

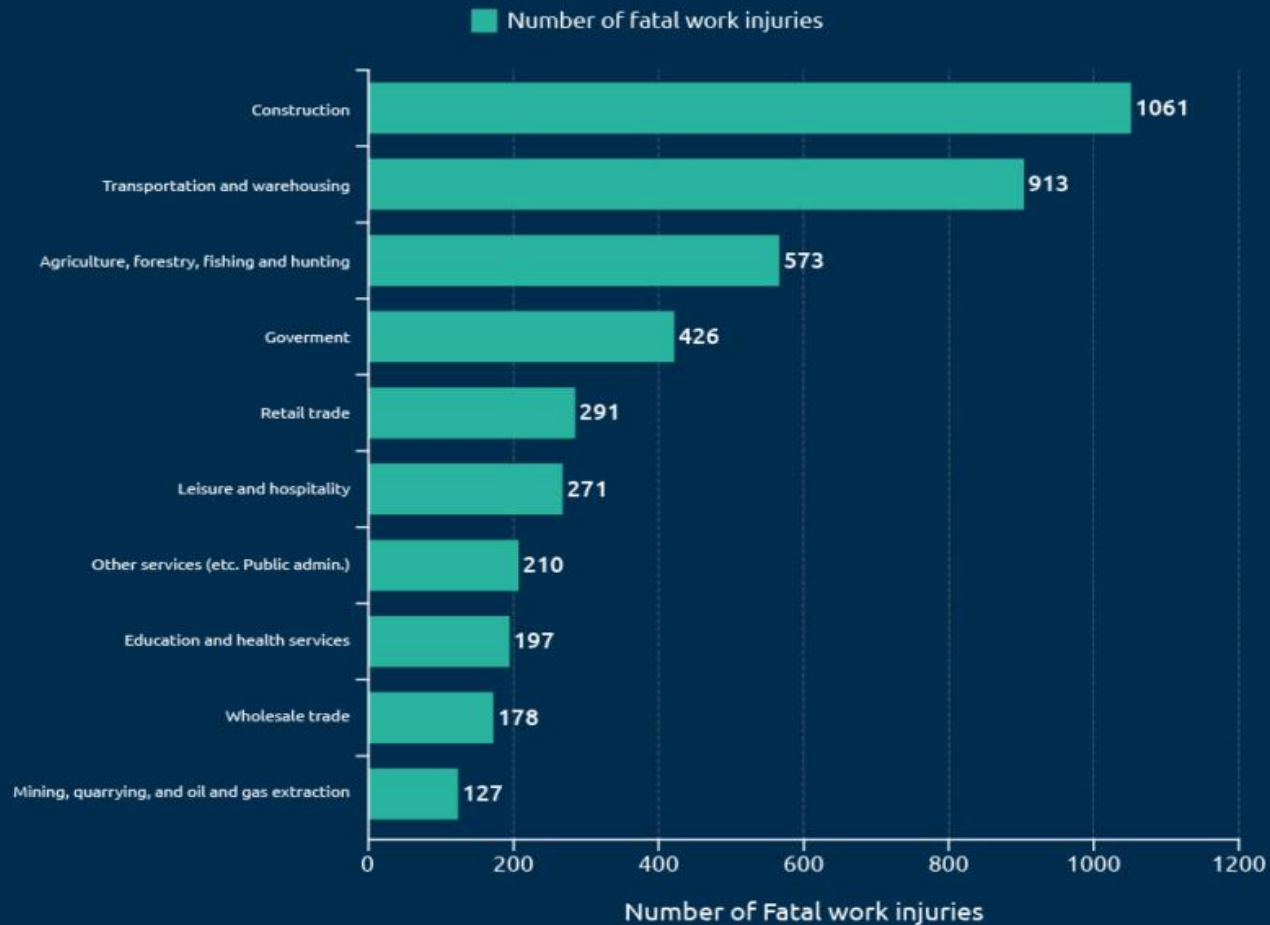
Chapter 19

Construction Safety and Health

Chapter 19

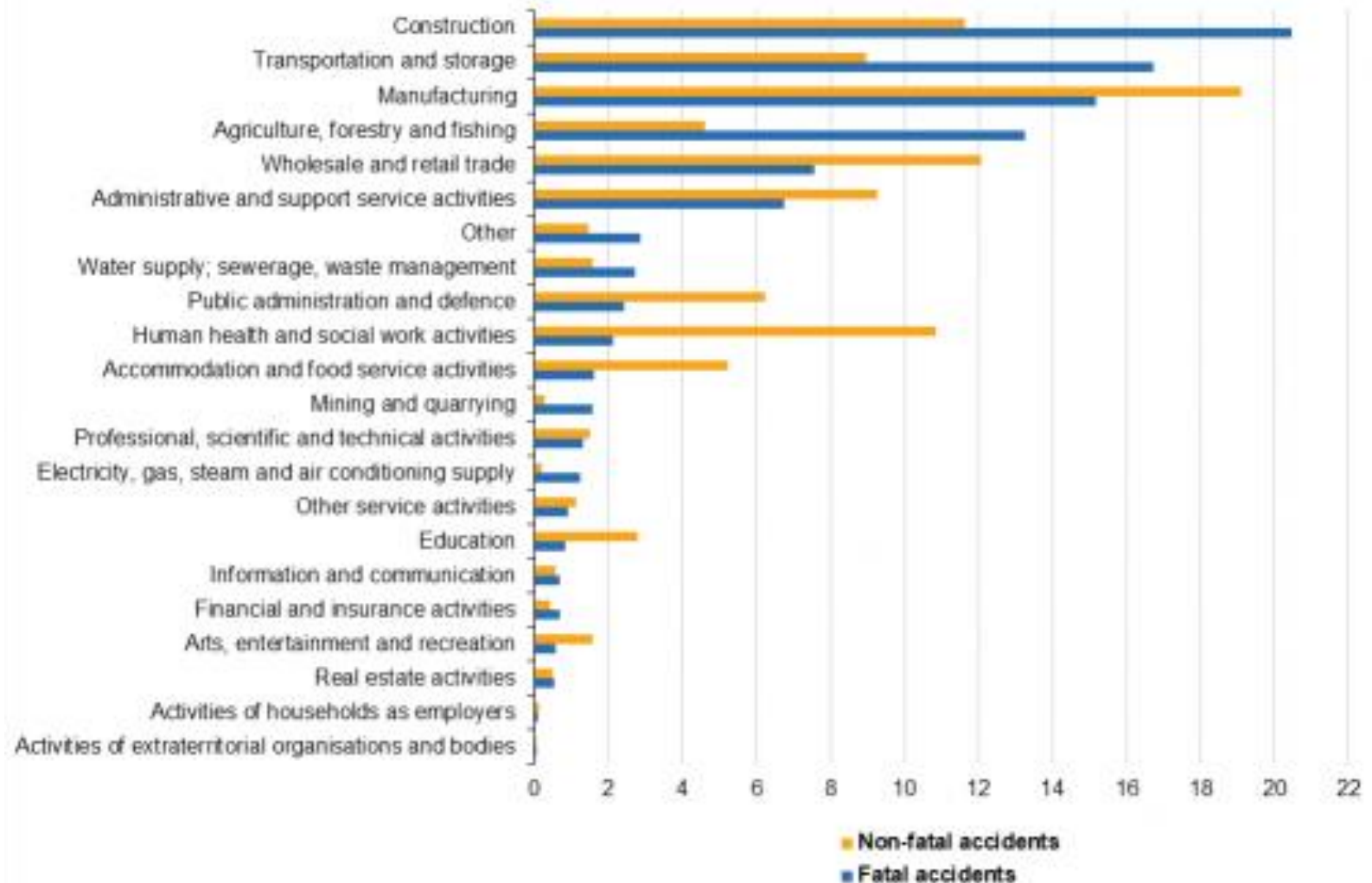
- **19-1 IMPORTANCE OF SAFETY**
- **19-2 OSHA**
- **19-3 SAFETY PROGRAMS**
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- **19-5 ENVIRONMENTAL HEALTH IN CONSTRUCTION**

» NUMBER OF FATAL WORK INJURIES « by industry sector, 2019



Source: U.S. Bureau of Labor Statistics.

Fatal and non-fatal accidents at work by NACE section, EU-27, 2018 (% of fatal and non-fatal accidents)



Note: non-fatal (serious) accidents reported in the framework of ESAW are accidents that imply at least four full calendar days of absence from work. Ranked on the values for fatal accidents.

