Oregon Department of Environmental Quality

Seismic Vulnerability Assessment Forms

Form 1: Questions for the Geotechnical Assessment of Each Facility

The following is a checklist to satisfy the DEQ requirements for the geotechnical component of the Seismic Vulnerability Assessment OAR 340-300-0003(6)(a). The geotechnical assessment is the first step to determine the seismic vulnerability. The next step is to address the required mitigation measures for each of the components of the facility. The amount of time it takes to complete the form varies, but the historical data and reports should be relatively easy to provide. To satisfy the OAR 340-300-0003 requirements and to determine the mitigation measures required in OAR 340-300-0004, please respond to the following questions and requests for investigation and reports:

1. Provide a scale plan or plot drawing of the entire facility, including all tanks, berms, marine terminals, loading racks, pipelines, etc. [GEO1]
2. Provide all available soil data, boring logs and geotechnical reports developed for the site since the original design and as-built properties of the facility. [GEO2]
3. Provide locations of all existing boreholes or CPTs on the plan or plot drawings. [GEO3]
4. Do the borings, CPTs and other geotechnical investigational tools meet the following criteria and conform to Oregon Structural Specialty Code 2022 ed. [GEO4]
    a. Boring or CPT depth shall be a minimum of 100ft (Appendix E, API 650, MOTEMS Section 3106F.2.2, ASCE7, Section 20.1).
    b. Borings are to be onshore and offshore (if any marine structures are present).
    c. Spacing of boreholes or CPTs along the berms shall not be more than 200 ft. (AASHTO, Table 10.4.2-1). For the perimeter of tank farms, there must be a minimum of one record at each corner., If there are minimal or no differences, this may be adequate. If not, a spacing of 200 ft along the berm or perimeter is necessary if there are erratic subsurface conditions encountered (AASHTO, Table 10.4.2-1).
    d. If CPTs are used, a few cases of verification of results should be compared to those from adjacent borings. Relationships between the SPTs, CPTs and full borings should be provided, using the latest geotechnical references and procedures.
    e. Provide geologic cross sections (color) of the facility to provide stratigraphy of the site, and to establish the site classification (A-F).
    f. If any other geotechnical data (other than CPT, SPT or borings) was available, provide details and dates.
    g. Employ contemporary standards of practice for all new soil investigations.
    h. Verify compliance with items (i) through (v) of OAR 340-300-0003(6)(a).

Before proceeding to create the geotechnical design report, the borehole and CPT locations and depth (both historical and recent) for the facility, should be reviewed by DEQ.

5. The following considerations must be addressed in the geotechnical design report [GEO5]
    a. Liquefaction Potential in “Sand-Like” Soil and Cyclic Degradation in “Clay-Like” Soil How was cyclic resistance ratio evaluated (simplified or site-specific)?
    b. If a site-specific response analysis has been performed, was it one or two dimensional?
    c. What ground motion parameters were used?

d. What methodology was used to calculate residual shear strength?

e. What safety factor for liquefaction in sand (CRR/CSR)

f. If using a simplified procedure, what current methodology has been used? Is the Safety Factor less than 1.4, what reduction factor has been applied to the initial shear strength of the soil?

g. If the Safety Factor is $1.0 < SF < 1.2$, how have the seismically induced ground movements been evaluated?

h. If the Safety Factor $SF<1.0$, what is the residual shear strength?

6. Provide evaluations for other geotechnical hazards, if applicable. [GEO6]
   a. Slope movement
   b. Lateral spreading
   c. Ground settlement
   d. Other surface manifestations
7. Slope stability [GEO7]
   a. Is there a possibility that a slope failure could affect any component of the facility?
   b. If a slope failure is possible, has a stability analysis been performed?
   c. Are seismically induced ground movements considered?
   d. If there are ground movements considered, what methods have been used to analyze them?
   e. Is the expected seismic (DE) displacement greater than 0.10 ft?
8. Soil Structure Interaction (SSI) [GEO8]
   a. What aspects of dynamic SSI have been evaluated (e.g., piles, pipelines, tanks, earth retention systems, or other)?
   b. What assumptions and procedures have been used to assess SSI?
9. The geotechnical design report documents the design requirements, assumptions and calculation processes and results. This document should present a complete set of information that allows for a thorough review of all calculations and data analyzed to develop design recommendations and provide input into the determination of the seismic demand (Ref. 4). [GEO9]
   a. Describe the local geologic and geomorphologic setting of the facility.
   b. Include any and all historical geotechnical data, reports, or boring information.
   c. Present subsurface profiles in graphical cross-sections.
   d. Describe groundwater levels and possible artesian or sub-artesian conditions.
   e. Identify main subsurface units, based on material type, strength, and deformability.
   f. Assess lateral variability of subsurface units.
   g. Summarize main soil and rock parameters, for each of the identified subsurface units.
   h. Describe the lateral variability to the top of rock, where the rock is present within the depth of concern.
   i. What is the likelihood of encountering rock or cobbles that might be present within the soil matrix?
   j. Provide justification for the “site classification” (A-F) for this facility.
   k. Any additional requirements per Oregon Specialty Code, Section 1803.6?

The determination of the site-specific seismic demand for this facility is the next step and should be a separate effort and report, based on the geotechnical report described above.

References

1. American Association of State Highway and Transportation Officials. 2020. “LRFD Bridge Design Specifications, 9th edition” AASHTO Publications, Washington, D.C.
2. American Society of Civil Engineers. 2021. “ASCE 7-22: Minimum Design Loads and Associated Criteria for Buildings and Other Structures”. ASCE, Reston, VA.
3. MOTEMS, Chapter 31F, California Building Code, Section 6.
4. World Association for Waterborne Transport Infrastructure. 2022. “PIANC WG 153B, Recommendations for the Design and Assessment of Marine Oil, Gas and Petrochemical Terminals.” PIANC, Alexandria, VA.
5. National Fire Protection Association. 2023. “59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)”. NFPA publications, Quincy, MA.

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