

MODULE 2b SHORING CONSTRUCTION

The Terminal and Enabling Objectives are listed in the two slides at the right. To summarize these, the intent is to discuss the **HOW** and the **WHERE** to build the emergency shoring for the **FEMA US&R Response System**.

There are many other types and methods to construct shoring, however, it is important that all rescue personnel within this program learn to efficiently construct these systems. They have been engineered as well braced, reliable systems that can be rapidly constructed in emergency conditions.

MITIGATION BASICS

- **Avoid It** - barrier tape around a hazardous area preventing access.
- **Remove It** - pull down a cracked and leaning brick chimney.
- **Shore It** - constructing shoring and/or bracing systems.
- **Monitor it** – setup Monitoring with a warning system and pre-planned escape/evacuation plan.

SHORING SIZE-UP

- The Shoring Size-Up provides a survey of structural damage and potential victim locations in buildings identified during the initial building triage and Structure/Hazards Evaluation process.
 - Identify structural hazards, damage and potential victim locations.
 - Determine best method to mitigate the structural hazards and damage. Avoid, remove, shore, or monitor.
 - Determine the type and placement of shoring systems in relation to structural hazards, damage and potential victim location.
- The shoring size-up should be performed by at least a Structural Specialist, Rescue Team Manager and/or Rescue Squad Officer.
- The shoring size-up must be extensive, accurate and continue throughout the rescue operation.

Terminal Objectives

- The Student shall learn how to maintain the integrity of all structurally unstable elements
- The Student shall learn how to properly transmit or redirect the collapse loads to stable ground or other suitable structural elements capable of handling the additional loads

Enabling Objectives

- have a basic understanding of how to conduct a proper shoring size-up
- be able to identify locations for proper shoring placement
- understand the shoring team concept and identify positions & purpose
- understand the different types of shoring components and equipment

HAZARD MITIGATION

- **AVOID IT** - prevent access to the hazardous area 1
- **REMOVE IT** - pull down cracked and leaning chimney 1
- **SHORE IT** - construct a shoring system 1
- **MONITOR IT** - setup warning sys & escape plan

SHORING SIZE-UP

- identify structural hazards, damage and potential victim locations
- determine best method to mitigate the hazard and damage
- determine the type & placement of shoring systems in relation to structural hazards and potential victim location

SIZE-UP Cont.

- performed by at least a structural specialist, rescue team manager and or a rescue squad officer
- it must be extensive, accurate and continue throughout the rescue operation

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SHORING SIZE-UP CONSIDERATIONS

Victims

- How many victims are trapped and where are they located?
- Is the information coming from reliable sources and can it be confirmed?

Six-sided Approach

- Survey all four sides, the top and the bottom of the entire structure paying particular attention to the collapse area.
- The top survey is extremely important because loose or hanging debris, structural elements and other overhead hazards must be identified and addressed.
- Gravity being constant, will continually try to pull the remains of the structure and its contents to the ground.
- Surveying the bottom is equally important because shifted loads created by the collapse must be transferred to other stable structural members or back to stable ground.

Structural Elements

- Walls out of plumb determine building stability immediately on arrival.
- Bearing walls are the most important structural elements in an unframed building and failure of any part of these walls can cause extensive damage and further collapse.
- Identification and assessment of all beams, columns, arches, joists and other structural supporting elements under the main debris pile or the victim's location should be among the top priorities of the shoring size-up.
 - All severely stressed, broken, missing, bowed or cracked supporting elements which could affect the rescue operation must be shored up before any personnel are committed to work in the area.
 - The building elements they supported must also be examined and re-supported.

Age and Condition of the Structure

- The shrinkage of structural elements over time results in a loss of strength and the loosening of important hangers and connecting supports which may require more shoring.
- Supporting elements of a well-maintained building may be utilized to help support and transfer the collapse load throughout the structure. However, if the building's condition was in a state of disrepair or suspect prior to the collapse, do not assume any structural support exists without a thorough inspection.

SIZE-UP CONSIDERATIONS

- VICTIMS
- SIX SIDED APPROACH
- STRUCTURAL ELEMENTS
- AGE & CONDITON OF THE STRUCTURE
- COLLAPSE WARNING SIGNS

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SHORING SIZE-UP CONSIDERATIONS (continued)

Collapse Warning Signs

- Continual surveillance of the structure from several vantage points must be maintained from the time of arrival to the time the last rescue personnel have terminated their operation and exited the building.
- Surveyor transits and theodolites are excellent tools for detecting any wall and floor movement.
- Pay particular attention to signs of a possible imminent secondary collapse which can include shifting debris, airborne dust, sliding plaster and unnatural sounds such as creaking, moaning and groaning coming from the structure.

SHORING PLACEMENT

Two Main Objectives

- Maintain the integrity of all structurally unstable elements
- Properly transmit or redirect the collapse loads to stable ground or other suitable structural elements capable of handling the additional loads.

Shoring Placement Considerations

- All shoring operations in wood and steel framed structures should be started at least one floor below the level in which structural damage has occurred, including stressed beams, or at the lowest level if a full-scale collapse has transpired.
- All shoring operations in concrete structures should be started at least two floors below the level in which structural damage has occurred.
- Shoring primary structural supporting elements such as bearing walls, girders, columns and arches will more effectively utilize shoring materials and existing construction features of the building.
- The area beneath the main debris pile must be examined and shored as needed to provide additional support to the existing structural elements currently sustaining the load before any personnel can be committed to rescue operations in or on top of the debris pile.
- The area directly underneath the victim(s) and rescue forces must be shored up before significant debris removal operations are attempted. Shores may need to be re-tightened continually as debris is removed.

SIZE-UP CONSIDERATIONS

- VICTIMS
- SIX SIDED APPROACH
- STRUCTURAL ELEMENTS
- AGE & CONDITON OF THE STRUCTURE
- COLLAPSE WARNING SIGNS

PLACEMENT

ALL SHORING OPERATIONS IN WOOD & STEEL FRAMED STRUCTURES SHOULD BE STARTED AT LEAST 1 FLOOR BELOW AND IN CONCRETE STRUCTURES AT LEAST 2 FLOORS BELOW THE LEVEL OF ANY DAMAGE

SHORING PLACEMENT

- SUPPORT UNSTABLE STRUCTURAL ELEMENTS
- UNDER MAIN DEBRIS PILE
- UNDER VICTIM LOCATION

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Shoring Placement Considerations (continued)

- Shoring system(s) must be located where they will not interfere with the removal of the victim(s).
- All loads transferred to earth or other suitable structural element capable of handling the additional load require the shoring systems(s) to be located where they will bear on each other. This is sometimes accomplished by aligning the shoring systems on top of each other between floors or on opposite sides of a wall.
- Access into the building may require shoring to be started from the point of entry to where the victim is located in the structure. Several sections of shoring may have to be constructed to create safe zones and safe passageways.

THE SHORING TEAM

To conduct shoring operations safely and efficiently two separate teams are formed.

- The Shore Assembly Team - Performs the actual shoring size-up and construction of the shores.
- **The Cutting Team** - Establishes the equipment area and cuts the shoring lumber.
- A single Rescue Squad can normally fill the six individual shoring team positions during most shoring operations.
- Larger or more complex shoring operations may require two complete Rescue Squads, with one squad assigned to the Shore Assembly Team and the other assigned to the Cutting Team.

THE SHORE ASSEMBLY TEAM – MINIMUM SIZE

- The **Shoring Officer** (Rescue Squad Officer) in charge of the operation and works with the structural specialist to determine where to place and erect the shores.
- The **Measurer** performs all the measuring required in the erection of the shoring and relays all measurements and lumber sizes to the layout of the cutting team.
- The **Shorer** clears away debris and obstructions that could interfere with constructing the shore, assists the measure as needed and erects the shores.

SHORING PLACEMENT

- SHORES TO BEAR ON EACH OTHER
- FROM THE OUTSIDE IN
- TEAM ACCESS & EGRESS

MISSING STRUCTURAL SUPPORTS

**BEAMS
COLUMNS
GIRDERS
ARCHES**

<i>The SHORING SQUAD</i>	
<u>SHORING TEAM</u>	<u>CUTTING TEAM</u>
SHORING OFFICER	LAYOUT FF
MEASURING FF	CUTTING FF
SHORING FF	TOOL & EQUIP FF

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THE CUTTING TEAM – MINIMUM SIZE

The initial responsibility of the cutting team is to secure an area as close as possible to the collapse operation so as to minimize the number of personnel needed to relay the materials to the shore assembly team. The assistance of several other personnel may be required to help expedite the movement of lumber and tools to the collapse area.

- The **Layout** in charge of setting up the cutting station and readying the materials to be cut.
 - Performs all measuring and layout of angles and should be in direct contact with the shore assembly team measurer via portable radio to eliminate problems in miscommunicating measurements of lengths to be cut.
- The **Cutter** cuts the shoring material.
- **Tools and Equipment** directs the movement of tools and equipment to be placed where they are requested, anticipates logistical needs of the shoring team and keeps an inventory checklist/log sheet for easier retrieval of tools and equipment at the conclusion of rescue operations.

<i>The SHORING SQUAD</i>	
<u>SHORING TEAM</u>	<u>CUTTING TEAM</u>
SHORING OFFICER	LAYOUT FF
MEASURING FF	CUTTING FF
SHORING FF	TOOL & EQUIP FF

THE SHORE ASSEMBLY TEAM – FULL SQUAD

- The Shoring Officer (Rescue Squad Officer)
- The Measurer
- Shorer [these two work together assembling
- Shorer and erecting shores in place]
- Safety
- Runner ensures tools, equipment and shoring materials are moved from the shoring operation primary access point to the shoring site and assists in the erection of shores as needed.

<i>The SHORING SQUAD</i>	
<u>SHORING TEAM</u>	<u>CUTTING TEAM</u>
SHORING OFFICER	LAYOUT FF
MEASURING FF	CUTTING FF
SHORING FF	TOOL & EQUIP FF

THE CUTTING TEAM – FULL SQUAD

- The Cutting Team Officer (Rescue Squad Officer)
- The Layout
- The Feeder moves and feeds measured and marked shoring material from the Layout to the Cutter and helps secure it when being cut.
- The Cutter
- Tool and Equipment
- Runner ensures tools, equipment and shoring materials are moved from the cutting area to the shoring operation primary access point.

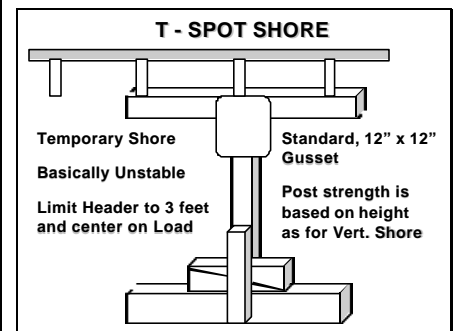
MODULE 2b SHORING CONSTRUCTION

THE "T" SPOT SHORE

- The main purpose of the "T" shore is to initially stabilize damaged floors, ceilings or roofs, so that the more substantial shoring can be constructed at less risk.
- The T Shore is basically unstable.
 - That is if the supported load is not centered directly over the Shore, it will tend to tip over.
 - The header beam is deliberately kept short so as to minimize to effect of tipping.
- The size of lumber most commonly used in the T shore is 4 X 4 douglas fir. The estimated weight of the floor and its contents will help to determine the number of shores that will be required.
- Structural Components of the T shore
 - The **Sole Plate** provides a foundation for the shoring system by supporting the weight being transferred from above/distributes it over a wider area.
 - The **Header** collects the weight from above and spreads it throughout the shoring system.
 - The **Posts** supports the weight being collected by the header or spreader beam and transfers it to the sole plate where it is distributed.
 - The **sole plate, header and posts** should be the same width for a more secure attachment.
 - **Cleats or Gusset Plates** short pieces of 2 X 4 (Cleat) or small pieces of $\frac{3}{4}$ " plywood (Gusset Plate) nailed to the top/bottom of posts to ease shore placement and secure the posts to header and sole plate.
 - **Wedges** two wooden incline planes **married** together and placed under the bottom of the post. They are simultaneously tapped together until the shoring system is under compression and takes the weight of the structural materials above.

THE "T" SHORE

INITIAL SAFETY SHORE
STANDARD "T"
TEMPORARY SHORING
MAXIMUM HEADER LENGTH = 3FT
*(may extend header to 4ft
if 18" sq. gussets are used)*



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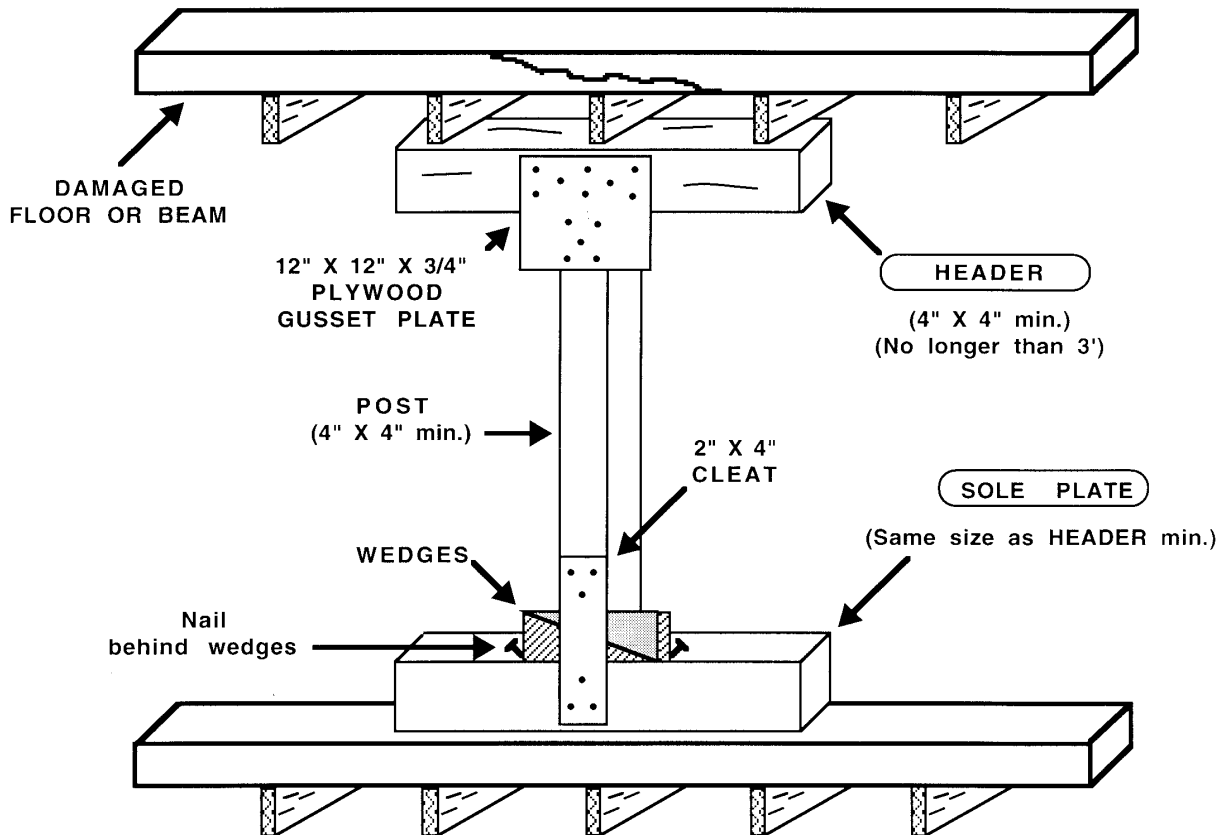
THE "T" SPOT SHORE (continued)

"T" SPOT SHORE

O/H-T
6/99

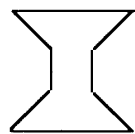
Position the HEADER & SOLE PLATE across the floor and ceiling joists and align the POST under the joists

Temporay shore ONLY until
a complete shoring system can be erected



"T" SPOT SHORES CAN ALSO BE CONSTRUCTED WITH PNEUMATIC SHORES, ELLIS CLAMPS, POST & PIPE SCREW JACKS

SHORING PRINCIPLE



HEADER, POSTS & SOLE PLATE SHOULD BE SAME WIDTH FOR GUSSET PLATES & CLEATS TO BE MORE EFFECTIVE

MODULE 2b SHORING CONSTRUCTION

THE “T” SPOT SHORE (continued)

HOW TO CONSTRUCT THE “T” SHORE

- Survey area and determine load displacement, and structurally unstable elements.
- Clean area to be shored
- Measure for proper lengths of shoring items.
- The overall height of the space to be shored is measured.
 - Deduct the depth of the header, sole plate, and the wedges, and cut the post to that length.
- Prefabricate “T” shore.
- Nail post to header, in center of header.
 - Place plywood gusset plate over joint and nail into position.
 - The header will get 8 nails and the post will get 5 nails.
 - Gusset is 12” x 12” for a shore with a 3 foot header.
 - **NOTE; if utilizing a “T” shore with a 4’ header, you must use an 18” x 18” gusset plate.**
- Flip over and nail other gusset in position, utilize the proper 5 nail pattern.
- Place “T” in position with the shore centered under the load.
- Slide sole plate under “T” and wedge in position
- Check shore for straightness and stability and tighten wedges
- Install bottom cleat and nail properly.
- Anchor the shore to the floor beams above and nail sole plate into the floor below.

MODULE 2b SHORING CONSTRUCTION

THE VERTICAL SHORE

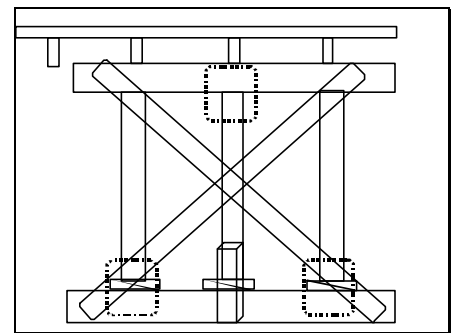
- The main purpose of the vertical shore is to stabilize damaged floors, ceilings or roofs. It can also be used to replace missing or unstable bearing walls or columns.
- The two sizes of lumber most commonly used in vertical shoring are 4 X 4 and 6 X 6 douglas fir. The estimated weight of the floor and its contents will help to determine the size of shoring materials and their spacing.
- Businesses and commercial occupancies with heavier structural elements and greater floor height and/or loading may require 8 X 8 or even 12 X 12 lumber. The Structural Specialist should be used to help determine the correct size and placement of shoring materials.
- Structural Components of the Vertical Shore
 - The **Sole Plate** provides a foundation for the shoring system by supporting the weight being transferred from above/distributes it over a wider area.
 - The **Header** collects the weight from above and spreads it throughout the shoring system.
 - The **Posts** supports the weight being collected by the header or spreader beam and transfers it to the sole plate where it is distributed.
 - The **sole plate, header and posts** should be the same width for a more secure attachment.
 - **Cleats or Gusset Plates** are short pieces of 2 x 4 or 2 x 6 (Cleat) or small pieces of $\frac{3}{4}$ " plywood (Gusset Plate) nailed to the top/bottom of posts to ease shore placement and secure the posts to header and sole plate.
 - Cleats should be at least 12 inches long or they will tend to split
 - **Wedges** two wooden incline planes **married** together and placed under the bottom of the post. They are simultaneously tapped together until the shoring system is under compression and takes the weight of the structural materials above.