Source: Eurostat (online data codes: hsw_n2_01 and hsw_n2_02)

CONSTRUCTION'S “FATAL FOUR”



Falls



Struck by an object



Electrocutions



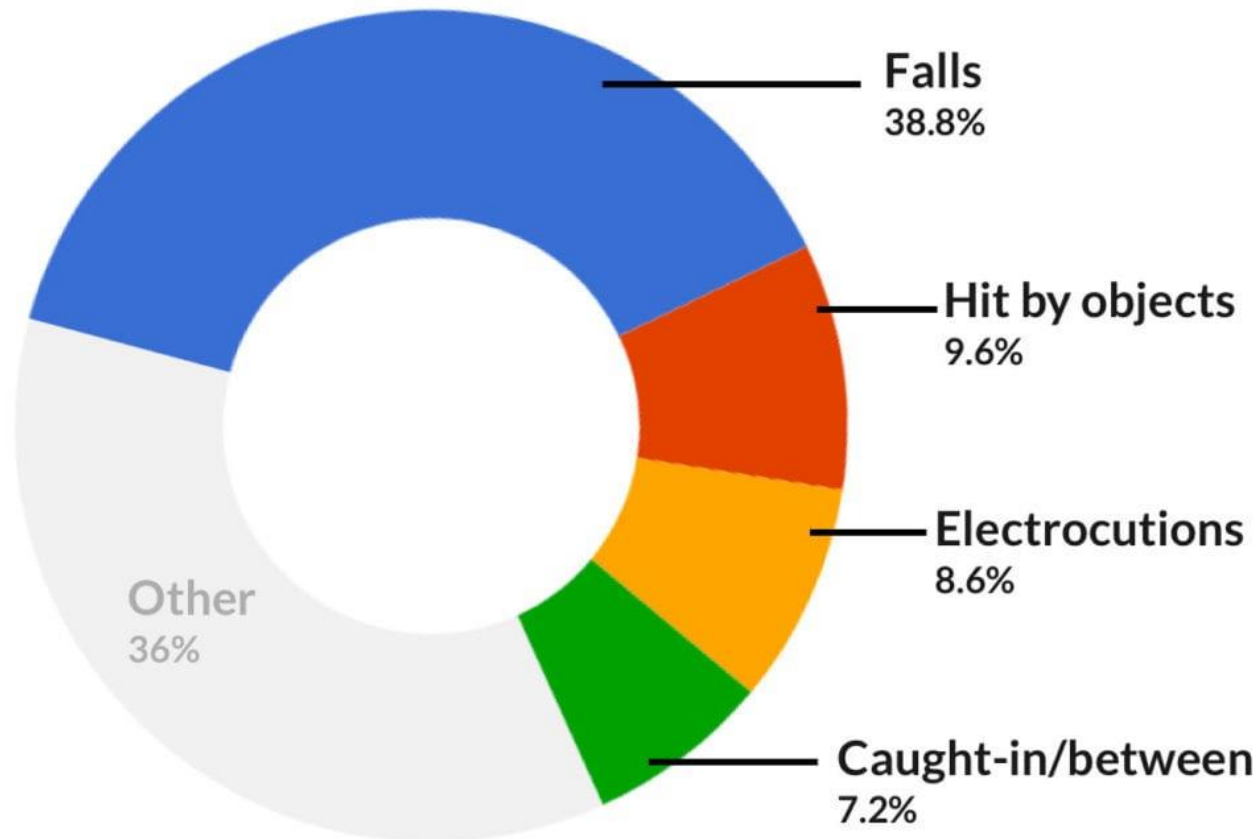
**Caught in or in
between an object**

**Together, these account for over 60 percent
of all construction-related deaths.**

Source: OSHA

Workplace Fatalities

Top Four Causes of Construction Site Fatalities



Out of 4,379 worker fatalities in private industry in calendar year 2015, 937 or 21.4% were in construction.
Data: OSHA Data & Statistics



