STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

MANUAL CHANGE TRANSMITTAL

NO. 12-2

TITLE:	APPROVED BY:	DATE ISSUED:
Department of Transportation *Construction Manual*	Mark Leja Chief Division of Construction	June 25, 2012
SUBJECT AREA Index and other sections of the *Construction Manual*	ISSUING UNIT Division of Construction	
SUPERSEDES	DISTRIBUTION All Requested Manual Holders	

The purpose of this manual change transmittal is to provide updates to the Caltrans *Construction Manual.*

Please update your manual according to the table below.

Section(s)	Incorporates	Remove Old Page(s)	Insert New/Revised Page(s)
Chapter 4, Section 25, "Aggregate Subbases"	None	4-25.1 thru 4-25.4	4-25.1 thru 4-25.3
Chapter 4, Section 26, "Aggregate Bases"	None	4-26.1 thru 4-26.3	4-26.1 thru 4-26.3
Goldenrod, Chapter 4, Section 83, "Railings and Barriers"	None	4-83.i	4-83.i
Chapter 4, Section 83, "Railings and Barriers"	None	4-83.1 thru 4.83.5	4-83.1 thru 4.83.4

This manual change transmittal delivers the revisions of Chapter 4, Sections 25, 26, and 83 of the *Construction Manual.* Updated sections may contain updated language, information, corrections, formatting, and references, especially as they relate to the 2010 *Standard Specifications*. Bracketed *Standard Specification* section numbers refer to the 2006 *Standard Specifications*.

Section 4-25, "Aggregate Subbases"

- Section 25-1.01A of the 2010 *Standard Specifications* deleted the requirement allowing up to 50% of reclaimed materials for use as aggregate subbase and replaced it with the requirement allowing any combination of broken stone, crushed gravel, natural rough surfaced gravel, sand, and processed reclaimed asphalt concrete, PCC, LCB, or CTB.
- Deleted the provisions for measuring and paying aggregate subbase by weight.

Section 4-26, "Aggregate Bases"

- Section 26-1.01A of the 2010 *Standard Specifications* deleted the requirement allowing up to 50% of reclaimed materials for use as aggregate base and replaced it with the requirement allowing any combination of broken stone, crushed gravel, natural rough surfaced gravel, sand, and processed reclaimed asphalt concrete, PCC, LCB, or CTB.

Section 4-83, "Railings and Barriers"

- Raised the minimum height of railings and barriers from 26–27 inches to 29–30 inches.
- Provides a link to the January 5, 2012 version of the *Traffic Manual* Chapter 7.

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 25 Aggregate Subbases

Section 25 Aggregate Subbases

4-2501 General

4-2501 General

Aggregate subbase is designated by class. The bid item list gives the class of aggregate subbase, and the *Standard Specifications* and special provisions provide the requirements for each class.

Aggregate subbase is usually the lowest layer in the pavement structure, as shown in the typical cross sections of the contract plans. Typical cross sections show the thickness of aggregate subbase and layout sheets show where to place it.

4-2502 Before Work Begins

4-2502 Before Work Begins

Before placement begins, review contract plans and specifications to determine the aggregate subbase requirements. For sampling and testing requirements, including frequency of testing, see Chapter 6, "Sampling and Testing," of this manual.

Include the following steps in the preliminary review and inspections:

Verify the design R-value by testing the basement material at the grading plane to verify the planned thickness shown in the pavement structure. Testing should be completed early enough before the placement of aggregate subbase to allow time for redesign if necessary. (See Topic 614.3, "California R-Value" in the *Highway Design Manual* for a discussion of R-value and pavement structure design.)

Test potential sources of aggregate subbase when the contractor requests such testing in writing. Deduct applicable Caltrans costs for sampling and testing from contract payments as required under Section 6-2.04 [*6-2.01*], "Local Materials," of the *Standard Specifications*.

