Medium Level Structural Collapse Concepts

Instructional Guide

Technical Rescue
01-04-0040 (Rev. ?)

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THE NYS OFFICE OF FIRE PREVENTION AND CONTROL AND THE NYS OFFICE OF COUNTER TERRORISM

Unit 1

Building Construction Related to Building Failure

UNIT TITLE

State of New York
Office of Fire Prevention and Control
Fire Training Program

Course: 1625

Medium Level Structural Collapse Concepts

Lesson:

Unit I Building Construction Related to Building Failure

Lesson Code:

1625-1 Time: 6 Hours

Mandatory Prerequisites:

Course #1602 – Basic Structural Collapse Operations

Recommended Prerequisites:

Course #15 - Accident Victim Extrication Training

Instructional Aids:

Chalkboard, Chalk, Eraser, Student Workbooks, Registration Cards and Lesson Plan. Computer Projection Equipment & Course CD.

Plan of Presentation:

This is a PowerPoint lecture program

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Unit 1

Building Construction Related to BUILDING FAILURE

II. Unit 1 Building Construction Related to Building Failure

This is the largest unit in the course; it deals with the relationship between structural stability and its results when structural items fail. Building failure can be due to numerous different situations, all of which your fire department will respond to at any given time. We will be discussing many things all of which are important to the safe completion of your collapse rescue operation. Safety in these situations is of paramount concern.

STRUCTURAL BUILDING COLLAPSE IS ONE OF THE MOST DANGEROUS SITUATIONS WE AS FIREFIGHTERS WILL ENCOUNTER

1. STRUCTURAL BUILDING COLLASPE

A. This statement is there to tell the students and make it very plain, that the unstable collapsed building they will be operating in is one of the most dangerous situations they will encounter in their careers.

B. The reason this is the most dangerous situation is that there is no predictability, and very little warning, if any, of impending secondary collapse. This extreme unpredictability is the main reason this makes such a dangerous situation.

A Structure Is An Arrangement Of Building Materials That Are Constantly Working To Defy Gravity

2. BUILDING MATERIALS

A. This statement is an overall generalization which encompassed every type of building condition on the planet. All buildings when erected are constantly and continually trying to stay up and not be pulled to the ground by the forces of gravity.

B. Every structure ever erected will be under this force for the entire time it will stand, whether for one year or for one thousand years.

Load Transfer

All loads generated within a structure, or received from any source outside that structure; must be transmitted from the point received to the earth, without any discontinuity in the load transference to its structural supporting elements.

3. LOAD TRANSFER

A. Basically, every load or structural element must be held up from the earth. This can be done by either itself or another structural member strong enough to support it.

B. The load must eventually bear directly to the ground no matter how tall the building will be, always and forever.

Load Transfer

- *If there is any break of continuity, or if the structure's foundation yields to any compression or shear forces the structure will fail*

4. LOAD TRANSFER

A. All parts, items and structural elements of the building MUST be supported by something strong enough to handle the load from above.

B. This can be a structural supporting element, beams, columns, arches, bearing wall, girders, and SOLID GROUND, or any combination of all of them, which is the most common.

C. ANY disconnect of any one of these elements will result in a collapse situation developing.

Load Transfer

- *All loads applied to any part of a structure must be transmitted to the ground.*
- *Most live loads are usually applied to the buildings floors and most structures are designed with that in mind.*
- *Structural supporting floor elements generally act as beams (floor joists).*

5. LOAD TRANSFER

A. Any load on a structure must be continually supported right down to the earth; the structural support must be continuous.

B. One major factor is ALL interior live, dead, static, or dynamic loads are applied to the building floors each and every building is designed with this in mind.

C. As a result, all floor joists in a building will act as beams, transferring the load at right angles to other structural supporting elements.

Load Transfer

- *Loads are transmitted by the beams to girders, bearing walls, columns, or arches or to any combination thereof*
- *The proportion of the load delivered to each support point depends on the distance from which point the load is applied to each end*

6. LOAD TRANSFER

A. The most common load transfers are from the floor beams to some sort of bearing element or combination of elements.

B. The amount of support force needed will depend on the distance from the load the support point will be. This can be mathematically calculated, and is generally less the further away the load is.

Engineered Construction

- *Construction Usually In Larger Buildings Or Commercial Structures Where There Is Extensive Testing And Inspection Of Material And Workmanship On The Job Site.*
- *Usually Done By Onsite Engineers Under Supervision Of The Architect. The Design Of The Building And Its Intended Loads Have Been Carefully Engineered Into Its Construction Features*

7. ENGINEERED CONSTRUCTION

A. This is one definition of quality controlled construction techniques and practices.

B. Continual testing of all materials and fabrication techniques is done until the end of the construction of the building.

C. This is usually done on larger structures, public works, commercial, governmental, retail and public assembly. It is rarely done on private homes.

Vernacular Construction

Usually Smaller Type Wood Frame Or URM Buildings Where Basic "Hand-me-down" Construction Techniques Are Utilized. There Is Little Engineering Practices Used And Almost No On Site Inspection Of Materials Or Workmanship. This Is A Dangerous Type Of Structure From A Collapse Standpoint Due To The Unknown Quality Of Its Construction Features.

8. VERNACULAR CONSTRUCTION

A. Typically done with new home and old home renovations and condo, town house situations.

B. These buildings may be more dangerous from a fire and rescue standpoint, due to lack of inspections and the result of poor workmanship.

Alteration

Is the construction on a building consisting of revisions which may change the structural elements of the building, including the moving of mechanical equipment, columns, bearing walls, or locations of openings. However, it does not increase the overall area or dimensions of the building.

9. ALTERATION

A. The two term alteration and renovation are very different. They are many times both used incorrectly.

B. Basically any change to the structure size, shape, or structural elements is and alteration.

C. The key point is that it does not increase the overall area of dimension of the building.

Renovation

Is the restoration of an existing structure, however, it does not affect any structural changes of that building. Usually cosmetic in nature such as window replacement or new ceiling or wall coverings. Probably the majority of the accidents we respond to are due to alterations not renovations

10. RENOVATION

A. A true renovation does not alter the structural elements of the building or their locations.

B. It is usually just cosmetic in nature and for our purposes is not generally a hazard.

C. Many times eye witness or workman will call a true alteration a renovation, this is not the case. On scene your rescue team must determine this for themselves.

Primary Structural Elements

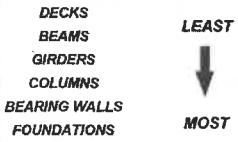
A structural element that supports another structural member in the same building, such as a bearing wall, column, or girder. The collapse of a primary member WILL cause the collapse of the structural member it supports

11. PRIMARY STRUCTURAL ELEMENTS

A. A structural element that supports other structural elements in the same building. These could be bearing walls, arches, columns, girders or beams.

B. The failure of one of these elements will cause the failure of any items this structural member supports. The failure can be local or catastrophic, depending on the location in the building.

Hierarchy Of Structural Elements



12. HIERARCHY OF STRUCTURAL EMEMENTS

A. This graphic is all about load transfer and the dangers if the transfer fails.

1. The least dangerous element for major failure is the floor deck material itself.

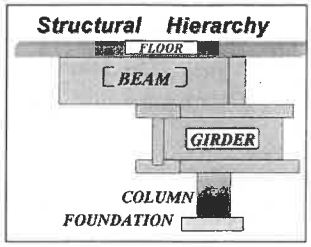
2. The next is if a beam fails, then the deck will fail as well as anything else the beam is holding.

3. If a girder fails, then any floors or beams the girder is holding will let go.

4. When a column goes, all above the column will fail. This can include several floors of decks, beams, girders and other columns.

5. Bearing walls typically will hold up either two sides or all four sides of a building, any failure could cause total collapse.

6. If the foundation fails, the whole building is gone. This situation has caused catastrophic events to occur all over the world.

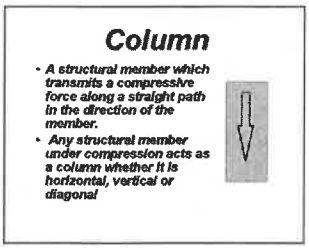


13. STRUCTURAL HIERARCHY

A. A visual look at the more common types of structural elements we will encounter in our emergency responses. If the bottom fails, all fails. If any of the ones above let go, there will be some type of collapse occurring, could be big or could be small.

14. STRUCTURAL HIERARCHY PHOTO

This photo shows the floor above a beam, the column and the foundation. This is the most basic simple principle of the majority of building construction in this country.

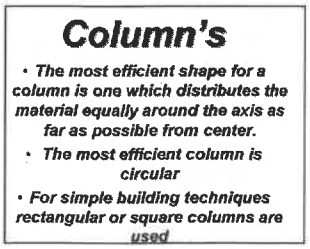


15. COLUMN

A. Any structural element under compression regardless of its orientation (direction) is technically considered a column. When placed under pressure it will react as such, no matter what direction it is facing.

B. Ideally all columns will transfer their load along a straight line. This is the most effective method of handling the loads applied to them.

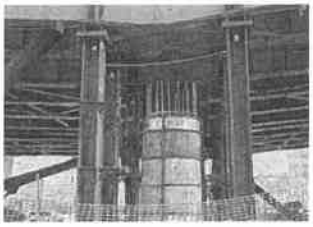
C. ANY unbalanced load shifting into the column from any direction may cause that column to fail.



16. COLUMN'S

A. A circular shape is the most efficient, and is used in many situations. It will evenly distribute the load thru the entire column uniformly.

B. Square or rectangular shapes are used often because of there ease of compatibility with construction building materials, especially in home construction.



17. COLUMN PHOTO

A. A concrete column under a major highway being repaired. (Cross Bronx Expressway, NYC)

B. The adjoining steel H beam columns are the temporary support of the existing steel I beam road base.

C. After the column is repaired. The load from the girder above will be placed right on top of the column, thus transferring the load directly to the ground.

Euler's Law of Column's

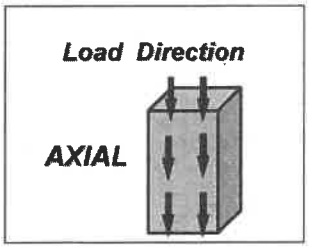
Long thin columns will hold up until a critical load is reached at which time the column will buckle causing an eccentric load on one end and thus the entire column will fail. The axial load changes causing a distributed load to become concentrated on one point causing that point to buckle

18. EULER'S LAW OF COLUMN'S

A. A Greek mathematician, who lived before Christ, realized the longer a column is the less it will support.

B. The basic premise is; when weight is applied to the column, deflection in that column will result, deforming the shape of the column. This will change the center of the column throwing off the axial load.

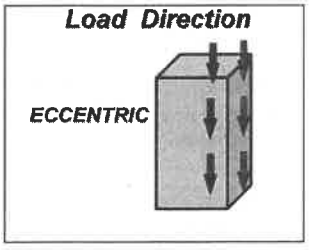
C. This deflection will cause the load to be eccentric (off center) and fail the column.



19. LOAD DIRECTION -- AXIAL

A. The most efficient load direction for a column is Axial.

B. The load is being evenly distributed throughout the entire column material.

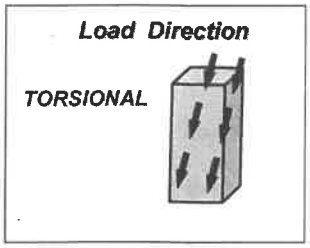


20. LOAD DIRECTION – ECCENTRIC

A. When the load is off center, it's called eccentric loading.

B. This WILL cause a deflection in the shape of the column, (generally buckling).

C. This deflection will cause the column to "buckle" as a result the column loading is not properly distributed and the column will fail prematurely.



21. LOAD DIRECTION – TORSIONAL

A. The worst case scenario for a column load, torsional loading is eccentric load in on two different planes.

B. A twisting action is cause which will fail the column 4 times faster then a single eccentric load.

C. There have been numerous catastrophic building failures as a result of this type of loading.

Bearing Walls

An interior or exterior wall that supports a load in addition to its own weight. Part of the skeletal framework of a structure, it most often supports the floors and roof of a building. The collapse of a bearing wall is more serious than the collapse of a column, floor or non-bearing wall.

22. BEARING WALLS

A. When a bearing wall collapses it will cause a catastrophic failure of that structure.

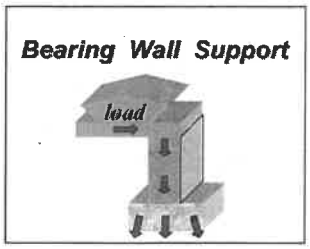
B. The bearing walls support all the floors above it, any failure will cause numerous structural supporting elements to fail.

The Load Received By A Bearing Wall Is Delivered Directly To The Foundation And Thus To The Ground.

23. BEARING WALLS

A. The prime reason the bearing wall is there is to support all the floor loads and funnel them directly to the foundation.

B. The foundations only job is to redistribute the buildings weight across the earth.

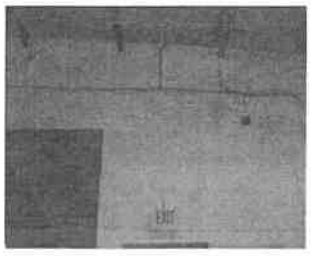


24. BEARING WALL SUPPORT

A. This graphic shows how the loads are distributed to the ground.

1. The floor loads go t the wall
2. The walls loads go to the foundation
3. The foundation takes all the weight from the loads above and spreads it around the ground.

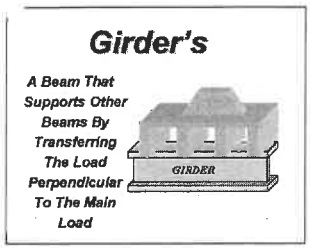
B. This is the basis of all building construction principles.



25. BEARING WALL PHOTO

A. This photo shows the roof sections being supported by the roof beams several feet on center.

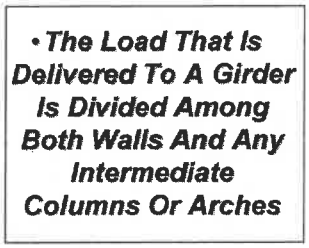
B. The roof beams in turn are supported by the masonry wall, taking the roof and beam load directly to the ground thru the masonry block.



26. GIRDER'S

A. This is the simple basic definition of a girder; a beam that supports other beams by transferring the load perpendicular to the main load.

B. Most girders take the load and transfer that load at right angles to the main load.

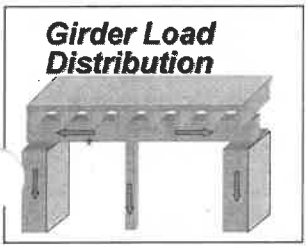


27. GIRDER LOADS

A. This is the main distribution system of the girder.

B. The girder collects specific loads from various points and transfers the loads to specific points.

C. Depending on the number of support points the girder will have, will depend on how the load will transfer throughout the structure.



28. GIRDER LOAD DISTRIBUTION

A. Depending on the amount of load and the length of the support points, will depend on the need for different support points.

B. In this graphic a column is needed to help the load be distributed evenly.

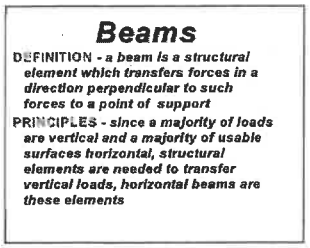
C. The girder would not be strong enough by itself to spread the load without the columns help.

29. GIRDER PHOTO

A. A view of two main girders which transfer this roof load and the roof joists to the exterior bearing walls.

B. Due to the long span, and the numerous possible roof loads, snow, ice, etc. the girders are very deep.

C. The deeper the span of the girder the stiffer the steel beam will be and the more load it can support.



30. BEAMS

A. This is the basic definition for most beams used in the typical building construction we are used to working and responding to.

