APPENDIX K

STRUCTURAL CRITERIA

TABLE OF CONTENTS

APPENDIX K

STRUCTURAL CRITERIA

A. COORDINATION OF DESIGN:

1. The consulting Structural Engineer shall coordinate his work with the Architect and the Mechanical, Plumbing and Electrical Engineers to avoid conflicts in dimensions and space requirements. See Item D under “Structural Elements.”

2. Close attention should be given to mechanical requirements for construction clearances, openings, penetration of structural members, inertia pads, equipment weights, vibrations and special framing. The Engineer shall show any support or reinforcing conditions on the Construction Documents with plan references to specific details.

3. The consulting Structural Engineer shall review architectural details to verify that all architectural elements (storefronts, overhead doors, finishes, life safety anchors, etc.) are supported. The Engineer shall verify that all lintels, shelf angles, handrail anchors, miscellaneous framing members, clip angles, anchors, bolts and welds have been properly sized and spaced for their required carrying capacity. The Engineer shall also evaluate the details for simplicity, economy, ease of erection and flexibility to meet construction tolerances. The Engineer shall show any support or reinforcing conditions on the Construction Documents with plan references to specific details. This review should be continuous as required during the preparation of Construction Contract Documents.

4. For cost estimating purposes, connections that are part of a delegated design and are not the responsibility of the Structural Engineer of Record may be required to be indicated on the Construction Documents for scope and coordination. The Basis of Design for the element to be supported shall be used to establish a reasonable baseline condition for sizing and detailing the connections that are to be shown on the Construction Documents. These connections are to be resolved through the submittal process. If the connection is proposed to be substantially changed by the Contractor, the Engineer of Record shall be consulted when determining the appropriate cost and performance for the connection.

5. The architectural elevations shall clearly indicate the locations of all vertical and horizontal joints in all masonry. These joints shall be reviewed by the Structural Engineer.

6. Any new openings or penetrations through existing structures shall be well coordinated with all other design disciplines and shall be clearly shown in the Structural drawings. Dimensions for openings shall be shown on the Structural Drawings.

7. All elevations noted on the Structural drawings shall match the Architectural sign convention and referenced datum.

8. The Structural Engineer review all structural submittals including concrete mix designs.

9. It is expected that the Structural Engineer performs field observations during construction especially at critical stages of the work such as rebar observations and during steel framing erection.

10. The Engineer shall include the following language in the Structural Steel Notes and the Concrete Reinforcing Notes:

    Domestic Iron and Steel Certification. Pursuant to Sections 2252.201-2252.205 of the Government Code, the Contractor certifies that it is in compliance with the requirement that any iron or steel product produced through a manufacturing process and used in the Project is produced in the United States.

B. DESIGN REVIEW SUBMITTAL REQUIREMENTS

The following outlines submittal requirements for Design Documents. The entire architectural and engineering team shall confirm that the Design Documents meet all the requirements of both this appendix and Appendix L.

The submittal requirements are not limited to the items listed below but are shown to be a minimum list. As the project warrants, the Architect and Engineer shall provide drawings, sections, calculations or other information as required to define a particular portion of the work as agreed upon by the Owner.

All Structural drawings and specifications issued for construction shall meet the requirements of TEXAS ENGINEERING PRACTICE ACT AND RULES CONCERNING THE PRACTICE OF ENGINEERING AND PROFESSIONAL ENGINEERING LICENSURE

Preliminary drawings and specifications issued for review shall meet Rule 137.33(e). “Preliminary documents released from a license holder’s control shall identify the purpose of the document, the Engineer(s) of record and the Engineer’s license number(s), and the release date by placing the following text or similar wording instead of a seal: “This document is released for the purpose of (Examples: interim review, mark-up, drafting) under the authority of (Example: Leslie H. Doe, P.E. 0112) on (date). It is not to be used for (Examples: construction, bidding, permit) purposes.”

1. Schematic Review

    a. Provide an Outline of Structural Criteria. The purpose of the Outline of Structural Design Criteria is to establish early agreement between the Structural Design Engineer and The University of Texas System Office of Facilities Planning and Construction (OFPC) Engineer as to overall design approach and detailed design assumptions.

b. The Outline of Structural Design Criteria shall include the following:

1). Project, title, OFPC project number, location

2). Architect, firm name, address, phone

3). Structural Engineer, firm name, address, phone

4). Brief Description of Structure:
   a). Building functions
   b). Number of floors, basement
   c). Exterior walls, interior partitions
   d). Overall building dimensions and frequency of expansion joints including those at exposed exterior building components
   e). Unusual design features

5). Structural System Selected:
   a). Describe the floor and roof structural systems.
   b). Discuss reasons for selection of System chosen. This should include comments on the economics of the system as opposed to others, unusual spans and loads, fireproofing and any other factors governing selection of structural system. The Engineer shall be prepared to provide typical framing plans (i.e. one to two (1-2) bays) for pricing and determination of the most cost effective system.
   c). See section D for additional requirements/information.

6). Stress Distribution in Frame:
   a). Give a brief statement of method of distributing loads and moments throughout frame. Except for complex structures, any recognized method will be satisfactory.
   b). Discuss method of distributing wind loads. Wind loads must be taken to the integral parts of the structure.

7). Structural Analysis and Proportioning Members:
   a). State method of stress analysis i.e. working stress, ultimate strength.
   b). List Codes, Standards and pertinent references to be used as criteria for sizing members.
   c). Give class and strength of structural materials to be used.
   d). Major analysis and design assumptions shall be briefly described in the "Structural Notes" on the design drawings.

