MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

TERMINAL OBJECTIVES

The student shall properly breach, break, cut and burn to gain access through concrete, steel or other structural components during rescue operations in heavy floor, heavy wall, steel and concrete structures

Enabling Objectives

- **Correctly identify types of concrete and their components**
- **Identify concrete components and their importance to systems design**
- **Understand their importance during collapse rescue operations**
- **Identify concrete construction types**
- **Understand the properties, strengths and weaknesses of concrete and its components**
- **Correctly select tools or tool packages for rescue operations**
- **Identify functional parts of an exothermic torch**
- **Identify functional parts of an oxy-acetylene or mapp gas torch**
- **Effectively trouble shoot each tool as needed**

MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

CONCRETE AS A MATERIAL

History

- Initially the Romans used a cement to make concrete. They used Pozzolan Cement made from volcanic ash, sand and lime. These raw materials were simply ground together to make the cement, and they mixed their cement with broken stone and brick to produce concrete.

- In 1824 Joseph Aspdin a brickmason from Leeds, England took out a patent on a material he called Portland cement. Aspidin is generally credited with inventing a method for proportioning limestone and clay, burning the mixture at a high temperature to produce clinkers, then grinding the clinkers to produce a hydraulic cement very similar to that used today.

Hydration

- When cement and water are mixed they form a paste. It is this paste that binds particles of aggregate (sand and stone) together to form concrete.

- The reaction of cement and water is exothermic; heat is generated during the reaction. Depending on the type of structure, heat can be an advantage (thin concrete) or a disadvantage if excessive (thick concrete). This hydration reaction can last for years if the concrete is very thick and has moisture i.e., Hoover dam. Generally, however, a slab or driveway of concrete will cure to its rated strength in about 28 days.

Concrete, Mortar and Grout

- When cement and water are mixed together with sand, broken rock or gravel (aggregate) we have concrete.
  - Mortar is usually made by mixing portland cement and water with sand, and lime. The lime makes the mix take on a buttery texture, which is especially helpful when bonding blocks and bricks together.
  - Grout is a mixture of portland cement and water with sand, and sometimes pea gravel. Grout is usually proportioned to be quite fluid when it is used for filling voids, but may be made to be more buttery (without pea gravel) when used in grouting tile.

CONCRETE AS A MATERIAL

- Initially used by the Romans
  - **They used Pozzolan Cement made from volcanic ash, sand, and lime**
- In 1824 Joseph Aspdin developed Portland Cement
  - **He mixed limestone and clay, burned them at high temperatures, produced clinkers and then ground them down to create Portland Cement**

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HYDRATION

- **When Portland Cement contacts water its called hydration**
- **Hydration creates a water cement paste, which in turn, holds the aggregate (sand & rocks) together.**
- **This paste and the aggregate forms Portland Cement Concrete, usually just called "Concrete"**

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REACTION ISSUES

- **The reaction of water and cement is exothermic**
  - **In thin concrete heat is an advantage**
  - **In thick concrete heat is a disadvantage**
  - **Hydration can last for years depending on the thickness of the concrete**
    - **Hoover Dam may take years**
    - **Overage slab or driveway will cure in less than 28 days**

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CONCRETE, MORTAR & GROUT

- In order to form Concrete we must mix cement and water with sand and gravel
  - **sand & gravel = aggregate**
- Mortar is made by mixing cement & water with sand, often lime is added
  - **used when bonding block or brick together**
- Grout is also made using cement/water + sand and sometimes pea gravel
  - **may be mixed to be quite fluid, as when filling voids, or may be mixed stiff as when grouting tile**

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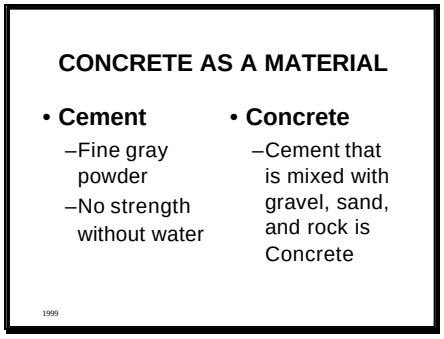
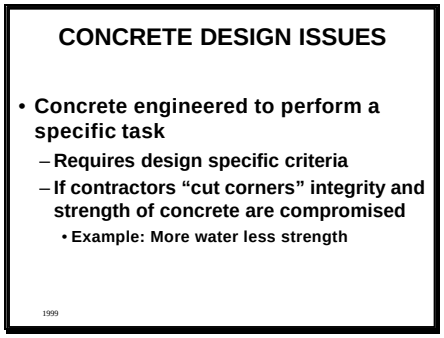
MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Types of concrete

- People often misuse the word cement and concrete. Cement is a fine gray powder, and once mixed with water, sand, gravel or stone becomes concrete. The strength and durability of concrete depend chiefly on the amount of water used. If too much water is used the cement paste will be too weak to hold the aggregates together. Generally, within limits the less water used the stronger the concrete.