B. The whole concept of the beam in construction is described in this principle.

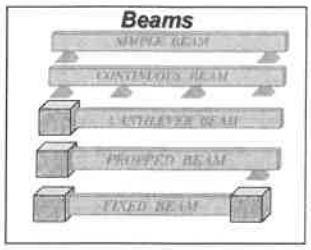
Beam Load

BEAM LOAD - *when a beam is loaded it deflects downward, deflection causes the top of a beam to shorten. The top of the beam is then in compression and the bottom of the beam elongates and thus is in tension. The force line along the length of the beam at some point between the top and the bottom does not change and is known as the neutral axis*

31. BEAM LOADING

A. This is an explanation of the most common load situation on all beams when under compression.

B. Explain to the student the load situation and how the more load on a beam the more deflection there will be.



32. BEAMS

A. The different types of the more common beams

B. Point out the difference of each beam type.

C. The fixed beam which the ends cannot rotate or deflect will support twice the load of a simple beam because it transfers the load to the solid material it is imbedded in.

Arches

Arches combine the function of the beam and the column simultaneously. An arch is under compression for its entire length, arches tend to push outward at the base and must therefore be either braced or tied. Some arches are braced by masses of masonry called buttress's, the removal of any part of an arch can cause the collapse of the entire arch.

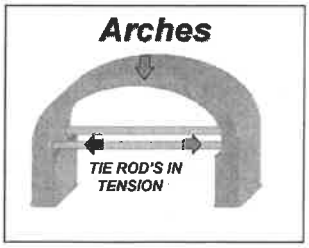
33. ARCHES

A. Although not very common anymore, much older structures may have supporting arches located in them.

B. Explain the arch principles as described in the slide.

C. Make sure you explain the highlighted statement of the removal of any part of the arch. This is extremely important.

D. Arches overloaded can fail without any warning, an extremely dangerous situation.



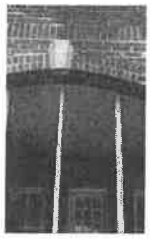
34. ARCHES

A. This is a graphic of a simple arch, there are numerous types of arches in use, and all of them are masonry.

B. Here we show the main load is applied to the walls and the lateral force of the base of the arch is held in place by wrought iron tension rods.

35. ARCH PHOTO

A. This is a photo of the classic arch setup in a cathedral; the arch is supported on one side by a masonry wall and the other by a column.



36. ARCH PHOTO

A. A deteriorating brick arch, all arches are constructed of masonry.

B. Notice the key stone and the damage to the right of the key stone.

C. The 2x4 bracing is helping to support the floor above, taking the load off the arch.

D. This arch is ready to fail and should be obvious to all your personnel.

Loads On Structures

DEAD LOAD - permanent structural material, built in/stationary items

LIVE LOAD - people, furnishing, items not built in, partitions

DYNAMIC LOAD - elevators, people on escalators, large moving objects

37. LOADS ON STRUCTURES

A. There are many types of loads applied to structures, these are a few of the most common loads.

1. Dead Load- permanent, built in, cannot be removed easily and add substantial weight to the structure.

2. Live Load- any load that continually moves thru the structure, temporary, will vary at all times.

3. Dynamic Load- moving objects that shift weight and cause motion against the structure.

Loads on Structures

WIND LOAD - the force that is trying to shear the building from the ground

THERMAL LOAD - the expansion and contraction on the structure due to weather conditions

STATIC LOAD - load that is constant but is applied slowly, but may change with time, stock

38. LOADS ON STRUCTURES

A. Wind Load- A constant but variable load that tries to shear the building from the ground, every structure is designed with wind load in mind.

B. Thermal Load- the expansion and contraction of structural elements due to the heat of the sun.

C. Static Load- A constant load applied slowly, but can change with time, generally stock in stores.

Loads on Structures

IMPACT LOAD - Is a load which is delivered in a short period of time. A load which the structure would resist as a static load, may cause a collapse if applied as an impact load.

The sudden application of a load provides a unit stress twice as great as that when the load is inactive.

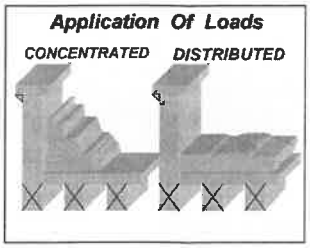
If the height of the load increases the unit stress increases rapidly

39. LOADS ON STRUCTURES

A. Impact Load- a load which the building would resist as a static load but would not be able to support if suddenly applied

B. The impact load is the greatest threat to our rescue forces. Very hard to predict and calculate.

C. A very dangerous condition for our rescue personnel in a rescue situation.

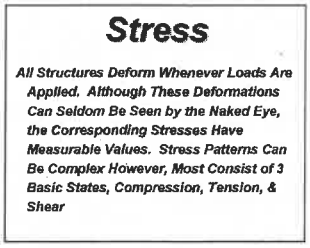


40. APPLICATION OF LOADS

A. Graphic of a snow load on a roof with a parapet wall.

B. When you have a distributed load that is spread out evenly the roof and roof joists can handle the load with no problem.

C. However when the load is concentrated and is bearing on only a few beams, an overload situation exists. This could cause a possible collapse situation to occur.

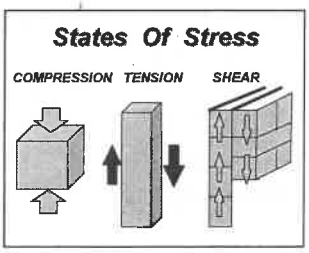


41. STRESS

A. All structures deform whenever loads are applied to them. Although these deformations can seldom be seen by the naked eye, the corresponding stresses have measurable values.

B. These stress patterns can be complex, however, most consist of the three basic states of stress; compression, tension and shear.

C. Bending and Torsion are two other states of stress that are common and are a combination of one or more of the three basic states of stress.

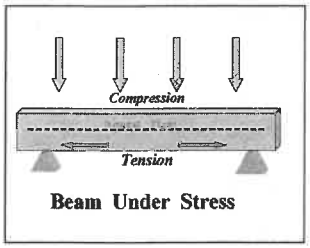


42. STATES OF STRESS

A. Compression is the state of stress when the entire element is under compression. As a result the element is being pressurized thru its axis from both ends. This can cause the element to be compressed and shorten under load. Any load under compression, whether horizontal, diagonal or vertical under compression will act as a column.

B. A load under tension is being pulled thru its axis, this has a tendency to elongate those members. Many materials are excellent under tension, steel, especially wire rope as an example. Other elements are not, such as masonry.

C. Shear is the result of two interacting forces in opposite directions in the same plane. Its actually when an element is placed in compression and tension in the same lineal plane. Simply put, it's a cutting action applied to a specific point or area.



43. BEAM UNDER STRESS

This graphic shows how a typical beam is stressed under load. With pressure normally applied from above, compression will force the beam down with the weight of what ever it is supporting. When the compressive force is applied from above, this causes the bottom of the beam to stretch and come under tension. The amount of tension the beam is under will be in relation to the amount of compression being applied.

A. Every beam will have an area within that beam where both compression and tension will be equal. This is known as the neutral plane, and is generally some where near the middle of the beam.

Strain

A CHANGE IN THE FORM OR SHAPE OF A BODY OR MATERIAL WHICH IS SUBJECTED TO AN EXTERNAL FORCE

44. STRAIN

A. The engineering definition of Strain. There is a big difference between stress and stain and it is imperative in a collapse situation we can determine the difference of the two.

B. In the field these two terms are often confused and interchanged, we must be able to pick up the difference quickly.

C. If a load is placed on an element and it deflects, this is stress. When that load is released from the element and the element does not return to its original shape, that is strain. When strain occurs in a structural element there has been failure of that element on a molecular level. The element has lost its strength and can possibly fail.

DEFLECTION

A bend, twist, or curve of a structural element under a load. All structures deflect slightly when supporting a load, but a structural element is designed to withstand a load without showing signs of deflection. When you notice the deflection of a column, beam, or wall, this condition indicates structural overload and should be reported

45. DEFLECTION

A. All structural elements deflect under a load, some very slightly others with visual effect.

B. Structural elements are designed to support loads without signs of visual deflection. Any visible sign of deflection will indicate an overload and a potential problem or collapse situation developing.

C. When you notice the deflection of a column, beam, or wall. This condition indicates structural overload and should be reported.

46. DEFLECTION PHOTO

This photo shows a classic visual deflection. This header has been bellied for a long time and shows consistent overload. When you encounter this situation in a collapse, report it right away.

General Construction Types

FIRE- RESISTIVE
NON-COMBUSTIBLE
HEAVY TIMBER
ORDINARY
WOOD FRAME

47. GENERAL CONSTRUCTION TYPES

The 5 general types of building construction that we as firefighters will normally encounter. These are categorized by the most fie proof first, to the least fire proof last.

A. Fire –Resistive

B. Non –Combustible

C. Heavy Timber

D. Ordinary

E. Wood Frame

48. CLASS 1 FIRE PROOF CONSTRUCTION

This is a photo of several different types of fireproof construction. Notice the different building construction features. Have the student identify each photo and possible building uses of each structure.

Fire - Resistive

A CONSTRUCTION TYPE OF STEEL OR CONCRETE IN WHICH STRUCTURAL ELEMENTS ARE PROTECTED WITH FIRE-RESISTIVE MATERIAL AS SPECIFIED IN NFPA STANDARDS

49. FIRE-RESISTIVE

A. Normally constructed of concrete or steel, or both. The main structural elements in these buildings are always protected with fire resistive material as specified in building codes and fire codes.

B. This type generally includes all high rises, hospitals, schools, public assembly's etc. Generally they will have a 2 hour fire rating or above.

Fire Resistive

50. FIRE- RESISTIVE PHOTO

The Empire State Building is a fire resistive structure with heavy steel and concrete elements. This building can withstand tremendous amounts of force applied to it by fire or other means.

A. A minimum two hour fire rating everywhere in the structure.

Non-combustible

CONSTRUCTION TYPE POSSESSING STRUCTURAL ELEMENTS ON THE INTERIOR AND EXTERIOR THAT ARE NON-COMBUSTIBLE. LIMITED AMOUNTS OF COMBUSTIBLE MATERIALS MAY BE USED IN NON-COMBUSTIVE CONSTRUCTION IF A FIRE -RESISTIVE COVERING IS APPLIED TO THEM.

51. NON-COMBUSTIBLE

A. This construction type possesses structural elements on the interior and exterior that is non combustible. However, limited amounts of combustible materials may be used in non combustive construction if a fire resistive covering is applied to them.

B. Usually constructed of steel and masonry, may have spray on fire coating for protection.

Non Combustible

52. NON-COMBUSTIBLE PHOTO

A. A photo of a non-combustible structure after a major fire. The fire proofing was burned off due to the contents of the structure becoming fully involved. Notice the partial collapse situation, because buildings are resistive to fire does not mean there cannot be serious consequences do to a major incident.

Heavy Timber

A CONSTRUCTION TYPE WITH EXTERIOR WALLS OF BRICK OR STONE AND WITH INTERIOR STRUCTURAL MEMBERS, SUCH AS COLUMNS, BEAMS, AND FLOORS, OF DIMENSIONS SPECIFIED IN NFPA STANDARDS

53. HEAVY TIMBER

A. A type of construction where exterior walls of brick or stone and with interior structural members, such as columns, beams. And floors which have dimensions specified in building codes.

B. Generally to be considered heavy timber your structural elements must be at 8 inches thick, and usually not less than 6 inches in the smallest dimension.

C. Usually consists of buildings constructed years ago with open areas and older truss type roofs.

54. HEAVY TIMBER PHOTO

A. A classic heavy timber building, old mill type construction. Wide open for commercial use, may exposed structural elements.

B. A heavy truss supported roof, these buildings are veritable lumber yards waiting to burn and collapse.

Ordinary

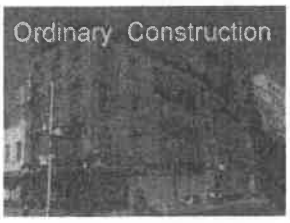
Construction Type Where All Or Part Of Whose Interior Structural Elements Are Combustible. The Exterior Walls Are Non-combustible. It Is Also Called Urm Or Brick & Joist Construction

55. ORDINARY

A. This construction type is where all or part of the interior structural element are combustible. The exterior walls are non combustible.

B. Generally referred to as URM construction, Un-Reinforced Masonry. The term Ordinary construction has been coined by the NFPA Standard

C. The typical tenements and apartment homes constructed on the east coast for the last 100 yrs fit this category.



56. ORDINARY CONSTRUCTION PHOTO

A. A classic brick URM tenement, many of these had stores on the ground floor. They can easily develop heavy fire situations and the building can literally burn itself and collapse.

Wood-frame

A Construction Type Whose Exterior Walls And Interior Structural Members Are Made Entirely Of Wood.

57. WOOD FRAME

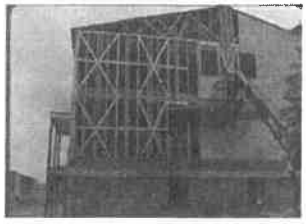
A. A construction type whose exterior walls and interior structural member are made entirely of wood.

B. In all cases with this type of construction, the exterior walls support the interior floors.

58. WOOD FRAME PHOTO

A. Typical older wood frame private dwelling you would see anywhere in the country. This one is over 100 yrs old, easily a collapse potential situation.

B. The outside walls hold up the interior floors. Depending on the location in the country, many had basements.



59. METAL FRAME PHOTO

A. This is a metal framed building, the norm now not the exception. Very flimsy, they must be diagonally braced all the time.

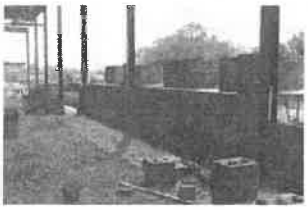
B. These type buildings are very dangerous from a fire and collapse standpoint.

Framed

A Building Who's Walls *DONOT* Support the Floors or Roof. Instead They Are Either Hung From or Rest on a Steel And or Concrete Skeleton. In This Type of Building Structural Collapse Many Times Can Be Localized to the Area of Failure of a Limited Number of Structural Elements.

60. FRAMED

A. A framed building is one in whose walls DONOT support the floors or roof. Instead these elements are either hung from or rest on a steel and or concrete skeleton. In this type of building structural collapse many times can be localized to the area of the particular element failure. A localized collapse will not transfer thru the structure causing catastrophic collapse.



61. FRAMED STRUCTURE PHOTO

A. Construction of a one story commercial framed structure. Notice that the steel columns are the supports for the roof. The walls are masonry infill. If these walls fail for some reason there would not be failure of the skeleton frame itself, keeping the rest of the building intact.

62. FRAMED STRUCTURE PHOTO

A. This is a typical high rise construction situation. ALL high rise building are framed structures. The exterior skeleton is the frame work for the building. The walls are infill and can be almost anything, glass, block, brick, aluminum, or even steel, or a combination of all of them.

Unframed

In This Type of Building the Walls ARE the Main Structural Element That Supports the Floors and the Roof. If There Is Any Failure of a Bearing Wall, Column, Arch and or Girder It Will Cause Extensive Collapse of That Floor and All Floors Above.

63. UNFRAMED

A. In this type of building the walls are the main structural element that supports the floor and roof. If there is any failure of a bearing wall, column, arch, and or girder it will cause extensive collapse of that floor and all floors above.

B. For this reason, we as firefighters must be able to quickly identify whether a structure we are responding to is framed or unframed.

64. UNFRAMED PHOTO

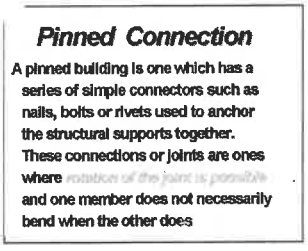
A. This photo shows a small two story private home found anywhere in America. In many cities this is the heart and sole of the middle to lower middle class home.

