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

Urban Search & Rescue Structures Specialist

FIELD OPERATIONS GUIDE

5th Edition
October 2006

US&R STRUCTURES SPECIALIST FIELD OPERATIONS GUIDE (FOG)

FOREWORD

This Field Operations Guide (FOG) 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, especially Structures Specialists (StS), during response operations. It condenses information provided during training, and was designed to be expanded to incorporate new information.

In this FOG, Sections 1 through 4 are identical to the same sections of the smaller US&R Shoring Operations Guide (SOG). That SOG is intended for use of Rescue Specialists in constructing shoring and other Rescue Operations. In addition to the first 4 Sections, this FOG contains Equipment Operation Procedures, Operational Check Lists, Engineering Data, Tables and Forms that make it a more useful Reference for the StS.

Users are encouraged to suggest changes that can be incorporated into future editions of this FOG. 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 FOG. Each Section has an Outline that gives the order in which subjects are presented

US&R STRUCTURES SPECIALIST
FIELD OPERATIONS GUIDE (FOG)

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).
- When nailing 2x lumber with 16d nails one must avoid splitting in order to maintain joint integrety.

For more Definitions, see Sect. 4, Glossary, of this document

INTRODUCTION to SECTION 1

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

Hazard I.D. and Failure Modes by Building Type
- US&R Field Communication Procedures
- On-Site Emergency Signaling Procedures
- US&R Building Marking System
- FEMA US&R Shoring Symbols
- Design Loads for US&R - Building Materials & Rescuers

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:

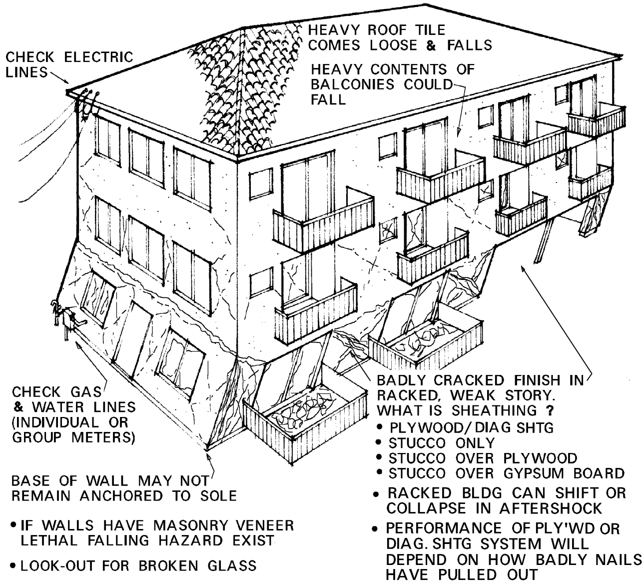
Building Types are:

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.

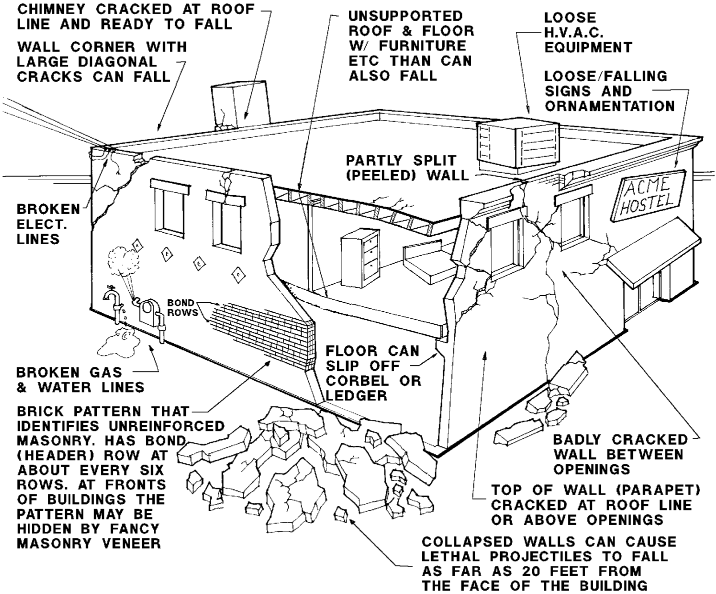
HAZARD REDUCTION

- 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.

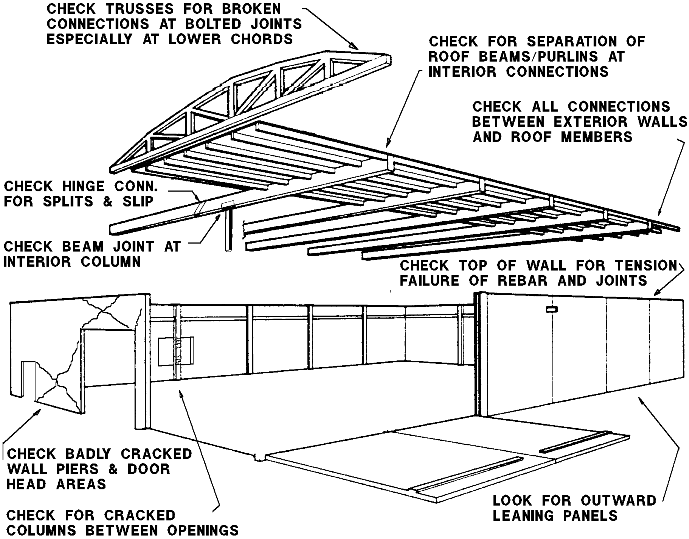
HAZARD REDUCTION

- 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.

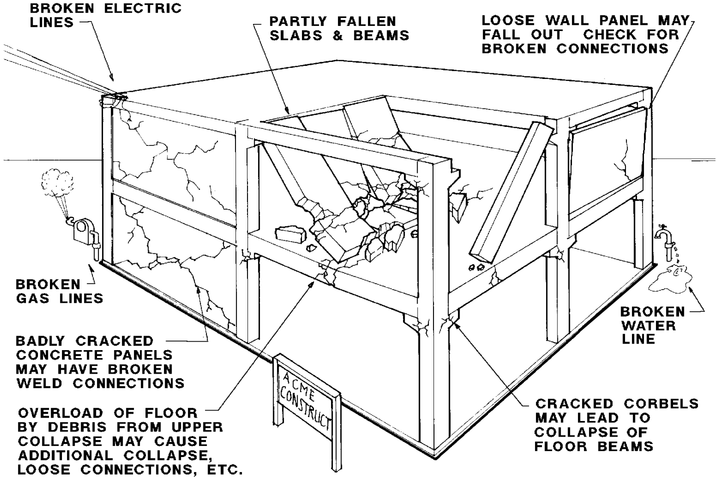
HAZARD REDUCTION

- 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.

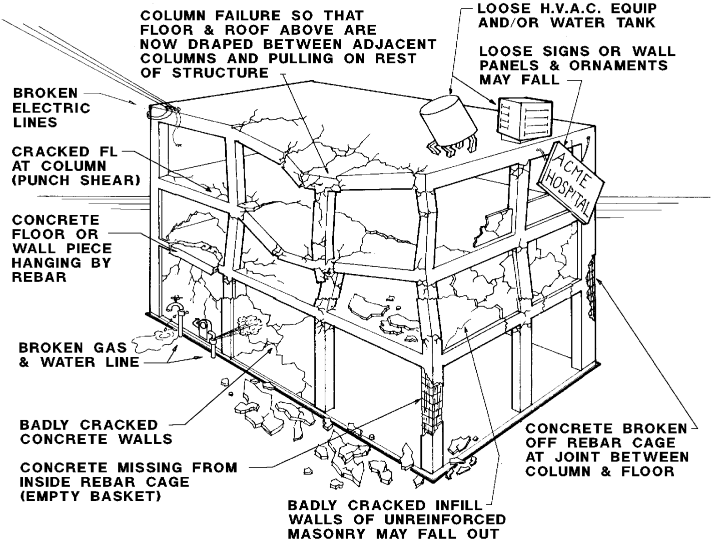
HAZARD REDUCTION

- 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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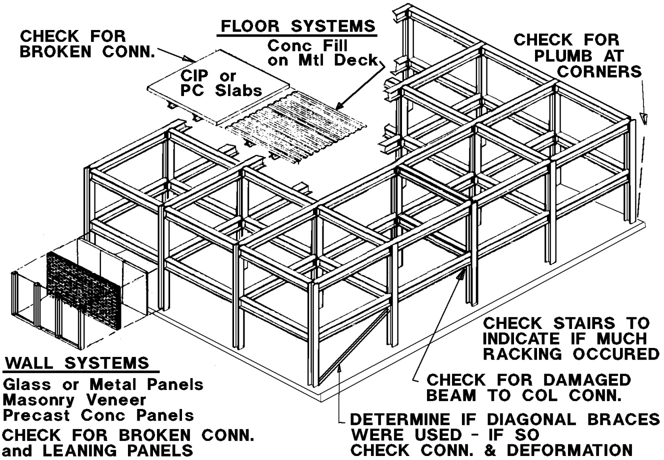
HEAVY STEEL FRAME BUILDING - HAZARDS



SINCE MOST MEMBERS AND CONNECTIONS ARE HIDDEN, BEST INDICATION OF FAILURE IS EXCESS MOVEMENT CAUSING DAMAGE TO NON-STRUCTURAL ELEMENTS AND OUT OF PLUMB CONDIDTIONS

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.

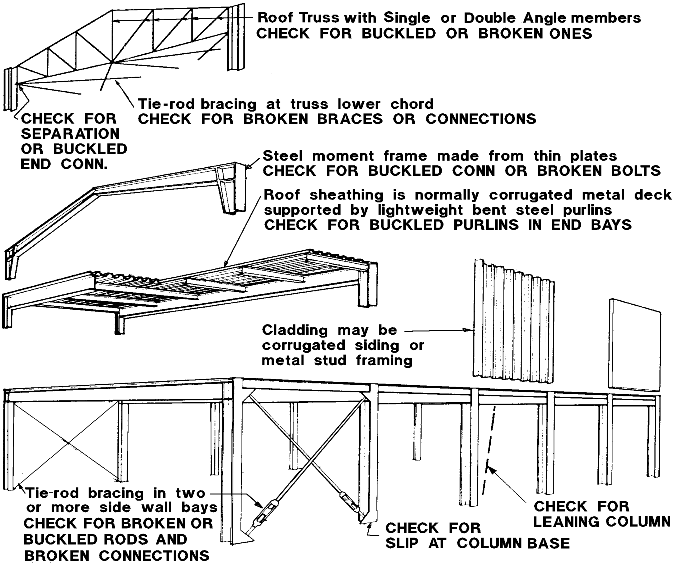
HAZARD REDUCTION

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

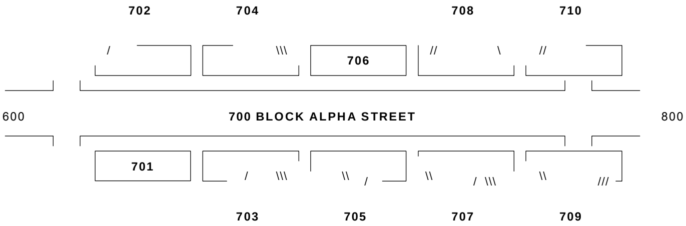
Markings should be placed on normal address side of the structure.

BUILDING MARKING SYS (continued)

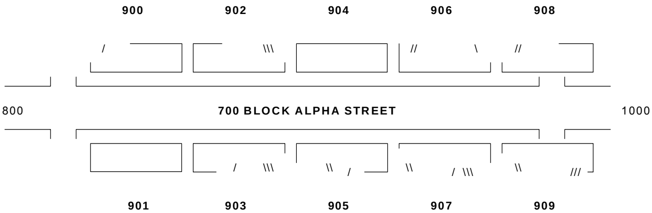
STRUCTURE IDENTIFICATION MARKING

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

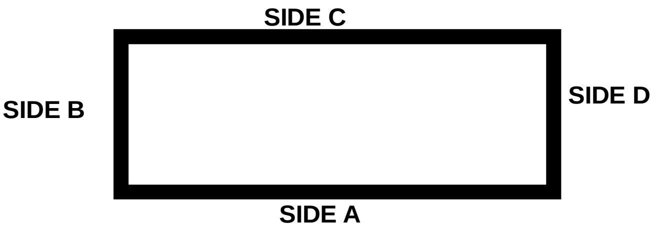


CASE 2 – IF NO NUMBERS ARE KNOWN, FILL IN USE SMALL NUMBERS

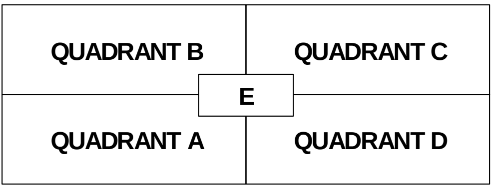
BUILDING MARKING SYS (continued)

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.).



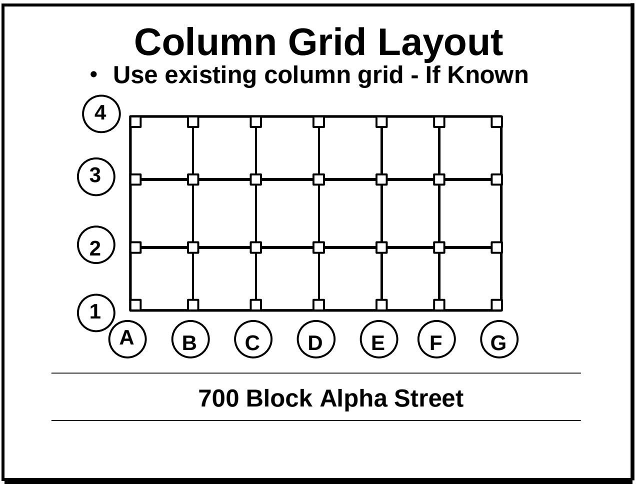
700 BLOCK ALPHA STREET

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. Aerosol cans of spray paint (International Orange color only) will be used for this marking system.

- It is important that an effort is made to mark all normal entry points to a building under evaluation to ensure that Task Force personnel approaching the building can identify that it has been evaluated and discern its condition.

- Specific markings will be clearly 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.

- Normally the square box marking would be made immediately adjacent to the entry point identified as safe. An arrow will be placed next to the box indicating the direction of the safe entrance if the Structure and Hazards Evaluation marking must be made somewhat remote from the safe entrance.

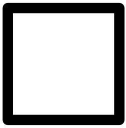
- All Task Force personnel must be aware of the possibility of, and look for other Structure and Hazards Evaluation markings made on the interior of the building.

- As each subsequent assessment is performed throughout the course of the mission, a new TIME, DATE, and SPECIALIST ID entry will be made (with carpenter's chalk) below the previous entry, or a completely new marking box made if the original information is now incorrect.

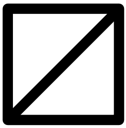
BUILDING MARKING SYS (continued)

STRUCTURE/HAZARDS EVALUATION MARKING

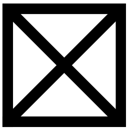
The depiction of the various markings is as follows:



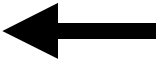
Structure is accessible and safe for search and rescue operations. Damage is minor with little danger of further collapse.



Structure is significantly damaged. Some areas are relatively safe, but other areas may need shoring, bracing, or removal of falling and collapse hazards. The structure may be completely pancaked.



Structure is not safe for search and rescue operations and may be subject to sudden additional collapse. Remote search operations may proceed at significant risk. If rescue operations are undertaken, safe haven areas and rapid evacuation routes should be created.



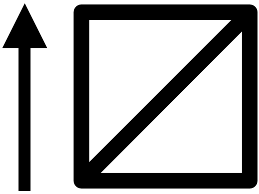
Arrow located next to a marking box indicates the direction to the safe entrance to the structure, should the marking box need to be made remote from the indicated entrance.

HM

Indicates that a Hazardous Material (HazMat) 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 upper right-hand side. This info is made with carpenter's chalk or lumber crayon. An optional method is to apply duct tape on the exterior of the structure and write the info with a grease pencil or black marker.



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

The example indicates that a safe point of entry exists above the marking (possibly a window, upper floor, etc.). The single slash means the structure may require some shoring and bracing. The assessment was made on July 15, 1991, at 1:10 PM. There is an apparent 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. (In this case the original mark should be crossed out)

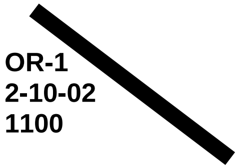
- As each subsequent assessment is performed throughout the course of the mission:
  - A new TIME, DATE, and TF ID entry will be made below the previous entry; and/or,
  - A completely new marking box made if the original information is now incorrect.

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

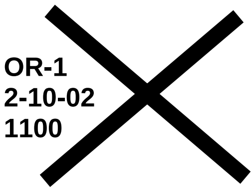
BUILDING MARKING SYS (continued)

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 color spray paint or Crayon **(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)

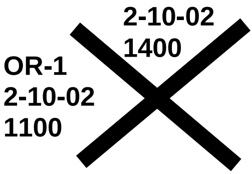


Note: OR-1 is used instead of OR-TF1 to save time. Also 1100 is used to abbreviate 1100hrs

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

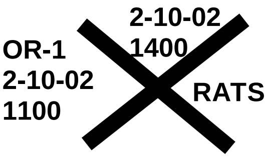
Distinct markings will be made inside the remaining quadrants of the X to clearly denote the search status and findings at the time of this assessment. The marks will be made with carpenter chalk or lumber crayon. The following illustrations define the Search Assessment marks:

SEARCH ASSESSMENT MARKING (continued)

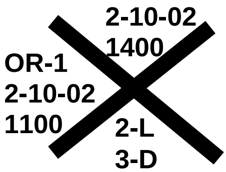


AFTER EXITING & DRAWING the 2nd SLASH, add the following INFO:

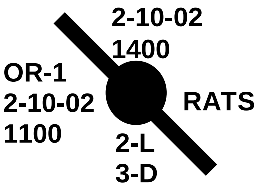
TOP QUADRANT - Time and date that the Search Team personnel left the structure.



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)

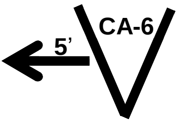
In most cases, extemporaneous information will not be conveyed using the marking system. This type of communication will usually take place as a result of face-to-face meetings between Search, Rescue, and other components of the Task Force.

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). Remember that K9 are adversely effected by paint vapors within an enclosed space.

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 diseased victim, mark the total number under the "V". Use both live and diseased victim marking symbols when a combination of live and diseased 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).

FEMA US&R SHORING SYMBOLS

These symbols were developed by the FEMA US&R Technical Working Group, and should be used to map locations of US&R Shoring

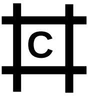
- Tee Shore — **T**

- Double T Shore — **DT**

- Vertical Shore (V-3 = 3 posts, V-2 = 2 posts) — **V-3**

- Laced Post Shore

- Cribbing



- Raker Shore
  - Place vertical side of triangle against wall
  - Each triangle represents one Raker
  - Rakers should be installed groups of two or larger

DESIGN DEAD LOADS for BUILDING MATERIALS

Normal Reinforced Concrete = 150 pcf

Heavily Reinf. Conc Beams & Cols = 160 to 180 pcf

Struct. Steel = 490 pcf = 3.4 lbs psi per foot of length

Aluminum = 165 pcf = 1.15 lbs psi per foot of length

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)

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)

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

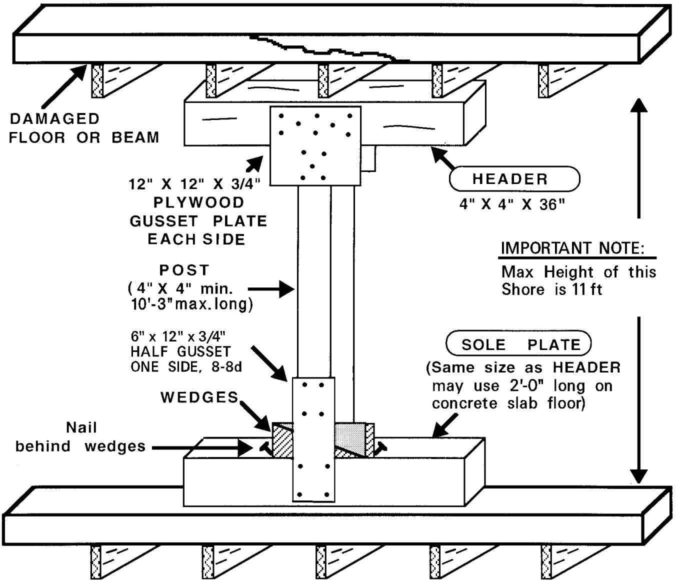
OH-T
08\06

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

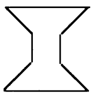
Temporary shore <u>ONLY</u> until a complete shoring system can be erected



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

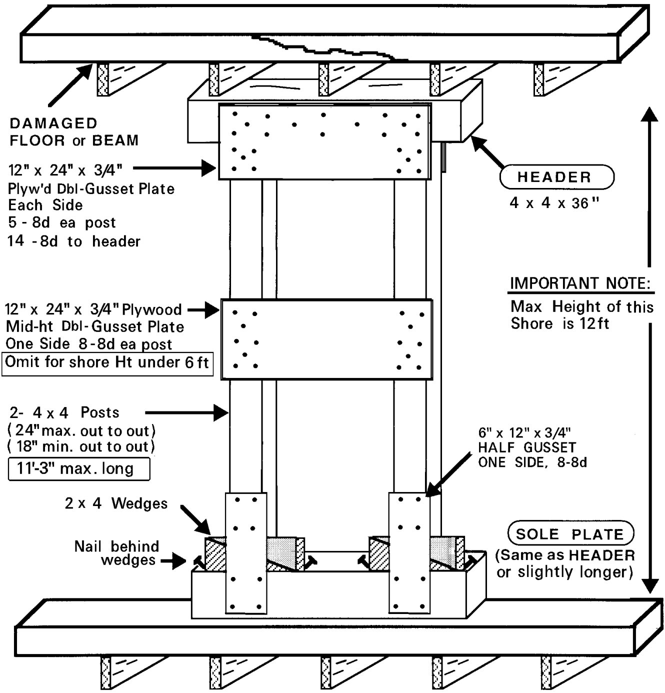
9. Anchor the shore to floor above and sole to floor below, if practical.

DBL "T" SHORE

O/H-Dbl T
08/06

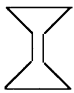
CLASS 2 SHORE

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.)
16,000 lb for 8 ft
10,000 lb for 10 ft
7,000 lb for 12 ft

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).

4. Prefabricate header to posts by 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.

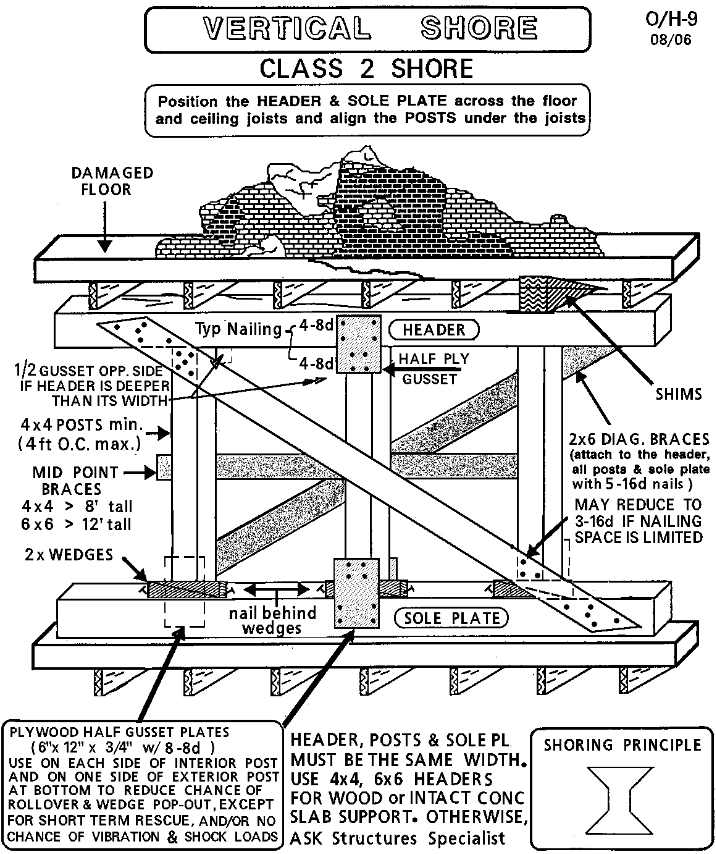
   a. If one post has been configured on slope for access, straighten it and complete nailing on Gussets

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

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

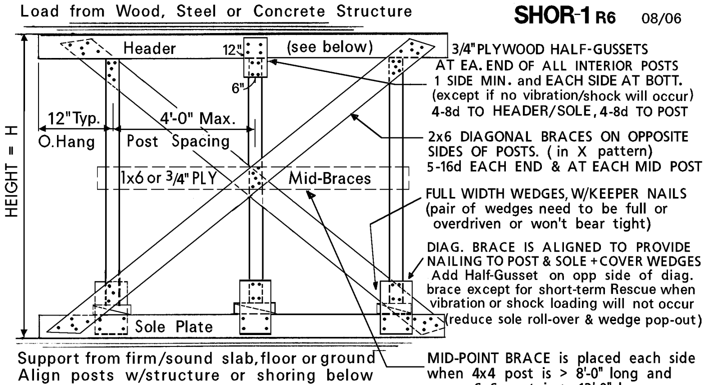
9. Install bottom half-gussets and nail 4-8d to ea. post & sole.

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


VERTICAL SHORE
O/H-9
08/06
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
1/2 GUSSET OPP. SIDE IF HEADER IS DEEPER THAN ITS WIDTH
SHIMS
4x4 POSTS min. (4ft O.C. max.)
2x6 DIAG. BRACES (attach to the header, all posts & sole plate with 5-16d nails)
MID POINT BRACES
4x4 > 8' tall
6x6 > 12' tall
MAY REDUCE TO 3-16d IF NAILING SPACE IS LIMITED
2x 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)

SHOR-1 R6 08/06



4x4 POST SYSTEM - USE 4X4 SOLE PLATE

HEIGHT = H	DESIGN LOAD, EA. POST
8'-0"	8,000 LB ✱
10'-0"	5,000 LB
12'-0"	3,500 LB

HEADER SIZE

Use 4x4 min. if place posts directly under floor beams or when supporting intact/rigid concrete slab or beam.
See Structure Specialist for other conditions

6x6 POST SYSTEM - USE 6x6 SOLE PLATE

HEIGHT = H	DESIGN LOAD, EA. POST
12'-0"	20,000 LB ✱
14'-0"	14,500 LB
16'-0"	12,000 LB
18'-0"	9,000 LB
20'-0"	7,500 LB

HEADER SIZE

Use 6x6 min. if place posts directly under floor beams or when supporting intact/rigid concrete slab or beam.
See Structure Specialist for other conditions

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. 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 braces, 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.

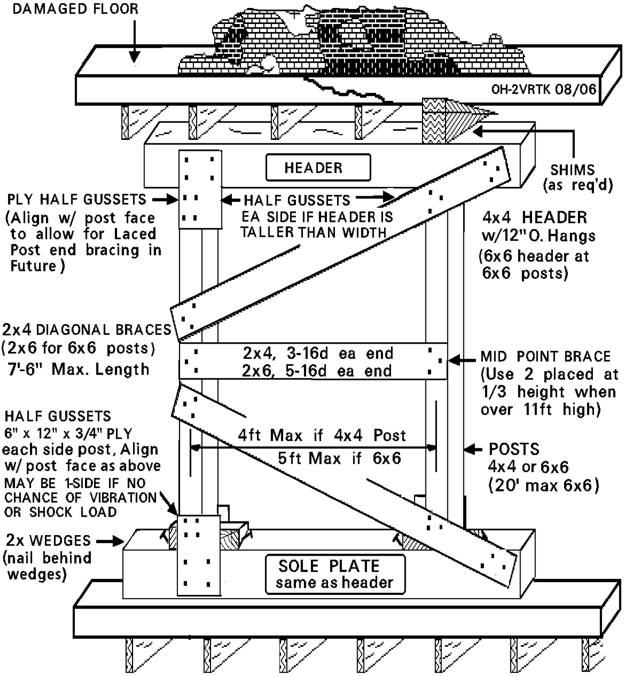
9. Attach half-gussets to at least one side of the sole plate and posts and nail in place. Half-gussets should be placed both sides to confine the wedges in all cases where any type of vibration or shock loading might occur.

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.

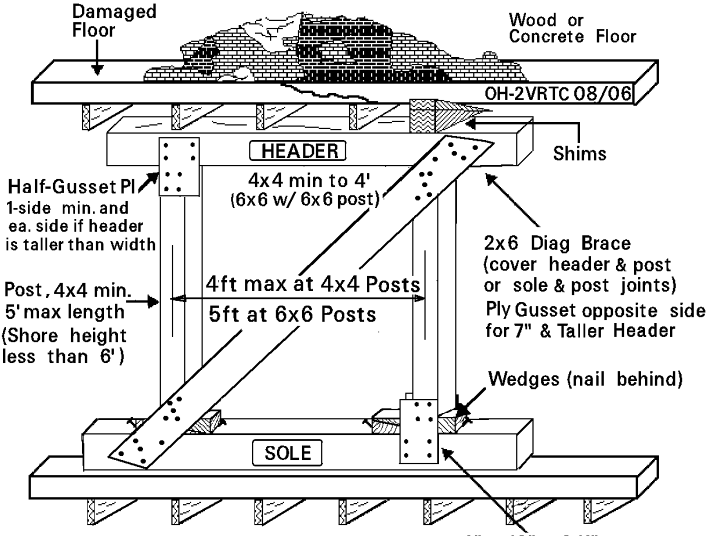
8. Anchor the shore to floor above and sole to floor below, if practical.

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.

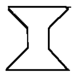


6" x 12" x 3/4" Ply Half-Gussets Ea. Side

DESIGN LOAD 4x4
16,000 lb

DESIGN LOAD 6x6
40,000 lb

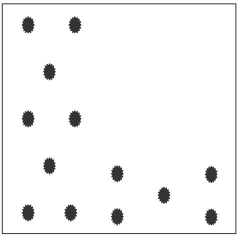
SHORING PRINCIPLE



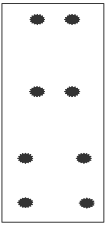
Header may need to be larger to support badly cracked conc. (see Structures Spec)

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

Standard Gusset Plates



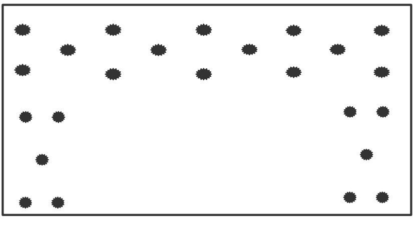
All 8d Nails

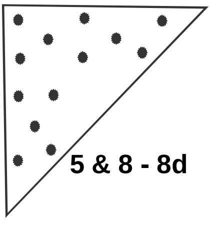


Full Gusset
12"x 12"x ¾" Ply
(Rakers & T- Shore)
"5 and 8 in Full Gusset Plate"

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

Special Gusset Plates





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

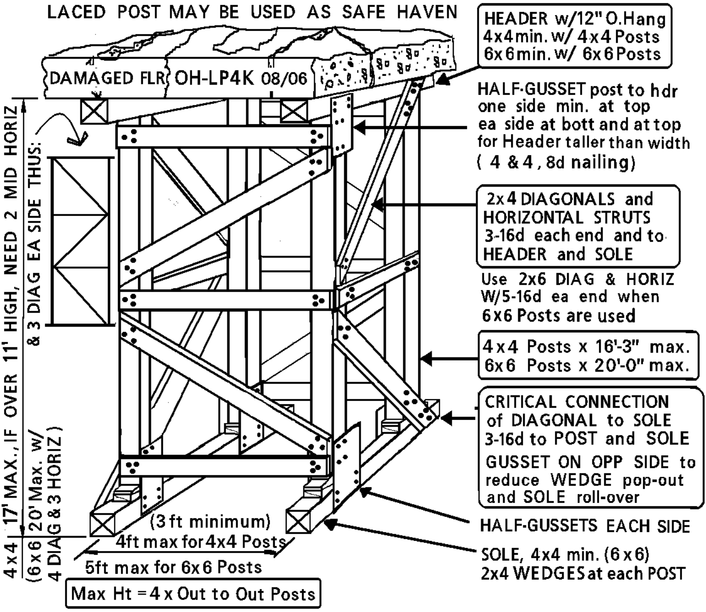
Triangle Gusset
12"x 12"x ¾" Ply
cut on diagonal
(Window Shores)

LACED POST SHORE

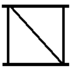
CLASS 3 SHORE • POSTS SAME SPACING EA. WAY

High capacity four post system that can be used to shore a damaged Concrete Floor or Heavily Loaded Wood Floor It is constructed similar to a pair of 2-Post Vertical Shores but laced together

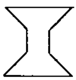
LACED POST MAY BE USED AS SAFE HAVEN



WHERE HEIGHT IS LESS THAN 6 FT ONLY NEED ONE DIAG EACH SIDE AS SHOW THUS:



SHORING PRINCIPLE



HEADER MAY NEED TO BE LARGER TO SUPPORT BADLY CRACKED CONC. SLABS/FLOORS (see Structures Specialist)

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.

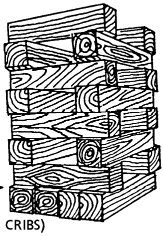
DESIGN STRENGTH is BASED on CROSSGRAIN BEARING

(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

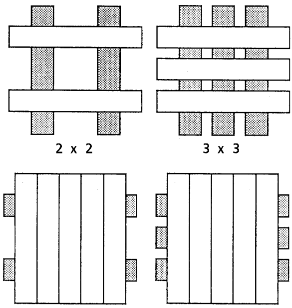
4 x 4 CRIB DESIGN LOAD = 24,000 LBS (12 TONS)
6 x 6 CRIB DESIGN LOAD = 60,000 LBS (30 TONS)

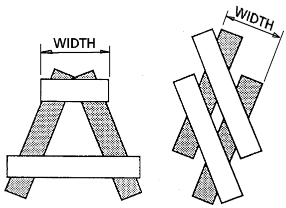
FOR 3-MEMBER x 3-MEMBER CRIB, DESIGN LOAD IS 9/4 AS MUCH
500 x 3.5" x 3.5" x 9 = 55,000, 500 x 5.5" x 5.5" x 9 = 136,000



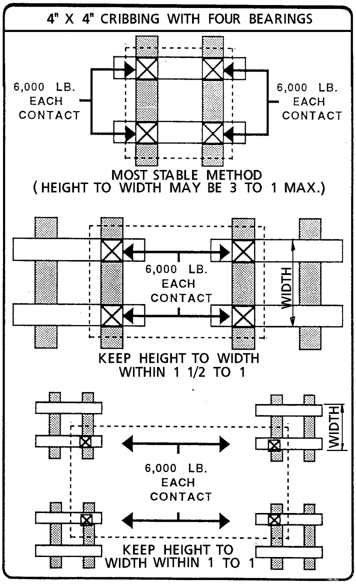
- BOTTOM LAYER SHOULD BE SOLID TO SPREAD THE LOAD ESPECIALLY ON SOIL OR ASPHALT PAVING
- LIMIT HEIGHT TO 3 TIMES WIDTH (SHORTEST WIDTH FOR NON-SQUARE CRIBS)
- OVERLAP CORNERS BY 4 INCHES TO ASSURE SLOW CRUSH TYPE FAILURE

SHOR-4 06/06

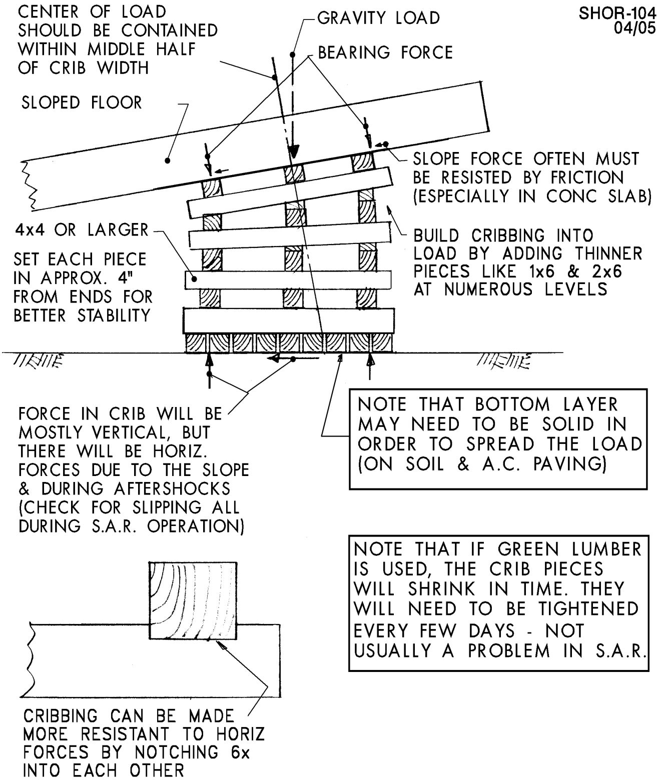


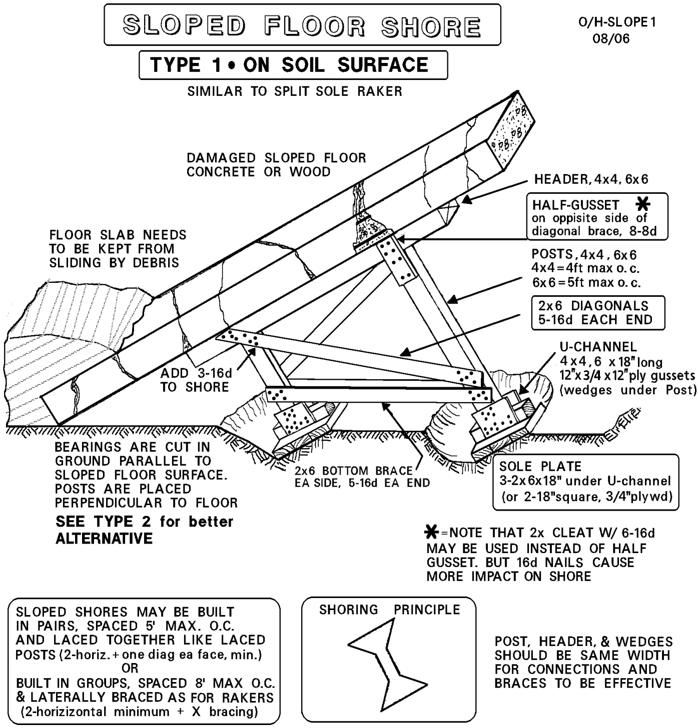


BOTH ARE NOT VERY STABLE, KEEP HEIGHT TO WIDTH WITHIN 1 TO 1



SHORES FOR SLOPED FLOORS • CRIBBING • TYPE 4





Note: This Sloped Shore is difficult to build, and it is dangerous to dig-in the footings in the confined space. Better to use the Type 2 Sloped Floor Shore, shown following

HOW TO CONSTRUCT A SLOPED FLOOR SHORE ON AN EARTH SURFACE – TYPE 1

1. Survey area and determine load displacement, based on 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.

   b. Install the header and anchor in position.