Review compaction tests of the subgrade that is to receive the aggregate subbase. Examine the subgrade to ensure that it has not deteriorated since it was tested and that it is still firm and stable. Give special attention to isolated areas where pumping occurs.

Measure the subgrade grading plane for compliance with Section 19-1.03C [*19-1.03*], "Grade Tolerance," of the *Standard Specifications*. When measuring for compliance, spot-check areas between stations where stakes are set, as well as the staked locations. Determine the extent of this measurement based on factors such as the nature of material, the efficiency of the contractor's operation, and the accuracy of the grading operation (as indicated during the early stages of checking). The grade will be established from markings on the final grade stakes that Caltrans Surveys set. (See the *Staking Information Booklet* for information on state-furnished construction surveys.)

When subgrade is cohesionless soil and you decide that the subgrade is unstable for placing aggregate subbase on the roadbed in layers or windrows, give the contractor written permission to dump aggregate subbase in piles and spread ahead.

Determine whether the contractor has complied with all requirements related to the use of local materials. See Section 5-1.20B(4) [*6-2.02*], "Contractor-Property Owner Agreement," of the *Standard Specifications*.

4-2503 During the Course of Work

4-2503
During the Course
of Work

During work operations, do the following:

Sample the aggregate subbase at the time it is deposited on the roadbed. Observe delivered aggregate subbase to ensure that it is clean of debris and other deleterious materials. For requirements related to material quality, perform the tests at the frequencies shown in Section 6-1, "Sample Types and Frequencies," of this manual. The frequency table has a provision for waiving the testing for R-value, but exercise caution when doing so. Previous tests must be current. For small amounts (under 500 tons), data from other projects or information from your district's laboratory is usually sufficient. On larger projects, consider using at least one potential source or acceptance test as well as past experience on which to base your decision. Include in the project records an explanation of why you waived R-value testing.

Compare sand equivalent and grading test results with requirements for operating range and contract compliance. (See Section 3-608A, "Operating Range and Contract Compliance," of this manual.) Note that the volume of aggregate subbase represented by one test for contract compliance is less than that required for testing frequency. It is prudent to take frequent samples, especially with borderline test results, but test only at the frequency shown in the table in Section 6-1 of this manual. If a test result fails to meet the requirement for contract compliance, you may test additional previously taken samples to determine the quantity of material represented by the failing test result.

Ensure that aggregate subbase is spread on the subgrade without significant segregation. Normally, you would verify this step through observation, but if problems persist, support your observations with a sieve analysis. If segregation is taking place, it can sometimes be avoided by wetting the material before it is hauled to the job or before spreading operations start. Watering and compacting go hand in hand. It is important that the proper amount of water is evenly distributed in the aggregate at the time of compaction.

Observe the spreading and compacting operation to ensure that it conforms to the layer thickness requirements of the specifications.

Test the relative compaction of aggregate subbase layers using the area concept procedures under California Test 231. Generally, if the operation is uniform and within specifications, you may decrease testing frequencies.

Observe the compacting operation to ensure that the material forms a uniformly firm, stable base.

Measure the surface of the finished aggregate subbase for conformance with tolerances specified in Section 25-1.03D [*25-1.05*], "Compacting," of the *Standard Specifications*. Use the markings on the final grade stakes Caltrans set to determine compliance with the planned elevation of the aggregate subbase surface. Require corrective action for any deficiencies.

Measure the thickness of the completed aggregate subbase. Use your judgment to determine the number of measurements necessary. The minimum acceptable thickness equals the planned thickness minus the sum of the specified tolerance for high subgrade and the specified tolerance for low finished aggregate subbase surface. A thin

section is acceptable if an increased thickness of the base material placed above the aggregate subbase makes up the deficiency. The *Standard Specifications* allow the engineer to accept a deduction for deficient thickness in lieu of other corrective action. Caltrans policy is to ensure that thickness complies with requirements by ordering corrective action if it is deficient. Therefore, apply the deduction in only the most extenuating circumstances. Keep adequate records for payments on progress pay and final estimates.

