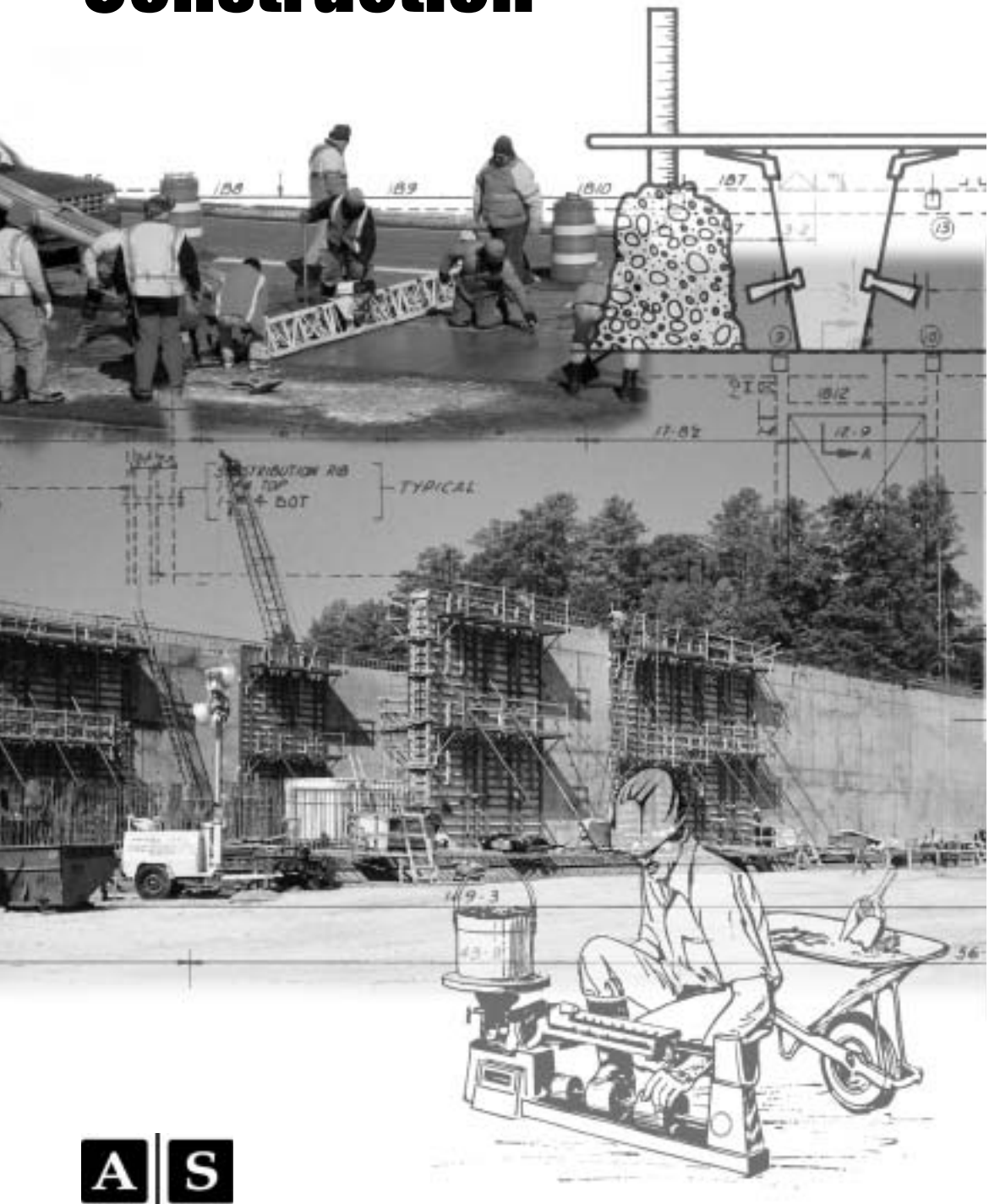
The Contractor's Guide to Quality Concrete Construction

Third Edition



AMERICAN SOCIETY OF CONCRETE CONTRACTORS

American Concrete Institute®
Advancing concrete knowledge

AMERICAN CONCRETE INSTITUTE

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Foreword
Safety

While there are many things important to concrete construction, such as quality work and making a profit, safety must always be the number one priority. For that reason, safety is in the front of this book to emphasize its importance as critical to a successful project.