3. Excavate the ground at the post locations.

   a. Place U-channel as a sole plate (Trough may also be used, see Split Sole Raker Shore Diagram)

   b. The minimum length of U-channel is 18 inches, and the Trough is 36” in length

4. Measure and install the two posts.

   a. Anchor to the header.

   b. Place a set of wedges under each post and "pressurize".

5. Install the bottom horizontal 2x6 braces on both sides of each shore section using the proper nail patterns.

6. Install the 2x6 cross 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, using the 4 and 4 nail pattern.

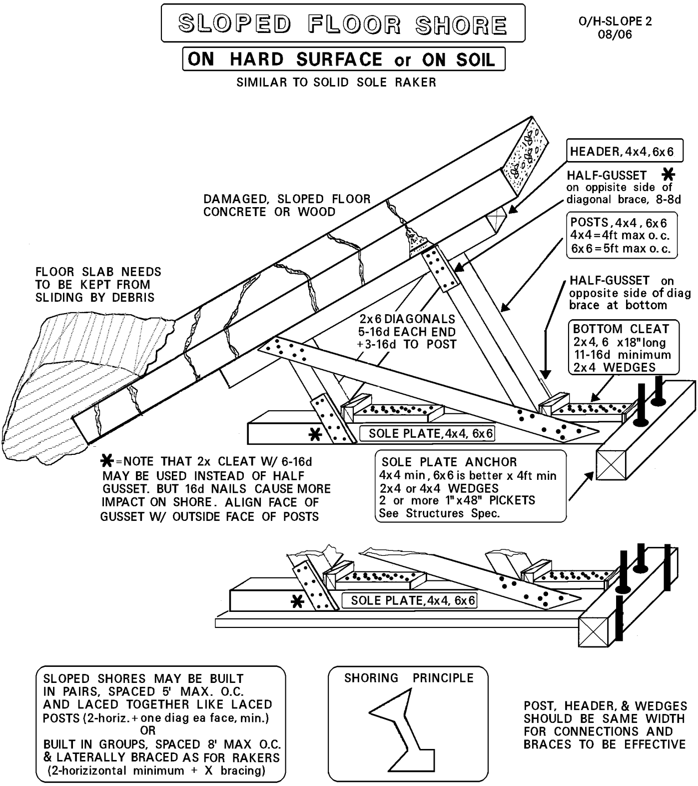
   b. Need to place gussets to clear the horizontal and diagonal braces (installed next), or use 2x cleats instead of gussets.

7. Brace the two sections together, same as in Laced Posts or Raker Shores (depending on spacing).

   a. Do this at both posts in order 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.

8. Make sure the shore is attached to the floor (If possible).

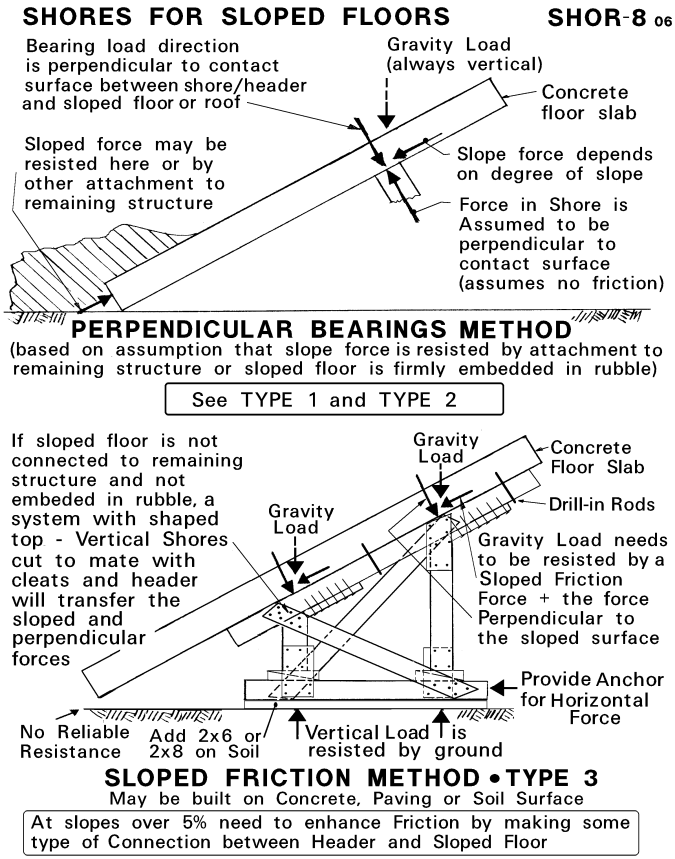


For conditions on Very Soft Soil, may need to add minimum of 2-2x6x18"crosswise under sole at each post.

HOW TO CONSTRUCT a SLOPED FLOOR SHORE ON PAVING or SOIL SURFACE – TYPE 2

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 and Anchor to header
4. Nail down the bottom cleats with the proper nail patterns. Place wedges in position.
5. Anchor down the sole plate, and "pressurize" the wedges.
    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 SLOPED FLOOR SHORE ON PAVING or SOIL SURFACE – FRICTION, TYPE 3

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

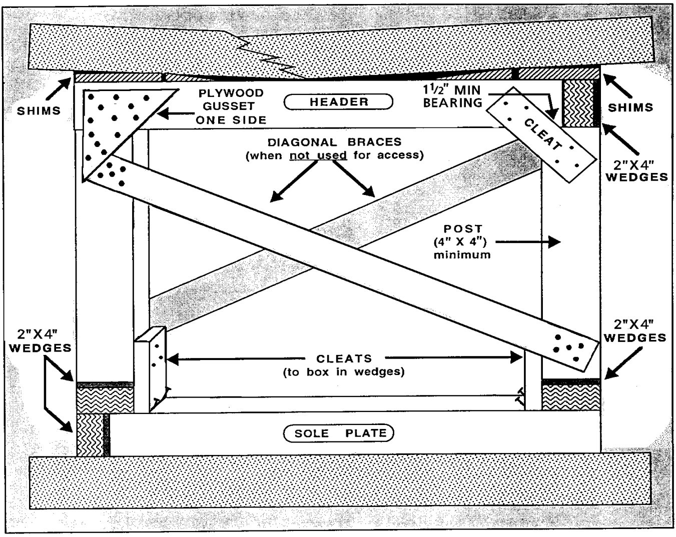
   a. Install temporary, spot shores if required.

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.

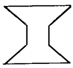
WINDOW & DOOR SHORE

O/H-11
06/06

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



SHORING PRINCIPLE



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

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 under 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 **not used** for access or egress.

PRE-CONSTRUCTED SHORING SYSTEMS

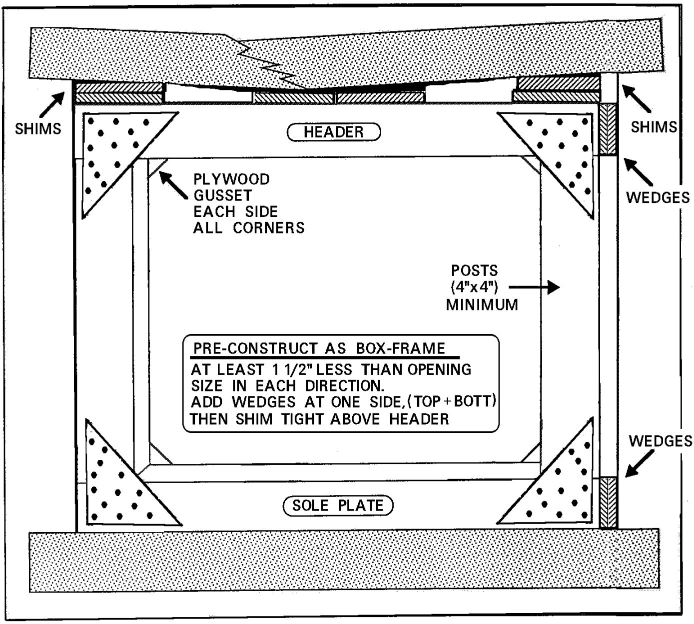
1. Window/Door Shores may be pre-constructed as shown in ALT WINDOW & DOOR SHORE.
   a. They should be made at least 1 ½" less than opening in each direction, and then tightened with wedges at one side and bottom + shims as required.
      - If header is badly damaged, great care should be taken during installation of the shoring and shims.
   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.

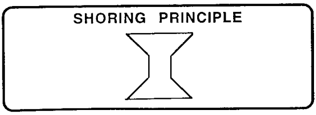
2. **Pneumatic Shores**, with a minimum of two shores with wood or metal rail header. (see page following Alt Window Shore)
   a. Metal ends should be nailed to header and sole.
   b. The manufacturers sell clamp fittings that allow for nailed 2x6 X bracing to be installed.
   c. Pneumatic shores are 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

PRE-CONSTRUCT, PLACE IN OPENING, AND TIGHTEN W/SHIMS

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

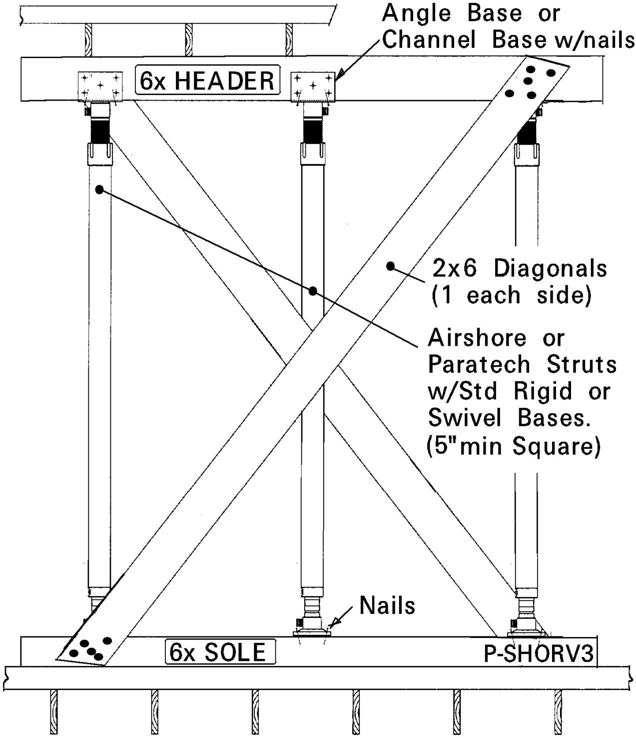




HEADER, POSTS & SOLE PLATE MUST BE SAME WIDTH

VERTICAL SHORE

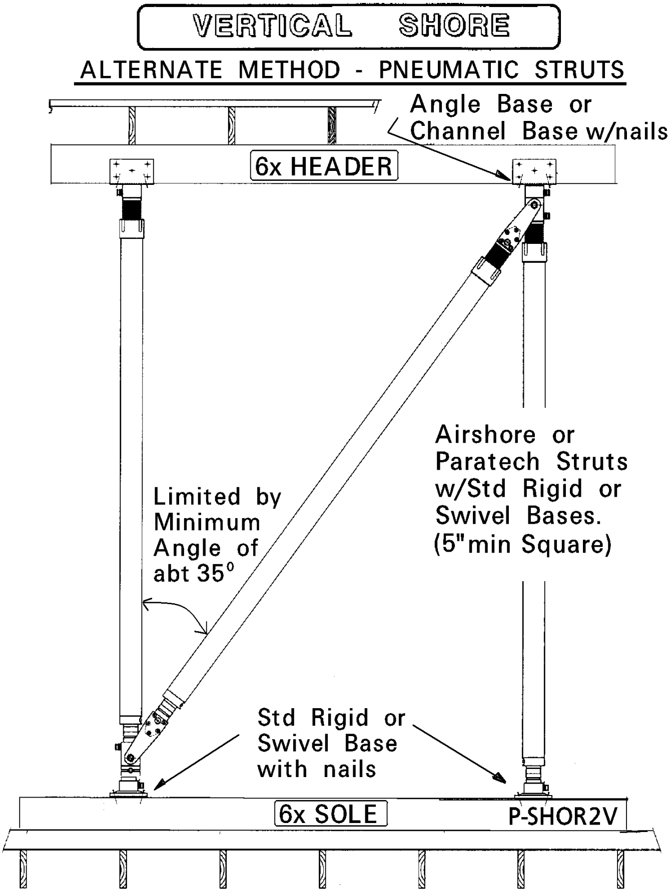
ALTERNATE METHOD - PNEUMATIC STRUTS



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



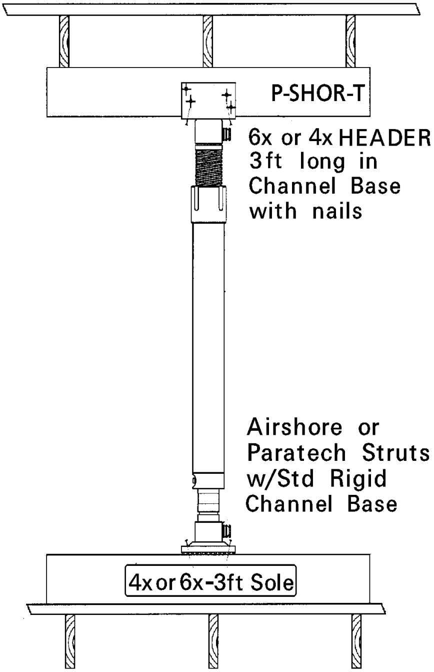
Need 6x Header and Sole due to width of Std Base
See previous pages, this Sect for notes on Vertical Shores

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

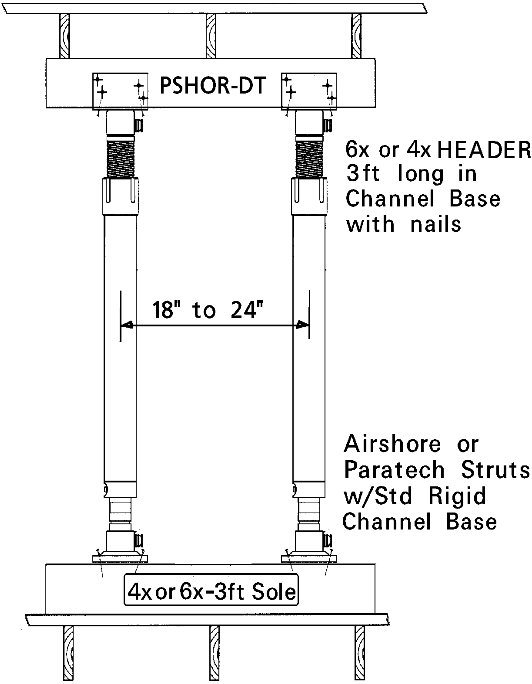
MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32

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

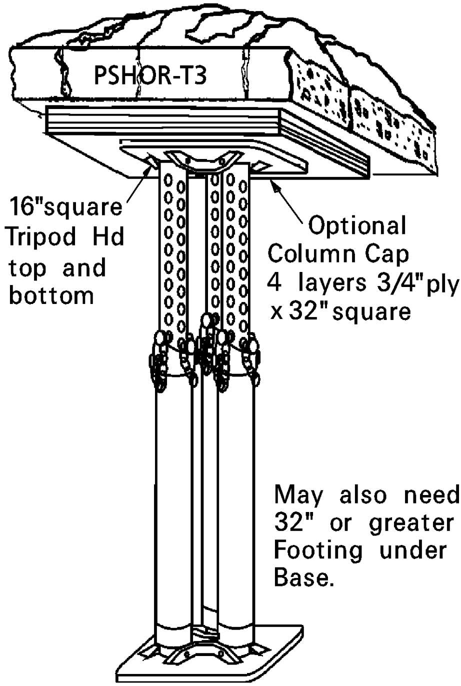


Use 4x or 6x depending on Width of Channel Base
Note that Channel Bases are not as strong as Gussets
See previous pages in this Section for Notes regarding Wood Double T Shores
MAX AIR PRESSURE = 50 PSI, SEE WARNING Pg 3-32
HAND TIGHTEN ALL PNEUMATIC STRUTS - SNUG TIGHT

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

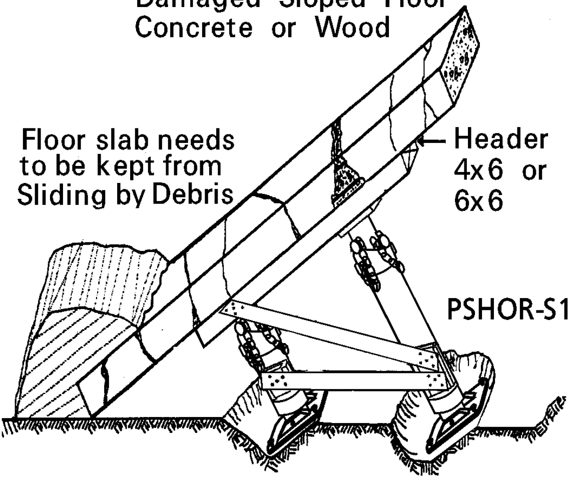
MAX AIR PRESSURE = 50 PSI,
HAND TIGHTEN ALL STRUTS - SNUG

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

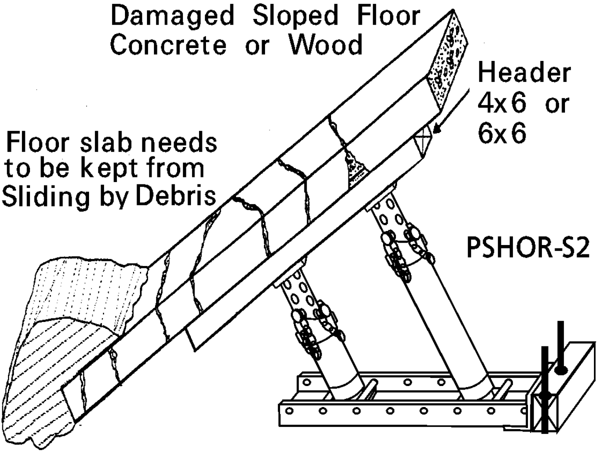
MAX AIR PRESSURE = 50 PSI,
HAND TIGHTEN ALL STRUTS - SNUG

SLOPED FLOOR SHORE

ON HARD SURFACE

ALTERNATE METHOD

PNEUMATIC STRUTS



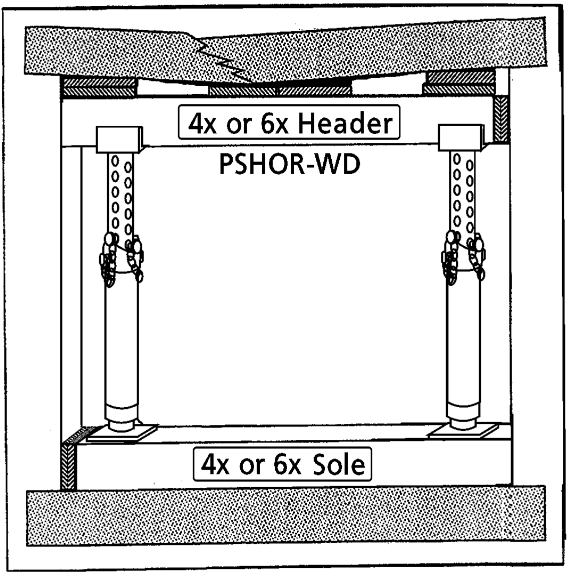
Struts by Airshore or Paratech with Angle Base or Channel Base to Header
Sole is Raker Wall Channel with Std Raker Connections and Bearing Angle against Sole Anchor

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.

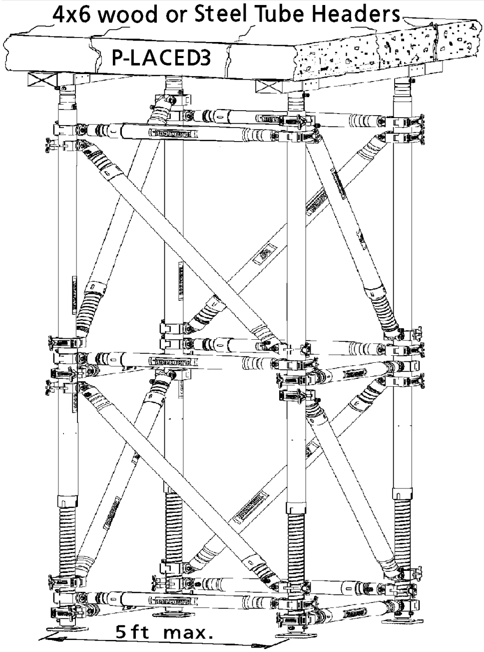
See Strut Tables in Sect. 7 of Struct. Spec FOG for Recommended Strut Loading, based on Height (Length)

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

HAND TIGHTEN ALL STRUTS - SNUG TIGHT

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

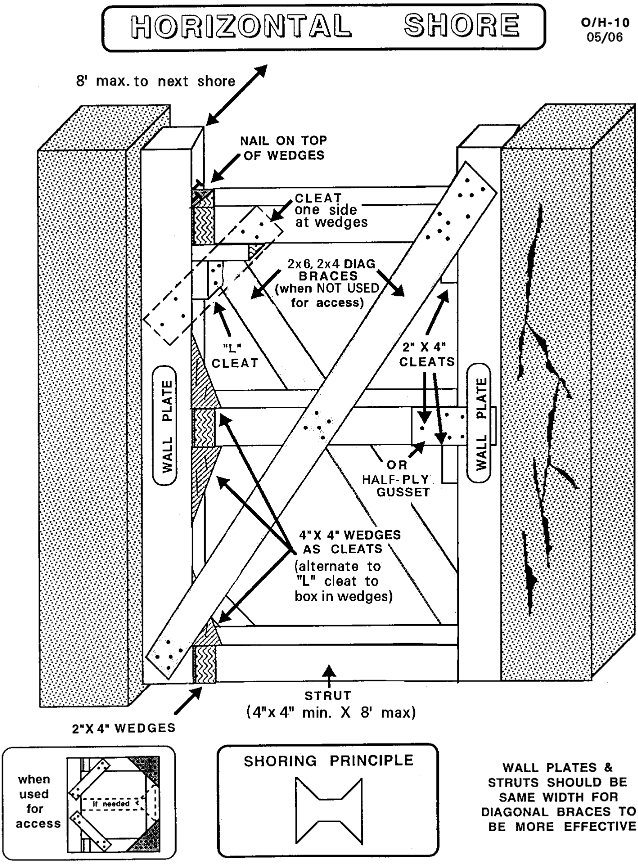
INTRODUCTION to SECTION 3

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

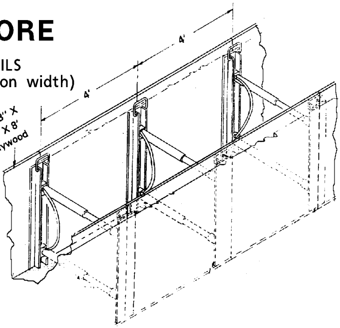
2. Measure and cut the wall plates & struts to the proper length.
   a. Place both wall plates against the walls.
   b. Measure between the wall plates where the struts are to be installed, deducting the width of the wedges to be used.
3. Place both wall plates next to each other and attach cleats to 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 **not used** 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

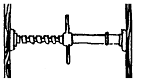
HYDRAULIC TRENCH SHORE

- 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

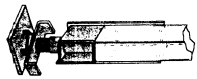


OTHER TRENCH SHORES

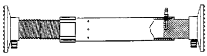
- TRENCH JACK - SAME CAPABILITY AS IN VERTICAL POSITION



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



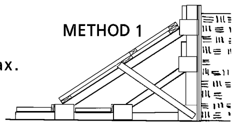
- PNEUMATIC SHORE - SAME CAPABILITY AS IN VERTICAL (These shores originally intended as trench shores)



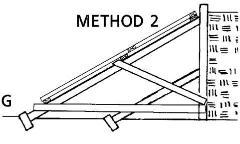
ONE SIDE LATERAL SHORE

- 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

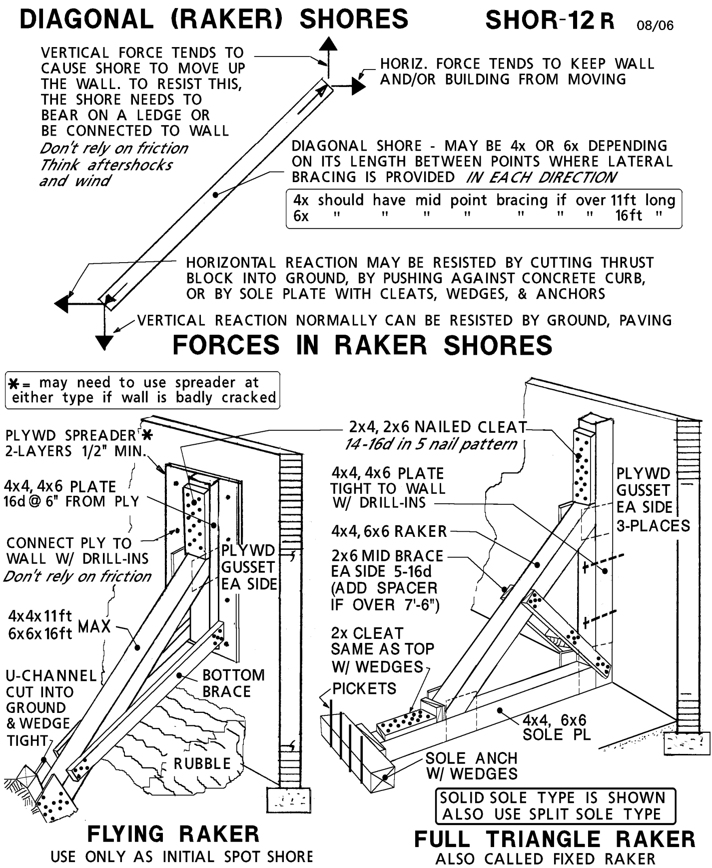


RAKER SHORE – DESIGN INFORMATION

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

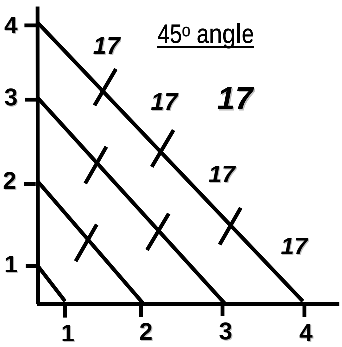
RAKER SHORE – DESIGN INFORMATION (continued)

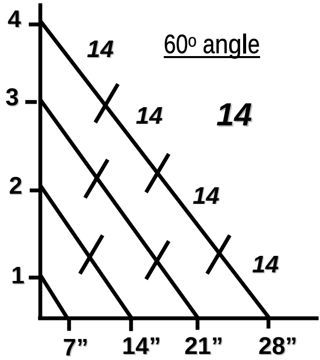


EXCEPT FOR INITIAL, TEMPORARY STABILIZATION, RAKER SHORES SHOULD BE BUILT IN SYSTEMS OF TWO OR MORE, WITH LATERAL BRACING BETWEEN THEM

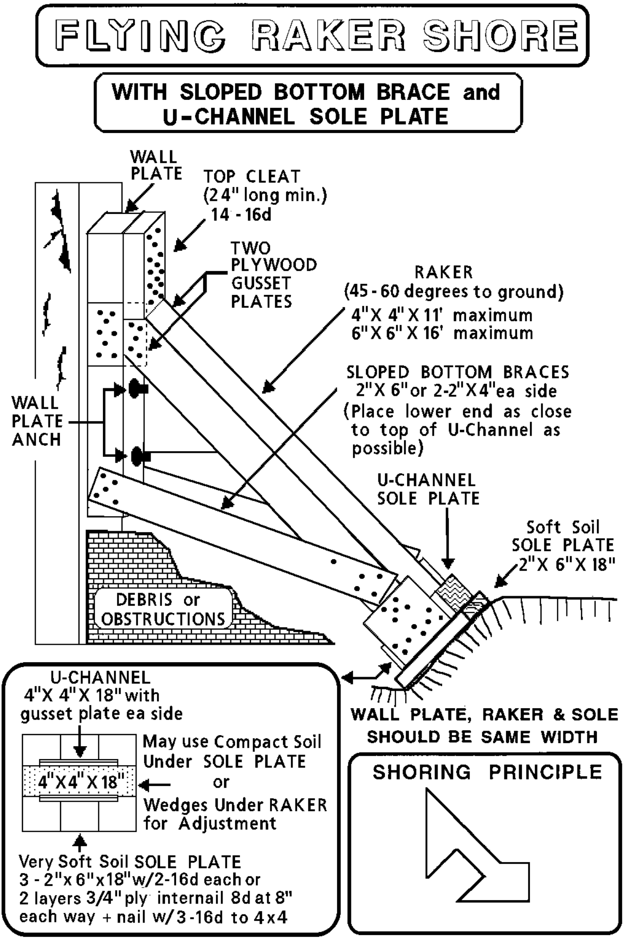
DETERMINING RAKER SHORE ANGLE & LENGTH

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").





CONSTRUCTION of RAKER SHORES



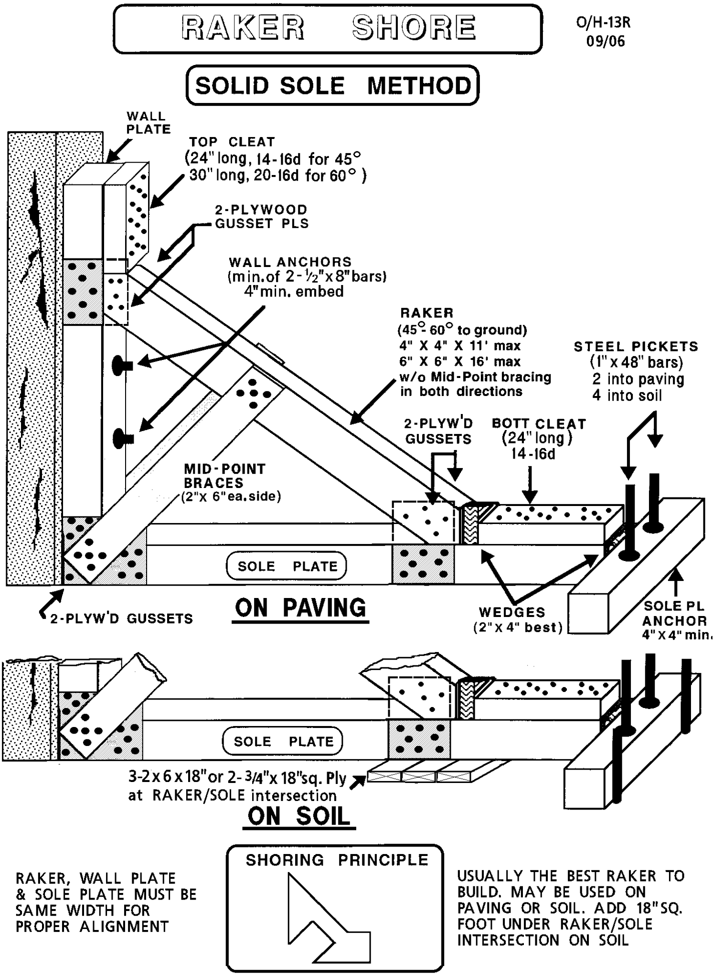
Design Load for One Flying Raker is 1,000 lb

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



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 **first brace to the Rakers** near the top and bottom between the upper and lower horizontal braces.

c. Attach the **second brace to the upper and lower horizontal braces** 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.

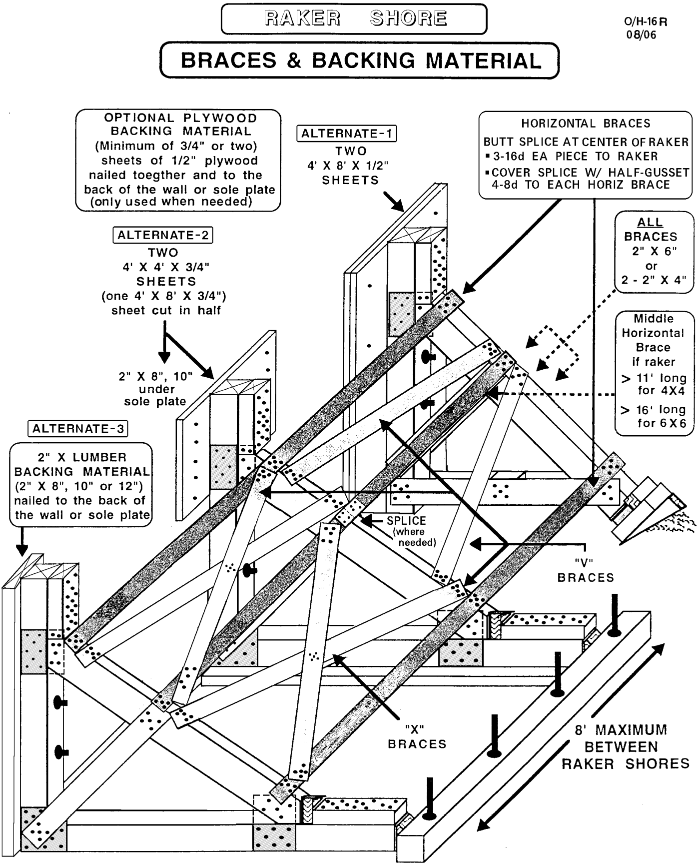
    a. To attach the sole plate directly to concrete, asphalt or soil: drill a minimum of two 1" holes through the sole plate, concrete, or asphalt and drive 1" x 48”steel pickets or rebar directly into the ground. Need at least 4 – 1"x 48” pickets if driven directly into ground, but may be more practical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

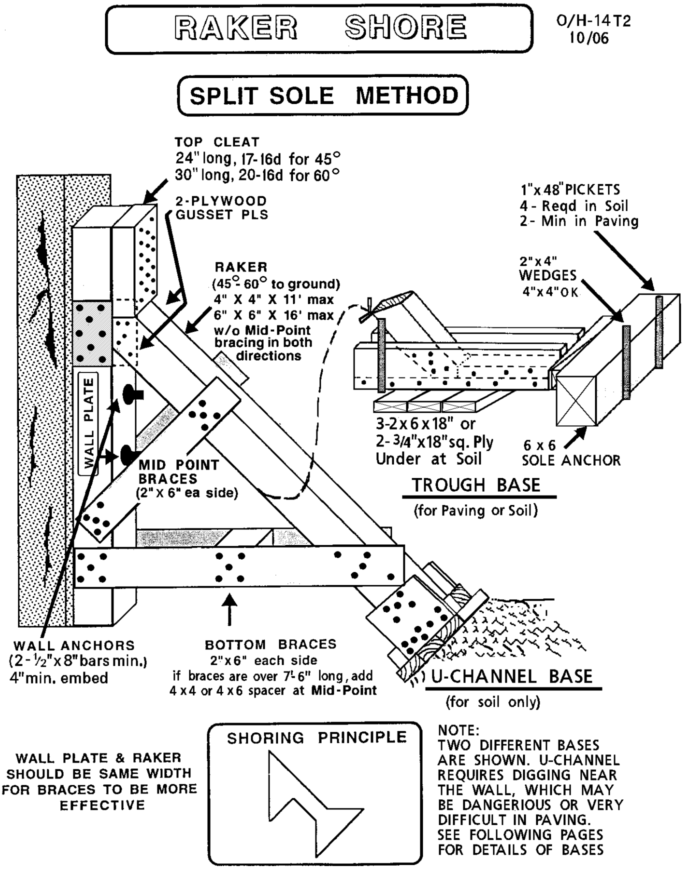
    b. To attach the sole plate to concrete and masonry.

    - 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
O/H-16 R
08/06
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 or sole plate (only used when needed)
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
TWO 4' X 4' X 3/4" SHEETS (one 4' X 8' X 3/4") sheet cut in half
2" X 8", 10" under sole plate
Middle Horizontal Brace if raker > 11' long for 4X4 > 16' long for 6X6
ALTERNATE-3
2" X LUMBER BACKING MATERIAL (2" X 8", 10" or 12") nailed to the back of the wall or sole plate
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

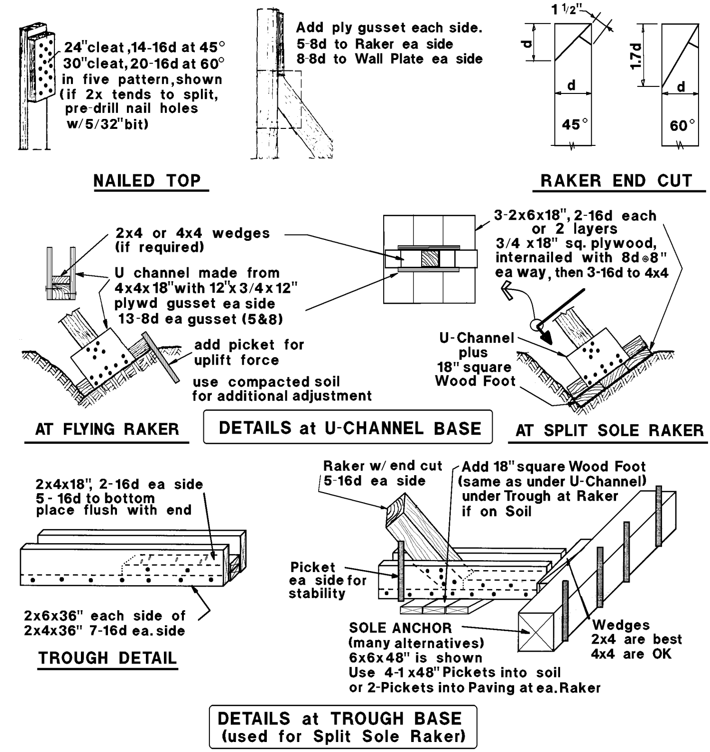
HOW TO CONSTRUCT SPLIT RAKER SHORE (continued)

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 T 10/06



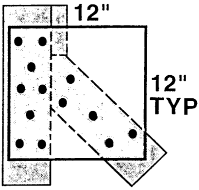
FABRICATION AND ERECTION

- 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.

