CHAPTER A-2

Revised January 2006

STRUCTURAL

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CHAPTER 2

STRUCTURAL

2.1 GENERAL

2.1.1 Mission and Function. The structural engineer is responsible for the investigation, design, and selection of the force resisting and load supporting members and their connections in a structure. Typical examples are foundations, walls, columns, slabs, girders, trusses, beams, diaphragms, and similar members. The investigation, design, and selection requires a knowledge of engineering laws, formulae, and practice; a knowledge of the physical properties of the materials used for such members; and a knowledge of the methods used in their erection.

2.1.2 Scope. This chapter states criteria, requirements, and guidance for structural design. Specific submittal requirements in this chapter supplement the requirements contained elsewhere in other volumes. All required documents, including the drawings and the design analysis, shall be prepared in accordance with applicable instructions. The Exhibits referenced in this chapter are located in Volume III, Chapter 2, STRUCTURAL.

2.2 APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this manual and contain criteria to be used in the structural design. Copies of these publications can be obtained from the Project Manager.

2.2.1 American Association of State Highway and Transportation Officials (AASHTO)

AASHTO HB-16Standard Specifications for Highway Bridges

2.2.2 American Concrete Institute (ACI)

ACI 318-02/318-02R Building Code Requirements for Structural Concrete and Commentary

2.2.3 American Society for Testing and Materials (ASTM)

ASTM A 36 Standard Specification for Carbon Structural Steel

ASTM A 572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steels

ASTM A 992 Standard Specification for Structural Steel Shapes
(For wide flange members only)

2.2.4 American Society of Civil Engineers (ASCE)

ASCE 7-02 Minimum Design Loads for Buildings and Other Structures

2.2.5 American Institute of Steel Construction (AISC)

ASD Manual of Steel Construction, 9th Edition

LRFD Manual of Steel Construction, 3rd Edition

2.2.6 Design References

IBC International Building Code 2003

AEI Design Manual for Military Construction, 01 Mar 1999

UFC 1-200-01 Design: General Building Requirements, 31 Jul 2002

UFC 3-310-01 Design Load Assumptions for Buildings, 30 Jun 2000

UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings, 08 Oct 2003

TI 809-02 Structural Design Criteria for Buildings, 01 Sep 1999

TI 809-04 Seismic Design for Buildings, 31 Dec 1998

TI 809-07 Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Systems, 30 Nov 1998

TI 809-26 Welding: Design Procedures and Inspections, 01 Mar 2000

TI 809-29 Structural Considerations for Metal Roofing, 03 Aug 1998

TI 809-30 Metal Building Systems, 01 Aug 1998

TM 5-809-3 Masonry Structural Design for Buildings (w/ changes 1-2), 30 Oct 1992

TM 5-809-6 Structural Design Criteria for Structures Other Than Buildings, 06 Dec 1991

TM 5-809-12 Concrete Floor Slabs on Grade Subject to Heavy Loads, 25 Aug 1987

TM 5-818-1 Soils and Geology Procedures for Foundation Design of Buildings and Other Structures (Except Hydraulic Structures), 21 Oct 1983

TM 5-818-6 Grouting Methods and Equipment (w/ changes 1), 27 Feb 70

TM 5-822-7 Standard Practice for Concrete Pavements, 16 Aug 87

EM 1110-2-2502 Retaining and Flood Walls, 29 Sep 1989

EM 1110-2-2906 Design of Pile Foundations, 15 Jan 1991

ETL 1110-1-125 Guidance for Fuel Resistant Sealers for Pavements, 04 May 1984

ETL 1110-3-447 Engineer of Record and Design Responsibilities, 30 Apr 1993

2.2.7 Guide Specifications:

UFGS	TITLE
02450	Precast/Prestressed Concrete Piling
02455	Cast-In-Place Concrete Piles, Steel Casing
02456A	Steel H-Piles
02457A	Round Timber Piles
02462	Piling: Composite, Wood and Cast-In-Place Concrete
02465	Auger Cast Grout Piles
02466A	Drilled Foundation Caissons (Piers)
03100A	Structural Concrete Formwork
03150A	Expansion Joints, Contraction Joints, and Waterstops
03200A	Concrete Reinforcement
03300A	Cast-In-Place Structural Concrete
03307	Concrete for Minor Structures
03340	Roof Decking, Cast-in-Place Low Density Concrete
03410	Precast/Prestressed Concrete Floor and Roof Units
03414A	Precast Roof Decking
03511	Gypsum Plank Decking (Contractor's Option)
05090A	Welding, Structural
05091A	Ultrasonic Inspection of Weldments
05092A	Ultrasonic Inspection of Plates
05120	Structural Steel
05210A	Steel Joists
05310	Steel Decks
05400	Cold-Formed Metal Framing
07416A	Structural Standing Seam Metal Roof (SSSMR) System

2.2.8 Structural Related Guide Specifications. The following guide specifications are prepared by other disciplines but frequently require structural review and input:

UFGS	TITLE
03330	Cast-In-Place Architectural Concrete
03413A	Precast Architectural Concrete
04200	Masonry
05500	Metal: Miscellaneous and Fabrications
06100A	Rough Carpentry
07110A	Bituminous Dampproofing
07132A	Bituminous Waterproofing
07413	Metal Wall Panels
08330	Overhead Rolling Doors
08361	Sectional Overhead Doors
13080	Seismic Protection for Miscellaneous Equipment
13120	Preengineered Metal Building
13121	Metal Building Systems (Minor Requirements)
13209	Water Storage Steel Tanks
13210	Aboveground Fuel Oil Storage Tanks
14210A	Elevators, Electric
14240	Hydraulic Elevators
14630A	Overhead Electric Cranes

2.3 **PRECONCEPT SUBMITTAL REQUIREMENTS** No submittal requirements.

2.4 **CODE 3 DESIGN REQUIREMENTS**

2.4.1 Submittal. Submittal content and format shall be as described in TI 802-01, "Code 3 Design with Parametric Estimating".

2.5 **CONCEPT/EARLY PRELIMINARY (35 PERCENT) DESIGN SUBMITTALREQUIREMENTS**
The structural portion of the concept brochure must outline the proposed methods and materials of design and construction for approval. An outline of the required brochure is shown in Exhibit A-2-3. The design shall include the following:

2.5.1 Structural Narrative

2.5.1.1 General. Use present tense wording for all paragraphs. Provide a general description of the scope of the project and all of the major structures. Give overall building dimensions and a description of the principal features such as wall and roof construction. If the building is irregularly shaped, explain where seismic joints will be placed to create regular shapes or provide a statement that a dynamic analysis of the building will be performed (seismic joints are preferred for most all of the structures we design).

2.5.1.2 Framing System

2.5.1.2.1 Provide a brief description of the framing system chosen and the reasons why. If a Structural System Selection Analysis (economic justification) was required then this paragraph should summarize the results of that analysis. The analysis will appear later in the outline and shall justify the system selection.

2.5.1.2.2 Provide a brief description of the lateral load resisting system and how these loads will be transmitted to the foundations.

2.5.1.2.3 Foundation. Give a brief description of the anticipated foundations based on similar construction in the area.

2.5.1.2.4 List special design features.

2.5.1.2.5 Fire Resistance Statement. State the required fire resistance criteria for all portions of the structural system and the proposed method of meeting these requirements.

2.5.1.2.6 List structural information needed to complete final design.

2.5.2 Concept/Early Preliminary Design Analysis
The following specific items shall be included.

2.5.2.1 Load Assumptions. State the live loads for which the facility is to be designed, including roof and floor loads. Calculate the wind loads, lateral earth pressure loads, seismic loads, etc. as applicable.

2.5.2.1.1 Both positive and negative wind pressures shall be calculated with the controlling pressures summarized in tabular form. The following pressures shall be included

as a minimum: wind on frame, wind on walls, wind on roof, wind on wall corners, wind on roof ridges, wind on eaves, and wind on roof corners.

2.5.2.1.2 Calculate the basic seismic loadings for the frame or lateral load resisting system and contrast them with the comparable wind loads. Detailed calculations for seismic loads on parts and portions are not required at this submittal level.

2.5.2.2 Working Stresses. Describe the values to be used for the allowable stresses of the principal structural materials.