VERTICAL SHORE

RESUPPORT UNSTABLE FLOORS
OR ROOFS

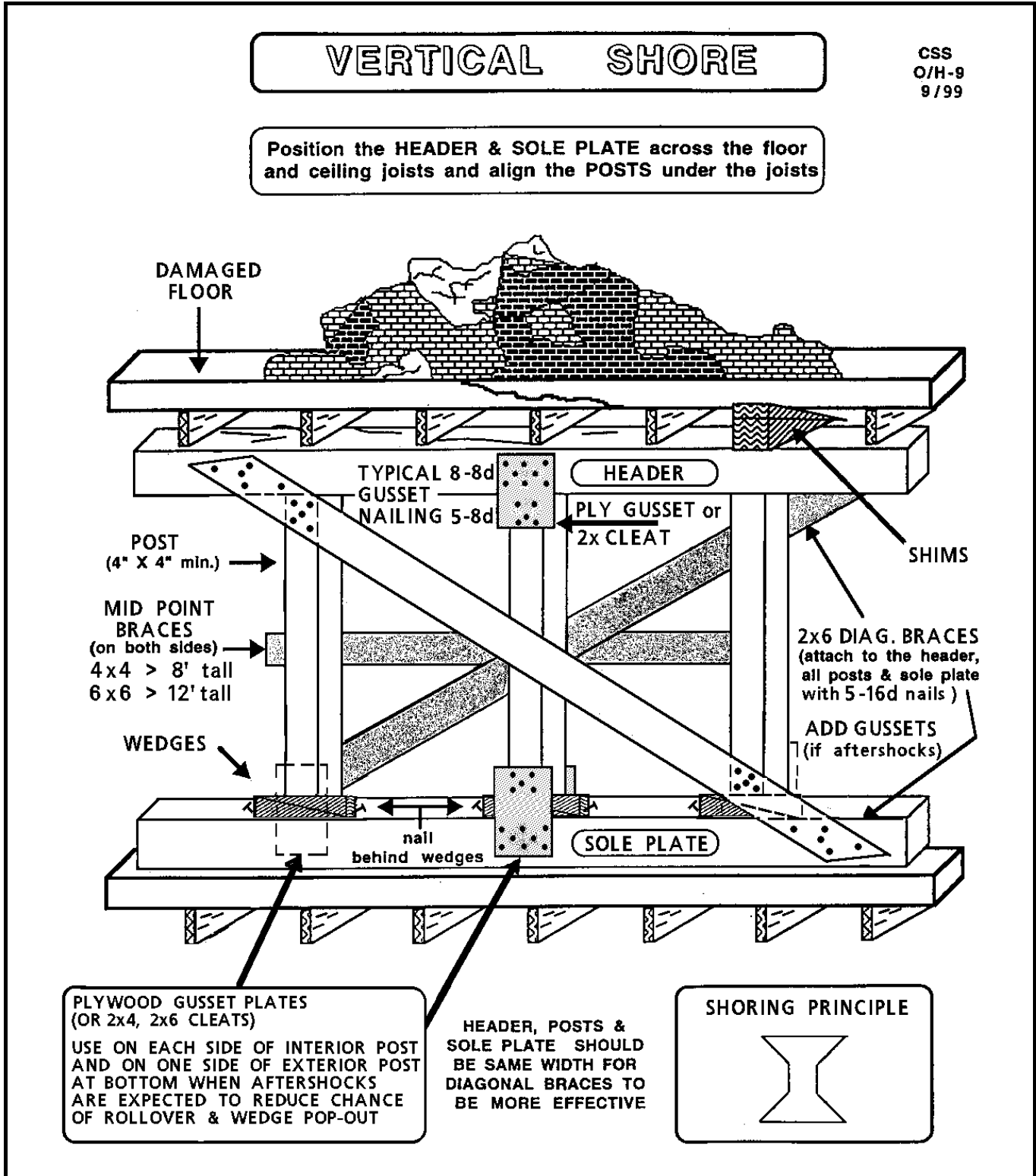
POSTS UNDER FLOOR BEAMS

MID-POINT BRACING AT 9 ft CEIL. HT
(Posts over 8ft plus header & sole)



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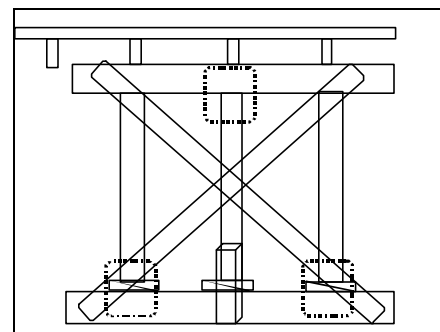
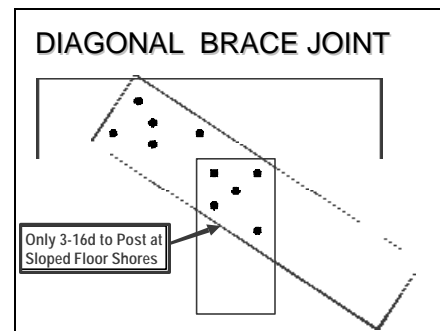
THE VERTICAL SHORE (continued)



MODULE 2b SHORING CONSTRUCTION

THE VERTICAL SHORE (continued)

- **Diagonal Braces** the last items to be installed on the vertical shore should be long enough to span its entire length and be attached to the header, each post and the sole plate to lock the entire shore together as one unit and support against possible eccentric loads applied to it.
 - A 2 X 6 or 2-2 X 4 nailed on both sides of the shore in opposite directions of each other to resist lateral deflection from either side.
- **Mid-Point Braces** are needed when 4 X 4 posts are greater than 8 ft long or 6 X 6 posts greater than 12 ft long.
 - A 1 X 6 or length of $\frac{3}{4}$ " plywood at least six inches wide nailed to the mid point of the posts on both sides takes deflection out of the post.
 - 2 X 4 or 2 x 6 may be used as mid point braces, but in that case the mid point braces must be installed after the Diagonal Braces (2x4x18" cleats should be added to the sides of the end posts to provide a step out)
 - To increase the posts bearing capabilities, mid point bracing must be in both directions with diagonal braces long enough to connect the header to the sole plate or two shorter diagonal braces, one connecting the header to the mid point braces and the other connecting the mid point braces to the sole plate.



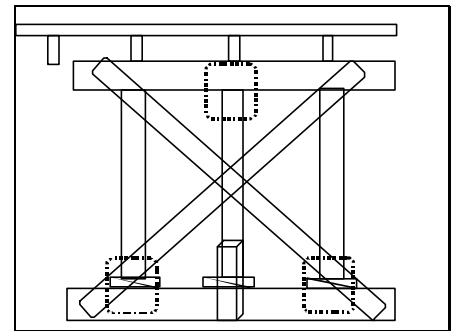
HOW TO CONSTRUCT THE VERTICAL SHORE

- Determine where to erect the vertical shore.
 - After initial temporary shoring has been installed as needed, clear the area of debris, down to the floor, removing thick carpeting if necessary. A clearance of three to four feet wide is usually adequate.
 - If the vertical shore is to bear directly on soil, examine the ground for stability. If the earth is soft, additional supports should be installed under the sole plate to transfer the load over a wider area.
- Lay the sole plate on the floor or ground directly under and in line where the header will be installed.
 - The sole plate should be as level as possible.

MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE VERTICAL SHORE (continued)

- Measure and cut the posts to the proper height.
 - Place the header on top of the sole plate.
 - With the end of the tape measure on top of the header where the posts are to be installed, slide the tape up to the bottom of the structural element to be shored and measure in at least three places deducting the width of the wedges to be used.
- If possible, anchor the header to the area that is to be shored, square and in line with the sole plate.
 - Secure it at the lowest point and shim the structural elements down to the header to keep it as level as possible.
- Install the posts between the header and sole plate under each structural element to be supported.
 - The first two posts are installed at opposite ends at least 12 in. from each end of the sole plate.
 - Keep the posts in line and plumb with header & sole plate.
- Install a set of wedges under the bottom of each post and tap them together simultaneously until the posts are under compression and tight.
 - Nail behind the wedges to secure them in place.
- Attach cleats or gusset plates to at least one side of the header and posts and nail in place if not done previously.
- Attach cleats or gusset plates to at least one side of the sole plate and posts and nail in place.
 - Nails may need to be Duplex for future adjustment of the wedges.
- Attach the diagonal braces to each side of the vertical shore.
 - Mid-point braces, when needed, should be installed prior to the diagonal braces. (except when 2x material is used, and then the mid point braces are placed over the diagonals)
 - The diagonal braces should be long enough to span its entire length and be attached to the sole plate and header and each post.
 - If possible, diagonal braces should be installed in an **X** pattern on opposite sides of the system.
 - Vertical shoring systems which span a long area may require several sets of diagonal braces to connect multiple posts.



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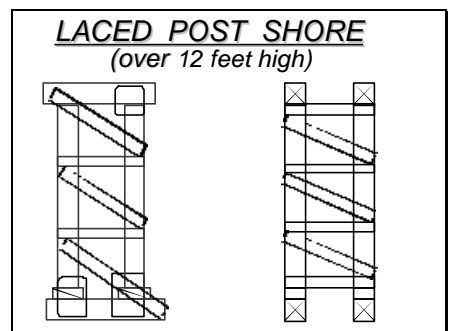
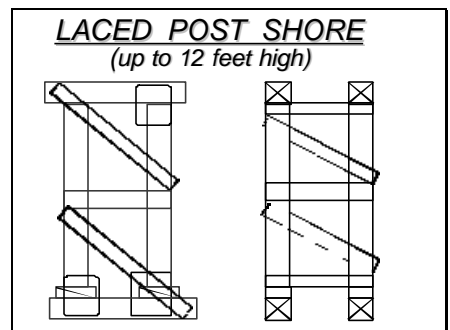
THE LACED POST SHORE

- The main purpose of the Laced Post Shore is to stabilize very heavy, damaged floors, ceilings or roofs.
- They can also be used to provide a safe haven.
- It is a very stable system, since each vertical post is braced in each direction
- The two sizes of lumber most commonly used as laced posts are 4 X 4 and 6 X 6 douglas fir. The estimated weight of the floor and its contents will help to determine the size of shoring materials and their spacing.
- The structural components of a Laced Post Shore are very similar to the Vertical Shore
 - A Laced Post is essentially two, 2 post vertical shores that are constructed separately and then laced together
 - When 4 x 4 posts are used, the diagonal braces and center, or mid point braces, are constructed using 2 x 4 lumber (instead of the 2 x 6 used in a vertical shore)
 - Nail 2 x 4s with 3-16d each end
 - When 6 x 6 posts are used, the diagonals and center braces should be 2 x 6 lumber.
 - Nail 2 x 6 with 5-16d each end

HOW TO CONSTRUCT A LACED POST SHORE

- Survey area and determine load displacement, and structurally unstable elements
- Clean area to be shored.
 - Install temporary, Spot Shores if required
- Determine the length of the shore.
 - Cut the header and sole plates 2 feet longer than length of the shore
 - There is to be a 12 inch overhang on each end.

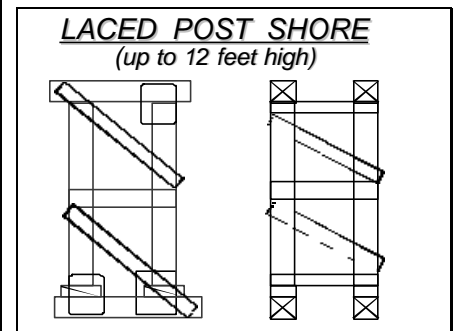
LACED POST SHORE
THE STONGEST AND STABILIST
SHORE WE CAN ERECT
CAN BE UTILIZED AS A SAFE HAVEN
AREA WHEN NECESSARY
4X4'S & 6X6'S USUAL
ONE MIDPOINT BRACE UP TO 12' HIGH
(2 mid point braces if higher than 12')
5' MAXIMUM POST SPACING



MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT A LACED POST SHORE (continued)

- Nail the posts into the header
- Keep them square to the header.
 - Nail the midpoint brace in position.
- Measure and install the top diagonal.
 - It must overlap the post and tie into the header, use the proper nail patterns.
 - Nail a gusset plate onto the other post joint.
- Fabricate the second section
 - Use the first as a template.
- Have the horizontal tie-in braces precut for ease of assembly.
- Bring both sections and the sole plates into position and place the prefabricated units on top of the sole plates.
- Install wedges under each post.
- Nail the horizontal braces to the two sections on both sides.
- Measure for all the diagonals, and make sure all but one set runs in the same direction when they are installed.
- At the sole plate, make sure the bottom diagonal extends past the post and nails into the sole plate.
 - Place a gusset plate onto the opposite side of this post and to each side of the other posts at the base.
- Anchor the shore to the ceiling and the floor.
- Make sure all wedges are snug and the proper nail patterns are done.



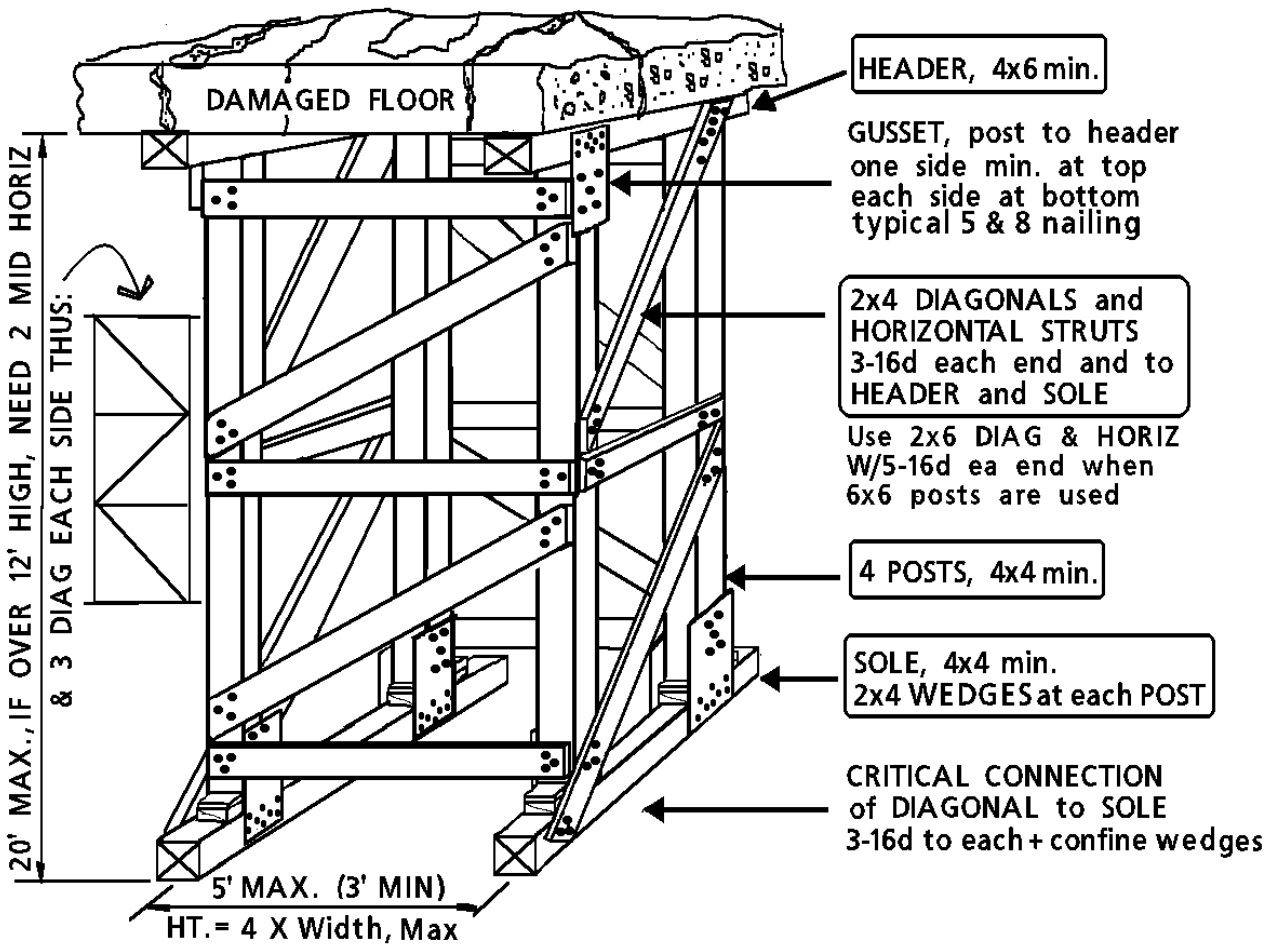
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LACED POST SHORE (continued)

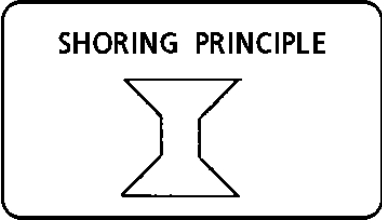
LACED POST SHORE

OH-LP
6/99

High capacity four post system that can be used to shore a damaged Concrete Floor or Heavily Loaded and damaged Wood Floor. It is constructed similar to a pair of Vertical Shores but laced together.



