

National Council of Examiners for Engineering and Surveying

Principles and Practice of Engineering Structural Examination

Effective Beginning with the April 2011 Examination

The structural engineering exam is a breadth and exam examination offered in **two components** on successive days. The 8-hour Vertical Forces (Gravity/Other) and Incidental Lateral component is offered only on Friday and focuses on gravity loads and lateral earth pressures. The 8-hour Lateral Forces (Wind/Earthquake) component is offered only on Saturday and focuses on wind/earthquake loads.

To become a licensed structural engineer, **examinees must pass both components**. The components may be taken and passed in different exam administrations.

Each component of the structural exam has a breadth (morning) module and a depth (afternoon) module.

- **Breadth exam** (morning session): This module contains questions covering a comprehensive range of structural engineering topics. All questions are multiple-choice.
- **Depth exams** (afternoon session): These modules focus more closely on a single area of practice in structural engineering. Examinees must choose either buildings or bridges. Examinees must work the same topic area on both components. That is, if buildings is the topic area chosen in the Vertical Forces component, then buildings must be the topic area chosen in the Lateral Forces component. All questions are constructed response (essay).

Examinees must take the breadth module of each component and **one** of the two depth modules in each component.

Detailed listings of topics in each component are shown in the following sections:

Friday Morning: PE Structural breadth exam – Vertical Forces (Gravity/Other) and Incidental Lateral

Friday Afternoon: PE Structural depth exam – Vertical Forces (Gravity/Other) and Incidental Lateral

Saturday Morning: PE Structural breadth exam – Lateral Forces (Wind/Earthquake)

Saturday Afternoon: PE Structural depth exam – Lateral Forces (Wind/Earthquake)

National Council of Examiners for Engineering and Surveying
Principles and Practice of Engineering
Vertical Forces (Gravity/Other) and Incidental Lateral Component of the
Structural BREADTH Examination

Effective Beginning with the April 2011 Examination

The 4-hour **Vertical Forces (Gravity/Other) and Incidental Lateral** breadth examination is offered on Friday morning and focuses on gravity loads.

	Approximate Percentage of Examination
I. Analysis of Structures	30%
A. Loads	10%
1. Dead	
2. Live	
3. Snow, including drifting	
4. Moving (e.g., vehicular, pedestrian, crane)	
5. Thermal	
6. Shrinkage and creep	
7. Impact (e.g., vehicular, crane, and elevator)	
8. Settlement	
9. Ponding	
10. Fluid	
11. Ice	
12. Static earth pressure	
13. Hydrostatic	
14. Hydraulics (e.g., stream flow, wave action, scour, flood)	
B. Methods	20%
1. Statics (e.g., determinate, location of forces and moments, free-body diagrams)	
2. Shear and moment diagrams	
3. Code coefficients and tables	
4. Computer-generated structural analysis techniques (e.g., modeling, interpreting, and verifying results)	
5. Simplified analysis methods (e.g., influence lines, portal frame method/cantilever method)	
6. Indeterminate analysis methods (e.g., deflection compatibility)	
II. Design and Details of Structures	65%
A. General Structural Considerations	7.5%
1. Material properties and standards	
2. Load combinations	
3. Serviceability requirements	
(a) Deflection	
(b) Camber	
(c) Vibration	

	Approximate Percentage of Examination
4. Fatigue (for AASHTO concrete and steel)	
5. Bearings	
6. Expansion joints	
7. Corrosion	
B. Structural Systems Integration	2.5%
1. Specifications, quality controls and coordination with other disciplines	
2. Constructability	
3. Construction sequencing	
4. Strengthening existing systems: reinforcing methods	
C. Structural Steel	12.5%
1. Tension members	
2. Columns and compression members	
3. Base plates	
4. Beams	
5. Plate girders—straight	
6. Plate girders—curved	
7. Trusses	
8. Beam-columns	
9. Connections—welded	
10. Connections—bolted	
11. Moment connections	
12. Weld design	
13. Composite steel design	
14. Relief angle (e.g., masonry support angle, facade support angle)	
15. Bridge piers	
16. Bridge cross-frame diaphragms	
D. Light Gage/Cold-Formed Steel	2.5%
1. Framing	
2. Connections	
3. Web crippling	
E. Concrete	12.5%
1. Flexural members (e.g., beams, joists, bridge decks, and slabs)	
2. Design for shear	
3. Columns and compression members	
4. Two-way slab systems	
5. Pre-tensioned concrete	
6. Post-tensioned concrete	
7. Attachment of elements and anchorage to concrete (e.g., inserts, attachment plates, dowels)	
8. Bridge piers	

