U.S. Army Corps of Engineers
Urban Search and Rescue Program

Urban Search & Rescue

SHORING OPERATIONS GUIDE

2nd Edition
February 2009

US&R SHORING OPERATIONS GUIDE (SOG)

FOREWORD

This Shoring Operations Guide (SOG) was developed by the FEMA US&R Technical Sub-committee in cooperation with U.S. Army Corps of Engineers (USACE), as a working reference tool for US&R Rescue Team Personnel during response operations. It condenses information provided during the initial training, and was designed to be expanded to incorporate new information.

In this SOG, Sections 1 through 4 are identical to the same sections of the larger and more comprehensive USACE Structures Specialist Field Operations Guide (FOG). That FOG has additional Operational Check Lists, Engineering Data, Tables and Forms that make it a more useful reference for the Structures Specialist.

Users are encouraged to suggest changes that can be incorporated into future editions of this SOG. Suggestions should be made to:

U.S. Army Corps of Engineers
Urban Search and Rescue Program
ATTN: CESPD-DD-E (US&R)

For mailing and e-mail address see USACE Link on:

www.disasterengineer.org

TABLE OF CONTENTS

The following Sections are contained in this SOG. Each Section has an Outline that gives the order in which subjects are presented

DEFINITIONS of ENGINEERING TERMS

Kips or K – 1000 pounds

Tons or T – 2000 pounds

Breaking Strength – Force reguired to cause complete failure of a structure, given in pounds, Kips or Tons, usually associated with Wire Rope

Ultimate Strength (also Ultimate Load & Ultimate Capacity) – Force required to cause complete failure of a structure, given in pounds or Kips

Design Load (also **Design Strength** & **Design Capacity**) – Some fraction of Ultimate Strength that is used to determine the Size or Number of Structural Components (posts, etc.) to support a Load at Low Risk of Collapse

Working Load, **Safe Working Load** – same as **Design Load**

Design Factor, Safety Factor – Ultimate Strength divided by Design Load. This Factor may be as high as 10 to 20 when using Wire Rope or Climbing Rope to suspend humans. For most building structures, it is narmally not less than about 3

Design Factor for Wood Structures – due to the variation in the quality of any grade and species of wood it is difficult to predict the Design Factor for any individual shore built using the guidelines of this document.

- The Shoring Squad must attempt to select the Posts for straightness of grain and minimum number of knots.
- The Lumber should be good quality Douglas Fir or Southern Pine (if not, the reductions in strength noted in Sect 4, FAQ, should be applied). Note that pressure treating D. Fir & So. Pine does not reduce strength.
- When nailing 2x lumber with 16d nails one must avoid splitting in order to maintain joint integrety.

For more Definitions, see Sect. 4 of this SOG

US&R SHORING OPERATIONS GUIDE
DISASTER SITE REFERENCE DATA

INTRODUCTION to SECTION 1

This section contains Documents that are Useful References for the US&R Disaster Site, listed as follows:

1

HAZARD I.D. and FAILURE MODE SUMMARY

The following pages contain brief descriptions and graphics of the most common building classifications used for US&R Evaluations:

Building Types are:

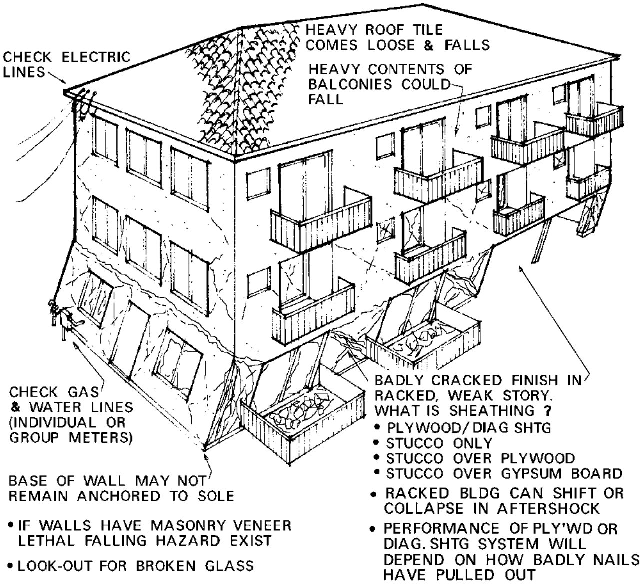
Wall Systems	**Frame Systems**
Light Frame, multi-story	Heavy Floor, C.I.P.
Heavy Wall, URM & Tilt-Up	Heavy Steel Bldgs
Precast Buildings	Light Metal Bldgs

Pages for each bldg type present the characteristics, typical failure modes, hazards, check points plus hazard reduction and victim access suggestions.

REMEMBER:

- Buildings may be varied, of combined types and complicated.
- Most important is to separate Brittle from Ductile Behavior.
- Judgments may not be able to be precise.
- Partial collapse is most difficult to assess.
- One needs to make judgments based on what type of forces are expected after initial event (aftershock, high winds, etc).
- Victim Survivability is highly dependent on Void Formations and their Accessibility.
- One should always consider Risk/Reward Ratio.
- The viability of the various Mitigation Choices is dependent on the potential for Ductile Behavior of the damaged structure.

MULTI-STORY LIGHT FRAME BUILDING - HAZARDS



CHARACTERISTICS

- Mostly wood frame, box type – up to 4 stories.
- Residential or Light Commercial.

KEY PERFORMANCE ASPECTS

- Many walls create redundant structures w/ductile failure modes, dependant on sheathing type.
- Presence of concrete floor fill can enhance possibility of P-delta collapse.

TYPICAL FAILURE MODES

- Failure in Wall Sheathing – Racking of Walls.
- Failure should be slow and noisy.
- Soft/Weak stories can rack and collapse.

COMMON COMBINATIONS

- Many are built over R/C parking garages.

MULTI-STORY LIGHT FRAME BUILDING (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Extensive connection failures. Members & components are likely to remain intact.
- **E. Quake** – Generally good performance - common failure is ductile racking of first story. Raked stories are subject to ratcheting and P-delta collapse in Aftershocks.
- **Explosion** – Walls become disconnected from floors (horizontal diaphragms), leading to part or total collapse.
- **Fire** – Rapid combustion and collapse unless fire resistant.
- **High Energy Impact** – Little resistance to collapse in immediate area. Remainder of structure remains stable.
- **Wind** – Damage is highly dependent on wind speed vs. shape and proper detailing. Tornados can destroy even well constructed wood buildings.
- **Struct Overload/Defect** – Roof failures due to snow, especially on longer span roofs.

CHECK POINTS

- Badly cracked and/or leaning walls.
- Leaning first story in multi-story buildings.
- Cracked, leaning/loose veneer or chimney.
- Offset of building from foundation.
- Separated porches, split level floors/roof.
- Connection failures - nail pullout/bolt pull-through.

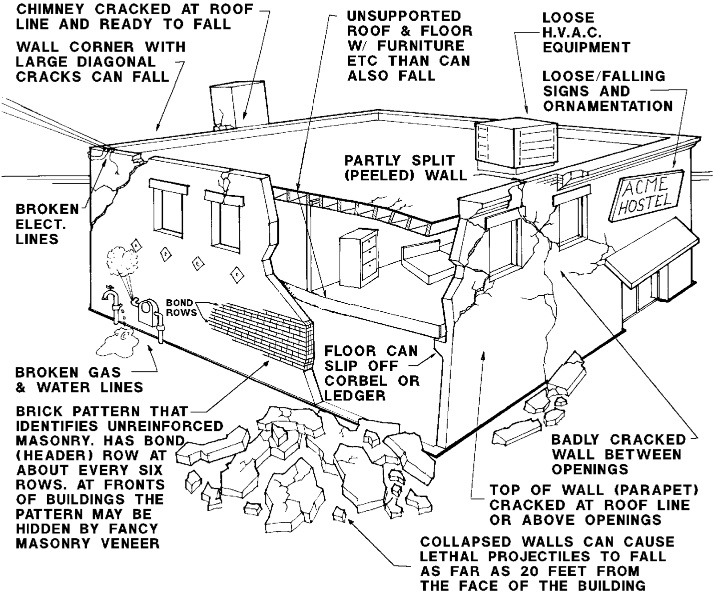
HAZARD REDUCTION

- Shut off gas and reduce other fire hazards.
- Avoid or pull-down damaged veneer and chimneys.
- Place vertical and/or lateral (diagonal) shores.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access through floor/roof from above collapsed area.
- Horizontal entry through existing cavities, or through walls.
- Remove or shore hazards near victims, if required.

HEAVY WALL- URM BUILDING - HAZARDS



CHARACTERISTICS
- URM Ext walls, wood floors/roof - box type – to 8 stories.
- Lack of wall strap anchors – Red Brick & CMU low-raise.
- Residential, Commercial and Industrial occupancies.

KEY PERFORMANCE ASPECTS
- Walls Brittle with little resistance to unanticipated loads.
- Redundant interior walls may prevent floor collapse.

TYPICAL FAILURE MODES
- Walls separate from roof/floors, leading to falling walls and collapsed roof/floors.
- Cracked/pealed walls create brittle falling hazards.

COMMON COMBINATIONS
- Heavy timber, light frame walls & floors.
- Steel joist floors w/concrete fill in multi-story buildings.

HEAVY WALL- URM BUILDING (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – URM walls likely to disintegrate, and interior structure may stand independently.
- **E. Quake** - Poor performance - out of plane ext wall failures, loss of connection to floors leading to partial or total collapse. Many lethal Aftershock falling and collapse hazards.
- **Explosion** – Walls become disconnected from floors (horizontal diaphragms), leading to part or total collapse.
- **Fire** – Loss of roof/floors will leave walls unbraced. Collapsing roof/floors can thrust walls in or out.
- **High Energy Impact** – Ext URM walls disintegrate upon impact leaving lethal falling hazards & possible floor collapse. **Massive masonry is more resistant.**
- **Wind** – Roof vulnerable to uplift, leading to partial or total collapse or roof & walls. Massive masonry is more resistant.
- **Struct Overload/Defect** – Roof failures due to ponding and snow. Wood decay, brick disintegration or remodeling in older buildings.

CHECK POINTS

- Loose, broken parapets and ornamentation.
- Connections between exterior walls and roof/floors.
- Cracked wall corners and openings, plus peeled walls.
- Unsupported and partly collapsed roof/floors.

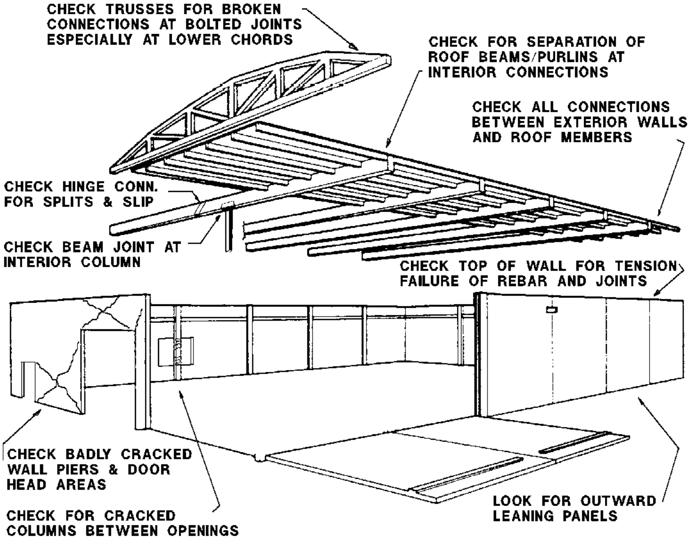
HAZARD REDUCTION

- Shut off gas and reduce other fire hazards.
- Diagonally shore. tie-back, avoid, remove hazardous walls.
- Shore hazardous roof/floor beams, etc.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access through floor/roof from above collapsed area.
- Horizontal entry through existing cavities and openings.
- Remove bricks by hand, excavator, or crane w/clamshell.
- Remove or shore hazards near victims, if required.

HEAVY WALL- TILT-UP BUILDING - HAZARDS



CHARACTERISTICS
- Conc. ext walls, wood floors/roof, some steel fl w/concrete fill.
- Long span roof (50ft+) and floors (25ft+).
- Similar performance with CIP conc. or reinforced CMU walls.
- Office, Commercial & Lt Industrial occupancies – to 4 stories.

KEY PERFORMANCE ASPECTS
- Robust ext walls, but may have weak connection to roof.
- Post 1995 and retrofit building should perform better.

TYPICAL FAILURE MODES
- Walls separate from roof/floors, leading to falling walls and collapsed roof/floors. Long span collapse is probable.

COMMON COMBINATIONS
- Light frame walls & floors – 1.5″concrete fill on floors.
- Steel joist, long span floors w/concrete fill.

HEAVY WALL- TILT UP BUILDING (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Out-leaning wall/walls could progress to roof/floor collapse in bay adjacent to exterior. Remainder could stand independently – but poorly braced.
- **E. Quake** – Pre 1995 - poor performance – out of plane ext wall failures, loss of connection to roofs leading to partial or total collapse. Lethal Aftershock falling and collapse hazards.
- **Explosion** – Walls become disconnected from floors (horizontal diaphragms), leading to part or total collapse
- **Fire** – Loss of roof/floors will leave walls unbraced. Collapsing roof/floors can thrust walls in or out.
- **High Energy Impact** – Impact on exterior walls likely to be localized. Could lead to localized roof/floor collapse.
- **Wind** – Roof vulnerable to uplift, leading to partial or total collapse or roof and walls. Penetration through large doors can lead to critical uplift and blow-out pressures.
- **Struct Overload/Defect** – Roof failures due to ponding and snow. Wood decay in older buildings.

CHECK POINTS

- Connections between exterior walls and roof/floors.
- Beam to beam and other interior roof connections.

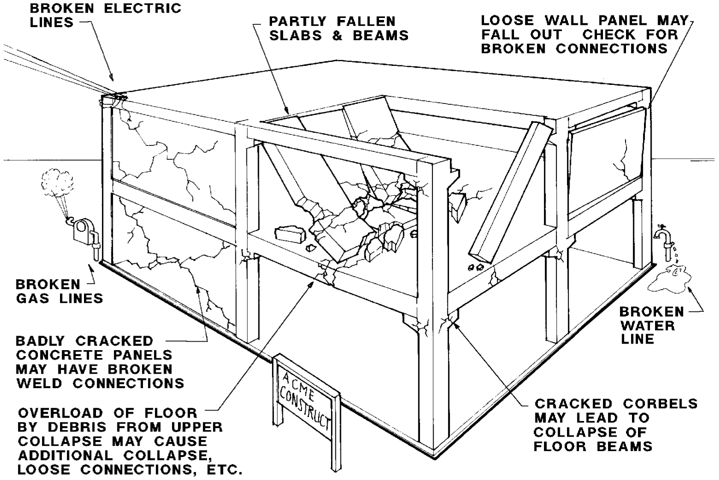
HAZARD REDUCTION

- Diagonal or Raker shore concrete walls.
- Shore hazardous roof/floor beams, etc.
- May pull-down leaning walls after dealing w/roof support.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access through floor/roof from above collapsed area. Horizontal entry through existing cavities and openings.
- Cut holes in wall panels, 2 feet min. from joints.
- Remove large wall panels and roof sections by crane.

PRECAST BUILDINGS - HAZARDS



AFTERSHOCKS ARE LIKELY TO CAUSE LARGE, LOOSELY CONNECTED CONCRETE PARTS TO SHIFT AND FALL. DEBRIS PILES OF LARGE CONCRETE PARTS CAN ALSO SHIFT AND TRAP RESCUE WORKERS. BE ESPECIALLY CAREFUL OF STANDING STRUCTURES WITH OUT OF PLUMB COLUMNS SINCE ADDITIONAL COLLAPSE IS MORE PROBABLE THAN OTHER TYPES OF STRUCTURES.

CHARACTERISTICS

- Factory built lightweight concrete parts – up to 14 stories.
- Systems w/o interior concrete panels are greatest problem.

KEY PERFORMANCE ASPECTS

- Highly engineered systems, but often brittle connections.
- Little capacity for unanticipated loads.
- Residence type may be highly redundant due to many walls.

TYPICAL FAILURE MODES

- Failure of interconnections between parts leading to partial or total collapse, depending on redundancy.

COMMON COMBINATIONS

- May have CIP floor slabs or reinforced concrete topping.
- Use of Reinforced Masonry shear walls and metal stud walls.
- PC is used as floor panels in masonry & steel buildings.

PRECAST BUILDINGS (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Failed single story columns have lead to progressive collapse. Heavy elements vs. brittle connections are critical issues. Members retain strength.
- **E. Quake** – Very poor performance – except for multi-wall residence buildings. Failed connections lead to partial or total collapse. Aftershock falling, shifting and collapse hazards.
- **Explosion** – Poor performance due to weak-link connections leading to part or total collapse.
- **Fire** – Could cause annealing of tendons and prestress loss.
- **High Energy Impact** – Impact on ext elements likely to be localized. Brittle connections could be damaged.
- **Wind** – Unlikely to be damaged by wind. Exterior skin and curtain walls could be damaged/destroyed.
- **Struct Overload/Defect** – Failures in connections, leading to cascading structure failure. Members should retain integrity.

CHECK POINTS

- Beam/column connections, broken welds and cracked corbels.
- Column cracking at top, bottom and wall joints.
- Wall connections at floors, columns and foundation.
- Badly cracked walls and columns plus falling hazards.

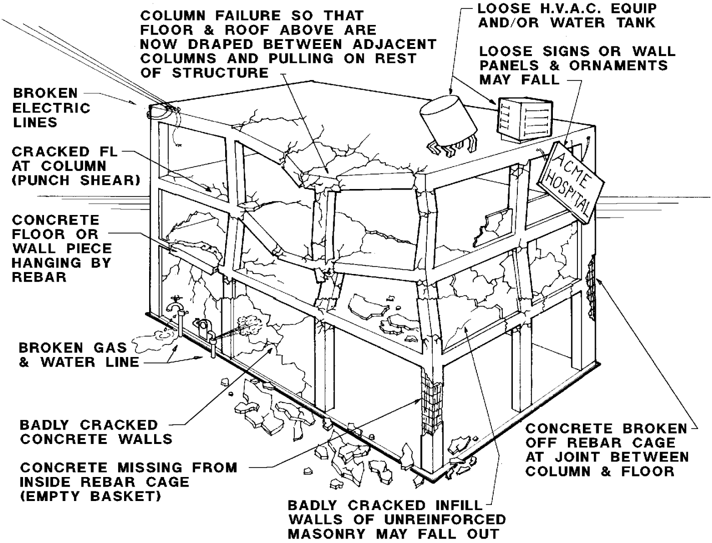
HAZARD REDUCTION

- Remove/avoid leaning/hanging, concrete elements.
- Shore damaged roof/floor beams, especially next to bad columns.
- Remove/shore unstable wall and floor elements.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access through thin horizontal sections from above.
- Horizontal entry through existing cavities and openings.
- Cut holes in wall panels, 2 feet min. from joints.
- Carefully remove large wall/floor sections by crane.

HEAVY FLOOR BLDGS (CIP non-DUCTILE) - HAZARDS



CHARACTERISTICS

- Cast in Place (CIP) concrete frames and highway structures, – up to 12 stories.
- Few concrete walls, but URM infill in older buildings.
- Eastern US – (Western pre 1975) Office & Commercial.

KEY PERFORMANCE ASPECTS

- Brittle failure modes when loaded beyond capacity.
- Post 1975 Ductile Frames in western US have systems that can absorb considerable energy w/o loss of integrity.

TYPICAL FAILURE MODES

- Beam-column joint failure or column shear leading to partial or total collapse.
- Collapse can be partial or complete pancake.

COMMON COMBINATIONS

- May have URM and/or metal stud wall partitions.

HEAVY FLOOR BLDGS (CIP non-DUCTILE) (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Members likely to break into smaller pieces. Rubble piles may shift.
- **E. Quake** – Very poor performance – Brittle failures of columns and beam/column connections, leading to partial or pancake collapse. Aftershocks cause added collapse, falling hazards and shifting.
- **Explosion** – Poor slab performance due to reverse gravity loading can lead to loss of column stability and collapse.
- **Fire** – May cause spalling of concrete cover on all elements.
- **High Energy Impact** – Damage limited to area of impact. Could leave damaged members of questionable strength.
- **Wind** – Unlikely to be damaged by wind. Exterior skin and curtain walls could be damaged/destroyed.
- **Struct Overload/Defect** –Construction falsework failures most common. Members break into pieces w/poor integrity.

CHECK POINTS

- Beam/column connections above and below floors.
- Badly confined concrete in columns (empty basket).
- Diag. shear cracks in beams and cracking in slabs near cols.
- Attachment of URM walls and other heavy objects.
- Cracks in concrete shear walls and stairs.

HAZARD REDUCTION

- Shore/avoid badly cracked slabs, beams and/or column.
- Shore/avoid overloaded slabs due to punching shear.
- Remove/shore unstable wall and floor elements.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access through existing access shafts.
- Vertical access by cutting through slabs from above victims.
- Horizontal entry through existing cavities and openings.
- Cut non-bearing/infill walls after careful assessment.
- Remove large pieces by crane, after rebar has been cut.

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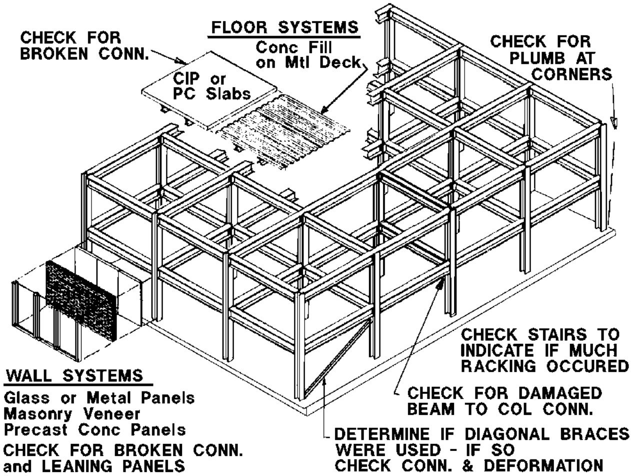
HEAVY STEEL FRAME BUILDING - HAZARDS



SINCE MOST MEMBERS AND CONNECTIONS ARE HIDDEN, BEST INDICATION OF FAILURE IS EXCESS MOVEMENT CAUSING DAMAGE TO NON-STRUCTURAL ELEMENTS AND OUT OF PLUMB CONDITIONS 02/08 HAS-HSR

CHARACTERISTICS

- Heavy ″W″ steel beam & column framing – 2 to many stories.
- Office and Commercial Occupancies, some industrial.

KEY PERFORMANCE ASPECTS

- Normally well engineered, but performance is dependent on ductility of connections. PC floor systems as suspect.
- Welded connections may be subject to brittle failure.
- Diagonally braced frames may have buckled cols or braces.

TYPICAL FAILURE MODES

- Connection failure leading to partial collapse. Total collapse is extremely rare.

COMMON COMBINATIONS

- May have masonry, precast or metal panel exterior walls.
- CIP floors over metal deck, or PC/CIP directly on steel.

HEAVY STEEL FRAME (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Rare, since members maintain integrity even with damaged/failed joints.
- **E. Quake** - Good performance of frame - Failure of diagonal bracing and fracture of welded joints have occurred. Facing, especially PC panels could fall and are danger in Aftershocks.
- **Explosion** – Good performance of frame but wall & floor panels could be dislodged. Frame collapse is unlikely.
- **Fire** – Plastic deformation of floors and some joint failure. Strength is regained upon cooling. Collapse very rare.
- **High Energy Impact** – Impacted members are severed/destroyed. Connection failures near impact only.
- **Wind** – Frame at low risk – Skin, especially glass may be destroyed leading to interior partition failure.
- **Struct Overload/Defect** – Failures during erection and long-span failures are most common. Members maintain integrity with failures at joints.

CHECK POINTS

- Indications of movement – plumb corners, stair and non-structural damage – as clues to potential structure damage.
- Main beam to column connections – remove finishes as required.
- Broken PC floor and miscellaneous beam bolt connections.

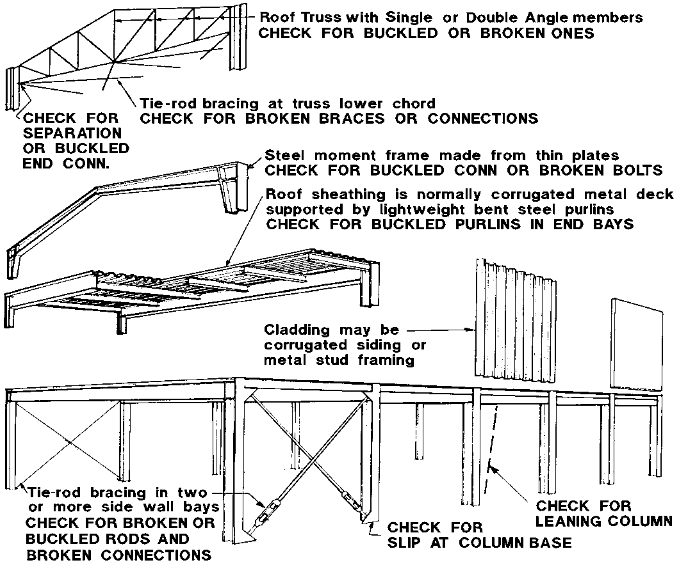
HAZARD REDUCTION

- Shore beams near damaged or broken connections.
- Remove/avoid/tieback damaged exterior facing.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical access by cutting through slabs from above victims.
- Horizontal entry through existing cavities & openings.
- Remove or shore hazards near victims, if required.

LIGHT METAL BUILDING – HAZARDS



CHARACTERISTICS

- Light-gage steel, pre-fab metal buildings – up to 3 stories.
- Industrial and Commercial Occupancies – most 1 story.

KEY PERFORMANCE ASPECTS

- Highly engineered with little redundancy or over-strength.
- Very flexible, especially in lateral direction.

TYPICAL FAILURE MODES

- Weakest Link Behavior – loss of sheathing allows buckling, leading to collapse of supporting structure.
- Diagonal rod bracing elongation & joint failure.

COMMON COMBINATIONS

- May have masonry, precast or tilt-up exterior walls.
- May have wood or metal interior partitions and mezzanine.

LIGHT METAL BLDGS (continued)

EXPECTED PERFORMANCE – for the following:

- **Progressive Collapse** – Joint failure and member buckling could lead to part or complete collapse.
- **E. Quake** – Good performance – Failure of rod bracing is common, but collapse is rare. Minor aftershock response.
- **Explosion** – Skin blown away, possibly leading to frame/roof collapse. Entire building blown away in some cases.
- **Fire** – Rapid loss of strength and collapse due to heating. Long span structure could suddenly collapse.
- **High Energy Impact** – Little resistance to impact. Damage may involve several bays of structure.
- **Wind** – At high risk – as skin is blown away, frames/trusses can buckle and collapse. Frames can rack and collapse.
- **Struct Overload/Defect** – Lateral torsion buckling of built-up members. Joint failure and member buckling, leading to part or complete collapse.

CHECK POINTS

- Broken, elongated and/or buckled rod bracing & connections.
- Buckled purlins, truss members, and steel frames.
- Broken and/or elongated bolt connections + anchor bolts.

HAZARD REDUCTION

- Shore and/or diagonally brace racked building frames.
- Remove loose or lightly connected members and sheathing.
- Monitor changes in racked/leaning structures.

VICTIM ACCESS

- Vertical/Horizontal access by removal or cutting sheathing.
- Horizontal entry through existing cavities and openings.
- Remove or shore hazards near victims, if required.

COMMUNICATIONS PROCEDURES

Effective communication is vital to the safe and successful operations of personnel assigned to a mission in the urban disaster environment. This is extremely important for clear, concise communications between the separate entities, or between personnel within those entities, that will be involved in a major response to an urban disaster. This would include emergency response and command personnel from the effected and adjacent jurisdictions, DOD personnel, state and federal officials and the various US&R task forces deployed to the disaster.

The following procedures are identified to promote this standardization for the Structures Specialist:

Phonetic Alphabet
Voice Communications Procedures
On-Site Emergency Signaling Procedures

PHONETIC ALPHABET

A - alpha (Al fah)
B - bravo (BRAH voh)
C - charlie (CHAR lee)
D - delta (DELL tah)
E - echo (ECK oh)
F - foxtrot (FOKS trot)
G - golf (GOLF)
H - hotel (HOH tell)
I - india (IN dee ah)
J - juliet (JEW lee ett)
K - kilo (KEY low)
L - lima (LEE mah)
M - mike (MIKE)
N - november (no VEM ber)
O - oscar (OSS car)
P - papa (pah PAH)
Q - quebec (keh BECK)
R - romeo (ROW me oh)
S - sierra (SEE air rah)
T - tango (TANG go)
U - uniform (YOU nee form)
V - victor (VIK tah)
W - whiskey (WISS key)
X - x-ray (ECKS ray)
Y - yankee (YANG key)
Z - zulu (ZOO loo)

COMMUNICATIONS PROCEDURES (continued)

VOICE COMMUNICATIONS PROCEDURES

What To Do	Why To Do It
1. **LISTEN**	A. To make sure your transmission won't interfere with another communication. B. To be aware of other things going on.
2. **THINK** about what you will say before you transmit.	A. To communicate your idea effectively. B. To use only the air time needed.
3. **MAKE THE CALL.** Give: a. the call sign or identification of the station called. b. the words "THIS IS" c. the call sign or identification of the calling station.	A. To be clear. B. To be understood reliably on the first call. C. To use a procedure that is universally accepted.
4. **COMMUNICATE.** Speak clearly. Plain English/no codes. Repeat back critical items for confirmation.	A. To be understood. B. To be fast. C. To avoid confusion. D. To be accurate.
5. **USE PHONETICS** for: a. call signs. b. station identification. c. spelling words and names that are not easily understood	A. To be clear. B. To be accurate. C. To be fast. D. To use a procedure that is universally accepted.

