

Section 25

Concrete, Masonry, and Formwork

25.1 Scope

This section establishes safety requirements for concrete, masonry construction, and formwork. Additionally, this section outlines safety as it relates to the topics of concrete conveyance, formwork and falsework, shoring, precast concrete, and masonry work. Civil flatwork concrete (unless used as a foundation) does not need to adhere to the professional engineering design requirements contained in this section, but is subject to all relevant safety requirements. The Reclamation Concrete Design Manuals specifically address design and construction related to the work outlined in this section.

25.2 General Requirements

All concrete and masonry work must comply with applicable standards and regulations from the Occupational Safety and Health Administration (OSHA) 29 C.F.R. 1926 Subpart Q, *Concrete and Masonry Construction*, and the American National Standards Institute (ANSI)/American Society of Safety Professionals (ASSP) A10.9-2013 (R2018), *Safety Requirements for Concrete and Masonry Work*.

25.3 Responsibilities

25.3.1 Area Office Safety Professional

25.3.1.1 Shall review and provide feedback on the work plan (see paragraph 25.5, *Pre-Job Briefing and Planning Requirements*).

25.3.2 Professional Engineer (PE)

25.3.2.1 Shall design and certify all concrete conveyance systems, concrete pumping systems, booms and boom supporting structures or equipment placement, boom mountings, concrete pumps, formwork or vertical shoring installations, precast concrete temporary shoring and bracing systems, and lift-slab operations as safe for intended use.

25.3.3 First-Line Supervisors

25.3.3.1 Shall review work plans.

25.3.3.2 Must create and seek approval of a Job Hazard Analysis (JHA) prior to performing this work.

25.3.3.3 Shall review and sign JHAs and Risk Analysis or Exposure Assessment forms.

25.3.3.4 Shall supervise, or ensure supervision of, all employees by an individual(s) competent in performing the assigned duties.

25.3.4 Employees

25.3.4.1 Shall report any change in conditions or hazards to the first-line supervisor or the job lead.

25.3.4.2 Shall coordinate with the first-line supervisor to incorporate ergonomic considerations into the work planning, particularly any work that includes prolonged exposure to kneeling, bending, squatting, or other awkward body positions.

25.4 Hazard Identification, Assessment, and Safety Measures

25.4.1 Vertical Work

Employees must establish a limited access zone for vertical work, or masonry wall work, prior to the start of construction. The zone must be equal to the height of the wall, plus 4 feet, running the entire length of the vertical work. Additionally, employees must establish the zone on the un-scaffolded side, restrict access to only personnel actively engaged in or supervising the work, and maintain the zone until the vertical work is self-supporting and fully cured or is supported to prevent overturning and collapse. All vertical work over 8 feet in height shall have bracing on both vertical sides until permanent supporting elements of the structure are in place.

25.4.2 Green Cutting, Concrete Sawing, or Abrasive Blasting

Employees must address and mitigate any silica dust hazards that result from green cutting, concrete sawing, or abrasive blasting (see OSHA 29 C.F.R. 1926.1153, *Toxic and Hazardous Substances – Respirable Crystalline Silica*). RSHS Section 32, *Respiratory Protection*, determines protocols for employee protections against silica dust hazards.

25.4.3 Exposed Rebar

Employees must mitigate exposed rebar hazards before work begins. Exposed rebar poses catching, tripping, and impalement hazards.

25.5 Pre-job Briefing and Planning Requirements

25.5.1 Work Plan

The work plan will detail the phases of concrete and masonry operations. The first-line supervisor must develop the sequencing of structural prior to the creation of the work plan. The work plan must identify all possible safety hazards and plans for mitigation, including those identified in the JHA. The work plan must include clear direction on the use of

Reclamation Manual Policy SAF P01 Appendix A, *Stop Work Procedures*. Additionally, the work plan must also include a site map with identified staging and work zones, a limited access zone for vertical work and shoring, and plans for erection and removal of formwork, shoring, and vertical work.

25.5.2 Job Hazard Analysis

The first-line supervisor must create a JHA for specific tasks (e.g., formwork, pouring, shoring, scaffolding) (see RSHS Section 4, *Work Safety Planning* for details).