Construction can be a hazardous business. With proper training procedures, hazard inspections, and rules enforcement, however, the hazards can be greatly reduced or eliminated. A well-conceived safety program is mandatory to keep everyone at the jobsite aware of possible hazards. People attracted to construction work tend to feel that they can "take care of themselves." While that may generally be true, concrete construction involves teamwork. You must consider the safety of others as you work. Without safety awareness, the self-confidence of a construction worker can create the attitude that safety regulations and protective equipment are an annoyance rather than a necessity. The "rookie" is the most feared person in construction. "Rookies" are exposed to more unknowns than those workers who are familiar with the project. Careful and complete safety training for "rookies" will produce safer and more efficient crews.

Failure to follow safety regulations and to use personal protective equipment can lead to injuries. Lost-time injuries tend to be severe, costly to both the company and the injured employee, and may even lead to a long-time or permanent reduction in a person's physical abilities.

In addition to the concern for the injured person, the company loses that person's skills and faces a potential drop in the quality of the work during the time that worker is off the job. Accidents disrupt the flow of work, causing further impacts to the project.

Most Accidents Are Not Accidents

Most accidents are preventable. Accidents are often due to carelessness in not thinking through what we are doing. You MUST plan for safety.

How many times have we used an overloaded or damaged forklift or other faulty equipment as the result of our desire to quickly complete a task? How many times have we not stopped to sand a slippery working surface, or lifted with our backs when we're tired?

Time spent for safety training is a basic cost of the construction business that pays off in increased production, lower insurance rates, and less lost time of skilled craftsmen. The full cost of accidents will far exceed the costs of a good safety program. Safety can be a profit center in both human and financial terms.

The Need for a Company Safety Program

This chapter is not a safety manual for concrete construction. The American Society of Concrete Contractors has published the *ASCC Safety Manual* that everyone working in concrete construction should read and periodically reread. You should also be familiar with the regulations of appropriate governmental agencies, especially those of the Occupational Safety and Health Administration (OSHA).

Every concrete project is unique. Casting a slab on ground is quite different from casting the 40th floor of a high-rise office building. Each has dangers that can be avoided, if we are aware of those dangers. That is why, in addition to the *ASCC Safety Manual*, every contracting firm must develop a written safety policy that sets out clear lines of authority for training new personnel and retraining long-term personnel in safety regulations and procedures related to their construction specialty, and in hazard recovery.

Every company is responsible for providing safe working conditions, and every person is responsible for following the safety rules of their company and making safety a part of their job. Helping new employees adjust to the specific dangers of the jobsite through training and mentoring are components of a successful safety program.

Concrete Construction

The following list of things to watch out for on a concrete construction jobsite is not intended to be comprehensive. This listing does, however, serve to alert you to *some* of the more common safety concerns of concrete construction:

