

## Chapter 26

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## Chapter 26

### Bridge Project Development

#### 26.1 General

All structural designs for new construction for the Florida Department of Transportation (FDOT) are developed under the direction of the Structures Design Office (SDO) and/or the District Structures Design Offices (DSDO). All designs are to be developed in accordance with the *Structures Manual* which includes the *Structures Design Guidelines (Topic No. 625-020-150)*, the *Structures Detailing Manual (Topic No. 625-020-200)*, this Manual, the *Design Standards (Topic No. 625-010-003)*, and the *AASHTO Standard Specifications for Highway Bridges* or the *AASHTO-LRFD Bridge Design Specifications* as referenced in the Structures Manual, applicable FHWA Directives, and other criteria as specified by the Department.

Designs for repair or rehabilitation of bridges are generally developed under the direction of the District Structures Maintenance Engineer (DSME) and may not include all the submittal types discussed in this chapter.

Structures for other agencies or authorities such as the Jacksonville Transportation Authority, various Expressway Authorities, etc. may be designed to meet the Department's criteria or additional criteria as specified by the authority.

For projects involving bridges over navigable water, the Project Manager must provide the District Structures Maintenance Engineer (DSME) sufficient notification prior to engaging in any action in, on, or around the bridge. Refer to **Section 13.5.3** of this volume for further information.

#### 26.2 Organization

The Structures Design Office (SDO) is a subdivision of the Office of Design under the direction of the State Highway Engineer and the Assistant Secretary for Transportation Policy. The SDO is under the direction of the State Structures Design Engineer (SSDE). Each District, including the Turnpike, has a staff of structural design engineers that comprise the District Structures Design Office (DSDO), and which is under the direction of the District Structures Design Engineer (DSDE).

## **26.3 Definitions**

All structures have been grouped into the following two categories based upon design difficulty and complexity:

### **26.3.1 Category 1 Structures**

Category 1 Structures consist of box or three-sided culverts, short span bridges (continuous reinforced slabs and prestressed slabs), simple span bridges with spans less than 150 feet, continuous straight steel plate girder bridges with spans less than 150 feet, bridge widenings for these structure types, retaining walls, roadway signing, signalization and lighting supports, sound barriers, and overhead sign structures.

### **26.3.2 Category 2 Structures**

A structure will be classified as a Category 2 Structure when any of the following are present: steel box girders, curved steel plate girders, span lengths equal to or greater than 150 feet, cast-in-place concrete box girder bridges, concrete segmental bridges, continuous post-tensioned concrete bridges with or without pretensioning, steel truss bridges, cable stayed bridges, movable bridges, depressed roadways, tunnels, , non-redundant foundations, straddle piers, integral caps, bridges designed for vessel collision, or any design concepts, components, details or construction techniques with a history of less than five (5) years of use in Florida.

## 26.4 Abbreviations Used in Structures Design

Terminology used in the area of Structures Design for the Florida Department of Transportation often is written or spoken in the form of abbreviations and/or acronyms. Following is a list of those terms frequently encountered in this manual and in other references used in structures design and include those commonly used for offices, organizations, materials, systems, features, equipment, conditions, and expertise:

<b>AASHTO</b>	<b><i>American Association of State Highway and Transportation Officials</i></b>
<b>ACI</b>	<b><i>American Concrete Institute</i></b>
<b>ACIA</b>	<b><i>Assigned Commercial Inspection Agency</i></b>
<b>ADA</b>	<b><i>Americans with Disabilities Act</i></b>
<b>AISC</b>	<b><i>American Institute of Steel Construction</i></b>
<b>ANSI</b>	<b><i>American National Standards Institute</i></b>
<b>AREMA</b>	<b><i>American Railway Engineering and Maintenance Association</i></b>
<b>ASTM</b>	<b><i>American Society for Testing and Materials</i></b>
<b>AWS</b>	<b><i>American Welding Society</i></b>
<b>BBS</b>	<b><i>Bulletin Board System</i></b>
<b>BDR</b>	<b><i>Bridge Development Report</i></b>
<b>BHR</b>	<b><i>Bridge Hydraulics Report</i></b>
<b>BHRS</b>	<b><i>Bridge Hydraulics Recommendation Sheet</i></b>
<b>CADD</b>	<b><i>Computer Aided Design and Drafting</i></b>
<b>CEI</b>	<b><i>Construction Engineering and Inspection</i></b>
<b>C.I.P. (C-I-P)</b>	<b><i>Cast-in-Place (Concrete)</i></b>
<b>CPAM</b>	<b><i>Construction Project Administration Manual</i></b>
<b>CVN</b>	<b><i>Charpy V-Notch (Impact Testing)</i></b>
<b>DSDE</b>	<b><i>District Structures Design Engineer</i></b>
<b>DSDO</b>	<b><i>District Structures Design Office</i></b>
<b>DSME</b>	<b><i>District Structures Maintenance Engineer</i></b>
<b>EMO</b>	<b><i>Environmental Management Office</i></b>
<b>EOR</b>	<b><i>Engineer of Record</i></b>
<b>FDOT</b>	<b><i>Florida Department of Transportation</i></b>
<b>FHWA</b>	<b><i>Federal Highway Administration</i></b>
<b>LRS</b>	<b><i>Low-relaxation Strands</i></b>
<b>LRFD</b>	<b><i>Load and Resistance Factor Design</i></b>
<b>MHW</b>	<b><i>Mean High Water</i></b>
<b>MSE</b>	<b><i>Mechanically Stabilized Earth (Walls)</i></b>
<b>MUTCD</b>	<b><i>Manual on Uniform Traffic Control Devices</i></b>
<b>NHS</b>	<b><i>National Highway System</i></b>
<b>NHW</b>	<b><i>Normal High Water</i></b>

