**Seismic Analysis of**
**Structures and Equipment**
**by Dr. Praveen K. Malhotra, P.E.**
**15-16 February 2018 | Mumbai, India**

## Overview

Structures (and equipment) are analyzed to identify their vulnerabilities to seismic ground shaking. The analysis is carried out by applying ground motions to a mathematical model of the structure. The ground motions are defined by their response spectra or time-histories. The structure is modeled by a lumped or distributed-mass system. The nonlinearities are explicitly modeled or empirically considered. As a result, there are many different methods of analyzing a structure. The objectives of this seminar are: (a) to discuss the pros and cons of different methods of analysis; and (b) to provide an understanding of the dynamic response of structures such that the most appropriate method of analysis can be selected and the most efficient design can be generated.

## Learning Objectives

- How seismic loads are different from other loads such as gravity and wind
- Why 'deformability' and 'damping' are as important as 'strength' in seismic design
- What are the advantages of performance-based design over prescriptive design
- Why dynamic analysis is not always more accurate than a static analysis

## Who should attend?

- Structural and geotechnical engineers
- Seismologists and geologists
- Students and educators
- Architects and building officials
- Risk managers and insurers

## Training Methodology

The course is based on a balanced combination of classroom teaching and syndicate exercises supported by case studies and exercises within the industrial environment. This course is designed in with leading industry knowledge and practical case studies discussion and analysis to provide an interactive learning environment.

**Customized Training Solutions Pte. Ltd. (Registration 201621001H)**
10 Anson Road #26-04 International Plaza, Singapore 079903
Email: enquiries@ctsolutionsglobal.com
Telephone: (+65) -6524 4973 | Fax (+65) -6226-1209

**Seismic Analysis of**
**Structures and Equipment**
**by Dr. Praveen K. Malhotra, P.E.**
**15-16 February 2018 | Mumbai, India**

## Day1

### Ground Motions during Past Earthquakes

- Ground motion parameters – peak ground acceleration, velocity and displacement (PGA, PGV and PGD); number of cycles; duration
- Response spectrum of ground motion – resultant versus geometric-mean, effect of damping Pseudo-acceleration, pseudo-velocity and deformation response spectra
- Tripartite and acceleration-deformation plots of response spectra
- Smooth response spectrum from PGA, PGV and PGD

### Prediction of Future Ground Motions

- Ground motion prediction equations for PGA, PGV and PGD
- Probabilistic seismic hazard analysis for predicting future ground motions
- Site-specific ground motions for performance-based seismic design:
  a. Response spectra for static analyses
  b. Ground motion histories for one-, two- and three-dimensional dynamic analyses

### Methods of Seismic Analyses

- Linear-static (response spectrum) analysis
- Linear-dynamic (time history) analysis
- Nonlinear-static (pushover) analysis
- Nonlinear-dynamic (nonlinear time history) analysis
- Pros and cons of different methods of analyses

### Seismic Analysis of Building Structures

- Period and damping of a linear structure
- Effects of material yielding on period and damping
- Concept of deformability (ductility)
- Critical responses – plastic rotations, inter-story drifts, floor accelerations, etc.
- Pushover and damping curves
- Static versus dynamic analyses; linear versus nonlinear analyses

## Day 2

### Sliding Analysis of Equipment

- Response of anchored versus unanchored equipment
- Factors affecting sliding and rocking of unanchored equipment
- Effects of sliding on damping and deformability of the system (equipment)
- Static analysis of sliding response
- Dynamic analysis of sliding response

### Rocking Analysis of Equipment

- Effects of rocking on deformability and damping of the system (equipment)
- Static (pushover) analysis of rocking response
- Dynamic (time history) analysis of rocking response
- Toppling response spectrum of ground motion

### Seismic Analysis of Storage Racks

- Modeling nonlinearities due to sliding, material yielding, and large deflections
- Improving performance of storage-racks in cross-aisle direction
- Improving performance of storage-racks in down-aisle direction
- Critical responses – sway, sliding, hinge rotations, etc.

### Seismic Analysis of Liquid-Storage Tanks

- Modeling impulsive and convective (sloshing) actions in a liquid-storage tank
- Effects of soil-structure- interaction on deformability and damping of a storage tank
- Modeling nonlinearities due to plastic yielding, base sliding, base uplifting, soil yielding and partial uplifting of foundation
- Critical responses – sloshing wave height, base sliding, plastic rotation, base uplifting, etc.