ON-SITE EMERGENCY SIGNALING PROCEDURES

Effective emergency signaling procedures are essential for the safe operation of rescue personnel operating at a disaster site. These signals must be clear and universally understood by all personnel involved in the operation. Air horns or other appropriate hailing devices shall be used to sound the appropriate signals as follows:

Cease Operation/All Quiet	**1 long blast (3 seconds) (QUIET)**
Evacuate the Area	**3 short blasts (1 second each) (OUT, OUT, OUT)**
Resume Operations	**1 long and 1 short (O - KAY)**

BUILDING MARKING SYSTEM

GENERAL:

A uniform building marking system has been developed by the National US&R Response System.

There are 4 categories of structural markings:

- Identification Marking
- Structure/Hazards Evaluation Marking
- Victim Location Marking
- Search Assessment Marking

The building marking system was established to ensure:

- Differentiation of structures within a geographic area.
- Communicate the structural condition and status of US&R operations within the structure.

Identification markings on structures may be made with International Orange spray paint (or crayon), placed on the building surface. In the case of hurricanes where many structures are involved, a system using a “Stick-on” Label should be used

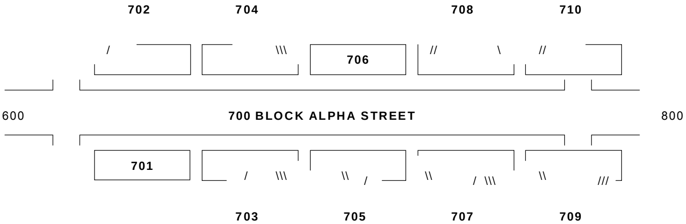
Markings should be placed on normal address side of the structure.

BUILDING MARKING SYS (continued)

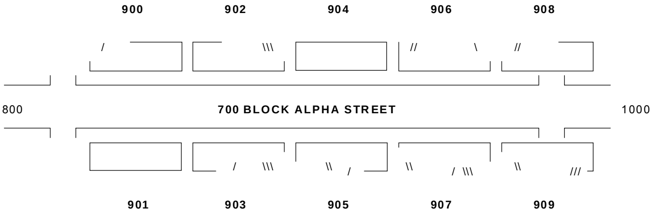
STRUCTURE IDENTIFICATION MARKING

If at all possible, the existing street name and building number will be used. If some numbers have been obliterated, attempt should be made to reestablish the numbering based on nearby structures.

If no numbers are identifiable on a given block, then US&R personnel will assign and identify the street name and numbers based on other structures in the proximity. The structures shall then be numbered to differentiate them (using paint or crayon).



CASE 1 – IF SOME NUMBERS ARE KNOWN, FILL IN BETWEEN

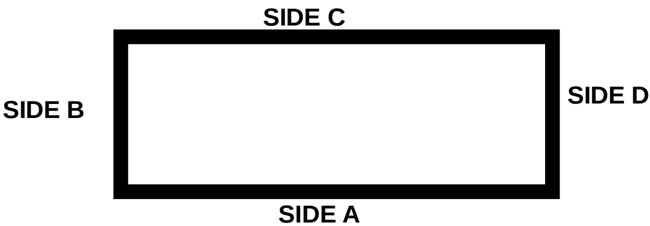


CASE 2 – IF NO NUMBERS ARE KNOWN, FILL IN USE SMALL NUMBERS

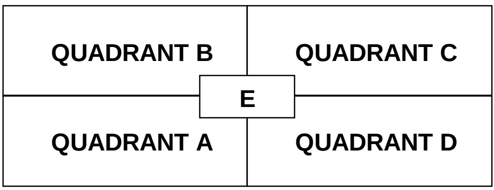
BUILDING MARKING SYS (continued)

STRUCTURE I.D. MARKING (continued)

It is also important to identify locations within a single structure. The address side of the structure shall be defined as SIDE A. Other sides of the structure shall be assigned alphabetically in a clockwise manner from SIDE A.



The interior of the structure will be divided into QUADRANTS. The quadrants shall be identified ALPHABETICALLY in a clockwise manner starting from where the SIDE A and SIDE B perimeter meet. The center core, where all four quadrants meet will be identified as Quadrant E (i.e., central core lobby, etc.).



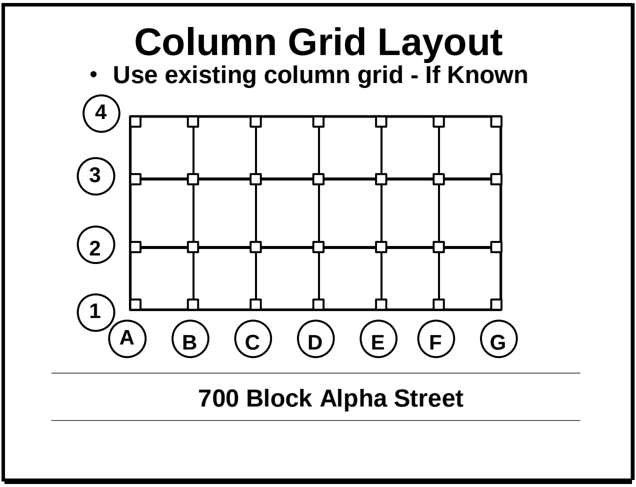
700 BLOCK ALPHA STREET

BUILDING MARKING SYS (continued)

STRUCTURE I.D. MARKING (continued)

Multi-story buildings must have each floor clearly identified. If not clearly discernable, the floors should be numbered as referenced from the exterior. The Grade (or Street) Level Floor would be designated Floor 1 and, moving upward the Second Floor would be Floor 2, etc. Conversely, the First Floor below Grade (or Street) level would be B-1, the Second B-2, etc. For buildings where the street slopes, all at the incident must be informed as to which level will be called the First Floor

If a structure contains a grid of structural columns, they should be marked with 2' high, orange letters/numbers to further identify enclosed areas. If plans are available, use the existing numbering system. If plans are not available, **Letter** the columns across the **Long Side** (Side A in this Example) starting from the left, and **Number** the columns along the **Short Side** (Side B in this example) starting from the front, Side A. The story level should be added to each marked Column, and be placed below the Column Locator Mark. Example: “FL-2” = Floor 2.



BUILDING MARKING SYS (continued)

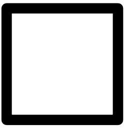
STRUCTURE/HAZARDS EVALUATION MARKING

- The Structures Spec (or other appropriate TF member) will outline a 2' X 2' square box at any entrance accessible for entry into any compromised structure. Paint sticks, lumber crayons or aerosol spray-paint cans (International Orange color) will be used for this marking system. Peel & Stick labels or stiff paper placards may be used to avoid paint damage.)
- Materials and methods used for marking shall be coordinated with FEMA IST as well as local Authority Having Jurisdiction, in order to avoid confusion with search and other marking.
- It is important that an effort is made to mark all normal entry points (Side A if possible) to a building under evaluation to ensure that Task Force personnel approaching the building can identify that it has been evaluated.
- The specific markings will be made inside the box to indicate the condition of the structure **at the time of the assessment.** Any identified hazards will be indicated, outside of the box, on the right side. (Placards have space below the box for comments on hazards)
- Normally the marking (or placards) would, also, be made immediately adjacent to the entry point identified as lowest risk. An arrow will be placed next to the box indicating the direction of the lowest risk entrance if the Structure/Hazards Evaluation Marking must be made somewhat remote from this entrance.
- All Task Force personnel must be aware of the possibility of, and look for other Structure/Hazards Evaluation markings made on the interior of the building.
- As each subsequent assessment is performed throughout the course of the mission, a new TIME, DATE, and TASK FORCE ID entry will be made below the previous entry, or a completely new marking made if the original information is now incorrect.

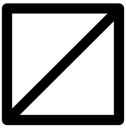
BUILDING MARKING SYS (continued)

STRUCTURE/HAZARDS EVALUATION MARKING

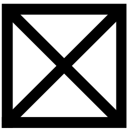
The depiction of the various markings is as follows:



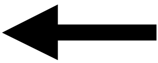
Low Risk for US&R Operations, with low probability of further collapse. Victims could be trapped by contents, or building could be completely pancaked or soft 1st story



Moderate Risk for US&R Ops, and structure is significantly damaged. May need shoring, bracing, removal, and/or monitoring of hazards. The structure may be partly collapsed.



High Risk for US&R Ops, and may be subject to sudden collapse. Remote search operations may proceed at significant risk. If rescue operations are undertaken, significant and time-consuming mitigation should be done.



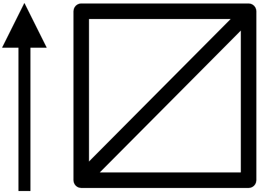
Arrow located next to a marking box indicates the direction to the lowest risk entrance to the structure, should the marking box need to be made remote from the indicated entrance.

HM

Indicates that a Hazardous Material condition exists in or adjacent to the structure. Personnel may be in jeopardy. Consideration for operations should be made in conjunction with the Hazardous Materials Specialist. Type of hazard may also be noted.

STRUCTURE/HAZARDS EVALUATION MARKING (cont.)

The TIME, DATE, and TF ID, are noted outside the box at the right-hand side. This info is made with paint stick or lumber crayon. The paper (or cardboard), stick-on placards may need to be attached using duct tape to assure their positioning.



7/15/91 1310 hrs.
HM - natural gas
OR-TF1

This example is for a Moderate Risk building, and the arrow indicates the direction to the lowest risk entry (possibly a window, upper floor, etc.). Assessment was made on July 15, 1991, at 1:10 PM. There is an indication of natural gas in the structure. The evaluation was made by the #1 TF from the State of Oregon.

It should be understood that this building would not be entered until the Hazmat (natural gas) had been mitigated. When that mitigation is performed, this mark should be altered by a placing a line thru the HM and adding the time and TF who performed the mitigation. An entirely new mark could also be added when the mitigation is done, or after any change in conditions such as an aftershock. To indicate changed conditions when using labels or placards, one may cross-out the hazard if mitigated or just replace the label/placard if appropriate.

Marking boxes may also be placed in each of the specific areas within the structure (i.e., rooms, hallways, stairwells, etc.) to denote hazardous conditions in separate parts of the building.

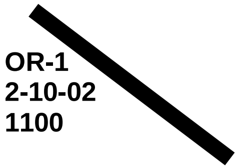
It should also be noted that the Structure/Hazards Mark might not be made in many situations, such as:

- Bldgs when StS are present at all times during the incident.
- Following hurricanes for very simple structures.

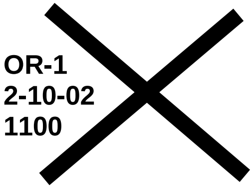
BUILDING MARKING SYS (continued)

SEARCH ASSESSMENT MARKING

A separate and distinct marking system is necessary to denote information relating to the victim location determinations in the areas searched. This separate Search Assessment marking system is designed to be used in conjunction with the Structure and Hazards Evaluation marking system. The Canine Search Specialists, Technical Search Specialists, and/or Search Team Manager (or any other Task Force member performing the search function) will draw an "X" that is 2' X 2' in size with International Orange paint stick, lumber crayon or color spray paint **(note that K9 may be adversely effected by the Fumes from Spray Paint).** This X will be constructed in two operations - one slash drawn upon entry into the structure (or room, hallway, etc.) and a second crossing slash drawn upon exit.



Single slash drawn upon entry to a structure or area indicates search operations are currently in progress. Upon entering a building or a separate wing of a large building, add the Search Team I.D., Date and Time (24hr) of entry. (Next to main entry)

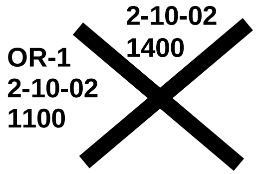


Note: OR-1 is used instead of OR-TF1 to save time. Also 1100 is used to abbreviate 1100hrs

Crossing slash is drawn as personnel exit from the structure or area.

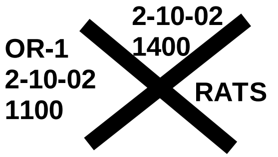
Distinct markings will be made inside the remaining quadrants of the X to clearly denote the search status and findings at the time of this assessment. The marks will be made with carpenter chalk or lumber crayon. The following illustrations define the Search Assessment marks:

SEARCH ASSESSMENT MARKING (continued)

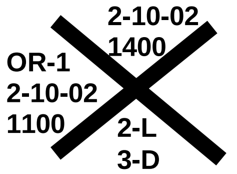


AFTER EXITING & DRAWING the 2nd SLASH, add the following INFO:

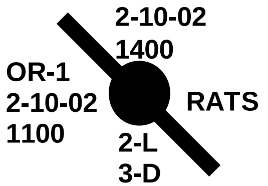
TOP QUADRANT - Time and date that the Search Team personnel left the structure.



RIGHT QUADRANT - Personal hazards.



BOTTOM QUADRANT - Number of live and dead victims still inside the structure. ["0" = no victims]



F = Floors
Q = Quadrants
or
No Entry

When the Recon Team leaves a structure **WITHOUT** completing the Search (aftershock, end of shift, etc), then the second slash **WILL NOT** be made. A **Solid Circle** is drawn at the mid-length of the First Slash, and Date/Time of Exit, Personal Hazards, & Victim Info will be filled in. Also indication of Quadrants or Floors completed should be added in a **BOX** below the X, or if the Bldg **HAS NOT** been entered (as in Hurricanes) mark **No Entry** in the **BOX**

BUILDING MARKING SYS (continued)

SEARCH ASSESSMENT MARKING (continued)

In most cases, extemporaneous information will not be conveyed using the marking system. This type of communication will usually take place as a result of face-to-face meetings between Search, Rescue, and other components of the Task Force.

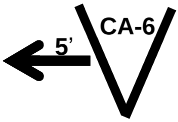
Search Markings should be made at each area within a structure, such as rooms, voids, etc, but only information related to the results of the search will be marked upon exiting each space (No Time or TF designation).

A stick-on search mark has been approved for use in incidents like Hurricanes and large earthquakes where many structures are involved. All FEMA Task Forces have been supplied with the graphic to be used in creating the stick-on search marks, which should be printed on orange paper.

VICTIM LOCATION MARKING SYSTEM

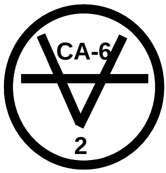
- During the search function it is necessary to identify the location of potential and known victims.
- The amount and type of debris in the area may completely cover or obstruct the location of any victim.
- The victim location marks are made by the search team or others aiding the search and rescue operations whenever a known or potential victim is located and not immediately removed.
- The victim location marking symbols should be made with orange spray paint (using line marking or “downward” spray can) or orange crayon.
- The following illustrates the marking system:

VICTIM LOCATION MARKING SYSTEM (cont.)



Make a large (2' x 2') "V" w/orange paint near the location of the known or **potential** victim. Mark the name of the search team as shown. An arrow may need to be painted next to "V" pointing towards the victims location is not immediately near where the "V" is painted. Show distance on arrow.

Paint a circle around the "V" when a potential victim has been **Confirmed to be alive** either visually, vocally, or by hearing sounds that would indicate a high probability of a victim. If more than one confirmed live victim, mark total number under the "V".



Paint a horizontal line through the middle of the "V" when a **Confirmed** victim is determined to be **deceased**. If more than one confirmed deseased victim, mark the total number under the "V". Use both live and diseased victim marking symbols when a combination of live and deseased victims are determined to be in the same location

Paint an "X" through the **Confirmed** victim symbol after **all victims** have been removed from the specific location identified by the marking.

- Paint new victim symbols next to additional victims that are later located near where the original victim(s) were removed. (assuming original symbol has been "X"ed out).

US&R SHORING OPERATIONS GUIDE
DISASTER SITE REFERENCE DATA

FEMA US&R SHORING SYMBOLS

These symbols were developed by the FEMA US&R Structures Sub-group, and should be used to map locations of US&R Shoring

• Tee Shore	**T**
• Double T Shore	**DT**
• Vertical Shore (V-3 = 3 posts, V-2 = 2 posts)	**V-3**
• Laced Post Shore	**LP**
• Cribbing	**C**
• Raker Shore - Place vertical side of triangle against wall - Each triangle represents one Raker - Rakers should be installed groups of two or larger	**R**
• Horizontal Shore (H - 3 = 3 struts, H - 2 = 2 struts)	**H-3**
• Window or Door Shore (W or D)	**W or D**

DESIGN DEAD LOADS for BUILDING MATERIALS

Normal Reinforced Concrete = 150 pcf = .087 lbs per cubic inch

Struct. Steel = 490 pcf = .28 lbs per cubic inch

Aluminum = 165 pcf = .095 lbs per cubic inch

Masonry and Cement Plaster = 125 pcf

Dry Wood = 35 pcf   Wet Wood = 45 to 60 pcf

Wood Joist@16″ o.c.	=	3 psf
3/4″ Wood Flooring	=	2.5 psf
5/8″ Gypsum Board	=	2.5 psf
Frame wall with1/2″ Gyp ea. Side	=	7 psf
Frame wall with 5/8″ Gyp ea. Side	=	8 psf
8″ PC Hollow Plank	=	60 psf
8″ Hollow Conc Masonry	=	40 psf
Concrete Masonry Rubble	=	10 psf per inch of thickness
Interior wood & metal stud walls	=	10 to 15 psf per floor
Normal home or office furniture	=	10 psf (more for storage)

Wood Floors weigh 10 psf to 25 psf (25 with 1.5″ conc fill)

Steel Floors with metal deck & conc fill weigh 50 to 70 psf

Concrete Floors weigh from 80 to 150 psf

RESCUE LIVE LOADS

Add 10 to 15 psf for Rescuers (4-250lb in 100 sq ft = 10 psf)
(Also need to account for heavy tools)

QUICK WEIGHT ESTIMATING (per square foot)

12” Concrete slab	= 150 psf	1” Steel plate	= 40 psf
10”	= 125 psf	3/4”	= 30 psf
9”	= 113 psf	5/8	= 25 psf
8”	= 100 psf	1/2”	= 20 psf
7”	= 88 psf	3/8”	= 15 psf
6”	= 75 psf	1/4”	= 10 psf
4”	= 50 psf	1/8”	= 5 psf

INTRODUCTION to SECTION 2

This section contains General Information, Graphics and Detailed Explanations of how to construct FEMA Vertical Shoring – arranged as follows:

- Key Design Issues
- Estimated time to build FEMA Shores & Multi-Story Conditions
- The Shoring Team
- How to construct Vertical Shores, 3 & 2-Post, T & Laced Post
- How to construct Sloped Floor Shores
- Pre-constructed Shoring Systems
- Alternate Vertical Shoring Systems using Pneumatic Struts

KEY DESIGN ISSUES

- How to configure US&R Shoring to ensure a Predictable and Slow initial Failure Mode.
- How to sequence the construction of US&R shoring in order to Minimize Risk.
- Use of the Class 1, 2, and 3 System Approach:
  - Class 1 = 1 Dimensional
  - Class 2 = 2 Dimensional
  - Class 3 = 3 Dimensional

FEMA DESIGN PARAMETERS

- All posts should be proportioned and/braced so that cupping of the wedges and crushing of header will occur before post buckling. This is assured if post L/D (Ht/Width) is 25 or less.
- Basic construction sequence should proceed as follows:
  - In very dangerous areas, it would be prudent to reduce risk by quickly installing Class 1 Spot Shores
  - Follow w/ Class 2 (two or more post) Vertical Shores
    - **In some cases these Class 2 shores may be installed as the initial shoring**
  - Finally, assure that all Shoring has all Posts braced in two directions as Class 3 Shores
- An efficient way that this can be achieved is as follows:
  - Place T or Double T shores initially if very dangerous
  - Then place pairs of 2-post Vertical Shores, 4 ft apart
  - Finally tie the 2-post Vert. Shores together as Laced Posts

FACTORS AFFECTING SHORING STRENGTH

- The strength of **Wood Systems** depend on the following:
  - Perpendicular to grain bearing of Post on Header
  - Vertical capacity of Posts (based on Height (Length)
  - Strength of Header and Sole
  - Strength of ground/floor slab below Sole
- The size of a **Header** depends on the stiffness of the header compared to the structure being supported:
  - When supporting intact concrete slabs and posts are no more than 4 ft o.c., the concrete structure is much stiffer than a wood header. Therefore, 4x4 or 6x6 header is OK
  - When supporting a wood floor, the Header should be a depth of 1" for each foot of span – 4x4 minimum
  - For all other conditions, the Header should be designed for the actual load, by a US&R Structures Specialist
- The Total Length of 2x4 & 2x6 Lacing (diagonal bracing members that are capable of resisting both Tension and Compression) should be limited to 7'-6"
- The Length of 2x4 & 2x6 X-bracing may be 10 or more feet long, since each member is only required to resist Tension.
- **Shoring Numbers To Remember (Doug Fir & So. Pine)**
  - **8, 20, 24, 32, 5**
  - **8K** is Design Strength of **4x4 Post, 8ft long**
  - **20K** is Design Strength of **6x6 Post, 12ft long**
  - **24K** is Design Strength of **2x2 lay-up of 4x4 Crib**
  - **32K** is Design Strength of **4x4 Laced Post**
  - **5K** is Design Strength of **4x Raker System**
    (2 – 45 or 60 deg Rakers + adequate bracing)

ESTIMATED TIME TO BUILD SHORES

The following table assumes that one, 6-person Rescue Squad is used, who has worked together before and has had proper training in constructing shoring. Also it is assumed that the tools, lumber and equipment are all laid out ready to go, along with a cutting table

For Pre-Fab Shoring Placed in a Relatively Open Area

Shore Type	**Pre-fab Time**	**Install Time**
T-Shore	5 – 8 min	60 sec
Dbl -T Shore	8 – 10 min	90 sec
2-Post Vert	8 – 10 min	90 sec
3-Post Vert	N/A	See In-place
Laced Post	10 – 12 min	12 – 15 min
Pr, Solid Sole Raker	20 min	12 – 15 min
Pr, Split Sole Raker	30 min	15 – 20 min
One Flying Raker	10 min	5 min
Prefab Window Shore	5 – 8 min	60 sec

For Built in Place Shores in a Relatively Open Area

Shore Type	**Erection Time**
2-Post Vert	10 – 12 min
3-Post Vert – 10ft max High	12 – 15 min
Laced Post	25 – 30 min
Crib-2x2 w/4x4 – 3ft High	5 – 8 min
Crib-2x2 w/4x4 – 6ft High	10 – 16 min
Crib 2x2 w/6x6 – 3ft High	8 – 10 min
Crib 2x2 w/6x6 – 6ft High	10 – 20 min
Window Shore	8 – 10 min
Door Shore	10 – 14 min
Pair, Sloped Floor Shores	20 – 25 min

NOTE for CARRY CONDITIONS

These times **Do Not** account for moving the pre- assembled shore into position or moving the material into position for the Built in Place Shores. That would have to be determined **On-Scene** at each event, and each area on the Site. (Carry Distance)

2

TIME TO BUILD SHORES - SPECIFIC CONDITIONS

Example 1 (Vert, Crib, Laced Post & Sloped floor)

Like Pentagon, Puerto Rico, (similar to OKC)
1st & 2nd story, Shore your way in, remove debris as you go.
Material & cutting area within 200ft outside
ADD 10 min for 1st floor and 15 min for 2nd floor.
Traveling thru heavy debris add 10minutes more

Example 2 (Vert, Crib & Sloped floor)

10 story concrete bldg - Need to carry material upstairs into bldg. Partly prefab in safe area on same floor. Need to move furniture, desks, etc to go 60 to 100 ft across floor to collapsed area
ADD 5 min for each additional floor ascended.

Example 3 Each Pair of Raker Shores

12 ft insertion point up Tilt-up wall - AC paving, parking lot next to building not much debris
Each Pair to be Assembled, Installed & Braced in 30 min

Example 4 Each Pair of Raker Shores

9 ft insertion point up URM wall w/ some debris
AC paving or Dirt next to wall
Use Split sole Rakers w/ sloping sole
Each Pair to be Assembled, Installed & Braced in 40 min

MULTI-STORY CONDITIONS & SEQUENCING

When shoring a single damaged floor in multi-story, sound, existing bldg the following procedure may be used:

- For Wood-frame,1-undamaged fl can supported 1-damaged fl
- For Steel-frame, 2- undamaged floors to support 1- damaged fl
- For Reinf. Conc, 3-undamaged floors to support 1- damaged fl
- For Precast Conc, the shoring should extend to the ground
- This does not apply to structures that are under construction, subject to cascading/progressive collapse, or to structures that have collapsed suddenly, without any apparent cause
- Usually the best strategy for multi-story shoring is to start directly under the damaged floor, and work down

THE SHORING TEAMS

To conduct Shoring Operations safely and efficiently, two separate Shoring Teams are formed.

1. **The Shore Assembly Team** – Performs the actual shoring size-up and construction of the shores.
2. **The Cutting Team** – Establishes the equipment area and cuts the shoring lumber.
3. The Shore Assembly Team consists of the following:
    a. The **Shoring Officer** (Rescue Squad Officer) – is in-charge of the operation and works with the **Structures Spec** to determine where to place and erect the shores.

    b. The **Measure** – performs all the measuring required in the erection of the shoring and relays all measurements and lumber size to the **Layout** of the Cutting Team.

    c. **Shores** – clears away debris and obstructions that could interfere with shore construction. He also assists the **Measure** as needed to erect the shores.

4. **The Cutting Team**

The initial responsibility of the cutting team is to secure an area as close as possible to the collapse operation 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.

a. The **Layout** – is in charge of setting up the cutting station and preparing the materials to be cut.

- Performs all measuring, layout of angle and should be in direct contact with the shore assembly team "measure" via portable radio to eliminate mis-communications on dimensions, etc.

THE SHORING TEAMS (continued)

b. The **Cutter** – cuts the shoring material.

c. **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.

5. A single Rescue Squad can normally fill the six individual shoring team positions during most shoring operations.

6. Larger or more complex shoring operations may require Two Rescue Squads, with One squad assigned to the Shore Assembly Team and the Other assigned to the Cutting Team.

7. **Shore Assembly Team** with a Six person Rescue Squad:

   a. The **Shoring Officer** (Rescue Squad Officer)

   b. The **Measure**

   c. **Shores**

   d. **Shores**

   e. **Safety**

   f. **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.

THE SHORING TEAMS (continued)

8. Cutting Team with a complete Six person Rescue Squad:

   a. The **Cutting Team Officer** (Rescue Squad Officer)

   b. The **Layout**

   c. The **Feeder** – moves and feeds measured and marked shoring material from the **Layout** to the **Cutter** and helps secure it when being cut.

   d. The **Cutter**

   e. **Tools and Equipment**

   f. **Runner** – ensures tools, equipment, and shoring materials are moved from the cutting area to the shoring operation primary access point.

2

NOTES for VERTICAL SHORING DIAGRAMS

1. Maximum Post Heights have been specified as 10’-3”, 12’-3”, etc. , and Shore is then limited to next Full Foot in Height
2. Design Load (Safe Working Load) for Class 1 & 2 Shores is based on Shore Height. (Not Post Length)
3. The use of 4x4 & 6x6 Headers is desirable, since this maintains a relatively stable1 to 1 height to width ratio. This allows the use of one sided connections to headers.
4. It is desirable to use 2-sided connections at Posts to Sole Plates at Wedges. The connectors should be 6”x12”, Half Gussets. This is change from the 12”x 12” gusset, and it uses fewer nails + allows a better view to see Cupped Wedges.
5. Use of 4x4 Headers for 4ft o.c. Posts and 6x6 for 5ft o.c. Posts is based on supporting Normal Wood Floors and Intact Concrete Floors. For supporting badly cracked Concrete Floors, and for shores with larger post spacing, obtain special design by US&R Structures Specialist.

"T" SPOT SHORE

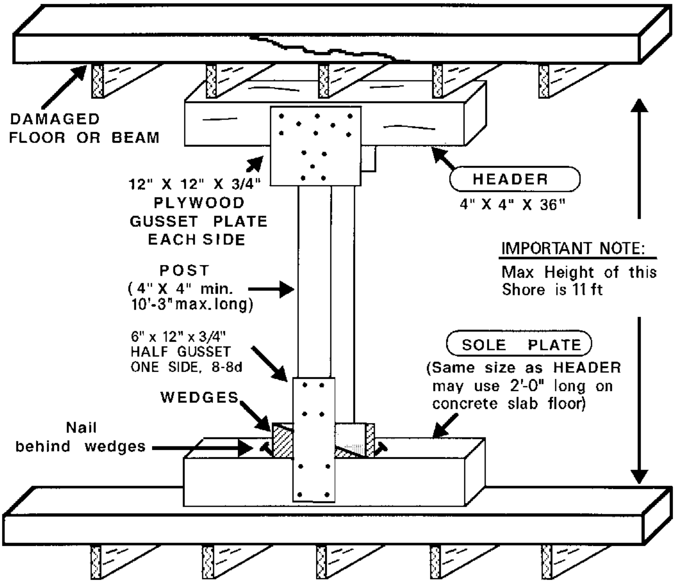
OH-T
08\06

CLASS 1 SHORE

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

Prefabricate Post & Header, then install on Sole

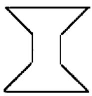
Temporary shore ONLY until a complete shoring system can be erected



DESIGN LOAD
1,000 TO 4,000 Lbs
BASED ON UNKNOWN
STABILITY.

