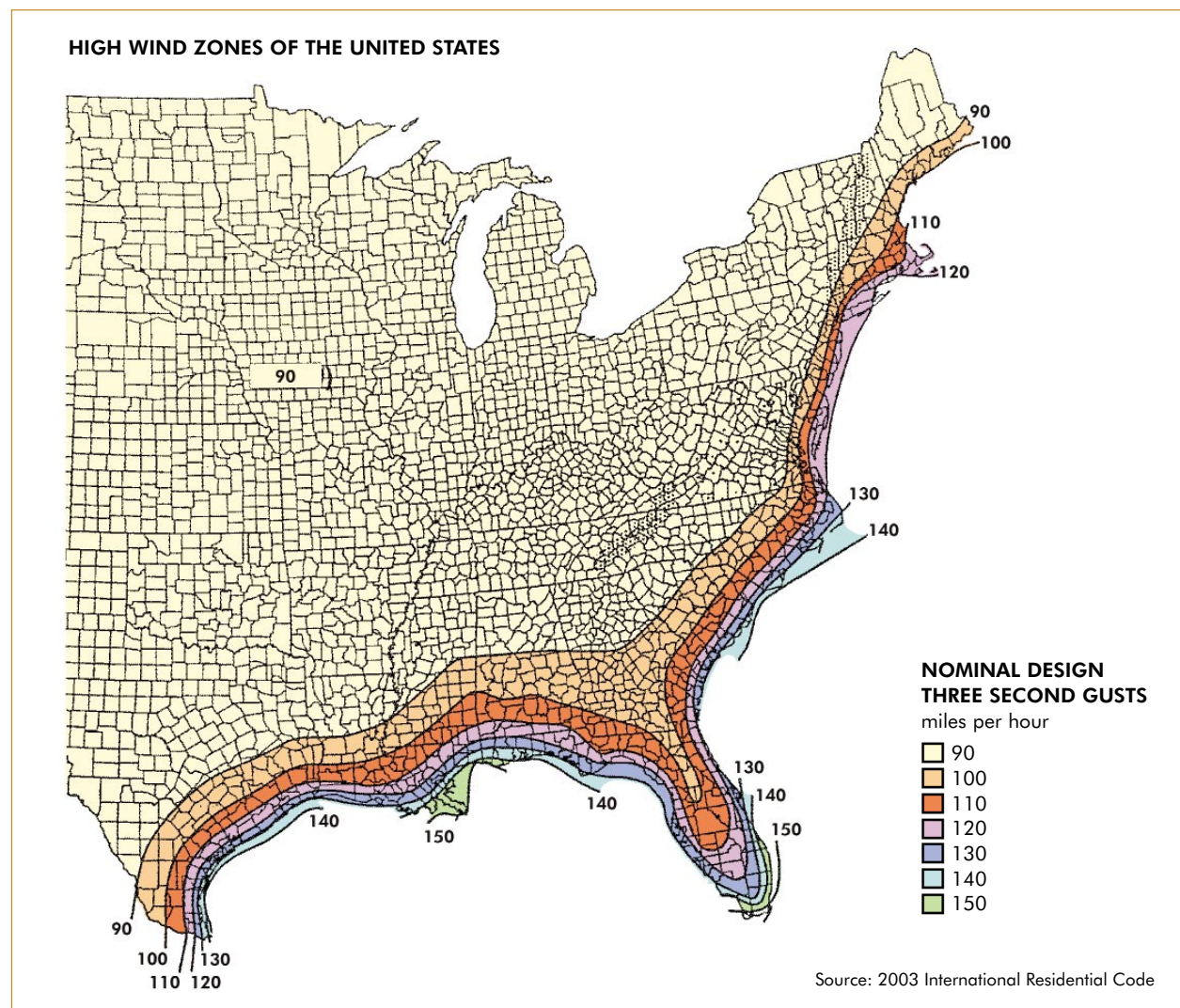


HURRICANE SHUTTER DESIGNS



One of the best ways to protect a home from damage in windstorms is to install shutters over all large windows and glass doors. Shutters protect doors and windows from windborne objects. They also prevent damage caused by sudden pressure changes when a window or door is broken.



The following designs are presented as two basic alternatives: The first is to present the minimum shutters that are permitted by the codes when such shutters are required. The requirements of the 2003 International Residential Code (IRC) and the 2001 Florida Building Code (FBC) are presented. They permit the use of minimum 7/16" Rated Sheathing as shutters to protect against the impact of windborne debris. Check with local building departments for verification or clarification of requirements.

The second approach provides some design details for stronger and stiffer shutters than provided for by the code-minimum designs. It should be noted that these designs were developed prior to the adoption of specific standards for shutter designs by any U.S. codes. The supports detailed for these shutters meet code requirements when mounted according to the specifications in Table R301.2.1.2. The mounting brackets for the masonry block structures have been tested for design wind loads but have not been impact or cyclic tested because they were developed as design guides before these standards were developed.

1. Code-Minimum Shutter Design:

The **2003 International Residential Code (IRC)**, Section R301.2.1.2, provides that "windows in buildings located in windborne debris regions shall have glazed openings protected from windborne debris or the building shall be designed as a partially enclosed building in accordance with the *International Building Code*. Glazed opening protection for windborne debris shall meet the requirements of the Large Missile Test of ASTM E 1996 and of ASTM E 1886 referenced therein.

Exception: Wood structural panels with a minimum thickness of 7/16 inch (11.1 mm) and a maximum span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings. Panels shall be precut to cover the glazed openings with attachment hardware provided. Attachments shall be provide in accordance with Table R301.2.1.2 or shall be designed to resist the components and cladding loads determined in accordance with the provisions of the *International Building Code*."

TABLE R301.2.1.2

WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS^{a,b,c}

| Fastener Type | Fastener Spacing | | |
|-----------------------|-------------------|--------------------------|--------------------------|
| | Panel Span ≤ 4 ft | 4 ft < Panel Span ≤ 6 ft | 6 ft < Panel Span ≤ 8 ft |
| 2-1/2" #6 Wood Screws | 16" | 12" | 9" |
| 2-1/2" #8 Wood Screws | 16" | 16" | 12" |

a. This table is based on 130 mph wind speeds and a 33-foot mean roof height.

b. Fasteners shall be installed at opposing ends of the wood structural panel.

c. Where screws are attached to masonry or masonry/stucco, they shall be attached utilizing vibration-resistant anchors having a minimum ultimate withdrawal capacity of 490 pounds.