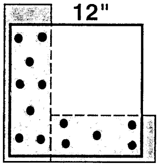
NAIL PATTERNS FOR 3/4"x12"x12" & 3/4"x 6"x12"PLY GUSSET PLATES & TRIANGLES, BRACES & CLEATS
(Use 8d nails on plywood & 16d nails on 2" lumber)

NOTE: OSB MAY BE USED AS PLYWOOD

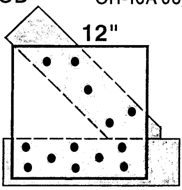
OH-16A 08/06



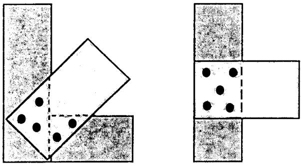
TOP OF RAKER
GUSSET PLATE



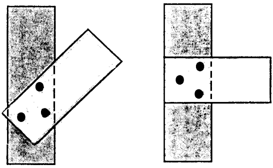
BOTTOM OF RAKER
GUSSET PLATE



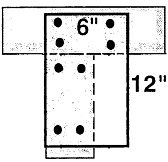
REAR OF RAKER
GUSSET PLATE



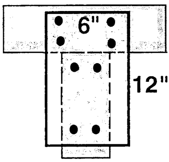
2" X 6" BRACES & CLEATS



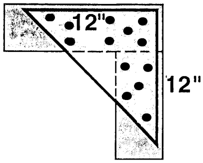
2" X 4" BRACES & CLEATS



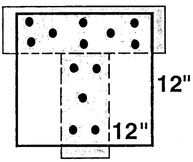
END VERT POST
TOP & BOTTOM
HALF-GUSSET PLATE



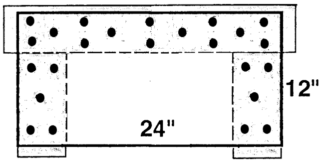
MID VERTICAL POST
TOP & BOTTOM
HALF-GUSSET PLATE



WINDOW/DOOR SHORE
TOP & BOTTOM
TRIANGLE GUSSET PLATE



TOP OF TEE SHORE
GUSSET PLATE

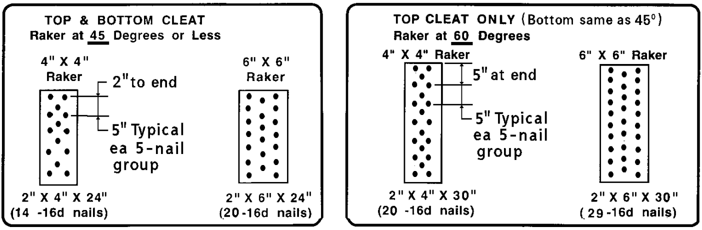


TOP OF DOUBLE TEE SHORE
DOUBLE GUSSET PLATE

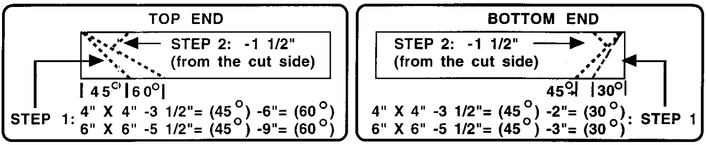
RAKER SHORE

O/H-17
R 08/06

CLEATS, CUTS & ANCHORS

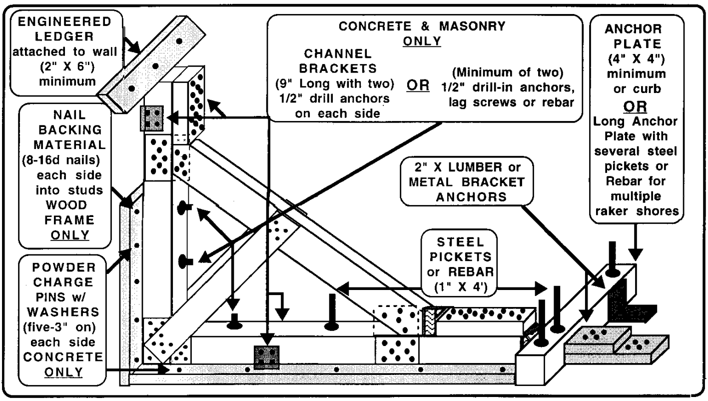


HOW TO CUT THE TOP & BOTTOM ENDS OF THE RAKER



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

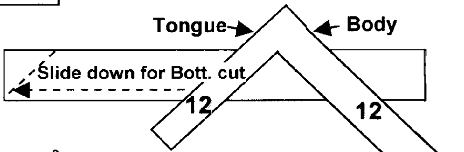
(Many alternatives are shown - need only one type at Wall and at Sole)



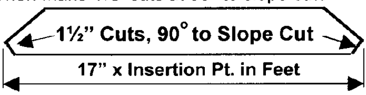
3

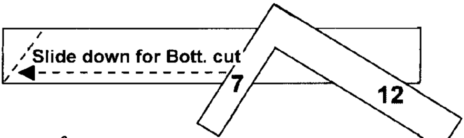
USING STEEL FRAMING SQUARE

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

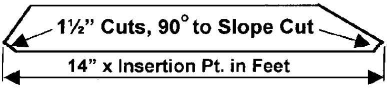
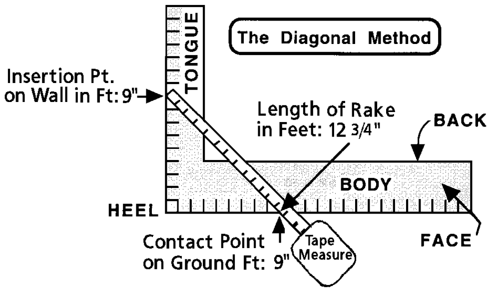
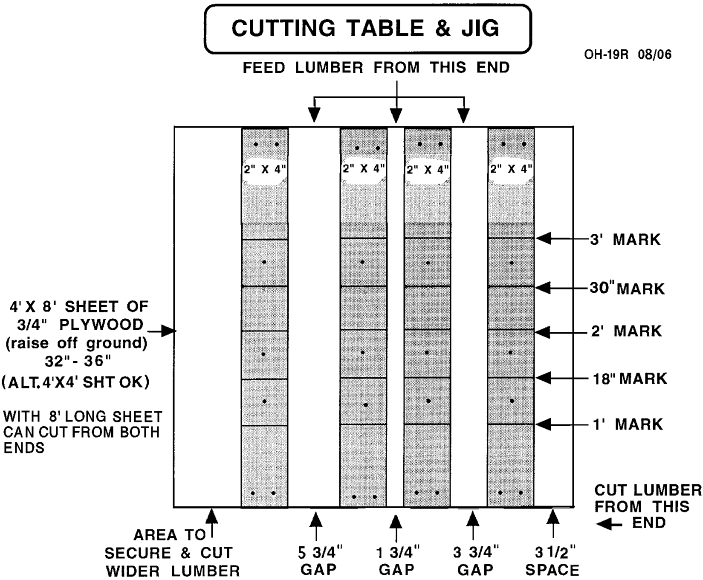
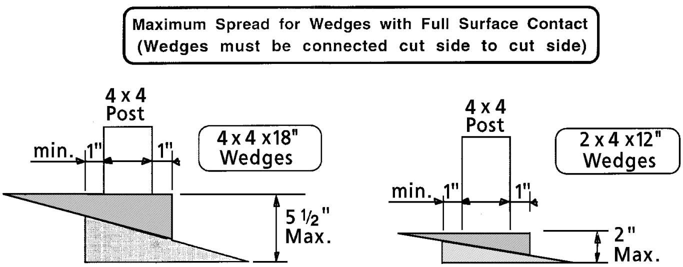


Figure:2 **TO FIND APPROX. LENGTH OF RAKE**

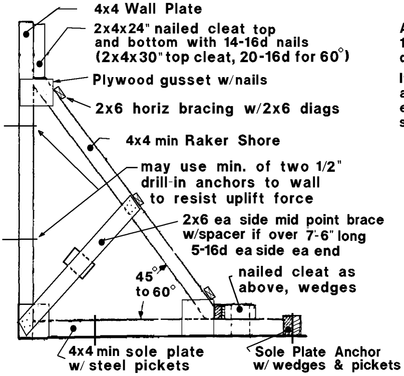



CUTTING TABLE & JIG
OH-19R 08/06
FEED LUMBER FROM THIS END
2" X 4"
2" X 4"
2" X 4"
2" X 4"
3' MARK
30" MARK
2' MARK
18" MARK
1' MARK
4' X 8' SHEET OF 3/4" PLYWOOD (raise off ground) 32" - 36"
(ALT. 4'X4' SHT OK)
WITH 8' LONG SHEET CAN CUT FROM BOTH ENDS
CUT LUMBER FROM THIS END
AREA TO SECURE & CUT WIDER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

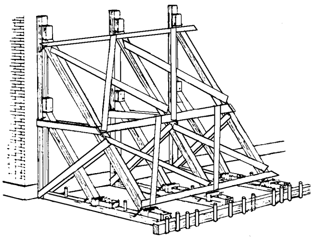
RAKER SHORE SYSTEMS SHOR-14 R 09/06



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

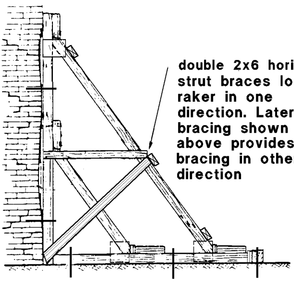
All systems using 4x4 members over 11ft long should be braced in two directions in order to limit L/D to 25±

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

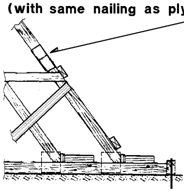


RAKER SHORE FRAMES MUST BE BRACED

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)

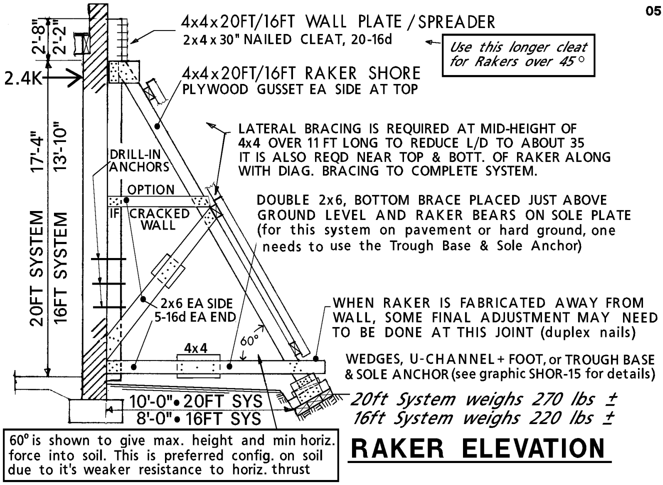


DOUBLE DIAGONAL

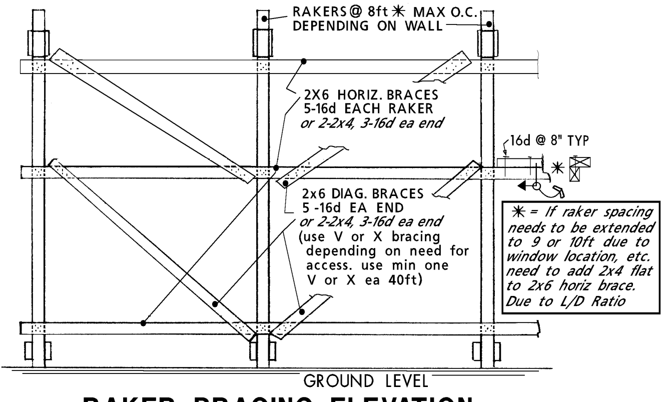
RAKER SHORES – EXAMPLE DESIGNS

FULL HEIGHT RAKER • SPLIT SOLE TYPE SHOR-17R

05/06

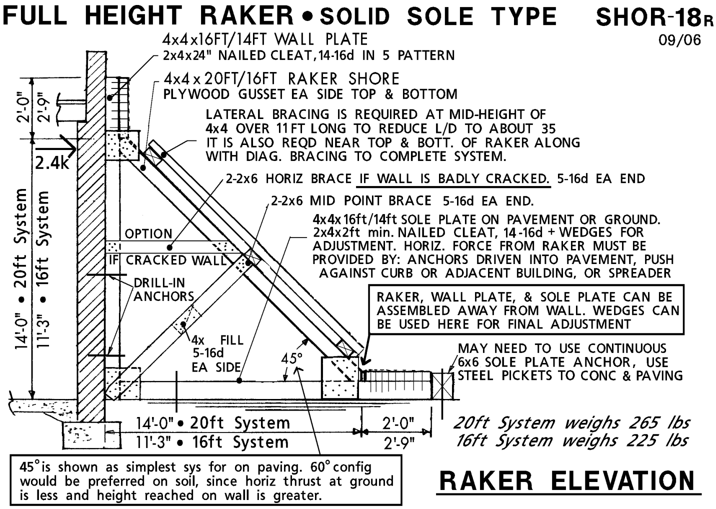


RAKER ELEVATION

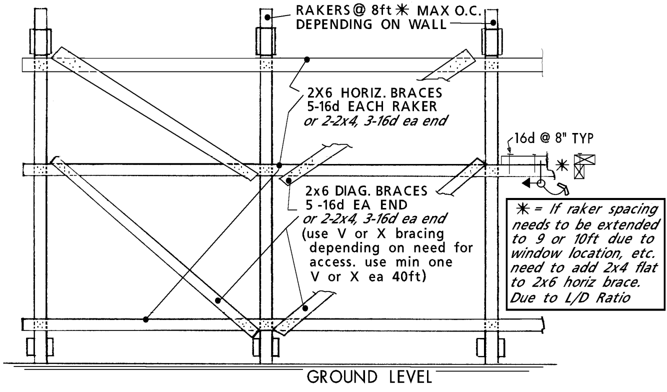


RAKER BRACING ELEVATION

RAKER SHORES – EXAMPLE DESIGNS (continued)



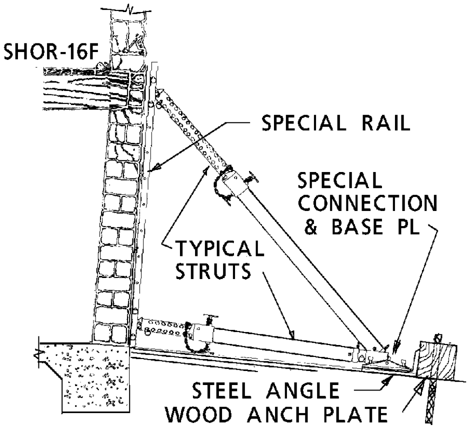
RAKER ELEVATION



RAKER BRACING ELEVATION

RAKER SHORE ALTERNATIVES

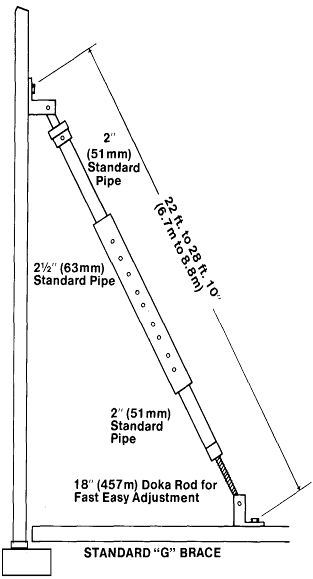
PNEUMATIC STRUTS AS RAKERS



- 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)

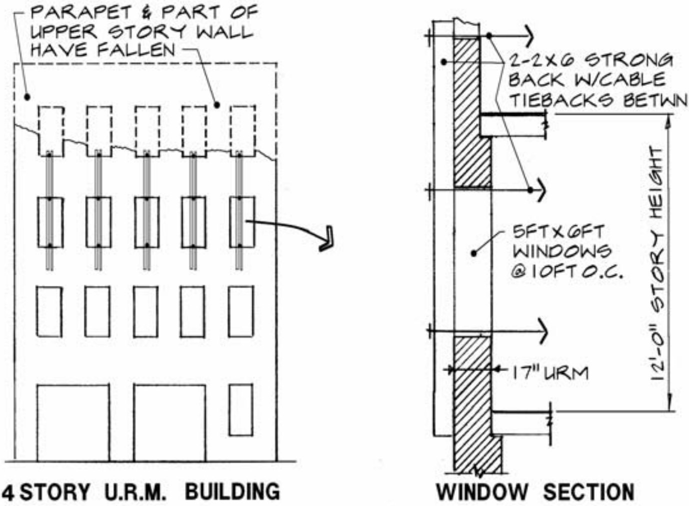
LITTLE "G" TILT-UP BRACE

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



- 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.

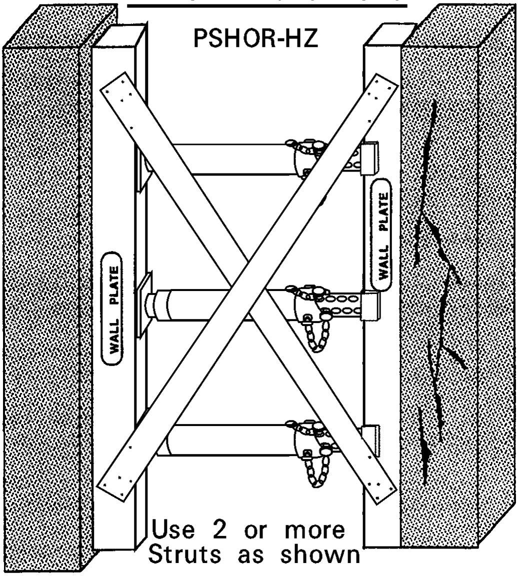
3

ALTERNATE SHORING USING STRUTS

HORIZONTAL SHORE

ALTERNATE METHOD

PNEUMATIC STRUTS



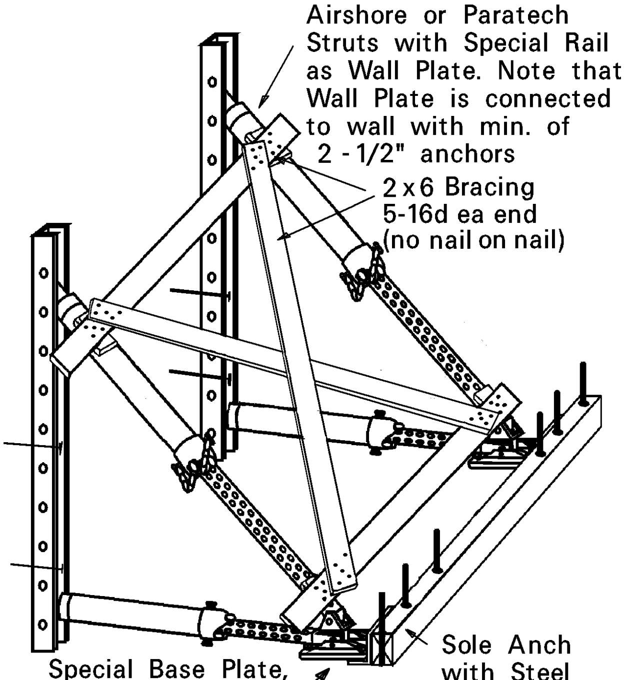
See previous sheet in this Section-
Wood Horizontal Shore for Wall Plates.
and Diagonal Bracing

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

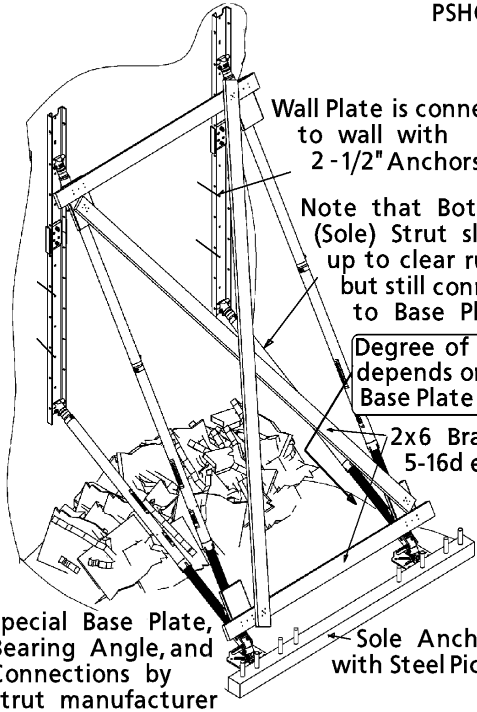
HAND TIGHTEN STRUTS USED AS RAKERS - NO AIR

3

RAKER SHORE

WITH SLOPED BOTTOM 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

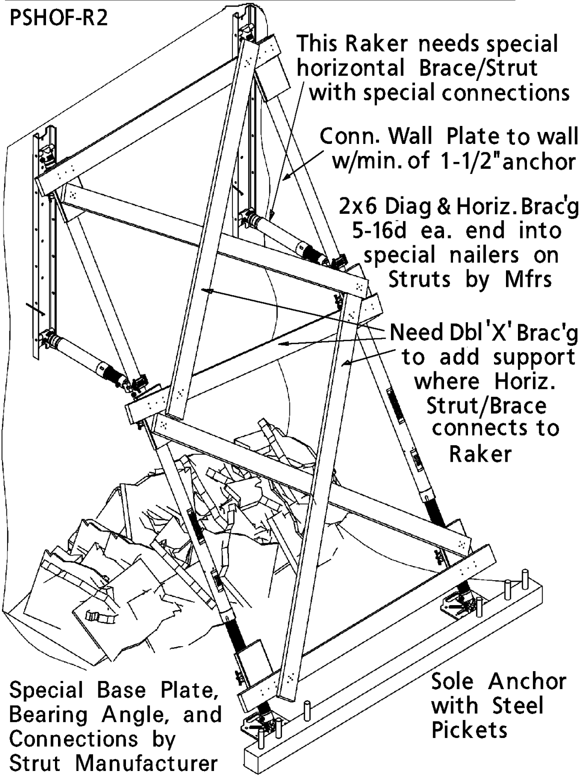
Sloped Bottom Strut allows it to clear Rubble but does not reduce capacity of System.

HAND TIGHTEN STRUTS USED AS RAKERS - NO AIR

FLYING RAKER SHORE

ALTERNATE METHOD - PNEUMATIC STRUTS

PSHOF-R2



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

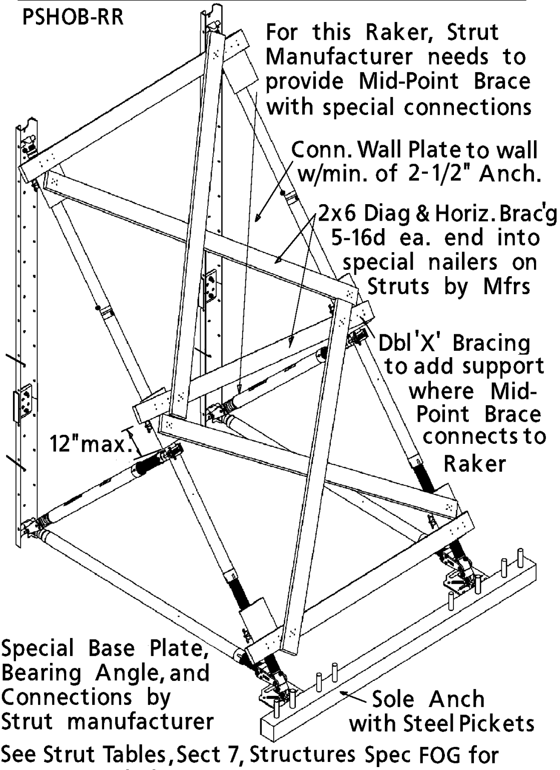
HAND TIGHTEN ALL STRUTS USED AS RAKERS-NO AIR

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 Emergency Shoring, plus a Glossary of Terms, regarding Building Construction and Engineering

The FAQ are arranged as follows: **Page**

The Glossary of Terms is arranged alphabetically, starting on Page 4-15

NOTES:

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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

4

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)

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 Collapse- The wall falls straight out as a monolithic 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.

NOTES:

INTRODUCTION to SECTION 5

This section contains instructions for the operation of various instruments that may be used by the Structures Specialist during a US&R deployment.

Instructions and operating information is provided for the following instruments:

- Global Positioning System (Garmin V)
- Global Positioning System (Garmin 60CS and 60CSx)
- Garmin MapSource Software
- Total Station (Nikon Model NPL 325)
- Wireless Building Monitoring System (WBMS)
- Laser Range Meter (Hilti PD32)

This information was developed to provide a quick refresher during deployment and is not meant as a substitute for formal training courses for each instrument. Additional, the provided information is limited to functions and usage most common to US&R operations and is not meant as a complete documentation of each instrument's functionality.

<u>NOTES</u>

NOTES:

Global Positioning System (Garmin V)

- Provides a position accuracy of approx. 50 ft. under normal conditions.
- Position coordinates should be given in deg:min:sec (Hdd.mm.ss), but FEMA US&R may change to UTM/UPS coordinates in the future
(Most all Garmin GPS can operate with either system)"
- Operates with 4-AA alkaline batteries. Each set should last approximately 24 hours of normal usage. Stored data is not lost when the batteries are removed or replaced.
- Remove the battery cover on the left side of the unit (when viewed horizontally) turn the metal D-ring 1/4 turn ccw.

The GPS V uses 4 different main page displays:

1. Satellite Page – Provides the satellite signal status including “sky view” and signal strength depictions, which shows how well the GPS receiver is doing at any given moment. At power up, this page is displayed as satellites are acquired. Three satellites are needed for a two-dimensional fix (no altimeter) and four satellites for a three-dimensional fix. This page has minimal use beyond power-up unless there is a need to confirm the loss of satellite acquisition.

2. Map Page – Provides a real-time moving map to illustrate the current position and surrounding area. Details maps are provided by preloading them using MapSource.

3. Current Route Page – Provides an electronic graphical compass and indicates direction to go and direction of travel.

4. Trip Info Page - Indicates current speed, average speed, trip odometer, and many other helpful statistics about a trip or route. This page has limited use during US&R operations.

There is also a Main Menu page (accessed by pressing the **MENU** key twice).

Keypad Usage

POWER (Red Lamp Symbol) – Turns the unit on and off. A momentary press while the power is on displays the backlight/ contrast adjustment window. Press and hold to turn the GPS V off.

PAGE – Switches between the main pages and returns the display from an option window back to a main page. Press and hold to switch between landscape (horizontal) and portrait (vertical) screen orientations.

QUIT – Returns the display to the previous page. When entering data, restores the previous value (cancels data entry).

ENTER/MARK – Confirms a selected menu option. When entering data, it allows you to initiate entry, and then to accept the selected value(s). It also marks the location of the panning arrow on the Map Page. Press and hold to capture your present position and save it as a waypoint.

ROCKER KEYPAD – Selects menu options and enters data. Also controls movement of cursor on the Map Page and your view on the Map Page.

Zoom OUT – Adjusts the map scale to show a larger area with less detail.

Zoom IN – Adjusts the map scale to show a smaller area with more detail.

FIND – Searches the database for Cities, Interstate Exits, Waypoints, and Recently Found places. With MapSource City Select, Points of Interest, Addresses, or Intersections are also searched. Can view items on a map or select as a destination.

MENU – Displays a menu of options available for each of the 4 main pages. Press twice to display the Main Menu page.

Start-Up and Satellite Acquisition

Before turning the GPS V on, find a location that provides a clear view of the sky and allow for the acquisition of a proper number of satellites.

To turn on the GPS V, press and hold the red **POWER** key. (You may press **ENTER** to move quickly past the opening pages and get directly to the Satellite Page. Once a sufficient number of satellites have been located, a “Ready to Navigate” message will appear at the top of the Satellite Status Page.

The GPS V can be used with limited functionality without acquiring satellites. With the Satellite Status Page Options displayed, use the **ROCKER** keypad to highlight “Use Indoors” and press **ENTE**R.

To turn the GPS V off, press and hold the red power key.

Adjusting Screen Contrast and Backlighting

If lighting conditions make it difficult to see the display screen, you can adjust the contrast or turn on the backlight. To adjust screen contrast and/or backlighting:

1. Press the red power key momentarily. A pop-up window appears for screen settings.

2. Use the Left/Right portion of the **ROCKER** to adjust screen contrast.

3. Use the Up/Down portion of the **ROCKER** to adjust backlighting.

4. Press **ENTER** or **PAGE**, to return to the previous screen. Or, press **QUIT** to cancel the settings.

Entering a Waypoint

To enter a Waypoint using its coordinates:

1. Press the **MARK** key on the unit. This will bring up a new waypoint with a coordinate of your current position or the last known position if unit is being used with the GPS off (satellites not acquired).

2. Scroll to the "Location" window using the **ROCKER**, press **ENTER**. Use keypad window to change coordinates to those of the waypoint. Press **OK** in keypad window when finished.

3. Scroll to top window to change Waypoint number or name if needed. Press **ENTER** key to edit. Press **OK** in keypad window when finished.

4. If required, scroll to "Note" window to add notation.

5. Press **OK** to record new waypoint.

6. The new waypoint can be shown on the map screen by highlighting the Map key and pressing **ENTER**.

Navigating to a Waypoint

To navigate to a waypoint, it must first be saved in the GPS unit (see above).

1. Press the **FIND** key on the unit. Scroll to the "waypoint" window, press **ENTER**.

2. Scroll to "By Name" window, press **ENTER**.

3. Scroll to the list of named waypoints and select the desired waypoint by pressing **ENTER**.

4. In the Waypoint window, scroll to the “Go To” window and press **ENTER**.

5. If traveling along established or mapped routes, select “Shortest Distance”, otherwise choose “Off Road”.

6. The “Short Distance” selection will bring up the Map Page with shortest route highlighted.

7. The “Off Road” selection will bring up the Current Route Page with the compass indicating the heading to the waypoint.

Using a Track Log

The path that the GPS unit takes can be recorded as a Track Log and includes information about points along the path, including time and position. The track log can also be used to measure the area of any space encompassed by a path as well as retracing a path in both directions. The GPS V has memory for 10 saved track logs. To create a Track Log:

1. Press **MENU** key twice to display the Main Menu page.

2. Use the **ROCKER** to highlight the Tracks icon and press the **ENTER** key to display the Tracks page.

3. Press the **MENU** key to display an options window.

4. Use the **ROCKER** to highlight “Setup Track Log” and press **ENTER**.

5. Use the **ROCKER** to highlight “Wrap When Full” and press **ENTER** to check (uncheck) this feature. (When unchecked, the track log is recorded until the available memory is full, then stops.)

Using a Track Log (continued)

6. Use the **ROCKER** to highlight “Record Interval” and press **ENTER**. Then use the **ROCKER** to select the desired interval option (Distance, Time, or Auto) and press **ENTER**.

7. Use the **ROCKER** to highlight “Value” (or “Resolution”) and press **ENTER**. Then use the **ROCKER** and **ENTER** to enter the desired value/setting.

8. When finished, use the **ROCKER** to highlight “OK” and press **ENTER**.

To Save a Track Log

From the Tracks page, highlight “Save” and press **ENTER**. The track log is saved using the current date. Information (distance, number of points, and enclosed area) for the track log can be viewed by highlighting the track log and pressing **ENTER**.

NOTES

Global Positioning System (Garmin 60CS or 60CSX)

- Provides a position accuracy of approx. 50 ft. under normal conditions (10-15 ft with WAAS).
- Position coordinates should be given in deg:min:sec (Hdd.mm.ss), but FEMA US&R may change to UTM/UPS coordinates in the future
- Operates with 2-AA alkaline batteries. Each pair of batteries should last approximately 20 hours of normal usage. Stored date is not lost when the batteries are removed or replaced.
- To remove the battery cover on the back of the unit turn the metal D-ring 1/4 turn ccw.

The Garmin 60CS uses 6 different main displays:

1. Satellite Page – Provides the satellite signal status. At power up, this page is displayed as satellites are acquired. Three satellites are required for a two-dimensional fix (no altimeter) and four satellites are required for a three-dimensional fix.
2. Trip Computer Page – Provides trip and navigation data such as Trip Odometer, Maximum Speed, and Elevation.
3. Map Page – Provides a detail map of the area surrounding the current location. Details maps are provide by preloading them using MapSource.
4. Compass Page – Provides an electronic graphical compass and indicates direction to go and direction of travel.
5. Altimeter Page – Provides the current elevation, rate of ascent/descent, a profile of elevation changes over distance or time, or a profile changes over time.
6. Main Menu – This page provides a directory of advanced features and settings.

When navigating a route, the Active Route Page is also displayed.

With the exception of the Main Menu, each page has a set of Menu Options that can be accessed by pressing the **MENU** key.

Keypad Usage

POWER/BACKLIGHT (located on top of the unit) – Turns the unit on and off. A momentary press while the power is on displays the backlight/ brightness adjustment slider. Press and hold to turn the GPS V off.

Zoom IN and **OUT** – From the Map Page, press to zone in or out on the displayed map. From any other page, press to scroll up or down a list.

FIND – Press and release at any time to view the Find Menu Page, including the Waypoints selection.

MARK – Press and release at any time to mark your current location as a waypoint.

QUIT – Returns the display to the previous page. When entering data, restores the previous value (cancels data entry).

PAGE – Press to cycle through the main pages. Press when using the on-screen keyboard to close. Press and hold to turn electronic compass On/Off.

MENU – Press and release to view options for a given page. Press twice to view the Main Menu.

ENTR – Press and release to enter highlighted options, data, or confirm on-screen messages.

ROCKER – Used to Move Up/Down or Right/Left to move through lists, highlight fields, on-screen key, icons, enter data, or move the map panning.

Start-Up and Satellite Acquisition

Before turning the 60CS on, find a location that provides a clear view of the sky and allow for the acquisition of a proper number of satellites.

To turn on the 60CS press and release the **POWER** key. A welcome page will briefly appear before moving to the Satellite Page. The "Acquiring Satellites" message will appear near the top of the screen. Once a sufficient number of satellites have been located, your "Location Coordinates" will be displayed.

The 60CS can be used with limited functionality without acquiring satellites. During satellite acquisition, press **MENU** and select "Use with GPS Off".

To turn the 60CS off, press and hold the **POWER** key.

Backlighting

The screen backlighting can be turned on by briefly depressing the **POWER** key. Backlighting will use significantly more battery power. The screen backlight level is adjusted using the **ROCKER** key while the backlight adjustment slider is displayed immediately following turning on the backlighting.

Calibrating the Electronic Compass

The electronic compass must be calibrated outdoors when the unit is first used the 60CS and after new batteries have been installed. The calibration must be performed outdoors with the unit held level and removed from objects that generate magnetic fields.

1. Use the **MENU** key to access the Options Menu.

2. Highlight the "Calibrate Compass" option and press **ENTR** to display the calibration page.

Press **ENTR** to activate the "Start" key and then follow the on-screen directions for holding and turning the unit.

A "Calibration Successful" message will appear when finished.

Entering a Waypoint

To enter a Waypoint using its coordinate:

1. Press the **MARK** key on the unit. This will bring up a new waypoint with a coordinate of your current position or the last known position if the unit is being used with the GPS off (satellites not acquired).

2. Scroll to the “Location” window using rocker key, press **ENTR**. Use keypad window to change coordinates to those of the waypoint. Press **OK** in keypad window when finished.

3. Scroll to top window to change Waypoint number or name if needed. Press **ENTR** key to edit. Press OK in keypad window when finished.

4. If needed, scroll to “Note” window to add notation as needed.

5. Press **OK** to record new waypoint.

6. Note that the new waypoint can be shown on the map screen by highlighting the Map key and pressing **ENTR**.

Create a Waypoint for Point on Map

1. In the Map Page, move the panning arrow to the location you want to use as a waypoint.

2. Press **ENTR** to display the waypoint information page. Highlight the “Save” key at the bottom of the page and press E**NTR**.

3. If the map item does not contain any information, a message appears, stating “No map information at this point. Do you want to create a user waypoint?” Select “Yes” and press **ENTR** to display a new waypoint page.

Navigating to a Waypoint

1. Press the **FIND** key on the unit to display the Find Menu.

2. Highlight the Waypoint icon and press **ENTR** to display the waypoint list.

3. Use the **ROCKER** to scroll up and down the list to find the waypoint.

4. With waypoint highlighted, press the **ENTR** key. Select “Go To” to navigate to the waypoint.

5. If traveling along established or mapped routes, select “Follow Road”, otherwise choose “Off Road”. The Map Page will be displayed.

6. The “Short Distance” selection will bring up the Map Page with shortest route highlighted.

7. The Compass Page can be displayed by pressing **PAGE**. The electronic compass will point and show the bearing and distance to the selected waypoint.

NOTES

Using a Track Log

The path that the GPS unit takes can be recorded as a Track Log and includes information about points along the path such as time, position, and elevation. The track log can also be used to measure the area of any space encompassed by a path as well as retracing a path in both directions. To create a Track Log:

1. Use the **PAGE** key on the unit to display the Main Menu.
2. Use the **ROCKER** to highlight the Tracks icon and press the ENTR key to display the Tracks page.
3. Highlight the "Setup" key and press the **ENTR** key to display the Setup page. This page is used to determine when and how often points are established to define the track
4. Highlight the "Record Method" field and press **ENTR**. Choose between "Distance", Time", or "Auto." The "Auto" option allows the selections of five different intervals.
5. Highlight the "Interval" field and set the interval for setting track points choosing between distance, time, or frequency values.
6. Press the **QUIT** key to return to the Track Log page.
7. In the Track Log page, highlight the "On" key to begin recording the track.
8. When the track is completed, return to the Track Log page and press the "Save" key.

Calculating the Area of a Track

1. With the Track Log page displayed and the track log on, press the **MENU** key to highlight the "Area Calculation" option and press **ENTR**.
2. Press **ENTR** to start the calculation. Move along the perimeter of the area to be calculated.
3. When the area has been completely defined, press the displayed "Stop" key.

Garmin MapSource® Software

- Necessary to interface a Garmin GPS unit (including the Garmin V and 60CS(x)) with a computer.
- Used to upload geographical date, such as detailed maps, as well as downloading waypoints, routes, tracks, and associated information obtained in the field.
- Data transfer is via a serial cable (Garmin V), USB cable (Garmin 60CS and 60CSx), or storage card (Garmin 60CSx).
- Various mapping products are available for use with MapSource and include:
  - City Select (US&R)
  - City Navigator
  - BlueChart
  - USA TOPO

The following information is provided primarily for the City Select mapping product (see p. 5-22 for typical MapSource window display with the City Select – North America product).

