TR: Trench Lesson One Load Stabilization Systems

DOMAIN: COGNITIVE / PSYCHOMOTOR

LEVEL OF LEARNING: COMPREHENSION / APPLICATION

MATERIALS

IFSTA 7th Edition Fire Service Search and Rescue; IFSTA Essentials for Firefighting 6th Edition; DHS Field Guide for Building Stabilization and Shoring Techniques; Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, by C.V. "Buddy" Martinette Jr.; IFSTA Technical Rescue for Structural Collapse, 1st Edition; NFPA 1006 Standard for Technical Rescuer Professional Qualifications; NFPA 1670 Standard on Operations and Training for Technical Rescue Incidents; multimedia projector and laptop computer; access to white board or flipchart; assorted marker pens: 1 set of high pressure air bags: 1 set of low pressure bags; cribbing and wedges.

NFPA 1006, 2013 Edition JPR

8.2.3 Construct load stabilization systems

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive manner. While it is critical that instructors be constantly aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Technical Rescuer shall correctly identify, describe the function of, and describe the operation of various load stabilization systems used during trench rescue incidents.

ENABLING OBJECTIVES

1. The Technical Rescuer shall correctly identify, describe, and demonstrate the setup, operation and function of various load stabilization systems used during trench rescue incidents.

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MOTIVATION

During a trench operation there can be instances where a heavy load such as a large concrete pipe within the trench, a piece of heavy machinery, or component of the heavy machinery, may have to be lifted and stabilized to ensure the safety of the rescuers and allow for safer access to the victim. Rescue personnel must be very knowledgeable with the weight limitations of equipment and systems selected for stabilization procedures in order to correctly select the appropriate stabilization devices.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer shall correctly identify, describe, and demonstrate the setup, operation, and function of various load stabilization systems used during trench rescue incidents.

1. Discuss the design and operational characteristics of high-pressure air bags.
    a) The outer shell is constructed of neoprene / butyl rubber.
    b) The interior is reinforced steel / Kevlar™.
    c) The rated capacity is calculated at 1” of lift.
    d) At maximum height the usable capacity is typically reduced to 50% of the rated capacity.
    e) Check the bag’s identification tag for the rated capacity of the bag.

2. Discuss the application of the high-pressure air bags in a trench collapse situation.

a) Bags are used for lifting and filling small voids. They should be centered under the load.
b) The higher any bag lifts, the more unstable the lifted object may become.
c) The lifting operation must be closely monitored and stopped if there is any indication of instability.
d) No more than two bags should be stacked on each other.
e) The maximum lifting capacity of the stacked bags is based on the rated capacity of the smallest bag, which should be placed on top of the stack. Make sure the smallest bag has the capacity to lift the load.
f) When using two bags side by side or at two points on a load, the maximum load capacity is based on adding the rated capacity of both bags together.
g) Consider lift height as well as load weight when choosing an air bag.

3. Discuss the application of the low-pressure air bag in a trench rescue situation.
   a) They are used primarily in trench rescue operations for filling voids.
   b) They can be used for some lifting operations.
   c) They have a higher lifting range than high-pressure bags but cannot lift as much weight.
   d) The operating pressure ranges from 7-12 psi.
   e) A low-pressure bag rated for 16 tons can take as much as 250 cubit feet of air to affect a lift.

4. Point out that the working area under the bags should be clear of any debris that may puncture the bags.
   a) A solid bearing surface should be provided.
   b) Any protective object placed between the top of the bag and the lifted object should be made of a pliable material to lessen the likelihood of forceful objection should the bag become distorted
   c) Pressurize the bag slowly and watch for load shift.
   d) If the load is uncontrolled, stop the lift and reevaluate.
   e) Use cribbing, shims and wedges to stabilize the load during the lifting operation.
   f) Establish safety zones around the working area.