Section R202 defines a Windborne Debris Region as any “areas within hurricane-prone regions within one mile of the coastal mean high water line where the basic wind speed is 110 mph or greater; or where the basic wind speed is equal to or greater than 120 mph; or Hawaii.” ([See map](#))

Alternatively, Section 1606.1.4 of the **2001 Florida Building Code**:

“In windborne debris regions, exterior glazing that receives positive pressure in the lower 60 feet in buildings shall be assumed to be openings unless such glazing is impact resistant or protected with an impact resistant covering meeting the requirements of SSTD 12, ASTM E 1886 and ASTM E 1996, or Miami-Dade PA 201, 202 and 203 referenced therein as follows:

1. Glazed openings located within 30 feet of grade shall meet the provisions of the Small Missile Test.
2. Glazed openings located more than 30 feet above grade shall meet the provision of the Small Missile Test.

Exception: Wood structural panels with a minimum thickness of 7/16 inch and maximum panel span of 8 feet shall be permitted for opening protection in one- and two-story buildings. Panels shall be precut to cover the glazed openings with attachment hardware provided. Attachment shall be designed to resist the components and cladding loads determined in accordance with Table 1606.2B. Attachment in accordance with Table 1606.1.4 is permitted for buildings with mean roof height of 33 feet or less where wind speeds do not exceed 130 mph.”

TABLE 1606.1.4

WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS

| Fastener Type | Fastener Spacing (in.) ^{a,b} | | | |
|----------------------------------|---------------------------------------|--------------------------|--------------------------|--------------------------|
| | Panel Span ≤ 2 ft | 2 ft < Panel Span < 4 ft | 4 ft < Panel Span < 6 ft | 6 ft < Panel Span < 8 ft |
| 2-1/2 #6 Wood Screw ^c | 16 | 16 | 12 | 9 |
| 2-1/2 #8 Wood Screw ^c | 16 | 16 | 16 | 12 |
| Double-Headed Nails ^d | 12 | 6 | 4 | 3 |

a. This table is based on a maximum wind speed of 130 mph and mean roof height of 33 feet or less.

b. Fasteners shall be installed at opposing ends of the wood structural panel.

c. Where screws are attached to masonry or masonry/stucco, they shall be attached using vibration-resistant anchors having a minimum withdrawal capacity of 490 lb.

d. Nails shall be 10d common or 12d box double-headed nails.

Section 1606.1.5 defines a Windborne Debris Region as:

1. Area within one mile of the coastal mean high water line where the basic wind speed is 110 mph or greater.
(See map)
2. Areas where the basic wind speed is 120 mph or greater except from the eastern border of Franklin County to the Florida-Alabama line where the region includes area only within 1 mile of the coast. ([See map](#))

2. Stronger, Stiffer Designs

The following design pages describe how to construct stronger, stiffer shutters for attachment to wood and masonry walls. The masonry attachments were designed prior to the adoption of specific test standards for shutter designs by U.S. codes. The shutters have been tested to resist the design wind loads and impacts but the attachments to masonry have not been impact or cyclic-load tested. The masonry attachment details are therefore supplied as guides in developing individual designs.

Most building codes include provisions for storm shutters. Earlier code had provisions for a deflection of less than the shutter span (in inches) divided by 30 (for instance, a 40-inch span should not bend more than $40/30 = 1.33$ inches when the wind blows). They also should bend less than 2 inches maximum and should remain at least one inch away from the window when under full wind force.

The easiest designs are those that simply cover the opening with a wood structural panel. In wood-frame construction, panels can be nailed over the openings when a hurricane approaches. Buildings made with concrete blocks, however, require advance preparation.

In some cases, stiffeners may be necessary to limit deflection of the shutter against the glass. Stiffeners function best if the 2 x 4s are on the outside of the shutter and oriented with the narrow edge against the shutter.

Tables 1 and 2 and Figure 1 on the following page apply to most of the designs, and are referenced accordingly.

These APA hurricane shutter designs are based on pressures associated with a 3-second gust wind speed of 120 mph. Building codes are currently being reviewed for possible changes. Before constructing shutters, therefore, it is important to check with your local building department for an update on current code requirements.

Note: The shutter designs shown herein will provide significant protection from hurricane-force winds. This publication contains recommendations to serve as a guide only. It does not include all possible shutter, anchor and fastening systems, and the installer must adjust all dimensions to compensate for particular installations and hardware used. These shutter designs by no means represent all possible workable designs and can always be upgraded to provide even greater margins of safety and protection. All shutter designs herein are intended to be temporary, and mounted and removed from outside the building. All designs are based on wind pressure capacities only.

While the design wind pressures used are based on ASCE 7-95, the building owner/installer must still carefully evaluate each system and then, if necessary, make any modifications consistent with good design and building practices.

DESIGN 1 SHUTTERS FOR WOOD-FRAME BUILDINGS

DESIGN 2 SHUTTERS FOR MASONRY BLOCK STRUCTURES BARREL BOLT LATCH SUPPORTS

DESIGN 3 SHUTTERS FOR MASONRY BLOCK STRUCTURES STEEL OR ALUMINUM ANGLE AND SCREW SUPPORTS

DESIGN 4 SHUTTERS FOR MASONRY BLOCK STRUCTURES SHUTTERS ATTACHED TO OUTSIDE WALL WITH PERMANENTLY MOUNTED BRACKETS

DESIGN 5 SHUTTERS FOR MASONRY BLOCK STRUCTURES FOR OPENINGS WIDER THAN 8 FEET

TABLE 1

MAXIMUM SPAN WITHOUT STIFFENERS

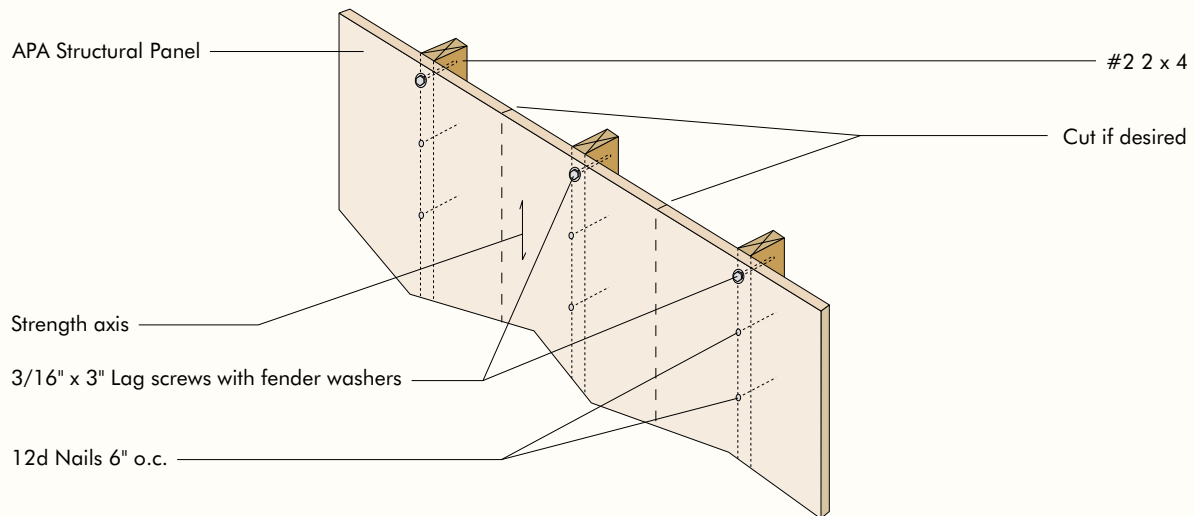
| APA Panel Span Rating | Approximate Weight (lb./ft. ²) | Maximum Shutter Span | Approximate Deflection (in.) at 120 mph Design Wind Speed at 15-ft. Height |
|-----------------------|--|----------------------|--|
| 32/16 | 1.5 | 30 | 0.5 |
| 40/20 | 2 | 36 | 0.5 |
| 48/24 | 2.4 | 48 | 0.9 |
| 48 oc | 3.6 | 72 | 1.5 |