2.5.3 Structural System Selection Analysis. For all projects with a construction value of $500,000 or greater furnish a comparative analysis of at least three competitive structural systems. These structural system alternatives are defined as the consideration of different structural materials and different framing systems supporting the loads imposed on the structure. Different structural systems are not the variations of the same framing scheme (i.e. changing bay widths of a steel frame). A portion of each facility, large enough to be representative of the entire structure, shall be designed in enough detail to provide for an estimate that will be the basis of the structural system selection. The portion of the structure selected for comparing alternate system costs shall include framing for at least one typical bay of the roof, floor, and foundation systems. Additional costs due to nonstructural systems but attributable to a structural alternative shall be included in the comparative cost estimate for that alternative. Determination of these additional costs must be based upon a concept of the complete building configuration, including architectural, mechanical, electrical, and other systems. Hence, the main structural members must be sized to check for compatibility with ceiling, duct, lighting, and all other space demands. The method of providing the required degree of fire resistance shall be determined for each alternative, and the costs included. The submittal shall include the following items:

a. A complete description, with sketches, of each structural system considered.

b. Design calculations supporting the member sizes used for the cost estimate.

c. A comparative cost for each system, clearly showing all costs and quantities used.

d. An analysis of the study results, with justification for the system selected.

2.5.4 Concept Drawings. Furnish sufficient framing plans for roof and floors, as applicable, to indicate layout of principal members. Typical sections should be furnished through roof, floor, and foundation indicating materials and type of construction proposed. These details may be shown on the architectural plates. Furnish a 1:200 scale plan identifying the location of all seismic joints.

2.5.5 Outline Specifications. The Engineer shall review the list of guide specifications in this section and shall list those sections he proposes to use at the end of his concept narrative.

2.6 **PRELIMINARY (OVER THE SHOULDER) (60 PERCENT) SUBMITTAL REQUIREMENTS**
See Volume I for submittal requirements.

2.7 **PRELIMINARY (60 PERCENT) DESIGN SUBMITTAL REQUIREMENTS**

The preliminary design will represent approximately 60 percent of the total structural design effort.

2.7.1 Preliminary Design Analysis. The preliminary design analysis shall include all items in the concept design analysis and any revisions necessitated by comments on the Concept Submittal. The design analysis will be substantially complete for all the major structural features of the primary structure and will include but not be limited to the following:

a. A brief narrative that provides the references, design loads, assumed allowable stresses, and a brief description of the structure to include type of foundation, type of framing, and method of resisting lateral loads.

b. A synopsis of special design criteria or technical requirements provided as a result of site visits or correspondence with the Corps of Engineers Project Managers. Copies of any letters or minutes of meetings which provide structural guidance not otherwise contained in this manual should be included in this section of the design analysis.

c. Complete calculation of seismic and wind loads for final design to include distribution of these loads to the lateral load resisting elements.

d. Design calculations for roof and floor decks, beams, joists, girders, and columns as applicable.

e. Design calculations for horizontal diaphragms and bracing to include shear transfer connections.

f. Design calculations for exterior cladding (masonry, steel, precast concrete) for flexure, shear, and overturning as appropriate.

g. Design calculations for shear walls and bracing.

h. Checking of the design at this stage will not be required. This submittal will not normally include the design of lesser related structures such as utility vaults, pits, tanks, retaining walls, tank hold down pads, etc. The structural design of these structures is the responsibility of the structural engineer even when shown on drawings for other disciplines. The design analysis of these structures is required at final design.

2.7.2 Preliminary Drawings. This submittal will include the following as applicable:

a. Foundation plans, framing plans for each floor, and roof plans for the building. Grid lines on center lines of columns shall be indicated on the plans for buildings framed with columns and beams. In framing plans consisting of repetitive bays, only a typical bay needs to be detailed to indicate the proposed framing.

b. Layout of floor joints in slab on grade. Layout of construction, control, expansion, and seismic joints in foundation, floor, and building framing.

c. Typical sections through foundations, floors, and roof framing for buildings.

d. Plans and sections of structures other than buildings.

e. Additional sections and details as required illustrating any special items or methods of framing for which approval is sought.

f. General, foundation, and superstructure notes as shown in the Exhibits.

2.7.3 Preliminary Specifications. Not required at this submittal.

2.8 FINAL (100 PERCENT) DESIGN SUBMITTAL REQUIREMENTS

2.8.1 Design Analysis. Furnish all items described above required by the Preliminary Submittal if no Preliminary Submittal is required or any revisions necessitated by comments for the Preliminary Submittal if it was required. Furnish complete checked calculations for all structural members. Incorporate any changes required by comments on Preliminary Review Submittal. Include a completed copy of Exhibit A-3-2, CERTIFICATE FOR DESIGN OF MASONRY WALLS, when masonry walls are part of the design.

2.8.2 Drawings. Furnish complete final plans and details of all structural elements. Prior to this submittal structural drawings shall be coordinated with all other design disciplines. Show on drawings a complete set of general and special notes as shown in the exhibits. The items listed below will always be included on the final drawings if applicable:

a. Roof framing plan and details including details of any opening in the roof.

b. Intermediate floor framing plans and stair details on multiple story structures.

c. Stress or load diagrams of features to be contractor designed (i.e., connector plates on wood trusses are contractor designed based on member stress information shown by the Engineer on the structural drawings).

d. Column schedule, beam schedules, and slab schedules.

e. Foundation plan including any notes relative to special foundation treatment required and cross references to proper specification sections.

f. Foundation sections and details.

g. Layout of expansion, construction, and dummy joints in floor slabs; horizontal and vertical joints in foundation walls; joints in footings; and layout of control joints in masonry walls.

h. Typical and special sections as required.

i. Details of expansion, construction, and contraction joints in concrete.

j. Layout and detail of exterior entrance pads and steps.

k. Details of any special items.

l. General and special notes as required except that the term "by others" shall not be used.

2.8.3 Specifications. Submit a completed set of final specifications for review.

2.8.4 Quality Assurance. Final drawings and specifications shall be checked by the same checker who checks the final design analysis. Structural drawings shall be coordinated with the other disciplines and the specifications. Dimensions, schedules, sections, and details shall be fully checked. Designers and checkers shall initial the pages of the design analysis and on the drawings. Exhibit A-2-8 is a sample of the quality review checklist that will be used by the District to review final design. The A-E is encouraged to use this or a similar form to review the final checked design documents.

2.9 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS

2.9.1 General. The corrected final submittal is not to be considered a normal design level and is required only when the final submittal must be revised or corrected due to error or omission.

2.9.2 Design Analysis. Furnish final structural calculations, incorporating any and all changes made during the process of review and redesign. Calculations will be checked and verified by an engineer other than the original designer.

2.9.3 Drawings. Drawings will implement all comments from previous submittals. Verify that all drawings are finalized and verify consistency between the plans and specifications.

2.10 ADDITIONS OR MODIFICATIONS TO EXISTING STRUCTURES

2.10.1 New Work. When new work is added to an existing structure or an existing structure is modified, the Engineer will be responsible for determining the adequacy of the existing structure for the addition or modification.

2.10.2 Inspection Report. An inspection of the existing structure shall be performed for the purpose of determining the condition and measurements of the areas affected by the new work. The Concept Design shall include a narrative that outlines the results of this inspection to include describing the layout and details of the existing structure, stating the calculated capability of the structure to support the new loads, and describing the strengthening that will be required.

2.10.3 Seismic or Wind Upgrade. Seismic or wind upgrade of the existing structure to meet the latest criteria will not be required unless specifically stated in the Structural Specific Instructions.

2.11 **SITE ADAPTS OF GOVERNMENT DESIGNS**. Where standard drawings or other drawings are to be site adapted the following applies:

2.11.1 Concept. The concept brochure shall be as previously described with the following clarifications:

a. A selection analysis is not required.

b. Wind and seismic calculations shall be performed to verify that the controlling lateral loads are higher or lower than the original design. Redesign of the structural features to

resist the higher loads will be required and the narrative will fully describe those items to be strengthened.

2.11.2 Final Design. Final design shall consist of complete plans, specifications, and design analysis. The specifications shall be the project specifications updated to include the latest revisions to the Federal and Military guide specifications, design codes, and other criteria. The design analysis shall include a narrative explanation of all changes to the original design to accomplish the site adaptation with backup calculations.

2.12 **GENERAL DESIGN REQUIREMENTS**

2.12.1 Technical Requirements. Design will be accomplished in accordance with the basic criteria provided herein and in Appendix A, Specific Instructions to the A-E.

2.12.2 Design Analysis

2.12.2.1 The design analysis shall be prepared in accordance with the general requirements contained in Volume I of this manual and the specific requirements in ER 1110-345-700 except that O&M provisions (Part 3) are not required. The structural O&M requirements are satisfied by the General Notes on the drawings.

2.12.2.2 Analysis by computer calculations is encouraged. Listed below are the commercially available programs currently used in the Structural Section. These or other similar programs may be used except that use of a program not listed will necessitate the submission of the following additional information for that program:

a. The name of the program.

b. A description of the program to include a flow chart showing how the program reaches solution. This description must be sufficient to verify the validity of methods, assumptions, theories, and formulas, but does not require source code documentation or other information that would compromise the propriety rights.

c. A benchmark run validating the program that includes both a computer analysis and a hand analysis of a typical or representative problem.