25.5.3 Precast Concrete Plan

A PE must design all precast concrete operations plans. These plans shall include detailed instructions, installation drawings, clear information on delivery and staging, equipment and method for placement, support and shoring during installation, connections and couplings, and lift planning. The work plan must include the precast concrete plan as described in paragraph 25.5.1, *Work Plan*, of this section.

25.6 Hazardous Environmental Conditions (Weather/Other)

25.6.1 Rain and Stormwater Runoff

Drainage for precipitation at the excavation work site shall direct rainwater away from the concrete formwork and fresh pours. Employees must use diversion ditches, dikes, or other means to prevent rainwater or other precipitation from entering the work site. Employees must use safe measures to prevent stormwater runoff from entering the work site.

25.6.2 Lightning

Work shall cease if lightning is spotted or reported within 5 miles of the work site. Work may resume when lightning is no longer present within a 5-mile radius of the work site.

25.6.3 Wind

Employees must manage loose materials and spoil piles to not allow wind to blow the materials into the active work area. Blowing particles or materials must not interfere with the ability of the workers to safely complete their duties. First-line supervisors and employees must monitor wind for its hazardous effects on the stability of structures, materials, and workers. Blowing particles or materials shall not interfere with the ability of workers to safely complete duties.

25.7 Personal Protective Equipment (PPE)

Employees placing or finishing concrete must wear applicable PPE, the minimum requirement being long-sleeved shirts, long pants, rubber safety boots, gloves, hardhat, and eyeglasses with side shields. The job site must provide eyewash facilities at each placement or finishing operation. Employees engaged in green cutting must wear eye and face protection. Employees engaged in wet or dry abrasive blasting using silica sand must wear an approved abrasive blasting air-line respirator, heavy-duty footwear, leather or rubber gloves, face/eye protection, and hardhat.

25.8 Safe Practices

25.8.1 Plants and Equipment

Refer to RSHS Section 20, *Mobile and Stationary Mechanized Equipment*, for additional mechanized construction equipment requirements.

- 25.8.1.1 Batching and Screening Plants.** Job sites must provide concrete batching and screening plants, aggregate production plants, hoppers, bins, silos, and related equipment designed with a safety factor to prevent structural failure or collapse. Job sites must provide batching plants, aggregate plants, and conveyor systems equipped with mechanical dust control, water spray systems, and/or other acceptable means to keep airborne dust concentrations within acceptable exposure limits. Employees must comply with permit-required confined space and hazardous energy control procedures (see RSHS Section 14, *Confined Spaces and Permit-Required Confined Spaces (2020)*) when entering silos, storage bins, tunnels, shafts, or similar enclosed areas.
- 25.8.1.2 Bulk Storage Bins.** Bulk storage bins, containers, and silos must have conical or tapered bottoms and be able to start material flow mechanically or pneumatically.
- 25.8.1.3 Loading Skips.** Loading skips 1 cubic-yard or larger must have protective guardrails installed on each side as well as a mechanical device to clear material.
- 25.8.1.4 Bull Floats.** Where bull float handles may contact energized electrical conductors, employees must establish a hazardous energy control clearance and lock out the power to those conductors. Where bull float handles might contact energized electrical sources, the first-line supervisor must ensure the handles are nonconductive, or have an insulated sheath equivalent to nonconductive materials.
- 25.8.1.5 Powered Concrete Trowels.** Manually-guided, powered, and rotating concrete troweling machines must have a control switch or positive mechanical release device which automatically stops trowel rotation when the operator releases the equipment handle.

25.8.1.6 Concrete Buggies. Handles of concrete buggies must not extend beyond the wheels on either side.

25.8.1.7 Concrete Buckets. Concrete buckets equipped with hydraulic or pneumatically operated gates, must have positive safety latches, or similar safety devices, to prevent premature or accidental dumping. Buckets must not accumulate aggregate on the bucket's top and sides. Personnel must not ride in concrete buckets or walk/stand under buckets as they are raised or lowered into position by cranes or cableways. Operators must not route elevated concrete buckets over employees. Concrete buckets with manually operated gates must contain self-closing mechanisms. First-line supervisors and employees must maintain all buckets in structurally sound condition. A PE must approve any alterations which affect structural competency.

25.8.1.8 Transmix Trucks. Transmix trucks and concrete pumping trucks, including operating procedures, must conform with requirements set in RSHS Section 20, *Mobile and Stationary Mechanized Equipment*.