<b>NOAA</b>	<b><i>National Oceanic and Atmospheric Administration</i></b>
<b>OIS</b>	<b><i>Office of Information Systems</i></b>
<b>OSHA</b>	<b><i>Occupational Safety and Health Administration</i></b>
<b>PDA</b>	<b><i>Pile Driving Analyzer</i></b>
<b>PD&amp;E</b>	<b><i>Project Development and Environment</i></b>
<b>PPD</b>	<b><i>Plans Production Date</i></b>
<b>PPM</b>	<b><i>Plans Preparation Manual</i></b>
<b>QPL</b>	<b><i>Qualified Products List</i></b>
<b>RDR</b>	<b><i>Required Driving Resistance</i></b>
<b>SDO</b>	<b><i>Structures Design Office</i></b>
<b>SIP (S-I-P)</b>	<b><i>Stay-in-Place (Forms)</i></b>
<b>SRS</b>	<b><i>Stress-relieved Strands</i></b>
<b>SSDE</b>	<b><i>State Structures Design Engineer</i></b>
<b>TAG</b>	<b><i>Technical Advisory Group (SDO and DSDEs)</i></b>
<b>TFE (PTFE)</b>	<b><i>Polytetrafluorethylene (Teflon)</i></b>
<b>TRB</b>	<b><i>Transportation Research Board</i></b>
<b>UBC</b>	<b><i>Ultimate Bearing Capacity</i></b>
<b>UV</b>	<b><i>Ultraviolet</i></b>
<b>VECP</b>	<b><i>Value Engineering Change Proposal</i></b>

## 26.5 Responsibility

The District Structures Design Office has total project development responsibility for projects involving Category 1 Structures, upon release by the Structures Design Office. The Structures Design Office has total project development responsibility for projects involving Category 2 Structures. This responsibility for Category 2 Structures extends to rehabilitation projects and repairs of bridge components that qualify the structure as a Category 2 Structure.

The District Project Manager shall coordinate with the District Structures Design Engineer who shall review and concur with the bridge aspect of all projects during the PD&E process in accordance with **Chapter 4** of the **PD&E Manual**.

The District Structures Design Engineer or the State Structures Design Engineer, as appropriate, shall concur/approve all bridge related work after location design approval is granted.

To assure a uniform approach to a project, the engineer shall coordinate with the appropriate Structures Design Office to discuss structures related phase review comments and get concurrence on how to proceed.

## 26.6 FHWA Oversight

See **Chapter 24** of this volume for FHWA requirements.

## 26.7 Bridge Project Development

The following sections will define, clarify and list the information necessary to produce an acceptable and reproducible set of contract documents (special provisions, bridge contract drawings, etc.) ready for advertisement and construction.

Bridge project development normally includes five phases of development. The first phase of development, bridge analysis, occurs during the Project Development and Environment (PD&E) process. After location design approval is granted, the second phase, Bridge Development Report/30% Structures Plans, is initiated. After approval of the BDR, the final phases of work will begin. The third phase is the 60% Structures Plans that consists of the substructure foundation submittal for all projects and 60% Structures Plans for most Category 2 Structures. The fourth phase includes the 90% Structures Plans and specifications. The fifth phase includes the 100% Structures Plans and specifications. For efficiency, one engineering firm (one design team) should be responsible for the BDR and the final plans and specifications.

For Category 2 bridges and some Category 1 bridges, step negotiations are suggested. Step negotiations are desirable because the final bridge type cannot be determined until the BDR is complete. Utilizing this scenario, the first step of the negotiations would include the BDR/30% Structures Plans. After submittal of the BDR/30% Structures Plans, negotiations for final three phases of work (60% Structures Plans, 90% Structures Plans and 100% Structures Plans) would begin. Negotiations should not be finalized until the BDR/30% Structures Plans are approved by the DSDO or the SDO as appropriate.



## 26.8 Bridge Analysis

### 26.8.1 General

The Bridge Analysis is performed during the PD&E phase by qualified bridge engineers. The District Structures Design Engineer must concur with the findings of the bridge analysis, which is part of the preliminary engineering report. The function of the bridge analysis is to determine the general attributes for the recommended bridge. The specific attributes of the bridge will be defined in the BDR.

For bridges over water, a location Hydraulics Report will be prepared in conjunction with the bridge analysis. General site geotechnical knowledge is also required (usually from existing bridge plans) or, in some cases, it may be desirable to obtain borings.

### 26.8.2 Contents

The bridge analysis shall provide conceptual guidance for the bridge design consultant. Conceptual guidance on how the bridge should fit into the uniqueness of the site should be provided. Bridge design and structure type should be left to the design team in the later phases of work. Bridge analysis shall include the following:

1. Environmental and site considerations.
2. Vertical and horizontal clearances (existing and proposed).
3. Disposition of existing structure. (Final disposition of demolished bridge debris will depend on whether or not a local, State or Federal agency has agreed to receive the debris. See **Section 13.5.2.3**).
4. Vertical and horizontal geometry.
5. Typical section.
6. Conceptual ship/barge impact data (sample of recreational and commercial traffic).
7. Identification of historical significance of bridge and surrounding structures.
8. Aesthetic level for bridge and bridge approaches.
9. Location Hydraulics Report.
10. Bridge deck drainage considerations.
11. Stream bottom profile.
12. Conceptual geotechnical data.

13. For sites with movable bridge options, a life cycle cost comparison will be prepared and compared to a fixed bridge.
14. Phase Construction Impacts.
15. Construction time.