LOAD MUST BE
CENTERED ON POST

SHORING PRINCIPLE



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

HOW TO CONSTRUCT THE “T” SPOT SHORE

1. Determine where Spot Shores should be built in order to quickly reduce risk. (Prior to building more stable shores).

2. Determine overall height of area to be shored and remove least amount of debris required to place shore.

    a. The 4x4 post should be 10’-3” max long, so the Total Height of the shore is not more than 11 feet

3. Measure and cut header, sole & post (remember to deduct header, sole and wedge height when cutting post).

4. Prefabricate header to post by placing the 12”x 12”, Full-Gusset plate on one side, then flip over and place another Full-Gusset on other side. Nail 5-8d to Post & 8-8d to Header

5. Place “T” in position, centered under the Load.

6. Slide sole plate under “T” and tap wedges into position.

7. Check for straightness plus stability, then tighten wedges.

8. Install bottom half-gusset and nail 4-8d to post and to sole.

    a. Note that a 2 x 4 x 18” cleat may be used, but the 3-16d nails to post and to sole may tend to split the cleat, and 16d require stronger nailing within the danger zone

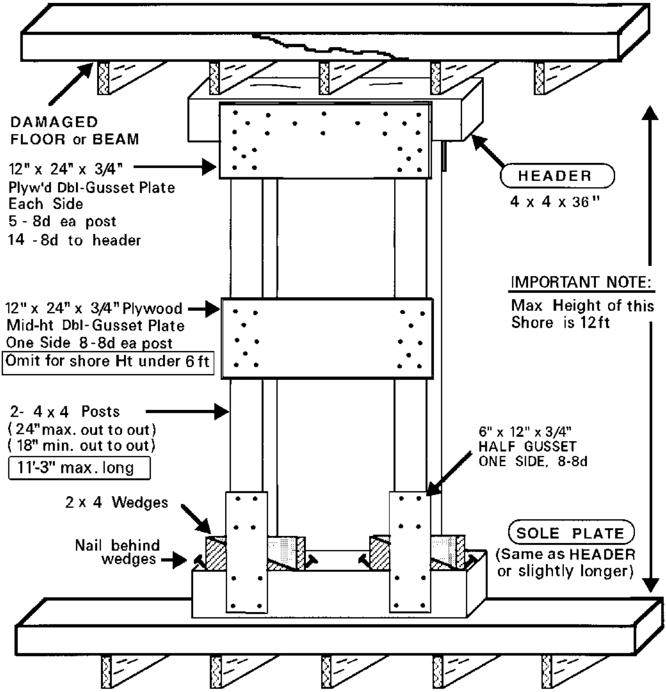
9. Anchor the shore to floor above and sole to floor below, if practical.

DBL "T" SHORE

O/H-Dbl T
08/06

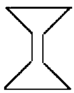
CLASS 2 SHORE

Position the HEADER & SOLE PLATE across the floor and ceiling joists and align the POST under the joists
Prefabricate Posts & Header, then install on Sole
Double T is more Stable than T Spot Shore



DESIGN LOAD
(based on Shore Ht.)
16,000lb for 8ft
10,000lb for 10ft
7,000lb for 12ft

SHORING PRINCIPLE



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

HOW TO CONSTRUCT THE DOUBLE “T” SHORE

1. Determine where Shores should be built in order to quickly reduce risk.

2. Determine overall height of area to be shored and remove least amount of debris required to place shore.

    a. The 4x4 post should be 11’-3” max long, so the Total Height of the shore is not more than 12 feet

3. Measure and cut header, sole & post (remember to deduct header, sole and wedge height when cutting post). 2

4. Prefabricate header to posts by first toe-nailing posts to header, then placing the 12”x 24”, double- gusset plate on one side, then flip over and place another dbl- gusset on other side. (Nail 5- 8d ea post, 14-8d to header)

    a. One post may be only tacked to header and temporarily configured on a slope to meet the other post at the bottom, if needed to provide for easier access

5. Nail mid-height plywood, dbl-gusset to one side of posts (8-8d to each post)

6. Place Double “T” in position, centered under the Load.

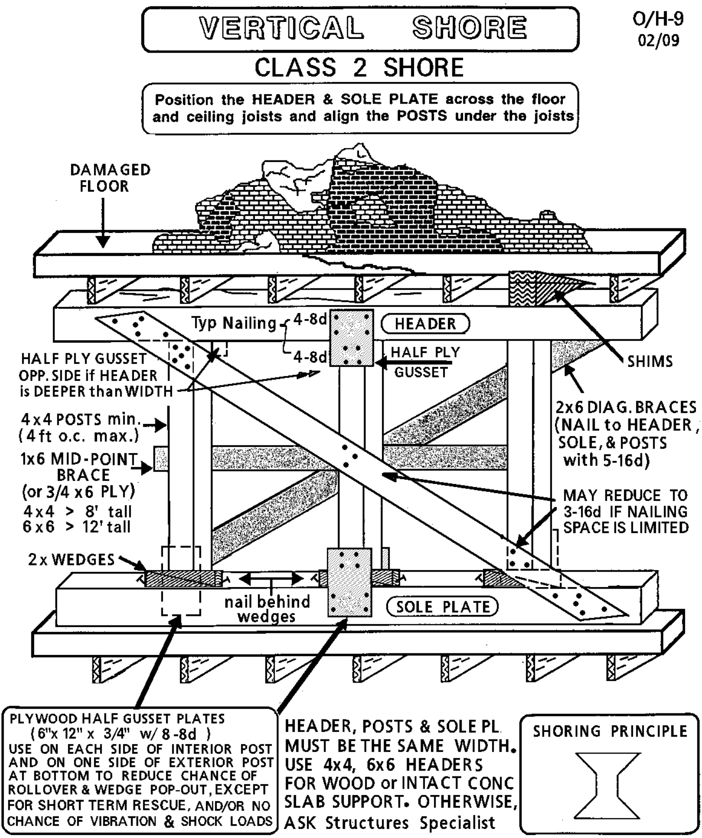
    a. If one post has been configured on slope for access, straighten it and complete nailing on Gussets

7. Slide sole plate under Dbl “T” and tap wedges into position.

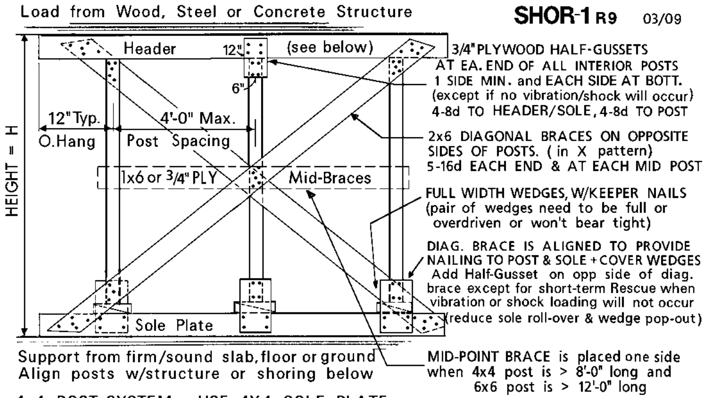
8. Check for straightness plus stability, then tighten wedges.

9. Install bottom half-gussets and nail 4-8d to ea. post & sole.

10. Anchor the shore to floor above and sole to floor below, if practical.


VERTICAL SHORE
O/H-9
02/09
CLASS 2 SHORE
Position the HEADER & SOLE PLATE across the floor and ceiling joists and align the POSTS under the joists
DAMAGED FLOOR
Typ Nailing
4-8d
4-8d
HEADER
HALF PLY GUSSET
HALF PLY GUSSET OPP. SIDE if HEADER is DEEPER than WIDTH
SHIMS
4x4 POSTS min. (4 ft o.c. max.)
1x6 MID-POINT BRACE (or 3/4 x 6 PLY)
4x4 > 8' tall
6x6 > 12' tall
2x6 DIAG. BRACES (NAIL to HEADER, SOLE, & POSTS with 5-16d)
MAY REDUCE TO 3-16d IF NAILING SPACE IS LIMITED
2 x WEDGES
nail behind wedges
SOLE PLATE
PLYWOOD HALF GUSSET PLATES (6"x 12" x 3/4" w/ 8-8d) USE ON EACH SIDE OF INTERIOR POST AND ON ONE SIDE OF EXTERIOR POST AT BOTTOM TO REDUCE CHANCE OF ROLLOVER & WEDGE POP-OUT, EXCEPT FOR SHORT TERM RESCUE, AND/OR NO CHANCE OF VIBRATION & SHOCK LOADS
HEADER, POSTS & SOLE PL MUST BE THE SAME WIDTH. USE 4x4, 6x6 HEADERS FOR WOOD or INTACT CONC SLAB SUPPORT. OTHERWISE, ASK Structures Specialist
SHORING PRINCIPLE

VERTICAL SHORE (continued)



4x4 POST SYSTEM - USE 4X4 SOLE PLATE

HEIGHT = H	DESIGN LOAD, EA. POST	HEADER SIZE
8'-0"	8,000 LB ✱	Use 4x4 min. if place posts directly under floor beams or when supporting intact/rigid concrete slab or beam.
10'-0"	5,000 LB	See Structure Specialist for other conditions
12'-0"	3,500 LB	

6x6 POST SYSTEM - USE 6x6 SOLE PLATE

HEIGHT = H	DESIGN LOAD, EA. POST	HEADER SIZE
12'-0"	20,000 LB ✱	Use 6x6 min. if place posts directly under floor beams or when supporting intact/rigid concrete slab or beam.
14'-0"	14,500 LB	See Structure Specialist for other conditions
16'-0"	12,000 LB	
18'-0"	9,000 LB	
20'-0"	7,500 LB	

SPECIAL NOTES:

- ✱ = Limited by 660 psi Cross Grain Bearing on Wood.
- Spacing of Posts may be closer than 4ft in order to increase system capacity and/or align Posts under floor beams or joist.
- Header Size is HIGHLY dependent on ability of The Shored Structure to bridge between the Shoring Posts. If in doubt check w/Structure Spec.

VALUES GIVEN FOR ALL WOOD SHORES IN THIS TEXT HAVE AN APPROXIMATE FACTOR OF SAFETY OF 2 TO 1 IF NO. 1 DOUGLAS FIR OR SOUTHERN PINE ARE USED. PIECES SHOULD BE SELECTED FOR GOOD GRAIN (MIN. OF 8 RINGS PER INCH, SLOPE OF GRAIN NOT GREATER THAN 8 TO 1, AND HAVING 1 1/2 INCH OR SMALLER TIGHT KNOTS / 3/4" MAX LOOSE KNOTS)

2

VERTICAL SHORE (continued)

HOW TO CONSTRUCT THE VERTICAL SHORE

1. Determine where to erect the vertical shore.

   a. 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 foot wide is usually adequate.

   b. 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. (2x8, or 2x10 under sole, or if very soft, 3-2x6x18" placed perpendicular under sole at each post)

2. 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.

3. Measure and cut the posts to the proper height.

   a. Place the header on top of the sole plate.

   b. With the end of the tape measure on top of header where the posts are to be installed, slide the tape up to the bottom of the structural element to be shored & measure in at least three places deducting the width of the wedges.

4. 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 trying to keep it as level as possible.

HOW TO CONSTRUCT THE VERTICAL SHORE (continued)

5. Install the posts between the header and sole plate under each structural element to be supported. 4x4 Posts should be spaced 4 feet on center, maximum

   a. The first two posts are installed 12" from ends of header.

   b. Toe-nail each post to header and sole, and keep the posts in line & plumb with header and sole plate.

6. Install a set of 2x4 wedges under each post, on top of Sole, and tap them together simultaneously until the posts are tight. Nail behind the wedges to secure them in place.

7. Attach the diagonal braces to each side of the vertical shore.

   a. Mid-point brace, when needed, should be installed prior to the diagonal braces.

   b. The diagonal braces should be long enough to span its entire length and be attached to the sole plate and header and each post.

   c. If possible, diagonal braces should be installed in a "X" pattern on opposite sides of the system.

   d. Vertical shoring systems which are very long may require several sets of diagonal braces to connect multiple posts

8. .Attach 6”x 12” half-gusset plates to at least one side of the header and posts and nail in place if not done previously.

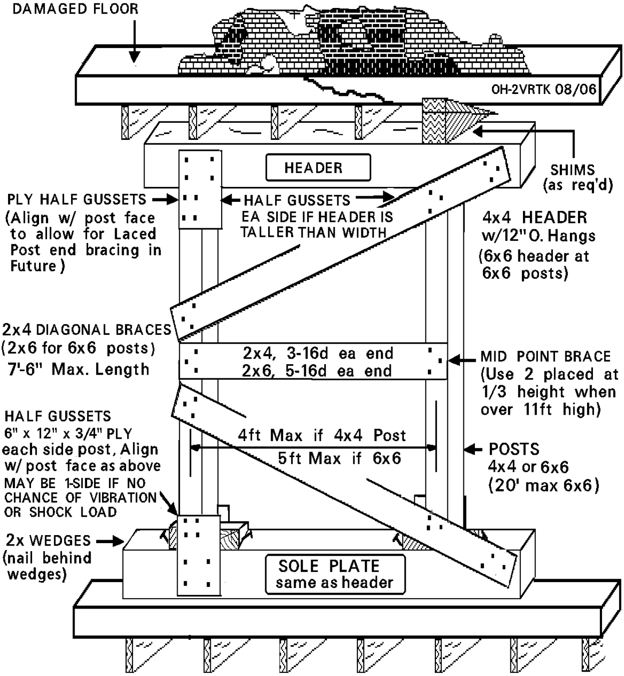
9. Attach half-gussets to at least one side of the sole plate and posts and nail in place. Half-gussets should be placed both sides to confine the wedges in all cases where any type of vibration or shock loading might occur.

TWO POST VERTICAL SHORE

CLASS 2 SHORE - PREFABRICATE AS MUCH AS POSSIBLE

THIS SHORE IS SAME AS ONE SIDE OF LACED POST

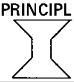
Position Header & Sole across floor & ceiling joists
Position Posts in line w/joists, NOT greater than 5' o.c.
Header and/or Sole may SLOPE 6" in 10 ft = about 3 Deg.



DESIGN LOAD (Shore Height)

4x4 POST	6x6 POST
16,000 lb for 8 ft	40,000 lb for 12 ft
10,000 lb for 10 ft	29,000 lb for 14 ft
7,000 lb for 12 ft	24,000 lb for 16 ft

SHORING PRINCIPLE



Header may need to be larger for supporting badly cracked concrete (see Structures Spec)

Max 4x4 Shore Height is 12 ft unless built as part of Laced Post

HOW TO CONSTRUCT THE 2-POST VERTICAL SHORE

1. Determine where to erect the 2-Post vertical shore and the condition of the supporting structure and/or ground.

   a. If practical, this shore should be partially prefabricated, same as for the Laced Post

   b. If using 4x4 posts, space them 4 feet, max on center. 6x6 posts may be 5 feet max on center. If access is limited, Post Spacing may be reduced to 3 feet o.c.

   c. The intent would be to support the damaged structure as quickly and safely as possible, but be able to later convert two adjacent, single 2-post vertical shores into a Laced Post for better stability

2. Measure and cut the posts to the proper height. (remember to deduct for header, sole & wedges when cutting posts) Also, cut the mid-brace and diagonals to proper lengths.

   a. Header shall have a 12 inch overhang each end

   b. Nail the header, posts, mid brace and upper diagonal together outside the damage zone, if practical. Use half-gussets at post to header and post to sole

3. Cut the sole and wedges. Sole is same length as header

4. Place 2-Post Shore in position, centered under the Load.

5. Slide sole plate under shore and tap wedges into position.

6. Check for straightness plus stability, then tighten wedges.

7. Install bottom cleats/gussets and nail properly.

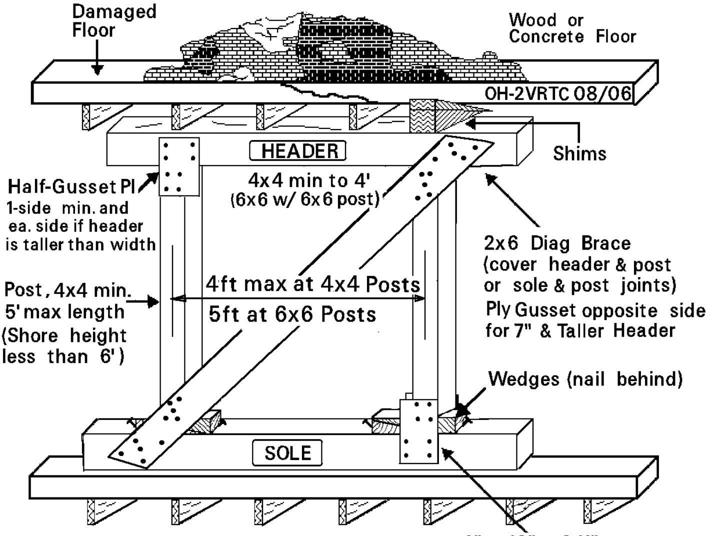
8. Anchor the shore to floor above and sole to floor below, if practical.

TWO POST VERTICAL SHORE

FOR CONFINED AREA

CLASS 2 SHORE - PREFABRICATE AS MUCH AS POSSIBLE

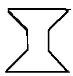
Position Header & Sole across floor & ceiling joists
Position Posts in line w/joists, NOT greater than 5' o.c.
Header and/or Sole may SLOPE 6" in 10ft = about 3 Deg.



DESIGN LOAD 4x4
16,000 lb

DESIGN LOAD 6x6
40,000 lb

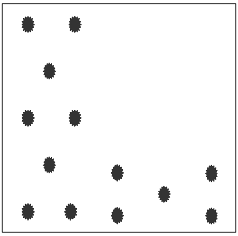
SHORING PRINCIPLE



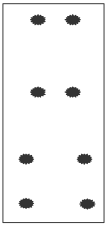
Header may need to be larger to support badly cracked conc. (see Structures Spec)

BUILT THE SAME AS ONE SIDE OF A HALF-HIGH LACED POST

Standard Gusset Plates



All 8d Nails

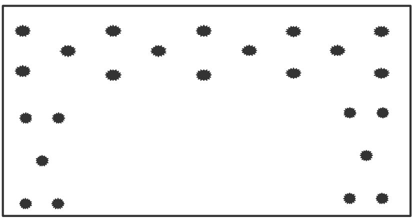


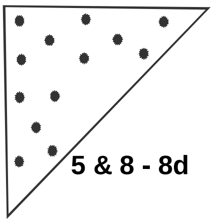
Full Gusset
12”x 12”x ¾” Ply
(Rakers & T- Shore)
“5 and 8 in Full Gusset Plate”

Half Gusset
6”x 12”x ¾” Ply
(All Vertical Shores)
“Only 8 in Half Gusset Plate”

2

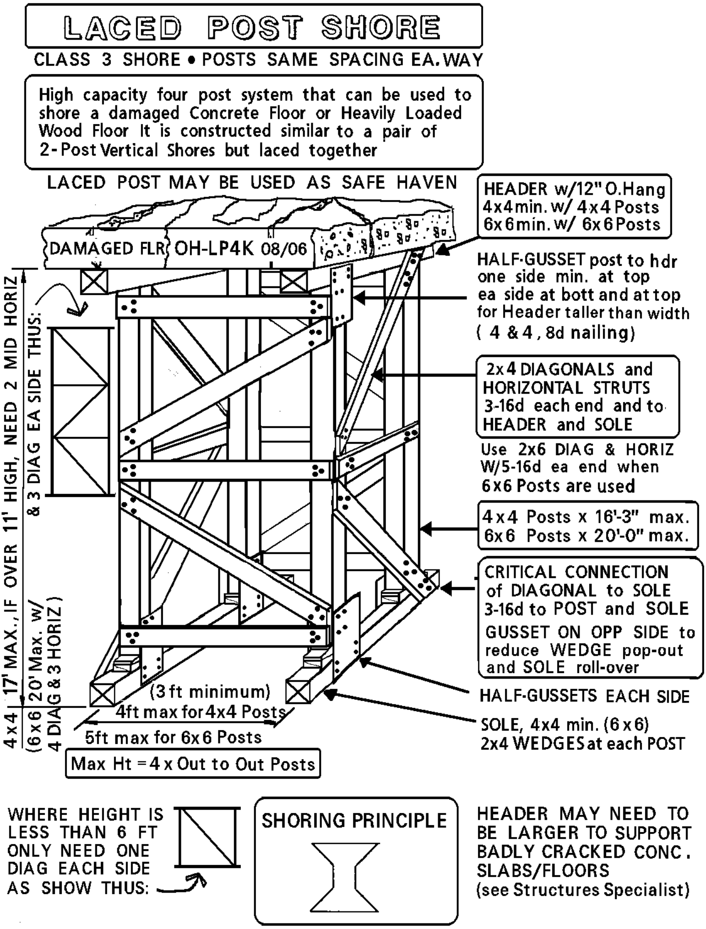
Special Gusset Plates





Double Gusset
12”x 24”x ¾” Ply
(Double T- Shore)
14-8d + 2 times 5 –8d

Triangle Gusset
12”x 12”x ¾” Ply
cut on diagonal
(Window Shores)



DESIGN LOAD: 4 - 4x4 = 32,000 lb   4 - 6 x 6 = 80,000 lb

HOW TO CONSTRUCT A LACED POST SHORE

1. Survey area and determine load displacement , based on structurally unstable elements & clean area to be shored
   a. Install temporary, spot shores if required.
2. Determine the length of the shore.
   a. Cut the header and sole plates 24 inches longer than length of the shore to allow for 12 inch overhangs.
3. Nail posts to header with toenails and keep them square.
   a. Check by making X measurements (outside top right to outside bottom left, should be same as outside top left to outside bottom right)
   b. If posts are not straight, set both with bow-out
   c. Nail a half-gusset to one post/header joint, then nail the midpoint brace in position. Re-check X measurement.
4. Measure and install the top diagonal.
5. Fabricate the second section, using first as template
6. Have the horizontal tie-in braces precut for ease of assembly.
7. Bring both sections and the sole plates into position and place the prefabricated units on top of the sole plates.
8. Install wedges under each post, and check post spacing.
9. Nail the horizontal braces to the two sections on both sides.
10. Measure for all the diagonals, and configure in K or parallel layout, as best works for the situation.
    a. Avoid intersecting too many diagonals on a post at a single location
11. At the sole plate, make sure the bottom diagonal extends past the post and nails into the sole plate.
    a. Place a half-gusset plate onto the opposite side of this post and to each side of the other posts at the base.
12. Anchor the shore to the ceiling and floor, if practical.
13. Make sure all wedges are snug and the proper nail patterns were used.

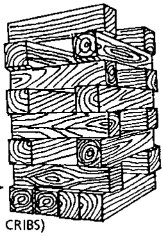
DESIGN STRENGTH is BASED on CROSSGRAIN BEARING

(VARIES FROM 200 PSI TO 1000 PSI DEPENDING ON WOOD SPECIES
500 PSI IS USED HERE - EXAMPLE 500 x 3.5 x 3.5 x 4 = 24,000)

FOR 2 MEMBER x 2 MEMBER LAYOUT

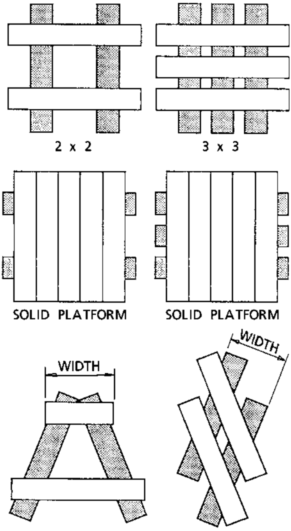
4 x 4 CRIB DESIGN LOAD = 24,000 LBS (12 TONS)
6 x 6 CRIB DESIGN LOAD = 60,000 LBS (30 TONS)

FOR 3-MEMBER x 3-MEMBER CRIB, DESIGN LOAD IS 9/4 AS MUCH
500 x 3.5" x 3.5" x 9 = 55,000, 500 x 5.5" x 5.5" x 9 = 136,000



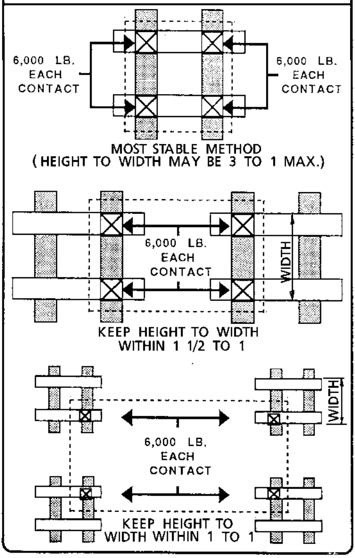
- BOTTOM LAYER SHOULD BE SOLID TO SPREAD THE LOAD ESPECIALLY ON SOIL OR ASPHALT PAVING
- LIMIT HEIGHT TO 3 TIMES WIDTH (SHORTEST WIDTH FOR NON-SQUARE CRIBS)
- OVERLAP CORNERS BY 4 INCHES TO ASSURE SLOW CRUSH TYPE FAILURE

SHOR-4 06/06

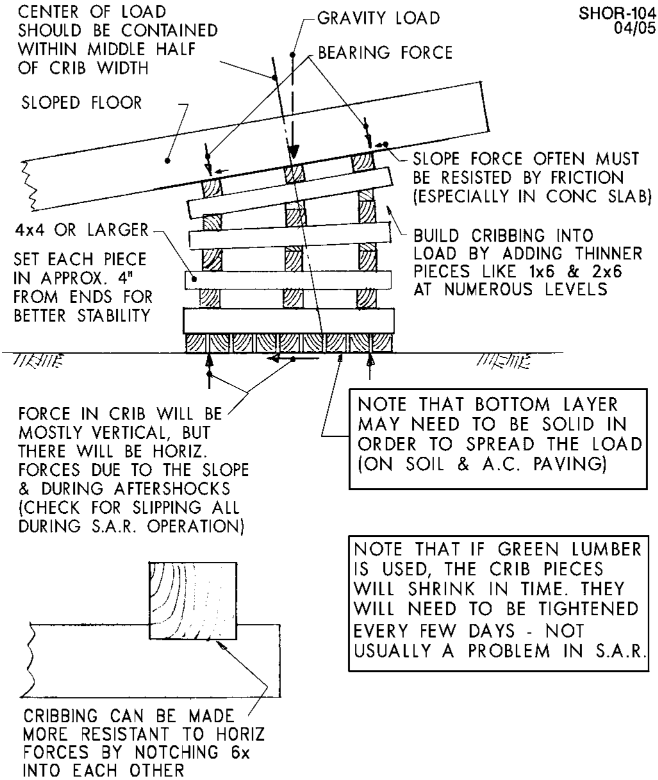


BOTH ARE NOT VERY STABLE, KEEP HEIGHT TO WIDTH WITHIN 1 TO 1

4" X 4" CRIBBING WITH FOUR BEARINGS



SHORES FOR SLOPED FLOORS • CRIBBING • TYPE 4



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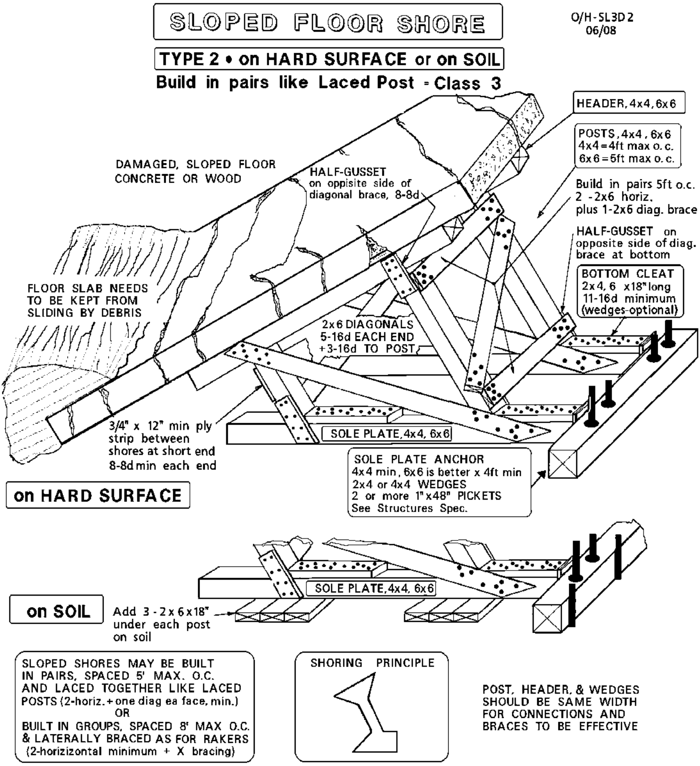
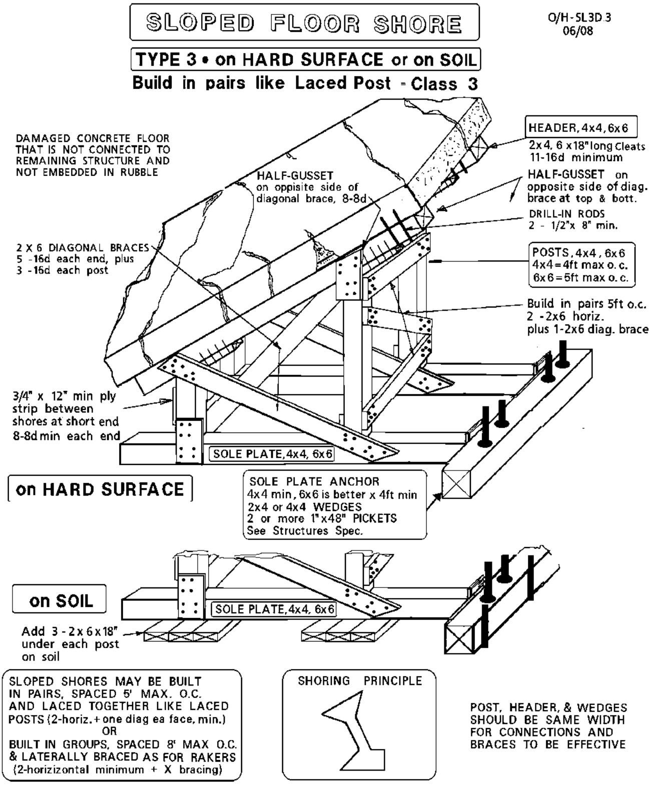


HOW to CONSTRUCT a <u>TYPE 2</u> SLOPED FLOOR SHORE on PAVING or SOIL SURFACE (Type 1 is not recommended)

1. Survey area and determine load displacement and structurally unstable elements, and clean area to be shored.
   a. Install temporary, spot shores if required.