**Customized Training Solutions Pte. Ltd. (Registration 201621001H)**
10 Anson Road #26-04 International Plaza, Singapore 079903
Email: enquiries@ctsolutionsglobal.com
Telephone: (+65) -6524 4973 | Fax (+65) -6226-1209

**Seismic Analysis of**
**Structures and Equipment**
**by Dr. Praveen K. Malhotra, P.E.**
**15-16 February 2018 | Mumbai, India**

## About the Trainer

### Dr. Praveen K. Malhotra, P.E.

After obtaining his Ph.D. in structural engineering from Rice University, Dr. Praveen Malhotra joined the California Geological Survey in Sacramento, CA. Working closely with geologists and seismologists for seven years, Dr. Malhotra closed the gap between earth sciences and engineering. Dr. Malhotra was then recruited by a worldwide property insurance company to help them understand, manage and mitigate their risk from earthquakes. Dr. Malhotra soon realized that there were two very different perspectives of risk – Aggregate Risk from insurance company's perspective and Individual Risk from insurer's perspective. Both risks needed to be addressed. After working for 13 years with the insurance company, Dr. Malhotra started his own consulting practice in 2010. He now provides services related to assessment and mitigation of risk. He publishes extensively and presents seismic training seminars throughout USA and different parts of the world. He is a licensed engineer in California and holds two patents.

**Seismic Analysis of**
**Structures and Equipment**
**by Dr. Praveen K. Malhotra, P.E.**
**15-16 February 2018 | Mumbai, India**

**Investment Fee**

| Course Title | Number of Days | Standard Price |
|---|---|---|
| Seismic Analysis of Structures and Equipment | 2 Days | SG$ 1,285.00 |

## DELEGATE DETAILS

| | |
|---|---|
| **1st Delegate Name** | **Mr□ Mrs□ Ms□ Dr□ Others□** |
| **Direct Line** | **Email** |
| **Job Title** | **Department** |
| **Head of Department** | |

| | |
|---|---|
| **2nd Delegate Name** | **Mr□ Mrs□ Ms□ Dr□ Others□** |
| **Direct Line** | **Email** |
| **Job Title** | **Department** |
| **Head of Department** | |

| | |
|---|---|
| **3rd Delegate Name** | **Mr□ Mrs□ Ms□ Dr□ Others□** |
| **Direct Line** | **Email** |
| **Job Title** | **Department** |
| **Head of Department** | |

## INVOICE DETAILS

| | |
|---|---|
| **Attention Invoice to:** | |
| **Direct Line Number** | **Fax** |
| **Company** | **Industry** |
| **Address** | **Postcode** |
| **Country** | **Email** |

**Customized Training Solutions Pte. Ltd. (Registration 201621001H)**
10 Anson Road #26-04 International Plaza, Singapore 079903
Email: enquiries@ctsolutionsglobal.com
Telephone: (+65) -6524 4973 | Fax (+65) -6226-1209

**Seismic Analysis of**
**Structures and Equipment**
**by Dr. Praveen K. Malhotra, P.E.**
**15-16 February 2018 | Mumbai, India**

**Disclaimer, Terms & Conditions:**

- Location is subject to change
- Minimum number of participants has to be reached prior to confirmation of event
- Please note that trainers and topics were confirmed at time of publishing, however, CTS may necessitate substitution, alterations or cancellations. CTS reserves the right to change or cancel any part of its published programmed due to unforeseen circumstances.
- Registrations should be made 4-8 weeks prior to training date
- Full payment for the course should be made 3-4 weeks prior to training date
- Cancellation 3 weeks prior to event date or no shows are liable to pay the full course with no refund, however you may substitute delegates at any time with notice
- Participants are required to attend at least 80% of the course program prior receipt of Certificate
- Rates are exclusive of taxes unless otherwise indicated in the invoice
- Receipt of this email to participate and/or register in any of the learning activities organized by CTS should not in any way be taken as a promise for employment or contract of employment of any kind.
- Force Majeure: Should for any reason outside the control of CTS, the trainer changes his dates or event cancels due to the act of terrorism, extreme weather conditions, industrial action or epidemic, CTS shall reserve the rights to replace the trainer or reschedule the event but the client hereby indemnifies and holds CTS harmless from and against any and all costs, damages and expenses, which are incurred by the client.

**For Payments:**

Singapore Dollar Account Details

Beneficiary Name: Customized Training Solutions Pte. Ltd
Beneficiary Bank Account No: 003-940925-7
Bank Name: DBS
Bank Address: DBS Bank Ltd.
12 Marina Boulevard, DBS Asia Central
Marina Bay Financial Centre Tower 3, Singapore 018982
Bank Code: 7171
Branch Code: 003
Swift Address: DBSSSGSG

**For more information, registration or any inquiries, kindly contact us at:**

Customized Training Solutions Pte. Ltd.
Registration No. 201621001H
Email: enquiries@ctsolutionsglobal.com/marylen@ctsolutionsglobal.com
Tel. #: +65- 6524 4973
Fax #: +65- 6226-1209