- There are a variety of concrete types. These depend on the aggregate used, the amount of water added and ultimately the end use required of the concrete. In all instances the concrete will be constructed and designed in accordance with what it is expected to accomplish. This may mean the addition of reinforcing mechanisms and may include a variety of engineering options. **Note: Contractors have been known to cut corners with regards to the specific engineering requirements of the concrete.**



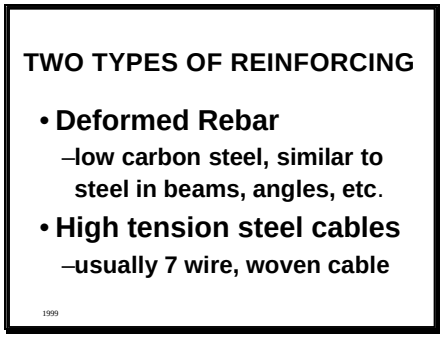


TYPES OF CONCRETE CONSTRUCTION

- Concrete can be used in a variety of structural members. The strength of the member is dependent upon construction. Obviously if you are expecting a portion of concrete to be used as a load bearing member it had better be engineered for the job. Depending upon the US&R mission you may be faced with a variety of different construction formats. Knowing how to identify each, what the properties of each are and establishing a best method scenario to breach and break provides you with a tactical edge.

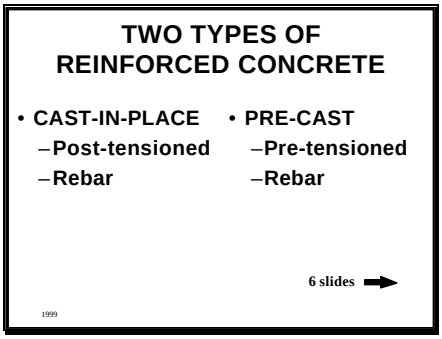
- There are two types of reinforcement used in concrete systems. Rebar and steel cable

  - Reinforcement systems: This is a composite material of steel (rebar) or steel cable and concrete. Steel provides the tensile strength that concrete alone lacks. Steel may also be used to provide compressive strength. You must remember that if the bond or anchorage is broken between the steel and the concrete the structural strength ceases to exist. Reinforced concrete examples include columns, floors, walls, beams, double T's and practically every concrete bearing structural member.



MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

TYPES OF CONCRETE CONSTRUCTION (continued)



- Concrete construction can be broken down into the following two types of formats.

  - CAST IN PLACE: This is concrete that has been molded in the location in which it is expected to remain. This could be a patio porch, a foundation for a house or a cast floor for a high rise structure. Cast in place concrete will often have rebar used as the reinforcing steel, buy may be constructed using post-tensioned cables (explained as follows)

    Post-tensioned: In this case high tensile strength steel cables or bars are encased in tubing (casing) and greased to prevent adhesion between steel and concrete, positioned in the forms and then the concrete is poured. After the concrete is set and reaches a specified strength the steel is stretched and anchored at the ends of the slab or structural member. Examples include floor slabs in concrete high rise buildings and parking structures. Note that the grease also provides protection from rust, etc.

  - PRECAST: This is concrete, which has been cast at a location other than the place it is to remain. These could be tilt up walls, which are made on site or are brought onto site, double T floor sections (joists) which are hauled in and connected together. Precast concrete may be constructed with rebar or pretensioned reinforcing (or both)

    Pretensioned: High tensile strength steel strands (cable) are stretched inside the concrete member. Concrete is placed into forms built around the strands. As the concrete sets it bonds to the tensioned steel. Pretensioning is done in a plant and the completed unit is shipped to the job site. Examples may include double T's or certain floor slabs for large concrete buildings.

- Each of these types of concrete has a specific place in the construction industry.

MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

PROPERTIES OF CONCRETE

Weight

- A basic understanding of concrete weights and calculations is critical to rescue personnel, both operationally and for your own safety. Understanding the weights you are dealing with will greatly effect your decisions at times when breaking and breaching becomes necessary.

- Generally a cubic foot of reinforced concrete weighs about 150 lb (145 for concrete & 5 for rebar). Knowing this basic information provides the rescue team with the ability to quickly calculate how much weight is to be moved from a certain piece of concrete. This becomes important not only during shoring and lifting operations but is critical when performing lift out operations, which require surgical precision.