TABLE 2

ESTIMATED DEFLECTION AT 120 MPH DESIGN WIND SPEED AT 15-FT. HEIGHT FOR SHUTTERS WITH 2 X 4s AT 16 INCHES o.c.

| APA Panel Span Rating | Approximate Weight (lb./ft. ²) | Shutter Span (in.) | | | | | | |
|-----------------------|--|--------------------|-----|-----|-----|-----|-----|-----|
| | | 24 | 36 | 48 | 60 | 72 | 84 | 96 |
| 32/16 | 2.5 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.8 | – |
| 40/20 | 2.9 | 0.1 | 0.1 | 0.2 | 0.2 | 0.4 | 0.7 | 1.1 |
| 48/24 | 3.4 | – | – | 0.1 | 0.2 | 0.3 | 0.6 | 1.0 |
| 48 oc | 4.6 | – | – | 0.1 | 0.1 | 0.3 | 0.5 | 0.9 |

FIGURE 1

SHUTTER STIFFENER ATTACHMENT – IF REQUIRED

DESIGN 1

SHUTTERS FOR WOOD-FRAME BUILDINGS

This design from APA – *The Engineered Wood Association* describes how to construct structural panel shutters for attachment to wood-frame buildings.

Steps to Constructing Shutters

1. Review [Tables 1 and 2](#) in the Design Considerations section to determine if stiffeners are needed. Attach stiffener as shown in Figures 1 and 1A.
2. Cut APA wood structural panels with adequate edge overlap to receive nails. Orient long panel axis (strength axis) of the panel as shown in Figures 1 and 1A.
3. Use a long brad or finishing nail to locate the framing behind the wood siding. The nails used to attach the shims and the shutters must hit the framing to be fully effective.
4. Nail shims to the framing with 12d nails. Use 16d nails for shims over 3/4 inch thick. For spans up to 5 feet, space the nails 6 inches o.c. at each shim. For spans over 5 feet, space nails 4 inches o.c. at each shim. (Figures 1B and 1C)
5. Attach the shutters with double-headed nails for ease of later removal. (Figures 1B and 1C) Use 12d nails for shutters up to 3/4 inch thick and 16d nails for shutters over 3/4 inch thick. For spans up to 5 feet, space the nails 6 inches o.c. at each end of the shutter panel. For spans over 5 feet, space nails 4 inches o.c. at each end of the shutter panel. Nailing the panel on all four sides, instead of just the two ends, will further limit deflection and maximize strength.
6. Any permanently installed hardware, shims or fastening devices must be installed using standard/acceptable methods of waterproofing. All abandoned holes must be sealed.
7. After fabrication each shutter should be marked for orientation and location to simplify installation.
8. If shims are to be left in place, use galvanized nails and finish like siding or exterior trim.