**NUMBER OF CONTRIBUTORS IN EMPLOYMENT AND NUMBER OF WORK INJURY CASES SPLIT BY EST.
ECONOMIC ACTIVITY DURING 1432 H.**

| ECONOMIC ACTIVITY | NO. OF CASES | NO. OF CONTRIBUTORS | PROPORTION OF CASES TO THE TOTAL OF CONTRIBUTORS |
|-------------------------|--------------|---------------------|--|
| POST & COMMUNICATIONS | 1517 | 163,664 | 0.9 |
| TRADE | 19385 | 1,329,348 | 1.4 |
| CONSTRUCTION | 36367 | 2,174,962 | 1.6 |
| MINING & QUARRY | 985 | 123,543 | 0.7 |
| SOCIAL SERVICES | 1789 | 505,003 | 0.3 |
| AGRICULTURE & FISHING | 608 | 59,721 | 1.01 |
| MANUFACTURING | 11921 | 609,923 | 1.9 |
| ELECTRICITY & WATER | 1074 | 81,407 | 1.3 |
| FINANCING & REAL ESTATE | 2179 | 377,127 | 0.5 |
| OTHER | 0 | 1,727 | 0 |
| TOTAL | 75,825 | 5,426,425 | 1.3 |

General Organization for Social Insurance (GOSI 1432H)

NUMBER OF WORK INJURY CASES SPLIT BY EST. ECONOMIC ACTIVITY AND INJURY CAUSE DURING 1432 H.

| ECONOMIC ACTIVITY \ INJURY CAUSE | CAUGHT IN | STRUCK BY OR AGAINST | RUBBED OR ABRADED | FALLING DOWN | VEHICLE ACCIDENTS | BODY REACTION | CONTACT WITH RADIATION OR CAUSTICS | CONTACT WITH COLD OR HEAT | STRESS | OTHER | TOTAL | PERCENTAGE |
|----------------------------------|-----------|----------------------|-------------------|--------------|-------------------|---------------|------------------------------------|---------------------------|--------|-------|-------|------------|
| POST & COMMUNICATIONS | 18 | 383 | 134 | 496 | 165 | 46 | 11 | 14 | 12 | 238 | 1517 | 2.0 |
| TRADE | 103 | 4120 | 1498 | 4378 | 435 | 1046 | 78 | 221 | 819 | 6687 | 19385 | 25.5 |
| CONSTRUCTION | 324 | 11590 | 3779 | 10440 | 1264 | 1557 | 220 | 594 | 907 | 5692 | 36367 | 47.9 |
| MINING & QUARRY | 32 | 295 | 139 | 214 | 85 | 37 | 13 | 32 | 36 | 102 | 985 | 1.2 |
| SOCIAL SERVICES | 24 | 356 | 202 | 604 | 110 | 87 | 23 | 31 | 49 | 303 | 1789 | 2.3 |
| AGRICULTURE & FISHING | 9 | 153 | 38 | 204 | 54 | 31 | 9 | 8 | 3 | 99 | 608 | 0.8 |
| MANUFACTURING | 256 | 3414 | 1851 | 2464 | 373 | 556 | 183 | 325 | 181 | 2318 | 11921 | 15.7 |
| ELECTRICITY & WATER | 12 | 271 | 77 | 233 | 87 | 93 | 16 | 29 | 15 | 241 | 1074 | 1.4 |
| FINANCING & REAL ESTATE | 25 | 642 | 320 | 546 | 130 | 81 | 20 | 28 | 22 | 365 | 2179 | 2.8 |
| TOTAL | 803 | 21224 | 8038 | 19579 | 2703 | 3534 | 573 | 1282 | 2044 | 16045 | 75825 | |
| PERCENTAGE | 1.0 | 27.9 | 10.6 | 25.8 | 3.6 | 4.6 | 0.7 | 1.6 | 2.6 | 21.1 | 100.0 | |

General Organization for Social Insurance (GOSI 1432H)

19-1 IMPORTANCE OF SAFETY

- It has been reported that construction, which consists of about 5% of the U.S. work force, accounts for some:
 - 20% of work fatalities and
 - 12% of disabling injuries.
- The total annual cost (direct and indirect) of construction accidents has been estimated to exceed \$17 billion.
- In the United States, national concern over the frequency and extent of industrial accidents and health hazards led to the passage of the **Occupational Safety and Health Act of 1970**, which established specific safety and health requirements for virtually all industries, including construction.

19-1 IMPORTANCE OF SAFETY

- The Occupational Safety and Health Administration (OSHA) is responsible for **developing and enforcing regulations implementing this act (decree)**.
- the concern over OSHA regulations and penalties has tended to obscure the fact that there are at least **two other major reasons** for construction management to be seriously concerned about safety. These reasons are:
 - humanitarian and
 - financial.