25.8.2 Masonry Construction

Employees must establish a limited access zone when erecting a masonry wall as described in paragraph 25.4.1, *Vertical work*, of this section. The supports must be able to withstand a load of at least 15 pounds per square inch.

25.8.2.1 Equipment. Employees must only use masonry saws with semicircular guard-enclosures over the blade and a slotted horizontal hinged bar mounted underneath the guard enclosure to retain fragments of shattered blades. Employees must use saws equipped with dust-control systems or provisions for wet sawing to control airborne dust concentrations.

25.8.2.2 Scaffolding. Masonry scaffolding shall have a loading capacity, at a minimum, of 50 pounds per square foot (psf). Scaffolding shall comply with RSHS Section 13, *Walking and Working Surfaces*. Facilities or job sites must provide guardrails, safety nets, or personal fall protection systems for employees working 4 feet or more above any ground or adjacent working surface.

25.8.3 Concrete Conveyance Systems

The manufacturer, or a PE, must design and certify all concrete conveyance systems and supporting equipment as safe for intended use. Only competent personnel shall assemble, operate, maintain, inspect, and test the systems in accordance with requirements set forth in

the manufacturer's instructions, PE's specifications, or the standards found in this RSHS section. Facilities or job sites must protect all operating platforms with guardrails and must guard all dangerous moving parts.

25.8.4 Reinforcing Steel

- 25.8.4.1 Lateral Supports.** Employees must laterally support reinforcing steel for walls, piers, columns, and similar structures to prevent overturning or collapse. The lateral supports for reinforcing steel must be able to withstand the forces applied during construction.
- 25.8.4.2 Rigging.** Employees must securely tie bundles of reinforcing steel together before moving by crane or cableway to prevent slipping. Employees must use two-part slings to handle steel more than 20 feet long. See RSHS Section 18, *Slings, Rigging Hardware, and Wire Rope*.
- 25.8.4.3 Impalement.** First-line supervisors or employees must eliminate the hazard of impalement by covering exposed rebar. Plastic cap coverings are not sufficient impalement protection. Employees must cover vertically protruding rebar with wood troughs or other substantial material.
- 25.8.4.4 Positioning Device Systems.** Employees must use a positioning device when working in a stationary location 4 feet, or higher, above any adjacent work surfaces or when placing and tying reinforcing steel in walls, piers, columns, etc. Employees must use a personal fall arrest system when moving on reinforcing steel higher than 24 feet above adjacent surfaces.
- 25.8.4.5 Walkways.** Reinforcing mats used as walkways must have planking to ensure safe footing.
- 25.8.4.6 Prohibited Uses.** Employees will not use reinforcing steel as guy attachments at any anchorage points for scaffolding hooks, stirrups, or as a load-bearing member of any lifting device.
- 25.8.4.7 Wire Mesh Mats.** Employees must secure wire mesh reinforcing mats at the end of each mat to prevent recoiling and secure unrolled wire mesh on each side before cutting.
- 25.8.4.8 Post Tensioning Operations.** First-line supervisors must not permit employees, except those essential to post-tensioning operations, behind the jack during tensioning operations. First-line supervisors or qualified personnel must erect signs and barricades to limit employee access to the post-tensioning area.

25.8.5 Formwork and Falsework

In addition to the specific requirements set forth in this section, the design and erection of formwork or falsework must be in accordance with the latest edition of the American Concrete Institute 347 *Guide to Formwork for Concrete*, the American Concrete Institute 318 *Building Code Requirements for Reinforced Concrete*, and the current edition of ANSI A10.9 *Safety Requirements for Masonry and Concrete Work*.

25.8.5.1 Safety Factor. Employees or qualified personnel must design, erect, brace, and maintain formwork, falsework, structural shoring, and bracing to safely support all vertical and lateral loads. First-line supervisors must incorporate the minimum safety factors as specified in ANSI A10.9 in the design and erection of all framework, shoring, falsework, and formwork accessories.

25.8.5.2 Construction Loads. Employees must not impose any construction loads on the partially completed structures unless such loading has been considered in the design, has been determined to be safe and capable of supporting the load by a PE, and is shown on the formwork design drawings or specifications.