2.12.2.3 District Approved Computer Programs

a. STRUDL (GT, Boeing, McAuto, etc.)

b. STAAD III (Research Engineers Inc.)

c. Lotus 123

d. ENERCALC

e. ADOSS (PCA)

f. DESCON (Omnitech Assoc.)

g. Intergraph Structural Design Software

h. AISC Software (CONXPRT)

2.13 **REQUIREMENTS FOR DESIGN/BUILD RFP PACKAGES:** To be furnished with specific instructions for the contract or delivery order.

2.14 **TECHNICAL DESIGN REQUIREMENTS**

2.14.1 General Structural Requirements

2.14.1.1 In addition to performing the design of the structural features, the structural engineer shall be responsible for ensuring that all mechanical and electrical equipment is properly supported and that all architectural features are adequately framed and connected.

2.14.1.2 Where future expansion of buildings or facilities is planned, it is especially important that the provisions made for the later extension be carefully developed and shown on the drawings.

2.14.1.3 Structural details will be shown on the structural plans and not intermixed with architectural plans and details.

2.14.1.4 All structures shall be designed in accordance with IBC 2003 except as modified by UFC 1-200-01. Use a wind velocity per sheet A-2-1 of this section, Category as determined in accordance with ASCE-7-02.

2.14.1.5 The design wind pressures will be shown on an isometric or 2D view of the building on one of the structural plates and shall be accompanied by a table that identifies the component and cladding pressures for each zone. Pressures for arched and gable roof on open sheds shall be similarly shown.

2.14.2 Design Loads. Load assumptions shall be in accordance with IBC 2003 with the following modifications.

2.14.2.1 Wind Loadings. Wind loads shall be in accordance with the IBC 2003.

2.14.2.1.1 General. The method of resisting wind loads must be described in the design analysis and supported by actual structural calculations.

2.14.2.1.2 Loading. The wind velocities at the various installations will be as indicated on Exhibit A-2-1. Exposure C conditions will be used unless specifically directed otherwise.

2.14.2.1.3 Wind Framing - Roof Plate System and Load-Bearing Walls. See Exhibit A-2-42. If end walls of buildings are less than 33 percent window and door area, and if the building length, between end walls or substantial partitions, is not more than three times the building width, then a stiff roof deck may be considered to act as a diaphragm transferring wind loads to partitions or end walls. Such a system must be detailed to show adequate anchorage between the diaphragm and the end walls. A stiff deck may be considered to be diagonal wood floor or roof sheathing, light gauge steel roof deck welded to supporting members, poured concrete or gypsum, precast concrete plank welded to supporting members with edges joined by welding. Other type decks must have supplementary cross bracing.

2.14.2.1.4 Wind Framing - Bent System. See Exhibit A-2-43. Adequate calculations must be submitted for this system. Adequate bracing in the roof and walls or diaphragm action of wall or roof covering must be used or adequate sections provided to resist loads in bending.

2.14.2.2 Seismic Load Criteria

2.14.2.2.1 Family Housing. Seismic criteria to be used for family housing shall be IBC 2003.

2.14.2.2.2 Bridges. Seismic criteria to be used for bridges shall be as set forth in the Standard Specification for Highway Bridges, American Association of State Highway and Transportation Officials (AASHTO).

2.14.2.2.3 All Other Structures. Seismic criteria to be used on structures other than family housing and bridges shall be as set forth in IBC 2003.

2.14.2.2.4 The seismic response accelerations for military installations within the Savannah District boundaries are shown on Exhibit A-2-1, or should be taken from IBC 2003.

2.14.2.3 Mechanical Loads. Roof systems over mechanical equipment rooms from which equipment or piping will be supported and roofs of HVAC plants, pump stations, etc., shall be designed for the equipment to be supported but not less than 60 PSF (2.9 kN/m2). Steel beams are the preferred framing members over these areas since they are not as sensitive to hanger attachment locations as are steel joists. Joists may be used over small mechanical rooms if suspended ceiling loads will not produce hanger loads in excess of 50 pounds (25 Kg) per hanger. Joists will not be used in HVAC plants, pump stations, or similar locations.

2.14.2.4 Anti-terrorism/Force Protection
Anti-terrorism/force protection systems must be included for this project and shall conform to the Unified Facilities Criteria (UFC) "DoD Minimum Antiterrorism Standards for Buildings" UFC 4-010-01, dated 08 October 2003. Additional guidance may be found in Department of Defense Interim Antiterrorism/Force Protection Construction Standards – "Design of Buildings to Resist Progressive Collapse" UFC 4-023-03, dated 25 January 2005. (The following sentence is optional if the above documents are not provided in the RFP: Manuals are available from U.S. Army Engineer District, Omaha, ATTN: CENWO-ED-ST, 12565 West Center Road, Omaha, NE 68144-3869.)

2.14.3 Structural Steel

2.14.3.1 Structural steel shall be designed in accordance with IBC 2003.

2.14.4 Steel Joist Construction

2.14.4.1 Steel joists shall be designed in accordance with IBC 2003.

2.14.5 Standing Seam Metal Roof. Standing seam metal roofs shall be structural standing seam metal roof with concealed clips (UFGS 07416A). Architectural standing seam metal roof shall not be used. Concealed clips shall not be fastened through rigid insulation to the structure below. If rigid insulation is provided between metal roofing and deck below, subpurlins shall be provided.

2.14.6 Concrete Design. Concrete design shall be in accordance with IBC 2003.

2.14.7 Masonry

2.14.7.1 Masonry construction shall be designed in accordance with IBC 2003. Location and details of bond beams and all reinforcing will be shown on the structural plans and sections and will be coordinated with the Architect. Lintels for all openings in exterior and interior masonry walls, including windows, doors, and mechanical work such as ducts, shall be shown on the drawings.

2.14.7.2 Masonry walls used in exterior applications that have a tendency to efflorescence shall be avoided.

2.14.7.3 Masonry specifications shall be reviewed by the structural engineer and the paragraphs of structural responsibility appropriately edited to include retaining or deleting testing of mortar and prisms. Testing requirements shall be based on the assumptions used for design and unnecessary tests will be deleted. Prism testing is rarely necessary and should normally be deleted from the specifications.

2.14.7.4 For the past few years reinforced masonry has been the source of numerous deficiencies in both design and construction. The structural designer shall thoroughly review IBC 2003 before beginning design. Especially note that minimum seismic reinforcement is required in the walls and partitions of all masonry structures. The structural engineer is responsible for the proper detailing of these walls to include vertical reinforcement, horizontal reinforcement (intermediate bond beams, bond beams at the floor and top course of each wall), dowels, joint reinforcement, additional reinforcement around openings, reinforcement each side of control joints, lintels, and bond beam intersections. Vertical and horizontal reinforcement shall not be required by general notes alone. Typical sections illustrating all reinforcement requirements shall be provided on the drawings. Wall elevations showing both horizontal and vertical reinforcing patterns for typical walls and typical openings are to be shown on the structural drawings.

2.14.8 Timber Trusses. Timber trusses and trussed joists shall be designed and detailed on the structural drawings. Since connections for the truss members frequently employ proprietary type plates, the connection design shall be specified to be accomplished by the joist/truss fabricator and submitted for design engineer (GA) review. The drawings prepared by the Engineer shall include member sizes and stress diagrams which indicate the maximum member forces for which the connections are to be designed. Support anchorage shall be specified and detailed by the Engineer on the structural drawings. Under certain circumstances, and with the prior approval of the Structural Section, the Engineer may delegate the design of the wood trusses to a truss design fabricator. In this case, the truss detail sheets and framing plan prepared by the Engineer shall number each truss, show its general configuration, and shall list the technical requirements and loading. The truss design fabricator shall then prepare the complete design of the truss and shall submit the design and design calculations to the Engineer for approval as part of the shop drawings as indicated above. As with the connections, this is a (GA) review.

2.14.9 Foundation Design

2.14.9.1 Concrete. All concrete building foundations should be designed in accordance with IBC 2003.

2.14.9.2 Type of Foundation and Allowable Soil Bearing Value. The type of foundation, allowable bearing value and foundation depth will be furnished by the District Soils Section (EN-GS).

2.14.9.3 Foundation Notes. The attached applicable notes shall appear on the foundation plan drawing as a minimum (Exhibit A-2-4).

2.14.10 Building Slab on Grade Design

2.14.10.1 Design. A "K" value for designing slabs subject to vehicular loads will be furnished by the Site Development Section (EN-DGO) for the project involved. "K" shall be 200 psi/in (5430MN/m^2/m) minimum due to use of compacted gravel and fill under the floor slab. Hangar floor slabs will be designed using aircraft pavement criteria.

