Chapter 1: Introduction

Table of Contents

1-1 Purpose and Scope

The *Reinforced Concrete Construction Manual* has been issued by the Department of Transportation's Division of Engineering Services (DES), Structure Construction (SC). The intended purpose is to provide an educational resource and administrative support to SC staff who are in responsible charge of the construction of reinforced concrete structures on State highway projects. Proper use of the *Reinforced Concrete Construction Manual* requires a thorough understanding of the principles of civil engineering design and construction, and familiarity with the relevant contract documents and *Contract Specifications*.

The scope of this manual is to provide a resource for typical construction of reinforced concrete structures on State highway projects and is not intended to cover all possible scenarios. Engineering judgment will be required to determine the applicability of this manual to any specific reinforced concrete structure or member.

1-2 Reinforced Concrete

Concrete is the most widely used construction material in the world, with Portland Cement Concrete (PCC) being the most common type. The key materials needed to produce concrete – rock, sand, water, admixtures, and cement – are abundant and relatively inexpensive. Cement itself is produced largely from limestone, one of the most abundant minerals on Earth.

Additionally, byproducts from industrial processes such as fly ash, blast furnace slag, and silica fume – which would otherwise constitute a waste disposal challenge – can be incorporated into PCC. These materials, known as Supplementary Cementitious Materials (SCMs), partially replace cement in the concrete mix and may enhance the concrete properties. While most SCMs are industrial byproducts, some, such as natural pozzolans and metakaolin, are naturally occurring materials.

With proper material selection, including the use of non-reactive aggregates and suitable admixtures, concrete remains a cost-effective, low-maintenance material that is known for its durability and high compressive strength. It is a versatile building material that has been used in virtually every type of civil infrastructure.

One limitation of concrete is its relatively low tensile strength. As a result, its early use was generally limited to heavy, short-span, compression-based structures such as arches. This limitation was addressed with the development of reinforced concrete. Reinforced concrete is a composite material that incorporates a high tensile strength material, typically bar reinforcement, into a PCC matrix. The result is a material that efficiently resists both compressive and tensile forces, leading to its widespread use in

bridge construction. Further enhancements to basic reinforced concrete, such as the development of prestressing technology and the addition of specialty admixtures to the basic components described above, have further extended its viability. Today, reinforced concrete is ubiquitous in bridge construction. Even structures with major structural steel components also extensively incorporate reinforced concrete.

1-3 Statement of Structure Construction Policy

SC policy is to construct reinforced concrete structures to the highest quality standards while ensuring the work is carried out in a safe, controlled manner that protects the public, workers, and the environment. This is accomplished by a comprehensive review and authorization process for applicable shop drawings and work plans. This is further achieved by verifying that the details and requirements of all authorized shop drawings, work plans, and contract requirements are properly implemented in the field, with an emphasis on the use of best construction practices.

1-4 Contract Specifications and References

Some of the key requirements for the construction of reinforced concrete structures can be found in the following *Contract Specifications* and references:

1. Caltrans *Contract Specifications*:
    a. Section 5, *Control of Work*:
        i. Section 5-1.02, *Control of Work – Contract Components*: Item 1.6 – *Supplemental Project Information*, includes permits and agreements negotiated by the State that are part of the contract and can include work and restrictions that can have a major impact on the means and methods used to construct reinforced concrete structures.
    b. Section 6, *Control of Materials*
        i. Outlines various requirements of materials to be incorporated into the project, including processes for documentation, testing, and acceptance. This section also includes requirements for material sources and facilities that are authorized for Caltrans projects.
    c. Section 7, *Legal Relations and Responsibility to the Public*:
        i. Contains provisions related to public safety and references applicable Cal/OSHA requirements.
    d. Section 12, *Temporary Traffic Control*:
        i. Specifies requirements for maintaining temporary access routes for pedestrians during construction.
    e. Section 14, *Environmental Stewardship*:

i. Emphasizes environmental consideration in the design and construction of bridges and other transportation structures, since many are either habitat for biological resources or are adjacent to such habitat.

f. Section 51, *Concrete Structures*

i. Provides requirements for constructing structural concrete facilities such as concrete bridges and their various components, retaining walls, etc. Minor concrete facilities, such as curb and gutter, are not necessarily covered. Some material requirements are also addressed.

g. Section 52, *Reinforcement*

i. Covers the fabrication and installation of reinforcement, typically bar reinforcing steel.

h. Section 83, *Railings and Barriers*

i. Provides requirements for constructing railings and barriers, including concrete barriers to be constructed on bridges and other structures.

i. Section 90, *Concrete*

i. Details material specifications for various types of concrete, including structural concrete. Also includes provisions for quality control, curing, and protection.