PROPERTIES OF CONCRETE

- An understanding of basic weight is important
  - Cubic foot of normal concrete weighs about 145 lbs.
  - Add 5 lbs for rebar, call it 150
  - Important to be able to calculate weights for moving or lifting concrete

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Strengths and Weaknesses

- Like all building materials, concrete has its strengths and weaknesses. Knowing these and taking advantage of the weaknesses while avoiding concrete's strengths will enable you to speed your breaching times and enable you to apply techniques suited to type of concrete you will be faced with.

BASIC FORCES APPLIED TO CONCRETE

- **Shear**
- **Tension**
- **Compression**

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- There are three basic "forces" which we should be concerned about when dealing with concrete, tension, shear and compression.

- As discussed earlier concrete is actually a mixture of materials. This mixture provides its strengths and enables us to use it in different forms of construction. Concrete is strong in compression but weak in tension and shear. These general characteristics explain the need to add reinforcement to load bearing concrete components.

STRENGTHS AND WEAKNESSES OF CONCRETE

- Strong in compression but weak in shear or tension
  - Consider a flat slab patio and the forces applied to it. What happens if you place the slab on blocks off the ground and jump on it?
  - Consider load bearing walls, columns, and beams, how do they maintain their strength?

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MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

PROPERTIES OF CONCRETE (continued)

- A backyard patio made of concrete, with limited reinforcement, perhaps just wire mesh holds up well under the wear and tear of parties, lawn furniture and even dropped items. This form of concrete is strong in its current form for several reasons. Primarily it is not load bearing and secondarily it remains in compression, with the static loads it is exposed to pressing down on top and ultimately to the ground. If we were to take that same slab and lift it up on blocks (off the ground) and jump up and down on it or strike it with a sledge hammer (placing it is shear) it would fail.

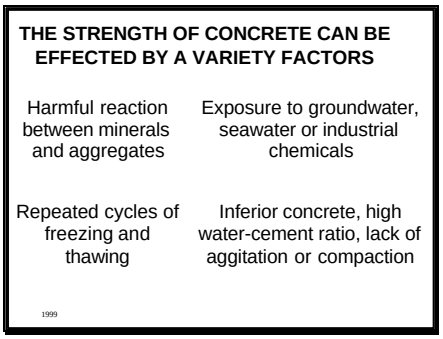
- Concrete used in load bearing walls, floors, or columns requires the addition of materials, typically rebar to provide tensile strength and the ability of the concrete to withstand the forces of shear. If you were to remove or damage the reinforcement(s) you would effectively have nothing but dead weight. In this case, both elements are equally important failure of any element or removal of any element results in system failure.

- An example of using this knowledge to effectively breach is using a saw to create relief cuts or a breaker/drill to create "stitch" drill holes.

Effects of Environment and Chemicals on Concrete

- Any number of factors can effect concrete. Under these conditions concrete may be subject to early failure or weakening.

    - A harmful reaction between minerals in the aggregates
    - Exposure to groundwater, seawater, or industrial chemicals
    - Repeated cycles of freezing and thawing
    - Inferior concrete resulting from inferior materials, high water-cement ratio, low cement content, inadequate agitation, compaction, and lack of curing.



MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

PROPERTIES OF CONCRETE (continued)

Definitions

Concrete often involves the discussion of the component parts associated with the make-up, failure or construction of any given system. For this reason certain definitions are standard within the industry.

- Cement
  - A fine gray powder, it is mixed with water and aggregates to form concrete.

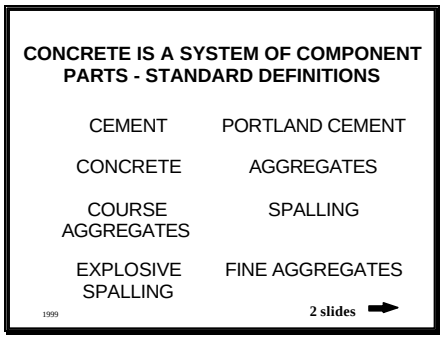
- Portland cement
  - Most commonly used cement, it is hydraulic cement, which means it hardens after the addition of water.

- Concrete
  - Is fire-retardant, watertight, and comparatively cheap to make

- Aggregates
  - Materials mixed with cement to make concrete, these may be fine or course

- Fine aggregates
  - Usually sand

- Course aggregates
  - Crushed stone, gravel, cinders, shale, lava, pumice, vermiculite, etc..



MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

PROPERTIES OF CONCRETE definitions (continued)

- Spalling
  - The loss of surface material when concrete is subject to heat or the force of breaking and breaching. It is due to the expansion of moisture in the concrete.