2. Determine length and width of shore and post locations.
   a. Header overhang is 12 inch max. and sole plate must be at least 24 inches longer at the base of the back post.
   b. If Shore is installed on Soil, a 2x6, flat, should be nailed to bottom of the Sole with 16d @ 8” o.c.
   c. Install the header and sole plates, and anchor header.
3. Measure, install the two posts, Anchor to header, and drive the bottoms up tight (wedges may be used between post & bottom cleat, but they tend to interfere with diagonal bracing
4. Nail down the bottom cleats with the proper nail patterns. **Posts can usually be driven tight without wedges.**
5. Anchor down the sole plate, as follows:
   a. Anchor sole using drilled-in anchors or ¾” rebar to anchor to concrete or paving, based on Struct Spec. recommendations.
   b. Alternate sole anchor using Sole Plate Anchor system shown with Rakers.
6. Measure for the diagonal braces inside and outside each section.
7. Install the 2x6 diagonal braces in position and nail into posts and header and sole plate.
   a. Cleat/Half-Gusset plate the opposite side of the posts, top and bottom, using the 4 and 4 nail pattern.
   b. Need to place Half-Gussets to clear the horizontal and diagonal braces (to be installed next), or use 2x cleats instead of gussets.(but cleats w/ 16d are not preferred)
8. Brace the two sections together, same as in Laced Posts or Raker Shores (depending on spacing).
   a. Do this at both posts to tie the two sections together.
   b. You may use a wide piece of 3/4" plywood (12” to 24" wide) if shore is too short to fit X braces.
9. Attached to the floor and ceiling. (If possible).



HOW to CONSTRUCT a <u>TYPE 3</u> SLOPED FLOOR SHORE on PAVING or SOIL SURFACE – Friction Type

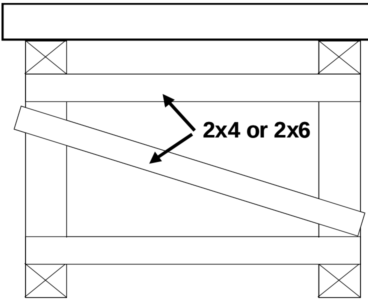
1. Survey area and determine load displacement and structurally unstable elements, and clean area to be shored.

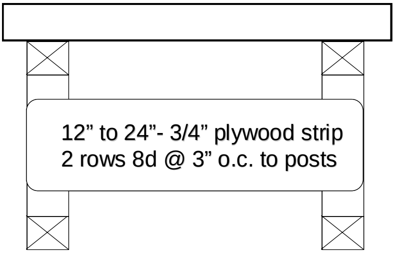
   a. Install temporary, spot shores if required.

2. Determine length and width of shore and post locations.
   a. Header overhang is 12 inches on lower end, but should be increased to 24 inches at high end. Sole plate should extend 12 inches beyond each post.
   b. Install the header and sole plates, and anchor header.
   c. If Shore is installed on Soil, a 2x6, flat, should be nailed to bottom of the Sole with 16d @ 8" o.c.
3. Measure, install the two posts and Anchor to header. Make sure posts are vertical
   a. Install one 18 inch cleat for each post on underside of header with 11-16d nails (should pre-install one or more of these cleats on header, when practical, to reduce nailing in Collapse Zone)
4. Place wedges in position and only snug up, then place a half-gusset one side of each post, but only nail to post.
5. Attached header to ceiling with at least 2 – 1/2" bar or rebar, embedded at least 3"
6. Anchor the sole plate, if required, and "pressurize" the wedges.
7. Measure for the diag. braces inside and outside each section.
8. Install the 2x6 diagonal braces in position and nail into posts and header and sole plate.
   a. Half-Gusset plate the opposite side of the posts, top and bottom, and complete the gusset nailing – 4 & 4, 8d.
   b. Need to place Half-Gussets to clear the horizontal and diagonal braces (to be installed next), or use 2x cleats instead of half-gussets. (cleats w/ 16d are not preferred)
9. Brace the two sections together, same as in Laced Posts or Raker Shores (depending on spacing).
   a. Do this at both posts to tie the two sections together.
   b. You may use a wide piece of 3/4" plywood (12" to 24" wide) if shore is too short to fit X braces.

BRACING BETWEEN PAIRS of SLOPED FLOOR SHORES

(When shores are spaced 5'-0" o.c. maximum.)

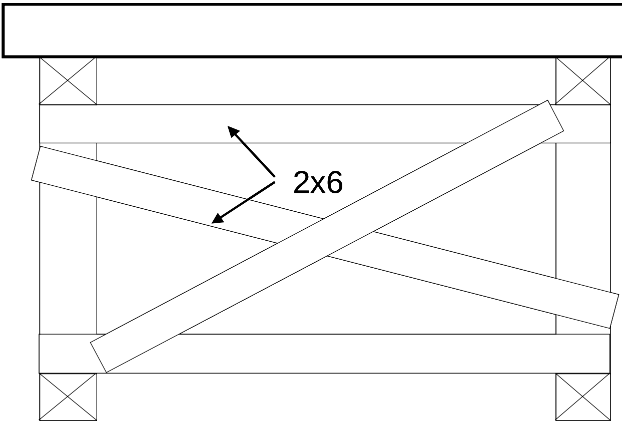




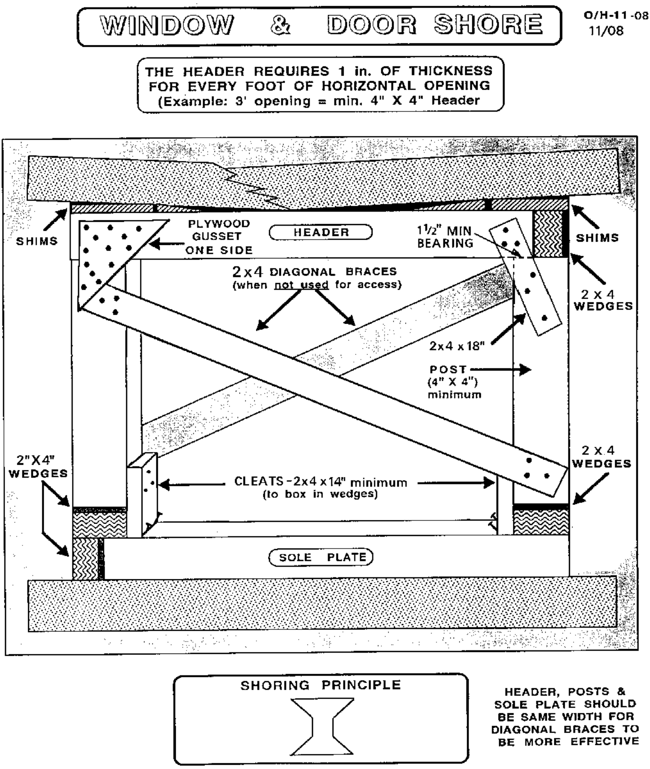
1. When Sloped Floor Shores are spaced a no more than 5'-0" o.c., brace the two sections together, same as in Laced Posts.
   a. Do this at both posts to tie the two sections together.
   b. You may use a wide piece of 3/4" plywood (12" to 24" wide) if shore height is 3ft or less. Nail plywood with 8d nails as shown.
   c. The 2x6 horizontals and diagonal should be nailed each end with 5-16d. 2x4s may be nailed with 3-16d.

BRACING BETWEEN PAIRS of SLOPED FLOOR SHORES

(When shores are spaced 8'-0" o.c. maximum.)



2. When Sloped Floor Shores are spaced more than 5'-0" but no more than 8'-0" o.c., brace the two sections together, same as in Raker Shores.
   a. Do this at both posts to tie the two sections together.
   b. The 2x6 diagonals should be placed so that one nails to the vertical posts, and the other nails to the horizontal braces (just beyond the nailing from horizontal to post.
   c. All 2x6 should be nailed with a 5-16d nail pattern.
   d. The diagonals should be internailed with at least 3-16d where they cross.



HOW TO CONSTRUCT THE WINDOW AND DOOR SHORE

1. Determine where to erect the window and door shore. After initial temporary shoring has been installed as needed, clear the area of debris or remaining framing material.
2. Measure and cut the sole plate to the proper length deducting the width of the wedges to be used.
3. Measure and cut the header to the proper length deducting the width of the wedges to be used.

CONSTRUCT THE WINDOW AND DOOR SHORE (continued)

4. Measure and cut the posts to the proper height.
   a. Place the header on top of the sole plate.
   b. 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.
   c. Use the shorter of the two measurements.
5. Install the sole plate with a set of wedges at one end and tap them together simultaneously until the sole plate is tight.
   a. The sole plate should be as level as possible: use shims as necessary under the sole plate.
6. Install the header with a set of wedges at the opposite end of the sole plate and tap them together until the header is tight.
   a. The header should be as level as possible; use shims as necessary above the header.
7. Install the posts between the header and sole plate and against the sides of the opening.
   a. Install the first post under the wedge side of the header to prevent movement if the header wedges loosen.
   b. Keep posts in line and plumb with header & sole plate.
   c. Install a wedge set <u>under</u> each post, on top of the sole plate. Wedges are then tightened to lock shore in place.
8. Attach cleat and triangular-gusset to at least one side of the header and posts (as shown) and nail in place.
9. Confine the wedges by placing a cleat against the inside face of each post at the bottom and nail them in place with 3-16d nails to each post and 2-16d toe nails to the sole plate.
   a. Nails may need to be Duplex for future adjustment of the wedges.
10. Install diagonal braces on the window and door shore when the opening is **<u>not used</u>** for access or egress.

PRE-CONSTRUCTED SHORING SYSTEMS

1. Window/Door Shores may be pre-constructed as shown in ALT WINDOW & DOOR SHORE.
    a. They should be made at least 1 ½" less than opening in each direction, and then tightened with wedges at one side and bottom + shims as required.
        - If header is badly damaged, great care should be taken during installation of the shoring and shims.
        - It shims are needed at the top, one should try to eliminate the wedges at the bottom.
    b. Pre-constructed Window & Door Shores will not be practical in racked or otherwise deformed openings.
    c. For large openings, pre-constructed shores may be too heavy to carry up to locations above ground floor.
    d. Main advantage is to allow pre-construction a safe distance from the dangerous wall or collapse zone.

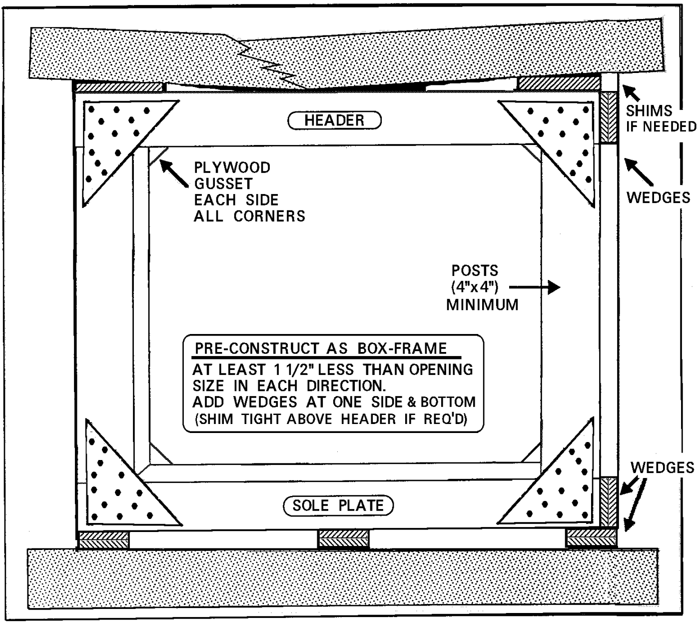
2. **Pneumatic Shores**, with a minimum of two shores with wood or metal rail header. (see page following Alt Window Shore)
    a. Metal ends should be nailed to header and sole.
    b. The manufacturers sell clamp fittings that allow for nailed 2x6 X bracing to be installed.
    c. Pneumatic shores are best used as temporary shores.
    d. Some manufacturers provide a Header Rail that may be per-assembled with two or more struts to provide a pre-constructed, vertical shore.
    e. **WARNING** – The use of Air Pressure to raise these shores into place has caused Accidents. Air Pressure should be limited to 50 PSI, and all Pneumatic Shores should be hand tightened – to snug condition
    f. See Strut Tables in Sect 7 of Struct. Spec FOG for recommended Strut Loading based on Height (length)

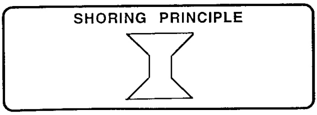
ALT • WINDOW & DOOR SHORE

O/H-11A
8/05

PRE-CONSTRUCT, PLACE IN OPENING, AND TIGHTEN WEDGES

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

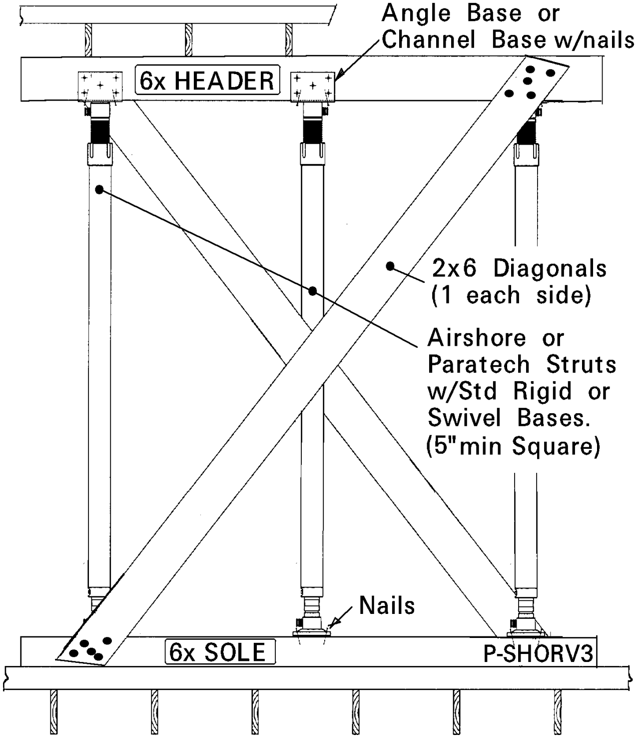




HEADER, POSTS & SOLE PLATE MUST BE SAME WIDTH

VERTICAL SHORE

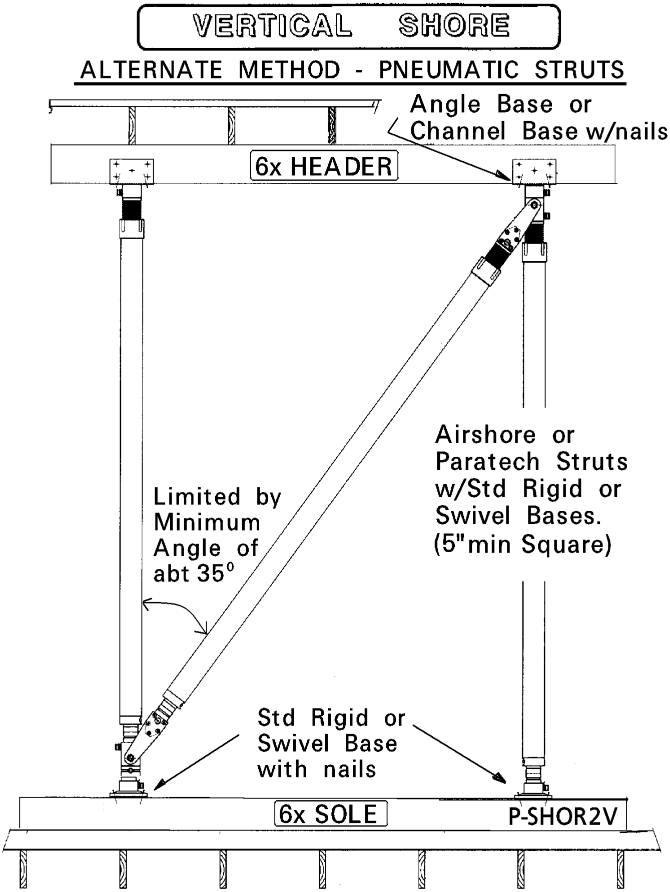
ALTERNATE METHOD - PNEUMATIC STRUTS



Need 6x Header and Sole due to width of Std Base
See previous pages, this Sect for notes on Vertical Shores

See Strut Tables in Sect.7 of Struct. Spec FOG for
Recommended Strut Loading, based on Height (Length)

MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32
HAND TIGHTEN ALL PNEUMATIC STRUTS - SNUG TIGHT



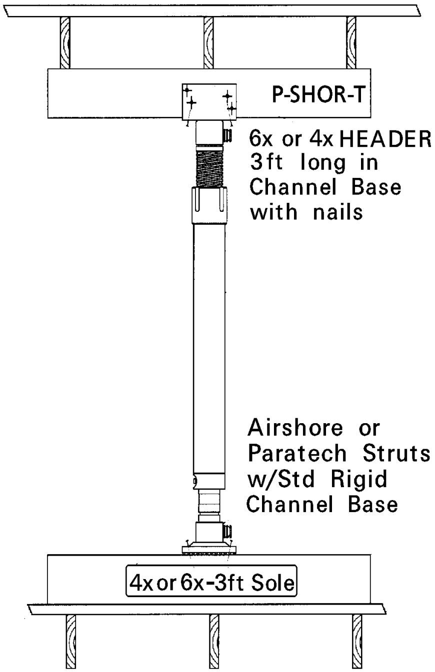
Need 6x Header and Sole due to width of Std Base
See previous pages, this Sect for notes on Vertical Shores

See Strut Tables in Sect.7 of Struct. Spec FOG for
Recommended Strut Loading, based on Height (Length)

MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32
HAND TIGHTEN ALL PNEUMATIC STRUTS - SNUG TIGHT

"T" SPOT SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS



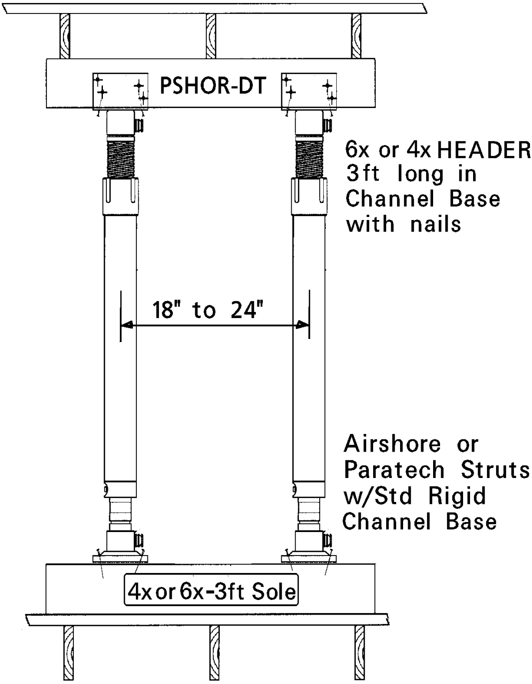
Use 4x or 6x depending on Width of Channel Base
Note that Channel Bases are not as strong as Gussets

See previous pages in this Section for Notes regarding Wood T-Spot Shores. They are relativly unstable and should be considered only as Temporary Shores, to be replaced by Laterally Braced, Multi-Post Systems
MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32
HAND TIGHTEN ALL PNEUMATIC STRUTS - SNUG TIGHT

DBL "T" SHORE

Position the HEADER & SOLE PLATE across the floor and ceiling joists and align the POST under the joists
Double T is more Stable than T Spot Shore

ALTERNATE METHOD - PNEUMATIC STRUTS



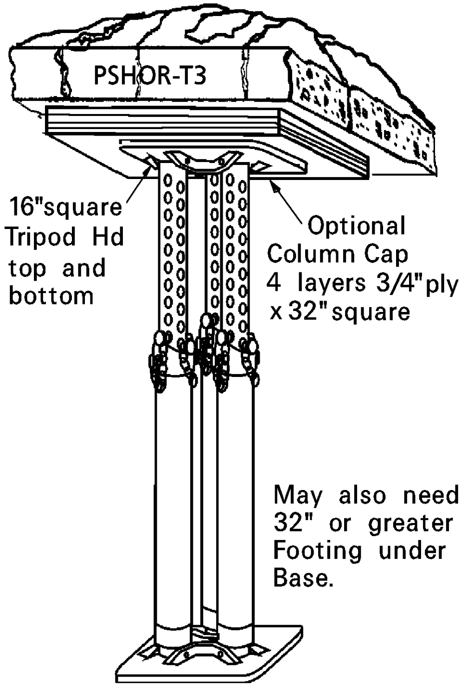
Use 4x or 6x depending on Width of Channel Base
Note that Channel Bases are not as strong as Gussets
See previous pages in this Section for Notes regarding Wood Double T Shores

MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32
HAND TIGHTEN ALL PNEUMATIC STRUTS - SNUG TIGHT

SPOT SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS

(CONCRETE FLOOR - USING 3-SHORE COLUMN)



Strength of 3 Column Shore may be taken as 3 times the values given for individual Struts of same height in Sect.7 of Struct. Spec FOG

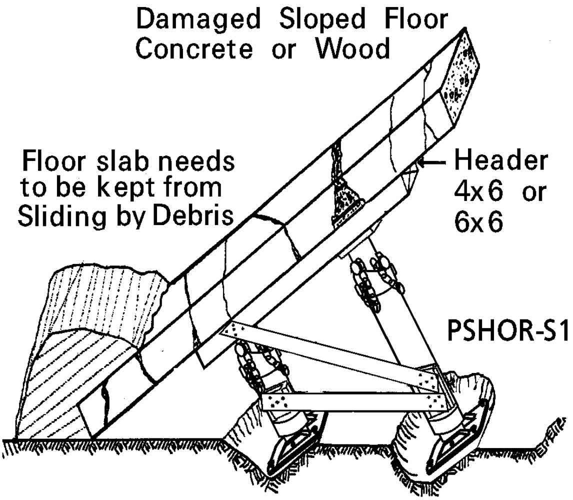
MAX AIR PRESSURE = 50 PSI, HAND TIGHTEN ALL STRUTS - SNUG

SLOPED FLOOR SHORE

ON EARTH SURFACE

ALTERNATE METHOD

PNEUMATIC STRUTS



Struts by Airshore or Paratech with Std Swivel Bases or 12"sq Base Plates depending on Soil Strength

See previous pages in this Section, Wood Sloped Floor Shores for Notes and Details

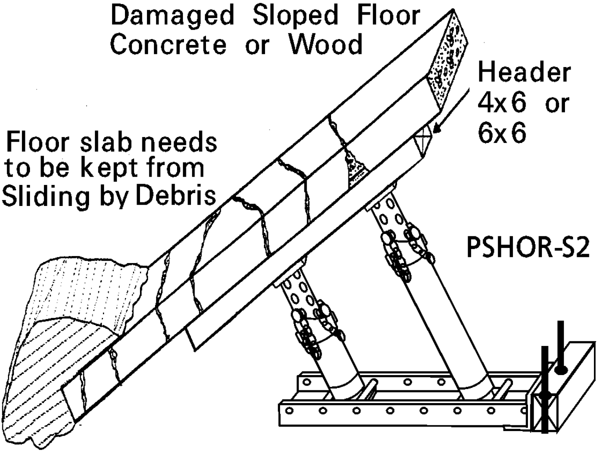
MAX AIR PRESSURE = 50 PSI,
HAND TIGHTEN ALL STRUTS - SNUG

SLOPED FLOOR SHORE

ON HARD SURFACE

ALTERNATE METHOD

PNEUMATIC STRUTS



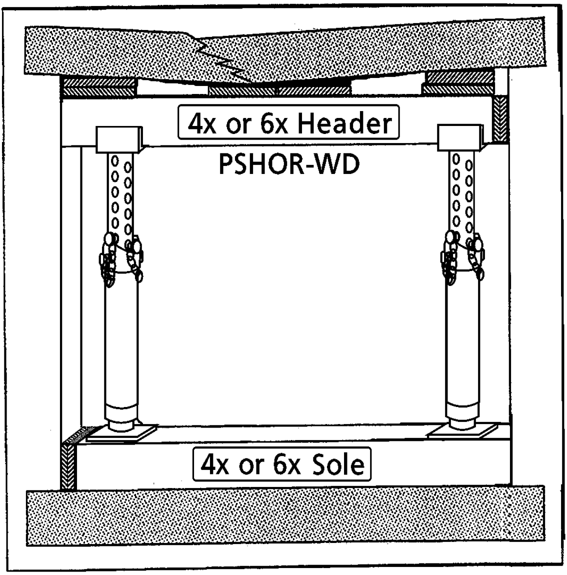
Struts by Airshore or Paratech with Angle Base or Channel Base to Header
Sole is Raker Wall Channel with Std Raker Connections and Bearing Angle against Sole Anchor

See previous pages in this Section, Wood Sloped Floor Shores for Notes and Details

MAX AIR PRESSURE = 50 PSI,
HAND TIGHTEN ALL STRUTS - SNUG TIGHT

ALT • WINDOW & DOOR SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS



Use min. of 2 Airshore or Paratech Struts
Wedges at one end of Header and Sole

See previous pages in this Section, Wood Window and Door Shores for Notes, etc.

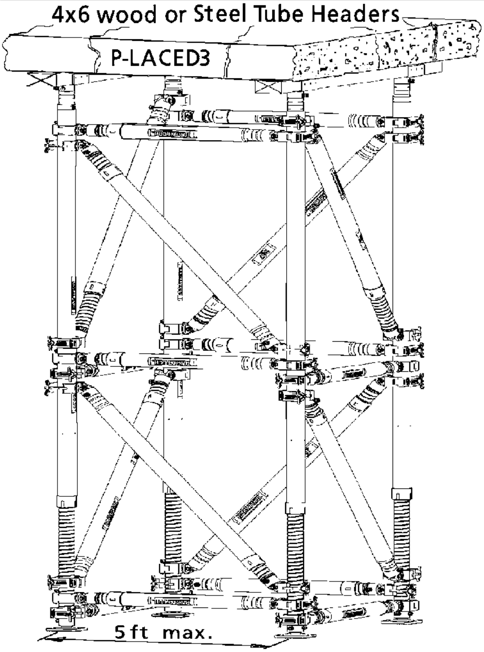
See Strut Tables in Sect. 7 of Struct. Spec FOG for Recommended Strut Loading, based on Height (Length)

MAX AIR PRESSURE = 50 PSI, SEE Pg 3-32
HAND TIGHTEN ALL STRUTS - SNUG TIGHT

2

LACED POST SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS



This configuration of Struts is intended for use where wood Laced Post Sys are not available. The Horiz. & Diagonal members must be able to resist, both Tension & Compression Forces.

The end clamp connections must be very securly tightened, in order to transfer the Loads.

See Strut Tables, Struct. Spec. FOG - Sect 7 for Recommended Values for individual Struts, based on Height (Length). This Laced Post configuration will improve lateral stability but may not be stronger than 4 individual Struts.

MAX AIR PRESSURE = 50 PSI, SEE Pg 3-32

HAND TIGHTEN ALL STRUTS - SNUG TIGHT

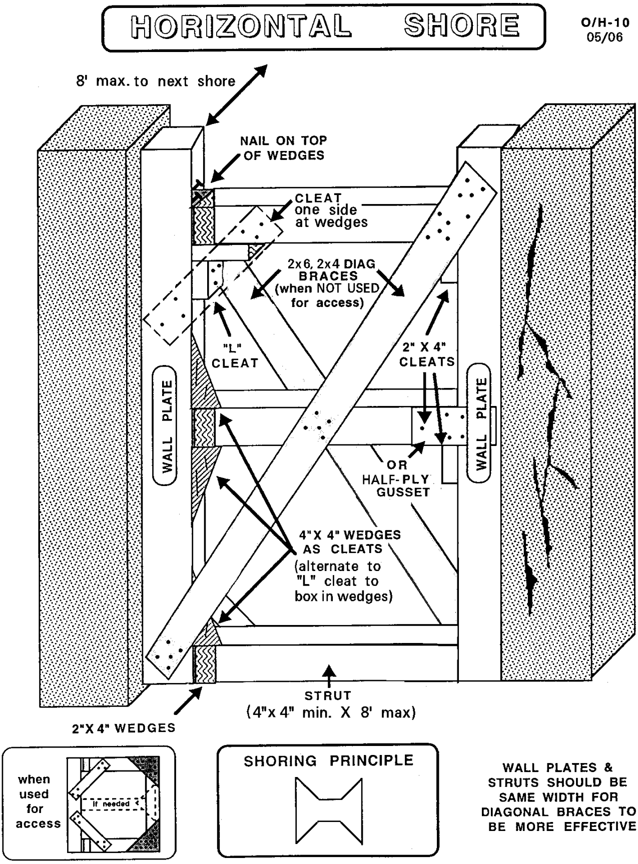
INTRODUCTION to SECTION 3

This section contains General Information, Graphics and Detailed Explanations of how to construct FEMA Horizontal Shoring – arranged as follows:

- How to construct Horizontal Shores
- Raker Shore Design Information
- How to construct Raker Shores
    - Flying Raker – Spot Shore
    - Solid Sole Raker
    - Split Sole Raker
- Raker Shore Design Examples
- Tiebacks and Alternate Raker Systems
- Horizontal & Raker Shoring Systems using Pneumatic Struts

RAKER LENGTH (L) BASED ON INSERTION POINT HEIGHT

Insertion Point, Ft	45° Raker L Inches / Feet	60° Raker L Inches / Feet	60° Horiz. Dist. Inches / Feet
3	51” / 4’- 3”	42” / 3’- 6”	21” / 1’-9”
4	68” / 5’- 8”	56” / 4’- 8”	28” / 2’-4”
5	85” / 7’-1”	70” / 5’- 10”	35” / 2’-11”
6	102” / 8’- 6”	84” / 7’- 0”	42” / 3’-6”
7	119” / 9’- 11”	98” / 8’- 2”	49” / 4’-1”
8	136” / 11’- 4”	112” / 9’- 4”	56” / 4’-8”
9	153” / 12’- 9”	126” / 10’- 6”	63” / 5’-3”
10	170” / 14’- 2”	140” / 11’- 8”	70” / 5’-10”
11	187” / 15’- 7”	154” / 12’- 10”	77”/ 6’-5”
12	204” / 17’- 0”	168” / 14’- 0”	84”/ 7’-0”
13	221” / 18’- 5”	182” / 15’- 2”	91” / 7’-7”
14	238” / 19’- 10”	196/ 16’- 4”	98” /8’-2”
15	255” / 21’- 3”	210” / 17’- 6”	105”/ 8’-9”
16	272” / 22’- 8”	224” / 18’- 8”	112”/ 9’-4”
17	289” / 24’- 1”	238” / 19’- 10”	119”/ 9’-11”
18	306” / 25’- 6”	252” / 21’- 0”	126”/ 10’-6”
19	323” / 26’- 11”	266” / 22’- 2”	133”/ 11’-1”
20	340”/ 28’- 4”	280” / 23’- 4”	140”/ 11’-8”



HOW TO CONSTRUCT THE HORIZONTAL SHORE

1. Determine where to erect the horizontal shore.

   a. After temporary shoring has been installed as needed, clear the area of debris. (3 ft to 4 ft wide is usually OK)

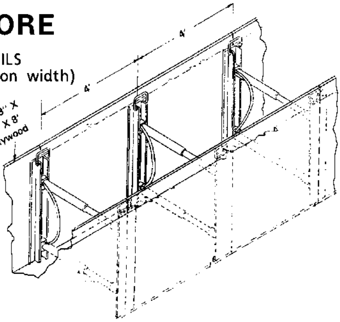
HOW TO CONSTRUCT THE HORIZONTAL SHORE

2. Measure and cut the wall plates & struts to the proper length.
    a. Place both wall plates against the walls.
    b. Measure between the wall plates where the struts are to be installed, deducting the width of the wedges to be used.
3. Place both wall plates next to each other and attach cleats to the wall plates just below where the struts will be installed.
4. 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.
5. Install the struts between the wall plates. Keep the struts in line and plumb with the wall plates.
6. Install a set of wedges horizontally between the Wall Plate and each end of each strut and tap them together simultaneously until the struts are under compression and tight.
    a. Secure the wedges 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.
    b. May need to be Duplex for future adjustment of wedges.
7. Attach cleats or half-gusset plates to at least one side of the wall plates and struts, where aftershocks or vibrations may occur.
8. If possible, attach the wall plates to the walls.
9. Attach the diagonal braces to each side of the horizontal shore when **<u>not used</u>** for access or egress.
    a. The diagonal braces should be long enough to span entire length and be attached to both wall plates and each strut.
    b. When used, diagonal braces should be installed in a "X" pattern on opposite sides of the system.