25.8.5.3 Drawings and Plans. A PE must approve and sign detailed design calculations and working drawings for all formwork or vertical shoring installations when any of the following conditions exist:

- the height, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet,
- individual horizon span lengths exceed 16 feet, and/or
- provisions are made for vehicular or railroad traffic through the falsework or vertical shoring.

For all formwork and vertical shoring installations not discussed above, one of the following must approve and sign the formwork plan or shoring layout:

- PE,
- manufacturer's authorized representative, or
- contractor's representative qualified in using and erecting formwork and vertical shoring.

A PE must make drawings or plans showing the jack layout, formwork, shoring, working decks, and scaffolding available at the jobsite.

25.8.5.4 Form Anchors. A PE must design form anchors, which support forms and scaffolding, with a minimum safety factor of three. Employees must not impose load on form anchors or concrete anchorages until the concrete has set the minimum period set forth in paragraph 25.8.8, *Releasing and Moving Forms* of this section.

Form sections supported by form anchors must be no more than 50 feet long and employees must design and install the form anchors so no forces, incurred by form or anchorage failure, can transfer to an adjacent section.

25.8.5.5 Housekeeping. In all areas where persons must work or pass, employees must promptly remove and stockpile all stripped forms and shoring. Additionally, employees must pull or cut protruding nails, wire ties, and other unneeded accessories to avoid hazards.

25.8.5.6 Fall Protection. Employees, when working 6 feet or more above any adjacent work surface (and not protected by fixed scaffolding, guardrails, or safety net), must use a personal fall protection system. Employees working in a stationary position may use a positioning system, but only until relocating.

25.8.6 Vertical Shoring

25.8.6.1 Additional Loading. Employees must only temporarily store reinforcing rods, materials, or equipment on top of formwork if structures have been designed or strengthened to support the additional loading. Employees must not load eccentric loads on shore heads or similar members unless these members are designed for intended loading.

25.8.6.2 Sills. Sills used in shoring must be sound, rigid, and able to carry the maximum intended load.

25.8.6.3 Inspection. The first-line supervisor or project lead must conduct visual inspections of vertical work and shoring during erection, prior to use, and during use. The first-line supervisor must also ensure all equipment conforms to the shoring layout and there is no damaged equipment. The first-line supervisor or qualified personnel must immediately reinforce or reshore any damaged or weakened shoring equipment. Work shall stop if the inspection indicates critical failure potential or unmitigated hazards. Work shall resume when the first-line supervisor or project lead has addressed the issue and the hazard is abated.

25.8.6.4 Reshoring. Employees must provide reshoring when necessary to safely support slabs and beams after stripping or where such structures are subject to superimposed loads.

25.8.6.5 Removal of Shoring. Employees must only remove shoring equipment after the concrete has reached the minimum strength required in the formwork and shoring design and a PE or supervisor has inspected and approved the placement. First-line

supervisors or PEs must plan removal so as not overload in-place shoring equipment.

25.8.7 Vertical Slip Forms

A PE experienced in slip-form design must design any vertical slip forms. The first-line supervisor must make a copy of the designs available on the jobsite. The first-line supervisor must have experience with vertical slip forms and shall oversee all vertical slip form operations. The first-line supervisor must be present on the deck during slipping.

25.8.7.1 Jack Supports. A PE must design any steel rods or pipes on which the jacks climb (or by which forms are lifted) for that purpose. Employees must encase supports in concrete or anchor the supports to the ground. Supports anchored or secured by form anchors must use two or more independent form anchors, separated by a minimum of 5 vertical feet.

25.8.7.2 Vertical Loading. Employees must position jacks and vertical supports to equally distribute vertical loads. Loads must not exceed the capacity of the jacks.

25.8.7.3 Line and Plumb. Employees must keep the form structure in line and plumb during jacking operations.

25.8.7.4 Lifting. Employees must not exceed the predetermined safe rate of lift.

25.8.7.5 Bracing. Employees must provide lateral and diagonal form bracing to prevent excessive distortion of the structure during jacking.

25.8.7.6 Holding Devices. The job site must provide jacks or other lifting devices with mechanical dogs and other automatic holding devices for protection in case the power supply or lifting mechanism fails.

25.8.7.7 Scaffolding and Platforms. Vertical lift forms must have scaffolding or work platforms which completely encircle the area of placement.