Note in the daily report any inspections performed on items that are not otherwise part of a permanent record. For instance, you do not need to note any compaction tests taken because these are recorded elsewhere. However, you do need to explain in the daily report any absence of testing. You also need to note that construction is being performed according to specified layer thicknesses, because this information is not recorded elsewhere.

4-2504 Measurement and Payment

4-2504 Measurement and Payment

Review quantity calculations found in the resident engineer's pending file to determine if they are sufficiently detailed and accurate to be used in the project records.

Calculate the aggregate subbase volume based on the dimensions shown on the plans. Make quantity calculations as early in the project as possible.

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 26 Aggregate Bases

Section 26
Aggregate Bases

4-2601 General

4-2601
General

Aggregate base is designated as Class 2 or Class 3. The bid item list gives the class and unit of measurement, and the *Standard Specifications* and special provisions provide the requirements for each class.

Typical cross-section sheets of the contract plans show the thickness and layer placement of aggregate base within the pavement structure, and layout sheets show where to place it.

4-2602 Before Work Begins

4-2602
Before Work
Begins

Before placement begins, review the contract plans and specifications to determine the aggregate base requirements. For sampling and testing requirements, including frequency of testing, see Chapter 6, "Sampling and Testing," of this manual.

Include the following steps in the preliminary review and inspections:

- If the pavement structure cross sections show aggregate base to be placed on soil, verify the design R-value by testing the basement material at the grading plane to verify the planned aggregate base thickness shown in the pavement structure. Complete testing early enough before placement to allow time for any redesign needed. (See Topic 614, "Soil Characteristics," in the *Highway Design Manual* for a discussion of R-value and pavement structure design.)
- Test potential sources of aggregate base when the contractor requests such testing in writing. Deduct applicable Caltrans costs for sampling and testing from contract payments as required under Section 6-2.04 [*6.02*], "Local Materials," of the *Standard Specifications*.
- Review compaction tests of the subgrade that is to receive aggregate base. Examine the subgrade to ensure that it has not deteriorated since it was tested and that it is still firm and stable. Give special attention to isolated areas where pumping occurs.
- Measure the subgrade grading plane for compliance with elevation tolerance requirements. When measuring for compliance, spot-check the staked locations and areas between stations where stakes are set. Determine the extent of this measurement based on factors such as the nature of material, the efficiency of the contractor's operation, and the accuracy of the grading operation (as indicated during the early stages of checking). The subgrade tolerances can be found in the specification for the subgrade material. The grade will be established from markings on the final grade stakes that Caltrans Surveys set. (See the Staking Information Booklet for information on Caltrans-furnished construction surveys.)

- When subgrade is cohesionless soil and you decide that the subgrade is unstable for placing aggregate base on the roadbed in layers or windrows, you may give the contractor written permission to dump aggregate base in piles and spread ahead.
- Determine whether the contractor has complied with all requirements related to the use of local materials. See Section 5-1.20B(4) [*6-2.02*], "Contractor-Property Owner Agreement," of the *Standard Specifications*.

4-2603 During the Course of Work

4-2603 During the Course of Work

During work operations, do the following:

- Sample the aggregate base at the time it is deposited on the roadbed. Observe delivered aggregate base to ensure that it is clean of debris and other deleterious materials. For requirements related to material quality, perform the tests at the frequencies shown in Section 6-1, "Sample Types and Frequencies," of this manual. The frequency table has a provision for waiving the testing for R-value, but exercise caution when doing so. Previous tests must be current. For amounts under 500 tons, data from other projects or information from your district's laboratory is usually sufficient. On larger projects, consider using at least one potential source or acceptance test as well as past experience on which to base your decision. Include in the project records an explanation of why you waived R-value testing.
- Compare sand equivalent and grading test results with requirements for operating range and contract compliance. See Section 3-608A, "Operating Range and Contract Compliance," of this manual. Note that the volume of aggregate base represented by one test for contract compliance is less than that required for testing frequency. It is prudent to take frequent samples, especially with borderline test results, but test only at the frequency shown in the table in Section 6-1 of this manual. If a test result fails to meet the requirement for contract compliance, you may test additional previously taken samples to determine the quantity of material represented by the failing test result.
- If aggregate base will be paid for by weight, obtain the optimum moisture content from the aggregate base moisture-density compaction curve and sufficient moisture samples to determine pay quantity adjustments.
- Ensure that the aggregate base is spread on the subgrade without significant segregation. Normally you would verify this through observation, but if problems persist, support your observations with a sieve analysis. If segregation is taking place, it can sometimes be avoided by wetting the material before it is hauled to the job or before spreading operations start. Watering and compacting go hand in hand. It is important that the proper amount of water is evenly distributed in the aggregate at the time of compaction.
- Observe the spreading and compacting operation to ensure that it conforms to the layer thickness requirements of the specifications. Note in the daily report any wasting of material.
- If payment is by weight, measure waste and deduct those quantities. Some material may be lost during any trimming, and district personnel will decide when to measure the trimmings. In general, measure trimmings when the cost of such measurement does not exceed the anticipated deduction.

- Test the relative compaction of aggregate base layers using the area concept procedures under California Test 231. Generally, if the operation is uniform and well within specifications, you may decrease testing frequency.
- Observe the compacting operation to ensure that the material forms a uniformly firm, stable base.
- Measure the surface of the finished aggregate base for conformance to tolerances specified in Section 26-1.03D [*26-1.05*], "Compacting," of the *Standard Specifications*. Use the markings on the final grade stakes that Caltrans set to determine compliance with the planned elevation of the aggregate base surface. Require corrective action for any deficiencies.
- Measure the thickness of the completed aggregate base. Use your judgment to determine the number of measurements necessary. The minimum acceptable thickness equals the planned thickness minus the sum of the specified tolerance for high subgrade and the specified tolerance for low-finished aggregate base surface. The *Standard Specifications* allow the engineer to accept a deduction for deficient thickness in lieu of other corrective action. However, Caltrans policy is to ensure that thickness complies with requirements by ordering corrective action if thickness is deficient. Therefore, apply the deduction in only the most extenuating circumstances. Keep adequate records for payments on progress payment and final estimates. The type and frequency of measurement for your records will depend on measurement and payment clauses of the contract.
- Note in the daily report any inspections performed on items that are not otherwise part of a permanent record. For instance, you do not need to note any compaction tests taken, because these are recorded elsewhere. However, you do need to explain in the daily report any absence of testing. You also need to note that construction is being performed according to specified layer thicknesses, because this information is not recorded elsewhere.

4-2604 Measurement and Payment

4-2604 Measurement and Payment

Review the quantity calculations in the resident engineer's pending file to determine if they are sufficiently detailed and accurate to be used in the project records.

If aggregate base is paid for by cubic yard, see the discussion of weighing and metering procedures in Section 3-9, "Measurement and Payment," of this manual.

If aggregate base will be paid for by volume, calculate the volume based on the dimensions shown on the plans. Make quantity calculations as early in the project as possible.

Section 83 Railings and Barriers

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 83 Railings and Barriers

Section 83 Railings and Barriers

4-8301 General

4-8301 General

Railings and barriers are used to reduce the severity of run-off-the-road accidents, to prevent out-of-control vehicles from crossing the median, and to decelerate errant vehicles. Construction personnel involved in the installation of railings, barriers, and other traffic safety systems should be familiar with Chapter 7, "Traffic Safety Systems," of the *Traffic Manual*. Chapter 7 is online at:

http://www.dot.ca.gov/hq/traffops/saferesr/Chapter-7-Traffic-Manual-1-2012.pdf

The following paragraphs discuss some of the details considered during design. The discussion centers on metal beam guard railing but can be applied to other types of railings and barriers.

The design for guardrail with end anchors contains many subtle details, the basis for which may not be readily apparent. Pay special attention to all connection details.

