

Discussion of Ballot Items - Seismic Guide Specifications and Revised LRFD Seismic Provisions

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Background

- 2006 Draft Guide Specification
 - Approx 700 comments
 - SGSIT (Seismic Guide Spec Improvement Team) formed
- 2007 Guide Specification and Revised LRFD Seismic Provisions
 - **Parking Lot – 75 items**
 - **SGSIT reconvened**
- **2008 Draft T- 3 Ballot in January**
 - **Comments from the States**
 - **2008 AASHTO T- 3 Ballot in May**



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2007-2008 AASHTO SGSIT

Elmer Marx – AK	Derrell Manceaux – FHWA
Dan Tobias – IL	Lucero Mesa – SC
Tony Allen – WA	Stephanie Brandenberger – MT
Chyuan –Shen Lee – WA	Ian Buckle – U. of Nevada-Reno
Mark Mahan – CA	Roy Imbsen – Imbsen Consult.
Fadel Alameddine – CA	Don Anderson – CH2M HILL
Mohammed Islam – CA	Lee Marsh – BERGER/ABAM



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Summary of Parking Lot Items (2008 Ballot Effort)

- Categories and number of items on Parking Lot (75 total)
 - Ground motion and site-related items (14)
 - General structural items (28)
 - Foundation items (16)
 - Liquefaction-associated items (17)
- Status
 - Addressed all 75 items
 - Some remain on Parking Lot



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T- 3 Ballot Items

- Guide Specifications (Agenda Item 74)
 - General Structural
 - Ground Motion and Site-Related Items
 - Foundations
- Span Length – Guide Spec and LRFD (Agenda Item 75)
- Liquefaction – Guide Spec and LRFD (Agenda Item 76)



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Span Length Ballot Item

- Article 3.10.1 LRFD and Article 3.1 Guide Spec
 - Eliminates current 500-ft span-length limitation for applicability of seismic provisions
 - Reasoning:
 - Original length was arbitrary
 - Intent was to limit use to more common construction and not include specialized long-span structures
 - Adds alternate language to explicitly describe types of structures to which the specification applies
 - Benefit: Clearer guidance to designers



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Liquefaction Ballot Item

- Articles 10.5.4.2, A10.1, 2, and 3 in LRFD
 - Complete replacement of Specifications and elimination of outdated Commentary
- Article 6.8 in Guide Spec
 - Complete replacement
- Key Changes
 - Expands areas requiring liquefaction assessment
 - Improves guidance on current best practices



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Liquefaction Ballot Item Highlights

- Made LRFD and Guide Spec consistent with each other
 - Requires liquefaction assessment in Zones 3 & 4 (SDCs C & D) and suggests in Zone 2 and SDC B
 - Basis is still S_1 partitioning
 - Once assessment is triggered, site-class adjusted ground acceleration ($A_s = PGA * F_{pga}$) used for evaluation
 - Provides additional criteria for liquefaction trigger
 - Ground water within 50 ft of surface
 - Soil characteristics favorable to liquefaction
 - SPT < 25 bpf, CPT < 150, $V_s < 660$ fps, or soil unit has previously liquefied
 - For SDC B: Assess when: SPT < 10 bpf, CPT < 75 and $A_s > 0.15$



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Liquefaction Highlights (cont)

- Identifies effects of liquefaction to be considered by designer
 - Loss of soil strength
 - Ground settlement
 - Lateral movement
- Clarifies approach → Analyze 'structural' response for two conditions
 - No liquefaction
 - Liquefied soil response
 - Use non-liquefied spectrum – standard approach
 - Use of site-specific spectrum permitted with Owner's approval or direction



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Liquefaction Highlights (cont)

- Defines options for adjustment of spectrum for liquefied conditions
 - IF no site-specific ground response study performed
 - Use non-liquefied spectrum if bridge period (T) < 1 sec
 - Consider Site Class E spectrum if $T \geq 1$ sec
 - IF site-specific ground response spectrum developed
 - Cannot reduce spectrum below $2/3^{\text{rd}}$ of 'Basic Spectrum' without Owner's approval
 - Typically reductions see at short periods and increases at longer periods – hence conservative guidance given above



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Liquefaction Highlights (cont)

- Provides general guidance to designer in following areas
 - Methods for screening liquefaction susceptibility
 - Design process to follow for flow failures and lateral spreading
 - Effects of liquefaction to consider – both vertical and lateral resistance/response of foundations
 - Commentary on timing of liquefaction versus peak inertial response of structure
 - Methods for mitigating liquefaction



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Liquefaction Parking Lot Items

- Specific topics requiring future review
 - Guidance on cyclic testing of soils for liquefaction, residual strength, and settlement evaluations
 - Liquefaction screening based on water table depth
 - Currently at 50 ft
 - Should it be deeper, e.g., as deep as 75 ft?
 - Article 6.8, 5th paragraph on response spectrum
 - Liquefied case “shall” not be less than 2/3rd of general spectrum
 - Revise wording to “should”?
 - Methods for determining liquefied lateral stiffness (P-y) parameters



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Liquefaction Parking Lot Items (cont.)

