CONCRETE OPERATIONS

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Introduction

Recognizing health and safety hazards is the most important element in preventing injury and death. The precaution implemented to prevent or reduce the hazard is vital.

The current direction in concrete construction related injuries is decreasing. This movement is due to increased awareness of the potential risks surrounding jobsites.

The concrete industry boasts one of the lower jobsite injury rates, although it is not necessarily the concrete that presents the greatest risk.

An understanding of the potential risks of concrete construction and proper training is necessary for limiting the number of concrete construction related injuries.

Every worker in concrete construction must be aware of safety. Any worker can call a halt to operations if conditions look unsafe. The ultimate safety of a construction project is the responsibility of everyone associated with the project.

- ❑ Owners are responsible for implementing a safety program and providing safety equipment.
- ❑ Managers are responsible for conducting safety training, planning jobs according to the safety program, and ensuring employees are adhering to safety standards.
- ❑ Superintendents and foremen must enforce the safety regulations and be prepared to halt unsafe actions.
- ❑ Workers must utilize safety training by recognizing hazards, wearing and using safety equipment, policing fellow workers, and reporting unsafe conditions.

Material Hazards

Cement comprises 7-15% of total concrete volume. As an alkaline material, wet cement is caustic, and can cause severe chemical burns to exposed skin and eyes.

Working with fresh concrete presents an obvious risk. It is important to always wear water-proof gloves, a long-sleeved shirt, full-length trousers, and proper eye protection.

When you have to stand in wet concrete, wear water-proof boots that are high enough to keep concrete from flowing into the boots.

Wash wet concrete, mortar, cement, or cement mixtures from your skin immediately. Flush eyes with clean water immediately after contact.

Indirect contact through clothing can be as serious as direct contact, so promptly rinse out wet concrete, mortar, cement or cement mixtures from clothing.

Always seek immediate medical attention if you have persistent or severe discomfort.

95% of cement particles are smaller than 45 μm (micrometer). Tobacco smoke is approximately 3 μm). The caustic nature of cement creates a danger from inhalation.

Workers opening bags or sacks of cement and cement products should always wear a dust mask in addition to their regular safety attire.

Machinery

Early-entry saws, concrete/masonry saws, cut-off saws, and power trowels pose a threat to appendages when used improperly.

Any sustained or sudden noise above 85 decibels emanating from machinery can be damaging to the ear.

Hydraulic jacks used in shoring, compressed air and hydraulic concrete pumps, belt conveyors, welding equipment, post-tensioning jacks, demolition devices, and other equipment also create potential hazards on a concrete construction site.

Tools

Sharp-edged trowels, hammers, chisels, utility knives, etc. can be dangerous when used carelessly or incorrectly.

Long-handled bullfloats, when used near utility wires, can be dangerous.

Height

The number one leading cause of construction related injuries and fatalities is attributed to falls from height. Sources of height associated with concrete construction include but are not limited to scaffolding, ladders, bucket-trucks, catwalks, elevated or wall forms, and elevated floors. Owners, managers, contractors, and laborers should be aware of specific height sources on a project as they are virtually unavoidable in construction.

Construction Practices

Certain practices associated with concrete construction contribute to risks. The use of cranes for lifting and placing concrete buckets, for tilt-up concrete panels, and for lifting precast members present hazards to the finishers and erectors.

Concrete pumping, hydro-demolition, or shotcreteing operations where high pressures are generated in hoses prompt safety concerns for the nozzlemen.

Reinforcement construction can demand heavy materials, protruding steel, oxyacetylene torches or welding equipment, and height sources, each of which introduces a safety hazard either singularly or in any combination.

Post-tensioning operations impart stresses nearly equal to the yield strength of prestressing tendons which can be 250,000 psi. Such forces are dangerous to jack operators or on looking personnel. Precast plants with heavy table forms, consolidation equipment, and curing rooms must follow safety procedures.

Jobsite Conditions

Cramped, confined projects or sections of a project, affect operations and safety. Locations exposed to traffic, utility wires, excavations, or hazardous materials can produce unsafe conditions. Even weather (ie: snow, ice, rain, standing water, heat) can result directly in injury or combine with another risk to inflict injury to workers.

Prevention

When potential hazards are considered and combined with preventive measures, the occurrence of work-related injuries and death can be significantly reduced.

Personal Protection

Hardhats and hearing protection are always necessary on a construction site when overhead hazards and loud or sustained noise is present. When working with cement, sand, or any other fine material, the use of a respirator is necessary.

Equipment Protection

All equipment should be properly maintained and equipped with manufacturer recommended safety devices. Disabling or removing safety devices is dangerous and should be avoided.

All unsafe or inoperable equipment should be marked as such to prevent further use of the equipment.

All workers should be trained and tested by the manager or superintendent before operating any equipment (from drills to backhoes). Knowledge of the hazards associated with specific equipment is the first line of defense against injury.

Jobsite Protection

Although anyone may recognize a safety hazard, it is the responsibility of the manager to provide a safe jobsite for workers. The manager or superintendent should ensure that potential hazards at the project site are identified and corrected or, at minimum, made known to employees.

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Vehicles operating within jobsite:

Employees engaged in site clearing shall be protected from hazards of irritant and toxic plants, dusts, and any hazardous materials. Employees should be suitably instructed in the first aid treatment available.

General requirements: All vehicles shall have a service brake system, an emergency brake system, and a parking brake system. These systems may use common components, and shall be maintained in operable condition.

- ❑ Whenever visibility conditions warrant additional light, all vehicles, or combinations of vehicles, in use shall be equipped with at least two headlights and two taillights in operable condition.
- ❑ All vehicles, or combination of vehicles, shall have brake lights in operable condition regardless of light conditions.
- ❑ All vehicles shall be equipped with an adequate audible warning device at the operator's station and in an operable condition.

No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

- ❑ The vehicle has a reverse signal alarm audible above the surrounding noise level or:
- ❑ The vehicle is backed up only when an observer signals that it is safe to do so.
- ❑ All vehicles with cabs shall be equipped with windshields and powered wipers. Cracked and broken glass shall be replaced. Vehicles operating in areas or under conditions that cause fogging or frosting of the windshields shall be equipped with operable defogging or defrosting devices.
- ❑ All haulage vehicles, whose pay load is loaded by means of cranes, power shovels, loaders, or similar equipment, shall have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.
- ❑ Tools and material shall be secured to prevent movement when transported in the same compartment with employees.
- ❑ Vehicles used to transport employees shall have seats firmly secured and adequate for the number of employees to be carried.
- ❑ Seat belts and anchorages meeting the requirements of 49 CFR Part 571 (Department of Transportation, Federal Motor Vehicle Safety Standards) shall be installed in all motor vehicles.
- ❑ Trucks with dump bodies shall be equipped with positive means of support, permanently attached, and capable of being locked in position to prevent accidental lowering of the body while maintenance or inspection work is being done.
- ❑ Operating levers controlling hoisting or dumping devices on haulage bodies shall be equipped with a latch or other device which will prevent accidental starting or tripping of the mechanism.
- ❑ Trip handles for tailgates of dump trucks shall be so arranged that, in dumping, the operator will be in the clear.
- ❑ All rubber-tired motor vehicle equipment manufactured on or after May 1, 1972, shall be equipped with fenders. All rubber-tired motor vehicle equipment manufactured before May 1, 1972, shall be equipped with fenders not later than May 1, 1973.
- ❑ Mud flaps may be used in lieu of fenders whenever motor vehicle equipment is not designed for fenders.
- ❑ All vehicles in use shall be checked at the beginning of each shift to assure that the following parts, equipment, and accessories are in safe operating condition and free of apparent damage that could cause failure while in use:
- ❑ Service brakes, including trailer brake connections; parking system (hand brake); emergency stopping system (brakes); tires; horn; steering mechanism; coupling devices; seat belts; operating controls; and safety devices. All defects shall be corrected before the vehicle is placed in service.

- These requirements also apply to equipment such as lights, reflectors, windshield wipers, defrosters, fire extinguishers, etc., where such equipment is necessary.

Earthmoving equipment

These rules apply to the following types of earthmoving equipment: scrapers, loaders, crawler or wheel tractors, bulldozers, off-highway trucks, graders, industrial tractors, and similar equipment. The promulgation of specific rules for compactors and rubber-tired "skid-steer" equipment is reserved pending consideration of standards currently being developed.

Seat belts: Seat belts shall be provided on all equipment and shall meet the requirements of the Society of Automotive Engineers, Seat Belts for Construction Equipment.

- Seat belts need not be provided for equipment which is designed only for standup operation.
- Seat belts need not be provided for equipment which does not have roll-over protective structure (ROPS) or adequate canopy protection.

Access roadways and grades: No employer shall move or cause to be moved construction equipment or vehicles upon any access roadway or grade unless the access roadway or grade is constructed and maintained to accommodate safely the movement of the equipment and vehicles involved.

Every emergency access ramp and berm used by an employer shall be constructed to restrain and control runaway vehicles.

Brakes: All earthmoving equipment mentioned shall have a service braking system capable of stopping and holding the equipment fully loaded.

Fenders: Pneumatic-tired earth-moving haulage equipment (trucks, scrapers, tractors, and trailing units) whose maximum speed exceeds 15 miles per hour, shall be equipped with fenders on all wheels to meet the requirements of Society of Automotive Engineers SAE J321a-1970, Fenders for Pneumatic-Tired Earthmoving Haulage Equipment.

- An employer may, of course, at any time seek to show under 1926.2, that the uncovered wheels present no hazard to personnel from flying materials.

Rollover protective structures (ROPS): All equipment used in site clearing operations shall be equipped with rollover guards.

In addition, rider-operated equipment shall be equipped with an overhead and rear canopy guard meeting the following requirements:

The overhead covering on this canopy structure shall be of not less than 1/8-inch steel plate or 1/4-inch woven wire mesh with openings no greater than 1 inch, or equivalent.

The opening in the rear of the canopy structure shall be covered with not less than 1/4-inch woven wire mesh with openings no greater than 1 inch.

Audible alarms: All bidirectional machines, such as rollers, compacters, front-end loaders, bulldozers, and similar equipment, shall be equipped with a horn, distinguishable from the surrounding noise level, which shall be operated as needed when the machine is moving in either direction. The horn shall be maintained in an operative condition.

- No employer shall permit earthmoving or compacting equipment which has an obstructed view to the rear to be used in reverse gear unless the equipment has in operation a reverse signal alarm distinguishable from the surrounding noise level or an employee signals that it is safe to do so.

Scissor points: Scissor points on all front-end loaders, which constitute a hazard to the operator during normal operation, shall be guarded.

Excavations and Trenching

- Find the location of all underground utilities by contacting the local utility locating service before digging.
- Keep workers away from digging equipment and never allow workers in an excavation when equipment is in use.

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- ❑ Keep workers from getting between equipment in use and other obstacles and machinery that can cause crushing hazards.
- ❑ Keep equipment and the excavated dirt (spoils pile) back 2 feet from the edge of the excavation.
- ❑ Have a competent person conduct daily inspections and correct any hazards before workers enter a trench or excavation.
- ❑ Provide workers a way to get into and out of a trench or excavation such as ladders and ramps. They must be within 25 feet of the worker.
- ❑ For excavations and utility trenches over 5 feet deep, use shoring, shields (trench boxes), benching, or slope back the sides. Unless soil analysis has been completed, the earth's slope must be at least 1½ feet horizontal to 1 vertical.
- ❑ Keep water out of trenches with a pump or drainage system, and inspect the area for soil movement and potential cave-ins.
- ❑ Keep drivers in the cab and workers away from dump trucks when dirt and other debris are being loaded into them. Don't allow workers under any load and train them to stay clear of the backs of vehicles.

Foundations: After the foundation walls are constructed, take special precautions to prevent injury from cave-ins in the area between the excavation wall and the foundation wall.

- ❑ The depth of the foundation/basement trench cannot exceed 7½ feet deep unless you provide other cave-in protection.
- ❑ Keep the horizontal width of the foundation trench at least 2 feet wide. Make sure no work activity vibrates the soil while workers are in the trench.
- ❑ Plan the foundation trench work to minimize the number of workers in the trench and the length of time they spend there.
- ❑ Inspect the trench regularly for changes in the stability of the earth (water, cracks, vibrations, spoils pile). Stop work if any potential for cave-in develops and fix the problem before work starts again.

Excavating is recognized as one of the most hazardous construction operations. Cave-ins are perhaps the most feared trenching hazard. But other potentially fatal hazards exist, including asphyxiation due to lack of oxygen in a confined space, inhalation of toxic fumes, drowning, etc. Electrocution or explosions can occur when workers contact underground utilities.

The following rules are to be followed at all times by all employees working on, in, or near excavations, as applicable:

Exposure to falling loads: No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped to provide adequate protection for the operator during loading and unloading operations.

Warning system for mobile equipment: When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

Exposure to vehicular traffic: Employees exposed to public vehicular traffic shall be provided with, and shall wear; warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

- ❑ ***Employees shall not work*** in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation.

The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

- ***Employees are not permitted*** under loads that are handled by lifting or digging equipment. Employees are not allowed to work in the excavation above other employees unless the lower level employees are adequately protected.
- ***Where oxygen deficiency*** (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists, or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.
- ***Adequate precautions*** shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.
- ***When controls are used*** that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.
- ***At least one copy*** of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.
- ***Guardrails are provided*** if there are walkways or bridges crossing over an excavation.
- ***Before temporary removal*** of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

Scope and Application of the Policy: This excavation policy applies to all open excavations made in the earth's surface.

- **A *trench*** is a narrow excavation made below the surface of the ground in which the depth is greater than the width — the width not exceeding 15 feet.
- **An *excavation*** is any man-made cut, cavity, trench, or depression in the earth's surface formed by earth removal. This can include excavations for anything from cellars to highways.

General Requirements: OSHA requires that workers in trenches and excavations be protected, and that safety and health programs address the variety of hazards they face. The following hazards cause the most trenching and excavation injuries:

- No Protective System
- Failure to Inspect Trench and Protective Systems
- Unsafe Spoil-Pile Placement
- Unsafe Access/Egress

No Protective System: All excavations are hazardous because they are inherently unstable. If they are restricted spaces they present the additional risks of oxygen depletion, toxic fumes, and water accumulation. If you are not using protective systems or equipment while working in trenches or excavations at your site, you are in danger of suffocating, inhaling toxic materials, fire, drowning, or being crushed by a cave-in.

Methods to Avoid Hazards: Pre-job planning is vital to accident-free trenching; safety cannot be improvised as work progresses. The following concerns must be addressed by a competent person:

- Evaluate soil conditions and select appropriate protective systems.

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- ❑ Construct protective systems in accordance with the standard requirements.
- ❑ Preplan; contact utilities (gas, electric) to locate underground lines, plan for traffic control if necessary, and determine proximity to structures that could affect choice of protective system.
- ❑ Test for low oxygen, hazardous fumes and toxic gases, especially when gasoline engine-driven equipment is running, or the dirt has been contaminated by leaking lines or storage tanks. Insure adequate ventilation or respiratory protection if necessary.
- ❑ Provide safe access into and out of the excavation.
- ❑ Provide appropriate protections if water accumulation is a problem.
- ❑ Inspect the site daily at the start of each shift, following a rainstorm, or after any other hazard-increasing event.
- ❑ Keep excavations open the minimum amount of time needed to complete operations.

Failure to Inspect Trench and Protective System: If trenches and excavations at your site are not inspected daily for evidence of possible cave-ins, hazardous atmospheres, failure of protective systems, or other unsafe conditions, you are in danger.

Methods to Avoid Hazards

Inspect excavations:

- ❑ Before construction begins.
- ❑ Daily before each shift.
- ❑ As needed throughout the shift.
- ❑ Following rainstorms or other hazard-increasing events (such as a vehicle or other equipment approaching the edge of an excavation).
- ❑ Inspections must be conducted by a competent person who:
- ❑ Has training in soil analysis.
- ❑ Has training in the use of protective systems.
- ❑ Is knowledgeable about the OSHA requirements.
- ❑ Has authority to immediately eliminate hazards.

Unsafe Spoil-Pile Placement: Excavated materials (spoils) at your site are hazardous if they are set too close to the edge of a trench/excavation. The weight of the spoils can cause a cave-in, or spoils and equipment can roll back on top of workers, causing serious injuries or death.

Methods to Avoid Hazards: ***Provide protection by one or more of the following:***

- ❑ Set spoils and equipment at least 2 feet back from the excavation.
- ❑ Use retaining devices, such as a trench box, which will extend above the top of the trench to prevent equipment and spoils from falling back into the excavation.
- ❑ Where the site does not permit a 2-foot set back, spoils may need to be temporarily hauled to another location.

Unsafe Access/Egress: To avoid fall injuries during normal entry and exit of a trench or excavation at your job site, ladders, stairways, or ramps are required. In some circumstances, when conditions in a trench or excavation become hazardous, survival may even depend on how quickly you can climb out.

Methods to Avoid Hazards

- ❑ Provide stairways, ladders, ramps, or other safe means of egress in all trenches that are 4 feet deep or more.
- ❑ Position means of egress within 25 lateral feet of workers.

- ❑ Structural ramps that are used solely for access or egress from excavations must be designed by a competent person.
- ❑ When two or more components form a ramp or runway, they must be connected to prevent displacement, and be of uniform thickness.
- ❑ Cleats or other means of connecting runway components must be attached in a way that would not cause tripping (e.g., to the bottom of the structure).
- ❑ Structural ramps used in place of steps must have a non-slip surface.
- ❑ Use earthen ramps as a means of egress only if a worker can walk them in an upright position, and only if they have been evaluated by a competent person.

Plan for Safety: Many on-the-job accidents are a direct result of inadequate initial planning. Correcting mistakes in shoring or sloping after work has begun slows the operation, adds to costs, and increases the possibility of an excavation failure (cave-in). Contractors must build safety into pre-bid planning. Developing safety checklists specific to each job will help accomplish this.

The following specific site conditions should be considered before preparing a bid:

- ❑ Traffic
- ❑ The Water Table
- ❑ Soil
- ❑ Surface and Groundwater
- ❑ Nearness of Structures and their Condition
- ❑ Overhead and Underground Utilities

The standard requires employers to determine the estimated location of utility installations (sewer, telephone, fuel, electric, water lines, or any other underground installations) that may be encountered during digging before opening an excavation. Allow two business days in advance of digging for locates. To find the exact location of underground installations, workers must use safe and acceptable means.

If such installations are exposed, OSHA regulations require that they be removed, protected, or properly supported. When all necessary, specific information about the job site is assembled, the contractor can determine the amount, kind, and cost of the safety equipment needed.

A careful inventory of safety items on hand should be made before deciding what additional material must be acquired. No matter how many trenching, shoring, and backfilling jobs have been done in the past, each job must be approached with great care and preparation.

Before Starting the Job

Before beginning work, employers must provide employees exposed to vehicular traffic with warning vests or other suitable garments marked with or made of reflectorized or high-visibility material and ensure that they wear them. Workers must also be instructed to remove or neutralize surface obstacles that may create hazards.

No employee should operate equipment without being properly trained and alert to potential hazards. In training and in the worksite safety and health program, it also is important to include procedures for fast notification and investigation of accidents.