- Explosive spalling
  - The violent projection of concrete. Heat or a portion of the concrete being "sheared" by a tool may cause this.

REBAR AND REINFORCING

General Steel Properties

- Steel rebar and a variety of other steel products are used to provide reinforcing strength to concrete structures. Deformed round bars are the most common types to be found and range in sizes from 3/8" to 1 3/8" diameter.

- Rebar is found in almost all concrete used in construction as a method to provide shear and tensile strength. Failure or breaking away of the rebar by either mechanical forces or natural forces will result in failure of the concrete.

REBAR AND REINFORCING

• Deformed round bars are the most common types and range in size from 3/8" to 1 3/8" in diameter

Placement of Rebar in Concrete Structures

- Rebar may generally be located in specific locations in certain types of construction. Not only can we predict the location but also the size and thickness of the rebar associated with each type of structural member.

- WALLS:

  - For thickness up to 8 inches will have one layer of bars, which will occur at the center of the wall. Spacing usually occurs from 8 to 16 inches each way. (vertical and horizontal). Bigger bars are normally added adjacent to the openings and will extend beyond edges of openings. There may even be diagonal bars at corners of openings.

  - Walls over 8 inches thick should have two layers of rebar, each about 1" clear of the surface. Spacing of each layer is 8" to 16" each way. Each bar will be 3/8" to 3/4" diameter.

REBAR APPEARS IN DIFFERENT LOCATIONS

- **Walls**
- **One way slabs**
- **Pan joists**
- **Two way slabs**
- **Beams and Girders**
- **Columns**

7 slides ➡

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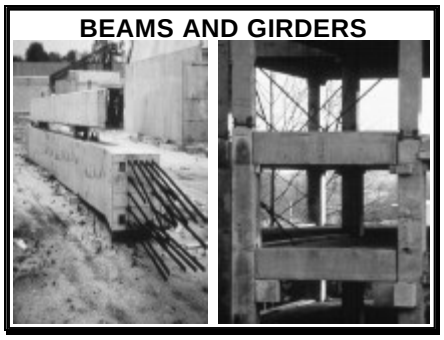
MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Placement of Rebar in Concrete Structures (continued)

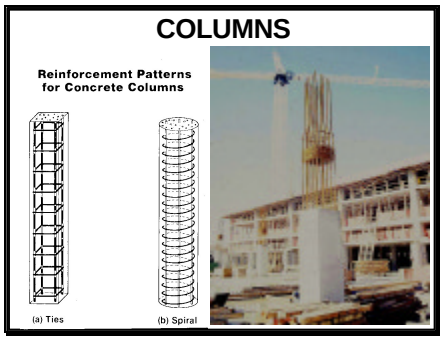
- ONE-WAY SLABS:
  - These normally span 8 to 16 feet between parallel beams and are from 6 to 10 inches thick. Normally bars near top and bottom of the slabs occur about 1" clear in each case. Bars may vary from 1/2" to 3/4" in diameter. Bottom bars extend throughout the slabs each way. In the short direction they are spaced between 4" to 12". In the long direction they are spaced 10" to 18".
- PAN JOISTS:
  - These are deep concrete ribs that are usually about 6" wide and are spaced 24" to 36". The bottom bars may be two 1/2" or 1" diameter bars. The top bars are two or four 1/2" to 3/4" bars placed in the slab above the rib and parallel, these run about 4 inches or so apart and are 1/2" clear from the top.
- TWO-WAY SLABS — FLAT SLABS (two way slabs supported by beams):
  - Normally these bars are similar to one way slabs except some top bars may extend through out the slab and will vary. Bars are usually 1" clear from the top and bottom of the slab. Bottom bars range from 1/2" to 3/4" diameter with spacing from 4" to 12". Top bars are most closely spaced over columns and placed each way.
- TWO-WAY SLAB — WAFFLE SLAB:
  - These are the same as two way flat slabs except the bottom bars are found only within the ribs and about 1" from the bottom. The ribs are typically 6" wide and spaced between 24" and 36".

MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Placement of Rebar in Concrete Structures (continued)



- BEAMS AND GIRDERS:
  - These usually are 12" to 18" wide and up to 18 to 24 inches deep. There are usually two to six bottom bars that are from 3/4" to 1 1/4" diameter and placed within 2" of the bottom. More bottom rebar occurs in the mid 2/3rds of the span. There may be two to eight top bars, also 3/4" to 1 1/4" diameter placed in the slab above the beam and parallel to it (usually 4" or so apart). Most top rebar will be within 5 feet of the support. You will also find vertical bars called stirrups, which extend from the top to the bottom of the beams. These range in size from 3/8" to 1/2" in diameter.



