

### 1.1.2.12 Final Design, General

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The final design phase can begin after receiving the TS&L approval. All bridge design projects will be completed by assigning personnel to perform the following duties:

1. Bridge Design Reviewer
2. Bridge Designer
3. Bridge Design Checker

All personnel assigned to any of these duties will be required to either stamp and/or sign the final plans. Current practice requires only one stamp on the plans. The literal interpretation indicates that a registered designer must stamp his/her own plans. ORS 672.002(10) just requires that the stamping engineer have supervision and control unless he/she is not registered, in which case the checker or reviewer will stamp the plans, in accordance with OSBEEL rules for work done under supervision and control of a registered PE.

- a. At least two out of the three functions listed above must have prior experience and minimum qualifications in the type of structure being designed, repaired, or strengthened, including bridge preservation work. Either the review or checking function must be done by someone with a minimum of five years experience in successful bridge design and construction support of bridges successfully constructed. If the unit, agency, or firm does not have the desired level of expertise, they will be expected to employ one of the following:
  - Provide a "tech advisory group" for the project, or
  - Hire a consultant or sub-consultant that does have the desired level of expertise
- b. When main structural members are being designed, repaired, or strengthened, the Class 2 design check will only be allowed under rare circumstances, when the designer has completed more than five designs of the specific type of bridge under design, and then specific critical portions of the design will be verified independently.

Bridge Design Reviewer – Generally, the designated "Bridge Design Reviewer" is the immediate supervisor of the work unit that has been assigned the bridge project, or the person that has overall management responsibility for the project. Serving in that capacity, the "Bridge Design Reviewer" will be responsible for selecting the Bridge Designer, the Bridge Design Checker, and the CAD Drafting support for the project. Large design projects with multiple or complex structures will most likely involve several Designers and several Drafters. Often, these large projects can be done more efficiently if the Design Team Supervisor chooses a Lead Bridge Designer and Lead CAD Drafter to help organize and manage the project, as well as, fulfilling the following tasks, or assure they are done:

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- 1) Fulfill the Design Team Supervisor's Responsibilities as specified in Bridge Section Office Practice 2.1.11.2
- 2) Review Plan as specified in 2.1.11.3(2)
- 3) Assure that the project is designed in accordance with accepted bridge design manuals as specified in 2.1.2.
- 4) Records are kept in accordance with 2.1.3.
- 5) Tracking Bridge Design Costs as specified in 2.1.7.
- 6) Measuring Design Productivity as specified in 2.1.8.
- 7) Assuring that Other Design Considerations were addressed 2.1.10.
- 8) Provide overall Project Guidance and Support 2.2.
- 9) Assure that Other Things are addressed 2.3.2.
- 10) Obtaining the appropriate Permits 2.3.3.

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- 11) Periodically Reviewing the Job record Folder 2.3.4.
- 12) Processing the TS&L Design Package.
- 13) Review any Special Provisions 2.4.5.
- 14) Review Final Plans to assure that the design meets project objectives 2.4.8.

15) Review Final Plans to assure that structural elements, specifically joints and bearings are inspectable.

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16) Review Final Plans to assure that enough room on beam seat is provided for bearing replacement and effects of jacking force on structural elements. Ensure that details are provided which show location of jacks needed for bearing replacement, including bearing replacement procedures.

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17) Review Final Plans to assure that enough room is provided beneath bridge deck for inspection and maintenance of Modular Bridge Joint Systems.

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18) Review all Project Changes initiated during the Construction Phase.

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19) Provide project support when handling Construction Problems.

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20) Review all Price Agreements.

21) Review all Working Drawings.

22) Review the Construction Narrative 3.1.9.

23) Assure As-Constructed Drawings are created in accordance with BDDM 2.1.3.1, 2.1.3.2 and 2.7.11 and submitted to Bridge Section along with the Calculation Book(s).

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24) Transfer all Electronic Files to Bridge Section for Archiving.