B. The exterior is brick and the interior is wood. All the floors and the roof are supported by the masonry outer walls.

65. UNFRAMED BUILDING PHOTO

A. In this situation we have three unframed structures right next to each other. The center one is a private dwelling. The one on the right is a public library, URM construction and fire restive, but still unframed. The one on the left is a commercial building with retail below and storage above.

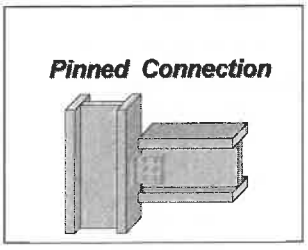
B. Three separate buildings and three separate occupancy types, not uncommon in the typical inner city environment.



66. PINNED CONNECTION

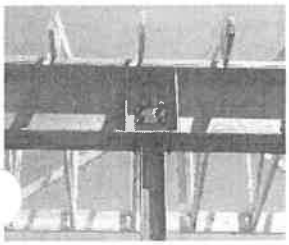
A. A pinned connection is one which has a series of simple connectors, such as but not limited to nails, bolts, or rivets. These are used to anchor the structural supports together. These connections or joints are ones where rotation of the joint is possible and one member does not necessarily bend when the other does.

B. In some situations this is a good thing and others, depending of the stress on the structure is a bad thing. For an overloaded condition and possible collapse situation, this would be a bad thing.



67. PINNED CONNECTION

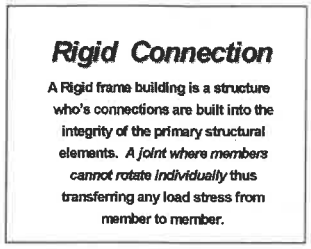
A. This is a graphic of a typical pinned connection in steel construction. The two beams are attached with a flange which is either riveted or bolted. Either one of these elements can move with out effecting the other.



68. PINNED CONNECTION PHOTO

A. This is a classic photo of a steel beam to beam connection, and the connection to a supporting column. The weakest part of the support scenario right here are the bolts.

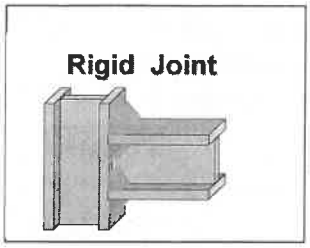
B. In a possible collapse situation, these connection points would be the first to fail, dropping the beams off the column.



69. RIGID CONNECTION

A. A rigid frame building is a structure whose connections are built into the integrity of the primary structural elements. A solid joint where members cannot rotate individually when loaded. This causes any load stress to be transferred from member to member.

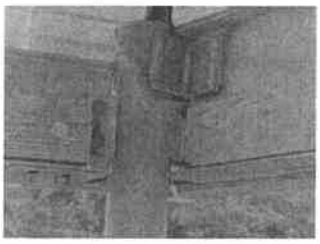
B. In a possible collapse situation this is the strongest connection and the most reliable. We are much safer in a structure with these types of connections; they can transfer the overloads much more efficiently.



70. RIGID JOINT GRAPHIC

A. This graphic shows two steel elements one beam anchored rigidly to one column. This is a welded connection point, very common. The weld joins the two elements together to form one.

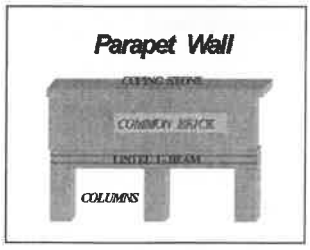
B. A solid movement free joint, any over load on either element can be transferred to the other member helping to spread out the overload and keep the structure from collapsing.



71. RIGID JOINT PHOTO

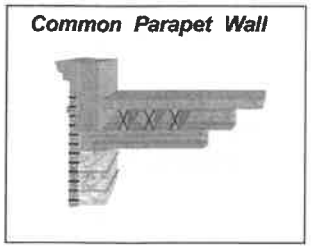
A. Here is a photo of a welded joint next to a pinned joint, this is not very common.

B. The welds here make the joint on the right side of the photo rigid and unable to rotate or twist by its self.



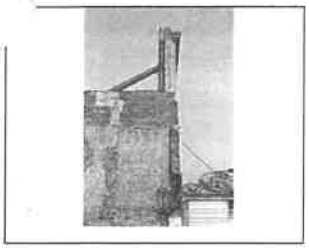
72. PARAPET WALL GRAPHIC

A. A classic parapet wall design, the problem with parapet's is they are constructed of several dissimilar materials. The expansion and contraction of the different elements is different under all conditions. As a result over time the connection points for all these elements either fails or deteriorates.



73. COMMON PARAPET WALL GRAPHIC

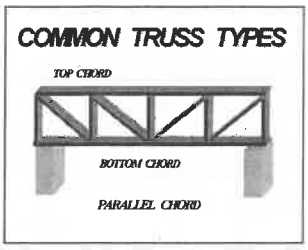
A. A side view of the most common roof and parapet wall connection. The roof beams rest on the wall and the parapet is constructed around the beam ends. The roof sheathing is then covered by metal flashing imbedded in the brick wall. Over time everything loosens up and becomes a collapse hazard under lateral load conditions.



74. COMMON PARAPET WALL PHOTO

A. This is a side photo of a free standing parapet face, a collapse waiting to happen. This is very unstable and can be unnoticed at night in a heavy smoke condition.

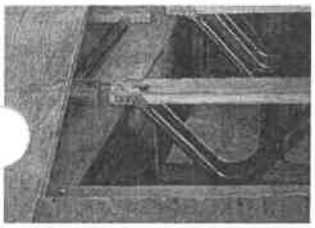
B. Very laterally unstable, many firefighters have been killed or seriously injured when these walls have let go.



75. COMMON TRUSS TYPES

A. This is an extremely common type of floor truss. ALL trusses interior shape is a triangle, the strongest shape in geometric design. The floor truss will have a top and bottom chord, with interior members under compression as well as tension.

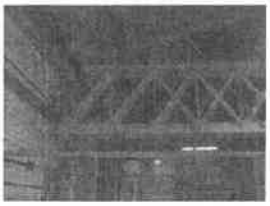
B. The nature of the truss makes it extremely efficient; as a result it can be constructed of lighter weight material. Although this is great for construction situations, it is very poor in fire and collapse scenarios.



76. TRUSS FLOOR CLOSE UP PHOTO

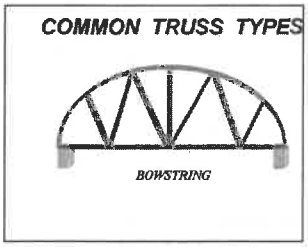
A. This photo shows several floor trusses being supported by a girder. Notice the amount of truss that is resting on the girder, only a few inches.

B. Connections like this one make for poor lateral strength when the structure is attacked by inordinate lateral loads such as high winds or earthquakes.



77. TRUSS GIRDER PHOTO

A. In this photo, a heavy timber building is utilizing a large solid truss to support other trusses and the outside wall section. An old technique with the large bolts this truss has been up and working for 75 years. Failure of these trusses will bring catastrophic results to the collapse of this building.



78. COMMON TRUSS TYPES

A. This is a very common older truss type used extensively for roofs. Used in extremely large structures where wide open expanses are needed, including large factories and retail stores.

B. This is called the bow string truss. Named for its bow type upper section which transfers the roof loads to the exterior walls.

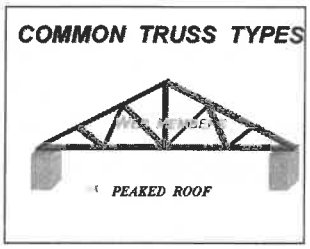
79. BOW STRING TRUSS PHOTO

A. A classic bow string truss roof and open area factory. The classic bow shape should be a dead giveaway for your troops responding to any incident in this building.

B. In either a fire or collapse situation, this would be one of the worst situations to respond to.

80. BOW STRING TRUSS PHOTO

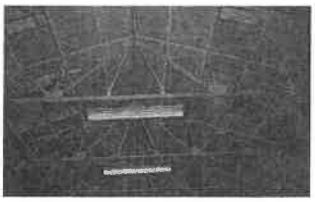
A. This is a photo of the interior make up of a bow string truss. Made completely of wood, this interior lattice section gives strength to the top and bottom chords. These trusses are designed to hold the load of the roof and not any interior loads. Unfortunately, many manufactures use the space inside the truss for storage, adding loads to the truss it was not designed for.



81. COMMON TRUSS TYPES

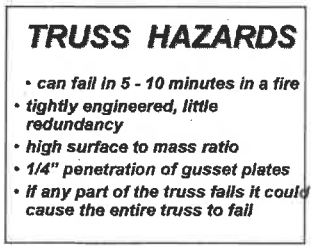
A. Now a days when you look at a building with a peak roof you cannot assume that is common roof rafter construction. Many condo's, townhouses and fast food places all have peak roofed trusses. All web members in any of these trusses will have a triangle shape.

B. If any part of a truss fails, the whole truss will fail, and with little warning.



82. PEAK ROOF TRUSS PHOTO

A. This photo shows a typical peak roof truss in use. Notice the different triangle type of configurations. The gusset plates anchor all the web members to the bottom and top chords. You would be unable to tell you have truss roof construction from the outside of the structure.



83. TRUSS HAZARDS

A. As with any highly engineered light weight item, we in the fire service will have problems with it. These trusses are probably the most dangerous structural element we have come across so far. They have failed in 5 minutes in fire situations.

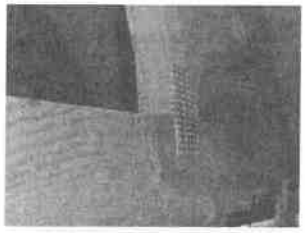
B. These trusses are engineered so tightly that they have no redundancy, a major problem for us. There high surface to mass ratio causes them to burn faster than the average floor or roof beam.

C. If ANY part of the truss fails; it could cause the collapse of the entire truss. The ¼ to 3/8 inch penetration of the gusset plates does not help our cause either, they fail early in fires.

Gang Nails

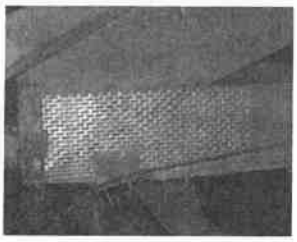
84. GANG NAILS

A. These gang nails are nothing but pressed sheets of galvanized steel. Small spikes ¼ to 3/8 in length in a triangle shape are punched out of the light weight plates. Anchored on both sides, this is all that holds the web members to the top and bottom chords. Not really a solid fireproof or collapse resistant connection point. They can fail easily.



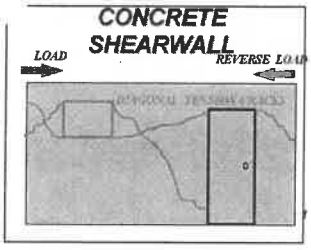
85. GANG NAILS PHOTO

A. This shows how much the gusset plate gang nail penetrates the lumber, not very much. Roughly ¼" of penetration or slightly more if you are lucky.



86. GANG NAILS PHOTO

A. Here you have a typical end gusset plate gang nail. Roughly about 1/3 rd the plate is attached to the top leg, if there are any knots, checks, cracks or splits of the lumber section, there will not be enough strength in the truss to accept an impact load such as a collapse.



87. CONCRETE SHEAR WALL

A. This graphic shows the reaction of concrete shear walls when they are cracked. A shear walls only job is to resist tension and compression laterally for the building. They are installed in structures in order to stop them from swaying.

B. If the shear wall is compromised some how, the building will sway too much and could fail.

88. SHEAR WALL PHOTO

A. Here we show the results of cracks in a wall which have taken the integrity of the walls shear strength away. There is no lateral strength to this wall, it is compromised and may fail.

B. Any visible deformation or major cracks from floor to ceiling will be major trouble to the buildings stability.

Unit II

Void

Search

&

Rescue

UNIT TITLE

State of New York
Office of Fire Prevention and Control
Fire Training Program

Course: 1625

Medium Level Structural Collapse Concepts

Lesson:

Unit II Void Search & Rescue

Lesson Code:

1625-2 Time: 3 Hours

Mandatory Prerequisites:

Course #1602 – Basic Structural Collapse Operations

Recommended Prerequisites:

Course #15 - Accident Victim Extrication Training

Instructional Aids:

Chalkboard, Chalk, Eraser, Student Workbooks, Registration Cards and Lesson Plan. Computer Projection Equipment & Course CD.

Plan of Presentation:

This is a PowerPoint lecture program

AUTHOR; John O'Connell ; FDNY Rescue 3

New York State Fire Instructor

Unit 2

SURVIVAL RATE vs TIME of EXTRICATION	
30 MINUTES	99.3 %
1 DAY	81 %
2 DAY	36.7 %
3 DAY	33.7 %
4 DAY	19 %
5 DAY	7.4 %

COLLAPSE WARNING SIGNS

BULGING WALLS
CRACKS IN WALLS
UNUSUAL SOUNDS
SLIDING PLASTER & DUST
VIBRATION SOURCES

UNIT II VOID SEARCH & RESCUE

The basic information your rescue team will need when operating in collapsed void areas will be discussed. These operations can be some of the most dangerous you as a firefighter may encounter. The instability of the area and the unpredictability of a secondary collapse make this an extremely dangerous situation.

1. SURVIVAL RATE VS TIME OF EXTRICATION

As with any rescue situation, how long the people are trapped will determine extensively their chances of survival.

A. If they are rescued in the first half hour of the incident, they have an excellent chance of surviving, over 99 percent.

B. If they are rescued in the first day, they have a lower but still good chance of surviving, roughly 80 %

C. If the victim is trapped for more than two days and less than four days, there odds drop down significantly. Almost 35%

D. The fourth day, with the type of injuries normally associated with this type of entrapment, your odds diminish greatly, about 19%

E. After five days and longer your chances are remote, about 7%

2. COLLAPSE WARNING SIGNS

A. Bulging walls will warn you of impending problems, any visible deformation to any structural element tells you there is a problem. All these warning signs are either deformation or visible movement. Walls that are bulged out are overloaded and unstable and can fail at anytime with additional loading.

B. Major cracks in walls indicate a torsional or eccentric loading of that wall, or both. This shows that walls to be pressurized from an angle not designed in the original building plans. A possible building collapse hazard.

C. Unusual sounds indicate continual movement is going on, AN IMMINENT SIGN OF POSSIBLE COLLAPSE. The building has not settled and there will be definitely some partial or total collapse of a section or the whole structure.

D. Sliding plaster and airborne dust are kicked up when the plaster walls are being pulled from the studs. This indicates torsional loading and twisting. After signs of this happening there has been total collapse of several structures.

E. Vibration at anytime can cause unwanted movement and possible collapse of almost any item in a structure, or around a structure for that matter. Always beware of vibration potential and keep all vibration sources away from the unstable collapse rubble pile.

WARNING SIGNS
- SAGGING FLOORS or ROOF
- SEPARATING WALLS
- COLUMNS OUT of PLUMB
- SWINGING DOORS
- DOORS WINDOWS OUT
- OF RACK

3. WARNING SIGNS CONTINUED

A. Sagging floors and or roofs are another sign of overload, the additional weight is causing the beams to sag and pull away from there end supports. This can also lead to possible collapse problems.

B. When you notice the inside corners of walls have separated from each other this warns you that the entire structure is twisting and or physically separating and spreading apart from itself. Another sure sign of possible collapse.

C. Columns out of plumb are another sign of visible deformation, columns leaning means they are supporting less weight. The more the column is leaning the less it will support, this must be constantly watched for further movement.

D. Doors swinging open or shut is an imminent sign of serious movement and impending collapse. A very dangerous condition.

E. When you have doors and windows out of rack, obviously the building has shifted and is in danger of causing a problem. The worse the rack, the sooner the collapse.

MOVEMENT !