- Fresh concrete can cause eye injuries and skin burns. When working with fresh concrete, wear protective clothing (long-sleeved shirt, rubber boots, and rubber gloves) and eye protection to avoid getting fresh concrete on your skin or in your eyes. If you do get fresh concrete on your skin, wash it off with clean water. Have eye wash solution on the job. Should concrete splash in your eye, flush the eye with clean water immediately, and obtain prompt medical attention. Think ahead. Have a supply of clean water and eye wash solution available whenever concrete placement is scheduled. And remember that the tool clean-off bucket is not clean water.
- Among concrete workers, the most common skin disorders are dry skin, irritant contact dermatitis, allergic contact dermatitis, and cement burns. The best way to keep skin healthy is to wear gloves and practice good hygiene. Wash your hands 2 to 4 times a day and whenever you remove your gloves, using pH-neutral or slightly acidic soap. Placement crew members should wear long-sleeved shirts and long pants, protective goggles or face shields, hardhats, chemical-resistant gloves, and over-boots. Finishers should wear long pants, work boots, knee pads (and use knee boards), and gloves. Immediately remove clothing that has become saturated with wet concrete.
- Keep your fingers away from the metal joints of a ready-mix truck chute. These are heavy! Should a finger be caught in the gap of the joint as the heavy chute is dropped from its folded, stored position, it can slice through a finger like scissors through cloth.
- The simple use of personal protection equipment (PPEs) can save workers from the short-term and long-term effects of construction site conditions (hard hats, gloves, boots, eye protection, fall protection, respirators, etc.). Have PPEs available and wear them!
- Safety glasses or goggles must be worn whenever there is the possibility of getting anything in your eyes.
- Ear plugs must be used when the noise level gets to the point where you have to raise your voice to speak to the person working next to you. It doesn't take much exposure to noise to permanently damage your hearing.
- Dust masks or respirators must be worn whenever there's a chance of inhaling dirt, dust, chips, or mist; when you are cutting, grinding, or chipping hardened concrete; or when you are mixing epoxy or grout. Be sure to ask for training in the selection and use of a proper respirator. Another solution to this problem is to use wet methods, or "dustless" vacuum tools.
- Ladders and stairways are a major source of injuries and fatalities among construction workers. Employers should ensure that employees are trained by a competent person in the nature of fall hazards; the correct procedure for erecting, maintaining, and disassembling fall protection systems; proper construction, use, placement, and care in handling stairways and ladders; and the maximum intended load-carrying capacity of ladders.
- Do you know how to properly set an extension ladder? The distance along the ground from the bottom of the ladder to a point beneath where the ladder is supported near its top should be about a quarter of the length of the ladder. If the slope is flatter than that, the ladder can easily become overloaded. If it's steeper, the ladder can fall. The ladder must be secured at both the top and bottom against displacement.
- Scaffolding should be solidly constructed, even if it is to be used only for a short time. Be sure uprights are uniformly spaced, plumb, and set on a good solid foundation. Use horizontal or diagonal bracing for stability. Planking should overlap the support by a minimum of 12 in. Scaffolding should be tied to walls, buildings, or other structures. A competent person should inspect the scaffolding daily.
- The most hazardous moment when working at heights is when you are moving from place to place. That's why you need to always be tied off to something substantial—something that can support a dead weight of 5000 lb. Any time you go over a guardrail to perform work, you must be tied off. Fall protection should also be worn when working at ground level around open excavations 6 ft or more in depth. Be sure to place guardrails around openings in decks.
- When welding or burning metal embedded in concrete, wear eye and face protection to protect yourself from flying pieces of concrete. Concrete can spall off, almost explosively, when heated by a torch.
- Treat compressed gas cylinders with respect. Secure the cylinders upright by tying them off or using other means to prevent them from moving freely.

- Use ground-fault circuit interruption devices at all times when using vibrators and other electrical tools. Wet concrete and water are excellent conductors. These devices will prevent electrocution.
- Electrical cords and tools must be inspected daily and repaired or replaced if damaged. Protect electrical cords by placing them in protected areas or by covering them with protective material.
- Keep the jobsite clean—even if it's not your job. It's far better to pick it up than to fall over it. A clean jobsite sets the tone for efficiency and quality workmanship.
- "Of all heavy equipment, mobile cranes are the least forgiving of misuse, abuse, and neglect," according to *Construction Equipment* magazine (June 1985). Stay out from under suspended hooks and loads. Think of the swing area as no-man's land and stay away.
- Make sure that wire rope, slings, shackles, and other lifting devices are sized correctly and inspected thoroughly before using. If something breaks under a lifting load, a lot of energy can be released. A flying cable can remove an arm or leg in an instant.
- Never walk underneath a load being lifted.
- To avoid electrocution, never touch a piece of equipment that is working near power lines.
- Do not allow pump trucks, cranes, forklifts and other equipment with high profiles to work within 15 ft of 50,000 kv or lower electrical lines. Higher voltage lines require even greater distances.
- Make sure that the person guiding a pump operator knows and uses the standard hand signals developed by the American Concrete Pumping Association.
- Watch where you are walking to avoid falls. If you see a board with nails sticking up, stop and pull them out or bend them over to prevent someone from stepping on a nail.
- Bend with your knees and lift with your legs, not your back.
- Lift only what you can comfortably handle. Get help with heavier or bulky items.
- Check equipment and tools before each shift to ensure they are in proper working condition.
- Keep the material safety data sheets (MSDS) for the chemicals on your project up-to-date and easily accessible. Have employees review this information before using new products on site.

