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CHAPTER 2--FOUNDATIONS

Section 2.1 Site Evaluations

2.1.1 Subsurface Investigation

2.1.1.1 Coordinate all subsurface investigation site access with Abe Fattaey, University Engineer; or Gary Kilner, Surveyor; in the Division of Facilities Planning at (785) 532-6377 to locate all underground utilities before beginning subsurface investigation.

2.1.1.2 All utilities need to be located by the Planning Office 48 hours in advance of start of work.

2.1.2 Soil Borings

2.1.2.1 Most soil borings shall be located, to the extent possible, near the location of proposed footings.

2.1.2.2 For each new building or addition, there shall be at least one boring for every 2,000 square feet of building footprint, with a minimum of four soil borings, or as recommended by the geotechnical engineer.

2.1.2.3 Immediately after completion of soil borings each location is to be backfilled, cleaned up, have all holes plugged/filled and sod, asphalt or concrete restored to original condition.

Section 2.2 Excavation and Backfill

2.2.1 Rock excavation

2.2.1.1 All contract documents that include any excavation work involving rock shall include a specific amount of each kind of rock excavation in the base bid of the contract. Any requirement for over excavation of rock surfaces is to be clearly stated in the bid documents.

2.2.1.2 A unit price shall be required for each kind of rock excavation that shall be used to adjust the base bid, for either more or less rock excavation than the amount included in the base bid.

2.2.1.3 At a minimum, rock excavation shall be divided into two categories: trench and general. A specific definition shall be included in the specifications for each type of rock excavation.

2.2.1.4 No explosives are to be used for rock excavation on the main campus, within the city limits of the City of Manhattan, without specific written owner approval.

2.2.2 Spread and pad footings

2.2.2.1 The bearing soil shall be placed in 6" lifts and compacted to a minimum of 95% of maximum density at optimum moisture content (± 2%), standard proctor, or as recommended by the geotechnical engineer. Excavation to undisturbed soil is not considered adequate.
2.2.2 Immediately prior to installation of reinforcing steel and placement of concrete, the soil shall be inspected by the geotechnical engineer. The inspecting agency will be retained by the Owner, but the inspections shall be scheduled by the contractor.

2.2.3 Piles and Piers

2.2.3.1 Auger Cast Piles – To be used only in certain areas of campus, generally bounded along the east and south edges of the main campus: from Justin Hall to Beach Museum, to Memorial Stadium.

2.2.3.1.1 Description: Furnish and install augered pressure grouted intrusion piles as required. The extent of piles is to be shown on the drawings, including locations, diameters of shafts (straight and battered), estimated bottom elevations, top elevations, and details of construction.

2.2.3.1.2 Quality Assurance

2.2.3.1.2.1 Codes and Standards: Perform pier work in compliance with the building code, including provisions for adequate protections to persons and property.

2.2.3.1.2.2 Contractor Qualification: Contractor shall have a minimum of five years experience in work of a nature and scope similar to that required by this section.

2.2.3.1.3 Job Conditions

2.2.3.1.3.1 Soils Report: The Owner will contract with a geotechnical engineer to provide a detailed soils report for the design team and contractors’ use. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by the Architect and Contractor. The data are made available solely for the convenience of the Architect and Contractor.

2.2.3.1.3.2 Additional Information: Additional test borings and other exploratory operations may be made by the Contractor, as he deems necessary, and at no cost to the Owner.

2.2.3.2 Products

2.2.3.2.1 Materials

2.2.3.2.1.1 Portland Cement: ASTM C150, Type I or Type II

2.2.3.2.1.2 Special Pozzolan: When available, provide an approved fly ash or other finely powdered siliceous material capable of combining with the lime liberated during the hydration of portland cement.

2.2.3.2.1.3 Grouting Agent: An approved admixture that affects the cement base mortar to reduce mixing water, retard setting time, decrease bleeding and segregation, and eliminate setting shrinkage.
2.2.3.2.1.4 Water: Fresh, clean and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

2.2.3.2.1.5 Fine Aggregate:

2.2.3.2.1.5.1 Sand conforming to the requirements of ASTM C33 except that gradation shall be as specified below.

2.2.3.2.1.5.2 Provide hard, dense, durable, uncoated rock particles, free from injurious amounts of silt, loam, lumps, soft or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, the washing method shall be such as will not remove desirable fines, and the sand shall subsequently be permitted to drain until the residual-free moisture is reasonably uniform and stable.