- *Any Type of Movement Is an Imminent Sign of Possible Collapse. You Must Be Constantly Watching the Remains of the Structure for Any Signs of This Movement. The Potential for Secondary Collapse Is Present at Every Structural Collapse.*

4. SUDDEN MOVEMENT

A. Any type of movement of the buildings materials can be an imminent sign of possible collapse.

B. It is imperative that you assign someone to watch the remains of the structure continually until operations are concluded.

C. The potential for secondary collapse is present at almost every collapse.

SAFETY PRECAUTIONS

SHUT DOWN UTILITIES
NEED PROPER LIGHTING
MINIMIZE PERSONNEL
SAFETY OPS OFFICER
RESCUE SHORING OPS

4. SAFETY PRECAUTIONS

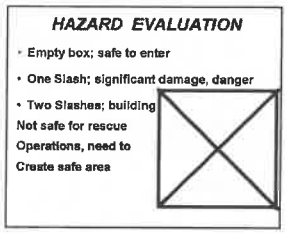
A. One of the first primary issues to address is the shutting down of all utilities to the affected structures. This is of primary importance for the safety of all rescue personnel and victims. Gas, electric, and water being the primary ones.

B. Make sure that proper lighting is available even during the day, especially when searching in covered voids.

C. Keep all personnel not fully engaged in operations from the collapse area. Too many people with no direction is a major safety problem. We can be our own worst enemy at times.

D. In any rescue operation you need to have a dedicated safety officer, this man should be one of your most experienced personnel. His only job is to make sure that the safety of all your rescue personnel is in hand. There are numerous ways of accomplishing this and each should be taken into account, every situation is different at every collapse.

E. If your team undertakes a shoring operation make sure you have someone on hand who is fully trained and experienced in this field. Placing the wrong shores or the right shores in the wrong position will cause negative results to occur.



5. SAFETY PRECAUTIONS CONTINUED

A. One important item that must be accomplished is to evaluate the remains of the structure for its stability. Preferably an engineer or someone with thorough building construction knowledge should make this determination.

B. When the 2x2 box is empty the building is safe to enter and work in.

C. When there is a diagonal slash in the box, there is significant damage to the structure, and extreme caution must be followed.

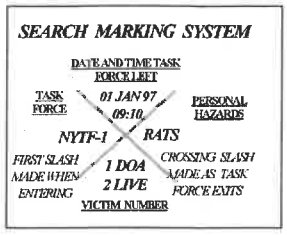
D. When there is an X in the box the building is too dangerous to enter without some serious hazard removed being done.

6. SEARCH MARKING PHOTO

A. This is a photo of a building behind a major collapse structure that was demolished in a gas explosion. This store was heavily damaged however, it remained structurally stable. Notice the marking systems. The building is safe to go into and it has been searched twice and no victims found.

SEARCH MARKING SYSTEMS

When searching structures and voids, we need to identify where we have been and what results have occurred. These slides will aid us in identifying the situation and any problems we encounter.



7. SEARCH MARKING SYSTEM

A. When searching an area or a entire structure, you must mark your results to let other rescuers know that you have search the area and identified any issues in that area or structure.

B. When entering the area place a diagonal slash on a visible area near the void opening, also to the left write your unit name.

C. After your search, write down the number of victims located on the bottom.

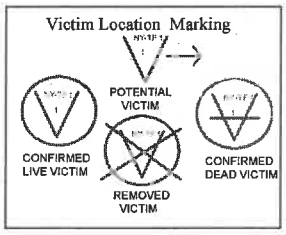
D. On the right hand side, write down any hazards

E. On the top, write down the day and time you're finished your search.

F. When you are completely finished, place another diagonal slash into the first one to let all other rescue personnel know that the search in that area has been completed.

8. PHYSCIAL MARKING SYSTEM

A. An area under a rubble pile has been searched and is marked at the entrance to the void. There is one DOA one live victim and snakes in the void, all identified by the search team.



9. VICTIM LOCATION MARKING

A. When a victim is found, or is potentially found by either searchers or dogs, we must identify that location.

B. For a potential victim, place a large "V" over the location with an arrow directly pointing to the location. Place your team designation in the center of the "V"

C. When finding a confirmed live victim, place a circle around the "V"

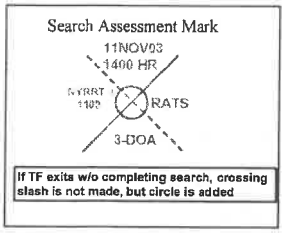
D. After removing the victim, place and "X" thru the circle and the "V", this acknowledges that the patient has been removed.

E. For a confirmed DOA, place the "V" with a circle and a straight line thru the "V" within the circle.

10. MARKING SYSTEMS

A. On the left is the location of a confirmed live victim.

B. On the right is the location of a confirmed dead victim.



11. SEARCH ASSESSMENT MARK

A. If your team cannot finish the search for what ever reason, there will be a different marking set up to identify that situation.

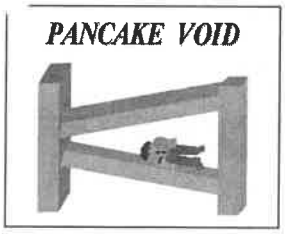
B. If your team leaves without completing the search, the marking system will be different. Do not place an "X" in the area.

C. Instead, you will have the one diagonal slash and a circle instead of the other slash. This is easily spotted by other rescuers.

II COLLAPSE VOID PATTERNS

Understanding the types of collapse patterns will provide valuable information in determining everything from the need for shoring, the types of shoring to be used, possible victim location, and victim access to the probability of victim survivability.

It is extremely important that your team is quickly capable of identifying these common void types and knowing the best probable victim survivable areas.



1. PANCAKE COLLAPSE

A. Formed when floors let go from bearing walls and stack up on top of each other. Floor collapses for various reasons, usually a catastrophic event of some type, earthquake, major explosion, and major bearing wall failure. Impact loads the next floor bringing that one down also and generally any other floors below.

B. Usually stops at the first floor because that floor is generally imbedded in the foundation slab giving it more strength.

C. Debris on the floors dictates where and how many voids may be located. Strength and size of the material on the floors i.e. furniture, machinery, appliances will dictate how many voids will be present.

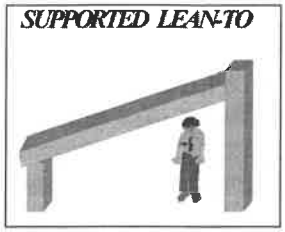
D. Access these floor voids through natural opens; thru roof hatch or openings, stairs, elevator shaft or breach through the floors or breach a wall. Try and find hallways there would be less debris in them.

2. PANCAKE COLLAPSE PHOTO

A. This is a photo of a complete pancake collapse of a hospital in Mexico City, Mexico. After a major earthquake shook the ground the entire building collapsed onto itself.

B. Numerous interior voids were created by many objects in the building; there were hundreds of voids in this situation. Numerous people were pulled out of this collapse over a period of several days.

3. SUPPORTED LEAN-TO COLLAPSE



A. Failure of one bearing wall is usually the main cause of this type of collapse pattern - beams pull away from their supports on one side of the structure - other side stays anchored.

B. The possible causes for this may be possible foundation failure, rotten beams, vibrations, fatigue or overloading.

C. People are usually found on top of floor near the bottom by the wall where debris has slid into. The best chance of anyone surviving is being located on the wall that has stayed intact.

D. It may be easy to access voids under the floor, on many occasions no shoring is needed for a search. Be careful moving debris; once we move or shift without shoring we could have problems.

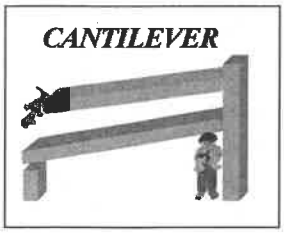
4. SUPPORTED LEAN- TO PHOTO

A. This is a photo of a brick tenement in downtown Manhattan that was converted into a store. The occupants removed a section of interior bearing wall causing the interior of the structure to collapse.

Numerous voids were created on the sides of the building on several floors.

B. Firefighters were able to search these voids with some degree of difficulty, however, it was done in a timely fashion and no victims were found on the upper floors.

5. CANTILEVER COLLAPSE (UNSUPPORTED LEAN-TO)



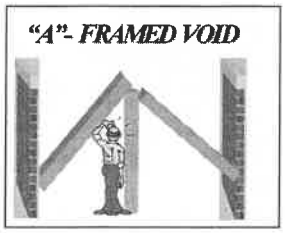
A. Failure of bearing wall - beams pull away from their supports on one side of the structure - other side stays anchored and floor stays suspended. Failed ends hang precariously.

B. Most unstable and the most dangerous collapse type we have. The floor end has no solid support and could be hanging on electric cable or pipes. The slightest additional impact could cause secondary collapses

C. Victims can be found near wall, above or below floor under lean-to hung or up on objects. Secure and shore unsupported floor first before searching. Shore from the bottom up and make sure shoring bears on each other.

6. CANTILEVER COLLAPSE PHOTO

A. This is a photo of a 5 story URM tenement converted into a commercial establishment. During renovations, a section of exterior bearing wall was removed from the center of the structure. As the building collapsed, it formed a cantilever section in the rear of the building. Three people that were trapped were rescued and one victim perished.

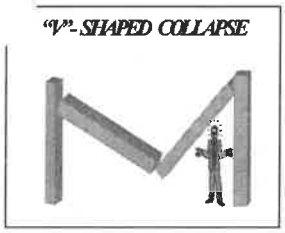


7. A - FRAME COLLAPSE

A. Opposite of a V collapse, the flooring separates from exterior bearing walls but is still supported by interior bearing or non bearing walls.

B. This can be caused by earthquakes, foundations failure, flooding, or excavation of an adjoining area,

C. The highest survival rate for victims would be those found near existing still intact partitions in the center of the collapse area. On the floor that collapses a victim could be pinned near exterior walls and have a much lower survival rate.



8. "V" COLLAPSE

A. This collapse pattern is the opposite of an "A" shaped. The bearing-partition wall lets go and the floor either breaks or separates from its connection points in the center and hinges down. The crude shape of a "V" is then created.

B. This type of collapse may be catastrophic or localized, voids which are created on both sides of the load failure are generally where survivable victims are located

C. Occupants on the floors below generally have high survival rate sheltered by floor, when trapped near the bearing wall supports. Occupants on top of the collapsed floor found near center of V will have low survival rate due to the concentration of heavy debris.

9. MULTIPLE COLLAPSE TYPES

A. Not unusual to have more than one collapse type at a given incident. As a matter of fact, it is generally more common in URM and wood frame to have more than one type of collapse pattern in the same structure.

B. In this photo and collapse you have a cantilever, supported lean-to and pancake in the same area of one building.

FAST VOIDS

Fire Suppression

Additional Collapse Potential

Structure Type & Condition

Trapped Victim Rescue

10. FAST VOIDS

A. Acronym for important safety items that should be addressed at a collapse BEFORE YOUR TEAM ENTERS THE VOID AREA - "Check List" of procedures

B. First and foremost is Fire Suppression, small fires can become big fires in a very short time. Smoke Kills! Heavy smoke in the void can suffocate any victims and make rescue efforts almost impossible.

C. Additional collapse potential- Is the building components still moving? What remains of the structure are still standing and what shape are they in?

D. Structure type & condition- is the building Old? New? Well Maintained, or is it in major disrepair? It is just as important to know what shape the building was in before it collapsed as well as after it collapsed.

E. Is this a trapped victim rescue- entering voids to search is one thing, when a victim is discovered, another operation will ensue. You must stabilize the void and the void opening and expand the void large enough to enter with several personnel, tools and rescue equipment. Victim rescue will be a sustained operation for the most part, and must be done safely.

VOIDS cont.

VOID TYPE & LOCATION

OCCUPANCY TYPE / HAZARDS

IMMEDIATE UTILITY SHUTDOWN

DAY OR NIGHT

SITUATION THAT CAUSED COLLAPSE

11. FAST VOIDS

A. Void Types & location- In many collapses there will be several voids located throughout the collapse area; all of these must be searched for possible live victims. Each type of void will present a unique problem for your rescue team, especially when these voids intersect each other and multiple teams are working together.

B. The type of occupancy and the inherent hazards for each type of occupancy must be known immediately upon arrival, or your team could be at a major disadvantage. All hazards have to be addressed before you go entering any voids to assist victims trapped. You cannot commit troops into contaminated areas without proper protection.

C. As a result, make sure all utilities are shut down to the structure, including all the electric, water and any type of fuel used in the structure, gas oil, etc.

D. Day or Night- this will dictate where in occupancy people may be located, at night in bed during day anywhere in a residential building. In a commercial occupancy it will be different, take into account maintenance personnel and night shift help if any.

E. One of the most important things to find out immediately after your arrival, just after finding out if anyone is trapped is to determine the Situation that caused the collapse. It is imperative you find out what caused the building to fail as this mechanism of failure may still be active and a major threat to the safety of your rescue personnel.

III. TEAM OPERATIONS

As with most fire department operation, team work is of the utmost importance. This is especially true in collapse void search procedures. As this is one of the most dangerous situations we as fire fighters will encounter we must follow the team concept in order to bring the operation to a safe conclusion.

VOID SEARCH OPERATIONS

THE SEARCH TEAM

THE SUPPORT TEAM

1. VOID SEARCH OPERATIONS

A. The Void Search team consists of a six man squad, broken down into two three person teams.

B. The Search team does primarily most of the void searching in the interior of the collapsed structure.

C. The Support team will backup and support the search team. This includes tools, manpower, and necessary equipment for the search team to complete their function.

THE SEARCH TEAM

VOID TEAM OFFICER

VOID ENTRY FIREFIGHTER

SHORING FIREFIGHTER

2. THE SEARCH TEAM

A. The Search team will consist of the Void Team Officer, the Void Entry firefighter, and the Shoring firefighter.

B. These three firefighters will begin the initial interior searches of the building, under the direction of the officer the two firefighters will work together as a team at all times.

VOID TEAM OFFICER

COMMAND of OPERATION
Picks Team Personnel
Chooses Void Access
Picks Search/ Removal Rte
Mouth Of The Void
Coordinates With Command Post

3. VOID TEAM OFFICER

A. The Void Team Officer is in command of the operation; he will pick his personnel's team assignments- using the personnel to there best advantage.

B. He will also chose the void access the team will be utilizing, after consulting with the team members and the incident commander.

C. He picks the teams search route, and the victim removal route. In many cases this will not always be the same way. It may be easier to take the victim out another way.

C. His position must be at the mouth of the void, this will ensure the proper supervision of both teams, in which he is directly responsible for.

D. He must be in constant communication with the command post at all times. These situations can change drastically very quickly. The officer must be aware of all that is going on around him.

4. ACTUAL VOID RESCUE

This is a photo of an actual successful rescue situation, this occurred on a weekday at Broadway and 31st, Manhattan New York. A firefighter is inside approximately 35-40 ft safely removing a trapped and injured workman. The officer is standing to the right, in the proper position for this operation.

VOID ENTRY FF

First To Enter Void
Check Atmosphere
Removes Loose Debris
Locates Existing Voids
Accesses Victim ASAP
Determines What Can & Cannot Be Cut

5. VOID ENTRY FIREFIGHTER

A. This will be the first firefighter to enter the void to be searched, make sure he tests the atmosphere before entering the void.

B. Check for O2 levels, CO levels, IDLH, and any other atmospheric problem that may be unique to the given collapse situation.

C. When entering and moving about in any void, make sure you remove any loose debris and have it sent out of the void. Do not block your access and egress in the void when searching.

D. Always keep an eye open for any additional voids when searching. You can easily come upon several new void areas.

E. If you spot a victim, notify the officer immediately and make physical contact with the victim as soon as possible.

F. Always when moving debris out of way, check to see what it is holding up, if anything. Cut only what you have too.

SHORING FF

Assists Void Entry Ff
Monitors Collapse Warning Signs
SHORES to PREVENT SECONDARY COLLAPSE
Passes Back Debris
Relays Information to Officer

6. SHORING FIREFIGHTER

A. His primary function is to assist the void entry ff.

B. He should at all times be on the look out for any possible secondary collapse warning signs.

C. He would erect and install any shoring necessary to protect himself as well as the void entry ff.

D. As the void entry ff. passes back debris the shoring ff must send it out of the void. Do not block access and egress at any time.