HEADER, POSTS & SOLE PLATE SHOULD BE SAME WIDTH FOR DIAGONAL BRACES TO BE MORE EFFECTIVE



Need to add GUSSET to inside of POST to SOLE where Aftershocks occur to reduce WEDGE pop-out and SOLE roll-over

MODULE 2b SHORING CONSTRUCTION

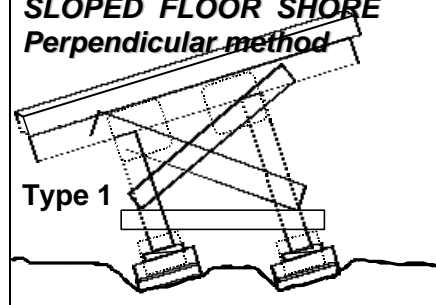
SLOPED FLOOR SHORES

- The main purpose of the Sloped Floor Shore is to stabilize damaged floors, ceilings or roofs that have collapsed into a sloped configuration
 - Vertical Shores may be used to support floors with a very slight slope, that is slopes up to 5% (5 feet in 100 feet).
- This shore is essentially a two post vertical shore system, constructed with the posts placed perpendicular to the sloped surface.
 - These shores should be built in pairs and laterally braced in two directions, with spacing between 4 and 8 feet.
- The two sizes of lumber most commonly used in vertical shoring are 4 X 4 and 6 X 6 douglas fir. The estimated weight of the floor and its contents will help to determine the size of shoring materials and their spacing.
- Components of a this shore are similar to the Vertical Shore.
- Sloped Floor Shores can be configured in two ways
 - Perpendicular Bearing Method is used when shoring a floor slab that is hinged off remaining structure or otherwise restrained from sliding. There are two types.
 - Type 1 is constructed on earth
 - Type 2 is constructed on a hard surface like concrete
 - Sloped Friction Method is used when floor slab is free to slide, and one type is used for on ground or hard surface.
- Cribbing may also be constructed to support a sloped surface
 - The crib is built into the slope by adding nailed, full width shims in various layers, so the top crib members end up flush and tight against the sloped surface
- Horizontal and diagonal bracing should be placed between pairs of Sloped Floor Shores, same as for Laced Posts for shores spaced not more than 5 ft o.c.
 - Where shores are spaced more than 5 but less than 8 ft o.c., the lateral bracing should consist of horizontals plus **X** or **V** bracing as for Raker Shores.
- When these shores are not over four feet tall, one may use $\frac{3}{4}$ " plywood strips (12" to 24" wide x 5 ft long) as the lateral bracing between pairs of shores.
 - The plywood should be nailed to the Sloped Floor Shore posts as shown in adjacent slide, and the plywood should extent to within about 12" of the top & bottom of shore.

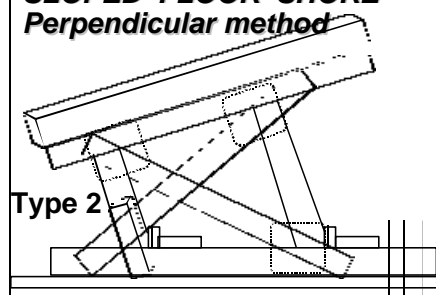
SLOPED FLOOR SHORE

Used Where Box Cribbing Is Not Practical
Must Be Erected In Pairs And Cross Braced
as for Laced Posts, spacing = 5ft max.
If need to space over 5 ft, 8 ft max, then
need to Cross Brace same as for Raker
Shores
Posts Are Erected At Right Angles To The
Floor In Question unless "Friction
System" is more practical.
Minimum of 3 - 1 Inch Pins as Anchors

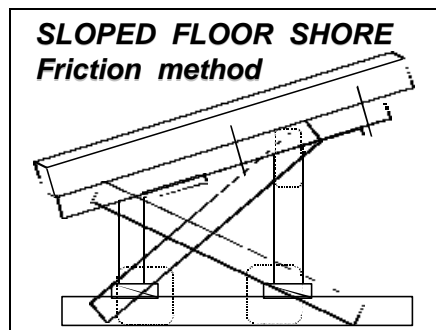
SLOPED FLOOR SHORE *Perpendicular method*



SLOPED FLOOR SHORE *Perpendicular method*



SLOPED FLOOR SHORE *Friction method*

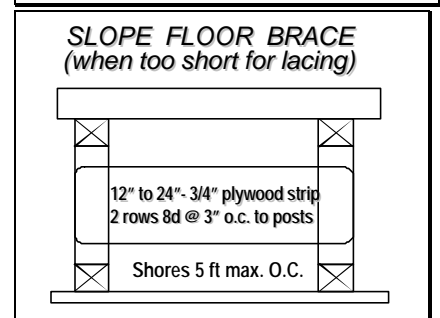
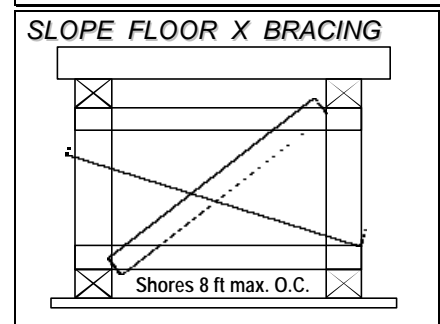
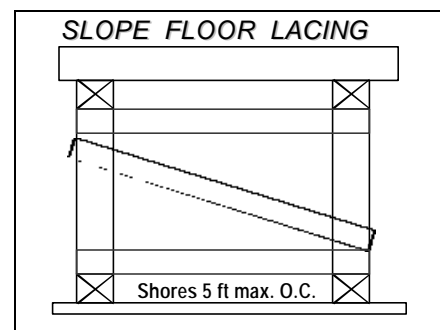
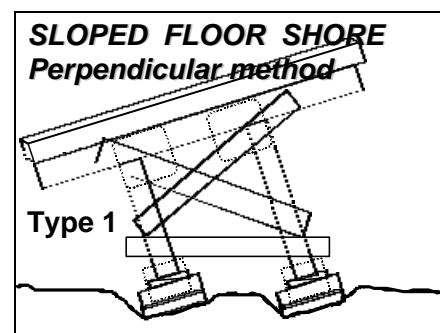


MODULE 2b SHORING CONSTRUCTION

SLOPED FLOOR SHORES (continued)

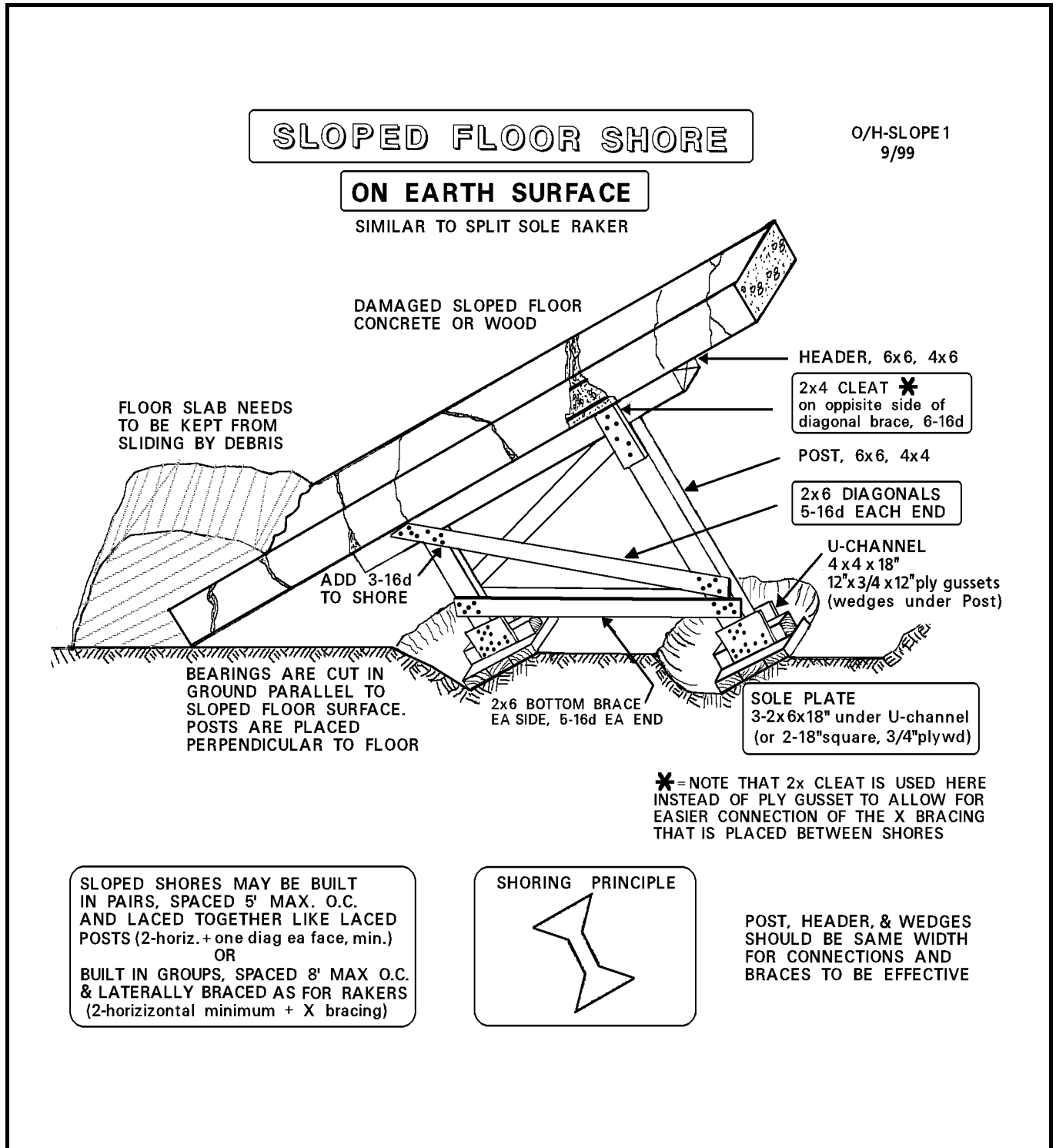
HOW TO CONSTRUCT A SLOPED FLOOR SHORE ON AN EARTH SURFACE

- Survey area and determine load displacement, and structurally unstable elements
- Clean area to be shored.
 - Install temporary, Spot Shores if required
- Determine length and width of shore and post locations.
 - Headers must overlap at least 12 inches.
 - These shores should be built in pairs, spaced no more than 8 feet on center. (5 ft if using Lacing type bracing)
 - Install the header and anchor in position.
- Excavate the ground at the post locations
 - Place U-channel as a sole plate.
 - The minimum size of this sole plate is 18 inches square.
- Measure and install the two posts.
 - Anchor to the header.
 - Place a set of wedges under each post and pressurize.
- Install the bottom horizontal 2x6 braces on both sides of each shore section using the proper nail patterns.
- Install the 2x6 diagonal braces in position and nail into posts and header and sole plate.
 - Gusset plate the opposite side of the posts, top and bottom, use the typical nail pattern.
 - Need to place gussets to clear the horizontal and diagonal braces (to be installed next) or use 2x cleats instead of gussets.
- Brace the two sections together, same as in Laced Posts or Raker Shores (depending on spacing).
 - Do this at both posts in order to tie the two sections together.
 - You may use a wide piece of 3/4" plywood (12 to 24" wide) if Shore is too short to fit X braces.
- Make sure the shore is attached to the floor (If possible)



MODULE 2b SHORING CONSTRUCTION

SLOPED FLOOR SHORES ON EARTH SURFACE

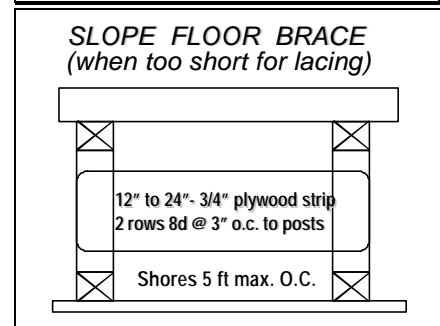
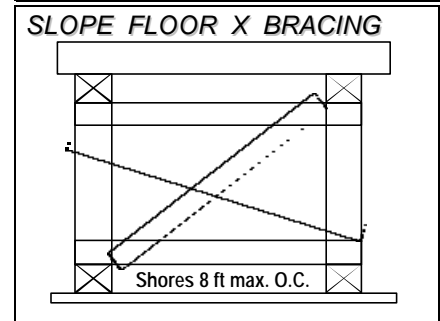
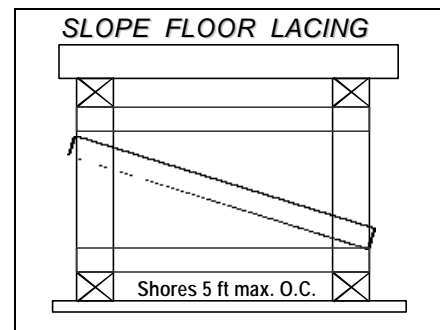
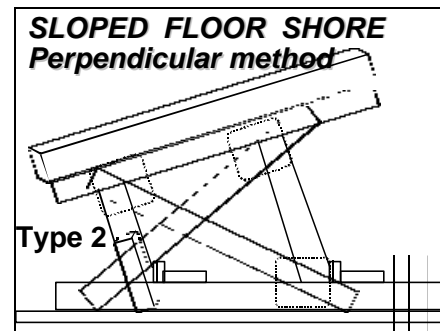


MODULE 2b SHORING CONSTRUCTION

SLOPED FLOOR SHORES (continued)

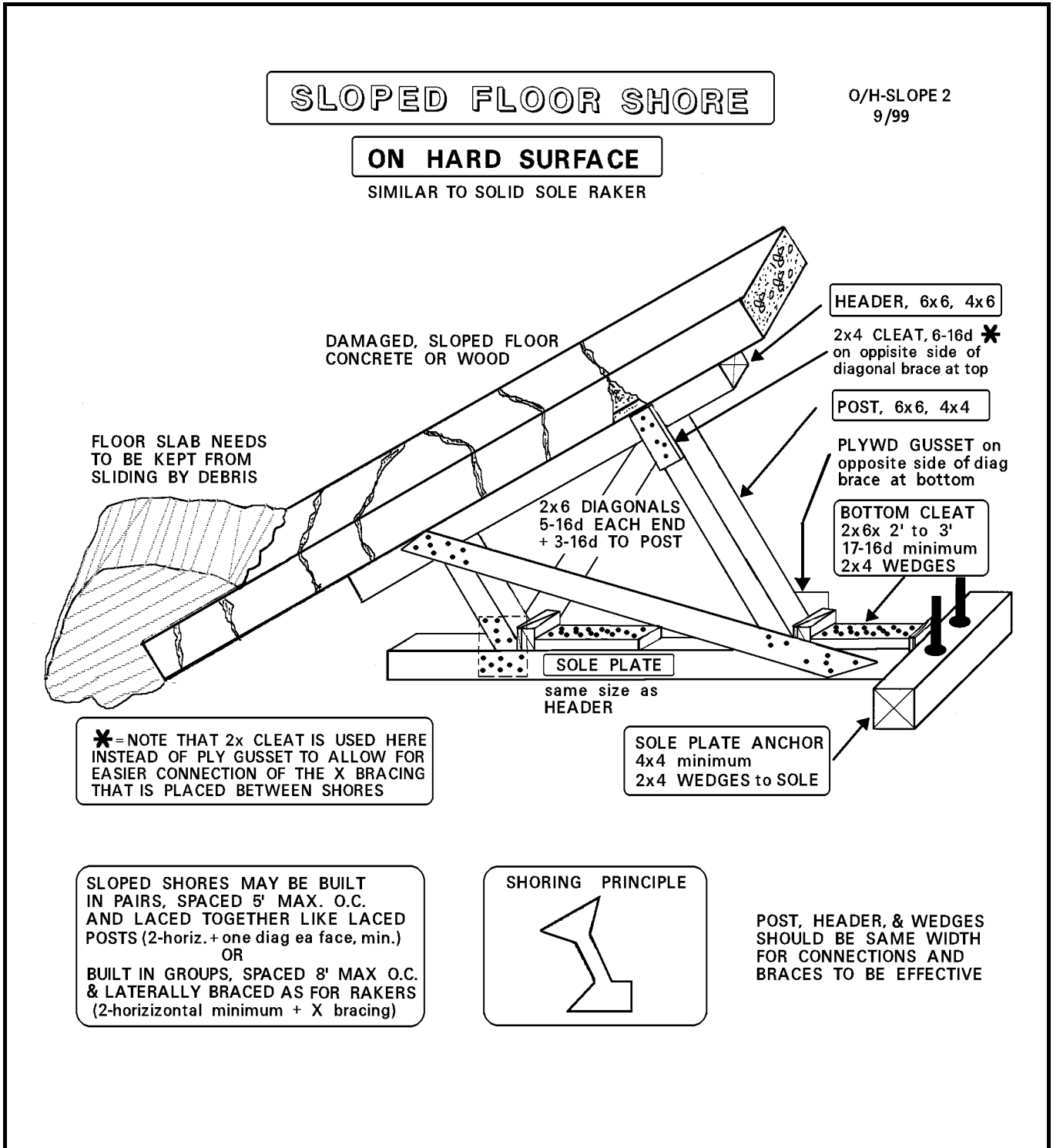
HOW TO CONSTRUCT A SLOPED FLOOR SHORE ON A HARD SURFACE

- Survey area and determine load displacement, and structurally unstable elements
- Clean area to be shored.
 - Install temporary Spot Shores if required.
- Determine length and width of shore and post locations.
 - Headers must overlap at least 12 inches.
 - The sole plate must be at least 2 feet longer at the base of the back post.
 - These shores should be built in pairs, spaced no more than 8 feet on center. (5 ft if using Lacing type bracing)
 - Install the header and sole plates, and anchor header.
- Measure and install the two posts
 - Anchor to the header.
- Nail down the bottom cleats with the proper nail patterns. Place wedges in position.
- Anchor down the sole plate, and pressurize the wedges.
 - Anchor sole using drilled in anchors or large rebar to anchor to concrete or paving, based on Structure Specialist recommendations.
 - Alternate Sole anchor using Sole Plate Anchor system shown with Rakers.
- Measure for the diag. braces inside and outside each section.
- Install the 2x6 braces in position and nail into posts, header, and sole plate.
 - Gusset plate (or use 2x cleats) the opposite side of the posts, top and bottom, using the typical nail pattern.
- Brace the two sections together, same as in Laced Posts or Raker Shores (depending on spacing).
 - Do this at both posts in order to tie the two sections together.
 - You may use a wide piece of 3/4" plywood (12 to 24" wide) if Shore is too short to fit X braces.
- Make sure the shore is attached to the floor and ceiling. (If possible)



MODULE 2b SHORING CONSTRUCTION

SLOPED FLOOR SHORES ON HARD SURFACE



MODULE 2b SHORING CONSTRUCTION

THE HORIZONTAL SHORE

The main purpose of the horizontal shore is to stabilize a damaged wall against an undamaged wall in hallways, corridors or between buildings.