FIGURE 1A

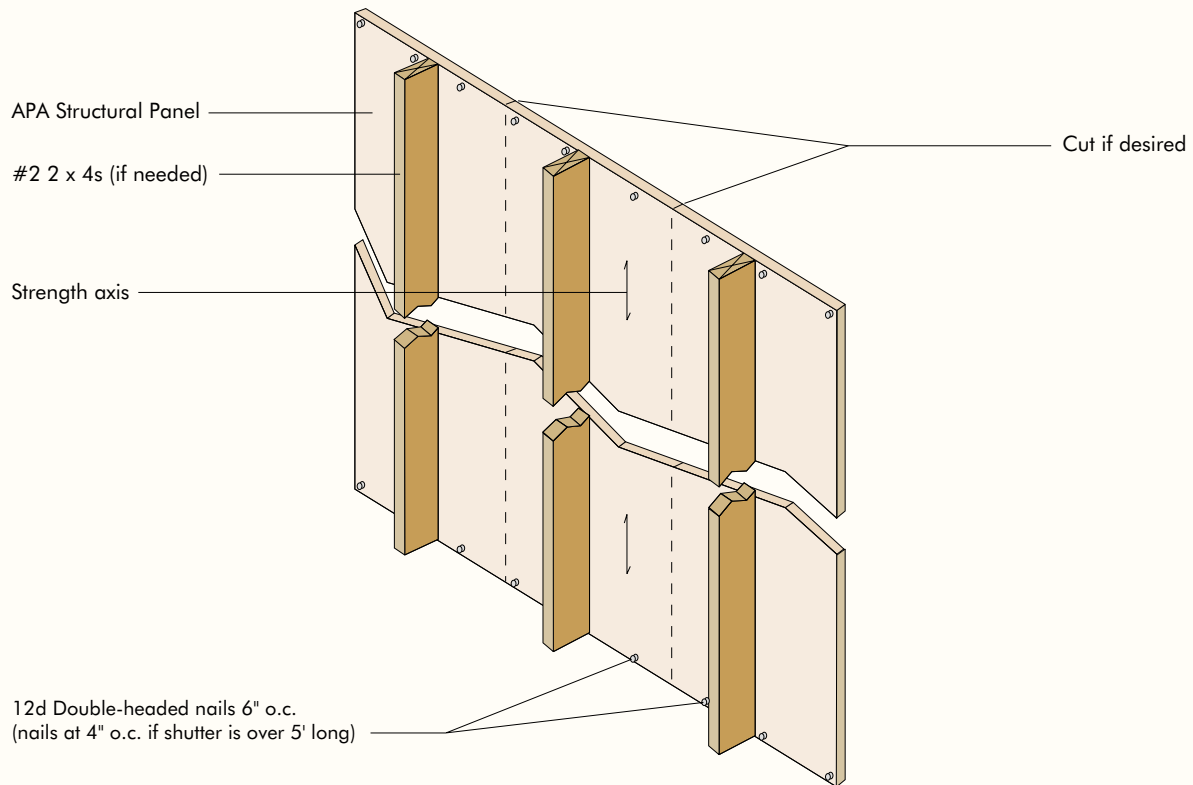
SHUTTER ATTACHMENT – VIEW FROM OUTSIDE

FIGURE 1B

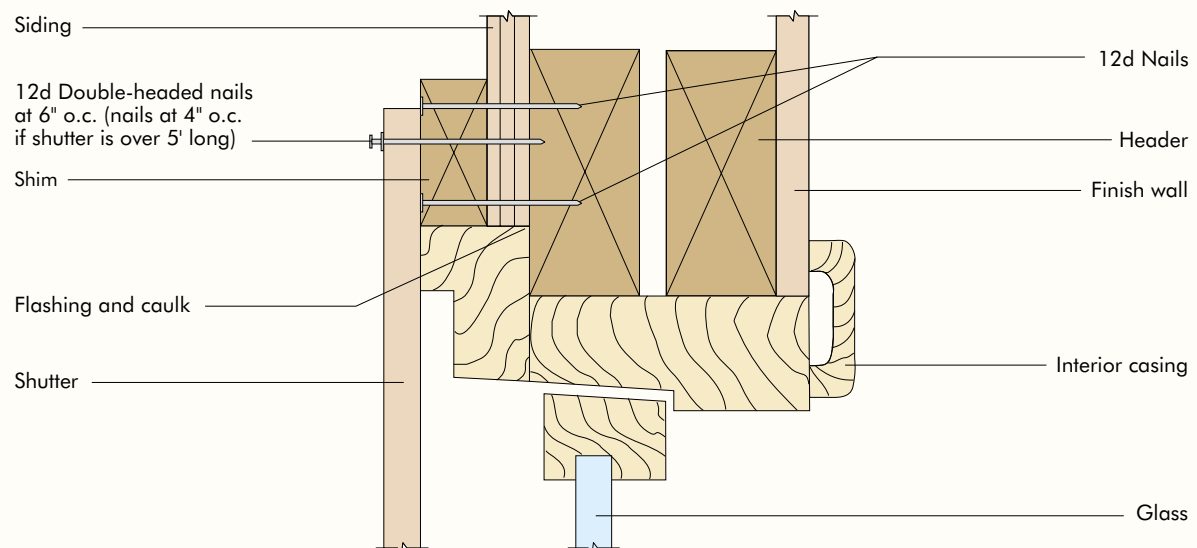
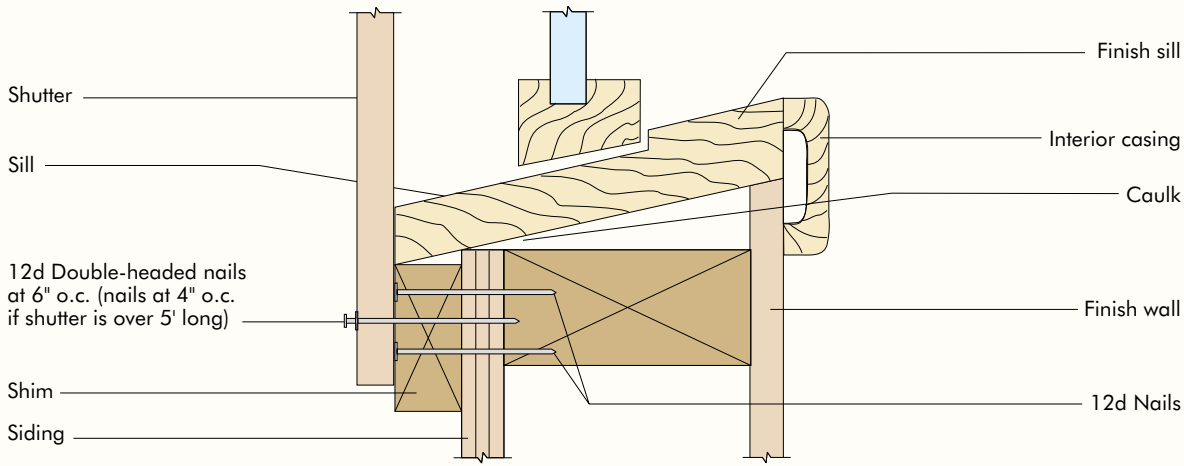
SHUTTER ATTACHMENT – TOP

FIGURE 1C

SHUTTER ATTACHMENT – BOTTOM



DESIGN 2**SHUTTERS FOR MASONRY BLOCK STRUCTURES****BARREL BOLT LATCH SUPPORTS**

This design from APA – *The Engineered Wood Association* describes how to construct structural panel shutters for attachment to masonry block buildings, using barrel bolt latch supports. The unique features of this design are the barrel bolt latches that support the shutter at either end. Once made, the shutters can be mounted or removed without any additional hardware or tools. The barrel bolt latches should be mounted to the panel with bolts, rather than the screws that usually come with them. Use a washer under the nuts and heads of the bolts. Place the nut-end of the bolts to the outside (latch side) of the shutter to allow for final adjustment of the latches.

Steps to Constructing Shutters

1. Use [Tables 1 and 2](#) in the Design Considerations section to determine if stiffeners are needed. Attach stiffeners as shown in Figure 1.
2. Cut the panel 1/8 inch smaller than the window opening. The long-panel axis (strength axis) must be oriented perpendicular to the supported ends (sides of the shutter with the barrel bolts), regardless of which shutter dimension is longer.
3. Make two templates that will help in mounting the latches and drilling the barrel bolt latch holes in the concrete blocks – one for each side of the window. The top and bottom holes should be no more than 8 inches from the window top and bottom and spaced equal distances from each other, but no greater than 16 inches o.c. and should miss the mortar joints between the blocks by 1-1/2 inches or more. (Figure 2A)
4. Mount 4-inch barrel bolts. The nuts go on the latch side (outside) of the shutter. Make the nuts only finger tight because the latches will be adjusted in the final fitting.
5. Drill latch-bolt holes in blocks. (Figure 2B)
6. Mount the shutter in the window frame and insert the barrel-bolt latches into the holes in the concrete blocks. Tighten bolts holding barrel bolts in place.
7. The barrel-bolt holes in the concrete blocks may be filled with a removable plug when not in use. (Figure 2C)
8. Any permanently installed hardware, shims or fastening devices must be installed using standard/acceptable methods of waterproofing. All abandoned holes must be sealed.
9. After fabrication each shutter should be marked for orientation and location to simplify installation.