- COLUMNS:
  - These are round, square or rectangular support members. Within these columns are horizontal ties with usually occur about 1" from the surface and are usually shaped the same as the column. (Spiral for round columns and individual square ties for square columns, but you can find spiral ties in square columns)
  - Tie sizes range from 3/8" to 5/8" in diameter and the tie spacing of 2 to 6 inches for spiral and 6 to 18 inches for horizontal ties. Vertical rebar is usually placed more or less evenly around the periphery of the column. These “Verts” range in size from 5/8" to 1 1/4" in diameter. You will normally find from 4 to 8 vertical bars, but there may be as many as 18 Verts in very large columns.

Tensioning Cables vs. Steel Rebar

- As previously discussed, in some instances concrete will be pre-stressed by using high strength steel cables. Pre-stressing places engineered stresses in architectural and structural concrete to offset stresses, which occur in the concrete when it is placed under load.
  - The concrete may be precast and pre-tensioned, where the steel is bonded to the concrete, or
  - The concrete may be cast in place and post-tensioned, where the steel is not bonded to the concrete

MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Tensioning Cables vs. Steel rebar (continued)

- Consider a row of books side by side. As a "beam" such a row will fail of its own weight without any superimposed load due to the lack of shear resistance between the books. Drill a hole through the row of books laterally, pass a wire through the books and tighten the wire against the end books. The row of books would be compressed by putting tensile stress in the wire and compression in the books. This "beam" could be placed across two chairs and stood on. The beam has been prestressed sufficiently to counteract the stresses placed on it by the load.

- Special high-strength cables, similar to those used in suspension bridges, or alloy steel bars are used. They are called “tendons”, "strands," or "cables”.

- These cables need to be identified early to assure the rescue team can recognize the difference between the cables and rebar. Cutting of cables can result in the immediate failure of slabs or structural members in both Precast, Pre-tensioned Concrete and Cast in Place, Post Tensioned Concrete.

TENSIONING CABLES v.s. REBAR

- **Pre-cast concrete may be pre-stressed using cables**
  - **or may have rebar reinforcing steel, in one or more layers**
- **Pre-stressing places engineered stresses in concrete to offset stresses which occur in the concrete when placed under load.**

8 slides ➡

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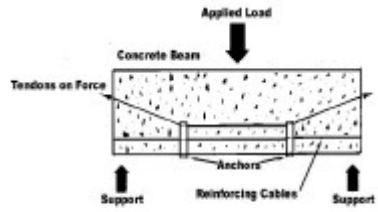

Pre-tensioned cables bound to the concrete - does not create a cutting problem

Pretensioned Tendons in Draped Position

Cutting of Cast in Place, Post-Tensioned Structural Members

- This type of reinforcing cable usually consists of a greased, seven strand, 1/2" diameter wire in a plastic casing that is cast into the concrete. After the concrete is properly hardened, the cable is tensioned to about 25000 LB and then anchored at the exterior edges of the slab. Except in some bridges the cable is not bonded to the concrete and will rapidly un-tension if cut or one of the anchorages comes loose.
  - Post-tensioned cables can be found in beam and slab floors, flat slabs, and joist and girder floors.

- The following is known about cutting post-tensioned cables.
  - When the cable is cut near or at the end of the slab, the cable may pop out of the slab surface (above or below the slab) in the form of a loop that may be as high as three feet and as long as five feet or more.
  - When the cable is cut in the middle of the slab it will usually pop out of each end of the slab. It may extend only a few inches, but in extreme cases it may be propelled beyond the building.

GUIDELINES FOR CUTTING POST-TENSIONED SYSTEMS

- **Avoid cutting if at all possible.**
- **If cutting is necessary, be sure you consult your engineer**
- **Tendon’s reaction <u>might</u> be predictable based on where the cable is cut.**
- **Slab / beam location, damage, applied forces will impact tendon’s reaction to cutting.**

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POTENTIAL TENDON CUTTING SCENERIOS - BOTH BAD

- **After cut, the cable may pop out of the top or bottom of the slab within the structure, forming a lethal loop.** (***as high as three and as long as five feet***)
- **Or, the cable may exit either (or both) ends of the slab as a lethal spear (Anywhere from a few inches to many feet)**
- **Both scenarios could occur after only one cut**

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MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Cutting of Post-Tensioned Structural Members (continued)

- In general the distance the cable is propelled is relative to the amount of tension, how tightly the plastic casing (sheath) is fitted around the cable, and how much grease was used.
- It is possible that cables could pop out of the slab surface, as well as exit the end of the slab

- Generally rescue teams should not cut post-tensioned cables, or should cut them only under the direction of a structural engineer. If you decide, for whatever reason, to cut a cable you should use a torch or carbide saw to cut one strand at a time to provide for slow de-tensioning

- To minimize the risk of cutting tensioned cable during US&R operations, proceed as follows.