LATERAL SHORING SYSTEMS

SHOR-11T

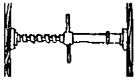
HYDRAULIC TRENCH SHORE



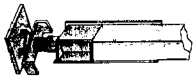
- ALUMINUM, HYDRAULIC RAMS W/ SIDE RAILS (may be single or double rams depending on width)
- PRESSURIZED WITH 5 GALLON HAND PUMP TO 500-1000 PSI
- SYSTEMS INSTALLED W/ PLYWOOD SHEATHING
- SPACING DEPENDS ON TYPE OF SOIL, AND DEPTH - WIDTH OF TRENCH
- FORCE IN SHORE DEPENDS ON PRESSURE BEING MAINTAINED BY CHECK VALVE. NO MECHANICAL CONNECTION

OTHER TRENCH SHORES

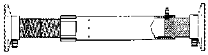
- TRENCH JACK - SAME CAPABILITY AS IN VERTICAL POSITION



- POST SCREW JACK (by Ellis) " " " " "



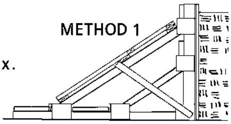
- PNEUMATIC SHORE - SAME CAPABILITY AS IN VERTICAL (These shores originally intended as trench shores)



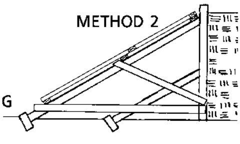
ONE SIDE LATERAL SHORE

- SYSTEMS NEED TO BE DESIGNED BY STRUCT. SPEC
- BRACING FRAMES (Like Raker Shores) 4 FT O.C.Max.
- BETTER TO USE 30° SLOPE (45° Max.)
- 4x4 or 6x6 MEMBERS MAY BE USED (Depends on Height and Soil Loading)
- NEED 3x or 4x SHEATHING (or Special Plywood)
- NEED VERY GOOD ANCHORING SYSTEM
- NEED PERPENDICULAR 2X6 HORIZ & X-BRACING SYSTEM (Like Raker Shores)

METHOD 1



METHOD 2



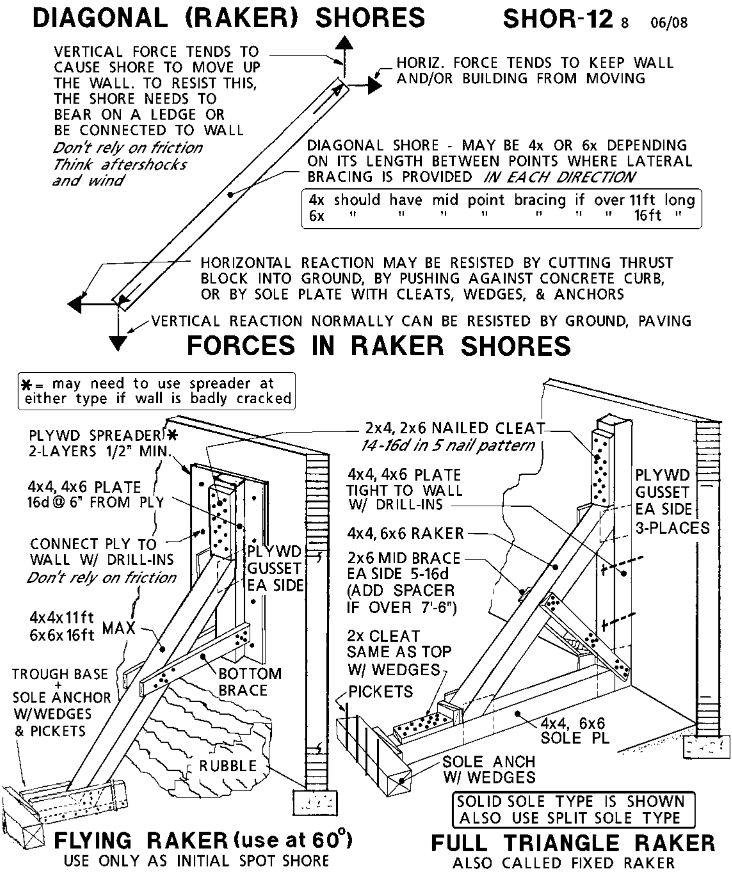
RAKER SHORE – DESIGN INFORMATION

1. There are three types of Raker Shores that are used in US&R Incidents to stabilize leaning and/or damaged walls. They are:
   a. Flying (or Friction) Rakers are used as temporary, spot rakers when debris are piled next to the base of the wall
   b. Solid Sole, full triangle, Rakers are the most desirable rakers, and are normally built in groups of 2 or more as Class 3 (3 dimension) Systems with lateral bracing.
      - They are most appropriately used where hard surfaces are adjacent to the wall, and there is no debris pile in the way
      - However they may be used when bearing on soil, if spreaders (2x6x18" or 2 thickness of plywood) are placed under the Sole at the intersection of the Raker

   c. Split Sole, full triangle, Rakers are intended to be used when there is soil adjacent to the wall, and/or there is a limited amount of debris next to the wall. They , also, should be built as Class 3 Systems
   d. Rakers are normally spaced at 8 feet on center maximum. However, actual conditions may require closer spacing.
   e. **NOTE: The nailing of the 2x4x24" Cleat has been reduced from 17 to 14 -16d nails.** The 14 -16d have adequate strength, and will also reduce splitting.

2. As with Vertical Shores, Raker Shores may be built in a logical progression, starting with Flying Raker, Spot Shores to initially stabilize the wall, followed by a group of Full Triangle Rakers (Since Full Triangle Rakers are mostly pre-fabricated, they may be installed w/o first installing Flying Rakers)
   a. Lateral Bracing between rakers is normally built using 2x6 horizontals and X-bracing
   b. Depending on height of insertion point, rakers may have mid-bracing to reduce to potential of buckling. In this case the lateral bracing will have a horizontal placed near the intersection of mid-brace and raker, and there will be two rows of X-bracing

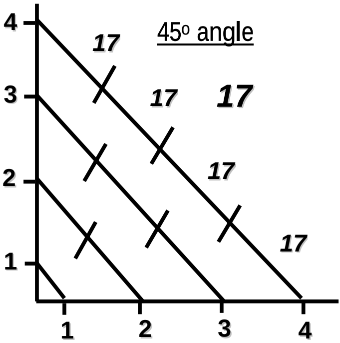
RAKER SHORE – DESIGN INFORMATION (continued)

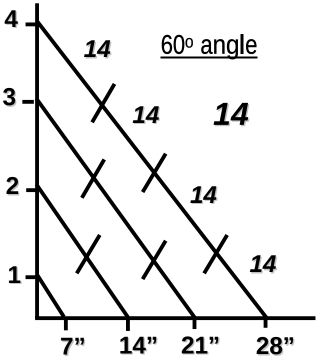


EXCEPT FOR INITIAL, TEMPORARY STABILIZATION, RAKER SHORES SHOULD BE BUILT IN SYSTEMS OF TWO OR MORE, WITH LATERAL BRACING BETWEEN THEM

DETERMINING RAKER SHORE ANGLE & LENGTH

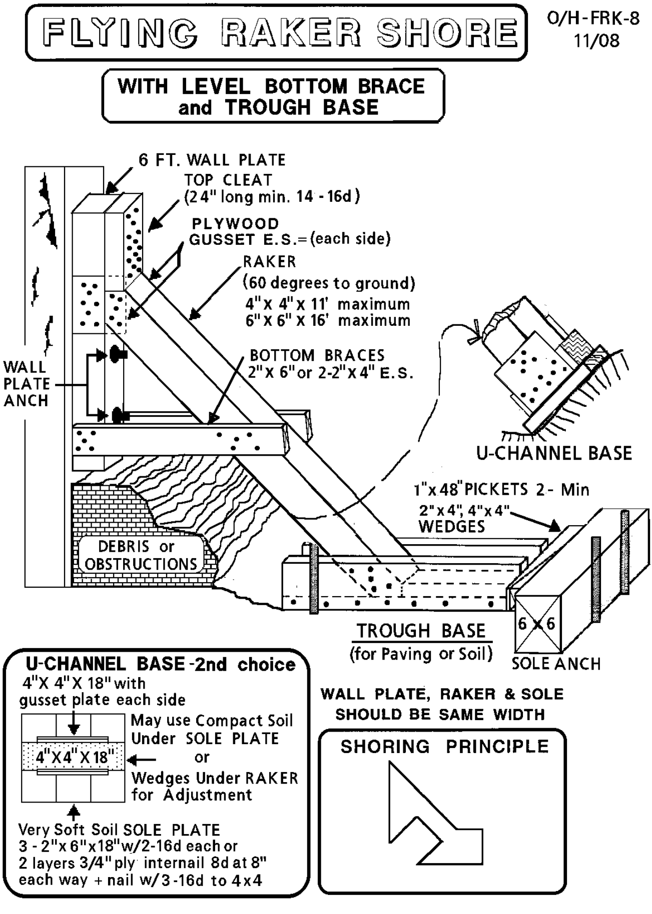
1. Any angle between 30 and 60 degrees will work effectively.
   a. The lower the angle, the more efficient the raker will be.
2. The two most common angles used are 45 and 60 degrees. A 60 degree angle is the maximum recommended angle used to safely erect a raker shore.
   a. **24” Cleats w/ 14-16d nails** are used with a **45 deg angle**, and a **30” Top Cleat w/ 20-16d** is used for **60 deg angle.**
3. Determining the height at which the raker shore needs to intersect the wall (Insertion Point) 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.
   a. The Insertion Point for a Wood Bldg should be between the Top of the Floor Joist and 2 feet below that point.
4. 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. See Pg 3-1 (8' X 17 = 136" or 11' 4").
5. 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. See Pg 3-1 (8' X 14 = 112" or 9' 4").





3

CONSTRUCTION of RAKER SHORES



Design Load for One Flying Raker is 1,000 lb

HOW TO CONSTRUCT FLYING RAKER SHORES

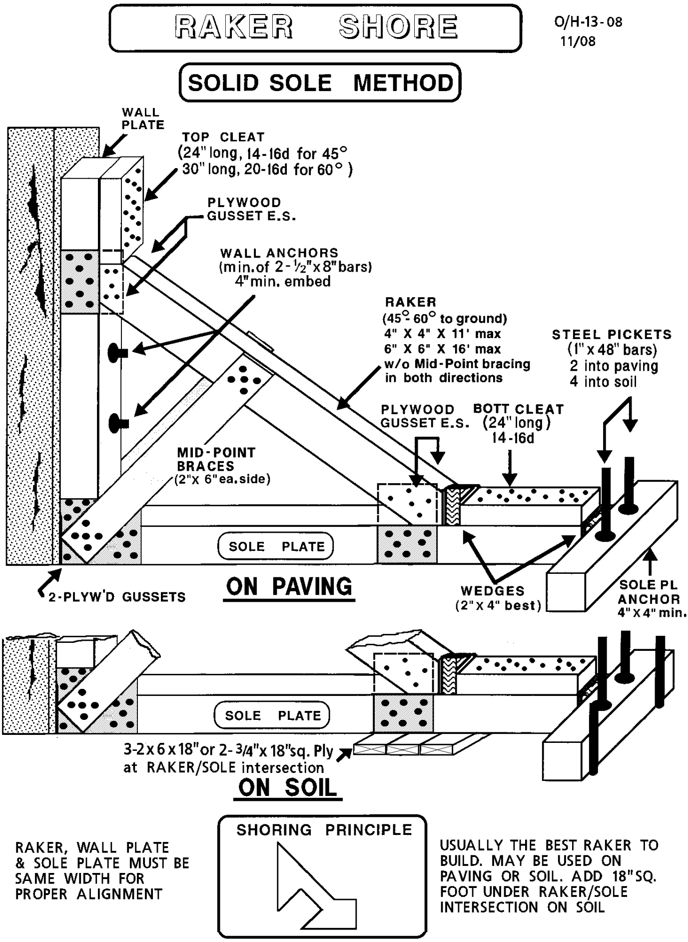
(Prefabricate as much as possible – Less Risk to Erect)

1. The areas to be supported by Raker Shores should be considered extremely dangerous. Temporary (Flying) Friction Raker Shores may need to be erected prior to building more permanent (Full Triangle) Fixed Raker shoring systems
   a. Determine where to erect the Raker Shores and the height of its support points. Determine height of Insertion Point
2. Flying Rakers can be erected against the wall without removing the Debris that may be piled up against it.
   a. They may be used as single Spot Shores, or may be built in pairs with horizontal & X bracing added between pairs.
   b. Flying Rakers should be prefabricated, fit into their U-Channel or Trough Base, Wedged and/or Shimmed, and then attached to the wall with drill-ins.
   c. In some cases the drill-ins may be omitted if the top of the Wall Plate can bear against a protrusion in brick/conc wall

      or

   d. At brick/conc wall, Raker may be built at one edge of a window, with a single or double 2x4 (24” min w/14-16d) pre-nailed to the Wall Plate so it will bear on the bottom of window header **(Only if header is not badly cracked)**
3. In order to pre-fabricate, Cut Raker, Wall Plate and Bottom Brace to proper length, and perform angle cuts on Raker
   a. Layout Wall Plate, Raker and Bottom Brace at selected angle, and toe-nail Raker to Wall Plate
   b. Nail-on Top Cleat, then gusset to one side of this joint
   c. Nail one-Bottom Brace to Wall Plate in position to clear debris, but only tack-nail it to Raker
   d. Turn shore over and nail-on other gusset plus other Bottom Brace (nailed to Wall Plate, tack to Raker)
4. Dig-in U-Channel (or anchor Trough), then carry the partly assembled Raker into place. Snug-up the Wedges, and complete the nailing of Bottom Brace to Raker
   a. Make whatever connection to wall that is selected, as indicated above, and retighten the Wedges

3



Design Load for 1- Pair of Raker Shores w/ Bracing is 5,000 lb

HOW TO CONSTRUCT SOLID SOLE RAKER SHORES
(Prefabricate as much as possible – Less Risk to Erect)

1. Determine where to erect the raker shores and the height of its support points. Determine height of Insertion Point
   a. After initial temporary shoring has been installed as needed, clear the area of debris.
   b. For each raker clear three feet wide and at least the height of the support point out from the wall.
2. Select angle of Raker, then measure and cut the Wall Plate, Sole Plate and Raker to the proper length.
   a. Sole plate and Wall Plate must extend at least 24 inches from where the raker intersects them to allow for the Cleats to be nailed.
   b. Both ends of the raker to be angle-cut with 1½ " return cuts for full contact with the wall plate, top cleat, sole plate, and wedges.
3. Pre-fabricate Wall Plate, Raker and Sole
   a. Toenail Sole to base of Wall Plate, square inside to 90deg, and secure with bottom, full- gusset plate on one side
   b. Layout Raker at selected angle, intersection with Wall Plate and Sole. Install Top Cleat and nail on gusset one side of this top joint
   c. Nail one Sole Gusset to Raker, but not to Sole at this time, since Raker may need adjusting when moved to wall.
   d. Mark Sole for approximate position of Bottom Cleat, allowing for Wedges
   e. Flip Raker Shore over and nail gussets on opposite side, but remember to nail the Raker to Sole Gusset, to Raker only, not to Sole to allow for later adjustment

HOW TO CONSTRUCT SOLID RAKER SHORE (continued)

4. Carefully move the partially prefabricated Rake Shore in place at the wall and make sure it is plumb.

    a. With Raker Shore placed against the wall, the Sole should be carefully driven-in so the Wall Plate is snug against the Wall, and the Bottom Cleat should be completely nailed, allowing space for the Wedges

    b. Full contact must be maintained between the wall plate and the support point of the Raker, and between the base of the wall plate and the wall.

        - If the wall has bulged out, shims may need to be added near bottom of wall plate

5. After Anchoring the Sole Plate as noted in 10. on page 3-14, install wedges between the bottom cleat and the base of the Raker and tighten them slightly.

    a. After adjusting the shims/spacers (if any) between the wall plate and the wall being shored to ensure full contact, as in 4a. above, finish tightening the wedges and complete nailing of gusset plates on each side.

6. With Raker shore erected, prevent the Raker shore from sliding up the wall. See Raker Shore - Cleats, Cuts & Anchors.

    a. To attach wall plate directly to a concrete/masonry wall.

        - A minimum of two 1/2" drill-in anchors, lag screws or rebar should be placed through the wall plate or four 1/2" drill-in anchors through two 9" long channel brackets attached with two on each side of the wall plate near the middle.
        - On concrete walls, if backing material is needed, then attached to wall plate, and use at least five 3" powder charge pins with washers through the backing material on each side of the Raker (also may use 3 - 3/8x4″ Concrete Screws each side.)

b. To attach the wall plate directly to a wood framed wall.

- A minimum of two 1/2" lag screws should be placed through the wall plate directly into the wall studs.
- When plywood backing material is attached to the wall plate, use at least 8-16d nails through the backing material into wall studs, each side of Raker

c. Another method is to attach an engineered ledger (2x6 minimum) to the wall above the wall plate.

7. Attach Mid Point Braces (required if 4x4 Raker is longer than 11 feet and/or 6x6 Raker is longer than 16 feet)

   a. One 2x6 are nailed to both sides of the Wall Plate/Sole Plate connection and mid-point on the Raker. (if 2x6 is not available, 2x4 may be used)

8. Attach Horizontal Braces

   a. Connect Raker shores together near the top and bottom of the Raker with at least 2x6 size material, or two 2x4s.

   b. For Insertion Point greater than 8 feet, a Horizontal Brace shall be placed at mid-point of the Raker, right where the Mid-Point Braces intersect

   c. Horiz braces may be butt-spliced at center of any raker. Use 3-16d ea end plus half-gusset with 4-8d ea side splice

9. Attach X or V Braces

   a. 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 2x4 or 2x6.

   b. Attach the **<u>first brace to the Rakers</u>** near the top and bottom between the upper and lower horizontal braces.

   c. Attach the **<u>second brace to the upper and lower horizontal braces</u>** near the Rakers.

HOW TO CONSTRUCT SOLID RAKER SHORE (continued)

10. **Methods to Anchor the Sole Plate**, in order to prevent the assembled shore from sliding back away from the wall.

    a. To attach the sole plate directly to concrete, asphalt or soil: drill a minimum of two 1" holes through the sole plate, concrete, or asphalt and drive 1" x 48”steel pickets or rebar directly into the ground. Need at least 4 – 1"x 48” pickets if driven directly into ground, but may be more practical to use Sole Anchor in 10 c. below.

    b. To attach the sole plate to concrete and masonry.

        - A minimum of two 1/2" drill-in anchors, lag screws or rebar should be placed through the sole plate or four 1/2" drill-in anchors through two 9" long channel brackets attached with two on each side of the sole plate.

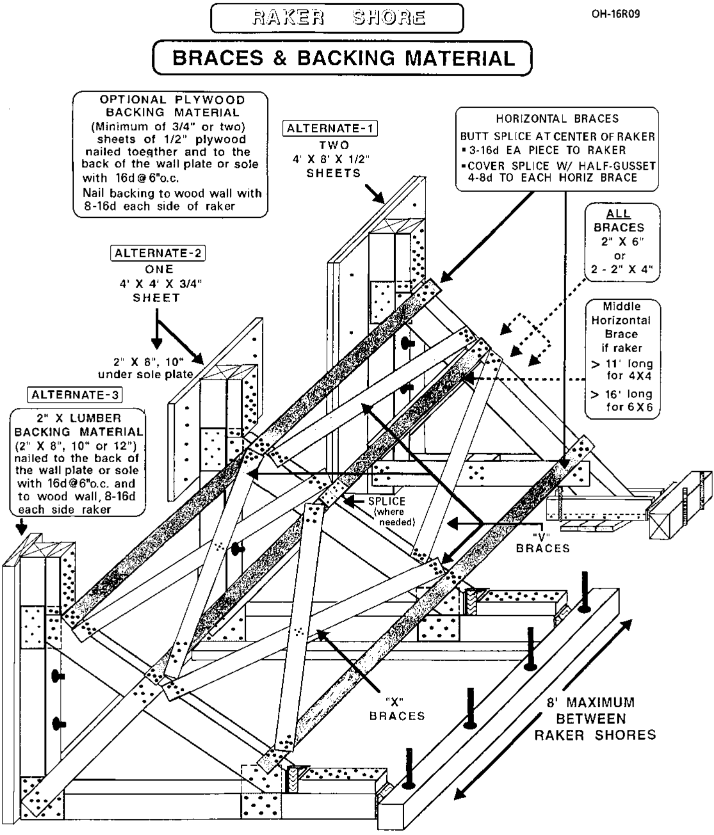
        - On concrete only, when backing material is attached to the sole plate, the use of at least five 3" powder charge pins with washers through the backing material on each side of the sole plate is acceptable.

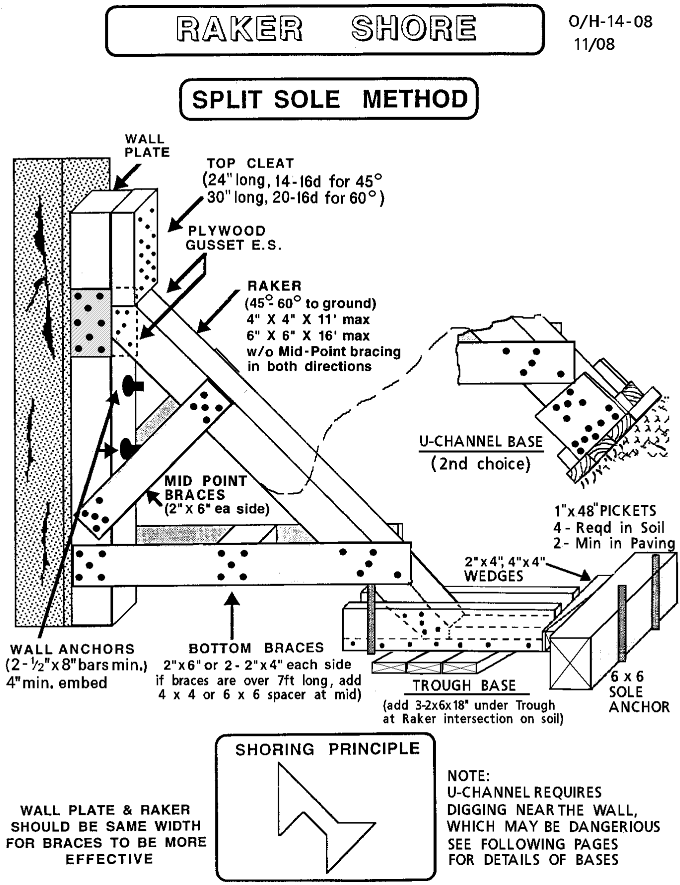
    c. An Sole Anchor can be secured to the ground or floor behind the sole plate to prevent the sole plate from backing away from the wall.

        - Timber Anchors should be as least 4x4 size lumber, (6x6 is better). Place 4 – 1” dia x 48” pickets, spaced about 12” o.c., directly behind Anchor on Soil. Two pickets may be used into Paving.

        - Steel anchors or channel brackets should be at least 1/4 inches thick.

        - Concrete curbs, walls and other nearby secure structures may also be used.


RAKER SHORE
OH-16R09
BRACES & BACKING MATERIAL
OPTIONAL PLYWOOD BACKING MATERIAL (Minimum of 3/4" or two) sheets of 1/2" plywood nailed toegther and to the back of the wall plate or sole with 16d @ 6"o.c.
Nail backing to wood wall with 8-16d each side of raker
ALTERNATE-1
TWO 4' X 8' X 1/2" SHEETS
HORIZONTAL BRACES
BUTT SPLICE AT CENTER OF RAKER
• 3-16d EA PIECE TO RAKER
• COVER SPLICE W/ HALF-GUSSET 4-8d TO EACH HORIZ BRACE
ALL BRACES 2" X 6" or 2 - 2" X 4"
ALTERNATE-2
ONE 4' X 4' X 3/4" SHEET
Middle Horizontal Brace if raker
> 11' long for 4X4
> 16' long for 6X6
2" X 8", 10" under sole plate
ALTERNATE-3
2" X LUMBER BACKING MATERIAL (2" X 8", 10" or 12") nailed to the back of the wall plate or sole with 16d@6"o.c. and to wood wall, 8-16d each side raker
SPLICE (where needed)
"V" BRACES
"X" BRACES
8' MAXIMUM BETWEEN RAKER SHORES



Design Load for 1- Pair of Raker Shores w/ Bracing is 5,000 lb (Trough Base is Preferred, since No Digging is Required next to Dangerous Wall. Add 18" sq. Wood Foot under intersection of Raker & Sole if bearing on Soil)

HOW TO CONSTRUCT SPLIT SOLE RAKER SHORES

1. Determine where to erect the Raker Shores and the height of its support points. Determine height of Insertion Point
   a. After initial temporary shoring has been installed as needed, clear the area of debris.
   b. For each Raker clear three feet wide and at least the height of the support point out from the wall.
2. Select angle of Raker, then measure and cut the Wall Plate, Raker, and Bottom Brace to the proper length.
   a. If there is rubble next to wall, Wall plate will not extend to the ground, and Bottom Brace should be attached 6" from bottom of Wall Plate, and slope down to Base
   b. Raker angle should be 60 deg if U-Channel Base is used, but may be 45 or 60 deg if Trough Base is used
   c. If Trough Base is used, both ends of the Raker to be angle-cut with 1½ " return cuts for full contact with the wall plate, top cleat, and Trough Cleat
   d. For U-Channel Base, one end of Raker will be angle cut.
3. In order to pre-fabricate, Cut Raker, Wall Plate and Bottom Brace to proper length, and perform angle cuts on Raker
   a. Layout Wall Plate, Raker and Bottom Brace at selected angle, and toe-nail Raker to Wall Plate
   b. Nail-on Top Cleat, then gusset to one side of this joint
   c. Nail one-Bottom Brace to Wall Plate, 12" from bottom, or in position to clear debris, but only tack-nail it to Raker
   d. Turn shore over and nail-on other gusset plus other Bottom Brace to Wall Plate
   e. Tack-nail Bottom Braces to Raker, so it can be moved into place at the wall.
      - If there is rubble against the wall the Bottom Brace should slope down from the wall to the Raker Base, and intersect as close to the Base as possible

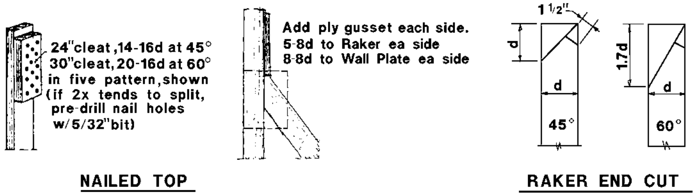
HOW TO CONSTRUCT SPLIT RAKER SHORE (continued)

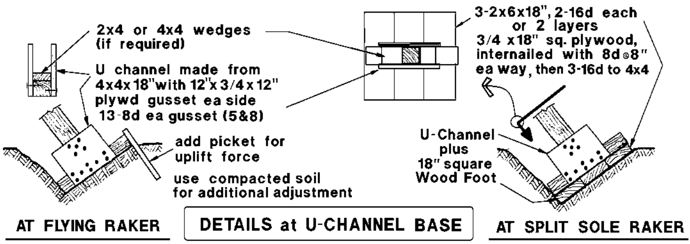
4. Carefully move the partially prefabricated Split Sole Raker Shore in place at the wall and make sure it is plumb.
   a. U-Channel Base requires a shallow hole dug at a 30 to 45 degree angle for the Raker bearing
      - Place the wedges on the top of the 4 x 4 x 18" bottom piece of the U-channel and drive them slightly.