- Other specific topics to address
 - Acceptable methods for estimating liquefaction settlement, particularly in silty soil
 - Approach for estimating downdrag loads after liquefaction
 - Article 3.11.8 in LRFD is potentially unconservative?
 - Capacity versus settlement approach?
 - Methods for considering soil inertial forces and liquefied conditions when assessing flow failure
 - Timing & magnitude of A_s
 - Development of liquefied residual strength



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Liquefaction Parking Lot Items (cont.)

- Other specific topics to resolve
 - Procedures to use when analyzing flow failures and lateral spreads
 - Methods for estimating lateral forces applied to foundations due to lateral spreading or flow failure
 - Minimum factor of safety against liquefaction ($FS_{liq} = CRR/CSR$) that requires consideration of liquefaction effects for a specific soil stratum
 - Use of site-specific total or effective stress numerical methods



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Guide Specification Ballot Item

- Revises each of nine sections to some extent
 - Many revisions are editorial or add definitions and clarifications
 - Some revise the application of the Provisions and are therefore more substantial
- Next slides are organized by Section



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Guide Specification Revisions

- Section 1– Introduction
 - Rewritten to eliminate narrative from the Guide Specification development
 - Includes updated general requirements for the SDCs (Seismic Design Categories)
 - Updates flowcharts showing design process
- Section 2 – Definitions
 - Includes updated definitions and notation



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Guide Specification Revisions

- Section 3 – General Requirements
 - Defines seismic ground shaking hazard in Article 3.2
 - Nominal 975-year return period (USGS → 5% in 50 years)
 - Use 7% in 75 years for site-specific hazard analyses
 - Suggests identifying ERS (Earthquake Resistance System) in SDC B in Article 3.3
 - Clarifies definitions on seismic ground shaking hazard in Article 3.4
 - Emphasizes difference between site-specific hazard and site-specific ground motion response analyses
 - Establishes when site-specific analyses required
 - Essential or critical bridges
 - Hazard not included in USGS/AASHTO maps
 - Site Class F



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Guide Specification Revisions

- Section 3 – General Requirements (cont.)
 - Adds commentary defining 'active' faults in Article 3.4
 - Clarifies methods for developing spectra in Article 3.4.1
 - Explains that spectral transition from A_s to S_{DS} is to be used in lieu of S_{DS} extending to zero period
 - Addresses long-period spectral transition
 - Provides guidance for site-specific procedures in Article 3.4.3
 - Maximum reduction is 2/3rd of the spectrum from general procedure
 - Requires Owner's approval to go below 2/3rd value
 - How to handle liquefiable and Site Class F sites



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Guide Specifications Revisions

- Section 3 – General Requirements (cont.)
 - Covers site-specific hazard analysis in Article 3.4.3.1
 - Provides guidance for both deterministic (DSHA) and probabilistic (PSHA) methods
 - Addresses NGA (Next Generation Attenuation) relationships
 - Identifies near-fault effects – though more work is needed
 - Covers site-specific ground motion response analysis Article 3.4.3.2
 - Gives guidance on when to use and what to include
 - Requires Owner's approval for nonlinear, effective stress modeling
 - Updates guidance for acceleration record selection in Article 3.4.4 – more work needed



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Guide Specifications Revisions

- Section 3 – General Requirements (cont.)
 - Revises Section 3.5 on selection of Seismic Design Category (SDC)
 - Suggests using SDC D when liquefaction-induced lateral spreading or slope failure could affect bridge
 - Updates summary of SDC basic requirements
 - Includes liquefaction assessment requirements
 - Defines new minimum transverse steel requirements for 'high' SDC A
 - Encourages ERS identification for SDC B
 - Suggests capacity checks to avoid undesirable weak links for SDC B
 - Encourages capacity design but elastic design permitted for SDC B



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Guide Specification Revisions

- Section 4 – Analysis and Design Requirements
 - Makes vertical ground motion effects non-mandatory for Essential or Critical bridges
 - Addresses foundation component of displacement for local displacement capacity assessment of columns
 - Clarifies basis of implicit displacement method for SDC B and C
 - Provides in-ground hinging ductility limits (requires Owner approval)
 - Suggests use of capacity checks in SDC B added
 - Adds commentary for plastic hinge length article



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Guide Specification Revisions