## 26.9 Bridge Development Report (BDR)/30% Structures Plans

### 26.9.1 General

The BDR is intended to establish all the basic parameters that will affect the work done in the Design and Plans Preparation phase. Initiation of the BDR shall occur after location design approval (For some sites only a programmatic categorical exclusion will be required before initiation of the BDR). Once approved, the BDR will define the continuing work by the Engineer of Record (EOR). It is mandatory that the EOR obtain and coordinate the information and requirements of the offices and engineering disciplines whose input is essential to the preparation of an effective BDR. Changes to the parameters after the BDR is approved could result in schedule delays and supplemental agreements; therefore, it is critical that District Offices, FHWA (if involved), the Structures Design Office and other involved agencies recognize the purpose and importance of the BDR. The BDR phase of work will contain sufficient detail for the justification of the proposed bridge type. For most projects, the 30% Structures Plans will be included as an appendix to the BDR. The BDR is developed from information outlined on the Bridge Development Report Submittal Checklist shown in **Exhibit 26-A**, located at the end of this chapter. This information is often provided by others; however, the EOR is responsible for ensuring that all of the information is adequate and appropriate. If the data is not sufficient, the EOR must obtain the required information before the BDR can be completed and submitted.

When alternate designs are considered, consistency between the alternates is essential in ensuring equitable competition and optimum cost-effectiveness. This consistency includes uniformity of design criteria, material requirements and development of unit costs.

The BDR should contain only supportable and defensible statements. Subjective opinions or unsubstantiated statements are not acceptable. All arguments must be clearly and logically defensible with calculations, sketches or other technical data.

The quantity of work necessary to prepare the BDR depends upon the project's complexity; however, the usual work effort for bridge types normally encountered is:

1. Minor Bridge Widening: The BDR will be a minor work effort; however, viable structural possibilities and economical options should be thoroughly investigated to determine if replacement of the bridge would be more appropriate than its widening. This is particularly true at sites where the existing bridge condition is marginal, where there has been a record of serious flooding or scouring, when the widening is part of a route improvement with a high potential for attracting traffic, if the existing

bridge has a history of structural problems (including vessel collision), or if the inventory rating is less than required by AASHTO and cannot be improved. Load rating considerations that shall be included in the BDR recommendations are provided in **Section 7.1.1 of the Structures Design Guidelines**.

2. Minor Grade Separations or Small Water Crossings: The BDR shall be a thorough document that adequately addresses all viable structure types; however, the BDR will not usually be an extensive document since the viable types of superstructure and substructure are generally limited. Scour and vessel collision shall be considered.
3. Major Bridges (including Movable) and Major Interchanges: The BDR shall be an extensive and comprehensive document that thoroughly considers all viable structure types and considers all design parameters (such as vessel collision and scour).

## 26.9.2 Contents

The major items to be considered in the BDR are:

1. General: The bridge length, height and pier locations are subject to vertical and horizontal design clearance requirements such as those for clear zone, navigation and hydrology. After these considerations are met, span lengths are governed by economics and aesthetic considerations. Superstructure depths (grade separation structures in particular) shall be kept to the minimum that is consistent with good engineering practice. Recommended span/depth ratios for steel superstructures are shown in AASHTO.

The length of the bridge will be affected by:

- a. Opening required by the Bridge Hydraulic Report.
  - b. Environmental Considerations.
  - c. Railroad clearances and cross sections.
  - d. Width of waterway and/or width of cross section of roadway being spanned including the use of retaining walls, or fender systems.
2. Statical System: The economic and engineering advantages of both simple span and continuous spans shall be addressed.
  3. Superstructure: Some superstructure types that could be considered are prestressed concrete girders, inverted-tee sections, reinforced or prestressed concrete slabs, steel rolled sections or plate girders, steel or concrete box girders, and post tensioned slabs, bulb-tees or boxes.
  4. Substructures: Some substructure types that could be considered are pile bents

- and multi-column or hammerhead piers. Variations of column shapes may be appropriate for aesthetic or economical requirements.
5. Foundations: Some foundation types that could be considered are steel and concrete piles, drilled shafts and spread footings.
  6. Vessel Collision: Vessel collision forces will often have a major effect on the structural configuration and overall economics. See vessel collision requirements in the **Structures Design Guidelines**.
  7. Scour: The 100 year and 500 year predicted scour elevations will often have a major effect on the foundation design. See the foundations and geotechnical requirements in the **Structures Design Guidelines**.
  8. Quantity estimates: For minor bridges rough quantities (such as reinforcing steel based on weight per volume of concrete) may be sufficient. For major and complex bridges the degree of accuracy may require more exact calculations keeping in mind that the intent is to establish relative and equitable costs between alternates and not necessarily to require the accuracy of the Final Estimate. For major and complex structures it may be necessary to develop unit costs from an analysis of fabrication, storage, delivery and erection costs of the different components. For projects involving the demolition of bridges, debris volume quantities must be calculated.
  9. Unit costs: Data available from the FDOT or contractors and suppliers should be used to arrive at unit costs. The sources of all price data shall be recorded for later reference. Base cost should be obtained from the **BDR Estimating Section** of the **Structures Manual**.
  10. Develop cost curves: For each alternative establish the most economical span arrangement, i.e., minimum combined superstructure and substructure cost.
  11. Retaining Wall Study: If retaining walls are present, a retaining wall study shall be included in the BDR. This study will conform with the work as specified in **Chapter 30** of this volume and **Chapter 4** of the **Structures Design Guidelines**.
  12. Movable Bridges: For movable bridges the BDR shall include information on the type of equipment for the machinery and electrical drive systems, together with a general description of the control system to be utilized. A written description and preliminary layouts of system components shall be included.
  13. Pedestrian Facilities: If pedestrian facilities are included, the report shall describe the facilities anticipated and the means to be used to comply with ADA requirements.

