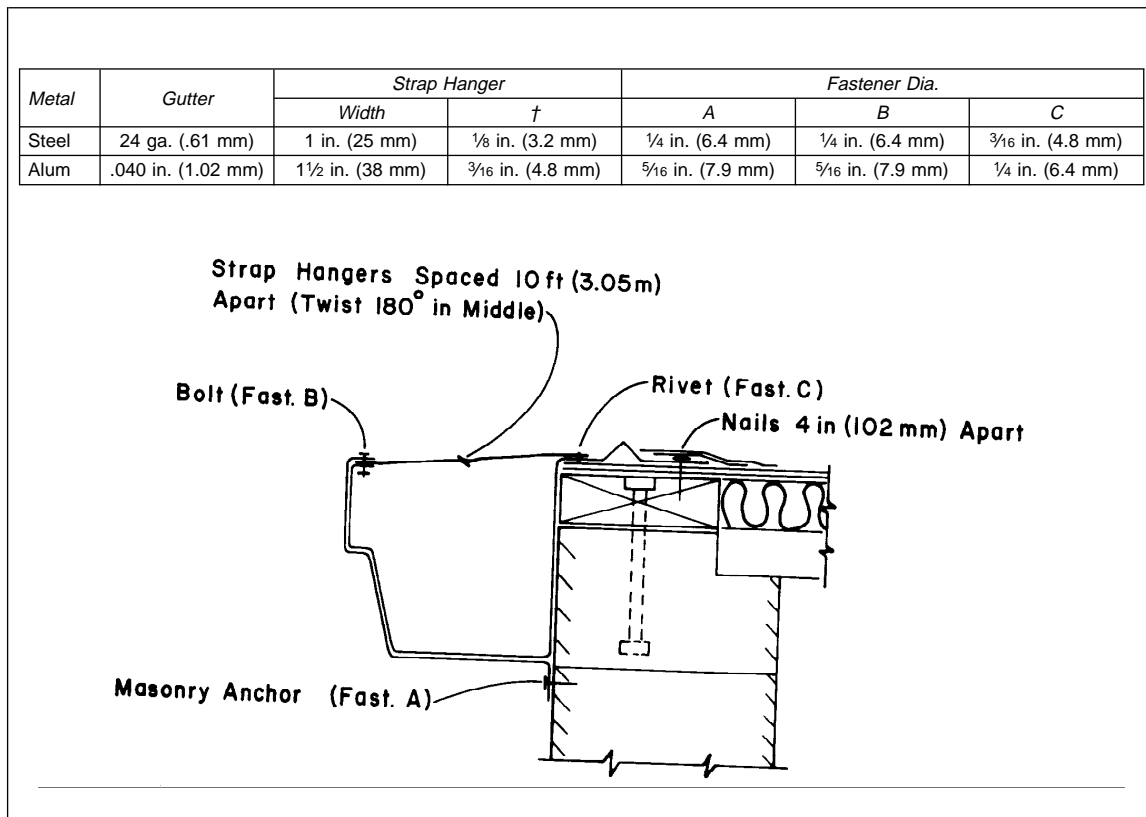


Fig. 12. Metal gutter with masonry wall.

as closely. Termination bars are of many shapes, such as angular, channel-shaped or curved. Good stiffness is needed to distribute the forces at the fasteners. As the membrane termination needs caulking to prevent entry of water behind it, the bar sometimes has the top turned outward to hold the caulking. Also, the bottom of the bar can be bent outward to direct dripping water away from the wall [Fig. 16 (a)].

Termination bars are not preferred over metal flashing inserted into reglets. They may be used in special cases where cutting a reglet may weaken the wall, or where it is difficult to cut a reglet into an existing wall. A good quality specified caulking compound is necessary to seal the space between the termination bar and the wall.

Sheet metal also may be utilized to protect the membrane termination [Fig. 16 (b)].

2.1.4.5 Decorative Fascia

When a decorative or colorful fascia is required, the metal can be designed to be clipped to the top of the gravel stop and engage the hook strip at the bottom. Some Approved flashing systems are designed in this manner.

2.1.4.6 Masonry Anchors and Fasteners

For attachment of metal counter flashing or wood nailers to a masonry wall, holes are first drilled, into which the masonry anchors are inserted [Fastener No. 2 - Figs. 15 (b) and 16 (b)]. Resistance is provided by expansion sleeves or threads on the anchor. Spacing is usually about 36 in. (914 mm). Plastic parts should not be used in these anchors. The penetrating type of fastener driven into the masonry by impact is not considered reliable. Membrane manufacturers can supply appropriate fasteners for securement of the membrane at its upper termination [Fastener No. 1 - Figs. 15 (b) and 16 (b)]. Spacing of these fasteners depends on a number of factors, such as fastener strength, membrane strength, whether or not a termination bar is used, height of membrane up a parapet wall, elasticity, dead weight, contractual forces and so forth. These fasteners are quite often spaced in the range of 4 to 6 in. (102 to 152 mm) when no termination bar is used;