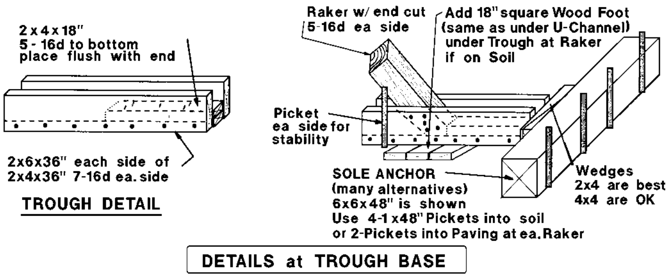
   b. When a Trough Base is used, after securing the Sole Anchor, drive wedges slightly against the Trough.
   c. Full contact must be maintained between the wall plate and the support point of the Raker, and between the base of the wall plate and the wall.
      - If the wall has bulged out, shims may need to be added near bottom of wall plate)
   d. After adjusting the shims/spacers (if any) between the wall plate and the wall being shored to ensure full contact, finish tightening the wedges and/or complete nailing of the Bottom Brace on each side.
5. With Split Sole Raker shore erected, prevent the Raker shore from sliding up the wall. See Solid Sole Raker Shore
6. Place the Mid-Brace, if required by length of Raker, and erect the Horizontal and X-bracing
7. Secure the Sole Anchor when Trough is used, same as for Solid Sole Raker Sole Anchor
8. Add Horizontal Braces and X or V bracing as described under Split Sole Raker

RAKER SHORE CONNECTIONS

SHOR - 15 8 06/08







Preferred Base at Split Sole & Flying Rakers. No need for digging

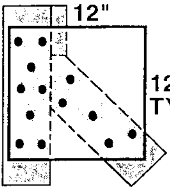
FABRICATION AND ERECTION

- ALL RAKERS SHOULD BE FABRICATED IN AN AREA AWAY FROM A DAMAGED MASONRY WALL, SINCE AFTERSHOCK COULD CAUSE COLLAPSE
- AFTER FABRICATION, THE RAKERS NEED TO BE CARRIED OR WALKED TO THE WALL, AND ADJUSTED FOR TIGHT FIT.

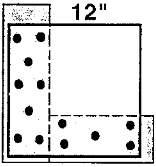
NAIL PATTERNS FOR 3/4"x12"x12" & 3/4"x 6"x12"PLY GUSSET PLATES & TRIANGLES, BRACES & CLEATS
(Use 8d nails on plywood & 16d nails on 2" lumber)

NOTE: OSB MAY BE USED AS PLYWOOD

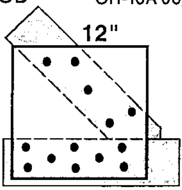
OH-16A 08/06



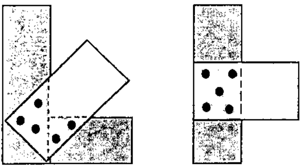
TOP OF RAKER
GUSSET PLATE



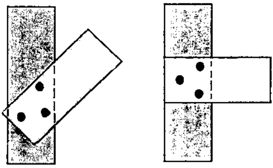
BOTTOM OF RAKER
GUSSET PLATE



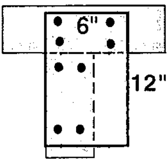
REAR OF RAKER
GUSSET PLATE



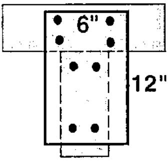
2" X 6" BRACES & CLEATS



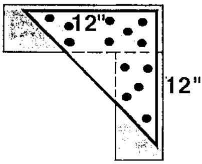
2" X 4" BRACES & CLEATS



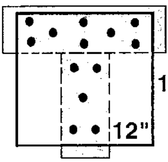
END VERT POST
TOP & BOTTOM
HALF-GUSSET PLATE



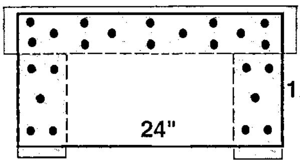
MID VERTICAL POST
TOP & BOTTOM
HALF-GUSSET PLATE



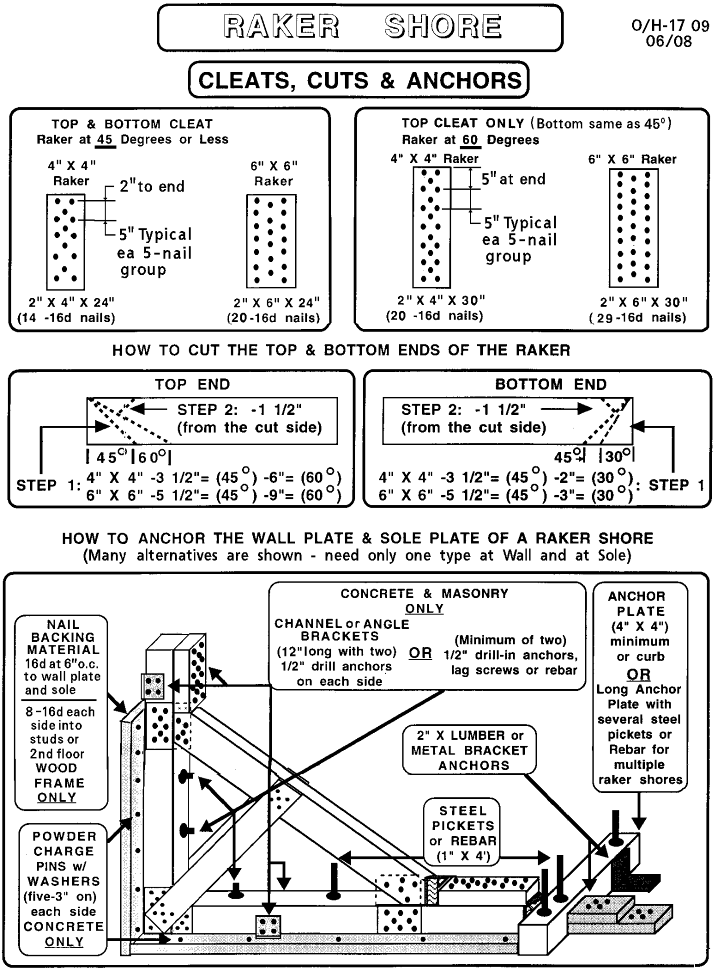
WINDOW/DOOR SHORE
TOP & BOTTOM
TRIANGLE GUSSET PLATE



TOP OF TEE SHORE
GUSSET PLATE



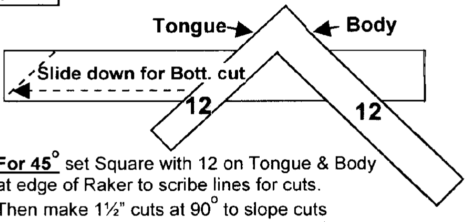
TOP OF DOUBLE TEE SHORE
DOUBLE GUSSET PLATE


RAKER SHORE
O/H-17 09
06/08
CLEATS, CUTS & ANCHORS
TOP & BOTTOM CLEAT
Raker at 45 Degrees or Less
4" X 4" Raker
2" to end
5" Typical ea 5-nail group
6" X 6" Raker
2" X 4" X 24" (14 -16d nails)
2" X 6" X 24" (20-16d nails)
TOP CLEAT ONLY (Bottom same as 45°)
Raker at 60 Degrees
4" X 4" Raker
5" at end
5" Typical ea 5-nail group
6" X 6" Raker
2" X 4" X 30" (20 -16d nails)
2" X 6" X 30" (29-16d nails)
HOW TO CUT THE TOP & BOTTOM ENDS OF THE RAKER
TOP END
STEP 2: -1 1/2" (from the cut side)
45° 60°
STEP 1: 4" X 4" -3 1/2"= (45°) -6"= (60°)
6" X 6" -5 1/2"= (45°) -9"= (60°)
BOTTOM END
STEP 2: -1 1/2" (from the cut side)
45° 30°
4" X 4" -3 1/2"= (45°) -2"= (30°)
6" X 6" -5 1/2"= (45°) -3"= (30°)
: STEP 1
HOW TO ANCHOR THE WALL PLATE & SOLE PLATE OF A RAKER SHORE
(Many alternatives are shown - need only one type at Wall and at Sole)
NAIL BACKING MATERIAL 16d at 6"o.c. to wall plate and sole
8-16d each side into studs or 2nd floor WOOD FRAME ONLY
POWDER CHARGE PINS w/ WASHERS (five-3" on) each side CONCRETE ONLY
CONCRETE & MASONRY ONLY
CHANNEL or ANGLE BRACKETS (12"long with two) 1/2" drill anchors on each side
OR
(Minimum of two) 1/2" drill-in anchors, lag screws or rebar
ANCHOR PLATE (4" X 4") minimum or curb
OR
Long Anchor Plate with several steel pickets or Rebar for multiple raker shores
2" X LUMBER or METAL BRACKET ANCHORS
STEEL PICKETS or REBAR (1" X 4')

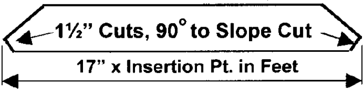
3

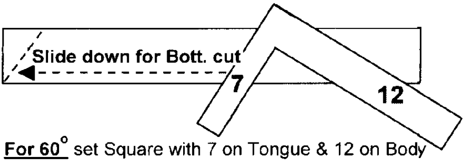
USING STEEL FRAMING SQUARE

Figure:1 TO SCRIBE THE CUT ANGLE ON RAKE



For 45° set Square with 12 on Tongue & Body at edge of Raker to scribe lines for cuts.
Then make 1½" cuts at 90° to slope cuts





For 60° set Square with 7 on Tongue & 12 on Body at edge of Raker to scribe lines for cuts.
Then make 1½" cuts at 90° to slope cuts

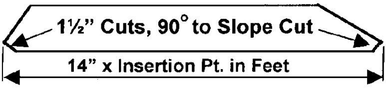
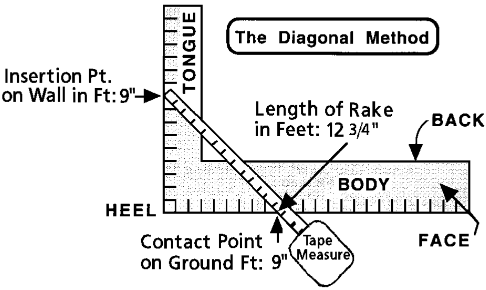
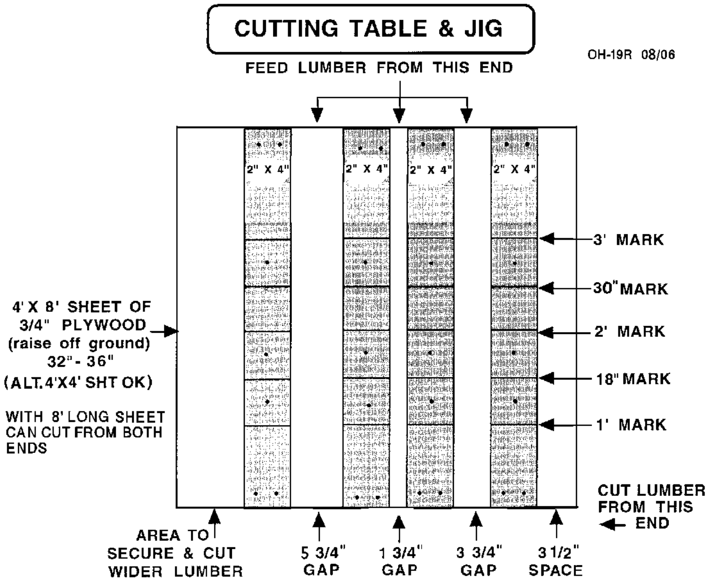
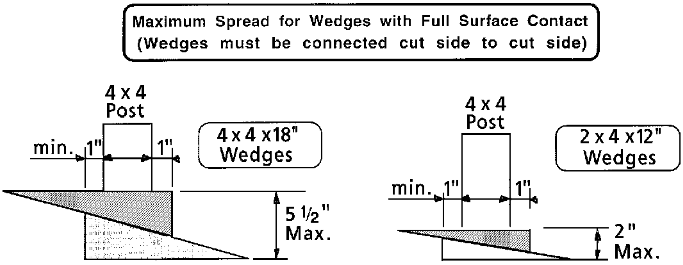


Figure:2 TO FIND APPROX. LENGTH OF RAKE

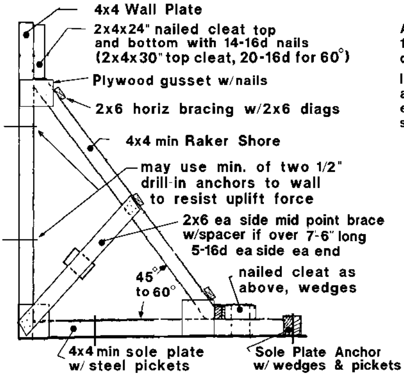



CUTTING TABLE & JIG
OH-19R 08/06
FEED LUMBER FROM THIS END
2" X 4"
2" X 4"
2" X 4"
2" X 4"
3' MARK
30" MARK
2' MARK
18" MARK
1' MARK
4' X 8' SHEET OF 3/4" PLYWOOD (raise off ground) 32" - 36"
(ALT. 4'X4' SHT OK)
WITH 8' LONG SHEET CAN CUT FROM BOTH ENDS
CUT LUMBER FROM THIS END
AREA TO SECURE & CUT WIDER LUMBER
5 3/4" GAP
1 3/4" GAP
3 3/4" GAP
3 1/2" SPACE


Maximum Spread for Wedges with Full Surface Contact
(Wedges must be connected cut side to cut side)
4 x 4 Post
min. 1"
1"
4 x 4 x18" Wedges
5 1/2" Max.
4 x 4 Post
2 x 4 x12" Wedges
min. 1"
1"
2" Max.

MULTIPLE RAKER SYSTEMS

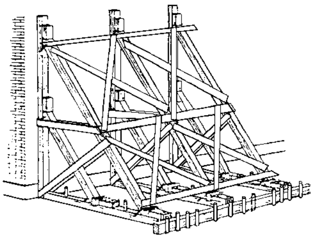
RAKER SHORE SYSTEMS SHOR-14 R 09/06



PREFERRED FULL TRIANGLE RAKER SHORE CONFIGURATION
(SOLID SOLE FULL TRIANGLE RAKER)

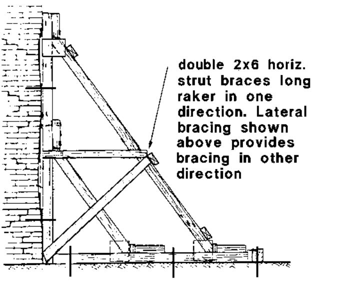
All systems using 4x4 members over 11ft long should be braced in two directions in order to limit L/D to 25±

Its better to have a 2x6 continuous at top, mid, & bottom w/ X-braces every forty ft or so than what is shown here.

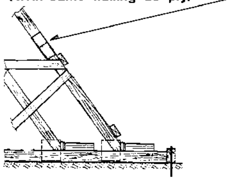


RAKER SHORE FRAMES MUST BE BRACED

Double configurations allow 4x4 members to be used in taller walls by providing bracing to reduce L/D to 35 or so



4x & 6x Rakers may be spliced using 36" long plywood strips x full width of Raker, placed each side. Splice needs to be located near intersection of lateral braces with raker. 8 - 8d in 5 nail pattern to each Raker, each side.
Use 1x material, same size as plywood if ply not available (with same nailing as ply)

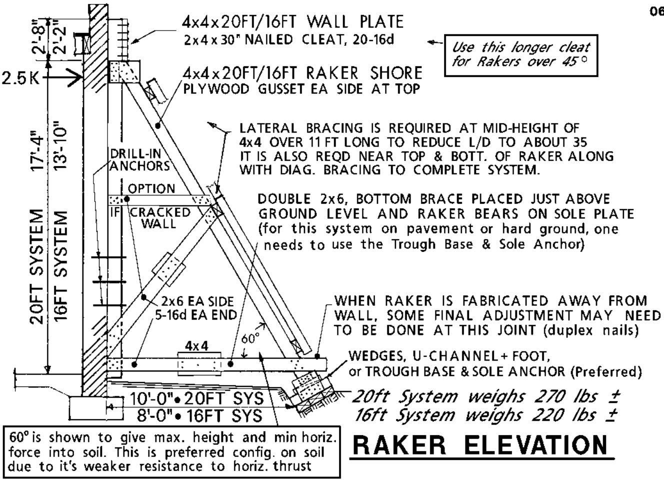


DOUBLE DIAGONAL

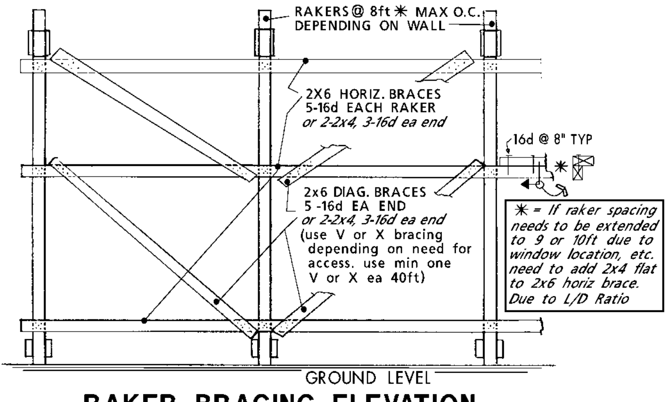
RAKER SHORES – EXAMPLE DESIGNS

FULL HEIGHT RAKER • SPLIT SOLE TYPE **SHOR-17₈**

06/08



RAKER ELEVATION

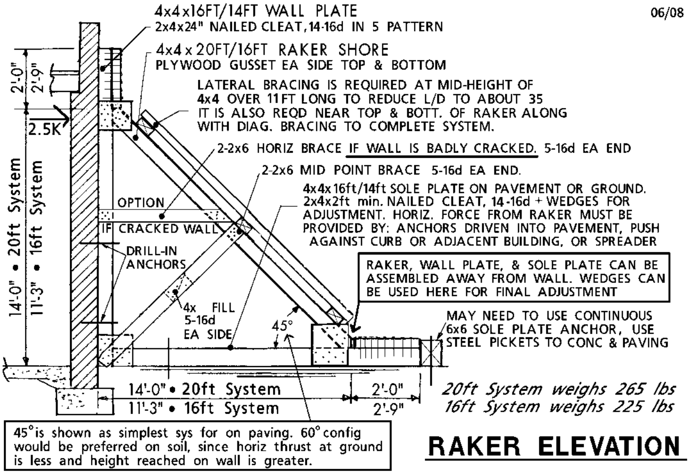


RAKER BRACING ELEVATION

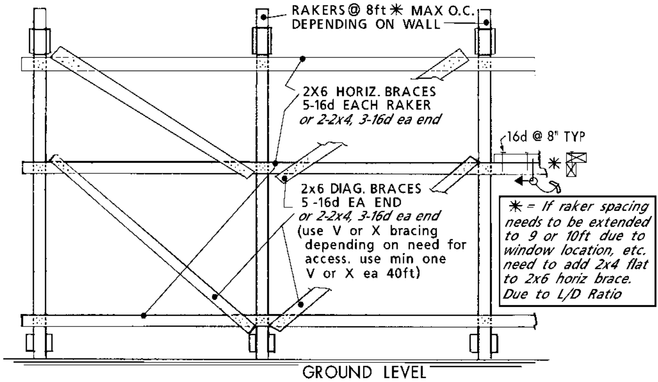
RAKER SHORES – EXAMPLE DESIGNS (continued)

FULL HEIGHT RAKER • SOLID SOLE TYPE SHOR-18 8

06/08



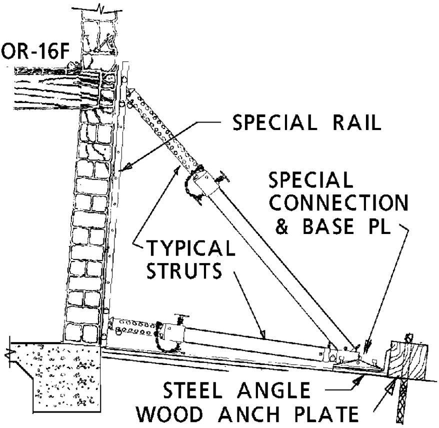
RAKER ELEVATION



RAKER BRACING ELEVATION

RAKER SHORE ALTERNATIVES

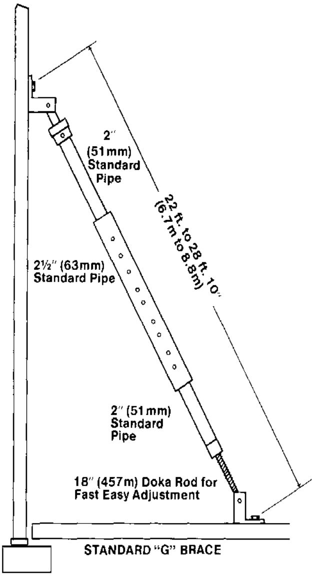
PNEUMATIC STRUTS AS RAKERS



- INDIVDUAL RAKERS CAN BE CONFIGURED FROM TWO STRUTS (UP TO 16FT LONG) + A SPECIAL RAIL WITH CONNECTION HOLES
- MANUFACTURED BASE PLATE CAN BE CONNECTED TO PAVING THRU EXISTING HOLES USING STEEL BARS/DRILL-INS. + STEEL ANGLE CAN BE ADDED UNDER BASE PLATE TO PROVIDE SURFACE TO BEAR ON TYPICAL WOOD SOLE PLATE ANCHOR
- THESE CAN BE MADE INTO SYSTEM USING TWO OR MORE RAKERS, INTERCONNECTED WITH HORIZONTAL + DIAGONAL 2x6 WOOD BRACING CONNECTED TO MANUFACTURED CLIPS (THAT HAVE WOOD NAILERS)
- RAKER RAILS NEED TO BE PINNED TO WALL AS W/TYP RAKERS. THESE CAN PROVIDE A QUICKLY PLACED, INITIAL SYSTEM TO BE FOLLOWED WITH STD. WOOD RAKER SYSTEM
- HAND TIGHTEN ALL PNEUMATIC STRUTS USING AIR HAS CAUSED INJURY

RAKER SHORE ALTERNATIVES

LATERAL WALL BRACING



STANDARD "G" TILT-UP BRACE

Standard "G" Brace is designed for use with large tilt-up panels. Major adjustments within 12 inches (305mm) of the insert are quickly made with sliding "L" pins. Fine adjustments then can be made utilizing the heavy-duty screw rod. Panels up to 30 ft. (9.1m) high are normally braced without knee braces or cross lacing.

Brace Weight: 155 lbs. (70kg)

BIG "G" TILT-UP BRACE

The Big "G" Brace is a Standard "G" Brace with a longer center pipe section. It is intended for use with panels over 30 ft. (9.1m) high. The Big "G" adjusts from 24 ft. to 39 ft. (7.3m to 11.8m). On very tall panels, knee braces and cross lacing can be used to increase brace spacing.

Brace Weight: 214 lbs. (97kg)

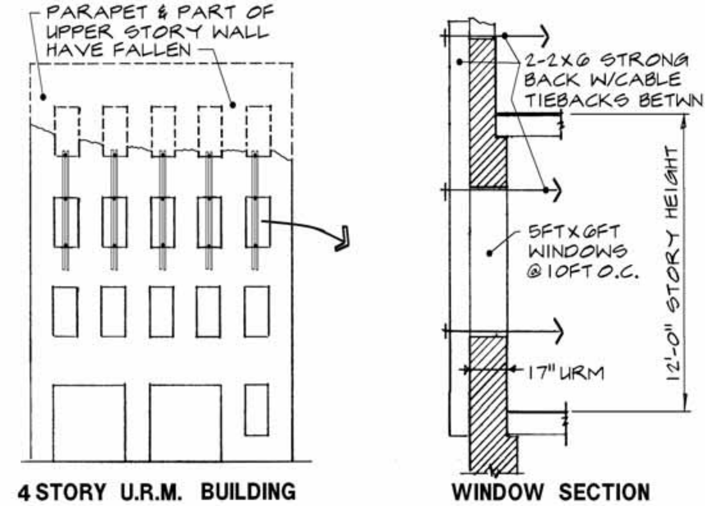
LITTLE "G" TILT-UP BRACE

The Little "G" Brace is a Standard "G" Brace with a shorter top inner pipe section. It is intended for use with panels up to 28 ft. (8.5m) high. The Little "G" adjusts from 14 ft. to 20 ft. (4.2m to 6.1m).

Brace Weight: 122 lbs. (55kg)

STANDARD BRACES • TILT-UP WALL CONSTRUCTION

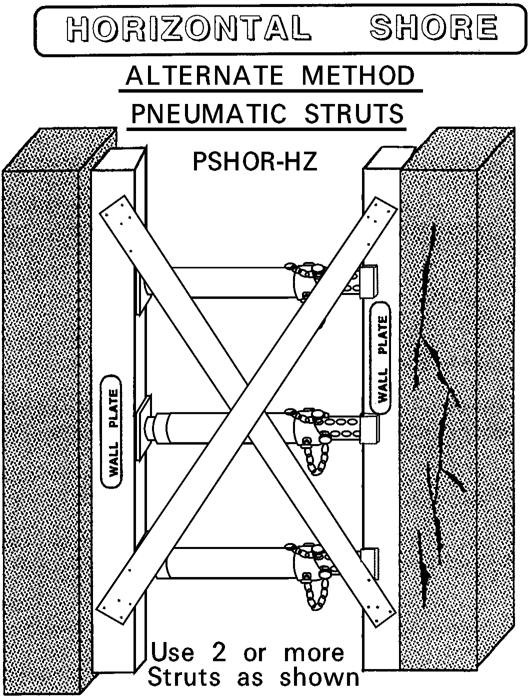
WALL TIE-BACK BRACING



3

- THIS SYSTEM COULD BE USED TO KEEP A HAZARDOUS WALL FROM FALLING ON RESCUE OPERATIONS WHERE THE WALL IS TOO HIGH TO USE RAKER SHORES
- THE STRONG-BACKS COULD BE MADE FROM 4x4, 4x6, OR 2-2x6.
- THE STRONG-BACKS SHOULD EXTEND FROM FLOOR TO FLOOR IN ORDER TO HAVE THE FLOOR PLANES TO PULL AGAINST.
- THE TIE-BACKS COULD BE MADE FROM UTILITY ROPE, CABLE, OR EVEN LONG PIECES OF 2x4 THAT WERE TIED TOGETHER. THEY COULD BE EXTENDED ACROSS THE BUILDING TO THE OPPOSITE WALL OR BE CONNECTED TO FLOOR BEAMS OR COLUMNS.

ALTERNATE SHORING USING STRUTS



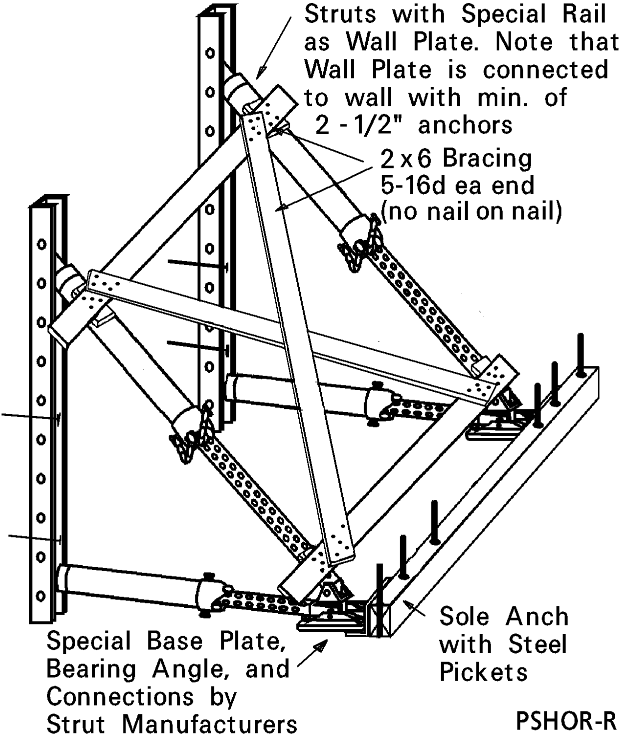
See previous sheet in this Section-
Wood Horizontal Shore for Wall Plates.
and Diagonal Bracing

See Strut Tables, Sect 7, Struct. Spec FOG
for Recommended Strut Loading,
based on Height (Length)

HAND TIGHTEN HORIZONTAL STRUTS
EXCEPT WHEN USED AS TRENCH SHORES

RAKER SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS



PSHOR-RN

See previous pages in this Section for Notes on Wood Raker Systems inc. Wall and Sole Anchors

See Strut Tables, Sect 7, Structures Spec FOG for Recommended Load on Pairs of Braced Rakers, based on Height of Insertion Point

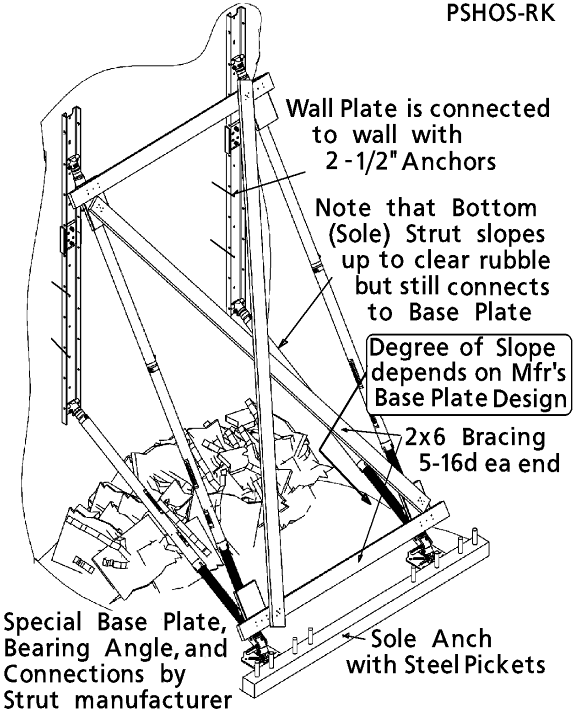
HAND TIGHTEN STRUTS USED AS RAKERS - NO AIR

RAKER SHORE

WITH SLOPED BOTTOM BRACE

ALTERNATE METHOD - PNEUMATIC STRUTS

PSHOS-RK



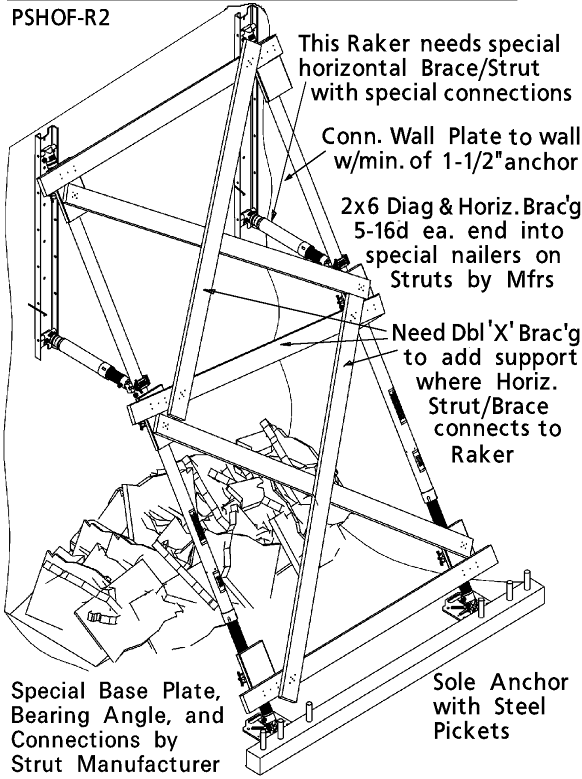
See Strut Tables, Sect 7, Structures Spec FOG for Recommended Load on Pairs of Braced Rakers, based on Height of Insertion Point

Sloped Bottom Strut allows it to clear Rubble but does not reduce capacity of System.

