



## INFORMATION BULLETIN / PUBLIC - BUILDING CODE

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# LIQUEFACTION ANALYSIS GUIDELINES

## General Requirements

Liquefaction analysis shall be based on the maximum historic groundwater level in accordance with CGS Seismic Hazard Reports (available from the CGS website).

Ground motions used to evaluate liquefaction shall be obtained based on methods prescribed in the 2020 LABC. Ground shaking hazard maps found in previous Seismic Hazard Zone Reports shall no longer be used to estimate ground shaking.

The so-called “Chinese Criteria” is no longer accepted as an indicator of potential soil failure. Screening criteria shall be performed in accordance to procedures referenced in SP 117A, page 35 (i.e., referenced papers by Bray and Sancio, 2006, for screening fine-grained soils, and Boulanger and Idriss, 2006, for screening and analyzing clay-like fine-grained soils). SP 117A states that “... *Bray and Sancio (2006) found loose soils with a plasticity index (PI) < 12 and moisture content > 85% of the liquid limit are susceptible to liquefaction*”, which in the referenced article is the boundary between soils that are considered “susceptible” to liquefaction and those that are considered “moderately susceptible”. In order to assume that a soil is not potentially liquefiable, the criteria of Bray and Sancio for soils “not susceptible” to liquefaction shall be utilized, i.e., a moisture content equal to or less than 80% of the liquid limit, or a PI equal to or greater than 18. The saturated moisture content shall be utilized for the moisture content percentage of the liquid limit.

Liquefaction potential shall not be based solely on CPT data. At least one boring with SPT data for each distinct soil profile will be required for evaluation of liquefaction potential.

Seismic-induced differential settlement shall be determined as two-thirds the total seismic-induced settlement when only one boring is used to evaluate the potential for liquefaction. Seismic-induced differential settlement may be determined as one-half the total seismic-induced settlement when multiple borings are used to evaluate the potential for liquefaction.

## Types of Analyses Required

Two types of analyses are required. The first analysis shall use a Peak Ground Acceleration (PGA) corresponding to two-thirds of the  $PGA_M$ , (*Maximum Considered Earthquake-Geometric Mean,  $MCE_G$  peak ground acceleration adjusted for site effects, ASCE 7-16 Eq. 11.8-1*); and, the second analysis shall use a Peak Ground Acceleration (PGA) corresponding to the full  $PGA_M$ . The  $PGA_M$  may be obtained from the web site <https://seismicmaps.org/>.

Requirements for the two analyses are presented below.

1. Two thirds of the  $PGA_M$  Analysis

For the PGA corresponding to two-thirds of the  $PGA_M$ , seismic-induced liquefaction settlements shall be determined. The predominant earthquake magnitude may be obtained from the USGS Interactive Deaggregation web site: <https://earthquake.usgs.gov/hazards/interactive/>. A 10% probability of exceedance in 50 years (475-year return period) may be used (either modal or mean values may be assumed). Potential seismic-induced settlements shall be determined when the safety factor is less than 1.1. Under this criteria, settlements limits for the use of different foundation systems, are as follows:

Foundation Type	Total Combined Settlement (seismic plus static) (inches)	Total Combined Differential Settlement (seismic plus static) (inches)
Conventional spread/continuous	1 1/2	3/4
Mat-type	4*	2*

\*: Where the above limits are exceeded, the Department requires the use of other foundation systems or ground improvement.

2. Full  $PGA_M$  Analysis

For the PGA corresponding to the  $PGA_M$ , seismic-induced liquefaction settlements shall be determined. The predominant earthquake magnitude may be obtained from the USGS Interactive Deaggregation web site: <https://earthquake.usgs.gov/hazards/interactive/>. A 2% probability of exceedance in 50 years (2475-year return period) shall be used (either modal or mean values may be assumed). Potential seismic-induced settlements shall be determined when the safety factor is less than 1.0.

Seismically induced settlements and surface rupture due to lateral spreading shall be evaluated based on Sections 11.8 "Geologic Hazards and Geotechnical Investigation" and 12.13.9 "Requirements for Foundations on Liquefiable Sites" of ASCE/SEI 7-16 "Minimum Design Loads and Associated Criteria for Buildings and Other Structures". Values of the lateral spreading horizontal ground displacement and differential settlement over a defined length (refer to Figure C12.13-1 in the ASCE/SEI 7-16 Commentary) shall be provided. The foundation system (shallow foundations [spread or continuous footings, or mat foundations], or deep foundations), shall satisfy the specifications in Section 12.13.9 of ASCE/SEI 7-16. Where deep foundations are required, design of piles shall incorporate the effects of downdrag caused by liquefaction, lateral resistance reduced for the effects of liquefaction, and any effects due to lateral spreading.

The recommended foundation system shall satisfy the requirements under the two analyses: the "Two thirds of the  $PGA_M$  Analysis", and the "Full  $PGA_M$  Analysis".

## **Related Department Information Bulletins**

- P/BC 2020-044      EXEMPTIONS FROM LIQUEFACTION, EARTHQUAKE-INDUCED  
LANDSLIDE, AND FAULT-RUPTURE HAZARD ZONE INVESTIGATIONS
- P/BC 2020-113      CONTENTS OF REPORTS FOR SUBMITTAL TO LADBS GRADING DIVISION
- P/BC 2020-049      SLOPE STABILITY EVALUATION AND ACCEPTANCE STANDARDS
- P/BC 2020-129      SURFACE RUPTURE HAZARD INVESTIGATION