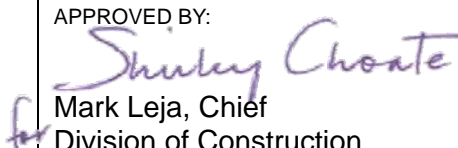


MANUAL CHANGE TRANSMITTAL		NO. 13-10
TITLE: Department of Transportation <i>Construction Manual</i>	APPROVED BY:  Mark Leja, Chief Division of Construction	DATE ISSUED: June 28, 2013
SUBJECT AREA Table of Contents and various sections of the <i>Construction Manual</i>	ISSUING UNIT Division of Construction	
SUPERSEDES CPD 01-15	DISTRIBUTION All Requested Manual Holders	

This manual change transmittal delivers the revisions of the Chapter 4, Sections 12, 56, 75, and 90 of the *Construction Manual*. Updated sections may contain updated language, information, corrections, and references resulting from updates to the 2010 *Standard Specifications*, and from policy, and procedural changes. Change bars in the margins of the revised sections indicate text that was changed or added.

Please update your manual according to the table below.

Section	Incorporates	Remove Old Page(s)	Insert New/Revised Page(s)
Table of Contents	None	TOC.1 and TOC.3	TOC.1 and TOC.3
Goldenrod, Chapter 4, Section 12, "Temporary Traffic Control"	None	4-12.i thru 4-12.ii	4-12.i thru 4-12.ii
Chapter 4, Section 12, "Temporary Traffic Control"	None	4-12.1 thru 4-12.11	4-12.1 thru 4-12.14
Goldenrod, Chapter 4, Section 56, "Signs"	CPD 01-15, "Overhead Sign Structures"	4-56.i	4-56.i
Chapter 4, Section 56, "Signs"	None	4-56.1 thru 4-56.4	4-56.1 thru 4-56.5
Chapter 4, Section 75, "Miscellaneous Metal"	None	4-75.1 thru 4-75.2	4-75.1 thru 4-75.2
Goldenrod, Chapter 4, Section 90, "Concrete"	None	4-90.i	4-90.i

Section	Incorporates	Remove Old Page(s)	Insert New/Revised Page(s)
Chapter 4, Section 90, “Concrete”	None	4-90-1 thru 4-90.16	4-90-1 thru 4-90.15

Section 4-12 Temporary Traffic Control

- Updates references to align with 2010 *Standard Specifications*.
- Adds language related to the “Maintaining Traffic” section of the 2010 *Standard Specifications*.
- Adds language regarding lane closure requirements.

Section 4-56, “Signs”

- Updates references to align with 2010 *Standard Specifications*.
- Provides web address for applicable Structures manuals.
- Eliminates CPD 01-15, "Overhead Sign Structures," because it is obsolete.

Section 4-75, “Miscellaneous Metal”

- Updates references to align with 2010 *Standard Specifications*.
- Includes web address for applicable Structures manuals.

Section 4-90, “Concrete”

- Updates references to align with 2010 *Standard Specifications*.
- Update cross reference within *Construction Manual*.
- Includes guidance for SSPs 90-1.02G(6), 90-1.02(H), 90-1.02I(2), 90-2.02B, 90-5.01 and 90-6
- Reorganized to include guidance on specialty concretes such as rapid strength concrete, precast concrete, self-consolidating concrete and light-weight concrete. Format aligns with 2010 Standard Specifications.
- Adds clarification for recycled concrete.
- Modified to eliminate design of concrete mix designs by Caltrans. Adds guidance on how to check contractor's concrete mix designs.
- Updates concrete material requirements throughout (e.g., cementitious materials must be on authorized material list).
- Adds guidance on authorized field addition of water to concrete

CONSTRUCTION MANUAL**TABLE OF CONTENTS***Chapter-Section***1 Caltrans Construction Organization**

1-0 Construction Manual Overview**1-1 Construction Organization****1-2 Public Relations****1-3 Personnel Development****1-4 Facilities and Equipment****1-5 Field Expenses and Purchases****2 Safety and Traffic**

2-1 Safety**2-2 Traffic****2-3 Major Construction Incidents****3 General Provisions**

3-0 Introduction**3-1 General****3-2 Bidding****3-3 Contract Award and Execution****3-4 Scope of Work****3-5 Control of Work****3-6 Control of Materials****3-7 Legal Relations and Responsibility to the Public****3-8 Prosecution and Progress****3-9 Payment****4 Construction Details**

4-00 Introduction**4-10 Dust Control****4-11 Quality Control and Assurance****4-12 Temporary Traffic Control****4-15 Existing Highway Facilities**

CONSTRUCTION MANUAL**TABLE OF CONTENTS***Chapter-Section*

4-64	Plastic Pipe
4-65	Concrete Pipe
4-66	Corrugated Metal Pipe
4-67	Structural Metal Plate Pipe
4-68	Subsurface Drains
4-69	Overside Drains
4-70	Miscellaneous Drainage Facilities
4-72	Slope Protection
4-73	Concrete Curbs and Sidewalks
4-74	Pumping Equipment and Controls
4-75	Miscellaneous Metal
4-80	Fences
4-81	Monuments
4-82	Markers and Delineators
4-83	Railings and Barriers
4-84	Traffic Stripes and Pavement Markings
4-85	Pavement Markers
4-86	Electrical Systems
4-88	Geosynthetics
4-90	Concrete
4-91	Paint
4-92	Asphalts
4-93	Liquid Asphalts
4-94	Asphaltic Emulsions
4-95	Epoxy

5 Contract Administration

5-0	Conduct of the Work
5-1	Project Records and Reports
5-2	Funds
5-3	Contract Change Orders
5-4	Disputes

Section 12 Temporary Traffic Control

4-1201 General

4-1202 Before Work Begins

- 4-1202A Flaggers
- 4-1202B Barricades
- 4-1202C Flashing Arrow Signs
- 4-1202D Portable Delineators
- 4-1202E Portable Flashing Beacons
- 4-1202F Construction Area Signs
- 4-1202G Channelizers
- 4-1202H Type K Temporary Railing
- 4-1202I Traffic Cones
- 4-1202J Traffic Plastic Drums
- 4-1202K Portable Changeable Message Signs
- 4-1202L Impact Attenuator Vehicle
- 4-1202M Temporary Traffic Screen
- 4-1202N Temporary Crash Cushion Module
- 4-1202O Temporary Signal System
- 4-1202P Maintaining Traffic

4-1203 During the Course of Work

- 4-1203A Flagging
- 4-1203B Barricades
- 4-1203C Flashing Arrow Signs
- 4-1203D Portable Delineators
- 4-1203E Portable Flashing Beacons
- 4-1203F Construction Area Signs
- 4-1203G Channelizers
- 4-1203H Type K Temporary Railing
- 4-1203I Traffic Cones
- 4-1203J Traffic Plastic Drums
- 4-1203K Portable Changeable Message Signs
- 4-1203L Impact Attenuator Vehicle
- 4-1203M Temporary Traffic Screen
- 4-1203N Temporary Crash Cushion Module
- 4-1203O Temporary Signal System

4-1203P Maintaining Traffic

4-1203P (1) Field Adjustments

4-1203P (2) Placement Sequence and the Start of Work

4-1203P (3) Drive-Through Inspection

4-1203P (4) Maintenance

4-1203P (5) Reverse Operations Inside Closures

4-1204 Measurement and Payment

4-1204A Flagging

4-1204B Barricades

4-1204C Flashing Arrow Signs

4-1204D Portable Delineators

4-1204E Portable Flashing Beacons

4-1204F Construction Area Signs

4-1204G Channelizers

4-1204H Type K Temporary Railing

4-1204I Traffic Cones

4-1204J Portable Changeable Message Signs

4-1204K Temporary Crash Cushion Module

4-1204L Temporary Traffic Screen

4-1204M Temporary Signal System

4-1204N Traffic Plastic Drums

4-1204O Traffic Control System

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 12 Temporary Traffic Control

Section 12 Temporary Traffic Control

4-1201 General

4-1201 General

This section provides guidelines for inspecting temporary traffic-handling equipment and devices in construction areas. Section 2-2, “Traffic,” of this manual provides guidelines and a general overview of providing a safe and convenient passage of public traffic through the construction area and is complementary to this section. Engineers who administer the provisions in Section 12, “Temporary Traffic Control,” of the *Standard Specifications* must be familiar with both Section 2-2 and this section of the manual.

Engineers administering traffic control must also be familiar with the current *California Manual on Uniform Traffic Control Devices (California MUTCD)*. If a discrepancy occurs between the contract plans and specifications and the *California MUTCD*, the plans and specifications govern.

Temporary traffic control devices are divided into categories:

- Category 1 devices include traffic cones, plastic traffic drums, portable delineators, and channelizers.
- Category 2 devices include barricades and portable sign supports.
- Category 3 devices include crash cushions, impact attenuator vehicles, temporary railing, temporary barrier, and end treatments for temporary railings and barriers.

4-1202 Before Work Begins

4-1202 Before Work Begins

Take the following general steps before work begins:

- To obtain a thorough understanding of the project’s traffic control needs and requirements, review the plans; special provisions; *Standard Specifications*; *Standard Plans*; and Part 6, “Temporary Traffic Control,” of the *California MUTCD*.
- Determine what signs must be placed before work begins for the entire project and before work begins for each stage of the project.
- Determine the methods and equipment the contractor will use for closing lanes, ramps, and roadways, and for flagging and controlling one-way traffic.
- Note the various traffic control devices specified to be used. Some of these devices will require certificates of compliance. Signage and delineation materials listed in the special provisions must be listed on the Caltrans authorized materials list for signing and delineation materials and must be covered by certificates of compliance. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

- Obtain self-certification for crashworthiness of Category 1 temporary traffic control devices.
- Request a list of Category 2 temporary traffic control devices to be used on the project.
- Visually inspect all traffic control devices to ensure conformity with the specifications. If you approve the devices for use, record the approval in the daily reports.

4-1202A Flaggers

Discuss any flagging operation with the contractor before the operation begins. Ensure flaggers will wear the appropriate flagging apparel and are trained in accordance with the *California MUTCD* and the *Construction Safety Orders*. Review with the contractor how flaggers will communicate with each other, with pilot cars, and with workers inside the controlled area. The contractor should develop a plan for handling emergencies and emergency vehicles in the control zone.