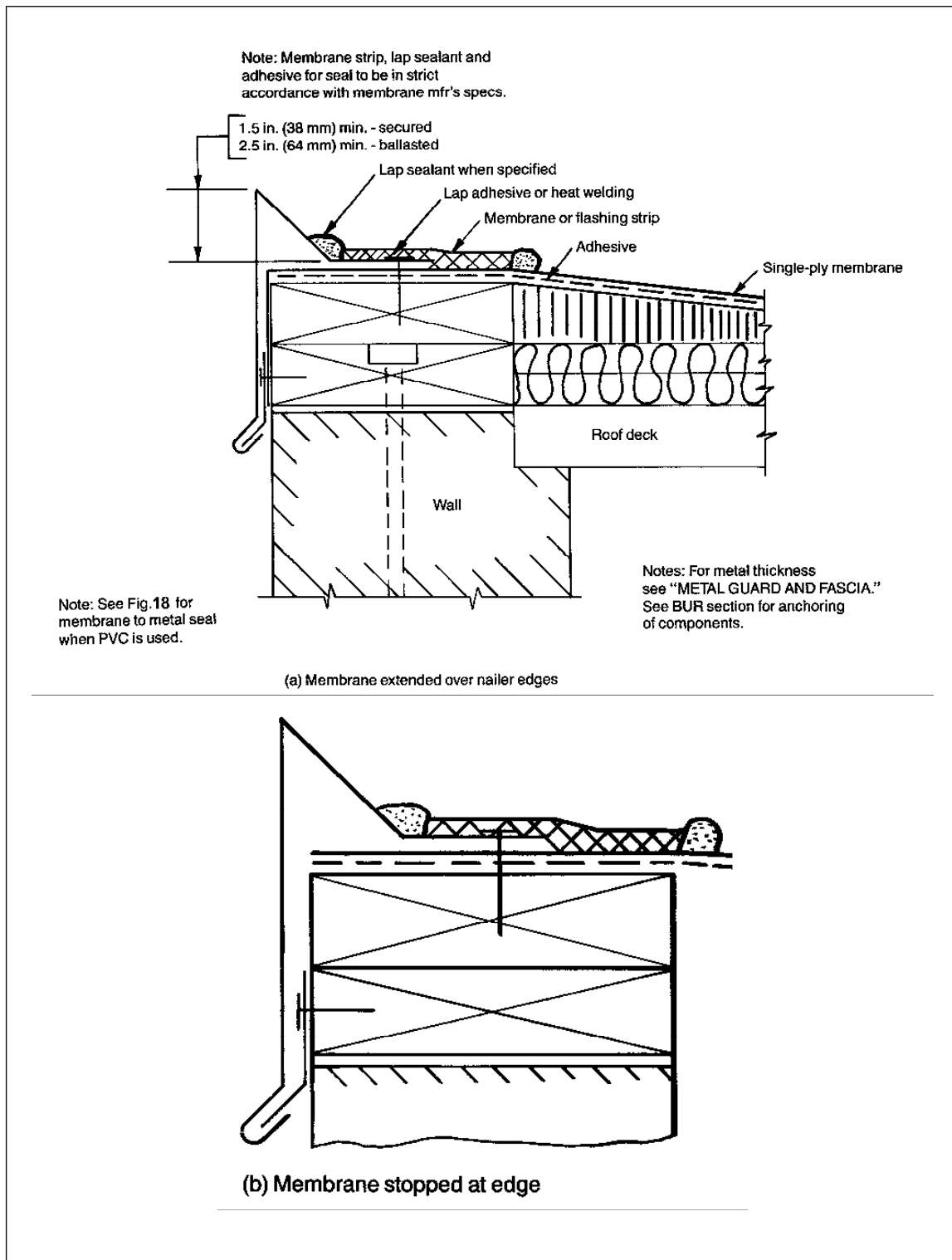


Fig. 13. Metal gravel guard and fascia.

however, spacing and type of fastener should be according to the membrane manufacturer's specifications. When a sheet metal flashing covers the termination, the same fastener may be used to secure both membrane and metal.

