



Section 9 – Final Design

GENERAL

According to Missouri State Statutes, plans, specifications, and cost estimates for public roadwork must be prepared by or under the immediate personal supervision of a registered professional engineer.

Plans and specifications must be prepared in such a manner that payment in the contract will be made on the basis of units of work and materials.

Plans and specifications prepared by the engineer may be reviewed by MoDOT on a cursory basis for an individual project basis only and should not necessarily be assumed to apply to other similar projects. Design computations do not need to be submitted to MoDOT unless requested, with the exception of vehicle load rating computations that meet the requirements described in this Section.

ROADWAY

There is no set standard for the order of sheets within the roadway portion of the plans. Items that must be included are typical sections, plan, profile, or plan and profile sheets, special sheets, erosion control plans, traffic control plans, and cross section sheets or data. Other sheets to be included if applicable include culvert sheets, lighting, signals, signing, utility sheets if part of the roadway contract, and standard plans.

Information that should be on the plan, profile, or plan and profile sheets should include a north arrow, graphic scale, description of the project's beginning and ending points, construction details, alignment and profile data, bench marks, and any construction notes. Construction notes should not be placed in the cross section sheets.

WATER QUALITY IMPACTS/LAND DISTURBANCE

The National Pollutant Discharge Elimination Systems (NPDES) program regulates construction activities where 1 acre or more of land is disturbed. If the project proponent has a general NPDES permit for all of their construction activities, this is adequate. If the project proponent does not have a valid general permit, and will disturb 1 acre or more of land, a project specific NPDES permit is required. A pollution prevention plan may be required with the NPDES application. Contact Missouri Department of Natural Resources at (573) 751-1300 for further information.

TRAFFIC CONTROL

A traffic control plan must be developed and included in the plans and specifications for the safe handling of traffic through or around the construction of each project. The basis for traffic control should be the Manual on Uniform Traffic Control Devices (MUTCD) and the MoDOT Traffic Control for Field Operations Manual. The scope of the traffic control plan should match the complexity of the project.

Projects should have a qualified person designated to have the responsibility and authority for assuring that the traffic control plan and other safety aspects of the contract are being followed. The plans and specifications should include pay items for providing, installing, moving, replacing, maintaining, cleaning, and removing traffic control devices required by the traffic control plan.

RAILROAD CROSSINGS

If the proposed improvements are on or cross railroad right of way, the railway company must be contacted. Railway company approval will be necessary to receive construction authorization. The Local Agency must contact the affected railway company directly.

UTILITIES

All existing and proposed utility facilities must be shown on the plan sheets. The minimum depth locations and encasement requirements for the utilities located on MHTC right of way is shown in Figure 9-2.

A utility Status Letter shall be written by the Local Agency and provided to MoDOT with the final plans submittal. See commonly used forms for a sample letter. Projects must be cleared for Bid Opening and MoDOT District Personnel must receive the status letter, prior to the bid opening date. Utilities “status” is defined as:

1. All utilities are physically adjusted on the projects, or
2. Utility construction work is active and has been completed to such a point that no impact would be expected to the road contractor. The status of the work is given in the utility job special provisions, or
3. Utilities are not expected to be adjusted by the notice to proceed date for the road project, but the utility work will have no impact on the progress of the road contractor’s work, or
4. Utilities must be adjusted after the contractor completes stage construction. This information must be outlined in a job special provision, or
5. Utility adjustments, plans and specifications, are included in the bid documents for the road project.

PROJECTS WITH BRIDGES

Bridge Drawings and Contract Documents

Structural drawings, specifications and special provisions for bridges or culverts must provide sufficient detail that will clearly identify all dimensional and materials requirements, and will allow the construction of all structural components in accordance with the engineer’s design.

The drawings shall provide appropriate general notes to identify all pertinent design criteria for the project; such as identification of all design loads, design unit stresses for the structural components, bearing pad and joint filler requirements, hydraulic data, geotechnical information, reinforcing steel clearances, etc. The notes should identify the usage of the appropriate AASHTO Design Standard

Specification for Highway Bridges along with a listing of significant exceptions. Also, plans should note the applicable construction specifications.

Drawings shall include a summary of estimated quantities, a reinforcing steel bar list and bending diagrams and a pile data table and footing design bearing table, where applicable.