4-1202B Barricades

Verify barricade construction complies with Section 12-3.02, “Barricades,” of the *Standard Specifications* and with Sheet A-73C of the *Standard Plans*. Reflective sheeting requires a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

Request proof that any Type III barricade used as sign support has been crash tested to *NCHRP Report 350* criteria as a single unit with a sign panel of the size and type used on the project.

4-1202C Flashing Arrow Signs

Verify Type I and Type II flashing arrow signs comply with Section 12-3.03, “Flashing Arrow Signs,” of the *Standard Specifications*.

4-1202D Portable Delineators

Before initial placement, verify that the type the contractor proposes conforms to requirements in Section 12-3.04, “Portable Delineators,” of the *Standard Specifications*. Obtain a sample of the type of delineator to be used on the project. Verify the base is shaped to prevent rolling after impact. Portable delineators require a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

4-1202E Portable Flashing Beacons

Verify portable flashing beacons conform to requirements in the special provisions.

4-1202F Construction Area Signs

At the preconstruction conference, remind the contractor of the following:

- The contractor must maintain an inventory of commonly required items at the job site and arrange for sign panels, posts, and mounting hardware or portable sign mounts to be furnished on short notice.

- The special provisions list requirements for signage materials. Substrate and reflective sheeting for construction area signs require a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.
- Before digging to install signposts, regional notification centers must be notified. Hand digging is required unless the location is free of underground utilities.

4-1202G Channelizers

For requirements for channelizers, review the plans, special provisions, and Section 12-3.07, “Channelizers,” of the *Standard Specifications*. Channelizers require a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

4-1202H Type K Temporary Railing

Determine if Type K temporary railing is to be cast on the project. For Type K temporary railing cast off the project, a certificate of compliance is required.

Determine if Type K temporary railing is to be placed within 10 feet of a traffic lane. The contractor must provide reflectors and adhesive, as noted in Section 12-3.08, “Type K Temporary Railing,” of the *Standard Specifications*.

Review Standard Plan T3B for new staking requirements.

Freshly painted Type K temporary railing is required only before its first use on the project unless the special provisions require otherwise.

Reflectors for Type K temporary railing require a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

4-1202I Traffic Cones

Verify traffic cones comply with Section 12-3.10, “Traffic Cones,” of the *Standard Specifications*. If the contractor plans to use cones for night work, determine the type of cone proposed. Removable reflective sleeves must be removed during daylight. Allow use of only one type of retroreflective cone. All cones must use the same type and brand of retroreflective sheeting. Reflective sleeves require a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

4-1202J Traffic Plastic Drums

Before initial placement, verify the type that the contractor proposes complies with Section 12-3.11, “Plastic Traffic Drums,” of the *Standard Specifications*. Allow use of only one type of drum. All drums must use the same type and brand of retroreflective sheeting. Reflective sheeting used on traffic plastic drums requires a certificate of compliance and must be listed on the Caltrans authorized materials list for signing and delineation materials. The resident engineer may accept another product as long as the district traffic engineer has approved it through written confirmation.

4-1202K Portable Changeable Message Signs

Before the first deployment of portable changeable message signs (PCMS), arrange with the contractor to have them inspected. Perform field tests to verify compliance with Section 12-3.12, "Portable Changeable Message Signs," of the *Standard Specifications*. Conduct these inspections and tests in conditions similar to those in which they will be used on the project, specifically during the night or during the day.

Verify that the sign is visible and legible according to the requirements.

Verify that the trailer can be leveled and that the sign operates within the required minimum and maximum heights.

4-1202L Impact Attenuator Vehicle

Review the special provisions for the impact attenuator vehicle (IAV) requirements. Verify that the weight of the attenuator and the weight of the support truck are within the specified limits. Refer to the Caltrans authorized material list for highway safety features.

4-1202M Temporary Traffic Screen

For requirements for temporary traffic screen, review the special provisions and Sheet T4 of the *Standard Plans*.

4-1202N Temporary Crash Cushion Module

Review the project plans and *Standard Plans* sheets T1A, T1B, and T2. Frequently the plans for stage construction, detour, or traffic handling will require arrays of temporary crash cushion modules. Changes to any of these plans may alter the need for temporary crash cushion modules.

If installing Type K temporary railing creates a blunt-end exposure within 15 feet of the edge of the traveled way, temporary crash cushions are required at that location. If the blunt end is within 8 feet, appropriate approved crash cushion protection, other than sand filled modules, must be provided.

The *Standard Plans* show temporary crash cushions installed on wooden pallets, but the use of pallets is optional. The maximum acceptable pallet height is 4-1/2 inches. Pallets that exceed this height raise the sand in the crash cushions above an acceptable level. Do not use typical commercial pallets that exceed the allowed height.

Visually inspect crash cushion modules to ensure they conform to the requirements in Section 12-3.15, "Temporary Crash Cushion Module," of the *Standard Specifications*.

4-1202O Temporary Signal System

As early as possible, verify that all Department-furnished equipment is available at the location specified in the special provisions. If the equipment is not available, make other arrangements as soon as possible.

Verify that the actual visibility in the field meets the expected visibility. If sight distance is not adequate, contact the district traffic engineer for suggestions or recommendations.

Remote area signal installations are often located in forests or grasslands. Ensure all fire safety requirements are in place and operative before using the system. Checking fire safety requirements will often involve working with personnel from the local U.S. Forest Service, Bureau of Land Management, or California Department of Forestry.

4-1202P Maintaining Traffic

- Before work begins, carefully review the plans, specifications, closure charts, and sheets T10 through T17 of the *Standard Plans*. It is important to know in advance what personnel, signage, and equipment will be required to implement the traffic control system. Ensure that the contractor has all components on hand and that all components meet specifications requirements before they set up any traffic control system.

Ensure the contractor notifies and cooperates with local authorities wherever the local authorities regulate traffic.

Frequently a project is one of many in the same vicinity or in the same transportation corridor. In such instances, require that the various contractors coordinate their efforts by submitting their schedules for lane closures in advance and resolving schedule conflicts before any closures are implemented. Review these requirements with the contractors before work starts. Remove or cover any construction area signs that duplicate or contradict the signs for a project within 250 feet of another project. Refer to Section 5-1.20 “Coordination with Other Entities,” of the *Standard Specifications*, if applicable, and the special provisions.

- In the contractor’s or subcontractor’s yard, if possible before the first use, inspect the signs and equipment the contractor proposes to use. Verify that all the necessary signs, cones, drums, and other equipment are on hand before setting up the system for the first time. If the proposed materials have already been used, check them for acceptability. Replace any unacceptable equipment. It is much easier to correct deficiencies before the system is installed.
- If the contractor is to place the traffic control system repeatedly in the same place, mark on the shoulder or pavement the locations of advance signs, cones, and drums. This will speed the placing of lane closures and ensure better taper alignment.

4-1203 During the Course of Work

Inspect Category 2 temporary traffic control devices to ensure they are labeled with the FHWA acceptance letter number and the name of the manufacturer.

Ensure Category 3 temporary traffic control devices are the type shown on the authorized material list for highway safety features.

Verify that traffic handling devices meet the visibility and legibility requirements.

Contractors should maintain all traffic control devices in good working order throughout the project’s life. During operations requiring traffic control systems, engineers should ensure that all traffic control devices are correctly located and functioning properly.

The condition of temporary traffic control devices must conform to the current American Traffic Safety Services Association (ATSSA) publication, *Quality Guidelines for Temporary Traffic Control Devices and Features*, which is available at:

<http://www.atssa.com/OnlineStore.aspx>.

Click on the “search for products” button and type “quality guidelines” in the “product name” input box.

4-1203 During the Course of Work

Do not allow the contractor to intermix different types of temporary traffic control devices on the same alignment. Types include plastic drums, portable delineators, channelizers, tubular markers, traffic cones, and Type I and Type II barricades.

Ensure the contractor removes traffic-handling equipment and devices from the job site when they are no longer needed for controlling traffic.

4-1203A Flagging

Observe the flagging operation to ensure that the flaggers are using correct procedures for directing motorists. Also, ensure that flagging stations are laid out correctly, are visible to approaching traffic, are illuminated during night time, and have correct advance warning signs. The contractor's flaggers must be properly trained and equipped and must perform their duties in accordance with Title 8, California Code of Regulations, Section 1599, and the *California MUTCD*. When pilot vehicles are used, radios are required.

4-1203B Barricades

Ensure the contractor maintains barricades in a good state of repair and keeps the reflective surfaces clean. If weighting is necessary, allow the contractor to use only bags of dry sand. Weights must be placed on the feet or lower parts of the frame or stays. Do not allow the contractor to place objects any higher, or use hard objects such as concrete or rocks for weights; this may lead to injury or property damage should a vehicle hit the barricades.

Ensure the contractor places barricades so that the stripes slope downward in the direction road users are to pass.

4-1203C Flashing Arrow Signs

See that the proper types of flashing arrow signs are used as shown in the plans or as described in the special provisions.

Observe the equipment in operation and do the following:

- Verify the flashing arrow sign trailer can be leveled and plumbed.
- Ensure the lights are dimmed at night and set on bright during daylight hours.
- Verify the lights are not glaring into approaching traffic, especially truck traffic.
- Ensure compliance with the minimum legibility distances.
- Ensure the signs are properly aimed at approaching traffic. Pay special attention to the aiming of the sign whenever solar-powered signs are used. The special bulbs used with solar signs have much narrower beams than conventional bulbs and, therefore, require greater care while being aimed.

4-1203D Portable Delineators

Require the contractor to immediately replace or restore portable delineators to their original location in an upright position when displaced or knocked down. Ensure the use of only one type of portable delineator on the project.

4-1203E Portable Flashing Beacons

Verify the proper operation and location of these beacons.

4-1203F Construction Area Signs

Ensure that the contractor promptly installs, relocates, covers, and removes signs as the contract requires. Construction signs should be covered or removed whenever they no longer serve a purpose. Verify that covers placed on sign panels completely block out any messages so that the messages cannot be seen day or night. The covers should also present a workmanlike appearance.

Allow only the use of sandbags when it is necessary to weight sign standards to prevent the wind from overturning them. Do not permit rocks, broken concrete, or other hard objects to be used for this purpose.

Review construction area signs often during the course of the work. Require that signs be maintained as provided for in the contract. Signs should be clean, clearly visible, and repaired immediately if damaged.

Ensure construction area signs do not block bicycle and pedestrian pathways.

Do not allow the use of nonretroreflective portable signs during hours of darkness.

Check sign posts to ensure compliance with breakaway features.

