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Structural

A. General Requirements

Design Loading – Live and Super-Imposed Dead Load

Provide key plans of each building level that clearly indicate the design live load and super-imposed dead load used for each different area, including but not limited to the roof, each floor, basement, and underground structures surrounding the building. Indicate if live load reduction is utilized in the design. This information will assist the University during future tenant improvements, etc.

Structural Details

The structural engineer is required to design all the structural details for the building; fabricator/contractor designed details are not allowed. The use of “Similar”, “Typical” details or the like is discouraged. If “Similar”, “Typical” or the like details are used where appropriate, then specifically indicate on the detail just what is “similar” about it.

Penetrations

Coordinate penetrations through structural members due to other trades. Sleeves shall be provided for penetrations and shall be 1” minimum larger than max penetration diameter. Penetrations required after structure is in place shall be reviewed and approved by Engineer of Record.

Building Envelope Maintenance Equipment

Refer to Roof and Building Envelope Safe Access requirements in the [Requirements Common to All Disciplines and Projects](#) document for roof and envelope access for maintenance and repair. Refer to the UW EH&S Fall Protection Program Manual for additional information and requirements.

Structure shall be designed to support the shear loading and overturning moment for all roof anchors and davits. Loading assumptions shall be provided in general notes and structural details.

Vibration and Acoustics

Coordinate vibration and acoustic requirements due to mechanical or other equipment with UW representative.

Site Vault Lids

Site vault lids shall be designed to support HS 20 wheel loads.

B. Seismic Improvements and Building Modifications

Seismic Studies

1. Study Components

Seismic study shall include copy of evaluation checklists, structural calculations, and prioritized list of deficiencies to be corrected.

2. Submittal Timing

Seismic studies shall be submitted to Engineering Services for review and discussion at a design team meeting prior to issuing final report. Final report shall be issued no later than when drawings are submitted for permit issuance.

Seismic Upgrades

1. URM Buildings

In Unreinforced Masonry (URM) Buildings, where the roof and floor structure is supported by a URM wall, provide secondary structure to support the vertical and lateral loads of the roof and floor members. This includes support of all the floor and roof structure including joists, beams, girders, rafters, etc.

2. Essential Facilities

For hospital and other essential facilities utilize the following Enhanced Rehabilitation Objective: Immediate Occupancy Performance Level (1-B) at BSE-1 Earthquake Hazard Level, and Collapse Prevention Performance Level (5-E) at BSE-2 Earthquake Hazard Level.

3. Existing Structural Defects

All existing structural defects discovered during design, demolition, and construction shall be repaired to current code. This includes but is not limited to patching of spalls at exposed rebar in slabs, beams, and columns; foundation settlement; wall cracks; expansion joints; seismic joints; and where existing walls or slabs have been removed.

4. Campus Studies

In addition to the drawings maintained in Campus Engineering Records, the University has completed structural analysis studies of some of the buildings on campus. Also, in October 1991, the Earthquake Readiness Advisory Committee (ERAC) at the University of Washington issued a report detailing its findings of its campus-wide seismic hazards survey. The purpose of the ERAC report was to establish a consistent set of rules to prioritize which existing buildings needed further seismic analysis. The ERAC report also prioritized existing buildings according to Damage Index numbers and Life Safety Index numbers, and recommended a number of facilities that should have further detailed seismic analysis performed by a licensed structural engineer. A pdf copy of the ERAC report is available from Engineering Services.

Modifications to Existing Buildings

1. Renovated Structures

The resulting structure shall be at least as strong as or stronger than before the modifications. In no case shall the structure be weakened by the modifications. This applies to both gravity loads as well as lateral (seismic and wind) loads.

2. Lateral Load Strength

Re-establish lateral load strength of the building if wall penetrations are cut into shear walls.

3. Diaphragm Effects

Analyze lateral load diaphragm effects if floor or roof penetrations are significant.

4. Existing Structural Defects

All existing structural defects discovered during design, demolition, and construction shall be repaired. This includes patching of spalls at exposed rebar in slabs, beams, and columns.

5. Penetrations

Prior to any cutting or drilling, contractor shall x-ray existing substrate for reinforcing and/or any other structural members. Reinforcing locations shall be marked on concrete. Penetrations shall be made by use of core drill not jack hammers. Should existing reinforcing be damaged, contractor shall repair the existing reinforcing.