  - An area within ten feet each way of the centerline of the cable should be evacuated within the building.
  - The area outside the building at each end of the slab should be evacuated for a distance of one hundred feet, within ten feet of the centerline of the cable, and/or a barrier should be built at end of the slab to stop the cable's projection.
  - No more than three adjacent tendons should be cut in each direction unless the structure has been collapsed and is being supported more or less uniformity.

MORE TENDON CUTTING SCENERIOS

- **In general the distance the cable is propelled is relative to the amount of tension, how well the tendon was greased, and how tightly the plastic casing (or sheath) is fitted around the cable.**
  - **The easier they can slide inside their casing, the farther they will go.**

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SAFETY WHEN CUTTING POST-TENSION TENDONS

- **Use a cutting torch to slowly de-tension the tendon by heating and cutting one strand at a time.**
- **Create a safety zone that extends ten feet each way from the Tendon centerline, and that extends 100 feet from each end of the slab or beam**
- **Cut no more than 3 adjacent tendons in any one slab**

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Cutting of Precast, Pre-Tensioned Structural Members

- These members usually consist of Beams, Single and Double Tees, and Slabs. The steel is bonded to the concrete, but the stresses are usually very high near the steel. The following is a guide to cutting pre-tensioned members. (Discuss with your Structural Engineer)

  - AVOID cutting pre-tensioned Beams, or the Stems of Tees unless they have collapsed and are supported as part of the rubble pile. (Even in that case, AVOID cutting near the ends)
  - One may cut slabs, including the very thin slabs of Tees. Since these members are usually only about four feet wide, it is best to cut access holes centered on the joint between two adjacent pieces. In this way most of the steel can be avoided.

GUIDELINES FOR CUTTING PRE-CAST, PRE-TENSIONED SYSTEMS

- **If cutting is necessary consult engineer**
- **Avoid cutting Beams and Stems of Single & Double Tees.**
  - **May carefully cut these when collapsed and are part of rubble pile.**
  - **Avoid cutting near the ends (all cases)**
- **May cut Slabs, including Slabs of Tees**
  - **Cut access holes, centered on the joint between two adjacent members**

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MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

TYPES OF TOOLS AND USES

- Tools for breaching and breaking must be used in a "systems" approach. No tool will accomplish the task of breaching and breaking by itself. In order to accomplish any breaching and breaking task a team must identify the tools it will need in advance. Once identified they must be used in the appropriate manner to accomplish the operation as quickly and safely as possible.

- These tools operate from a variety of power sources. They may be pneumatic, hydraulic, fuel driven, battery, electric or manually operated

- For our purposes we will categorize tools in the following manner.
  - Cutting
  - Breaking
  - Breaching
  - Torches
  - Support

TYPES OF TOOLS & APPLICATIONS

- **Tools for beaching, breaking and burning must be applied in a systems approach.**
- **No tool will accomplish the task on its own**
- **Operate from a variety of power sources**

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FIVE CATEGORIES OF TOOLS

- **Cutting**
- **Breaking**
- **Breaching**
- **Torches**
- **Support**

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Cutting Tools

- These are tools, which are used to cut concrete, steel, wood or reinforcing bars. They come in a variety of forms and sizes with certain tools best suited for specific jobs. The following are tools that you will encounter during this course:
  - Circular saws with diamond segmented blades
  - Diamond-tip chain saws
  - Wizzer saws, electric or pneumatic
  - Reciprocating saws, electric or pneumatic
  - Chainsaws (electric and fuel)
  - Rebar cutters, manual and hydraulic
  - Hacksaws, bolt cutters, chisels
  - Hydraulic rescue tools

CUTTING TOOLS

- **Circular saws with diamond blades**
- **Diamond tip chain saws**
- **Wizzer saws, electric or pneumatic**
- **Reciprocating saws, electric or pneumatic**
- **Chainsaws (electric and fuel)**
- **Rebar cutters, manual and hydraulic**
- **Hacksaws, bolt cutters, chisels**
- **Hydraulic rescue tools**

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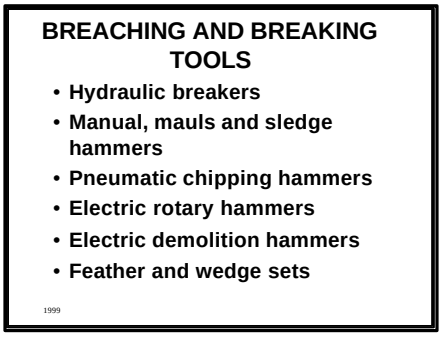
MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