4-1203G Channelizers

Check the contractor's layout work. Determine that the pavement is clean and dry and that the contractor places the channelizers in conditions that meet the required temperatures. If channelizers are displaced or fail to remain in an upright position, they are to be replaced at the contractor's expense.

Do not allow the contractor to use the double-stick butyl pads provided by the channelizer manufacturer; these pads do not meet Caltrans requirements.

4-1203H Type K Temporary Railing

Verify all new and used rail elements comply with requirements for end connection and surface finish. Order repainting when needed. Refer to ATSSA publication, *Quality Guidelines for Temporary Traffic Control Devices and Features*.

Ensure railing is placed on a firm, stable foundation uniformly graded throughout the entire length of the railing.

Check railing alignment for any substantial offset to each other.

Verify staking of railing according to the *Standard Plans*.

Ensure the contractor offsets the approach end of Type K temporary railing a minimum of 15 feet from the edge of an open traffic lane, according to Section 7-1.04 "Public Safety," of the *Standard Specifications*.

Verify installation and maintenance of Type P marker panel at each end of railing, according to the *Standard Specification* requirements.

Ensure the contractor installs a reflector on each rail unit placed within 10 feet of a traffic lane.

4-1203I Traffic Cones

Prohibit the use of traffic cones that have been damaged or coated with asphalt or other substances to the extent the cones have lost their ability to function as intended. Refer to ATSSA publication, *Quality Guidelines for Temporary Traffic Control Devices and Features*.

4-1203J Traffic Plastic Drums

Check the contractor's layout work. Require the proper maintenance of traffic plastic drums. Require that water or sand ballast for the drums is placed in the base only. Sandbags are not allowed for ballast.

4-1203K Portable Changeable Message Signs

Make a drive-through inspection while the signs are in operation. A portable changeable message sign needs to be located where it provides the approaching motorist with at least the minimum visibility and legibility distances required by specification. Pay special attention to locations where vertical or horizontal curvature restricts the sight distance. Drivers must be able to read the entire message at least two times before passing the sign.

PCMSs are to display only pre-approved messages. The resident engineer must ensure that the messages conform to the changeable message sign guidelines, and district and Caltrans policy. Prohibit messages that do not convey real-time information to the motorist. Examples of unacceptable messages include "Drive carefully," "Have a Nice Day," and "Thank you."

PCMSs, like any other pieces of equipment, are subject to the "Public Safety" clauses of the contract. When they actively display a message, PCMSs are working equipment. At all other times, they are parked or nonworking. Ensure the contractor delineates PCMSs with a taper consisting of nine traffic cones. Protect or remove non-operating signs within 15 feet of traffic to comply with the requirements of Section 7-1.04 "Public Safety" of the *Standard Specifications*. In many cases, placing a PCMS behind existing guard railing will protect it. In cases when it is not practicable to remove non-operating PCMSs, consult the district traffic engineer. The district traffic engineer may permit the PCMSs to be protected with an array of crash cushions in lieu of the Type K temporary railing required by the "Public Safety" specification.

Unless the contract states otherwise, contractors are not required to have PCMSs available at all times for the discretionary use of the resident engineer.

The contractor is also not obliged to have a PCMS available during periods when the traffic control system is nonoperational.

A PCMS for information and guidance to motorists is required only during times, places, or activities stated in the plans and specifications.

4-1203L Impact Attenuator Vehicle

Verify there is enough shoulder width before allowing the use of an IAV for placement and removal of components on two-lane, two-way highways.

Ensure the contractor uses an IAV as a shadow vehicle in moving closures and during placement and removal of components in stationary closures. After placing components of stationary closures, the contractor may place the IAV in advance of the work area to protect workers and traffic.

Do not allow the use of a damaged IAV.

4-1203M Temporary Traffic Screen

Immediately after installation, review the screen placement, especially near entrance and exit ramps. If the screen blocks motorist visibility, order its removal and consult with the district traffic engineer concerning possible alternatives.

Ensure supporting steel pipes are placed on the traffic side of the screen. Then, if a panel becomes dislodged, the plywood will fall away from traffic.

4-1203N Temporary Crash Cushion Module

Check that crash cushion module arrays are installed according to the manufacturer's instructions. Verify that all crash cushion modules are filled with the proper weight of sand. Check pallet heights when used. Also, ensure that when arrays are placed, a minimum clearance of 8 feet exists between the array and the nearest traffic lane. Contact the district traffic engineer for recommendations if you cannot obtain proper clearance to the traffic lane.

Be sure that the contractor installs "P" or "R" markers when required.

4-1203O Temporary Signal System

Periodically review the temporary signal system to document its maintenance. Record inspection dates and conditions observed in the project records.

If a system shutdown occurs, planned or unplanned, the contractor must immediately provide flaggers to control traffic until the traffic signals are functioning correctly.

4-1203P Maintaining Traffic

Ensure the contractor submits a schedule of planned closures in advance as required by Section 12-4.03, "Closure Schedule and Conditions," of the *Standard Specifications*. Closures that will reduce horizontal or vertical clearances require even more advanced notification. Inform the transportation permits unit 15 days in advance of the closure. This advance notification affords Caltrans the opportunity to coordinate work within the highway corridor. Review the contractor's requests both to avoid oversights and also to identify and reduce the number of unnecessary requests (overbooking).

Review the closure requests to ensure the contractor complies with the closure charts requirements.

The contractor should not close two adjacent ramps in the same direction of travel unless you give the approval. Ensure the contractor sets up an off-the-highway detour before closing all ramps in both directions of travel at the same interchange.

Ensure the contractor cancels scheduled closures not needed at least 2 days in advance.

Verify the contractor follows the advance notification and signing requirements before setting up any closures.

Inform the contractor of ADA requirements if the closure will affect pedestrian traffic and a temporary pedestrian facility is needed.

On the day of the closure, notify the district traffic management center (TMC) of any cancellations (10-22).

Before the contractor places the first cone, notify the district TMC of the closure setup (10-97).

After the contractor removes the last cone, notify the district TMC of the closure pickup (10-98).

If the contractor fails to comply with Section 12-4.03 "Closure Schedule and Conditions," of the *Standard Specifications* by not opening the highway according to the closure charts, the contractor must submit a written detailed construction contingency plan demonstrating that the highway will be opened in a timely manner in

the future (refer to Section 2-2 of this manual). The contractor's contingency plan must include two elements:

1. A critical path analysis of the operation. This analysis must include a detailed review of each segment of the operation, including placing and removing traffic control.
2. Actions to be taken if the operation is not proceeding as planned and needs to be terminated early. Early termination can consist of either stopping the contractor's operation so that lanes can be reopened within the specified time limits or stopping the contractor's operation to reopen the lanes before the time specified for reopening.

When an operation is terminated before the time the specifications allow because of circumstances beyond the contractor's control, consider granting time, compensation, or both, within the terms of the contract. If the operation is terminated before completion of the planned work because of circumstances within the contractor's control or because of equipment breakdown, do not allow compensation and charge a working day as appropriate.

Do not permit any lane closures until the contractor submits this plan and it is approved in accordance with the specifications.

4-1203P (1) Field Adjustments

Field adjustments to the traffic handling plans are frequent occurrences. Adjustments must be made to ensure adequate sight distance, to avoid locations with multiple decisions, to accommodate expected queues, and to coordinate activities at multiple locations. The following are typical situations where field adjustments are necessary:

- Vertical and horizontal curves—Ensure tapers are visible for their entire length to approaching traffic. Do not hide the taper of a traffic control system behind a vertical or horizontal curve. Extend the tangent portion of the closure to better position the taper. (Under ideal conditions, all advance warning signs and the taper would be located in a tangent with the taper placed on a slight upgrade for improved visibility.)
- Ramps and connectors—Managing ramps and connectors within a lane closure presents several problems. Extend exit ramp tapers back through the lane closure as an extension of the ramp's shoulder line. Avoid sharply angled tapers. Extend entrance ramps through the closed lane by projecting the left shoulder line.
- Traffic queues—Contain traffic queues completely within the advanced warning signs of any closure. Containment may require modestly increasing the spacing between signs or require the placing of additional signs. Some districts have adopted a practice of providing motorists additional advanced warning by displaying information a mile or more in advance of the closure using portable or fixed changeable message signs. In metropolitan areas, this type of advance warning may be feasible through the cooperation of the TMC.
- Multiple closures and inter-project coordination—Avoid multiple closures with overlapping sign patterns. Connect closures by extending the tangents.
- Length of closure—Avoid long closures with no evidence of activity. Consider placing supplemental tapers within an existing closure. When the work has safely

progressed beyond the supplemental taper, remove the upstream taper and tangent. Ensure advanced warning signs for the new taper are located correctly.

If long closures are unavoidable, protect the active work area by placing barricades or drums across the closed lanes, upstream of the work area. Also, when possible, use barrier vehicles or an IAV between the approaching motorist and workers on foot.

4-1203P (2) Placement Sequence and the Start of Work

Ensure the contractor completely installs the traffic control system before commencing work. The following are some installation instructions for the contractor depending on the situation in which the system will be used:

- Systems affecting traffic only in one direction—Start with the first device that the drivers will see as they enter the work zone (usually a C23 “Road Work Ahead” sign). Additional devices are placed in sequence, moving in the direction of the traffic flow. Move the workers and equipment onto the closed lanes only after all system components are in place.
- Systems affecting traffic in both directions—Install the first sign drivers will see traveling in the opposing direction. Then install in sequence all remaining signs and devices in the opposing direction of travel. Next install the first sign drivers will see in approaching the work area from the affected direction. Place all remaining signs and devices in sequence through the work area. If flaggers are to be used, have flaggers take their stations; then move workers and equipment onto the road.
- Removal of the traffic control system—Remove all workers and equipment from the roadway. Then remove the devices and signs in the reverse order of placement. Restore all signs and signals to normal operation.

4-1203P (3) Drive-Through Inspection

Immediately after installation, make a drive-through inspection of the system. During the inspection, drive the system as though you had no knowledge of the work zone. Ensure the intended vehicle path is clearly visible. Remember that the motorist has no knowledge of the traffic control plan and is entirely dependent on the system for warning and guidance. Document this inspection in the daily report; indicate weather and traffic conditions and time of inspection.

4-1203P (4) Maintenance

Ensure a contractor’s employee is assigned to maintain all night closures and any daytime closures over 1 mile in length. Maintaining such closures is a full-time assignment, and the assigned worker should have no other duty. Ideally, the assistant resident engineer should be able to communicate directly with the contractor’s maintenance person by radio or cellular phone. The maintenance person should have spare cones, signs, and barricades available to replace or restore, system elements displaced or destroyed by traffic.

