

Chapter 13

Safety

Supervisors are responsible for ensuring that personnel follow safety standards. Time is usually the controlling factor in construction operations in the theater of operations. The necessity for economy of time, coupled with the temporary nature of much of the work, sometimes results in safety precautions that are substantially lower than those used in civilian practice, but this does not mean safety can be ignored. Construction equipment, except for dump trucks, is designed to accommodate only the operator.

SAFETY PROGRAM

13-1. Do not construe the lack of documentation of hazards as an indication of their nonexistence or insignificance. Where safety precautions are necessary but are not documented, or where existing precautions are judged to be inadequate, the commanding officer must issue new or supplementary warnings. Each job has its own particular safety hazards. Identify dangers and prepare a safety program to reduce or eliminate all hazards. Supervisors must conduct all operations following the guidance in the safety program. For help in making safety decisions, review the safety information in United States (US) Army Corps of Engineers Manual (EM) 385-1-1. Additionally, operators' manuals give do's and don'ts, cautions, and safety warnings. Check them!

GENERAL SAFETY RULES

13-2. The appropriate chapters of this manual identify safety rules for specific equipment. Also, check applicable technical and operator manuals prior to operating all equipment. Some general safety rules are as follows:

- Inspect equipment before use, and periodically on a regular basis.
- Ensure that mechanized equipment is operated by qualified and authorized personnel only.
- Use seat belts when they are available.
- Provide barriers to prevent personnel from walking under loading equipment that has a hoist or lift capability.
- Operate equipment in a manner that will not endanger persons or property.
- Observe safe operating speeds.
- Shut down and turn off the engine when equipment is unattended.
- Stop the equipment completely (apply the parking brake if available) before mounting or dismounting.

- Do not operate any machinery or equipment for more than 10 consecutive hours without an 8-hour rest interval.
- Post the safe load capacities at the operator's position on all equipment not rigged to prevent overloading.
- Post the safe operating speeds at the operator's position on all equipment not having a speed governor.
- Mount a ROPS on equipment whenever it is available. Do not make any modifications to the ROPS.
- Ensure that only the operator is on the equipment while it is running. Supervisors can authorize exceptions in emergency situations, some training situations, and when required for maintenance.
- Shut down and turn off the engine when refueling motor vehicles and mechanized equipment.

OPERATOR INDOCTRINATION

13-3. Teach operator safety practices during machine operation training. Indoctrinate operators about job hazards and ways to reduce or avoid them. Instruct operators to observe fellow workers and to warn them when they get into dangerous situations. Personnel should receive continuing instruction during the project to ensure that they appreciate the job hazards and understand the objectives of the safety program. Horseplay and practical jokes create very dangerous situations on the work site.

OPERATOR QUALIFICATIONS AND REQUIREMENTS

13-4. Construction and material-handling equipment operators must be tested and licensed according to Army Regulation (AR) 600-55. An apprentice or applicant can only operate equipment under the direct supervision of a licensed operator. Do not permit anyone who is not physically or mentally capable to operate any equipment. Operators are responsible for the safe operation of their equipment and for the safety of their passengers and cargo.

EQUIPMENT INSPECTION

13-5. Before using a machine, a qualified, licensed operator should inspect and test the equipment to determine its safe operating condition. Equipment-operator maintenance checks, service charts, and common sense ensure safe operation and proper maintenance. Tag any unsafe machinery or equipment "Out Of Service, Do Not Use" at the operator's position, to prevent its use until repaired. Ensure that the equipment's safety features (backup alarms, lights, and so on) are operational.

REPAIRS AND MAINTENANCE

13-6. Besides the following items, check the unit's SOP for special repair and maintenance procedures.

- Shut down or lock out equipment controls while a machine is being repaired, adjusted, or serviced.
- Position the equipment in a place, away from the project area, that is safe for the mechanic to work.

- Crib or block suspended machinery, equipment, or parts, and machines held apart by slings, hoists, or jacks. Do not work underneath or between items not properly blocked.
- Lower blades, bowls, hooks, buckets, and forks to the ground or onto suitable blocking material when equipment is undergoing maintenance or repairs.

GUARDS AND SAFETY DEVICES

13-7. Equipment guards, appliances, and similar devices are for the protection of personnel. Do not remove these devices or render them ineffective. During repairs, lubrication, or adjustments, remove guards temporarily, but only after shutting off the power. Replace all guards and devices immediately after completing repairs and adjustments. All equipment should have properly working warning devices, such as backup alarms and turn signals.

SIGNALS

13-8. Provide a warning device or a signal person wherever there is possible danger to fellow workers or others from moving equipment. If the tactical situation allows, the signal person should wear a reflective, orange vest.

ROPES, CABLES, AND CHAINS

13-9. *Table 13-1* and *Tables 13-2* and *13-3*, *page 13-4*, give load limitations and safety factors for ropes, cables, and chains. Ropes, cables, and chains used in construction operations present some of the largest potential safety hazards. To eliminate these hazards—

- Perform periodic inspections of their physical condition.
- Use only according to manufacturers' recommended procedures or within the safe limits recommended by the manufacturers of the equipment.
- Wear leather gloves when handling wire rope.