STRUCTURAL COMPONENTS OF HORIZONTAL SHORE

- The **Wall Plates** provide a foundation for the shoring system by collecting the weight being transferred laterally and spreads it throughout the shoring system.
- The **Struts** supports the weight being collected by one wall plate and transfers it to the other wall plate.
 - The wall plates and struts should be the same width for a more secure attachment.
- **Cleats or Gusset Plates**
 - Cleats: short pieces of (2 X 4) nailed under the struts to ease in their placement and prevent the struts from being dislodged.
 - Gusset Plates: small pieces of $\frac{3}{4}$ " plywood nailed on at least one side of the wall plates and struts to prevent struts from being dislodged.
- **Wedges** two wooden incline planes "married" together and placed under one end of the strut.
 - Simultaneously tapped together until the shoring system is under compression and takes the weight of the structural materials.
- **Diagonal Braces** the last items to be installed on the horizontal shore when the hallway or corridor is **not used** for access or egress.
 - Should be long enough to contact both the top and bottom of the wall plates and all the struts to lock the entire shore together as one unit and support against possible eccentric loads applied to it.
 - A 2 X 4 or 2 X 6 nailed on both sides of the wall plates in opposite directions of each other to resist lateral deflection from either side.

HORIZONTAL SHORE

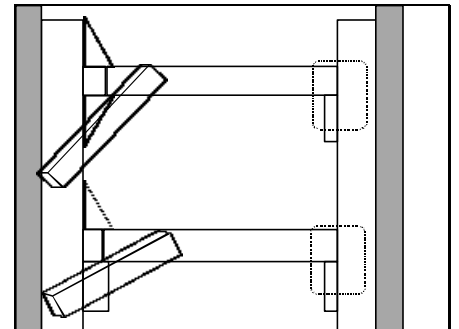
STABILIZE PASSAGEWAYS

2 - 3 SUPPORT STRUTS

DEBRIS WEIGHT WILL

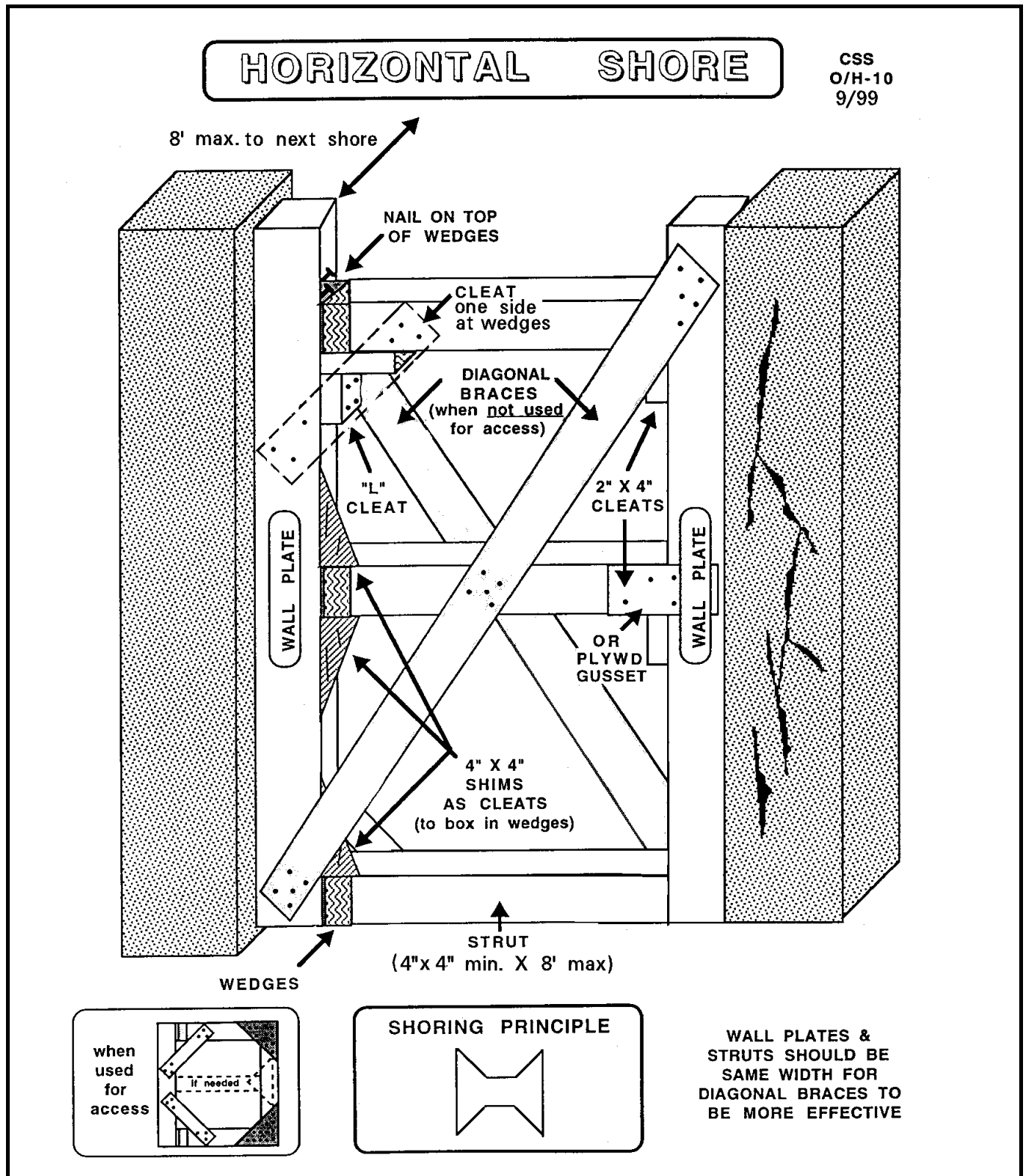
DETERMINE THE SIZE

AND # OF STRUTS NEEDED



MODULE 2b SHORING CONSTRUCTION

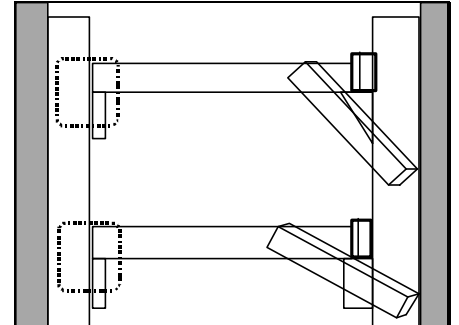
THE HORIZONTAL SHORE (continued)



MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE HORIZONTAL SHORE

- Determine where to erect the horizontal shore
 - After initial temporary shoring has been installed as needed, clear the area of debris.
 - A clearance of three to four feet wide is usually adequate.
- Measure and cut the wall plates to the proper length.
- Measure and cut the struts to the proper length.
 - Place both wall plates against the walls.
 - Measure between the wall plates where the struts are to be installed, deducting the width of the wedges to be used.
- Place both wall plates next to each other and attach cleats to the wall plates just below where the struts will be installed.
- Place the wall plates in the area that is to be shored, square and in line with each other and as plumb as possible by shimming any void spaces behind the wall plates.
- Install the struts between the wall plates. Keep the struts in line and plumb with the wall plates.
- Install a set of wedges behind one end of each strut and tap them together simultaneously until the struts are under compression and tight.
 - Secure the wedges in by placing the back of a shim on top of the wedges and nail it to the wall plate or toe nail the wedges to the wall plate.
 - Nails may need to be Duplex for future adjustment of the wedges.
- Attach cleats or gusset plates to at least one side of the wall plates and struts, where aftershocks or vibrations may occur.
- If possible, attach the wall plates to the walls.
- Attach the diagonal braces to each side of the horizontal shore when **not used** for access or egress.
 - The diagonal braces should be long enough to span entire length and be attached to both wall plates and each strut.
 - When used, diagonal braces should be installed in an **X** pattern on opposite sides of the system.



MODULE 2b SHORING CONSTRUCTION

WINDOW AND DOOR SHORE

- The main purpose of the window and door shore is to stabilize a window, doorway or other access way. An extensive collapse can generate a tremendous amount of debris that blocks the primary entrances into a building and/or sometimes require a window entry.
- The window and door shore is usually installed in entry points intended for use by rescue personnel to hold up or stabilize loose headers or lintels that have lost their integrity.
- Additional load stress is usually exerted from above and therefore, constructed similar to the vertical shore.
 - If additional load stress is exerted from the side, the window and door shore is constructed similar to the horizontal shore.

STRUCTURAL COMPONENTS - WINDOW & DOOR SHORE

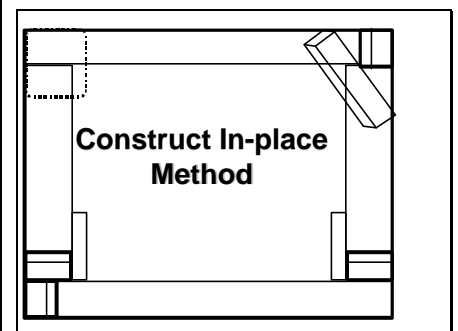
- The **Sole Plate** provides a foundation for the shoring system by supporting the weight being transferred from above and distributing it over a wider area.
- The **Header** collects the weight from above and spreads it throughout the shoring system.
- The **Posts** supports the weight being collected by the header and transfers it to the sole plate where it is distributed.
 - The sole plate, header and posts should be the same width for a more secure attachment.
 - Buildings with large structural elements or openings greater than four feet usually require lumber larger than 4 X 4 for the sole plate, header and posts.
- **Cleats or Gusset Plates** short pieces of 2 X 4 (Cleat) or small pieces of $\frac{3}{4}$ " plywood (Gusset Plate) nailed to both ends of the posts and struts to ease in the placement and securing the posts to the header and sole plate.
- **Wedges** two wooden incline planes "married" together and placed under the bottom of the posts or struts.
 - Simultaneously tapped together until the shoring system is under compression and takes the weight of the structural materials.

THE DOOR SHORE

*RESUPPORT ENTRANCE
SUPPORT WALL BREACH
1 inch THICKNESS FOR
EVERY FOOT OF HEADER
LENGTH*

The WINDOW SHORE

*STABILIZE WINDOW OPENING
SUPPORT DAMAGED HEADER
1 inch THICKNESS FOR EVERY
FOOT OF HEADER OPENING*



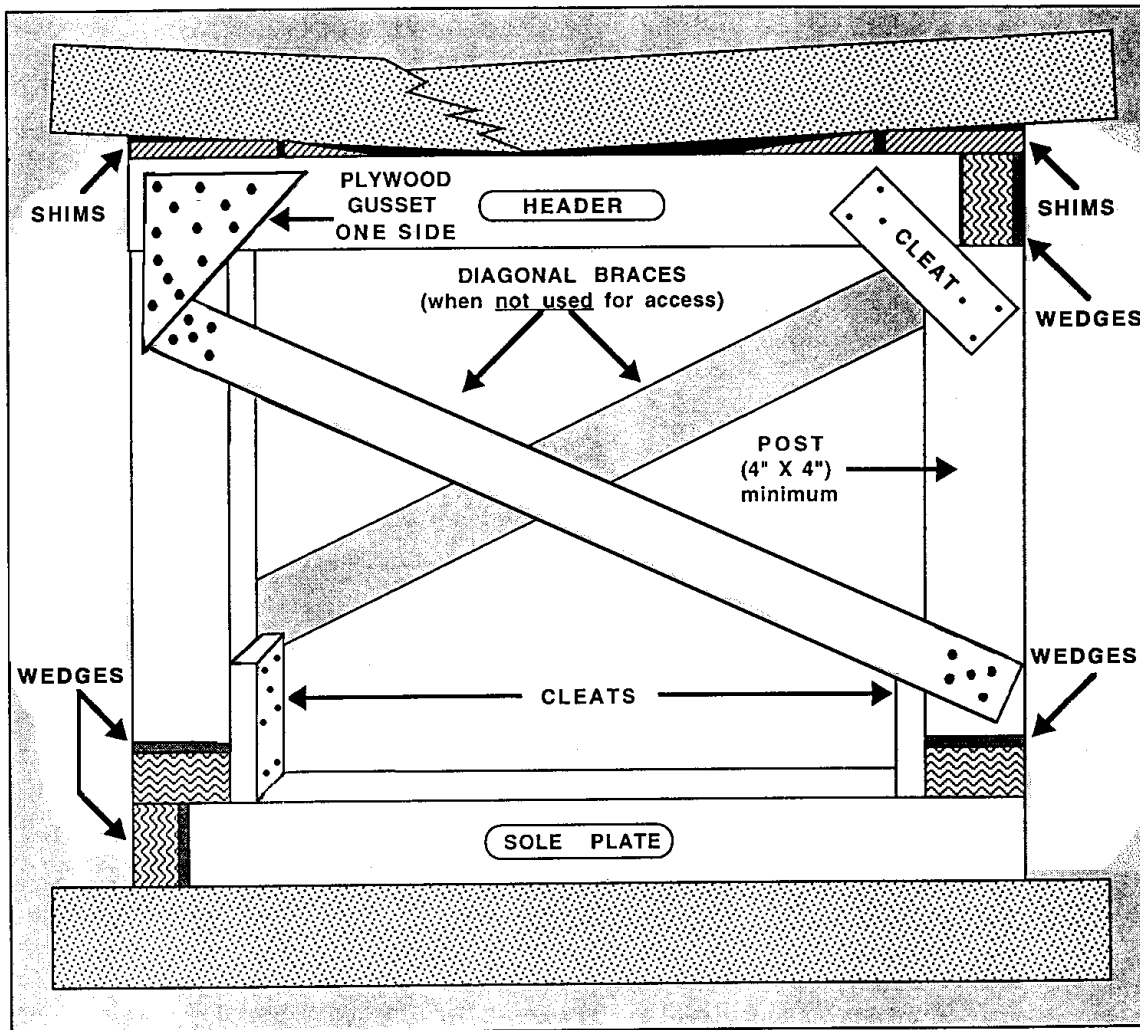
MODULE 2b SHORING CONSTRUCTION

WINDOW AND DOOR SHORE (continued)

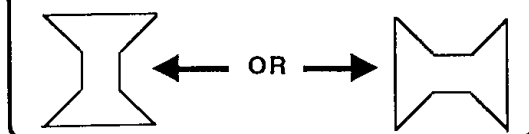
WINDOW & DOOR SHORE

O/H-11
9/99

THE HEADER REQUIRES 1 in. OF THICKNESS
FOR EVERY FOOT OF HORIZONTAL OPENING
(Example: 3' opening = min. 4" X 4" Header)



SHORING PRINCIPLE

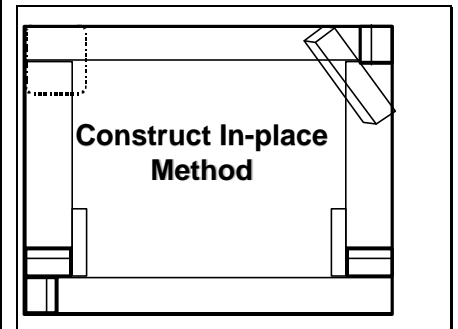


HEADER, POSTS &
SOLE PLATE SHOULD
BE SAME WIDTH FOR
DIAGONAL BRACES TO
BE MORE EFFECTIVE

MODULE 2b SHORING CONSTRUCTION

STRUCTURAL COMPONENTS - WINDOW & DOOR SHORE (continued)

- **Diagonal Braces** the last items to be installed on the window and door shore when the opening is **not used** for access or egress.
 - The diagonal braces should be long enough to contact the top of the posts on one side and the bottom of the posts on the other to lock the entire shore together as one unit and support against possible eccentric loads applied to it.
 - A 2 X 4 or 2 X 6 nailed on both sides of the shore in opposite directions of each other to resist lateral deflection from either side.
- **Built-up Header** used when additional support is needed or if the opening is more than six feet wide and only 4 X 4 material is available.
 - Prior to installation of header, cut 2- 4 X 4 to proper length for header and set them one on top of the other. Place 6" wide plywood strips (as long as the headers) on each side to join the two pieces, and nail **8d @ 3" o.c.** from each strip of plywood to each 4 X 4.
 - Total nailing will be 4 rows of 8d spaced 3"o.c.
 - Header will be 7" high, almost equivalent to a 4 X 8



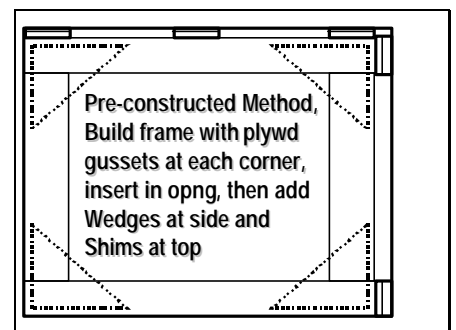
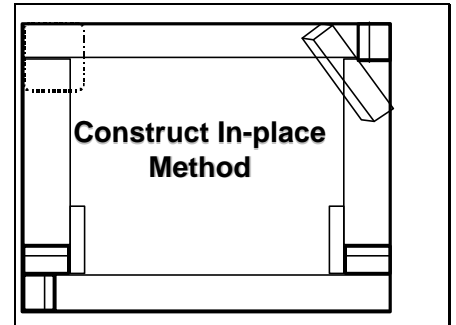
HOW TO CONSTRUCT THE WINDOW AND DOOR SHORE

- Determine where to erect the window and door shore
 - After initial temporary shoring has been installed clear the area of debris or remaining framing material.
- Measure and cut the sole plate to the proper length deducting the width of the wedges to be used.
- Measure and cut the header to the proper length deducting the width of the wedges to be used.
 - Prefabricate a Built-up Header as noted above, if req'd.
- Measure and cut the posts to the proper height.
 - Place the header on top of the sole plate.
 - With the end of the tape measure on top of the header where the posts are to be installed, slide the tape up to the bottom of the structural element to be shored on both sides deducting the width of the wedges to be used.
 - Use the shorter of the two measurements.

MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE WINDOW AND DOOR SHORE (continued)

- Install the sole plate with a set of wedges at one end and tap them together simultaneously until the sole plate is under compression and tight.
 - The sole plate should be as level as possible, use shims as necessary under the sole plate.
- Install the header with a set of wedges at the opposite end of the sole plate and tap them together simultaneously until the header is under compression and tight.
 - The header should be as level as possible, use shims as necessary above the header.
- Install the posts between the header and sole plate and against the sides of the opening.
 - Install the first post under the wedge side of the header to prevent accidental movement if the header wedges loosen up.
 - Keep the posts in line and plumb with the header and sole plate.
 - A set of wedges is installed under each post, on top of the sole plate. The wedges are then tightened to lock the shore in place.
- Attach cleats or gusset plates to at least one side of the header and posts and nail in place.
- Confine the wedges by placing a cleat against the inside face of each post at the bottom and nail them in place with 5-16d to each post and 2-16d toe nails to the sole plate
 - Nails may need to be Duplex for future adjustment of the wedges.
- Install diagonal braces on the window and door shore when the opening is **not used** for access or egress.
- Window and Door shores may also be pre-constructed as shown in adjacent slide
 - See discussion under Pre-Constructed Shores

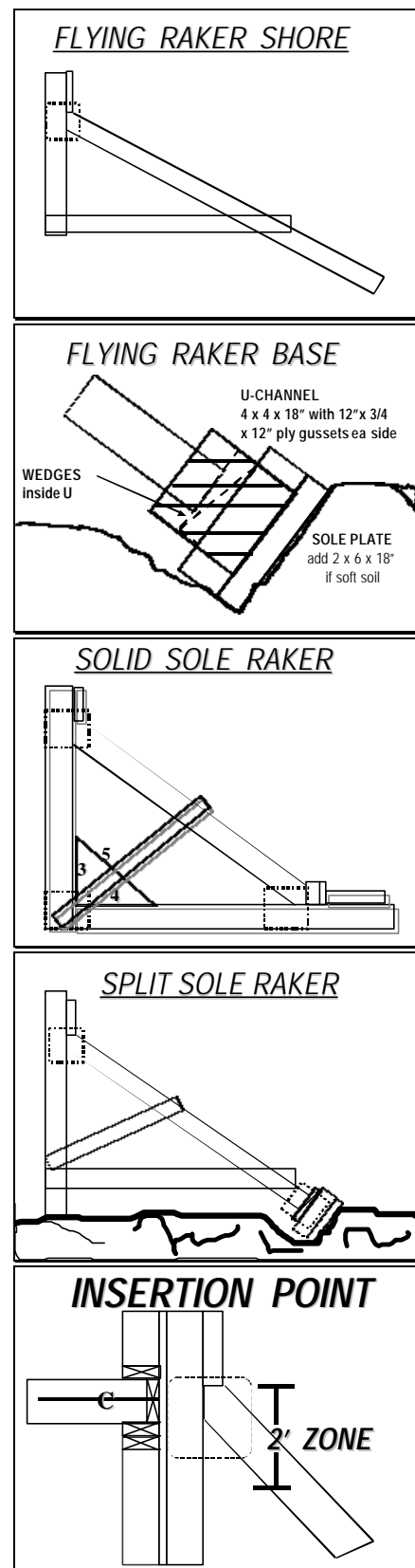


MODULE 2b SHORING CONSTRUCTION

THE RAKER SHORE

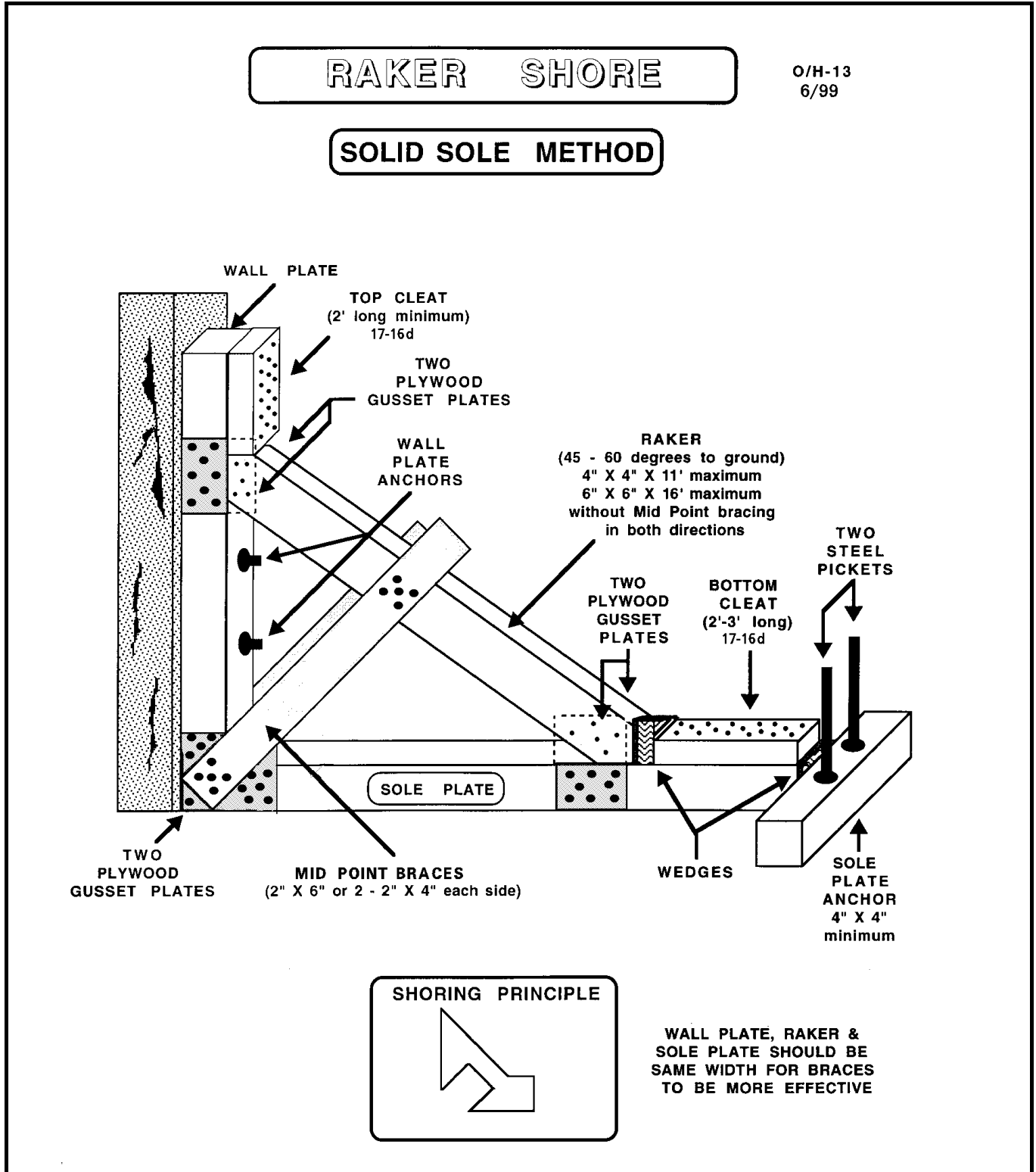
The main purpose of the raker shore is to support leaning or unstable walls and columns by transferring additional weight down the raker, to the ground or other structural supporting members, and away from the wall or column.

- Raker shores must always be installed in series, at least two must be erected in any given situation and braced together with a recommended separation of 8 feet.
- Two general styles of raker shores are the (Flying) Friction Raker Shore and the (Full Triangle) Fixed Raker Shore.
- The (Flying) **Friction Raker Shore**
 - May be considered for initial temporary shoring due to its ease of construction and fewer shoring materials when followed with a group of well braced (Full Triangle) Fixed Raker Shores.
 - Stability is increased by attaching the wall plate directly to the wall to reduce or eliminate slippage/shifting.
- (Full Triangle) **Fixed Raker Shore**
 - All of the structural elements are tied together, making the shore one integral unit and provides the best method of anchoring and bracing, but requires the most shoring material.
 - The shore itself is stable and because of its ability to stay together this style of shoring is most often recommended for rescue situations.
- The two types of (Full Triangle) Fixed Raker Shores are the solid sole plate and the split sole plate.
 - The Solid Sole Plate (Full Triangle) Fixed Raker Shore (**O/H-13**) utilized more in urban environments where concrete/asphalt commonly cover the ground.
 - The Split Sole Plate (Full Triangle) Fixed Raker Shore (**O/H-14**) utilized more in suburban environments where open ground is available.
- Raker Shore Support Point
 - The support point at which the raker shore should intercept the buildings load is within two feet below the center of the floor or roof joist.
 - Rounding off the height of the raker shore support point to the nearest foot will make it easier to measure and cut.



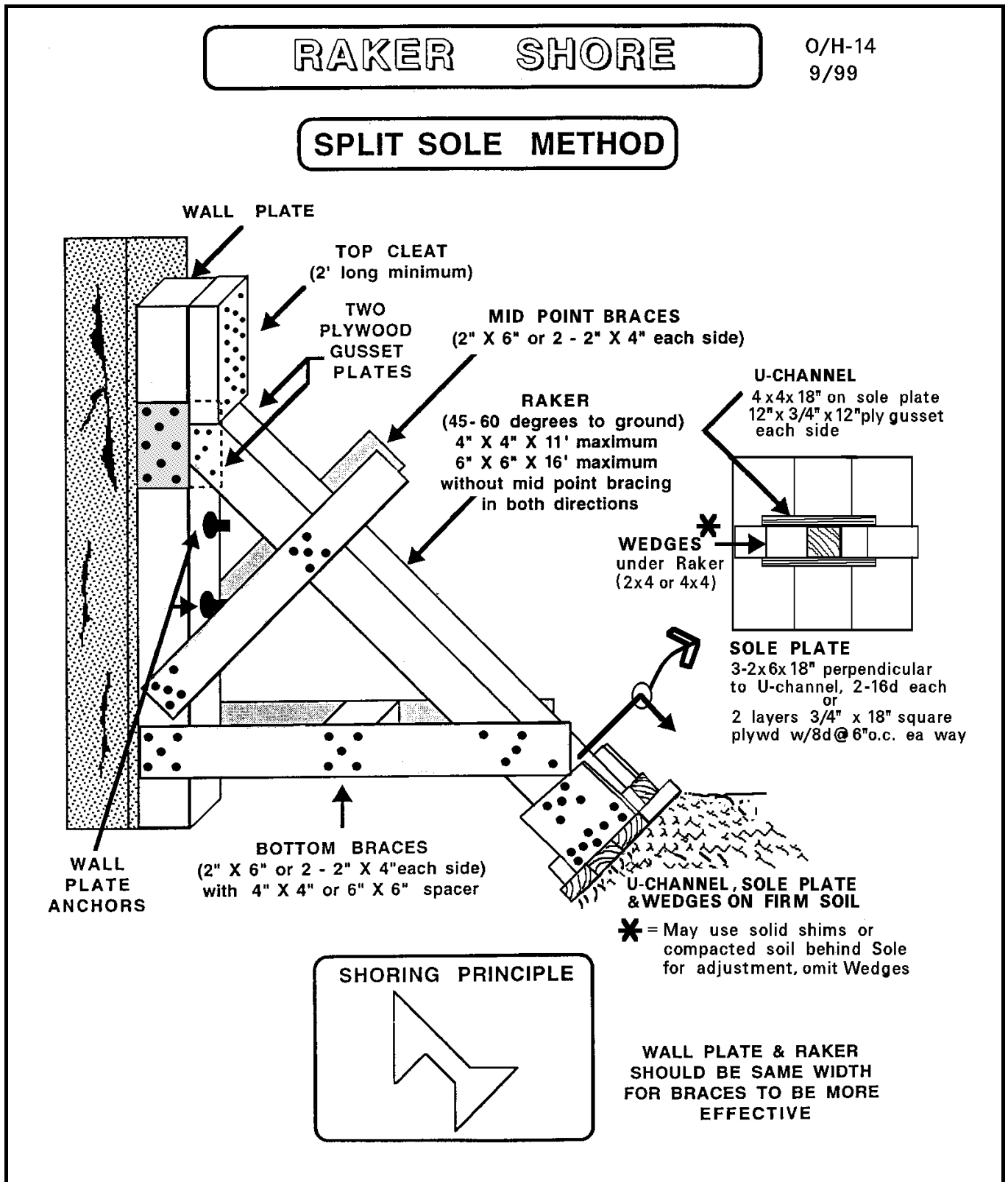
MODULE 2b SHORING CONSTRUCTION

THE RAKER SHORE (continued)



MODULE 2b SHORING CONSTRUCTION

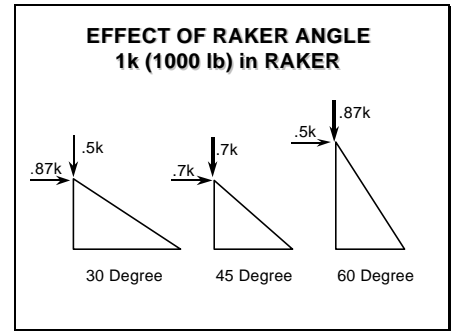
THE RAKER SHORE (continued)



MODULE 2b SHORING CONSTRUCTION

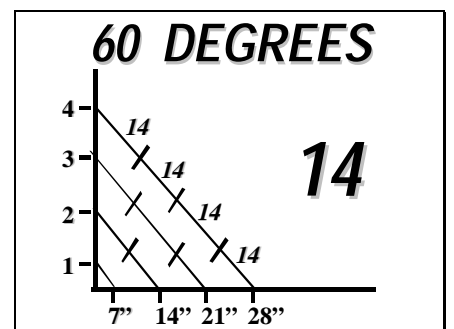
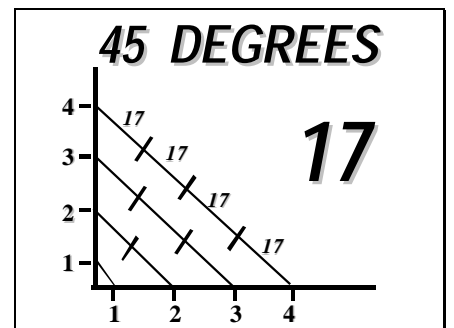
THE RAKER SHORE (continued)

- The two most common angles used are 45 and 60 degrees.
 - A 60 degree angle is the maximum recommended angle used to safely erect a raker shore.
- Determining the height at which the raker shore needs to intersect the wall will identify the angle to work best with the available lengths of lumber.
 - A 45 degree angle raker shore requires longer lumber than a 60 degree raker shore.
- The length of a 45-degree angle raker shore: Height of the raker shore support point in feet multiplied by 17 will give the length of the raker, tip to tip, in inches. (8 ft x 17 = 136" or 11'- 4").
- The length of a 60-degree angle raker shore: Height of the raker shore support point in feet multiplied by 14 will give the length of the raker, tip to tip, in inches. (8 ft x 14 = 112" or 9'- 4").



RAKER SHORE
ANGLES

DEGREE	PITCH	LENGTH
45	12/12	17
60	12/7	14



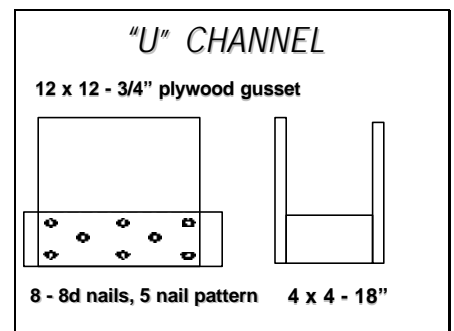
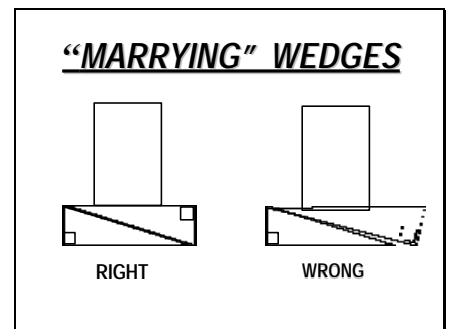
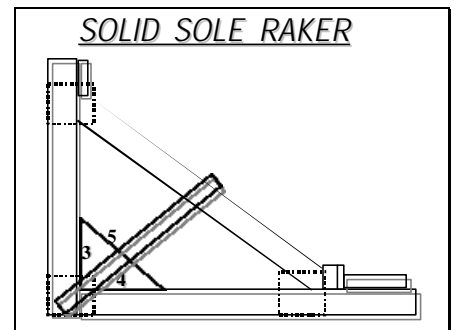
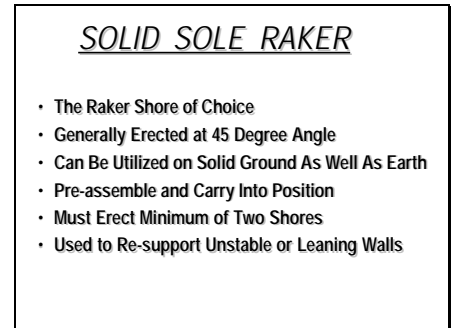
STRUCTURAL COMPONENTS OF THE RAKER SHORE

- The **Wall Plate** provides a foundation for the shoring system by collecting the weight being transferred laterally and spreads it throughout the shoring system.
- The **Sole Plate** collects the weight being transferred laterally and distributes it to the ground or other structural supporting member.
- The **Raker** supports the weight being collected by the wall plate and transfers it to the sole plate.
 - The wall plate, sole plate and raker should be the same width for a more secure attachment.
 - Buildings with heavy structural elements or support points taller than 12 feet usually require lumber larger than 4 X 4 for the wall plate, sole plate and raker.
- The **Top Cleat** short two foot piece of 2X lumber nailed to the top of the wall plate to keep the raker from riding up the wall plate.