E. The shoring ff. is the eyes and ears of the officer when he is in the void. Be sure to relay any updates or relevant information directly to the officer.

THE SUPPORT TEAM
VOID EXPANDER FIREFIGHTER
SUPPORT FIREFIGHTER
TOOL & EQUIPMENT FIREFIGHTER

7. THE SUPPORT TEAM

A. The second section of the team, this group also consists of 3 firefighters. Their primary responsibility is to support the ff's searching the void.

B. The void expander ff. will make the void entrance larger if necessary

C. The support ff. will basically be the runner or "utility player"

D. The tool & equipment ff. will keep account and up keep all tools and equipment necessary to the operation.

VOID EXPANDER FF
1st Member SUPPORT Tm
POSITION at MOUTH of VOID
Passes Back Debris
Widens Void If Possible
Assists With Shoring
ıters Void To Assist if Necessary

8. VOID EXPANDER FIREFIGHTER

A. He is the first member of the support team and his position would be directly at the mouth of the void.

B. He will collect and make sure all debris is removed from the area.

C. If the initial void opening needs to be enlarged, it would be the void expanders function to make the opening larger.

D. He may also assist the shoring ff. if necessary in the erection and installation of any shoring or cribbing.

E. If there is a need for additional manpower in the void he would be the first one in to assist.

SUPPORT FF
Relays Tools From Staging Area
Passes In Needed Tools
Passes Back Debris
Assists In Shoring And Void Expanding
Relieves Void Team

9. SUPPORT FIREFIGHTER

A. His main function is too support the operation with any tools and equipment necessary to complete the job.

B. He will pass in any tools requested and remove void debris away from the operational area.

C. Assist in any shoring and void entrance expansion if necessary.

D. Relieve the members of the void team if they are tired or have been inside too long.

TOOL / EQUIPMENT FF

SETS UP STAGING AREA
TESTS RESCUE TOOLS
REQUESTS MANPOWER
MAINTAINS TOOL LOG

10. TOOL AND EQUIPMENT FIREFIGHTER

A. Generally the company chauffeur, he will immediately set up the tool staging area as close to the void entrance as is safe and prudent.

B. Make sure he tests all tools and equipment before they are sent it to the rescue site.

C. If additional manpower is needed to relay tools and equipment, he must request that need from his officer and the command post.

D. Always maintain a tool inventory log on where every tool is located and who has it.

11. SUPPORT TEAM PHOTO

Here is a support team section in action at the mouth of a void. They are clearing an area and organizing tools as a victim is being rescued inside the void. This team is just as important as the rescue team, without them effectively moving tools, debris and equipment the rescue will not get done in a timely fashion.

INITIAL FIRST AID

FOLLOW LOCAL PROTOCOLS
SPINAL IMOBILIZATION
ADMINSTER OXYGEN
CRUSH INJURY SYNDROME
VICTIM REMOVAL

12. INITIAL FIRST AID

Due to the unique nature of injuries in collapse situations, several specific tactics should be considered.

A. Whenever dealing with patients is collapse situations, you must follow your local protocols; they do vary from region to region.

B. As in any trauma and accident situation, spinal immobilization is a must. Blunt trauma is a very common injury and many times it will involve the spinal column.

C. If appropriate administer oxygen when necessary.

D. After one hour of entrapment, start thinking about crush injury syndrome. After two hours of entrapment, treat for CIS

VICTIM PACKAGING

- CERVICAL COLLAR blanket roll
- STOKES
- HALF BACK
- BACKBOARD
- SKED KED
- VITALS

13. VICTIM PACKAGING

A. Always utilize a cervical collar on any trapped or rescued victim in a collapse situation. You must immobilize the spine and neck.

B. If at all possible use a stokes basket to transport the patient from the collapse void.

C. The use of a half back, sked, ked or backboard is always warranted in these situations. Always immobilize the patient, no matter what their condition or how they tell you they feel.

D. Have your paramedics or EMT's check vital signs as soon as practical. You must know the patients condition.

CRUSH INJURY SYNDROME

- *Trapped Victims Tend To Be Crushed And/or Pinned*
- *Motionless/compressed Muscles Create Poisons After One Hour*
- *Poisons Stay in the Muscle As Long As It Is Motionless/ Compressed*
- *Release From Compression Sends Poison Into Body and Kills Victim*

14. CRUSH INJURY SYNDROME

A. When victims are trapped in collapse debris, their bodies tend to have pressure placed upon them.

B. When your body parts cannot move, you circulation is impeded. When this occurs, the blood cannot remove toxins fast enough.

C. When the body part is released from compression, the blood sends all the poisons back to the heart, overpowering the organs and possibly killing the patient.

CRUSH INJURY SYNDROME

- *Medics Can Determine If CIS Is Likely or Present*
- *Victim May Need to Be Treated in the Void Area*
- *Don't Free the Victim Until Stabilization Has Been Accomplished ( )*
- *This May Have to Occur Under Adverse Conditions*

15. CRUSH INJURY SYNDROME

A. With new technology, medics can now determine if patient has CIS

B. If the patient shows signs of CIS then they must be treated immediately in the void area before being removed and freed.

C. Unfortunately this may occur under very adverse conditions, but it must be done if the patient is to survive.

SEARCH SIZE-UP

STRUCTURAL DAMAGE
STRUCTURE SIZE
TRAPPED VICTIMS
NATURAL BARRIERS
VOID TYPE & NUMBER
TRAINED RESCUERS

16. SEARCH SIZE-UP

Another very important size-up, slightly different that the initial size-up, even though some of the same items are addressed.

A. The amount and volume of structural damage will be a very important determination of your search. You must be able to determine the damage and secondary collapse potential as a result of that damage.

B. The buildings size will determine the amount of rescue personnel you will need to search the structure in a timely fashion.

C. How many confirmed and unconfirmed trapped victims will determine the size and extent of the rescue operation.

D. Natural barriers here mean the way the structure collapsed. Use the shape of the building's remains to your advantage, not disadvantage.

E. The number of voids and the types will also have an impact on your rescue effort and size of your search task force.

F. One of the biggest questions is do we have enough trained rescuers? In many situations, there is enough rescue personnel on the scene, but how many are specifically collapsed trained.

SIX - SIDED APPROACH

THE TOP
THE BOTTOM
ALL FOUR SIDES

17. SIX SIDED APPROACH

A. Every collapse situation is a three dimensional situation, and must be approached as such. When you are doing your size-up and surveys you must check all around you.

B. The top, check for hanging debris and unstable structural elements.

C. The bottom, make sure underneath where you are located is stable and can support your rescue operation.

D. All four sides, check the entire area around the collapse site, along side and out side the building.

TOOLS

- SAWZALL
- PNEUMATIC NAILER
- AIRBAGS
- AIR CHIESEL
- UTILITY KNIFE
- SEARCHCAM
- LISTENING DEVICES
- HOTSTICK
- BOTTLE JACK
- FLASH LIGHT

18. TOOLS

This is one rescue operation that cannot be accomplished, or finished successfully without the use of specialized tools. Hand tools, pneumatic, hydraulic, gas and electric tools can all be utilized to accomplish your mission.

A. The use of specialized equipment and tools listed in column two are a major help in searching the voids and assisting the rescue team with their work.

B. Have students give examples and uses for each type of tool listed.

IV. SHORING AND CRIBBING

THE "T" SHORE

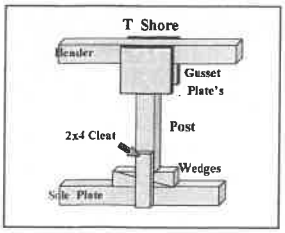
Initial Safety Shore
Standard "T"
Temporary Shoring
"T" Shore Header Length no more than 3'
Must be centered under the load

1. THE "T" SHORE

A. A very common shore, simple to use, but remember this shore is marginally stable at best.

B. Generally the header is not usually longer than ½ the height of the post. This helps with stability. In no case can it be longer than 3 feet.

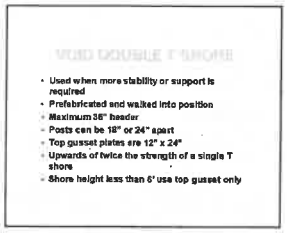
C. The sole plate should not be less than ½ the length of the header.



2. "T" SHORE GRAPHIC

A. The T shore consists of 6 specific items.

1. A 4x4 header
2. A 4x4 post
3. A 4x4 sole plate
4. A set of wedges
5. Two 12"x12" gusset plates
6. A 2x4 cleat



3. VOID DOUBLE "T" SHORE

A. The double T shore is used when more stability or support are needed.

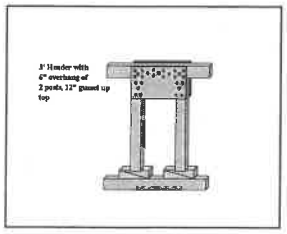
B. Prefabricate the shore and move into position, makes for quicker and safer set up.

C. Keep the header no longer than 36 inches

D. The posts can be either 18" or 24" apart, depending on access and support needed.

E. The gusset plate sizes here are 12" x 24" for all double T shores, when the shore is less than 6 feet in height, there is no reason for a middle gusset plate.

F. This double post shore has upwards of twice the strength and stability of a single post shore.

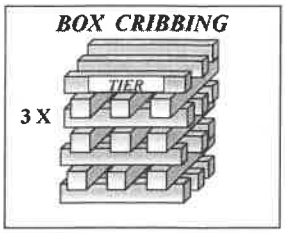


4. DOUBLE "T" SHORE GRAPHIC

A. The double T shore erected, this shore is much more stable and stronger than the regular T shore.

5. DOUBLE "T" SHORE PHOTO

A. This is a photo of a baby double T shore in position under a partially demolished partition. The shore is in place to stop the rest of the wall section from collapsing and causing injuries to the rescue workers.



1. BOX CRIBBING

One of the simplest types of shoring there is, box cribbing is quick and easy to install. Their main advantage is ease of installation and its strength.

A. Identifying the different items of the cribbing is a start in communicating how to put together and what type of crib you are requesting.

B. Each layer is known as a tier, this graphic has 7 layers or tiers.

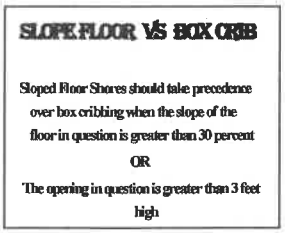
C. The crib is identified by the number of pieces per tier, in this case, we have a 3x (by) crib with three pieces per layer.

2. RULES OF THUMB

A. We overlap the cribbing on each layer; the overhang should be the same as the thickness of the cribbing material. 4 inches for 4x4's and 6 inches for 6x6's

B. The maximum you should stack your cribbing is three times the height to the width. This is strictly for stability issues.

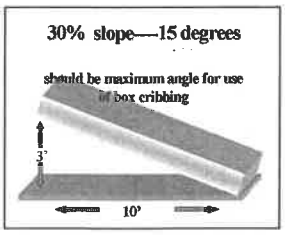
C. As your cribbing gets to be more than 3 feet high, you can switch to other shoring options. There is more room to install the other types of shores and it will utilize less material.



3. SLOPE FLOOR VS BOX CRIB

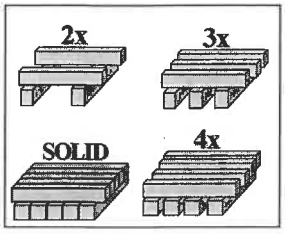
A. The slope floor shore will take precedent over box cribbing when two things occur. When the slope of the floor is over 30 % and.

B. The opening in question would be greater than 3 feet high.



4. 30% SLOPE

A. The easiest way to determine when the slope of the floor above is more than 30% or 15 degrees is to measure a triangle. If the floor section is 10 ft long and goes from zero to 3 ft high, then u have reached 30%. Any greater than this and you have to switch to a slope floor shore.



5. CRIBBING IDENTIFICATION

The cribs are named for the number of pieces per tier.

A. The two by crib has two layers per tier

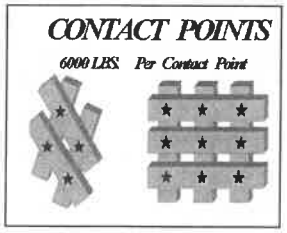
B. the three by crib has three layers per tier

C. The four by crib has four layers per tier

D. The solid crib has full capacity and no spacing, rarely used

6. CRIBBING PHOTO

This is a photo of a 3x three tier 4x4 box crib, the cribbing is 24 inches long. This is known as a cross tie crib, each layer is at right angles to the next.

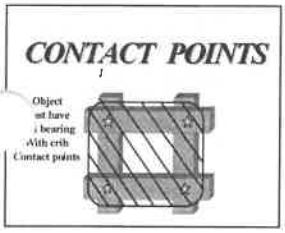


7. CONTACT POINTS

A. On a 4x4 Douglas fir crib, each contact point is good for 6000 lbs of compressive strength, with a 2 to 1 safety factor. The contact point is where the two pieces each intersect each other.

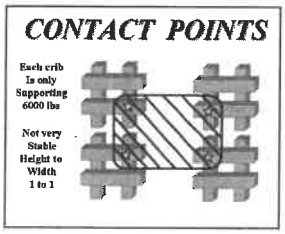
B. On the left you have 4 contact points, 24,000 lbs of support.

C. On the right we have 9 contact points 56,000 lbs of support



8. CONTACT POINTS

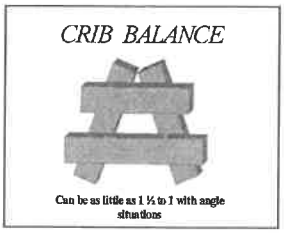
A. Every time we put the crib to use, we must make sure that there is full bearing on all the contact points. You will not get the full capacity of the crib if the contact point is not under compression



9. CONTACT POINTS

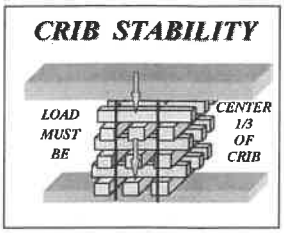
A. Each crib must have full compression of all its contact points in order to be properly loaded.

B. Cribbing loaded like this is unstable and only good for 6000 Lbs per crib, not very efficient.



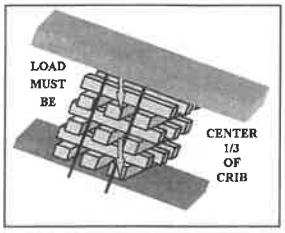
10. CRIB BALANCE

A. It is important to keep the balance of the load over the center of the crib. When you have angle situations with cribs, and you certainly can easily have that, you must be aware of the limitations of the crib balance. Typically, 3 times the height to the width is the rule of thumb. However, with angled cribs, it can be as little as 1 ½ to 1 ratio. Keep this in mind when assembling your odd shaped cribs.



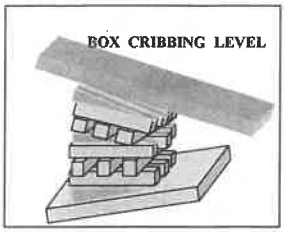
11. CRIB STABILITY

A. It is very important that the crib be balanced and that the load is in the center third of that crib. This will afford you the most efficient use of that cribs strength. Keep this in mind at all times; erecting inefficient cribbing will only be detrimental to your rescue team.



12. CRIB STABILITY

A. This would be the maximum angle you should be installing box cribbing, 30%. If the load of floor above is at a greater angle, the crib will not be able to fully distribute the load thru itself.