<u>Comments on the Use of Gramin Software</u>

- Most of the Garmin software must be unlocked with a 25-digit code in order for it to be installed on a computer.
- Unlocked software can be associated with up to 2 Garmin GPS units. Therefore, Map Sets cannot be uploaded to Garmin GPS units that are not unlocked to the specific software.
- Software unlocked to a particular Garmin GPS unit can be installed on an unlimited number of computers.
- Uploading Map Sets to a Garmin GPS unit can require more than one hour when using a serial connection.
- Uploading of information to a Garmin GPS unit should be done prior to mobilization, if at all possible.

Graphic Maps

The Graphic Map is the display of the currently selected geographical information within MapSource. The view can be changed by either zooming in or out, or by panning in all directions. These view changes can be done using the on-screen scroll bars, the keyboard's arrow keys, or the Hand tools.

Creating Map Sets

Geographical information must be contained in a Map Set in order be uploaded to a GPS unit. A Map Set is one or more detailed area maps that have been selected from the Graphic Map. City Select divides the United States into detailed area maps of varying geographical size depending on the population and development densities. To create a Map Set in MapSource:

1. Select a zoom scale that allows viewing of the map area boundaries.

2. Select "Map" from the Tools menu or the "Map" tool icon in the Tools toolbar. The map area boundaries will be outlined in yellow when the Map tool is located with a detailed map.

3. Click the left mouse key in the selected area. To select several map areas, drag the mouse to draw a box through the different areas. Selected map areas are shaded in pink.

4. Selected map areas are given in listed in the Maps tab on the left of the screen along with the memory requirements for each map area.

5. Ensure that the total member requirement, given at the bottom of the Map tab does not exceed the memory capacity of the GPS unit (Garmin V = 19 Mb, Garmin 60CS = 56 Mb, Garmin 60CSx = func of storage card).

6. Save Map Set by selecting “Save” in the File menu. Map Sets, along with associated waypoints, routes, etc., are saved as GPS data files have the .gdb file extension.

Creating a Waypoint on the Graphic Map

Waypoints can be created within the MapSource program using geographical information for later uploading to a GPS unit:

1. Select “Waypoint” from the Tools menu or the “Waypoint” tool icon in the Tools toolbar. 

2. Position the mouse pointer at the desired location for the waypoint on the Graphic Map.

3. Left-click the mouse, or right-click the mouse and select “New Waypoint.” In either case, the “Waypoint Properties” dialog box will open.

4. Make any desired changes to the “Waypoint Properties,” then click “OK” to save the new waypoint.

Creating a Waypoint using Know Coordinates

A waypoint can be created within the MapSource program using the known coordinates of a location for later uploading to a GPS unit:

1. Select “Waypoint” for the Tools menu. The “Waypoint Properties” dialog box will open.

2. Edit the waypoint name and enter a description, if desired. Note that Garmin GPS units can only display a limited number of characters. Names that are too long are truncated for display on the GPS unit. Other properties of the waypoint can also be edited.

Creating a Waypoint using Know Coordinates (continued)

3. Enter the coordinates of the new waypoint. Only a single space is used to separate the N and E decimal coordinates.

4. The new waypoint can be shown on the Graphic Map by clicking the "Show on Map" key at bottom right of dialog box.

5. Click "OK" to record the waypoint.

Waypoint Right-Click Menu

The following options may appear by clicking the right mouse key on a waypoint on the Graphic Map or a waypoint in the Waypoints tab list:

Move Waypoint – Activates the Selection tool and allows you to move the selected waypoint to another location on the Graphic Map.

New Waypoint, Begin Route, Begin Measurement, Find Nearest Places – for finding places and creating routes.

Remove Waypoint from Route – Selecting this option removes the selected waypoint from the route, but does not delete the waypoint (if waypoint is a route waypoint).

Cut/Copy/Paste – Allows one to cut, copy, and paste waypoints from one active MapSource document to another.

Delete Waypoint – Delete the selected waypoint

Show Selected Waypoint on Map – Zooms to the selected waypoint and centers it on the Graphic Map.

Waypoint Properties – Activate the "Waypoint Properties," allowing for their review and editing for the selected waypoint.

Creating Routes

Routes can be created in MapSource for uploading to a GPS unit. Routes are either direct (straight-line) or an automatic route (turn-by-turn) (default for City Select).

1. Select “Route” from the Tools menu or the “Route” tool icon in the Tools toolbar.
2. Click on waypoints or map locations on the Graphic Map in the sequence required for the route. If a waypoint does not exist on the map, a new waypoint will be created. Route legs are created as direct lines between waypoints.
3. After end point of route has been entered, press **Esc** or right-click the end point and select “Cancel.” The route is created and automatically named using the names of the first and last waypoints.
4. The total distance of the route is given in Route tab list.
5. Properties of the route can be edited by right-clicking the route in the Route tab list and selecting “Route Properties…”

Determining Distance/Bearing Between Two Waypoints

The straight-line distance and bearing between two points can be determined using MapSource:

1. Select “Distance/Bearing” from the Tools menu or the “Distance/Bearing” tool icon in the Tools toolbar.
2. Click on the point of origin waypoint or map location then move mouse cursor to termination point. Distance and bearing to the termination point is displayed at the bottom of the MapSource window.
3. By clicking on the termination point, additional points can be added but the bearing is measured from the beginning point while the distance is measure along the series of segments

Transferring MapSource Date to a GPS Unit

Map Sets, with their associated waypoints, routes, and tracks can be uploaded to a Garmin GPS unit (or storage card) from the MapSource program:

1. Attach serial or USB cable between computer and GPS unit.

2. Select “Save To Device …” in the Transfer menu or click on the “Send To Device” icon in the Tools toolbar and choose the device type. A different dialog box will appear depending on the attached GPS unit.

3. In the “What to Save” dialog box, select the date type for transfer by placing a check mark in the box(es) next to the type of data to be transferred.

4. If saving to a storage card, select the drive letter in the “Storage Card Reader” dialog box.

5. Click “Save” to begin transfer of data. The GPS unit can automatically turned off upon completion of the date transfer by placing a check mark in the box just above the “Save” key.

Transferring MapSource Date from a GPS Unit

Maps, waypoints, routes, and tracks can be downloaded from a Garmin GPS unit (or storage card) to the MapSource program:

1. Attach serial or USB cable between computer and GPS unit.

2. Select “Receive From Device …” in the Transfer menu or click on the “Receive From Device” icon in the Tools toolbar and choose the device type. A different dialog box will appear depending on the attached GPS unit.

3. In the “What to Save” dialog box, select the date type for transfer by placing a check mark in the box(se) nest to the type of data to be transferred.

4. If transferring from a storage card, select the drive letter in the “Storage Card Reader” dialog box.

5. Click “Save” to begin transfer of data. The GPS unit can automatically turned off upon completion of the date transfer by placing a check mark in the box just above the “Save” key.

Real-Time Tracking

MapSource can read information for a GPS unit in real time. The location of the GPS unit is shown as a red triangle on the Graphic Map, tracking data is displayed on the GPS tab and the track is recorded.

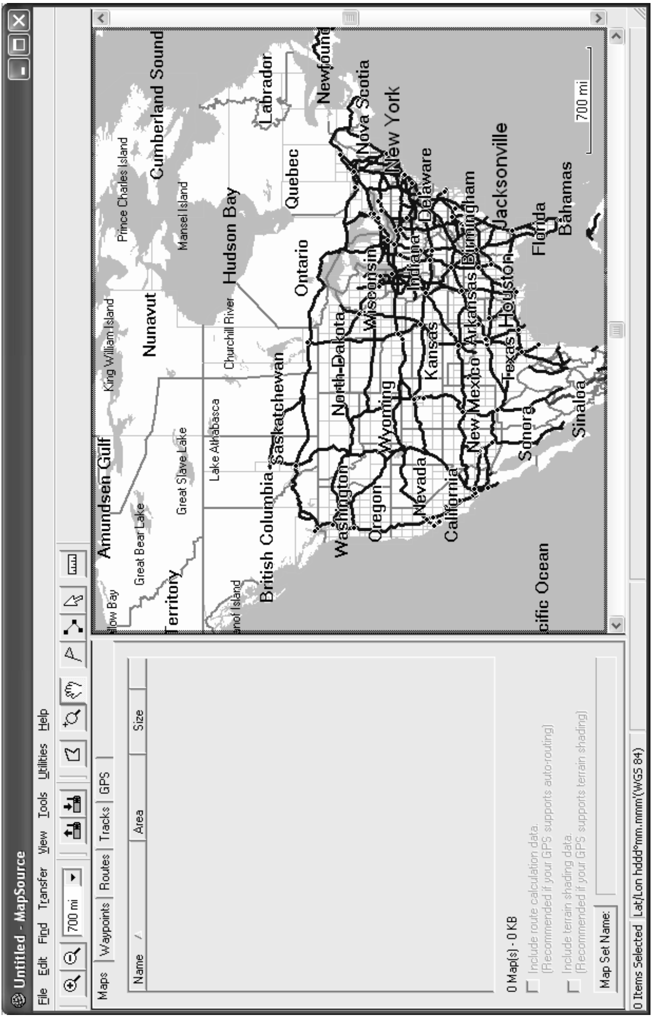
1. Attach serial or USB cable between computer and GPS unit.

2. Set the “Serial Data Format” of “USB Data Format” on the GPS unit to either Garmin or NMEA format.

3. Select the GPS tab in MapSource and click “Select Device.” Select the proper connection type.

4. Check the “Record Track” box and MapSource will begin to track the movement of the GPS unit.

5. To have MapSource automatically adjust the Display Map to keep the GPS unit visible on the Graphic Map, check the box next to “Keep Vehicle Visible on Map.”


Untitled - MapSource
File Edit Find Transfer View Tools Utilities Help
700 mi
Maps Waypoints Routes Tracks GPS
Name Area Size
0 Map(s) - 0 KB
Include route calculation data.
(Recommended if your GPS supports auto-routing)
Include terrain shading data.
(Recommended if your GPS supports terrain shading)
Map Set Name:
0 Items Selected
Lat/Lon hddd°mm.mmm' (WGS 84)
Amundsen Gulf
Great Bear Lake
Great Slave Lake
Lake Athabasca
King William Island
Nunavut
Churchill River
Hudson Bay
Mansel Island
Prince Charles Island
Cumberland Sound
Quebec
Labrador
Newfound
Nova Scotia
Ontario
British Columbia
Saskatchewan
Washington
Oregon
California
Nevada
Wyoming
North Dakota
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Total Station (Nikon NPL 352)

- A Total Station measures distances in addition to the usual capabilities of a theodolite (measurement of both horizontal and vertical angles)
- Distances up to 5000 ft can be measured using a continuous laser signal with either a prism or reflector-type target.
- Distances can also be measured reflectorless using a timed-pulse infrared signal but at a reduced maximum distance of approx. 300 ft. (Type of surface measurement is taken to will influence maximum measurable distance.)
- This capability allows for the monitoring of building movement over time.
- Can spot check an individual point on a damaged structure, such as Falling or Collapse Hazards (Total Stations can measure and determine XYZ coordinates).
- The instrument also performs data logging and calculations.

Initial Setup Procedure

1. Set tripod over the station point without the Total Station attached
   - With legs together, extend to chin height
   - Spread legs so tripod mounting surface is approx. level and over point.
   - Use hole in set screw to center over point.
   - Set far leg first, spacing other legs to level.
   - Ensure all leg clamps are securely fastened.
2. Remove Total Station from carrying case and mount on tripod. Insert the tripod mounting screw into the center hole of the base plate of the instrument.
3. While looking through the optical plummet, align the reticle with the station point by moving the position of the legs. (Note that that leveling of the instrument is not critical at this point.) Only two legs should be moved, other remains planted.

Initial Setup Procedure (continued)

4. Level the instrument by loosen tripod leg clamp and adjusting the leg length until the air bubble is in the center of the circular level. Lengthening a leg moves the bubble towards that leg. Retighten leg clamps. Note that changing the leg length will not change the optical plummet sight mark relative to the image of the station.

5. The instrument should be leveled further by using the procedure described in the Leveling section below.

6. Use optical plummet to check that the image of the station is still in the center of the reticle crosshairs. If station point is slightly off center, loosen the tripod mounting screw and slide instrument on tripod top surface by pushing on instrument base plate. For major offset, reposition tripod.

7. Turn on Total Station. The start-up screen will appear showing the current temperature, pressure, date, and time. To change the temp or pressure, use the ▲ or ▼ keys to move the cursor to the field requiring change and press the **ENT** key. Use the numeric key pad to enter the new value (note that the **MODE** key toggles between numeric and alpha characters.

8. Tilt the telescope to initialize the vertical angle.

9. Check level compensators (appear automatically after the telescope is tilted or 0 – key). The level compensators electronically adjust the measurements for out-of-plumb instruments, up to 3 degrees vertical. Note that this compensation introduces error into the horizontal measurements as the instrument is not located over the setup point. However, this error is only approx. 1/8-inch for a 3 degree vertical error.

Creating a New Job

To use the instrument, a new job must be creating (or an existing job must be selected):

1. Press the **MENU** key and select "1. Job" by pressing the (1) key or **REC/ENT** key to get to the Job Manager screen. Press the "Creat" softkey (MSR1).

2. Enter a job name. The default job name can be used (the date (YYMMDD) followed by a dash and a sequential digit) or enter a new job name using the keypad. Press the **ENT** key.

3. Check the job setting by pressing the "Sett" softkey or use the current job settings by pressing **ENT** or the "OK" softkey. The default US&R settings are:

Scale:	1.000000
T-P corr:	ON
Sea Level:	OFF
C&R Corr:	0.132
Angle:	DEG
Distance:	US-Ft
Temp:	ºF
Press:	inHg
VA zero:	Zenith
AZ zero:	North
Order:	ENZ
HA:	Azimuth

4. Enter current station information by pressing the **STN** (7) key. Select "1. Known" by pressing the **REC/ENT** key.

5. Enter the station name/number and station coordinates.

6. Measure the distance from the station point to the horizontal axis indicator mark on the side of the instrument (side opposite the battery). Insert this instrument height (HT) by pressing the **HOT** key and 1 (or scrolling to "1. HT" and pressing **ENT**).

Creating a New Job (continued

7. Configure **MSR1** and **MSR2** keys. Hold each key down for 3 seconds to enter/check parameters:

MSR1:	Target:	Prism
	Prism Constant:	18mm (or 30mm)
	Mode:	Precise
	AVE:	3
MSR2:	Target:	N-Prism
	Prism Constant:	0
	Mode:	Precise
	AVE:	1

8. Check that the XYZ coordinates are given as ENZ using the **MENU** key, “3. Settings”, “3. Coord.”.
9. For XYZ coordinate date collection, use BMS screen 4/4. For theodolite operations (angle measurements), BMS screen 1/4.
10. Input station information by pressing **STN** (7 key).

Menu Key

The MENU screen is used to access important functions and settings of the Total Station. To display the MENU screen, press the **MENU** key. The following options are given in the MENU screen:

1. Job (Job Manager) – Used to create and manage stored jobs.
2. Cogo – Coordinate geometry calculations, such as:
3. Settings – Used to change various settings (use the left or right arrow keys (◄/►) to toggle between the available selections.
4. Data – Used to view data (Use Screen 4/4 for US&R X,Y,Z coordinate data collection).

5. Comm. (Communication) - Transfer data to and from a computer.

6. 1sec-Key – 5 keys (illumination key, REC/ENT, MSR1, MSR2, and DSP) have additional functionality if held down for 1 second.

7. Calibrat. (Calibration) – Used to make corrections to the instrument to assure correctly measured data.

8. Time – Edit date and time.

Leveling

1) Loosen the upper plate clamp.

2) Rotate the alidade until the plate level is parallel with any two of the leveling screws.

3) Use these two leveling screws to move the bubble to the center of the level. Note: bubble moves in direction of left thumb.

4) Rotate the alidade approximately 90°.

5) Use the third screw to move the bubble into the center of the level. Do not move one of the other two screws while adjusting the third screw.

6) Repeat Steps 1 through 5 to center the bubble in both positions.

7) Use the electronic level key (0) to fine tune the leveling process, adjusting the leveling screws as described above. It will not be necessary to rotate the instrument.

Sighting Adjustments

To measure distances accurately, the instrument must be properly adjusted and focused on the target.

- To adjust the diopter, aim the telescope at a blank area, such as the sky or a piece of paper. Looking through the telescope, rotate the diopter ring (small ring at the end of the eyepiece) until the reticle crosshairs are in sharp focus.

- To check for parallax, aim the telescope at the target image. Rotate the focusing ring (large ring between the eyepiece and the telescope body) until the target image is in sharp focus on the reticle crosshairs. Move your eye vertically and laterally to check whether the target image moves relative to the reticle crosshairs. If there is relative movement, parallax had not been eliminated and the diopter needs to be adjusted.

Building Monitoring Setup

To monitor a building for movement the following steps are recommended:

1) Select a control point location that is does not interfere with other US&R operations yet provides sight lines to potential monitoring points on the structure.

2) Set up instrument as described previously.

3) Establish the control point as the Reference Point. Press the STN (7) key. Select “Known” by pressing the 1 key. Input the Station Point Number. Input the station coordinates (use X = 1000 ft, Y = 100 ft, and Z = 10 ft).

4) Enter the instrument height (HI) when prompted.

5) The next screen to be displayed is the Backsight Menu screen. Establish a back sight using a point outside the zone of US&R operations, if possible, This point should be approximately 180º from the face of the building. Select the Angle option and input 0º.

6) At the prompt for the target height (HT), enter zero if measuring to a point without a prism pole.

Sighting and Measuring

1) Loosen both the horizontal plate clamp and vertical clamp.

2) Ensure that the telescope focuses properly.

3) Use the optical sight to roughly point the telescope to the target.

4) Tighten the horizontal plate clamp.

5) Look through the eyepiece and move the telescope vertically until the target is in view.

6) Tighten the vertical clamp.

7) While looking through the telescope, use the horizontal and vertical tangent screws to sight the telescope crosshairs on the center of the target.

8) Rotate the focusing ring to bring the target into sharp focus on the reticle crosshairs.

9) Use the horizontal and vertical tangent screws to fine tune the sight to the target.

10) Press either **MSR1** or **MSR2** to take measurement (see Item 7, p. 5-26).

Sighting and Measuring (continued)

11) When the distance is displayed on the SD line, press the **REC** key. The Record RT Data Input screen is displayed.

12) Use the default Point Number (PT) or input a new number. Input Point Code (CD) if necessary.

13) Press the **ENT** key to record the point.

Establishing a New Station within an Existing Coordinate Sys

There are several methods that are available to move the instrument to a new location and then tie it back into an existing coordinate system (a form of Resection). These methods are accessed by pressing the **STN** (7) key. To set up on a known station point within an established coordinate grid:

1) Setup and level the instrument on a point with known coordinates within the current coordinate system.

2) Highlight the "1. Known" line and press **REC/ENT** or press the **1 key**.

3) Input the station or point name/number. This can be selected from a list if it has been established within the current job. Otherwise, input the known coordinates by inputting the name and pressing **REC/ENT**. Once the HI is entered, press **REC/ENT**.

4) Backsight on another known point on the grid. Input backsight name and then press **REC/ENT** to input its coordinates.

US&R STRUCTURES SPECIALIST FOG
EQUIPMENT OPERATING PROCEDURES

Instrument Handling

- Always carry the instrument in its case.
- Never place the instrument on the ground.
- Do not hold the two standards to carry the instrument around a job site.
- When leaving the instrument set up place the lens cap on and cover the whole instrument with the vinyl cover.
- Protect the instrument against the elements rain, strong direct sunlight, etc.
- During transportation always place accessories in their correct position to prevent displacement.

Drying a wet instrument

- Wipe the instrument carefully, remove the foam inserts and let them dry out completely. Never place the instrument on the ground.
- Allow instrument to air-dry before instrument is returned to its container. This prevents the telescope from fogging.

NOTES

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Nikon NPL 352 Keyboard and Display

Key	Function
PWR	Turns the instrument on or off.
	Illumination key. Turns the backlight on or off. Provides access to the 2-switch window if held down for one second.
MENU	Displays the MENU screen.
MODE	Changes the key input mode between alphanumeric and numeric if pressed when you are in a PT or CD field. Activates Qcode mode if pressed when you are in the Basic Measurement Screen (BMS).
REC ENT	Records measured data, moves on to the next screen, or confirms and accepts the entered data in input mode. You have the option to record the measurement as a CP record instead of an SS record, if you hold this key down for one second in the Basic Measurement Screen (BMS). The instrument outputs the current measurement data (PT, HA, VA, and SD) on the COM port if you press this key in the BMS or in a Stakeout observation screen. (The Data Rec settings must be set to COM.)
ESC	Returns to the previous screen. In numeric or alphanumeric mode, deletes input.
MSR1	Starts distance measurement, using the measure mode settings for the [MSR1] key. Displays measurement mode settings, if held down for one second.

Key	Function
MSR2	Starts distance measurement, using the measure mode settings for the [MSR2] key. Displays measurement mode settings, if held down for one second.
DSP	Moves to the next available display screen. Changes the fields that appear on the DSP1, DSP2, and DSP3 screens, if held down for one second.
ANG	Displays the Angle menu.
STN ABC 7	Displays the Station Setup menu. In numeric mode, enters 7. In alphanumeric mode, enters A, B, C, or 7.
S-O DEF 8	Displays the Stakeout menu. Shows stakeout settings, if held down for one second. In numeric mode, enters 8. In alphanumeric mode, enters D, E, F, or 8.
O/S GHI 9	Displays the Offset Point Measurement menu. In numeric mode, enters 9. In alphanumeric mode, enters G, H, I, or 9.
PRG JKL 4	Displays the Programs menu, which contains additional measuring programs. In numeric mode, enters 4. In alphanumeric mode, enters J, K, L, or 4.
MNO 5	In numeric mode, enters 5. In alphanumeric mode, enters M, N, O, or 5.
DAT PQR 6	Displays RAW, XYZ, or STN data, depending on your setting. In numeric mode, enters 6. In alphanumeric mode, enters P, Q, R, or 6.

Nikon NPL 352 Keyboard and Display

Key	Function
USR / STU 1	Executes the function that is assigned to the [USR1] key. In numeric mode, enters 1. In alphanumeric mode, enters S, T, U, or 1.
USR / VWX 2	Executes the function that is assigned to the [USR2] key. In numeric mode, enters 2. In alphanumeric mode, enters V, W, X, or 2.
COD / YZ 3	Opens a window where you can enter a code. The default code value is the last code entered. In numeric mode, enters 3. In alphanumeric mode, enters Y, Z, a space, or 3.
HOT / .-+ -	Displays the (HOT) menu, which includes Height of Target, Temp-Press, Target, Note recording, and Default PT settings. In numeric mode, enters – (minus). In alphanumeric mode, enters . (period), – (minus), or + (plus).
(Bubble) / */= 0	Displays the Bubble indicator. In numeric mode, enters 0. In alphanumeric mode, enters *, /, =, or 0.

NOTES


Nikon
PWR
MODE
MENU
STN ABC
PRG JKL
USR STU
S-O DEF
LG MNO
USR VWX
O/S GHI
DAT PQR
COD YZ
HOT
REC/ENT
BS
DSP 4/4
X:
Y:
Z:
PT: 1
HT: 0.000 m
ANG
DSP
MSR2
MSR1
ESC

NOTES

Wireless Building Monitoring System (WBMS)

The Wireless Building Monitoring System (WBMS) allows monitoring and detection of the tilt angle of various building structures. It is intended to provide a remote sensor for use at an emergency rescue site where these structures may be unstable. The system displays angular tilt information on a Personal Digital Assistant (PDA) or laptop computer.

Shipping Container Contents

There are 2 shipping containers for each system. Each container has the following equipment:

1) 2 Sensor Units
2) 1 Receiver Units
3) 2 Sensor Battery Units
4) 2 AC Charging Cables
5) 2 Battery Unit to Sensor Unit Power Cables
6) 1 PDA, Charger, and 128 Mb SD memory card (w/ WBMS software) – iPAQ h-2210 for USACE Units and hp-2110 for FEMA Units – all have Pocket PC 2003 Operating Sys
7) 1 Extended-life PDA battery
8) 1 PDA Earpiece
9) Users Guide and Software

System Pre-Test

Prior to mounting the Sensor Units to structural members, a system pre-test is highly recommended.

1. Unpack the system shipping container.

2. Verify that the PDA, Receiver Unit, and Sensor Unit batteries are fresh or fully charged. The PDA uses its own battery (an extended life battery may be available). The Receiving Units operates on 8 – AA batteries. The Sensor Units operate on an external battery (USACE WBMS sensor units have an optional internal battery).

System Pre-Test (continued)

3. If using external Battery Units, connect the Sensor Unit to Battery Unit power cable for the Sensor Units to be used. If the Sensor Units are to be operated on internal batteries, connect the dongle to the external power plug.

4. Turn on the power switch for one of the Receiver Units (prior to powering on the PDA).

5. Turn on the PDA. Perform a soft reset by pressing the reset key near the bottom of the backside of the PDA. Verify that the Bluetooth symbol in the lower right hand corner of the PDA screen does not have a small red circle containing an ‘X’ next to it. If not, the Bluetooth is enabled by going to the PDA Start Menu and selecting the Bluetooth Manager.

6. Select the WBMS application from the Start Menu (upper left hand corner of the PDA screen. If the WBMS application does not appear on the Start Menu, restore the application from the memory card as described later in this section.

7. Once the WBMS application starts, you will be prompted to enter a System ID. This ID is the System number of the 2 Sensor Units (e.g. “4”). (Note: any active system can be monitored by selecting its ID number.)

8. Select the appropriate Receiver Unit from the Bluetooth Manager screen. If both Receiver Units are powered on, both units will appear on the screen. (Note: both receiving units can monitor all 4 sensor units at the same time. Alarm triggering is initiated by the PDA.) A PDA can monitor only one Receiver Unit at a time.

9. The WBMS application should now be running. Verify that all the desired Sensor Units for the system show a connection and that you hear the PDA pinging noise. If less than 4 units are being used go into Settings and uncheck the unused units. This will eliminate the confirmation beep for the inactive sensor unit. This will help with both the PDA and receiver battery life.

10. Verify that the Alarm Thresholds for the desired Sensor Units are set correctly. To view the Alarm Thresholds, click the Setup key.

11. If the alarm thresholds need to be adjusted, tap on the appropriate box under the correct axis and unit designation, and use the keyboard to input the proper alarm thresholds.

12. Tilt each Sensor Unit by hand and verify that the alarm sounds, then replace to its prior orientation to stop the alarm.

13. Once proper operation is confirmed, the Sensor Units are ready to be mounted (see Sensor Unit Mounting section below). Disconnect the power cable from the Sensor Units and install Sensor Units in the desired locations. Re-attach the power cable (if using external Battery Unit) or plug in the power dongle to activate the internal battery pack.

14. Verify communications with the appropriate Sensor Units. This box indicates the Alarm Threshold for Sensor Unit A, Axis 2. Note that the ‘Error’ message is an indication of sensor data beyond the calibration limits of the sensors (see Exponent WBMS Operation Manual).

15. If there are any alarm conditions that appear immediately after powering-up the Sensor Units, use the ‘Zero All’ key found on the main screen. This will zero both of the sensors in all of the system Sensor Units. There should be no system alarms at this point.

16. The system is ready for monitoring. Note however that readings may fluctuate for the first few minutes as the sensors come to equilibrium. In normal operation, readings may occasionally fluctuate +/- 0.05 degrees. Larger fluctuations can occur due to normal movement of the structure, such as those associated with wind or temperature changes. These conditions may require increasing the Alarm Thresholds.

WBMS Operation

To monitor a structure such as a column or beam, the Sensor Unit would be attached securely to the structure via some form of strapping (rope, bungee cords, tie downs, etc.) The Sensor Units are color-coded and have a standard alphabetic designation that corresponds to the Sensor Unit color. This color corresponds to the PDA or Laptop screen where the angular data is displayed.

Data from the sensors contained in the Sensor Unit is broadcast every five seconds under normal operation, and broadcast every second when a Sensor Unit is in an alarmed state. The alarm is triggered when either clinometer measures an angular change greater than the limit specified by the user. The allowable range for the alarm threshold is from 0.01 degrees to 60 degrees. The sensitivity of the clinometers is 0.01° with a full-scale range of ±60 degrees.

The following information is shown on the main screen of the PDA or Laptop software:

- System ID number.
- Angle information for four Sensor Units.
- Sensor connection status.
- Sliding indicator that represents how close the current data is to the alarm condition.

Sensor Unit Mounting

The Sensor Units must be mounted on structural elements that will realize rotation in at least one of the monitored axes during an impending collapse. Mounting a Sensor Unit to structural elements that only translate during the early stages of a collapse may not provide enough advanced warning. It may be necessary to mount multiple Sensor units in the same region of the structure to insure the appropriate rotation is captured.

The Sensor Unit case must be firmly attached to a surface, in an upright position with the arrows on the sides of the Sensor Unit pointing up (the Sensor Unit handle will be pointing down). A cargo strap, bungee cord, or other suitable strapping material can be used to securely attach the Sensor Unit to the structure. The units should not be mounted loosely to the structure because vibration or incidental contact could trip the alarms of either axis. If mounting to a structure where vibration is unavoidable, the alarm thresholds may have to have to be increased.

PDA Power Settings

The iPaq h2210 factory default power setting turns the PDA off after 3 minutes with no user input. This feature must be disabled to keep the PDA from turning off while the WBMS software is active. To disable the automatic power down:

1. Click on Start, then click Settings.
2. Select the System tab (found near the bottom of the screen) by clicking on it.
3. Click on the Power icon, then select the Advanced tab (found near the bottom of the screen.)
4. Remove the check in the box found below ‘On battery power:’ by clicking on the checkbox, or clicking on the text to the right of the checkbox.
5. Click on ‘ok’ found in the top right corner of the screen.

The PDA contains enough battery power for four hours of continuous operation before it will need to be recharged. To charge the PDA, place it in the charging cradle or plug in the smaller charger. Note that the PDA can be operated while in the charging cradle or the smaller charger, and the battery will be charging at the same time.

The PDA screen back-lighting can be toggled on and off by depressing the power key for at least 1-second.

WBMS Sensor Unit Operation

Each of Sensor Unit contains a pair of inclinometers accurate to approximately 0.05° over a range of +/- 60 degrees) that measure the angular change, in degrees, in two orthogonal planes. A 900 mHz radio transceiver broadcasts the sensor readings and accepts user commands. The Sensor Unit is powered either by 8 or 16 AA cell (internal) or from an external Battery Unit. Battery life with both internal battery packs fully charged is over 24 hours, and the external Battery Unit provides over seven days of normal (non-alarmed) operation.

Restoring Software (based on Pocket PC 2003 operating sys)

Ideally, the iPAQ h2210 should be plugged into the charger when not in use. If the battery drains, the software will be erased from memory, and will need to be restored from the SD memory card. You can tell when this happens if you turn on the PDA and you have to re-initialize the touch screen (you see the message 'Tap the screen to setup up your Pocket PC.'). Perform the following steps to restore software from the SD card:

1. Follow the onscreen instructions to setup the PDA
2. Open the iPaq h2210 Backup software: Click on Start, Programs, then iPAQ Backup
3. Click on the Restore tab, then click the Restore… key followed by the Start key.
4. You will be notified to perform a soft reset. Upon doing this, the WBMS software will be restored.

NOTE: For later model PDA, such as hp2190 with **Mobile 5 Operating System**, the WBMS Program will not be dropped. Therefore, not Backup Software is included and no Backup and Restore is needed

Laser Range Meter (Hilti PD32)

- Allows for accurate measurement of distances using emitted visible laser beam with measuring waves, which are reflected back to the range meter with a phase shift.
- The measuring range depends on the reflectivity and the surface structure of the target surface.
- Calculations of area and volume can be performed with multiple distance measurements, as well as the addition and subtraction of distances.
- Powered by 2-AA Alkaline batteries with a life of approx. 15,000 single measurements.

Operation

- The measuring reference defaults to the rear edge of the instrument.
- The measuring reference can be changed to the front edge of the instrument by pressing the "Reference Point Shift" key located in the upper left-hand corner of the instrument.
- A spike can be extended from the rear of the instrument for measuring from inaccessible corners. The additional distance of the spike is incorporated into the measured distance.

1. Turn range meter on using the "On / Off" key located near the top right corner of instrument. The range meter is ready to use.
2. To take a single distance measurement, place the range meter measuring reference at desired location. Press the "Measuring" key (large circular key). Red laser dot will be active.
3. Position red laser dot on surface to which distance is to be measured.
4. Press the "Measuring" key again to take the distance measurement. The distance is displayed on the screen.

PD-32 Operation (continued)

The screen will display up to four successive measurements with the last measurement taken displayed at the bottom of the screen in large type.

Continuous measurements can be taken by pressing the "Measure" key for approximately 2 seconds. Distances are updated in the result line between 8 and 15 times a second, depending on the target reflectivity. A continuous measurement is indicated by a beeping when the beep signal is switched on. The continuous measuring process is stopped by pressing the "Measure" key again. The last valid distance measurement is displayed.

Area or Volume measurements are taken by first pressing either the "Area Function" or "Volume Function" keys to the left of the "Measure" key. The "Measure" key is then pressed once for each measure. The area or volume is given in the display line with individual distance measurements displayed above.

Two distance measurements can be added together by pressing the "+" key (located to the right of the "Measure" key) between the first and second measurements. Two distance measurements can be subtracted from each other by pressing the "-" key. Pressing either the "+" or "-" activates the red laser dot for the second measurement.

The normal maximum measurable distance is approximately 50 ft. Longer distances may be possible depending on the target reflectivity. A special target plate (Hilti PDA 50) is available to extend the maximum distance that can be measured to over 100 ft. Distance measurements generally improve with darker lighting conditions. Shading the instrument from direct sunlight also increases the measuring range.

The Hilti PD32 has a magnified viewer that can be used to locate the laser dot on the target.

Measurement ranges are reduced by very bright ambient light or when measuring through glass.

The display can be illuminated by pressing the illumination key located near the rear of the instrument. Shorter battery life can be expected with frequent use of the display illumination.

Settings

Several instrument settings can be changed in the setting menu which is accessed by pressing the “on / off” key for approximately 2 seconds with the instrument is turned off. Settings that can be changed are: beep signal and units. The setting menu is terminated by pressing the “on / off” again.

Maintenance

Remove the range meter from its case if it becomes wet. Clean the range meter, carrying case, and accessories. Repack the equipment only after it is completely dry.

Check the accuracy of the equipment if is used after a long period of storage or transportation.

Batteries should be removed from the range meter if it is not going to be used for an extended period of time.

Calibration

The calibration of the instrument can be preformed by measuring a distance of known length approximately 3 to 15 ft in length, 5 times. The mean of the deviations to the known distance should be within the specific accuracy tolerance of the range meter.

NOTES

INTRODUCTION to SECTION 6

This section contains information on various subjects that could become needed References at a Disaster Site.

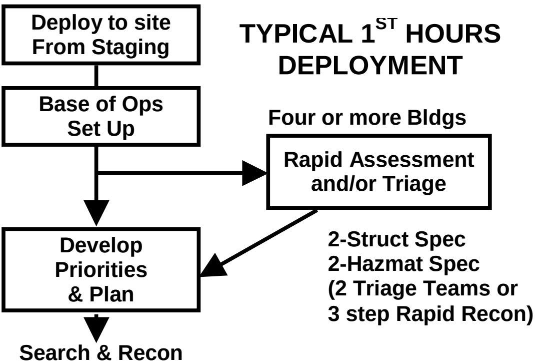
The References are arranged as follows:

- Triage Procedures & Sample Forms
- Sample Calculations of Shoring
- US&R Site Mapping Symbols
- Critical Incident Stress Information
- Rope, Knot, and, Harness Refresher
- Standard Rope Anchor Using Pickets
- Crane Hand Signals
- Excavator Hand Signals

TYPICAL FIRST DAY'S DEPLOYMENT

Immediately following deployment,(depending on incident specific conditions), the following tasks may need to be performed:

- Identification of Individual buildings
- Structure Triage / Rapid Assessment (4 or more structures)
- Structure Hazard Evaluation and Marking
- Initial Search with Search and Victim Marking
- Develop Structure Hazard Mitigation List and Priorities



STRUCTURE TRIAGE

GENERAL:

TRIAGE refers to the process of evaluating several collapsed structures and determining which structures will receive operational priority.

There are several factors which will influence the triage process:

- Occupancy
- Collapse Mechanism
- Time of Day (Relates to Occupancy)
- Prior Intelligence
- Resources Available
- Structural Condition

There are some conditions that would indicate a NO GO for US&R operations:

- Fire
- Significant HAZMAT
- Unoccupied

NO GO buildings would be re-evaluated after mitigation of the conditions.

STRUCTURE TRIAGE (continued)

TRIAGE SCORING:

The following sections refer to the Structure Triage Form, shown on Page 3-32. In general, the highest priority structures will be those with the highest score.

1. ZERO VICTIMS
If zero victims are probable, write zero and go to next building.

2. POTENTIAL NUMBER OF VICTIMS
There are 2 methods for calculating the potential number of trapped victims: Building Area or Building Occupancy.

A. BUILDING AREA

Public Assembly	1 per 25 sq ft.
Schools	1 per 70 sq ft.
Hospitals	1 per 100 sq ft.
Commercial	1 per 100 sq ft.
Office/Gov't	1 per 150 sq ft.
Public Safety	1 per 150 sq ft.
Multi-Residential	1 per 200 sq ft.
Industrial	1 per 200 sq ft.
Warehouse	1 per 600 sq ft.

B. OCCUPANCY

School	20-30 per Classroom
Hospital	1.5 per Bed
Residential	2.0 per Bedroom
Other/Unknown	1.5 per Parking Space

The numerical value of this portion will vary from 1 to 50 as the number of potential victims varies from 1 to >200.

STRUCTURE TRIAGE (continued)

TRIAGE SCORING (continued)

3. CONDITION OF VOIDS

Victims do not survive well in tightly compacted collapse areas consisting of masonry rubble, or broken concrete.

Open survivable voids are often found under wooden floor panels that collapse into angular, interlocking planes and concrete structures where floors have projecting beam elements that hold slabs apart.

Partially collapsed structures may have large triangular voids. These voids have the best chance of having surviving victims.

The value of this will vary from 1 (no survivable voids) to 20 (many survivable voids).