MODULE 2b SHORING CONSTRUCTION

STRUCTURAL COMPONENTS OF THE RAKER SHORE (cont)

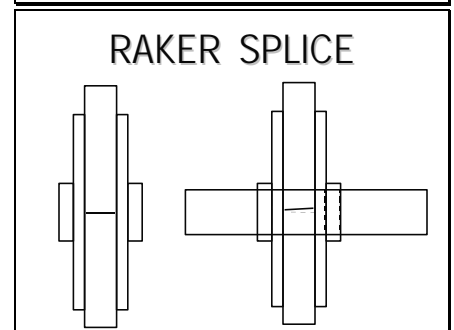
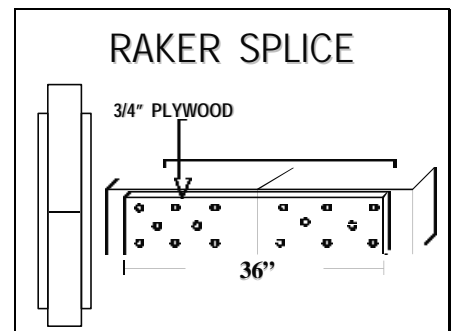
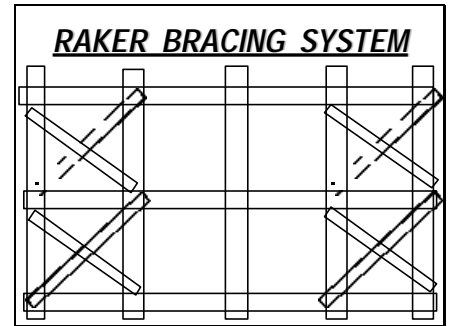
- The **Bottom Cleat** short two foot piece of 2x lumber nailed to the top of the sole plate to keep the raker from riding back on the sole plate.
 - If possible and practical, the bottom cleat and sole on the solid sole plate raker shore should be made long enough to return back to a solid object, such as an adjoining wall.
- **Wedges** two wooden incline planes **married** together and placed against the back end of the raker and the bottom cleat.
 - Simultaneously tapped together until the shoring system is under compression and takes the weight of the structural materials.
- **Gusset Plates** 12" X 12" pieces of 3/4" plywood nailed on both sides of the wall plate and sole plate connection and the top and bottom of the raker to prevent the them from being dislodged.
 - Split sole raker shores require gusset plates on both sides of the wall plate at the top of the raker only.
- **Mid Point Braces** increase the strength of the raker by reducing the L/D ratio.
 - These braces should be long enough to reach from the wall plate and sole plate connection to near the mid point of the raker.
 - On the solid sole raker shore, a 2 X 6 or two 2 X 4 are nailed to both sides of the wall plate and sole plate connection and mid point on the raker.
 - On the split sole raker shore, a 2 X 6 or two 2 X 4 are nailed to both sides of the wall plate and just above the bottom braces connection and mid point on the raker.
- **Bottom Braces** on split sole raker shores, a 2 X 6 or two 2 X 4 are nailed just above the ground and attached as close to the bottom of the raker as possible and the bottom of the wall plate with a fill block near the middle for additional stability.
 - Placed at the bottom of the wall plate and along the raker above the ground on the (Flying) Friction Raker Shore.
- **U-Channel** is used to provide a foot for the Friction and Split Sole Raker
 - It is nailed to 3-2 X 6 X 18" (or 2 layers of 18" sq. x 3/4" plywood) to provide better proper soil bearing for the Split Sole.
 - It may be placed directly against firm soil for the Flying Raker.



MODULE 2b SHORING CONSTRUCTION

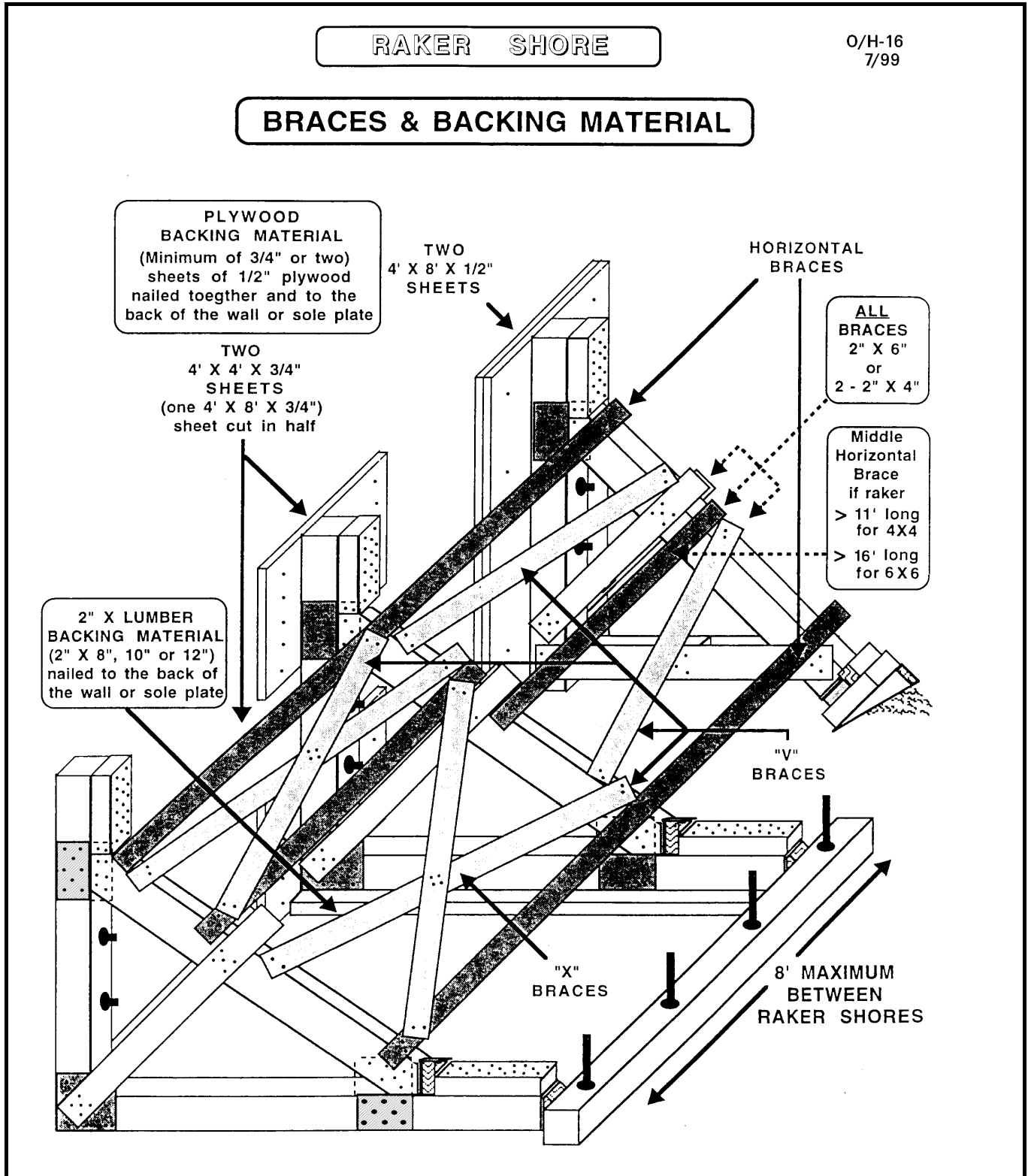
STRUCTURAL COMPONENTS OF THE RAKER SHORE (cont)

- **Horizontal Braces** horizontally connects the raker shores together near the top and bottom of the raker to provide additional stability to the raker shore system.
 - Horizontal braces attached to the mid point of the raker increase the strength of the raker by reducing the L/D ratio.
- **X and V Braces** connects the raker shores in an **X** or **V** pattern near the bottom and middle of the raker depending on access needs and available lumber.
 - Provides additional stability to the raker shore system and decreases the lateral movement when at least a pair are used at the beginning and end of the raker shore system.
 - This bracing should be placed no farther than 40 feet on center for a multi-raker system
- **Backing Material**
 - Plywood (Full and Half Sheets) require a minimum of 3/4" or two 1/2" sheets of plywood nailed together.
 - 2 X Lumber (2 X 8, 10 & 12)
 - Nailed to the back of the wall plate can help distribute the weight of the wall over a wider area and prevent the wall plate from pushing through an unstable wall.
 - Very useful on unreinforced masonry (URM)
 - Nailed to the back of the sole plate can help distribute the weight of the wall over a wider area and prevent the sole plate from pushing into soft or muddy soil.
 - Backing material must contact the wall at the raker support point and at the bottom of the wall plate.
 - Shims may be needed to fill void spaces.
 - Backing material can be used to attach the wall plate to the wall or sole plate to the ground.
- **Splicing the Raker Shore**
 - When the available length of 4x4 or 6x6 is insufficient to extend to the required insertion point, the Raker may be spliced.
 - The splice should be constructed where mid-brace and mid horizontal lateral brace intersect, as shown in adjacent slide.



MODULE 2b SHORING CONSTRUCTION

STRUCTURAL COMPONENTS OF THE RAKER SHORE (continued)

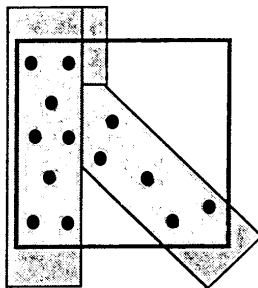


MODULE 2b SHORING CONSTRUCTION

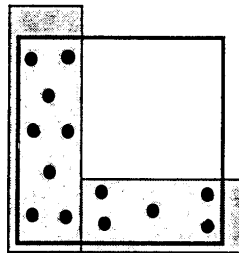
NAIL PATTERNS FOR RAKER AND OTHER SHORES

**NAIL PATTERNS FOR 3/4" X 12" X 12" PLYWOOD
GUSSET PLATES & TRIANGLES, BRACES & CLEATS**
(Use 8d nails on plywood & 16d nails on 2" lumber)

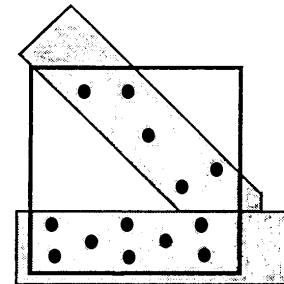
O/H-16A 6/99



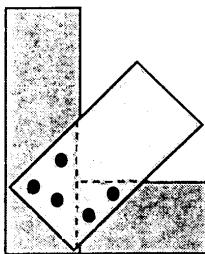
TOP OF RAKER
GUSSET PLATE



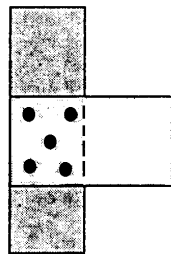
BOTTOM OF RAKER
GUSSET PLATE



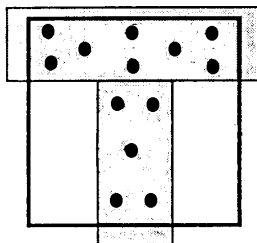
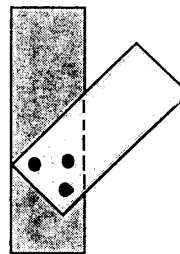
REAR OF RAKER
GUSSET PLATE



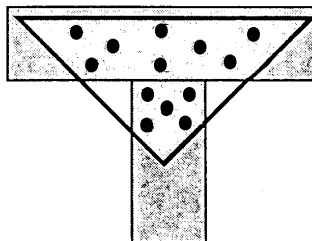
2" X 6" BRACES & CLEATS



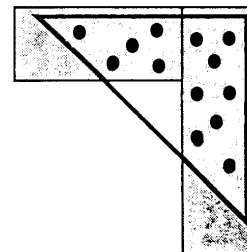
2" X 4" BRACES & CLEATS



TOP & BOTTOM
GUSSET PLATE



TOP & BOTTOM
GUSSET PLATE
TRIANGLE

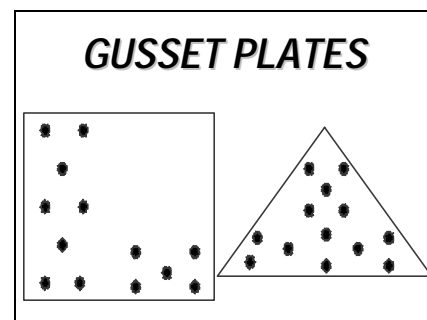
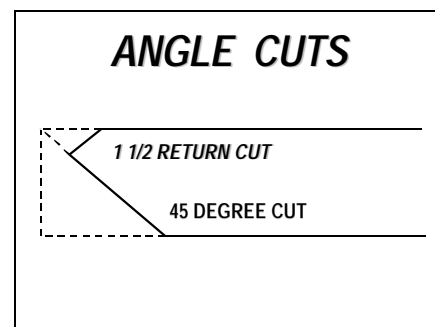
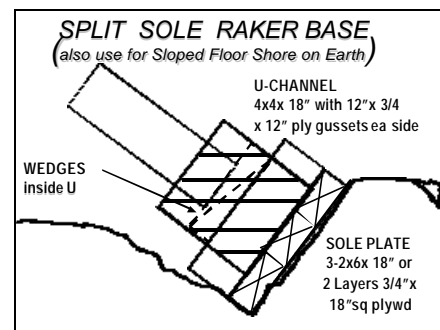


CORNER
GUSSET PLATE
TRIANGLE

MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE RAKER SHORE

- Determine where to erect the raker shores and the height of its support points.
 - After initial temporary shoring has been installed as needed, clear the area of debris.
 - For each raker clear three feet wide and at least the height of the support point out from the wall.
- Measure and cut the wall plate to the proper length, if needed.
- Measure and cut the sole plate to the proper length, if needed.
 - The solid sole raker sole plate must extend from the wall plate to several feet past the point at which the raker intersects it at the ground or floor.
 - For the split sole raker, the sole plate should be made from a U-channel with an 18 inch square foot made from 2x6 or two layers of $\frac{3}{4}$ " plywood as shown in **OH-14**.
- Measure and cut the raker to the proper length and angle to reach the support point.
 - Solid sole raker shores need both ends of the raker to be angle cut with 1 $\frac{1}{2}$ " return cuts for full contact with the wall plate, top cleat, sole plate and wedges.
 - Split sole raker shores only need one end of the raker to be angle cut with a 1 $\frac{1}{2}$ " return cut for full contact with the wall plate and top cleat.
 - The other end of the raker will contact the short sole plate dug into the ground at a 30 to 45 degree angle.
- Attach the sole plate to the bottom of the wall plate with gusset plates and nails on both sides on solid sole raker shores.
 - The wall plate and sole plate should be level, plumb and at right angles to each other.
 - Attach the sole plate to the floor if possible and use shims as necessary to keep it level.
 - Split sole raker shores require a shallow hole dug at a 30 to 45 degree angle for the sole plate and raker bearing.
- Install the raker by gently lowering it onto the wall plate and sliding it up into position under the top cleat.
 - The ends of the raker should be flush and in full contact with the wall plate, top cleat and sole plate.
 - Attach the top of the raker to the wall plate with gusset plates and nails on both sides.



MODULE 2b SHORING CONSTRUCTION

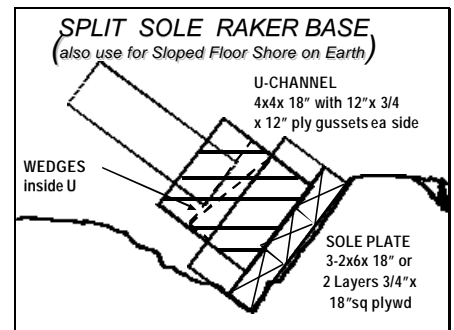
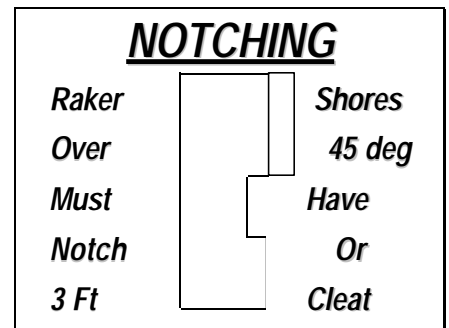
HOW TO CONSTRUCT THE RAKER SHORE (continued)

- Measure, cut the top cleat and attach it to the top of the wall plate with at least 17-16d nails.
 - The top cleat is usually 2 X lumber two feet long for rakers at 45 degree angles or less.
 - The top cleat is usually 2 X lumber three feet long with 26-16d nails for rakers at 60 degree angles.
 - Another method for 60 degree angle rakers is to use the two foot cleat with 17-16d nails and cut a 1" deep notch just below the location for the bottom of the cleat. Length of the notch will be two times the width of the raker (8" for 4 X 4 and 12" for 6 x 6)
 - The longer cleat with more nails or the notch below the two foot cleat are required because of the greater vertical forces applied to rakers at 60 degree angles.

- On the solid sole raker shore, attach the bottom cleat to the sole plate just behind the base of the raker with room left to apply wedges.
 - On the split sole raker shore, the 18" square foot may be pre- attached to the U-channel (2-16d per 2x6, or with 4-16d for the plywood per **OH-14**)
 - As an alternate the U-channel may be placed on top of the 18" square foot and toenailed to it with 3-16d each side.

- Place Raker with the wall plate against the area to be shored and plumb it up in both directions.
 - If the area is bulged or cracked due to the strain exerted by the collapse debris, the wall plate may need to be shimmed.
 - Full contact must be maintained between the base of the wall plate and the area being shored.
 - Full contact must also be maintained between the wall plate and the support point of the raker.

- On the solid sole raker shore, install wedges between the bottom cleat and the base of the raker and tighten them slightly.
 - After adjusting the shims or spacers between the wall plate and the object being shored to ensure full contact with the support point and the raker and the bottom of the wall plate, finish tightening the wedges, and nail gusset plates on each side.



MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE RAKER SHORE (continued)

- For the Split Sole Raker, place the wedges to the top of the 4 x 4 x 18" bottom piece of the U – channel and drive until tight.
 - The butt end of the bottom wedge may be restrained by the soil, or nails could be used to hold this lower wedge in place when driving in upper wedge. (2-8d min)

- Attach Bottom Braces on Split Sole Raker Shores
 - A 2 X 6 or two 2 X 4 are nailed just above the ground and attached as close to the bottom of the raker as possible and the bottom of the wall plate.
 - Add a fill block near the middle for additional stability.