8). Design Loads:
   a). The Structural Engineer should review Architectural drawings and determine the appropriate loads using the IBC and the Unit Live Loads listed in this guide. The Engineer shall use the increased Live Loads listed in this guide. The loads have been

increased above the usual Code requirements in order to satisfy future loading possibilities often encountered in The University of Texas System buildings.

b). If the Architect or Engineer feels that the project is of a nature where there could be changes in function and therefore increases in future applied loads, then the Engineer should alert the OFPC Project Manager. A live load schedule can then be determined to fit the specific requirements of the structure.

c). List unit loads.

d). List wind loads.

e). List the seismic load factors.

f). Live load maps are required for the Design Development Documents but are not required for Schematic Design Development review.

9). Foundation Design:

a). As soon as soils investigations have been completed, give detailed description of foundation type and soils capacities actually used in sizing foundation members. State anticipated settlements if known.

b). Basement and Ground floor foundations shall be designed in accordance with the Geotechnical Recommendations given in the Geotechnical Report. Considerations should be given to having a crawl space if required by the Institution or if soil conditions warrant. The Structural Engineer shall confirm requirements as soon as possible through the OFPC Project Manager. If crawl spaces are included, use of mud slabs are encouraged but not required unless they are required by the Institution. In addition, the design team needs to consider crawl space ventilation as required by the IBC by using a vapor barrier, cross ventilation, forced ventilation or other waterproofing methods for the floor above the crawl space.

c). Discuss below grade waterproofing and method of removing water at exterior walls, under slab or in crawl space.

d). Discuss lateral load assumptions at below grade locations.

c. Discuss unusual foundation and shoring problems due to nature of soils, proximity of adjacent structures, etc.

d. Provide a detailed discussion of why the particular framing and foundation system was chosen.

e. Provide schematic layout drawings and framing plans.

f. Provide sample calculations proposed for use on project - computer input, program utilized, etc. <u>if requested by OFPC.</u>

2. Design Development Criteria

   a. *The A/E team should understand the project delivery method. A GMP (guaranteed maximum price) is required for CMR (Construction Manager at Risk) or DB (Design Build) projects at the end of the DD phase. All typical structural systems and representative details and any other details necessary to reach a GMP by the CMR/DB Contractor shall be included so that the CMR/DB Contractor can make a reasonable take-off and cost estimate for the GMP. This requires more plan work and detail that is normally not included at the DD phase. Early construction packages may be required. The Engineer shall prepare and provide appropriate drawings to facilitate early construction packages.*

   b. Design Development Structural Drawings and Specification sections:

      1). Foundation, floor and roof plans shall show all major structural members and preliminary sizes along with approximate reinforcing quantities to assist in the preliminary pricing of the structure.

      2). The plans shall show all major structural members along with approximate reinforcing quantities to assist in the preliminary pricing of the structure.

      3). Indicate recessed areas in slabs, major openings, elevator and sump pits.

      4). Indicate subsurface drainage system if required. This system should be coordinated with the Architectural Drawings and the Civil and Plumbing Engineers.

      5). Provide typical details including; pier layout, lateral bracing and framing details to assist in the preliminary pricing of the structure.

      6). Show locations and heights of soil retentions systems.

      7). Provide preliminary structural demolition drawings if demolition is required for the project.

      8). Provide preliminary specifications sections.

      9). Provide preliminary Live Load maps. Floor Live Load maps shall have an Architectural Background in lieu of a Structural Background as these maps will be used for future renovation projects. Backgrounds shall include appropriate grid lines and callouts and any dimensioning that is required. Provide Floor Live Load maps after the Structural Notes but before the framing plans.

10). Provide Roof Uplift Load map showing gross uplift loads for all roof areas, including canopies and other architectural features that may be subject to wind uplift forces. Coordinate roof uplift map with Architectural Drawings and Specifications including roofing specifications. Backgrounds shall include appropriate grid lines and callouts and any dimensioning that is required. Provide Wind Load maps after the Structural Notes but before the framing plans.

3. Construction Documents

a. OFPC may request one copy of complete structural calculations. Because complete calculations are often bulky and repetitious in standard design operations, calculations for representative parts of the building usually will be acceptable. Calculations and design assumptions shall be presented in a manner that can readily be followed. Members shall be cross-referenced to plans and (rough) details with any number system that permits easy identification of the member and its location in the structure. If requested, calculations at minimum will show:

1). Unit dead loads with partitions load assumptions.
2). Unit live loads with sustained load assumptions and reduction factors.
3). Deflections. Show justification for long, slender members.
4). Ponding.
5). Vibration considerations where applicable.

b. Drawings and specification sections will be required at each construction document review.

c. Drawings shall be as complete as possible at each CD phase. The preferred progression would be: Design structural frame including lateral design, add details as necessary to define the plan work at each phase, complete the detailing after frame is designed.

d. Design drawings shall include plan Live Load maps for all floors including the foundation. The maps shall indicate live loads and dead loads requiring special consideration. The floor load maps shall have an Architectural Background in lieu of a Structural Background as these maps will be used for future renovation projects. Backgrounds shall include appropriate grid lines and callouts.

e. Design drawings shall include Roof Uplift Load maps showing gross uplift loads. Coordinate roof uplift map with Architectural Drawings and Specifications. Backgrounds shall include appropriate grid lines and callouts and any dimensioning that is required.

f. Design documents (drawings and/or specifications) shall include general post-construction penetration guidelines including:

1). Where penetrations are allowed (with noted restrictions).
2). Where penetrations may be allowed with the review and approval of a Structural Engineer.

3). Where penetrations will never be allowed.

g. Review the possibility of special loads due to specialized equipment with the A/E team and the OFPC Project Manager.