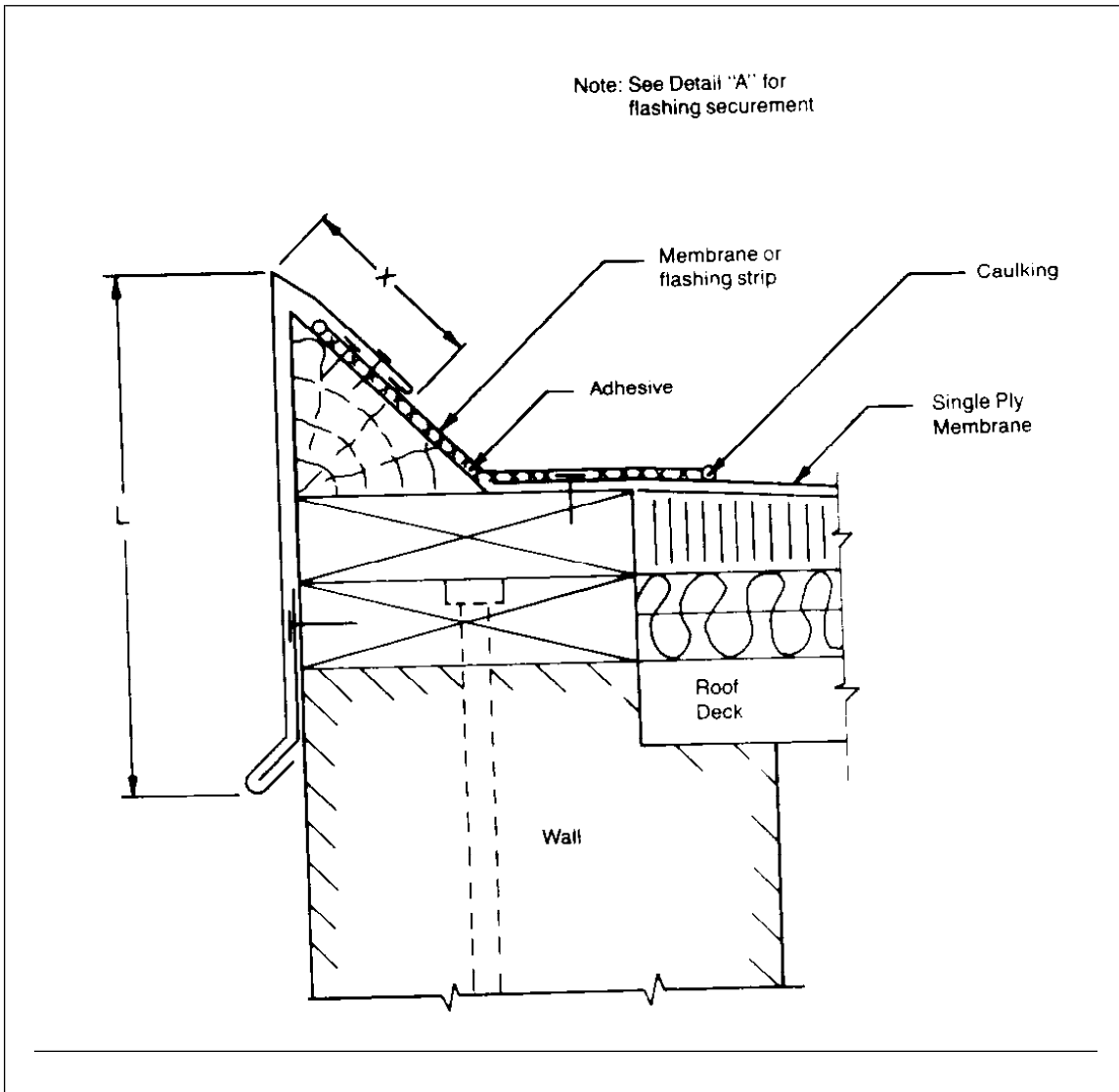


Fig. 14. Roof edge cant with flashing.

2.1.4.7 Parapets

Sometimes owners wish to carry the membrane up the face of the parapet and under the coping cap. This may be done when the parapet is low, or if the owners wish to cover deteriorating masonry. As it may be difficult to fasten the membrane under some masonry copings [Fig. 17 (b)], it may be simpler to remove the coping and carry the membrane partly under it. The coping can be either reset or replaced with sheet metal [Fig. 17 (a)].

2.1.4.8 Gutters, Scuppers and Roof Penetrations

When elasto-plastic membranes are used, special adhesives or laminations are used for attachment and sealing to the metal. Otherwise, items specified in *BUR Flashing Details* can be used.

2.2 Construction and Location

2.2.1. Flashing details shown in Figures 1 through 18, or an Approved flashing system are recommended, where appropriate.