25.8.8 Releasing and Moving Forms

Any form raising or moving by crane, cableway, A-frame, or other mechanical lifting device, requires a lift plan. Personnel shall not ride forms or scaffolding during lifts. Personnel shall not be directly underneath any lifted forms.

25.8.8.1 Lifting. When raising or moving forms by crane, cableway, A-frame, or similar mechanical lifting device, employees must securely attach the forms to wire rope slings with a minimum safety factor of 8. Employees must equip the panels and form

sections with hoisting brackets to attach slings and must remove loose tools and materials before moving forms. Employees must use taglines for controlling forms whenever necessary to protect personnel or structures.

25.8.8.2 Releasing. Employees must adequately brace or secure vertical and overhead forms before releasing them. Before releasing and moving forms, the first-line supervisor must relocate any employees at risk to falling materials.

25.8.8.3 Form Removal. Employees must not remove forms, shoring, or bracing until the first-line supervisor or the job lead have determined the concrete is sufficiently strong to support its weight with all loads placed on it.

25.8.9 Precast Concrete

Employees must brace precast concrete walls, structural framing, or tilt-up wall panels until after making permanent connections.

25.8.9.1 Temporary Bracing. A PE must design temporary bracing for precast concrete walls, structural framing, or tilt-up wall panels. Such bracing must provide at least 15 psf on projected surfaces.

25.8.9.2 Suspended Loads. First-line supervisors must not allow employees under precast concrete members as lifted or tilted into position.

25.8.9.3 Lifting Inserts. The lifting inserts for tilt-up concrete members must be able to support at least two times the maximum intended load. Other types of lifting inserts for precast concrete members must be able to support at least four times the maximum intended load. Lifting hardware must be able to support at least five times the maximum intended load.

25.8.10 Lift-Slab Operations

A PE experienced in lift-slab construction shall design and plan all lift-slab operations. Such plans shall include detailed instructions and design drawings which prescribe the method of erection and ensure lateral stability of the structure.

25.8.10.1 Jacks/Lifting Units. Employees must mark jacks/lifting units to show the rated capacity established by the manufacturer. Employees must not load jacks/lifting units beyond the rated capacity and must install a safety device for jacks/lifting units to ensure loads will remain supported in any position if jacks malfunction.

25.8.10.2 Jacking Operations. Operators must synchronize jacking operations so the slab will remain level at all support points to within a 0.5-inch tolerance. If leveling is

automatically controlled, job sites must install a device which will stop the operation when tolerance is exceeded or when the jacking system malfunctions. If manual controls maintain leveling, the operator must locate these controls in a central location. An experienced, competent person must attend the controls during lifting. First-line supervisors must limit the maximum number of manually controlled jacks/lifting units on one slab so the operator can maintain the slab level. The maximum number must not exceed fourteen jacks/lifting units. During jacking operations, only essential employees may remain in the building/structure.

- 25.8.10.2.1** **Wedges.** When making temporary connections to support slabs, employees must secure wedges with tack welding, or an equivalent method, to prevent them from falling out of position. Employees will only release lifting rods after securing column wedges.
- 25.8.10.2.2** **Welding.** A certified welder must perform all welding on temporary and permanent connections. Employees must not execute load transfer from jack/lifting units to building columns until the welds on the column shear plates cool to air temperature.
- 25.8.10.2.3** **Secure Installation.** Employees must secure jacks/lifting units to building columns so to not dislodge or dislocate. The PE must design, and employees must install, equipment so the lifting rods cannot slip out of position.

25.9 Definitions

Concrete Conveyance Systems	Mechanical devices used to move concrete from the receiving hopper of the delivery system to the point of use (e.g., pumps, tremies, conveyor belts, hoses).
Green Cutting	Roughening of concrete surface by using high-pressure water cutting equipment. Typically done for impermeable construction joints where material joint systems are not possible to use.
Formwork	The total system of support for freshly placed or partially cured concrete including the mold or sheathing that contacts the concrete as well as all supporting members, hardware, and bracing.
Individual Horizon Span	The distance between vertical members.
Project Lead	Designated by the first-line supervisor to oversee work on the job site.
Shoring	Temporary vertical support member in a formwork system, designed to carry the weight of the formwork, concrete, and construction loads.
Vertical Slip Form	A form raised as concrete is placed and moves vertically to form walls, bins, or slips.

25.10 References

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