For rehabilitation project plans, the BDR stage shall include plans and written descriptions of those system components to be modified from the existing configuration, along with plans of the existing configuration. Submittal of information described in the previous paragraph is not required unless the electrical and mechanical configuration is modified from the existing configuration.

### **26.9.3 Format**

The report shall use standard, letter-size pages with any larger sheets or drawings folded to fit the report size. The report shall be neatly written and the contents presented in a logical sequence with narrative, as required, to explain the section contents. An Executive Summary shall compare the relative features and costs of the alternates considered and recommend alternate(s) to be carried forward into the Final Structures Plans Preparation phase.

The BDR shall be as self-contained as possible by including all arguments that establish, justify, support, or prove the conclusions. It is acceptable to make reference to other documents that will be included in the final submittal package; however, any documentation that will help emphasize a point, support a statement, or clarify a conclusion shall be included. Such documentation may include drawings, clear and concise views, or other such illustrated information.

The BDR shall address construction time requirements and the effect that components, systems, site constraints and conditions, or other site characteristics or criteria have upon the construction time, whether additive or deductive.

For most projects, the 30% Plans shall be an appendix to the BDR.

## 26.9.4 Aesthetics

1. General: Any bridge design must integrate three basic elements: efficiency, economy and elegance. Regardless of size and location, the quality of the structure, its aesthetic attributes and the resulting impact on its surroundings must be carefully considered. Achieving the desired results involves:
  - a. Full integration of the three basic elements listed previously.
  - b. The EOR's willingness to accept the challenge and opportunity presented. A successful bridge design will then be elegant or aesthetically pleasing in and of itself and will be compatible with the site by proper attention to form, shapes and proportions. Attention to details is of primary importance in achieving a continuity of line and form. In general, the rule of "form following function" shall be used.

The designer must consider the totality of the structure as well as its individual components and the environment of its surroundings. A disregard for continuity or lack of attention to detail can negate the best intent. Formulas cannot be established; however, the ACI's ***Aesthetic Considerations for Concrete Bridges*** and the TRB's ***Bridge Aesthetics Around the World*** as well as authors such as David P. Billington can guide the designer. A book developed by the Maryland Department of Transportation entitled ***Aesthetic Bridges*** provides excellent guidance. In bridge aesthetics the designer is dealing with the basic structure itself; not with enhancement, additions or other superficial touches. The EOR is expected to be well read on the subject of bridge aesthetics and committed to fulfilling both the structural and aesthetic needs of the site.

The challenge differs for major and minor structures. Indeed, the challenge may be greater the smaller the project. Major structures, because of their longer spans, taller piers, or curving geometry often offer inherent opportunities not available for minor bridges.

Some basic guidelines where aesthetics may play a more important role are:

- a. Bridges highly visible to large numbers of users (maritime and/or motorists).
- b. Bridges located in or adjacent to parks, recreational areas, or other major public gathering points.
- c. Pedestrian bridges.
- d. Bridges in urban areas in or adjacent to commercial and/or residential areas.
- e. Multi-bridge projects, such as interchanges, or corridors should attain conformity of theme and unifying appearance. Avoid abrupt changes in structural features.

Considering these guidelines, the District will determine the level of aesthetic effort warranted on a project early in its development. When significant aesthetic expense is proposed, such as is the case with Level Three (Level of Aesthetics), Federally funded projects require legitimate written justification.

2. Levels of Aesthetics:

Normally the District will establish one of the following three general levels of aesthetic consideration and effort at each structure's site:

- a. **Level One:** Consists of cosmetic improvements to conventional Department bridge types, such as the use of color pigments in the concrete, texturing the surfaces, modifications to fascia walls, beams, and surfaces, or more pleasing shapes for columns and/or caps.
- b. **Level Two:** The emphasis is on full integration of efficiency, economy and elegance in all bridge components and the structure as a whole. Consideration should be given to structural systems that are inherently more pleasing, such as hammerhead or "T" shaped piers, oval or polygonal shaped columns, integral caps, piers in lieu of bents, smooth transitions at superstructure depth change locations, box-type superstructures, etc.
- c. **Level Three:** The emphasis in this level applies more to the overall aesthetics when passing through or under an interchange or at other sites such as historic or highly urbanized areas where landscaping or unique neighborhood features must be considered. The bridge itself shall comply with Level Two requirements. This level of work may require, at the District's option, a subconsultant (architect to consider adjacent building styles, and landscape themes) with the necessary expertise and credentials to perform the desired work.

These aesthetic levels are not exclusive. For example, where the EOR believes a specific landscape feature might significantly enhance bridge site elegance, even on a Level 1 design, the recommendation should be offered for the Department's consideration. For aesthetic Levels 2 and 3, public input into this issue may be appropriate. The EOR may recommend particular public involvement to the Department for consideration or the district might specify such efforts at specific times during the BDR and/or final plan development phase of the project.

The BDR shall include a summary of aesthetic considerations for the structure and the site. The summary shall consist of sketches, drawings, etc. of recommended treatment as well as the options considered in the aesthetic study but not recommended as appropriate. It shall also include an estimate of cost to implement the recommended aesthetic treatment.