5. Discuss the lifting capacity formula:
   a) Measure the surface area of the object to be lifted and multiply them together, plus calculate the weight of the object. Example: 6” x 6” surface area = 36 square inches of contact surface and the object weighs 6000 pounds.
   b) Multiply 36 x 120 psi (average operating pressure for high pressure bags) = 4,320 pounds.
   c) Based on the above formula, 4,320 pounds is the maximum amount of weight the contact area can support.
   d) Based on the above formula can the bag chosen lift the object?

6. Demonstrate setup procedures for high and low pressure bags to include attaching all hoses to air supply lines and the bag, as well as operating the control box properly.

Reference: IFSTA 7th Edition Fire Service Search and Rescue, pages 87 through 90.
Reference: IFSTA Technical Rescue for Structural Collapse 1st Edition, pages 154 through 156.
Reference: IFSTA Essentials of Firefighting 6th Edition, page 498.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, pages 124 through 127.

7. Discuss the characteristics of using cribbing for load stabilization.
   a) The preferred wood is Douglas fir or Southern Pine.
   b) This wood tends to crush slowly.
   c) These woods provide advanced warning of failure by creaking and cracking.
   d) The height of cribbing when stabilizing collapsed structures can be up to 3 times the length of the cribbing piece, based on load resting on all contact points of each crib box.
   e) When used to stabilize loads to be moved, cribbing height should be limited to 2 times the width.
   f) The recommended height for 4” x 4” systems is 4 feet and the recommended height of 6” x 6” systems is 6 feet.

g) With the load resting on two contact points of each box crib, keep the height to width ratio to 1½:1.
h) With the load resting on one contact point of each box crib, keep the height to width ratio to 1:1.
i) Overlap the corners by at least the width of the cribbing to ensure slow crushing failure.
j) To provide lateral resistance in addition to friction, cribbing should be notched to minimize slippage.
k) Heavily loaded cribbing can crush so that it will lose from 10% to 20% of its height.
l) The load capacity is determined by the number of contact points between the load and each box crib.

8. Discuss the formula used to determine load capacities.
   a) Cribbing strength is determined by figuring the surface area at each point of contact and multiplying by the wood strength: 500psi for Douglas fir, lower for softer woods.
   b) The nominal dimension of a 4" X 4" timber is actually 3.5".
   c) 3.5 X 3.5 = 12.25 X 500 psi = 6,125 pounds. Round off to 6000 pounds per contact point.
   d) Box Crib - 4 contact points X 6000 pounds = 24,000 pounds.
   e) 3 X 3 Crib - 9 contact points X 6000 pounds = 54,000 pounds.
   f) The nominal dimension of a 6" X 6" timber is actually 5.5". 5.5 X 5.5 = 30.25 X 500 psi = 15,125 pounds. Round off to 15,000 pounds per contact point.

9. Identify and discuss various cribbing types to include the Box Crib (2x2 Crib), Crosstie Crib (3x3 Crib), and Solid Crib (entire surface area contact).
   a) Box Crib = 4 contact points, 6" x 6" timber, X 15,000 pounds = 60,000 pounds.
   b) 3 x 3 Crib = 9 contact points X 15,000 pounds = 135,000 pounds.

Reference: IFSTA 7th Edition Fire Service Search and Rescue, pages 93 and 94.
Reference: IFSTA Technical Rescue for Structural Collapse 1st Edition, pages 148 through 152.

Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, pages 127 and 128.
Reference: FEMA Collapse Manual, page 12.
Reference: DHS Field Guide for Building Stabilization and Shoring Techniques, page 96.

APPLICATION

Demonstrate constructing a box crib, and a crosstie crib.

Demonstrate stabilizing a cylindrical pipe using an angled crib system.

Demonstrate stabilizing a backhoe sitting on the lip of a trench to include the body of the backhoe, the hydraulic cylinders on the boom and outriggers and the bucket.

Demonstrate setup procedures for high and low pressure air bags to include proper placement of the bag(s), stacking bags, hose connection procedures and operation of the control box.

SUMMARY

The importance of selecting the appropriate tool for the task and operating it in a safe manner cannot be stressed enough. The goal of this lesson plan is to teach rescuers the importance of evaluating equipment and systems to ensure that they can support the loads to which these systems will be subjected.