HAND TIGHTEN STRUTS USED AS RAKERS - NO AIR

FLYING RAKER SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS



See previous pages in this Sect. for Notes on Wood Flying Rakers. These Rakers are weaker than Full-Ht Rakers, but may be useful as Initial, Spot Rakers

There are No Recommended Values for Flying Rakers in the Strut Tables, Sect.7, Struct. Spec FOG. Flying Raker strength may be less than for Full Triangle Rakers, depending on the condition of the Wall

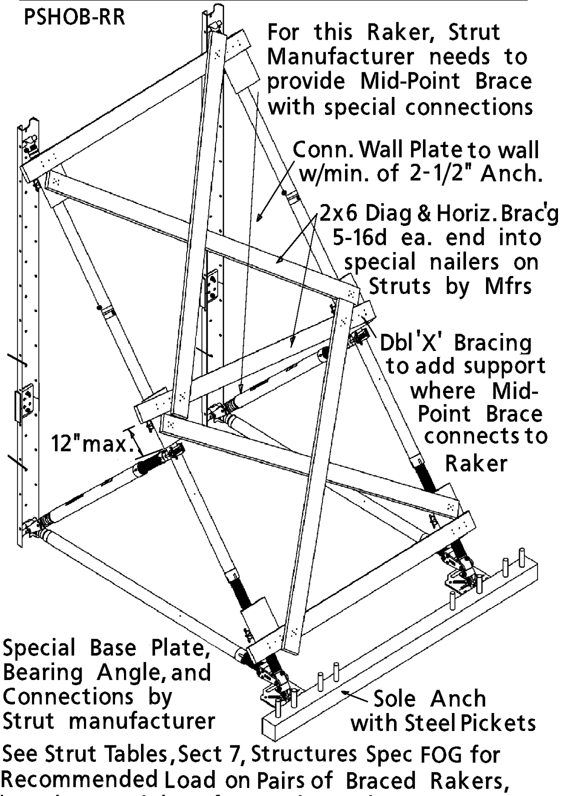
HAND TIGHTEN ALL STRUTS USED AS RAKERS-NO AIR

3

RAKER SHORE

WITH MID - POINT BRACE

ALTERNATE METHOD - PNEUMATIC STRUTS



See Strut Tables, Sect 7, Structures Spec FOG for Recommended Load on Pairs of Braced Rakers, based on Height of Insertion Point

When Insertion Point is greater than 9 feet the Raker with Mid-Point Brace should be significantly stronger than the values shown in these Strut Tables

HAND TIGHTEN STRUTS USED AS RAKERS-NO AIR

INTRODUCTION to SECTION 4

This section contains Frequently Asked Questions and their Answers for FEMA US&R Shoring, a Glossary of Building & Engineering Terms, plus some Engineering Tables.

The FAQ are arranged as follows: Page

The Glossary of Terms is arranged alphabetically, starting on Page 4-15 and ending on page 4-23

The following useful Engineering Tables are shown:

<u>Table:</u> Page

HEADERS

Question H-1 What to do if need 4x6 header and only have 4x4 and 2x4 material?

Ans.H-1a Nail 2x4 to top of 4x4 with 16d@3" o.c. This build-up is about 80% as strong as 4x6

Ans.H-1b Stack 2-4x4 and toenail together. This build-up is slightly stronger than 4x6

Ans.H-1c Place 2-2x6 side-by-side with ½" or ¾" plywood in between. Inter-nail with 16d@8″ o.c.

Question H-2 What to do if need 4x8 header and only have 4x4 and 2x4 material?

Ans.H-2 Stack 2-4x4 and place ½" or ¾" plywood each side. Nail 8d@4" o.c. each side to each 4x4.

Question H-3 How big of a Header is needed?

Ans.H-3a To support a damaged wood structure, use a 4x4 header as minimum and add 1" to depth for each additional foot of span larger than 4 ft. Example use 4x6 for 5 ft span and 4x8 for 8 ft spans. For 6x6 posts you may use a 6x6 header for 5ft o.c.

Ans.H-3b To support a damaged concrete structure, header size depends on the condition of the concrete structure.

- To support a minimally cracked concrete beam or slab, with 4x4 posts spaced at 4 ft o.c., use a 6x6 header with 6x6 post spaced 5ft o.c. Since the concrete structure is stiffer and stronger than most any wood header, the concrete will span between posts so the header functions mostly as an interconnection of the posts and diagonal bracing
- To support badly cracked concrete slabs and beams, the header should be sized by the Structure Specialist (StS)
    - If StS is not available, then use 4x8 header for 4x4x 8ft long posts (8000lb capacity) spaced up to 4 feet. Use 6x12 for 6x6x12ft long posts for spans up to 4ft. For 5ft spans the capacity would be reduced by 10%, and for 6ft spans the capacity would be reduced by 25%

POSTS

Question P-1 If only 2x4, 2x6, 2x8 and 4x4 are available, how to create a 6x6 or 8x8 post?

Ans. P-1a To construct a 6x6 one may use the following:

Build-up 4-2x6 to form a 5½" x 6" net post. Inter-nail with 16d@8"o.c. staggered plus add ½″ carriage bolt 6" from each end and 3ft o.c. As alternate to the bolts add 6"x ¾" x 12" plywood gussets on 6" faces at same spacing

As a less desirable option, add 2x6 to side of 4x4, plus 2x4 +½″ plywood fill to adjacent side. Inter-nail with 16d@8"o.c.

Ans. P-1b To construct an 8x8 one may use the following:

Build-up 5-2x8 and inter-nail with 16d@8" o.c., plus add ½" carriage bolt 6" from each end and 3ft o.c. As alternate to the bolts add 6"x ¾" x 12" plywood gussets on 8″ faces at same spacing

or

Build-up 4-4x4 to from a 7"x7" net post. Place 12" long x ¾" plywood gussets on all 4 sides at top and bottom, plus 3ft max. o.c. Nail each gusset to each 4x4 with 8d in 5-nail pattern

Question P-2 What to do if post spacing is not exactly as shown in FOG?

Ans. P-2 Most types of shores that we build have posts spaced at between 30" and 4ft o.c. and headers should be sized accordingly (as indicated in Ans. H1 through H3). The total capacity of the posts should always be more than the total load. Remember that the capacity of a 4x4x8ft high post is 8000lb and a 6x6x12ft high post is 20,000lb.

- If the post spacing is more than 5ft o.c. the header size should be increased, or the capacity should be decreased. Decrease capacity 10% for a 6" increase in post spacing , and 25% for a 1ft increase in spacing.

LACED POSTS

Question LP-1 What is the correct configuration of the diagonals, and does it really matter?

Ans. LP-1 The following standard has been adopted:

The two sides of the Laced Post should be made the same (for simplicity) and the diagonals should be in a ″K″ configuration. When one looks through the finished Laced Post from the side, the diagonals should form an ″X″

After the end horizontals are placed, the end diagonals should also be configured as a ″K″. When one looks through the Laced Post from the end, the diagonals should form an ″X″

This configuration is the easiest to remember, but any other configuration may be used, as long as one does not have too many diagonals intersecting at same location on a single post.

In previous editions of the USACE StS FOG, it was stated that having the diagonals at one side of the Laced Post configured as a reverse K (and the other 3 as a K) was preferred. However, when this is done, there will be 4 diagonals and 2 horizontal braces intersecting at one location on one 4x4 post. This can cause splitting of the post.

It should be noted that twelve Laced Post Systems, (13ft high) were tested from April 2000 to May 2006 - All failures occurred at more than 3 times the design load. Also significant cupping of wedges was observable when the load reached 2 times the design load, giving ample warning of system failure. Various configurations of diagonals were used.

Question LP-2 If the Maximum Height to Width Ratio of Laced Post is 4 to 1, why can you build a system with 4x4 post at 4ft o.c. up to 17ft high ?

Ans. LP-2 The 4 to 1 max. is based on the out to out dimension, and for posts 4ft o.c., the 4x out to out is 17’-2” **USE 17 feet** (Please note that the maximum height tested is 13 feet)

CRIBBING

Question CB-1 Maximum height to width ratio is specified as 3 to 1 in the Shoring Training (SCT, Mod 2) and 2 to 1 in Lifting and Moving Training (SCT Mod4), which is correct?

Ans.CB-1 Actually, both are correct. For normal shoring where Cribbing is constructed to support a damaged structure the 3 to 1 ratio may be used, assuming that the Crib is being loaded, more or less, uniformly.

- When Cribbing is being used in a "Lift a little and Crib a little" application the 2 to 1 ratio is more appropriate due to the more dynamic nature of the potential loading.

WINDOW SHORES

Question W-1 Why do we need to provide wedges in both Horizontal and Vertical directions for these shores?

Ans.W-1 The need for the wedges in the Vertical direction is easily understood. The wedges that bear on the Sides of the openings at top and bottom are very important is situations where the Openings will tend to Rack or Bulge, such as Earthquakes, and the Window Shore should be strongly ″X″ braced in this case.

NAILS

Question N-1 What embedment is required to develop the full value of a nail?

Ans.N-1 In general, nails should be embedded a little more than one half their length in the piece into which they are anchored. Example: 16d is 3.5" long and required full embedment is 1.94".

Question N-2 What should we do when nailing a 2x to a 2x, since the embedment is only 1.5"?

Ans.N-2 The strength of these nails is 77% since the embedment ratio is 1.5/1.94. Since most 2x to 2x nailing involves lateral bracing connections, this is close enough.

Question N-3 Can we use 16d Cooler Nails (9gax3.25") instead of 16d common? (8ga.x3.5")

Ans.N-3 Yes, since it is very important to minimize the splitting of wood in nailed joints, and 16d vinyl coated nails cause much less splitting and drive easier. These cooler nails may be used in FEMA shoring without significant reduction in strength.

- 8d & 16d cooler nails have been used in Rakers as well as Laced Posts that have been tested during Struct Spec Training. There was no significant difference in test results, from those tests using common nails

NAILS (continued)

Question N-4 What nailing should be used if Doug. Fir or Southern Pine lumber is unavailable?

Ans.N-4 As previously discussed, the nail strength value is approximately based on the density of wood, therefore reduce all nail values for the following:

- For Hem-Fir and Spruce-Pine-Fir reduce strength by 15%
- For Eastern Softwoods, Western Cedar & Western Woods reduce strength by 25%

This means that one should, accordingly, reduce the capacity of shoring, built using these species. However, for Raker Shores, since the strength is effectively based on the Cleat nailing or the Picket/Soil strength, one may add 3-nails to the 17-nail pattern when using species with either 15% or 25% strength reduction species.

Question N-5 What nailing should be used to connect rough cut 2x lumber, that is a full 2" thick?

Ans.N-5 In order to obtain adequate embedment, one should use 20d box nails instead of 16d. The 20 box nail has about 90% the strength of 16d common and same as the 16d cooler.

RAKER SHORES

Question R-1 What is the most appropriate spacing for Raker Shores?

Ans.R-1 The spacing should be based on the height, weight and condition of the wall being supported. Solid Sole and Split Sole Rakers are designed to support a 2500lbs horizontal force. A Structure Specialist should be asked to evaluate the situation, and specify the required spacing. In any case Raker Shores should not be spaced more than 8 feet.

Question R-2 How far should a Raker be spaced from the corner?

Ans. R-2a This depends on the condition of the wall. If the wall corner is badly cracked, it would be appropriate to place the first Raker as near the corner as possible. Also in many cases URM corners may have large diagonal cracks that appear to form a "V" that tends to allow a large wedge of masonry to fall from the corner. In this case one may need to place one or more Rakers in each direction near the corner.

Ans. R-2b When wall corners have little damage, the first Raker may be spaced from 4ft to 8ft from the corner.

Question R-3 What is the best configuration of the Flying (or Friction) Raker?

Ans.R-3 Flying Raker is the weakest type of Raker, but are useful when debris are found at the base of the damaged wall. When the Bottom Brace is configured as a horizontal, there is a tendency to bend the Raker and Kick it Out at the Ground. Therefore, the Bottom Brace should be sloped down to intersect the Raker as near to the top of the U-channel base as possible.

RAKER SHORES (continued)

Question R-4 When should one use a 30 degree Raker?

Ans. R-4 The 30 degree Raker is the most efficient Raker, since the flatter angle allows the horizontal resistance to be 86% of the Raker Force, and the Vertical lift is only 50% of the Raker Force. However, access, and height of insertion point may not allow the 30 degree configuration to be easily constructed.

- Also it takes a longer Raker to reach the same insertion point as for 45 & 60 degree Rakers
- 30 degree Rakers should be used when bracing the One-Sided Trench (if possible)

Question R-5 How should one cut the ends of the Raker when construction a 60 degree Raker when the wall plate has been notched out as per instructions?

ANS. R-5 The 1” notch is no longer recommended for 60 degree Rakers. Use a 30” cleat with 20-16d nails for a 4x4 Raker System

DIAGONAL BRACING

Question DB-1 Under what conditions does one need to use Diagonals in a ″X″ configuration, and when is a single Diagonal acceptable (as in Laced Posts)?

Ans.DB-1 Based on the Maximum Length to Width Ratio of 50 (L/D=50 max.), if a 2x Diagonal Brace is more than 7’-6” long, one must use an ″X″ since it must be assumed that the 2x can only resist a tension force. If the Diagonal is 7’-6” or less in length, the 2x can resist tension or compression, and, therefore a single Diagonal may be used.

- Based on this information, it should be understood that the maximum spacing for Laced Posts is 4 ft for 4x4 & 5 ft for 6x6
  - If the Laced Post is more than 11 feet high, a configuration of three Diagonals per side is required.
  - If the Laced Post is more than 17 feet high, a configuration of four Diagonals per side is required.

Question DB-2 Is it necessary to nail one X-brace to the other at the crossing?

Ans. DB-2 Technically, no nailing is required, but it is a good idea, since it could make the bracing system stiffer by allowing each brace to partly restrain the other in the weak (1 1/2") direction. A minimum of 3 nails should be used

LUMBER GRADE

Question L-1 What adjustments are needed if Douglas Fir or Southern Yellow Pine timber is not available?
(Applies to Vertical and Laced Post shores, Cribbing, Sloped Floor and Raker shores)

Ans. L-1 Lumber strength and nail strength values , in general, are based on the density of the wood species. The following reduction in strength values should be used:

- For Hem-Fir and Spruce-Pine-Fir, reduce strength by 15%
- For Eastern Softwoods, Western Cedar & Western Woods, reduce strength by 25%

This means that the capacity of the shoring should be reduced proportionally or the post spacing should be reduced proportionally
Example: for 15% reduction in post spacing, 4ft would become 3′ - 6". For 25% reduction, 4ft would become 3ft

Question L-2 What is strength reduction if pressure treated lumber is used? (may be called CCA, Wolmanized, NatureWood, Natural Select)

4

Ans. L-2a Most all commercially treated sawn lumber that has been treated with a "Preservative" to reduce its susceptibility to insects and decay, has been embedded with some sort of Copper-based preservative or with Creosote. Chromated Copper Arsenate (CCA) has been the most common for sawn lumber, but due to environmental concerns, other Copper based preservatives are being introduced.

Ans. L-2b No "Significant" reduction in wood strength occurs due to treatment using Copper based compounds. However, most pressure treated sawn lumber will be sold in a "Dry" condition which makes it more susceptible to splitting caused by nailing. Also some treated wood may be split and or warped.
One should use a "Common Sense" approach and avoid badly split or warped wood, especially for critical parts of shoring like Raker Cleats and the Diagonals in Laced Post Systems

MISCELLANEOUS QUESTIONS

Question M-1 Should we shore Steel Bar Joist from the bottom (Bottom Chord), or do we need to place the shoring system up under the top (Top Chord)?

ANS. M-1 One should not place a shoring system directly under the bottom of bar joist or any thin, tall truss (like timber trusses made from 2x). However, there may be cases where you don't have any other reasonable choice. In that case one needs to do the following:

- Check with your Structures Specialist (StS)
- Place shores directly under the intersection of the web members in more than one location for the same group of trusses. That is, spread out the load as much as possible so as not to overload any one of the truss diagonals.
- If some perpendicular to the truss, bracing is present, place the shores as near that location as practical, keeping the other considerations, listed above
- It is best to have a StS give you advice on any particular situation

Question M-2 Should we secure the sole of a sloped floor shore?

ANS. M-2 Absolutely, yes one should secure the sole. Most sloped floors would be somewhat unpredictable, and securing the sole could be very beneficial

Question M-3 Should we place the wedges at the top or at the bottom of a Prefabricated Door or Window Shore, when there is the possibility that the bottom will become submerged?

ANS. M-3 There is no structural problem in placing the wedges at the bottom in this case, but how would one check and re-tighten, if under water. In this (or any) case, there is no problem in having the wedges at the top. In fact in all cases of Prefabricated Window/Door one could have wedges and/or shims at the top and/or bottom, especially if the header is sloped.

PREFERRED SHORE CONSTRUCTION SEQUENCE

Shoring during long-term incidents should be constructed with as much prefabrication as practical, and in a sequence that provided an increasingly safer rescue environment.

However, there will be many incidents that have a relatively short duration, and may only require spot shores and/or 2 and 3 post vertical shores. In these and other cases it also may not be practical to prefabricate the shoring.

The "**Preferred Sequence**" that is suggested here, should be followed, only if it is practical, as in a damaged concrete structure that requires a prolonged shoring operation.

- Vertical Shoring should begin with the installation of spot shores, such as a Tee Shore, Double Tee Shore, Pneumatic Struts or a single post.
  - These may be called **Class 1 Shores** (one dimensional).
  - Class 1 shores are intended to quickly reduce risk, for a short period of time.
  - The Double Tee is actually more like a Class 2 Shore.
- If the Rescue Scenario is prolonged, then one should further reduce risk by installing 2-Post Vertical Shores (or single Sloped Floor Shores)
  - The 2-Post Vertical is just half of a Laced Post, and can be partly prefabricated, and quickly carried into place.
  - These may be **Class 2 Shores** (two dimensional)
  - Vertical Shores with 3 or more posts are difficult to prefabricate and to develop into a full 3-Dimensional Systems. However they may be very useful in providing continuous support under damaged beams or a series of broken wood, floor joist.

PREFERRED SHORE CONSTRUCTION SEQUENCE (continued)

- The next step in the Shoring Sequence would be to convert the 2-Post Shores into Laced Post Shores (or complete the Sloped Floor Shores as Braced Pairs).
  - These are well braced 3-Dimensional Systems, and may be called Class 3 Shores.
  - **Class 3 Shores** are the most stable systems that we can build, and one may make them more stable by anchoring the Sole Plates to the concrete slab.
- Cribbing is a 3-dimensial system, but most cribs rely on, only, friction for lateral bracing.
  - If more positive lateral bracing is desired, cribs may be sheathed with plywood on all 4 sides, or metal clips may be installed at the corners.
  - The base members could also be restrained from sliding on the concrete slab by using anchor bolts or assemblies similar to Rake Sole Anchors.
- Rakers Shores should be installed using a similar progression
  - First one Raker would be built and moved into place.
  - Then another could be paired with the first, with X bracing between them.
  - This could be followed by an entire series of Rakers that extend the full length of the damaged wall.
  - All Rakers should be prefabricated as much as possible.
- A Pneumatic Strut, Raker System or Systems may be used as the initial, temporary Raker System.
  - Preplan to make sure that the temporary Raker System is smaller than the Final Systems, so it may be built over, and removed after the final Raker System is completed.
  - Pneumatic Strut Systems are available that allow a pair of Rakers to be cross braced, also they can have a mid-point brace installed to improve the stability of the system.

GLOSSARY OF TERMS

Arch- A curved structure used as a support over an open space. It produces an outward thrust as well as downward forces at its supported ends.

Axial load- A tension or compression load which passes through the center of a structural member (like a column, beam, truss member, diagonal brace or hanger rod)

Bay- The space between beams/trusses or between rows of columns considered in transverse planes

Beam- A horizontal structural member, subject to compression, tension, and shear, usually found in any one of three different configurations: cantilever, continuous, and simple.

Bearing Wall- An interior or exterior wall that supports a load in addition to its own weight.

Brick Veneer- A single thickness of brick wall facing placed over frame construction or structural masonry.

Buttress- A wall reinforcement or brace built on the outside of a structure, sometimes called a "wall column." When separated from the wall and connected by an arch at the top, it is called a flying buttress.

Cantilever Beam- A beam that has two or more supports but extends beyond one end support and ends in clear space (similar to a diving board).

Cavity Wall- A wall of two parallels wythes (vertical wall of bricks, one masonry unit thick) separated by an air space. Wythes are connected by metal ties.

Chair- A device of bent wire used to hold reinforcing bars in position.

Check- A lengthwise separation of wood fibers, usually extending across the annular rings. Check commonly result from stresses that develop in wood during the seasoning process.

Choker Hitch- A sling where one end passes through the eye of the opposite end (or through the inside of the opposite loop of an endless sling) and is pulled tight around the object that is to be lifted (like a Larks Foot).

Chord- Main members of trusses as distinguished from diagonals.

Collapse

Definition- The failure of any portion of a structure.

Cantilever Collapse- when many sections of floor collapse, and one or more sections extend out from the remainder, like a diving board.

Curtain Fall Wall Collapse- One of the three types of masonry wall collapse, it occurs when an exterior masonry wall drops like a falling curtain cut loose at the top.

Lean-over Collapse- typical wood frame building collapse when the structure starts to Rack (form a parallelogram), and eventually collapses so that the structure is offset by the story height of however many stories collapse .

Lean-to-Floor Collapse- A floor collapse in which one end of the floor remains partially supported by the bearing wall and the other end of the floor collapses on to the floor below.

Ninety Degree Wall Fall Collapse- The wall falls straight out as a single piece at a 90 degree angle, similar to a falling tree.

Pancake Floor Collapse- collapse of one or more floors upon the floors or ground below into a pancake configuration.

Tent Floor Collapse- floor collapse into the shape of a tent.

V-shape Floor Collapse- The collapse of a floor at the interior of a building, so that one end of two adjoining sections of floor are no longer supported (by a beam or wall)

Column- A vertical structural member subject to compressive forces.

Compression- A force which tends to push the mass of a material together.

Concentrated Load- A load applied at one point or within a limited area of a structure.

Concrete –

Definition- A material used in construction that is extremely versatile and relatively noncombustible. Extremely effective in compression, but weak in tension and requires the use of reinforcing steel, either deformed bars *Rebar) or high strength cable.

Post-tension- Tension is applied to the reinforcing steel cable after the concrete is hardened and anchored only at the ends of the structure.

Poured in place- Concrete that is poured into the location where it is going to exist.

Precast- Concrete that is cast, allowed to harden, and then placed.

Pretension- Tension is applied to the reinforcing steel cable in a factory, prior to pouring the concrete. The concrete is then poured and bonds to the reinforcing.

Confined Space- Any space that lacks ventilation; usually the space is larger in area than the point of entry.

Continuous Beam- A beam supported at both ends and at the center.

Cornice- A horizontal projection which crowns or finishes the eaves of a building.

Cribbing- Short pieces of lumber used to support and stabilize an object.

Curtain Wall- An exterior wall supported by the structural frame of the building. Also called an infill wall. Usually has no structural value (but may carry some load after a collapse.

Dead Load- One of the five major loads that must be considered in the design of a building (live, wind, impact, and seismic loads are the others). A Dead Load is a static or fixed load created by the structure itself and all permanent elements within.

Deck- A horizontal surface covering supported by floor or roof beams.

Deflection- The movement of a structural element under a load.

Drywall- A system of interior wall finish using sheets of gypsum board and taped joints.

Efflorescence- Crystals of salt appearing as a white powder on concrete and masonry surfaces, usually indicating the presence of moisture.

Enclosure Wall- An interior wall that separates a vertical opening for a stairway, elevator, duct space, etc. that connects two or more floors.

Expansion Joint- A flexible joint in concrete used to prevent cracking or breaking because of expansion and contraction due to temperature changes.

Exterior Wall- A wall that forms a boundary to a building and is usually exposed to the weather.

Facade- The front or face of a building.

Fascia- A flat vertical board located at the outer face of a cornice.

Fire Cut Beam- A gravity support beam end designed to release itself from the masonry wall during collapse.

Fire Wall- A wall of sufficient durability and stability to withstand the effects of the most severe anticipated fire exposure. Openings in the wall, if allowed, must be protected.

Flashing- Sheet metal used in roof and wall construction to keep water out.

Footing- The part of a building which rests on the bearing soil and is wider than the foundation wall. Also the base for a column.

Furring- Wood strips fastened to a wall, floor, or ceiling for the purpose of attaching covering material.

Girder- A structural element that supports a floor or roof beam.

Gusset Plate- A metal fastener in the form of a flat plate used to connect structural members.

Header Beam- A support used to reinforce an opening in the floor of a wood frame, ordinary, or heavy timber building.

Hollow Wall- A wall of two parallel wythes which are separated by an air space between them, but lack ties to hold the wythes together.

Hydraulic Shoring- Trench shores or jacks with movable parts that are operated by the action of hydraulic fluid.

Impact Load- A sudden load applied to a structure suddenly, such as a shock wave or a vibrating load.

Joist- A piece of lumber used as a floor or roof beam.

Kiln-Dried Lumber- Lumber that is artificially dried in an oven-like structure.

Kip- One thousand pounds.

Knot- A hard, irregular lump formed at the point where a branch grew out of a tree.

Nonbearing Wall- A wall that supports only its own weight.

Open Web Joist- A lightweight steel truss used as a floor or roof beam. It is made from a steel bar, bent at 90 degree angles, and welded between angle irons at the top and bottom bar bends.

Operating Radius- The horizontal distance from the centerline of rotation (the center pin of the cab) to a vertical line through the center of the sieve at the end of the boom.

Parapet Wall- A portion of an exterior, fire, or party wall that extends above the roof line.

Partition- An interior wall, not more than one story in height, that separates two areas in the same building but is not intended to serve as a fire barrier (similar to curtain wall).

Party Wall- A wall that lies on a common lot line for two buildings and is common to both buildings. Most of these walls may be constructed in a wide range of materials or assemblies.

Pier- A supporting section of wall between two openings. Also a short masonry column. Also a deep concrete foundation

Pilaster- A masonry or concrete column bonded to and built as an integral part of the inside of a masonry wall.

Plate- The top or bottom horizontal structural member of a wood frame wall or partition.

Platform Construction- most common method of wood frame residential building construction (older structures may be balloon framed). A building of this construction has one complete level of single or double 2" x flat plates at every floor level

Pneumatic Shoring- Trench shores or jacks with movable parts that are operated by the action of a compressed gas.

Purlin- A horizontal member between trusses which supports the roof. These are usually 4x or 6x members

Rafter- A 2x or 3x member, usually spaced at 16” or 24” that supports a sloped roof.

Restrained beam- A beam who’s ends are so securely welded or bolted so that they cannot rotate.

Ridgepole- (Ridge Beam) A horizontal timber that frames the highest point of a peak roof. Roof rafters fastened to the ridgepole.

Sandwich Wall- A nonbearing wall whose outer faces enclose an insulating core material. (some may be used as bearing walls)

Scab- A short piece of lumber generally cut from 2" x 4" stock, that is nailed to an upright to prevent the shifting of a shore.

Screw Jack- A trench shore or jack with threaded parts. The threading allows the jack to be lengthened or shortened.

Secondary Collapse- A collapse which follows the initial collapse. Can be caused by application of additional loads (rescue equipment, rescuers, etc.), settling of collapsed structures, drying of the soil, aftershocks, etc.

Sheathing- The covering applied to the floor/roof or wall framing of a building to which siding is applied.

Sheeting- Generally speaking, wood planks and wood panels that support trench walls when held in place by shoring.

Shoring- The general term used for lengths of timber, screw jacks, hydraulic and pneumatic jacks and other devices that can be used to hold sheeting against trench walls. Individual supports are called shores, cross-braces, or struts.

Simply Supported Beam- A beam supported at both ends.

Slope of Grain- In lumber, the angle formed between the direction of wood fibers and the long axis of the member; usually expressed as a ratio of rise-to-run, for example, 1:12.

Snatch Block- A wood or steel shell single pulley block that can be opened on one side to accept a rope or cable.