On-the-Job Evaluation

The OSHA Standard requires that a competent person inspect excavations and adjacent areas at least daily for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. If these conditions are encountered, exposed employees must be removed from the hazardous area until necessary safety precautions have been taken. Inspections are also required after heavy rains or man-made events such as blasting that may increase the potential for hazards.

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Larger and more complex operations should have a full-time safety person who makes recommendations to improve implementation of the safety plan. In smaller operations, the safety person may be part-time and will usually be a supervisor.

Supervisors are the contractor's representatives on the job. They should conduct inspections, investigate accidents, anticipate hazards, and ensure that employees receive on-the-job safety and health training. They must also review and strengthen overall safety and health precautions to guard against potential hazards, get necessary worker cooperation in safety matters, and report frequently to the contractor.

Managers and supervisors must set the example for safety at the job site. When visiting job sites, all managers must wear prescribed personal protective equipment such as safety shoes, safety glasses, hardhats, and other necessary gear.

Employees must also take an active role in job safety. The contractor and supervisor must make certain that workers have been properly trained in the use and fit of protective gear and equipment, that they are wearing and using the equipment correctly, and that they are using safe work practices.

Cave-Ins and Protective Support Systems

Support systems: Excavation workers are exposed to many hazards, but the chief hazard is cave-ins. Employees must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

All deep excavations must be protected by a system designed by a registered professional engineer. Before any sloping, benching, or support system is selected, the excavation soil type must be classified by a competent person.

Designing or selecting a protective system can be complex because of the number of factors involved — soil classification, depth of cut, water content of soil, changes due to weather and climate, or other operations in the vicinity.

The OSHA Standard, however, provides four methods each for sloping and shoring, including the use of shields to provide the required level of protection against cave-ins.

One method of ensuring the safety and health of workers in an excavation is to slope the sides to an angle not steeper than 1½ H: 1V (34 degrees measured from the horizontal). These slopes must be excavated to form configurations that are in accordance with those for Type C soil. A slope of this gradation or less is considered safe for any type of soil.

A second design method, which can be applied for both sloping and shoring, involves using tabulated data such as tables and charts approved by a registered professional engineer. The data, its limitations, and the selection criteria must be in writing.

At least one copy of the information that includes the identity of the registered professional engineer who approved the data must be kept at the worksite during construction of the protective system. Upon completion of the system, the data may be stored away from the site, but a copy must be made available, upon request, to OSHA.

Contractors may also use a trench box or shield designed or approved by a registered professional engineer or based on tabulated data prepared or approved by such an engineer. Timber, aluminum, or other suitable materials may also be used. OSHA permits the use of a trench shield as long as the protection it provides is equal to or greater than the protection that would be provided by the appropriate shoring system.

Employers are free to choose the most practical option for the circumstances. Once an option has been selected, however, that system must meet required performance criteria.

Safety Precautions: OSHA requires employers to provide support systems such as shoring, bracing, or underpinning to ensure the stability of nearby structures such as buildings, walls, sidewalks, or pavements.

The Standard also prohibits excavation below the level of the base or footing of any foundation or retaining wall unless a support system such as underpinning is provided, the excavation is in stable rock, or a registered professional engineer determines that the structure is far enough away from the excavation that the excavation will not pose a hazard to employees.

Excavations under sidewalks and pavements are also prohibited unless an appropriately designed support system is provided, or another effective method is used.

Installation and Removal of Protective Systems

OSHA requires the following procedures for the protection of employees when installing support systems:

- ❑ Connect support system members securely
- ❑ Install support systems safely
- ❑ Never overload support system members
- ❑ Install other structural members to carry loads imposed on the support system when temporary removal of individual members is necessary

As soon as work is completed, the excavation should be backfilled as the protective system is dismantled. After the excavation has been cleared, workers should slowly remove the protective system from the bottom up, taking care to release members slowly.

Materials and Equipment: The employer is responsible for the safe condition of materials and equipment used for protective systems. Defective and damaged materials and equipment can result in the failure of a protective system and cause excavation hazards.

To avoid possible failure of a protective system, the employer must ensure that:

- ❑ Materials and equipment are free from damage or defect.
- ❑ Manufactured materials and equipment are used and maintained consistent with manufacturers' recommendations and in a way that prevents employee exposure to hazards.
- ❑ Materials and equipment damaged while in operation are examined by a competent person.

If materials and equipment are not safe for use, they must be removed from service. These materials cannot be returned to service without the evaluation and approval of a registered professional engineer.

Falls and Equipment: In addition to cave-in hazards and secondary hazards related to cave-ins, workers must be protected from other hazards during excavation-related work. These include exposure to falls, falling loads, and mobile equipment.

OSHA requires employers to take the following precautions:

- ❑ Keep materials or equipment that might fall or roll into an excavation at least two feet from the edge of excavations or use retaining devices, or both.
- ❑ Provide warning systems such as mobile equipment, barricades, hand or mechanical signals, or stop logs, to alert operators of the edge of an excavation. If possible, keep the grade away from the excavation.
- ❑ Provide scaling to remove loose rock or soil, or install protective barricades and other equivalent protection to protect employees from falling rock, soil, or materials.
- ❑ Prohibit employees from working on faces of sloped or benched excavations at levels above other employees unless employees at lower levels are properly protected from falling, rolling, or sliding material or equipment hazards.
- ❑ Prohibit employees under loads handled by lifting or digging equipment. To avoid being struck by any spillage or falling materials, require employees to stand away from a vehicle being loaded or unloaded.

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Operators may remain inside a vehicle if the cab of the vehicle provides adequate protection from falling loads during loading and unloading operation.

Water Accumulation: Employees shall not be permitted to work in excavations where water has built up or is building. If water removal equipment is used to control or prevent water from accumulating equipment operations must be monitored by a competent person to ensure proper use.

Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. A competent person must inspect excavations subject to runoffs from heavy rains.

Hazardous Atmospheres: A competent person must test excavations, or excavations where oxygen deficiency or a hazardous atmosphere exists or could reasonably be expected to exist, before employees may enter. If hazardous conditions exist, proper respiratory protection or ventilation must be provided. Controls used to reduce atmospheric contaminants to acceptable levels must be tested regularly.

Where adverse atmospheric conditions may exist or develop in an excavation, the employer must provide and ensure that emergency rescue equipment (e.g., breathing apparatus, a safety harness and line, basket stretcher, etc.) is readily available.

When an employee enters bell-bottom pier holes and similar deep and confined footing excavations, the employee must wear a harness with a lifeline. The lifeline must be securely attached to the harness and must be separate from any line used to handle materials. While the employee wearing the lifeline is in the excavation, an observer must ensure that the lifeline is working properly and maintain communication with the employee.

Access and Egress: Employers must provide safe access and egress to all excavations. When employees are in trench excavations the Standard requires adequate means of entry and exit (ladders, steps, ramps, or other safe means of access and egress) within 25 feet of lateral travel. Structural ramps used for employee access or egress must be designed by a competent person. If the ramps are used by vehicles, they must be designed by a competent person qualified in structural design. Also, structural members used for ramps or runways must be uniform in thickness and joined in a manner to prevent tripping or displacement.

Inspections: Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions.

An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

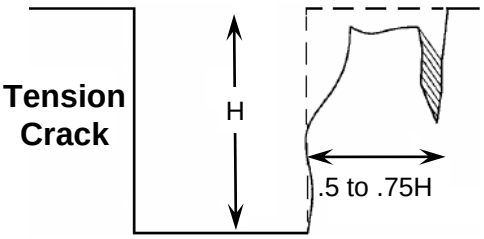
Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

An Overview of Soil Mechanics: The following information is intended to provide options when classifying soil, selecting employee protection methods, and recognition of trenching and shoring hazards and their prevention.

A number of stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can adversely affect the stability of a trench or excavation. The following diagrams show some of the more frequently identified causes of trench failure.

Tension Cracks

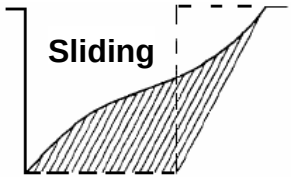
Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See the drawing for additional details.



Sliding

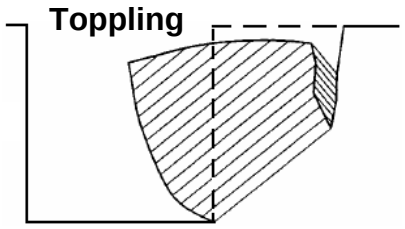
Sliding or sluffing may occur as a result of tension cracks.

The illustration shows sliding.



Toppling

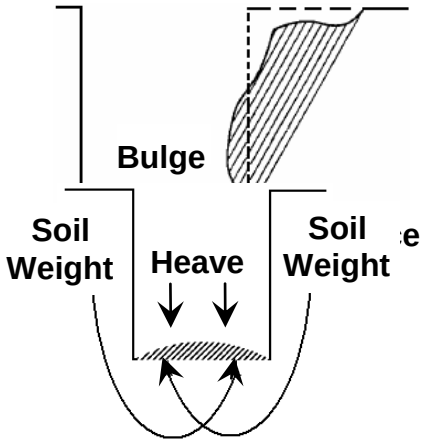
In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excexcavation.



Subsidence and Bulging

An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench.

If uncorrected, this condition can cause face failure and entrapment of workers in the trench.

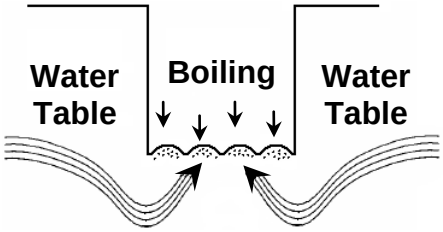


Heaving or Squeezing

Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

Boiling

Boiling is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.



Unit Weight of Soils refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh more than 3000 pounds.

Soil Type: OSHA categorizes soil and rock deposits into four types.

Stable Rock: Stable rock is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

Type A Soils: Type A soils are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils are often: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam.

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(No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, is part of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical (4H:1V) or greater, or has seeping water.

Type B Soils: Type B soils are cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of other Type B soils are: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).

Type C Soils: Type C soils are cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.

Layered Geological Strata: Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

Visual Test: A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration. During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions.

In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

Shoring Types: Shoring is the provision of a support system for trench faces used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. There are two basic types of shoring, timber and aluminum hydraulic.

Shoring systems consist of posts, wales, struts, and sheeting. The trend today is toward the use of hydraulic shoring, a prefabricated strut and/or wale system manufactured of aluminum or steel.

Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring. Other advantages of most hydraulic systems are that they:

- ❑ Are light enough to be installed by one worker.
- ❑ Are gauge-regulated to ensure even distribution of pressure along the trench line.
- ❑ Can have their trench faces "preloaded," to use the soil's natural cohesion to prevent movement.
- ❑ Can be adapted easily to various trench depths and widths.

All shoring should be installed from the top down and removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

Pneumatic Shoring: Pneumatic shoring works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure. A disadvantage to the use of pneumatic shoring is that an air compressor must be on site.

Screw Jacks: Screw jack systems differ from hydraulic and pneumatic systems in that the struts of a screw jack system must be adjusted manually. This creates a hazard because the worker is required to be in the trench in order to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their weight creates handling difficulties.

Single-Cylinder Hydraulic Shores: Shores of this type are generally used in a waler system, as an assist to timber shoring systems, and in shallow trenches where face stability is required.

Underpinning: This process involves stabilizing adjacent structures, foundations, and other intrusions that may have an impact on the excavation. As the term indicates, underpinning is a procedure in which the foundation is physically reinforced. Underpinning should be conducted only under the direction and with the approval of a registered professional engineer.

Shielding Types: Trench boxes are different from shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and similar incidents.

The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench boxes and the excavation side are backfilled to prevent lateral movement of the box. Shields may not be subjected to loads exceeding those which the system was designed to withstand.

Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching. The box should extend at least 18 inches above the surrounding area if there is sloping toward excavation. This can be accomplished by providing a benched area adjacent to the box.

Earth excavation to a depth of 2 feet below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of possible loss of soil from behind or below the bottom of the support system.

Conditions of this type require observation on the effects of bulging, heaving, and boiling as well as surcharging, vibration, adjacent structures, etc., on excavating below the bottom of a shield.

Careful visual inspection of the conditions mentioned above is the primary and most prudent approach to hazard identification and control.

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Sloping and Benching

Sloping

Maximum allowable slopes for excavations less than 20 feet based on soil type and angle to the horizontal are on the following table:

Soil Type	*Height to Depth Ratio*	*Slope Angle*
Stable Rock	Vertical	90°
Type A	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°
Type A (short-term)	½:1	63°
(For a maximum excavation depth of 12 feet)		

Benching

There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

As a general rule, the bottom vertical height of the trench must not exceed 4 feet for the first bench. Subsequent benches may be up to a maximum of 5 feet vertical in Type A soil and 4 feet in Type B soil to a total trench depth of 20 feet. All subsequent benches must be below the maximum allowable slope for that soil type. For Type B soil the trench excavation is permitted in cohesive soil only.

Spoil

Temporary Spoil: Temporary spoil must be placed no closer than 2 feet from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Spoil should be placed so that it cannot accidentally run, slide, or fall back into the excavation.

Permanent Spoil: Permanent spoil should be placed some distance from the excavation. Permanent spoil is often created where underpasses are built or utilities are buried.

The improper placement of permanent spoil, i.e., insufficient distance from the working excavation, can cause an excavation to be out of compliance with the horizontal to vertical ratio requirement for a particular excavation. This can usually be determined through visual observation. Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

Special Health and Safety Considerations

Competent Person: ***The designated competent person should have and be able to demonstrate the following:***

- ❑ Training, experience, and knowledge of:
- ❑ Soil analysis
- ❑ Use of protective systems
- ❑ Requirements of 29 CFR Part 1926 Subpart P

Ability to detect:

- ❑ Conditions that could result in cave-ins
    1) Failures in protective systems
    2) Hazardous atmospheres
    3) Other hazards including those associated with confined spaces
- ❑ Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

Surface Crossing of Trenches: Surface crossing of trenches should be discouraged; however, if trenches must be crossed, ***such crossings are permitted only under the following conditions:***

- ❑ Vehicle crossings must be designed by and installed under the supervision of a registered professional engineer.
- ❑ Walkways or bridges must be provided for foot traffic. ***These structures shall:***
    1) Have a safety factor of 4
    2) Have a minimum clear width of 20 inches
    3) Be fitted with standard rails
    4) Extend a minimum of 24 inches past the surface edge of the trench

Ingress and Egress: ***Access to and exit from the trench require:***

- ❑ Trenches 4 feet or more in depth should be provided with a fixed means of egress.
- ❑ Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 feet laterally to the nearest means of egress.
- ❑ Ladders must be secured and extend a minimum of 36 inches above the landing.
- ❑ Metal ladders should be used with caution, particularly when electric utilities are present.

Exposure to Vehicles: ***Procedures to protect employees from being injured or killed by vehicle traffic include:***

- ❑ Providing employees with and requiring them to wear warning vests or other suitable garments marked with or made of reflectorized or high-visibility materials.
- ❑ Requiring a designated, trained flagperson along with signs, signals, and barricades when necessary.

Exposure to Falling Loads: Employees must be protected from loads or objects falling from lifting or digging equipment. ***Procedures designed to ensure their protection include:***

- ❑ Employees are not permitted to work under raised loads.
- ❑ Employees are required to stand away from equipment that is being loaded or unloaded.
- ❑ Equipment operators or truck drivers may stay in their equipment during loading and unloading if the equipment is properly equipped with a cab shield or adequate canopy.

Warning Systems for Mobile Equipment: ***The following steps should be taken to prevent vehicles from accidentally falling into the trench:***

- ❑ Barricades must be installed where necessary.
- ❑ Hand or mechanical signals must be used as required.
- ❑ Stop logs must be installed if there is a danger of vehicles falling into the trench.
- ❑ Soil should be graded away from the excavation; this will assist in vehicle control and channeling of run-off water.

Hazardous Atmospheres and Confined Spaces

Employees shall not be permitted to work in hazardous and/or toxic atmospheres. Such atmospheres include those with:

- ❑ Less than 19.5% or more than 23.5% oxygen.
- ❑ A combustible gas concentration greater than 20% of the lower flammable limit.
- ❑ Concentrations of hazardous substances that exceed those specified in the Threshold Limit Values for airborne contaminants established by the ACGIH (American Conference of Governmental Industrial Hygienists).

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls (see Subpart D of 29

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CPR 1926) for personal protective equipment and for lifesaving equipment (see Subpart E, 29 CFR 1926).

Engineering controls (e.g., ventilation) and respiratory protection may be required.

Testing for Atmospheric Contaminants

- ❑ Testing should be conducted before employees enter the trench and should be done regularly to ensure that the trench remains safe. The frequency of testing should be increased if equipment is operating in the trench.
- ❑ Testing frequency should also be increased if welding, cutting, or burning is done in the trench.

Employees required to wear respiratory protection must be trained, fit-tested, and enrolled in a respiratory protection program.

Some trenches qualify as confined spaces. When this occurs, compliance with the Confined Space Standard is also required.

Emergency Rescue Equipment: Emergency rescue equipment is required when a hazardous atmosphere exists or can reasonably be expected to exist.

Requirements are as follows:

- ❑ Respirators must be of the type suitable for the exposure. Employees must be trained in their use and a respirator program must be instituted.
- ❑ Attended (at all times) lifelines must be provided when employees enter bell-bottom pier holes, deep confined spaces, or other similar hazards.
- ❑ Employees who enter confined spaces must be trained.

Standing Water and Water Accumulation: ***Methods for controlling standing water and water accumulation must be provided and should consist of the following if employees are permitted to work in the excavation:***

- ❑ Use of special support or shield systems approved by a registered professional engineer.
- ❑ Water removal equipment, i.e., well pointing, used and monitored by a competent person.
- ❑ Safety harnesses and lifelines used in conformance with 29 CFR 1926.104.
- ❑ Surface water diverted away from the trench.
- ❑ Employees removed from the trench during rain storms.
- ❑ Trenches carefully inspected by a competent person after each rain and before employees are permitted to re-enter the trench.

Inspections: Inspections shall be made by a competent person and should be documented. ***The following guide specifies the frequency and conditions requiring inspections:***

- ❑ Daily and before the start of each shift.
- ❑ As dictated by the work being done in the trench.
- ❑ After every rain storm.
- ❑ After other events that could increase hazards, e.g., snowstorm, windstorm, thaw, earthquake, etc.
- ❑ When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur.
- ❑ When there is a change in the size, location, or placement of the spoil pile.
- ❑ When there is any indication of change or movement in adjacent structures.

Trenching and excavation work presents serious risks to all workers involved. The greatest risk is that of a cave-in. When cave-ins occur, they are more likely to result in worker fatalities than other excavation-related accidents. Strict compliance with all sections of the standard will prevent or greatly reduce the risk of cave-ins as well as other excavation-related accidents.

Equipment and tools

General provisions

All equipment, material, and construction techniques used in concrete construction and masonry work should meet the applicable requirements for design, construction, inspection, testing, maintenance and operations as prescribed in ANSI A10.9-1970, Safety Requirements for Concrete Construction and Masonry Work.