2.2.3.2.1.5.3 Sand shall be well graded from fine to coarse, with fineness modulus between 1.40 and 3.40. Fineness modulus is defined as the total divided by 100 of the cumulative percentages retained on U.S. Standard Sieve Nos. 16, 30, 50 and 100.

2.2.3.2.1.6 Piles: Piles shall be of a diameter recommended by the geotechnical or structural engineer, extending at least two feet into the underlying shale bedrock, reinforced as shown on the drawings, and capable of sustaining the minimum allowable working load to achieve the design loading.

2.2.3.2.2 Mixes

2.2.3.2.2.1 Provide cement-based, non-shrink grout consisting of portland cement, special pozzolan, grouting agent, sand, and water so proportioned and mixed as to produce a grout capable of maintaining the solids in suspension without appreciable water gain, and which may be pumped without difficulty, and will penetrate and fill any voids in the adjacent soils.

2.2.3.2.2.2 Hardened grout shall have an ultimate compressive strength of 4,000 psi at 28 days.

2.2.3.2.2.3 Submit proposed grout mix design to Architect for approval at least fifteen days before beginning work.

2.2.3.3 Execution

2.2.3.3.1 Examine areas and conditions under which piles are to be installed. Notify Contractor in writing of conditions detrimental to the proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

2.2.3.4 Installation

2.2.3.4.1 Tolerances: Install piles within a tolerance of 3” or less from locations shown on drawings.
2.2.3.4.2 Log: Maintain accurate record of piles installed showing location, date placed, length of pile, and final tip elevation. Submit three copies of pile log to Architect weekly.

2.2.3.4.3 Obstructions: Should obstructions be encountered which would prevent installation of pile to required depth, stop work on that pile group until corrective methods are provided by the Architect.

2.2.3.4.4 Pile Installation:

2.2.3.4.4.1 Install piles using a continuous flight, hollow shaft auger, drilled to the required depth.

2.2.3.4.4.2 Use only approved pumping equipment in preparing and handling grout. Locate a pressure gauge in good operating condition on the grout pump so that the grouting pressure can be checked continuously by the operator and the Architect. Measure all materials by volume or weight as they are fed into the mixer.

2.2.3.4.4.3 Leave auger in hole and inject grout mix under pressure through the hollow shaft of the auger. Slowly withdraw auger. Use earth or gravel fill surrounding auger to retain shape of hole and prevent grout under pressure from escaping along the sides of the auger. Do not raise auger and spin off earth prior to grouting. Earth fill, at least 10 feet deep, shall remain on auger before grouting operation begins.

2.2.3.4.4.4 Place grout continuously without interruption and in a smooth flow without segregating the mixed materials. Consolidate grout with mechanical vibrating equipment.

2.2.3.4.4.5 Grout piles to an elevation of at least one foot above bottoms of pile cap or grade beam. Cut top of pile accurately to final elevation following placement of reinforcing steel, and when grout has stiffened enough to allow cutting of grout without spalling.

2.2.3.4.4.6 At installer's option, pressure grout piles to approximately 6" above pile cut-off elevation and dip out fresh grout to the cut-off elevation prior to initial set.

2.2.3.4.4.7 Do not permit lateral pressure of soil to reduce pile diameter. Avoid sudden withdrawal of auger to prevent collapse of hole or reduction of pile diameter. Doubt on the part of either the Architect or the Contractor that a pile is continuous and of uniform diameter shall be sufficient cause to require that the grout be reamed out and the pile re-grouted.

2.2.3.4.4.8 Take necessary precautions to prevent mud, frozen material or other debris from falling into uncured grout.

2.2.3.4.4.9 Any concentrated loads from equipment must be distributed to prevent compressing or shearing soil in the top area of the pile. Keep concentrated loads at least 10 feet from pile until initial grout set has occurred.
2.2.3.4.5 Excavated Material: Remove excavated material and legally dispose of it off the site.