2.14.10.2 Criteria. The following criteria should be observed:

a. Use the joint details shown on Exhibit A-2-15 and the technical requirements indicated on Exhibit A-2-16.

b. Floor joints should always be shown on the structural drawings and the spacing will vary depending upon whether reinforced or unreinforced design is selected. For guidance see TM 5-809-12 and UFGS 03300A, "Cast-In-Place Structural Concrete."

c. Use a vapor barrier under all slabs on grade for buildings sensitive to moisture.

d. Use 4 inches (100 mm) gravel capillary water barrier under all building slabs on grade when directed by the soil report.

e. Use #30 felt between floor slabs on grade and foundation beams and piers.

f. Slabs on grade shall not bear on grade beams, walls, or piers except where provision is made to reinforce the slab to prevent cracking should soil settlement beneath the slab occur.

g. Slabs on grade subjected to vehicular loading should be minimum 4000 psi (27.5 Mpa) concrete even if reinforced. This is for durability of the wearing surface as well as for increased flexural strength.

h. Rebars or welded wire fabric (plain or deformed) may be used. Where columns occur, floor control joints should be placed on column centerlines.

i. Slabs on grade with perimeter felt joints and with floor drains, such as in mechanical rooms, will have a rubber joint sealant on top of the felt joint.

j. In wash rack areas, joints should be minimized by use of more reinforcement. The joint between slab on grade and foundation should have a rubber joint sealant.

k. Topping over concrete slabs must be avoided where possible. Where it is not possible, it should be a minimum of 2 inches (50 mm) thick and reinforced with 0.1 percent reinforcement in bars or mesh in flat sheets. Fiber reinforcement may also be provided in accordance with manufacturer's instructions.

l. Use of expansive cement and elimination of most joints may be considered where economical. Where used, it should be at the Contractor's option.

2.14.11 Masonry Wall Considerations

2.14.11.1 For approved wall types, technical requirements, and testing requirements see IBC 2003.

2.14.11.2 Mortar. Normally, type N or S mortar will be used. Typically, only one type of mortar is used for all wall types on a project.

2.14.11.3 Standard Details. See standard detail sheet (architectural) for details of control joints, bond beams, lintels, joint reinforcing, connection to steel columns, etc., in addition to the details in the structural exhibits.

2.14.11.4 Exterior Walls. Masonry walls should be engineered in accordance with referenced criteria. Normally, only a single row of vertical reinforcing will be used in walls. Horizontal steel will be joint reinforcing supplemented with intermediate bond beams as required. Exterior CMU walls and the cavity in cavity or anchored veneer walls will be filled with grout below grade.

2.14.11.5 Interior Masonry Partitions. Interior partitions must be supported at the top of the wall by adequate means such as angle braces to roof system, etc., where they do not receive adequate lateral support from cross walls or columns, or where walls are broken by control joints such that horizontal loads cannot be transferred longitudinally. Interior partitions which can be exposed to wind forces due to the opening of large doors must be designed as exterior walls. Minimum seismic provisions apply to both interior partitions and to exterior walls.

2.14.11.6 Design Analysis. The design analysis should explain where it was necessary to design interior partitions as exterior walls.

2.14.11.7 Openings in Walls. Where walls span horizontally between columns, the lintel over the opening must be extended to the columns, and a bond beam below the opening must be extended to the columns. Steel girts may be used for this purpose if necessary. Vertical reinforcing in concrete filled cells will be used to take wind loads at large openings or to act as pilasters where heavy lintels or beams bear on the walls.

2.14.11.8 Steel beams which bear on masonry walls should have slip plates and slotted holes at anchor bolts to provide for thermal movement.

2.14.11.9 Control Joints

2.14.11.9.1 Control joint spacing shall not be greater than recommended by the masonry associations, except that the spacing may increase where intermediate bond beams are used.

2.14.11.9.2 Joints at the normal spacing must be coordinated with the additional joints required:

a. At corners and intersections of exterior walls and partitions where roof framing (steel

frame or load bearing) would impose horizontal loads to the top of the wall if the framing was subjected to change of length due to change in temperature. This is aggravated when insulation is placed on the ceiling instead of on top of the deck.

b. At all bond beam breaks.

c. At all large openings [10 feet (3m) or more in width or height].

d. At change in wall thickness or wall heights.

2.14.11.9.3 Reinforcement in bond beams shall be continuous through control joints at all floor and roof levels.

2.14.11.9.4 Brick expansion joints and masonry contraction joints are normally shown in plan and detail on the architectural drawings. Their locations should be approved by the structural engineer. Note that these joints do not have to coincide.

2.14.11.10 Reinforcing

2.14.11.10.1 Bond beams shall be placed at top of all masonry walls. Minimum reinforcing shall be two #5 (#13) in bottom of 4 inches (100 mm) and 8 inches (200 mm) wide bond beams and one #7 (#19) in bottom of 6 inches (150 mm) wide CMU bond beams, (two #4 in bottom of 8-inch and 12-inch and one #6 in bottom of 6-inch). In lieu of a reinforced "U" block bond beam, three courses of horizontal joint reinforcement may be used at top of non-load bearing partitions and exterior curtain walls.

2.14.11.11 Miscellaneous

2.14.11.11.1 Masonry must be set ¾ inch (20 mm) minimum clear of all steel columns and ¾ inch (20 mm) clear from the bottom flange of steel roof beams.

2.14.11.11.2 Lintels will be provided over all masonry openings, and slip joints will be used under lintel bearings when a control joint is located within 2 feet (600 mm) of a masonry opening.

2.14.11.11.3 If masonry is used with a rigid frame, the frame drift must be less than the allowable deflection of the masonry wall as defined in IBC 2003.

2.14.11.12 Lintel Design. All lintels should be designed in accordance with IBC 2003.

2.14.12 Building Frame Design Considerations

2.14.12.1 Load-Bearing Walls Versus Frame Type Buildings. Some type of building frame usually is required where a building length or length between shear walls is more than three times its width, where long clear spans are required [30 m (100 feet) or more], or where the building one-story height is in excess of 5.5 m (18 feet). Provide expansion joints through building frame at 300-foot (90 m) o.c., maximum. A comparative cost estimate should accompany concept plans to show the basis for frame selection.

2.14.12.2 Concrete Building Frames. Normally, it will be most economical to use grade 60 reinforcing due to the higher allowable stress. Lightweight concrete may be used for floor

framing but not for columns; 5000 psi (35 Mpa) concrete may be used where economical; 4000 psi (27.5 Mpa) concrete is normally used for pan joist floors. Types of concrete floors which have proved economical are flat slab, waffle slab, pan joist and precast concrete joists. Design dead loads should include the additional concrete topping required due to precast joist camber. Reinforcing in pan joist slabs should be bars or mesh in flat sheets. Minimum reinforcing should be 0.18 percent in each direction for mesh, or 0.2 percent for bars in a direction at right angles to joists, but bar spacing must not be greater than 3t. Bars must also be tied with cross bars at 18-inch (450 mm) o.c. maximum. Thickness of pan joist slab shall be 2-1/2 inch (65 mm) minimum.

2.14.12.3 Steel Building Frames. In general, shop welded, field bolted construction should be used, except that hanger straps supporting cranes or monorails shall be high strength bolted. High strength bolts for field connections may be used where economy or ease of construction dictates. ASTM A572, A992 for wide flange shapes, steel should be used where strength can be utilized; otherwise, use ASTM A 36. Bar joists should be K series as defined by the Steel Joist Institute. Long-span joists may be used where required by span and load. Use standard joists where possible. The attached steel framing notes (Exhibit A-2-6) and details should be used where applicable. Steel columns must be clear of masonry walls. Where steel members are anchored to masonry walls to provide support, care must be used to provide slotted holes to allow the wall to move relative to the steel. Specify a nondestructive test on 100 percent of all butt-welded beam or column connections. See guide specifications.

Where steel beams are used to support the metal form system, the spacing can be increased up to about 2.75 m (9 feet) o.c. provided the floor slab is thickened and the metal form system is properly designed. A vibration analysis of these type floor systems is required.

2.14.12.4 Pre-engineered buildings may be used where indicated by the directive or as otherwise approved by the Structural Section. If negotiations assumed a custom designed building and a pre-engineered building is later approved for use, then the original design contract is subject to renegotiation for the reduction in architectural and structural effort. The attached notes on Exhibit A-2-7 relating to this type building should be used. It will be necessary to select these from a catalogue to get standard dimensions or standard structural frames. The Contractor will design the building foundation based on the criteria contained in the notes and on the drawings.

2.14.12.5 Basements. Usually, basement floors will be slab-on-grade construction separated from basement walls by #30 felt. Basement walls should have membrane waterproofing on the outside and under the slab with a continuous perforated tile drain around the basement where required by the soils report.

2.14.12.6 Suspended ceilings on the exterior of building over entrances, docks, etc., must be designed for wind loads. Structural steel angles instead of wire hangers are normally used here since uplift can be a problem. Ceilings may be considered as support for metal stud partitions.