Impact tests and automobile configurations show that the specified height of 29 to 30 inches is necessary to prevent errant vehicles from climbing over the guardrail. Spacing posts 6 feet 3 inches apart provides resistance to guardrail deflection on impact and lessens the tendency of the guardrail to form a pocket during impact.

A block spaces the guardrail out from the post. As a result, the contact area is moved away from the post so that little possibility exists of a vehicle snagging on the post. The block allows the guardrail to rise slightly on initial impact, reducing a vehicle's potential for rolling.

When timber shrinks, it introduces enough slack in the mounting bolts to allow the timber blocks to rotate. Toenailing the blocks prevents this rotation.

When timber posts are used, do not allow use of washers on the rail face, so the bolts will not pull through when a vehicle strikes the guardrail. Also, during installation, the square hole in the plate washer will keep the carriage bolt from rotating.

The metal box spacer used at transitions to a concrete barrier or wall allows the guardrail to approach the barrier on a straight line and minimizes the possibility of vehicles snagging on the end.

Frequently, when lateral clearances are limited, the plans and special provisions specify a proprietary end terminal system. When the terminal system is required, ensure the system is installed in accordance with the manufacturer's instructions.

4-8302 Before Work Begins

4-8302 Before Work Begins

Before work begins, take the following steps:

- Carefully review the required details, and ensure that construction conforms to them. Review the locations in the field, and decide whether changes are necessary.

- If drainage inlets or other obstructions conflict with the planned locations for guardrail posts, consider using long-span, nested guardrail. Refer to Chapter 7-03.6, "Design Considerations," and Figure 7.9, "Long Span Nested Guardrail," of the *Traffic Manual*. Consult with the district traffic engineer for information. If the contract does not provide for long-span, nested guardrail, a change order will be necessary.
- Verify the receipt and proper distribution of form CEM-3101, "Notice of Materials to be Used," which lists all fabricated materials. Examine the material as it arrives on the project to ensure that it meets specifications. Refer to Table 6-2.2, "Inspection of Fabricated and Manufactured Materials," in this manual.
- Look for the identification tags or markings that indicate the Office of Materials Engineering and Testing Services (METS) previously inspected the materials. If the materials are properly identified as inspected, project personnel do not need the certificates of compliance or mill test reports. Normally, the METS inspector will have obtained these documents.
- Ensure that markers and delineators for railings and barriers are the correct type and are covered by a certificate of compliance in accordance with the section titled "Prequalified and Tested Signing and Delineation Materials" in the special provisions.
- Review the contractor's stakes and layout work. Ascertain that offsets and flares for guardrail will be installed as shown on the plans.
- Ensure that all concrete mix designs have been approved before use.
- Review all shop plans for metal railing on structures.
- To avoid possible conflicts, verify scupper, side drain, pull box, and conduit locations.
- When connections to structures are required, coordinate with the Office of Structure Construction. Also, when applicable, discuss the allocation of work with them.

4-8303 During the Course of Work

4-8303 During the Course of Work

Once work begins, take the steps below for each type of railing and barrier:

4-8303A Metal Beam Guard Railing and Thrie Beam Barrier

- Measure wood posts at the jobsite to ensure that they conform to specifications.
- When required, ensure that bolt holes in treated posts are filled with grease. Note this inspection in the daily report.
- Ensure that the backfilling of postholes conforms to specifications. Posts should be set to the full depth shown on the plans. When spread footings or other underground obstructions interfere with placing at full depth, refer to the *Standard Plans* for alternatives.
- Periodically measure the spacing of posts.
- Ensure that wood blocks for metal beam guard railing are toenailed to timber posts.

