ADMINISTRATIVE MANUAL
LOS ANGELES COUNTY PUBLIC WORKS
GEOTECHNICAL AND MATERIALS ENGINEERING DIVISION

LIQUEFACTION/LATERAL SPREAD

These guidelines address the geotechnical review of "Projects" (see SP117A, Table 1) in areas that have been designated by the California Geological Survey (CGS) to have a potential for liquefaction in accordance with the provisions of the Seismic Hazard Mapping Act of 1990 and the 2023 County of Los Angeles Building Code Section 1803. These guidelines may be used to address the geotechnical review of non-Projects when directed to do so by the Building Official. Supporting documents for these guidelines are as follows:

- CGS Special Publication SP117A; 2008.
- State of California Seismic Hazard Mapping Act of 1990 (Public Resources Code, Chapter 7.8, Division 2).
- Recommended Procedure for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction Hazards in California, Southern California Earthquake Center (SCEC); 1999.

Per SP117A, "The State Mining and Geology Board recommends that engineering geologists and civil engineers conduct the assessment of the surface and subsurface geological/geotechnical conditions at the site, including off-site conditions, to identify potential hazards to the project. It is appropriate for the civil engineer to design and recommend mitigation measures. It is also appropriate for both the engineering geologist and civil engineers to be involved in the implementation of the mitigation measures – engineering geologist to confirm the geological conditions and civil engineers to oversee the implementation of the approved mitigation measures."

Reports in Liquefaction Hazard Zones based upon Seismic Hazards Maps by CGS should address the potential for liquefaction at the site (including settlement, lateral spreading, and surface manifestation). Sites with a perched water condition should also address the potential for liquefaction at the site.

Borings should be selected sufficiently deep to quantify the level of seismically induced settlement. Liquefaction analyses provided in geotechnical reports should have a depth of exploration 50 feet below ground surface, finished surface, or 20 feet below the lowest expected foundation level, whichever is deepest. Also, when proposed developments are within several hundred feet of a free face of slope, the depth of exploration shall be adequate to evaluate the site’s lateral spreading capacity.

Bedrock or other similarly dense, lithified formational material underlying the site need not be considered liquefiable. The presence of bedrock or other similar lithified formational material must be substantiated by providing Boring Log(s) showing that at least 5 feet of such materials exist. Sites where refusal is encountered, and the minimum 5-foot penetration into bedrock is not possible, will be handled on a case-by-case basis. It should be noted that hand augered refusals will not be accepted as adequate exploratory effort.

Geotechnical reports addressing potential for liquefaction and lateral spreading must, at a minimum, include and consider the following:

1. A description of the proposed project's location, proposed grading, drainage, topographic relief, and subsurface geologic conditions.

2. A site plan of the subject site showing the location of all exploratory work, including test pits, borings, and/or Cone Penetration Tests (CPTs). The site plan shall also include the direction of north, plan scale, and location of proposed site improvements and property lines.

3. Boring Logs, CPT soundings, test pits, and other subsurface data obtained. Boring Logs shall provide raw (unmodified) N-values if Standard Penetrations Tests (SPTs) are performed; CPT soundings shall provide raw qc-values and plots of raw sleeve friction values. Logs should show the depth soil/rock samples were obtained.

4. Groundwater level to be used in the liquefaction analysis. The historical high groundwater level shall be used in the liquefaction analysis unless a shallower level (higher elevation than historical high) is determined to be appropriate. If perched water conditions are encountered, or expected, they should be considered in the liquefaction analysis.

5. Description of seismic setting, historical seismicity, and methods and/or sources used to determine earthquake ground-motion parameters used in the liquefaction analysis. Peak ground acceleration shall be determined based on the peak ground acceleration adjusted for site class effects, PGA_M. The magnitude should be determined as the mean magnitude from a Probabilistic Seismic Hazard Analysis of a hazard level of 2 percent probability of exceedance in 50 years.

   County reviewers will review the seismic parameters submitted in the site-specific hazard analysis by utilizing the national earthquake source database at https://earthquake.usgs.gov/hazards/interactive/ and design map tool at https://seismicmaps.org/. The peak ground acceleration adjusted for class effects and mean magnitude will be compared against the acceleration and magnitude values utilized in the submitted liquefaction analysis. Seismic parameters utilized in the consultant's analysis will be accepted if they are equal

to or more conservative than the parameters obtained by the County reviewer. Seismic parameters that do not meet the values obtained by the County reviewer must be justified by the consultant and approved by the reviewer.

6. The geotechnical report must comply with and contain a finding in accordance with Section 111 of the County of Los Angeles Building Code.