4. ACCESS TIME

This is the estimate of the time required to reach the first victim. It should include the time required to mitigate hazards or breach floors, walls, etc.

Score will vary from 1 (taking more than one day) to 20 (for taking less than 2 hours).

5. CHANCE OF ADDITIONAL COLLAPSE

This is the potential for additional collapse due to aftershocks. Score -1 for low chance to -20 for high chance.

6. SPECIAL OCCUPANCY INFORMATION

This would entail special information, such as involving children, etc.

STRUCTURE TRIAGE FORM - TRI-1 DATE/TIME: ________ BY: ____________ PAGE ____ OF ____

TEAM: ______ **STRUCTURES SPECIALIST:** ______ **DATE/TIME OF CATASTROPHE:** ____________

AREA MAP

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE		(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5		(MIN=1 MAX=50)		
No. STORIES: ______	3. CONDITION OF VOIDS	1	>VERY COMPACT>SEPARATE LAYERS>PART COLLAPSE	20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1	> ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE	-1	> LOW CHANCE >>>>>>>>>>>> HIGH CHANCE	- 20	-
	6. SPECIAL INF.:		SCHOOL / HOSPITAL = +25 KNOWN LIVE VICTIM = +5 EACH		
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______				BLDG. TOTAL

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE		(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5		(MIN=1 MAX=50)		
No. STORIES: ______	3. CONDITION OF VOIDS	1	>VERY COMPACT>SEPARATE LAYERS>PART COLLAPSE	20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1	> ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE	-1	> LOW CHANCE >>>>>>>>>>>> HIGH CHANCE	- 20	-
	6. SPECIAL INF.:		SCHOOL / HOSPITAL = +25 KNOWN LIVE VICTIM = +5 EACH		
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______				BLDG. TOTAL

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE		(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5		(MIN=1 MAX=50)		
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OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1	> ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
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CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______				BLDG. TOTAL

Structure Triage Form - TRI-2 **Date/Time:** ______ **By:** ______ **Page** ___ **of** ___

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE	(WRITE ZERO) GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5	(MIN=1 MAX=50)	
No. STORIES: ______	3. CONDITION OF VOIDS	1 >VERY COMPACT>>SEPARATE LAYERS>>PARTIAL COLLAPSE> 20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1 > ONE DAY >>>>>>>>>>>>>>>>>>>>> 2 HOURS > 20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE	-1 > LOW CHANCE >>>>>>>>>>>>>>>> HIGH CHANCE > -20	-
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CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______		BLDG. TOTAL

Methods to Calculate Number of Occupants Depending on Use

Based on Area		Variation	Based on other than Area
Schools, Library	1 per 70 sq ft	50 to 100	25 to 35 students per classroom
Hospitals	1 per 100	80 to 150	1.5 occupants per bed
Multi Residential	1 per 200	100 to 200	1.5 occupants per bedroom
Commercial	1 per 100	50 to 200	
Office, inc Govt.	1 per 150	100 to 200	Others
Public	1 per 25	10 to 50	1.5 occupance per Parking space
EOC, PD, FD	1 per 125	100 to 150	
Industrial	1 per 200	100 to 300	Also - how many cars are left in
Warehouse	1 per 600	400 to 900	parking lot?

Notes & Calcs

STRUCTURAL CALCULATIONS

MATERIAL PROPERTIES USED IN CALCULATIONS

Concrete Properties

Weight = 150 pcf F_c' = 3000 psi (28-Day Strength)

Wood Allow Stress Design Properties – D. Fir & So. Pine
One may increase these values by 60% for US&R Shores
See Section 5 (FAQ) for Strength of other Wood Species

Mod. of Elasticity = E = 1,400 to 1,600 ksi

Bending Stress = F_b = 1500 psi for 4x and 1200 psi for 6x

(Sect. Modulus = S = $BD^2/6$, Mom. of Inertia = I = $BD^3/12$)

Horiz. Shear Stress = F_v = 95 psi for 4x and 85 psi for 6x

Compression Parallel to Grain = F_c = 1100 psi

Compression Perpendicular to Grain = $F_{c\perp}$ = 625 psi

Buckling Strength = F_a = 480,000 psi / $(L/D)^2$

L/D = 25 max. (to see crushed cross-grain before buckling)

L/D = 50 max. (but failure may be by sudden buckling)

INDEX of SHORING CALCULATIONS

I-880 Vertical shoring of typical bent at the 2-story highway bridge (1989 Loma Prieta Quake) using 12x12 posts.

Pun-1 Vertical shoring schemes to reduce possibility of punching shear failure in typical flat-slab floor w/drop panel at column. Using 6x6 posts or 4x4 cribbing.

6

4-Story Diagonal bracing used from curb to 2nd floor in Marina Dist. (1989 Loma Prieta Quake) to stabilize 4-story wood apartment bldg. Work was done by Trost House Movers.

Rak2 Sample calc of Solid Sole, Double Raker System.

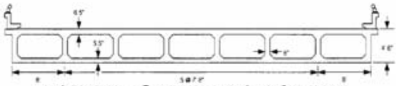
Rak1 Sample calc using Flying (Friction) Raker. Illustrates that capacity is reduced due to bending stress in Raker.

Tieback Sample calc for use of Tied-back Strongbacks, to restrain un-collapsed but damaged URM wall in multi-story bldg

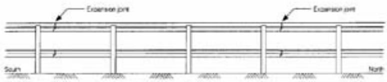
STRUCTURAL CALCULATIONS (continued)

EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

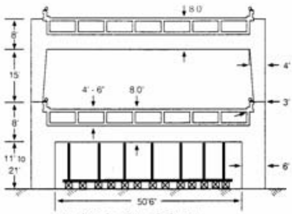
1-880 PG•1
OCT 91



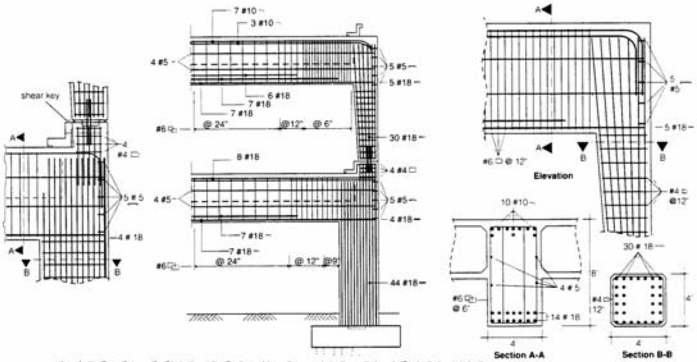
TYPICAL ROADWAY SECTION



TYPICAL SIDE ELEVATION/LAYOUT



TYPE B1 BENT



TYPE B1 BENT DETAILS AND DIMENSIONS

WEIGHT OF ONE BAY, ONE LEVEL

ROADWAY BOX-BEAM	6½"+5½" SLABS = 150PSF×56' = 8400 PLF
	RIBS = 3.5'×10"AVE/12×150PCF×8 = 3500 PLF
BENT CAP BEAM	8'×4'×150PCF × 50' = 240K PER BENT
BENT COLUMNS	3.5'×4'×150×15'×2 COLS = 63K (NOT SHORED)
SAY BENT IS 80' O.C.	BOX-BEAM = 12KLF×76' = 912K
	CAP BEAM = 240K EA = 240K
	AUTOS, ETC = 38K
	TOTAL 1200K × .8✳ = 960K

✳ = ASSUME 10% IN CONC COLUMN AT EA END

EMERGENCY SHORING OF STRUCTURES — 1-880 PG•2
D. HAMMOND — OCT 91

- CHECK CAPACITY OF 7-12X12 WOOD POSTS, 18FT LONG

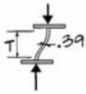
  L/D = 216"/11.3" = 19 Fa = $480,000/(19)^2$ = 1310PSI
  1200PSI MAX. GOVERNS
  OR
  730PSI IF ⊥ GRAIN BRG. ON WEDGES

- CAPACITY BASED ON POSTS = 1200X128SQ.IN.X7 = 1075K

  IF BASED ON 730PSI BEARING = 730/1200 X 1075 = 672K N.G.
  (VS. 960K)

- CHECK CAPACITY OF W12X65 SPREADER BEAM

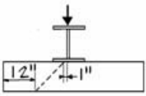
  SAY POSTS AVE. 6FT O.C. M = 137K PER X 6/6 = 137FT-K
  M/S = 137X12/88 = 18.7KSI O.K.



CHK BUCKLE STR OF WEB KL = 1.2 X T = 1.2 X 9½" = 11.4"
R = t WEB/$\sqrt{12}$ = .113
KL/R = 11.4/.113 = 101
Fa = 13KSI

CAPACITY OF 13 BEARINGS = 13X13KSIX.39X(11.3+2) = 870K O.K.
(WITHIN 10% OF 960K)

- CHECK USE OF 13- 12X12X4FT SPREADERS TO SLAB PAVING



LOAD IN EACH = 960/13 = 74K

LOAD PER FT = 74/4 = 18.5K

M = $18.5X2^2/2$ = 37 FT-K
M/S = 37X12/240 = 1850PSI (HIGH BUT CLOSE)

Vd = 18.5X1 = 18.5K
SHEAR CAPACITY = 85PSIX.67X11.3 = 7.2K

NEED ABOUT TWICE AS MANY SPREADERS TO REDUCE HORIZ. SHEAR STRESS AND REDUCE THE 19KSF BEARING ON THE SLAB

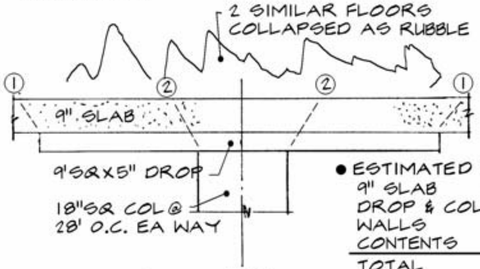
- FINAL QUESTION : WE HAVE CHECKED TO SHORING FOR LOAD OF ONE LEVEL OF FLOOR ONLY. IF LOWER FRAME IS DAMAGED ONE WOULD THINK THAT THE SHORES SHOULD FIGURE FOR THE LOAD OF BOTH FLOOR LEVELS

6

STRUCTURAL CALCULATIONS (continued)

EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

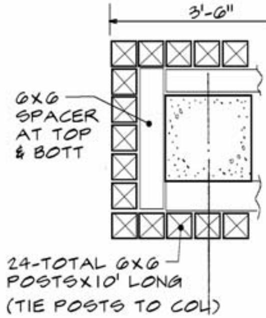
PUNCHING 1 PG-1
REV. NOV03



- ESTIMATED LOAD

9" SLAB	125PSF
DROP & COL	25
WALLS	10
CONTENTS	10
TOTAL	170/FLOOR

$\times 28' \times 28' \times 3 = 400K$



- CHECK PERIF. SHEAR (AT DISTANCE d/2 FROM FACE OF DROP 1 & FACE OF COL 2)

AT 1

349K

$$V_u = \frac{(400K - .51KSF \times 100SQ') \times 1.4 \text{ ULT}}{.85 \times (9" - 2")\ 4\ (108" + 12")}$$

$V_u = 171$ PSI ALLOW $4\sqrt{F'_c} = 220$PSI FOR 3000PSI CONC

AT 2

$$V_u = \frac{(400K - 5K) \times 1.4}{.85 \times (14-2) 4 (18+12)} = 452\text{PSI N.G.}$$

- 6X6 POSTS

$P/A = 400K/24 \times 30.3$
$= 550$PSI

$L/D = 120/5\tfrac{1}{2} = 22$

$Fa = 480{,}000/22^2 = 1010$PSI

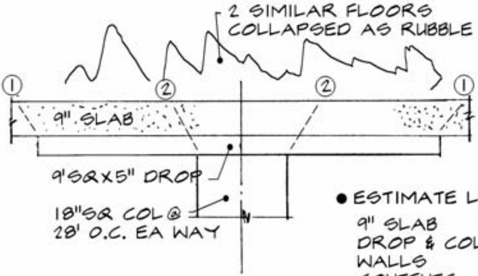
- INCREASE PERIPHERY - ADD 6X6 VERT. WOOD POSTS TO PROVIDE 42" SQUARE

$$V_u = \frac{(400K - 10K) \times 1.4}{.85 \times (14-2) 4 (42+12)} = 248 \text{ CLOSE}$$

POSTS FIGURE FOR PERP. TO GRAIN BEARING (730PSI MAX) SO SHIMS & SPREADER MAY BE USED. LOAD MUST BE SPREAD TO FLOORS BELOW (THRU PERIF SHEAR OR ON TO EXISTING FOOTING. ONE MUST ALSO CONSIDER IF THE SLAB SHOULD BE SHORED AT MID-SPAN ETC. BY OBSERVING CRACKS SINCE THEY ARE NORMALLY VISIBLE FROM BOTTOM OF SLAB.

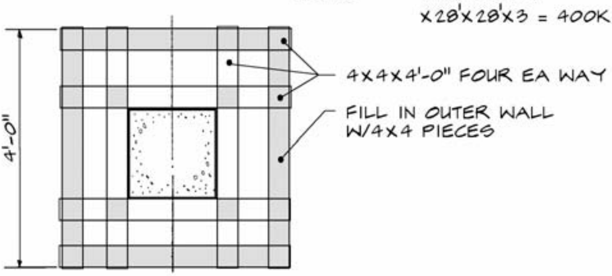
EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

PUNCHING 1 PG-2
REV. NOV03



- ESTIMATE LOAD

9" SLAB	125PSF
DROP & COL	25
WALLS	10
CONTENTS	10
TOTAL	170/FLOOR
	x28'x28'x3 = 400K



- CRIB

BEARING AREA
48x48 - 41x41 = 623SQ"

P/A = 400K/623 = 642PSI
O.K. FOR DOUGLAS FIR

- INCREASE PERIPHERY BY ADDING CRIB MADE FROM 4x4x4' LAID IN 4 EACH WAY PATTERN W/OUTSIDE EDGES BEING FILLED IN.

$$V_u = \frac{(400K-12K)\times 1.4}{.85\times(14-2)\,4\,(48+12)} = 222\text{PSI O.K.}$$

THIS METHOD USES SMALLER PIECES THAN USING 6x6 POSTS AND IS FAST TO BUILD, SINCE ALL SHIMMING MAY BE DONE AFTER CRIB IS IN PLACE. IF 4x6 LUMBER IS USED THIS CAN BE LAID-UP FASTER. NEED TO CHECK CRIB DAILY FOR TIGHT FIT IF GREEN LUMBER IS USED.

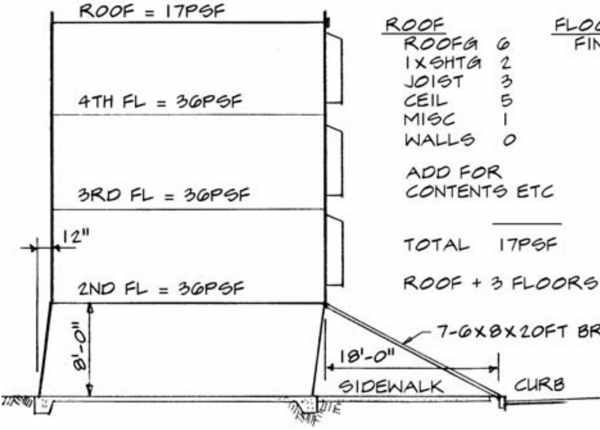
STRUCTURAL CALCULATIONS (continued)

EMERGENCY SHORING OF STRUCTURES — 4 STORY PG•1
D. HAMMOND — OCT 91

TYPICAL LOADS

ROOF		FLOOR	
ROOFG	6	FINISH	1
1XSHTG	2		2
JOIST	3		4
CEIL	5		5
MISC	1		1
WALLS	0		17
ADD FOR CONTENTS ETC			6
TOTAL	17PSF		36PSF

ROOF + 3 FLOORS = 125PSF



CROSS SECTION OF 4 STORY WOOD APARTMENT

EXAMPLE IS 50'X88' BLDG AT BEACH & DIVADERO, SAN FRANCISCO
OFFSET BY LOMA PRIETA QUAKE & BRACED BY CONTRACTOR

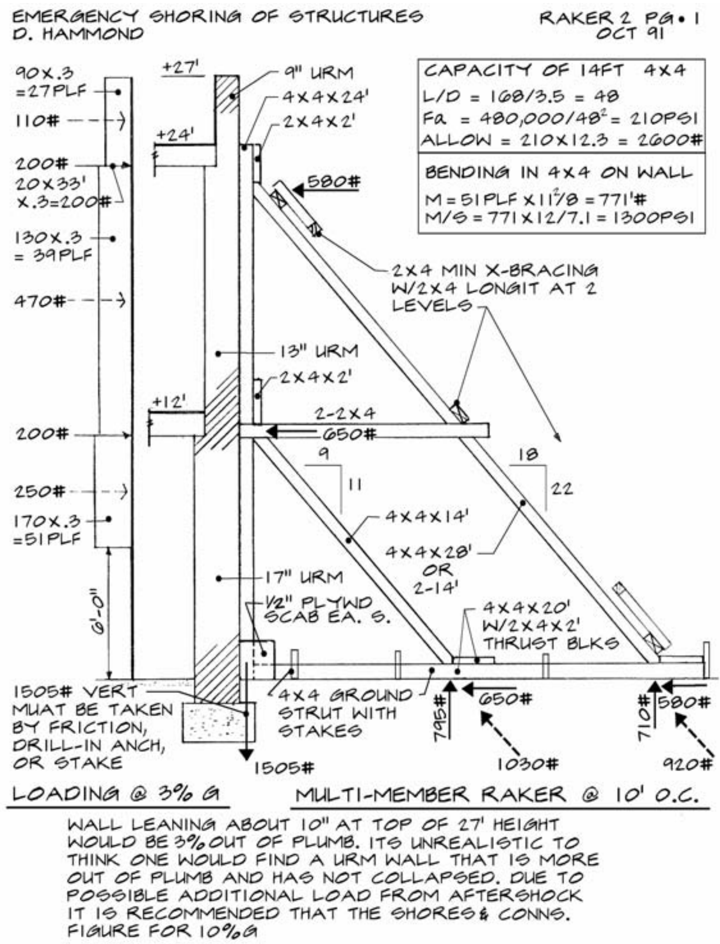
- TOTAL LOAD OF BLDG = 125PSFX50'X88' = 550K

  OFFSET IS 12" IN 96" = 12.5%
- REQD BRACE FORCE = 550KX.125X20/18 = 76K
- 6X8 L/D = 240"/5.5 = 44 Fa = 480,000/44 = 250PSI

  CAPACITY OF BRACES = 250X41SQ.IN.X7 = 72K
  X1.25 FOR SHORT TERM LOAD = 90K
- FORCE PER BRACE = 11K IF SPREAD 4' AT CURB = 2.7K/FT

  VERTICAL COMPONANT AT 2ND FLOOR = 11KX8/20 = 4.4K

STRUCTURAL CALCULATIONS (continued)



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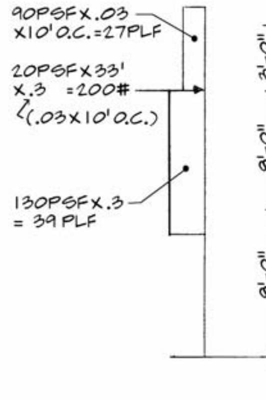
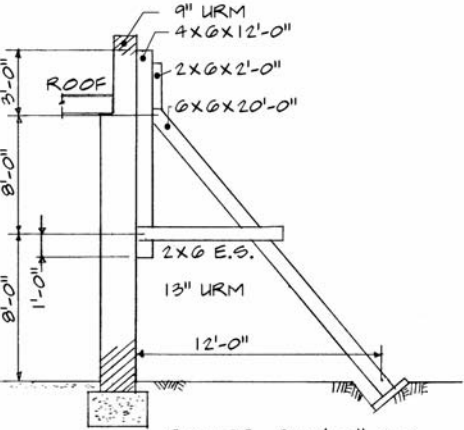
STRUCTURAL CALCULATIONS (continued)

EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

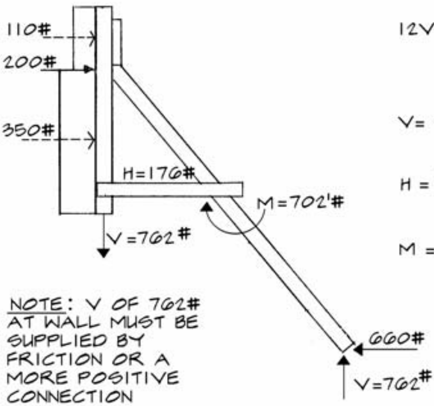
RAKER 1 PG•1
OCT 91



LOADING @ 3% G



RAKER @ 10'-0" O.C.



$$
\begin{aligned}
12V &= 110\# \times 17.5' = 1925 \\
&\quad + 200 \times 16' = 3200 \\
&\quad + 350 \times 11.5' = \underline{4025} \\
&\qquad 9150
\end{aligned}
$$

$$V = 9150/12 = 762\#$$

$$H = \frac{660 \times 16 - 762 \times 12}{8} = 176\#$$

$$M = 660 \times 8 - 762 \times 6 = 702'\#$$

NOTE: V OF 762# AT WALL MUST BE SUPPLIED BY FRICTION OR A MORE POSITIVE CONNECTION

EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

RAKER 1 PG•2
OCT 91

CHECK MEMBER STRESSES

6X6 BRACE

L/D = 240"/5.5 = 44   Fa = 480,000/44^2 = 250PSI

P/A = 10/6 X 660#/30.25SQ.IN. = 36PSI
M/S = 702'#X12/27.7IN = 304PSI

INTERACTION = 36/250 + 304/1200-36 = .40 ALLOW 1.25

4X6 SPREADER

M = 110#X1.5' = 165'# OR 39X8 /8 = 312'#

M/S = 312X12/11.2 (WEAKWAY) = 330PSI

2-2X6 STRUT

L/D (INDIVIDUAL PIECE) = 70"/1.5"^{2} = 47   Fa = 220

P/A = 176#/2X1.5X5.5 = 11PSI

CONNECTIONS

ALLOW FOR ONE 16d NAIL = 108#X1.25 = 135#

THRUST BLOCK = 762# NEED ONLY 6 NAILS
STRUT = 176" NEED ONLY 2 FOR 2 PIECES

COMMENT

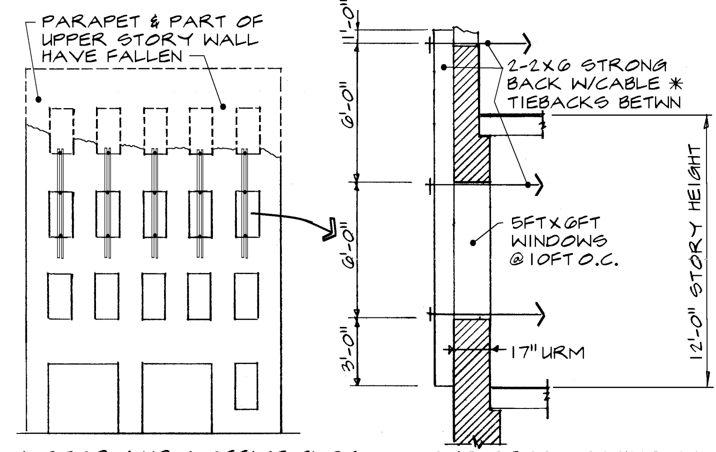
MEMBERS COULD SUPPORT 3 TIMES THE 3%LOAD OR ABOUT 10%G WHICH IS RECOMMENDED. THE CRITICAL ISSUE REMAINS "HOW TO RELIABLY RESIST THE VERT. REACTION AT THE WALL FACE".

ONE 5/8"Φ STEEL DOWEL OR DRILL-IN ANCHOR WILL RESIST A FORCE OF SOMEWHERE BETWEEN 500 & 1000#, DEPENDING ON QUALITY OF THE MASONRY.

STRUCTURAL CALCULATIONS (continued)

EMERGENCY SHORING OF STRUCTURES
D. HAMMOND

TIEBACK 1 PG•1
OCT 91



4 STORY URM OFFICE BLDG

TYP SECT AT WINDOW

- LOAD ON TIEBACK

  170PSF X .1 X 10FT = 170PLF

  ADD FOR PIER BETWN WINDOWS
  170PSF X .1 X 5FT X 6FT/2 = 255#

- MAX BENDING IN STRONGBACK

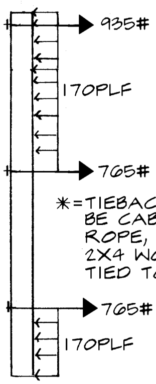
  170PLF X 6^2/8 = 765'#

  M/S = 765 X 12/2 X 7.6 = 600PSI

- MAX LOAD ON TIEBACK

  170PLF X (3FT + 1FT) + 255# = 935#
  (AT TOP)

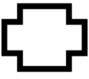
  170PLF X 3FT + 255# = 765#
  (AT WINDOW HEAD & SILL)



*= TIEBACKS COULD BE CABLE, UTILITY ROPE, OR EVEN 2X4 WOOD PIECES TIED TOGETHER

* TIEBACKS COULD BE EXTENDED ACROSS BLDG TO OPP WALL AND ANCHORED. OR ANCHORED TO FLOOR BEAMS.

ICS BASE MAP SYMBOLOGY

- Time denoted—22Aug03 0700hrs
  - (with arrow pointing to activity site)
- Incident Command Post 
- Incident Base — B
- Camp — C
- Decon Area — D
- Fire Station — F
- Helibase — H
- Telephone — T
- Repeater/Mobile Relay — R
- Staging Area (by name) — S
- Mobile Weather Station — W
- First Aid Station 
- Drop Point — D-P ●

INSARAG MAP SYMBOLS

These symbols were developed by the U.N. International Search & Rescue Advisory group are used Internationally. They should be used for FEMA US&R Mapping

- EOC (box w/ EOC) — EOC
- SAR Base of Ops (circle w/ BoO) — BoO
- Work Site (circle with WS) — WS
- Airport (AP in circle) — AP
- Landing Zone (circle w/ LZ) — LZ
- Hospital (circle w/ Hos, changed from H due to conflict w/H for ICS Helibase) — Hos
- Hazards (write hazards & specify zone) — GASES
- Fuel (circle w/ F) — F
- Reference Point/Landmark (triangle - include descriptor) — △

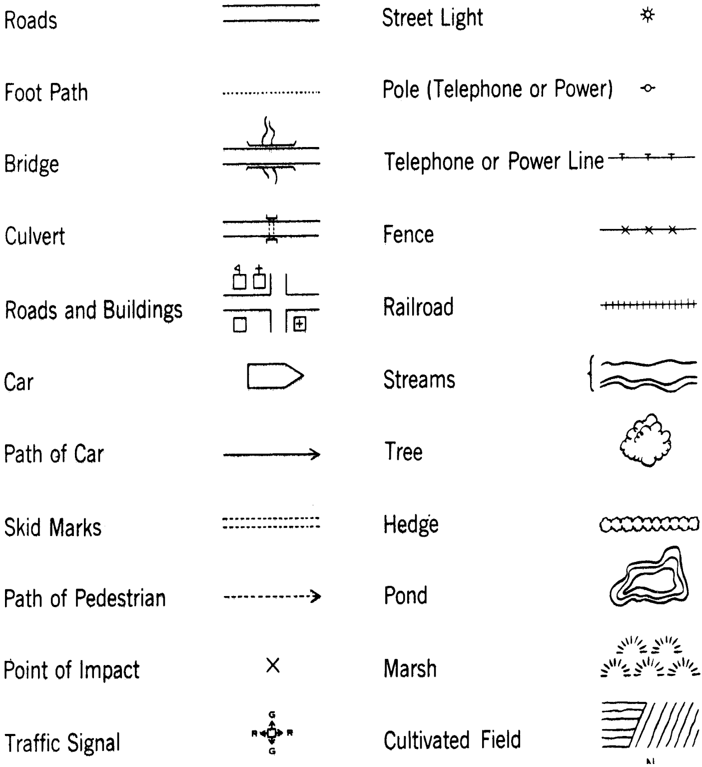
FEMA US&R SHORING SYMBOLS

These symbols were developed by the FEMA US&R Technical Working Group, and should be used to map locations of US&R Shoring

- Tee Shore — **T**
- Vertical Shore (V-3 = 3 posts) — **V-3**
- Laced Post Shore — **LP**
- Cribbing — **C**
- Raker Shore — **R**
  - Place vertical side of triangle against wall
  - Each triangle represents one Raker
  - Rakers should be installed groups of two or larger

OTHER STANDARD DRAWING SYMBOLS

These symbols should be used as needed for FEMA US&R Sketches, Maps and Drawings



OTHER STANDARD DRAWING SYMBOLS (continued)

Man

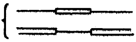
House

Church

School

Hospital

Window

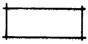


Door

Chair (Straight Back)

Chair (Overstuffed)

Furniture



Stairway

Elevator Shaft

6

CRITICAL INCIDENT STRESS

CRITICAL INCIDENT STRESS (CIS) results from a crisis event, so overwhelming to the individual that it is likely to cause short or long term malfunctioning.

GENERAL:

1. The effects of CIS impair functioning on-scene and may continue to emerge upon demobilization or thereafter.

2. Self monitoring and management of CIS is critical for both short and long term personal well being and team performance.

3. As a Structures Specialist, you will be working in an environment that is difficult (at best) that may produce CIS reactions because of the following factors:

    a. Exposure to extreme stimulus involving death, mutilation, destruction, and threat under arduous conditions.

    b. Pressure to make consequential decisions under aggravated conditions of uncertainty, fatigue, and duress.

    c. Role conflict, competing demands, shifting command and assignments, and an unlimited/changing scope of work.

CRITICAL INCIDENT STRESS (continued)

ALERT:

1. If after self examination you feel unready to proceed with the assignment, do not accept it. It is better to remain fit for future assignments than to become impaired from this one.

2. The following factors can create special vulnerability to CIS:

   Prior Trauma
   Background Stress
   Family Disruption/Discord
   Physical Fatigue
   Psychological Need
   Recent Changes/Loss
   Feelings of Inadequacy
   Overly Optimistic or Pessimistic Beliefs

RECOGNITION:

On-scene CIS is termed **ACUTE STRESS RESPONSE (ASR).** ASR at the disaster scene can manifest itself in altered thought process, emotions, physical symptoms, and behavior. ASR may manifest in yourself or others. The signs of ASR can include various combinations of the symptoms listed below:

CRITICAL INCIDENT STRESS (continued)

COGNITIVE:

- Confusion
- Memory Loss
- Can't Recall Words
- Time Distortion
- Difficulties with Problem Solving
- Trouble Prioritizing

EMOTIONAL:

- Fear
- Anger
- Frustration
- Anguish
- Numb
- Anxiety
- Intense Frustration
- "Inappropriate" Feelings
- "Overwhelmed"

PHYSICAL:

- Headaches
- Heart Palpitations
- Muffled Hearing
- Nausea
- Cramps
- Profuse Sweating
- Rapid Breathing
- Fainting
- Other Signs of Shock

CRITICAL INCIDENT STRESS (continued)

ASR normally consists of some combination of these symptoms into one of two general categories: **AGITATED** or **DEPRESSED**. Look for the following:

AGITATED (25% of ASR Cases):

Appearance:	Flushed, sweating, agitated
Mood:	Panicked, enraged, hysterical
Behavior:	Rapid, frenzied, ineffectual, uncontrolled

DEPRESSED (75% of ASR Cases):

Appearance:	Pale, submissive, shock-like
Mood:	Blunted, numb, emotionally unresponsive
Behavior:	Slowed, automatic, paralyzed, immobilized

CRITICAL INCIDENT STRESS (continued)

SELF MANAGEMENT:

Remember and resist your tendency to ignore your own needs. If you are not functioning fully, you will be a danger to others on-scene, to yourself, and later on to your family.

If you are experiencing some of the signs of ASR:

Let your partner and supervisor know about it.

Act on your own behalf:

Take an extended break away from the disaster scene.

Take fluids and nourishment (cut down caffeine and sugar - increase carbohydrates).

Discuss your experiences and reactions with others.

Listen to the advice of trusted others.

Do not resume duties until you are reoriented and restabilized.

Ask for and accept support services, such as on-scene consultation or debriefing ASAP.

CRITICAL INCIDENT STRESS (continued)

MANAGEMENT OF OTHERS:

If you observe others (partners, colleagues, or supervisors) exhibiting ASR signs:

Convey your observations and concerns to that person.

Advise that person to follow the general protocols for self-management.

If person is **AGITATED**:

Use firm, calm directions to gain attention and provide direction.

When providing feedback regarding your concerns, focus on behavior rather than the person.

Provide simple but relevant and useful tasks.

Get medical assistance.

If person is **DEPRESSED**:

Have individual sit or lie down.

Be supportive and check for comprehension.

Do not overload with information or negative content.

Screen for shock.

Get medical assistance.

CRITICAL INCIDENT STRESS (continued)

ON-SCENE CIS SERVICES:

CIS services may be available through the Task Force or Unit to which you are assigned.

Initially you should request CIS services through the Task Force or Unit Leader.

If CIS services are unavailable through your unit of assignment, they can be obtained through the IST Overhead personnel.

The Corps US&R Field Coordinators are authorized to arrange CIS services for Corps US&R personnel. These services may be available to US&R Task Force personnel.

CIS debriefings are normally provided at the demobilization site prior to your return home as part of the standard out-processing procedures, and will be coordinated through overhead personnel.

CRITICAL INCIDENT STRESS (continued)

HOME STATION (POST DEPLOYMENT):

Delayed stress reactions are possible in the days, weeks, or months following your return from the disaster.

SELF-MONITORING:

Self-monitoring is just as important after returning home as it is during US8 R operations. You should monitor yourself for any of the following reactions:

Flashbacks
Nightmares
Problems at Home
Problems at Work
Depression
Anxiety
Guilt
Fears
Isolation
Difficulty Relating to Others
Problems with Self-Control
Disproportionate Emotionality
Obsessive Thoughts About Incident
Psychosomatic Illness
Precipitous Life Changes
Unhappiness/Dissatisfaction

These reactions, if moderate, are fairly normal and transient. If they last more than four to six months, however, or are negatively effecting your personal or work life, you should get help in working through those thoughts, feelings or attitudes engendered by the disaster experience.

CRITICAL INCIDENT STRESS (continued)

FOLLOW-UP:

It is suggested that you make 3 visits with your home station CIS provider after returning home. The schedule of suggested visits is as follows (R = return date):

R + 3-5 Days
R + 2 Weeks
R + 2 Months

Take full advantage of these opportunities to discuss your feelings and reactions. These can include reactions encountered privately, within your family, and at work. Any of the reactions listed earlier should be included in the discussion(s).

CIS guidelines have been furnished to your local CIS provider. In addition, they have been given material to assist your family and supervisors.

If your CIS provider or your family suggest meeting together, take the request seriously, even if you do not see the need yourself. They may see something that you don't. They are worth the effort.

The last people you want to hurt are your family members and loved ones. You can hurt them by your left over fears and anger. You can also hurt them by withdrawing into yourself and shutting them out.

Talk to them about your experiences (children can be spared the graphic details).

HAZMAT FIRST RESPONDER AWARENESS

Structures Specialists should carry their Department of Transportation's Emergency Response Guidebook (DOT P 5800.5) during deployment.

As a Structures Specialist conducting an initial evaluation of an incident, you may be the first to encounter or discover a HAZMAT condition.

When surveying the incident, be aware of potential HAZMAT indicators:

Unusual colors/odors
People running from scene
Evidence of Leak
Unusual noise in fittings/valves
Container Shapes
Placards or Signs
Occupancy/Location

Upon discovery or suspicion of a HAZMAT situation your mission is:

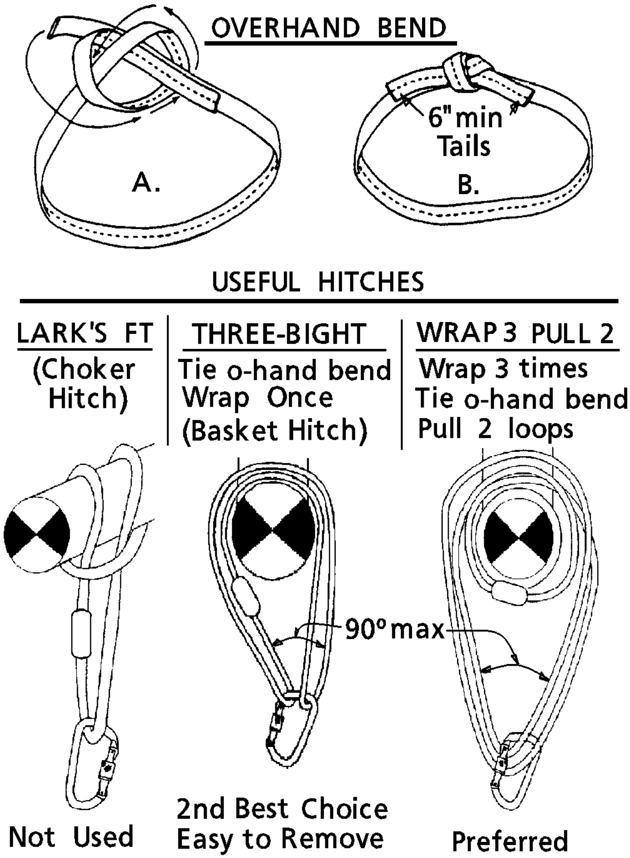
SAFETY of yourself and team members.

ISOLATE & DENY ENTRY.

NOTIFICATION of Team HAZMAT specialist or local authorities.

THINK SAFETY AT ALL TIMES.