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Bridge Designer – Generally, the assigned “Bridge Designer” will be the designated “Engineer-of-Record” for the project and will generally see the project through to completion, from-cradle-to-grave. The designated Bridge Designer (“Engineer-of-Record”) will be responsible for fulfilling the following:

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- 1) Fulfill the Lead Designer’s duties as specified in Bridge Section Office Practice 2.1.11.3. Assure that the bridge is designed in accordance with accepted ODOT Standard Bridge Design References shown in (Office Practice 2.1.2).
- 2) Fulfill the duties listed in the Bridge Section Office Practice 2.1.11.
- 3) Create the Preliminary Documents specified in Bridge Section Office Practice 2.2.2.
- 4) Fulfill the Preliminary Design Tasks specified in Bridge Section Office Practice 2.2.3..
- 5) Provide the Type, Size, and Location (TS & L) Design as specified in Bridge Section Office Practice 2.3.
- 6) Provide and keep the Bridge Design Calc Book current and up-to-date in accordance with 2.1.5 and 2.1.6.
- 7) The designated Bridge Designer will assure that the bridge is designed in accordance with Bridge Section Office Practice 2.4 “Final Design”.
- 8) The designated Bridge Designer will be responsible for working with the CAD Drafting staff, with the Bridge Plans and/or modification of the Standard Drawings for the project.
- 9) Throughout the project development phase the designated Bridge Designer will maintain a Book of Design Calculations, so that it is current and up-to-date and contains the information specified in Bridge Section Office Practice 2.1.5 and 2.1.6.
- 10) The designated Bridge Designer will normally act as the project consultant throughout the Construction Phase, performing those duties specified in Bridge Section Office Practice 3.1.
- 11) Assure Design Standards and Project Development Criteria are met or given exceptions from

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ODOT Roadway Section.

- 12) In addition to Design using authorized Computer System and Software (2.1.4), perform cursory bridge design calculation by hand to assure input and output from the computer software is correct..
- 13) Review any Special Provisions 2.4.5.

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#### 14) National Bridge Inventory System Requirements:

- a. The Bridge Operations Work Unit will be kept apprised of all bridge inventory data changes.
- b. The following Bridge Operations, Standards and Practices personnel will receive a copy of the advanced plans when they become available:
  - i. Bridge Operations Engineer
  - ii. The Region Bridge Inspector where the structure resides
  - iii. The Bridge Inventory Coordinator
  - iv. If the structure is a local agency bridge – the Local Agency Bridge Inspection Coordinator.
- c. The Region Bridge Inspector, where the structure resides, will be given a notice prior to opening the structure to public travel.

Bridge Design Checker – All Bridge Design Projects must also have a designated “Bridge Design Checker”. Even though the designated Bridge Designer is the Engineer-of-Record, the checker will perform an independent calculation for the bridge being designed, as well as fulfilling the following duties:

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- 1) Fulfill duties as specified in Bridge Section Office Practice
  - a. Bridge Design Checker, Class 1 – 2.4.9,
  - b. Checking Last Minute Changes – 2.4.10.2,
  - c. Check Working Drawings when not in conformance with the design drawings – 3.1.8,
  - d. Perform a Review of the Construction Narrative – 3.1.9.
- 2) Stay involved throughout the life of the project so that a check of calculations and a review of design decisions can be performed.

The final design end product includes:

- Plans – Clear and complete detailed plans with all information necessary to obtain a fair bid and to layout and construct the project.
- Specifications – Preparation or assembly of all Specifications, Supplemental Specifications, and Special Provisions necessary for construction of the project.
- Estimates – Calculated quantities of all materials in the project, based upon the current Bid Item list. Estimate of the time required for construction using a graph format showing all critical stages of the construction. Estimate of the cost of design assistance during construction.
- Calculation Book(s)
  1. Design Calculations – A structural analysis and design of the bridge and related components. Documentation of the work with hand calculations, computer output and detailed notes. The Design Engineer is responsible for the meaning and applicability of all computer generated data.

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2. Design Check Calculations – An independent check of: the structural analysis and design of the bridge and related components, plan detail sheets, specifications and special provisions, and project quantities; Documentation of the work with hand calculations, computer output and detailed notes; the meaning and applicability of all computer generated data by the checking Engineer.

The level of detail to be checked varies with the complexity of the project and the amount of experience of the Designer and Checker.