7. Discussion of proposed mitigation measures, if any, necessary to reduce potential damage caused by liquefaction.

8. A Factor of Safety (FS) of 1.30 shall be used in liquefaction hazard evaluation to determine the exclusion of layers from settlement calculations. The FS is the ratio of the magnitude corrected cyclic resistance ratio (CRR) to the cyclic stress ratio (CSR) or simply FS = CRR/CSR. Layers that do not have a FS greater than or equal to 1.30 shall be included in the seismically induced settlement calculations.

9. The consultant should not mix factors from different empirical methods. The magnitude scaling factor, equivalent clean sand adjustment, overburden correction factor, etc., used in the analysis should correspond to its respective empirical method.

10. All correction factors applied to raw SPT blow counts and CPT soundings shall be discussed and sufficiently justified.

11. Bridging of non-liquefiable soil layers above liquefiable layers is not considered an adequate explanation or justification for exclusion of those layers in the seismically induced settlement calculations.

12. Total seismically induced settlement must be the sum of seismically induced settlements of both the saturated and unsaturated soils.

13. Seismically induced differential settlement shall be determined as one half of the total seismic-induced settlement over a span of 30 feet when only one boring is used to evaluate the potential for liquefaction-induced settlement. If more than one boring/sounding is used to evaluate liquefaction-induced settlement, differential settlement may be determined as the difference of settlement from two borings/soundings over their spatial distance.

14. Assessment of lateral spreading must be conducted when gently sloping ground or free faces (e.g., marina seawalls, drainage channels) are within or in close proximity to the site. Soil layers having equivalent $(N_1)_{60}$ blow counts less than 15 should be evaluated to assess the lateral spreading hazard.

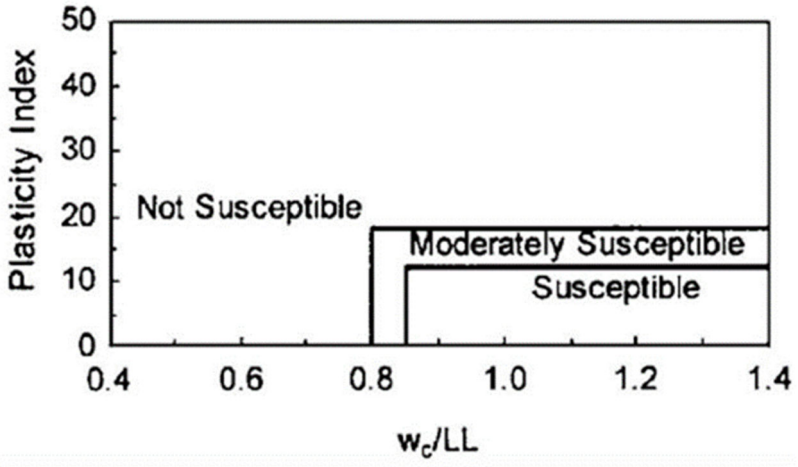
15. Structural mitigation alone is acceptable for: (1) up to 2 inches of seismically induced differential vertical displacement over a horizontal distance of 30 feet, (2) up to 4 inches of total seismically induced settlement, and (3) up to 12 horizontal inches of lateral ground displacement. Anything more than the aforementioned values requires ground modification. A combination of ground modification, piles, and structural mitigation may be acceptable on a case-by-case basis.

16. A "Project" and applicable non-Projects will be approved only when the nature and severity of liquefaction potential at the site has been evaluated in a geotechnical report and appropriate mitigation measures have been proposed and incorporated into the plans.

17. If CPT data is used in liquefaction analysis, the electronic version of the CPT data in a spreadsheet format or text file should be submitted.

When calculating seismically induced settlement, specific layers may be considered not susceptible to liquefaction. Layers not susceptible to liquefaction may include the following:

1. Soils that behave like clays and do not undergo severe strength loss during ground shaking may be generally considered not susceptible to liquefaction. To determine if soils are susceptible to liquefaction, the Plasticity Index (PI) and in-situ moisture content must be determined. Bray and Sancio (2006) found loose soils with a PI less than 12 and moisture content greater than 85 percent of the liquid limit (LL) are susceptible to liquefaction (Figure 1). Soil layers where the moisture content is greater than 80 percent of the LL and have a PI ranging from 12 to 18 are considered moderately susceptible and should be included in liquefaction induced settlement calculations. Soils with a PI equal to or greater than 18 and moisture content equal to or less than 80 percent of the LL were considered to not be susceptible to liquefaction. Moisture content of susceptible unsaturated layers below the historical high ground water may be less at the time of sampling than during a seismic event; therefore, moisture content should be calculated as the saturated moisture content.



2. Soils with a soil behavior type index, Ic, greater than 2.60 are considered to not liquefy due to clay-like tendencies (Robertson and Wride, 1998).

A copy of all submitted geotechnical reports and review sheets approving the "Project" must be sent to the State Geologist within 30 days of recommending the plan for approval.

Approved By:

William Man
Division Head