Spalling- The expansion of excess moisture trapped within the cement of the concrete which in results in tensile forces within the concrete, causing it to break apart. Common occurrence when the concrete is exposed to fire.

Spandrel- That part of a wall between the head of a window and the sill of the window above.

Static Load- A load that remains constant.

Stress –

> **Definition-** A force per unit area exerted upon a structural member that strains or deforms its shape.
>
> **Compression-** A stress pressing or squeezing a structure together.
>
> **Shear -** A stress causing a structure to collapse when contacting parts or layers of the structure slide past one another. (Shearwall, Beam Shear, Slab Punching Shear)
>
> **Tension-** Stress placed on a structural member by the pull of forces causing extension.

Stud- Vertical structural uprights (2x4, 2x6 spaced 16" to 24") which make up the walls and partitions in a frame building.

Suspended Ceiling- A ceiling built several inches or feet below the supporting roof or floor beams above, sometimes called a "hanging" or "dropped" ceiling. The concealed space is sometimes called a "cockloft" or "plenum" if it is used for HVAC.

Tensile Strength- The rated strength of a structural element or rope when it is loaded in tension. (Also Breaking Strength)

Torsional Load- A load that creates a twisting stress on a structural member.

Truss- A braced arrangement of steel or wood frame work made with triangular connecting members.

Vertical Collapse Zone- The expected ground area that a falling wall will cover when it collapse.

Wane- An edge or corner defect in lumber characterized by the presence of bark or the lack of wood.

Web- The wide vertical part of a beam between the flanges.

Web member- Secondary members of a truss contained between chords, usually configured diagonally.

Wind load- Horizontal and vertical pressure imposed on a structure by the wind.

Wood frame- Type of construction using small wood, horizontal and vertical members, usually spaced at 16 to 24 inches, that is then covered by some sort of sheathing.

Wythe- A single vertical stack of bricks that are most often found in a multi-brick wall.

INTRO TO USEFUL TABLES – CRANE & RIGGING

Following this page there are tables that provide information that needs to be considered when ordering a Crane, information on the following:

Crane Stability Safety Factors
Wire Rope Slings
Wire Rope Inspection
Terminations
Synthetic Slings
Hoist Rings & Eye Nuts
Wedge Anchors
Concrete Screws
Pneumatic Strut Design Strength Tables
Crane Hand Signals

This Information has been reproduced from various sources, including:

The Crosby Group Inc, P.O. Box 3128 Tulsa, OK
1-800-777-1555
www.thecrosbygroup.com

The very useful Crosby User's Pocket Guide is highly recommended as a reference to be used during all Urban Search & Rescue Activities. It may be obtained directly from The Crosby Group.

WORKING LOAD LIMIT or DESIGN LOAD

Given in terms of Diameter ^{2}

ITEM	Working Load in Tons
Wire Rope (S.F.=5)	D^2 x 9 Tons
Wire Rope Slings	D^2 x 8.5 Tons
Shackles (Alloy)	D^2 x 12.5 Ton
Shackles (carbon)	D^2 x 8.5 Tons
Chain Slings (I. D. as Type A)	D^2 x 24 Tons
Turnbuckles	D^2 x 5 Tons

(Improved Plow, IWRC Wire Rope)

CRANE STABILITY

Percent of Tipping & Safety Factor (for leveled crane)

Crane Type	% of Tipping	S.F.
Locomotive	85%	1.18
Crawlers	75	1.33
Mobile (on O. Riggers)	85	1.18
Mobile (on Tires)	75	1.33
Boom Truck	85	1.18

GENERAL SLING INFORMATION

Center of Gravity

The center of gravity of an object is that point at which the entire weight may be considered as concentrated. In order to make a level lift, the crane hook must be directly above this point. While slight variations are usually permissible, if the crane hook is too far to one side of the center of gravity, dangerous tilting and/or swinging will result and should be corrected at once. For this reason, when the center of gravity is closer to one point of the sling attachment than to the other, the slings must be of unequal length. The sling stresses and sling angle will also be unequal.

Working Load Limit or Design Load

The working load limit, or design load is the useful working capacity of a sling. This varies, depending upon the type of hitch. The working load limit table indicates, by illustration the applications for which the various loads apply, when the slings are new. All ratings are in tons or 2,000 pounds.

Safety Factor

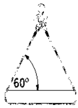
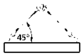
In general, a safety factor of approximately five is maintained throughout these tables. However, certain sling fittings, such as hooks, which will straighten without breaking, or links, which will deform beyond usefulness before breaking, cannot be assigned a definite numerical safety factor. In such cases, suitable safe loads are listed, based upon wide experience and sound engineering practice.

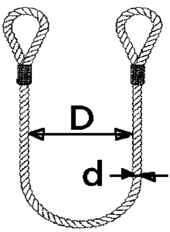
Sling Care

Proper care and usage are essential for maximum service and safety. Wire rope slings should be protected from sharp bends and cutting edges by means of corner saddles, burlap padding, or wood blocking. Heavy or continuous over-loading should be avoided as well as sudden jerks, which can build up a momentary over-load sufficient to break the sling. Wire rope slings should be stored where they are protected from moisture, and properly coiled when not in use.

WIRE ROPE SLINGS CAPACITIES – FLEMISH EYE

Allowable Loads in Lbs (S.F. = 5) – 6 x 19 Improved Plow

Rope Dia. Inch						
1/4	1120	800	2200	1940	1500	1120
5/16	1740	1280	3400	3000	2400	1740
3/8	2400	1840	4800	4200	3400	2400
7/16	3400	2400	6800	5800	4800	3400
1/2	4400	3200	8800	7600	6200	4400
9/16	5600	4000	11200	9600	7900	5600
5/8	6800	5000	13600	11800	9600	6800
3/4	9800	7200	19600	16900	13800	9800
7/8	13200	9600	26400	22800	18600	13200
1	17000	12600	34000	30000	24000	17000
1 1/8	20000	15800	40000	34600	28300	20000
1/1/4	26000	19400	52000	45000	36700	26000
1 3/8	30000	24000	60000	52000	42400	30000



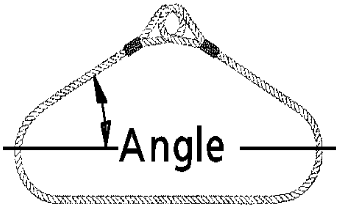
A Basket Hitch has Twice the Capacity of a Single Leg only If the D/d Ratio is 25/1 and the Legs are Vertical

In order for ANY of the above Sling Capacities to be correct the Size of any SHACKLE used Must be One Size GREATER or LARGER

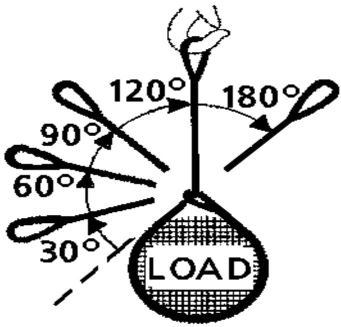
SPECIAL SLING CAPACITY INFORMATION

Wire Rope, Chain & Synthetic Basket Slings

Sling Angle	Capacity as Percent of Single Vertical Hitch
90	200%
60	170%
45	141%
30	100%

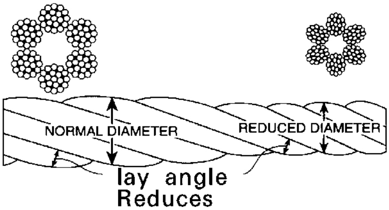


Choker Hitches – Reduction Due to Angle

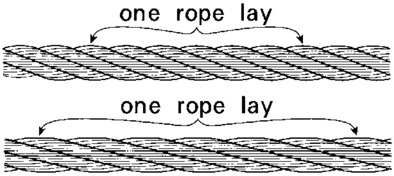


CHOKE ANGLE	CAPACITY
120° - 180°	75% of Vertical
90° - 109°	65% of Vertical
80° - 89°	55% of Vertical
30° - 59°	40% of Vertical

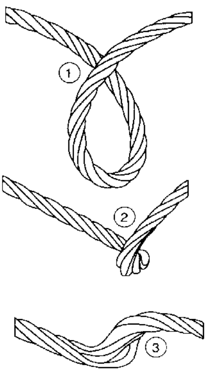
Wire Rope • Discard Conditions

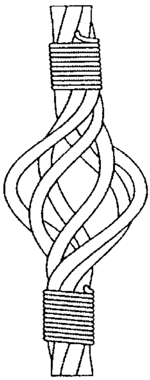


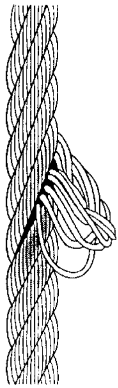
Core Failure



Rope Stretch



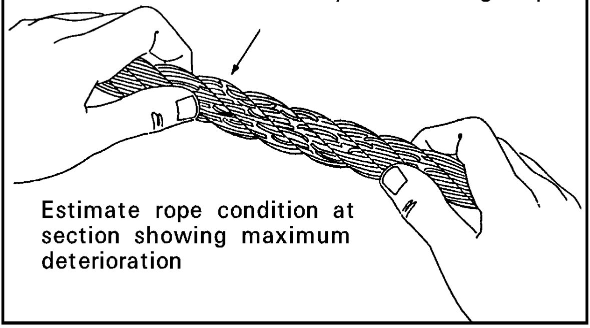




Kinks **Bird Cage** **Core Protrude**

Wire Rope Inspection & Replacement

Replace rope if there are:
6 broken wires in one lay
3 broken wires in one strand in one lay
3 broken wires in one lay in Standing Ropes



Estimate rope condition at section showing maximum deterioration

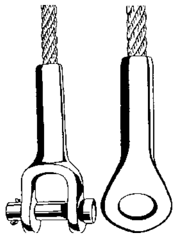
Replace if:
1. See criteria above
2. One or more broken wires at a fitting
3. If any wire breaks in the valley between strands.
4. If any wire in a strand is worn by 1/3 it's diameter
5. Reduction in rope diameter should not exceed:
   3/64" for 3/4" rope   1/16" for 7/8 to 1-1/4" ropes
   3/32" for larger ropes
6. Normal stretch for newer ropes can be expected to be 6" in 100' for 6 strand rope and 9" for 8 strand.
7. Corroded, kinked, cut, crushed, heat burnt, or bulging wires indicate improper handling - Discard Conditions

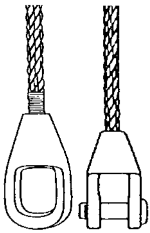
Note that broken wires should not be cut due to sharp edges. Bend wire back and forth until it breaks off inside the rope and is tucked away

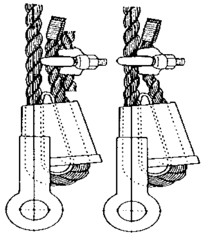
Keep ropes well lubricated inside and out to prevent deterioration. Document any broken wires

WIRE ROPE SOCKET TERMINATIONS

- Swaged & Spelter Sockets are used on standing ropes and permanent ropes like pendants
- Wedge Sockets are used to attach Crane Whip Line to the Headache Ball, etc.
  Do not attach dead end to live with wire rope clip







O.K. NO

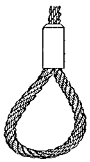
Swaged Socket (100%)

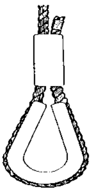
Spelter Socket (100%)

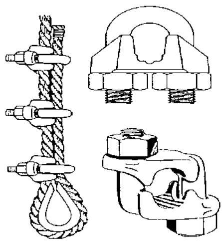
Wedge Socket (75 to 90%)

WIRE ROPE LOOP TERMINATIONS

- Without thimble, eye efficiency may be reduced as much as 10%
- Wire Rope Clips must be properly installed







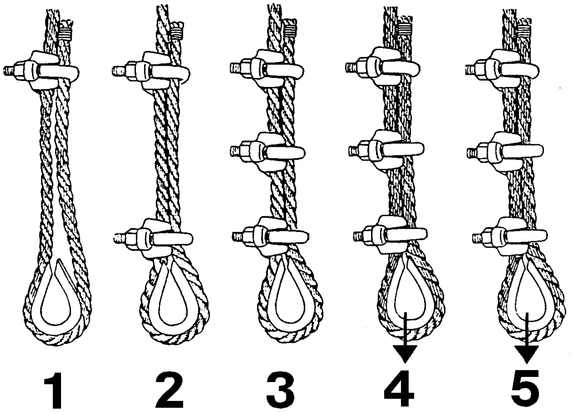
Flemish Eye Eye (95-100%)

Fold Back Eye (Don't use for lifting)

Wire Rope Clips U bolt & Fist Grip (80%)

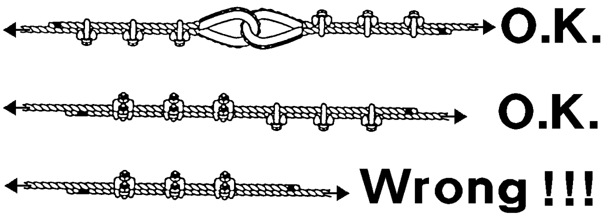
WIRE ROPE CLIP INSTALLATION

1. Turnback, place 1st clip & torque/tighten
2. Place 2nd clip only snug, no torque
3. Place other clips at equal spacing
4. Apply some tension and torque/tighten
5. Recheck torque after initial operations



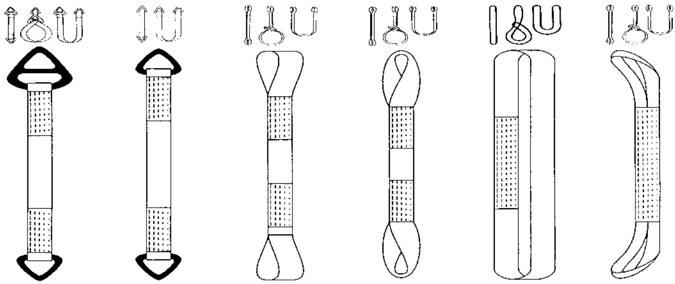
WIRE ROPE CLIP SPLICES

1. Use two loop ends with thimble eye
2. Overlap rope, use twice number clips reqd for 1 loop
3. Clips must be properly installed



SYNTHETIC SLING INFORMATION

- Must include manufacturer's sewn on Tag
  - Gives Fiber Type & Safe Working Load
- Provided with seamless protective cover
- Use corner protection
- Need careful Inspection
- Slings stretch as much as 10%, Polyethylene 1%

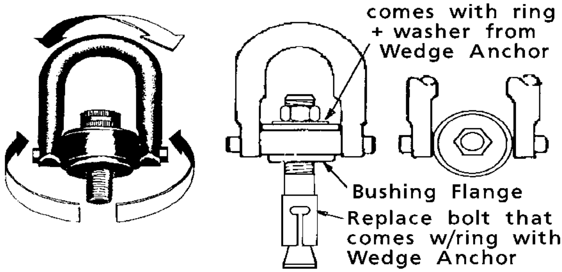


Triangle Choker | Double Triangle | Dbl Eye | Rev Eye | Endless Loop | Return Eye

ENDLESS ROUND SLING CAPACITY

Safe Working Load, in pounds

COLOR	Wt #/ft	Vertical	Choker	Basket
Purple	0.2	2,650 lb	2,120	5,300
Black	0.25	4,000	3,200	8,000
Green	0.3	5,300	4,240	10,600
Yellow	0.4	8,400	6,720	16,800
Tan	0.55	10,600	8,500	21,200
Red	0.6	13,200	10,560	26,400
White	0.9	16,800	13,400	33,600
Blue	1.0	21,200	17,000	42,400
Grey	2.15	31,000	24,800	62,000



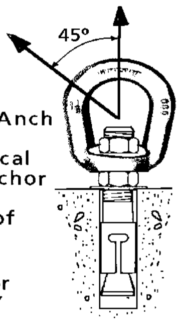
Allowable Tension & Shear Loads

Expansion Bolt Dia.	Working Load of Ring (lbs)	Working Load of Anchor (lbs)	Required Torque (ft-lbs)
3/8	1000	1200	25
1/2	2500	2000	50
5/8	4000	2700	100
3/4	5000	3700	225

CAST STEEL HOIST RINGS

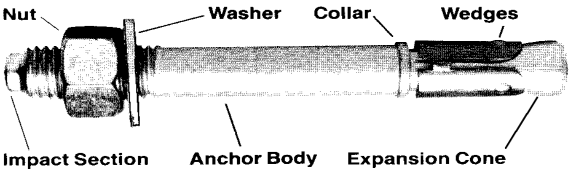
EYE NUTS

Forged, Quenched & Tempered



- Place over installed Wedge Anch
- Safe Working Load for Vertical Tension Load is Same as Anchor
- Working load at 45° is 25% of Vertical Tension Load
- Recommended for Vertical or nearly vertical loading ONLY

WEDGE ANCHORS



Kwik-bolt, Wedge-all or Trubolt

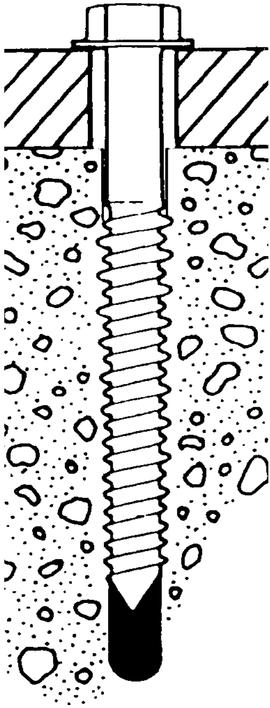
Allowable Tensile Loads (lbs)

Diameter	Embedment	Required Torque (ft-lb)	f'_c = 2000 psi	f'_c = 3000 psi
3/8″	1 5/8″	20	530	605
	2 1/2″	use 25	1130	1210
	4 1/4″	25	1200	1230
1/2″	2 1/4″	40	870	970
	3 1/2″	use 50	1750	2000
	6″	65	1970	2170
5/8″	2 3/4″	85	1430	1690
	4″	use 100	2170	2670
	7″	110	3000	3270
3/4″	3 1/4″	150	1850	2180
	4 3/4″	use 225	2750	3630
	8″	235	3750	4630
1″	4 1/2″	250	2930	3650
	6″	use 350	4000	5310
	9″	450	6070	7070

Allowable Shear Loads (lbs)

Diameter	Embedment	f'_c = 2000 psi	f'_c = 3000 psi
3/8″	1 5/8″	930	970
	≥ 2 1/2″ *	1100	1100
1/2″	2 1/4″	1810	1840
	≥ 3 1/2″ *	1840	1840
5/8″	2 3/4″	2880	2880
	≥ 4″ * *	3140	3140
3/4″	3 1/4″	3880	3880
	≥ 4 3/4″ * *	4220	4220
1″	4 1/2″	6620	7120
	≥ 6″	8620	8620

CONCRETE SCREW INFORMATION



INFO on 1/4″ SCREWS
(by Hilti or ITW Buildex)

- Use to connect devices
(WBMS & Smartlevel)
- HammerDrill hole, 5/32″ bit
- Drive with Driver Drill & ¼″ Hex Socket
- Use 1/4″ x 1 ¼ ″ screw with 1″ min embed
- Design Load/Allowable Load = 175 lb Ten. & 350 lb Shear

INFO on 3/8″ SCREWS
(by Simpson StrongTie)

- As alternative to wedge anch for lifting concrete
- Drill 5″ min hole w/ 3/8″ bit
- Drive w/Socket or Impact Wrench & 9/16″ Socket
- Use 3/8″ x 6″ TITAN Screw with 4 ½″ min. embed.
- Design Load/Allowable Load = 2000 lb Tension & Shear
- Use with Swivel Hoist Ring or Steel Tee
(WT 3x7.5 x 0' - 4″)

AIRSHORE RESCUE TOOL (A.R.T.)

- Adjustable aluminum, pneumatic struts. **DO NOT USE AIR TO EXTEND STRUTS FOR US&R**
- See **Section 2 & 3** for other recommendations.
- **Struts are available in various ranges of length (** F strut = 7 to 11 ft, E strut = 4 to 7ft, long) see Manufacturers Data for available lengths.
- Use adjustable collar and double pin system to transfer load from inner to outer tube.
- Listed loads are for use of 3 ½″ O.D. struts with **SWIVEL ENDS and WITH or WITHOUT ONE 6ft, or 4ft EXTENSION placed on large (3 ½″) end.**
- Adequacy of supporting material under strut, and need for header and sole should be verified by a competent Professional Engineer.

RECOMMENDED DESIGN STRENGTH AIRSHORE STRUTS USED IN US&R

Length Feet	Recommended Load lbs (kg)	Comment
16 ft	3500lbs (1600 kg)	Use strut plus extension
15	4500 (2000)	or single adjustable strut
14	5500 (2500)	″
13	6500 (3000)	″
12	7500 (3400)	″
11	10,000 (4500)	″
10	12,000 (5400)	Do not use extensions
9	14,000 (6400)	″
8	15,000 (6800)	″
7	18,000 (8200)	″
6 ft & less	20,000 (9100 kg)	Max. Recommended Load for Airshore Strut

AIRSHORE RAKER SHORE SYSTEM

- System is made from 2 rakers spaced 8ft max. apart with X bracing. See **Section 3**
- **Use adjustable struts With or Without one 4ft or 6ft extension per strut, placed on large end**
- Raker Systems should be configured with the angle between the Raker and the Ground being between 40 and 60 degrees
- Add 12″ long, 4″ high, ½″ thick angles to Base Plates to provide a vertical bearing surface.
- Rakers should be attached to the wall surface and restrained at the ground as in timber rakers.
- The Safe Working Strength for a pair of Airshore Rakers used in US&R should be determined by a US&R Structure Specialist from the following chart:
  (Safe Horizontal load at Point of Insertion)

RECOMMENDED DESIGN STRENGTH
AIRSHORE RAKER SYSTEM at 45degrees

Raker Length	Height to Point of Insertion	Horizontal Load on 2 Rakers w/ X-bracing
16 ft	11.0 ft	5000 lbs (2300 kg)
15 ft	10.5 ft	6400 lbs (2900 kg)
14 ft	10.0 ft	7800 lbs (3500 kg)
13 ft	9.0 ft	9200 lbs (4200 kg)
12 ft	8.5 ft	10,600lbs (4800 kg)

AIRSHORE RAKER SYSTEM at 60degrees

16 ft	13.8 ft	3500 lbs (1600 kg)
15 ft	13.0 ft	4500 lbs (2000 kg)
14 ft	12.0 ft	5500 lbs (2500 kg)
13 ft	11.3 ft	6500 lbs (3000kg)
12 ft	10.4 ft	7500 lbs (3400 kg)
11 ft	9.5 ft	10,000 lbs (4500 kg)

PARATECH LONG SHORE STRUTS (GOLD ANODIZED COLOR)

- Adjustable aluminum, pneumatic struts. Use Acme Nut to transfer load from inner to outer tube.
- See **Section 2 & 3** for other recommendations.
- Struts are available in three ranges of length. (10ft to 16ft, 8 ft to 12ft and 6 ft to 10ft long)
- Listed loads are for use of 3 ½" O.D. struts with **SWIVEL ENDS and WITH or WITHOUT ONE 6ft, 4ft or 2ft EXTENSION.**
- Listed loads are **NOT** for **Paratech 3" O.D. LOCK STRUT & ACME THREAD, RESCUE STRUT**. See 2nd page following for Paratech Rescue Struts.
- Adequacy of supporting material under strut, and need for header and sole should be verified by a competent Professional Engineer.

RECOMMENDED DESIGN STRENGTH PARATECH LONG SHORE STRUTS USED IN US&R

Length Feet	Recommended Load lbs (kg)	Comment
16 ft	3500lbs (1600)	Use strut plus extension
15	4500 (2000)	or single adjustable strut
14	5500 (2500)	"
13	6500 (3000)	"
12	7500 (3400)	"
11	10,000 (4500)	"
10	12,000 (5400)	Do not use extensions
9	16,000 (7200)	"
8	20,000 (9100)	"
7 & 6 ft	22,000 (10,000)	"

PARATECH LONG STRUT RAKER SHORE SYSTEM

- System is made from 2 rakers spaced 8ft max. apart with X bracing. See **Section 3.**
- **Use 6 to 10 ft or 8 to 12 ft struts With or Without one 2ft, 4ft, or 6ft extension per strut.**
- Raker Systems should be configured with the angle between the Raker and the Ground being between 40 and 60 degrees.
- Add 12″ long, 4″ high, ½″ thick angles to Base Plates to provide a vertical bearing surface.
- Rakers should be attached to the wall surface and restrained at the ground as in timber systems.
- The Safe Working Strength for a pair of Paratech Rakers used in US&R should be determined by a US&R Structure Specialist from the following chart:
  (Safe Horizontal load at Point of Insertion)

RECOMMENDED DESIGN STRENGTH
PARATECH RAKER SYSTEM at 45degrees

Raker Length	Height to Point of Insertion	Horizontal Load on 2 Rakers w/ X-bracing
16 ft	11.0 ft	5000 lbs (2300 kg)
15 ft	10.5 ft	6400 lbs (2900 kg)
14 ft	10.0 ft	7800 lbs (3500 kg)
13 ft	9.0 ft	9200 lbs (4200 kg)
12 ft	8.5 ft	10,600lbs (4800 kg)

PARATECH RAKER SYSTEM at 60degrees

16 ft	13.8 ft	3500 lbs (1600 kg)
15 ft	13.0 ft	4500 lbs (2000 kg)
14 ft	12.0 ft	5500 lbs (2500 kg)
13 ft	11.3 ft	6500 lbs (3000 kg)
12 ft	10.4 ft	7500 lbs (3400 kg)
11 ft	9.5 ft	10,000 lbs (4500 kg)

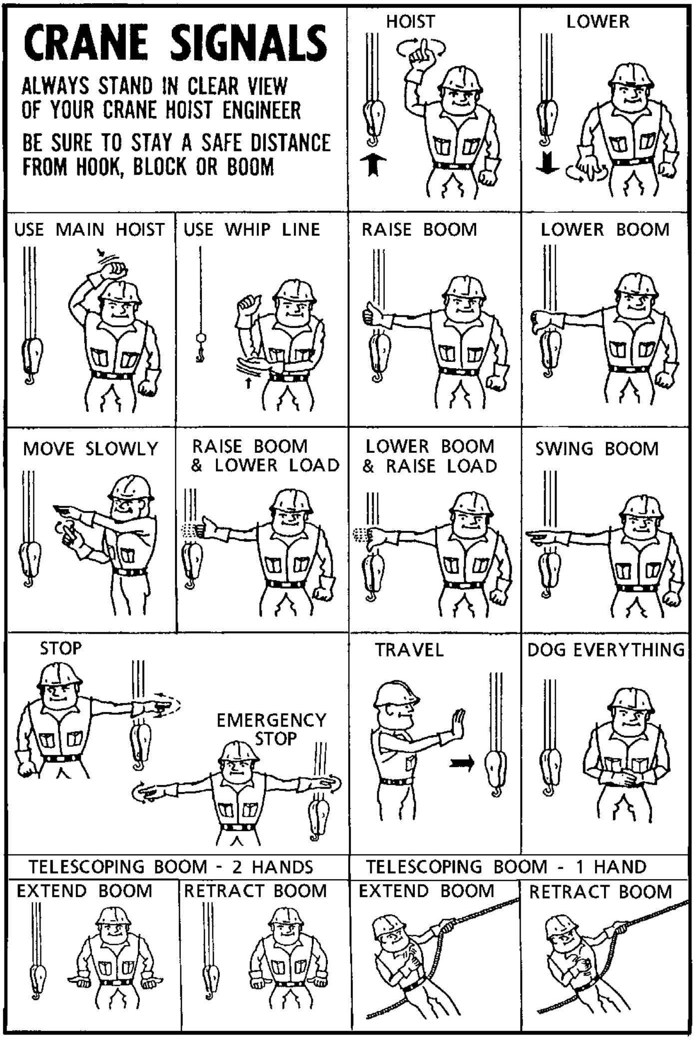
PARATECH RESCUE STRUTS
(DARK GREY ANODIZED COLOR)

- Adjustable aluminum, pneumatic struts. Use Acme Nut to transfer load from inner to outer tube.
- See **Section 2 & 3** for other recommendations
- Struts are available in 1.5 to 2ft, 2ft to 3ft, 3ft to 5ft, & 5ft to 7.2ft ranges of length. (12″, 24″ & 36″ extensions are also available)
- Listed loads are based on **3 ″ O.D.** struts, tested with swivel ends, with and without one extension.
- **See Pg 4-40 for Paratech 3 ½″ O.D. Long Shore (Gold Color) Struts**
- Adequacy of supporting material under strut, and need for header and sole should be verified by a competent Professional Engineer.
- **The following Load Table is based on tests performed by PARATECH and reviewed by Wiss, Janney, Elstner, Assoc., Engineers**

4

PARATECH RESCUE STRUTS LOAD TABLE
Based on compression tests using swivel bases

Length Feet	Average Failure Strut Force (Ultimate strength)	Design Strength based on the following Safety Factors	
		3 to 1	4 to 1
2 ft	87,000 lbs	29,000 lbs	21,750 lbs
4 ft	71,750 lbs	23,920 lbs	17,940 lbs
6 ft	56,500 lbs	18,830 lbs	14,125 lbs
8 ft	48,100 lbs	16,030 lbs	12,025 lbs


CRANE SIGNALS
ALWAYS STAND IN CLEAR VIEW
OF YOUR CRANE HOIST ENGINEER
BE SURE TO STAY A SAFE DISTANCE
FROM HOOK, BLOCK OR BOOM
HOIST
LOWER
USE MAIN HOIST
USE WHIP LINE
RAISE BOOM
LOWER BOOM
MOVE SLOWLY
RAISE BOOM & LOWER LOAD
LOWER BOOM & RAISE LOAD
SWING BOOM
STOP
EMERGENCY STOP
TRAVEL
DOG EVERYTHING
TELESCOPING BOOM - 2 HANDS
EXTEND BOOM
RETRACT BOOM
TELESCOPING BOOM - 1 HAND
EXTEND BOOM
RETRACT BOOM