ROPES, KNOTS & HARNESSES



ROPES, KNOTS & HARNESSES (continued)

FIGURE EIGHT STOPPER

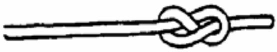
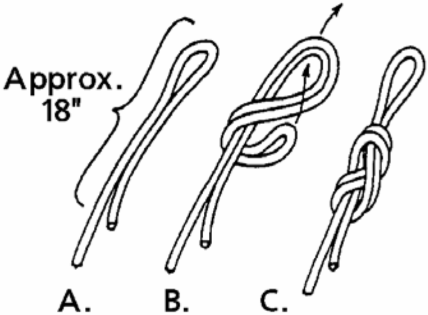
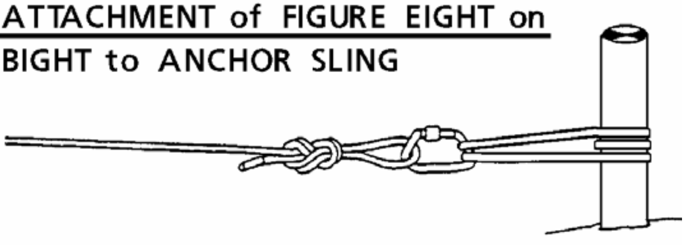


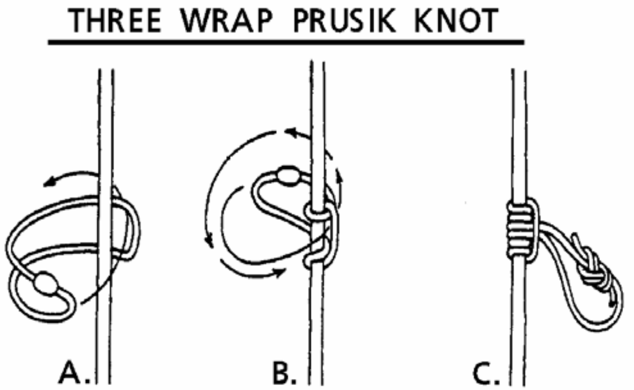
FIGURE EIGHT ON A BIGHT

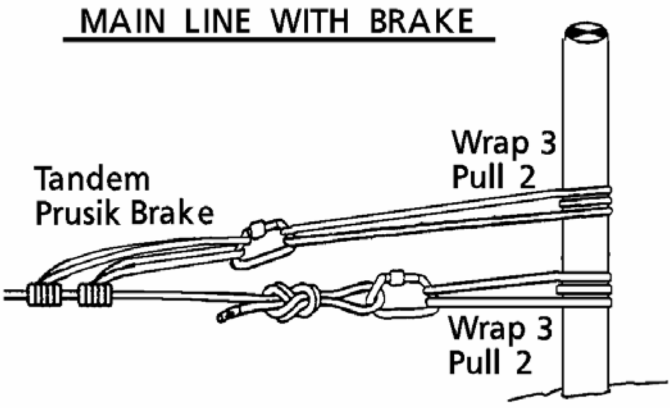


ATTACHMENT of FIGURE EIGHT on BIGHT to ANCHOR SLING

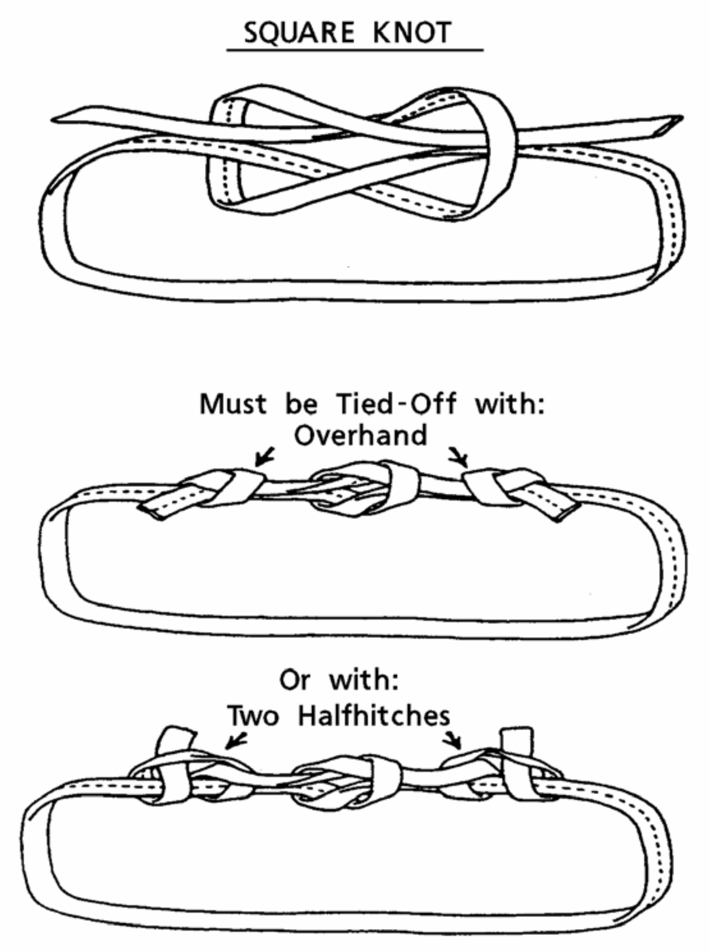


ROPES, KNOTS & HARNESSES (continued)

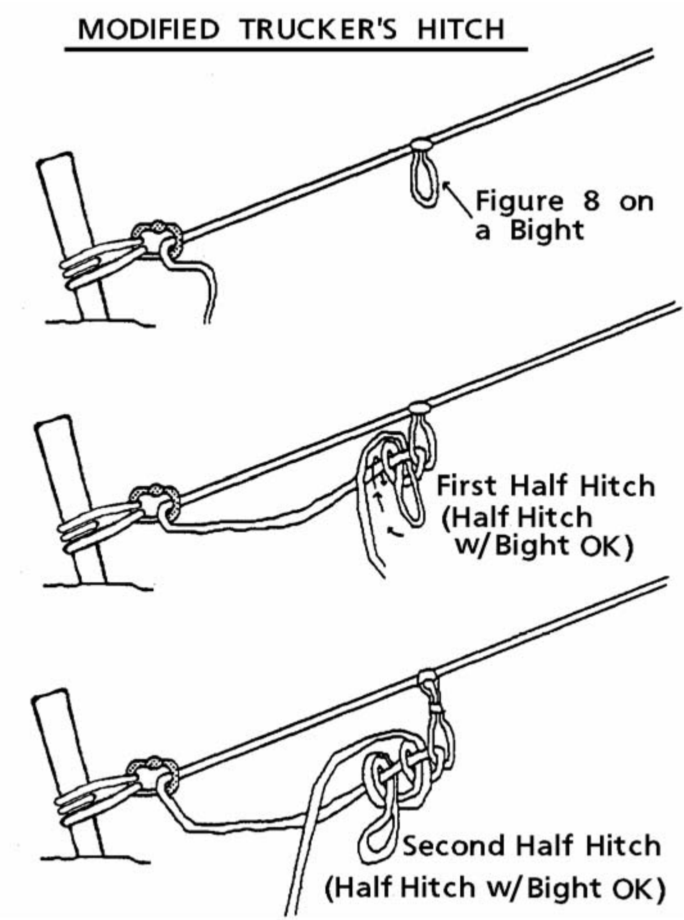




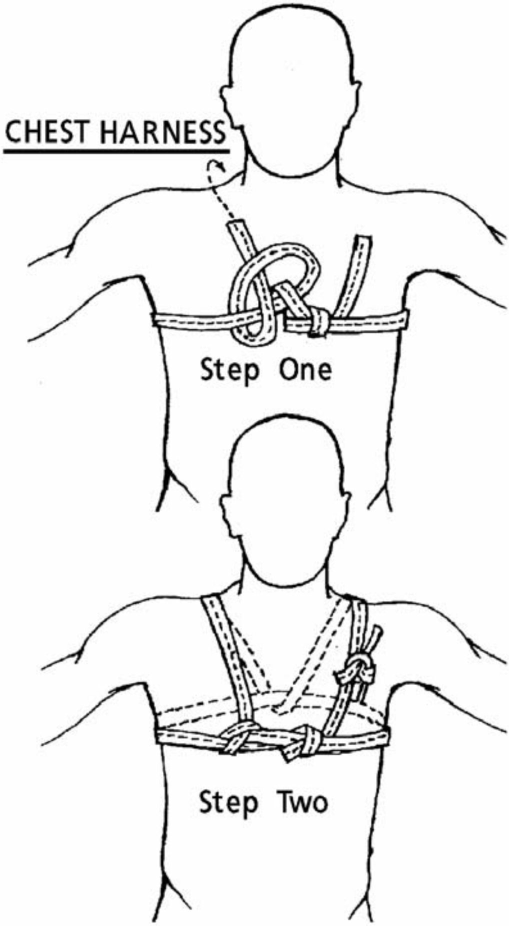
ROPES, KNOTS & HARNESSES (continued)



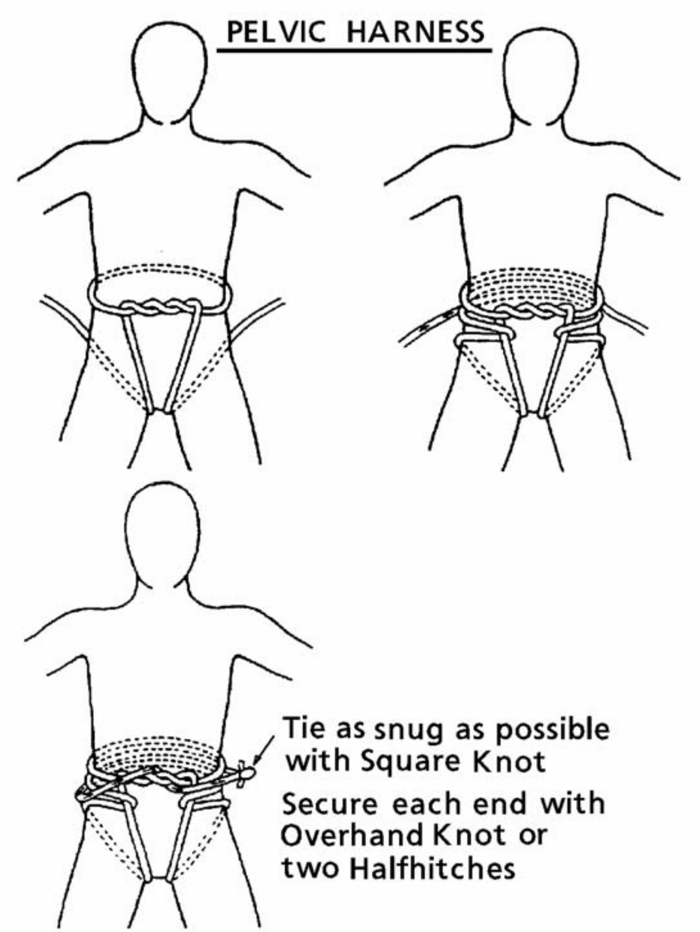
ROPES, KNOTS & HARNESSES (continued)



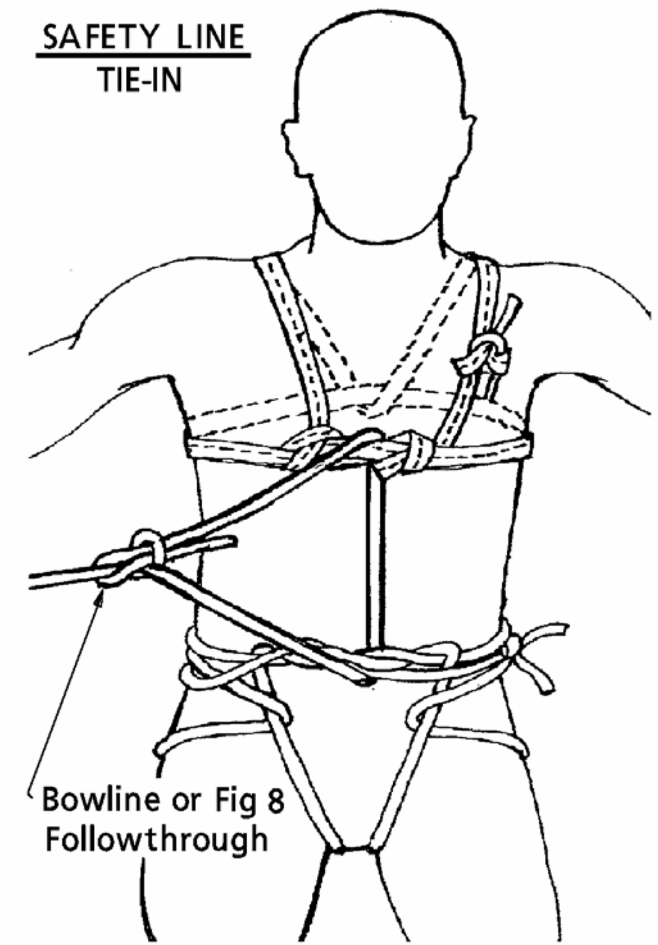
ROPES, KNOTS & HARNESSES (continued)



<u>ROPES, KNOTS & HARNESSES</u> (continued)

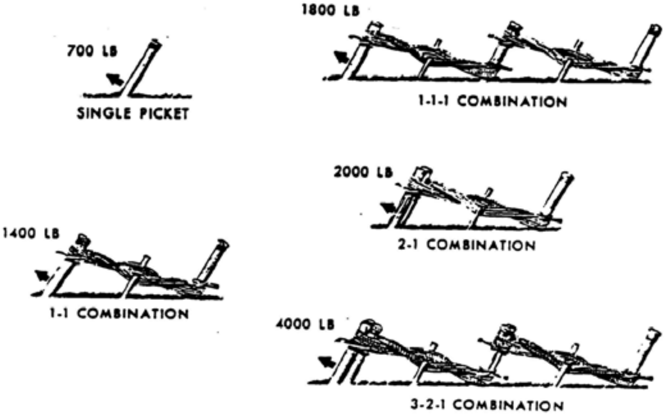


ROPES, KNOTS & HARNESSES (continued)



ROPE ANCHORS USING PICKETS

The 700lb Design Load per Picket (given below) applies only to 1" x 48" Steel Pickets driven into Firm Cohesive Soils



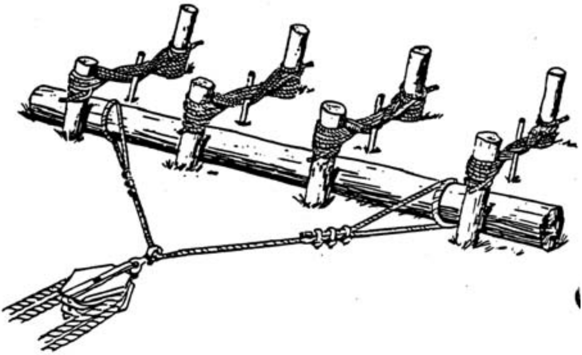
Picket holdfasts (loamy soil).

Holding Power of Picket Holdfast in Loamy Soil

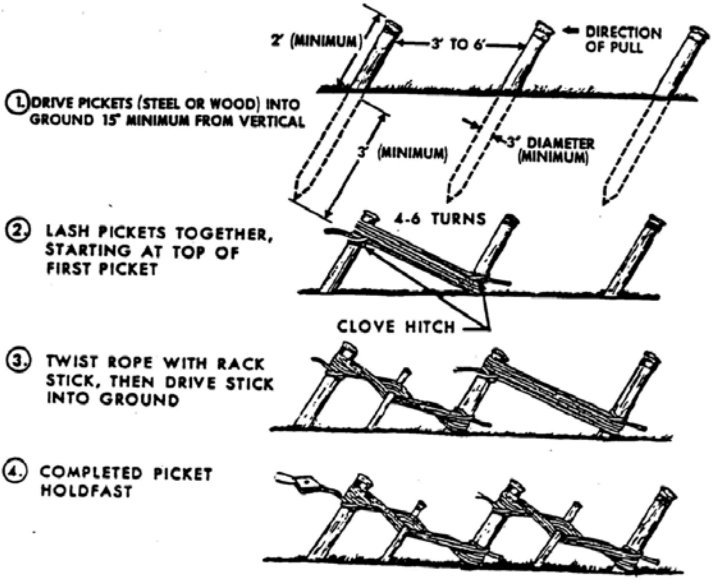
Holdfast	Pounds
Single picket	700
1–1 picket holdfast	1,400
1–1–1 picket holdfast	1,800
2–1 picket holdfast	2,000
3–2–1 picket holdfast	4,000

Note. Wet earth factors:
- Clay and gravel mixtures 0.9
- River clay and sand 0.5

ROPE ANCHORS USING PICKETS (continued)

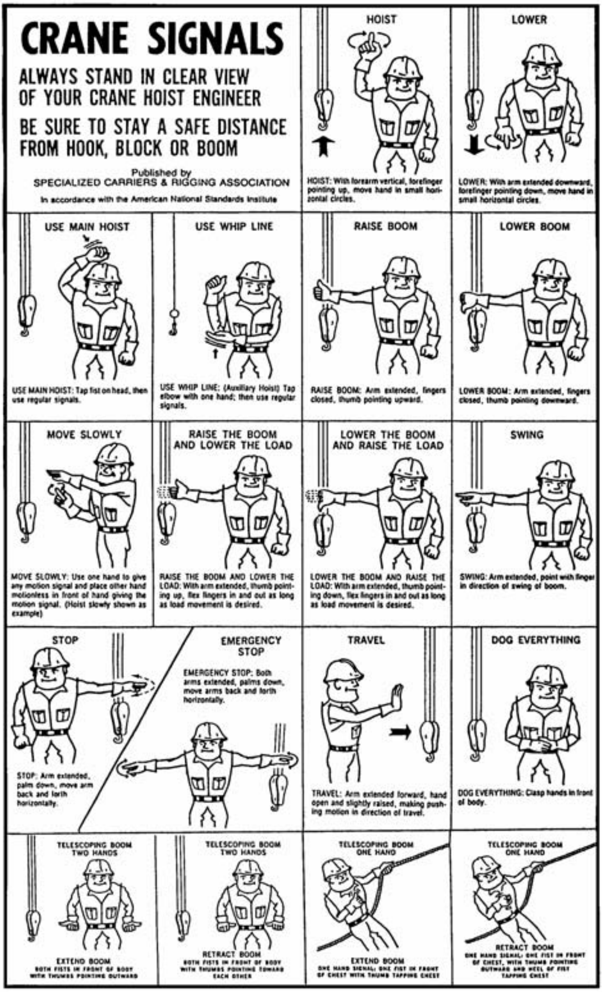


Combination log and picket holdfast.

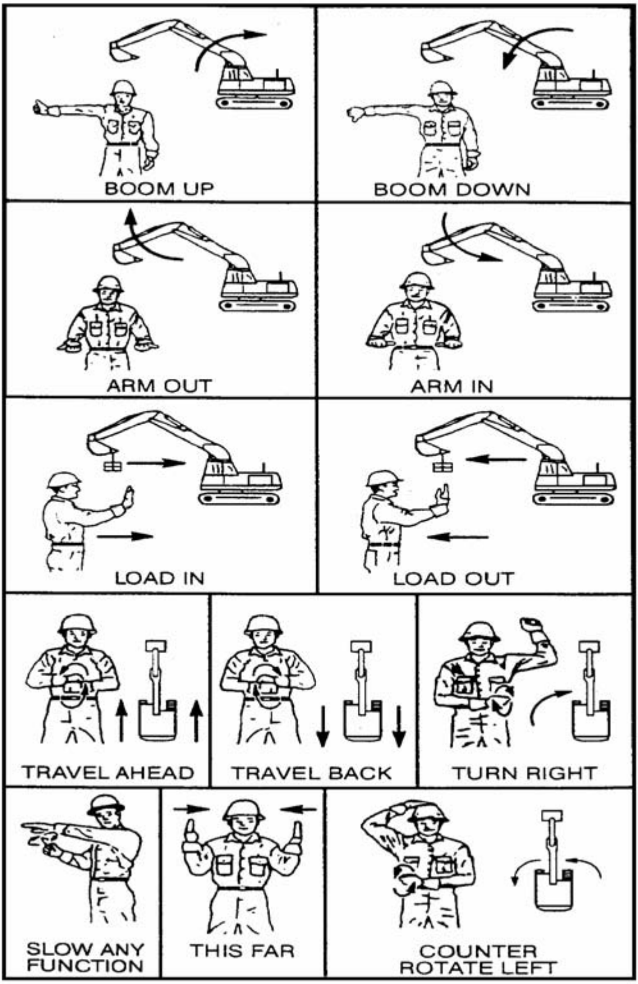


Preparing a picket holdfast.

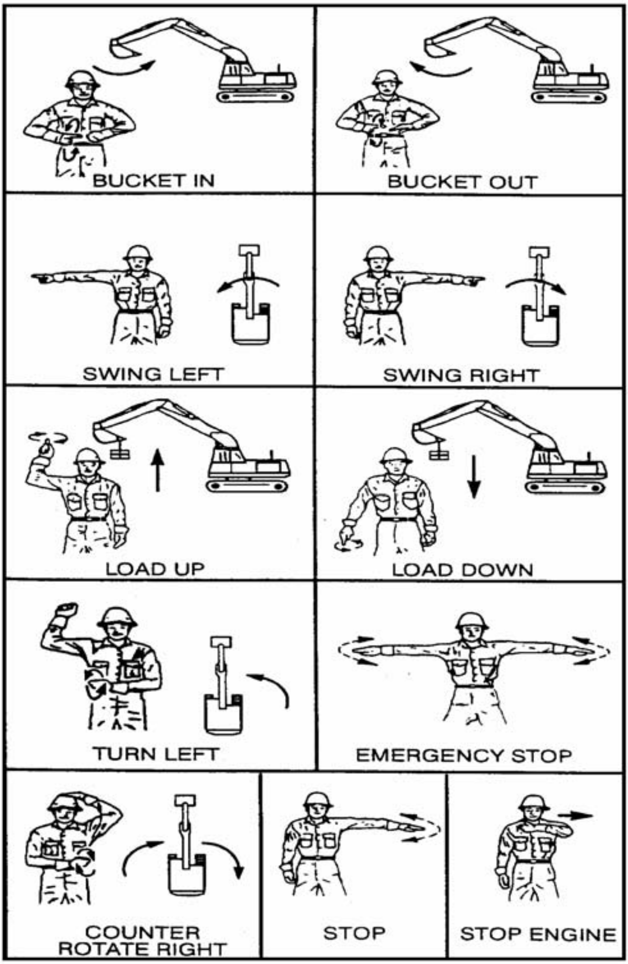
CRANE HAND SIGNALS



EXCAVATOR HAND SIGNALS



EXCAVATOR HAND SIGNALS (continued)



INTRODUCTION to SECTION 7

This section contains Information and Engineering Tables that may become useful during US&R Operations.

The following sets of Tables are contained in this section:

WIND PRESSURES ON BUILDINGS, PSF

Height	Wind Speed in Miles per Hour									
Feet	10	20	30	40	50	60	70	80	90	100
15	.21	.83	1.9	3.3	5.2	7.4	10	13	17	21
20	.22	.89	2.0	3.6	5.6	8.0	11	14	18	22
25	.24	.96	2.2	3.8	6.0	8.6	12	15	19	24
30	.25	1.0	2.3	4.0	6.3	9.1	12	16	20	25
40	.28	1.1	2.5	4.5	7.0	10	14	18	23	28
60	.32	1.3	2.8	5.1	7.9	11	15	20	26	32
80	.35	1.4	3.1	5.5	8.7	12	17	22	28	35
100	.38	1.5	3.4	6.0	9.4	13	18	24	30	38
120	.40	1.6	3.6	6.4	10	14	20	26	32	40
160	.44	1.7	3.9	7.0	11	16	21	28	35	44
200	.47	1.9	4.3	7.6	12	17	23	30	38	47
300	.54	2.2	4.9	8.7	14	20	27	35	44	54
400	.60	2.4	5.4	9.6	15	22	29	38	49	60

Notes:

1. Ref. wind speed measured at height of 30 feet above grade.
2. Basic stagnation pressure, $P = 0.00256V^2$, where V is in mph and P is in psf.
3. Pressure coeff. based on exposure B for urban environment.
4. Pressures include gust factor & shape coefficient of 1.3.
5. Pressure acting on net area normal to wind.
6. For open frame towers built with members angular cross-section multiply table values by 3 and apply to total normal projected area of all elements on one face.
7. For open frame towers built with members of circular cross-section multiply table values by 2 and apply to total normal projected area of all elements on one face.
8. Reference 1997 UBC Chapter 16, Division III.

INTRODUCTION TO USEFUL TABLES - TIMBER DESIGN

Following this page there are tables that provide:

- Allowable Loads for Plywood
- Allowable Loads in Bolts and Lag Screws
- Allowable Loads in Nails & Screws

This information is provided for Southern Pine, Douglas Fir, Hem-Fir Group and Spruce-Pine-Fir Species.

The Tables have been reproduced from "National Design Specifications for Wood Construction, 1991 Edition".

WORKING LOAD STRESSES – DOUG. FIR & SO. PINE

<u>One may increase these values by 60% for US&R Shores</u>

Mod. of Elasticity = E = 1,400 to 1,600 ksi

Bending Stress = F_b = 1500 psi for 4x & 1200 psi for 6x
(Sect. Modulus = S = $BD^2/6$, Mom. of Inertia = I = $BD^3/12$)

Horiz. Shear Stress = F_v = 95 psi for 4x & 85 psi for 6x

Compression Parallel to Grain = F_c = 1100 psi

Compression Perpendicular to Grain = $F_{c\perp}$ = 625 psi

Buckling Strength = F_a = 480,000 psi $(L/D)^2$

L/D = 25 max. (to see crushed cross-grain before buckling)

L/D = 50 max. (but failure may be by sudden buckling)

See Section 5 (FAQ) for Strength of other Wood Species

DESIGN DEAD LOADS for COMMON MATERIALS
(Repeated from page 1- 30)

Normal Reinforced Concrete = 150 pcf

Heavily Reinf. Conc Beams & Cols = 160 to 180 pcf

Struct. Steel = 490 pcf = 3.4 lbs psi per foot of length

Aluminum = 165 pcf = 1.15 lbs psi per foot of length

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)

Plywood for Uniformly Loaded Floors (Rated Sturd-I-Floor, PS-1)			
Uniform Load, psf.	Center to Center Spacing of Supports, in.		
	12	16	24
50	32/16,16 oc	32/16,16 oc	48/24, 24 oc
100	32/16,16 oc	32/16,16 oc	48/24, 24 oc
150	32/16,16 oc	32/16,16 oc	48/24, 48 oc
200	32/16,16 oc	40/20, 20 oc	48 oc
250	32/16,16 oc	40/20, 24 oc	48 oc
300	32/16,16 oc	48/24, 24 oc	48 oc
350	40/20, 20 oc	48/24, 48 oc	1-1/8 Struc I
400	40/20, 20 oc	48 oc	1-1/4 Struc I
450	40/20, 24 oc	48 oc	1-3/8 Struc I
500	48/24, 24 oc	48 oc	1-1/2 Struc I
Table from APA. Block all edges, unless T&G or separate wearing surface. 2" nominal wide supports minimum.			

7

Plywood Floors for Fork-Lift Truck Traffic (Struc. I A-C, except 2-4-1)			
Tire Width, in.	Wheel Load, lbs.	Spacing of Supports, in.	
		12	16
3	500	2-4-1	2-4-1
	1000	1-1/4	1-1/4
	1500	1-1/2	1-3/4
	2000	2	2
5	1000	2-4-1	2-4-1
	1500	1-1/8	1-1/8
	2000	1-1/4	1-1/2
	2500	1-1/2	2
	3000	1-3/4	2
7	2000	1-1/8	1-1/8
	3000	1-1/4	1-1/2
	4000	1-3/4	1-3/4
	5000	2	2
	6000	2-1/4	2-1/2
9	4000	1-1/2	1-1/2
	5000	1-3/4	1-3/4
	6000	2	2
	7000	2-1/4	2-1/4

Table from APA. Block all edges. Nails @ 4"o.c. at edge, 8"o.c. at interior. Provide wearing surface. 3" nominal wide supports minimum.

BOLT VALUES • DOUBLE SHEAR (three member) for sawn lumber with all members of identical species

THICKNESS MAIN MEMBER t_m inches	THICKNESS SIDE MEMBER t_s inches	BOLT DIAMETER D inches	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE) $Z_{\|\|}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\|\|}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.
1-1/2	1-1/2	1/2	1050	730	470	410	250	250
		5/8	1310	1040	530	520	300	300
		3/4	1580	1170	590	620	350	350
		7/8	1840	1260	630	720	390	390
		1	2100	1350	680	830	440	440
3-1/2	1-1/2	1/2	1230	730	860	550	320	380
		5/8	1760	1040	1190	790	420	440
		3/4	2400	1170	1370	1100	460	500
		7/8	3180	1260	1470	1370	500	550
		1	4090	1350	1580	1570	540	600
	3-1/2	1/2	1430	970	970	660	440	440
		5/8	2240	1410	1230	1040	600	600
		3/4	3220	1750	1370	1450	740	740
		7/8	4290	2130	1470	1690	910	910
		1	4900	2580	1580	1930	1030	1030
5-1/2	1-1/2	5/8	1760	1040	1190	790	420	530
		3/4	2400	1170	1580	1100	460	700
		7/8	3180	1260	2030	1460	500	780
		1	4090	1350	2480	1800	540	860
	3-1/2	5/8	2240	1410	1460	1040	600	660
		3/4	3220	1750	2050	1490	740	920
		7/8	4390	2130	2310	1950	920	1030
		1	5330	2580	2480	2370	1140	1150
7-1/2	1-1/2	5/8	1760	1040	1190	790	420	530
		3/4	2400	1170	1580	1100	460	700
		7/8	3180	1260	2030	1460	500	900
		1	4090	1350	2530	1800	540	1130
	3-1/2	5/8	2240	1410	1460	1040	600	660
		3/4	3220	1750	2050	1490	740	920
		7/8	4390	2130	2720	1950	920	1210
		1	5330	2580	3380	2370	1140	1340

7

BOLT VALUES • DOUBLE SHEAR (three member)
for sawn lumber with 1/4" ASTM A36 steel side plates

THICKNESS: MAIN MEMBER t_m inches	THICKNESS: STEEL SIDE PLATE t_s inches	BOLT DIAMETER D inches	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE) $Z_{\parallel}$ lbs.	G=0.50 DOUGLAS FIR-LARCH $Z_{\perp}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\parallel}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\perp}$ lbs.
1-1/2	1/4	1/2	1050	470	900	380
		5/8	1310	530	1130	420
		3/4	1580	590	1350	460
		7/8	1840	630	1580	500
		1	2100	680	1800	540
2-1/2	1/4	1/2	1510	790	1410	640
		5/8	2190	880	1880	700
		3/4	2630	980	2250	770
		7/8	3060	1050	2630	830
		1	3500	1130	3000	900
3	1/4	1/2	1510	940	1410	770
		5/8	2250	1050	2110	840
		3/4	3150	1170	2700	920
		7/8	3680	1260	3150	1000
		1	4200	1350	3600	1080
3-1/2	1/4	1/2	1510	940	1410	860
		5/8	2250	1230	2110	980
		3/4	3170	1370	2960	1080
		7/8	4260	1470	3680	1160
		1	4900	1580	4200	1260
5-1/2	1/4	5/8	2250	1330	2110	1200
		3/4	3170	1800	2960	1610
		7/8	4260	2310	3980	1830
		1	5520	2480	5150	1980
7-1/2	1/4	5/8	2250	1330	2110	1200
		3/4	3170	1800	2960	1610
		7/8	4260	2320	3980	2080
		1	5520	2910	5150	2620

BOLT VALUES (Z) for SINGLE SHEAR (two member for sawn lumber with both members of identical species

THICKNESS: MAIN MEMBER t_m inches	THICKNESS: SIDE MEMBER t_s inches	BOLT DIAMETER D inches	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE) $Z_{\|\|}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\|\|}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.
1-1/2	1-1/2	1/2	480	300	300	410	250	250
		5/8	600	360	360	520	300	300
		3/4	720	420	420	620	350	350
		7/8	850	470	470	720	390	390
		1	970	530	530	830	440	440
3-1/2	1-1/2	1/2	610	370	430	550	320	380
		5/8	880	520	540	790	420	440
		3/4	1200	590	610	1100	460	500
		7/8	1590	630	680	1370	500	550
		1	1830	680	740	1570	540	600
	3-1/2	1/2	720	490	490	660	440	440
		5/8	1120	700	700	1040	600	600
		3/4	1610	870	870	1450	740	740
		7/8	1970	1060	1060	1690	910	910
		1	2260	1230	1230	1930	1030	1030
5-1/2	1-1/2	5/8	880	520	590	790	420	530
		3/4	1200	590	790	1100	460	700
		7/8	1590	630	980	1460	500	780
		1	2050	680	1060	1800	540	860
	3-1/2	5/8	1120	700	730	1040	600	660
		3/4	1610	870	1030	1490	740	920
		7/8	2190	1060	1260	1950	920	1030
		1	2660	1290	1390	2370	1140	1150
7-1/2	1-1/2	5/8	880	520	590	790	420	530
		3/4	1200	590	790	1100	460	700
		7/8	1590	630	1010	1460	500	900
		1	2050	680	1270	1800	540	1130
	3-1/2	5/8	1120	700	730	1040	600	660
		3/4	1610	870	1030	1490	740	920
		7/8	2190	1060	1360	1950	920	1210
		1	2660	1290	1630	2370	1140	1340

7

BOLT VALUES (Z) for SINGLE SHEAR (two member) for sawn lumber with 1/4" ASTM A36 steel side plate

THICKNESS: MAIN MEMBER t_m inches	THICKNESS: STEEL SIDE PLATE t_s inches	BOLT DIAMETER D inches	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE) $Z_{\parallel}$ lbs.	G=0.50 DOUGLAS FIR-LARCH $Z_{\perp}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\parallel}$ lbs.	G=0.43 HEM-FIR SPRUCE-PINE-FIR $Z_{\perp}$ lbs.
1-1/2	1/4	1/2	530	270	470	240
		5/8	660	320	590	270
		3/4	800	360	700	310
		7/8	930	400	820	340
		1	1060	440	940	380
2-1/2	1/4	1/2	750	390	700	320
		5/8	1010	440	880	370
		3/4	1210	490	1050	410
		7/8	1410	540	1230	450
		1	1620	590	1410	490
3	1/4	1/2	750	450	710	370
		5/8	1130	510	1040	420
		3/4	1430	570	1240	470
		7/8	1670	620	1450	510
		1	1910	670	1660	560
3-1/2	1/4	1/2	750	470	710	430
		5/8	1130	580	1050	480
		3/4	1580	650	1440	530
		7/8	1940	710	1680	570
		1	2210	760	1910	630
5-1/2	1/4	5/8	1130	660	1050	600
		3/4	1580	900	1480	790
		7/8	2130	1070	1990	860
		1	2760	1150	2580	930
7-1/2	1/4	5/8	1130	660	1050	600
		3/4	1580	900	1480	810
		7/8	2130	1160	1990	1040
		1	2760	1460	2580	1250

LAG SCREW DESIGN VALUES for SINGLE SHEAR CONNECTIONS with both members of identical species

SIDE MEMBER THICKNESS	LAG SCREW DIAMETER	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE)			G=0.43 HEM-FIR SPRUCE-PINE-FIR		
t_s inches	D inches	$Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.
1/2	1/4	160	110	120	150	90	110
	5/16	210	120	170	190	100	150
	3/8	260	130	200	230	110	180
5/8	1/4	170	120	130	160	110	120
	5/16	240	150	170	220	130	160
	3/8	290	170	210	270	140	190
3/4	1/4	180	130	140	160	110	120
	5/16	250	170	180	230	150	170
	3/8	310	200	220	280	170	200
1-1/2	1/4	220	170	170	210	150	150
	5/16	320	230	230	300	200	210
	3/8	400	260	280	370	230	260
	7/16	540	310	380	480	270	340
	1/2	650	370	450	580	330	400
	5/8	910	520	620	820	420	550
	3/4	1220	560	800	1120	460	720
	7/8	1600	600	1020	1470	500	920
	1	2040	650	1260	1800	540	1150

LAG SCREW DESIGN VALUES for SINGLE SHEAR CONNECTIONS with steel side plate

STEEL SIDE PLATE	LAG SCREW DIAMETER	G=0.50 DOUGLAS FIR-LARCH (INCREASE VALUES BY 10% FOR SOUTHERN PINE)		G=0.43 HEM-FIR SPRUCE-PINE-FIR	
t_s inches	D inches	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.
1/4"	1/4	300	210	280	200
	5/16	400	270	370	250
	3/8	480	320	460	300
	7/16	620	470	580	370
	1/2	770	560	730	440
	5/8	1140	780	1070	610
	3/4	1580	1050	1490	820
	7/8	2120	1620	1990	1050
	1	2730	1970	2570	1310

WORKING LOAD VALUES

COMMON WIRE NAILS

Douglas Fir & Southern Pine (Emergency Shoring)

Nail Size	Nail Length	Nail Diameter	Shear Value (in pounds)
8d	2 ½″	0.113	120
10d	3″	0.128	135
16d	3 ¼″	0.128	135 (Vinyl coated)
16d	3 ½″	0.135	150

Min. Penetration & Spacing is ½ of the Nail Length

LAG SCREW WITHDRAWAL VALUES
In pounds per inch of threaded penetration

Shank Diameter Inches	Southern Pine	Douglas Fir	Hem-Fir & Spruce-Pine-Fir
1/4	260	225	175
5/16	307	266	210
3/8	352	305	240
7/16	395	342	270
1/2	437	378	295
5/8	516	447	350
3/4	592	513	400
7/8	664	576	450
1	734	636	500

INTRODUCTION TO USEFUL TABLES - STEEL DESIGN

Following this page there are tables used in steel design:

- Allowable Stress for 50ksi Columns
- Allowable loads for Steel Tubes
- Allowable loads for Steel Pipes
- Allowable Loads for Steel bolts

The Tables have been reproduced from "Manual of Steel Construction – ASD, 9th Edition"

USEFUL INFORMATION – A36 STEEL DESIGN GUIDE

One may increase these values by 33% for US&R Shores

Mod. of Elasticity = E = 29,000 ksi

Bending Stress = F_b = 22 ksi
(Assumes lateral bracing is spaced 16 x width, max.)
(Sect. Modulus of W sect = S = 0.1 x wt. per ft. x depth)
(Moment of Inertia = I = S x d/2)

Shear Stress = F_v = 14 KSI

Radius of Gyration – X direction = $r_x = (I/A)^{1/2}$

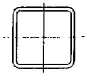
Radius of Gyration – Y direction of W sect = Flange Width/4