C. Foundations, Shoring, Slab on Grade, Sub-Grade Walls, Tunnels

Foundations

1. Montlake Landfill

Structures, roads, existing slabs, and utilities located on the Montlake Landfill should be supported on pilings and need to have the pilings extend down to the underlying firm clay layer in order to avoid additional loading on the refuse and peat.

2. Drilled Piers

Concrete placed into drilled piers shall be conveyed in a manner to prevent separation or loss of materials. In no case shall the concrete be allowed to freefall more than 5 feet. Tremie concrete where required.

3. Temporary Foundations

Temporary foundations, such as for tower cranes, that are outside the footprint of the building shall be removed.

4. Utility Tunnels and Clearance

Locate piling, drilled piers, etc. no closer than 3 feet clear from the outside face of existing utility tunnels or vaults.

5. Utility Tunnels and Loading

New construction shall not impose any added load or surcharge to the existing utility tunnel or vault walls or lid/top.

6. Water Table

If the foundation extends below the water table, demonstrate how the design team will address the issues involved with designing and constructing a structure below the water table. This effort should include, but not be limited to the following:

- a. Temporary dewatering the site for construction,
- b. Permanent sub-grade wall and/or under slab drainage systems if needed,
- c. Penetrations through the waterproof membrane for utilities, drainage systems, etc.,
- d. Excavation type, laid back or shored, shoring location relative to subgrade walls,
- e. Show how rebar and formwork, etc. is to be supported without penetrating the subgrade wall waterproof membrane,
- f. Demonstrate the phasing required to account for hydrostatic uplift issues. For example: how much of the building needs to be constructed prior to turning off the dewatering pumps?

Shoring

1. Water Table

At shoring for structures located below the water table, locate the shoring walls a sufficient distance outside the face of the permanent basement walls to allow for proper installation and inspection of positive-side waterproofing.

2. Underpinning

Soldier piles used as underpinning shall be jacked to a load as specified by the engineer of record to preload the piles to prevent settlement of the existing building.

3. Voids Behind Lagging

All voids behind lagging shall be filled prior to excavating subsequent lifts. Use material and method that will not interfere with the free drainage system.

4. Top of Shoring

Remove top of shoring system a minimum of 3 feet below finished grade. Also remove additional depth as required by the local municipality or adjacent property owner.

5. Temporary Tiebacks

De-stress all temporary tiebacks.

Slab On Grade**1. Joints**

Provide joints in all concrete slabs on grade.

2. Joint Spacing

Provide control or construction joints on all column lines and at 20'-0" maximum spacing each way in between. Structural engineer to determine closer spacing requirements.

3. Plans

Show the location of control and construction joints on the plans.

4. Reinforcement

Reinforce with conventional reinforcing steel each way. Welded wire fabric is not allowed.

5. Flatness

Design and specify floors that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 35, Localized FF = 25. Garage floors may be Overall FF = 25, Localized FF = 20.

6. Levelness

Design and specify floors that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 25, Localized FL = 17. Garage floors may be Overall FL = 17, Localized FL = 13.

7. Capillary Breaks

Provide below slab capillary break at all slabs on grade. Provide additional details and groundwater collection and drainage systems as required for slabs on grade located below the ground water table.

Sub-Grade Walls**1. Material**

Use only concrete construction. Masonry is not allowable.

2. Wall Length

Place below-grade building walls in lengths limited to 40 feet.

3. Retaining Wall Joint Spacing

Space vertical expansion joints in site concrete retaining walls no more than 20 feet on center. Show specific location of joints on the drawings.

4. Weep Holes

Provide 2-inch round weep holes at 10'-0" on center maximum spacing in site concrete retaining walls.

5. Joint Details

Include all types of joint details on the drawings.

6. Waterstops

Provide waterstops at all construction joints below grade.

Tunnels

1. Wheel Loads

Design bar grating and hatch at top of utility vault manholes to support HS 20 wheel loads.

2. Future Loads

Size all components for piping support racks for the maximum possible loads and forces taking into account future piping.

D. Structured Floors and Roofs

Typical Building Floors

1. Penthouse Floors

Design penthouse floors to support a live load of 75 PSF minimum or the actual equipment weights, whichever is greater.

2. Vehicle Loading

Design areas where trucks, man lifts or other vehicles have access for a minimum of HS 20 loading. Design for fire truck loading in all fire lanes and appropriate areas.