TYPES OF TOOLS AND USES (continued)

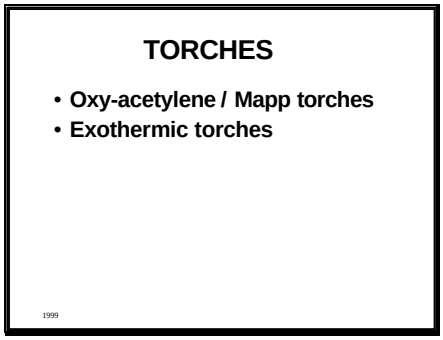
Breaking and Breaching Tools

- These tools are used to remove large or small section of concrete by removing it under tension or sheer. Breaking and breaching tools are most effective when some method of compression relief is provided for the concrete, such as relief cuts or stitch drilling.
  - Hydraulic breakers
  - Manual, mauls and sledge hammers
  - Pneumatic chipping hammers
  - Electric rotary hammers
  - Electric demolition hammers
  - Feather and wedge sets



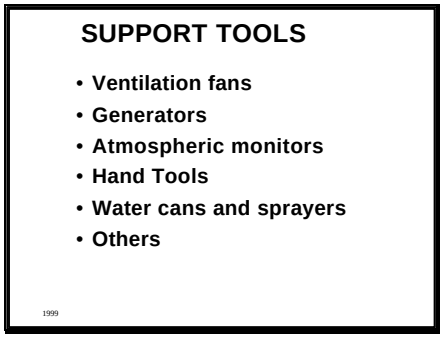
Torches

- These devices are used most appropriately to cut steel reinforcing, plates, beams or cables. They come in a variety of sizes and operate from a variety of different power sources. These include the following:
  - Oxy-acetylene/Mapp torches
  - Exothermic torches



Support Tools

- These tools include all of the accessories you will need to accomplish your breaching and breaking. Without these tools your operation may not be as effective or safe. These may include:
  - Ventilation fans
  - Generators
  - Atmospheric monitors
  - Hand tools
  - Water cans, sprayers
  - Bolts
  - Lights and accessories
  - Cribbing
  - Fuel and repair tools
  - Webbing
  - Extinguishers
  - Mechanical advantage systems, and rope systems



MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

Other Optional Equipment

- There are other tools on the market or in the trades that can be used effectively at a rescue site. They may include the following:
  - Plasma cutters
  - Exothermic torches
  - Gasoline powered breakers
  - Electric chipping hammers
  - Pneumatic breakers

OPTIONAL EQUIPMENT

- **Plasma cutters**
- **Exothermic cutters**
- **Gasoline power breakers**
- **Electric chipping hammers**
- **Pneumatic cutters**

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METHODS TO DEFEAT CONCRETE PROPERTIES

In order to effectively breach and break concrete you must know how to apply your tools using specific techniques. These techniques are designed to defeat the structural strengths of concrete based on its construction type. Listed below are several techniques, which used together, will enhance your operational capabilities.

METHODS TO DEFEAT CONCRETE

- **Relief cuts**
- **Bevel cuts**
- **Step cuts**
- **Stitch cuts**
- **Bolting**
- **Wetting**
- **Burning and cutting**

7 slides ➡

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- RELIEF CUTS: (Tension vs. shear) These cuts are usually made with saws and provide the concrete, which is being broken the ability to be taken out of compression. These may be square relief cuts, triangular or x shaped. The gap created by the relief allows you to attack an inherent weakness of concrete, which is its poor structural stability when placed in shear or tension.

RELIEF CUTS

- BEVEL CUTS: This is an angled cut which is made during a "lift out" operation. The bevel cut allows the rescue team to cut deep within the concrete while limiting the possibility that the cut section will slip through the hole. These types of cuts are critical when cutting over the top of a victim(s).

- STEP CUTS: This is a cut which is used during a “lift out” operation, when the slab is thicker than what can be cut with one pass of the saw. Two cuts are made parallel to one another the width of the saw blade guard. The concrete is then chipped out between the two cuts forming a trench. This allows the saw to complete the cut through the full depth of concrete.

MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

METHODS TO DEFEAT CONCRETE PROPERTIES (continued)

- STITCH DRILLS: These are bore holes which are partially or completely drilled thorough the concrete in a close stitch pattern within a predetermined area. These holes act very similar to the relief cut, allowing you to place the concrete in sheer or tension when applying a breaker.