C. LOADING AND DEFLECTION STANDARDS

1. Minimum Live Loads – Per the IBC with the following modifications

OCCUPANCY OR USE		LBS. PER SQ.FT.
Auditoriums, Theaters, Assembly Areas		
	Fixed Seats	80
	Movable Seats	100
	Seated Balconies	80
	Stages	150
	Assembly areas, Lobbies	100
Classrooms		80
Corridors Above 1st Floor		80
Exterior Balconies		100
Garages-	If story heights and level floors permit conversion to some function other than storage of private cars, contact the Project Manager about the appropriate design live loads.	
Hospitals- Patient Rooms/Operating Rooms		80
Laboratories -	Standard Equipment	80
	Heavy Equipment	100
Libraries	Reading Room	80
	Stack Room	150
Mechanical/MEP Rooms		150
Multipurpose Rooms		100
Offices		80
Public Areas/Lobbies/Assembly Areas		100
Rest Rooms		80
Roof Loads	Flat or rise less than 7” per foot	30
	Rise 7” per foot and greater	20
Stairways		100
Stores Retail (all floors)		100

Additional Notes

a. For items not specifically covered in the list above- the live load shall be approved by OFPC Engineer.

b. Design shall provide for maximum wheel loads.

c. All roofs shall be designed with sufficient slope or camber to assure adequate drainage after long-time deflection from dead load or shall be designed to support maximum loads including possible ponding due to deflection.

d. Provisions for Partitions - The above live loads for classrooms and office spaces include the IBC 15 psf for partitions. The Structural Engineer shall consult with the OFPC Engineer for inclusion of the partition loading provision in areas not noted by the above or by the IBC.

e. Concentrated Loads - In the design of floors, probable concentrated loads shall be considered as described in the IBC. Where such loads may occur, the supporting beams, girders and slabs shall be designed to carry either the concentrated loads or the live load described in the IBC or above, whichever produces the greater stresses.

f. Structural systems and members shall be designed and detailed to accommodate the specific mechanical, electrical, and other equipment as specified by the Architect. Minimum Design Live Load for MEP areas/rooms shall be 150 psf. All substitutions resulting in changes in the magnitude or location of these loads, or in the revision in the number, location, or size of penetrations through structural elements shall be coordinated by the Contractor at Contractor expense including providing design calculations by a registered Professional Engineer addressing the proposed substitution.

2. Reduction of Live Loads

   a. No reduction shall be applied to the roof live load.

   b. No reduction of the floor live load shall be allowed in the design of any slabs or joists (concrete or steel).

   c. Beams, girders, trusses, columns, walls, pier or foundation elements shall be designed to support the full dead and live loads with allowable Code reductions with the following restrictions:

      1). Maximum allowable live load reduction is 20%. Live load reductions shall follow the IBC live load reductions formulas (both basic and alternate) up to a maximum amount of 20%. Per Code, live load reductions are not allowed for members supporting less than 150 SF.

      2). For parking garages, a reduction in live load is not permitted except that the live loads for members supporting two or more floors may be reduced by a maximum of 20 percent (20%).

      3). For warehouses and storage facilities, no reduction in live load is permitted.

3. Wind Loads

    a. Buildings and structures shall be designed to withstand the minimum horizontal and uplift pressures set forth in the International Building Code (IBC). The IBC wind design parameters shall be clearly indicated on the design drawings. All Institutional Buildings shall be classified as Category III (per ASCE-7) unless determined by the Design Team and the OFPC Engineer to be Category IV. If determined by the Design Team that a special wind category/classification is required for the Project, written notification shall be sent to the OFPC Engineer for approval.

    b. Provide a wind uplift load map showing <u>gross</u> uplifts and clearly note coordination with Architectural Drawings and Specifications, including roofing specifications.

    c. <u>Projects in Tier-1 counties</u> (i.e. Galveston, Cameron or Nueces) shall also be designed to meet TDI (Texas Department of Insurance) Windstorm requirements. It is required that the Building shall be able to obtain Texas Windstorm Insurance Association (TWIA) insurance coverage. The Structural Engineer of Record shall assist/take the necessary steps to understand his/her project responsibility with the structural, architectural and construction inspection requirements of TDI to insure that the Windstorm Insurance can be obtained.

       The Structural Engineer of Record shall file any and all paper work with TDI to ensure that the WPI-8 certificate will be obtained at the end of the project. The Structural Engineer of Record shall forward the WPI-8 Certificate (once obtained from TDI) to the OFPC Engineer as soon as possible at the end of the project.

    d. In design for Wind, the integral structural parts shall be designed to resist the total lateral loads. Non-structure elements shall be sufficiently attached to the structural framing system to prevent shedding of components in a design loading event.

    e. If the building components are in a location considered by the consulting Structural Engineer, or the OFPC Engineer, to be unusually exposed, higher wind loads may be specified. Written notification shall be sent to the OFPC Engineer for approval.

4. Seismic and Geologic Factors - Notify the OFPC Engineer in writing (email is acceptable) if seismic or unusual geologic conditions occur affecting the design of the structure.

5. Ice Sensitive Structures- The Engineer shall evaluate ice sensitive structures or architectural features for proper support and detailing.