Construction loads: No construction loads will be placed on a concrete structure or portion of a concrete structure unless the employer determines, based on information received from a person who is qualified in structural design, that the structure or portion of the structure is capable of supporting the loads.

Vertical loads: Vertical loads consist of a dead load plus an allowance for live load. The weight of formwork together with the weight of freshly placed concrete is dead load. The live load consists of the weight of workers, equipment, runways and impact, and must be computed in pounds per square foot (psf) of horizontal projection.

Lateral loads: Braces and shores must be designed to resist all foreseeable lateral loads such as wind, cable tensions, and inclined supports, impact of placement, and starting and stopping of equipment. The assumed value of load due to wind, impact of concrete, and equipment acting in any direction at each floor line shall not be less than one hundred pounds per lineal foot of floor edge or two percent of total dead load of the floor, whichever is greater. Wall forms must be designed for a minimum wind load of ten psf, and bracing for wall forms should be designed for a lateral load of at least one hundred pounds per lineal foot of wall, applied at the top. Walls of unusual height require special consideration.

Special loads: Formwork must be designed for all special conditions of construction likely to occur, such as unsymmetrical placement of concrete, impact of machine-delivered concrete, uplift, and concentrated loads. Form supports and wedges shall be checked during concrete placement to prevent distortion or failure.

Reinforcing steel: All protruding reinforcing steel, onto and into which employees could fall, is required to be guarded to eliminate the hazard of impalement.

Wire mesh rolls: Wire mesh rolls must be secured at each end to prevent dangerous recoiling action.

Guying: Reinforcing steel for walls, piers, columns, and similar vertical structures must be guyed and supported to prevent overturning and to prevent collapse.

Post-tensioning operations

- ❑ No employee (except those essential to the post-tensioning operations) shall be permitted to be behind the jack during tensioning operations.
- ❑ Signs and barriers are required to be erected to limit employee access to the post-tensioning area during tensioning operations.

Working under loads

- ❑ No employee shall be permitted to work under concrete buckets while buckets are being elevated or lowered into position.
- ❑ To the extent practical, elevated concrete buckets must be routed so that no employee, (or the fewest number of employees), are exposed to the hazards associated with falling concrete buckets.

Personal protective equipment

- ❑ No employee shall be permitted to apply a cement, sand, and water mixture through a pneumatic hose unless the employee is wearing protective head and face equipment.
- ❑ No employee shall be permitted to place or tie reinforcing steel more than six feet (1.8 m) above any adjacent working surface unless the employee is protected by personal fall arrest systems, safety net systems, or positioning device systems.

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- ❑ Each employee on the face of formwork or reinforcing steel shall be protected from falling 6 feet (1.8m) or more to lower levels by personal fall arrest systems, safety net systems, or positioning device systems.

Safe walking surfaces on concrete structural members

- ❑ Structural members with studs, dowels, or shear connectors installed on the top side must not be used as a walkway and/or means of access unless such studs, dowels, or shear connectors are covered with suitable material and in such a manner as to provide a walking surface at least as stable and free of hazards as the top surface of the member would provide without attachments installed.

Note: For the purpose of this section, "stud" means all protruding metal attachments to structural members.

Bulk cement storage: Bulk storage bins, containers, and silos must be equipped with the following:

- ❑ Conical or tapered bottoms and mechanical or pneumatic means of starting the flow of material.
- ❑ No employee shall be permitted to enter storage facilities unless the ejection system has been shut down and locked out.
- ❑ Safety belts, harnesses, lanyards, lifelines or droplines, independently attached or attended, must be used properly.

Concrete mixers: Concrete mixers with one cubic yard (.8 m3) or larger loading skips are required to be equipped a mechanical device to clear the skip of materials and guardrails installed on each side of the skip.

Power concrete trowels: Powered and rotating type concrete troweling machines that are manually guided must be equipped with a control switch that will automatically shut off the power whenever the hands of the operator are removed from the equipment handles.

Concrete buggies: Concrete buggy handles must not extend beyond the wheels on either side of the buggy.

Note: Installation of knuckle guards on buggy handles is recommended.

Runways

- ❑ Runways are required to be constructed to carry the maximum contemplated load with a safety factor of four, have a smooth running surface, and be of sufficient width for two buggies to pass. Single runs to have a minimum width of forty-two inches with turnouts. Runways to have standard railings. Where motor driven concrete buggies are used, a minimum four inches by four inches wheel guard shall be securely fastened to outside edge of runways.
- ❑ All concrete buggy runways which are 12 inches or more above a work surface or floor, or ramps with more than 4 percent incline must be considered "elevated" runways.

Exception: Small jobs utilizing only one concrete buggy, or larger jobs utilizing a "one-way traffic pattern" may be exempt from the requirements for "turnouts" or for" sufficient width for two buggies to pass."

Exemption: Runways less than 12 inches above the floor or ground which are utilized by hard-powered buggies only, may be exempt from the requirements for guardrails and wheel guards.

Concrete buckets

- Concrete buckets equipped with hydraulic or pneumatic gates are required to have positive safety latches or similar safety devices installed to prevent premature or accidental dumping.
- Concrete buckets are required to be designed to prevent concrete from hanging up on top and the sides.
- Riding of concrete buckets for any purpose must be prohibited, and vibrator crews shall be kept out from under concrete buckets suspended from cranes or cableways.
- When discharging on a slope, the wheels of ready-mix trucks are required to be blocked and the brakes set to prevent movement.

Tremies: Sections of tremies and similar concrete conveyances must be secured with wire rope (or equivalent materials in addition to the regular couplings or connections).

Bull floats: Bull float handles, used where they might contact energized electrical conductors, are required to be constructed of nonconductive material or insulated with a nonconductive sheath whose electrical and mechanical characteristics provide the equivalent protection of a handle constructed of nonconductive material.

Lockout/tagout procedures: No employee shall be permitted to perform maintenance or repair activity on equipment (such as compressors, mixers, screens, or pumps used for concrete and masonry construction activities) where the inadvertent operation of the equipment could occur and cause injury, unless all potentially hazardous energy sources have been locked out and tagged.

Concrete finishing

- Scaffolds for use of cement finishers must comply with all scaffolding requirements.
- Where grinders, chippers, and other equipment is used which creates a thrust force while working on scaffolding, such scaffold must be securely tied to a structure or held in with weighted drop lines.
- Grinding and dressing operations carried on within closed rooms, stairwells, elevator shafts, etc., must be provided with forced air ventilation.
- Grinding machine operators are required to wear respirators whenever machines are in operation or where dust hazard exists.
- Eye protection must be worn by workers engaged in grinding, chipping, or sacking concrete.

Requirements for cast in place concrete

Requirements for formwork:

- Formwork must be designed, fabricated, erected, supported, braced, and maintained so that it will be capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.
- Formwork which is designed, fabricated, erected, supported, braced, and maintained will be deemed to meet all requirements.
- Any form, regardless of size, must be planned in every particular and designed and constructed with an adequate factor of safety.
- In addition to computable loading, additional form pressures may result from impact during concrete placement, sudden lowering of temperatures retarding the set and increasing the liquid head or static pressure, vibrations of the form or concrete, uneven stressing resulting from failure or weakening of form members, or impact from concrete buckets or placing equipment.
- As a result, an adequate factor of safety is required to offset these unpredictable conditions.
- The thoroughness of planning and design shall be governed by the size, complexity, and intended use of the form.

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- Formwork which is complex in nature or which will be subjected to unusually high concrete pressures must be designed or approved for use by an engineer or experienced form designer.
- Drawings or plans, including all revisions, for the jack layout, formwork (including shoring equipment), working decks, and scaffolds, shall be available at the jobsite.

Shoring and reshoring: All shoring equipment must be inspected prior to erection to determine that it is as specified in the shoring layout.

- A shoring layout must be prepared or approved by a person qualified to analyze the loadings and stresses which are induced during the construction process.
- A copy of the shoring layout is required to be available at the jobsite.
- The shoring layout shall include all details of the specification, including unusual conditions such as heavy beams, sloping areas, ramps, and cantilevered slabs, as well as plan and elevation views.
- Shoring equipment found to be damaged such that its strength is reduced to less than that required must not be used for shoring.
- Erected shoring equipment shall be inspected immediately prior to, during, and immediately after concrete placement.
- Upon inspection, shoring equipment that is found to be damaged or weakened must be immediately removed and replaced.
- The sills for shoring shall be sound, rigid, and capable of carrying the maximum intended load without settlement or displacement.
- All base plates, shore heads, extension devices, and adjustment screws must be in firm contact, and secured when necessary, with the foundation and the form.
- Eccentric loads on shore heads and similar members shall be prohibited unless these members have been designed for such loading.
- The minimum total design load for any shoring used in slab and beam structures must be not less than one hundred pounds per square foot for the combined live and dead load regardless of slab thickness; however, the minimum allowance for live load and formwork must be not less than twenty pounds per square foot in addition to the weight of the concrete.
- Additional allowance for live load shall be added for special conditions other than when placing concrete for standard-type slabs and beams.
- Shoring must also be designed to resist all foreseeable lateral loads such as wind, cable tensions, inclined supports, impact of placement, and starting and stopping of equipment.
- The assumed value of load due to wind, impact of concrete, and equipment acting in any direction at each floor line shall not be less than one hundred pounds per lineal foot of floor edge or two percent of total dead load of the floor, whichever is greater.
- When motorized carts are used, the design load is required to be increased twenty-five pounds per square foot.
- The design stresses for form lumber and timbers shall be within the tolerance of the grade, condition, and species of lumber used.
- The design stresses used for form lumber and timber must be shown on all drawings, specifications, and shoring layouts.
- All load-carrying timber members of scaffold framing shall be a minimum of 1500 f (stress grade) construction grade lumber. All dimensions are nominal sizes except that where rough sizes are noted, only rough or undressed lumber of the size specified shall satisfy minimum requirements.
- When shoring from soil, an engineer or other qualified person must determine that the soil is adequate to support the loads which are to be placed on it.

- Precautions must be taken so that weather conditions do not change the load-carrying conditions of the soil below the design minimum.
- When shoring from fill or when excessive earth disturbance has occurred, an engineer or other qualified person must supervise the compaction and reworking of the disturbed area and determine that it is capable of carrying the loads which are to be imposed upon it.
- Suitable sills are required to be used on a pan or grid dome floor or any other floor system involving voids where vertical shoring equipment could concentrate an excessive load on a thin concrete section.
- When temporary storage of reinforcing rods, material, or equipment on top of formwork becomes necessary, these areas must be sufficient to meet the loads.
- If any deviation in the shoring plan is necessary because of field conditions, the person who prepared the shoring layout must be consulted for approval of the actual field setup before concrete is placed.
- The shoring setup must be checked to insure that all details of the layout have been met.
- The completed shoring setup must be a homogenous unit or units and is required to have the specified bracing to give it lateral stability.
- The shoring setup must be checked to make certain that bracing specified in the shoring layout for lateral stability is in place.
- All vertical shoring equipment must be plumb. Maximum allowable deviation from the vertical is one eighth inch in three feet. If this tolerance is exceeded, the shoring equipment must not be used until readjusted within this limit.
- Upon inspection, shoring equipment that is found to be damaged or weakened must be immediately removed and replaced.
- Shoring equipment must not be released or removed until the approval of a qualified engineer has been received.
- Removal of shoring equipment must be planned so that the equipment which is still in place is not overloaded.
- Slabs or beams which are to be reshored should be allowed to take their actual permanent deflection before final adjustment of reshoring equipment is made.
- While the reshoring is underway, no construction loads are to be permitted on the partially-cured concrete.
- The allowable load on the supporting slab must not be exceeded when reshoring.
- The reshoring must be thoroughly checked to determine that it is properly placed and that it has the load capacity to support the areas that are being reshored.

Tubular welded frame shoring

- Metal tubular frames used for shoring must have allowable loads based on tests conducted according to the Recommended Procedure for Compression Testing of Scaffolds and Shores, of the Scaffolding & Shoring Institute.
- Design of shoring layouts must be based on allowable loads which were obtained using test procedures and on at least a two and one-half to one safety factor.
- All metal frame shoring equipment shall be inspected before erection.
- Metal frame shoring equipment and accessories must not be used if heavily rusted, bent, dented, rewelded, or having broken weldments or other defects.
- All locking devices on frames and braces must be in good working order, coupling pins must align the frame or panel legs, pivoted cross braces must have their center pivot in place, and all components are required to be in a condition similar to that of original manufacture.

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- When checking the erected shoring frames with the shoring layout, the spacing between towers and crossbrace spacing must not exceed that shown on the layout and all locking devices are required to be in the closed position.
- Devices for attaching the external lateral stability bracing must be securely fastened to the legs of the shoring frames.
- All base plates, shore heads, extension devices, or adjustment screws are required to be in firm contact with the footing sill and the form material, and shall be snug against the legs of the frames.
- Eccentric loads on shore heads and similar members must be prohibited unless the shore heads have been designed for such loading.
- When formwork is installed at an angle, or sloping, or when the surface shored from is sloping, the shoring must be designed for such loading.
- Adjustment screws shall not be adjusted to raise formwork after the concrete is in place.

Tube and coupler shoring

- Tube and coupler towers used for shoring must have allowable loads based on tests conducted according to the Recommended Procedure for Compression Testing of Scaffolds and Shores, of the Scaffolding & Shoring Institute.
- Design of shoring layouts must be based on working loads which were obtained using the test procedures on at least a two and one-half to one safety factor.
- All tube and coupler components must be inspected before being used.
- Tubes of shoring structures shall not be used if heavily rusted, bent, dented, or having other defects.
- Couplers (clamps) must not be used if deformed, broken, or having defective or missing threads on bolts, or other defects.
- The material used for the couplers (clamps) is required to be of a structural type such as drop-forged steel, malleable iron, or structural grade aluminum. Gray cast iron must not be used.
- When checking the erected shoring towers with the shoring layout, the spacing between posts must not exceed that shown on the layout, and all interlocking of tubular members and tightness of couplers should be checked.
- All base plates, shore heads, extension devices, or adjustment screws must be in firm contact with the footing sill and the form material, and shall be snug against the posts.
- Eccentric loads on shore heads and similar members must be prohibited unless the shore heads have been designed for such loading.
- Special precautions shall be taken when formwork is at angles, or sloping, or when the surface shored from is sloping.
- Adjustment screws must not be adjusted to raise formwork after the concrete is in place.

Single post shores

- When checking erected single post shores with the shoring layout, the spacing between shores in either direction must not exceed that shown on the layout, and all clamps, screws, pins, and all other components must be in the closed or engaged position.
- For stability, single post shores are required to be horizontally braced in both the longitudinal and transverse directions. Diagonal bracing must also be installed. Such bracing shall be installed as the shores are being erected.
- Devices which attach to the external lateral stability bracing must be securely fastened to the single post shores.

- All base plates or shore heads of single post shores must be in firm contact with the footing sill and the form material.
- Whenever single post shores are used in more than one tier, the layout must be designed and inspected by a structural engineer.
- Eccentric loads on shore heads must be prohibited unless the shore heads have been designed for such loading.
- When formwork is at an angle, or sloping, or when the surface shored from is sloping, the shoring is required to be designed for such loading.
- Adjustment of single post shores to raise formwork must not be made after concrete is in place.

Fabricated single post shores

- The clamp used for adjustable timber single post shores must have working load ratings based on tests conducted according to the standard test procedures for fabricated single post shores in Recommended Procedure for Compression Testing of Scaffolds and Shores, Scaffolding & Shoring Institute, 1967, and on at least a three to one safety factor.
- Shoring layouts are required to be made using working loads which were obtained using test procedures and on at least a three to one safety factor.
- All fabricated single post shores must be inspected before being used.
- Fabricated single post shores must not be used if heavily rusted, bent, dented, rewelded, or having broken weldments or other defects. If they contain timber, they must not be used if timber is split, cut, has sections removed, is rotted, or otherwise structurally damaged.
- All clamps, screws, pins, threads, and all other components are required to be in a condition similar to that of original manufacture.

Adjustable timber single post shores

- The clamp used for adjustable timber single post shores must have working load ratings based on tests conducted according to the standard test procedures for fabricated single post shores in Recommended Procedure for Compression Testing of Scaffolds and Shores, Scaffolding & Shoring Institute, 1967, and on at least a three to one safety factor.
- Timber used must have the safety factor and allowable working load for each grade and species as recommended in the Tables for wooden columns in the Wood Structural Design Data Book, National Forest Products Association, 1970.
- The shoring layout must be made using the allowable load obtained by using the test procedure for the clamp or Tables for timber.
- All timber and adjusting devices to be used for adjustable timber single post shores are required to be inspected before erection.
- Timber must not be used if it is split, cut, has sections removed, is rotted, or is otherwise structurally damaged.
- Adjusting devices shall not be used if heavily rusted, bent, dented, rewelded, or having broken weldments or other defects.
- All nails used to secure bracing on adjustable timber single post shores must be driven home and the point of the nail bent over.

Timber single post shores:

- Timber used as single post shores must have the safety factor and allowable working load for each grade and species as recommended in the Tables for wooden columns in the Wood Structural Design Data Book, National Forest Products Association, 1970.
- The shoring layout must be prepared by using working loads obtained by using the Tables referred to before.
- All timber to be used for single post shoring must be inspected before erection.

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- Timber must not be used if it is split, cut, has sections removed, is rotted, or is otherwise structurally damaged.
- All nails used to secure bracing on timber single post shores shall be driven home and the point of the nail bent over.

Tiered single post shores

Whenever single post shores are used one on top of another (tiered), the employer must comply with the following specific requirements in addition to the general requirements for formwork:

- The design of the shoring must be prepared by a qualified designer and the erected shoring shall be inspected by an engineer qualified in structural design.
- The single post shores are required to be vertically aligned.
- The single post shores must be spliced to prevent misalignment.
- The single post shores are required to be adequately braced in two mutually perpendicular directions at the splice level. Each tier must also be diagonally braced in the same two directions.
- Adjustment of single post shores to raise formwork must not be made after the placement of concrete.
- Reshoring must be erected, as the original forms and shores are removed, whenever the concrete is required to support loads in excess of its capacity.

Vertical slip forms

- Slip forms are required to be designed, constructed, and the form movement carried out, under the immediate supervision of a person or persons experienced in slip form design and operation. Drawings prepared by a qualified engineer, showing the jack layout, formwork, working decks, and scaffolding, must be available at the jobsite, and followed.
- The steel rods or pipe on which the jacks climb or by which the forms are lifted are required to be designed for this purpose. Such rods must be adequately braced where not encased in concrete.
- Forms must be designed to prevent excessive distortion of the structure during the jacking operation.
- All vertical slip forms must be provided with scaffolding or work platforms completely encircling the area of placement.
- Jacks and vertical supports must be positioned in such a manner that the loads do not exceed the rated capacity of the jacks.
- The jacks or other lifting devices are required to be provided with mechanical dogs or other automatic holding devices to support the slip forms whenever failure of the power supply or lifting mechanism occurs.
- The form structure must be maintained within all design tolerances specified for plumbness during the jacking operation.
- Lifting must proceed steadily and uniformly and must not exceed the predetermined safe rate of lift. A jacking system, which provides precise, simultaneous movement of the entire form in small preselected increments, is recommended for large structures.
- Workers placing reinforcing steel must comply with the requirements when working above the scaffold level.
- The total allowable load on slip form platforms is required to be determined by the design engineer and enforced by the field supervisor.
- Lateral and diagonal bracing of the forms must be provided to prevent excessive distortion of the structure during the sliding operation.
- While the slide is in operation, the form structure must be maintained in line and plumb.