Please remember, accidents don't just happen—they are caused. They are more often than not the results of poor planning, improper training, or not thinking through each of your work activities. For example, if you throw a chain up and over a beam, think about where the hook on the free end is going to swing and move out of the way before it does!

Experience Modification Rating and Incident Rate

The cost of workers' compensation insurance is directly affected by your company's accident history. When an employee is injured, the costs are added to the company's experience modification rating (EMR). Accidents can increase a company's EMR to where it significantly increases their workers' compensation insurance rates. A large component of any company's insurance rates are the cost of past claims. This cost can be controlled. Effectively implemented, a safety program can help to reduce insurance rates and make a company more competitive and more profitable.

Another measure of safety is the incident rate, a nationally recognized number that equalizes the accident rate for firms of all sizes. The incident rate represents the number of lost workdays for 100 employees working

40 hours per week for 50 weeks per year. The incident rate is calculated as the number of lost workday cases from a company's OSHA Form 300, Log of Work-Related Injuries and Illnesses, times 200,000, divided by the number of total work hours in a calendar year. Expressed as an equation

$$IR = (N \times 200{,}000) \div WH$$

where:

IR = incident rate

N = number of lost workday cases away from work for both injuries and illnesses. This number is the sum of the check marks in column H on OSHA Form 300.

WH = the total number of work hours for the company in a calendar year, which includes everyone on the payroll, hourly and non-hourly, including overtime.

For example, the incident rate for a company that has 10 lost workday cases and 40,000 work hours is

$$IR = (10 \times 200{,}000) \div 40{,}000 = 50$$

Recommended Reading

ACI Committee E 703, "Formwork Safety," Topic 24, *Toolbox Meeting Flyers 2*, American Concrete Institute, Farmington Hills, Mich., 1998.

ASCC Safety Bulletins, The American Society of Concrete Contractors, St. Louis, Mo.

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Occupational Health and Safety Administration, www.osha.gov.

PCI Erectors Committee, *Erection Safety for Precast and Prestressed Concrete,* Precast/Prestressed Concrete Institute, Chicago, Ill., 1998.

Pump Safety, American Concrete Pumping Association.

"Safety Basics Posters," 18 x 24 in. posters on safe construction practices, Hanley Wood, Addison, Ill.

"Skin Safety with Cement and Concrete," Training Videos, Portland Cement Association, Skokie, Ill., 1998.

Contents

Chapter 1:
Organizing for Quality

The American Society of Concrete Contractors and the American Concrete Institute are dedicated to continually improving the quality of concrete construction through experience, sharing, and education.

Quality concrete construction is achievable when all levels of management insist on quality and all employees know what is expected of them. It is always less costly to build it right the first time.

How does the employee know that quality is a basic company requirement? When he is trained in what is expected of him and when he sees poor workmanship or materials removed and replaced voluntarily by the company regardless of the cost.

Consistent quality construction can only occur when each person knows that he/she has been properly trained and is expected to produce quality work. Quality construction then becomes the norm rather than the exception.

Quality Control

Although everyone should be aware of their quality responsibilities, there must be a system of quality control, including inspections.

Inspection does not take responsibility away from the construction worker. It provides management with a measure of the level of quality and the data for improving the system.

Every contractor, no matter the size of the company, should feel personally responsible for quality and must instill the feeling in each employee that, "We do quality construction and are proud of each of our projects."

One of the first tasks of management for any size company is to develop a written plan for quality control including which parts of each phase of a project are critical to quality, when they should be checked, and by whom. A checklist can then be developed for inspection by the quality control personnel or, in a small firm, the knowledgeable person who will do the inspection.

The number of people devoted to quality control will vary with the size of the job and its complexity. People must be available to verify that materials arriving at the jobsite meet project specifications.

Qualified personnel must be available to complete required inspections on time with minimum delay of work crews.

Ideally, every jobsite should have at least one American Concrete Institute (ACI) Grade I Certified Technician available.* ACI certification programs are designed to provide the basis for training and certifying experienced personnel, alleviate problems related to improper job practices, upgrade the quality of concrete construction, and prepare the industry for possible future mandatory certification requirements. Several technician, inspector, and craftsman programs are available for sponsorship by local, state, and national organizations.