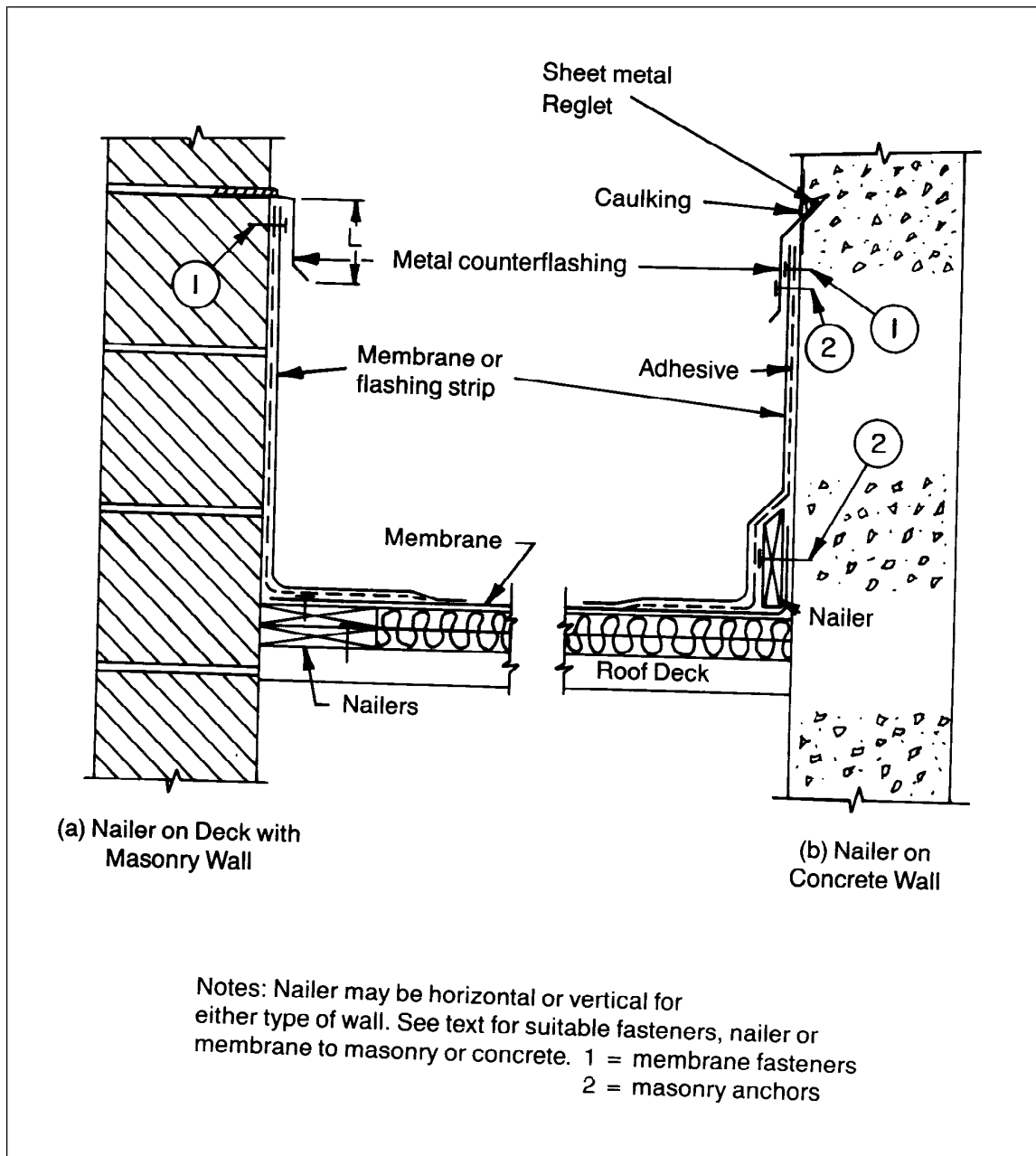


Fig. 15. Wall or parapet terminations.

2.2.2 When the velocity pressure for the roof field area is >30 psf or is Class 1-75 or Class 1-90, and the wall is of hollow block masonry, all cores or voids in the top course should be solidly filled with concrete.

2.2.3 When masonry wall block is lightweight aggregate (cinders, slag, etc.), embed nailer anchor bolt at least 12 in. (305 mm); when heavy aggregate (sand and gravel) is used, embed bolt at least 8 in. (203 mm) into the block cores filled with concrete.

2.2.4 Bolts anchoring wood nailers to concrete block walls should be 1/2 in. (13 mm) diameter spaced 4 ft (1.22 m) apart, staggered if the nailer is wider than 6 in. (152 mm). At outside building corners, bolts should be 2 ft (610 mm) apart, for 8 ft (2.44 m) each way from the corner. As an alternate, 3/8 in. (10 mm) bolts can be spaced 2 ft 8 in. (813 mm) apart and 16 in. (406 mm) apart at corners. When a steel beam has been installed at the top of the wall, the nailer may be bolted to it. Wood filler blocks may be required.