3. Equipment Access

Design platforms for equipment to provide adequate access for maintenance personnel. This may include the design of catwalks and ladders at or above the main platform level. Design team to coordinate with mechanical design consultant and UW facilities shops on where platforms are needed.

4. Flatness

Design and specify floors that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 35, Localized FF = 25.

5. Levelness

Design and specify floors that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 25, Localized FL = 17. Note that the use of FL on structured floors is limited to when the slab is still supported in its original as-cast position (still shored) and when the slab has no camber.

6. Sleeves and Curbs

Provide sleeve and/or curb at all floor slab penetrations.

7. Future Loads

If a floor is designed for a future load, indicate clearly on the plan (or a key plan) the location, footprint, operating weight and move-in pathway as applicable. This includes but is not limited to future MEP, medical, or lab equipment.

8. Shrinkage

Limit the shrinkage to 0.00030 inches per inch (including all admixtures) in the concrete in garage floor framing. The contractor shall submit shrinkage test results of mix, conducted per ASTM C-157, a minimum of 4 weeks prior to use.

9. Garages

Garage floors may be Overall FF = 25, Localized FF = 20.

10. Pedestrian Bridges

Design pedestrian bridges to support a minimum live load of 100 PSF. Also coordinate with Project Manager for any equipment loads that may be used on the bridge.

11. Electrical Rooms

Design slabs over electrical rooms with micro silica concrete mix or limit shrinkage to 0.00030 inches per inch and add polypropylene fibers. Treat all cracks with Methylmethacrylate.

12. Post-Tensioned Slabs

In post-tensioned slabs, provide for a method of permanently identifying each tendon's location on the soffit of the structure for future remodels. Identification shall be a maximum of 10 feet oc. Possible method is by use of ¾" chamfer strips on soffit of forms. Discuss with Project Manager and Engineering Services.

13. Floating Slabs

Avoid using “Floating Slabs” i.e., slabs that are acoustically isolated from the structural slab with insulation between the two slabs. These slabs are usually constructed before the building is “closed in” or protected from rain. Consequentially they are exposed to rain which saturates the insulation, making the acoustical performance ineffective and providing a breeding place for mold and mildew. Consult with Engineering Services if floating slabs are considered.

Laboratory Building Floors

1. Live Loads

Design all floors in new laboratory buildings to support a live load of 100 PSF. In addition, use 30 PSF for equipment load plus 20 PSF uniformly distributed partition load. Do not reduce the live load in the design of the floor slabs, floor beams and floor girders. Consider the equipment load as a live load.

2. Columns and Footings

Design the columns and footings to carry the 100 PSF floor live load reduced in accordance with the current building code. Do not reduce the equipment or partition loads.

3. Shrinkage

Limit the shrinkage to 0.00030 inches per inch (including all admixtures) in the concrete in the floor framing. The contractor shall submit shrinkage test results of mix, conducted per ASTM C-157, a minimum of 4 weeks prior to use.

Vibration

1. Framing Scheme

Some buildings on campus contain research instrumentation that is extremely sensitive to vibration. The structural engineer shall select a framing scheme as well as the size and spacing of columns to keep the floor vibrations within the criteria established for the project.

2. Maximum Vibration – Laboratory Buildings

Provide key plans that clearly indicate design vibration criteria used for different areas. Basic design criteria is 2000 micro-inches/sec. maximum for lab areas. Refer to building program or specific equipment requirements for more restrictive vibration criteria.

Provide vibration analysis report for lab or sensitive equipment areas with slow walking minimum in lab areas, slow walking in private corridors, and moderate walking in public corridors. Report shall be submitted to Engineering Services for review prior to issuing final report. Final report shall be issued no later than when drawings are submitted for permit issuance.

Roofs

1. Slope

Slope the structural roof system to accomplish the roof slopes shown on the drawings. This also applies to plaza decks and walkways.

2. Snow Load

Design for a minimum Snow Load of 25 PSF.

3. Flatness

Design and specify roofs that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 25, Localized FF = 20.

4. Levelness

Design and specify roofs that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 17, Localized FL = 13. Note that the use of FL on roofs is limited to when the slab is still supported in its original as-cast position (still shored) and when the slab has no camber or slope.

5. Camber

Camber structural system as needed to assure positive flow of rainwater. Check for progressive deflection due to ponding.

6. Dead Load for Re-Roofing

Design with an additional 10 PSF minimum dead load to allow for reroofing once.