- ❑ A field supervisor experienced in slip form construction is required to be present on the deck at all times.

Placing and removal of forms: When moved or raised by crane, cableway, A-frame, or similar mechanical device, forms must be securely attached to slings having a minimum safety factor of five. Use of No. 9 tie wire, fiber rope, and similar makeshift lashing shall be prohibited.

- ❑ Taglines are required to be used in moving panels or other large sections of forms by crane or hoist.
- ❑ All hoisting equipment, including hoisting cable used to raise and move forms must have a minimum safety factor incorporated in the manufacturer's design, and the manufacturer's recommended loading shall not be exceeded.
- ❑ Field-fabricated or shop-fabricated hoisting equipment must be designed or approved by a registered professional engineer, incorporating a minimum safety factor of five in its design. Panels and built-up form sections shall be equipped with metal hoisting brackets for attachment of slings.
- ❑ Forms intended for use where there is a free fall of over ten feet must be equipped with adequate scaffolding and guardrails, or employees working on the forms shall be protected from falls during forming and stripping operations.
- ❑ Vertical forms being raised or removed in sections must not be released until adequately braced or secured. Overhead forms shall not be released until adequately braced or secured.
- ❑ Workers or others at lower levels must be protected from falling materials. Appropriate warning signs shall be erected along walkways.
- ❑ Forms must not be removed until the concrete is cured. The concrete is required to be adequately set in order to permit safe removal of the forms, shoring, and bracing.
- ❑ Engineer's specifications and local building codes shall be adhered to in determining the length of time forms should remain in place following concrete placement. In addition, tests shall be made on field-cured concrete specimens in order to insure that concrete has obtained sufficient strength to safely support the load prior to removal of forms.

Precast concrete and tilt-up operations

- ❑ It must be the responsibility of the contractor to use accessories which are designed to be compatible.
- ❑ The design capacity of all lifting devices and accessories must be known. The devices and accessories with the appropriate capacity shall be used.
- ❑ Prior to pouring the panels of a tilt-up type construction job, a set of plans or job specifications, including lifting procedures, must be drawn up.
- ❑ These plans are required to be at the job site and made available upon request.
- ❑ Any changes made in the rigging procedure of a tilt-up panel or slab must provide the same degree of safety as required by the original plans.

The plans or specifications must contain the following information:

1) The type, size, and location of all lifting inserts.
2) The type, size, and location of all brace inserts or fittings for guy wires in each panel and floor or support.
3) The size of braces or guys to be used.
4) The compression strength which concrete panels must attain prior to being lifted.

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The following conditions must be included in the erection process and are required to be incorporated in the design plan:

- Braces and all associated components of the bracing system must be designed to incorporate a safety factor of one and one-half to resist any normal stresses to which they may be subjected, including normal high wind velocity pressures for the area.
- Precast concrete wall units, structural framing, and tilt-up wall panels are required to be adequately supported to prevent overturning and to prevent collapse until permanent connections are completed.
- Floor braces used to secure panel sections must be placed at an angle of not less than forty-five degrees or more than sixty degrees from horizontal when physically possible to install in this manner.
- The bracing on all panel sections shall be installed in such a manner as to prevent the panel from accidentally rotating.
- Each panel section not secured by other means must have a minimum of two braces. The braces must be installed in such a manner as to evenly distribute the load or guy wires, when properly installed, may be used in lieu of stiff leg braces.
- If braces are attached to a panel or slab by bolts tightened into inserts installed in holes drilled in concrete, the type of inserts used and method of installation must be such as to develop the required strength to be maintained for the bracing system.
- Inserts to be installed for lifting sections of tilt-up precast panels shall be designed mechanically to maintain a safety factor of three.
- Lifting inserts which are embedded or otherwise attached to precast concrete members, other than the tilt-up members, must be capable of supporting at least four times the maximum intended load applied or transmitted to them.
- The compression strength of the concrete shall be such that when the proper type, size, and amount of inserts are installed a minimum safety factor of two will be maintained.
- Lifting hardware must be capable of supporting at least five times the maximum intended load applied or transmitted to the lifting hardware.
- Lifting bolts or other lifting devices which have been bent, worn, or are defective are required to be discarded.
- The upper and lower sections of telescoping type braces must be secured by high tensile steel pins or bolts which provide adequate shear strength and which will positively secure against accidental removal.
- Manufactured products must not be altered in a manner which would reduce the safe working load to less than its original value.
- Inserts shall be positioned so that bolts, or lifting devices, when inserted, will be perpendicular to the face on which they are placed.

Design of the panels and layout of the pour must be made in such a manner so that when picking, the top of the panel will be away from the crane.

If this is not possible, the contractor must consult with a representative of the department and the crane company involved, determining the procedure to be followed in lifting and placing it in its permanent position, safely.

- Panels must be lifted and handled in such a manner that they will not strike the hoisting equipment, in case of failure.
- Physical stops shall be provided which will prevent the bottom edge of a panel being set from slipping off the edge of its supporting structure.
- Tilt-up panels must not be set when there is a possibility that wind velocity would create a hazardous condition.

- A qualified signalperson must be designated and must consult with the crane operator on lifting procedures prior to making the pick. The signalperson shall be located in such a position during the pick of the panel that they can observe both the crane operator and the employees working in the immediate area.
- During the lifting process, workers must keep clear of the under side of the panel.
- Persons not involved in the lifting process must be kept clear of the hazardous area near where panels are being raised, moved or placed.
- If braces must be removed temporarily during construction, other effective means shall be provided to safely support the panel during the interim period.
- Each panel is required to be properly braced or otherwise secured prior to removal of the hoisting equipment.
- Short panels or sections not otherwise supported by floor, footings, columns or other structure, shall be properly shored.

Requirements for lift-slab construction operations

- Lift-slab operations must be designed and planned by a registered professional engineer who has experience in lift-slab construction.
- Such plans and designs must be implemented by the employer and shall include detailed instructions and sketches indicating the prescribed method of erection.
- These plans and designs must also include provisions for ensuring lateral stability of the building/structure during construction.
- Jacks/lifting units must be marked to indicate their rated capacity as established by the manufacturer.
- Jacks/lifting units must not be loaded beyond their rated capacity as established by the manufacturer.
- Jacking equipment must be capable of supporting at least two and one-half times the load being lifted during jacking operations and the equipment shall not be overloaded. For the purpose of this provision, jacking equipment includes any load bearing component which is used to carry out the lifting operation(s).

Such equipment includes, but is not limited to, the following: Threaded rods, lifting attachments, lifting nuts, hook-up collars, T-caps, shearheads, columns, and footings.

- Jacks/lifting units shall be designed and installed so that they will neither lift nor continue to lift when they are loaded in excess of their rated capacity.
- Jacks/lifting units shall have a safety device installed which will cause the jacks/lifting units to support the load in any position in the event any jack/lifting unit malfunctions or losses [loses] its lifting ability.
- Jacking operations shall be synchronized in such a manner to ensure even and uniform lifting of the slab. During lifting, all points at which the slab is supported shall be kept within 1/2 inch of that needed to maintain the slab in a level position.
- If leveling is automatically controlled, a device shall be installed that will stop the operation when the ½ inch tolerance set forth is exceeded or where there is a malfunction in the jacking (lifting) system.
- If leveling is maintained by manual controls, such controls shall be located in a central location and attended by a competent person while lifting is in progress. The competent person must be experienced in the lifting operation and with the lifting equipment being used.
- The maximum number of manually controlled jacks/lifting units on one slab shall be limited to a number that will permit the operator to maintain the slab level within specified tolerances, but in no case shall that number exceed 14.
- No employee, except those essential to the jacking operation, shall be permitted in the building/structure while any jacking operation is taking place unless the

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building/structure has been reinforced sufficiently to ensure its integrity during erection.

- The phrase **"reinforced sufficiently to ensure its integrity"** means that a registered professional engineer, independent of the engineer who designed and planned the lifting operation, has determined from the plans that if there is a loss of support at any jack location, that loss will be confined to that location and the structure as a whole will remain stable.
    1) Under no circumstances, shall any employee who is not essential to the jacking operation be permitted immediately beneath a slab while it is being lifted.
    2) A jacking operation begins when a slab or group of slabs is lifted and ends when such slabs are secured (with either temporary connections or permanent connections).
- When making temporary connections to support slabs, wedges must be secured by tack welding, or an equivalent method of securing the wedges to prevent them from falling out of position. Lifting rods may not be released until the wedges at that column have been secured.
- All welding on temporary and permanent connections must be performed by a certified welder, familiar with the welding requirements specified in the plans and specifications for the lift-slab operation.
- Load transfer from jack/lifting units to building columns must not be executed unit the welds on the column shear plates (weld blocks) are cooled to air temperature.
- Jacks/lifting units shall be positively secured to building columns so that they do not become dislodged or dislocated.
- Equipment shall be designed and installed so that the lifting rods cannot slip out of position or the employer shall institute other measures, such as the use of locking or blocking devices, which will provide positive connection between the lifting rods and attachments and will prevent components from disengaging during lifting operations.

Nonmandatory lift-slab operations: Operations may require employees to be removed from the building/structure during jacking operations unless an independent registered professional engineer, other than the engineer who designed and planned the lifting operation, has determined that the building/structure has been sufficiently reinforced to insure the integrity of the building/structure.

One method to comply with this provision is for the employer to ensure that continuous bottom steel is provided in every slab and in both directions through every wall or column head area.

Column head area means the distance between lines that are one and one half times the thickness of the slab or drop panel. These lines are located outside opposite faces of the outer edges of the shearhead sections.

The amount of bottom steel must be established by assuming loss of support at a given lifting jack and then determining the steel necessary to carry, by catenary action over the span between surrounding supports, the slab service dead load plus any service dead and live loads likely to be acting on the slab during jacking.

The surrounding supports must be capable of resisting any additional load transferred to them as a result of the loss of support at the lifting jack considered.

Miscellaneous concrete construction

- Deadheads used in post tensioning of tendons must be the type that will increase the grip on the cable as the tension is increased.
- Proper means and equipment shall be used to prevent the over-tensioning of the tendons.
- Only qualified workers are required to perform this type work.

Prestressed and poststressed concrete operations

Anchor fitting: In utilizing anchor fittings for tensioned strands, the recommendations and instructions of the supplier concerning installation, maintenance, and replacement shall be followed.

- ❑ Tools and strand vices must be kept clean and in good repair.

Safety factor

1) Expendable strand deflection devices used to pretension concrete members must have a minimum safety factor of two.
2) Reusable strand deflection devices shall have a minimum safety factor of three.

Jacking operations

- ❑ During jacking operations of any tensioning element or group of tensioning elements, the anchors must be kept turned up close to the anchor plate.
- ❑ No one shall be permitted to stand in line or directly over the jacking equipment during tensioning operations.
- ❑ Employees shall not stand behind the jack during tensioning operations.

Jacking and pulling equipment: Pulling headers, bolts, and hydraulic rams are required to be frequently inspected for indication of fatigue, and the threads on bolts and nuts inspected for diminishing cross section.

Storage: Stressed members must be stored on a level base and adequately supported during storage and transportation to prevent tipping.

Rigging

- ❑ Stressed members must be handled at pick points specifically designated on the manufacturer's drawings.
- ❑ Stressed members shall be lifted with lifting devices recommended by the manufacturer or the engineer in charge.
- ❑ No one shall be allowed under stressed members during lifting and erection.

Masonry construction

A limited access zone must be established whenever a masonry wall is being constructed. The limited access zone shall conform to the following:

1) The limited access zone shall be established prior to the start of construction of the wall.
2) The limited access zone shall be equal to the height of the wall to be constructed plus four feet, and shall run the entire length of the wall.
3) The limited access zone shall be established on the side of the wall which will be unscaffolded.
4) The limited access zone shall be restricted to entry by employees actively engaged in constructing the wall. No other employees shall be permitted to enter the zone.
5) The limited access zone shall remain in place until the wall is adequately supported to prevent overturning and to prevent collapse unless the height of wall is over eight feet, in which case, the limited access zone shall remain in place until the requirements have been met.

- ❑ All masonry walls over eight feet in height shall be adequately braced to prevent overturning and to prevent collapse unless the wall is adequately supported so that it will not overturn or collapse.
- ❑ The bracing shall remain in place until permanent supporting elements of the structure are in place.
- ❑ Employees engaged in cutting or chipping shall wear suitable eye protection.
- ❑ Masonry saws shall be constructed, guarded and operated properly.

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- ❑ Persons charged with operation of derricks used for stone setting shall be qualified in that type of work.
- ❑ Stone shall be set directly on the wall by the derrick.
- ❑ Breast derricks when used in setting stone shall be secured against a slip or kick back and guyed with wire cables. Provide hold down line to prevent derrick from falling back.
- ❑ Stone cutters shall wear goggles while trimming stone or cutting holes.
- ❑ Pins shall be tested for security before stone is hoisted.
- ❑ Hoisting cables shall be protected from chafing and wearing over corners.
- ❑ Mason's mortar mixers shall have a bar-type grill installed over the mixer opening. The guard shall be installed with an automatic disconnect switch to stop the mixer tub rotation and prevent the mixer from starting whenever the guard is not in place.

Hand tools: Sharp-edged trowels, hammers, chisels, utility knives

Maintain all hand tools and equipment in a safe condition and check them regularly for defects. Remove broken or damaged tools and equipment from the jobsite.

- ❑ Use double insulated tools, or ensure that the tools are grounded.
- ❑ Keep cutting tools sharp. Wear gloves to protect the hands.
- ❑ Make sure guards are in place before using power saws.
- ❑ Keep hand tools in a tool belt or toolbox. When hand tools are worn down or worn out, replace them.
- ❑ Do not use impact tools with mushroomed heads. Replace them.
- ❑ Keep wooden handles free of splinters or cracks and be sure the handles stay tight in the tool.
- ❑ Workers using powder-activated tools must receive proper training prior to using the tools.
- ❑ Always be sure that hose connections are secure when using pneumatic tools.
- ❑ Never leave cartridges for pneumatic or powder-actuated tools unattended.
- ❑ Keep equipment in a safe place, according to the manufacturer's instructions.
- ❑ Require proper eye protection for workers.

Stairways and ladders

- ❑ Install permanent or temporary guardrails on stairs.
- ❑ Do not store materials on stairways that are used for general access.
- ❑ Keep hazardous projections such as protruding nails, large splinters, etc. out of the stairs, treads, or handrails.
- ❑ Correct any slippery conditions on stairways before they are used.
- ❑ Inspect ladders before use for broken rungs or other defects so falls do not happen. Discard or repair defective ladders.
- ❑ Secure ladders near the top or at the bottom to prevent them from slipping.
- ❑ When you cannot tie the ladder off, be sure the ladder is on a stable and level surface so it cannot be knocked over or the bottom of it kicked out.
- ❑ Place ladders at the proper angle (1 foot out from the base for every 4 feet of vertical rise.
- ❑ Extend ladders at least 3 feet above the landing to provide a handhold or for balance when getting on and off the ladder from other surfaces.
- ❑ Do not set up a ladder near passageways or high traffic areas.
- ❑ Use ladders only for what they were made and not as a platform, runway, or as scaffold planks.
- ❑ Always face the ladder and maintain 3 points of contact when climbing a ladder.

Mobile equipment and crane

- ❑ Train workers to stay clear of backing and turning vehicles and equipment with rotating cabs.
- ❑ Be sure that all off-road equipment used on site is equipped with rollover protection (ROPS).
- ❑ Maintain back-up alarms for equipment with limited rear view or use someone to help guide them back.
- ❑ Be sure that all vehicles have fully operational braking systems and brake lights.
- ❑ Use seat belts when transporting workers in motor and construction vehicles.
- ❑ Wear high visibility traffic vests when working near roadways.
- ❑ Use flaggers and barricades to keep traffic away from workers.
- ❑ Post warning signs to alert all pedestrian traffic to stay away from job site.
- ❑ Know the rated capacity of the crane and use accordingly.
- ❑ Ensure the stability of the crane. Know crane hand signals.
- ❑ Use a tag line to control materials moved by a crane.
- ❑ Verify experience or provide training to crane and heavy equipment operators.

Handling rebar

- ❑ Cut rebar will always have sharp chisel ends which can cause lacerations and puncture wounds. Rebar often has scale, rust, or burs which can cause abrasions or lacerations. Wear proper personal protective equipment such as heavy leather gloves when working with rebar.
- ❑ When manually bending rebar, make sure you have a firm footing, and a firm grip on the bar. Do not place your entire weight on the bar being bent, to prevent falling, if the bar should slip or break.
- ❑ Use mechanical hoists or lifts to handle heavy bundles of rebar.
- ❑ When carrying full lengths of rebar, lift the load forward of center, letting the trailing end drag, if necessary, to prevent the front end from whipping and possibly catching on the ground, coworkers, or other objects.

Welding and Cutting:

- ❑ Perform Safety Check on all equipment.
- ❑ Ensure tanks have gas and fittings are tight.
- ❑ Ensure fire extinguisher is charged and available.
- ❑ Inspect hoses for defects.
- ❑ Ensure PPE (welding hood, gloves, rubber boots/soled shoes, and aprons) are available and have no defects.
- ❑ All defective equipment must be repaired or replaced before use.
- ❑ Remove flammables and combustibles
- ❑ No welding is permitted on or near containers of flammable material, combustible material or unprotected flammable structures.
- ❑ Place welding screen or suitable barricade around work area to provide a fire safety zone and prevent injuries to passersby (do not block emergency exits or restrict ventilation).
- ❑ Use an authorized Air Filtering Respirator, if required.
- ❑ Ensure adequate ventilation and lighting.
- ❑ Execute Hot Work Permit procedures.
- ❑ Open valves on oxygen and gas tanks to desired flow.
- ❑ Shut tank valves and relieve hose pressure. Store hoses.
- ❑ Maintain fire watch for one hour after welding and until all welds have cooled.
- ❑ Perform final fire watch and terminate permit.

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Fall-protection for rebar and concrete formwork

Workers on the face of formwork or reinforcing steel are required to use fall protection if they are six feet or more above a lower level. Workers and employers can choose from among the following types of fall protection: personal fall-arrest systems, safety nets, or positioning-device systems.

Personal fall-arrest systems: Personal fall-arrest systems are designed to stop a worker from free falling to a lower level. A personal fall arrest system consists of an anchorage, connectors, and a full body harness.

- Other system components may include a lanyard, a lifeline, and a deceleration device. These components must be used only for fall protection and not for any other purpose.
- If the system, or any system component, is subjected to a fall, it must be immediately removed from service and cannot be used again until a ***competent person*** determines it is undamaged.

Competent person: A competent person is capable of identifying existing and predictable hazards in the work environment and who has authorization to take prompt measures to eliminate the hazards.