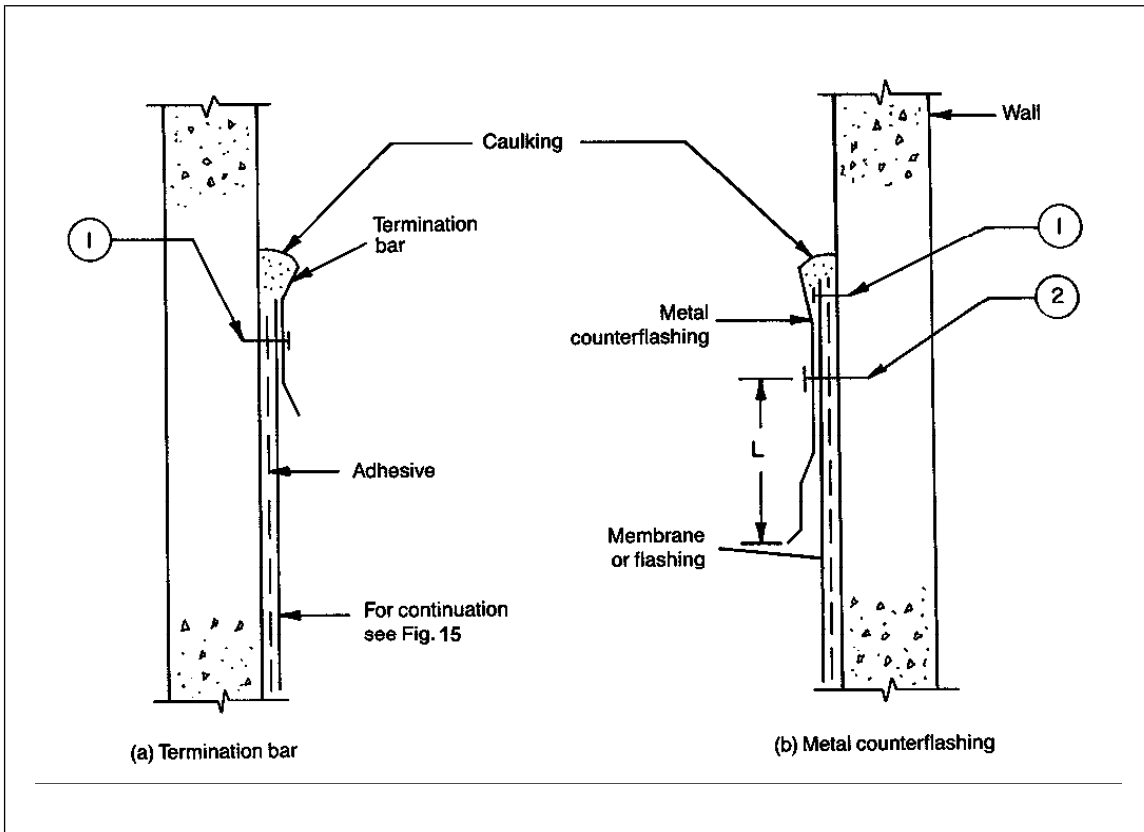
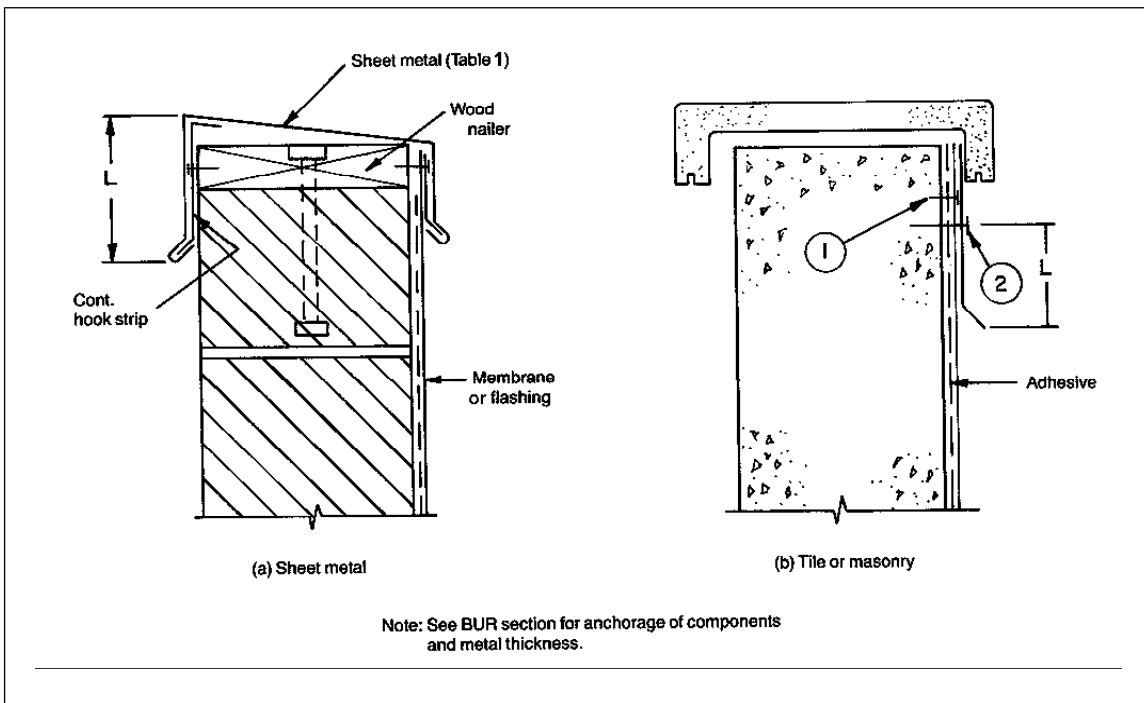


Fig. 16. Attachment to pre-cast walls (where reglet was formed).



Note: See BUR section for anchorage of components and metal thickness.

Fig. 17. Termination under parapet coping.

