Civil Engineer Examination
Seismic Principles Test Plan
*July 2006**

Definition of Seismic Principles:
Seismic Principles is defined as the fundamental principles, tasks and knowledges underlying those activities involved in the California practice of seismic design, seismic analysis or seismic evaluation of new and existing civil engineering projects such as:

- buildings
- non-building structures
- non-structural components, equipment and lifelines

This area of practice is structured into five primary content areas:

A. Seismic Data and Seismic Design Criteria (25%)
B. Seismic Characteristics of Engineered Systems (16%)
C. Seismic Forces (32%)
D. Seismic Analysis Procedures (16%)
E. Seismic Detailing and Construction Quality Control (11%)

Glossary of Seismic Principles Terms

Please note that these abilities are arranged hierarchically from the least complex to the most complex. That is, **recognize** constitutes the least complex ability in the hierarchy and **perform** constitutes the most complex. Each ability presupposes all abilities preceding it in the hierarchy. For example, the ability to **determine** presupposes the abilities to **recognize** and **understand.**

As used in the test plan task statements, the following abilities are defined as:

Recognize	To know or identify seismic principles from past experience or knowledge.
Understand	To recognize and comprehend seismic principles.
Determine	To identify and select after consideration, investigation or calculation seismic forces or systems.
Perform	To execute and complete a task in accordance with seismic principles.

(**NOTE:** As used throughout this Test Plan, the term **applicable code** refers to the **current California Building Code** ***including the adopted edition of ASCE 7***.)

* *Reviewed August 2007 relative to the adoption of the IBC. Annotations and revisions are italicized.*

A. SEISMIC DATA AND SEISMIC DESIGN CRITERIA (25%)

Tasks required for the development of the project seismic design methodology considering the effects that the seismic environment has on the civil engineering project.

SPA1. Understand geological and geotechnical issues that may influence design of projects.

- SPA1.1 Knowledge of geologic seismic hazards and geotechnical data that affect design, including liquefaction.
- SPA1.2 Knowledge of site related seismic coefficients.
- SPA1.3 Knowledge of soil-structure interaction, including the effective natural period of the structure and the expected period of the seismic ground motion.

SPA2. Recognize design performance goals for a project.

- SPA2.1 Knowledge of the seismic design philosophy of the applicable code.

SPA3. Recognize laws, codes and standards governing seismic design.

- SPA3.1 Knowledge of laws regulating civil engineering/limits of practice.
- SPA3.2 Knowledge of the applicable codes for civil engineering construction.

B. SEISMIC CHARACTERISTICS OF ENGINEERED SYSTEMS (16%)

Tasks required to select new seismic structural systems, to understand the methods of strengthening existing structural systems and to recognize seismic performance and damage vulnerability of structures.

SPB4. Understand appropriate seismic resisting structural systems.

- SPB4.1 Knowledge of the different structural systems and their design parameters.
- SPB4.2 Knowledge of the influence of structural configuration on torsional response (e.g., plan irregularities, unbalanced resistance).
- SPB4.3 Knowledge of requirements for a structure having vertical irregularities (e.g., vertical discontinuities, offsets, soft stories).
- SPB4.4 Knowledge of drift and P-Delta to control deflections.
- SPB4.5 Knowledge of effects of ductility, damping redistribution and redundancy on seismic performance.

SPB5. Recognize vulnerability of structures with previous poor seismic performance.

- SPB5.1 Knowledge of anchorage and stability in unreinforced masonry (URM) bearing wall buildings.
- SPB5.2 Knowledge of buckling or brittle connections in steel-braced frames.
- SPB5.3 Knowledge of assemblies with weak connections in precast concrete structures.
- SPB5.4 Knowledge of punching shear problems in flat slab concrete structures.
- SPB5.5 Knowledge of diaphragm-wall connection problems in tilt-up and masonry industrial buildings.
- SPB5.6 Knowledge of welded connection problems in steel moment frames.
- SPB5.7 Knowledge of seismic performance of residential buildings with weak cripple walls, non-anchored foundations, pier/post foundations and buildings with parking that create a soft story.
- SPB5.8 Knowledge of post-earthquake safety evaluation.

SPB6. Understand methods for seismic strengthening of existing structures.

- SPB6.1 Knowledge of methods and effects of adding overall strength.
- SPB6.2 Knowledge of methods and effects of adding stiffness to protect brittle elements.
- SPB6.3 Knowledge of methods and effects of improving ductility of brittle elements.
- SPB6.4 Knowledge of methods and effects of strengthening problematic elements or connections in structural systems.