2.2.3.5 Field Quality Control Testing

2.2.3.5.1 During the progress of the work, make standard 2” x 2” x 2” test cube samples for determining compressive strength of grout injected into the auger borings.

2.2.3.5.2 Furnish molds, make, cure, and store cubes in accordance with ASTM C109. Deliver samples to the testing laboratory. Furnish testing laboratory with information of the location, mix, admixtures, etc. of the batch from which each set of test cubes was taken. Provide a minimum of three pairs of cubes (six cubes) for each day's work. When special pozzolan is used, provide fourth pair. Make each pair of cubes a minimum of three hours apart in the course of the work. Carefully identify samples and record the location of piles from which each sample of grout was taken.

2.2.3.5.3 From each set of six sample cubes, perform tests as follows:

2.2.3.5.3.1 For greater pile length than indicated on the drawings, per linear foot;

2.2.3.5.3.2 For lesser pile length than indicated on the drawings, per linear foot;

2.2.3.5.3.3 For added or subtracted piles of length indicated on the drawings, each.

2.2.3.6 Backfill

2.2.3.6.1 Typical Backfill Materials

2.2.3.6.1.1 Backfill around foundations shall be installed in no more than 12” lifts. Specific situations or soils may require smaller lifts, at direction of geotechnical engineer.

2.2.3.6.1.2 Using a standard proctor at optimum moisture content (±2%), all backfill shall be mechanically compacted to a minimum of 88% and a maximum of 92% of maximum density under landscape areas and minimum of 95% of maximum density under other areas.

2.2.3.6.1.3 The backfill shall be inspected and tested at the discretion of the owner’s representative and the geotechnical engineer. The owner shall retain the services of an engineering inspection and testing firm. The contractor shall be responsible for coordinating and scheduling the inspections.

2.2.3.6.1.4 The use of fly ash and/or lime as an additive shall be considered on a case-by-case basis.

2.2.3.6.2 Alternate Backfill Material
2.2.3.6.2.1 Flowable Fill, such as that provided by MidWest Concrete, can be considered for use for subgrade and in trenches backfilling utilities.

Section 2.3 Concrete

2.3.1 All concrete used in footings, foundations, slabs or sidewalks shall have a minimum strength of 4,000 psi. All concrete used in exterior, exposed to the weather type applications shall be air-entrained concrete.

2.3.2 Calcium chloride shall not be used in any concrete. A noncalcium accelerator may be considered for use in concrete.

2.3.3 Masonry units shall not be used for foundation walls below grade.

Section 2.4 Reinforcement

2.4.1 Reinforcing steel and accessories shall conform to CRSI Standards and shall not be placed in contact with soil. Reinforcing steel shall not extend to the surface of the concrete. Chairs shall be used on all horizontal concrete surfaces, either formed or on grade. Chairs and other accessories shall be metal. Use of Fiber Mesh in lieu of reinforcing steel is not allowed.

2.4.2 Reinforcing systems may be required to be engineered.

Section 2.5 Penetrations

2.5.1 General guidelines

2.5.1.1 All penetrations of foundation walls shall be leak-proofed. Where required they shall be fire resistant.

2.5.1.2 All penetrations, except steam tunnels, shall be individual pipes or conduits. Groups of pipes or conduits in a common penetration shall not be allowed.

2.5.1.3 In instances where reinforcing steel is used to attach another mass of existing concrete to the foundation walls (duct banks, steam tunnels, etc.), the steel pins shall be attached to the foundation walls through the use of epoxy capsules similar to those supplied by Hilti.

2.5.1.4 Minimum clearances shall be 3” clearances between pipes or sleeves.

2.5.1.5 The conduit shall penetrate the foundation in the following manner:

2.5.1.5.1 For new construction, the foundation wall shall have a steel sleeve installed that is 2” larger in diameter than the conduit to be installed. For existing construction, the hole shall be core drilled. In multiple duct situations, sufficient space shall remain between the penetrations to maintain the structural integrity of the foundation wall.

2.5.1.5.2 A rubber seal, equal to link-seal, shall be installed in the space between the conduit and the sleeve or drilled hole, near the interior surface of the foundation wall. The same space shall have waterproofing installed on the exterior side of the rubber seal.
2.5.2 Electrical duct banks

2.5.2.1 Concrete encased duct banks shall terminate at the exterior surface of the foundation wall. The conduit shall make individual penetrations of the foundation wall.