- Section 5 – Analytical Models and Procedures
 - Adds commentary for inclusion of soil effects behind abutments
 - Removes standard-size pile reference
 - Revises spread footing modeling article
 - Adds effective flexural stiffness for prestressed piling



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Guide Specification Revisions

- Section 6 – Foundation and Abutment Design
 - Revises foundation investigation Commentary to address specific seismic issues
 - Depth of investigation (characterize site to 100-ft depth)
 - Groundwater elevation
 - Cyclic testing requirements (silts, sensitive clays, etc.)
 - Clarifies hazards to evaluate and include in geotechnical report
 - Liquefaction potential, seismic-induced settlement, and lateral spreading
 - Surface rupture, lurching, cyclic loading effects



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Guide Specification Revisions

- Section 6 – Foundation and Abutment Design (cont.)
 - Updates spread footing requirements
 - Not permitted in liquefiable soils unless ground improved
 - Limits on spread footing uplift included. If uplift exceeded, then use Appendix A – Rocking
 - Revises pile-cap foundation requirements
 - Modifies to essentially match Caltrans' approach
 - Provides guidance for pile-cap passive soil resistance and side friction contributions
 - Clarifies abutment longitudinal soil resistance requirements (including use of 50% reduction factor)



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Guide Specification Revisions

- Section 7 – Structural Steel Components
 - Adds reference to LRFD force-based procedure
 - Clarifies nominal capacities (F_{ye} and $\phi = 1.0$)
 - Adds requirements for pipe steel (A53 Gr B or API 5L X52)
 - Rearranges a number of requirements to more logical sections



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Guide Specification Revisions

- Section 8 – Reinforced Concrete Components
 - Updates SDC requirements
 - SDC A: When $S_{D1} > 0.10$, minimum transverse reinforcement as for SDC B required
 - SDC B: M_{ne} can be taken as M_p ; no $M-\phi$ required
 - SDC B: Elastic shear or plastic shear of column may be used to design transverse reinforcement
 - Adds definition of ultimate curvature condition (as function permissible strains)
 - Adds detailing requirements for transverse (lateral) reinforcement for consistency with LRFD
 - Adds detailing requirements for piles



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Guide Specification Revisions

- Section 9 – References
 - Updates references
- Appendix A – Rocking
 - Adds limitations on method (i.e., method derived based on SDOF, single-column bent behavior)
 - Updates notation to match LRFD



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Comments from States

- California (Liquefaction Ballot Item)
 - Requested clear statement that liquefied soil cannot be considered for bearing resistance
 - Concur and addressed
 - Suggested using same elevation for ground water table and depth of potentially liquefiable soils (75') for liquefaction assessment threshold
 - Parking Lot
 - Provided 22 optional suggestions for consideration
 - 14 suggestions implemented, all considered



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Comments (cont.)

- California Comments on Guide Specification
 - Suggested modifying site-specific terminology as follows
 - Site-Specific Ground Motion Response Analysis > Site-Specific **Dynamic** Ground Response Analysis
 - Site-Specific Hazard Analysis > Site-specific **Ground Motion** Hazard Analysis
 - Left “as-is” for now
 - Terms currently used are common
 - Too many places to change = risk at this time



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Comments (cont)

- Texas (Span Length and Guide Spec)
 - Suggest definition of “Small to Moderate Earthquakes”, etc.
 - Language has been in specification since ATC-6
 - Recommended leaving it alone
 - Suggest adding trestle bents and drilled shafts to conventional construction list and R-factor table
 - Pile-bents are in substructure list, and ‘shafts’ are included, as well
 - Recommend leaving as is



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Comments (cont)

- Missouri (Liquefaction Ballot Item)
 - Suggest non-mandatory liquefaction assessment
 - Recommend retain mandatory language, as written
- Others
 - Suggest short-period partitioning
 - Parking Lot



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Potential Future Parking Lot Items – Other Than Liquefaction

- Handling near-fault effects
- Acceleration time histories
 - Scaling and spectral matching
 - Clarifications on uses of time histories and how that affects development
- Vertical effects
- Short-period partitioning for SDCs: S_{DS} with S_{D1}
- Abutment design for seismic earth pressures (active and passive) – incorporate NCHRP 12-70 recommendations



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Potential Future Parking Lot Items – Other Than Liquefaction (cont.)

- Pile group effects - group reduction factors for P-y curves for seismic loading
- Use of FEMA 273 versus FEMA 356 to adjust the soil shear modulus for spread footing springs
- Abutment modeling and design procedures – improve shear key fusing procedures
- Eventual conversion of steel substructure design from force-based to displacement-based approach
- Improvement to concrete piling provisions – update as current research is completed



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Current Status

- AASHTO currently combining 2007 Guide Specification and 2008 Ballot Item into single document
- Target date for availability
 - November 2008



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