2.14.13 Seismic Design Considerations

2.14.13.1 The basic seismic technical requirements are contained in IBC 2003 as modified by UFC 1-200-01, dated 31 July 2002.

2.14.13.2 The following is a list of exceptions and clarifications to the references:

a. Avoid use of tie rods for bracing. Use structural rolled shapes.

b. Precast concrete, prestressed concrete, and flat slabs do not qualify as components of ductile moment resisting elements.

c. Pre-engineered Metal Buildings. Panels thinner than 22 gauge (0.75 mm) with self-tapping screws are not permitted for diaphragms or shear walls. All roof or wall systems using siding or roofing as a diaphragm must be tested for in-plane loading for diaphragm or shear wall effects. Test reports and recommendations must be submitted for evaluation and approval. The steel deck system must have the ability to transmit diaphragm loads and is dependent upon the deck strength, stiffness, panel configuration, fastening method and condition of installation. Since approval of tests on these systems is tedious and time consuming, cross-bracing, rigid frame wind bents, or wind columns are the preferred system. Specifications for pre-engineered metal buildings must require submission of load tests on metal panel walls and roof where used as a diaphragm.

d. The allowable drift of walls, in all cases, must be considered before selecting the type of diaphragm. All story drifts must be checked so that they will be compatible with the diaphragm deflection (especially for brittle walls).

e. The criteria for separation of buildings will apply to seismic joints for parts of buildings. Portions of a building with differing dynamic responses will be separated from each other with seismic joints. Analysis of setbacks in plan and/or elevation per IBC 2003 shall be required to preclude use of seismic joints.

f. Connection of diaphragm to vertical-load-carrying precast elements is necessary to transmit the lateral force generated from the weights of the frame and other masses attached thereto to the diaphragm. Also, the response of the supporting element when subjected to earthquake motion must be in resonance with the diaphragm. Therefore, positive anchorage, such as mechanical fasteners, dowels, or welding as appropriate must be provided.

g. Prestressed, precast concrete frames are not permitted to be used as semiductile frames. The capability or performance of semiductile moment resisting frames of prestressed, precast construction is questioned. Based on our knowledge, its use has not been accepted by codes. Therefore, we cannot allow its use without any specific information or design data to confirm its performance and structural adequacy.

h. Buildings with basements or buried structures may be required to be analyzed for the effect of dynamic soil loadings.

2.14.13.3 Seismic vs Wind. When comparing wind and seismic calculations the general perception that wind or seismic governs totally in a particular direction is not valid. Even though wind or seismic governs a particular direction based on the overall magnitude of load in that direction does not mean that the other is ruled out when considering the design of individual elements of the building that are affected by lateral load in that direction. As will be demonstrated below, wind and seismic calculations have, for different systems and elements, different factors applied to the loads on those elements. This greatly complicates a "controlling load determination," and mandates that this determination not be made on the building as a whole, but that each element of the building must be considered separately,

(i.e., parts and portions of a building are to be designed individually for the highest load on them). Both seismic and wind loads should be taken to individual elements and then only after placing the proper factors to the loads should the highest load be selected.

2.14.13.3.1 Wind Loads (IBC 2003)

2.14.13.3.1.1 The minimum factor of safety for overturning or uplift shall be 1.5. Some textbooks and codes require a higher factor of safety and use of higher factors of safety are not discouraged but are left up to the discretion of the individual designer.

2.14.13.3.2 Seismic Loads (IBC 2003 as modified by UFC 1-200-01)

2.14.14 Miscellanées Structures

2.14.14.1 Manholes, Pullboxes, Surface Inlets, etc. These structures should be similar to those shown in the attached Exhibits A-2-70, A-2-71, and A-2-72. A minimum 3000 psi (20 Mpa) compressive strength concrete will be used. Verify location of water table with Soils Section (EN-GS) and check for uplift. Precast concrete structures are acceptable and desired where more economical. H-15 wheel loads will be used except for structures in pavement which will be designed for the wheel load for which the pavement was designed.

2.14.14.2 Headwalls and Box Culverts. Minimum 3000 psi (20 Mpa) compressive strength concrete should be used.

2.14.14.3 Transformer Pads, Condenser Pads, and Generator Pads. See attached details (Exhibit A-2-17) for these structures. Concrete should be minimum 3000 psi (20 Mpa) compressive strength.

2.14.14.4 Retaining Walls, Basement Walls. Lateral earth loads on structures should be based on $p = whK$; where p = lateral pressure, w = wet unit weight of earth [120 psf (20 kN/m^3) minimum, may be higher in some areas], h = depth of structure, and K is a coefficient (use 0.5 for retaining walls, 0.7 for basement walls and box culverts), and verify with Soils Section (EN-GS). Surcharge loads should be included where applicable. Investigation should also be made using 100 percent hydrostatic pressure (where applicable) at one-third overstress (50 percent where drains are used). The working stress method of design is preferred with actual loads on the wall.

2.14.14.5 Monorail Design. Monorail beams shall be designed for maximum bending stress of:

$$f = \frac{3{,}000{,}000}{1d/bt}$$ but not greater than 10,000 psi (69 Mpa).

based on rated capacity of the hoist plus 25 percent impact and full dead loads for vertical loads, and 20 percent of rated capacity + 25 percent impact for horizontal loads. Deflections should be limited to L/800.

Beams shall also be checked for a maximum overload of 2.75 times the rated hoist capacity at 75 percent of the yield stress. An "I" beam, with channel on top, (T) section should be used for all but very short spans. The hangers and system supporting the monorail beam should be designed for the same loads but at normal stresses. Knee braces should be

provided where applicable. Field connections should be A325 bolted connections.

2.14.14.6 Traveling Crane Runway Girders. Runway girders will normally be designed by the crane vendor and will be provided based on performance specifications. The following guidelines should be included in these specifications.

2.14.14.6.1 Continuous girders should not be used where significant unequal foundation settlement is likely to occur. Where foundations are other than shale or hard rock, check anticipated differential settlement so that the difference is limited to 0.003 L between adjacent supports. (Simply supported girders are not ordinarily affected by differential foundation movements.)

2.14.14.6.2 Limit live load deflection at midspan to "L"/1,000.

2.14.14.6.3 For continuous girders, limit ratio of length of adjacent spans to 2:1.

2.14.14.6.4 Connect ends of simply supported girders in such a manner that will allow the ends to rotate under vertical loading.

2.14.14.6.5 Proprietary hanging systems by the successful bidder are preferred over direct bolted connections.

2.14.14.7 Precast Concrete Panels. Precast concrete panels used as non-load bearing construction should have connections such that thermal expansion or contraction may occur without damage to the panels. These connections should at least allow movement at one end of the panel. These connections could be in the form of studs welded to embedded steel plates and anchored into an angle with allotted holes in the direction of expected movement. Also, when the panels bear on other members such as steel or concrete, the expansion end of the panels should bear on neoprene pads, steel or some such material that will minimize the frictional resistance to movement. The precast concrete of the shearing areas should be reinforced additionally horizontally and vertically to minimize cracking of these bearing areas. Reference is made to PCI Manual for Structural Design of Architectural Precast Concrete. Seismic connections should be in accordance with IBC 2003.

2.14.14.8 Valve Pits. Valve pit details and schedule of thickness and reinforcing is included on Exhibits A-2-24, A-2-25, A-2-26, and A-2-27 and may be used for design as appropriate. These valve pits were designed using the conservative assumptions shown on Exhibit A-2-27 realizing that we occasionally design valve pits in remote locations without any soils data. The design procedure is on file in the Structural Section and can be adjusted for any specific location.

2.14.15 Fire Walls

2.14.15.1 In order to meet fire codes, single fire walls (4-hour rating) must be self-supporting rather than depending upon steel or wood building frame for support, the idea being that if the steel or wood frame collapses due to fire, the wall will still survive. What this means is that in these cases, fire walls should be designed to cantilever off the foundation and should not be connected to the building frame in any way unless the frame has a 1-1/2 hour fire rating. Reinforced pilasters, brick or CMU, are probably the best way to do this. The foundation must be able to take these imposed loads. If it is desirable to connect the wall to a building's steel or wood frame, then a double firewall must be

provided. The lateral design load for fire walls should be 10 psf (0.5 kN/m$^{2)}$ unless a portion of it serves as an exterior wall. Building framing members that have 1-1/2 hour fire rating or more, may bear on fire walls and provide lateral support for them.

2.14.15.2 Walls with less than 4-hour fire rating do not have to be self-supporting. These walls are sometimes called fire partitions.

2.14.15.3 Control joints in fire walls should be well keyed, caulked with rockwool and with rockwool held in place by mortar (each side). If the fire wall is reinforced, control joints can be 50-foot (15 m) o.c.