## 26.9.5 Construction and Maintenance Considerations

All viable structure concepts shall be evaluated for constructability. Items such as member sizes, handling, fabricating, and transporting members as well as maintenance of traffic, construction staging, equipment access, equipment requirements, etc. must be considered. Special evaluation shall be made to insure against potential problems that may occur in obtaining permits and equipment to transport long and/or heavy members from point of manufacture to the project site. The Department's Road Use Permits Office shall be contacted for questions concerning the feasibility of transporting long and/or heavy structural components. Also, considerations for future maintenance inspection shall be taken into account in the structure's design. Such considerations shall include those described in **Section 26.14** of this Chapter and the bearings and joint requirements of the **Structures Design Guidelines**, or the need for 6'-0" minimum headroom inside steel or concrete box girder superstructures. All special construction and maintenance requirements should be identified and appropriately considered in any concepts recommended for design. A design is properly inspectable when it permits safe inspector access to all portions of the structure using equipment available to District Structures Maintenance personnel.

## 26.9.6 Historical Significance Considerations

When an older bridge is considered for rehabilitation or replacement, the Environmental Management Office will evaluate the historical significance of the structure. A structure may be historically significant due to some of the following characteristics:

1. The structure may be an historic example in the development of engineering.
2. The crossing may be historically significant.
3. The bridge may be associated with an historical property or area.
4. The bridge might be associated with significant events or circumstances.
5. National Register of Historic Places or on a state or local historical register. If it is determined that the structure is historically significant, then the project should be developed to preserve the historic character of the structure.

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## 26.9.7 Bridge Security

Perform a refined evaluation of all new Category 2 bridges identified in a PD&E study as critical, landmark or signature bridges to determine if anti-terrorist countermeasures must be included as part of the design. Contact the State Structures Design Office and the State Maintenance Office for guidance and assistance. Alternative designs developed in the BDR shall minimize the bridge vulnerability. Countermeasures shall be designed to minimize the effectiveness of explosives. Vulnerability to shape charges and vehicle bombs shall be minimized. The use of structural redundancy and continuity shall be maximized to limit structural damage.

Countermeasures designed into the bridge alternatives shall meet one or more of the following objectives:

1. Maximizing explosive standoff distance;
2. Denial of access;
3. Minimizing time-on-target;
4. Selective protection of the structural integrity of key members;
5. Structural redundancy.

Use one or more of the following countermeasure strategies in the design:

1. Deter attacks by the possibility of exposure, capture or failure of the attacker due to visible countermeasures;
2. Detect potential attacks before they occur and provide the appropriate response force;
3. Defend the bridge by delaying and distancing the attacker from the bridge and protecting the bridge from the effects of weapons, fire and vehicle and vessel impacts;
4. Design the bridge to minimize the potential effects of Weapons of Mass Destruction (WMDs) and conventional explosives, fire and vehicle and vessel impacts.

Structural members that are fracture critical and/or are cable stays, cable stay pylons, hollow boxes, single columns, twin wall columns and thin wall columns require design modification to reduce the potential impact of explosions. Access into cable stay pylons, box superstructures and movable bridge machinery require heavy doors with secure lock systems. Bridges with essential communication utilities and or gas lines require the design to minimize risk to the utility.

## 26.9.8 Alternative Designs

The use of alternative designs for some larger or complex projects may result in more competitive bids and lower costs. Accordingly, the EOR shall evaluate benefits from alternatives for the particular structure being developed and provide a recommendation for or against preparing alternative designs. The alternative designs recommended shall be supported by the evaluations included in the BDR. As a guide, consider the following in evaluating justification for alternative designs:

1. Alternative designs shall be considered for all structures that cost more than \$25 Million and a difference in alternate material (steel versus concrete) construction costs that are within twice the cost of producing the alternate plans. For example, alternative designs would be warranted if the additional preliminary engineering cost for final plans preparation is \$1.5 million per alternate and the difference between the construction cost estimates utilizing FDOT estimating practices in the BDR was less than \$3 million.
2. For bridges that cost less than \$25 million consider alternative designs when project issues reflect possible advantages (i.e., MOT, A+B) from competitive bids.
3. For bridges estimated to cost more than \$10 million consider evaluation of alternative designs whenever a unique design concept is proposed until such time that a bid history is established for the unique design.
4. Projects containing multiple bridges with a reasonable mixture of concrete and steel designs do not require alternate designs.

Steel box structures and steel plate girders should be evaluated including the differences in corrosion potential. Box Girders are preferred over plate girders when located in extremely aggressive environments.

## 26.9.9 Conclusions and Recommendations

With due consideration for all applicable data, the engineer shall recommend the final bridge design system for the site. Thorough justification for the selection will be presented which examines each element of data, and the total estimated construction cost of the recommended design shall be indicated in the BDR. For most projects, the recommended design shall be supported by thirty percent plans (preliminary) as an appendix to the BDR.

The following sections will define, clarify and list the information necessary to produce an acceptable and reproducible set of contract documents (special provisions, bridge contract drawings, etc.) ready for advertisement and construction. The production of a bridge

project commences with the Bridge Development Report (BDR) and ends with complete Contract Documents.

## 26.9.10 30% Structures Plans

The 30% Structures Plans should be submitted with the Bridge Development Report for most structures. The consultant's scope of services should clearly state at what point are the 30% plans to be submitted. If the 30% Structures Plans are submitted separately, the BDR shall contain enough information and drawings to depict the information needed to properly determine the type, size and location of the bridge. The Phase 1 Geotechnical Report and the Hydraulic Report shall be included with the submittal containing the BDR.