2.5.2.2 All duct banks shall be attached to the foundation wall in one of two manners. In new construction, the reinforcing steel of the foundation wall may be extended into the concrete encasement of the duct bank at the time of placement. Alternately, reinforcing steel may be drilled into the foundation wall and extended into the duct bank concrete. The steel that is inserted into the foundation wall shall be attached through the use of epoxy capsules, similar to those supplied by Hilti.

2.5.2.3 All duct bank conduits within the limits of the project site of the foundation wall penetration shall be rigid steel conduit. The conduit shall be installed with a sloped grade down and away from the building.

2.5.3 Steam and condensate

2.5.3.1 The point of attachment for steam tunnels shall have a concrete, cast-in-place transition, with waterstopping material cast into the concrete. The waterstopping shall be embedded into the foundation wall according to the manufacturer’s recommendations. Waterstopping material shall be equal to Volclay RX-102.

2.5.3.2 Individual penetrations of steam and condensate lines shall be installed as follows: The foundation penetration shall be the anchor point. The penetration shall be sleeved with a galvanized steel sleeve.

2.5.4 Other pipe penetrations

2.5.4.1 The minimum strength of pipe penetrating foundation walls shall be equal to schedule 40.

2.5.4.2 All penetrations, except steam, steam condensate, or other high temperature piping, shall be waterproofed in the same manner as described in previous paragraph 2.5.1.5.1.

2.5.5 Other penetrations

2.5.5.1 Penetrations of foundation walls by direct burial cable shall be sleeved or core drilled, and shall be sealed through the use of 3M Scotchcase 2114, or equal sealant. Direct burial of cable is described in Chapter 9 of the Specifications: paragraph 9.2.2.

Section 2.6 Drainage Systems

2.6.1 A footing/foundation positive drainage system shall be installed on all buildings with usable space below grade. There are various methods and systems available to provide good foundation drainage. Drainage system recommendations will be provided by geotechnical engineers.

2.6.2 Piping
2.6.2.1 All pipe used in foundation drainage systems shall be a minimum of Schedule 40.

2.6.2.2 Cleanouts shall be installed downstream of each 90-degree elbow, within 12" of the elbow. On straight runs of pipe, cleanouts shall not be located more than 100' apart. All cleanouts shall be supplied with brass plugs.

2.6.2.3 All drainage piping shall be connected as required to storm sewer piping or sump pumps, not sanitary sewer.

2.6.2.4 Filter fabric shall be used.

Section 2.7 Slab On Grade (Interior, Structural)

2.7.1 The bearing soil under slabs on grade shall be compacted to a minimum of 95% of maximum density at optimum moisture content or as recommended by the geotechnical engineer. Excavation to undisturbed soil is not considered adequate. Depth of compaction for slabs on grade to be provided by designer of slab system.

2.7.2 Joints

2.7.2.1 Joint spacing and joint detail shall be shown in the drawings.

2.7.2.2 Expansion joints shall be required with a maximum spacing between joints of 30 feet. Expansion joints shall have dowel bars and shall allow load transfer and slab expansion. Non-extruding expansion joint material shall be used.

2.7.2.3 Control joints shall be cut as soon as the concrete can be walked on without damage to the finish (soft cut). Control joints shall be cut a minimum of 2" deep or to a depth of 25% of the slab thickness; whichever is greater.

2.7.2.4 Slab flatness and levelness shall be within 1/8" in 10'. ASTM E1155 shall not be used to specify flatness and levelness unless the particular use requires a high level of accuracy. Areas that have floor drains shall not be required to meet the levelness tests, but shall have positive slope to the floor drain. The amount and direction of slope for floor drains shall be indicated on the drawings.

2.7.2.5 All slabs on grade shall have a positive drainage system installed. This can be a system of drain piping beneath the slab, with a sump pump, to collect and remove the water beneath the slab or a drainage system which extends direct to grade.