FIGURE 2A

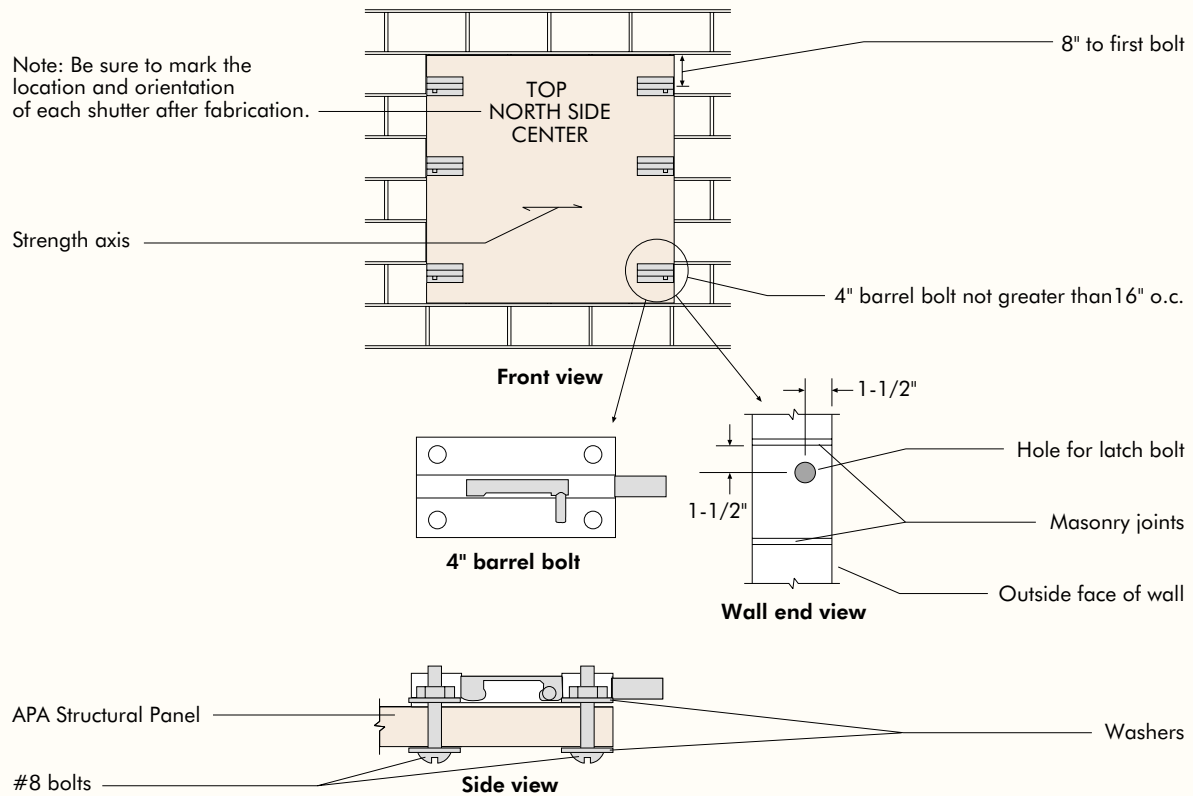
LATCH-BOLT PLACEMENT DETAILS

FIGURE 2B

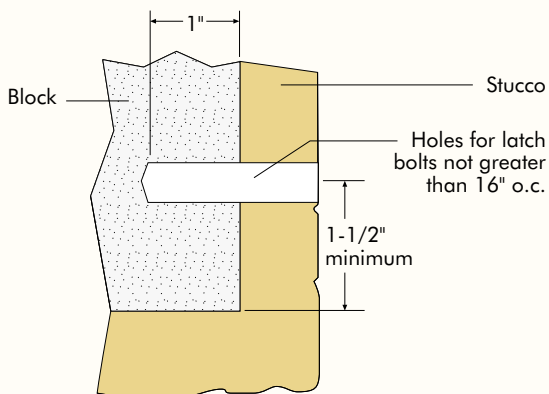
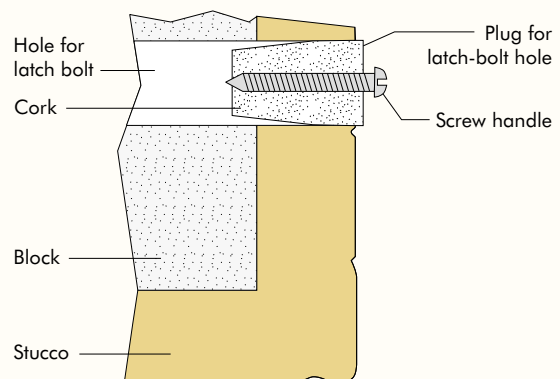
LATCH-BOLT HOLE IN SIDE OF WINDOW OPENING

FIGURE 2C

TEMPORARY PLUG FOR LATCH-BOLT HOLE

DESIGN 3**SHUTTERS FOR MASONRY BLOCK STRUCTURES****STEEL OR ALUMINUM ANGLE AND SCREW SUPPORTS**

This design from APA – *The Engineered Wood Association* describes how to construct structural panel shutters for attachment to masonry block buildings, using steel or aluminum angle and screw supports. The design is less costly to build than shutters with permanent hardware for attachment and removal.

Anchorage to Masonry Block

The plastic anchors* referenced in this plan have sufficient lateral and withdrawal capacity to handle the expected forces and are recommended because they are rated as being vibration resistant – a characteristic that may be of some value under buffeting wind loads. (Standard lead anchors are not usually rated as vibration resistant.)

Keep masonry anchors at least 1-1/2 inches from the block edges, joints and corners to minimize the danger of cracking the concrete blocks.

Steps to Constructing Shutters

1. Use [Tables 1 and 2](#) in the Design Considerations section to determine if stiffeners are needed. Attach stiffeners as shown in Figure 1.
2. In the dimension from support to support, cut the panel 3/8 inch less than the measurement of the window opening (side to side in Figure 3A). In the dimension from unsupported edge to unsupported edge, cut the panel 1/8 inch less than the measurement of the opening. The long-panel axis (strength axis) must be oriented perpendicular to the supported sides (side to side in Figure 3A), regardless of which shutter dimension is longer.
3. Cut 1-1/2 x 1-1/2 x 1/8-inch steel or aluminum angles to the same length as the width of the shutter ends to be supported.
4. Drill 1/4-inch diameter holes at 6 inches o.c. in one side of the angle. These holes are for bolts that hold the angle to the panel and may be centered between the corner and the edge of the angle.
5. Drill 3/16-inch diameter holes at 6 inches o.c., offset 1 inch from the panel bolt holes, in the remaining leg of the angle. Make the centerline of the holes 1/4 inch from edge of the angle. These holes are to receive #10 screws that will go through the holes into masonry anchors in the concrete blocks. (Figure 3B)
6. Drill holes in blocks for the plastic anchors. (Figure 3C)
7. Mount the shutter, with angles mounted, to the window frame using #10 screws with washers. (Figure 3A)
8. Any permanently installed hardware, shims or fastening devices must be installed using standard/acceptable methods of waterproofing. All abandoned holes must be sealed.
9. After fabrication each shutter should be marked for orientation and location to simplify installation.

*Lateral ultimate value 350 lbs. or greater in 4000 psi concrete, with screws specified (1-1/2 inches with stucco).