1. If useful as an aid and/or reference, MoDOT Bridge Division's *Bridge Manual* covering design and detail of prestress double tee, prestress I-beam and other type structures, including steel is available from MoDOT for a fee. The information in the Bridge Manual is also accessible via the MoDOT Internet address:
<http://www.modot.mo.gov/business/manuals/bridgedesign.htm>
2. Detail sheets are also available for many superstructure details and substructure units. These may be obtained from MoDOT, in hard copy or electronic version, for a fee - or, may be accessed at
http://www.modot.mo.gov/business/consultant_resources/bridgestandards.htm
3. If a concrete box culvert structure is appropriate, plans are readily available for single, double, or triple box culverts from the *Missouri Standard Plans for Highway Construction*. These may be used in conjunction with an additional front sheet for the double and triple box culverts to be completed with information from the standard plans. The standard plans and appropriate front sheet may be obtained from MoDOT for a fee - or, may be accessed at the following address:
http://www.modot.org/business/standards_and_specs/standardplans.htm

Structural Inventory and Appraisal Sheet

The Structural Inventory & Appraisal (SI&A) Sheet must be completed and provided with the PS&E by the engineer for any replacement structure (or rehabilitated structure) that will meet the National Bridge Inventory definition of a "bridge". The SI&A Sheet must be completed in accordance with the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, by FHWA (which can be accessed at the Internet web site address www.fhwa.dot.gov/bridge/mtguide.pdf)

A blank form for the Structural Inventory and Appraisal Sheet is provided under "Commonly Used Forms" at the following LPA Manual Internet address. This form can be filled out electronically and printed. <http://www.modot.mo.gov/business/manuals/documents/siaform.pdf>

Load Rating Calculations and Load Rating Summary Sheet

Load rating calculations are required for all structures that will be classified as a "bridge" on the National Bridge Inventory (as defined in the above-referenced *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*). Inventory and Operating Load Ratings shall be provided compared to the AASHTO HS20 design loading. Load rating calculations for any NBI structure carrying vehicular traffic shall also account for all MoDOT standard load posting vehicles (the H20 and 3S2 vehicles) used to represent truck legal loads in the state. For bridges or

culverts located within the limits of commercial zones, an additional load posting recommendation for the commercial loading shall be included, utilizing the MO5 vehicle. (For example, when the operating rating for the MO5 vehicle is less than 70T, a S-C3 posting is required). For information and details regarding MoDOT's rating vehicles see Section Four of MoDOT's *Bridge Inspection Rating Manual*.

All load ratings are to be calculated using the Load Factor Rating Method in accordance with the *AASHTO Manual for Condition Evaluation of Bridges*. A Load Rating Summary Sheet, signed and sealed by a Missouri Registered Professional Engineer, shall clearly list all of the determined controlling load ratings, indicated in tons. The Load Rating Summary Sheet shall indicate all information needed for the completion of the Load Rating and Posting portion of the SI&A Sheet and the load rating calculations shall provide the information necessary to support the data indicated on the Load Rating Summary Sheet.

Load rating calculations and the load rating summary sheet will generally not be required with the PS&E submittals for projects which will utilize structural systems that are essentially proprietary based such as CMP or concrete arch culvert structures, since identification of a single proprietary manufacturer is generally not allowed in the contract documents. Unless informed otherwise by the local agency or engineer of record at the time of the PS&E submittal, MoDOT will in the interim assume that the presumptive values for the inventory and operating ratings are being achieved through the manufacturer's conformance with the design loading indicated by the local agency's consultant in the contract documents. However, the contract specifications should include the requirement that the actual load ratings, signed and sealed by a professional engineer licensed in Missouri be provided by the awarded manufacturer. MoDOT -Districts should secure this information along with an updated SI&A form and forward to the MoDOT-Bridge Division prior to project closeout. Upon receipt of the additional information from the local agency, MoDOT-Bridge Division will update the National Bridge Inventory to indicate the actual ratings.

ESTIMATES

An engineer's estimate, showing estimated quantities, unit prices, and extended totals shall be submitted to MoDOT with the detailed plans. Subtotals shall be shown for roadway items, signals, lighting, signing, striping, and bridges. The bid proposal will also need to include an itemized listing of all pay items included in the project, quantities of each individual pay item and blanks for the contractor to submit a unit price (and extension) for each pay item. Non-participating work (work that is not eligible for federal participation) shall be identified in the submitted estimate prepared by engineer of record. Any non-reimbursable utility work shall be separated from utility work that is eligible for participation. The use of lump sum contract will not be allowed.

The engineer's estimate should be treated as a confidential document. Any knowledge of the estimate may cause unbalanced bids or provide a contractor who has knowledge of the engineer's estimate an advantage.