6. Control of Deflection - Steel

   a. Structural steel members shall be designed in accordance with A.I.S.C. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, latest edition with the following exceptions:

Roof and Floor Load	Maximum Deflection
Live Load Only	L/360
Dead Load and Live Load	L/240
CMU support masonry cladding (lat. deflection)*	L/600*
Light gauge metal studs for the lateral load resisting system for masonry cladding *	L/700*

   * CMU is the preferred lateral load back-up system for masonry veneer. Cold-formed metal studs may only be used upon written authorization (email notification is preferred) by OFPC’s Engineer. Requests shall be sent through the OFPC Project Manager.

   b. It is preferred that flexural members be selected with sufficient depth and stiffness to deflect approximately L/360 maximum under dead load plus live load conditions. If in the Engineer’s judgment this requirement creates unreasonable cost or aesthetic problems, L/240 may be used with written consent from the OFPC Engineer.

7. Ponding and Vibration - Use A.I.S.C. Manual of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, latest edition. Consulting Structural Engineers shall use due regard in proportioning to resist vibration to avoid occupancy discomfort due to transient live load vibrations.

8. Control of Deflection - Concrete

   a. Design documents shall include FF/FL testing guidelines for deflection requirements for structural slabs.

   b. Reinforced concrete members subject to bending shall be designed with adequate stiffness to limit deflections or any deformations as set forth in building Code Requirements for Reinforced Concrete (ACI 318 - latest edition), except that the following Allowable Deflection Table shall govern.

Type of Member	Deflection to be Considered	Deflection Limitation
Flat roofs not supporting or attached to non-structural elements likely to be damaged by large deflections.	Immediate deflection due to live load, L	L/240**
Floors not supporting or	Immediate deflection due	L/360

attached to nonstructural elements likely to be damaged by large deflections.	to live load, L	
Roof or floor construction supporting or attached to nonstructural elements likely to be damaged by large deflections.	That part of the total deflection which occurs after attachment of the nonstructural elements, the sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load.*	L/480***
Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections.		L/360****

* Total long-time deflection may be reduced by the amount of deflection which occurs before attachment of the nonstructural elements. This amount shall be determined on the basis of accepted engineering data relating to the time-deflection characteristics of members similar to those being considered.

** This limit is not intended to safeguard against ponding. Ponding should be checked by suitable calculations of deflection, including the added deflections due to pond water, and considering long-time effects of all sustained loads, camber, construction tolerances and reliability of provisions for drainage.

*** This limit may be exceeded if adequate measures are taken to prevent damage to supported or attached elements.

**** But not greater than the tolerance provided for the nonstructural elements. This limit may be exceeded if camber is provided so that the total deflection minus the camber does not exceed the limitation.

c. Assume a minimum 50% of live load as acting with sustained load.

9. Architectural Detailing for Deflections - The Structural Engineer shall inform the Architect of anticipated deflections so connections of nonstructural walls, partitions, shelves, laboratory equipment, etc. may be detailed with sufficient tolerance and flexibility to allow for frame movement. This includes recommendations for CMU, brick and stucco joint details and locations.

D. STRUCTURAL ELEMENTS

This section consists of various systems and details which OFPC prefers to use or avoid, as stated. It is not the intent that these items must be included or excluded from consideration; they are to be listed and discussed to assure special attention be given to them in order to eliminate recurrent problems. A thorough discussion of the merits of possible structural systems should be held early in the design process. Many of these requirements are based on historic "challenges" that UT System has faced in the design and maintenance of their structures.

1. Foundation:

    a. Avoid precast-pre-stressed piling

    b. Avoid slab-on-fill in areas of expansive soils. If a slab-on-fill is approved then it shall include a 10-mil vapor barrier which meets ASTM E1745 standards.

    c. Avoid the use of waxed cardboard carton forms to form a void space for isolation purposes at active soils. Carton Forms shall not be used without written authorization from the OFPC Engineer. A 12" minimum void shall be used when approved. Email requests shall be sent through the OFPC Project Manager.

2. Concrete Systems:

    a. Avoid structural suspended slabs less than 5 inches thick. This includes pan formed slabs.

    b. Strive to use standard depth for girders and joists and obtain a "flush" bottom structure, i.e., joists and beams are the same depth throughout the structure. The savings in formwork usually more than offset the expense of extra concrete.

    c. Avoid sprayed-on fireproofing requiring a monolithic finish on thin slab, pan-joist or waffle-joist systems.

    d. Avoid pan-joist and/or particularly waffle-joist systems where extensive penetration of floors will occur. Skip-joists with clear rib dimensions of at least 48" are preferred.

    e. Post-tensioning

        1). Post Tensioning (PT) is an appropriate choice for many applications such as parking garages with typical 20' x 60' bays which lend themselves to a post-tensioned beam and slab system supported on cast in place columns.

2). Another highly appropriate usage for post-tensioning would be in a girder supporting skip-joist ribbed slab. In many cases, the overall building systems work best when the girders supporting the skip-joists are maintained at a depth no greater than the skip-joist ribs. For longer spans, post-tensioning is helpful in controlling the deflections of the girder without deepening it past the pan rib depth.

3). Provide detailed sections at column/PT beam intersections that show typical reinforcing and post tension anchors. Include all typical reinforcing that is typically designed by the PT designer. The intent is to highlight congestion at column/PT beam intersections and to confirm all reinforcing is correctly positioned prior to concrete placement. It is preferred that realistic representations of rebar sizes and posttensioned anchors and cables are shown (do not use single line weight/type representations of rebar/cables).