FIGURE 3A

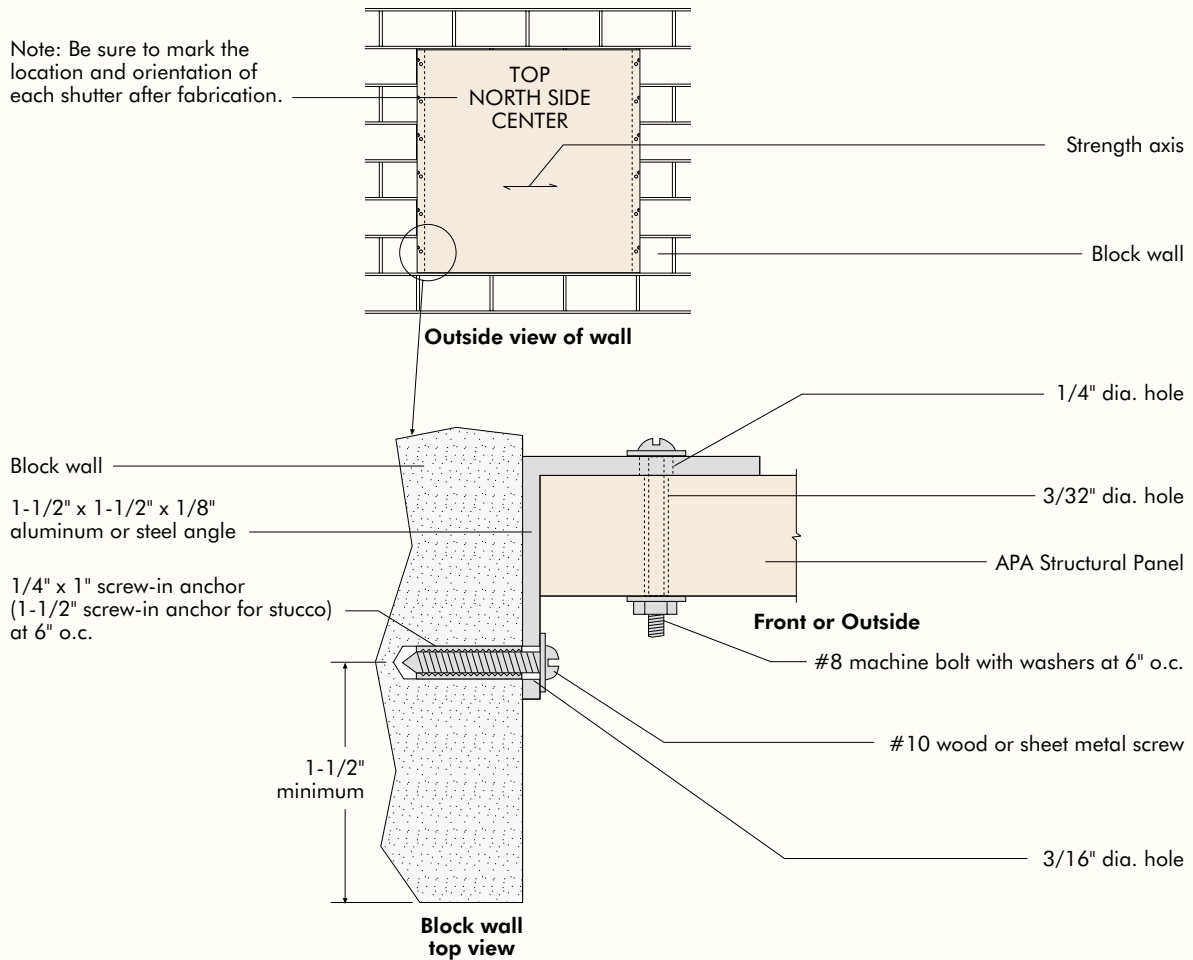
SHUTTER ATTACHMENT DETAIL

FIGURE 3B

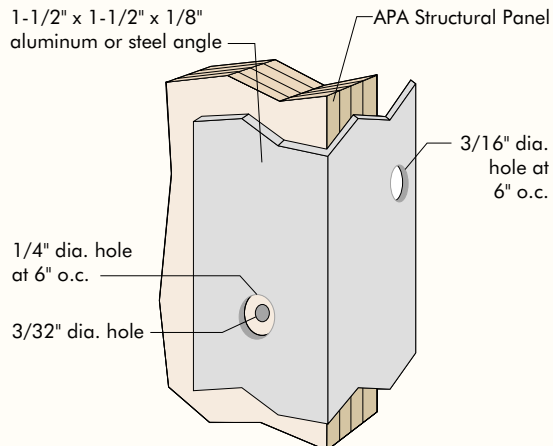
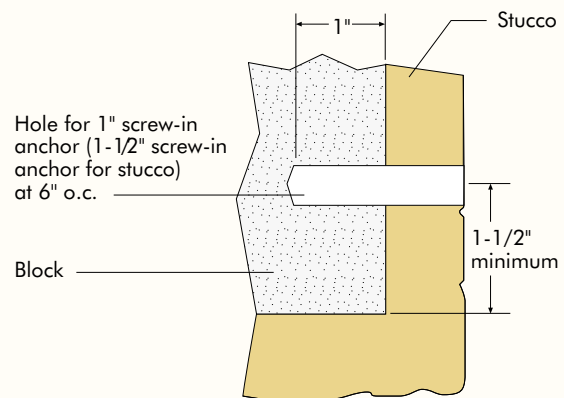
ANGLE-TO-SHUTTER ATTACHMENT DETAIL

FIGURE 3C

SCREW-IN ANCHOR HOLE IN SIDE OF WINDOW OPENING

DESIGN 4**SHUTTERS FOR MASONRY BLOCK STRUCTURES****SHUTTERS ATTACHED TO OUTSIDE WALL WITH PERMANENTLY MOUNTED BRACKETS**

This design from APA – *The Engineered Wood Association* describes how to construct structural panel shutters for attachment to masonry block buildings, using permanently mounted brackets on the outside wall. Two layers of APA Exterior plywood are attached to the outside of the concrete block wall with #10 flat-head screws in masonry anchors. Once the brackets are installed, no tools are required to install or remove the shutters unless stiffeners are required. It has the advantage of moving the shutter almost two inches farther away from the glass than shutters mounted to the interior of the window frame and is therefore less likely to require stiffeners.

Fasteners

Screws or bolts that will be permanently exposed to the weather should be made of stainless steel.

Anchorage to Masonry Block

The plastic anchors* referenced in this plan have sufficient lateral and withdrawal capacity to handle the expected forces and are recommended because they are rated as being vibration resistant – a characteristic that may be of some value under buffeting wind loads. (Standard lead anchors are not usually rated as vibration resistant.)

Keep masonry anchors at least 1-1/2 inches from the block edges, joints and corners to minimize the danger of cracking the concrete blocks.