WORK BY LOCAL FORCES

As indicated in the Code of Federal Regulations, the contract method based on competitive bidding shall be used for performance of highway work financed with the aid of federal funds unless it can be demonstrated that some other method is more cost effective. When a local agency desires that highway construction work financed with the aid of federal funds be undertaken by local forces, a request must be submitted identifying and describing the following:

1. the project and the kind of work to be performed,
2. the estimated costs,
3. the estimated federal funds to be provided, and
4. the reason or reasons that force account for such project is considered cost effective.

Work by local forces is considered to be the direct performance of work by the contracting agency or its designee utilizing labor, equipment, materials, and supplies furnished by the agency and used under its direct control. When the local agency desires to construct any portion of the project with its own forces, it must be in the public interest that this is the most cost effective way to construct the project (the efficient use of labor, equipment, materials, and supplies to assure the lowest overall cost). Local agencies must demonstrate to MoDOT that they have the equipment and experience to perform the items of work specified. MoDOT shall determine that the organization to undertake the work is so staffed and equipped as to perform such work satisfactorily and cost effectively.

There are two methods by which the local agency can be reimbursed for this type of work, and the estimate should be prepared accordingly. The first method is actual cost. Payment will be made for labor, materials and equipment rental rates. Estimated hours and rates should be included and final reimbursement will be made based on an audit of actual costs.

The other method is agreed to unit prices. This method requires more extensive justification at the PS&E stage, but reimbursement will be made based on the number of units constructed. This eliminates some record keeping and detailed audit. The agreed unit prices must be developed using quantities, man-hours, pay rates, material costs and equipment rental rates. The local agency by agreeing to these unit prices also agrees that no construction change order can be made to adjust the unit prices, but a construction change order is allowable for quantity changes. If the local agency and MoDOT can't come to an agreement on the unit price, the local agency can still perform the work by using the actual cost method described above.

MoDOT will not approve work by the local agency's forces unless it can be demonstrated that it can be accomplished at lower cost than if performed by contract. If the local agency determines they do not want to perform an item and the work is within the scope of the construction contract, they can negotiate a change order with the contractor to perform the work and execute a construction change order. The local agency will need to execute a work by local forces proposal (**Figure 9-2**) that must be submitted with the construction estimate.

SPECIFICATIONS AND JOB SPECIAL PROVISIONS

It is recommended that the engineer shall use the latest edition of the *Missouri Standard Specifications for Highway Construction* and Supplemental Specification Revisions. The engineer may modify these specifications, where appropriate for job-specific requirements or conditions, by creating job special provisions. Also, the engineer of record and/or local agency may write their own custom set of specifications. The specification used shall be referenced on both the drawings and the specifications package as the basic standard for materials and construction - except as modified or superceded by job special provisions or other specifications included in the specifications package. When the *Missouri Standard Specifications for Highway Construction* are supplemented by job special provisions or substituted by other specifications, the cover sheet of the supplementary or substituting specifications package is to be signed and sealed by the engineer.

MoDOT specifications can be made available to local agencies as either a reference or for actual use in contracts. Certain job special provisions are available from MoDOT for a nominal fee; however, MoDOT Job Special Provisions and Standard Specifications information can also be accessed at the MoDOT Internet address: <http://www.modot.mo.gov/business/index.htm>

Local agencies are urged to prepare the specifications and special provisions carefully to ensure that the inspection, testing, and sampling procedures are adequately covered.

When the local agency decides not to inspect at the fabricators shop, the following specifications regarding acceptance of fabricated structural members shall be included in the specification documents (as Job Special Provisions), as applicable to the following categories of structural members:

Acceptance of Precast Double Tee, I-Girder, Box-Girder and Slab Panels

The following procedures have been established for the acceptance of precast double tee, I-girder, box-girder and slab panels. Shop drawings shall be submitted to the local agency's engineer for review and approval. The approval is expected to cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in the shop drawings. The local agency or their consultant has the option of inspecting the precast units during fabrication or requiring the fabricator to furnish a certification of contract compliance and substantiating test reports. In addition, the following reports will be required:

1. Certified mill test reports, including results of physical tests on the prestressed strands, and reinforcement as required.
2. Test reports on concrete cylinder breaks.

The local agency or consultant must verify and document that dimensions of the units were checked at the job and found to be in compliance with the shop drawings.

Acceptance of Structural Steel

The following procedures have been established for the acceptance of structural steel. Shop drawings shall be submitted to the local agency's engineer for review and approval. The approval is expected to cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in the shop drawings. It is recommended that the contract documents contain provisions that the contractor shall utilize a fabricator that meets the appropriate American Institute of Steel Construction (AISC) certification provisions as outlined in Section 1080.3.1.6 of the 2004 *Missouri Standard Specifications for Highway Construction* and Supplemental Specification Revisions. All welding operations, including material and personnel, shall meet the American Welding Society (AWS) specifications. The local agency or their consultant has the option of inspecting the steel units during fabrication or requiring the fabricator to furnish a certification of contract compliance and substantiating test reports. In addition, the following reports will be required:

1. Certified mill test reports, including results of chemical and physical tests on all structural steel as furnished; and
2. Non-destructive testing reports.