4). Avoid two-way post-tensioned systems such as banded flat plates. These highly optimized systems do not lend themselves to future penetrations and live load changes and will be used only with written authorization from the OFPC Engineer.

f. The consulting Structural Engineer shall present various options for consideration at the Schematic and Design Development stages which consider various approaches in lieu of girders deeper than the pan ribs. A preference hierarchy would go something like this: l) Post tensioning 2) Deep girders 3) Cambered formwork 4) Haunch Girders. Combinations of these four approaches shall not be used without specific written approval by the OFPC Engineer.

g. Two-way flat slab systems are not allowed without written approval by the OFPC Engineer.

h. Avoid precast-pre-stressed double-tees. Use only with written authorization from the OFPC Engineer. The decision for use of precast double tees in lieu of CIP framing shall be made based on cost-benefit analysis for life cycle costing for a 50-year life cycle. (exception – parking garages.)

i. Avoid excessive Span/Depth ratios to minimize deflections and keep the system rigid.

j. Pan joists or ribbed slabs shall not be designed as “tee beams” to save (slightly) in the cost of the reinforcing bars in the pan ribs because this practice compromises future flexibility of the structure in terms of slab penetrations between the ribs. Future renovations may require openings in the pan slab. Do not locate pan joist top steel in the slab area. Consider/detail slab steel placement to be above joist top steel whenever possible.

k. Avoid the assignment of large bending moments to columns for the sake of beam design and then neglecting these beam moments when designing the columns.

3. Structural Steel Framing:

    a. Avoid light steel structures with long-span joists without a positive shear diaphragm, i.e. metal decking.

    b. Avoid columns without seat angles for beam and girder connections.

    c. Avoid full penetration field welding (in both the shop and field) without strict specification to welder qualifications, welding procedures, inspection and testing, including X-ray testing or Ultrasonic testing. Specify ultrasonic testing when possible. When specifying on the Contract Documents clearly indicate on plan where moment connections are required. It is best to call out on plan rather than use a small symbol that is defined in the Structural Notes or the Plan Notes.

    d. Avoid all "weathering" steel including "weathering" sheet metal.

    e. Avoid higher strength steels other than ASTM A992 Grade 50 for W-shaped members, ASTM A500, Grade B, 46 ksi steel for tube shaped members and A36 steel for miscellaneous plates and members.

    f. Avoid ASTM A-490 bolts.

    g. Avoid high-strength bolted connections without investigating and specifying latest state of the art methods of bolt tightening, inspection, and documentation.

    h. Avoid use of touching dissimilar metals conditions in all structural situations. Use compatible metals or provide isolation devices.

       Clearly identify Architecturally Exposed Structural Steel (AESS) on the Construction Documents. Show on plan with shading, labels or other means to indicate AESS. Provide appropriate specifications and details. Minimize its use due to probably additional associated costs associated with its usage.

4. Precast Concrete:

    a. Avoid extra-long span floor members or very large wall panels without thorough research as to transport route from various supply sources, traffic congestion on campus, availability of local machines capable of handling, etc.

    b. Avoid the use of systems not commonly used to the local construction trades.

    c. Avoid systems that flimsy or difficult to support and attach.

d. Avoid lightweight concrete (weight less than 145 pcf) without written authorization from the OFPC Engineer.

e. Avoid the use of epoxy-coated rebar without written authorization from the OFPC Engineer. Email requests shall be sent through the OFPC Project Manager.

5. Cast in Place Concrete:

a. Avoid the use of grade 80 rebar, full penetration weld splices and bar spacing which provides less than 1-1/2" clear separation. Should this prove unavoidable, specify 3/4" maximum aggregate and 1" clear separation. Use lap splices on column bars or use cad-weld or acceptable mechanical devices where possible.

b. Avoid lightweight structural concrete with monolithic finish, particularly in Austin. In general, Austin has exceptional hard rock aggregates available making lightweight concrete (less than 125 pcf) cost a premium. UT-Austin sites typically have shallow rock strata for low-cost high-strength foundations, thus reducing the potential benefit of using lightweight concrete.

c. Avoid the use of several concrete strengths for structural elements. Limit upper working stress to 6,000 psi for major construction areas (Houston, Dallas, San Antonio and Austin) unless approved in writing by the OFPC Engineer. Limit upper working stress to 5,000 psi for other construction areas (Tyler, El Paso, South Texas and Permian Basin) unless approved in writing by the OFPC Engineer. The individual institution's OFPC construction inspectors and RCMs should be asked for input to problems encountered with concrete mixes, strengths, placement issues, finish issues, supply issues, etc.

d. Avoid architectural cast-in-place concrete with conventional reinforcement cover. Use 2" minimum cover typically, in addition to rustications. Provide 4-1/2" minimum clearance for vibrators. Tie wires must not have long free ends and must be bent away from concrete faces. Clipped ends must be removed from forms prior to concrete placement.

e. Avoid the use of sandblasted concrete without written approval by OFPC Engineer. Email requests shall be sent through the OFPC Project Manager. If approved, use stainless steel or plastic bolsters.

f. Avoid the repair of cracks in architectural concrete with conventional caulking compounds. Repairs shall be made by low-pressure epoxy material.

g. Fly ash in structural concrete is to be used only with the written permission of the OFPC Engineer for architecturally exposed concrete. For all other concrete, a maximum of 25% (by weight) of type C or F fly ash may be used. Higher amounts of fly ash may be used with written approval from the OFPC Engineer. The fly ash shall come from a TxDOT approved source and shall include monthly mill certificates confirming the adequacy of the ash.

h. Avoid dapped beam and corbels in lieu of double columns at expansion joints.

i. Minimum rebar size for slabs are #4 bars. (Note: #3 bars do not support the weight of the concrete placement personnel with typical #3 bar support spacing.) Do not use WWF except in steel deck supported slabs.