19-1 IMPORTANCE OF SAFETY

- Everyone is understandably distressed when a fellow employee is killed or disabled, so the humanitarian basis for safety is apparent.
- many managers do not fully appreciate the financial consequences of accidents.
- **Worker's compensation insurance premiums**, for example, are based on a **firm's accident rate**.
- Public liability, property damage, and equipment insurance rates are also affected by accident rates.

19-1 IMPORTANCE OF SAFETY

- It has been shown that a construction firm can lose its **competitive bidding** position simply because of the effect of high insurance premiums resulting from a poor safety record.

19-1 IMPORTANCE OF SAFETY

- Other costs, which are difficult to estimate, that are associated with an accident include:
 - the monetary value of lost project time while the accident is investigated and damages are repaired,
 - the time required to replace critical materials and equipment and to train replacement workers,
 - the effect on those portions of the project not directly involved in the accident.

19-2 OSHA

- The U.S. Occupational Safety and Health Administration (OSHA) has produced a comprehensive set of :
 - safety and health regulations,
 - inspection procedures, and
 - record-keeping requirements.
- The law has also established both civil and criminal penalties for violations of OSHA regulations.
- Table 19-1 indicates the maximum penalty for major categories of violations.

TABLE 19-1: Maximum penalties under OSHA

| Administrative Proceedings | | |
|---|------------------------|-----------------------------|
| Violation | Maximum Penalty | |
| Willful or repeated | \$70,000/violation | |
| Routine or serious | \$7,000/violation | |
| Failing to correct cited violation | \$7,000/day | |
| Failing to post citation near the place where violation exists | \$7,000/violation | |
| Criminal Proceedings | | |
| Violation | Maximum Fine | Maximum Imprisonment |
| Killing, assaulting, or resisting OSHA officials | \$10,000 | Life |
| Willful violation resulting in death of employee, first conviction | 10,000 | 6 months |
| Willful violation resulting in death of employee, second conviction | 20,000 | 1 year |
| Falsifying required records | 10,000 | 6 months |
| Unauthorized advanced notice of inspection | 1,000 | 6 months |

19-2 OSHA

- As shown in Table 19-1, civil penalties of \$7000 per day may be assessed for failure to correct a cited violation.
- Under criminal proceedings, a fine of \$20,000 and imprisonment for 1 year may be adjudged for a second conviction of a violation resulting in the death of an employee.
- OSHA officials may also seek **a restraining order** through a U.S. District Court to stop work or take other action required to alleviate a condition identified as presenting imminent danger of serious injury or death.

-Record-keeping requirements.

- Under OSHA regulations employers are required to keep records of all work-related deaths, injuries, and illnesses.
 - It is not necessary to record minor injuries that require only first-aid treatment.
- all injuries involving :
 - medical treatment,
 - loss of consciousness,
 - restrictions on work or body motion, or
 - transfer to another job
 - must be recorded.
- A special report of serious accidents resulting in one or more deaths or the hospitalization of five or more employees must be made to OSHA officials within 48 hours.

- One of the major inequities of OSHA is that **only management may be penalized for safety violations.**
 - So, management may enforce safety regulations is to *discipline or fire workers engaging in unsafe acts.*
- It should be pointed out that **OSHA safety regulations are considered to be the minimum federal safety standards.**

19-3 SAFETY PROGRAMS

- All construction firms need a carefully planned and directed safety program to minimize accidents and ensure compliance with OSHA and other safety regulations.
- **no safety program** will be successful without the active **support of top management**.
- Job-site supervisors have traditionally neglected safety in their haste to get the job done on time and within budget.

19-3 SAFETY PROGRAMS

- Only when supervisors are convinced by higher management that safety is equally as important as production will the benefits of an effective safety program be achieved.
- An effective safety program must instill a **sense of safety consciousness** in every employee.

- some of the major elements of safety program are:
 1. A formal safety training program for all **new employees**.
 2. Periodic refresher training for each worker.
 3. A formal supervisory safety training program for all **supervisors**.
 4. A program of regular site visits by safety personnel to review and control job hazards.
 5. Provision of adequate personal protective equipment, first-aid equipment, and trained emergency personnel.
 6. An established procedure for the emergency evacuation of injured workers.
 7. Provisions for maintaining safety records and reporting accidents in compliance with OSHA requirements.