- Use a personal fall-arrest system as fall protection when you are constructing standard forms or doing dismantling work, exterior building work, or erecting precast concrete members.

Safety-net systems: Safety-net systems consist of mesh nets, panels, connectors, and other impact-absorbing components. Use safety nets as fall protection for doing standard formwork, slipform work, and erecting precast concrete members.

Positioning-device systems: Positioning-device systems are the most appropriate type of personal fall-protection for working on and placing rebar. A positioning-device system enables one person to work on a vertical surface with both hands free and it limits free-fall distance to two feet or less.

- The difference between a positioning device system and a personal fall-arrest system is that a positioning-device system supports a worker on an elevated surface and limits a fall to two feet.
- A personal fall arrest system, on the other hand, prevents a worker from free falling more than six feet.

The major components of a positioning-device system are:

Body support: a body belt or full body harness.

Connectors and connecting assemblies: a chain/ web rebar assembly or rope/web lanyard, snaphooks, and D-rings.

Anchorage connector: a carabiner or snaphook.

Anchorage: a rebar or other support structure.

Positioning-device systems must meet the following requirements:

Body support: A body belt must limit the maximum arrest force on a worker to 900 pounds and cannot be used for any purpose other than personal fall protection. A body harness must limit the maximum arrest force to 1,800 pounds and must be used only for fall protection.

- Make sure the body belt or harness has side D-rings, or a single front D-ring for positioning. (Rear D-rings are for fall arrest only.)
- Use a body belt or full body harness that is properly fitted; belts and harnesses come in different sizes. Body belts must not ride up and compress the rib cage.

Connectors and connecting assemblies: Connecting assemblies must have a minimum tensile strength of 5,000 pounds. Snaphooks and D-rings must be proof-tested to a minimum tensile load of 3,600 pounds without cracking, deforming, or breaking.

- ❑ They must be made of drop-forged steel or equivalent materials, the finish must be corrosion-resistant, and the surfaces smooth. The dimensions of snaphooks must be compatible with the members to which they are connected or the snaphooks must be of the double-locking type to prevent roll out.

Anchorage: Positioning-device systems must be secured to an anchorage that can support at least twice the potential impact load of a worker's fall or 3,000 pounds, whichever is greater.

- ❑ Be sure to inspect positioning device systems for wear, damage, or deterioration before using them. Remove defective components from service.

Climbing rebar: Workers may free-climb concrete forms and rebar to reach work areas. The maximum free-climbing height is 24 feet. The horizontal bars must be spaced not less than six inches, or more than 16 inches on center.

- ❑ When rebar spacing is more than 16 inches on center, use a ladder or lift to reach work areas. Upon reaching a work area, you must use a personal fall-arrest system, safety net, or positioning-device system for fall protection.
- ❑ Check the rebar's rigidity before climbing it. If it's not rigid, brace it to meet the required 3,000-pound anchor load requirement.
- ❑ Avoid climbing overhanging rebar or forms. This type of climbing increases your risk of falling and overexerting your muscles and joints.
- ❑ If you have to work on overhanging objects, use a powered elevated lift or ladder.

Capping rebar: Whenever you work above rebar that protrudes from the floor, cover the rebar with protective caps that will prevent you from being impaled if you fall. Cap rebar protruding horizontally to prevent scrapes, cuts, or eye injuries.

Standard formwork: When you work on standard forms more than six feet above a lower level, you must use appropriate fall protection (personal fall-arrest, safety-net, or positioning-device systems) or work from a platform such as a carpenter bracket scaffold. Railings on work platforms must be 42+3 inches high. Include midrails and toeboards if people are working below.

- ❑ When you climb standard forms with walers or cross-ties to gain access to a work area, make sure the climbing members are no more than 16 inches apart. Use a ladder or lift to reach the work area if the climbing members are spaced more than 16 inches apart. Ladder rungs must offer reliable footing. Tie off an unstable ladder so that it is anchored at the access to the work area and at the ladder's base.

Note: Walers have depths ranging from 1 1/2 inches to 3 1/2 inches. The smaller walers do not offer much toehold. Use caution when you climb walers with narrow depths.

- ❑ If you are doing dismantling or erecting work outside protective guardrails, you must use a personal fall-arrest system.
- ❑ When rebar protrudes from wall forms that you are dismantling, you may tie off to the exposed rebar if it's strong enough and if you can't slide off the end. A number three, grade 60, bar (0.375-inches diameter) has ultimate shear strength of about 6,000 pounds. A number-four grade 60 bar (0.500 in diameter) has a shear strength of 8,000 pounds.
- ❑ Do not walk, sit, or stand on top of wall forms.

Slipforms: Workers using slipforms are usually protected from falls by safety-net systems or catch platforms attached to the forms by carpenter brackets. Special hooks that anchor directly to slipforms are available, too. Follow the manufacturer's recommendations and instructions if you use these hooks.

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CONCRETE OPERATIONS

Tilt-up work: ***When doing tilt-up work:***

1) Make sure wall anchors are cast in the wall when it is formed on the ground.
2) Attach braces to the wall before the lift.
3) Install appropriately sized bolts and shackles to do the lift.
4) After the wall is tilted into place, secure the braces at an appropriate angle before the lifting cables are released.
5) Stand clear of the wall and out of its drop zone until it is securely braced.
6) Use appropriate fall-protection equipment to walk or straddle upper wall areas.
7) Use ladders to gain access to the upper wall area.

Precast concrete: When you erect precast concrete members such as wall panels and columns, or do related work such as grouting precast members and you are six feet or more above a lower level: you must be protected from falling by one of the following methods:

1) Guardrail systems
2) Safety-net systems
3) Personal fall-arrest systems
4) A written fall protection plan and a controlled-access zone.

A fall protection plan allows workers doing precast concrete erection work to use alternative fall-protection systems or methods when conventional systems are infeasible. However, the employer must be able to show that conventional systems aren't practical or that they pose a greater safety hazard to workers than other alternatives.
Employers must make sure these plans meet other requirements as well.
A controlled-access zone is created by erecting a control line, or lines, to restrict access to a work area. The control line warns others that access to the zone is limited to authorized workers. You must have a safety monitor to warn workers of fall hazards within the controlled-access zone.

Exterior building work: If you work on an unguarded surface or an exterior wall six or more feet above a lower level, you must use ladders, lifts, or appropriate fall protection (such as a personal fall-arrest system, safety-net system, or positioning-device system).

Ladders: Falls from ladders occur frequently among workers doing rebar and exterior building work. Most ladder falls involve portable ladders that move, tilt, or shift while a worker is climbing or descending.

Keep in mind the following points when using a ladder:

1) If the ladder is not stable, tie it off (at the top and bottom) before climbing it.
2) Stay within the side rails when climbing or working from a ladder. You can reach out from a ladder, but your torso must remain within the side rails.
3) Face the ladder when climbing or descending it. Don't try to carry objects that could cause you to lose your balance. Keep hands free to grasp the ladder.

Protective equipment: When working with concrete, wear protective clothing and equipment appropriate for the task.

Important items are gloves, safety glasses, leather work shoes, and a hard hat.

Training: Employers must be aware of workplace fall hazards and take appropriate action to eliminate or minimize those hazards. They should select appropriate fall protection for a particular area or operation and train workers to use it correctly. Employers are required to provide training for all workers exposed to fall hazards. The training must be provided by a competent person and should ensure that workers can:

1) Recognize fall hazards in their work area.
2) Use appropriate procedures to minimize their exposure to fall hazards.

Workers who use or intend to use a personal fall-arrest system also should know:

1) How to inspect the equipment before they use it.
2) How to wear the equipment.
3) Proper hook-up and attachment methods for the equipment.
4) Anchoring and tie-off techniques appropriate for the work.
5) How to estimate free-fall distances.
6) Equipment care and storage procedures.
7) Rescue procedures and techniques.

Retraining: Workers who do not recognize fall hazards at a particular work area must be retrained. Workers may need retraining because of changes at a worksite that make earlier training obsolete, changes in the types of fall-protection equipment used, and failure to demonstrate skills for using fall-protection equipment effectively.

Training records: Employers must maintain a written record for each worker who has received fall-protection training. The record must document the worker's name, the date the worker was trained, and the trainer's signature. Below is an example of a training record that documents a worker's ongoing fall protection training.

Emergencies: Fall-protection systems are designed to minimize workers' exposure to fall hazards and to reduce their risk of injury if they do fall. However, employers are responsible for establishing procedures to ensure that workers who do fall receive prompt emergency and medical attention. Emergency procedures should identify key rescue and medical personnel, equipment available for rescue, emergency communications procedures, retrieval methods, and primary first-aid requirements. Employers should also establish rescue procedures for personal fall-arrest systems before workers use the systems.

NOTE: Workers in 911 service areas can use the 911 number for ambulance service; however, most 911 responders are not trained to rescue an injured worker suspended in a personal fall-arrest system. Rescue procedures must assure prompt rescue of a suspended worker. The 911 number does not ensure prompt rescue.

Use the guidelines below to develop your own emergency-response procedures.

Before on-site work begins

1) Make fire department or emergency-response units aware of the job specifications at the site and any factors that may slow response time.
2) Document the rescue plan and make sure it's posted at the worksite.
3) Post emergency responder phone numbers and addresses at the worksite.
4) Mark the worksite with signs and note the easiest access routes in and out of the site.
5) Make sure you have quick access to rescue and retrieval equipment, such as lifts and ladders.

As on-site work progresses

1) Identify on-site equipment that can be used for rescue and retrieval. Examples: lifts and ladders.
2) Maintain a current equipment inventory at the worksite. Equipment may change frequently as the job progresses.
3) Reevaluate and update the emergency-response plan if on-site work tasks change.

Respond to emergencies: If the worker is injured, call 911 or other emergency numbers indicated on the emergency-response plan for ambulance service. Remember, 911 responders are not trained to rescue an injured worker suspended in a personal fall-arrest system. First responders should clear a path to the victim. Others should be sent to direct emergency personnel to the scene.

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1) Make sure only qualified personnel attempt a technical rescue.
2) Prohibit all nonessential personnel from the fall/rescue site.
3) Talk to the fall victim.
4) Determine the victim's condition if possible.
5) If the victim is accessible, provide comfort and check vital signs.
6) If necessary, administer chest compressions, and attempt to stop bleeding.

Investigating accidents:

1) Report fatalities and catastrophes to OSHA within eight hours. Report injuries requiring overnight hospitalization and medical treatment other than first aid within 24 hours.
2) Identify all equipment associated with the accident and place it out of service until the accident investigation is complete.
3) Document step by step what went wrong and what went right.
4) Review the fall-protection plan. Determine how the plan could be changed to prevent similar accidents. Revise the plan accordingly.
5) Have a competent person examine equipment associated with the accident. If it contributed to the accident, determine how and why. Replace it if necessary.

Definitions of selected terms

Anchorage: A secure point of attachment for workers' lifelines, lanyards, or deceleration devices. Anchorages for personal fall-arrest systems must be capable of supporting a minimum load of 5,000 pounds per worker (or be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall-arrest system that maintains a safety factor of at least two). Anchorages for positioning-device systems must be capable of supporting a minimum load of 3,000 pounds per worker.

Body belt (safety belt): A strap that cinches around a person's waist and attaches to a lanyard, lifeline, or deceleration device. The maximum permissible arresting force for a body belt is 900 pounds. The use of a body belt in a positioning-device system is acceptable and is regulated under section 1926.502, paragraph (e) of Subdivision M.

Body harness: Straps that an individual wears to distribute fall-arresting forces over the thighs, waist, chest, shoulders, and pelvis, and attaches to other components of a personal fall-arrest system. The maximum permissible arresting force for a body harness is 1,800 pounds.

Carpenter bracket scaffold: A scaffold consisting of wood or metal brackets supporting a platform.

Competent person: A person who is capable of identifying existing and predictable hazards in the work environment and who has authorization to take prompt measures to eliminate the hazards.

Connector: A device used to couple (connect) components of a personal fall protection system or positioning-device system. The connector may be an independent component (such as a carabiner) or an integral component (such as a buckle or D-ring sewn into a body belt) of the system.

Connectors must be made of drop forged steel or equivalent material and proof-tested to a minimum tensile load of 3,600 pounds; they must have a corrosion-resistant finish and all surfaces and edges must be smooth to prevent damage to other parts of the system.

Controlled-access zone (CAZ): An area designated for overhand bricklaying operations or leading edge construction, or as required in a fall-protection plan. Conventional fall protection systems; guardrail systems, personal fall-arrest systems, or safety-net systems are not required in the area; access is permitted only to workers performing overhand bricklaying and leading edge construction tasks.

Conventional fall protection: A guardrail system, safety-net system, or personal fall-arrest system.

Deceleration device: A mechanism that dissipates or limits energy imposed on a person during fall arrest. Examples include rope grabs, rip-stitch lanyards, special woven lanyards, and automatic self-retracting lifelines.

D-rings: Attachment points on a body belt or harness for deceleration devices or lanyards. D-rings must have a minimum strength of 5,000 pounds and must be proof-tested to a minimum tensile load of 3,600 pounds.

Formwork: The total system of support for freshly placed or partially cured concrete, including the mold or sheeting (form) that is in contact with the concrete, as well as all supporting members including shores, reshores, braces, and related hardware.

Free fall: Falling before fall protection begins to arrest the fall.

Guardrail system: Vertical barriers erected to prevent workers from falling to a lower level.

Lanyard: A flexible rope, strap, or webbing that connects a body belt or harness to a deceleration device, lifeline, or anchor. Lanyards that tie-off one worker must have a minimum breaking strength of 5,000 pounds. Lanyards that automatically limit free-fall distance to two feet or less must have components capable of sustaining a minimum static tensile load of 3,000 pounds with the lanyard in the fully extended position.

Lifeline: A flexible line that attaches directly to a person's body belt, harness, lanyard, or deceleration device at one end and to an anchor at the other end. A lifeline that hangs vertically and is connected to one anchor is a vertical lifeline. A lifeline that stretches horizontally between two anchors is a horizontal lifeline. All lifelines must be protected against cuts or abrasions; they cannot be made of natural fiber rope.

Personal fall-arrest system: A conventional fall-protection system designed to stop a single worker from free falling to a lower level. Components include an anchorage, connectors, a body belt, or body harness and may include a lanyard, deceleration device, or lifeline.

Positioning-device system: A type of personal fall protection system that supports a person who needs to work with both hands free on surfaces, such as walls or window sills. Also, used for formwork construction and concrete rebar placement.

Precast concrete: Concrete members (such as walls, panels, slabs, columns, and beams) that have been formed, cast, and cured prior to final placement in a structure.

Qualified person: A person who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to resolve problems relating to a specific subject, operation, or project.

Safety-net system: A fall-arrest system of mesh nets including panels, connectors, and other impact-absorbing components.

Slipform: A form that is pulled or raised as concrete is placed.

Snaphook: A connector consisting of a hook-shaped member and a keeper. It can be opened to receive an object and, when released, automatically closes to retain the object. There are two types of snaphooks — locking and nonlocking.

Tilt-up work: A method of concrete construction in which members are cast horizontally at a location adjacent to their eventual position and tilted into place after forms are removed.

Waler: A horizontal timber or steel member used for bracing vertical members.

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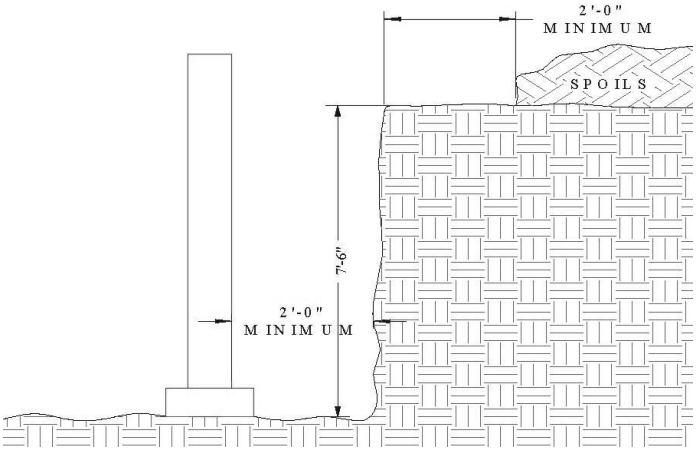
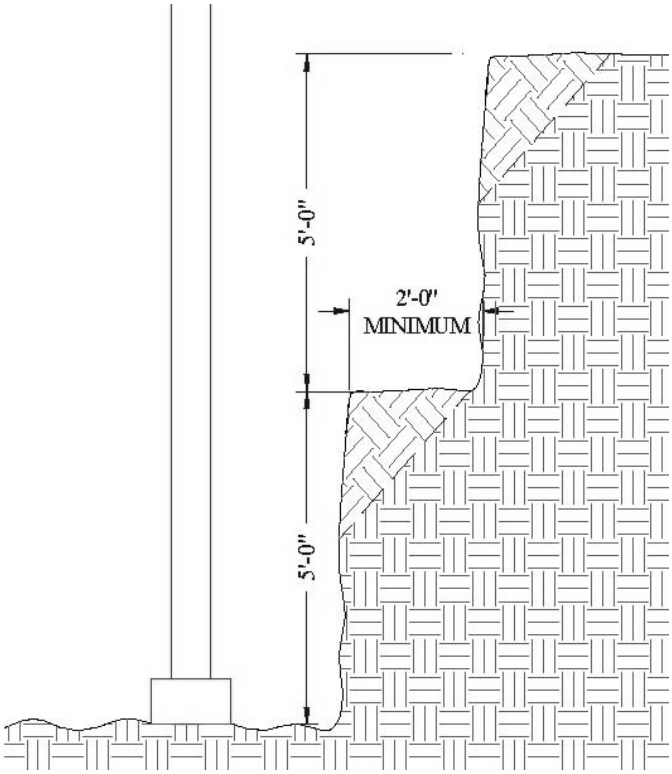
Foundation Concrete Truck Placement

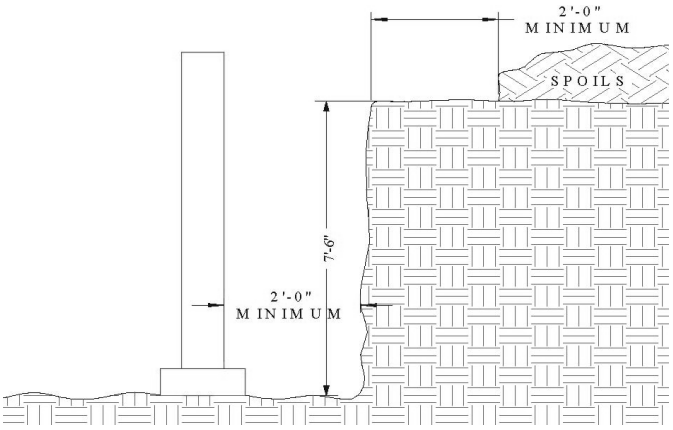
- Effective immediately and until further notice, 29 CFR 1926.652 shall not be applied to house foundation/basement excavations when all the following conditions are present.
- The house foundation/basement excavation is less than seven and one-half feet in depth or is benched for at least (2) feet horizontally for every five (5) feet or less of vertical height:



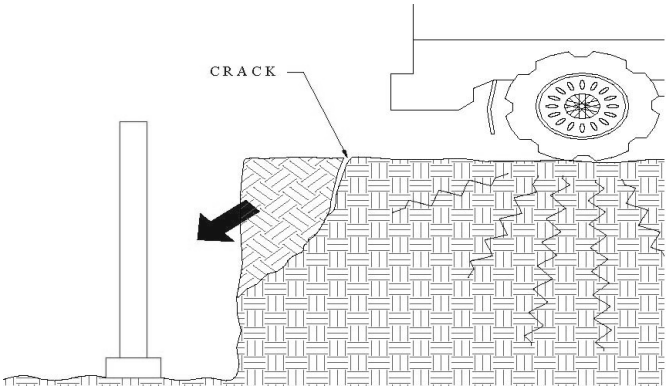
- The house foundation/basement excavation is less than seven and one-half feet in depth or is benched for at least (2) feet horizontally for every five (5) feet or less of vertical height:



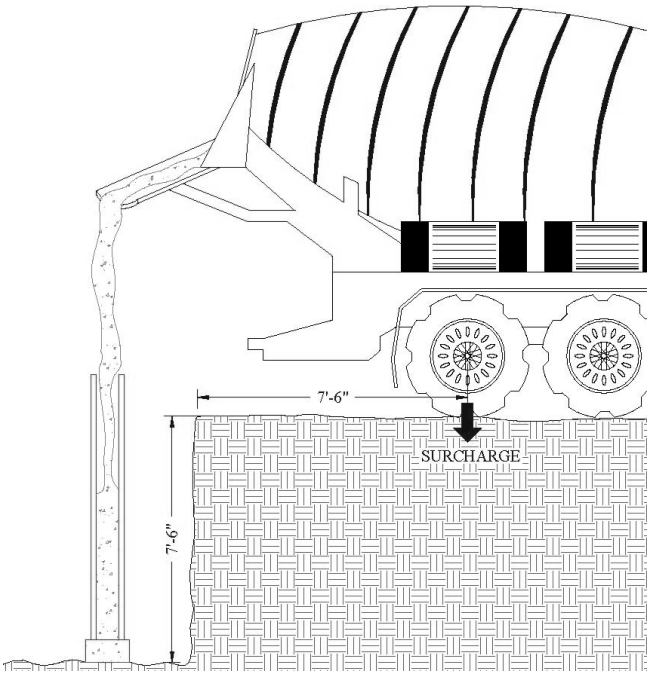
- The minimum horizontal width (excavation face to formwork/wall) at the bottom of the excavation is as wide as practicable but not less than two (2) feet:



- There is no water, surface tension cracks, nor other environmental conditions present that reduce the stability of the excavation:



- There is no heavy equipment operating in the vicinity that causes vibration to the excavation while employees are in the excavation:



- All soil, equipment, and material surcharge loads are no closer in distance to the top edge of the excavation than the excavation is deep:

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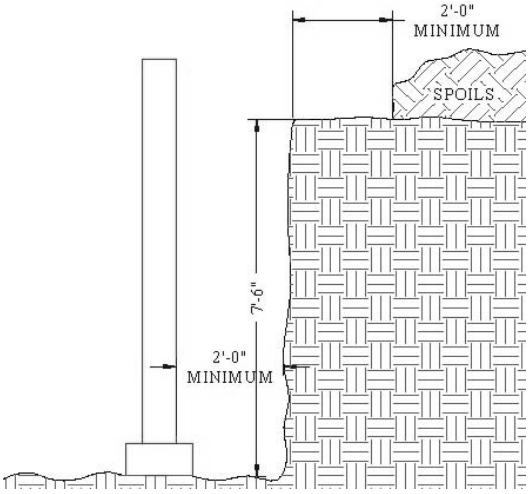
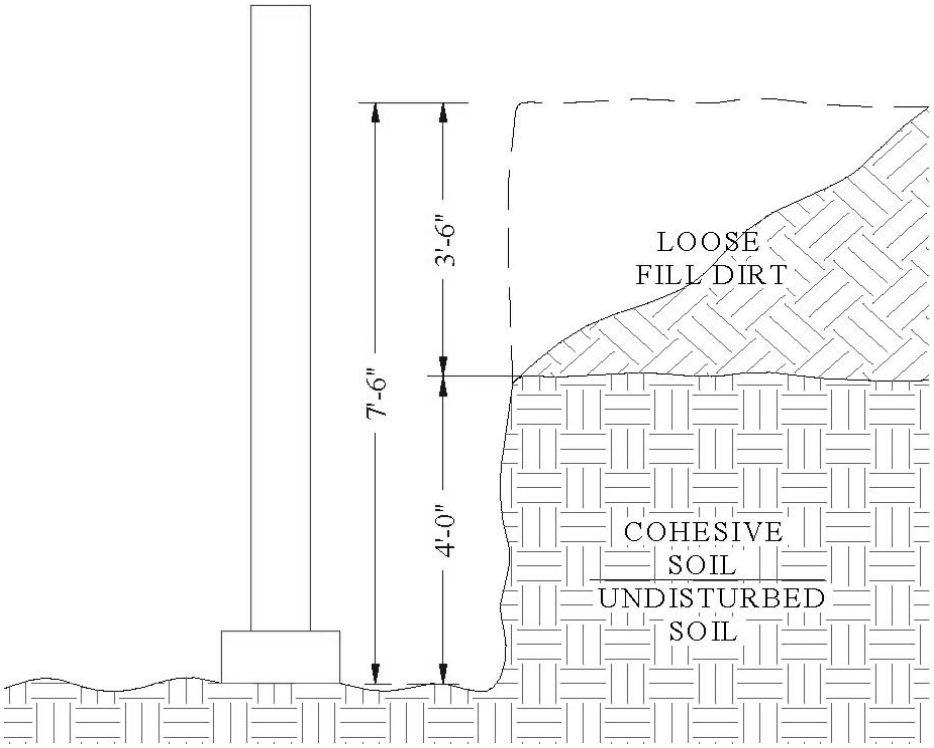


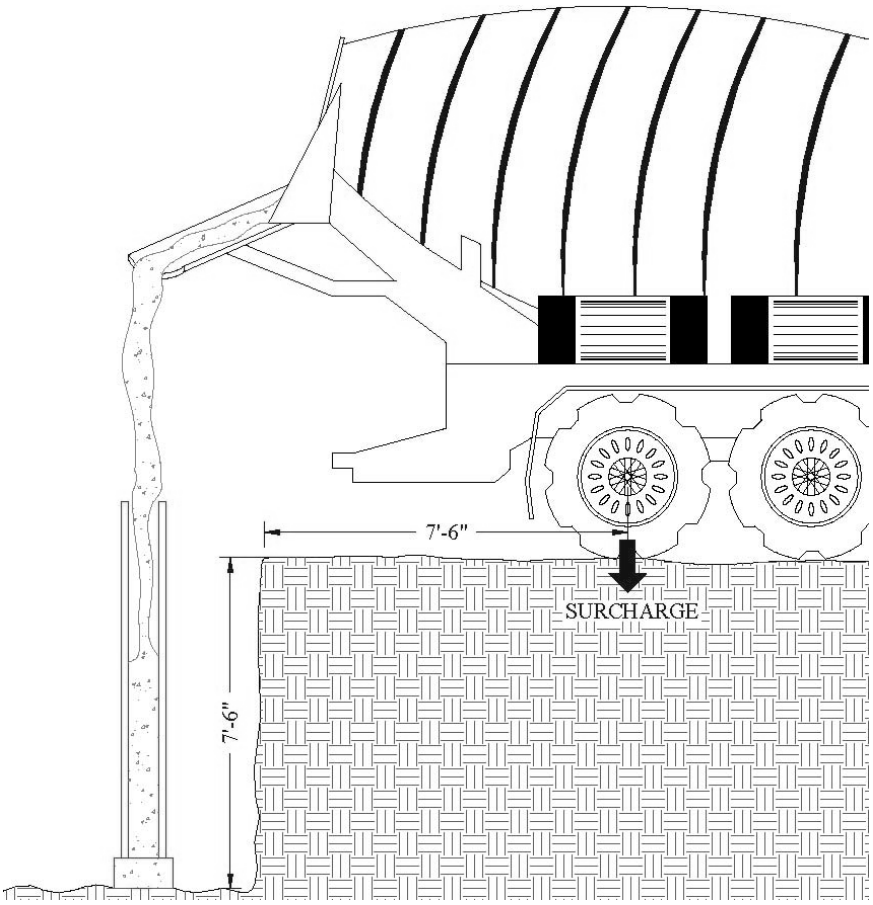
- However, when front end loaders are used to dig the excavations, the soil surcharge load shall be placed as far back from the edge of the excavation as possible, but never closer than two (2) feet:

- Work crews in the excavation are the minimum number needed to perform the work:
- The work has been planned and is carried out in a manner to minimize the time employees are in the excavation:

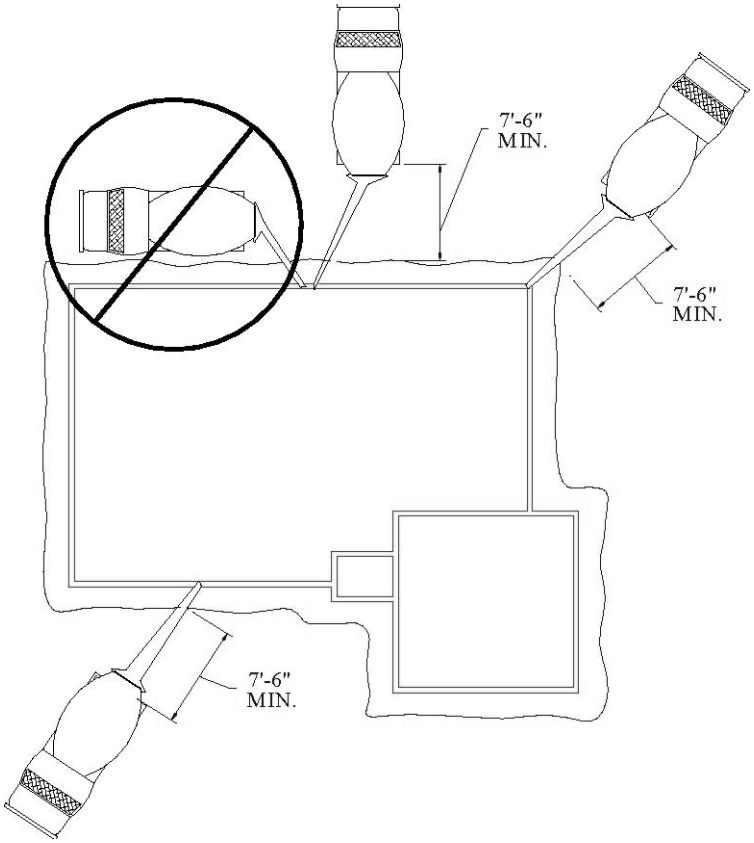
Fill Dirt on Site



Correct Direct Placement



Correct Direct Placement



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Concrete trucks, drivers, spotters

Personal protective equipment:

- ❑ Hard hat
- ❑ Ear plugs or muffs
- ❑ Safety glasses or goggles
- ❑ Cloth or leather gloves, rubber for wet conditions
- ❑ Steel toed boots, rubber when standing in wet concrete
- ❑ Dust mask when exposed to cement dust
- ❑ Snug fitting clothes
- ❑ Tie long hair back
- ❑ Do not wear jewelry

Safety: Federal regulations require every driver to record a pre-trip and post-trip inspection report.

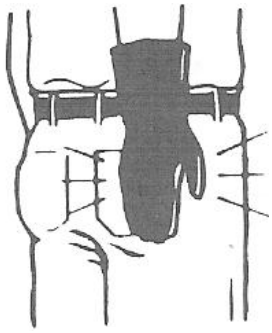
- ❑ All drivers need a commercial driver's license.
- ❑ Stay alert to all traffic movements.
- ❑ Look for workers, vehicles, or obstacles that may be in the trucks path.
- ❑ Check for flat, low, or damaged tires. Repair or replace immediately.
- ❑ Check for fluid leaks.
- ❑ Keep chutes cleaned and stowed properly to avoid dropping concrete or stones while traveling.
- ❑ The circle of safety is a perimeter check around the entire vehicle. Do this daily.
- ❑ Maintain a current medical card.
- ❑ Us the three point rule for getting on and off the vehicle.
- ❑ Stay alert to pinch point hazards (e.g. rotating parts, chutes).
- ❑ Keep hands away from pivot points.
- ❑ Do not let anyone stand or walk under the chutes or near the discharge end of the mixer.

Backing up to pump operators: Drive slowly. Know the conditions of the brakes.

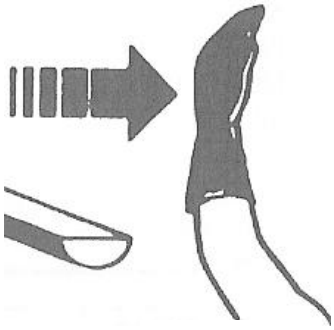
- ❑ Designate a spotter. Maintain visual contact all times.
- ❑ Take direction from only one spotter. The spotter and truck driver must know hand signals. Make sure to agree on the signal used. Stop immediately if you do not understand.
- ❑ Use only one rear view mirror (the one on the spotter) while backing up.
- ❑ Never get closer than 10 ft. to the pump unless there is a clear view of the spotter.
- ❑ When the spotter is not seen, stop the truck immediately. Wait until the spotter is seen.
- ❑ Do not allow any worker to move, raise, lower, adjust or unfold the discharge chute while backing up.

The spotter and driver must know the following hand signals:

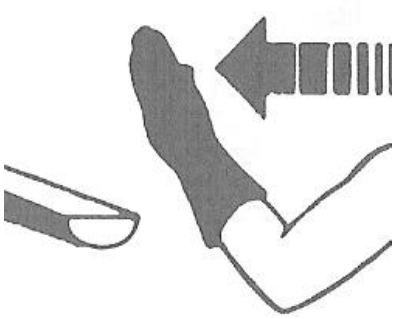
DRIVE IN



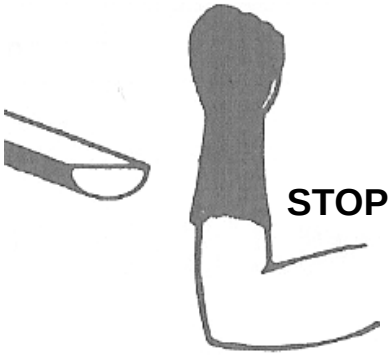
BACK IN



BACK UP

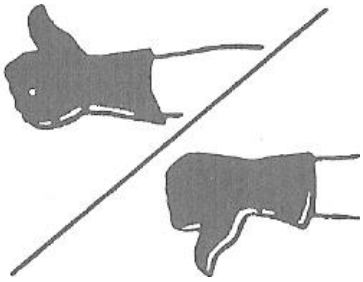


PULL FORWARD

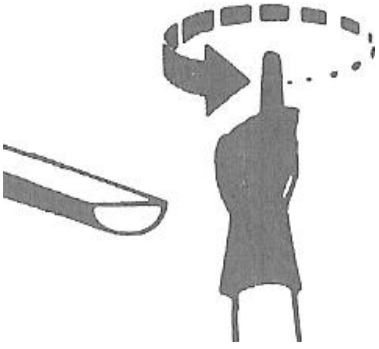


STOP

RAISE CHUTE



LOWER CHUTE



START POURING

MORE WATER

STOP POURING

Outside of the truck: Set the parking brake before leaving the cab.

- ❑ Make sure the transmission is in neutral.
- ❑ Put on a hard hat and safety glasses or goggles before leaving the cab.
- ❑ Never get between the pump and the truck.
- ❑ When more than one truck is delivering to the hopper, keep communicating to all workers to stay out.

Delivering the Concrete: Learn where all E-stop switches are.

- ❑ Put the concrete into the pump hopper only when directed to do so by the pump operator.
- ❑ When there is foreign matter coming from the truck into the hopper, signal the operator to stop the pump or hit the emergency stop switch (E-stop).
- ❑ Never reach into the hopper, while it is running, to retrieve objects.
- ❑ Remember; even when the pump is stopped, the pump is remote controlled and can start up at any time.
- ❑ Stay in direct communication with the pump operator at all times.
- ❑ Some pumps are equipped with horns. Learn how to use them.

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- ❑ Stand away from a hopper that has to have trapped air removed from the delivery system. Wait for the go ahead from the pump operator.
- ❑ The release of trapped air can cause hose whipping and spewing hazards.
- ❑ Never stand on the hopper grate.
- ❑ Never lift or move the hopper grate.
- ❑ Avoid walking under any boom or outrigger.
- ❑ Do not overfill the hopper. Excess concrete causes tripping hazards.

Clean up: Do not wash out the truck into the pump hopper.

- ❑ Do not allow the level of material in the hopper to become so low that air is sucked into the material cylinders.
- ❑ If concrete is being pumped back into the truck, stay away from the hopper or stay in the cab.
- ❑ Let the pump operator handle the end hose.
- ❑ Do not drive under the boom when pulling away. Have the operator move the boom or take a different path off the job.
- ❑ Make sure all workers are a safe distance before pulling away.

Electrocution: When a boom becomes energized from touching an electrical wire, the electricity passing through the concrete going into the hopper will energize the truck. A worker touching the truck can be electrocuted.

- ❑ Monitor boom movements.
- ❑ Alert operator when boom moves closer than 17 ft. to any electrical wire.
- ❑ Never stand on a concrete pipeline when it is in use. Never touch the pipe, clamps, or hoses.
- ❑ Move away from pipelines that are being worked on. When pressure is still in the line and the line is opened, concrete will be spewed at a high velocity.
- ❑ Use the 3 point rule for getting on and off the truck. The three point rule is one foot and two hands or vice versa.
- ❑ Never carry loads or objects that could cause you to lose your balance and fall.
- ❑ Keep a safe distance when monitoring the hopper.
- ❑ Never look into the end of a connected pipe or hose.

Concrete Pumping

Personal Protective Equipment:

- ❑ Hard hat
- ❑ Safety goggles or glasses
- ❑ Heavy duty work shoes or boots
- ❑ Rubber boots (for clean outs)
- ❑ Work gloves (rubber when necessary)
- ❑ Long sleeved shirt (when necessary)
- ❑ Ear plugs or muffs

Read and understand the manufacturer's operating manual.

- ❑ Check engine oil, hydraulic oil, and radiator water before operations begin.
- ❑ Inspect all safety covers, instruments, gauges, grates, outriggers, and other equipment for safe and proper operating procedures.
- ❑ Inspect safety slings, cables, and chains. All clamps should be pinned at all times, including the boom system.

In the cab of the truck should be a:

- ❑ Fire extinguisher
- ❑ Safety flares
- ❑ Safety reflector
- ❑ First-aid kit

General rule: One safety sling for every item hanging from the boom. The anchor point for a safety sling should be the boom itself, not the pipeline.

- ❑ Only one worker is to give directions to the pump operator.
- ❑ Pump operators' and the ground worker must know the proper hand signals.
- ❑ Keep a minimum of 17 feet away from all electrical lines.
- ❑ Water boxes must be in place when the machine is in operation.
- ❑ Never reach into the valve or water box.