**Class I Check** – The Class I check is a comprehensive design review covering all aspects of the project. It will be done primarily for:

- Major complex structures.
- Steel and post-tensioned bridges.
- Structures designed by an inexperienced Designer.
- Structures checked by an inexperienced Checker.

The Checker is responsible for the following:

- Review of location data and correspondence files.
- Review of construction time and seasonal requirements, permit applications, work-in-stream restriction, and utility installations and conflicts.
- Review of foundation and hydraulic requirements.
- Check for consistency of alignment and details with roadway plans.
- Thorough check of geometry, alignment, grades, clearances, and construction details.
- Verification of structure length, roadway width, structure type selection, aesthetic treatment, span arrangement, bent type and configuration, and rail type.
- Complete independent structural analysis of all components according to design specifications and current design practice. The Checker should make a quick, longhand check of the most important structural elements before beginning a computer analysis of the design.
- Independent check of Final Estimate quantities and reconciliation of figures with Designer.
- Confirmation that all items listed in the Checklist for Final Design (BDDM A2.7.2) have been satisfied.

**Class II Check** – The Class II check is a review of design concepts and construction details and does not necessarily include a structural analysis. It will be done primarily for:

- Minor bridges designed by an experienced Designer.

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The Checker is responsible for the following:

- Review of correspondence, job files, and design calculations.
- Confirmation that foundation and hydraulic requirements are met.
- Verification of geometry, alignment, and structure type selection.
- Confirmation with Designer that critical structural items have been analyzed during the final design.
- Completeness of plans
- Check of construction details and Final Estimate quantities.

Complex, Unconventional or Unusual Systems or Details – Operations and Maintenance Manuals

Bridge engineering has been changing and numerous emerging technologies are on the horizons that enable facility owners to improve the performance and/or to monitor the safety of their bridges. To ensure that these innovations are properly applied and monitored for their effectiveness, the owner is requiring operations and maintenance manuals to be submitted along with the design calculations for all unconventional, complex or unusual systems or details. The specifics of the service manuals will be determined at the beginning of design of which they relate to the bridge type design selected.

The intent of this provision is to provide additional information to the agency for the efficient and effective operation of any innovations that are installed and specific to a facility. The manual may include shop drawings, fabrication details and manufacturer's technical product information. The manual should be clear in providing instructions on how and when to inspect and maintain the systems or details and how often to perform condition assessment of the unit.

Examples of deliverables:

1. NDT/E Monitoring Systems:
  - a. Example of deliverable: Operations and Maintenance Manual for all the NDT/E monitoring systems for recording fracture critical stresses and potential fatigue crack locations
2. Electrical and Mechanical Systems on Movable Bridges
  - a. Operations and Maintenance Service Manuals for all electrical controls on movable bridges. Maintenance manual should include servicing the machine components and gears, brake systems, drive motors and span locks.
  - b. Operating instructions should include electrical service disconnect, wiring and labeling of electrical power distributions, traffic control systems, span lift control and lock systems, navigational and channel lightings, HVAC, fire and security alarms, and remote camera and sensing systems.
3. Seismic Monitoring Systems:
  - a. Operations and Maintenance Manual for seismic monitoring system for recording ground motions.
  - b. Operating instructions should include system inspection and checks, recorder working properly, troubleshooting, and accelerometers working condition.
4. Cathodic Protection Systems:
  - a. Operations and Maintenance Manual for all cathodic protection system to include such components like cabinets, wiring system, reference cells, anodes, and terminal plates.
  - b. Operating instructions should include system and inspection checks, battery power operated checks, trouble shooting, presence of corrosion, and sensors integrity check.

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5. Bridge design types that are unique or unconventional to Oregon:

- a. Segmental and cable stayed bridges – inspection and maintenance manuals for its critical details and main force carrying components. Such examples include post-tensioning ducts and tendons, stay cables, anchorage and cradle details, deviators, pot bearings, modular joints, seismic isolation and/or damping devices, wind shear locks. Maintenance instructions should include the inspection and replacement of its components when they are no longer performing as designed.
- b. Suspension bridges – inspection and maintenance manual for its critical details and main force carrying components. Such examples include main cable, saddles, anchorages, shoes, suspender ropes, corrosion protection systems, seismic isolation and/or damping devices, and wind shear locks.

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