7. Roofs as Future Floors

If the roof is to be designed as a future floor, detail tops of columns and walls above the roof level for ease of future vertical extensions and to minimize the disturbance to the existing roofing. Clearly indicate on the drawings the extent of future addition that is designed for. Drawings shall also indicate acceptable future loading, including but not limited to future columns and lateral system loading.

8. Rooftop Platforms

Design rooftop elevated platforms for equipment to provide adequate access for maintenance personnel. This may include the design of catwalks and ladders at or above the main platform level. Design team to coordinate with mechanical design consultant and UW facilities shops on where platforms are needed.

9. Bracing of Rooftop Equipment

Design for bracing of fume hood exhausts and other items that project above the roof including towers, antennas, etc. Arrange guy wires and supports in a manner to minimize aesthetic disturbance.

10. Window Washing Equipment and Fall Arrest Anchors

Design for all window washing equipment and fall arrest anchor support.

E. Structural Materials

Concrete

1. Strength

Concrete strength shall be not less than 3,000 psi at 28 days.

2. Dowels

Dowels shall be provided at each construction joint to lap with all reinforcing in the adjoining member. This includes: each curtain of wall reinforcing, top and bottom slab and beam reinforcing, and all column reinforcing.

3. Slab Temperature Steel

Slab temperature steel shall be provided each way throughout all slabs. Provide each way top and bottom for slabs greater than or equal to 8" thick.

4. Concrete Fill Over Steel Deck

In structural steel construction with steel deck and concrete fill, specify a minimum of #4 @ 12" oc top over steel members that are parallel to the steel deck. Extend bars a minimum of 2'-0" beyond the edge of the member flange. This will mainly occur over steel girders.

5. Concrete Chart

Provide chart on the structural drawings that clearly indicates each type of concrete used on the project. Include the following minimum information: strength, test age, exposure class and where each type of concrete is to be used.

6. Water/Cement Ratio

Specify low water/cement ratio for concrete to reduce potential shrinkage cracks.

7. Ramps

Use silica fume in concrete for all ramps greater than or equal to 5% grade.

8. Epoxy and Powder-Driven Fasteners

Epoxy and powder-driven type fasteners are not allowed for tension applications.

9. Curing

Curing compounds are not allowed on slabs in laboratories and mechanical rooms and slabs over electrical rooms. Provide water curing only.

Reinforced Masonry

1. Below-Grade

Do not use masonry below grade.

2. Control Joints

Provide control joints in CMU walls and expansion joints in multi-wythe brick walls at a spacing not to exceed $1 \frac{1}{2}$ x the wall height or 25'-0", whichever is less. Provide vertical and horizontal reinforcing in CMU walls. Wall reinforcing shall not be less than #5 at 48" oc vertical and 2 #4 in horizontal bond beam at 4'-0" oc.

3. Exterior Wall Metal Accessories

At exterior walls, all metal accessories shall be stainless steel.

Steel

For buildings located at Friday Harbor and Forks or other locations near saltwater, roofs shall not be constructed of steel. Aluminum roofs are recommended to mitigate the effects of saltwater corrosion.

1. Connection Design

All connections are to be designed by the engineer of record. Fabricator designed connections are allowed, but shall be verified by Engineer of Record.

2. Open Web Steel Joists

Use of open web steel joists is acceptable only for roofs in areas that are not supporting rooftop or suspended units greater than 400 pounds operating weight. Do not utilize open web steel joists to support fall arrest anchors, or loads from fall arrest anchors. Do not utilize open web steel joists for floor construction.

3. Steel Decking

Steel decking may be used for garage construction as a form only. Provide reinforcing bars (not WWF) in slab to support 100% of the design loads.

4. Structural Steel Fabricator

Structural steel fabricator shall be an AISC-Certified Plant Category Standard (Std). As an alternate to this requirement, the contractor shall pay for full-time inspection during the fabrication of the project steel. This inspection will be conducted at the fabrication plant by the owner's inspection agency.

5. Button Punching of Side Lap Connections

Button punching of side lap connections of steel roof deck (where no concrete topping) is not allowed. Provide welded, screwed, or other means to connect side laps.

Timber

Review current environmental codes when building over water. Consult the following when building over fresh water: City of Seattle, Army Corps of Engineers, Department of Natural Resources, Department of Fisheries

1. OSB

OSB (oriented strand board) is not allowed for floors and roof.

2. Gluing

Glue all floor sheathing with minimum 3/16" diameter continuous bead of construction adhesive. Use two continuous beads at abutting panels.