4-1203P (5) Reverse Operations Inside Closures

Workers may operate vehicles opposite the flow of traffic inside a closed lane. However, the workers should do so in a way that does not confuse approaching drivers or upset approaching traffic. The following practices are recommended if opposing operations are undertaken:

- During daylight operations, the vehicles facing oncoming traffic should have their headlights and their flashing amber lights turned on at all times.
- During night operations, the vehicles should have their headlights turned off and their hazard lights and flashing amber lights turned on.
- At no time should a U-turn be permitted in traffic, and no vehicle should face towards traffic except when completely within a closed lane.

4-1204 Measurement and Payment

4-1204 Measurement and Payment

The following are directions for measuring and paying for various traffic control devices for construction areas:

4-1204A Flagging

Section 12-1.03 [12-2.02], “Flagging Costs,” of the *Standard Specifications* requires that the cost of providing flaggers be divided equally between Caltrans and the contractor. Determine the total cost using the force account method. The contractor is to be paid one-half of the computed total amount.

The division of costs applies to all flagging required to perform the planned work except in special situations cited in the special provisions. Caltrans’ share of flagging costs is to be paid only when public traffic is involved.

The cost of providing flaggers includes the cost of transporting personnel between a central point and the location of the work, or from one location to another as necessary. The cost for flaggers also includes the costs of any stands or towers required for the flaggers to do their jobs properly. The cost does not include the costs of placing, maintaining, and removing construction area signs during flagging operations.

The flagging costs incurred in connection with increased or decreased work paid for at contract prices will be subject to the 50-50 split. It is assumed that the contractor’s share of such costs is included in the contract item price.

When work is added and paid for as extra work, the contractor should be compensated 100 percent for flagging costs associated with the extra work.

If changes are made at the request of, and for the benefit of the contractor, the contractor must pay for the additional flagging costs unless there are also particular benefits to the state that would warrant a sharing of the costs.

Include 50 percent of flagging costs in costs calculated according to Section 4-1.05 [4-1.03C] “Changes and Extra Work,” of the *Standard Specifications*. Also, include the contractor’s 50 percent share of flagging costs in cost calculations for computing adjustments for increased or decreased item quantities.

4-1204B Barricades

Initial placement of each barricade (as shown on the plans or as directed by the resident engineer) is paid for as a contract item at the time of placement. Subsequent relocations of each barricade are paid for as extra work using the force account method. Damaged barricades must be repaired at the contractor’s expense, regardless of the cause, including damage by public traffic.

4-1204C Flashing Arrow Signs

Flashing arrow signs are paid for as part of the contract item for the traffic control system.

4-1204D Portable Delineators

Portable delineators are paid for as part of the contract item for the traffic control system.

4-1204E Portable Flashing Beacons

Portable flashing beacons are measured and paid for at contract item price by the unit except when they are part of a traffic control system. In that case, portable flashing beacons are paid for as part of the contract item for the traffic control system.

4-1204F Construction Area Signs

Construction area signs, except those used in traffic control systems for lane closures, are paid for as a lump sum item. The cost of the contractor's inventory of replacement sign materials is included in the contract price for construction area signs. Additional signs ordered by the resident engineer are paid for as extra work.

The cost of covering, uncovering, and removing signs (when they are no longer needed) is included in the contract price for construction area signs.

When determining how much to include on a progress pay estimate, withhold some payment sufficient to cover the cost of maintaining and removing the signs.

4-1204G Channelizers

Channelizers are paid for by the unit. The contract item price includes the costs of maintaining, replacing, and repairing channelizers. The contract item price also includes the costs of work necessary to restore channelizers damaged by public traffic.

4-1204H Type K Temporary Railing

Review the "Public Safety" section in the contract. Do not use the contract item for Type K temporary railing to pay for temporary railing that is placed to fulfill the requirements of the "Public Safety" section.

Withhold some payment from progress pay estimates to cover the cost of removing Type K temporary railing

4-1204I Traffic Cones

Traffic cones are paid for as part of the contract item for the traffic control system.

4-1204J Portable Changeable Message Signs

A PCMS, commonly bid as "Furnish-Each" or "Furnish-Lump Sum," requires the contractor to place, operate, maintain, and remove the sign as directed by the resident engineer.

The resident engineer, with a minimum notice of 1 full working day, may direct the contractor to provide PCMSs for use not otherwise provided for in the contract. Payment due the contractor is to be computed as extra work.

4-1204K Temporary Crash Cushion Modules

Review the "Public Safety" section in the contract. Do not use the contract item for temporary crash cushion modules to pay for temporary crash cushion modules that are placed to fulfill the requirements of the "Public Safety" section.

Withhold some payment from progress pay estimates to cover the cost of removing temporary crash cushion modules.

4-1204L Temporary Traffic Screen

Temporary traffic screen is measured and paid for according to the special provisions.

4-1204M Temporary Signal System

The lump sum payment for this item includes all the costs of hauling Department-furnished materials between the designated pickup locations, the project, and the designated salvage location. If the pickup or salvage location is changed, then any additional costs or savings to Caltrans should be recognized.

Flaggers are not a shared cost if the contractor provides them as a result of a shutdown of the signals for any reason. This provision is an exception to the general practice of sharing the cost of flaggers.

4-1204N Traffic Plastic Drums

Count the traffic plastic drums for payment as they are placed in the locations shown on the plans. Drums used instead of cones, barricades, or delineators as part of a traffic control system or used as specified under "Public Safety" section in the contract are not to be paid for at contract item price.

4-1204O Traffic Control System

For all project work, the lump sum payment for the traffic control system includes payment for all labor, equipment, and materials to install, maintain, and remove the traffic control system as shown on the plans or *Standard Plans*. The contract item for the traffic control system includes payment for portable signs, cones, delineators, and flashing arrow signs as shown on the plans for the traffic control system.

Include compensation or credit in the change order when an ordered change in the work affects the contract item for the traffic control system.

Traffic control costs in support of extra work are to be paid as part of the extra work. Compute the payment as a force account or as an adjustment of compensation based on a force account analysis. The change order that authorizes the extra work must reflect these costs.

In addition to adjustments for ordered changes, the resident engineer may consider adjustments to the contract item for the traffic control system when the following circumstances exist and result in additional lane closures:

- A material change exists over or under the engineer's estimated quantity that is not caused by an ordered change for a contract item or items.
- Insufficient information exists in the contract for the contractor to verify the engineer's estimated quantity for the contract item or items. The contractor relied on the engineer's estimated quantity or quantities to determine the number of lane closures required.
- The additional lane closures are solely for work on the contract item or items meeting the criteria for the above.

Calculate adjustments for the circumstances listed above on a force account basis.

Section 56 Signs

4-5601 General

4-5602 Before Work Begins

4-5603 During the Course of Work

4-5603A Overhead Sign Structures

4-5603B Roadside Signs

4-5604 Measurement and Payment

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 56 Signs

4-5601 General

Signs and sign structures are of various types, from simple roadside signs to complicated sign bridges containing changeable message signs. The resident engineer must apply the correct inspection to ensure the contractor installs signs and sign structures to function properly.

The Office of Structure Construction (OSC) is responsible for reviewing and authorizing all overhead sign structure shop drawings on contracts administered by Caltrans. District construction engineers will contact the local structure construction area manager or senior bridge engineer before the preconstruction meeting to arrange for the review of the overhead sign structure shop drawings submitted by the contractor. Structure construction personnel review shop drawings for standard overhead sign structures and coordinate, when needed, with the appropriate structure design engineer for review of shop drawings for non-standard overhead sign structures.

The Division of Engineering Services provides technical support to structure construction personnel upon request. Send a copy of the shop drawings to Structure Policy and Innovation if technical assistance is needed. The *Overhead Sign Structures Manual* provides guidance for reviewing shop drawings and is available at:

<http://onramp.dot.ca.gov/hq/oscnet/>

To review the shop drawings of changeable message signs, refer to Section 168-3.0, “Shop Plan Review for Changeable Message Sign (CMS) Structures,” of Volume II in OSC’s *Bridge Construction Records and Procedures* manual.

<http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCompleteManuals/>

4-5602 Before Work Begins

Before work begins, do the following:

- Review the plans and specifications to determine the types of signs to be installed and any special requirements included in the contract. Obtain and review as-built drawings for the structures to be modified.
- Verify that Form CEM-3101, “Notice of Materials to Be Used,” includes signs. Refer to Section 6-202, “Responsibilities and Procedures for Acceptance of Materials,” of this manual for additional information.
- If required, before the manufacturers furnish the materials, obtain from the Office of Materials Engineering and Testing Services (METS) an approval of foreign manufacturers. Refer to Section 6-2.05C [6-1.08], “Steel and Iron Materials (23 CFR 635.410),” of the *Standard Specifications*, which covers the use of foreign materials.

Section 56 Signs

4-5601 General

4-5602 Before Work Begins

- Refer to the contract specifications and Section 3-606, “Certificates of Compliance,” of this manual regarding provisions of the Buy America requirements.
- Obtain shop drawings, including, but not limited to, anchor bolt layouts, shop details, erection plans, and equipment lists for sign structures as required by the contract. With the assistance of the structure representative, review these shop drawings and authorize them if they comply with the contract. After review (and correction if necessary), return one set of the shop drawings to the contractor with the following statement: “The plans are authorized pursuant to Section 5-1.23 [5-1.02], “Submittals,” of the *Standard Specifications*.”
- Do a field review of all sign locations, and check for possible conflicts with other structures, electrical and irrigation lines, and underground and overhead utilities. Verify that existing structures to be modified agree with as-built drawings. Ensure adequate horizontal and vertical sight distance. Trees or other landscape features may need to be trimmed or removed to obtain adequate sight distance. Advise the contractor of any changes and, if necessary, prepare change orders. In addition, because relocating signs can impair or nullify their effectiveness, consult with the district traffic unit whenever changes must be made or the effectiveness of any signage is questionable.
- After control stakes have been placed, ensure the markings have the following:
 1. The correct span lengths.
 2. The correct elevation of footing pedestals (usually 3 inches above the finished grade or the top of curbs).
 3. The minimum vertical clearance shown on the plans.
 4. The required cover over the tops of footings.
- To ensure incorporation into the work during shop fabrication, verify that the structure representative has given the source inspector any changes that revise materials, specifications, or structural design. Normally, METS is notified of any changes through the receipt of a copy of the change order. However, allow sufficient lead time for the normal distribution of change orders. If changes are underway based on a “prior authorization,” the resident engineer (through the structure representative) may need to send the revised specifications or drawings directly to METS in advance of the approved change order. Resident engineers should call METS to confirm receipt of the changes.
- Review the contract for any requirements for Department-furnished material. Resident engineers must ensure that Department-furnished sign materials have been ordered and will be ready for timely delivery. Make a physical inspection and inventory to confirm that all Department-furnished sign materials are delivered in good condition. After delivery, the contractor is responsible for any damage to Department-furnished materials.