Trailer Pumps

- ❑ Check the condition of the truck and trailer.
- ❑ Hitch is closed and secured.
- ❑ Safety chain is connected.
- ❑ Air and electric connections are working.
- ❑ Safety pins in place.
- ❑ Equipment is secure.
- ❑ Emergency shut off buttons labeled.

Set up

- ❑ Locate pump in an area for easy access to ready mix trucks and pour.
- ❑ Locate wash out area and water access.
- ❑ Placing line should be short and straight.
- ❑ A 90 degree bend creates as much pressure as nine ft. of straight pipe.
- ❑ Clamp the steel pipeline directly to the pump reducer whenever possible.
- ❑ Avoid using a rubber hose between the pump and the placing line.
- ❑ It is three times as hard to pump through rubber hose as opposed to steel.
- ❑ Check the pipes thickness and inspect for wear.
- ❑ Frayed or worn hoses can cause kinking. Kinking builds up unwanted pressure, causing the hose to jerk and rupture. Kinking can cause a hydraulic line to burst and can blow the end off a hose or burst a clamp.
- ❑ Know the pump piston face pressure and the placing line working pressure.
- ❑ Concrete poured on high rises wears out the standpipe faster than the upper line.
- ❑ Raised ends on the placing line will withstand higher pressure.
- ❑ Prime the pump and placing line with a mixture of slurry.

During the pour

- ❑ Grease the pumps seals and bearings.
- ❑ Manufacturers recommend greasing every hour or every 50 yards during the day.

Remember: Pumping up 200 ft. is equal to pumping 800 ft. straight out.

- ❑ A 10 ft. section of 5 inch pipe contains 200 pounds of concrete.

When a pump stops or breaks down: Notify the superintendent

- ❑ Attempt a repair
- ❑ If repair is too slow, clean out the placing line and clean out the pump.

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High rise pumping

- ❑ Secure the placing line or pour a concrete thrust block.
- ❑ Use a shut off or switching valve in the line right after the pump.
- ❑ The pipe from the valve to the clean out area must include a slurry tee.
- ❑ Everyone on site needs to know who is responsible for checking and maintaining the placing line and clean out procedures.
- ❑ Be aware of any admixtures in the concrete.

Lightweight concrete

- ❑ Concrete is porous and may absorb water under the pressure of the pumping.
- ❑ Person responsible for the pour should add any needed water.
- ❑ Too much water can cause the rock and sand to separate, causing a plug (segregation).
- ❑ Never reach into the concrete pump valve. Use special tools.
- ❑ Do not remove the grate from the hopper or operate the pump without a grate on the hopper.
- ❑ Never reach into the hopper when the pump engine is running or the agitator is turning.

Clean Out (compressed air)

- ❑ Clean out should begin within 5 minutes after pumping is complete.
- ❑ Verify with pump operator that the shut off valve is closed.
- ❑ All pipe added to the discharge end must be lubricated by using a grout tee or by adding slurry.
- ❑ No one is allowed near the discharge end.
- ❑ Attach a catch basket to the discharge end or use established control methods.
- ❑ Position the pipe high enough to allow easy discharge.
- ❑ The sponge or plug must be tight to prevent air flow around the plug into the concrete.
- ❑ Connect blow out cap onto the placing line.
- ❑ Connect the air hose to the blow out cap.
- ❑ Open the bleeder valve.
- ❑ Once the concrete is moving, close the bleeder valve and slowly add air.
- ❑ After the blow out is completed, retrieve all disconnected hoses and pipe.
- ❑ Insure that the air pressure has been completely relieved before working on the line.

Multiple section boom pumps

- ❑ Clean set up area of debris and position pump so obstructions do not interfere.
- ❑ Extend outriggers fully and lock. If the area is cramped, the outriggers on the side of the pump away from the pour should be jacked down.
- ❑ All outriggers that feel the weight of the boom must be fully extended.
- ❑ The boom must not rotate beyond an extended outrigger toward a non extended outrigger.
- ❑ Use pads and dunnage for stabilization. Make sure pads do not sink.
- ❑ All truck mounted boom pumps are required to be level for safe operation. Make sure tires are blocked.

One to One Rule: For every 1 foot of vertical drop, stay back from the base edge 1 foot. Make sure the base is not undercut.

- ❑ Unfold the boom sections in the proper sequence.
- ❑ Make sure safety hooks or straps used for transport are not bent or binding.
- ❑ Never force the boom when it is in a bind. Eliminate the problem.

- ❑ Never over rotate the boom.
- ❑ Never drag the hoses sideways with the boom.
- ❑ Never move the truck concrete pump without folding the boom fully and placing the outrigger in the proper travel position.

Lightning: Lower or fold the boom and seek shelter.

Power lines: Power lines cause electrocutions.

- ❑ Assign a spotter to watch the boom to warn if the boom comes within 17 feet of lines.
- ❑ Take all necessary precautions to rectify the situation. Move to a safer area.

Small line pumps: A small-line pump is defined as a pump that pumps grout or a 3/8" pea gravel mix through pipe and hose that has a diameter of 2 inches, 2-1/2 inches, or 3 inches. The size of any coarse aggregate and the proportioning of the mix will dictate the diameter of the pipe or hose that is required.

It is recommended that the diameter of the placing line be at least 3 times and, preferably, 4 times the size of the largest aggregate in the mix.

Grout may contain as little as five sacks of cement (470 pounds), or as much as 10 sacks (940 pounds) of cement per cubic yard. It may be desirable to request a retarder be added to the mix if a slow pour with high cement content is anticipated.

- ❑ When using a high cement content and a high ambient temperature, extreme care should be taken to prevent the mix from setting in the placing line.
- ❑ The pump operator may make recommendations concerning the mix design or slump, but the contractor has the final responsibility for mix design and slump.
- ❑ The pump operator should never add any water without the contractor or superintendent's approval.
- ❑ Check all fluid levels of the truck and concrete pump before starting the truck or pump engine.
- ❑ On the pump, check the engine oil, hydraulic oil, radiator water, and flush box water.

Hose and pipe: When selecting hose and pipe size, it is recommended that you remember the rule concerning the diameter of the largest aggregate in relation to the diameter of the placing line.

- ❑ When it is necessary to pump a long distance, it is recommended that steel pipe be used for as much of the distance as is practical; then rubber hoses for distribution at point or placement.
- ❑ Use only raise-end fittings for pipe or hoses. The clamps must be properly adjusted to give a tight fit and gaskets must be used in all clamps.
- ❑ Make sure all your clamps are complete with gaskets and they are clean. A clamp without a gasket leaks slurry and may cause a plug. It will also leak air, giving you trouble when you try to suck a ball back.

Inspect hoses daily: Any frayed or worn hoses should be taken out of service because of the increased danger of kinking or bursting. Kinking can be dangerous because it almost instantly builds pressure to the maximum pressure that the pumps can produce.

- ❑ When starting to pump, it is important that the first material through the placing line has the ability to lubricate the placing line.
- ❑ If a high slump, wet grout is pumped; it may be adequate to lubricate the placing line. When a low slump or low cement content grout is pumped, it may be necessary to add additional water to the first hopper full of concrete.
- ❑ When a pea gravel mix is to be pumped, it is recommended that a line lubrication mixture be put into the hopper ahead of the concrete. This lubricating mix may be cement and water or there are several commercial priming products on the market that may be used.

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- A plug in the line may be caused by a number of problems. It may be caused when starting to pump by a lack of lubrication in front of the grout or pea gravel. It may be caused by dirty placing lines that were not properly cleaned on the previous day.
- A plug can be caused by the mix bleeding for segregation of the sand and aggregate. A plug may occur when larger stones or aggregates that are not designed to be in the mix are dropped into the pump hopper. It is recommended when using small diameter line that a grate with smaller holes be placed on the hopper to prevent large stones or other contaminants from entering the pump.
- If plugging conditions in the pump or hose occur for and reason at all, do not attempt to use more power or correct the condition. Reverse the pump or release the line pressure, determine the cause of the plug, correct it, clean the plug, and resume pumping.
- Trying to force material through under jammed conditions may result in serious injury to people or damage to the pump or placing line. If the hose or pipe connected to the reducer and hose starts to move or rise up as pressure is applied, the blockage is down the line.
- Check the system until you locate a soft spot in the hose or a hollow sound with a hammer if it is pipe. If the reducer rises up, but the hose is soft, you know the plug is in the reducer.
- Never open a coupling when the placing line is pressurized. Consult the manufacturer's operation manual for the method releasing pressure from the pipeline or hose. Extreme caution must be taken when this condition occurs.
- Plugs usually occur in reducers, and sometimes in hoses as they have more friction than pipe. To remove a plug when reversing does not work, first relieve the line pressure, then disconnect the plugged system, elevate it and tap on the plugged area with a hammer. Break down the plug and shake it out the end of the hose or pipe. Do not re-hook the system until the plug is removed.

Clean out: Immediately upon completion of placing operation, attention must be given to clean out. During some pours, hose and pipes can be cleaned out as they are being removed from the system. Do not leave your machine to help drag hose during the pour.

When the pour is complete, there are several ways to clean out the placing line depending on the pump you are operating.

1) Clean out the hopper, dump the hopper, or pump the hopper down, and re-hook the hose to the pump with a sponge inside of the hose. Fill the hopper with water and pump the water through the hose until the sponge comes out. Never handle concrete with your bare hands, as it contains lime and can burn your skin.
2) Dump all hoses and place long hoses with one end uphill and fill lowest end with water. After the hose is full of water, walk the hose in a rolling direction until empty, and then repeat using opposite end.
3) When cleaning inside the hopper, make sure the grate is in place and properly secured, or the engine is shut off, and the accumulator circuit is bled.

When pumping and clean-out operations are completed, make sure your unit is safe and ready for travel back to your yard.

- Check to make sure that the safety chains are properly fastened and the tongue jack and outriggers are raised and locked in position.
- Do a final walk around the truck and pump to be certain there are no loose objects that may fall off during travel.

Pumps with placing booms: Make sure all warning labels and signs are visible and in good shape. When missing, replace immediately. Safety reminders are important.

Spreaders: Always communicate with your fellow workers.

- ❑ Wear the proper protective equipment. (Rubber boots, goggles, gloves)
- ❑ Plan the layout ahead of beginning operations.
- ❑ Hold the pipe firmly. Pumping pressures can cause injury.
- ❑ Keep moving. Do not let the concrete build up to overflow in one area.
- ❑ Do not let the pipe whip.
- ❑ Do not work during strong winds.
- ❑ Have a spotter keep you appraised of where you are.
- ❑ Only one tip hose may be safely hung from the tip of the placing boom.
- ❑ The safety cable or strap between the boom pipeline and the end of the hose must be in place, attached, and in good working order.
- ❑ All connections must be capable of handling the pumping pressures of the pump being used.

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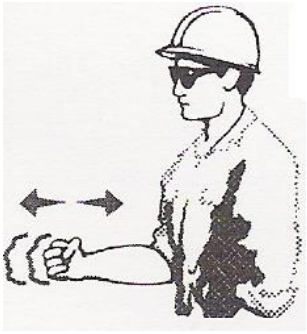
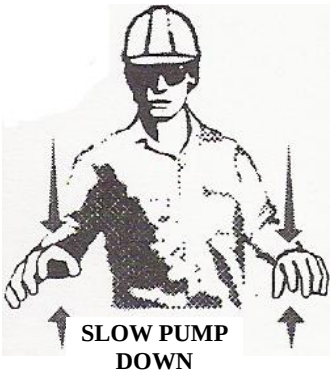
CONCRETE OPERATIONS

Signals: The spotter and truck driver must know hand signals. Make sure to agree on the signal used. Stop immediately if you do not understand. Only one spotter gives signals.



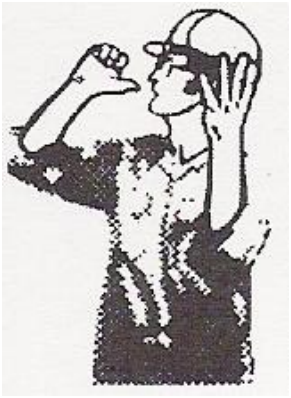
START PUMP (SPEED UP)



SLOW PUMP DOWN

STOP PUMP

LITTLE BIT



ADD WATER (4 GALLONS)

ALL DONE (CLEAN UP)

BOOM UP

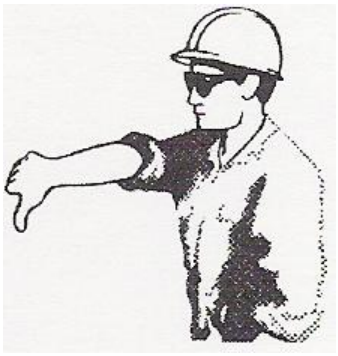
BOOM LEFT

BOOM RIGHT

OPEN OR EXTEND BOOM

CLOSE OR RETRACT BOOM

STOP BOOM



BOOM DOWN

2 TAPS

RELIEVE PRESSURE

Health effects: Thousands of construction workers are exposed to concrete every day without harm. Anyone who uses or supervises the use of cement should know its health hazards and the safe working procedures necessary to minimize exposure.

- Cement can cause ill health by skin contact, eye contact, or inhalation. Risk of injury depends on duration and level of exposure and individual sensitivity.

Hazardous materials in wet concrete and mortar include: Different cements have different ingredients that can be harmful. Many types of cement contain substances that can be hazardous, like silica, lime, gypsum, nickel, cobalt, and chromium compounds.

- Alkaline compounds such as lime (calcium oxide) that are corrosive to human tissue
- Trace amounts of crystalline silica which is abrasive to the skin and can damage lungs
- Trace amounts of chromium that can cause allergic reactions.

Skin contact: The hazards of wet cement are due to its caustic, abrasive, and drying properties.

- Wet concrete contacting the skin for a short period and then thoroughly washed off causes little irritation. Continuous contact between skin and wet concrete allows alkaline compounds to penetrate and burn the skin.
- When wet concrete or mortar is trapped against the skin (e.g. by falling inside a worker's boots or gloves or by soaking through protective clothing) the result may be first, second, or third degree burns or skin ulcers. These injuries can take several months to heal and may involve hospitalization and skin grafts.
- Severe cases can occur when personal protective clothing or equipment is worn.
- Wet concrete may get trapped inside rubber boots or gloves or gradually soak through coveralls. Concrete finishers kneeling on fresh concrete have had their knees severely burned. Corrosive bleed water from the concrete is absorbed by the worker's pants and held against the skin for prolonged periods.
- Cement dust released during bag dumping or concrete cutting can also irritate the skin. Moisture from sweat or wet clothing reacts with the cement dust to form a caustic solution.

Allergic skin reaction: Some workers become allergic to the hexavalent chromium in cement. A small yet significant percentage of all workers using cement will develop an allergy to chromium, with symptoms ranging from a mild rash to severe skin ulcers.

- In addition to skin reactions, hexavalent chromium can cause a respiratory allergy called occupational asthma. Symptoms include wheezing and difficulty breathing. Workers may develop both skin and respiratory allergies to hexavalent chromium.
- It is possible to work with cement for years without any allergic skin reaction and then to suddenly develop such a reaction. The condition gets worse until exposure to even minute quantities triggers a severe reaction. The allergy usually lasts a lifetime and prevents any future work with wet concrete or powder cement.

Eye contact: Exposure to airborne dust may cause immediate or delayed irritation of the eyes. Depending on the level of exposure, effects may range from redness to chemical burns and blindness.

Inhalation: Inhaling high levels of dust may occur when workers empty bags of cement. In the short term, such exposure irritates the nose and throat and causes choking and difficult breathing.

- Sanding, grinding, or cutting concrete can also release large amounts of dust containing high levels of crystalline silica. Prolonged or repeated exposure can lead to a disabling and often fatal lung disease called silicosis. Some studies also indicate a link between crystalline silica exposure and lung cancer.

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Symptoms of silicosis:

- ❑ Acute silicosis can occur after a few weeks of very high exposure (for example, in sandblasters). Symptoms are shortness of breath, coughing, fever, and weight loss.
- ❑ Chronic silicosis is rarely seen in workers with less than ten years of exposure. It permanently damages your lungs.
- ❑ Silicosis also increases your chance of getting tuberculosis.

Controls: ***Recommendations for handling and using cement safely:***

Personal protection: ***To protect skin from cement and cement mixtures, workers should wear:***

- ❑ Alkali-resistant gloves
- ❑ Coveralls with long sleeves and full-length trousers (pull sleeves down over gloves and tuck pants inside boots and duct-tape at the top to keep mortar and concrete out)
- ❑ Waterproof boots high enough to prevent concrete from flowing in when workers must stand in fresh concrete
- ❑ Respiratory protective equipment such as a P, N, or R 95 respirator when cement dust cannot be avoided
- ❑ Eye protection where mixing, pouring, or other activities may endanger eyes (minimum—safety glasses with sideshields or goggles, under extremely dusty conditions, tight-fitting unvented or indirectly vented goggles. Do not wear contact lenses when handling cement or cement products).

Work practices

- ❑ When laying concrete block, have different sizes on hand to avoid cutting or hammering to make them fit.
- ❑ Work in ways that minimize the amount of cement dust released.
- ❑ Where possible, wet-cut rather than dry-cut masonry products.
- ❑ Mix dry cement in well-ventilated areas.
- ❑ Make sure to work upwind from dust sources.
- ❑ Where possible, use ready-mixed concrete instead of mixing on site.
- ❑ When kneeling on fresh concrete, use a dry board or waterproof kneepads to protect knees from water that can soak through fabric.
- ❑ Remove jewelry such as rings and watches because wet cement can collect under them.
- ❑ Use power tools with HEPA filters when cutting or drilling concrete.
- ❑ Use a special HEPA vacuum to clean up dust, not dry sweeping.
- ❑ Wear a respirator with HEPA cartridges if there is a lot of dust in the air.

How can you find out the ingredients in the cement?

- ❑ Find a list of ingredients, a safety warning, or both.
- ❑ Read the **Material Safety Data Sheet** (MSDS) for the product. MSDSs are required by law. They will tell you the ingredients and possible health hazards. Everyone working on the site has a right to see MSDSs.
- ❑ When you work with cement you often use other chemicals (form oils, curing agents, bond breakers, and retardants). Remember to check their MSDSs.

Hygiene

- ❑ Clothing contaminated by wet cement should be quickly removed. Skin in contact with wet cement should be washed immediately with large amounts of cool clean water.
- ❑ Do not wash your hands with water from buckets used for cleaning tools.

- ❑ Provide adequate hygiene facilities on site for workers to wash hands and face at the end of a job and before eating, drinking, smoking, or using the toilet. Facilities for cleaning boots and changing clothes should also be available.

First aid: Skin contaminated with wet or dry cement should be washed with cold running water as soon as possible.

- ❑ Open sores or cuts should be thoroughly flushed and covered with suitable dressings.
- ❑ Get medical attention if discomfort persists.
- ❑ Contaminated eyes should be washed with cold tap water for at least 15 minutes before the affected person is taken to hospital.

Concrete Curing

Concrete curing includes the use of both chemical and water methods. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines.