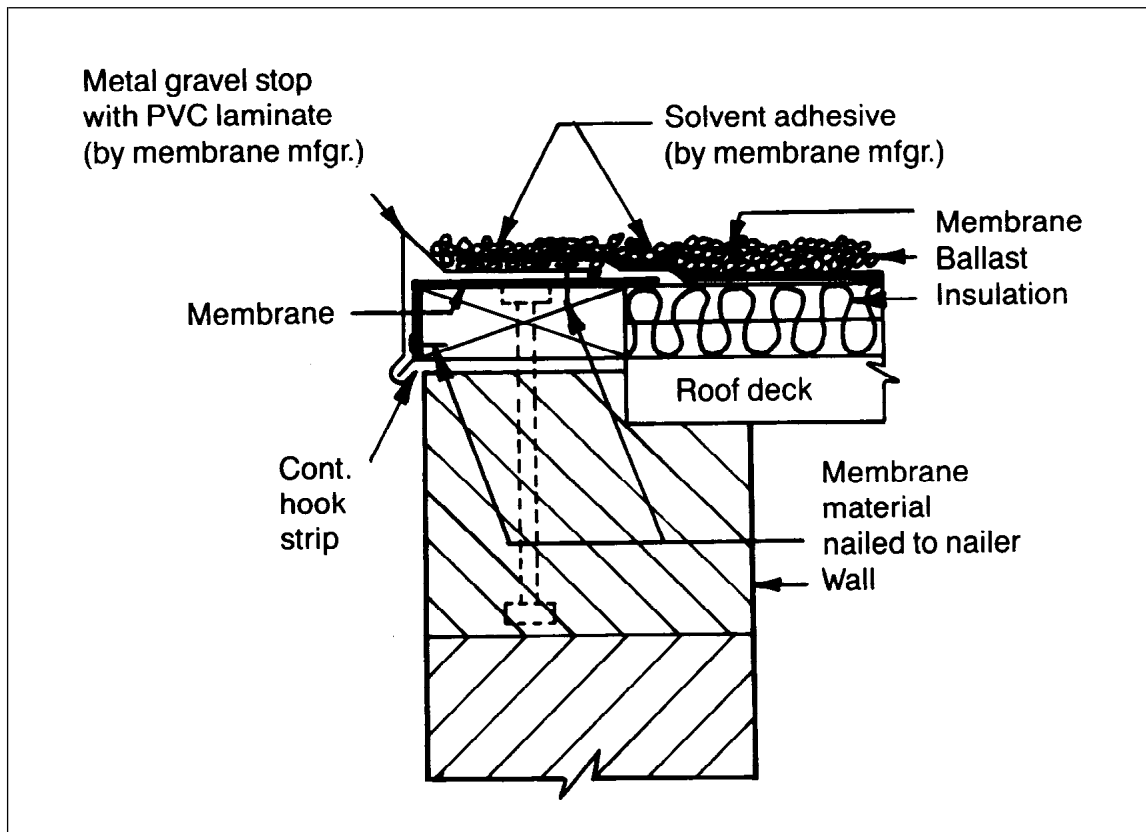


Fig. 18. Edge detail with gravel stop and PVC membrane.

2.2.5 Wood nailers anchored to masonry or steel should be a minimum of 1-½ by 5-½ in. (38 by 140 mm). They should be Douglas Fir, Southern Yellow Pine or of wood having similar decay-resistant properties. Fiberboard or other insulating materials are not recommended as cant strips.

2.2.6 Nailer parallel to ribs: When fastening wood nailers that are parallel to steel deck ribs (deck span 7 ft [2.13 m] or less), attach the nailer to each roof joist with a ¾ in. (19 mm) steel bolt (Fig. 6). For deck spans greater than 7 ft (2.13 m), a steel angle welded to the structure is advised to limit nailer deflection. Use ¾ in. (19 mm) steel bolts spaced 4 ft (1.22 m) apart to attach nailer to angle (Fig. 9).

As an alternate method, the nailer can be secured to the deck with two rows of No. 10 (5 mm) galvanized steel metal screws at 24 in. (610 mm) centers or equivalent (Fig. 7). A galvanized steel washer ⅝ in. (16 mm) outside diameter should be used under the screw heads.

2.2.7 For nailers at 90° to steel deck ribs, the nailer should be fastened to the deck with two rows of No. 10 (5 mm) galvanized sheet metal screws at 24 in. (610 mm) centers or equivalent. When the deck is non-metal, use anchors of equivalent strength at the same spacing (Fig. 8).

2.2.8 Nails used to secure wood such as fascias, cant strips and top nailers to other wood members should be long enough to penetrate 1-¼ in. (32 mm). Two rows are recommended, staggered if feasible. Spacing in any one row should not exceed 24 in. (610 mm). Spacing should not exceed 12 in. (305 mm), 8 ft (2.44 m) each way from outside corners. Withdrawal resistance should be 100 lb (45 kg) per nail minimum. Lag screws of equivalent strength may be used if desired.

2.2.9 Hook strips should be continuous, and at least one gauge heavier than the fascia metal (see Table 1). They should be secured with annular threaded nails long enough to penetrate the wood 1-¼ in. (32 mm). The nail head should be 3/16 in. (5 mm) minimum. When screws are used, they should be No. 8 (4 mm) minimum and long enough to penetrate wood ¾ in. (19 mm) or metal ⅜ in. (10 mm). Fasteners should be either corrosion-resistant steel or treated to resist corrosion. When an existing metal panel wall has no hook strip, the fascia metal should be fastened directly to the wall with No. 8 (4 mm) galvanized sheet metal screws, through neoprene washers. Where estimated roof field area velocity pressures are ≤ 30 lb/ft<sup>2</sup> (1.44 kPa) or

Class 1-60, the maximum fastener spacing should be 24 in. (610 mm). For pressures greater than this and  $\leq 45 \text{ lb/ft}^2$  (2.15 kPa), this spacing should be 16 in. (406 mm) maximum.