4-5603
During the
Course of Work

4-5603 During the Course of Work

Inspect both overhead sign structures and roadside signs.

4-5603A Overhead Sign Structures

Sign structures often involve many details that are critical to the structure's permanence. Maintaining sign structures is expensive. Attention to detail during construction can mitigate future problems.

The resident engineer has final responsibility for ensuring that signs and sign structures are constructed in accordance with the contract. The resident engineer also has final responsibility for making any changes that are necessary to serve the public as the designer intended. To perform the required duties properly, the resident engineer must obtain the relevant technical data. For overhead signs and bridge-mounted signs, copies of Section 168-1.0, "Bolted Connections for Overhead Sign Structures," and Section 170, "Structural Steel," of Volume II of the *Bridge Construction Records and Procedures* manual will provide the information.

Construction inspectors should check the following items or perform the following duties:

- Upon delivery, check the materials' identification marks or inspection tags (using Form TL-0624, "Inspection Release Tag,") and match these marks and tags against those listed in Form TL-0029, "Report of Inspection of Material." (Refer to Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," of this manual for more explanation.) METS will check items for compliance with specifications. These items can also be checked at the source during fabrication. This check will include determining the adequacy of workmanship for activities such as welding, painting, and galvanizing and also ensuring the use of the proper materials. For changeable message signs, METS will also ensure that all control components are connected and operating properly before release to the job site.
- Require the repair of any minor damage to galvanizing or coatings, as specified in Section 75-1.05, "Galvanizing," of the *Standard Specifications*.
- Determine that METS has inspected and approved anchorage devices for bridge-mounted signs. Ensure that anchorage devices are installed as recommended by the manufacturer, as shown on the plans, and as specified. For more information on anchorage devices, refer to Section 135, "Miscellaneous Construction Materials," Volume II of the *Bridge Construction Records and Procedures* manual.
- Ensure the proper type of bolts in field connections. Observe the installation of high-strength bolts to ensure the correct method and sequence for tightening. Refer to Section 170, "Structural Steel," Volume II of the *Bridge Construction Records and Procedures* manual for the specifications of the American Society for Testing and Materials for high-strength bolts.
- METS inspects welding at the fabrication plant. If welding will be performed at the job site, contact METS for assistance. Also, at the job site, visually check for any obvious defects. During sign erection, ensure a proper fit between the post and the sign frame. Also, verify the provision of the proper minimum clearances.
- Ensure that the surface finishes of all metal parts of sign structures meet specifications. Inspect portions of the work completed in the field.
- Ensure through observation that sign panels and fastening hardware comply with specifications. Ensure that exposed portions of fastening hardware on the panel faces have been finished as specified.

- Ensure that the construction of footing pedestals complies with specifications. It is particularly critical that the contractor correctly position and align anchor bolts for sign bridges.
- To ensure the minimum horizontal and vertical clearances, verify that the location and elevation of the footing pedestals are correct.
- Ensure the contractor performs electrical work according to the specifications.
- Ensure the contractor performs field painting, including touch-up, according to the specifications.
- Examine sign panels for compliance with specified workmanship.
- Whenever an installation exceeds the scope of knowledge of available personnel, request assistance from, or consult with, other units. For instance, you may call upon mechanical and electrical engineers from the Office of Structure Design for assistance with changeable message signs.
- Ensure sign panels over lanes and lane arrows are correctly centered over the appropriate lanes.
- Report any temporary or permanent changes to horizontal and vertical clearances to the Transportation Permits Branch in accordance with Section 3-703A, "Temporary Clearance and Bridge Permit Rating Changes," of this manual.
- Ensure adherence to the public safety requirements of the special provisions regarding permanent obstacles that are temporarily unprotected.

4-5603B Roadside Signs

Do the following for these types of signs:

- Upon delivery, check the materials' identification marks or inspection tags (using Form TL-0624, "Inspection Release Tag") and match these marks and tags against those listed in Form TL-0029, "Report of Inspection of Material." (Refer to Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," of this manual for more explanation.) METS will check items for compliance with specifications. These items can also be checked at the source during fabrication. Note the type of preservative used to treat wood posts.
- Ensure postholes are located so that the signs will have the correct horizontal clearance and will not be obstructed by other objects. Also, verify that holes are excavated to the full depth and backfilled as specified.
- Ensure the provision of minimum vertical clearances to the bottom of the sign panels, as required by the *Standard Plans*.
- If posts are cut or drilled in the field, ensure the contractor treats exposed areas as specified.
- Ensure that the attaching of signs to posts complies with requirements.
- You may request the assistance of the district traffic unit. Such assistance may include a field review of sign staking, and day and night observation of completed signage. Include in the daily report notes on assistance received and changes made.

4-5604 Measurement and Payment

- For details of measurement and payment, review contract specifications. Make any necessary measurements and counts.
- Refer to Section 6-3.05B, “Source Inspection Expense Deductions,” of the *Standard Specifications*, for information about standard deductions taken for Caltrans doing inspection or testing at material sources.

4-5604 Measurement and Payment

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 75 Miscellaneous Metal

Section 75 Miscellaneous Metal

4-7501 General

4-7501 General

This section describes steps assistant resident engineers should follow when inspecting the installation of miscellaneous metal materials on the project. Miscellaneous metal materials include miscellaneous iron and steel, miscellaneous bridge metal, and pumping plant metal work.

4-7502 Before Work Begins

4-7502 Before Work Begins

Before the start of work, review the contract plans and note all the miscellaneous metal materials to be installed on the project. Review these items sufficiently in advance to help prevent scheduling conflicts and errors in ordering materials. During the preliminary review and inspections, the assistant resident engineer should also do the following:

- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes miscellaneous metal materials. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials" of this manual for additional information.
- If required, obtain from Materials Engineering and Testing Services (METS) approval of foreign manufacturers before the manufacturers furnish the materials. Refer to Section 6-2.05C [6-1.08], "Steel and Iron Materials (23 CFR 635.410)," of the *Standard Specifications*, which covers the use of foreign materials.
- Upon delivery, check the materials' identification marks or inspection tags (using Form TL-0624, "Inspection Release Tag") and match these marks and tags against those listed in Form TL-0029, "Report of Inspection of Material." Refer to Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," of this manual for more explanation.
- Require the repair of any minor damage to galvanizing or coatings, as specified in Section 75-1.05, "Galvanizing," of the *Standard Specifications*.
- Refer to the contract specifications and Section 3-606, "Certificates of Compliance," of this manual regarding Buy America requirements.

4-7503 During the Course of Work

4-7503 During the Course of Work

During work operations, the assistant resident engineer should do the following:

- Ensure that any welding of miscellaneous metal materials conforms to appropriate American Welding Society (AWS) requirements or as specified in the contract documents.
- Ensure that pairs of frames and grates, and pairs of frames and covers, are match marked.

- Ensure that deck drains and other grating openings are covered until final cleanup of the deck.
- Require testing of deck drains as specified.

Additional information about concrete anchorage devices and high strength bolts can be found in the Office of Structure Construction's *Bridge Construction Records and Procedures* manual in sections 135 and 170, respectively:

<http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCCompleteManuals/>

4-7504 Measurement and Payment

4-7504 Measurement and Payment

Require scale weights for miscellaneous metal materials unless quantities are designated as final pay quantities. Make the specified deductions when materials are inspected or tested at the source, per Section 6-3.05B [75-1.07], "Source Inspection Expense Deductions," of the *Standard Specifications*.

Section 90 Concrete

4-9001 General

4-9001A Before Work Begins

4-9001A (1) Materials

4-9001A (1a) Cementitious Materials

4-9001A (1b) Aggregates

4-9001A (1c) Admixtures

4-9001A (2) Check of Mix Design

4-9001A (2a) Checking Proportions

4-9001A (2a).1 Cementitious Material Content

4-9001A (2a).2 Water Content

4-9001A (2a).3 Aggregates

4-9001A (2a).4 Admixtures

4-9001A (2a).5 Volume

4-9001A (3) Proportioning

4-9001A (4) Curing Concrete

4-9001A (5) Compressive Strength

4-9001B During the Course of Work

4-9001B (1) Proportioning and Mixing Operations

4-9001B (2) Mixing and Transporting

4-9001B (3) Curing Concrete

4-9001B (4) Protecting Concrete

4-9001C Measurement and Payment

4-9002 Minor Concrete

4-9003 Rapid Strength Concrete

4-9003A Before Work Begins

4-9003B During the Course of Work

4-9003C Measurement and Payment

4-9004 Precast Concrete

4-9004A Before Work Begins

4-9004B During the Course of Work

4-9004C Measurement and Payment

4-9005 Self-Consolidating Concrete

4-9005A Before Work Begins

4-9005B During the Course of Work

4-9006 Lightweight Concrete

4-9006A Before Work Begins

4-9006B During the Course of Work

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 90 Concrete

Section 90 Concrete

4-9001 General

4-9001 General

This section covers concrete. The *Standard Specifications* identifies concrete with the following descriptions:

- General
- Minor concrete
- Rapid strength concrete
- Precast concrete
- Self-consolidating concrete
- Lightweight Concrete

For a complete discussion on various items using concrete, refer to Sections 40, “Concrete Pavement”; 41, “Concrete Pavement Repair”; 50, “Prestressing Concrete”; 51, “Concrete Structures”; 72, “Slope Protection”; and 73, “Concrete Curbs and Sidewalks,” among other sections of the *Standard Specifications*. Also, refer to the corresponding Sections 4-40, 4-41, 4-50, 4-51, 4-72, and 4-73 of this manual. The resident engineer should contact the Division of Construction, Materials Engineering and Testing Services (METS), and the district materials engineer for additional guidance on specialty concretes. Additional information on concrete is available in the Office of Structure Construction’s *Concrete Technology Manual* and the *Bridge Construction Records and Procedures* manual.

Regardless of the type of concrete to be used, no recycled concrete is used on Caltrans contracts unless specifically allowed by the specifications. Recycled concrete includes use of plastic concrete combined with fresh concrete, use of reclaimed concrete materials from unhardened concrete, and use of materials from crushed concrete.