C. SEISMIC FORCES (32%)

Tasks required for the determination and distribution of seismic forces.

SPC7. Determine structural characteristics required to calculate seismic design forces.

SPC7.1 Knowledge of mass and stiffness.
SPC7.2 Knowledge of methods to determine the structure's fundamental period.
SPC7.3 Knowledge of ~~*reliability*~~, redundancy and other seismic factors.

SPC8. Determine seismic design forces for buildings.

SPC8.1 Knowledge of static force procedures. *(Note: 'static force procedures' refers to equivalent lateral force procedures.)*
SPC8.2 Knowledge of choice and application of structural system seismic coefficients.
SPC8.3 Knowledge of choice and application of seismic importance factors.
SPC8.4 Knowledge of design base shear.

SPC9. Perform vertical distribution of seismic forces for buildings.

SPC9.1 Knowledge of vertical force distribution methods.

SPC10. Determine seismic diaphragm forces.

SPC10.1 Knowledge of forces on diaphragm elements of structures.

SPC11. Determine seismic forces for elements of structures. *(Note: 'elements of structures' refers to 'Architectural Components.')*

SPC11.1 Knowledge of design seismic forces for elements of structures.
SPC11.2 Knowledge of horizontal force factors for elements of structures.

SPC12. Determine seismic forces for non-structural components, equipment and lifelines.
(Note: 'non-structural components' refers to 'Mechanical and Electrical Components')

SPC12.1 Knowledge of design seismic forces.
SPC12.2 Knowledge of horizontal force factors.

SPC13. Determine seismic forces for non-building structures.

SPC13.1 Knowledge of choice and application of non-building structural system seismic coefficients.
SPC13.2 Knowledge of design lateral force formulas.

D. SEISMIC ANALYSIS PROCEDURES (16%)

Tasks required for the analysis of engineered structures.

SPD14. Perform analysis of lateral load resisting systems.

SPD14.1 Knowledge of applicable load combinations.
SPD14.2 Knowledge of distribution of internal and external forces.
SPD14.3 Knowledge of deflection and drift requirements.

SPD15. Perform the distribution of seismic forces to structural elements based on their rigidities.

SPD15.1 Knowledge of methods used to calculate rigidities of structural elements, including the effects of fixed, pinned or semi-rigid member end conditions.
SPD15.2 Knowledge of distribution of seismic forces based on rigidity.
SPD15.3 Knowledge of diaphragm chord forces, drag forces and diaphragm shear.

SPD16. Perform the seismic analysis of rigid diaphragm structures.

SPD16.1 Knowledge of assumptions controlling the analysis for rigid diaphragms.
SPD16.2 Knowledge of methods to determine centers of rigidity and mass.
SPD16.3 Knowledge of methods to distribute shear forces to structural elements.
SPD16.4 Knowledge of horizontal torsional moment requirements.

SPD17. Perform the seismic analysis of flexible diaphragm structures.

SPD17.1 Knowledge of assumptions controlling the analysis of flexible diaphragms.
SPD17.2 Knowledge of sub-diaphragm analysis.

E. SEISMIC DETAILING AND CONSTRUCTION QUALITY CONTROL (11%)

Tasks required for the seismic detailing of structural elements and assemblies and for the quality control requirements necessary to assure seismic performance.

SPE18. Understand the detailing requirements that are critical for seismic performance.

- SPE18.1 Knowledge of seismic detailing and inherent seismic performance characteristics for steel.
- SPE18.2 Knowledge of seismic detailing and inherent seismic performance characteristics for concrete.
- SPE18.3 Knowledge of seismic detailing and inherent seismic performance characteristics for masonry.
- SPE18.4 Knowledge of seismic detailing and inherent seismic performance characteristics for wood.
- SPE18.5 Knowledge of deformation compatibility requirements for non-structural elements and building separations.
- SPE18.6 Knowledge of requirements for ties and continuity, collectors or drags.
- SPE18.7 Knowledge of requirements for anchorage of concrete and masonry walls.

SPE19. Recognize need for construction quality control of the seismic design aspects of the project.

- SPE19.1 Knowledge of testing requirements.
- SPE19.2 Knowledge of special inspection requirements.
- SPE19.3 Knowledge of structural observation requirements.