Table 13-1. Breaking Strengths of 6 x 19 Standard Wire Hoisting Rope

Diameter (Inches)	Approximate Weight Per 100 Feet (Pounds)	Breaking Strength in Tons (2,000-Pound Ton)		
		Mild Plow Steel	Plow Steel	Improved Plow Steel
1/4	10	2.07	2.39	2.74
3/8	23	5.00	5.50	6.30
1/2	40	8.50	9.40	10.80
5/8	63	13.10	14.40	16.60
3/4	90	18.70	20.60	23.70
7/8	123	25.40	28.00	32.20
1	160	33.00	36.50	42.00
1 1/8	203	41.50	46.00	53.00
1 1/4	250	57.00	56.50	65.00
1 1/2	360	72.50	80.50	92.50

NOTES:

1. A 6 x 19 rope is composed of 6 strands of 19 wires each. The strength of wire rope varies slightly with the strand construction and the number of strands.
2. The maximum allowable load is the breaking strength divided by the appropriate safety factor. The safety factors are shown in *Table 13-3*, *page 13-4*.

Table 13-2. Breaking Strengths and Safe Loads for Manila and Sisal Rope

Nominal Diameter (Inches)	Circumference (Inches)	Weight Per 100 Feet (Pounds)	Number 1 Manila		Sisal	
			Breaking Strength (Pounds)	Safe Load (Pounds) (Safety Factor = 4)	Breaking Strength (Pounds)	Safe Load (Pounds) (Safety Factor = 4)
1/4	3/4	2.00	540	140	440	120
3/8	1 1/8	4.10	1,260	320	1,020	260
1/2	1 1/2	7.50	2,640	660	2,120	530
5/8	2	13.30	4,400	1,100	3,520	880
3/4	2 1/4	16.70	5,400	1,350	4,320	1,080
7/8	2 3/4	18.60	7,700	1,920	6,160	1,540
1	3	27.00	9,000	2,250	7,200	1,800
1 1/8	3 1/2	36.00	12,000	3,000	9,600	2,400
1 1/4	3 3/4	41.80	13,440	3,360	10,800	2,700
1 1/2	4 1/2	60.00	18,500	4,620	14,800	3,700
1 3/4	5 1/2	89.50	26,500	6,620	21,200	5,300
2	6	108.00	31,000	7,750	24,800	6,200
2 1/2	7 1/2	135.00	46,500	11,620	37,200	9,300
3	9	242.00	64,000	16,000	51,200	12,800

NOTE: The above figures are for new rope used under favorable conditions. As rope ages or deteriorates, progressively reduce safe load values to one-half the values given. See safety factors shown in *Table 13-3*.

Table 13-3. Safety Factors for Ropes, Cables, and Chains

Type of Service	Wire Rope (Cable)	Manila or Sisal Rope	Chain
Guy lines	3.5	3.5	3.5
Miscellaneous hoisting equipment	5.0	7.0	5.0
Haulage lines	6.0	8.0	6.0
Overhead and gantry cranes	6.0	—	—
Jib and pillar cranes	6.0	—	—
Derricks	6.0	—	—
Small, electric or air hoists	7.0	—	7.0
Slings	8.0	10.0	8.0

NOTE: To determine the safe load for a single line, divide the breaking strength of the line by the applicable safety factor and multiply the result by an assumed efficiency factor of 80 percent for fittings.

INSPECTION

13-10. Inspect wire rope or cable at the time of installation and as part of daily operator maintenance. Remove the wire rope or cable from hoisting service when it is kinked, or when it has a number of broken wires in a strand. Remove the wire rope or cable when—

- Three broken wires are found in one strand of 6 × 7 wire rope.
- Six broken wires are found in one strand of 6 × 19 wire rope.
- Eight broken wires are found in one strand of 8 × 19 wire rope.
- Nine broken wires are found in one strand of 6 × 37 wire rope.

NOTE: Plainly mark defective wire rope as unsuitable for further use and dispose of properly.

SLINGS

13-11. Only qualified rigging personnel should attach slings to a load. When using slings, their fasteners, and other rigging attachments—

- Inspect daily for evidence of overloading, excessive wear, or damage. Replace defective slings or accessories.
- Make all eye splices (*Figure 13-1*) using the proper size of wire-rope thimbles.
- Place the U-bolt of the U-bolt clips on the dead (short) end of the wire rope (see *Figure 13-1*). Tighten the U-bolts immediately after initial load application and at frequent intervals thereafter. *Table 13-4* shows the number and spacing of clips and the proper torque to apply to the nuts of the clips (do not over torque). The minimum number of clips is three.