	Approximate Percentage of Examination
9. Crack control	
10. Composite design	
11. Slab-on-grade	
F. Wood	10%
1. Sawn beams	
2. Glue-laminated beams	
3. Engineered lumber	
4. Columns	
5. Bearing walls	
6. Trusses	
7. Bolted, nailed, and screwed connections	
G. Masonry	7.5%
1. Flexural members	
2. Compression members	
3. Bearing walls	
4. Detailing (e.g., crack control, deflection, masonry openings)	
H. Foundations and Retaining Structures	10%
1. Use of design pressure coefficients (e.g., active, passive, at rest, bearing, coefficient of friction, cohesion)	
2. Selection of foundation systems (e.g., based on geotechnical information, boring logs, settlement, and groundwater table)	
3. Overturning, sliding and bearing	
4. Combined footings/mat foundations	
5. Piles (concrete, steel, timber)	
6. Drilled shafts/drilled piers/caissons	
7. Gravity walls	
8. Anchored walls	
9. Cantilever walls	
10. Basement walls for buildings	
11. Effect of adjacent loads	
12. Use of modulus of sub-grade reaction	
III. Construction Administration	5%
A. Procedures for Mitigating Nonconforming Work	
B. Inspection Methods	

Notes

1. The examination is developed with questions that will require a variety of approaches and methodologies including design, analysis, and application.
2. The knowledge areas specified under 1, 2, 3, etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
3. The breadth (AM) exam contains 40 multiple-choice questions. Examinee works all questions.
4. Score results are combined with depth exam results for final score of this component.

National Council of Examiners for Engineering and Surveying
Principles and Practice of Engineering
Vertical Forces (Gravity/Other) and Incidental Lateral Component of the
Structural DEPTH Examination

Effective Beginning with the April 2011 Examination

The 4-hour **Vertical Forces (Gravity/Other) and Incidental Lateral** depth examination is offered on Friday afternoon. The depth modules of the Structural exam focus on a single area of practice in structural engineering. Examinees must choose either the **BUILDINGS** or the **BRIDGES** module. Examinees must work the same module on both components. That is, if bridges is the module chosen in the Vertical Forces component, then bridges must be the module chosen in the Lateral Forces component. All questions are constructed response (essay).

BUILDINGS

The **Vertical Forces (Gravity/Other) and Incidental Lateral** Structural depth exam in **BUILDINGS** covers loads, lateral earth pressures, analysis methods, general structural considerations (element design), structural systems integration (connections), and foundations and retaining structures. This module contains four 1-hour problems in each of the following areas:

- Steel structure
- Concrete structure
- Wood structure
- Masonry structure

At least one problem includes a multistory building, and at least one problem includes a foundation.

BRIDGES

The **Vertical Forces (Gravity/Other) and Incidental Lateral** Structural depth exam in **BRIDGES** covers gravity loads, superstructures, substructures, and lateral loads other than wind and seismic and may test pedestrian bridge and/or vehicular bridge knowledge. This module contains one 2-hour **BRIDGE** problem and two 1-hour **BRIDGE** problems, as indicated below:

- Steel superstructure (2 hours)
- Concrete superstructure (1 hour)
- Other elements of bridges (e.g., culverts, abutments, retaining walls) (1 hour)

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Principles and Practice of Engineering Lateral Forces (Wind/Earthquake) Component of the Structural BREADTH Exam

Effective Beginning with the April 2011 Examination

The 4-hour **Lateral Forces (Wind/Earthquake)** breadth examination is offered on Saturday morning and focuses on wind/earthquake loads.

	Approximate Percentage of Examination
I. Analysis of Structures	37%
A. Lateral Forces	10%
1. Wind	
2. Horizontal seismic	
3. Vertical seismic	
4. Dynamic earth pressure	
B. Lateral Force Distribution	22%
1. Statics (e.g., determinate and indeterminate, location of forces and moments, free-body diagrams)	
2. Seismic design categories (C and lower)	
3. Seismic design categories (D and higher)	
4. Seismic static force procedures	
5. Seismic dynamic force procedures	
6. Configuration of a structural system to resist effects of horizontal torsional moments	
7. Relative rigidity force distribution	
8. Horizontal/plan and vertical irregularities	
9. Flexible diaphragms	
10. Rigid diaphragms	
11. Simplified wind	
12. Wind analytic procedures	
13. Wind components and cladding	
14. Main wind force resisting systems	
C. Methods	5%
1. Computer-generated structural analysis techniques (e.g., modeling, interpreting, and verifying results)	
2. Simplified analysis methods (e.g., influence lines, portal frame method/cantilever method)	
II. Design and Detailing of Structures	60%
A. General Structural Considerations	7.5%
1. Load combinations	
2. Serviceability requirements: building drift	
3. Anchorage of a structural system to resist uplift and sliding forces	

