

**CHAPTER 4**  
**STRUCTURAL**

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## 4.1 GENERAL

This chapter provides design criteria and guidance for preparation and development for each of the different required submittal stages. Guidance for structural design not included is provided in the AE contract.

## 4.2 REQUEST FOR PROPOSAL

Design-Build Requests for Proposal (RFP) shall require that the design conform to this design guide and all applicable Federal, Department of Defense, and agency specific criteria. The following shall also be provided in the RFP:

### 4.2.1 STRUCTURAL MATERIALS TO AVOID

List any structural materials to be avoided, if any, due to site specific limits in materials or user defined preferences. However, every attempt should be made to consider all options to obtain the best value design.

### 4.2.2 SERVICEABILITY REQUIREMENTS

Provide serviceability requirements to include deflection limits, expansion and contraction, and vibration mitigation.

## 4.3 DESIGN DEVELOPMENT

### 4.3.1 CONCEPT/PROJECT DEFINITION DESIGN (30%) SUBMITTAL REQUIREMENTS

#### 4.3.1.1 Concept Design Analysis

The narrative forms the basis of the future Interim and Final Design Analysis. Include the following in narrative form:

##### 4.3.1.1.1 Criteria, Loading, and Structural Materials

- a. Criteria listings – include regulations, UFCs, handbooks, manuals, codes, standards, etc. applicable to the project.
- b. Design conditions used in calculations – include wind, snow and seismic loads applicable to the project location. Also include the anticipated Dead Loads and Live Loads for the project.
- c. Structural materials – list the structural properties for the materials to be used in the construction of the facility, including, but not limited to Concrete, Reinforcement, Masonry, Structural Steel, Cold formed Steel and Timber, etc.
- d. Serviceability – include deflection limits of materials, design for expansion and contraction of materials, and limiting vibration.

##### 4.3.1.1.2 Foundation Design

- a. Discuss the type of foundations expected to be used for the facility in accordance with the recommendations from the Geotechnical Report.
- b. Include the minimum depth of footings to account for frost depth, and include any minimum sizes of footings required.
- c. Discussion may include but not be limited to deep foundations, shallow foundations, continuous wall footings, isolated column footings, slabs on grade and reinforcement.

##### 4.3.1.1.3 Floor and Roof Framing Design

- a. Include the type of floor framing, roof framing, decking and slab materials anticipated for the loads and conditions of the given project.
- b. Discuss the spacing and spans expected for the structural framing members.
- c. Explain the load paths anticipated from the roof down to the foundation members.
- d. Consider different framing materials and options, and justify why the ones chosen were most appropriate for the project.

##### 4.3.1.1.4 Lateral Load Resistance Design

- a. Discuss the primary lateral load resistance method, or combinations thereof, used in the building design. These may include but not be limited to shear walls, x-bracing, moment resisting frames, etc.
- b. Include in the discussion, the reason for the location of these members, such as to avoid window openings, for example.
- c. Also discuss the types and materials of diaphragms to be used as part of the lateral load resistance system.
- d. Explain the load paths anticipated for the lateral loads from the uppermost diaphragm down to the foundation.

#### **4.3.1.2 Concept Drawings**

##### **4.3.1.2.1 Structural General Notes**

A Structural General Notes Sheet(s) shall list structural criteria, loading, and structural material specifications.

##### **4.3.1.2.2 Foundation Plan**

A basic foundation plan shall be included to depict the overall foundation layout anticipated to include grid lines, preliminary location and sizes of continuous wall footings and isolated column footings. Overall plan dimensions and known grid dimensions should also be shown.

##### **4.3.1.2.3 Floor Framing and Roof Framing Plans**

Preliminary framing plans shall also be included, but like the foundation plan, precise sizing and layout is not expected to be complete at the Concept level.

##### **4.3.1.2.4 Basic Structural Details**

Preliminary structural details may be included, but complete foundation and framing details are not required at the concept stage.

#### **4.3.1.3 Concept Specifications**

Provide a list of structural specifications to be used for the project.

### **4.3.2 PRELIMINARY/INTERIM (60%) DESIGN SUBMITTAL REQUIREMENTS**

#### **4.3.2.1 Interim Design Analysis**

##### **4.3.2.1.1 General**

The Interim (60%) Design Submittal shall further developed the information in the Concept (30%) Design Analysis Narrative.

##### **4.3.2.1.2 Calculations**

Provide interim calculations and/or structural software output for all preliminary structural design to include foundation and framing systems.

##### **4.3.2.1.3 Member Sizes**

Show preliminary structural member sizes to prepare the 60% Cost Estimate.

#### **4.3.2.2 Interim Drawings**

Show all information provided in Concept (30%) drawings but in greater detail. In addition, show the following:

##### **4.3.2.2.1 Structural General Notes**

Add general design tables and include a components and cladding wind loading chart(s) and plan(s).