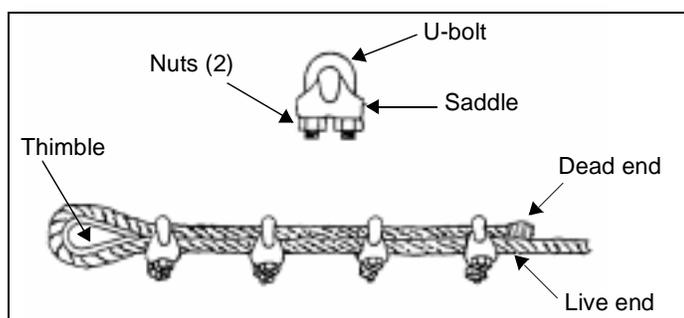


Figure 13-1. Eye splice

Table 13-4. Number and Spacing of U-Bolt clips for Wire-Rope Eye Connections

Wire-Rope Diameter		Nominal Clip Size (Inches)	Number of Clips	Spacing of Clips		Torque to be Applied to Nuts of Clips	
Inches	Millimeters			Inches	Millimeters	Foot-Pounds	(M-Kg) (0.1383)
5/16	7.95	3/8	3	2	50	25	3.5
3/8	9.52	3/8	3	2 1/4	57	25	3.5
7/16	11.11	1/2	4	2 3/4	70	40	5.5
1/2	12.70	1/2	4	3	76	40	5.5
5/8	15.85	5/8	4	3 3/4	95	65	9.0
3/4	19.05	3/4	4	4 1/2	114	100	14.0
7/8	22.22	1	5	5 1/4	133	165	23.0
1	25.40	1	5	6	152	165	23.0
1 1/4	31.75	1 1/4	5	7 1/2	190	250	35.0
1 3/8	34.92	1 1/2	6	8 1/4	210	375	52.0
1 1/2	38.10	1 1/2	6	9	230	375	52.0
1 3/4	44.45	1 3/4	6	10 1/2	267	560	78.0

NOTE: The spacing of clips should be six times the diameter of the wire rope. For end-to-end connections, increase the number of clips listed above by two, and apply the proper torque listed above on all clips. Reverse U-bolts at the center of the connection, so that they are on the dead (reduced load) end of each wire rope.

HOOKS AND SHACKLES

13-12. When using hooks and shackles—

- Replace bent, twisted, or otherwise damaged hooks, shackles, rings, and pad eyes and other fittings that show excessive wear.
- Close all hooks used to support human loads or loads that pass over workers. Where there is danger of relieving the tension on the cable due to the load or hook catching or fouling (such as lowering a load in a confined space), do not use open hooks.
- Extend the dead end of the wire rope a distance of six to nine times the wire rope's diameter beyond the socket when using a wedge-socket fastener (*Figure 13-2*). Clamp the dead end of the wire rope to an extra piece of short wire rope. Place the clamp as close to the wedge as possible. Never clamp the dead end of wire to the live end. The U-bolt should bear against the tail, and the saddle of the clip should bear against the short extra piece.

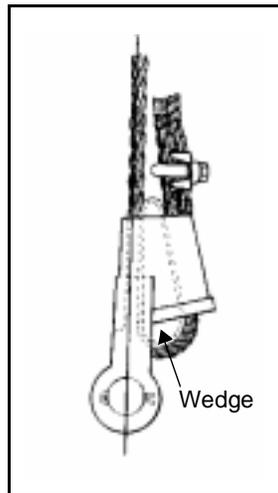


Figure 13-2. Wedge-Socket Fastener

EQUIPMENT LOADING

13-13. When loading equipment using suspended or overhead loading devices, the operator of the truck to be loaded must leave the cab. When loading equipment for transporting—

- Distribute, chock, and tie down the load.
- Make sure that the forward and side vision are clear, and that the load does not interfere in any way with the safe operation of the vehicle.
- Keep the load within the sides of the hauling equipment. When working with oversize loads that extend beyond the sides or end of hauling equipment, give adequate warnings and precautions to prevent endangering passing or opposing traffic, or damaging the vehicle.

EQUIPMENT TRANSPORTING

13-14. Give special consideration to equipment that is wider than standard vehicles or that protrudes past the sides or end of the hauling trailer. When oversized equipment is traveling or being transported from one job site to another—

- Travel or transport during daylight hours.
- Use warning flags and/or lights.
- Accompany the equipment with a lead and/or follow vehicle with warning signs whenever possible, especially in congested or heavy traffic areas.

NIGHT OPERATIONS

13-15. When operating equipment at night—

- Equip all mobile equipment with adequate headlights and taillights.
- Keep construction roads and working areas well illuminated until all workers have left the area.
- Ensure that signalers, spotters, inspectors, maintenance personnel, and others who work in dark areas exposed to vehicular traffic wear reflectorized vests or other such apparel if the tactical situation permits.

EXCAVATIONS

13-16. When excavating—

- Shore, brace, or slope excavations that are more than 4 feet deep, unless working in solid rock, hard shale, hardpan, cemented sand and gravel, or other similar materials.
- Design shoring and bracing to be effective all the way to the bottom of the excavation.
- Use sheet piling, bracing, shoring, trench boxes, or other methods of protection, including sloping, based upon calculation of the pressures exerted by and the condition and nature of the materials being retained.
- Provide additional shoring and bracing to prevent slides or cave-ins when excavating or trenching in locations adjacent to backfilled excavations or when subjected to vibrations from traffic, vehicles, or machinery.