Steps to Constructing Shutters

1. Use [Tables 1 and 2](#) in the Design Considerations section to determine if stiffeners are needed. Attach stiffeners as shown in [Figure 1](#).
2. Cut APA EXTERIOR plywood for the shutter support – window trim. Make the thickness of the inner spacer slightly greater than that of the shutter to allow the shutters to slide without binding. (The inner trim spacer of plywood is left out of one side of the window framing to allow for the insertion of the shutters.) Orient the plywood face grain of the trim as indicated in the diagram. (Plywood with four or more plies may be oriented either direction.) Lap the corners to allow the outer trim to be attached to the inner spacer at the corners. (Figure 4A)
3. Drill 1/2-inch diameter vertical drain holes in bottom inner spacer to allow rain water to escape out the bottom.
4. Cut the shutter to be 1/4 inch less than the distance from the bottom of the bottom slot to the top of the top slot, and about 2 inches wider than the window opening width (assuming that the panels are supported top and bottom). Orient the long panel axis (strength axis) as shown in Figure 1. Slide the shutter into place.
5. Drill hole halfway down the trim and diagonally downward (at about 30° from the surface) in the trim board covering the shutter entrance opening. The hole should be about 1/8 inch outside the edge of the installed shutter. This hole will receive a 12d box nail to prevent the shutter panel or panels from getting blown back out the entrance slot.
6. Any permanently installed hardware, shims or fastening devices must be installed using standard/acceptable methods of waterproofing. All abandoned holes must be sealed.
7. After fabrication each shutter should be marked for orientation and location to simplify installation.

*Withdrawal ultimate value 490 lbs. or greater in 4000 psi concrete, with screws specified (1-1/2 inches with stucco).

Design Alternative

As an alternative to Design 4, the wood trim can be replaced with 1 x 1 x 1-inch (outside measurements) x 1/8-inch aluminum channels (channel outside dimensions may be changed to better accommodate panels thicker than 5/8 inch, i.e., 1-1/8-inch-thick shutters will require a channel slot opening of about 1-1/4 inches) mounted approximately the same way as the wood trim. (Figure 1) Make holes at both ends to hold a latching device to prevent shutters from being blown out.

Note: using sawn lumber instead of plywood for the outer layer of trim may result in the failure of the trim when suction loads are applied to the shutter.

FIGURE 4A

SHUTTER FRAME AND ATTACHMENT – STRUCTURAL PANEL OPTION

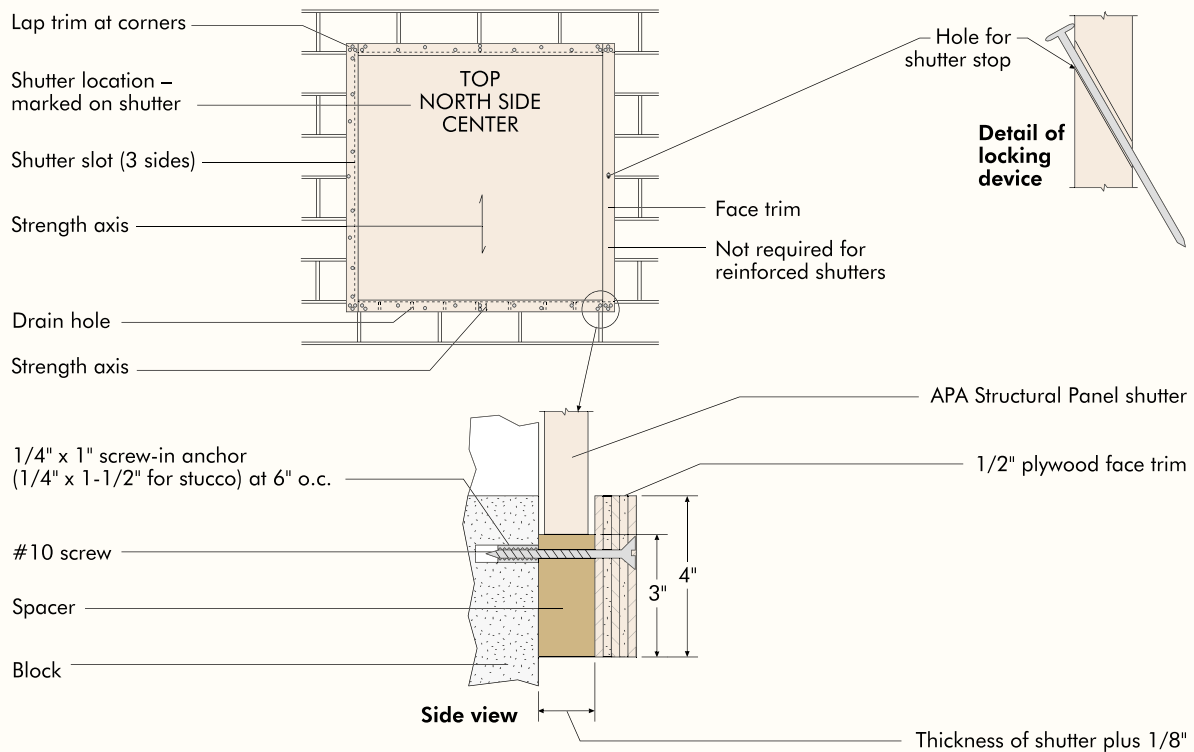
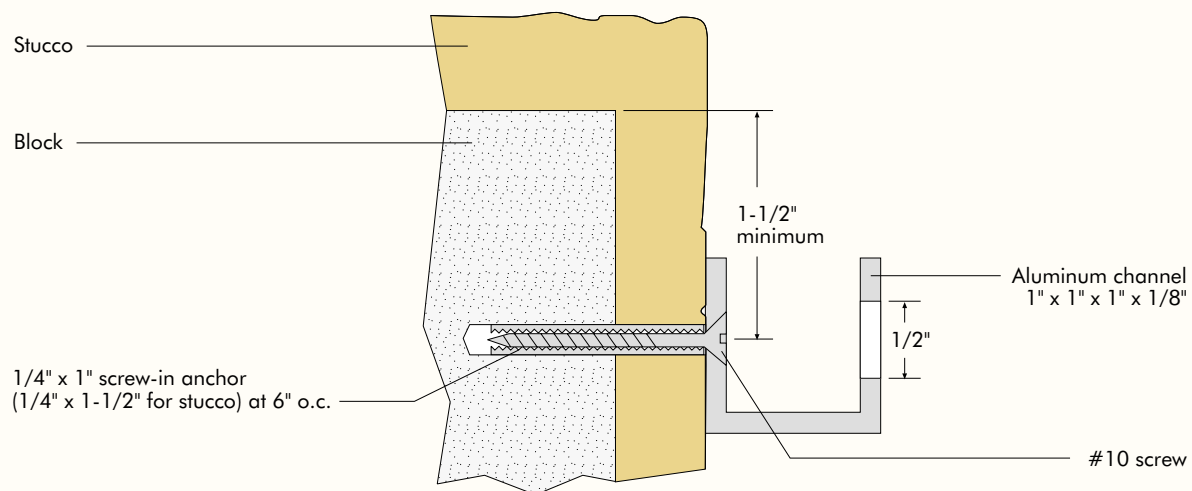


FIGURE 4B

SHUTTER FRAME AND ATTACHMENT – ALUMINUM CHANNEL OPTION

DESIGN 5**SHUTTERS FOR MASONRY BLOCK STRUCTURES****FOR OPENINGS WIDER THAN 8 FEET**

This design from APA – *The Engineered Wood Association* describes how to construct structural panel shutters for attachment to masonry block buildings, where glass windows and doors are wider than 8 ft. The shutters run from top to bottom and are attached to a temporary 2 x 4 lumber strip at the top and bottom of the opening.