4-9001A Before Work Begins

In general, the *Standard Specifications* require the contractor to determine the mix proportions for all concrete. To determine the various types of concrete that will be required, review the contract provisions. Pay particular attention to concrete information such as “cementitious material content,” “compressive strength,” “minor concrete,” “rapid strength concrete,” “precast concrete,” “self-consolidating concrete,” or “lightweight concrete.” Also, note the type of cement to be used and any special requirements for the aggregate and use of admixtures. Projects in corrosive environments or freeze-thaw areas will contain additional concrete requirements. Make a list of the various mix designs the contractor will need to submit and a note of the concrete that needs to be prequalified before use. To avoid potential project delays and aid in the review process, encourage the contractor to submit the mix designs early in the project.

Review the mix designs for compliance with the special provisions, *Standard Specifications*, and contract plans, or forward the mix designs to the district materials unit for review. Before the contractor places any concrete, the district materials unit will need an authorized copy of the mix design for the unit's plant inspectors. If the concrete is designated by compressive strength, obtain certified test data or trial batch test results in advance of the concrete use to avoid delays. Refer to Section 90-1.01D(5)(b), "Prequalification," of the *Standard Specifications* for additional information. Review the data and results for contract compliance.

Review the current certifications of Caltrans field staff who will perform acceptance testing of the concrete. Staff must be certified in the following common test methods:

- California Test 125, "Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections."
- California Test 518, "Method of Test for Unit Weight of Fresh Concrete."
- California Test 521, "Method of Test for Compressive Strength of Molded Concrete Cylinders."
- California Test 523, "Method of Test for Flexural Strength of Concrete."
- California Test 533, "Method of Test for Ball Penetration in Fresh Portland Cement Concrete."
- California Test 540, "Method of Test for Making, Handling, and Storing Concrete Compressive Test Specimens in the Field."
- California Test 539, "Method of Test for Sampling Fresh Concrete."

Review specifications for specific concrete acceptance testing requirements and determine if additional certifications will be required for field staff performing acceptance testing. Contact the district materials engineer for assistance in obtaining any specialty certifications.

4-9001A (1) *Materials*

Before work begins, do the following for materials:

- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes concrete materials such as cement, fly ash, and aggregate. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Review the contractor's concrete mix designs under Section 4-9001A (2) of this manual.

4-9001A (1a) *Cementitious Materials*

Cementitious materials are normally accepted based on certificate of compliance, so initial samples are not taken. Cementitious materials are required to be on the authorized material list at the time of mix design submittal. Refer to:

http://www.dot.ca.gov/hq/esc/approved_products_list/

If shrinkage limitations are specified for the concrete, ensure shrinkage test data is submitted with the mix design. If special requirements exist for the cementitious materials, initial testing should be considered. For more details about cementitious materials sampling and testing, refer to Chapter 6, "Sampling and Testing," of this manual.

4-9001A (1b) Aggregates

From the contractor, obtain in writing the primary aggregate nominal sizes to be furnished and their source pit locations. Ensure aggregate material sources comply with Section 7-103D (2) of this manual. Note that for concrete aggregate to be considered innocuous, both coarse aggregate and fine aggregate sources must be listed on the authorized material list. Refer to:

http://www.dot.ca.gov/hq/esc/approved_products_list/

Aggregate sources not on this list will impact cementitious material calculations as discussed in Section 4-9001A (2a).1.

- Verify with the district materials unit that current tests have been performed on aggregates as listed in Section 6-1, “Sample Types and Frequencies,” of this manual.
- You may omit initial sampling and testing if the specified aggregate is currently being used on another Caltrans contract with acceptable testing results. In the daily report, record any reasons for not taking initial samples.
- If aggregate test data is not available, obtain initial samples of aggregate to be used and have them tested for all specified attributes. For reference, see the table in Section 6-1 of this manual. To prevent unnecessary expense and delay, send samples that can be made to conform to the specification grading. Indicate whether oversized material will be crushed or if any special blends are contemplated.

When the type or amount of concrete work doesn’t require furnishing the proposed gradation, advise the contractor and note such a decision in the daily report.

4-9001A (1c) Admixtures

Before work begins, do the following for admixtures:

- Ensure admixtures are a type allowed by the *Standard Specifications* or special provisions. Admixtures must be on the authorized material list maintained by METS, available at:

http://www.dot.ca.gov/hq/esc/approved_products_list/

- Accept admixtures by certificate of compliance from the admixture manufacturer.
- Even when a contract specifically allows or requires admixtures, check the proposed dosage rate for each specific product other than air-entraining agents.
- Section 100, “Concrete Materials and Mixing,” of the *Bridge Construction Records and Procedures* manual contains detailed information under Memo 100-4.0, “Admixtures for Portland Cement Concrete.” Before making a final decision on the allowable use of admixtures, review this data.

4-9001A (2) Check of Mix Design

Before use of any concrete, the contractor is required to submit in writing a copy of their mix designs. Likewise, revisions in proportions of a previously authorized mix design will require a new mix design submittal. An integral part of quality assurance is the review of the submitted concrete mix designs for compliance with contract requirements. Attention must be paid to concrete requirements within the plans and specifications because, on most projects, there will be a need for multiple concrete mix

designs for different uses, locations, and exposures. While it is the contractor's responsibility to design their concrete mixes using ingredients in compliance with contract requirements, it is critical that any submitted mix design that does not meet contract requirements be brought immediately to the contractor's attention. Once the submitted mix design, including required supporting documentation and qualifications, has been reviewed and determined to comply with contract requirements, notify the contractor of mix design authorization for the specific intended use. Ensure a copy of the authorization letter is filed in the project records.

Concrete mixes should generally be designed with proportions that will produce concrete with the following qualities:

- The stiffest consistency (lowest penetration) that can be placed efficiently.
- Adequate mortar content to provide the required finish.
- The lowest water demand consistent with the aggregate specified.

4-9001A (2a) Checking Proportions

Office of Structure Construction's *Concrete Technology Manual* contains multiple examples of concrete mix design reviews. The following narrative identifies key elements to consider during the mix design review process.

4-9001A (2a).1 Cementitious Material Content

The cementitious material content is limited, and the design must conform to the specified limited amounts and requirements of Section 90-1.02B, "Cementitious Materials," of the *Standard Specifications*.

Cementitious material content minimums and maximums will generally be found in the specifications covering that item of work and not in Section 90. For example, Section 51-1.02B, "Concrete," of the *Standard Specifications* contains a table for general cementitious material content requirements for structures, though special provision requirements may modify these requirements for particular concrete structural elements.

Be aware that if the submitted mix design uses an authorized water-reducing admixture at the authorized dosage, the specified cementitious material content may be reduced up to 5 percent by weight under Section 90-1.02E(2), "Chemical Admixtures," of the *Standard Specifications*.

Once the mix design's cementitious material content has been verified, ensure that equations 1 and 2 of Section 90-1.02B(3), "Supplementary Cementitious Materials," of the *Standard Specifications* have been met. Note that in evaluating equation 1, for aggregate to be considered innocuous, all aggregates must be innocuous.

Also, note that concrete in certain exposure areas will have special cementitious material requirements that need to be verified. Examples of these areas include concrete in corrosive environments under Section 90-1.02H and concrete in freeze-thaw areas under Section 90-1.02I of the *Standard Specifications*. Concrete subject to these exposure areas will be designated in the contract.

4-9001A (2a).2 Water Content

Section 90-1.02G(6), "Quantity of Water and Penetration or Slump," of the *Standard Specifications* provides the general requirements for maximum free water allowed in concrete mix designs. There may be specific provisions concerning water allowance

for the contract item that will govern. When evaluating free water amounts, keep in mind that free water is defined as the amount of water in the mix excluding the amount of moisture in aggregates at their saturated surface dry condition. Note that if liquid admixtures are used in a cumulative amount of more than 1/2 gallon per cubic yard, the amount of liquid admixture is to be considered free water.

Nominal penetration and or slump requirements must also be considered during the mix design review. Concrete mixes requiring prequalification under Section 90-1.01D(5)(b) of the *Standard Specifications* require either certified test data or trial batch reports that include penetration or slump information. Use caution when reviewing and authorizing concrete mix designs that indicate maximum nominal penetration or slump values or have used the maximum amount of allowable free water within the mix design. Both cases leave little in the way of adjustment if problems are encountered and may result in significant delays if new mix designs are required.

Certain concrete or exposure areas may also specify water to cementitious material ratio requirements on the concrete. These are typically based on the weight of free water to the weight of cementitious materials in the mix. Ensure any such requirements are evaluated during the mix design review.

4-9001A (2a).3 Aggregates

Aggregates for concrete must conform to Section 90-1.02C “Aggregates,” of the *Standard Specifications* unless specified otherwise. These requirements include durability and cleanness testing requirements for coarse aggregates, and organic impurities and sand equivalent testing requirements for fine aggregates.

There are multiple gradation requirements (coarse aggregate, fine aggregate, and combined aggregate) that the mix design must be checked against. Note that the contractor controls a portion of the grading requirements by proposing the “X” values within a specified allowable range for certain sieve sizes. These proposed “X” values complete the individual grading limit requirements of Sections 90-1.02C(4)(b), “Coarse Aggregate Grading,” and 90-1.02C(4)(c), “Fine Aggregate Grading,” of the *Standard Specifications*. Verify that proposed “X” values are within allowable ranges for each sieve size. Check submitted gradations for coarse and fine aggregates and verify that gradations are within the specified operating range limits. Check additional individual grading requirements at this time, including limitations on differences between total percentage passing adjacent sieve sizes.

Using a combined analysis of the gradings in the proportions of the mix design, determine if the combined grading meets the grading limits shown in Section 90-1.02C(4)(d), “Combined Aggregate Grading,” of the *Standard Specifications*.

4-9001A (2a).4 Admixtures

Verify that dosage amounts for each admixture within the mix design are within those listed on the authorized material list.

4-9001A (2a).5 Volume

Verify that individual mix design constituent volumes total to a cubic yard by using the weights and specific gravities of the constituents.