##### **4.3.2.2.2 Foundation Plans**

Show more detailed dimensioning and sizing of foundation members. Include foundation and building joints and slab crack control joints. Also include any foundation schedules to better tabulate member sizes for the 60% Cost Estimate.

##### **4.3.2.2.3 Floor and Roof Framing Plans**

Show more detailed dimensioning and sizing of framing members. Include deck and/or diaphragm call-outs, and braced frame, shearwall, and/or moment frame call-outs.

#### **4.3.2.2.4 Structural Details**

Provide a more complete set of foundation sections and details, framing sections and details and any wall and/or framing elevations.

#### **4.3.2.2.5 Structural Schedules**

Footings, columns, and beam schedules, etc. may be developed at this stage and can be included on the same sheets as the appropriate structural plans, or they may be included in structural schedule sheets near the end of the structural set of drawings.

#### **4.3.2.3 Interim Specifications**

The outline specifications previously submitted with the 30% phase shall be revised, updated, further developed and resubmitted. Prepare outline specifications for structural work included in the project. Where District or UFGS are to be used without change, a listing of the appropriate Guide specification numbers will suffice.

### **4.3.3 FINAL (90%) DESIGN SUBMITTAL REQUIREMENTS**

#### **4.3.3.1 Final Design Analysis**

##### **4.3.3.1.1 General**

The Final Design Analysis is a refinement of the 30% and/or 60% Design Analysis and contains all the information called for in those sections of this chapter, even when Concept (30%) or Interim (60%) submittal is not required, as well as any analysis of significant design changes.

##### **4.3.3.1.2 Calculations**

Provide complete final calculations and/or structural software output for all structural design to include foundation and framing systems.

##### **4.3.3.1.3 Member Sizes**

Show final structural member sizes to prepare the Final Cost Estimate. Make an attempt to refine or limit the number of differing sizes for efficiency.

##### **4.3.3.1.4 Checking**

All computations must be performed, or checked, by a registered professional engineer. All calculation sheets must be initialed by both the designer and checker.

#### **4.3.3.2 Final Drawings**

Final plans are refinements of the 30% and 60% drawings and add additional detail. Unified Facilities Criteria (UFC) shall not be referenced; all requirements for the project shall be explicitly shown in the drawings.

##### **4.3.3.2.1 Structural General Notes**

Refine and complete all general notes, design tables and loading chart(s) and plan(s). Special structural inspections required may be added to the end of the general note sheets at the final submittal.

##### **4.3.3.2.2 Foundation Plans**

Show complete detailed dimensioning and sizing of foundation members. Include all foundation and building joints and slab crack control joints. Also complete any foundation schedules to better tabulate member sizes for the Final Cost Estimate. All plans shall include North arrows and graphic scales.

##### **4.3.3.2.3 Floor and Roof Framing Plans**

Show complete detailed dimensioning and sizing of framing members. Include complete deck and/or diaphragm call-outs, and braced frame, shearwall, and/or moment frame call-outs. Once again, ensure the completeness of North arrows and graphic scales.

##### **4.3.3.2.4 Structural Details**

Provide a refined and complete set of foundation sections and details, framing sections and details and any wall and/or framing elevations. Ensure that all detail call-outs are correctly numbered and referenced. Also make certain that all graphic scales are correct, or label the detail as Not to Scale.

### ***4.3.3.2.5 Structural Schedules***

Footing, column, and beam schedules, if used, must be fully refined and accurate for the final submittal.

### **4.3.3.3 Final Specifications**

#### ***4.3.3.3.1 General***

Provide original final project specifications. Unified Facilities Criteria (UFC) shall not be referenced; all requirements for the project shall be explicitly described in the specifications.

#### ***4.3.3.3.2 Trade Names***

Specifications must not be restrictive or proprietary. Generally, the description will be such that at least three manufacturers can meet the specified requirements. Specifications shall be adequate to maintain quality of product and installation. Where trade names and model numbers are listed, provide from at least three manufacturers and indicate OR APPROVED EQUAL.

#### ***4.3.3.3.3 Materials***

Give particular care to the compatibility of materials. For example, avoid contact of dissimilar materials.

#### ***4.3.3.3.4 Coordination with Drawings***

Ensure that structural systems are fully specified through combination of drawings and specifications. Avoid duplicating requirements and conflicts.

#### ***4.3.3.3.5 Submittal Register***

Ensure that all appropriate submittals are correctly marked for Government Approval and approving office in the submittal register. Generally, the designer of record should review the following:

- a. Major structural items which include reinforcement and framing submittals, etc.
- b. Extensions of design. Examples: steel connection design, metal building systems design, etc.

### **4.3.4 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS**

Update design submittals based on resolutions to Final design review comments.

---END OF SECTION---