Strength of E60 Weld = F_{weld} = 1kip/in. per 1/16″ thickness

Wt. of Steel Sections per ft = 3.4 lbs x Area of cross-section

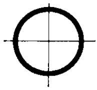
Allowable Stress Compression Members • 50-ksi Yield Stress Steel							
$\frac{Kl}{r}$	F_a (ksi)	$\frac{Kl}{r}$	F_a (ksi)	$\frac{Kl}{r}$	F_a (ksi)	$\frac{Kl}{r}$	F_a (ksi)
41	25.69	81	18.81	121	10.20	161	5.76
42	25.55	82	18.61	122	10.03	162	5.69
43	25.40	83	18.41	123	9.87	163	5.62
44	25.26	84	18.20	124	9.71	164	5.55
45	25.11	85	17.99	125	9.56	165	5.49
46	24.96	86	17.79	126	9.41	166	5.42
47	24.81	87	17.58	127	9.26	167	5.35
48	24.66	88	17.37	128	9.11	168	5.29
49	24.51	89	17.15	129	8.97	169	5.23
50	24.35	90	16.94	130	8.84	170	5.17
51	24.19	91	16.72	131	8.70	171	5.11
52	24.04	92	16.50	132	8.57	172	5.05
53	23.88	93	16.29	133	8.44	173	4.99
54	23.72	94	16.06	134	8.32	174	4.93
55	23.55	95	15.84	135	8.19	175	4.88
56	23.39	96	15.62	136	8.07	176	4.82
57	23.22	97	15.39	137	7.96	177	4.77
58	23.06	98	15.17	138	7.84	178	4.71
59	22.89	99	14.94	139	7.73	179	4.66
60	22.72	100	14.71	140	7.62	180	4.61
61	22.55	101	14.47	141	7.51	181	4.56
62	22.37	102	14.24	142	7.41	182	4.51
63	22.20	103	14.00	143	7.30	183	4.46
64	22.02	104	13.77	144	7.20	184	4.41
65	21.85	105	13.53	145	7.10	185	4.36
66	21.67	106	13.29	146	7.01	186	4.32
67	21.49	107	13.04	147	6.91	187	4.27
68	21.31	108	12.80	148	6.82	188	4.23
69	21.12	109	12.57	149	6.73	189	4.18
70	20.94	110	12.34	150	6.64	190	4.14
71	20.75	111	12.12	151	6.55	191	4.09
72	20.56	112	11.90	152	6.46	192	4.05
73	20.38	113	11.69	153	6.38	193	4.01
74	20.10	114	11.49	154	6.30	194	3.97
75	19.99	115	11.29	155	6.22	195	3.93
76	19.80	116	11.10	156	6.14	196	3.89
77	19.61	117	10.91	157	6.06	197	3.85
78	19.41	118	10.72	158	5.98	198	3.81
79	19.21	119	10.55	159	5.91	199	3.77
80	19.01	120	10.37	160	5.83	200	3.73

STRUCTURAL TUBING
Dimensions and properties

Square 

Dimensions			Properties			
Nominal Size	Wall Thickness		Area	I	S	r
In.	In.		In.^{2}	In.^{4}	In.^{3}	In.
8×8	0.6250	5/8	17.4	153	38.3	2.96
	0.5625	9/16	15.9	143	35.7	3.00
	0.5000	1/2	14.4	131	32.9	3.03
	0.3750	3/8	11.1	106	26.4	3.09
	0.3125	5/16	9.36	90.9	22.7	3.12
	0.2500	1/4	7.59	75.1	18.8	3.15
	0.1875	3/16	5.77	58.2	14.6	3.18
6×6	0.5625	9/16	11.4	54.1	18.0	2.18
	0.5000	1/2	10.4	50.5	16.8	2.21
	0.3750	3/8	8.08	41.6	13.9	2.27
	0.3125	5/16	6.86	36.3	12.1	2.30
	0.2500	1/4	5.59	30.3	10.1	2.33
	0.1875	3/16	4.27	23.8	7.93	2.36
5×5	0.5000	1/2	8.36	27.0	10.8	1.80
	0.3750	3/8	6.58	22.8	9.11	1.86
	0.3125	5/16	5.61	20.1	8.02	1.89
	0.2500	1/4	4.59	16.9	6.78	1.92
	0.1875	3/16	3.52	13.4	5.36	1.95
4×4	0.5000	1/2	6.36	12.3	6.13	1.39
	0.3750	3/8	5.08	10.7	5.35	1.45
	0.3125	5/16	4.36	9.58	4.79	1.48
	0.2500	1/4	3.59	8.22	4.11	1.51
	0.1875	3/16	2.77	6.59	3.30	1.54
3.5×3.5	0.3125	5/16	3.73	6.09	3.48	1.28
	0.2500	1/4	3.09	5.29	3.02	1.31
	0.1875	3/16	2.39	4.29	2.45	1.34
3×3	0.3125	5/16	3.11	3.58	2.39	1.07
	0.2500	1/4	2.59	3.16	2.10	1.10
	0.1875	3/16	2.02	2.60	1.73	1.13
2×2	0.2500	1/4	1.59	0.766	0.766	0.694
	0.1875	3/16	1.27	0.668	0.668	0.726

PIPE
Dimensions and properties



Dimensions			Weight per Ft Lbs. Plain Ends	Properties			
Nominal Diameter In.	Outside Diameter In.	Inside Diameter In.		*A* In.^{2}	*I* In.^{4}	*S* In.^{3}	*r* In.
Standard Weight Schedule 40							
1	1.315	1.049	1.68	.494	.087	.133	.421
1¼	1.660	1.380	2.27	.669	.195	.235	.540
1½	1.900	1.610	2.72	.799	.310	.326	.623
2	2:375	2.067	3.65	1.07	.666	.561	.787
2½	2.875	2.469	5.79	1.70	1.53	1.06	.947
3	3.500	3.068	7.58	2.23	3.02	1.72	1.16
3½	4.000	3.548	9.11	2.68	4.79	2.39	1.34
4	4.500	4.026	10.79	3.17	7.23	3.21	1.51
5	5.563	5.047	14.62	4.30	15.2	5.45	1.88
6	6.625	6.065	18.97	5.58	28.1	8.50	2.25
8	8.625	7.981	28.55	8.40	72.5	16.8	2.94
10	10.750	10.020	40.48	11.9	161	29.9	3.67
12	12.750	12.000	49.56	14.6	279	43.8	4.38
Extra Strong Schedule 80							
2	2.375	1.939	5.02	1.48	.868	.731	.766
2½	2.875	2.323	7.66	2.25	1.92	1.34	.924
3	3.500	2.900	10.25	3.02	3.89	2.23	1.14
3½	4.000	3.364	12.50	3.68	6.28	3.14	1.31
4	4.500	3.826	14.98	4.41	9.61	4.27	1.48
5	5.563	4.813	20.78	6.11	20.7	7.43	1.84
6	6.625	5.761	28.57	8.40	40.5	12.2	2.19
8	8.625	7.625	43.39	12.8	106	24.5	2.88
10	10.750	9.750	54.74	16.1	212	39.4	3.63
12	12.750	11.750	65.42	19.2	362	56.7	4.33
Double-Extra Strong							
2	2.375	1.503	9.03	2.66	1.31	1.10	.703
2½	2.875	1.771	13.69	4.03	2.87	2.00	.844
3	3.500	2.300	18.58	5.47	5.99	3.42	1.05
4	4.500	3.152	27.54	8.10	15.3	6.79	1.37
5	5.563	4.063	38.55	11.3	33.6	12.1	1.72
6	6.625	4.897	53.16	15.6	66.3	20.0	2.06
8	8.625	6.875	72.42	21.3	162	37.6	2.76

BOLTS IN AISC STEEL

Shear • Allowable load in kips

	ASTM Designation	Connection Type	Hole Type	F_v ksi	Loading	Nominal Diameter d, in.					
						5/8	3/4	7/8	1	1 1/8	1 1/4
						Area (Based on Nominal Diameter) in.^{2}					
						.3068	.4418	.6013	.7854	.9940	1.227
Bolts	A307	—	STD NSL	10.0	S	3.1	4.4	6.0	7.9	9.9	12.3
					D	6.1	8.8	12.0	15.7	19.9	24.5
	A325	SC Class A	STD	17.0	S	5.22	7.51	10.2	13.4	16.9	20.9
					D	10.4	15.0	20.4	26.7	33.8	41.7
			OVS, SSL	15.0	S	4.60	6.63	9.02	11.8	14.9	18.4
					D	9.20	13.3	18.0	23.6	29.8	36.8
			LSL	12.0	S	3.68	5.30	7.22	9.42	11.9	14.7
					D	7.36	10.6	14.4	18.8	23.9	29.4
		N	STD, NSL	21.0	S	6.4	9.3	12.6	16.5	20.9	25.8
					D	12.9	18.6	25.3	33.0	41.7	51.5
		X	STD, NSL	30.0	S	9.2	13.3	18.0	23.6	29.8	36.8
					D	18.4	26.5	36.1	47.1	59.6	73.6

Allowable loads in kips
Tension on gross (nominal) area

ASTM Designation	F_t Ksi	Nominal Diameter d, In.					
		5/8	3/4	7/8	1	1 1/8	1 1/4
		Area (Based on Nominal Diameter), In.^{2}					
		0.3068	0.4418	0.6013	0.7854	0.9940	1.227
A307 bolts	20.0	6.1	8.8	12.0	15.7	19.9	24.5
A325 bolts	44.0	13.5	19.4	26.5	34.6	43.7	54.0
A490 bolts	54.0	16.6	23.9	32.5	42.4	53.7	66.3
A502-1 rivets	23.0	7.1	10.2	13.8	18.1	22.9	28.2

USEFUL INFORMATION – CONCRETE DESIGN GUIDE

The following information is intended as a Quick Field Design Guide for Reinforced Concrete. It is not intended to replace the more rigorous analysis that is required for "Normal" Engineering Calculations.

Approx. Moment Capacity of Reinforced Slabs or Beams

M (ft-k) = 2.8 x A_s x d (for 40 ksi yield strength)

M (ft-k) = 4.0 x A_s x d (for 60 ksi yield strength)

Where: M = Moment Capacity in ft-kips

A_s = Area of reinforcing steel (sq. in.) listed below

d = depth from compression face to center of steel

Notes:

1. If in doubt, assume 40ksi yield strength for rebar
2. The above assumes that the area of rebar is 1% or less, of the concrete cross-section (b x d)
3. Shear capacity may govern any reinforced concrete design.

AREA & WEIGHT of A615 REINFORCING STEEL

Size	3	4	5	6	7	8	9	10	11
Area	0.11	0.20	0.31	0.44	0.60	0.79	1.0	1.27	1.56
Wt/Ft	0.38	0.67	1.1	1.5	2.0	2.7	3.4	4.3	5.3
Metric Size	10	13	16	19	22	25	29	32	36

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
- Wedge Anchors
- Concrete Screws

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.

20 QUESTIONS to ANSWER WHEN ORDERING A CRANE

When you contact a rental source of heavy lift equipment, they will start asking questions to permit them to give you what you need. If you can have answers to their questions ready beforehand, you will speed the process considerably. If you have answers to the following questions, you will be well prepared for the rental agent's questions.

1. Who are you and what are you doing?
2. How quickly do you want a machine?
3. What do you intend for this machine to do?
   - Pick and swing?
   - Pick and carry?
   - Lift large objects at small distance?
   - Lift small objects at large distance?
4. Will multiple machines be needed? (Second machine to set up primary machine).
5. What are the capabilities of the onsite crew? (Are they qualified to assist with set up?)
6. If this machine is for a single task, what is the load weight and what is the load radius?
7. If this is for multiple tasks?
   - What are several combinations of load and distance?
   - Max load / min distance
   - Max distance / min load
   - Possible mid load/mid distance?
8. Will this task require pick and carry capability?
9. What are the limits of room available for operation of the machine?
   - Overhead clearance?
   - Tail swing clearance?
   - Underground obstructions?
10. Is there a place to assemble boom (if lattice) and crane (counterweights)? Including room for assisting crane?

20 QUESTIONS to ANSWER WHEN ORDERING A CRANE (continued)

11. Are there limitations on delivery of crane or parts?
    - Posted bridges?
    - Low clearances?
    - Underground utilities?
12. What areas of operation are anticipated?
    - Over rear?
    - Over side?
    - Over front?
    - On rubber?
13. Are two crane (simultaneous) picks anticipated?
14. Will work be performed on a continuous (24 hr) basis? Is auxiliary lighting available?
15. Will radio communication be required to control load? Are dedicated radios available?
16. How much boom is required? Are special boom features (offset, open-throat) needed?
17. What size hook block is needed? Are shackles to fit hook available?
18. Will jib be needed?
    - Jib length?
    - Offset?
    - Load?
19. Are additional rigging components needed?
    - Load cell?
    - Lift beams?
    - Slings
    - Shackles?
20. Who is the contact person and who is the person directing the rigging operations?

SAFE WORKING LOAD

Given in terms of Diameter ^{2}

ITEM	Safe 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

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 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.

Safe Load

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

Safety Factor

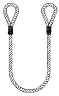
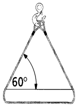
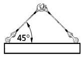
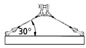
In general, a safety factor of approximately five is maintained throughout these tables. However, certain sling fittings, such as hooks, which will straighten without breaking, or links, which will deform beyond usefulness before breaking, cannot be assigned a definite numerical safety factor. In such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

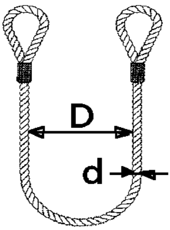
Sling Care

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. Slings should be lubricated to prevent rust, and hung up 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



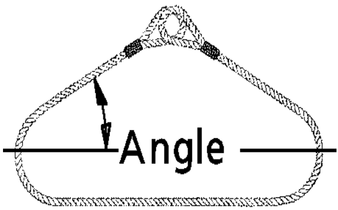
A Basket Hitch has Twice the Capacity of a Single Leg only If the D/d Ratio is 25/1 and the Legs are Vertical

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

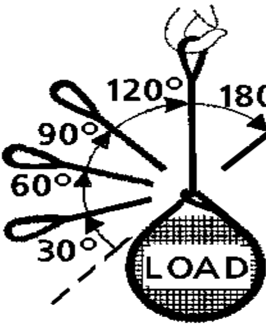
SPECIAL SLING CAPACITY INFORMATION

Wire Rope, Chain & Synthetic Basket Slings

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

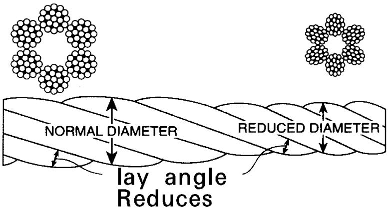


Choker Hitches – Reduction Due to Angle

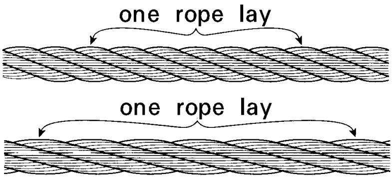


CHOKE ANGLE	CAPACITY
120° - 180°	75% of Vertical
90° - 109°	65% of Vertical
80° - 89°	55% of Vertical
30° - 59°	40% of Vertical

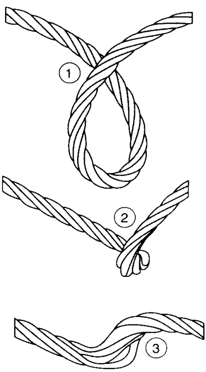
Wire Rope • Discard Conditions



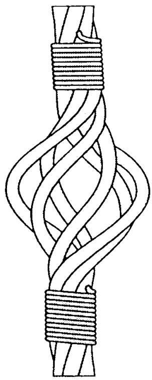
Core Failure



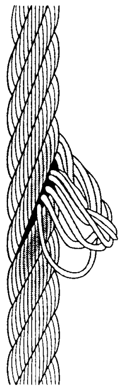
Rope Stretch



Kinks



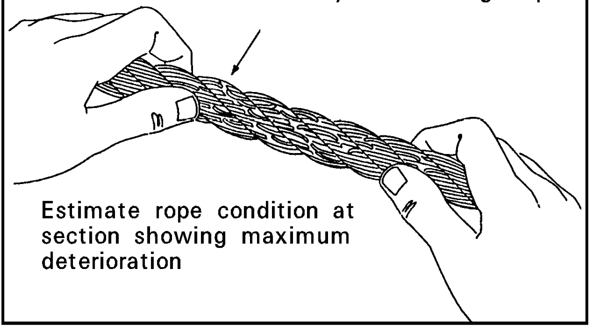
Bird Cage



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

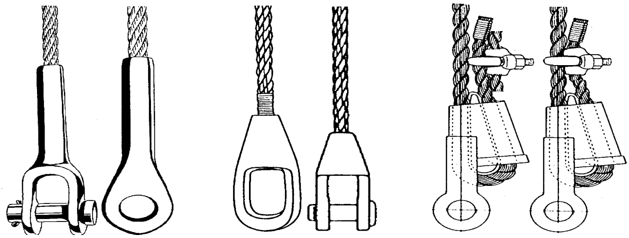
Replace if:
1. See criteria above
2. One or more broken wires at a fitting
3. If any wire breaks in the valley between strands.
4. If any wire in a strand is worn by 1/3 it's diameter
5. Reduction in rope diameter should not exceed:
   3/64" for 3/4" rope 1/16" for 7/8 to 1-1/4" ropes
   3/32" for larger 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

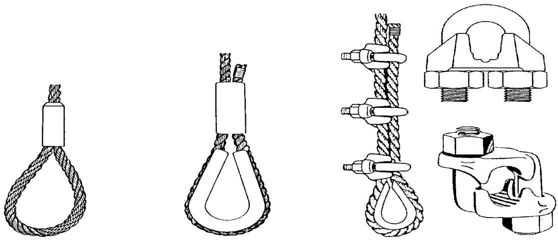


O.K. NO

Swaged Socket (100%) **Spelter Socket (100%)** **Wedge Socket (75 to 90%)**

WIRE ROPE LOOP TERMINATIONS

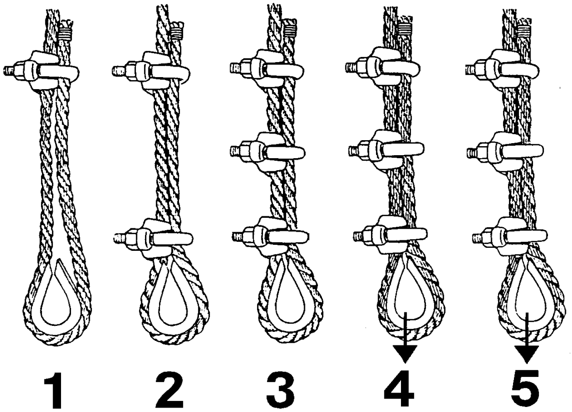
- Without thimble, eye efficiency may be reduced as much as 10%
- Wire Rope Clips must be properly installed



Flemish Eye Eye (95-100%) **Fold Back Eye (Don’t use for lifting)** **Wire Rope Clips U bolt & Fist Grip (80%)**

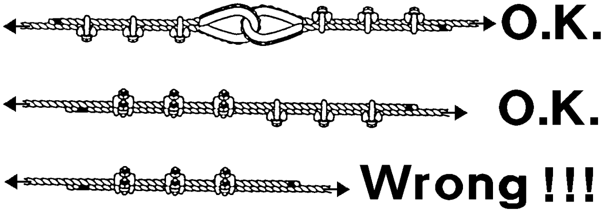
WIRE ROPE CLIP INSTALLATION

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



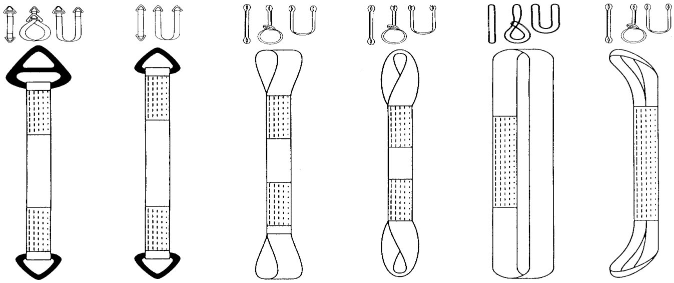
WIRE ROPE CLIP SPLICES

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%

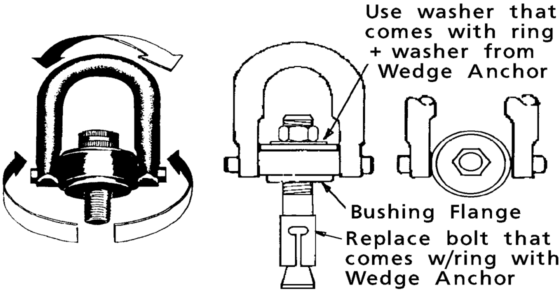


Triangle Choker | Double Triangle | Dbl Eye | Rev Eye | Endless Loop | Return Eye

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



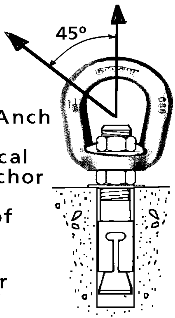
Allowable Tension & Shear Loads

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

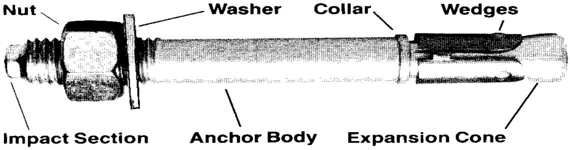
EYE NUTS

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

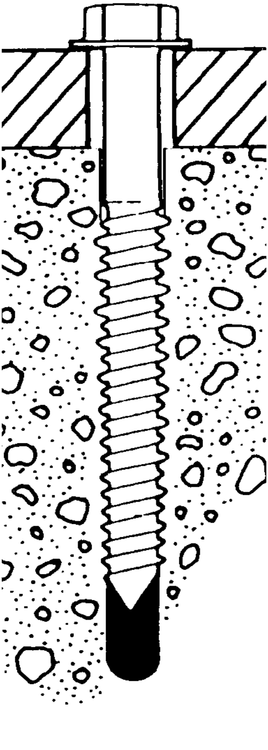
Allowable Shear Loads (lbs)

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

INCREASE TEN. & SHEAR VALUES 1.33x
FOR WIND & EARTHQUAKE LOADING

TEN + SHEAR: $(P/P_{allow})^{5/3} + (V/V_{allow})^{5/3} \leq 1$

CONCRETE SCREW INFORMATION



INFO on 3/16″ 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 3/16″ x 1 ¼ ″ screw with 1″ min embed
- Safe Allow load = 200 lb Tension and 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.
- Safe Allow Load = 2000 lb Tension and Shear
- Use with Swivel Hoist Ring or Steel Tee (WT 3x7.5 x 0' - 4″)

ANCHORS - EPOXY & ACRYLIC ADHESIVES

Allowable Loads – Threaded Rod – 2000psi Conc
Allowable Tensile Loads – (Lbs) Dimensions in inches

Stud Dia. Inch	Drill Bit Dia	Min Embed Depth	Spa-cing	Edge Dist.	Ave Ult Lbs	Allow Load Lbs
3/8	1/2	3 1/2	6	5	8800	2100
1/2	5/8	4 1/4	7 1/2	6	15,700	3750
5/8	3/4	5	9 1/2	7 1/2	23,000	5720
3/4	7/8	6 3/4	12	10	35,600	8460
7/8	1	7 3/4	13 1/2	11 1/2	42,800	10,900
1"	1 1/8	9	15 3/4	13 1/2	50,500	13,800

Allowable Shear Loads (Lbs)

Stud Dia. Inch	Drill Bit Dia	Min Embed Depth	Edge Dist.	Ave Ult Lbs	Allow Load Lbs	Allow A307 Steel
3/8	1/2	3 1/2	5	5500	1380	1085
1/2	5/8	4 1/4	6	10,000	2500	1930
5/8	3/4	5	7 1/2	15,600	3900	3025
3/4	7/8	6 3/4	10	20,300	5000	4360
7/8	1	7 3/4	11 1/2	30,800	7700	5925
1”	1 1/8	9	13 1/2	33,500	8400	7740

Allowable Loads – A615 Gr 60 Rebar – 2000psi Conc
Allowable Tensile / Shear Loads – (Lbs) Dimen. in inches

Bar Size No.	Drill Bit Dia	Min Embed Depth	Spa-cing	Edge Dist.	Allow Ten. Load	Allow Shear Load
#4	5/8	4 1/4	7 1/2	6	3185	2750
#5	3/4	5	10	7 1/2	5100	3940
#6	7/8	6 3/4	12	10	7960	5830
#8	1 1/8	9	15 1/2	13 1/2	12500	8360

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 7-35 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**

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

Approximate Design Load of Pickets (Pins) in Soils

Based on July 1984, FHWA-IP-84-11,
Handbook, Design of Piles & Drilled Shafts Under Lateral Load.
Pin Design Load is based on approx 50% of Capacity

Lateral Load Capacity in Cohesive Soil 3” dia x 48” long pin, driven 36 inches into soil		
Soil Type	Soil Capacity, lb/sq ft	Pin Design Load
Poor	1400	1000
Average	2200	1500
Good/Hard	3200	2000
Lateral Load Capacity in Cohesionless Soil 3-inch dia, 48-inch pin, driven 36 inches into soil		
Soil Type	Soil density, lb/sq ft	Pin Design Load
Loose	100	150
Medium	115	180
Dense	125	190
Lateral Load Capacity of Pin in Cohesive Soil 1-inch dia, 48-inch pin, driven 36 inches into soil		
Soil Type	Soil Capacity, lb/sq ft	Pin Design Load
Poor	1400	500
Average	2200	750
Good/Hard	3200	1000
Lateral Load Capacity in Cohesionless Soil 1-inch dia, 48-inch pin, driven 36 inches into soil		
Soil Type	Soil density, lb/sq ft	Pin Design Load
Loose	100	50
Medium	115	55
Dense	125	63
Lateral Load Capacity of Pin in Cohesive Soil 5/8-inch dia, 36-inch Screed Pin, driven 30 inches into soil		
Soil Type	Soil Capacity, lb/sq ft	Pin Design Load
Poor	1400	250
Average	2200	375

INTRODUCTION to SECTION 8

This section contains information that is primarily useful for the Structures Specialists that are deployed by the U.S. Army Corps of Engineers. USACE Structures Specialists may be deployed to a FEMA or non-FEMA US&R response.

The Information in Sect 8 is presented in the following order:

- Description of Duties
- Mission Priorities
- Management of Structures Specialist Cadre
- Personal Equipment List
- Operational Checklists and Procedures
- System Description
- ICS Terminology
- INSARAG Marking System
  (To be used in Foreign Deployments only)

Section 9 contains FEMA Structures Specialist General Instructions that includes: Position Descriptions, Operational Checklists, and Equipment Checklists.

Both USACE and FEMA Structures Specialist should review Section 9, prior to every incident.

The Structures Specialist is responsible for performing the various structural assessments for the rescue personnel during incident operations.

DESCRIPTION OF DUTIES

- The Structures Specialist is responsible for evaluating the immediate structural condition of the area to be entered during rescue operations.
- The Structures Specialist is responsible for determining the appropriate type and amount of structural hazard mitigation in order to minimize risks on site to rescue personnel.
- The Structures Specialist is responsible for cooperating with and assisting other search and rescue resources.
- The Structures Specialist is accountable for all issued equipment.
- The Structures Specialist performs additional tasks or duties as assigned during a mission.

MISSION PRIORITIES

Specific mission priorities will be decided by the State in conjunction with the Federal US&R team leaders; however, based on input from State Emergency Management personnel and the status of the Federal US&R mission, the following priorities are listed for planning purposes:

Priority 1: Support to FEMA Task Forces for either backfilling or augmentation. Support the FEMA Incident Support Team (IST) engineering element. Support the Corps US&R Technical Search Specialist Teams.

MISSION PRIORITIES (continued)

Priority 2: Technical assistance to local jurisdictions with rescue efforts.

Priority 3: Technical assistance to military personnel who will continue to provide US&R support.

Priority 4: Other agency support.

MANAGEMENT OF STRUCTURES SPECIALIST CADRE

To effectively provide a management strategy needed to ensure the Structures Specialist cadre is used effectively, the Urban Search and Rescue Program will be responsible for composition of the teams, which will be dependent on the scope and type of US&R mission. Once in the field, the Incident Commander should coordinate any action with the Disaster Field Office (DFO) and US&R staff members supporting the mission. The staff will normally be the US&R Mission Managers for the Corps. The Mission Managers will physically be located at the IST, be part of the IST engineering element, and coordinate with the Corps, DFO, IST, and cadre members

.

PERSONAL EQUIPMENT CHECKLIST

Due to the need for rapid response to a disaster event, all personnel must have all necessary personal clothing, equipment and supplies readily available for immediate mobilization. Each US&R cadre member should also pack two weeks of personal prescription medications, over-the-counter medications commonly used for colds, allergies, etc., and extra prescription eye wear. The following list provides the suggested minimum requirements to promote individual sufficiency during mission operations:

1. PROVIDED BY THE USACE US&R PROGRAM

_____ Vest, Structures Specialist
_____ Backpack w/ Harness & 2 Canteens
_____ Safety Goggles, Hearing Protection
_____ Safety Helmet w/ Crescent Stickers
_____ Safety Helmet Light w/ Batteries
_____ Flashlight w/ Batteries
_____ Dust Masks, Face Mask, Gloves, Knee Pads
_____ First Aid Kit
_____ Compass, Lightsticks, Poncho
_____ Clipboard w/ Triage & Hazard Evaluation Forms
_____ Weather Proof Field Level Book
_____ Structures Specialist FOG
_____ BDU Style Uniforms, US&R Operations Field Cap
_____ Flight Bag

PERSONAL EQUIPMENT CHECKLIST (continued)

2. ESSENTIAL PERSONAL ITEMS

______ Firefighter Style Black Boots w/ Protective Toes
______ Rain Gear & Extra Clothing for 7-10 Days
______ Cash, Personal I.D., Credit Cards, etc.
______ Personal Hygiene & Medication Items
______ Eyeglasses + Extras

3. RECOMMENDED PERSONAL EQUIPMENT

______ Paper/Notebook, Pens/Pencils
______ Pocket Calculator w/ batteries
______ USACE US&R Field Operations Guide (FOG)
______ Tape Measure (20' steel or 50' cloth)
______ Knife Tool, Field Glasses, Geology Hammer
______ Cellular Phone

4. SUGGESTED ADDITIONAL EQUIPMENT

______ Camera w/ Extra Batteries & Film
______ Small Portable Radio
______ Voice Activated Tape Recorder
______ Laser Pointer, Whistle
______ Radio Harness and/or Hand Mike

5. PERSONAL ITEMS AND SUGGESTED CLOTHING

______ Sun Glasses, Sun Screen, Insect Repellent
______ Emergency Phone Numbers
______ Bandannas, Long Underwear, Cotton Socks
______ Underwear, Tee-Shirts, Pants, Heavy Sweater
______ Wool Socks, Gym-Type Shorts, Sweatshirt
______ Coat or Heavy Jacket
______ Global Positioning System

PERSONAL EQUIPMENT CHECKLIST (continued)

6. PERSONAL ITEMS TO REMEMBER

______ ____

______ ____

______ ____

______ ____

______ ____

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______ ____

______ ____

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______ ____

______ ____

______ ____

PERSONAL EQUIPMENT CHECKLIST (continued)

7. EQUIPMENT NOTES

OPERATIONAL CHECKLISTS

The following operational checklists define the duties and responsibilities of the Corps Structures Specialist during mission assignments. The lists are intended to be a general summary of actions and may not include all actions required to complete the mission.

ALERT CHECKLIST

An **ALERT** is a warning message to stand by for possible deployment.

PROCEDURES:

_____ Confirm message is an ALERT message.

_____ Report current availability status.

_____ Take Situation Information, including:

- Nature of Disaster
- Possible Destination
- Duration of Alert
- Special Instructions

_____ Check Equipment.

_____ Review Structures Specialist policies, procedures, and technical information.

_____ Make preliminary preparations with family.

_____ Stand by for further instructions.

_____ Stand down from ALERT only upon expiration of alert period or notification from HQ USACE or US&R Program Manager.

OPERATIONAL CHECKLISTS (continued)

DEPLOYMENT CHECKLIST

A **DEPLOYMENT** message indicates that you are being activated and will deploy to the disaster.

PROCEDURES:

Obtain:

_____ Point of departure
_____ Point of arrival
_____ Travel instructions
_____ Initial situation briefing
_____ Weather and climate conditions
_____ Maps of local disaster area (if possible)
_____ Reporting instructions
_____ HQ USACE & US&R PM POC

_____ Prepare family (See Family Preparedness Checklist).

_____ Monitor disaster-related information from local sources.

_____ Gather, prepare and pack equipment.

_____ Pack clothing and personal items for disaster area climate.

_____ Notify Supervisor and Emergency Management POC.

_____ Notify home station Critical Incident Stress provider.

_____ Move to Point of Departure (POD).

_____ At POD, notify HQ USACE and/or the US&R PM of status.

_____ Review Triage and Structures/Hazards Evaluation Forms.

OPERATIONAL CHECKLISTS (continued)

POINT OF ARRIVAL (POA) CHECKLIST

The POA will likely be the same location as the Mobilization Area. This is the initial entry point for all disaster response resources.

PROCEDURES:

_____ Report to Emergency Support Function #3, Public Works and Engineering and/or FEMA IST.

_____ Check-in with designated support unit/individual or Corps Cadre Overhead personnel if they have arrived.

_____ If no Corps Cadre Overhead personnel, report arrival to HQ USACE EOC or US&R PM.

_____ Receive Situation Briefing/Update.

_____ Await assignment.

_____ Obtain food/quarters if required.

In some cases, you may be required to move to another location where US&R resources are being marshalled. If so:

_____ Obtain transportation to designated area.

_____ Execute other actions on this list.

<u>OPERATIONAL CHECKLISTS</u> (continued)

FAMILY PREPAREDNESS CHECKLIST

Ensuring that your family is taken care of and is informed about your deployment is an important part of your duties.

Some of the items on this checklist need to be taken care of prior to any alert or deployment message. Such items are in italics, and the checklist serves as a verification that you have reviewed them with your family.

_____ *Will (Location, etc.)*

_____ *Power of Attorney (Location, scope, and provisions).*

_____ Contact number at HQ USACE or USACE US&R Program Office.

_____ Employee Assistance Program telephone number.

_____ Family Critical Incident Stress (CIS) information.

OPERATIONAL CHECKLISTS (continued)

ASSIGNMENT CHECKLIST

The **ASSIGNMENT** is when you have been assigned to a specific Task Force, Unit, or Team.

PROCEDURES:

_____ Report to Unit/Task Force Leader.

_____ Obtain mission/assignment briefing.

_____ Obtain support information.

_____ Review Unit Chain of Command.

_____ Provide Leader overview of capability.

_____ Contact other technical resources.

_____ Establish work plan in coordination with Unit Leader and other support resources.

_____ Report time and attendance to the Corps US&R Mission Manager at the IST or DFO.

_____ Submit daily reports to the US&R IST (Incident Support Team) Engineering Cell or the Corps US&R Mission Managers at the end of the duty shift. Reports should contain the following:

- _____ Previous day's activities.
- _____ Planned activities (next shift)
- _____ Any problems experienced
- _____ Any other items/topics of importance
- _____ Site conditions, date, time, temp, etc.

OPERATIONAL CHECKLISTS (continued)

INCIDENT CHECKLIST

The **INCIDENT** is the actual disaster site, which may be a single or multiple collapse, and may require light, medium or heavy US&R.

PROCEDURES:

_____ Obtain incident briefing from Incident Commander IST or Unit Leader.

_____ Obtain pertinent building data (occupancy, special conditions, citizen reports, etc.).

_____ Gather appropriate building plans, etc., as available.

_____ Contact local structural engineers, contractors, and/or building department officials to determine construction data.

_____ Ensure use of all safety practices and procedures.

_____ Ensure your physical readiness through proper nutrition, water intake, rest and stress control techniques.

_____ Report any signs/symptoms of critical incident stress exhibited by yourself/coworkers.

_____ Brief your shift replacement fully on all ongoing operations when relieved at work cycle rotations.

_____ Participate in daily briefing.

_____ Assist remaining Task Force/Unit members as required.

_____ Support other IST missions.

OPERATIONAL CHECKLISTS (continued)

STRUCTURAL ASSESSMENT CHECKLIST

The **STRUCTURAL ASSESSMENT** is the key function of the Structures Specialist. Detailed references are located in Section 3 of this FOG.

PROCEDURES:

_____ Develop building element identification system (Section 3).

_____ Perform Structural Triage operations as directed:
- Concise ID/location of structures and monitoring equipment.
- Identify monitoring equipment used by description or serial number.
- Rapid assessment of the affected area.
- ID potential buildings that require more detailed assessment/search.
- Use the Structure Triage Form to capture information.

_____ Perform an assessment of the assigned structures' exterior and interior to determine structure type, location of falling or collapse hazards, and access points. This would include:
- Clearly mark the structure(s) assessed at the point of entry in accordance with the standard marking system.
- Draw a crude plan to indicate possible access points, location of structural hazards and the most productive methods of hazard reduction.
- Note the indication of normal egress routes (i.e., corridors, stairs, etc.) for any possible voids or victim locations.
- Clearly mark off hazardous areas that are to be avoided.
- Use the Structure/Hazards Evaluation Form to capture information.

OPERATIONAL CHECKLISTS (continued)

STRUCTURAL ASSESSMENT CHECKLIST (continued)

_____ Provide assessment to Task Force/Team Leader, including:
- Recommendations for areas requiring hazard mitigation:
    - Shoring and bracing
    - Removal
    - Monitor with warning escape system
    - Avoidance
    - Discuss the most productive method of access relative to probable location of victims

_____ Work with search and rescue personnel. Brief team on structural considerations. Mark building in accordance with the Structure/Hazards Evaluation and Search Assessment procedures. Determine the most appropriate course of action to gain access to victims, including:
- Most appropriate routes to conduct searches.
- Available tools and shoring materials.
- Structural materials likely to be found while gaining access.
- Effects of rescue operations on other building elements.
- Special precautions required during breaching operations.
- Special considerations for buildings with basements.
- Advice on the placement of shoring and bracing.
- Monitor the assigned structures for changing conditions.

_____ Re-assess structures as required.

OPERATIONAL CHECKLISTS (continued)

DEMOBILIZATION CHECKLIST

DEMOBILIZATION refers to all of the actions from disengaging from the last US&R incident through out-processing and your return home.

PROCEDURES:

UNIT & MOB AREA

_____ Conduct out-brief with IST Engineering Cell or Unit Leader.

_____ Return any unit/team equipment.

_____ Check-out from unit.

_____ Report to Corps Overhead personnel.

_____ Participate in CIS debriefing.

_____ Re-supply of issued equipment if required.

_____ Participate in any mission out-briefs or after-action sessions conducted by US&R managers and/or host jurisdiction.