 - Finish tightening the wedges after adjusting the shims or spacers between wall plate and object being shored as for Solid Sole Raker.
 - Nail the U-channel to the Raker with at least 3-8d each side (5 –8d is preferred, and will fit only if 2x4 wedges are used)

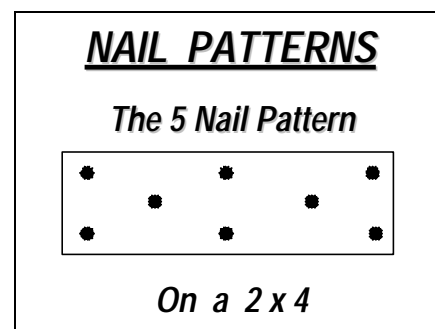
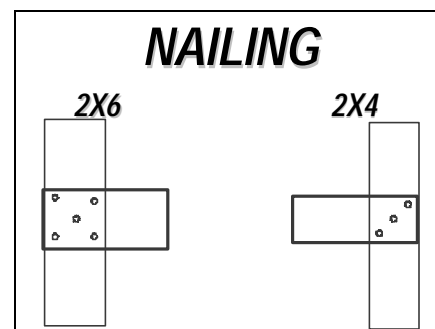
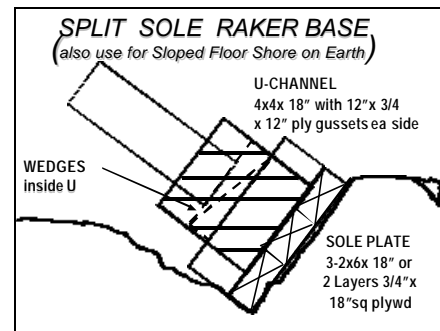
- Attach Mid Point Braces
 - On the solid sole raker shore, a 2 X 6 or two 2 X 4 are nailed to both sides of the wall plate and sole plate connection and mid point on the raker.
 - On the split sole raker shore, a 2 X 6 or two 2 X 4 are nailed to both sides of the wall plate and just above the bottom braces connection and mid point on the raker.

- Attach Horizontal Braces
 - Connect the raker shores together near the top and bottom of the raker with at least 2 X 6 size material, or two 2 X 4.

- Attach X or V Braces
 - All raker shore systems must be connected with either X or V bracing near the top and bottom of the raker between at least two raker shores with 2 X 6 or 2-2 X 4 size material.

 - Attach the **first brace to the rakers** near the top and bottom between the upper and lower horizontal braces.

 - Attach the **second brace to the upper and lower horizontal braces** near the raker



MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE RAKER SHORE (continued)

- After the raker shore is assembled, prevent the raker shore from sliding up the wall. (O/H-17)
 - To attach wall plate directly to a concrete/masonry wall.
 - a minimum of two ½” drill-in anchors, lag screws or rebar should be placed through the wall plate or four ½” drill-in anchors through two 9” long channel brackets attached with two on each side of the wall plate near the top.
 - on concrete walls only, when backing material is attached to the wall plate, the use of at least five 3” powder charge pins with washers through the backing material on each side of the raker is acceptable.
 - To attach the wall plate directly to a wood framed wall.
 - a minimum of two ½” lag screws should be placed through the wall plate directly into the wall studs.
 - when plywood backing material is attached to the wall plate, the use of at least 8-16d nails through the backing material directly into the wall studs on each side of the raker is acceptable.
 - Another method is to attach a engineered ledger (2 x 6 minimum) to the wall above the wall plate.
- After the solid sole raker shore is assembled, prevent the sole plate from sliding back away from the wall.
 - To attach the sole plate directly to concrete, asphalt or dirt. Drill a minimum of two 1” holes through the sole plate, concrete or asphalt and pound 1” steel pickets or rebar directly into the ground.
 - To attach the sole plate to concrete and masonry.
 - a minimum of two ½” drill-in anchors, lag screws or rebar should be placed through the sole plate or four ½” drill-in anchors through two 9” long channel brackets attached with two on each side of the sole plate.
 - on concrete only, when backing material is attached to the sole plate, the use of at least five 3” powder charge pins with washers through the backing material on each side of the sole plate is acceptable.

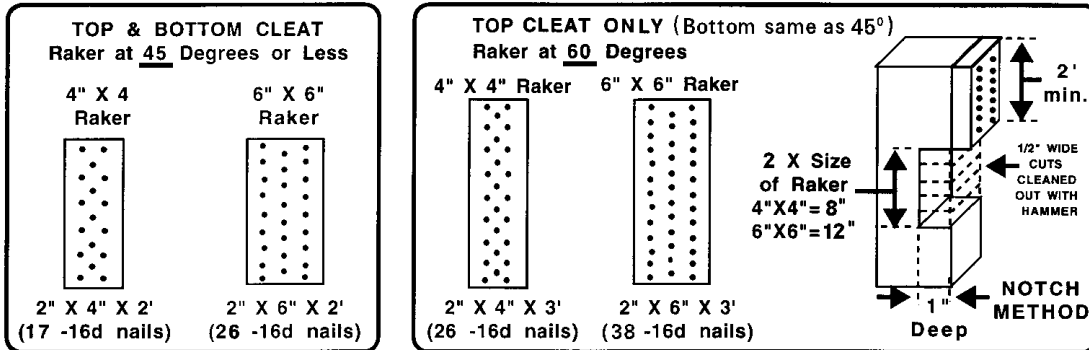
MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE RAKER SHORE (continued)

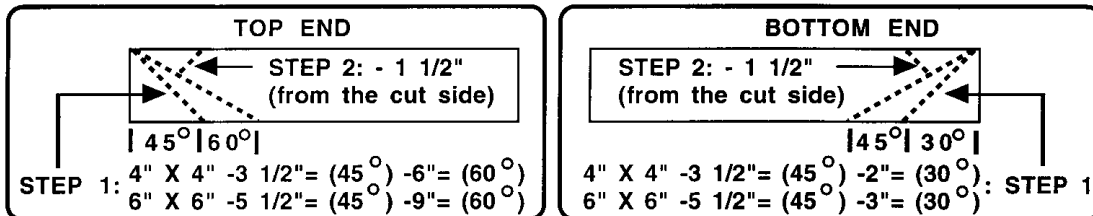
RAKER SHORE

O/H-17
7/99

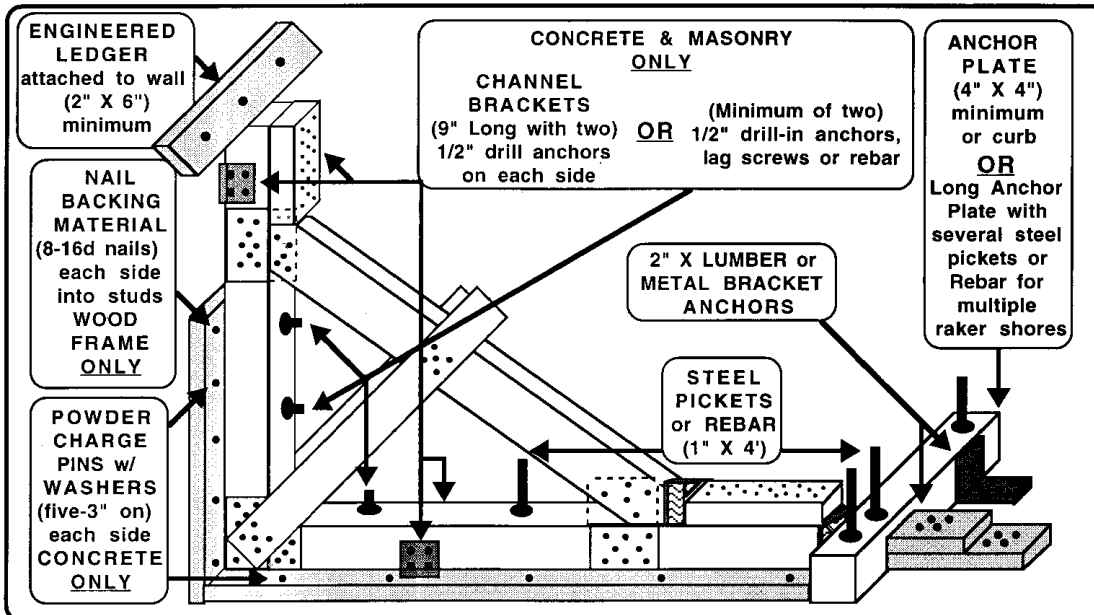
CLEATS, CUTS & ANCHORS



HOW TO CUT THE TOP & BOTTOM ENDS OF THE RAKER



HOW TO ANCHOR THE WALL PLATE & SOLE PLATE OF A RAKER SHORE



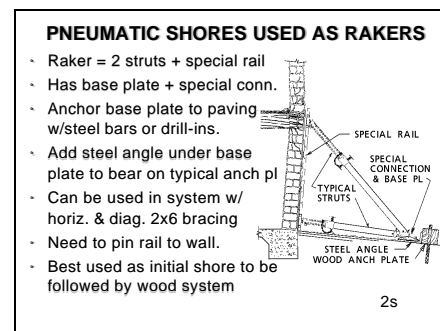
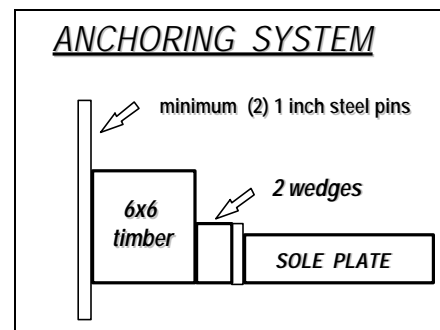
MODULE 2b SHORING CONSTRUCTION

HOW TO CONSTRUCT THE RAKER SHORE (continued)

- After the solid sole raker shore is assembled, prevent the sole plate from sliding back away from the wall. (continued)
 - An anchor can be secured to the ground or floor behind the sole plate to prevent the sole plate from backing away from the wall.
 - timber anchors should be as least 4 X 4 size lumber.
 - steel anchors or channel brackets should be at least ¼ inches thick.
 - concrete curbs, walls and other nearby secure structures may also be used.

How to Pre-Construct the Raker Shore

- The areas to be supported by raker shores should be considered extremely dangerous most of the time. Temporary (Flying) Friction raker shores may need to be erected prior to building more permanent (Full Triangle) Fixed raker shores.
- One way to reduce the amount of time spent in front of unstable structural elements receiving a raker shore is to pre-construct the majority of the shore in a safe location near the shoring site.
 - When possible, pre-construction of raker shores should be your first choice.
- The Split Sole Raker Shore can be pre-constructed with the wall plate, raker and bottom braces pre-attached.
 - After placing the raker shore in position, final adjustments are made with wedges at the U-channel/sole plate at the ground and in the bottom brace and raker connections.
 - Shims may also be placed between the ground and the sole plate
- The Solid Sole Raker Shore can be pre-constructed with the wall plate, raker and sole plate pre-attached.
 - After placing the raker shore in position, final adjustments are made with wedges at the bottom cleat / sole plate.
- Pneumatic Shores can be used as temporary Rakers as illustrated in adjacent slide. They would be replaced with properly braced wood system for ongoing operations.

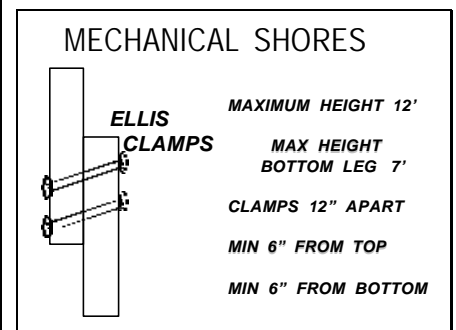
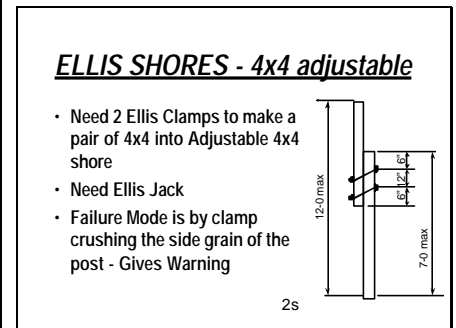
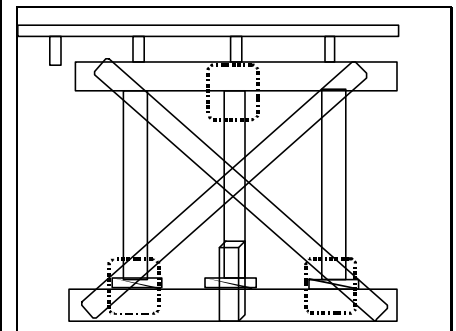
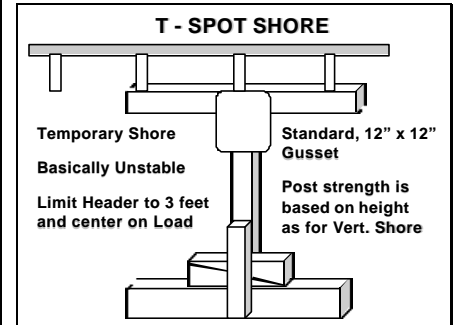


MODULE 2b SHORING CONSTRUCTION

PRE-CONSTRUCTED VERTICAL SHORING SYS

The Vertical Shoring Systems to pre-construct are:

- The “T” Spot Shore
 - Assemble header and post by nailing the upper gussets on both sides.
 - Sole plate, wedges, and lower cleats are added after shore is positioned (as previously discussed)
- Vertical Shore with a minimum of two posts, diagonal braces and gusset plates or cleats connecting the header to the posts.
 - Assemble entire system except for diagonal braces, with lower gussets only tack nailed to sole.
 - After moving shore into position, tighten wedges, add diagonal braces, nail bottom gussets, & add req'd shims
- Ellis Shores with a minimum of two posts with gusset plates or cleats connecting the header and sole plate to the posts.
 - Ellis Clamp positions on posts are as listed in adjacent slide. (use two nails at each clamp, 8 per post)
 - Slide the upper post under the clamps and manually raise to proper height and pull down on the top clamp.
 - Attach the shore-jack to the lower post under the upper post and lift on the handle.
 - While pressure is being applied to the shore-jack, tap downward on the unsecured end plate of the top clamp and then tap downward on the unsecured end plate of the bottom clamp with a hammer to lock the clamps in place.
 - Gusset plates or cleats connecting the header and sole plate to the posts can be done before or after the shores are in place.
 - Diagonal braces are attached last.



MODULE 2b SHORING CONSTRUCTION

PRE-CONSTRUCTED VERTICAL SHORING SYS (continued)

- Post Screw Jack, with a minimum of two posts with gusset plates or cleats connecting the header to the posts.
 - Metal Foot should be nailed to sole.
 - Diagonal braces should be added to multi-post system as for Vertical Shores.
- Pipe Shores, with a minimum of two shores.
 - Metal ends should be nailed to header and sole.
 - Diagonal braces cannot be attached unless a special metal fitting is provided by manufacturer.
 - Capacity of 2" pipe is similar to 4x4 wood post, and is dependent on height.
 - Special pipe frames are available that are assembled as a group of four columns with cross bracing, similar to a Laced Post System
- Pneumatic Shores, with a minimum of two shores with wood or metal rail header.
 - Metal ends should be nailed to header and sole
 - One manufacturer sells a clamp fitting that allows for, nailed 2x 6 "X" bracing to be installed.
 - Pneumatic shores are best used as temporary, spot shores.
 - Some manufacturers provide a Header Rail that may be pre-assembled with two or more struts to provide a pre-constructed, vertical shore.
- Window/Door Shores may be pre-constructed as shown in adjacent slide
 - They should be made at least 1 ½" less than opening in each direction, and then tightened with wedges at one side shims on top.
 - If header is badly damaged, great care may be taken while inserting the shore and the shims
 - They will not be practical in racked or otherwise deformed openings.
 - For large openings, they may be too heavy to carry up to locations above ground floor.
 - Their main advantage is allowing pre-construction away from the dangerous wall.

SCREW JACK by ELLIS

- Adjustable metal foot for 4x4 and 6x6 wood posts
- 6 inch adjustment - set half way to get 3 in. up & down
- Metal Foot is stronger than wood post
- Use sill beam to spread load



MECHANICAL SHORES

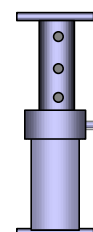
PIPE SHORES TRENCH JACKS

SEVERAL TYPES, ADJUSTABLE
 PIN ANCHOR & SCREW ARE THE
 MOST COMMON

1 1/2 " & 2" ARE THE NORM

MIN IS SCHEDULE 40

CAPACITY IS BASED ON L/D RATIO 7

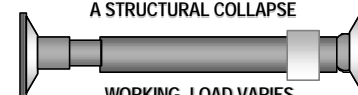


PNEUMATIC SHORES

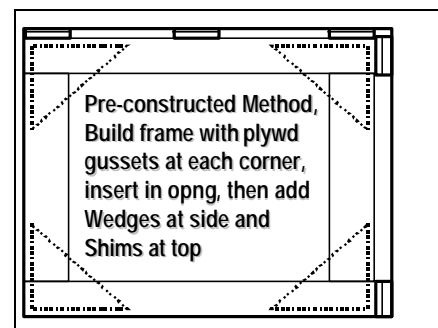
AIRCRAFT ALUMINUM

18" EXTENDING TO 16'

DO NOT USE AIR TO SET THESE STRUTS IN
 A STRUCTURAL COLLAPSE



WORKING LOAD VARIES
 DEPENDING ON LENGTH



MODULE 2b SHORING CONSTRUCTION

MEASURING NOTES

The following explain how to measure shoring materials while deducting for wedges, the proper use of wedges and maximum thickness while maintaining full contact with perpendicular shoring materials.

- When possible, round off shoring material measurements to the nearest $\frac{1}{2}$ inch to ease in marking and cutting.
- When using 4 X 4 X 18" wedges deduct the thickness of one wedge from the length of the shoring material being measured.
- When using 2 X 4 X 12" wedges deduct the thickness of one wedge from the length of the shoring material being measured.
- 4 X 4 X 18" wedges can be moved together to a thickness of 6" while still maintaining full contact with a perpendicular 4 X 4.
- 2 X 4 X 12" wedges can be moved together to a thickness of 2 $\frac{1}{4}$ " while still maintaining full contact with a perpendicular 4 X 4.

SUPPLIES AND EQUIPMENT

The use of the same dimension lumber for the headers, wall plates, sole plates, posts and struts will ease in the construction of the shoring systems and make the braces more effective.

(The use of Duplex 16d and 8d nails will assist in the dismantling of the shoring systems and reduce the amount of destroyed shoring materials during the dismantling process.)

- Cleats should be 2 X 4 X 12" min (18" for less splitting)
- Plywood gusset plates should be 12" X 12" X $\frac{3}{4}$ " thick. (18" square X $\frac{3}{4}$ " is used with Raker and Sloped Floor Shores bearing on Ground)
- Smaller square gusset plates can easily be formed by cutting the larger square gusset plates in half in both directions making four 6" X 6" gusset plates.
- Triangle gusset plates (12" X 12" X 17") can easily be formed by cutting the larger square gusset plates in half from one corner to the opposite diagonal corner.