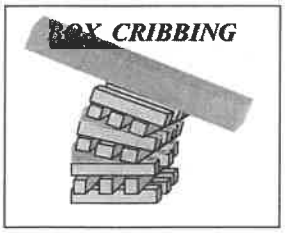


13. BOX CRIBBING LEVEL

A. When erecting cribbing on an unleveled surface, you should first attempt to place wedges or blocks in position to start your crib level. It is much easier to erect when level.

15. ANGLE CRIB PHOTO

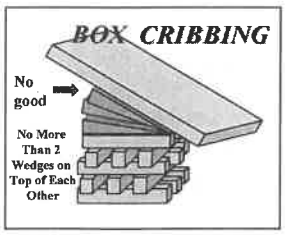
A photo of a properly angled box crib under a sloped and angled floor situation. Notice the different levels of wedges and how they gradually have angled the cribbing to the proper point.



14. BOX CRIBBING FLOOR ANGLE

A. When you are assembling a crib under an angled floor section you want to gently angle the cribbing to the floor, do not drastically angle the crib, it will be unstable. Gradually tilt the crib layers, it is much easier to erect and is far more effective in transferring the load thru the cribbing.

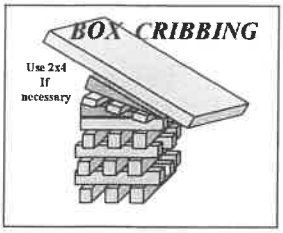
B. Here is the crib completed, notice the even fit at the top of the crib. Gradually angle the crib to make it more efficient and easier for you to install.



16. CRIBBING AND WEDGES

A. It is imperative when using wedges in box cribbing situations that you do not place too many wedges on top of each other. Never do more than two wedges on top of each other, your cribbing will fail under pressure.

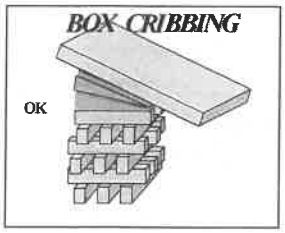
B. Any force on the crib will cause the middle wedge to come flying out.



17. CRIBBING AND WEDGES

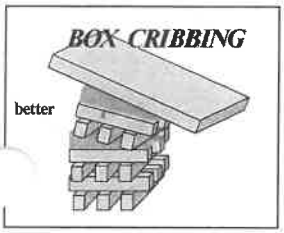
A. In the situation when you come across an angle that needs to be wedged, think of the options that you have. Instead of three wedges on top of each other you can use two wedges and place a board in between the wedges. It can be a 2x4, plywood, or whatever is necessary.

B. Your cribbing must be stable to be safe.



18. CRIBBING AND WEDGES

In several instances with an angle you maybe able to assemble your crib level, and then place one or two wedges in position to secure the crib and pressurize it properly. Make sure that you securely anchor these wedges and nail them in place. We cannot have them moving under pressure.

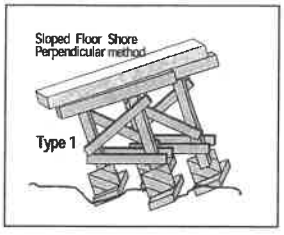


19. CRIBBING AND WEDGES

In this graphic we show how the gradual angling of the crib is far more effective and efficient that just adding wedges at the end. You have far more secure nailing points in this manner and the transfer of weight to the crib is much more effective.

20. BOX CRIBBING PHOTO

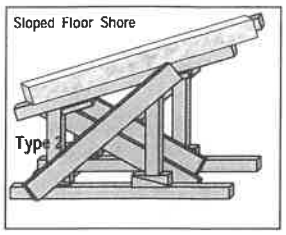
A. A photo of a crib properly wedged and angled to the opening it is supporting. It is imperative the cribs are erected properly or they will not function, and you could have crib failure in a secondary collapse situation.



21. SLOPE FLOOR SHORES

A. This is a graphic of a slope floor shore, the alternative to box cribbing when the angle is over 30% or 15 degrees. This is an option and this option shown; Type 1 is normally for placement in soil conditions. The ground is dug out and 4 posts are placed in position under two headers and pressurized.

B. With the posts angled at 90 degrees to the slab, this type is best suited for slabs that are anchored down or buried in the ground and cannot shift at all.



22. SLOPE FLOOR SHORES

A. Type 2 shown here is best suited for slabs that may shift or are free hanging at the end, the posts are perpendicular to the ground and much more stable if a shift in the slab above occurs.

B. We always erect these shores in pairs and each shore will have two posts. The pair of posts is then braced together laterally for additional stability.

23. SLOPE FLOOR SHORE PHOTO

A. A type 1 shore erected on a solid sole plate. A very strong and stable shore. It is "X" braced in both directions to give it additional stability.

Unit III

Emergency

Rescue

Shoring

Concepts

UNIT TITLE

State of New York
Office of Fire Prevention and Control
Fire Training Program

Course: 1625

Medium Level Structural Collapse Concepts

Lesson:

Unit III Emergency Rescue Shoring Concepts

Lesson Code:

1625-3 Time: 3 Hours

Mandatory Prerequisites:

Course #1602 – Basic Structural Collapse Operations

Recommended Prerequisites:

Course #15 - Accident Victim Extrication Training

Instructional Aids:

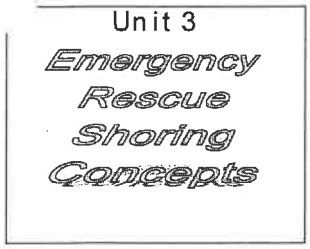
Chalkboard, Chalk, Eraser, Student Workbooks, Registration Cards and Lesson Plan. Computer Projection Equipment & Course CD.

Plan of Presentation:

This is a PowerPoint lecture program

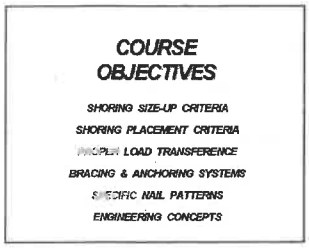
AUTHOR; John O'Connell ; FDNY Rescue 3

New York State Fire Instructor



I. EMERGENCY RESCUE SHORING CONCEPTS

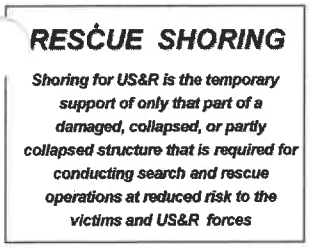
A. This section will deal with the concept of installing, sizing up and safely working around and with Emergency Rescue Shoring.



1. COURSE OBJECTIVES

In this section the areas we will be covering include;

1. Shoring size-up criteria
2. Shoring placement criteria
3. Proper load transfer
4. Bracing and anchoring systems
5. Specific nail patterns
6. Engineering concepts

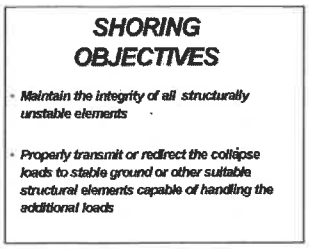


2. DEFINITION OF RESCUE SHORING

A. Temporary support of a partially collapsed structure for the search and rescue of trapped victims, at reduced risk to the victim as well as our rescue forces.

This may be a temporary support but we don't remove it other shoring in place.

B. i.e. we don't just pull out our pneumatic struts at the end of the operation without replacing them with wood



3. SHORING OBJECTIVES.

A. To maintain the integrity of all structurally unstable elements. Columns, arches, beams, girders, and bearing walls are all elements that support other elements. If they fail, there will be a collapse of some type occuring.

B. Properly transmit or redirect the collapse loads to stable ground or other structural elements capable of handling the additional loads. We must resupport any over loaded elements.

BASIC POINTS

- Shoring Should Be Built As A Complete System
- Lateral Brace To Prevent System From Buckling
- Minimum Level Of Lateral Strength In Vertical Support Should Be 2 %
- Ideal Would Be 10%

4. BASIC POINTS

A. Shoring should be built as a complete system- in rescue shoring we must always protect against the possibility of secondary collape. As a result, all our shores must be erected as a system which can withstand shifting and lateral forces applied to them.

B. Lateral brace to prevent system from buckling- In rescue shoring we must be able to prevent our shoring from becoming dislodged or knocked down during a secondary collapse situation. To prevent this we latterally brace all our shores, every time we install one.

C. Minimum level of lateral strength in vertical support should be 2%- This is the absolute minimum we must have in lateral brace strength for each of our shores.

D. Ideal would be 10%- we are shooting for 10% lateral support for compensating for any lateral attacks from secondary collapses. All our shores are designed with at least 10% lateral strength in mind.

CONSIDERATIONS

SHORE
MITIGATE
AVOID

5. CONSIDERATIONS

A. Shore- To Stabilize and make the rescue area safe for the duration of the incident. This decision would be made by the incident commander with the advise of the rescue officer.

B. Mitgate- Many times it is easier and safer to remove the hazard instead of trying to shore it up or work around it.

C. Avoid - If there is no one trapped in the area, we can avoid the dangerous situation until all the rescues are concluded. This will speed up the recovery and rescue operation.

L D RATIO

THE LENGTH TO DIAMETER RATIO OF ALL OUR SHORING MATERIAL IS VERY CRITICAL, THE STRENGTH OF OUR SHORES DEPENDS ON KEEPING IT WITHIN EXCEPTED LIMITS

6. LENGTH TO DIAMETER RATIO

A. The length to the diameter of the shoring lumber can be very critical. The longer the lumber the more deflection that can occur. With this deflection comes bending and loss of strength of the shoring material. As a result of this loss of strength, we must keep the overall length of the shores to a safe minimum.

L D RATIO

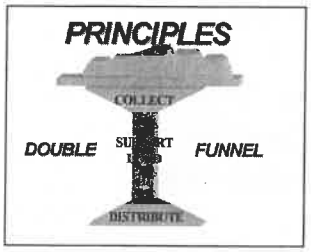
MAXIMUM 50

IDEAL 25

7. LENGTH TO DIAMETER RATIO

A. In the typical URM construction that we normally deal with day to day, that ratio will be a maximum of 50 to 1. with a 4x4 this equates to 14 feet 7 inches

B. The ideal length we are looking to use will be 25 times the diameter. This equates to 7 feet 4 inches. For ease of measuring we will use 8 feet as the norm. This is where we start to make sure that we cross brace our shoring lumber.



8. PRINCIPLES

A. The main principle our shoring is based on is shown in this graphic. We collect the overload from above, transfer it thru our shoring and redistribute it thru our sole plate and many times with additional sleepers.

B. All our shoring systems are designed and based on this premise.

SHORING SIZE-UP

- *determine the type & placement of shoring systems in relation to structural hazards and potential victim location*
- *it must be extensive, accurate and continue throughout the rescue operation*

9. SHORING SIZE-UP

A. Determine the type & placement of shoring systems in relation to structural hazards and potential victim location. Determine the size of the shoring material and which type of shore will be the most effective in each given situation.

B. It must be extensive, accurate and continue throughout the rescue operation. Determine the best method to control and stabilize the damage and the structural hazards. Your size-up must be continual and last the entire rescue operation, from your initial collapse size-up until your team terminates operations.

SIZE-UP CONSIDERATIONS

- *VICTIM LOCATION*
- *SIX SIDED APPROACH*
- *STRUCTURAL ELEMENTS*

10. SIZE-UP CONSIDERATIONS

A. The victims location will be one of the primary areas to survey for potential shoring situations

B. The six side approach; the top, bottom, & all four sides are very important for the placement of the shores. Especially the bottom where the shores will bear upon.

C. Determine what type of structure it is and what are the supporting structural elements of that building. Evaluate if any elements are missing, damaged, or destroyed.

SIZE-UP CONSIDERATIONS

•AGE & CONDITON OF THE STRUCTURE
•LOCATION OF COLLAPSE IN BUILDING
•COLLAPSE WARNING SIGNS

11. SIZE-UP CONSIDERATIONS

A. The age of the building is of concern, for its stability as well as what type of building materials were utilized in its construction.

The condition of the building, before as well as after the collapse will inform your team of how much potential for secondary collapse exists.

B. The location in the building of the collapse will predicate on how fast we can get our shoring equipment and lumber into position. Whether we can pre erect some of our shores will also be dictated by this situation.

C. Any time any members of the rescue team are operating in the collapsed structure, they must keep a constant eye on the remains of the building for any type of movement that could potentially give them a problem.

SHORING PLACEMENT

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

12. SHORING PLACEMENT

A. Steel and wood floors tend to be lighter and far more flexible than concrete floors. As a result, they can typically support and redistribute overloads and debris more efficiently. Of course this rule of thumb applies when the amount of damage and debris is not too severe. Each situation will be different and must be always checked.

SHORING PLACEMENT

- BELOW ANY DAMAGE
- SUPPORT UNSTABLE STRUCTURAL ELEMENTS
- UNDER MAIN DEBRIS PILE
- UNDER VICTIM LOCATION

13. SHORING PLACEMENT

A. Whenever you encounter a partial collapse of a structure you must evaluate the entire building for damage. Your shoring should start the floor below any damage.

B. Columns, archs, girders, bearing walls and beams are all structural elements that if are damaged or missing will cause some sort of collapse to occur. These items must be replaced or resupported whenever necessary.

C. In many collapse situations, there will be a main debris pile. This will be a concentrated load that must be supported and redistributed back to good support.

D. When work is being performed on victim extrication, then support underneath the victims location should be of primary concern. Make sure the area below will not collapse under the weight of the rescuers.

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

14. SHORING PLACEMENT

A. When erecting multiple shores on several floors, they must be erected in line with the previous shore below. This will keep the load properly supported.

B. Always shore from the first sign of any damage. Start from the good area, then shore into the main damage.

C. Always be aware of the needs for tools and equipment in the collapsed structure. Don't block off your access with shoring systems. Your team may have to alter the shores in order for this to work.

The SHORING TEAM

SHORING SQUAD	CUTTING SQUAD
SHORING OFFICER	LAYOUT FF
MEASURING FF	CUTTING FF
SHORING FF	TOOL & EQUIP FF

15. SHORING TEAM

1. Shoring squad

A. Shoring officer- in charge of team, works with engineers and operations chief in determing types and placements of shores.

B. Measuring ff- does all the measurements for the shores, relays info directly to layout ff

C. Shoring ff- along with the measuring ff erects the shores in position, he is responsible for the handling of tools and fabrication of the shores

2. Cutting team

A. Layout ff- responsible for the proper layout of the measurements he receives from the measuring ff. tells the cutting ff what and where to cut.

B. Cutting ff- handles all the saws and cuts the material marked by the layout ff. responsible for the upkeep of the tools he is using.

C. Tool & equipment ff- his job is to procure all the necessary tools, lumber and accessories needed to complete the cutting and layout of the shoring lumber.

SHORE ASSEMBLY TEAM	CUTTING TEAM
SHORING OIC	CUTTING TEAM OIC
MEASURING FF	LAYOUT FF
SHORING FF	FEEDER
SHORING FF	CUTTING FF
SAFETY FF	TOOL& EQ FF
RUNNER	RUNNER

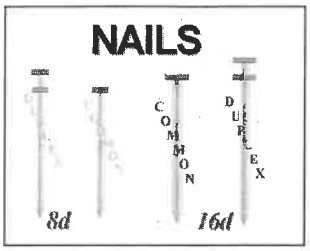
16. SEPARATE ASSEMBLY AND CUTTING TEAMS

1. Assembly team

A. All the existing position responsibilities remain the same.

B. The safety ff job is to survey the entire area around where the team is operating.

C. The runners job is to both work together whenver possible, normally they will be carrying the necessary lumber an tools needed to accomplish this objective.

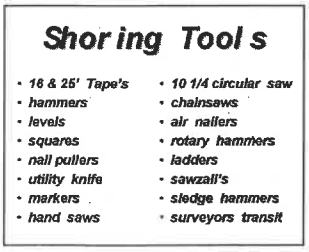


17. NAIL TYPES

A. The 8d is 2 ½" long and the 16d is 3 ½" long. The two most common types of nails are the comon nail, with one head, and the scaffold or double headed nail. We utilize the double headed nail during training in order to be able to easily extricate the nail when finished training, saving the lumber for further use.

