2021 IBC SEISMIC DESIGN PARAMETERS

The 2021 International Building Code (IBC) references the 2016 version of Minimum Design Loads for Buildings and Other Structures (American Society of Civil Engineers [ASCE] 7-16) for the Site Class determination and the development of seismic design parameters. Based on the subsurface conditions in historic borings at the site, and per ASCE 7-16 Section 20.3.1, the site is classified as Site Class C. IBC seismic parameters are provided in Table 1, 2021 IBC Seismic Parameters.

TABLE 1. 2021 IBC SEISMIC PARAMETERS

2021 IBC PARAMETER[1]	VALUE
Site Class	C
Mapped MCE_R Spectral Response Acceleration at Short Period, S_s (g)	1.257
Mapped MCE_R Spectral Response Acceleration at 1-second period, S_1 (g)	0.434
Short Period Site Coefficient, F_a	1.20
Long Period Site Coefficient, F_v	1.5
Design Spectral Acceleration at 0.2-second period, S_{DS} (g)	1.006

Notes:
1. Parameters developed based on latitude 47.159461 and longitude -122.27983 using the ASCE Hazard Tool

SHALLOW FOUNDATIONS

We understand seismic retrofit of existing shallow foundations will be completed at the 1015 Building at the South Hill Business and Technology Center. Based on our discussions with Quantum Consulting Engineers (structural engineer for the project), original building foundations were designed for an allowable soil bearing pressure of 5,000 pounds per square foot (psf). Historic borings at the site and observations during previous improvements at the site indicate dense to very dense glacial deposits are present at shallow depths. New foundations supported on dense native soils can be designed for an allowable soil bearing pressure of 5,000 psf. We recommend all loose soils be removed from the subgrade following excavation, and the exposed footing subgrade be observed by the geotechnical engineer to confirm dense native soils are present. The allowable soil bearing pressure applies to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads.

Provided all loose soil is removed and the subgrade is prepared as recommended, we estimate that the total settlement of shallow foundations will be less than about ½ inch. The settlement will occur rapidly, essentially as loads are applied. Differential settlements between footings could be half of the total settlement.

SLAB-ON-GRADE

New slabs should be supported on a minimum 4-inch thickness of base rock/capillary break overlying the recompacted medium dense to dense soils. The exposed subgrade soils should be compacted to 95 percent of the maximum dry density (MDD) in accordance with ASTM International (ASTM) D-1557 prior to base rock placement. If this is not possible or if soft soils are encountered, we recommend that the unsuitable soils be overexcavated and replaced with compacted crushed rock or structural fill.

Slabs supported as recommended above can be evaluated using a modulus of subgrade reaction of 150 pounds per cubic inch (pci). We recommend the geotechnical engineer observe the excavation for base rock, evaluate the exposed subgrade by proof-rolling or performing hand probing, monitor the compaction of the base rock and recommend modifications if required.

LATERAL RESISTANCE

Lateral foundation loads may be resisted by passive resistance on the sides of footings and by friction on the base of the shallow foundations. For shallow foundations supported on the recompacted native soils or on structural fill, the allowable frictional resistance may be computed using a coefficient of friction of 0.4 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf) (triangular distribution). These values are appropriate for foundation elements that are surrounded by medium dense to dense native soils or compacted structural fill. The structural fill should extend out from the face of the foundation for a distance equal to at least 2½ times the depth of the foundation element. These values also assume the ground surface in front of the footing will be level for a horizontal distance equal to at least 2 times the depth of the footing. If soils adjacent to footings are disturbed during construction, the disturbed soils must be recompacted; otherwise, the lateral passive resistance value must be reduced.

Resistance to passive pressure should be calculated from the bottom of adjacent slabs and paving, or below a depth of 1 foot where the adjacent area is unpaved, as appropriate. The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of about 1.5.

BELOW-GRADE WALLS AND RETAINING WALLS

Design Parameters

Lateral earth pressures for design of below-grade walls and retaining structures should be evaluated using an equivalent fluid density of 35 pcf provided that the walls will not be restrained against rotation when backfill is placed. If the walls will be restrained from rotation, we recommend using an equivalent fluid density of 55 pcf. Walls are assumed to be restrained if top movement during backfilling is less than H/1000, where H is the wall height. These lateral soil pressures assume that the ground surface behind the wall is horizontal. For unrestrained walls with backfill sloping up at 2H:1V (horizontal to vertical), the design lateral earth pressure should be increased to 55 pcf, while restrained walls with a 2H:1V sloping backfill should be designed using an equivalent fluid density of 75 pcf. These lateral soil pressures do not include the effects of surcharges such as slab/floor loads, traffic loads or other surface loading. Surcharge effects should be included as appropriate. Seismic earth pressures should also be considered in design using a rectangular distribution of 8H in psf, where H is the wall height.

These recommendations assume that all retaining walls will be provided with adequate drainage. The values for soil bearing, frictional resistance and passive resistance presented above for foundation design are applicable to retaining wall design. Walls located in level ground areas should be founded at a depth of 18 inches below the adjacent grade.

Wall Drainage

To reduce the potential for hydrostatic water pressure buildup behind retaining walls, we recommend that the walls be provided with adequate drainage. Wall drainage can be achieved by using free draining wall drainage material with perforated pipes to discharge the collected water.

Wall drainage material may consist of Gravel Backfill for Walls per Washington State Department of Transportation (WSDOT) Standard Specification Section 9-03.12(2) surrounded with a nonwoven geotextile filter fabric such as Mirafi 140N (or approved equivalent), or imported Gravel Borrow with less than 5 percent fines may be used in conjunction with a geocomposite wall drainage layer. The zone of wall drainage material should be 2 feet wide and should extend from the base of the wall to within 2 feet of the ground surface. The wall drainage material should be covered with a geotextile separator (such as Mirafi 140N) and then 2 feet of less permeable material, such as the on-site silty sand that is properly moisture conditioned and compacted.

A 4-inch-diameter perforated drain pipe should be installed within the free-draining material at the base of each wall. We recommend using either heavy-wall solid pipe (SDR-35 PVC) or rigid corrugated polyethylene pipe (ADS N-12, or equal). We recommend against using flexible tubing for the wall drain pipe. The footing drain recommended above can be incorporated into the bottom of the drainage zone and used for this purpose. If gravel borrow is used against the wall in conjunction with a geocomposite wall drainage layer, then the drainage pipe at the base of the wall should be surrounded with at least 12 inches of Gravel Backfill for Drains per WSDOT Standard Specification Section 9-03.12(4) that is wrapped with a nonwoven geotextile filter fabric such as Mirafi 140N (or approved equivalent).

The pipes should be laid with minimum slopes of one-quarter percent and discharged to a suitable discharge. The pipe installations should include a cleanout riser with cover located at the upper end of each pipe run. The cleanouts could be placed in flush mounted access boxes. Where applicable, collected downspout water should be routed to appropriate discharge points in separate pipe systems.