_____ Return to home duty station.

HOME DUTY STATION

_____ Attend CIS aftercare sessions.

_____ Prepare and submit After-Action Report to Emergency Management POC and the US&R PM.

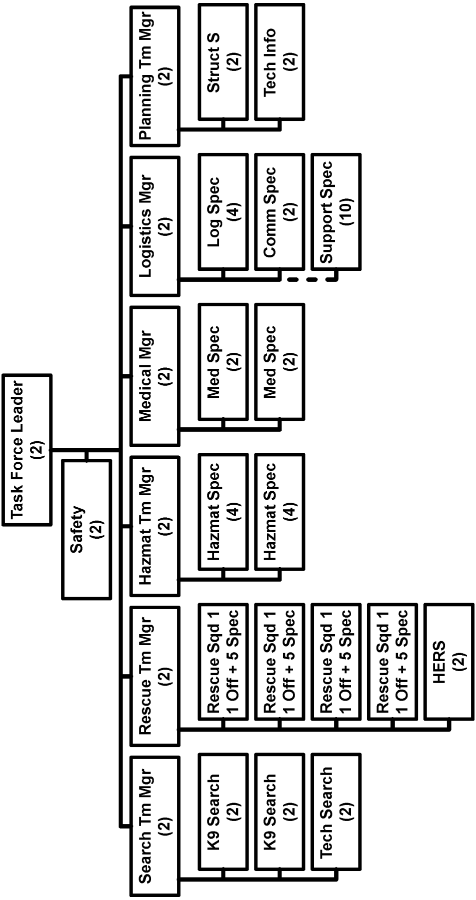
SYSTEM DESCRIPTION

FEMA US&R TASK FORCES

MISSION:	Heavy Rescue
STRENGTH:	70 positions / 24-hour operations
AUGMENTATION:	DoD Liaison Team (4 Personnel)
AREA OF OPERATIONS:	Single Incident or Geographic Area
STRUCTURES SPECIALIST:	2/Task Force
DATA:	Multi-disciplinary Task Force
	Self Contained for 72 hrs.
	Extensive Medical & Equipment Cache
	Organic Internal Communications
	Extensive & Specialized Rescue Training

SYSTEM DESCRIPTION (continued)

FEMA US&R TASK FORCE (continued)



SYSTEM DESCRIPTION (continued)

CORPS US&R

Trains and maintains cadre of Structures Specialists and Technical Search Specialists using the specialist equipment.

Corps US&R cadres are HQ USACE resources.

Cadres are managed by the US&R Program Manager.

After coordination with the FEMA IST or DoD, cadres will be activated upon order from HQ USACE and the US&R Program Manager will undertake their notification and mobilization.

HQ USACE EOC will conduct cadre notification and mobilization in the event that the US&R Program Manager is unable to fulfill that function.

By direction of HQ USACE, operational overhead and management support will be provided by US&R Program Manager.

Upon arrival at the Mobilization Area, Structures Specialists assignments will be coordinated through the IST or the DFO.

Upon assignment, Structures Specialists will operate under the tactical control of the IC or Unit/Task Force Leader.

Logistical support will be provided by the receiving unit with DoD support if needed.

Corps Overhead personnel will be assigned to the IST to assist cadre members with mobilization and demobilization.

SYSTEM DESCRIPTION (continued)

INCIDENT COMMAND SYSTEM

GENERAL:

The Incident Command System (ICS) is a standardized incident management system that provides maximum flexibility in providing resources in a changing situation.

ORGANIZATION:

The basic ICS organization is divided into 4 sections working under the direction of the Incident Commander (IC) and General Staff.

Incident Commander: The IC is responsible for all incident activities, including ordering and releasing of resources.

General Staff: The General Staff is comprised of the Safety Officer, Information Officer, Liaison Officer and the Section Chiefs. They provide support to the IC in the management of the incident.

Operations Section: This section is responsible for the planning and execution of all operations related to the primary incident mission.

Planning Section: This section is responsible for the collection, analysis and dissemination of all information about the incident and resource status.

Logistics Section: This section is responsible for providing facilities, services, and materials in support of the incident.

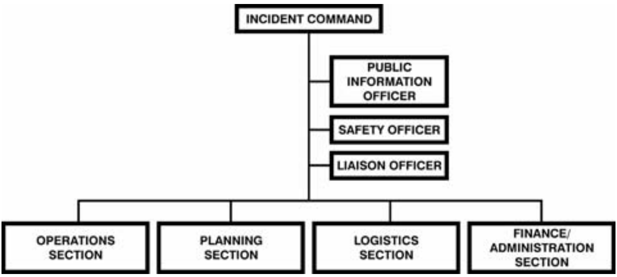
Finance Section: This section is responsible for financial and cost analysis aspects of the incident.

SYSTEM DESCRIPTION (continued)

INCIDENT COMMAND SYSTEM (continued)

US&R OPERATIONS

Below is an example of an ICS Flow Chart in its most basic form. US&R Task Forces normally operate under the Operations Section:



SYSTEM DESCRIPTION (continued)

INCIDENT COMMAND SYSTEM (continued)

ICS TERMINOLOGY

Agency Representative. Reporting to the Liaison Officer, this individual represents their agency and has the authority to make decisions on all matters regarding the agency's participation in the incident.

Allocated Resources. Resources dispatched to an incident that have not yet checked in with the Incident Communications Center.

Assigned Resources. Resources checked in and assigned work tasks on an incident.

Available Resources. Resources assigned to an incident and available for an assignment.

Base. That location at which the primary logistical functions are coordinated and administered.

Branch. The organizational level having a geographic/functional responsibility for major parts of incident operations. It is between the Section and Division/Group levels.

Dispatch. The implementation of a command to move a resource(s) from one place to another.

Dispatch Center. A facility where resources are directly assigned to an incident.

<u>SYSTEM DESCRIPTION</u> (continued)

INCIDENT COMMAND SYSTEM (continued)

ICS TERMINOLOGY (continued)

Division. That organizational level having responsibility over a defined geographic area. It sits between the Strike Team/Task Force and the Branch.

Group. A functionally organized Division (i.e., Rescue, Fire Suppression).

Helibase. A location within the incident area for parking, fueling, maintaining and loading helicopters.

Mobilization Center. An off-incident location where resources are temporarily located pending assignment, reassignment, or release.

Operational Period. The period of time scheduled for the execution of a given set of operational actions.

Staging Area. That location where incident personnel and equipment are assigned on a 3-minute available status.

Strike Team. Specified combinations of the same type of resource with common communications and a leader.

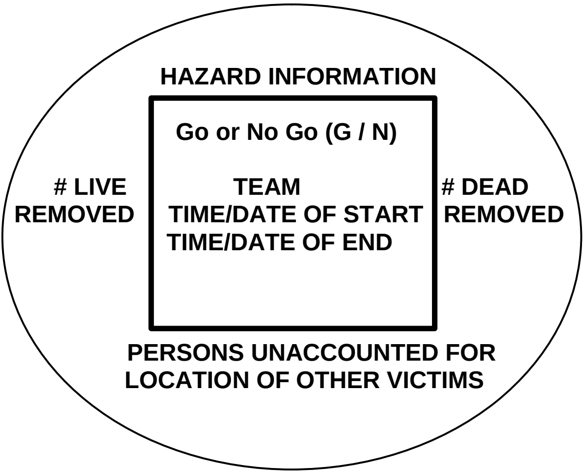
Task Force. A group of resources with a leader and common communications temporarily assembled for a given mission.

INSARAG MARKING SYSTEM

This is the marking system that was developed by the United Nations, International Search & Rescue Advisory Group. It is used outside of the US for marking structures where SAR operations are taking place. USACE StS may encounter this if serving overseas.

The basic symbol consists of a 1 meter by 1 meter square box at the primary access point into any compromised structure.

- Information will be conspicuously made with florescent color to permanently identify and mark the structure.
- Upon entry the name of the Team is written, and the remainder of the information will be added as the Search and Rescue proceeds.
- If another Team relieves the first Team, their name symbol is added as well as the time that they began operations.
- When all operations have been completed, the Square will be encircled so that all information is contained within the circle.



INTRODUCTION to SECTION 9

This section contains information that is useful for all Structures Specialists, and should be reviewed while in transit to an incident.

The Information in Section 9 is presented as follows:

- Description of Duties
- Personal Equipment Checklists
- Operational Checklists and Procedures
- Ten StS Talking Points – What StS can do for Task Forces
- Fire Service Uniform Insignia – How to I.D. Leadership
- Structures Spec Forms (small scale examples)

The Structures Specialist is responsible for performing the various structural assessments for the Task Force during incident operations. The Structures Specialist reports directly to the Planning Team Manager, but during operations, will normally be assigned to the Search Team Manager or Rescue team manager

DESCRIPTION OF DUTIES

- The Structures Specialist is responsible for evaluating the immediate structural condition of the area to be entered at the rescue site during task force operations.
- The Structures Specialist is responsible for determining the appropriate type and amount of structural hazard mitigation in order to minimize risks to task force personnel on site.
- The Structures Specialist is responsible for cooperating with and assisting search and rescue resources.
- The Structures Specialist is accountable for all issued equipment.
- The Structures Specialist performs additional tasks or duties as assigned during a mission.

PERSONAL EQUIPMENT CHECKLIST

Due to the need for rapid response to a disaster event, all personnel must have all necessary personal clothing, equipment, and supplies readily available for immediate mobilization. Each team member should also pack two weeks of personal prescription medications, over-the-counter medications commonly used for colds, allergies, etc. and extra prescription eye wear. The following list is the suggested minimum requirements to promote individual sufficiency during mission operations:

1. PROVIDED BY TASK FORCE

[ ] BACKPACK & SLEEPING BAG
[ ] SAFETY GOGGLES W/LIGHT & FLASHLIGHT
[ ] HARD HAT (BE SURE IT FITS WELL)
[ ] DUST MASK, GLOVES, & KNEE PADS
[ ] FIRST AID KIT + MEDICAL ATTENTION
[ ] PORTABLE RADIO (EMERGENCY FREQUENCY)
[ ] CANTEEN, WATER, FOOD, & SHELTER
[ ] TRANSIT (NOT ALL TASK FORCES)

2. ESSENTIAL PERSONAL ITEMS

[ ] COMFORTABLE BOOTS W/ STEEL TOES & SHANK
[ ] RAIN GEAR & EXTRA CLOTHING FOR 7 DAYS
[ ] CASH, PERSONAL I.D., CREDIT CARDS, ETC.
[ ] PERSONAL HYGIENE & MEDICATION ITEMS
[ ] EYEGLASSES, SAFETY GLASSES, + EXTRAS

PERSONAL EQUIPMENT CHECKLIST (continued)

3. RECOMMENDED PERSONAL EQUIPMENT

[ ] CLIPBOARD, KNEEBOARD, PAPER/ PENS/PENCILS
[ ] WATERPROOF NOTEBOOK & PEN + COVER
[ ] FINE POINT INDELIBLE MARKER
[ ] PERSONAL FIELD GUIDE (ATC-20-1)
[ ] USACE StS FOG & FEMA US&R FOG
[ ] PRINTED COPIES OF ALL STS FORMS
[ ] TAPE MEASURE, COMPASS, KNIFE TOOL
[ ] BINOCULARS, GEOLOGY HAMMER, PHILLIPS S. DRIVER
[ ] EQUIPMENT BELT OR FANNY PACK/DAY PACK
[ ] ELECTRONIC LEVEL, PLASTIC STRAIN GAGE
[ ] DIGITAL CAMERA, EXTRA BATTERIES & STORAGE MEDIA
[ ] CALCULATOR, LUMBER CRAYONS, SPRAY PAINT
[ ] VOICE ACTIVATED TAPE RECORDER, LASER LEVEL
[ ] METAL DETECTOR, LASER POINTER, WHISTLE
[ ] LARGE RADIO HARNESS (FOR RADIO, KNEE BD, ETC)
[ ] LASER DISTANCE METER, INCLINOMETER
[ ] SOIL PENETROMETER, WIND METER, SPY SCOPE

4. PERSONAL ITEMS AND SUGGESTED CLOTHING

[ ] SMALL PORTABLE RADIO & PDA W/CHARGER
[ ] SUN GLASSES, SUN SCREEN, INSECT REPELLENT
[ ] EMERGENCY PHONE NUMBERS, POCKET NOTE PAD
[ ] CELL PHONE, PAGER, TRAVEL ALARM
[ ] BANDANNAS, LONG UNDERWEAR, COTTON SOCKS
[ ] UNDERWEAR, TEE SHIRTS, TROUSERS, HVY SWEATER
[ ] WOOL SOCKS, GYM-TYPE SHORTS, SNEAKERS
[ ] BALL CAP, SWEAT SUIT, LIGHT JACKET, NAIL CLIPPERS

OPERATIONAL CHECKLIST

UPON ACTIVATION / AT TF ASSEMBLY POINT

[ ] Receive notification of assignment and instructions from the initiating organization.

[ ] Establish communications with the assigned Planning Team Manager and receive initial briefing, and determine if IST has been Activated for this incident

[ ] Monitor disaster-related information from local sources.

[ ] Gather relevant data on building construction in disaster area.

[ ] Review the personal equipment checklist. Assess your personal gear readiness for the specific disaster area climate. Make necessary changes.

[ ] Report to the assigned assembly point at the prescribed time.

[ ] Forward an accurate Responder Information Sheet to the Medical Team Manager.

[ ] Identify immediate TF supervisor. Initiate and maintain the organizational structure integrity of the Search Team throughout all phases of the mission.

[ ] Assist with the transfer and loading of the task force equip.

[ ] Brief TF personnel on building construction/considerations to be anticipated in the affected area.

[ ] Review operation of equipment (electronic level, total station, theodolite, metal detector, etc.).

[ ] Review all Structures Specialist forms, especially Triage (TRI-1 & 2) plus Hazard Assessment (HAZ-1, 2, & 3)

OPERATIONAL CHECKLIST continued)

AT POINT OF DEPARTURE

[ ] Assemble for a task force briefing from the Task Force Leader and appropriate officials.

[ ] Assist with the movement and loading of equipment.

[ ] Ensure that you receive any appropriate issue of gear (radio, functional vest, etc.) pertinent to the position.

[ ] Ensure that you have personal day pack, ear plugs, warm clothes for flight.

[ ] Ensure that the battery is removed from your portable radio prior to boarding aircraft.

IN TRANSIT

[ ] Review the latest disaster-related information as it becomes available.

[ ] Review the FEMA US&R Field Operations Guide for information pertinent to your position description, operational checklist, operational procedure, and safety procedures.

[ ] Take advantage of available travel time for rest prior to arrival.

OPERATIONAL CHECKLIST (continued)

ARRIVAL AT MOBILIZATION CENTER

[ ] Identify cache supplies and equipment that should receive priority for initial movement to the assigned area. Assist as necessary in the departure to the assigned jurisdiction or incident site.

[ ] Brief Rescue Mgr, Search Mgr, Safety Officer, and Heavy Equipment and Rigging Spec of relevant structural concerns.

[ ] Determine coordination and communication protocol with IST Structures Specialist to include:
- Request access to Structural, Architectural & Mechanical-Electrical-Plumbing plans.
- Determine number, occupancies, & building construction.
- Determine age & occupancy of structures.
- Determine numbers of people in buildings at time of incident, and how many assumed trapped.

ON-SITE OPERATIONS

[ ] If required, assist the Logistics Specialist with the unloading, sorting and set-up of the equipment cache and the task force support facilities. (should not interfere with critical Recon and Triage Tasks).

[ ] Receive initial briefing of tactical assignment from the Task Force Leader or Planning Team Manager to include:
- Incident situation report.
- Task force objectives and tactical assignments.
- TF support layout/requirements (Base of Ops).
- Communications plan.
- Review emergency signaling/evacuation procedures.
- Review medical treatment/evacuation procedures.
- Review process for ordering supplies/equipment.

[ ] Carry out tactical assignments as directed. Be prepared to go into immediate operations.

<u>OPERATIONAL CHECKLIST</u> (continued)

ON-SITE OPERATIONS (continued)

[ ] Conduct Structure Triage and/or Recon operations as directed:
- Concise ID/location of structures.
- Rapid assessment of the affected area.
- ID potential buildings that require a more detailed assessment/search.
- Use the Structure Triage Form (see Sec. 8).

[ ] Perform an assessment of assigned structures exterior and interior to determine structure type, location of falling or collapse hazards, and access points. This would include:
- Use StS Checklist Form HAZ-3.
- Seek the following information:
  - Type, age & occupancy of structure
  - Availability of Structural, Arch & MEP plans
  - Layout of bldg & probable location of occupants
  - Location and status of utilities, emergency generators, fuel tanks, batteries and solar electric systems
  - Pre-existing problems and/or ongoing construction
- Clearly mark the structure(s) assessed at the point of entry in accordance with the standard marking system.
- Draw a crude plan to indicate possible access points, locations of structural hazards, and the most productive methods of hazard reduction.
- Note the indication of all access/egress routes (i.e., corridors, stairs, elevators, duct & pipe access) for possible voids, victim locations, and access.
- Clearly mark off hazardous areas that are to be avoided.

[ ] Participate in recon operations as directed. Brief Recon Team on structural considerations. Mark buildings in accordance with the Structure/Hazards Evaluation Marking Sys.

[ ] Gather Structural, Architectural & MEP plans, etc. as available from facilities staff, building officials, engineer of record & contractors. (coordinate this with IST StS).

[ ] Work with HERS to determine availability of heavy equipment and contractors.

OPERATIONAL CHECKLIST (continued)

ON-SITE OPERATIONS (continued)

[ ] Provide assessment to TF team managers, including:
- Recommendation for areas requiring hazard mitigation:
  - Avoid & place barrier tape
  - Minimize Exposure
  - Monitor with warning/evacuation plan
  - Carefully Remove
  - Shore and Brace
- Discuss the most productive method of access relative to probable location of victims.

[ ] Work with search and rescue personnel to determine the most appropriate course of action to gain access to victims. This would include:
- Most appropriate routes to conduct searches.
- Determine what structural materials are likely to be found while gaining access.
- Effects of rescue operations on other building elements.
- Special precautions required during breaching operations.
- Special considerations of buildings with basements.
- Advice on the placement of shoring and bracing material.
- Monitor the assigned structures for changing conditions.

[ ] Ensure your physical readiness through proper nutrition, water intake, rest, and stress control techniques.

[ ] Coordinate and communicate all activities with IST Structures Specialist per established protocols.

[ ] Keep the Planning Team Manager apprised of any tactical accomplishments or conflicts, supply deficiencies, or equipment malfunctions.

[ ] Brief your shift replacement fully on all ongoing operations when relieved at work cycle rotations.

<u>OPERATIONAL CHECKLIST</u> (continued)

REASSIGNMENT / DEMOBILIZATION

[ ] Assemble for a team briefing on the mission status and reassignment/demobilization determinations.

[ ] Ensure that assigned tools and equipment are inventoried, returned to the cache, and prepared for movement.

[ ] Prepare personal belongings for demobilization.

[ ] Notify the Logistics Specialist of losses or potential maintenance requirements of any tools and equipment.

[ ] Assist with the break down and policing of the Base of Operations.

[ ] Assist with the packaging, movement, and loading of the equipment cache.

[ ] Submit personal notes to the Planning Team Manager for inclusion in the after-action reports. This should include reviewing pertinent position descriptions and operational checklists and procedures for recommended changes.

[ ] Ensure the return of items issued during the activation phase.

[ ] Upon return, participate in the task force mission critique and CISD debriefing.

WHAT CAN StS DO FOR THE TASK FORCE?

1. Identify structural hazards that threaten the safety of rescue personnel.
2. Identify alternatives for Mitigation of Structural Hazards to minimize risks to rescue personnel.
3. Design Mitigation Measures, including shoring and bracing using available materials.
4. Monitor Structural Stability under changing conditions to minimize risks to rescue personnel.
5. Identify potential voids where victims may be located; identify most efficient access route to voids.
6. Provide Orientation and Marking within a structure.
7. Assist with safe placement of Heavy Equipment.
8. Assist Rigger and Rescue Squads with heavy debris removal.
9. Triage collapse areas for Search and Recon operations.
10. Assist Plans with preparation of search maps and IAP. Liaison with IST and other TF StS for detailed and current building information.

HOW DO YOU KNOW WHO ARE WE TALKING TO?
Typical Insignia on Fire Personnel Uniforms

Firefighter I or II - No insignia on the uniform.

Fire Apparatus Engineer - Single silver bugle - West Coast

Lieutenant - Single silver bugle - elsewhere

Fire Captain - Double silver bugles

Battalion Chief -Two crossed gold bugles

Division Chief - Three crossed gold bugles

Deputy Chief - Four crossed gold bugles

Fire Chief or Chief of Department- Five crossed gold bugles

FEMA STRUCTURES SPECIALISTS FORMS

The following shows samples of Forms that should be used by FEMA US&R Structures Specialists in order to efficiently document their activities during an incident.

The Forms are arranged as follows:

- Triage Forms - TRI-1 & TRI-2
- Structure/Hazard Assessment Forms - HAZ-1 and HAZ-2
- Structure/Hazard Assessment Checklist - HAZ-3
- Struct Hazard Mitigation - Form MIT-1
- Struct Hazard Mitigation - Log MIT-Log
- Structure Monitoring Form - MON-1
- Structure Monitoring Log - MON-Log
- Struct. Spec. Shift Change Form – Hand-Off
- Crane Use Form – CU-1

Full size copies of these forms may be downloaded from DisasterEngineer.org in the Library Section

The use of the Triage and Structure/Hazard Assessment is discussed in Section 6.

MIT-1 is formatted like a Termite Report Form, where a sketch is used as a location map where specific types of Mitigation are located by writing in a Locator Number. This number is then related to a specific type of Mitigation, that is defined in the upper right of the form by an abbreviation. A numerical priority is also assigned to this specific Mitigation. More than one Mitigation may have the same number used to specify its priority. Form **MIT-Log** is then used to record significant actions taken to complete each of the specific mitigations. **MIT-Log** can also be used as a communication tool to Hand-off to the oncoming StS, and to be recorded in the Incident Action Plan

MON-1 and **MON-Log** should be used to identify Instrument setup controls, and to record periodic readings. These too are useful communication docs for Handoff and the IAP

Hand-Off and **CU-1** are good communication/check list records

Structure Triage Form - TRI-1 Date/Time: ______ By: ______ Page ___ of ___

TEAM: ______ STRUCTURES SPECIALIST: ______ | DATE/TIME OF CATASTROPHE: ______

AREA MAP

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE	(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5	(MIN=1 MAX=50)		
No. STORIES: ______	3. CONDITION OF VOIDS	1 >VERY COMPACT>SEPARATE LAYERS>PART COLLAPSE	20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1 > ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
MATERIAL: (CIRCLE ALL THAT APPLY)	5. CHANCE OF FURTHER COLLAPSE	-1 > LOW CHANCE >>>>>>>>>>>> HIGH CHANCE	- 20	-
WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	6. SPECIAL INF.:	SCHOOL / HOSPITAL = +25 KNOWN LIVE VICTIM = +5 EACH		
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______			BLDG. TOTAL

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE	(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5	(MIN=1 MAX=50)		
No. STORIES: ______	3. CONDITION OF VOIDS	1 >VERY COMPACT>SEPARATE LAYERS>PART COLLAPSE	20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1 > ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
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BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE	(WRITE ZERO)	GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5	(MIN=1 MAX=50)		
No. STORIES: ______	3. CONDITION OF VOIDS	1 >VERY COMPACT>SEPARATE LAYERS>PART COLLAPSE	20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM	1 > ONE DAY >>>>>>>>>>>>>>>>>> 2 HOURS	20	
MATERIAL: (CIRCLE ALL THAT APPLY)	5. CHANCE OF FURTHER COLLAPSE	-1 > LOW CHANCE >>>>>>>>>>>> HIGH CHANCE	- 20	-
WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	6. SPECIAL INF.:	SCHOOL / HOSPITAL = +25 KNOWN LIVE VICTIM = +5 EACH		
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______			BLDG. TOTAL

Structure Triage Form - TRI-2 Date/Time:__________ By:__________ Page____ of____

BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE (WRITE ZERO) GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5 (MIN=1 MAX=50)	
No. STORIES: ______	3. CONDITION OF VOIDS 1 >VERY COMPACT>>SEPARATE LAYERS>>PARTIAL COLLAPSE> 20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM 1 > ONE DAY >>>>>>>>>>>>>>>>>>>>> 2 HOURS > 20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE -1 > LOW CHANCE >>>>>>>>>>>>>>>> HIGH CHANCE > -20	-
	6. SPECIAL INF.: SCHOOL / HOSPITAL = +25; KNOWN LIVE VICTIM = +5 EACH	
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______	BLDG. TOTAL
BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE (WRITE ZERO) GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5 (MIN=1 MAX=50)	
No. STORIES: ______	3. CONDITION OF VOIDS 1 >VERY COMPACT>>SEPARATE LAYERS>>PARTIAL COLLAPSE> 20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM 1 > ONE DAY >>>>>>>>>>>>>>>>>>>>> 2 HOURS > 20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE -1 > LOW CHANCE >>>>>>>>>>>>>>>> HIGH CHANCE > -20	-
	6. SPECIAL INF.: SCHOOL / HOSPITAL = +25; KNOWN LIVE VICTIM = +5 EACH	
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______	BLDG. TOTAL
BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE (WRITE ZERO) GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5 (MIN=1 MAX=50)	
No. STORIES: ______	3. CONDITION OF VOIDS 1 >VERY COMPACT>>SEPARATE LAYERS>>PARTIAL COLLAPSE> 20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM 1 > ONE DAY >>>>>>>>>>>>>>>>>>>>> 2 HOURS > 20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE -1 > LOW CHANCE >>>>>>>>>>>>>>>> HIGH CHANCE > -20	-
	6. SPECIAL INF.: SCHOOL / HOSPITAL = +25; KNOWN LIVE VICTIM = +5 EACH	
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______	BLDG. TOTAL
BLDG. ID: ______	1. ZERO VICTIMS POSSIBLE (WRITE ZERO) GO TO NEXT BUILDING	
FLOOR AREA: ______	2. POTENTIAL No. OF TRAPPED / 5 (MIN=1 MAX=50)	
No. STORIES: ______	3. CONDITION OF VOIDS 1 >VERY COMPACT>>SEPARATE LAYERS>>PARTIAL COLLAPSE> 20	
OCCUPANCY: ______	4. TIME TO GET TO VICTIM 1 > ONE DAY >>>>>>>>>>>>>>>>>>>>> 2 HOURS > 20	
MATERIAL: (CIRCLE ALL THAT APPLY) WOOD CONCRETE STEEL UNREINFORCED MASONRY PRECAST CONCRETE	5. CHANCE OF FURTHER COLLAPSE -1 > LOW CHANCE >>>>>>>>>>>>>>>> HIGH CHANCE > -20	-
	6. SPECIAL INF.: SCHOOL / HOSPITAL = +25; KNOWN LIVE VICTIM = +5 EACH	
CALCULATE AREA NUMBER TRAPPED:	NO GO (CIRCLE, WRITE NO-GO & WHEN / IF TO REVISIT) FIRE HAZARDOUS MATERIALS OTHER: ______	BLDG. TOTAL

Methods to Calculate Number of Occupants Depending on Use

Based on Area		Variation	Based on other than Area
Schools, Library	1 per 70 sq ft	50 to 100	25 to 35 students per classroom
Hospitals	1 per 100	80 to 150	1.5 occupants per bed
Multi Residential	1 per 200	100 to 200	1.5 occupants per bedroom
Commercial	1 per 100	50 to 200	
Office, inc Govt.	1 per 150	100 to 200	Others
Public	1 per 25	10 to 50	1.5 occupance per Parking space
EOC, PD, FD	1 per 125	100 to 150	
Industrial	1 per 200	100 to 300	Also - how many cars are left in
Warehouse	1 per 600	400 to 900	parking lot?

Notes & Calcs

US&R Structure / Hazards Evaluation Form - HAZ-1 **By:** ______________________

Where required, circle all the information or items that apply. NOTE: AFTERSHOCKS MAY CAUSE ADDITIONAL DAMAGE OTHER THAN NOTED.

STRUCTURE DESCRIPTION: **Bldg ID:** ______ **No. Stories:** **No. Basements:**	**BUILDING MARKING:** ☐ **Date/Time of Evaluation:** ______ **Date/Time of Catastrophe:** ______
MATERIALS: Wood Concrete Steel URM PC Concrete Other:	**TYPE OF COLLAPSE:** Pancake Soft 1st Floor Wall Failure Torsion Middle Story Overturn Other:
FRAMING SYSTEM: Shearwall Moment Frame Braced Frame Other:	**LOCATION OF VOIDS:** Between Floors Basement Shafts Other:
OCCUPANCY: Hospital Police Station Fire Station Emergency Operations Center Office Building School Public Assembly Industrial Hotel Apartment Retail Store Other:	**DESCRIPTION OF UNSAFE AREAS & HAZARDS:** ______ ______ ______ ______ ______ ______ ______
VICTIM & OTHER INFORMATION: ______ ______	
LOCATION OF BEST ACCESS & SAR STRATEGY: ______ ______	
SKETCH:	

US&R Structure / Hazards Evaluation Form - HAZ-2 **By:** ______________________

Where required, circle all the information or items that apply. NOTE: AFTERSHOCKS MAY CAUSE ADDITIONAL DAMAGE OTHER THAN NOTED.

SKETCH:

US&R Structure / Hazards Check List - HAZ-3

By: ____________________

This is only a Check List. Check all Appropriate Structure Hazards

STRUCTURE DESCRIPTION:

Bldg ID: ____________________

No. Stories: No. Basements:

TYPE OF COLLAPSE:

Pancake	Soft 1st Floor	Wall Failure
Torsion	Middle Story	Overturn
Other:		

From a SAFE Distance, CHECK:

- ☐ Alignment of Structure's Corners & Faces
- ☐ Alignment of Structure's Floors
- ☐ Condition of Openings
- ☐ Condition of Facing or Projecting Elements
- ☐ Presence of Precast Conc Facing or Brick/Stone Veneer
- ☐ Presence of other FALLING HAZARDS
- ☐ Presence of Rootop Equipment, Towers, etc
- ☐ Presence of Distinctive Elements, Additions, Stairwells
- ☐ Any Alternate Energy Source - Generator, Solar Elec
- ☐ Presence of Tanks w/Explosive/Corrosive Material

Walk around Structure and CHECK:

- ☐ Continuity of Vertical load Path
- ☐ Continuity of Lateral Load Path
- ☐ Alignment & Condition of all Wall Piers
- ☐ Condition of Foundation & Adjacent Ground
- ☐ Presence of Flowing Liquids
- ☐ I.D Areas of Structure to be avoided
- ☐ I.D. Sections with potential for Brittle Failure
- ☐ I.D most PROBABLE Collapse Mode
- ☐ I.D All Exterior FALLING HAZARDS
- ☐ I.D All Ingress and Egress Locations

If you choose to enter the Structure:

- ☐ Make sure that at least one other Team Member remains outside and you maintain radio contact
- ☐ Notify TFL you are entering structure - Which Side
- ☐ Leave Easily Visable Trail as you explore interior **
- ☐ Check Each Closed Door for heat PRIOR to OPENING
- ☐ Inspect Ground Floor Level Before moving Upward
- ☐ Check Main Columns and Shear Walls-Cracks, Spalling
- ☐ Check Main Beam to Column Connections
- ☐ Check Stair wells for Damage and Access
- ☐ Check Condition of Floor System
- ☐ I.D. All Interior Collapse Hazards
- ☐ I.D All Interior Falling Hazards
- ☐ Locate Safe Havans and Escape Routes
- ☐ Report all Data to Outside Person before continuing
- ☐ Proceed Up/Down Only if Can Maintain Radio Contact
- ☐ Proceed to Upper Stories, Check each before Proceding
- ☐ Proceed to Basement and Check Structure & Foundation

NOTES

1. ** Suggestions for Visable Trail are: Light Sticks, Paint Arrows on floor, Electronic Relay Devices

NOTES:

US&R Struct. Haz. Mitigation Form - MIT-1

By: ______________________________ **Date:** __________

Where required, circle all the information or items that apply. NOTE: AFTERSHOCKS MAY CAUSE ADDITIONAL DAMAGE OTHER THAN NOTED.

STRUCTURE DESCRIPTION:

Bldg ID: ______________________________

No. Stories: __________ **No. Basements:** __________

MATERIALS:

Wood Concrete Steel URM PC Concrete

TYPE OF COLLAPSE:

Pancake Soft 1st Story Wall Failure O-turn Other

MITIGATION METHODS & ABBREVIATIONS

Avoid and Barracade	A&B	Horiz. Tieback	H-TB
Remove	Remo	Vert Tieback	V-TB
Minimize Exposure	Exp-M	Shield	Shld
Vertical Shore	V-Sho		
Horiz. Shore	H-Sho	Monitor	Mon
Raker Shore	R-Sho	(GoTo Monitor Form)	
Daigonal Brace	DB	Other (specify)	

LIST OF POSSIBLE HAZARDS	HAZ LOCATOR (Use Circled No. & locate on Sketch)	MIT METHOD (Use abbrev. indicated above	PRIORITY (From 1 to 9, may be several of ea.)	TIME REQD (Est. to complete reqd mitigation)	COMMENT
FALLING HAZARD TYPE					
Glass, Light Bldg Facing					
Bldg Contents, H'vy inc Safe					
Brick Veneer					
Rock Veneer Panels					
P.C. Panels					
HVAC Units					
Ducts, Elec Conduit					
Structure Element - Loose					
Str Elmt, Hanging & Attached					
Other					
LOCAL COLLAPSE HAZARD					
Leaning Wall					
Damaged Column					
Damaged Floor					
Un-braced Column					
Punching Shear Potential					
Debris Overload-Floor					
ResQ Equip Overload					
Rain & Clogged Roof Drains					
Damaged Retaining Wall					
Other					
GLOBAL COLLAPSE HAZARD					
Leaning Building					
Multi Floor Collapse					
Multi Column Collapse					
Other					

SKETCH:

US&R Struct. Mitigation Log - MIT-Log **By:** ______________________ **Sht** ____ **of** ______

STRUCTURE I.D.

DATE	TIME	HAZARD LOCATOR	MIT METHOD	COMMENT
Example mm / dd / yy	1100 hrs	4	R-Shore	

9

US&R Structure Monitoring Form - MON-1

By: ______________________ **Date:** __________

Monitoring Began **Monitoring Ended** **Sheet** _____ **of** ______

STRUCTURE DESCRIPTION:
Bldg ID: ______________________

____

No. Stories: __________ **No. Basements:** __________

ATMOSPHERIC CONDITIONS **Temperature**______ °F

☐ Day ☐ Clear ☐ Calm ☐ Overcast

☐ Nite ☐ Cloudy ☐ Windy ☐ Gusty

INSTRUMENT SETUP

Model/Serial No. ______________________

Location ______________________

Protection ______________________

Description ______________________

REFERENCE (Control) POINTS - at least two

Name(s) ______________________

Locations ______________________

Descriptions ______________________

SKETCH OF MP1

MONITORING POINT #1(MP1)

Location ______________________

Description ______________________

ALERT displacement = __________

ALARM displacment = __________

SKETCH OF MP2

MONITORING POINT #2 (MP2)

Location ______________________

Description ______________________

ALERT displacement = __________

ALARM displacment = __________

SKETCH OF MP3

MONITORING POINT #3 (MP3)

Location ______________________

Description ______________________

ALERT displacement = __________

ALARM displacment = __________

SKETCH OF SITE (show structure, instrument, RPs):

US&R Structure Monitoring Log - MON-Log **By:** ______________________ **Sht** ____ **of** ____

DATE	TIME	REF (Control) POINT	MONITORING POINT	COMMENT
Example				
mm / dd / yy	1000 Hrs	RP1-1 actual reading		Temp = 77F, establish control #1
	1000 Hrs	RP1-2 actual reading		Establish control #2
	1005 Hrs		MP1-1 initial reading	Establish monitoring point #1
	1015 Hrs		MP1-1 reading	No change from previous reading.

US&R StS Shift Change Form - Hand-Off

BY: DATE:

STRUCTURE DESCRIPTION:	**HAZARDS:**
	Haz Mat situations
	Hanging or falling debris
Bldg I.D.	Heavy Equipmein in area
	Other rescue personnel in area

ENDING SHIFT SUMMARY:

PRIORITIES FOR NEW SHIFT:

OPERATIONS:	**NEW/ADDITIONAL FORCES**
Monitoring devices	Aftershocks
Status of debris removel	Wind
Ongoing rescue operations	Rain (settlement due to undermining)
Victim removal	Possible secondary explosions
	New partial collapses
MITIGATION STATUS REPORT:	**EQUIPMENT AVAILABLE:**
Changes to mitigation operations	Lost
Locations of shores to be checked	Broken
Areas requiring shoring	Used up
Monitoring devices	Needed

MISCELLANEOUS:

SKETCH:

US&R Crane Use/Order Form CU-1 By: ______ Date: ______ Page ____ of ____

Situation Name: ______	**Date and Time of Lift:** ______
Rigging Task: ______	**Task Force Name:** ______
Weather Conditions: ______	**Task Force Leader:** ______
Load Description: ______	Crane Operator: ______
Load Weight: ______	Crane Make & Model: ______
Block Weight: ______	Crane Serial No: ______
Rigging Weight: ______	Boom Length: ______
Jib Weight: ______	Jib Length: ______
Jib Ball Weight: ______	Jib Position: ☐ Stowed ☐ Retracted ☐ Offset at ______
Hoist Line Weight: ______	Size of Counterweights Installed: ______
Other Weight: ______	Front Outrigger Installed: Yes No
Total Weight:	**Setup On:** ☐ Crawlers ☐ Outriggers ☐ Tires
Lift will be On: ☐ On Main Block ☐ On Jib	☐ Extended ☐ Retracted ☐ Other

Max. Intended Working Radius	Boom Angle:	Rated Capacity:	Percent of Capacity : (Total Load / Rated Capacity)
Over Rear: ______	Over Rear: ______	Over Rear: ______	Over Rear: ______
Over Side: ______	Over Side: ______	Over Side: ______	Over Side: ______
Over Front: ______	Over Front: ______	Over Front: ______	Over Front: ______

Hazards: ☐ Electrical ☐ Fire ☐ Underground ☐ Other ______ Are Crane Mats, Blocking Reqd: ______

SKETCH:

9

NOTES:

BY: ______________________ DATE: __________

BY: ______________________ DATE: ____________