18. NAILS

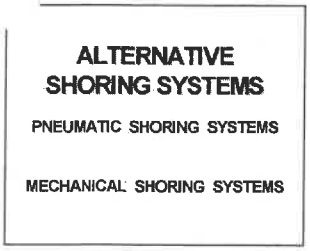
A. These are the two sizes of nails that we will be using in all of our shoring operations. All plywood is anchored with 8d nails only. All dimensional lumber is anchored with the use of 16d nails, this includes all 2x4's, 2x6's, all 4x's and 6x's, whether face nailed or toe nailed.



19. SHORING TOOLS

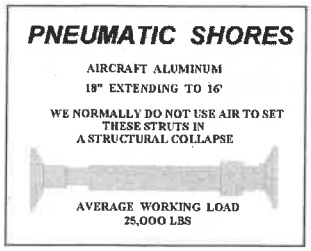
A. These are the necessary tools needed to measure, fabricate, and erect your shoring systems.

B. This is the minumum tool compliment, there are other tools that may be needed in specific situations.



20. ALTERNATIVE SHORING SYSTEMS

A. There are two main types of alternative shoring systems available to your rescue team. These are pneumatic shoring struts, very strong and easy to assemble. The other shoring system readily available from the construction industry are mechanical shores. There are several types of these and they all can be gotten to your rescue site with relative ease.



21. PNEUMATIC SHORES

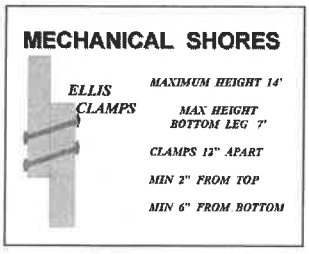
A. An excellent item for your rescue cache, they are constructed out of aircraft grade aluminum and are very strong. We can use these from 18" to upwards of 16'.

B. We normally do not use air to set these struts in a structural collapse situation. We install these by hand and tighten up the same way.

C. The working load is generally around 25,000 lbs and will vary with the length to diameter ratio of the strut.

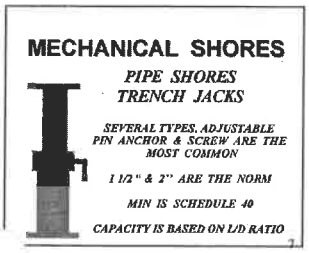
22. PNEUMATIC RAKER SHORE PHOTO

A. A photo of a set of pneumatic raker shores showing wooden cross bracing. This set up can be erected in 90 seconds. Very strong and easily adjustable to any leaning wall situation.



23. MECHANICAL SHORES

A. Another option open to your rescue team is the use of Ellis clamps, from the construction trades they are a set of clampse that can join two pieces of lumber together to form one shore. The working load limitiation will be 6,000 lbs. they are good for use when you do not have lumber long enough to reach a certain height. You can then place two pieces of lumber together with the clamps and accomplish your objective.



24. MECHANICAL SHORES

A. This option is also easily available from the construction trades. These are called pipe shores or trench jacks, they are steel pipe sections of either 1 ½" or 2" minmun schedule

40 pipe. Again like the pneumatic struts the capacity of these shores will depend on the length to diameter ratio of the shore.

25. MECHNICAL SHORE PHOTO

A. These are typical construction type pipe shores found at many construction sites, generally used to support concrete forms while the concrete is being set. However they can and are used to shore up or stabilize many different items.

B. Here we are shoring up an broken concrete beam in order to keep it from failing any further or falling to the deck below.

Interior Rescue Shoring

INTERIOR RESCUE SHORING

This section will cover the most common types of interior rescue shores that your team will erect in our average building collapse. All these shores follow the double funnel principle and consist of a header, posts and a sole plate. Wedges are placed at the bottom of all these posts for fine tuning and adjusting the pressure of the posts.

THE "T" SHORE

RULES OF THUMB

MARGINALLY STABLE AT BEST

HEADER LENGTH – 3' to 4'

SOLE PLATE 1/2 LENGTH OF HEADER MINIMUM

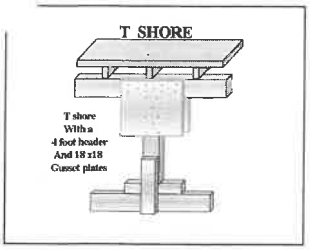
1. THE "T" SHORE

A. This is a one column vertical shore. It can only be used as a temporary support and should be replaced with the proper shores as soon as conditions allow.

B. Used exclusively as an initial safety shore. Its stability is marginal at best, this is a very key factor in its use.

C. Its is a quick safety shore that is temporary, only designed to give the rescuers some degree of safety while erecting the permanent shoring systems that will be necessary to safely stabilize the structure.

D. Generally constructed of 4x4s and plywood gusset plates, a 3 foot header is normal, with 12x12 inch gusset plates. A 4 foot header can be used with 18x18 gusset plates when necessary.

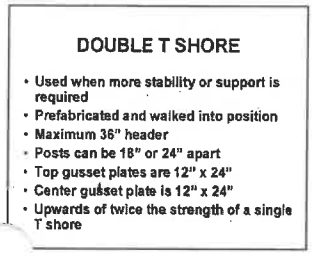


2. T SHORE GRAPHIC

This grapic shows the T shore in position centered under three floor beams. The shore must be centered under the load in order to be effective. It also must be as plumb as possible to properly carry the load without becoming unstable.

3. T SHORE PHOTO

A. Here is a photo of a simple T shore in position at a partial collapse of a townhouse. It is placed directly under a two beam connection point at the edge of the building, it is supporting the corner of the building as the end wall has collapsed.

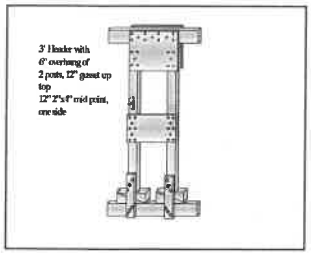


4. THE DOUBLE "T" SHORE

A. The double T shore is utilized when more stability or support is called for. It is still considered a temporary safety shore and is to be used as such. As with the single T shore it is prefabricated and walked into position.

B. The maximum header length of this shore will be 36" and constructed of 4x4's. The two top gusset plates will be 12" x24" and the center gusset plate will also be 12" x24".

C. The strength of this shore properly loaded may be upwards of twice that of the single T shore



5. DOUBLE T SHORE WITH POSTS SPACED 24" APART

A. This shore has the posts spaced 24" apart from outside to outside. There is a 6" overhang of the header over the ends of both posts. Two sets of wedges are at the bottom, make sure they both are tightened up evenly.

6. DOUBLE T SHORE PHOTO

A. Here is a photo of a double T shore in position under a leaning and partially collapsed floor section. This shore is much more stable and quite a bit stronger than the single post T shore.

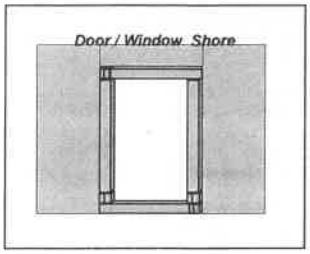
THE DOOR SHORE

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

7. THE DOOR SHORE

A. The door shore is generally constructed of 4x4s and is utilized to support damaged door ways or major wall breaches. Used extensively if the suspected opening is being utilized as a access and egress point by rescue personnel.

B. The rule of thumb for the header thickness in a typical URM constructed building is that we have at least 1" of header thickness for every foot of header length.



8. DOOR / WINDOW SHORE

A. This is the basic door / window shore in poisiton in an opening 4 feet or less in width. Normally constructed of 4x4's.

B. For openings greater than 4 feet we would increase the depth of the header for more support.

C. NOTE: THE WEDGES ALWAYS GO ON THE BOTTOM OF THE POSTS!

9. DOOR SHORE PHOTO

A. This photo shows the use of a door shore erected in position to support the opening as your rescue team utilizes it as an access and egress point.

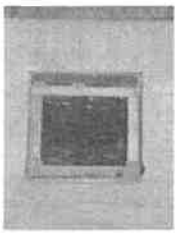
The WINDOW SHORE

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

10. THE WINDOW SHORE

A. An extensive collapse can generate a tremendous amount of debris. Blocking the primary entrances into a building and sometimes requiring a window entry. Generally constructed of 4x4s and can be installed in several ways.

B. The same rule of thumb applies, one inch of header thickness for every length of header opening.



11. WINDOW SHORE PHOTO

A. Photo of a window shore in position and wedged in placed to and uneven header section. This shore is used to keep the opening intact and stop any possible collapse of the existing opening.

HORIZONTAL SHORE

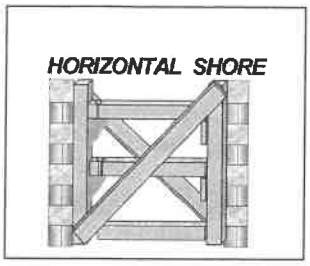
STABILIZE PASSAGEWAYS
2 - 3 SUPPORT STRUTS

DEBRIS WEIGHT WILL DETERMINE THE SIZE AND # OF STRUTS NEEDED

12. HORIZONTAL SHORE

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

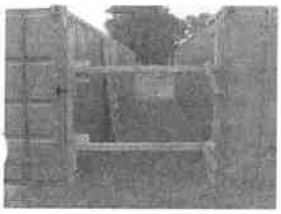
B. The debris weight in the building will determine how many struts you will need for the shore.



13. HORIZONTAL SHORE GRAPHIC

A. The shore consists of two wall plates, usually 4x4s, the struts usually 2 or 3, depending on amount of damage, also 4x4s are typical. Wedges are used to pressurize the struts. Paratech sturts can be used also.

B. If the shore is not in the way of access you can cross brace for additional lateral stability if necessary.



14. HORIZONTAL SHORE PHOTO

A. A photo of a simple two strut horizontal shore between two simulated wall sections. This shore is strictly used to keep the interior walls of a building from bulging or collasping.

VERTICAL SHORE

- RESUPPORT UNSTABLE FLOORS OR ROOFS
- POSTS UNDER FLOOR BEAMS
- MID-POINT BRACING AT
- 9 ft CEILING HEIGHT

15. VERTICAL SHORE

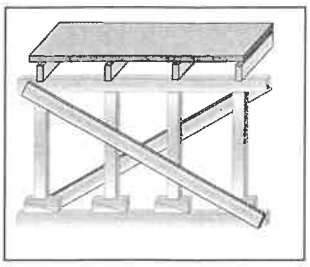
A. This is one of the most commonly used shores in rescue operations. Usually constructed of 4x4s but larger lumber has been utilized when necessary.

B. The main purpose of this vetical shore is to stabilize damaged floors, ceilings or roofs.

C. The posts should be placed under the floor beams when ever possible for maximum support and load transfer.

D. When you reach a 9 ft ceiling height you should think about mid point bracing the shore.

E. Can also be used to replace missing or unstable bearing walls or columns.



16. VERTICAL SHORE GRAPHIC

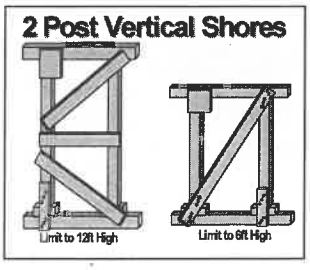
A. The shore consists of a header, soleplate, posts, wedges and diagonal bracing. THE SHORES POSTS BELONG UNDER THE FLOOR BEAMS FOR PROPER SUPPORT.

B. At no time should the posts be more than 4' apart.

C. At all times the vertical shore should be cross braced against any possible lateral attack from a secondary collaspe possibility.

17. VERTICAL SHORE PHOTO

A. Here is a photo of a 6 post vertical shore erected in a 5th alarm gas explosion in brooklyn. This shore was erected under two floors of building supporting bearing walls above.



18. TWO POST VERTICAL SHORES

A. These two post vertical shores are an option for your rescue team. In many instances a three or four post shore is not really needed or very efficient.

B. This graphic shows two options that you have, you can erect this two post up too 12' high, if you do brace it as shown.

C. If you erect this shore at 6' high or less, you can brace it this way. These are the two basic options available.

19. TWO POST SHORES PHOTO

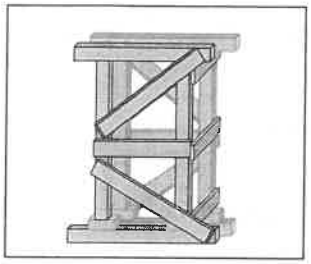
A. This photo shows two, two posts shores under and exterior free hanging wall of a townhouse. They are framed square and then shimmed into position. The cross bracing is in place to keep any lateral shifting of the free hanging wall from occuring.

20. LACED POST SHORE

A. The strongest and most stable shore that we can erect. Usually erected of either 4x4's or 6x6's. It is an excellent stand alone shore, and can be used as a safe haven in event of an aftershock or a secondary collapse.

B. At approximately every 4 feet in height we have to cross brace the shore. This is done in order to keep the initial strength of the shore consistent even though the height is increased.

C. With the use of 2 inch dimensional lumber as bracing we must keep the distance between the posts at a maximum of 5 feet. Any further apart and the bracing becomes less effective due to deflection.



21. LACED POST GRAPHIC

A. The shore consists of two headers and two soleplates, each 2 feet longer the the outside width of the shore posts. Each section is preassembled an then crossbraced together with either 2x4's or 2x6's.

B. The shore always consists of four posts. The bracing is crossed every four feet and diagonals are placed in between each set of braces.

22. LACED POST PHOTO

A. A photo of a laced post properly installed and braced off with the "K" brace configuration. This is the most effective bracing system availble.

Exterior Rescue Shoring

EXTERIOR RESCUE SHORING

This section will show you the most common types of exterior shores your team will encounter and erect. The majority of exterior rescue shoring is there to stop the building from leaning and falling down, usually applied to the outside supporting walls of the structure.

RAKER SHORES

- *Used in bracing walls that are cracked or leaning away from the building*
- *Placed eight feet on center in most cases*
- *Must be laterally braced at all times*
- *Built away from dangerous wall and carried into place*
- *The raker capacity must be 2% of the weight of the wall in question*

1. EXTERIOR RAKER SHORES

A. Exterior rake shores are erected in emergency situations primarily to stabilize and re-support existing bearing or nonbearing exterior walls. These walls may be cracked, damaged, leaning, bulged, or in some way not properly supporting their loads.

B. In general, the solid sole rake is utilized in urban environments where concrete and asphalt commonly cover the ground.

C. These shores are placed maximum 8' on center and are always erected in pairs and cross braced at all times.

D. They are prefabed and their capacity must be at least 2% of the weight of the wall in question.

SOLID SOLE RAKER

RAKER SHORE OF CHOICE
GENERALLY ERECTED AT 45 DEGREE ANGLE
CAN BE USED ON SOLID SURFACE OR SOIL
PREFABRICATE AND WALK INTO POSITION

2. SOLID SOLE RAKER

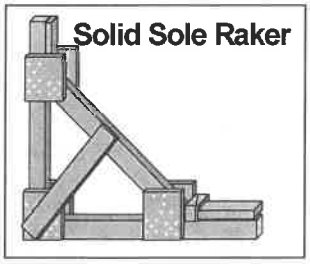
A. This is the raker shore of choice whenever we can erect it.

B. Generally erected at a 45 degree angle, for rescue shoring this is the optimum angle for our typical uses.

C. This shore can be utilized on both solid ground and earth, generally used where solid ground such as concrete or asphalt is in position.

D. All of the structural elements are tied together making the shore one integral unit before the shore is placed in position.

E. This style of shoring is recommended for rescue situations because of it's ability to stay together after additional unexpected stresses are applied to it.



3. SOLID SOLE RAKER

A. Assembled at either a 45 or 60 degree angle. Usually used to support leaning walls up to and including the third floor.