2.2.10 Metal fascia and cant flashing should be secured to wood nailers at the bottom edge with a continuous hook strip (Recommendation No. 2.2.9). Metal sections should be secured at each end under the joint cover in the outside face with two large nails through slotted holes to permit expansion and contraction. Nail heads should be somewhat larger than the slotted holes. Four in. (100 mm) wide joint covers should be hooked over the metal at the upper and lower ends. A bead of caulking should be applied under the joint cover approximately 1 in. (25 mm) from the end of each metal fascia section. Where estimated roof field area velocity pressures are in the range of 30 to 45 lb/ft<sup>2</sup> (1.44 to 2.15 kPa), or are Class 1-75 or Class 1-90, add a screw with neoprene washer through the "X" dimension at the center of each section, and center of the joint cover (Detail "A"). The sections of the metal fascia should be separated  $\frac{3}{4}$  in. (19 mm) so that the screw through the joint cover clears the fascia metal.

2.2.11 Metal coping and counterflashing should be secured by a hook strip attached to the wall exterior (Recommendation No. 2.2.9). It should be secured on the inside with No. 10 (5 mm) galvanized screw fasteners through neoprene washers at 30 in. (762 mm) spacing, long enough to penetrate the wood 1 in. (25 mm) (Fig. 10). Where estimated roof field area velocity pressures are in the range of 30 to 45 lb/ft<sup>2</sup> (1.44 to 2.15 kPa), or are Class 1-75 or Class 1-90, place the fasteners 20 in. (508 mm) apart. Holes should be oversized to permit movement when heavy gauge metal or aluminum is used.

2.2.12 Metal counterflashing should be attached to masonry walls with masonry anchors (metal with no plastic materials) at 36 in. (914 mm) spacing (Fig. 5). Each anchor should have a minimum pull-out resistance of 200 lb (91 kg). The anchor should be at least 1 in. (25 mm) below the top edge of the felt base flashing and should penetrate the masonry wall 1 in. (25 mm).

2.2.13 Where estimated roof field area velocity pressures exceed 45 lb/ft<sup>2</sup> (2.15 kPa), or are greater than Class 1-90, the design of the flashing components should receive particular attention. These components should be designed by a professional engineer or other specialist, and be capable of withstanding applicable wind forces outlined in Data Sheet 1-7, *Wind Forces on Buildings and Other Structures*.

2.2.14 An overflow scupper approximately 6 in. (152 mm) wide should be installed at one-half the depth of cant for flat roof areas, and at roof edge height through parapet walls. Where the roof slopes away from the edge, it may be necessary to set the scupper invert at roof level. At least one overflow should be provided per 5000 ft<sup>2</sup> (465 m<sup>2</sup>) area and, in the case of large areas, at least one per roof drain.

It is essential that good workmanship, attention to detail, and proper supervision be employed at all times in the construction of the perimeter flashing assembly.

Refer to the latest edition of the Factory Mutual Research *Approval Guide* for Approved perimeter flashing assembly manufacturers.

## 3.0 SUPPORT FOR RECOMMENDATIONS

### 3.1 Sample Problem Solving

#### 3.1.1 Sample Problem

Design perimeter assembly components and anchorages for a 50 ft (15.2 m) high, flat-roof building having cinder-concrete block walls. A wood cant strip is to be used. The metal is aluminum having an "L" distance of 8 in. (203 mm). The wind isotach for the area (see Data Sheet 1-28 for wind maps) is 100 mph. Ground roughness is "C."

#### 3.1.2 Solution

According to Data Sheet 1-28, the roof field area velocity pressure is 37 lb/ft<sup>2</sup> (1.77 kPa).

- a) All cores or voids in the top course of masonry blocks or the bond beam are to be filled level with concrete (Recommendation No. 2.2.2).
- b) Cores that contain anchor bolts will be filled to a depth of 12 in. (305 mm) (Recommendation No. 2.2.3).

- c) Spacing of the ½ in. (13 mm) anchor bolts securing the basic wood nailer will be 4 ft (1.22 m). The bolt spacing for 8 ft (2.44 m) each way from outside corners will be 2 ft (610 mm) (Recommendation No. 2.2.4).
- d) Nailer size will be 1-½ by 5-½ in. (38 by 140 mm) minimum. The wood should be Douglas fir, Southern Yellow Pine or their equivalent. (Recommendation No. 2.2.5).
- e) Two rows minimum of nails or other fasteners of equivalent strength, having a penetration of at least 1-¼ in. (32 mm) into the wood and a withdrawal resistance of at least 100 lb (45 kg) spaced at 24 in. (610 mm) apart, are needed to adequately attach the wood cant strip to the nailer. Space nails 12 in. (305 mm) apart for 8 ft (2.44 m) each way from outside corners (Recommendation No. 2.2.8).
- f) An “L” distance of 8 in. (203 mm) calls for a minimum fascia metal thickness of 0.060 in. (1.52 mm). For this thickness, an “X” distance up to 3-½ in. (89 mm) is acceptable. Hook strip thickness should be 0.070 in. (1.73 mm) (Table 1). Install metal hook strip and fascia in accordance with Recommendation Nos. 2.2.9 and 2.2.10. Also see Detail “A.” Where estimated roof field area velocity pressures are in the range of 30 to 45 lb/ft<sup>2</sup> (1.44 to 2.15 kPa), or Class 1-75 or Class 1-90, fastening the metal to the inside sloping surface of the wood cant is required per Recommendation No. 2.2.10.