6. Masonry:

a. Horizontal control joints with corresponding masonry support shelf angles for exterior masonry veneer shall be <u>located at each elevated floor</u>, including two-story buildings. A horizontal control joint is not needed between the top floor and the roof parapet. Vertical control joints shall be located at a maximum of approximately 30 feet on center on continuous planar exterior walls. Masonry shall have control joints at each side of masonry openings, (doors, windows, etc.) The exact locations of the horizontal and vertical control joints shall be clearly shown on the architectural elevation drawings. The Structural Engineer and the Architect should coordinate the location of these control joints.

b. Requirements for shelf angle supports for masonry veneer:
   1). The Structural Engineer shall design the support angles for the full weight of the masonry which it supports. This includes the lintels above all wall openings.
   2). Angles shall be discontinuous at building expansion joints.
   3). Angles shall be discontinuous at masonry inside and outside corners.
   4). Breaks in the angles shall only be located at corresponding building expansion joints or masonry control joints. However, breaks in the angles need not occur at each control joint. Coordinate breaks with Architectural Drawings.
   5). Continuous spans of shelf angles shall not exceed approximately 30 feet.
   6). Shelf angles shall be protected from corrosion.
   7). Provide a loose lintel and/or a lintel schedule in the Documents.

c. Avoid light gauge metal stud backup for exposed masonry veneer (especially brick). CMU is the preferred masonry backup. Use light gauge metal stud backup only with written authorization from the OFPC Engineer. Email requests shall be sent through the OFPC Project Manager. When allowed, the light gauge framing shall limit deflections under service wind loads to L/700.

d. The use of masonry cement is not allowed. Use Portland cement only for mortar.

e. Use stainless steel masonry wall anchors for all Institution locations except Permian Basin and El Paso. UT Permian Basin and UT El Paso locations may use galvanized masonry wall anchors.

f. Type “N” mortar is preferred. Type “S” mortar should only be used when absolutely necessary since it is less durable than type “N” mortar. Use of type S mortar should not be used without written notification by the OFPC Engineer.

g. Mortar cube testing and prism testing are not reliable indications of the in-place strength of the masonry. They shall not be prescribed unless specific project requirements warrant. Confirm with OFPC Engineer prior to specifying.

E. <u>GENERAL REQUIREMENTS & COMMENTS</u>

1. Geotechnical Report

a. OFPC maintains two to four geotechnical firms under contract for each of our eight Institution areas on a rotating basis. OFPC will request a new geotechnical study for virtually all OFPC-managed projects. The A/E consulting team will be asked by the OFPC Project Manager to provide a plan of proposed boring locations and a written description of the project to be attached to the RFP to assist the Geotechnical Engineer in understanding the geotechnical requirements. Representative information to be included in this attachment:
   1). Anticipated live and dead column loads
   2). Number of stories
   3). Cladding type
   4). General size of retaining walls
   5). Specific PVR guidelines
   6). Vehicle traffic loads
   7). Request sidewalk/paving design recommendations
   8). Request percolation test.
   9). Preliminary building elevation of lowest level. Final building elevation of lowest level should be reviewed with Geotechnical Engineer at 50% CD.
   10). Describe any freestanding structures that require special foundations.
   11). Request lateral load design recommendations such as “L-Pile” values.

b. The OFPC Project Manager will submit a request to the OFPC Contract Manager for a geotechnical RFP. Hard copies of the geotechnical report will be distributed to the A/E team, the Project Manager, the OFPC Engineer and the Institution. In addition OFPC requires an electronic copy of the Geotechnical Report be sent to the OFPC Engineer.

c. The A/E team is encouraged to communicate directly with the Geotechnical Engineer during all phases of the design process for clarifications; however, copies of all substantive communications and discussions should be sent to the OFPC Project Manager and the OFPC Engineer. OFPC Engineering department maintains a library of geotechnical reports for all OFPC-managed projects. Copies of these reports may be obtained to assist in early design assumptions. Geotechnical reports may be used for the final design of only the specific project for which they were prepared.

2. Renovation Work

   a. Structural demolition drawings are to be included.

   b. All penetrations of existing structural components shall be shown in the structural drawings. Reinforcement of these structural components shall be designed and detailed as required. Drawings shall show all original framing in the areas near the new penetrations.

   c. Drawings shall show all original structural framing with new framing superimposed. Clearly show original framing to remain in place.

   d. Where portions of an existing structure are required to be completely demolished, drawings shall show all original structural framing and provide adequate details clarifying location of concrete saw cuts and details of any reinforcement required.

   e. Small penetrations of existing concrete slabs (cores for pipes, saw cut openings for ductwork, etc.) shall require the contractor to drill pilot holes to verify that these penetrations will not cut beams or joists. Use of Ferroscan or ground penetrating radar is recommended as a precaution to help identify conduit which may be embedded in the concrete. Note: Neither Ferroscan nor radar can differentiate between metal rebar and conduit.

   f. When possible, provide existing drawings in the construction document set for Contractor use. Add any disclaimer as necessary to convey that the existing drawings are for Contractor information only.

3. Future Loads - Structures built for The University of Texas System must be designed to accept future loads large enough to permit wide flexibility in their functions. Therefore, the loads listed in part C may be larger than those specified in building codes.

4. Load Reductions - These structures are subject to increased loads and high sustained live loads. Loads are often applied to large areas of usable floor space (thereby making liberal live load reduction factors undesirable).

5. Deflections - Live loads and deflection limitations must be assumed to accommodate these conditions of design. Care must be exercised in control of immediate and long-time deflections to prevent immediate and future damage to non-structural elements attached to the structure.

6. Building Codes – The more stringent design requirements between the applicable building codes and the guidelines within this appendix shall be used. The code edition of the International Building Code (IBC) listed in Appendix C of these guidelines shall be used unless otherwise directed in writing by the OFPC Project Manager and the OFPC Engineer.