Anchorage to Masonry Block

The plastic anchors* referenced in this plan have sufficient lateral and withdrawal capacity to handle the expected forces and are recommended because they are rated as being vibration resistant – a characteristic that may be of some value under buffeting wind loads. (Standard lead anchors are not usually rated as vibration resistant.)

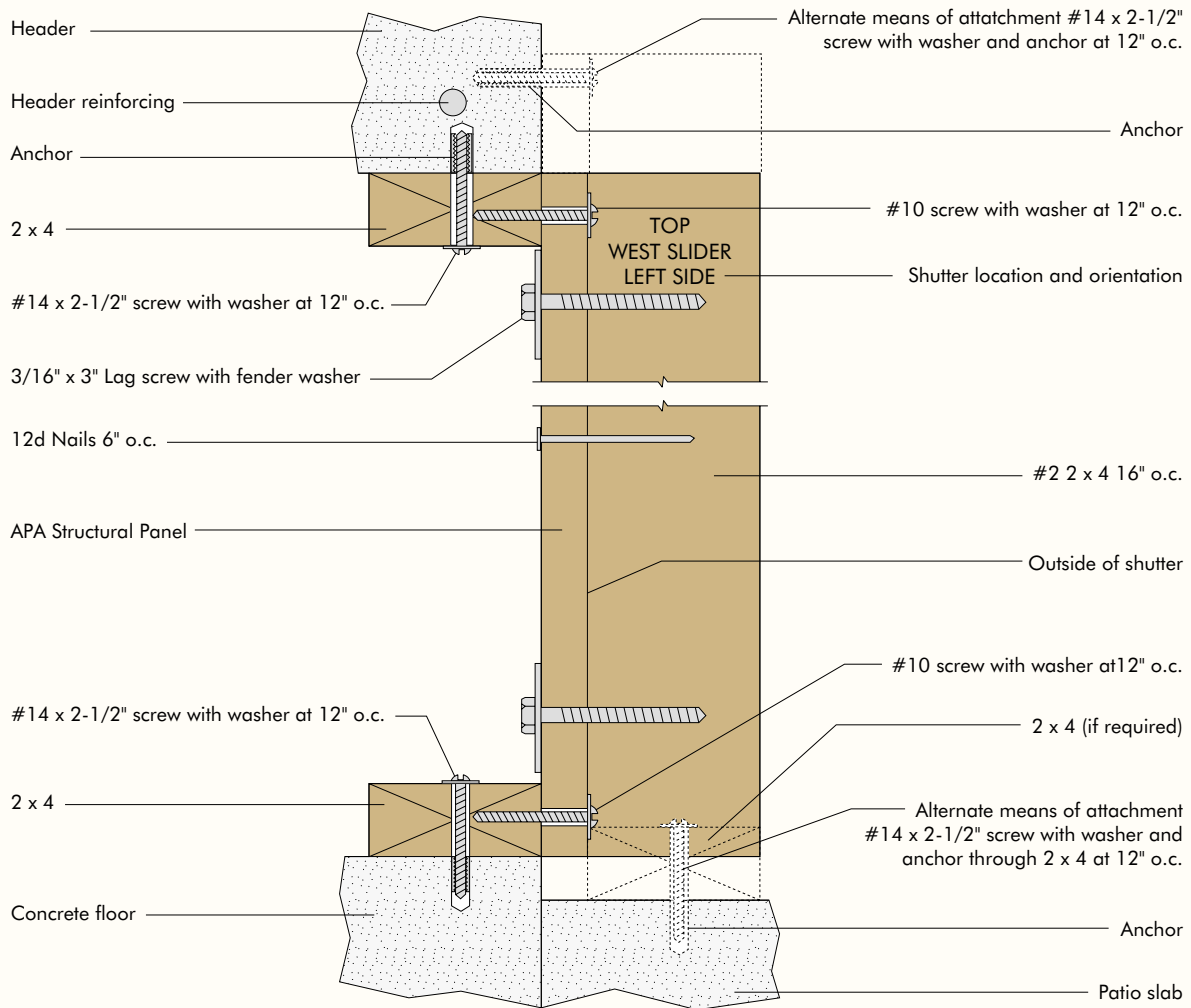
Keep masonry anchors at least 1-1/2 inches from the block edges, joints and corners to minimize the danger of cracking the concrete blocks.

Steps to Constructing Shutters

1. Use [Table 2](#) in the Design Considerations section to determine which panel to use.
2. Cut two 2 x 4s to a length that is 1 inch less than the width of the door opening to be covered. Rip the 2 x 4s lengthwise, if necessary, to the width of the distance of the door frame to the front of the wall. (Note: If holes or hole plugs on the front of the building are not a concern, the top 2 x 4 may be eliminated by extending the shutter above the opening and attaching the top of the shutter directly to the front of the header.) (Figure 1)
3. Predrill 1/4-inch diameter holes in the 2 x 4s at 12 inches o.c. and at least 1-1/2 inches from the front edge of the 2 x 4s.
4. Drill holes in the concrete blocks.
5. Tap vibration-resistant anchors into the holes in the concrete.
6. Attach the 2 x 4s to top and bottom of the opening using 2-1/2-inch #14 round or pan head wood or sheet metal screws with washers. (Figure 5A)
7. Cut the shutter to span the opening (plus the width of the supports – 3 inches for two 2 x 4s). Orient the long panel axis (strength axis) as shown in Figure 1.
8. Drill holes at 16 inches o.c. along the supported panel edges and in the 2 x 4s.
9. Attach the shutter to the 2 x 4s with 2-inch #10 wood or sheet metal screws.
10. To prevent the bottom 2 x 4 anchor holes in the concrete block from becoming clogged with dirt between shutter uses, insert 1/2-inch #14 pan- or flat-head screws into the anchor holes. Remove these screws prior to reattaching the 2 x 4s.
11. Any permanently installed hardware, shims or fastening devices must be installed using standard/acceptable methods of waterproofing. All abandoned holes must be sealed.
12. After fabrication each shutter should be marked for orientation and location to simplify installation.

*Withdrawal ultimate value 490 lbs. or greater in 4000 psi concrete, with screws specified (1-1/2 inches with stucco).

FIGURE 5A

SHUTTER ATTACHMENT TO HEADER AND SLAB FLOOR

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