4-9001A (3) Proportioning

The following is primarily a guide for the Caltrans plant inspector, but anyone who needs to verify that plant operations are contract compliant can also use this guide:

- Ensure that storage of aggregates conforms to specification requirements. When various sizes are to be stored separately, require physical separation, either by space between stockpiles or some type of wall that will provide positive separation. Pay particular attention to the method used to prevent contamination of the aggregate. In general, a hard surface, as specified in Section 90-1.02F(2), “Storage of Aggregates,” of the *Standard Specifications* is required for storage of the aggregate stockpile.
- Determine whether the stockpiled aggregate is similar to material upon which the mix design was based.
- As a part of California Test 109, “Method for Testing of Material Production Plants,” the district weights and measures coordinator will have completed a safety inspection of the plant facilities frequented by the Caltrans plant inspector for the plant in question. Review the sampling facilities to ensure they will deliver a sample in a safe manner that accurately represents the material. For sampling requirements, refer to California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections.”
- Before use for Caltrans projects, the plant scales and meters must have a current Form CEM-4204, “California Test 109 Sticker.” The district weights and measures coordinator administers this test. Examine the plant to determine whether weighing equipment matches the testing results. Ensure that scales and meters have been sealed or tested as required. Request from the district weights and measures coordinator the material plant approval report. For additional details, see Section 3-902E, “Weighing Equipment and Procedures,” of this manual.

The county sealer of weights and measures tests and seals weighing and metering devices at commercial plants. During the sealing of these plants, the county sealer does not test the interlocks. Therefore, even though the county sealer has sealed the scales and meters, the interlocks must be tested and approved as for noncommercial plants in accordance with California Test 109, “Method for Testing of Material Production Plants.”

- Ensure that cementitious materials can be kept separate from the aggregate until they are discharged into the mixer.
- Ensure the plant or mixer has the specified automatic timing device. When automatic batching is used, the timing device must be interlocked with the mixer discharge mechanism as specified.
- Examine mixers to ensure that blades are not worn beyond specified tolerances. See that mixers are free of accumulations of hard concrete or mortar.
- Ensure truck mixers have the required metal plates containing the specified information. Also, check truck mixers to ensure they have the specified revolution counters.
- Ensure the contractor will not use equipment with aluminum or magnesium components if these components will contact plastic concrete.
- Check the following when the concrete to be produced is for concrete pavement:
 1. If specified, ensure that the plant has a moisture meter. Be aware that any moisture determination is calculated “as a percent of the dry aggregate.” Commonly used moisture meters measure the total moisture in the material

being tested. However, specifications for moisture content in the fine aggregate and batch proportion calculations are based on the free moisture rather than the total moisture content. Therefore, ensure the moisture meter is calibrated for the absorption of the aggregate upon which it is to be used.

2. Ensure that the system contains the specified proportioning interlocks. Determine whether the proportioning system is capable of full automatic operation.
3. Determine whether the equipment is capable of accepting changes in proportions or sequence of weighing individual sizes without delay.

4-9001A (4) Curing Concrete

Review the various methods of curing concrete contained in Section 90-1.03B, “Curing Concrete,” in the *Standard Specifications*, and discuss with the contractor the proposed methods. Before concrete work begins, ensure the contractor has the required curing materials onsite. Such materials include rugs, a water supply, or acceptable curing compound.

The curing compound must be of the type specified by the special provisions, *Standard Specifications*, or both. Obtain a certificate of compliance for the curing compound prior to its use.

4-9001A (5) Compressive Strength

If the 28-day compressive strength described is 3600 pounds per square inch (psi) or greater, the concrete is designated as compressive strength. When concrete has a described 28-day compressive strength greater than 3600 psi or a minimum concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member or as specified, the contractor must prequalify the concrete before its use in the work. For additional details, refer to Section 6-305D (2), “Trial Batches,” of this manual; the *Bridge Construction Records and Procedures* manual; *Concrete Technology Manual*; and Section 90-1.01D(5), “Compressive Strength,” of the *Standard Specifications*.

4-9001B During the Course of Work

During the work, the resident engineer must do the following:

- Sample the concrete within the requirements and frequencies of Section 90, “Concrete,” and item of work sections of the *Standard Specifications*, and Chapter 6, “Sampling and Testing,” of this manual.
- Make appropriate arrangements for plant inspection.
- Review placement, protection, curing, and staging.
- Review concrete washout procedures as they apply to the water pollution control plan.

4-9001B (1) Proportioning and Mixing Operations

This section is primarily a guide for the Caltrans plant inspector, but can be used by anyone who may need to verify that plant operations comply with the contract. During proportioning and mixing operations, do the following:

- Obtain and ensure that the certificates of compliance for cementitious materials are signed as specified.

- Observe the cementitious material storage facilities to ensure cementitious materials are protected from moisture.
- Obtain samples of the aggregate in accordance with California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections,” and test them for the specified properties in accordance with the frequencies shown in Section 6-1, “Sample Types and Frequencies,” of this manual. For the surface moisture content of fine aggregate, vary the testing frequency depending on the uniformity of supply. A change of 1 percent in the moisture content of sand, if not compensated, may change the penetration of concrete as much as 3/4 inch and the compressive strength as much as 300 psi. You can use California Test 223, “Method of Test for Surface Moisture in Concrete Aggregates by the Displacement Method (Field Method),” or the oven-dry method, in which case you must consider an adjustment for absorption.
- Compare the test results with the data upon which the design was based, and ensure the contractor takes any necessary corrective actions. When cementitious content designates the concrete, ensure the contractor adjusts the design to compensate for any significant differences within the nominal sizes the contractor proposed. When the concrete is designated by compressive strength, ensure the contractor takes immediate corrective action for any significant deviations in production operations from those used during the production of trial batches.
- Observe the addition of admixtures to ensure they are as shown on the authorized mix design and are dispensed in the specified manner. Obtain certificates of compliance for each admixture product.

During proportioning and mixing of materials, ensure the following occur in the quantities and by the methods specified:

1. At least twice during each shift, ensure scales are balanced at zero load and inspect them for signs of sluggishness, inaccuracy, or damage. Should an apparent problem with the weighing or measurement systems exist, contact the district weights and measures coordinator for the method of correcting the problem. Also, check for sticking materials that do not discharge.
2. Batch controllers that have the ability to provide an estimate of returned concrete for rebatching must have that feature disabled. Check that delivery trucks are completely empty prior to loading. Ready-mix trucks can be verified to be empty by spinning the mixing drum in reverse immediately prior to loading.
3. Check that the entry of water into the mixer is timed to ensure that some water is introduced in advance of aggregate and cement. Also, check that all water has been introduced by the end of the first one-fourth of the specified mixing time. Finally, see that no leakage exists that would affect the proper water content.
4. Check the batch size to ensure it does not exceed the specified capacity or the limit to which the scales were tested during California Test 109, “Method for Testing of Material Production Plants.”
5. Check the mixer operation to ensure that the automatic timing device is interlocked as specified and that the mixing time is as specified.

6. Observe the hand-mixing of concrete to ensure it is being mixed in the specified manner.

- For concrete used in pavement, or when required for other types of concrete, ensure that automatic devices perform the proportioning operation as specified. Require the plant operator to demonstrate the function of interlock devices. Limit this check of proportioning interlock tolerances to a visual witnessing of the maximum tolerance settings in the batch computer.
- Perform California Test 518, “Method of Test for Unit Weight of Fresh Concrete,” to verify the unit weight, volume, and cementitious material content of concrete in accordance with the frequencies shown in Section 6-1, “Sample Types and Frequencies,” of this manual. Advise the contractor of any changes to be made when the test results do not confirm the correctness of the proportions being used.

Whenever California Test 518 is performed, the data for batch weights must be the *actual* weights as observed for the batch to be tested. Actual batch weights are available from the delivery ticket. It is not sufficiently accurate to use the ordered batch weights.

When the unit weight or cement factor varies considerably for no apparent reason, check the accuracy of the scales. For a quick method, weigh a loaded and unloaded truck on platform scales. With this method, you can also detect erratic weighing because of binding scales.

- When air-entraining agents are used, perform California Test 504, “Method of Test for Determining Air Content of Freshly Mixed Concrete by the Pressure Method,” to determine the air content of concrete in accordance with the frequencies shown in Section 6-1 of this manual.
- To determine the consistency of the concrete, perform California Test 533, “Method of Test for Ball Penetration in Fresh Portland Cement Concrete.” When specified values are exceeded, ensure the contractor makes adjustments.

Use the results of California Test 533, and California Test 529, “Method of Test for Proportions of Coarse Aggregate in Fresh Concrete,” to determine the uniformity of concrete. When differences exceed specified values, require the contractor to improve the mixing operation.

- Periodically check the recording of data on tickets for truck mixers or agitators to ensure that the required information is being entered.
- Periodically determine the concrete’s temperature to ensure it falls within the specified values.
- Obtain samples of the completed concrete mixture and perform tests in accordance with Section 6-1, “Sample Types and Frequencies,” of this manual.
- Analyze the test results continuously and remain alert to any changes in the concrete’s uniformity or consistency. Ensure the contractor complies with their quality control plan where specified and review quality control information in a timely manner. When test results indicate, ensure the contractor makes corrections in the production operation. Where necessary, ensure the contractor revises the mix design. Reject (based on penetration) excessively wet batches discharged from mixers and do not use in the work. Prohibit indiscriminate additions of water to the mixer solely to increase the flow of already workable concrete.

- Record all tests and keep them in the project files. When a specific form is not used for recording test results, such as California Test 533, record the results in the daily report.

4-9001B (2) *Mixing and Transporting*

During the work, do the following:

- Ensure that concrete is transported in accordance with the applicable specifications.
- Ensure that the proper mix design is being batched and arrives at the job site. The concrete must arrive with a load ticket that contains the specified information and certificates of compliance for cementitious materials. The weight certificate must also show the actual scale weights (pounds) for the ingredients batched. Prohibit theoretical or target batch weights as substitutes for actual scale weights. Check the load tickets, and verify that the specified information is actually on the ticket.
- As the concrete is placed, ensure that it is homogeneous and thoroughly mixed and that no lumps or evidence of undispersed cementitious material exists.
- Check truck agitators to determine whether they are being operated at the speed designated by the manufacturer.
- Ensure that nonagitating hauling equipment does not leak and self-cleans during discharge.
- Ensure that concrete hauled in open-top vehicles is protected as specified.
- Verify the consistency of the concrete through California Test 533. Record the results on the daily report. If the concrete exceeds the nominal or maximum penetration allowed by the *Standard Specifications*, take appropriate action.
- When authorized, water withheld during batching can be added at the delivery point to truck mixers. Ensure that withheld water is mixed as specified. Ensure the proportioning is corrected if constant mixing is necessary at the discharge point.
- When adverse or difficult conditions affect concrete placement, the contractor may request that the specified penetration and free-water content limitations be exceeded under Section 90-1.02G(6), “Quantity of Water and Penetration or Slump,” of the *Standard Specifications*. Where such requests are authorized, ensure that the added water and cementitious materials do not exceed the specified ratio allowance.
- Measure the temperature of the concrete periodically. You can obtain the temperature of the fresh concrete from a sample withdrawn from the mixer just before discharge or from within the forms during or immediately after discharge from the mixer.
- Temperature requirements for specialty concrete may vary. Refer to the specifications for these requirements.
- When concrete is being hauled in truck mixers or agitators, ensure the discharge is completed within 1-1/2 hours or 250 revolutions after introducing the cementitious material to the aggregates. If the concrete temperature is 85° F or above, determine the time (less than 1-1/2 hours) that will be allowed. Advise the contractor accordingly.