2.7.2.6 Dowel into existing sidewalks, building or other surfaces.

Section 2.8 Crawl Spaces

2.8.1 Crawl spaces should be avoided in favor of basements. However, they shall not have earth floors. The preferred treatment is the placement of concrete on the floor areas.

2.8.2 Crawl spaces shall be ventilated, have a drainage system to prevent standing water, and shall have fluorescent lighting installed as required by the UBC/NEC with switching at each exit door.

2.8.3 Crawl spaces shall be a minimum clearance of five feet to the lowest hanging pipe, beam or ductwork.
Section 2.9 Equipment Pits

2.9.1 Equipment pits shall be drained by gravity.

2.9.2 Where gravity drainage is not possible, a sump with a pump shall be installed. The sump shall have an alarm installed and be connected to the campus security system, to alert maintenance personnel whenever the water level rises and before the water overflows the pit. Where the campus security system is not available, a local alarm shall be installed. In circumstances with a high water table or underground stream install a secondary pump at a higher level for backup in case the first pump were to fail. Verify underground water characteristics prior to design of backup system.

2.9.3 A ladder and fluorescent lighting shall be provided in each equipment pit.

Section 2.10 Thermal and Moisture Protection

2.10.1 Insulation

2.10.1.1 Foundation walls shall be insulated on the exterior surface of the wall from the finish grade, to a minimum of 30" below finish grade. Insulation installed on the exterior of foundation walls shall be attached to the wall. All insulation shall comply with ASHRAE 90.1.

2.10.1.2 Foundation walls associated with a slab on grade that is above the surrounding grade shall be insulated in the interior of the foundation wall surrounding the bottom of the slab to a minimum of 30" below the exterior grade.

2.10.2 Waterproofing

2.10.2.1 All foundation walls shall be waterproofed below grade.

2.10.2.2 All foundation drains are to be installed according to Section 2.6, Drainage Systems.

Section 2.11 Cleaning Procedures

2.11.1 Cleaning services to be provided:

2.11.1.1 Daily: Contractor to power wash streets and sidewalks after contractor vehicles have left tracks on the way to or from the project site. Spud hoe up clods of dirt thrown from or crushed by tires, etc. and remove from site. Street sweep access routes used by contractors to edge of campus as well as provide follow up cleaning – broom and wash.

2.11.1.2 Weekly: Contractor to remove stains from paved surfaces caused by rubber from tire tracks, oils, fuels, solvents, etc.

2.11.1.3 Daily: Contractor to pick up litter within project site and any litter within 50 feet of the university’s side of the project site fence, along access routes, contractor storage yards and parking area. Debris to be placed in contractor’s trash containers. Contractor is responsible for removal of all construction debris.
2.11.1.4 Weekly: keep weeds and grasses in control every 5 days within project site along and either side of project fence and in contractor parking/storage yards (use weed eater for cutting).

2.11.2 Contractor Specifications

2.11.2.1 The campus is a pedestrian campus and must remain accessible for the safe movement of pedestrians through the entire campus.

2.11.2.2 Contractor shall provide alternate or temporary sidewalks to keep people moving, with adequate all-weather surfaces for safety.

2.11.2.3 Contractor to use boring methods to pass utility lines under and keep all paved areas intact to the greatest extent possible.

2.11.2.4 Contractor must share sidewalks and streets with pedestrians and other service vehicles along their access route to their project site boundaries.

2.11.2.5 Alternative traffic methods need to comply with all applicable codes and regulations.

2.11.2.6 ADA accessibility for personnel and vehicles must be maintained.

2.11.2.7 Required fire exit paths from building must be maintained with a hard all-weather surface and never be blocked by contractor equipment, materials or work at any time during the workday.

2.11.2.8 Access to site for university personnel or other contractors must be maintained at all times.

2.11.2.9 Contractor may use sidewalks/streets for limited access to site, provided:

   2.11.2.9.1 When the ground is moist, planking is required along the path of access to prevent construction vehicle damage to grounds.

   2.11.2.9.2 Contractor personnel shall direct pedestrian traffic for safety purposes adjacent to project site when heavy equipment needs access to and from project site across sidewalks/streets.

2.11.2.10 Contractor is to use planking, or other protective measures.

2.11.2.11 Contractor is to either clean concrete trucks within the project site or do it off campus property.