- Ensure that rail elements are lapped so that the exposed ends will not face approaching traffic. Check bolts for tightness and threaded rods for proper trimming.
- Measure the height of the guardrail and barrier above the ground or finished grade to ensure that the height conforms to the plans.
- Ensure that connections to bridge railings, retaining walls, abutments, or other flat surfaces comply with specifications. When high-strength bolts are required, check markings on the bolts to ensure that they match specifications. When necessary, consult with district laboratory personnel about the proper markings.
- Ensure that anchor assemblies are constructed as specified and the cable clips installed in the proper direction and tightened to the required torque. When a sample cable is required for testing, the METS inspector will normally have obtained one with swaged fitting. If cable is properly identified as previously inspected, project personnel do not need to obtain a sample.
- When posts are installed in loose soil or near embankment edges, longer posts or some design modifications may be necessary to ensure a barrier with adequate strength. Refer to Sheets A77E 1-6 in the *Standard Plans*.
- Immediately before placing concrete, ensure that holes for concrete anchors and footings are excavated to the dimensions shown on the plans.
- Ensure that anchor cables are tight enough to prevent any obvious slack in the cable once the footing concrete has cured for the required period.
- Ensure that the contractor directs the disposal of surplus material from excavation. When traffic uses an adjacent lane, prohibit spoil piles or windrows of material from remaining in front of guardrail or median barriers. Such material alters the effective height of the railings and barriers.
- Ensure that asphalt concrete dikes are positioned under the guardrail as shown on the plans.
- Bolts or threaded rods must be long enough so the nuts are completely threaded onto the bolt. Ensure that no more than 1/2 inch of thread is exposed on the traffic side of the guardrail as shown on the plans.
- Ensure that the construction of flares conforms to the plans.
- Keep adequate records and take sufficient measurements to support both partial and final payment.

4-8303B Pipe Handrailing, Steel Bridge Railing, Cable Railing, Metal Railing (Tubular), and Chain Link Railing

- Ensure that materials and methods used in anchorage and connections conform to the specifications and plans.
- Ensure the contractor connects, stretches, and tightens cables, chain link fabric, and tension wires as required.
- Check railings for proper alignment, appearance, and workmanship.

4-8303C Concrete Barriers and Railing

- Prohibit the placement of concrete barriers or railing on new structures until the falsework is released. The Office of Structure Construction will provide height adjustments to compensate for camber and dead load deflections.
- Review the specifications for closing temporary gaps in barriers during construction. Determine that the contractor has planned this work before removing existing barriers or constructing new barriers. Ensure that blunt ends exposed to traffic are adequately protected. Refer to the "Public Safety" section in the special provisions.
- Ensure that forms comply with Section 51-1.05, "Forms," of the *Standard Specifications*. For additional guidelines, see Section 4-51, "Concrete Structures," of this manual.
- When extrusion or slipform machines are used to construct concrete barriers, inspect the grade on which the machine will ride to determine if the grade is smooth enough to prevent foreseeable violations of specified tolerances. Check guide wires for obvious variations or measurable sags between supporting stakes.
- Ensure that the placing of bar reinforcing steel conforms to specified requirements and the details on the plans. For guidelines, see Section 4-52, "Reinforcement," of this manual.
- Review applicable specifications for producing, placing, finishing, and curing portland cement concrete to be used in concrete railing and barriers. For guidelines, refer to Sections 4-51, "Concrete Structures," and 4-90, "Portland Cement Concrete," of this manual.
- Require stripping the forms for Type 50 and Type 60 series barrier early enough so the concrete surface may be given a light brush finish without resorting to tempering with grout.
- During the placing of extruded or slipform barriers, the design of the concrete and placing method should require no hand finishing other than a light brush finish. The surface of the traffic side of the concrete median barrier should be as smooth as possible. Prohibit heavy brooming or other activity that will leave a roughly textured finish.
- Observe the abrasive blast finish applied to Type 50 and Type 60 series concrete barriers. The surface should have a uniform appearance without heavy texturing.

4-8304 Measurement and Payment

4-8304 Measurement and Payment

Measure railings, barriers, and terminal systems as specified and, where appropriate, to the limits shown on the plans. Also, count to determine the number of cable anchor assemblies and connections to be paid for.