- For proper mixing, verify that the concrete delivered in truck mixers or agitators has received the minimum number of revolutions recommended by the manufacturer. However, a minimum of 70 revolutions is a good rule of thumb.
- When nonagitating equipment is used, ensure the discharge is completed within 1 hour as specified. If the concrete's temperature is 85°F or above, or under other conditions contributing to quick stiffening of the concrete, ensure the discharge is completed within 45 minutes as specified.
- In the daily report, note the concrete's temperature and decisions relating to that measurement.
- For transit-mixed concrete, you cannot determine directly from the revolution counter the requirements for minimum and maximum revolutions of mixing at the mixing speed. However, in many instances, a simple calculation based on the total number of mixing revolutions and the hauling time will verify compliance with the specifications. If, because of the circumstances of long hauls or other reasons, such a calculation is not possible, you can ask the supplier for the schedule of time the drum will be operated at mixing speed. At the end of that time, the operator can reduce drum speed to agitating range. The number of revolutions at mixing speed is not considered to be as important as the total number of revolutions of mixing. However, at very low mixer rpm and at the minimum number of revolutions, it is possible that inadequate mixing will result.
- Sample concrete and fabricate test cylinders in accordance with Section 6-1, "Sample Types and Frequencies," of this manual and specification requirements for acceptance testing.
- Do not allow trucks to exceed the weight limits, especially for bridges, given in Section 5-1.37B, "Load Limits," of the *Standard Specifications*.

4-9001B (3) Curing Concrete

Ensure the contractor applies the proper cure method in accordance with the specifications. Periodically check that the contractor is maintaining the cure through the curing period.

4-9001B (4) Protecting Concrete

Anticipate adverse weather conditions and discuss options with the contractor. Require the contractor to submit a written plan on methods to protect the concrete if adverse weather sets in or is anticipated.

Concrete needs time to attain sufficient strength to carry loads. Do not allow anyone to drive or place equipment or loads on the pavement when those loads are greater than those allowed by the contract.

4-9001C Measurement and Payment

Measurement and payment must comply with the applicable sections of this manual and the special provisions, *Standard Specifications*, and *Bridge Construction Records and Procedures* manual.

Review and document the results of acceptance testing in accordance with Chapter 6, "Sampling and Testing," of this manual and specification requirements. Take appropriate remedial action or deductions for failing results on acceptance tests.

4-9002 Minor Concrete

4-9002 Minor Concrete

The general provisions of Section 90-1, “General,” of the *Standard Specifications* apply to minor concrete unless otherwise specified. Similarly, guidance contained in Section 4-9001, “General,” of this manual is applicable to minor concrete unless otherwise stated.

Ensure that the minor concrete mix design contains at least the minimum amount of cementitious materials specified.

Ensure that mix designs for minor concrete are submitted and authorized prior to use on the contract. Ensure compressive strength test results are submitted with the mix design as specified in Section 90-2.01C, “Submittals,” of the *Standard Specifications*.

Ensure that the contractor submits a proposed combined aggregate grading unless this requirement is waived by the resident engineer. Note that Section 90-2.02C, “Aggregate,” of the *Standard Specifications* includes aggregate requirements for minor concrete and specifically excludes certain aggregate requirements in Section 90-1, “General,” of the *Standard Specifications*.

Note that Section 90-2.02D, “Water,” of the *Standard Specifications* includes water requirements for minor concrete and specifically excludes certain water requirements in Section 90-1, “General,” of the *Standard Specifications*.

Production requirements for minor concrete are contained in Section 90-2.02E, “Production,” of the *Standard Specifications*. Note that these requirements specifically exclude certain sections of proportioning, mixing, and transporting concrete requirements in Section 90-1, “General,” of the *Standard Specifications*.

Ensure that a certificate of compliance is provided for minor concrete and that each load is accompanied by a weighmaster certificate with the specified information. Refer to Section 90-2, “Minor Concrete,” of the *Standard Specifications* for additional information on minor concrete.

Be sure to review any contract item specifications that require minor concrete as they may have additional or modified concrete requirements.

4-9003 Rapid Strength Concrete

4-9003 Rapid Strength Concrete

The general provisions of Section 90-1, “General,” of the *Standard Specifications* apply to rapid strength concrete (RSC) unless otherwise specified. Similarly, guidance contained in Section 4-9001, “General,” of this manual is applicable to RSC unless otherwise stated.

If RSC is proportioned volumetrically, the following additional guidance will apply:

4-9003A Before Work Begins

- Ensure that each volumetric mixer is calibrated prior to beginning production work.
- Ensure that certificates of compliance are provided for each delivery of aggregate, cementitious material and admixtures used in calibration tests and that the material sources are the same as those that will be used for the planned work.

4-9003B During the Course of Work

- Ensure that weighmaster certificates are provided for cement as required in Section 90-3.01C(4), “Weighmaster Certificate,” of the *Standard Specifications*.
- Ensure that aggregate moisture test results, log of production data and test samples of freshly mixed concrete for uniformity testing are submitted.
- Ensure that the contractor measures aggregate moistures every 2 hours during production and that the information is being submitted at the end of each production shift.
- Ensure that production data is provided at the end of each production shift in the format specified.
- Ensure that the contractor maintains a witness scale at the production site throughout the production period. When concerns arise, accuracy checks can be made using the witness scale. Recalibration of proportioning devices may also be performed with the witness scales. Contact the district's weights and measure coordinator to witness the accuracy checks, recalibrations, and spot calibrations (cement proportion system only).
- Ensure that volumetric mixers comply and operate with the requirements specified in Section 90-3.02B(3) “Mixer Requirements,” of the *Standard Specifications*.
- Check for uniformity by measuring penetration with California Test 533, “Method of Test for Ball Penetration in Fresh Portland Cement Concrete.” Ensure penetration comparisons are made on two test samples of mixed concrete from the same batch or volumetric mixer load. Any difference in readings must be within the specified tolerance.
- Ensure that RSC is properly cured. If using a cement other than portland cement, the RSC is to be cured as recommended by the cement manufacturer. The method of curing must be authorized before starting construction.

4-9003C Measurement and Payment

Where volumetric mixer calibration is performed more than 100 miles from the project limits, ensure that the specified deduction amount is taken for each calibration session.

4-9004 Precast Concrete

The general provisions of Section 90-1, “General,” of the *Standard Specifications* apply to precast concrete unless otherwise specified. Similarly, guidance contained in Section 4-9001, “General,” of this manual is applicable to precast concrete unless otherwise stated.

4-9004A Before Work Begins

- Ensure that expansion test data is submitted with the mix design when required under Section 90-4.02, “Materials,” of the *Standard Specifications*.
- Ensure that a trial batch and prequalification of the materials, mix proportions, mixing equipment and procedures are performed if precast concrete is not manufactured at an established precast concrete plant.
- Review precast concrete specification requirements and note any special requirements including specified exceptions to those of general concrete.

4-9004 Precast Concrete

4-9005 Self-Consolidating Concrete

- Review specifications and this manual concerning precast concrete items of work to determine method of acceptance. Pay particular attention to which precast items will receive source inspection as opposed to those which will be inspected in the field.

4-9004B During the Course of Work

Ensure certificates of compliance, signed by the concrete manufacturer, are submitted for cementitious materials used in purchased precast concrete products.

4-9004C Measurement and Payment

Review payment provisions within the specifications based on the contract item number of the precast concrete element. Associated guidance may be found in this manual in the corresponding section (e.g., Section 4-51, “Concrete Structures,” of this manual) or *Bridge Construction Records and Procedures* manual.

4-9005 Self-Consolidating Concrete

Self-consolidating concrete (SCC) is defined as flowing concrete that is capable of spreading to a level state without segregation and without the use of internal or external vibration.

The general provisions of Section 90-1, “General,” of the *Standard Specifications* apply to self-consolidating concrete unless otherwise specified. Similarly, guidance contained in Section 4-9001, “General,” of this manual is applicable to self-consolidating concrete unless otherwise stated.

SCC may only be used where the specifications allow, such as for precast concrete.

4-9005A Before Work Begins

- Ensure that placement procedures are included with the proposed mix design submittal before placement of SCC. Ensure a trial batch test report is submitted including test results for the tests specified in Section 90-5.01D(3), “Prequalification of Mix Design,” of the *Standard Specifications*.
- Ensure that the aggregate gradings to be used are provided as an informational submittal.
- Where the contract specifies, ensure that an acceptable mock-up is placed and evaluated in accordance with Section 90-5.01D(4), “Mock-up,” of the *Standard Specifications* prior to placing SCC for production work.

4-9005B During the Course of Work

- Ensure the contractor is performing specified quality control sampling and testing for the SCC throughout production operations.
- Perform acceptance testing of SCC in conformance with specified requirements.

4-9006 Lightweight Concrete

4-9006 Lightweight Concrete

The general provisions of Section 90-1, “General” of the *Standard Specifications* apply to lightweight concrete unless otherwise specified. Similarly, guidance contained in Section 4-9001, “General,” of this manual is applicable to lightweight concrete unless otherwise stated.

4-9006A Before Work Begins

- Review contract requirements and determine which concrete elements require lightweight concrete.
- Ensure that prequalification data or reports and proposed mix design are submitted far in advance of placing lightweight concrete. Discuss these requirements with the contractor early in the contract.
- Ensure that test samples of lightweight aggregates for each grading are taken and evaluated. The mix design submittal needs to include written verification that arrangements have been made for obtaining test samples of these aggregates. Coordinate aggregate sampling with the district materials engineer and METS.

4-9006B During the Course of Work

- Ensure that lightweight concrete acceptance sampling and testing are performed for penetration, air content, and compressive strength.
- Ensure that unit weight testing of lightweight concrete is performed as prescribed throughout production operations.