The local agency or consultant must verify and document that dimensions of the units were checked at the job and found to be in compliance with the shop drawings.

(Additional information regarding the AISC Certification provisions may be found at the AISC Internet web site address: www.aisc.org)

Preparation of Contract Documents Involving Proprietary Products or System

Generally, on federal aid projects, the use of trade names in plans and specifications is not allowed except as outlined below. The practice of utilizing essentially proprietary products or systems is acceptable if it can be assured that three or more companies can provide an acceptable product. Overall, there are three basic approaches which are available to provide construction plans and specifications that can accommodate the use of proprietary based products or systems.

1. If the product or system will be specified by using trade names, the contract documents need to be prepared so that at least three (3) different brand names of viable producers are specified in conjunction with appropriate contract requirements and also acceptable equivalents are allowed. If structures are involved, the requirements for final plans and shop drawings in no. 2 below will apply.
2. The engineer can prepare generic or performance based contract documents which can be met by at least three (3) viable producers or vendors that are identified by the engineer when the PS&E is submitted. Contracts set up to permit alternate bidding of different types or products providing the same function may also be used provided three vendors are available for each type. For structures, the engineer will prepare complete plans and specifications which will include sufficient key parameters to define the scope of the project such as

structure and opening size, important geometrics, loading, hydraulics and foundation information. Using this approach the successful fabricator will provide design computations and shop drawings which are signed and sealed by a professional engineer for review and approval by the local agency's engineer. Approved final plans for bridge structures should be secured by the MoDOT -Districts and forwarded to the MoDOT-Bridge Division for inventory purposes as part of the project closeout.

3. Less than three (3) specified materials or products may be approved if MoDOT concurs in a finding that it is in the public interest. For instance, a local agency may find it desirable to limit traffic signal controllers to one brand for ease of maintenance and the stocking of repair parts. If the local agency wishes to use less than three (3) trade names, the following justification will need to be provided to MoDOT for review/approval:
 1. Show how the item(s) is essential for synchronization with the existing roadway facility or that no equally suitable alternative exists.
 2. Show how the use of the product(s) will prove to be cost-effective. This should include historical data supporting the cost effectiveness of the products.
 3. Show how using the product(s) will provide ease of maintenance.
 4. Provide more detail on its spare parts inventory on what impact using the trade name products(s) will have on this inventory (where applicable).
 5. Provide more detail on standardization – that is, provide estimated quantity of product that was implemented in areas surrounding the product (also include the date when the trade name product was implemented) (where applicable).

If MoDOT concurs, we will forward to FHWA for their approval as may be required.

If the single source material cannot be justified, the item will be non-participating unless bidding procedures are used that establish the unit price of each acceptable alternative, in which case participation will be based on the lowest price established.

Shop Drawings

Shop drawings which are prepared in conformance with the engineer's detailed plans and specifications are not typically required to be signed and sealed by a professional engineer. However, this is not applicable for projects where the contractor may be responsible for the design at the shop drawing stage, e.g., MSE walls, precast culverts, and steel trusses.

INSPECTION BY MoDOT AND FHWA

The project Job Special Provisions or drawings shall stipulate that MoDOT and FHWA may make inspections of the work and that the contractor shall grant them access to all parts of the work.

Representatives of MoDOT will make a final inspection on all projects, preferably at the same time as the local agency makes final inspection.

PLANS, SPECIFICATIONS AND ESTIMATE (PS&E) SUBMITTAL

When the plans, specifications and the engineer's estimate of project cost and construction engineering have been completed, the Local Agency shall submit the "PS&E" documents to MoDOT for review.

Four sets of plans, specifications and estimate of project cost and construction engineering should be submitted to MoDOT. If the project contains a bridge, the completed Structure Inventory and Appraisal Sheet, the vehicle Load Rating Summary Sheet (signed and sealed by the engineer) and load rating calculations must also be submitted at this time. The title sheet of the drawings must be signed by the Local Agency and all plan sheets signed and sealed by the appropriate professional before MoDOT will provide approval of the submittals. **Submitted drawings shall be 11" x 17".** When the 2004 Missouri Standard Specifications for Highway Construction are supplemented by job special provisions or substituted by other MoDOT-approved specifications, the cover sheet of the supplementary or substituting specifications package is to be signed and sealed by the engineer.