- BOLTING: Bolting can be used in a variety of situations. Bolts can be permanent or re-usable. In most instances they are placed in the concrete as anchors to support either the slab portion being removed or to support a tool.

- WETTING: The application of water from tool attachments or from manual spray devices is often critical when using diamond saws. The application of water keeps blades and chains cool and lubricated. Which keeps the diamonds from becoming polished and ineffective. This also keeps down dust.

- BURNING AND CUTTING: Cutting with a torch is often an art and requires experience to become an accomplished burner. Oxy-acetylene/Mapp requires the most knowledge while exothermic cutters can be used after only a few minutes of instruction and practice. ***ALWAYS!!! Wear proper burners goggles***. It only takes one piece of slag to end a career. In some instances cutting with a torch provides the most controllable method of cutting cables and rebar. When using any torch you must be aware of the fire hazard. You must also be aware of radiant heat transfer. Before and during operations you must monitor the atmosphere to assure you are not in, or creating a hazardous atmosphere.
  The most common method of cutting is to place the tip of the flame halfway over the edge, with the preheat flames 1/16 in. to 1/8 in. from the surface to be cut. When the flame starts to produce an orange color the metal has reached it's kindling point, slowly squeeze the oxygen-cutting lever and the process will begin. Once the cut has been started, the torch is moved with a smooth and steady motion maintaining a constant tip to work surface distance. Move the torch with a speed that will produce a light ripping sound and a smooth, steady stream of sparks.

BURNING AND CUTTING
- **Often an art that requires experience**
- **Oxy-acetylene and Mapp gas require the most knowledge, while exothermic cutters can be learned in a few moments.**

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TORCH SAFETY
- **Always wear proper burners goggles, one piece of slag can end your career**
- **Always be aware of the potential fire hazard**
- **Always be aware of heat transfer**
- **Monitor the atmosphere before,and during use**

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AS A CUTTER YOU SHOULD:
- **Understand the different torch functions**
- **Understand fuel and oxygen supply**
- **Understand torch heads and handle**
- **Select cutting tips**
- **Set up and cut using proper application**
- **Understand exothermic systems**
- **Set-up and cut with rods**

9 slides

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MODULE 3 – BREACHING-BREAKING-CUTTING-BURNING

SAFETY ISSUES

- The safety of the rescuers and support crews is critical to a successful operation. It is the responsibility of the Rescue Specialist to utilize all appropriate Personal Protective Equipment (PPE) for the task at hand. During breaching and breaking operations you may be confronted with a variety of hazards which may effect your operations. These may include but are not necessarily limited to the following:
  - Exposure to heat
  - Shifting or movement of large weights
  - Deficient or dangerous atmospheres
  - Confined spaces
  - Tool reaction
  - Materials reaction
  - Sharp objects, tools and blades
  - Trip and fall hazards

OTHER ISSUES

- Concrete movement during tool use
  - Rescuer must be aware of the ability of slabs to shift vertical lift out section to fall and the movement of concrete in large or small pieces as a result of tool reaction. You must also be aware of and anticipate tool reaction/torque during operation. The rescuer should be prepared for violent tool reactions during breaching and cutting operations.

- As in any cutting operation you must be aware and prepared for saw kickback and blade movement. During operations you must also be aware of your environment and fellow rescuers to assure you do not strike them with a running saw.

GENERAL SAFETY ISSUES DURING TOOL OPERATION

- **Exposure to heat**
- **Shifting or movement of large weights**
- **IDLH atmospheres**
- **Confined spaces**
- **Tool reaction**
- **Materials reaction**
- **Sharp objects, tools and blades**
- **Trip and fall hazards**

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CONCRETE MOVEMENT

- **Rescue team members must be aware of the potential for slabs to shift, fall, or explosively react during tool application and personnel movement**
- **Additionally violent tool movement, kickback or blade movement may occur. Be aware of your surroundings and locations of team mates**

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CONCLUSIONS

- **We must understand properties of concrete to effectively breach and break**
- **We must understand and be able to identify engineered concrete systems**
- **We must create weaknesses in construction material to effectively breach and break**
- **We must understand what to break, breach or cut and what to leave alone**

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CONCLUSIONS

- We must apply specific tools to a specific task to be effective
- We must apply tools in complimentary packages
- We must understand torches and their applications
- We must effectively and safely set up and use torches
- We must apply effective and proven cutting techniques to be effective

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CONCLUSIONS

- We must always understand the power and potential dangers of working around concrete
- We must appreciate the power and danger of our tools and torches
- We need to always consider force/counter force issues with large weights
- We must appreciate the time needed to effect these applications

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