7. Document Review Schedule - The A/E will be required to present the plans and specifications for review to OFPC at the intervals outlined in Appendix L of these Guidelines. Intermediate reviews may be required if the scope of the project has been changed or if an earlier review found the plans and specifications unacceptable, either as a whole or in part.

8. Review Meetings - The Structural Engineering Consultant(s) will participate in all reviews, work sessions and presentations where this discipline is involved. OFPC Engineer will review the documents for compliance with Code, OFPC Guidelines, Institutional requirements, consistency of design, efficiency of design and any other items unique to the Project. The Structural Engineer of Record, along with the Architect, shall be prepared to discuss any concerns or unique design requirements at the meetings or in a separate meeting with the OFPC Engineer.

9. Consistency of Design Assumptions - Design assumptions made for efficiency in analysis must be carried through the design and proportioning of the actual members. The design assumptions must be consistent with the institutional goals as stated in the preceding paragraphs. For example, the practice of designing pan joists or ribbed slabs as “tee beams” may save slightly in the cost of the reinforcing bars in the pan ribs. However, this practice compromises future flexibility of the structure in terms of slab penetrations between the ribs. Another example would be the assignment of large bending moments to columns for the sake of beam design, and then neglecting these beam moments when designing the columns.

10. Structural Integrity - The structural system selected should be adequately described and detailed such that all parts of the facility are incorporated and connected with the structure to allow the facility to function as a unit under extreme service conditions. An example would be in the cases for exterior cladding and roofing systems, which must be adequately fastened to the structure to resist the worst case loading conditions, but which also must be detailed to avoid distress under more typical thermal and moisture exposures. It makes little sense to design a roof system capable of resisting Code wind loads unless the connections to the structure and the structure itself are substantial enough to resist the loads to be transferred.

F. <u>ENGINEERING TESTING</u>:

1. During the design stage of a construction project, it will be necessary for The University of Texas System to provide the Architect/Engineer with “Pre-Design Engineering Information.” Requests for these services as deemed necessary by the Architect/Engineer should be made to The University of Texas System. The University of Texas System will select a qualified engineering testing firm to provide

the Architect/Engineer with information when required.

2. It is the practice of The University of Texas System to assign its own personnel to both "represent the Owner" and provide for inspection during the construction of a project. An independent, commercial testing agency will be selected by and paid for by The University of Texas System to provide the engineering testing and materials inspection during the construction of the project. These services provide the Owner, Architect/Engineer and the Contractor unbiased, third party, technical information and also augment The University of Texas System personnel in specific technical inspections.

   a. Pre-Design Testing:

      1). Sub-Surface Investigations for Foundations: The primary purpose of a sub-surface investigation for foundation design is to accomplish an efficient use of natural, in place materials for the support of imposed structural loads. Soil and rock formations have specific engineering properties of shearing strength, stress deformation, consolidation, volume change and grain size. These engineering properties affect the supporting value and stability of the founding media and are influenced by the geological history of the formation.

      2). Sub-surface exploration for foundation design should delineate the horizontal and vertical limits of the deposition and establish the engineering properties that will affect the foundation design. The location and depth of the borings are selected to accomplish this purpose. Test borings are normally spaced geometrically to provide one boring for each 6,000 to 10,000 square feet of area. Inconsistencies or non-uniform conditions require a much closer spacing. The depths of borings are influenced by several factors such as the depth to a primary or non-yielding formation, the strength, stability and uniformity of the soil strata, the magnitude of column loads, the water table and the swelling potential of the upper surface soil. The borings should be of adequate depth to determine the proper foundation for the structure.

      3). The spacing of borings, the establishment of boring depth and the selection of engineering tests are the responsibility of an experienced Soil Engineer with consultation of the Architect and his Structural Engineer and OFPC to obtain the necessary information at a minimum of cost.

      4). Procedure:

         a). On or before the Pre-Design Conference, the OFPC Project Manager will forward the results of any sub-surface investigations performed at or near the site for A/E study.

b). The A/E and his consultants will study preliminary information, and with the OFPC Project Manager and OFPC Engineer will determine whether additional exploratory testing will be required, and to what extent. If so, the A/E will proceed to acquire testing information through a testing lab approved by OFPC. OFPC will pay for testing information not to exceed the agreed estimated cost.

c). Embankments and Fill Areas: The use of soil for engineering purposes such as compacted fill for the support of structural load, levees and berms, and slope improvement should be accomplished by using soil mechanics technology. Soils compacted to arbitrarily selected degrees of compaction rarely perform in relation to actual requirements. Over-compaction results in increased costs and creates a potential for excessive swelling. Under-compaction lowers the shear strength and increases the potential for detrimental settlement. The compaction of the soil should accomplish an improvement in the ability of the soil to withstand shearing stresses, prevent excessive settlement and minimize volume changes in the soil. The degree of compaction that more nearly satisfies the majority of these considerations shall be determined by an approved soils laboratory. The optimum degree of compaction that will accomplish the intended purpose is selected from the resulting test data.

d). Pavement Design: The soil investigation for pavement design includes shallow undisturbed core borings spaced approximately every 200 feet along the proposed street or at approximately every 10,000 square feet for a parking area. Intermediate borings are drilled in those instances where inconsistencies are encountered. The engineering design of the pavement section utilizes the soil investigation data provided by the soils laboratory, an analysis of the available construction materials, and a study to determine the types of vehicles that will utilize the pavement and a projection of the number of wheel load applications anticipated during the design period. The A/E and his consultants are expected to design a pavement which will meet the desired performance level with a minimum of maintenance expenditure.

e). Concrete Materials: Concrete construction in remote areas or unusual applications of concrete construction can be assisted by a pre-design material investigation. Some areas do not have facilities available for producing concrete aggregates that meet recognized standards or quality. The durability and concrete making properties of local sources should be investigated prior to establishing an acceptable specification for material quality.