CHAPTER A-2

STRUCTURAL

EXHIBITS

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A-2-3 Concept/Early Preliminary Design Brochure Outline
A-2-4 Foundation Notes
A-2-5 Building Slab-on-Grade
A-2-6 Structural Steel Notes
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WIND PRESSURES AND SEISMIC ACCELERATIONS

(Wind based on ASCE 7-02)
(Seismic based on IBC 2003)

Installation	Wind Velocity (3 sec.) MPH	(m/s)	Seismic* Ss	S1
Fort Benning, Georgia	95	42	0.17	0.08
Fort Bragg, North Carolina	100	42	0.29	0.13
Charleston Army Depot, South Carolina	125	56	1.55	0.43
Dobbins AFB, Georgia	90	40	0.28	0.12
Fort Fisher AFS, North Carolina	135	60	0.35	0.14
Fort Gordon, Georgia	95	42	0.40	0.14
Fort Gillem, Georgia	90	40	0.25	0.11
Hunter AAF, Georgia	120	54	0.41	0.15
Fort Jackson, South Carolina	95	42	0.59	0.19
Kings Bay Army Terminal, Georgia	120	54	0.18	0.09
Fort McPherson, Georgia	90	40	0.25	0.11
Moody AFB, Georgia	100	45	0.14	0.08
Pope AFB, North Carolina	100	45	0.28	0.13
Robins AFB, Georgia	95	42	0.20	0.10
Seymour Johnson AFB, North Carolina	110	49	0.22	0.10
Fort Stewart, Georgia	115	51	0.28	0.12
Sunny Point Army Terminal, N. C.	135	60	0.35	0.14
Tarheel Army Missile Plant, N. C.	90	40	0.23	0.11

*Maximum Considered Earthquake, Spectral Response Accelerations for 0.2 second (Ss) and 1.0 second (S1). Values shown are for general location of each installation and should be verified for actual project site. See Spectral Response Seismic Design Maps by USGS/BSSC Project 97 (also on USGS Web page, **http://geohazards.cr.usgs.gov/eq/index.shtml**).

GENERAL NOTES

1. DESIGN LOADS:

ROOF LIVE LOADS:	ROOF	=	20 psf
FLOOR LIVE LOADS:	SLABS-ON-GRADE	=	150 psf
	STAIRWELLS	=	100 psf
	CORRIDORS	=	100 psf
	CLASSROOMS & STORAGE	=	100 psf
	MECHANICAL, ELECTRICAL, & ATTIC SPACE	=	150 psf
WIND LOADS:	REFERENCE: ASCE 7-02		
	VELOCITY	=	95 Mph
	I	=	1.0
	EXPOSURE	=	C

SEISMIC LOADS:

1. WHERE A SECTION OR DETAIL IS SHOWN FOR ONE CONDITION, IT SHALL APPLY TO ALL LIKE AND SIMILAR CONDITIONS.

2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN AND DETAIL OF SIMPLE (SHEAR ONLY) CONNECTIONS NOT SHOWN ON THE DRAWINGS.

3. NO CORE DRILLING WILL BE PERMITTED IN THE FOUNDATION WALLS OR IN THE ELEVATED SLABS. REFER TO THE MECHANICAL, ELECTRICAL, AND PLUMBING PLATES TO LOCATE PENETRATIONS. THE PENETRATION LOCATIONS MUST BE SHOWN IN THE SHOP DRAWING SUBMITTALS.

CONCRETE MASONRY NOTES

1. ALL CMU SHALL BE TWO-CELL TYPE UNITS EXCEPT LINTELS WHICH SHALL BE U-SHAPED UNITS.
2. BOND BEAM UNITS MAY BE U-SHAPED OR TWO-CELL TYPE.
3. ALL CMU SHALL CONFORM TO ASTM C-90 OR EQUIVALENT METRIC STANDARD.
4. ALL CELLS CONTAINING REINFORCING SHALL BE FULL GROUTED.
5. USE TYPE S MORTAR WITH A MINIMUM COMPRESSIVE STRENGTH OF 1800 psi AT 28 DAYS.
6. VERTICAL CELLS TO BE FILLED SHALL HAVE VERTICAL ALIGNMENT SUFFICIENT TO MAINTAIN A CLEAR UNOBSTRUCTED CONTINUOUS VERTICAL CELL NOT LESS THAN 50 X 75mm PLAN DIMENSIONS.
7. ALL MASONRY BOND BEAMS, LINTELS, AND VERTICALLY GROUTED CELLS SHALL BE FILLED SOLIDLY WITH 2500 psi GROUT.

8. BOND BEAMS AT CMU WALLS THAT ARE PERPENDICULAR TO EACH OTHER SHALL MEET AT THE SAME ELEVATION AND THE REINFORCING SHALL BE LAPPED AS REQUIRED.
9. ALL CONCRETE MASONRY UNITS SHALL HAVE A GROSS SPECIFIED COMPRESSIVE STRENGTH OF 2000 psi AT 28 DAYS.
10. DOWELS FROM THE ATTIC SLAB SHALL BE PROVIDED. THE SPACING AND SIZE OF THE DOWELS SHALL MATCH THE VERTICAL REINFORCING BARS.
11. THE ASSUMED F_M FOR MASONRY = 1350 psi.

CONCRETE NOTES

1. ALL CONCRETE WORK SHALL CONFORM TO ACI 318-02, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
2. CONCRETE STRENGTH = 4000 psi AT 28 DAYS FOR CONCRETE MEMBERS INCLUDING FOOTINGS AND TRENCHES.
3. REINFORCING BARS SHALL CONFORM TO ASTM A615M, A184, A184M F_Y = 60 ksi.
4. ALL SPLICES SHALL BE CLASS "B" TENSION LAP SPLICES UNLESS NOTED OTHERWISE.
5. MINIMUM CONCRETE COVER FOR REINFORCING:
   FOOTINGS.....3 in
   SLABS .....1.5 in
6. VERTICAL FOUNDATION WALL REINFORCING DOWELS SHALL EXTEND INTO THE FOUNDATION WITH HOOKED BARS OF THE SAME SIZE AND SPACING AS THE VERTICAL REINFORCING.
7. SLABS-ON-GRADE SHALL INCLUDE FIBER MESH REINFORCING AS PRESCRIBED IN THE SPECIFICATIONS TO CONTROL SHRINKAGE.
8. DURING PLACEMENT OF THE CONCRETE SLABS, ALL PRECAUTIONARY STEPS MUST BE TAKEN TO AVOID PLASTIC CRACKS DUE TO WEATHER CHANGES. THE CONTRACTOR SHALL COMPUTE THE PROJECTED RATE OF EVAPORATION IN ACCORDANCE WITH ACI 308-02 AND DCAF BULLETIN 96-08 WITHIN 24 HOURS OF PLACEMENT. IF THE PROJECTED EVAPORATION RATE EXCEEDS THE MAXIMUM ALLOWABLE, THEN THE ERECTION OF SUNSHADES, WINDBREAKERS, AND OTHER SUCH MEASURES AS MAY BE REQUIRED MUST BE TAKEN TO MINIMIZE PLASTIC CRACK FORMATION.
9. THE BAR BENDING SCHEDULE FOR THE FOUNDATION MUST BE SUBMITTED FOR APPROVAL. THE BAR BENDING SCHEDULE SHALL CONFORM TO THE REQUIREMENTS OF ACI 315 AND SPECIFICATION SECTION 3307.

ABBREVIATIONS

ACI	= AMERICAN CONCRETE INSTITUTE	No.	= NUMBER
AFF	= ABOVE FINISHED FLOOR	O.C.	= ON CENTER
AISC	= AMERICAN INSTITUTE OF STEEL CONSTRUCTION	OPP.	= OPPOSITE
ASTM	= AMERICAN SOCIETY FOR TESTING MATERIALS	Kg/M^2	= KILOGRAMS PER SQUARE METER
BRG	= BEARING	Pa	= PASCAL – UNIT OF PRESSURE
CMU	= CONCRETE MASONRY UNIT	KPa	= KILOPASCAL
CONC.	= CONCRETE	P.E.J.	= PREMOLDED EXPANSION JOINT
CONT.	= CONTINUOUS	REINF.	= REINFORCED, REINFORCING
C.J.	= CONSTRUCTION JOINT	SIM.	= SIMILAR
DIA.	= DIAMETER	SLV	= SHORT LEG VERTICAL
EL.	= ELEVATION	T.O.S.	= TOP OF STEEL
E.W.	= EACH WAY	TYP.	= TYPICAL
FIN.	= FINISHED	U.N.O.	= UNLESS NOTED OTHERWISE
HORIZ.	= HORIZONTAL, HORIZONTALLY	VERT.	= VERTICAL
IN3	= INCHES CUBED	w/	= WITH
IN4	= INCHES TO THE FOURTH POWER	x	= BY
LLV	= LONG LEG VERTICAL	W.P.	= WORK POINT
MAX.	= MAXIMUM	L	= ANGLE
MIN.	= MINIMUM		

CONCEPT/EARLY PRELIMINARY DESIGN BROCHURE OUTLINE

1. Structural Narrative.

   a. General.

   b. Framing System.

   c. Foundation.

   d. Special Design Features.

   e. Fire Resistance Statement.

   f. List structural information needed to complete final design.

