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Update of MOTEMS Division 6
Geotechnical Hazards and Foundations

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MOTEMS Development Timeline

- Approved – California State Lands Commission  August 17, 2004
- Adopted – California Building Standards Commission  January 19, 2005
- Published – California Building Standards Code (Title 24, Part 2, Vol. 2, Chapter 31F)  August 6, 2005
- First Revision in 2009 (CBC 2010)  January 1, 2011
- Second Revision in 2012 (CBC 2013)  Late 2013 (Est.)
- Third Revision in 2014/2015 (CBC 2016)  2016 (Est.)
2010 California Building Code

Chapter 31F: Marine Oil Terminals

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Typical Marine Structure/Bulkhead Types
Geotechnical Hazards
Liquefaction & Lateral Spreading

Geotechnical Hazards
Seismic Settlement & Lateral Spreading
Geotechnical Hazards
Foundation Settlement & Failure

Geotechnical Hazards
Bulkhead Failure
MOTEMS Division 6 – Upcoming Revisions

- Revisions are being made under the auspices of CSLC
- Will incorporate most recent (and future) practices adopted in several new Codes, Design Guidelines, and Criteria:
  - Port of Long Beach Wharf Design Criteria, Version 3.0 (2012)
  - Proposed ASCE Standards for Seismic Design of Pile-Supported Piers and Wharves (Est. 2013)
  - Other future codes and standards

MOTEMS Division 6: Current Version (CBC 2010)

- Section 3106F – GEOTECHNICAL HAZARDS AND FOUNDATIONS
  - 3106F.1 General
  - 3106F.2 Site Characterization
  - 3106F.3 Liquefaction
  - 3106F.4 Other Geotechnical Hazard
    - Stability of Earth Structures
    - Earthquake Induced Ground Movements
  - 3106F.5 Soil Structure Interaction
  - 3106F.6 Mitigation Measures and Alternatives
  - 3106F.7 Symbols
  - 3106F.8 References
**MOTEMS Division 6 - Revision**

**Soil-Structure Interaction (SSI)**
- **Inertial Loading**: Structure Pushes the Pile => Pile Pushes the Ground
- **Kinematic Loading**: Slope Movement => Ground Pushes the Pile

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**Inertial Loading**
- **p-y Springs**
  - Best-Estimate (Level Ground)
  - Upper Bound
  - Lower Bound
MOTEMS Division 6 - Revision

- **Kinematic Loading**

  - Use Consistent Ground Displacement and p-y Springs
  - Best-Estimate Ground Displacement and p-y Springs are appropriate
**MOTEMS Division 6 - Revisions**

**Combination of Inertial and Kinematic Loadings**

**SSI : Current Version (CBC 2010)**

3104F.2.3.1.3 Soil-structure interaction (SSI).

Load-deformation characteristics for foundations shall be modeled as per Section 3106F.5. Selection of soil springs shall be based on the following:

1. Effect of the large difference in up and down slope stiffnesses for wharf type structures
2. Effect of upper and lower bound soil parameters, especially for t-z curves used to model batter pile behavior

A separate analysis that captures the demand (Section 3104F.2.3.2) on the piles due to permanent ground deformations, at embankments only, shall be performed.

If a simplified methodology is followed, the piles need to be checked for the following load combinations:

\[ 1.0E_{\text{inertial}} \]

\[ 1.0H_d + 0.25E_{\text{inertial}} \]

**where:**

\[ E_{\text{inertial}} = \text{Inertial seismic load} \]

\[ H_d = \text{Foundation deformation load} \]
**SSI : Proposed Version (CBC 2013)**

**3106F.5 Soil structure interaction.** Two separate loading conditions for the piles shall be considered: (1) Inertial loading under seismic conditions, and (2) Kinematic loading from lateral ground spreading. Inertial loading is associated with earthquake-induced lateral loading on a structure, while kinematic loading refers to loading on foundation piles from earthquake induced lateral deformations of the slope/embankment/dike system.

*Simultaneous application of these loading conditions shall be evaluated with due consideration of the phasing and locations of these loads on foundation elements. The foundation design shall meet the structural performance requirements of this Code, when subjected to both inertial and kinematic loadings.*

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**MOTEAMS Division 6 – Additional Revisions (CBC 2016)**

- Additional revisions are anticipated in 2014/2015 to incorporate future developments related to evaluation of geotechnical hazards and foundations (CBC 2016)
THANK YOU!