2. Project *Special Provisions*:

a. Define project-specific requirements and restrictions above and beyond what are in the *Standard Specifications* and will frequently include requirements outlined in the project permits and agreements.

3. *Information Handout*:

a. Contains supplemental project-specific permits and agreements, including railroad and other stakeholder agreements, environmental permits, foundation report, asbestos report, and lead report when applicable.

1-5 Cal/OSHA References

There are many specific Cal/OSHA regulations related to the construction of reinforced concrete structures, and those references will not be covered in this section specifically. Rather, this section highlights some general areas of importance regulated by Cal/OSHA in relation to the construction of reinforced concrete structures, some of which will be discussed in this manual. Key hazards and safety concerns associated with the construction of reinforced concrete structures that are addressed in various safety regulations include:

1. Falls from elevated work areas
2. Formwork and falsework design, installation, and removal

3. Impalement hazards
4. Concrete placement operations
5. Public safety
6. Heavy construction equipment and traffic.

1-6 Definitions and Acronyms

Americans with Disabilities Act (ADA) – Federal civil rights law that prohibits discrimination against individuals with disabilities in all areas of public life. It requires public and private entities to provide reasonable accommodations and ensure accessibility in transportation, employment, and public spaces. It became law in 1990.

As-built Drawings – Historical record and detailed documentation of the final constructed state of a bridge or other structure, including any deviations from the original design and modifications implemented during construction, maintenance, or retrofit. May be referred to as “as-builts”.

Accelerated Bridge Construction (ABC) – Bridge construction methods that use the most efficient combination of innovative planning, design, materials, and construction techniques to significantly reduce construction related impacts by reducing the number of onsite construction days and/or minimizing traffic disruption.

APA – The Engineered Wood Association, formerly known as the American Plywood Association. A nonprofit trade association comprised of structural wood product manufacturers and experts. They develop and maintain performance standards, testing methods, and certification programs for the industry.

ASTM – ASTM International, formerly known as American Society for Testing Materials. An international nonprofit organization that develops and establishes standards for a variety of products and processes.

Authorized Material List (AML) – A catalog of products that meet the requirements set in the *Contract Specifications* and are prequalified and preauthorized for use on Caltrans construction projects. It includes authorized products for mechanical couplers (service and ultimate splice systems), concrete admixtures, cementitious materials, etc.

Bar Reinforcement – Steel bars cast into concrete structures to improve structural integrity, primarily by enhancing resistance to tensile forces. Also referred to as bar reinforcing steel, reinforcing bar, reinforcement, and rebar.

Bulkhead – Formwork that acts as a vertical barrier or edge for a concrete pour, confining the concrete placed during a concrete pour to a specific area. It may function to separate different sections of a concrete structure, such as at a construction joint.

Cal/OSHA; California Department of Industrial Relations, Division of Occupational Safety and Health (DOSH) – Regulatory agency within the California Department of Industrial Relations responsible for protecting and improving the health and safety of workers in California.

Construction Safety Orders (CSO) – Regulations that outline safety standards and requirements for the construction industry. The CSO are part of the California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 4, and are enforced by Cal/OSHA.

Constructability Review – Iterative review of project plans, specifications, and estimate, performed at various stages during project development. The purpose is to assure that these documents effectively define the project, are free of conflicts, and are both biddable and buildable using current industry means, methods, and technologies. Refer to Bridge Construction Memo (BCM) D-2, *SC Responsibilities for Constructability Review*, for additional information.

Construction Joint – Interface between separate, adjoining concrete placements.

Contract Documents – Combined documents described in *Standard Specifications* Section 5-1.02, *Control of Work – Contract Components*, including the standard specifications, revised standard specifications, special provisions, supplemental project information, project plans, standard plans, change orders, permits, licenses, agreements, and certifications that encompass the definition and scope of work as agreed to by Caltrans and the Contractor.

Contract Specifications – Portion of the contract documents that include the special provisions, revised standard specifications, and standard specifications.

Cross Slope – Slope that is perpendicular to the direction of travel. It is transverse (or radial) with respect to the centerline of bridge or roadway. Also known as crossfall or superelevation.