For the small concrete contractor, only one or two qualified persons may be required to handle quality control. As a company grows, or when several jobs are underway, more people can be added until an organized quality control department is in place.

Even with one quality control person, there should be a clear sense of organization. The quality control people should report to company management, not to jobsite management. The reason? The person responsible for jobsite schedules often faces conflicts between the goals of quality construction and meeting a tight completion schedule.

Quality control should not be dependent on schedule, and a schedule should not be delayed by a lack of quality

*Contact ACI at (248) 848-3700 for information on Certification classes to be held in your area.

control personnel. The quality control effort, however, works best when it is in tune with the construction team's schedule demands.

To build this harmony, management needs to participate in meetings of the quality control personnel, the foremen, and their crews on quality shortcomings. The purpose of quality control meetings should be to pinpoint inadequate procedures and equipment, and to improve the knowledge and skills of the people doing the work.

Management should use these meetings to strengthen the purpose of the quality control program—that is, to improve quality, not to pin the blame for lapses in quality on a particular person or department.

Improved quality means more business for the company, lower costs (it is less costly to build it right the first time), and continued employment for construction workers and quality control personnel.

Record Keeping

A good quality control program will include organizing a complete and accurate record of operations. A recorded diary of a construction project is extremely valuable, especially when a problem develops. Daily photographs, properly dated, can also be beneficial.

In general, records of the following construction operations should be included in the quality control system:

- Identification, examination, acceptance, and testing of materials and subassemblies.
- Inspection prior to casting concrete, including a check of form dimensions, size and position of reinforcing or prestressing steel, joint materials, inserts, form condition, cleanliness of reinforcement, shoring and support for forms, and the condition of soil in excavations.
- Preparation of concrete specimens and their proper storage while awaiting testing. Performance of tests for slump, compressive or flexural strength, air content, and density (unit weight).
- A quality project will require the care and coordination of embedded materials (weld plates, piping, conduit, floor drains, sleeves, openings) in both horizontal and vertical concrete work.
- The quality of a concrete project can be greatly improved through the use of concrete coordination drawings (lift drawings or shop drawings) to assist in the location, routing, temporary support, sealing, construction joints, anchor bolts, reinforcing steel, weld plates, piping, conduit, grounding, floor drains, plumbing, sleeves, openings, and blockouts. It is extremely important to assure that architectural concrete surfaces and floor tolerances (F-numbers) be apparent on the drawings.
- Inspection of form removal, and finishing of formed and unformed surfaces. (Quality control personnel should know that it is good practice to remove interior forms first. This relieves pressure on the outside corners, reducing the chance of cracking the corners during form removal.)
- General observation of equipment, working conditions, weather, and other items that could affect the long-term durability of the concrete. Curing and protection from the elements should also be observed. Temperature records are particularly important.
- Records should be kept on materials testing; concrete proportions; placing, finishing, and curing of concrete; size, placement, and cover over steel reinforcement; details on welding that may affect quality; plus details on subgrade preparation for slabs on ground and foundation footings. A checklist can provide a record of such inspections.
- The owner's representative, after witnessing or making an inspection required by the specifications, should sign the inspection report, including a statement describing what was inspected, when, and what action is required. This should become a part of the job records.
- Prepare and periodically update a pre-construction checklist (refer to Chapter 9 for an example).

Contract Documents

The purpose of a concrete construction quality control organization is to ensure that the project is being constructed in compliance with plans and specifications (the contract documents).

Contract documents are a part of a legal, binding contract and must be treated with high regard. The purpose of contract documents is to ensure that the quality of workmanship, tolerance control, or materials needed for the finished construction are as specified, and will produce construction that will perform as intended by the designer.

Sometimes contract documents may conflict with local practice or the experience of the contractor. Should a contractor find that the quality of the project as specified cannot be achieved, he should seek a meeting with the designer to fully discuss the issue. All such meetings, and the decisions reached, should be recorded and kept with the contract documents.

Quality and Profit

Every concrete contractor faces two choices regarding quality. He can pay the controlled cost of a quality control system designed to provide the appropriate level of quality, or the uncontrolled costs associated with low-quality work.