Unusual concrete application problems should also be studied prior to design in order to resolve problems that are created by the uniqueness of design. Pre-design testing is extremely helpful in eliminating unnecessary expenses and potential construction problems.

G. CONSTRUCTION TESTING:

1. Provide Construction Testing requirements that are reasonable for the Project. Do not specify testing that will give little or no value to the Project. For example, do not require test cylinders to be tested at 56 days when the 28-day tests are acceptable. If the 28-day test do not pass, then it is reasonable to test at 56 days. In addition, coordinate testing requirements with the Contractor that provide the desired construction Quality Assurance that is also beneficial to the construction process/schedule. It does not make sense to have concrete tests at 7 days that are required by the Construction Documents only to have the Contractor request to have concrete tests at 3 days and 5 days. Testing should be beneficial to both the Owner and the Contractor.

   If there is a specific test that is required that is not common, discuss the test with the OFPC Engineer regarding all aspects of the proposed test.

2. Concrete:

   All concrete tests performed in the laboratory and on the job site, the design of mixes, and the inspection of concrete production should be performed in accordance with the applicable ASTM and ACI standards. The technician should be properly trained and completely familiar with the standards for the work he is performing. These standard methods have been proven to be satisfactory when conscientiously applied by the testing agency and cooperatively accepted by all parties concerned with the concrete construction work. The prime purpose of concrete testing and inspection is to provide all parties with the pertinent information required for successfully accomplishing the work. The testing agency must meet and comply with the requirements of ASTM E-329.

3. Soil/Subgrade

   a. Compaction Testing (Roadway Embankments, Roadway Base, Structural Fill, Utility or Wall Backfill and Subgrades):

      1). The testing for soil compaction during construction is accomplished by frequent tests of the moisture and field density (ASTM D2922) of the compacted material. The minimum frequency of field density tests is as follows:

         a). Roadway subgrade, roadway embankment or roadway base-one for each 6,000 to 10,000 square feet in each lift or one for each 1000 linear feet per traffic lane of street.

b). Structural fill- one test per 4000 to 8000 square feet per lift of fill with a minimum of two tests per lift.

c). Utility or wall backfill- one test per 200 to 500 linear feet of fill with a minimum of two tests per lift.

2). Fill areas with limited access to compaction equipment should be tested more frequently. A laboratory moisture-density curve is required for each of the materials to allow comparison with the field density in order to determine the percent of compaction obtained. Mixing of different materials during the excavation of fill material will also necessitate a moisture-density curve. Blends of materials should be frequently checked with a single compacted specimen to obtain the compacted weight of material for comparison with the available moisture-density curves. Each of the soils encountered in the project should be identified by liquid limit, plastic index and minus 200 mesh sieve tests. These identification test correlations should be accompanied by a description of the materials with respect to color, texture and soil type. The common method of identification and description is found in the Unified System of Soil Classification (ASTM D 2487). The degree of compaction required in the specifications should be established by a pre-design analysis of the soil. The field density tests are made to confirm compliance with the specification requirements. To be of value, the test results must be representative of an area that has been uniformly prepared.

b. Acceptance Testing (Roadway embankments, roadway base, structural fill):

1). Prior to stockpiling or delivery of materials to the project site, the Contractor should be required to make submittals of the soil or base properties. The acceptance tests may be duplicated during the progress of the work when deemed necessary by the job inspector. The minimum properties tested may vary between projects and regions of the State, but are generally summarized below:

a). Roadway base material- Acceptance tests for the pavement sub-base and base materials normally include the Los Angeles abrasion or the Wet Ball Mill of the aggregate, the gradation of the material and the plasticity index of the fines. The gradation of the material and the plasticity of the fines should be checked at frequent intervals during the construction to maintain the specified quality. The selection of quality standards for specifying materials should be done carefully to prevent the use of requirements that are uncommon in the area or that specify a quality which cannot be obtained within an economical distance. Texas Department of Transportation (TxDOT) standards may prevail in one portion of the state and federal specifications might be the controlling factor in other parts of the state. A quality pavement can be obtained with either of the two standards, but the familiarity to the suppliers in the area is important in specifying a material that would be easily recognized. If neither TxDOT nor federal standard quality materials are available, a modification of the design and specifications should be considered. These determinations should be made prior to the completion of the Construction Contract Documents and Specifications.

b). Roadway embankments and structural fill: Acceptance testing of these materials is normally defined by the project design team and will include the gradation of the material and the plasticity index. Other required tests may include organics content, pH, and/or resistivity of soluble sulfate content.

4. Structural Metals

   a. Provide an outline or guideline for inspection/observation of Structural Metals and connections.

   b. Welded connections: Provide connections that are common. All welds shall conform to ANSI/AWS D1.1. Request that all welders (both shop and field) shall be certified to make desired welds and that the welder has been certified to perform the desired welds within the past 6 months.

   c. Perform Non-Destructive Testing (NDT) (ultrasonic or radiographic) on all full penetration field welds in accordance with ANSI/AWS D1.1. See D.3.c.

   d. Bolted Connections - connections shall be snug tight unless noted otherwise on plans or specifications. Test ten percent (10%) of all bolts with at least two (2) bolts tested per connection, per AISC Chapter 5.

5. Other Building Materials:

   a. There are other building materials that may require testing on a Project. There shall be a discussion during the design reviews for the appropriateness of each test or inspection requirement.