Division of Engineering Services (DES) – Division and lead project delivery organization of Caltrans responsible for the design and construction engineering/ contract administration of bridges and other transportation structures within Caltrans right-of-way. This includes oversight of bridges constructed by other agencies within Caltrans right-of-way or by other agreement outside Caltrans right-of-way.

Data Interchange for Materials Engineering (DIME) – Online database developed by Caltrans Materials Engineering & Testing Services (METS) for contractors and Caltrans staff to input sample information and test data, including data for concrete materials.

Epoxy-Coated Prefabricated Reinforcement – Bar reinforcement that is cut to the specified length and bent to the required shape prior to being epoxy coated and may not be bent after coating.

Falsework – Temporary structure used to support the permanent structure until it becomes self-supporting.

Gang Forms – Large, prefabricated panels designed to be hoisted and placed as a unit during concrete forming.

Holiday – Discontinuity or incomplete section in a coating. It may or may not be discernible to a person with normal or corrected vision.

Hopper – Container or funnel-shaped device used to hold and help convey poured concrete in a controlled manner from one location to another, typically used in combination with equipment like a concrete pump, truck mixer, or chute.

Lift – In terms of concrete placement, a horizontal layer of poured or placed concrete. Subsequent lifts, or layers, may be placed on top.

Lot of Material – Quantity of material, as defined in the *Contract Specifications*, for the specific material, treated as a single unit for sampling purposes. For example, a "lot" of bar reinforcement splices is one hundred and fifty (150), or fraction thereof, of the same coupler model for each bar size, deformation pattern, and hoop diameter. Also referred to as a "lot".

Materials Engineering and Testing Services (METS) – Subdivision within Caltrans DES. METS performs material inspection services on behalf of the Resident Engineer, typically at the place of fabrication, and authorizes the shipment of materials from the fabrication shop to a construction project.

Operator and Procedure Prequalification – Requirement of the splice prequalification report; splice operators and procedures must be certified. Splice test samples must be prepared and tested no more than two (2) years before the submittal.

Patching Material – For epoxy-coated reinforcement, liquid two-part epoxy coating used to repair areas of damaged epoxy coating.

Precast/Prestressed Concrete Institute (PCI) - Trade institute and association representing the precast and prestressed concrete industry. It plays a key role in developing and maintaining technical standards, and promoting the use of precast concrete in construction.

Prefabricated Bridge Element (PBE) – Single prefabricated structural component of a bridge assembled in place, typically using ABC methods. It is feasible to use PBEs in a bridge system installation.

Resident Engineer's Pending File (RE Pending File) – Compilation of project guidance and information collected by the project engineer(s) necessary to administer a construction contract. For projects with structures work, project engineers from the

District and DES compile and distribute the RE Pending File components separately. Refer to BCM C-2, *Using the Resident Engineer's Pending File for Structure Work*, for additional information.

Running Slope – For pedestrian facilities, the slope that is parallel to the direction of travel. Also known as profile slope or profile grade for a bridge or roadway.

Splice Prequalification Report – Report that documents the contractor's proposed splicing system, splice locations, splicing operators, and certified splice test results for bar reinforcement.

Structure Maintenance & Investigations (SM&I) – Subdivision within Caltrans Maintenance responsible for inspecting and recording condition data, load rating analysis, and the preservation of in-service state and local agency owned bridges and tunnels.

Skew – In terms of bridges, angle between the centerline of bridge and centerline of supports (e.g., bent or abutment). Bridges with supports that are not transverse with respect to the bridge centerline are typically referred to as "skewed".

Soffit – Underside of a structure, commonly associated with the underside of a concrete box girder bridge.

Splicing Quality Control Manager (QCM) – Contractor designated person who is responsible for both field and administrative work regarding the quality of all service splices or ultimate butt splices for bar reinforcement.

Structure Construction (SC) – Subdivision within Caltrans DES responsible for the administration of bridge (and other structures) construction contracts within Caltrans right-of-way or oversight thereof. This subdivision provides engineering oversight for construction projects throughout California, ensuring that projects are built in compliance with plans and specifications.

Tailgating – Method of placing concrete directly from the concrete truck mixer, conveyed using the truck-mounted chute, into its final location.

Tining – Surface finishing technique for bridge deck and roadway surfaces, used to provide grooved texture on concrete surfaces while the concrete is plastic.