2. Design Analysis.

   a. Load Assumptions:

      (1) Dead loads will be loads actually calculated.

      (2) Live loads:

         (a) Roof - - - - - - - - - - - - - - - _____.
         (b) Floor - - - - - - - - - - - - - - _____.

      (3) Wind Load:

         Velocity = _____mph (m/s)
         Exposure = ____.
         Importance Factor = _____.

      (4) Crane Loads and Coverage Requirements:

      (5) Seismic Forces:

   b. Working Stresses.

      (1) Concrete - 28-day ultimate compressive strength.

      (2) Reinforcing - - - - - - - - - - - - - - - - - -

      (3) Structural steel - - - - - - - - - - - - - - - -

      (4) Other as appropriate.

   c. Calculations: Nominal calculations are required as described in the "Technical Design

Manual."

3. Structural System Selection Analysis.

4. Drawings.

5. Outline Specifications.

FOUNDATION NOTES

1. REFERENCE ELEVATION 100 ft IS THE ASSUMED FIRST FLOOR FINISHED ELEVATION WITHIN S PLATES. SEE PLATE _____ FOR ACTUAL FIRST FLOOR FINISHED ELEVATION.

2. CONSTRUCTION JOINTS IN CONTINUOUS FOOTINGS ARE TO BE FORMED VERTICALLY WITH MINIMUM 24 in LAPS IN CONTINUOUS REINFORCING UNLESS NOTED OTHERWISE.

3. PLACE VAPOR BARRIER AND 4 in CAPILLARY WATER BARRIER UNDER ALL SLABS-ON-GRADE (TYPICAL).

4. CONCRETE FLOOR SLAB-ON-GRADE MAY BE PLACED IN EITHER A CHECKERBOARD PATTERN OR IN LANES. SPACING OF JOINTS SHALL BE AS SHOWN ON THE FOUNDATION PLAN. IN EITHER CASE, PRE-FORMED JOINTS ARE REQUIRED.

5. ALL FLOOR ISOLATION JOINTS SHALL BE No. 30 FELT.

6. FILL ALL CMU CAVITIES BELOW GRADE WITH GROUT.

7. THE ALLOWABLE SOIL BEARING CAPACITY IS 2500 psf.

BUILDING SLAB ON GRADE

Concrete floor slab-on-grade may be placed in either checkerboard pattern or in lanes. Spacing of joints shall be as shown on the foundation plan. If checkerboard pattern is used, all joints shall be construction joints. If lane placement is used, construction joints shall be used for the joints between lanes, while weakened plane joints shall be used down each lane. The reinforcing in the slab shall be _____.

STRUCTURAL STEEL NOTES

1. ALL STRUCTURAL STEEL WORK SHALL CONFORM TO THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC) SPECIFICATIONS FOR DESIGN, FABRICATION, AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS, NINTH EDITION, HEREINAFTER REFERRED TO AS AISC-9. THE SIZES OF STRUCTURAL MEMBERS SHALL BE GOVERNED BY ASTM A6/M.

2. CONNECTIONS - GENERAL:

3. ALL CONNECTIONS NOT DETAILED OR OTHERWISE NOTED SHALL BE DESIGNED AS AISC TYPE 2 BOLTED CONNECTIONS DESIGNED FOR THE FULL LOAD CAPACITY OF THE CONNECTING MEMBERS.

4. THE DESIGN AND DETAILING OF ALL CONNECTIONS SHALL CONFORM TO THE AISC SPECIFICATION CONTAINED IN AISC-9.

5. MATERIAL SPECIFICATION FOR ROLLED SECTIONS, PLATES, AND FLAT BAR STRUCTURAL STEEL SHALL CONFORM TO ASTM A 572/A 572M (GRADE 50), UNLESS NOTED OTHERWISE. TUBULAR STEEL SECTIONS SHALL CONFORM TO ASTM A500 (GRADE B).

6. MINIMUM WELD SIZE FOR STRUCTURAL STEEL CONNECTIONS IS $^{3}/_{16}$ in FILLET, UNLESS NOTED OTHERWISE.

7. STEEL ROOF DECK TO BE MINIMUM DIMENSION OF 1.5 in DEEP AND 0.0379 in THICK (20 GAGE). THE DIMENSIONS SHOWN IN THE DRAWINGS FOR STRUCTURAL STEEL BEAMS, COLUMNS, PLATES, RODS, METAL DECK, AND SCREWS ARE NOMINAL DIMENSIONS.

8. THIS STRUCTURE IS CONSIDERED A NON-SELF-SUPPORTING BRACED FRAME. THE CONTRACTOR SHALL PROVIDE ADEQUATE TEMPORARY SUPPORTS UNTIL ALL PERMANENT BRACING AND FLOOR SLABS ARE IN PLACE.

LIGHT GAGE TRUSS AND FRAMING NOTES

1. ROOF LAYOUT AND COMPONENTS SHOWN ON THE DRAWINGS ARE FOR GENERAL CONFIGURATION ONLY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL DIMENSIONS, ELEVATIONS CONNECTION DETAILS, QUANTITIES, ETC. NECESSARY FOR THE COMPLETE DESIGN, FABRICATION, AND ERECTION OF THE METAL ROOF FRAMING SYSTEM. THE CONTRACTOR SHALL COORDINATE THE DESIGN WITH THE ARCHITECTURAL PLANS, ELEVATIONS, AND DETAILS.

2. LIGHT GAGE TRUSS AND FRAMING MEMBERS SHALL BE DESIGNED IN ACCORDANCE WITH THE AMERICAN IRON AND STEEL INSTITUTE (AISI)

SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS.

3. ALL CALCULATIONS AND DRAWINGS USED IN THIS DESIGN MUST BE SIGNED AND STAMPED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF GEORGIA AND SUBMITTED TO THE GOVERNMENT FOR APPROVAL. IN ADDITION TO THE CALCULATIONS, THIS SUBMITTAL SHALL INCLUDE DETAILS OF CONNECTIONS, ERECTION PLAN, LAYOUT, OUTRIGGERS, HEADERS, BRIDGING, AND BOTH TEMPORARY AND PERMANENT BRACING.

4. THE CONTRACTOR SHALL SUBMIT COMPLETE PRODUCT CATALOGS FROM THE TRUSS MANUFACTURER FOR REVIEW PRIOR TO FABRICATION. THE CATALOGS SHALL INDICATE QUALIFICATIONS, MATERIAL SPECIFICATIONS, DESIGN REFERENCES, ETC.

5. ALL COLD-FORMED STEEL MEMBERS, THEIR COMPONENTS, AND CONNECTION MATERIAL SHALL BE HOT-DIPPED GALVANIZED.

6. ALL TOP CHORD MEMBERS SHALL HAVE A MINIMUM THICKNESS OF 0.06 in.

PRE-ENGINEERED BUILDING NOTES:

Pre-engineered metal buildings shall be procured using Guide Specification UFGS-13120, PREENGINEERED METAL BUILDING or UFGS-13121, METAL BUILDING SYSTEMS (MINOR REQUIREMENTS) as appropriate. The structural drawings shall include a foundation plan which indicates an estimate of the foundation requirements for a typical pre-engineered building that will meet the project requirements. The foundation plan shall be consistent with the requirements of the Government-furnished foundation report. This plan will be supported by notes that clearly define any additional requirements required by the COE. As a minimum, the following notes will be included:

1. Building shall be a pre-engineered building as specified in Section UFGS-13121, METAL BUILDING SYSTEMS (MINOR REQUIREMENTS). The building shall be a manufacturer's standard prefabricated metal structure of the approximate inside area shown, except as noted. Rigid frames shall be spaced at center to center, but overall dimensions and construction details may vary to suit manufacturer's standard design.

2. The building shall be designed and fabricated according to AISC and AISI latest specifications. The dimensional tolerances outlined in the AWS code under workmanship and the tolerances applicable to roll form steel under the AISC "Standard Mill Practice" section shall be required in the fabrication of the steel building frames.

3. A complete design analysis showing all calculations for the rigid frames, girts, and purlins, and a layout of anchor bolts and other embedded items shall be submitted for approval with the shop drawings. Shop drawings shall include details of all main members, typical connections (showing bolt holes and welds), and erection drawings.