B. Constructed in the shape of a right triangle for stability. Consists of a wall plate, sole plate, raker, gusset plates, top and bottom cleat, and diagonal center braces.

C. Can be constructed of 4x4's – however, 4x6's and 6x6's have been utilized many times before.

4. PHOTO OF RAKER SHORES

this is the face of a structure which was braced at all four corners to prevent the building from racking during a drill. Raker shores must be erected in pairs.

SPLIT SOLE RAKER

- RAKER OF SECOND CHOICE
- USED IN SOIL CONDITIONS MAINLY
- CAN BE UTILIZED WHERE DEBRIS IS BLOCKING THE BASE OF THE WALL
- PARTIALLY PREASSEMBLED

5. RAKER SHORE PHOTO OF BRACING

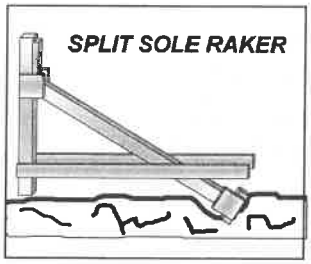
A . A typcial two raker set up with bracing, this insertion point is 9 feet high and the dobuel X bracing is called for at this wall insertion point height.

6. SPLIT SOLE RAKER SHORE

A. This shore will be our second choice when it comes to using raker shoring systems. Also a fixed shore and is generally used in suburban areas where open ground is prevalent. It has two ideal locations where its use would be benifical over that of a solid sole raker.

B. It can be easily utilized in areas where there are soil conditions at the base of the wall in question. If this is the case, the angle of the shore must be 60 degrees.

C. Another ideal use would be if there was debris blocking the base of the wall to be shored. This shore can have a shorter wall plate an then angle the bottom braces, eliminating the need to remove the debris on the ground.

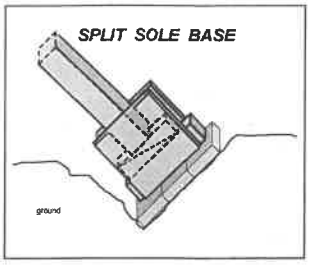


7. SPLIT SOLE SHORE GRAPHIC

A. The split sole raker consits of a wall plate, raker, top cleat, gusset plates and diagonal braces just like the solid sole raker and is erected in the same manner. The difference in this shore is the base, there is two 2x6's anchored on the outside of the wall plate and the raker, one on each side, hense the name split sole.

8. SPLIT SOLE RAKER PHOTO

A. A photo of two split sole raker shores cross braced together. The raker insertion point here is7 feet high against the building. That is why there is only one X bace in place.



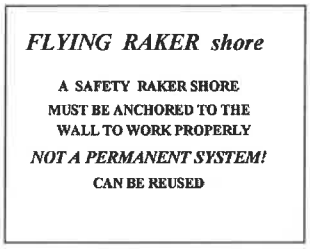
9. SPLIT SOLE RAKER SHORE BASE

A. The base of this raker shore is set into the ground differently than the solid sole raker would be. The bottom of the raker is left square. The whole is then dug at the corresponding angle, generally 60 degrees.

B. Blocking must be placed in the whole first, it must be 18" x18" minumin. Wedges are then placed between the blocking and the raker. After the wall plate is anchored to the building then the wedges are tightened.

10. PHOTO OF SPLIT SOLE RAKER SHORE

A. This photo shows a perfect situation where you would utilize the split sole raker. There is an obstruction in the way that cannot be moved without some major effort. Instead of using the solid sole raker, we can use the split sole and go over the obstruction.

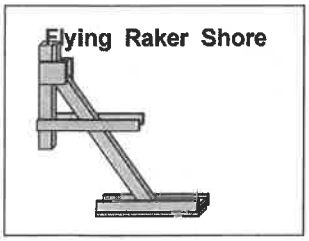


11. FLYING RAKER SHORE

A. A friction rake shore whose stability relies on the compression force applied to the rake itself.

B. Generally consists of the raker and some wedges or blocking at either the top or the base or sometimes in both positions. The rake generally is installed against the object or wall to be supported and then wedged tightly into posiion. The only way this type of raker usually can stay in position is by being kept under constant compression.

C. This is not a permanent system and is only as a safety raker while the other rakers are being permanently installed.



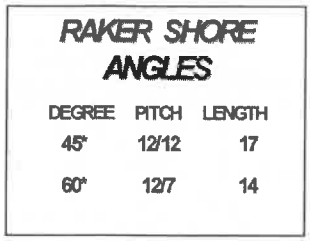
12. FLYING RAKER SHORE GRAPHIC

The flying raker consists of a top cleat, gusset plates,wall plate, raker, and bottom braces. it consists of the exact same components as the split sole raker.

The difference is that the wall plate is generally 4' to 6' length maximum. And the bottom braces generally are near the middle of the raker, not at the bottom.

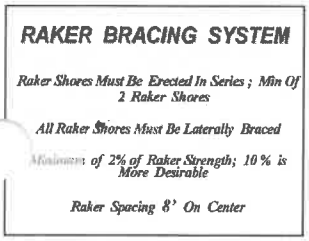
13. FLYING RAKER SHORE PHOTO

A. A photo of a flying raker shore in position against a masonry block wall, this wall plate is 6 feet long and is fronted with a section of ¾" plywood. The plywood is in place to help spread out the force from the raker to the wall.



14. RAKER SHORE ANGLES

The two angles we will utilize in rescue shoring are the 45 degree angle and the 60 degree angle. The "pitch" and the numbers we use on the framing square are 12/12 for the 45 degree angle, and 12/7 for the 60/30 degree angle. The numbers we use for the length of the raker per foot of rise will be 17 for the 45 degree angle and 14 for the 60 degree angle.

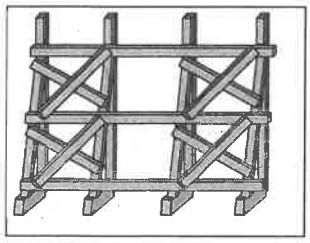


15. RAKER BRACING SYSTEMS

A. Any time we erect a raker shore it must be in pairs. There is no lateral strength in the rakers. As a result we must also brace them together.

B. The rakers are placed 8' on center and lateraly braced with 2x6's.

C. The bracing system must be a minimum of 2% of the strength of the rakers and 10% would be more desirable.



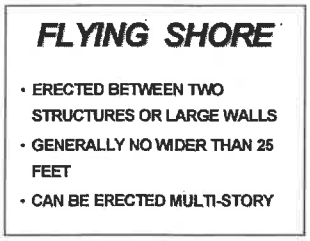
16. RAKER BRACING ABOVE 8' HEIGHT

A. This graphic shows how to brace the shores when the raker insertion point is above 8 feet, you must place a center horizontal into the system at the center of the raker shores. This will add the additional stability necessary to secure these shores. The "X" braces will then be assembled in each bay. You will have two X braces instead of one.

17. RAKER BRACING PHOTO

A. Here is a photo of 9 raker shores at a 9 ft insertion point being properly braced for lateral secondary collapse possibilites.

B. This system will withstand a tremendous amount of lateral force if applied to it from earthquake tremors or possible secondary collapse situations.

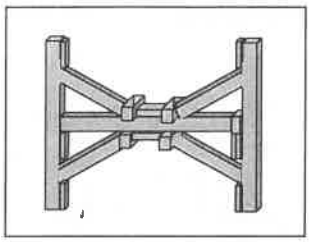


18. FLYING SHORE

A. This shore is generally erected between two sturctures or lanrge walls.

B. It is generall no larger than 25 feet wide, unless you utilize lumber larger then 6x6's.

C. This system can be erected in a multi- story fashion.

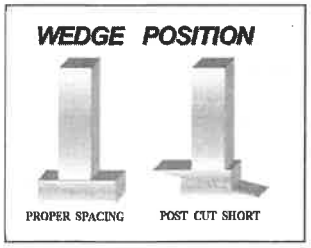


19. FLYING SHORE GRAPHIC

a. Altough this shore looks complicated its not really difficult to erect or install. The main struct supports the load and the angle braces are in place to cut down on the LD ratio of the strut for more efficiency.

20. FLYING SHORE PHOTO

A. A photo of a 24 foot wide 6x6 flying shore between two strutures. They braces are 45 degrees, they also can be 60 degrees if necessary.



21. WEDGE POSITION

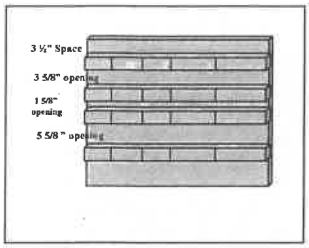
A. We need to place wedges under every post and infront of every strut we erect. This is done in order to properly adjust the shores when in position.

B. Wedge spacing should be determined by the thickness of the wedges we are using. We alsways use the wedges is pairs so we can properly tighten up the shores. The thickness of one wedge should be subtracted from the post length. This will have the set of wedges sit properly under the post. Any different lengths may not fit properly.

C. The post on the left is properly installed, on the rightthe post is too short.

22. "MARRYING" WEDGES

A. When marrying the wedges together, we must make sure they are placed in the proper positions. The right angles of the wedges must be directly opposite each other in order for the wedge to fit right. A rule of thumb will be place the cut side to the cut side.

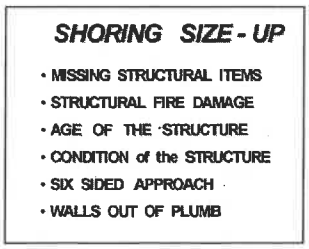


23. THE CUTTING TABLE

A. There are several ways to set up the cutting table. Here we have the table ready for cutting 2x4's and wedges. The use of the cutting tables is necessary for safety of the firefighters. We don't need any mistakes or cutting of our personnel. This whole area must be kept clean and free from debris. And it should be continually watched for safety precautions.

24. THE CUTTING TABLE PHOTO

A. An 8 foot by 8 foot table with two men working together, when using this table make sure that all shorts and cut off pieces are cleaned up. We do not want anyone getting hurt or tripping on these pieces.



25. SHORING SIZE - UP

A. Missing structural supports— one of the first concerns is to evaluate the remains of the building and check the major supporting elements. If they are missing they must be replaced with shoring.

B. Structural fire damage— in many cases fire can cause collapse, evaluate the structure for burnt and alligatored lumber. Resupport where necessary.

C. Age of the structure— the older the building the more unstable they tend to be, especially if they have not been properly maintained.

D. Condition of the structure—the shape of the building before and after the collapse will be of paramount concern to your rescue personnel. If it was well maintained it may hold up much better than if it was not.

E. Six sided appproach— always check the top, the bottom an all four sides in a structural collapse situation. These are three dimensional situations, always be on guard.

F. Walls out of plumb—if any walls are out of plumb, there will be some type of loss of strength. The further the wall is out of plumb the worse it will be.

SIZE - UP cont.

- STRAINED STRUCT. ITEMS
- TYPE of CONST. MATERIALS
- FLOOR CONSTRUCTION TYPE
- PROPER BEAM CONNECTIONS
- DOOR & WINDOW ACCESS
- DOOR & WINDOWS RACKED

26. SHORING SIZE - UP

A. Strained structural elements— any time a structural element has be deformed it may have been strained, if this is the case they that element has lost some capacity of supporting its load properly. It must be evaluated and checked to see if it can support its load properly.

B. Type of construction materials—the type of building materials that were used to erect the structure will directly dictate on the size and position of your shoring systems. The heavier the material the larger the shoring lumber.

C. Floor construction type—the type of floor will also dictate the orientation and the size of your floor shoring systems.

D. Proper beam connection— all beam connections in a structure must be examined and checked for integrity. Any problems with the connection points must be addressed immediately.

E. Door & window access—many times with a catastrophic collapse situation the main access to the structure will be blocked or too dangerous to enter. Windows and side doors may be the only way into the building, check them for stability.

F. Door & windows racked- when you find any openings racked you must consider the building compromised. Determine how badly racked they really are and if bracing them will have an impact.

SIZE - UP cont.

- SAGGING FLOORS & ROOFS
- COLUMNS OUT of PLUMB
- FRAMED OR UNFRAMED
- ACCESS to THE STRUCTURE
- WALLS THAT are BULGING
- WALLS THAT are CRACKED

27. SHORING SIZE - UP

A. Sagging floors and roofs— when you have visable deformation such as sagging, you have a problem. Usually the sag goes away when the overload is removed, if it does not there is major structural problems.

B. Columns out of plumb— when a column is out of plumb it has lost some of its support capabilities. This visible deformation must be immediately addressed and corrected.

C. framed or unframed—you rescue team must be able with just a brief look determine if a structure is framed or unframed. This will predicate on where to place your shoring inside and outside the building.

D. Access to the structure— in many major events, access can be and has been very limited. Determine the best and safest way into and out of the building. Make sure this way is not blocked by tools or equipment.

E. Walls that are bulging— again any visible deformation is an issue. Walls that have bulged out are about to fail and have lost their ability to support the necessary loads they were designed for.

F. Walls that are cracked— in masonry, cracked walls may or may not be a problem. Severe cracks are a definite issue.

SIZE - UP cont.

WALLS That Are SEPARATING
POTENTIAL FOR VIBRATION
- UNPROTECTED STEEL BEAMS
- WOODEN And STEEL TRUSSES
- THE TYPES OF VOID ACCESS
- BEARING WALL STABILITY

28. SHORING SIZE - UP

A. Walls that are separating— walls that have separated from the building or from each other present a stability problem. This can easily be detected, usually this means the structure has twisted or bulged, a very serious structural problem that must be addressed immediately.

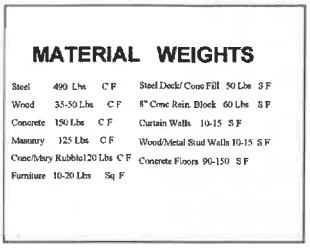
B. Potential for vibration— remember every tool we use in a rescue situation can cause vibrations to occur. We must keep vibration to an absolute minimun or diaster can ensue.

C. Unprotected steel—during fire situations unprotected steel can fail rapidly, be wary of this and any warped steel structural elements may have to be replaced of resupported.

D. Wooden and steel trusses— trusses will fail with almost no notice. They must be shored at the top chord if they are overloaded and shoring is justified.

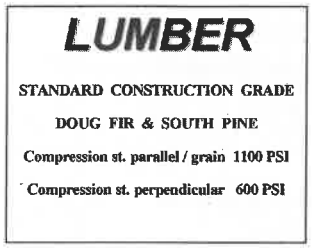
E. The types of voids— there may be several types of voids in the collapse, each type of void will have to be shored in its own specific places.

F. Bearing wall stability – very important to watch the bearing walls and resupport them immediately if there is any chance of a problem occurring.



29. MATERIAL WEIGHTS

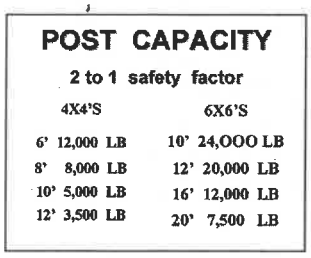
A. It is important that we all have a working knowledge of building materials and how much these items weight. We need to know this in order to calculate the amount of weight we are going to have to support wit h out shores.



30. LUMBER

A. The type of lumber we are going to use in every shoring situation will be of high importance. All our loads are figured using douglas fir standard constrution grade.

B. The grain and compressive strength of this lumber as a definite rating and we try to utilize this type of lumber at every operation. Other types of lumber may be less effective.



31. POST CAPACITY

A. It is imperative that we are totally aware of the capacity of our lumber and posts. This chart must be within easy reach of your rescue shoring operation. You must quickly be able to determine how much you shores can hold up while under pressure.

B. This chart has a 2 to 1 safety factor to take into account any deformations or weakness in the lumber. It is based on the strength of Douglas Fir.

32. THE ULTIMATE REASON FOR INSTALLING RESCUE SHORING, To Protect the Rescuer