The 30% Structures Plans should show, as a minimum, the following information:

1. General Notes Sheet: As many general notes as possible should be included on this sheet at this stage. Subsequent additions shall be made, when necessary, as the design progresses (for example of General Notes, see **Chapter 3** of the **Structures Detailing Manual**).
2. Plan and Elevation Sheet: provide contents as required by the **Structures Detailing Manual**.
3. Substructures: For piers or intermediate bents, show substructure elements and sizes including all deviations from the typical dimensions, foundation type including element spacing and the arrangement of piles or drilled shafts.
4. Superstructure: Include cross section showing lanes, shoulders, railings, slab thickness, beam type and spacing and web depth for steel girders. If applicable, show geometric changes in shapes of various components. Also show construction phases and maintenance of traffic data, outline of the existing structure and portions to be removed, and utilities (existing and proposed as available).
5. Retaining Walls: Preliminary control drawings shall be submitted when proprietary or standard cast-in-place walls are proposed. Include control drawings for all critical temporary walls.
6. Bridge Hydraulics Recommendation Sheet.
7. Report of core borings.
8. Preliminary bearing type(s).
9. Proposed construction sequence and methods, indicate construction easements and methods of construction access.
10. Preliminary aesthetic details.
11. Preliminary post-tensioning layouts.
12. Preliminary foundation layouts and installation table.

13. Sidewalks: If provided, show preliminary accessible elements.
14. Any other special details required by the Engineer or details which are not normally used on Department projects.

In addition to these requirements, the following items will be included for moveable bridges: preliminary electrical and mechanical equipment layouts in plan and elevation, submarine cable routing, and single line electrical diagrams including service voltage. All equipment shall be rough sized and supporting calculations shall be submitted.

Requests for design exceptions and/or variations for structural design criteria, shall be included in the 30% Structures Plans Submittal. Design exceptions and design variations shall be approved in accordance with **Chapter 23** of this volume with concurrence of the DSDO or SDO as appropriate.

## 26.10 Bridge Development Report (BDR) Submittal Checklist

The Bridge Development Report (BDR) Submittal Checklist (**Exhibit 26-A**) contains a list of the key supporting elements that are required for the preparation, submittal and review of a BDR. This Checklist must be included with the BDR when submitted for review and consists of the following items:

1. Typical Sections for Roadway and Bridge  
The approved typical sections for both the bridge and roadway are required.
2. Roadway Plans  
Preliminary roadway plans covering the bridge vicinity are required.
3. Maintenance of Traffic Requirements  
The Maintenance of Traffic Plan must show the number of required lanes as well as lane widths of all affected roadways.
4. Bridge Hydraulics Report and Bridge Hydraulics Recommendation Sheet  
The Bridge Hydraulics Report (BHR) shall be prepared in accordance with the FDOT Drainage Manual. It shall include the Bridge Hydraulic Recommendations Sheet (BHRS) and address the required hydraulic opening, clearances, scour and deck drainage requirements. In addition to design water elevations normally shown, the BHRS shall include the Mean High Water (MHW) elevation for tidal crossings and Normal High Water (NHW) for non-tidal crossings. Concurrence of the BHR by the District Drainage Engineer with the District Structures Design Engineer for Category 1 Structures and State Structures Design Engineer for Category 2 Structures is required.
5. Geotechnical Report  
The Bridge Geotechnical Report (Phase I) shall be prepared in accordance with **Chapter 4** of the **Structures Design Guidelines** and the Department's **Soils and Foundation Handbook**. The report shall document a thorough investigation of all viable foundation types for the bridge and retaining walls. Concurrence of the District Geotechnical Engineer is required for Category 1 Structures and of both the State and District Geotechnical Engineers for Category 2 Structures.

6 Bridge Corrosion Environment Report

A Bridge Corrosion Report shall be prepared to determine the environmental classifications for the structure in accordance with the **Structures Design Guidelines** and must be approved by the District Materials Office.

7. Existing Bridge Plans

A set of prints of the existing (preferably as-built) bridge plans should be included for replacement structures and widenings. This is of particular importance for widenings and phase construction. These plans are not usually necessary for completely separate alignments or new interchanges unless the existing structures either will be used for new construction activities or will infringe upon the Contractor's allowed work zone.

8. Existing Bridge Inspection Report

A copy of the latest existing Bridge Inspection Report and Structures Inventory and Appraisal Form is required for all widenings and rehabilitations and may be required for new structures. The existing paint system(s) on all significant metal elements of existing structures shall be identified. The presence of lead-based paint and/or asbestos shall be clearly delineated.

9. Utility Requirements

All proposed utility attachments to the structure as well as all existing and proposed utilities in the vicinity of the structure shall be identified. The requirements of the Department's **Utility Accommodation Manual (Topic No. 710-020-001)** shall be followed regarding attachments to the structure.

10. Railroad Requirements

Existing as well as future railroad requirements must be identified. This will include all clearances as well as crash wall or other construction parameters. Copies of correspondence with the Railroad Agency shall be included.

11. Retaining Wall and Bulkhead Requirement

All permanent and temporary retaining wall requirements shall be identified and the proposed type of wall shall be shown. The type, location and extent of temporary walls to accommodate phased construction and/or maintenance of traffic must be identified.

For water crossings where erosion and/or wave action is anticipated, the type,



location and extent of bulkhead production shall be identified. The tie-back and anchor system proposed for use shall be included in the submittal.

12. Lighting Requirements

All proposed lighting on or under the structure shall be identified.

13. ADA Access Requirements

Any ADA access requirements that affect the structure shall be identified.

## **26.11 Final Plans and Specifications Preparation**

### **26.11.1 General**

Within this phase of work, for both Category 1 and 2 Structures, there are three phases of work; viz., 60% Substructure submittal or 60% Structure Plans, 90% Structure Plans and 100% Structures Plans and Specifications. For projects where preapproved proprietary wall systems cannot be used and fully designed proprietary wall plans are required, approved control drawings shall be submitted to the appropriate proprietary wall companies as soon as possible and no later than the 60% substructure submittal. A copy of this submission shall be sent to the DSDO or SDO as appropriate. At any time during the project development, the reviewer may require submittal of design calculations.