### 3.2 Loss History

Some flashing details involved in recent wind losses are shown in Figure 19. ***These details should not be used in the construction of flashings since adequate anchorage is not provided.*** In Example 1, failure occurred when steel anchors pulled out of the masonry. In Example 2, failure occurred either because the metal flashing was too thin or because there was no hook strip. Wind forces bent the flashing upward, with the resulting prying action causing the nail fastening to pull out. Failure of the bolts that anchor the nailer to the deck can result in the same situation. In Example 3, the wood blocking to which the cant strip is attached was fastened to the brick by short nails driven vertically into the masonry joints. The entire detail failed when these nails pulled out. Failure in Example 4 occurred because the wood blocking was not anchored to the masonry or steel and the entire assembly was displaced.

A number of failures have occurred when attempts were made to secure the nailer, either by driving nails through it and into the edges of the hollow masonry, or into wood blocks wedged into the masonry cores. Securing the nailer in this manner is not satisfactory.

Bolts anchored into the masonry joints may not hold under severe wind conditions. See Recommendation Nos. 2.2.3 and 2.2.4 for proper anchorage methods.

## 4.0 REFERENCES

### 4.1 FM Global

Data Sheet 1-7, *Wind Forces on Buildings and Other Structures.*

Data Sheet 1-28, *Wind Loads to Roof Systems and Roof Deck Securement.*

Data Sheet 1-29, *Above-Deck Roof Components.*

Data Sheet 1-54, *Roof Loads for New Construction.*

Factory Mutual Research *Approval Guide.*

## APPENDIX A GLOSSARY OF TERMS

*Approved:* references to “Approved” in this data sheet means the product and services have satisfied the criteria for Factory Mutual Research Approval. Refer to the *Approval Guide* for a complete listing of products and services that are Factory Mutual Research Approved.

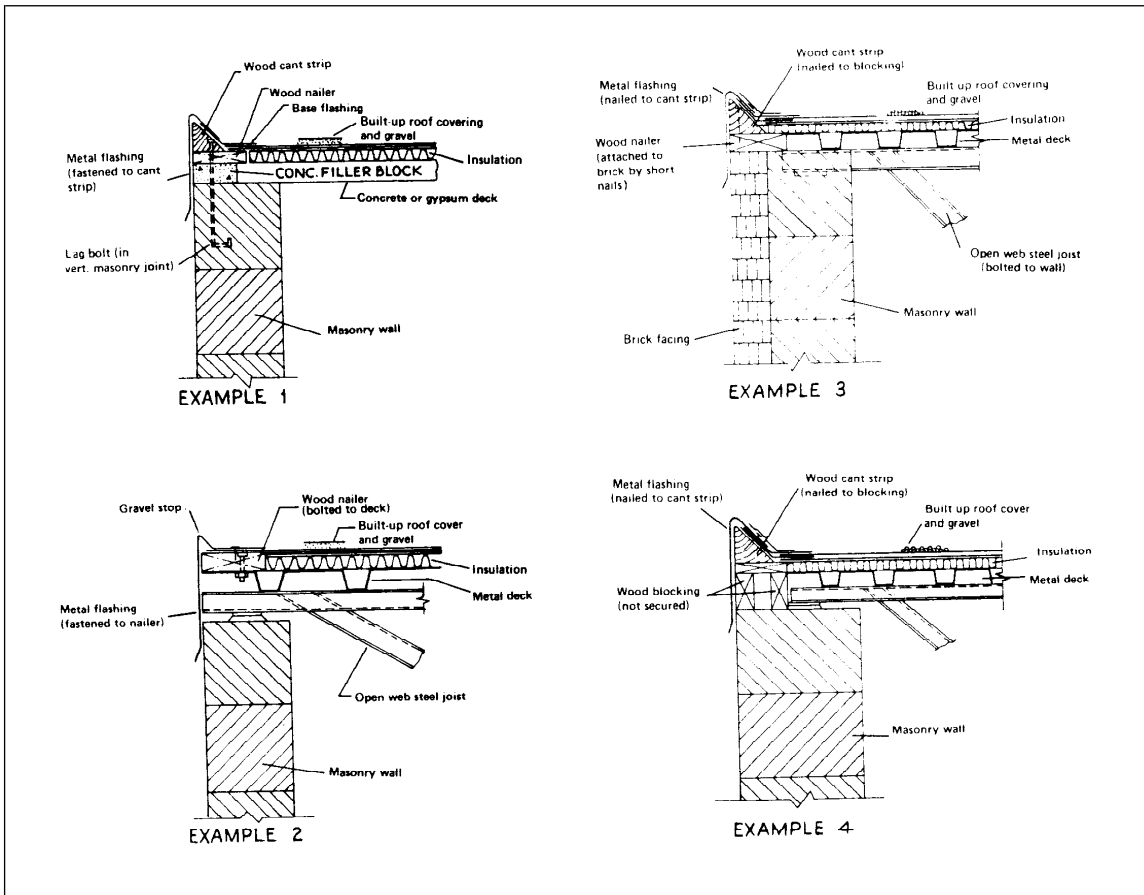


Fig. 19. Examples of perimeter flashing installations THAT ARE NOT RECOMMENDED.

## APPENDIX B DOCUMENT REVISION HISTORY

This document does not have any revision history.

FM Engr. Comm. February 1985