MODULE 2b SHORING CONSTRUCTION

THE STEEL FRAMING SQUARE & DETERMINING THE LENGTH OF RAKER SHORES

- **The Tongue:**
 - Shorter, narrower part is usually 16" long and 1 ½" wide.
- **The Body (blade):**
 - Usually 24" long and 2" wide.
- **The Heel:**
 - The point where the tongue and the body meet on the outside edge.
- **The Face:**
 - The side with the manufacturer's stamp.
 - The side that is visible when the body is held in the left hand and the tongue in the right hand.
- **The Back:**
 - Opposite of the face.

THE SCALES AND TABLES

- There are seven different scales and tables on the steel framing square:
 - Four of the seven scales and tables commonly used for rescue shoring.
- **The Rafter Table:**
 - Found on the face of the square, on the body, starting on the left.
 - Used to determine the lengths of common, hip, valley and jack rafters and the angles at which they must be cut to properly fit ridge board/top plates for roof framing.
 - Can be used to determine the length of the raker.
- **The Brace Table:**
 - Found along the center of the back of the tongue, giving lengths from 24" to 60" forming 45° angles.
 - Determine the length of short rakers/corner bracing.
- **The Hundredths Scale:**
 - Found on the back of the tongue, near the heel.
 - Consists of one inch divided into one hundred parts.
 - Useful to convert lengths given in hundredths.
- **The Inch Scale:**
 - Found on both the body and the tongue along the inside and outside edges of the square.
 - Used for measuring inches and graduations of an inch.

MODULE 2b SHORING CONSTRUCTION

USING THE STEEL FRAMING SQUARE TO DETERMINE THE LENGTH OF A RAKER (continued)

- Three Methods to determine the length of a raker with the steel framing square:
 - The Diagonal Method
 - The Step-Off Method
 - The Length-Per-Foot Run Method
- The Diagonal Method (**Figure: 1 on O/H - 18**)
 - The least accurate of the three methods.
 - Use the tongue to simulate the wall and the body to simulate the floor.
 - Use the inch markings on the outside edges as “foot measurements”.
 - Place the tape measure tip on the outside inch mark simulating the support point on the wall and lay it across the square until it intersects the outside inch mark on the body simulating the contact point on the floor.
 - The length of the tape measure when it is intersecting the outside tongue and body inch marks will be the length of the raker from tip to tip.
 - Example: 9 ft high support point on the wall, 12 ft back from the wall will be a 15 ft long raker.
- The Step-Off Method (**Figure: 2 on O/H - 18**)
 - Place the square on the raker with heel pointing up and the body on the left side and the tongue on the right.
 - Use the tongue to simulate the wall and the body to simulate the floor.
 - Use the inch markings on the outside edges as “foot measurements”
 - Align the tongue outside edge inch mark representing the height **in feet** of the support point on the wall with the bottom edge of the raker.
 - Align the outside edge inch mark on the body representing the length in feet away from the wall the contact point on the floor with the bottom edge of the raker.
 - Scribe a line, which will be the top cut of the raker along the outer edge of the tongue.
 - Mark the point where the outer edge inch mark of the body contacts the bottom edge of the raker.
 - Hold the square with the outer edge inch marks remaining constant and “step” over the pencil mark to the left and place outer edge inch mark of the tongue next to it.

MODULE 2b SHORING CONSTRUCTION

USING THE STEEL FRAMING SQUARE TO DETERMINE THE LENGTH OF A RAKER (continued)

- The Step-Off Method (continued) **(Figure: 2 on O/H - 18)**.
 - Realign the same outer edge inch marks as before and mark the point where the outer edge inch mark of the body contacts the bottom edge of the raker.
 - Repeat this “step” as many times as there are feet in the length away from the wall.
 - On the last “step” scribe a line along the outer edge of the body for the bottom cut of the raker.
 - Example: 9 ft high support point on the wall, 12 ft back from the wall will be a 15 ft long raker.
 - 9” mark on the outer edge of the tongue and the 12” mark on the outer edge of the body is “stepped” over these marks twelve times.
 - Measuring the distance covered after twelve steps is 15 ft tip to tip.

- The Length-Per-Foot Run Method **(Figure: 3 on O/H - 18)**
 - The most accurate of the three methods.
 - Using the rafter table, located on the body, on the face.
 - The first line under the inch graduations, the table if broken down into inches and hundredths of an inch.
 - Use the number 12 as the horizontal constant.

 - When the height of the support point on the wall is eight feet, then the pitch will be 8/12.
 - When the height of the support point on the wall is nine feet, then the pitch will be 9/12, etc., etc.

 - The length-per-run table on the square, under the inch number which corresponds to the height of the support point on the wall in feet, will be the length of the raker in inches and hundredths of an inch, which will stand for the raker in feet.

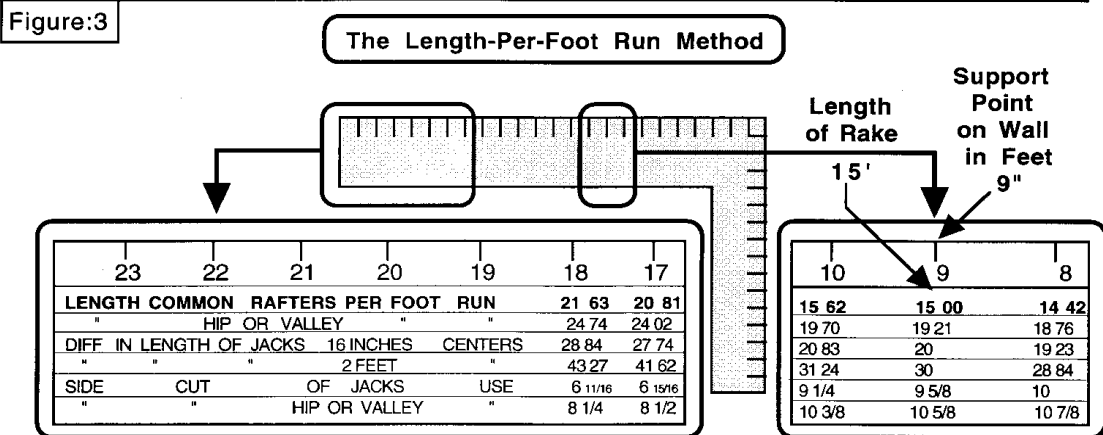
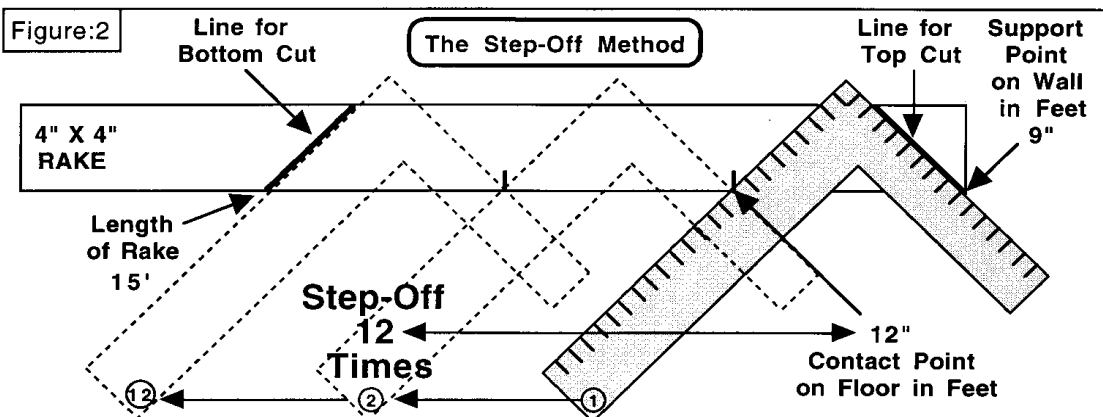
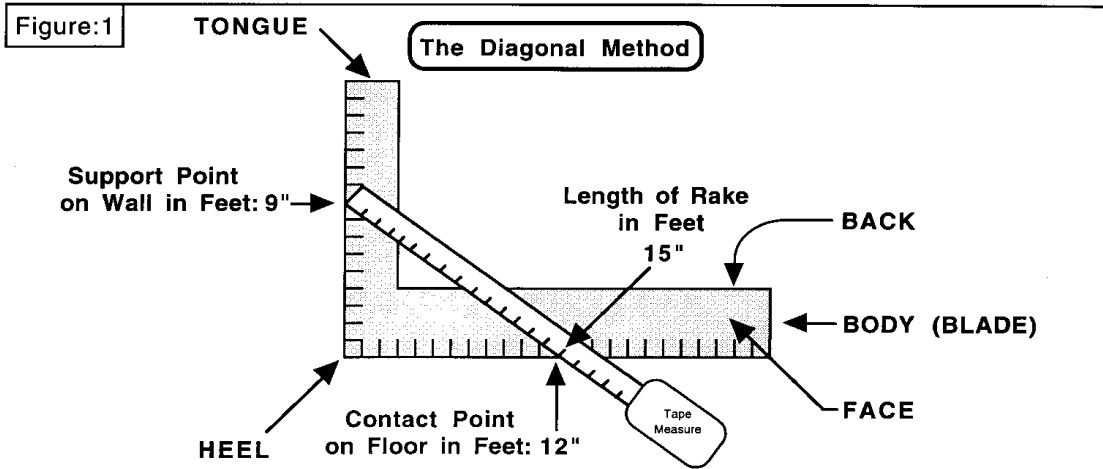
 - Example: 9 ft high support point on the wall.
 - Under the number 9 on the first line on the length-per-foot run table is the number 15, which represents 15” and stands for 15’ for the raker from tip to tip.

MODULE 2b SHORING CONSTRUCTION

USING THE STEEL FRAMING SQUARE TO DETERMINE THE LENGTH OF A RAKE
 (continued)

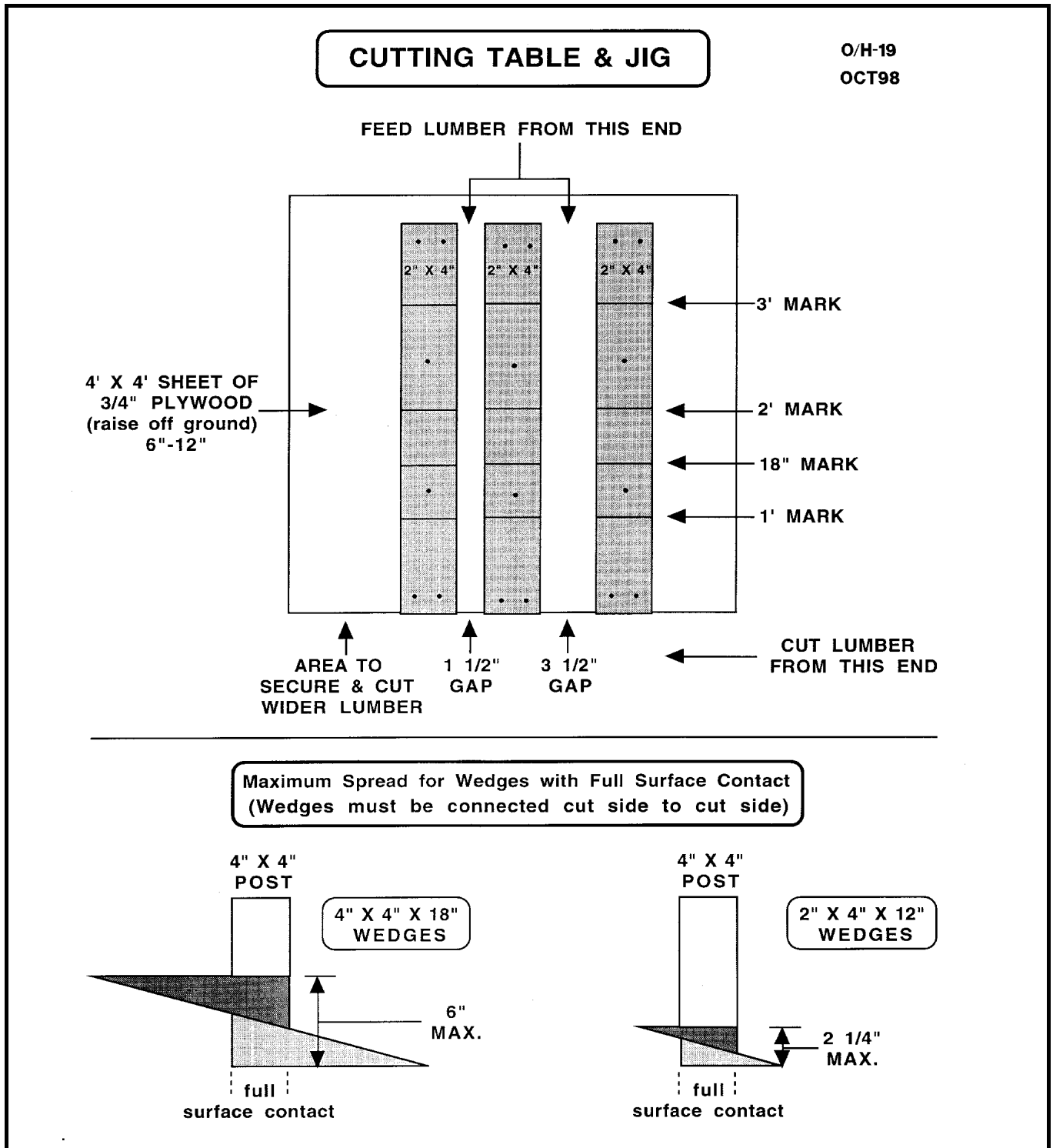
USING THE STEEL FRAMING SQUARE
 TO DETERMINE THE LENGTH OF A RAKE

O/H-18
 OCT98



MODULE 2b SHORING CONSTRUCTION

EQUIPMENT AND CUTTING STATION (continued)



MODULE 2b SHORING CONSTRUCTION

HOW TO CUT WEDGES

- Cutting 4 X 4 X 18" wedges.
 - Mark a full length 4 X 4 X 8 ft every 18".
 - This will make five pair of wedges with a 6" piece left to secure the last pair while being cut.
 - Mark a diagonal line from the top edge of one 18" line to the bottom edge of the opposite 18" line every 18 inches.
- Cutting Wedges with a Rotary Saw
 - Score the line with the blade ½" deep.
 - Second pass cut half way through.
 - Third pass cut all the way through.
 - Cut the other half of the wedge off of the remaining 4 X 4 at the 18" line.
- Cutting Wedges with a Chain Saw
 - Align the blade with the diagonal line on the 4 X 4 with the tip of the saw pointing towards the cutting table.
 - Start cutting with the tip of the saw bar approximately 2" past the edge of the 4 X 4.
 - Once the tip of the saw bar is through the full thickness of the 4 X 4 start to drag the saw towards the opposite end of the diagonal line.
 - Once the heel of the saw is past the end of the 4 X 4, flatten the saw and cut the remaining part of the 4 X 4 with the full bar.
 - Cut the other half of the wedge off of the remaining
- Cutting Wedges with a Circular Saw
 - Difficult to do unless the saw has at least a 10 ¼" blade.
 - Circular saws with blades 10 ¼" or larger need only one pass from corner to corner along the diagonal line.
 - Circular saw with blades less than 10 ¼" require marking and cutting on both sides and do not always align correctly.

MODULE 2b SHORING CONSTRUCTION

HOW TO CUT THE TOP END OF THE RAKE AT 45 & 60 DEG

- Mark the end of the rake to be cut
- 4 X 4 = 3 ½" from the end for 45 degrees
- 4 X 4 = 6" from the end for 60 degrees
- 6 X 6 = 5 ½" from the end for 45 degrees
- 6 X 6 = 9" from the end for 60 degrees
- Mark a diagonal line from the upper end of the lumber to the mark on the lower edge of the lumber and cut the end off at this angle.
- Measure 1 ½" wide on the tapered end and mark a line on the cut side for the relief cut to make full contact with the end of a cleat.
- Cut this line from the cut side with a circular saw.

- The cutting team will mark and cut the end of a rake at 45 degrees and after cutting the angle end cut off the rake, they will cut the end of the rake at 60 degrees.

HOW TO CUT THE BOTTOM END OF THE RAKE AT 45 & 60 DEGREES.

- Mark the end of the rake to be cut
- 4 X 4 = 3 ½" from the end for 45 degrees
- 4 X 4 = 2" from the end for 30 degrees
- 6 X 6 = 5 ½" from the end for 45 degrees
- 6 X 6 = 3" from the end for 30 degree
- Mark a diagonal line from the upper end of the lumber to the mark on the lower edge of the lumber and cut the end off at this angle.
- Measure 1 ½" wide on the tapered end and mark a line on the cut side for the relief cut to make full contact with the end of a cleat.
- Cut this line from the cut side with a circular saw.

- The cutting team will mark and cut the end of a rake at 45 degrees and after cutting the angle end cut off the rake, they will cut the end of the rake at 60 degrees.

MODULE 2b SHORING CONSTRUCTION

HOW TO NOTCH LUMBER FOR ADDED STABILITY

■ How to notch Cribbing

- Mark 4" from the end of the cribbing to prevent the end piece from splitting off.
- From the 4" mark, make a second mark the true thickness of the lumber being used for cribbing.
- 4 X 4 = 3 ½" - 6 X 6 = 5 ½"
- Adjust a circular saw to the depth of ½" and cut the two lines and then between the two lines every ½" to 1 inch.
- Ensure saw is unplugged while adjusting blade depth.
- Hit the sliced pieces of lumber with a hammer towards the remaining cribbing to break off the pieces.
- Clean out the notch with the claw end of the hammer until smooth.
- Have one of the squad members repeat this process on the opposite end of the cribbing.
- Notches should only be made on each side of the cribbing to provide full interlock of each piece in each direction.

■ How to notch Raker Shore Wall Plate Support Point

- Used in conjunction with a top and bottom cleat when using a 60 degree raker.
- Mark 2 ft down from the top of the raker shore wall plate.
- From the 2 ft mark, make a second mark two times the size what the raker lumber is called.
- 4 X 4 = 8" - 6 X 6 = 12"
- Adjust a circular saw to the depth of 1" and cut the two lines and then between the two lines every ½ to 1 inch.
- Ensure saw is unplugged while adjusting blade depth.
- Hit the sliced pieces of lumber with a hammer towards the remaining wall plate to break off the pieces.
- Clean out the notch with the claw end of the hammer until smooth.
- Attach a 2 foot cleat above the notch and flush with the top of the notch.
- Demonstrate how the angle end cut of a rake will connect in the wall plate notch