After each of the phases, except the 100% Structures Plans Phase, review comments from the FDOT are sent to the EOR by letter and/or a marked-up set of prints. The EOR must address each of the comments in writing and resolve each comment prior to the next submittal. The FDOT 100% Structures Plans review comments are to be handled in the same manner; except that unresolved comments may be handled by telephone, in some instances, if confirmed in writing. Also, for any phase, items and drawings from a preceding phase must be included. These drawings shall reflect the comments resolved from the previous phase as well as the accumulated design and drafting effort required of the current phase.

### **26.11.2 60% Substructure Submittal / 60% Structures Plans**

This submittal phase is divided into two distinct parts; viz., the 60% Substructure Submittal (required for all projects) and the 60% Structures Plans for Category 2 Structures and some Category 1 Structures.

1. 60% Substructure Submittal:

This submittal is required for every project and should be made a part of the 60% Structures Plans phase when that phase is part of the project. The submission is only a partial plans set. The purpose of this submittal is to communicate essential project information to the Geotechnical and Hydraulic Engineers so that all remaining calculations can be performed using actual structural shapes, loads, and dimensions. Plan sheets required for this submittal include: Plan & Elevation, Bridge Hydraulics Recommendation Sheet, Boring Logs, Foundation layout, Substructure Plans, and draft technical specifications.

60% Substructure Submittal Contents:

- a. Foundation Layouts
- b. Foundation Installation Notes
- c. Pile/Drilled Shaft Installation Table
- d. Footing Concrete Outlines (All Variations)
- e. Pier Concrete Outline (All Variations)
- f. Wall Plans - Control Drawings
- g. Pile Details
- h. List of Pay Items
- i. Lateral Stability Analysis Completed
- j. Phase II Geotechnical Report
- k. Draft Technical Specifications
- l. Reinforcement of Footing and Column
- m. Post-Tensioning Details
- n. Plan and Elevation Sheet
- o. Bridge Hydraulics Recommendation Sheet
- p. Boring Logs

2. 60% Structures Plans:

When a 60% Structures Plans submittal is required, all comments from earlier reviews shall have been resolved. At this phase, the design should be 90% complete and the plans, 60% complete. In addition to the documents required for the 60% Substructure Submittal, the 60% Structures Plans shall include a list of pay items to be used and plans containing the following details as applicable: final concrete outlines of all individual components, major reinforcing steel, final post-tensioning layouts, steel box/I-girder details, segmental concrete box details, bearing details, seismic details, details of congested areas, details of unique features, accessible pedestrian facilities details, and other details as required. For moveable bridges the following additional information is required: electrical calculations (for generator size, service voltage drop, short circuit, service size, automatic transfer switch, etc.), single line diagram showing equipment sizes and utilities, conduit and wire sizes, panelboard schedules, and light fixture schedules.

### 26.11.3 90% Structures Plans

Upon approval of the BDR/30% Structures Plans or 60% Structures Plans, as applicable, 90% Structures Plans shall begin. At this stage of plans development, the EOR shall have resolved the 30% and/or 60% Structures Plans review comments and developed the plans for completion. The design and plan production shall be 100% complete. This submittal shall include prints of the completed plans, Summary of Pay Items (complete with quantities), design calculations, Final Phase II Geotechnical Report, Addendums to Hydraulic Report and, if appropriate, Technical Special Provisions. No sheet or detail should be missing at this stage.

### 26.11.4 100% Structures Plans and Specifications

After resolution of the 90% Structures Plan comments, the EOR shall make all authorized changes necessary to complete the plans and Technical Special Provisions. The EOR shall provide a list of all changes made to the Plans or Specifications that were not directly related to the 90% Structures Plans review comments. The intent is to help minimize the Department's review time and to help the Department's review office to focus on only those new items or details proposed by the EOR. This will, in turn, help to expedite the project's authorization.

The 100% Structures Plans submittal is divided into two distinct phases. First, prints of the original drawings and technical special provisions are submitted 30 days prior to the District's Plans Production Date (PPD). Secondly, once notified by the FDOT, the original drawings and all other documents are submitted to the District.

Within the 30-day period allotted, the EOR will receive notification either of additional changes/corrections to be made or to submit the Final Plans as they are. If at anytime during the 30-day period the EOR finds additional changes/corrections that should be made, the Structures Design Office responsible for plans approval (either the District Structures Design Engineer (DSDE) or the Structures Design Office (SDO) as appropriate) must be notified for discussion and resolution.

Once all changes/corrections are made, or if no changes/corrections are necessary, the EOR shall submit all his work to the District prior to or on the PPD. Submittal of this stage of the work shall include the original drawings, one record set of prints with each sheet sealed in accordance with **Chapter 19** of this volume, quantities book assembled as specified in the Department's **Basis of Estimates Handbook**, sealed Technical Special Provisions (if required), and sealed Summary of Pay Items with estimated bridge quantities.

If included in the Scope of Services, original documents in electronic media such as CADD diskettes may also be required.

## **26.12 Plans Assembly**

Consult the *Structures Detailing Manual* for plans assembly, materials, content of plans, and other drafting information.

## **26.13 Plans Submittal**

### **26.13.1 Schedule**

The District Project Manager is responsible for establishing the schedule of submittals with input from the EOR and either the District Structures Design Engineer for Category 1 or Structures Design Office for Category 2 projects.