19-4 SAFETY PROCEDURES

- It has been found that most serious construction accidents involve:
 - construction equipment operations,
 - trench and embankment failure,
 - falls from elevated positions,
 - collapse of temporary structures and formwork, or
 - the failure of structures under construction.

<https://www.youtube.com/watch?v=WZrMK9lizfM>

<https://www.youtube.com/watch?v=veF4uSUtrEY>

19-4 SAFETY PROCEDURES

- **General**
- **Equipment Operations**
- **Construction Plant**
- **Excavations**
- **Construction of Structures**
- **Marine or Over-Water Construction**

General

- **Good housekeeping** on a project site is both a safety measure and an indicator of good project supervision.
- Lumber, used formwork, and other material lying around a work area increase the likelihood of falls and puncture wounds.

Equipment Operations

- Require operators and mechanics to use steps and hand holds when mounting equipment.
- Utilize guides or signalmen when the operator's visibility is limited or when there is danger to nearby workers.
 - Backup alarms or guides must be used when equipment operates in reverse.
- Exercise extreme caution and comply with safety regulations when operating near high-voltage lines.
 - In case of accidental contact with a high-voltage line, the operator should attempt to move the equipment enough to break contact.
 - If unsuccessful, the operator should remain on the equipment until the line can be deenergized.

Equipment Operations

- Make sure that machines are equipped with required safety features and that operators use seat belts when provided.
- Use care when operating equipment on side slopes to prevent overturning.
- When operating cranes, be extremely careful not to exceed **safe load limits** for the operating radius and boom position.
 - Electronic load indicators are available.
- Do not allow workers to ride on equipment unless proper seating is provided.

Equipment Operations

- Haul roads must be properly maintained.
 - Items to check include:
 - condition of the road surface (holes, slippery surface, excess dust),
 - visibility (curves, obstacles, intersections, and dust), and
 - adequate width for vehicles to pass (unless one-way).

Equipment Operations

- Park equipment with the brake set, blade or bowl grounded, and ignition key removed at the end of work.
 - Equipment used for land clearing must be equipped with overhead and rear canopy protection.
 - Workers engaged in clearing must be protected from the hazards of irritant and toxic plants and instructed in the first-aid treatment for such hazards.

Equipment Operations

- When hauling heavy or oversized loads on highways, make sure that loads are properly secured and covered if necessary.
 - Slow-moving and over-sized vehicles must use required markings and signals to warn other traffic.
- Take positive action to ensure that equipment under repair **cannot** be accidentally operated.

Equipment Operations

- Utilize blocking, cribbing, or other positive support when employees must work under heavy loads supported by cables, jacks, or hydraulic systems.
- Ensure that any guards or safety devices removed during equipment repair are promptly replaced.
- Shut down engines and do not allow smoking during refueling.

Construction Plant

- Set equipment containing hot or flammable fluids on firm foundations to prevent overturning.
 - Clearly mark high-temperature lines and containers to prevent burns.
 - Be especially careful of live steam.
 - Provide fire extinguishers and other required safety equipment.

Construction Plant

- Aggregate bins and batching plants should be emptied before performing major repairs.
- When electrical equipment is being repaired, shut off and tag electrical circuits.
- Ensure that wire rope and cable is of the proper size and strength, well maintained, and inspected at least weekly.

Excavations

- The location of underground utilities and other hazards must be determined before starting an excavation.
 - the contractor must employ detection equipment or other acceptable means to locate and avoid underground hazards.

Excavations

- The sides of excavations must be properly **shored or sloped** to the angle of repose to prevent cave-ins.
 - **OSHA regulations require that banks over 5 ft (1.5 m)** must be shored, cut back to a stable slope, or otherwise protected.
 - Regulations also require that protective systems (sloping, benching, shoring, or shielding) for excavations over 20 ft (6.1 m) deep must be designed by a registered professional engineer.
- When workers are required to enter a trench excavation 4 ft (1.2192 m) or more in depth, a stairway, ladder, ramp, or other safe means of egress must be located in such a manner as to require no more than 25 ft (7.62 m) of lateral travel by any worker in the trench.

Excavations

- Avoid the operation of equipment near the top edge of an excavation because this increases the chance of slope failure.
 - The storage of materials near the top edge of an excavation, vibration, and the presence of water also increase the chance of slope failure.
 - When these conditions cannot be avoided, additional measures must be taken to increase slope stability.
 - If workers are required to enter the excavation, no spoil or other material may be stored within 2 ft (0.6 m) of the edge of the excavation.