Proper procedures reduce or eliminate the contamination of stormwater runoff during concrete curing.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Chemical Curing

- ❑ Avoid over spray of curing compounds.
- ❑ Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface.
- ❑ Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.
- ❑ Use proper storage and handling techniques for concrete curing compounds. Protect drain inlets prior to the application of curing compounds.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- ❑ Direct cure water away from inlets and watercourses to collection areas for infiltration or other means of removal in accordance with all applicable permits.
- ❑ Collect cure water at the top of slopes and transport or dispose of water in a non-erodible manner.
- ❑ Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Inspection and Maintenance

- ❑ Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- ❑ Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- ❑ Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- ❑ Inspect cure containers and spraying equipment for leaks.

Concrete Finishing

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines.

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CONCRETE OPERATIONS

Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Implementation

- ❑ Collect and properly dispose of water from high-pressure water blasting operations.
- ❑ Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control.
- ❑ Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering).
- ❑ Protect inlets during sandblasting operations.
- ❑ Concrete Waste Management for disposal of concrete based debris.
- ❑ Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- ❑ When blast residue contains a potentially hazardous waste.

Inspection and Maintenance

- ❑ Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- ❑ Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- ❑ Sweep or vacuum up debris from sandblasting at the end of each shift.
- ❑ At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.

Concrete Waste Management

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- ❑ Concrete is used as a construction material or where concrete dust and debris result form demolition activities
- ❑ Slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition
- ❑ Concrete trucks and other concrete-coated equipment are washed onsite
- ❑ Mortar-mixing stations exist

The following steps will help reduce stormwater pollution from concrete wastes:

- ❑ Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.
- ❑ Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- ❑ Store dry and wet materials under cover, away from drainage areas.

- ❑ Avoid mixing excess amounts of fresh concrete.
- ❑ Perform washout of concrete trucks offsite or in designated areas only.
- ❑ Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- ❑ Do not allow excess concrete to be dumped onsite, except in designated areas.

For onsite washout:

- ❑ Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
- ❑ Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.
- ❑ Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and expose the aggregate.
- ❑ Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.

Education

- ❑ Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- ❑ Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- ❑ PCC and AC waste should not be allowed to enter storm drains or watercourses.
- ❑ PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility.
- ❑ A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.
- ❑ Below grade concrete washout facilities are typical. Above grade facilities are used if excavation is not practical.
- ❑ A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- ❑ Saw-cut PCC slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement.
- ❑ Slurry residue should be vacuumed and disposed in a temporary pit and allowed to dry. Dispose of dry slurry residue properly.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- ❑ Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- ❑ A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- ❑ Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

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- ❑ Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- ❑ Washout of concrete trucks should be performed in designated areas only.
- ❑ Only concrete from mixer truck chutes should be washed into concrete wash out.
- ❑ Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.
- ❑ Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of hardened concrete on a regular basis.

Temporary Concrete Washout Facility (Type above Grade)

- ❑ Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
- ❑ Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Temporary Concrete Washout Facility (Type below Grade)

- ❑ Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
- ❑ Lath and flagging should be commercial type.
- ❑ Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- ❑ When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.
- ❑ Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Inspection and Maintenance

- ❑ Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- ❑ Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.
- ❑ Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

Temporary Batch Plants

The construction of roads, bridges, retaining walls, and other large structures in remote areas, often requires temporary batch plant facilities to manufacture Portland Cement Concrete (PCC) or asphalt cement (AC). Temporary batch plant facilities typically consist of silos containing fly ash, lime, and cement; heated tanks of liquid asphalt; sand and gravel material storage areas; mixing equipment; above ground storage tanks containing concrete additives and water; and designated areas for sand and gravel truck unloading, concrete truck loading, and concrete truck washout.

Proper control and use of equipment, materials, and waste products from temporary batch plant facilities will reduce the discharge of potential pollutants to the storm drain system or watercourses, reduce air emissions, and mitigate noise impacts.

Suitable Applications

These procedures typically apply to construction sites where temporary batch plant facilities are used.

Limitations

The General Permit for discharges of stormwater associated with industrial activities may be applicable to temporary batch plants.

Specific permit requirements or mitigation measures such as Air Resources Board (ARB), Air Quality Management District (AQMD), Air Pollution Control District (APCD), Regional Water Quality Control Board (RWQCB), county ordinances and city ordinances may require alternative mitigation measures for temporary batch plants.

Implementation steps are as follows:

- ❑ Temporary batch plants may be subject to the General Industrial NPDES permit. To comply with the permit, a Notice of Intent (NOI) must be submitted to the State Water Resource Control Board.
- ❑ Proper planning, design, and construction of temporary batch plants should be implemented to minimize potential water quality, air pollution, and noise impacts associated with temporary batch plants.
- ❑ BMPs and a Sampling and Analysis Plan (SAP) must be included in the project Stormwater Pollution Prevention Plan (SWPPP). BMPs must be implemented, inspected, and maintained.
- ❑ Temporary batch plants should be managed to comply with AQMD Statewide Registration Program and/or local AQMD Portable Equipment Registration requirements.
- ❑ Construct temporary batch plants down-wind of existing developments whenever possible.
- ❑ Placement of access roads should be planned to mitigate water and air quality impacts.

Layout and Design

- ❑ Temporary batch plants should be properly located and designed to mitigate water quality impacts to receiving water bodies. Batch plants should be located away from watercourses, drainage courses, and drain inlets. Batch plants should be located to minimize the potential for stormwater run-on onto the site.
- ❑ Temporary batch plant facilities (including associated stationary equipment and stockpiles) should be located at least 300 ft from any recreational area, school, residence, or other structure not associated with the construction project.
- ❑ Construct continuous interior AC or PCC berms around batch plant equipment (mixing equipment, silos, concrete drop points, conveyor belts, admixture tanks, etc.) to facilitate proper containment and cleanup of releases. Rollover or flip top curb or dikes should be placed at ingress and egress points.

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- ❑ Direct runoff from the paved or unpaved portion of the batch plant into a sump and pipe to a lined washout area or dewatering tank.
- ❑ Direct stormwater and non-stormwater runoff from unpaved portions of batch plant facility to catchment ponds or tanks.
- ❑ Construct and remove concrete washout facilities in accordance with WM-8, Concrete Waste Management.
- ❑ Layout of a typical batch plant and associated BMP is located at the end of this BMP fact sheet.

Operational Procedures

- ❑ Washout of concrete trucks should be conducted in a designated area.
- ❑ Do not dispose of concrete into drain inlets, the stormwater drainage system, or watercourses.
- ❑ Equipment washing should occur in a designated area.
- ❑ All dry material transfer points should be ducted through a fabric or cartridge type filter unless there are no visible emissions from the transfer point.
- ❑ Equip all bulk storage silos, including auxiliary bulk storage trailers, with fabric or cartridge type filter(s).
- ❑ Maintain silo vent filters in proper operating condition.
- ❑ Equip silos and auxiliary bulk storage trailers with dust-tight service hatches.
- ❑ Fabric dust collection system should be capable of controlling 99 percent of the particulate matter.
- ❑ Fabric dust collectors (except for vent filters) should be equipped with an operational pressure differential gauge to measure the pressure drop across the filters.
- ❑ All transfer points should be equipped with a wet suppression system to control fugitive particulate emissions unless there are no visible emissions.
- ❑ All conveyors should be covered, unless the material being transferred results in no visible emissions.
- ❑ There should be no visible emissions beyond the property line, while the equipment is being operated.
- ❑ Collect dust emissions from the loading of open-bodied trucks at the drip point of dry batch plants, or dust emissions from the drum feed for central mix plants.
- ❑ Equip silos and auxiliary bulk storage trailers with a visible and/or audible warning mechanism to warn operators that the silo or trailer is full.
- ❑ All open-bodied vehicles transporting material should be loaded with a final layer of wet sand and the truck shall be covered with a tarp to reduce emissions.

Tracking Control

- ❑ Plant roads (batch truck and material delivery truck roads) and areas between stockpiles and conveyor hoppers should be stabilized, watered, treated with dust-suppressant chemicals, or paved with a cohesive hard surface that can be repeatedly swept, maintained intact, and cleaned as necessary to control dust emissions.
- ❑ Trucks should not track PCC from plants onto public roads. Use appropriate practices to prevent tracking.

Materials Storage

- ❑ All batch plants using concrete components or compounds should have an effective strategy is to cover and contain materials.
- ❑ Material use should be conducted in a way to minimize or eliminate the discharge of materials to storm drain system or watercourse.
- ❑ Ensure that finer materials are not dispersed into the air during operations, such as unloading of cement delivery trucks.
- ❑ Stockpiles should be covered and enclosed with perimeter sediment barriers.

- ❑ Uncovered stockpiles should be sprinkled with water and/or dust-suppressant chemicals as necessary to control dust emissions, unless the stockpiled material results in no visible emissions. An operable stockpile watering system should be onsite at all times.
- ❑ Store bagged and boxed materials on pallets and cover on non-working days prior to rain.
- ❑ Minimize stockpiles of demolished PCC by recycling them in a timely manner.
- ❑ Provide secondary containment for liquid materials. Containment should provide sufficient volume to contain precipitation from a 25-year storm plus 10% of the aggregate volume of all containers or plus 100% of the largest container, whichever is greater.
- ❑ Handle solid and liquid waste properly.
- ❑ Maintain adequate supplies of spill cleanup materials and train staff to respond to spills.
- ❑ Immediately clean up spilled cement and fly ash and contain or dampen so that dust or emissions from wind erosion or vehicle traffic are minimized.

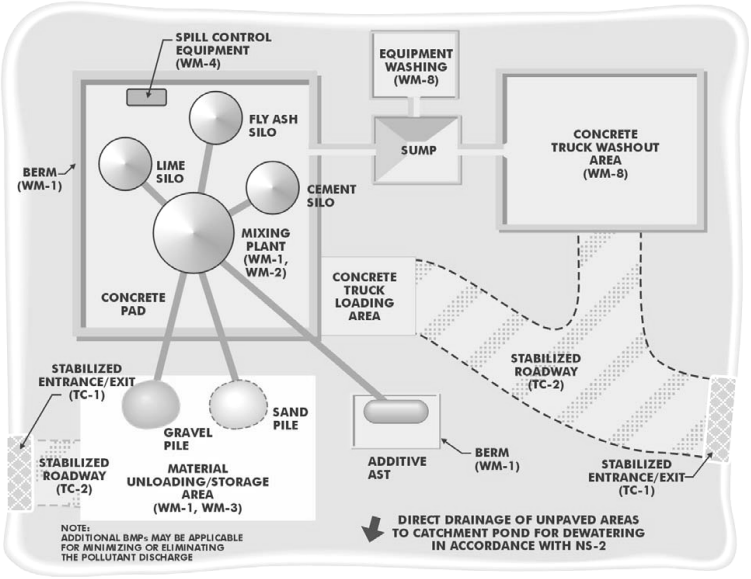
Equipment Maintenance

- ❑ Equipment should be maintained to prevent fluid leaks and spills.
- ❑ Maintain adequate supplies of spill cleanup materials and train staff to respond to spills.

Inspection and Maintenance

- ❑ Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities.
- ❑ While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- ❑ Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- ❑ Inspect and repair equipment (for damaged hoses, fittings, and gaskets).
- ❑ Inspect and maintain stabilized haul roads as needed.
- ❑ Inspect and maintain materials and waste storage areas as needed.

Temporary Batch Plant



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CHECK DEFECTS ONLY (Explain under REMARKS)

DRIVER INSPECTION REPORT

Truck No. **Mileage |__|__|__|__|__|__|**

TRUCK

GENERAL CONDITION	IN-CAB	EXTERIOR
[ ] Cab/Doors/Windows	[ ] Gauges/Warning Indicators	[ ] Lights
[ ] Body/Doors	[ ] Windshield Wipers/Washers	[ ] Reflectors
[ ] Oil Leak_____	[ ] Horn(s)	[ ] Suspension
[ ] Grease Leak_____	[ ] Heater/Defroster	[ ] Tires
[ ] Coolant	[ ] Mirrors	[ ] Wheels/Rims/Lugs
[ ] Fuel Leak	[ ] Steering	[ ] Battery
[ ] Other_____	[ ] Clutch	[ ] Exhaust
_____	[ ] Service Brakes	[ ] Brakes
(Identify)	[ ] Parking Brake	[ ] Air Lines
	[ ] Emergency Brakes	[ ] Mud Flaps
	[ ] Seat	[ ] Overall Appearance
ENGINE COMPARTMENT	[ ] Radio	[ ] Cleanliness
[ ] Oil Level	[ ] Radio Antenna	[ ] Paint
[ ] Coolant Level	[ ] _____	[ ] Other_____
[ ] Belts	[ ] _____	_____
[ ] Other_____	[ ] Other_____	(Identify)
_____	_____	
(Identify)		**[ ]NO DEFECTS**

MIXER

[ ] Chutes	[ ] Counter	[ ] Oil Leak	[ ] Other_____
[ ] Hold Downs	[ ] Water Hose	[ ] Hydraulic Leak	_____
[ ] Lifts	[ ] Water Line	[ ] Air Leak	(Identify)
[ ] Controls	[ ] Water Tank	[ ] _____	
			[ ]NO DEFECTS

REMARKS: _____

_____

_____

REPORTING DRIVER: **Date:**

Name: **Emp. No.**

MAINTENANCE ACTION: **Date:**

[ ] Repairs Made **[ ] No Repairs Made**

Certified By:

Location:

SHOP REMARKS:_____

_____

_____

_____

_____

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CONCRETE OPERATIONS
ACCIDENT REPORT FORM

GENERAL INFORMATION	
Date and Time of Accident:	
Place:	
Name of other Operator:	
Address:	Phone No.
License No. of other Operator:	
Registration No. of other Vehicle:	

Other Vehicle or Property Damage	
Owner's Name:	
Address:	Phone No:
Vehicle Insured Policy No.	
Insurance Company:	
Make, Type, and Year:	
Serial No.	
Damage to other Vehicle or Property:	
Estimated cost of repairs:	
Where vehicle can be seen:	
Did vehicle leave the scene of the accident under its own power: [ ] YES [ ] NO	

Injured Persons	
Name:	
Address:	Phone No.
Nature of Injury:	
Where treated:	
Statements Made:	
Name:	
Address:	Phone No.
Nature of Injury:	
Where treated:	
Statements Made:	
Name:	
Address:	Phone No.
Nature of Injury:	
Where treated:	
Statements Made:	

OCCUPANTS OF VEHICLE	
Name:	
Address:	Phone No.
Name:	
Address:	Phone No.
Witnesses:	
Reported to Police? [ ] YES [ ] NO	
Officer's Name:	
Officer's Phone No.	
Municipality:	

(Continued)

DRIVER'S TRUCK
Policy No.
Registration No.
Serial No.
License No.
Date of Birth:
Estimated cost of repairs:
Which side of street were you:
Which direction were you heading:
How far from the curb:
Speed in miles per hour:
Were you turning:
Condition of pavement:
Weather conditions:
Traffic lights:
Vehicle lights:
Other vehicle lights:
Additional information:

WHAT HAPPENED

ADDITIONAL RIDER	
Name:	
Address:	Phone No.:
Remarks:	

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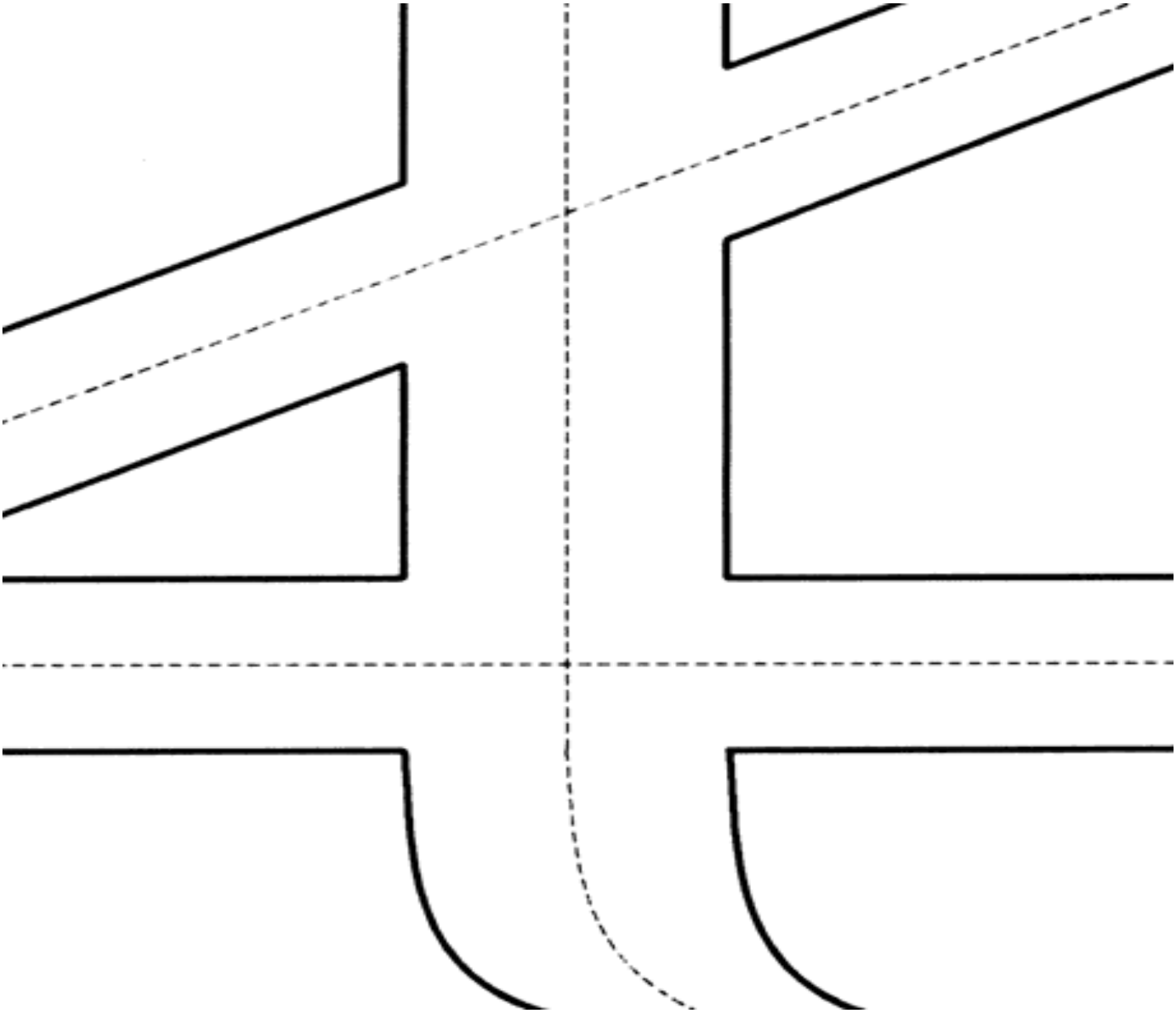
CONCRETE OPERATIONS
ACCIDENT DIAGRAM

1) **Illustrate how the accident happened.**
2) **Write in the street names.**
3) **Show which way is north.**
4) **Draw squares to show where the vehicles were (that were involved in the accident).**
5) **Use arrows to show which way the vehicles were traveling.**
6) **Estimate distances.**



Notes:

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