### **26.13.2 Submittal Schedule**

1. BDR/30% Structures Plans
2. 60% Substructure Submittal/60% Structures Plans
3. 90% Structures Plans
4. 100% Structures Plans

## **26.14 Review for Constructability and Maintainability**

### **26.14.1 Purpose**

The purpose of this review is to provide reasonable and practical use of fabrication and construction techniques and equipment without overloading and/or overstressing components, provide for proper material handling and transportation, provide safe maintenance of traffic and provide an appropriate construction sequence. Additionally, provide features which will retard bridge deterioration, permit reasonable access to all parts of the bridge for inspection and performance evaluation and provide features to facilitate replacement of damaged and/or deteriorated bridge components.

### **26.14.2 Responsibility**

For Category 1 and 2 Structures, it will be the responsibility of the project manager or his designee to coordinate a review of both the 30% and 90% Structures Plans submittals by the appropriate District Construction and Maintenance personnel for constructability and maintainability. For Category 1 Structures, technical issues shall be resolved by the appropriate DSDE. For Category 2 Structures, technical issues shall be resolved by the SDO.

The Construction and Maintenance Offices should be given adequate time to perform these reviews. All comments from these reviews shall be addressed prior to the next submittal and its subsequent review.

## 26.15 Review for Biddability

### 26.15.1 Purpose

To prevent construction problems, the District Construction Office will review the plans to make certain the plans are clearly understandable, contain all pertinent notes and have sufficient and correct pay items. During the biddability review, the Construction Office will check for the interface with the roadway segment of the project, utility agreements and environmental permits.

### 26.15.2 Responsibility

For Category 1 and 2 Structures, it will be the responsibility of the project manager to coordinate a review of the 90% Structures Plan submittal. This review should occur at the same time as the Phase III Plans submittal for the roadway segments of the project.

Additionally, for Category 2 Structures, it will be the responsibility of the Structures Design Office to coordinate a review of the 90% Structures Plans submittal.

The Construction Offices should be given adequate time to perform these reviews. All comments from these reviews shall be addressed prior to the 100% Structures Plans Stage submittal.

## 26.16 Bridge Load Rating

Load rating analysis of new or existing bridges shall be performed in accordance with the **AASHTO “Manual for Condition Evaluation and Load Resistance Factor Rating (LRFR) of Highway Bridges”** as amended by the **FDOT “Structures Manual”, Volumes 1 and 8**. Load rating procedural matters can be found in the **“Bridge Load Rating, Permitting and Posting Manual (Topic 850-010-035-b)**.

For new bridges the Engineer of Record shall load rate the bridge(s) and submit the calculations with the 90% plan submittal.

Prior to developing the scope-of-work for bridge widening and/or rehabilitation projects, the FDOT or their consultant will determine the suitability of the bridge project using the load rating. If the existing load rating is inaccurate or was performed using older methods (e.g.



load Factor), perform a new load rating using the procedures outlined in the **“FDOT Structure Manual”, Volume 1 - Structures Design Guidelines, Chapter 7**. Load rating calculations for the entire structure (existing and new) shall be submitted with the 90% plan submittal for the project.

## **26.17 Review of Non-FDOT Funded Projects (New Construction)**

FDOT review will be required whenever a privately funded structure crosses over Department owned right of way or when such work otherwise affects such a route; i.e., lane closures, access, R/W changes, etc. FHWA review will be required whenever a privately funded structure crosses over an interstate route, or when such work otherwise affects such a route; i.e., lane closures, access, R/W changes, etc. The extent of FDOT and FHWA review is that:

1. Plans must meet all current clearance requirements (vertical and horizontal).
2. Maintenance of traffic scheme for construction must be reviewed and approved.
3. All attachments to the structure over the highway must be securely fastened.
4. Design must be sealed by a licensed professional engineer.
5. Design must be in accordance with a nationally recognized code such as AASHTO, ACI, AISC, etc.
6. Plans must meet all District permit requirements and procedures.
7. Only projects over or affecting a NHS facility shall be submitted to FHWA for approval.
8. FDOT review for these structures shall be performed by the District Structures Design Office for Category 1 and State Structures Design Office for Category 2 Structures.

**Exhibit 26-A Bridge Development Report (BDR) Submittal Checklist**

Project Name \_\_\_\_\_

Financial Project ID \_\_\_\_\_

FA No. \_\_\_\_\_ FHWA Oversight ( yes no) NHS ( yes no)

Date \_\_\_\_\_ FDOT Project Manager \_\_\_\_\_

ITEMS		STATUS <sup>(b)</sup>		
1.	Typical Sections for Roadway and Bridge <sup>(a)</sup> .....	P	NA	C
2.	Roadway Plans in Vicinity of Bridge <sup>(a)</sup> .....	P	NA	C
3.	Maintenance of Traffic Requirements <sup>(a)</sup> .....	P	NA	C
4.	Bridge Hydraulics Report <sup>(c)</sup> .....	P	NA	C
5.	Geotechnical Report <sup>(c)</sup> .....	P	NA	C
6.	Bridge Corrosion Environmental Report <sup>(c)</sup> .....	P	NA	C
7.	Existing Bridge Plans.....	P	NA	C
8.	Existing Bridge Inspection Report.....	P	NA	C
9.	Utility Requirements.....	P	NA	C
10.	Railroad Requirements.....	P	NA	C
11.	Retaining Wall and Bulkhead Requirements.....	P	NA	C
12.	Lighting Requirements.....	P	NA	C
13.	ADA Access Requirements.....	P	NA	C
14.	Other.....	P	NA	C

(a) Must be approved by District before BDR submittal.

(b) Circle appropriate status:  
 P - Provided NA - Not Applicable C - Comments attached

(c) See approval requirements for these documents elsewhere in this chapter.