Excavations

- Ensure that workers are not allowed under loads being handled by excavators or hoists.
- Watch out for buried lines and containers when excavating.
 - Possible hazards include toxic and flammable gases, electricity, and collapse of side slopes due to sudden release of liquids.
 - If a gas line is ruptured and catches fire, get personnel and flammable material away from the fire and have the gas turned off as quickly as possible.
 - Do not attempt to extinguish the fire because an accumulation of unburned gas poses a greater threat than does a fire.

Construction of Structures

- Properly guard all openings above ground level.
- Provide guard rails, safety lines, safety belts, and/or safety nets for workers on scaffolds or steelwork.
- Ensure that temporary structures are properly designed, constructed, and braced.

Construction of Structures

- Special caution should be exercised in high-rise concrete construction.
 - Forms must be of adequate strength and properly braced.
 - The rate of pour must be maintained at or below design limits.
 - Shoring and reshoring must be adequately braced and not removed until the concrete has developed the required strength.

Marine or Over-Water Construction

- Marine or over-water construction operations present all of the usual construction hazards plus additional hazards posed by the marine environment.
- These additional hazards include drowning, slippery surfaces, increased tripping and height hazards, as well as weather and wave action.
- Some of the major safety precautions that should be taken are listed below.
 - Unless workers can safely step onto vessels, a ramp or safe walkway must be provided.
 - Access ways must be adequately illuminated, free of obstructions, and located clear of suspended loads.

Marine or Over-Water Construction

- Working areas should have nonslip surfaces, be maintained clear of obstructions, and be equipped with adequate handrails.
- Workers on unguarded decks or surfaces over water must wear approved lifejackets or buoyant vests.
 - Life rings and a rescue boat must also be available.
 - Workers more than 25 ft (7.6 m) above a water surface must be protected by safety belts, safety nets, or similar protective equipment.

19-5 ENVIRONMENTAL HEALTH IN CONSTRUCTION

- Increased governmental interest in occupational safety has been accompanied by an increased concern for occupational health and environmental controls.
- The **major environmental health problems** encountered in construction consist of:
 - noise,
 - dust,
 - radiation (ionizing and nonionizing),
 - toxic materials,
 - heat, and
 - cold.

Noise

- OSHA construction safety and health regulations prescribe maximum noise levels to which workers may be exposed.
- **Permissible noise** levels are a **function of length of exposure** and range from **90 dBA** (decibels measured on the A-scale of a standard sound meter) for an 8-h exposure to **140 dBA** for impulse or impact noise.
- When a satisfactory noise level cannot be attained by engineering controls, personal ear protection must be provided.

Dust

- creating a safety hazard due to loss of **visibility,**
- dust may be responsible for a number of **lung diseases.**
- Silica dust and asbestos dust are particularly dangerous and produce specific lung diseases (asbestosis and silicosis).

Radiation

- **Ionizing** radiation is produced by X-ray equipment and by radioactive material.
- Such radiation may be present on the construction site when **X-raying welds, measuring soil density, or performing nondestructive materials testing.**
- Any use of such equipment must be accomplished by trained personnel in accordance with regulations of the Nuclear Regulatory Commission.
- **Nonionizing** radiation is produced by laser equipment and electronic microwave equipment. **Laser equipment** is coming into widespread use for **surveying** and for **alignment** of pipelines, tunnels, and structural members. Again, only well-trained employees should be permitted to operate such equipment.

Toxic Materials

- Construction workers may accidentally encounter toxic materials at any time, particularly on **reconstruction projects**.
- the most frequent hazards consist of buried utility lines and underground gases.

Heat

- Construction workers are often required to work under high-temperature conditions. Fortunately, the human body will **acclimate** itself to high-temperature conditions within a period of **7 to 10 days**. However, serious heat illness may result when workers are not properly acclimated and protected.

Cold

- Extreme cold-weather conditions, although not encountered as often as heat conditions, pose essentially opposite problems to those of hot-weather operations. The human body will acclimate itself to cold as it will to heat, but the **acclimation period for cold is much longer**. Medical effects of cold include frostbite, trenchfoot, and general hypothermia (reduction of the core body temperature).



Frostbite



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