	Approximate Percentage of Examination
4. Components, attachments, and cladding	
5. Redundancy factors	
6. Overstrength	
7. Ductility requirements	
8. Abutment/pier seat width	
B. Structural Systems Integration	5%
1. Structural systems to resist effects of lateral forces	
2. Constructability	
3. Strengthening existing systems: seismic retrofit	
a. Details	
b. System compatibility	
C. Structural Steel	10%
1. Ordinary moment frames	
2. Intermediate moment-resisting frames	
3. Special moment-resisting frames	
4. Bracing	
5. Ordinary concentric braced frames	
6. Special concentric braced frames	
7. Eccentric braced frames	
8. Bridge piers	
D. Light Gage/Cold-Formed Steel	2.5%
1. Metal deck diaphragms	
2. Light-framed wall systems (e.g., shearwall systems)	
E. Concrete	12.5%
1. Ordinary or intermediate shear walls	
2. Special shear walls	
3. Ordinary or intermediate moment-resisting frames	
4. Special moment-resisting frames	
5. Diaphragms	
6. Reinforcement details (e.g., ductile detailing, anchorage)	
7. Bridge piers	
8. Tilt-up construction	
F. Wood	7.5%
1. Shear walls	
2. Plywood diaphragms (e.g., drag struts, chords)	
3. Plywood sub-diaphragms	
G. Masonry	7.5%
1. Flexural-compression members	
2. Slender walls	
3. Ordinary or intermediate shear walls	
4. Special shear walls	

	Approximate Percentage of Examination
5. Anchorage for walls (e.g., out-of-plane)	
6. Attachment of elements to masonry	
H. Foundations and Retaining Structures	7.5%
1. Spread footings	
2. Piles (concrete, steel, timber)	
3. Drilled shafts/drilled piers/caissons	
III. Construction Administration	3%
A. Structural observation	

Notes

1. The examination is developed with questions that will require a variety of approaches and methodologies including design, analysis, and application.
2. The knowledge areas specified under 1, 2, 3, etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
3. The breadth (AM) exam contains 40 multiple-choice questions. Examinee works all questions.
4. Score results are combined with depth exam results for final score of this component.

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Principles and Practice of Engineering Lateral Forces (Wind/Earthquake) Component of the Structural DEPTH Examination

Effective Beginning with the April 2011 Examination

The **4-hour Lateral Forces (Wind/Earthquake)** depth examination is offered on Saturday afternoon. The depth modules of the Structural exam focus on a single area of practice in structural engineering. Examinees must choose either the **BUILDINGS** or the **BRIDGES** module. Examinees must work the same module on both components. That is, if bridges is the module chosen in the Vertical Forces component, then bridges must be the module chosen in the Lateral Forces component. All questions are constructed response (essay).

BUILDINGS

The **Lateral Forces (Wind/Earthquake)** Structural depth exam in **BUILDINGS** covers lateral forces, lateral force distribution, analysis methods, general structural considerations (element design), structural systems integration (connections), and foundations and retaining structures. This module contains four 1-hour problems in the following areas:

- Steel structure
- Concrete structure
- Wood and/or masonry structure
- General analysis (e.g., existing structures, secondary structures, nonbuilding structures, and/or computer verification)

At least two problems include seismic content at Seismic Design Category D and above.

At least one problem includes wind content of at least 110 mph.

Problems may include a multistory building.

Problems may include a foundation.

BRIDGES

The **Lateral Forces (Wind/Earthquake)** Structural depth exam in **BRIDGES** covers gravity loads, superstructures, substructures, and lateral forces and may test pedestrian bridge and/or vehicular bridge knowledge. This module contains one 2-hour **BRIDGE** problem and two 1-hour **BRIDGE** problems, as indicated below:

- Columns (1 hour)
- Footings (1 hour)
- General analysis (i.e., seismic and/or wind) (2 hours)