4. The building shall be designed to support all mechanical equipment including heaters, sprinklers, exhaust systems, and all other such devices. Additional girts or purlins shall be placed in convenient locations for attachment of all mechanical equipment.

5. Wind loads, live loads and load combinations shall be in accordance with UFC 3-310-01, "Design Load Assumptions for Buildings."

6. Cross bracing shall be used to take lateral loads.

7. The foundations shown are estimates for the building type shown on the drawings and are to be used as a guide for the building supplied. The Contractor shall design the foundations for the loads shown and the building supplied.

8. The Contractor shall use in his design the basic criteria shown by this drawing, such as slab thickness, control joints, capillary water barrier, vapor barrier, design loads, and minimum depth of footing.

9. Footings shall be sized for an allowable soil bearing value of SF. This value is based on a minimum footing width of feet and a minimum depth of feet to the base of the footing measured from finish floor or finish grade elevation, whichever is lower.

10. Foundation design shall be performed by a Registered Professional Engineer and shall be submitted for approval with and as part of the shop drawings.

STRUCTURAL SECTION
QUALITY CONTROL CHECKLIST

FOR REVIEW OF A-E AND IN-HOUSE FINAL DESIGNS

Project Title:	**Date:**
Designed by:	**Checked by:**

GENERAL	
1. Before beginning the review, check to see that you have a complete package, check A-E Standard Procedures manual and the Specific Instructions to see if everything required was furnished. If anything is missing, see the Work Load Manager before proceeding.	☐
2. Before beginning the review, scan the directive, 1391, instructions, prior review comments, and correspondence.	☐
3. After beginning the review, if it appears that the submittal is unsatisfactory, do not proceed. Notify the Work Load Manager.	☐
SPECIFICATION CHECK	
4. Verify that the required sections of the specifications are in the job by comparing the specification index to the plans.	☐
5. Verify that the specifications have been properly edited for the project by reviewing the marked-up sections.	☐
6. Verify that the appropriate review level is indicated for all submittals.	☐
7. Check UFGS-04200, MASONRY structural items to ensure specification is coordinated with the design. Especially check the testing and/or reinforcing requirements to verify that they are appropriate.	☐
8. Cross check other section's specifications to ensure that any included structural information is correct, i.e., UFGS-06100A, ROUGH CARPENTRY needs to be checked if stress rated lumber or wood trusses are used, UFGS-13120, PREENGINEERED METAL BUILDING for pre-engineered structures, UFGS-13080, SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT for seismic, etc.	☐
DESIGN CHECK	
9. Verify that the design analysis has been signed by both the designer and the checker.	☐
10. Verify that the live loads are in accordance with criteria, particularly over	☐

mechanical rooms.	
11. Verify that the wind loads are correctly computed and applied.	☐
12. Verify that the seismic loads are correctly calculated and applied.	☐
13. Verify the appropriateness of the seismic design assumptions and details such as building separation, etc.	☐
14. Verify the design of the major structural elements, i.e. columns, girders, beams, walls, etc., by spot checking the design of at least one member in each category. Investigate additional members depending upon the results of the initial spot check.	☐
15. Verify the design of the lateral load resisting system from the roof diaphragm to the foundation.	☐
16. Verify that the assumptions used in the foundation analysis are consistent with the foundation report.	☐
17. Verify the adequacy of the foundation design by spot checking the design of a least one type of each foundation element used.	☐
18. If computer programs are used, verify that the necessary backup material has been provided and the assumptions within the backup material are appropriate.	☐
DRAWING CHECK	
19. General Notes:	
a) Verify that ALL design loads are indicated, i.e., live, wind, seismic, crane, etc.	☐
b) Verify that the strength of materials used is specified, i.e., A36 steel, 3,000 psi (20,684 kPa) concrete, Grade 60 reinforcing, f'm 1,350 psi (9307 kPa) compressive strength masonry.	☐
c) Verify that the type of mortar to be used for masonry walls is specified and matches the specifications.	☐
d) Verify that concrete reinforcing requirements such as grade of reinforcing and splice lengths are given (i.e., Grade 60 and 40 bar diameters, respectively).	☐
e) Verify that slab-on-grade thickness and reinforcing requirements are given.	☐
f) Verify that slab-on-grade notes similar to those shown on Exhibit A-2-5 of the Standard Procedures Manual are provided.	☐
g) Verify notes are provided for attachment of metal deck diaphragms to supporting members.	☐

h) Verify that notes are provided for details on any design element not otherwise shown on the drawings.	☐
20. **Metal Building Notes:** Verify that notes similar to those shown on exhibit A-2-7 are used. Also ensure that the same design philosophy indicated on the notes is used in the design.	☐
21. Foundation Notes:	
a) Verify that the allowable soil bearing value and depth required to develop this value are shown.	☐
b) Verify that any other soil design data for designing retaining structures is shown.	☐
c) Verify that appropriate bracing or shoring notes are provided.	☐
d) Verify that any special foundation conditions or requirements are described in the notes.	☐
22. Superstructure Notes:	
a) Verify that the strength of all materials used is indicated here or in the general notes.	☐
b) Verify that the appropriate type of connections is specified, i.e., type/grade of bolts, welds with electrode types, minimum size of fillet welds where not indicated.	☐
c) Verify that the minimum S, I, and weld requirements are given for all metal decks to include rib type (narrow, intermediate, or wide).	☐
d) Verify that a note is added prohibiting the application of loads greater than 50 pounds (22.7 kg) to steel joists without the use of the joist strengthening detail.	☐
e) Verify that an appropriate amount of draw is indicated for all X-bracing.	☐
23. Verify that all depressed or raised slabs are indicated.	☐
24. Verify that proper sizes are indicated on the drawings for structural elements by a spot check comparison of member sizes shown in the calculations and on the drawings. Include at least one type of each structural member in the spot check.	☐
25. Verify that the drawing notes do not conflict with the specifications.	☐
26. Verify that the slab elevations are shown and agree with architectural and site	☐

plans.	
27. Verify that top-of-steel, top-of-wall bearing, etc. elevations are clearly indicated.	☐
28. Verify that sufficient sections are cut on the plans to indicate clearly the details of construction. Verify that section cuts are properly oriented and properly referenced. Spot-check as required.	☐
29. Verify by scanning all sections and details that no criteria violations are present, i.e., slabs resting on footings, etc.	☐
30. Check slab-on-grade jointing to verify compliance with criteria.	☐
31. Verify that stress diagrams are provided for all trusses.	☐
32. Verify that waterproofing is properly shown where required by the soils report.	☐
33. Verify that Plate S-1 has been initialed by both the designer and checker.	☐
34. Verify that appropriate details and notes are provided to indicate CMU reinforcing, thickness, and lintel requirements. Interior walls must be designed to span horizontal or vertical under a 10 psf (48.8 kg/m2) lateral load. Verify that vertical spanning walls are properly supported at the top.	☐
35. Verify that minimum seismic reinforcement is provided in masonry walls if required. Verify that cavity walls are properly designed and have the appropriate reinforcement, i.e., bond beams shown, joint reinforcing 3/16 diameter for seismic walls, etc.	☐
36. Verify that masonry walls are properly jointed and that reinforcement is not continuous through joints except at floor and roof levels. Locations to be shown on the "S" plates and "A" plates with appropriate details.	☐
37. Verify that moment connections are either detailed or that the plans indicate the moment for which the joint is to be designed.	☐
38. Determine if the following items are required and delete them from the specifications as appropriate: capillary water barrier, floor hardener, waterproofing, floor slab reinforcing (increase joint spacing and use 4,000 psi (27,579 kPa) concrete if omitted), flexural strength concrete (pavement only).	☐
39. Verify that a roof slope greater than 1/4" (6 mm — Army) and 1/4" (6 mm — Air Force) is provided.	☐
40. Verify that the minimum depth of the footings agrees with the soils report.	☐
41. Verify that the structural details of vaults, arms rooms and secure areas meet criteria requirements.	☐

42. Verify that perimeter insulation is shown along exterior walls under slabs-on-grade for all air-conditioned spaces. It should be specified in section UFGS-03300A, *CAST-IN-PLACE STRUCTURAL CONCRETE* or 03300A, *CAST-IN-PLACE STRUCTURAL CONCRETE* (Abridged) and shown on all "S" plate and "A" plate wall sections.	☐
43. Verify all cells of CMU walls below grade are filled with grout.	☐
44. Verify that drawings clearly indicate which buildings, by name, are to be constructed using specification UFGS-13120, *PREENGINEERED METAL BUILDING* or UFGS-13121, *METAL BUILDING SYSTEMS (MINOR REQUIREMENTS)*.	☐
45. Verify coordination of mechanical and electrical equipment for support details on the "S" plates.	☐
46. Check for details when pipes through exterior foundation walls.	☐