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Vertical Forces (Gravity/Other) and Incidental Lateral Component of the Structural Engineering BREADTH Exam Specifications

Effective Beginning with the April 2018 Examinations

- The 4-hour **Vertical Forces (Gravity/Other) and Incidental Lateral** breadth examination is offered on Friday morning and focuses on gravity loads. It contains 40 multiple-choice questions.
- The exam uses the US Customary System (USCS) of units.
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.
- Score results are combined with depth exam results for final score of this component.

	Approximate Number of Questions
I. Analysis of Structures	**13**
A. Generation of Loads	5
1. Dead	
2. Live (e.g., occupancy, roof, pedestrian)	
3. Moving (e.g., vehicular, crane)	
4. Impact (e.g., vehicular, crane, elevator)	
5. Vessel collision	
6. Earth pressure	
7. Differential settlement	
8. Hydrostatic/hydrodynamic	
9. Flood	
10. Snow	
11. Rain (i.e., ponding)	
12. Ice	
13. Thermal	
14. Shrinkage	
15. Load combinations	
16. Wind and other loads on bridges	
B. Load Distribution and Analysis Methods	8
1. Static (e.g., determinate and indeterminate, location of forces and moments, free-body diagrams)	
2. Shear and moment diagrams	
3. Code coefficients and tables	
4. Truss analysis methods (i.e., method of sections and/or method of joints)	
5. Approximate beam or truss analysis methods	
6. Approximate frame analysis methods	

7. Influence lines
8. Computer-generated structural analysis techniques (e.g., modeling, interpreting and verifying results)

II. Design and Details of Structures — 27

A. General Structural Considerations — 3
1. Material properties and standards
2. Construction administration (procedures for correcting nonconforming work, testing methods, inspection methods, structural observation)
3. Environmental considerations (e.g., corrosion, frost depth, sustainability)
4. Serviceability requirements (i.e., deflection, camber, vibration, creep, movement joints)
5. Fatigue (e.g., AASHTO, AISC)
6. Bridge bearings
7. Bridge expansion joints
8. Bridge barriers

B. Structural Systems Integration — 2
1. Specifications, quality controls, and coordination with other disciplines
2. Constructability
3. Construction sequencing
4. Strengthening existing systems

C. Structural Steel — 5
1. Tension members
2. Columns and compression members
3. Trusses
4. Flexural members (e.g., beams)
5. Plate girders—straight
6. Secondary support systems (e.g., masonry support angles, facade support angles, struts)
7. Shear in steel members
8. Combined axial and flexural members
9. Composite design
10. Bolted connections
11. Welded connections
12. Base plates/bearing plates
13. Thermal effects
14. Bridge piers

D. Cold-Formed Steel — 1
1. Framing
2. Connections
3. Web crippling

E. Concrete — 5
1. Flexural members (e.g., beams, joists, bridge decks, one-way slabs)
2. Two-way slabs
3. Design for shear (e.g., beam, punching shear, shear friction)
4. Columns and compression members
5. Bridge piers/abutments
6. Walls

7. Prestressed concrete
8. Post-tensioned concrete
9. Composite design
10. Attachment of elements and anchorage to concrete (e.g., inserts, attachment plates, dowels)
11. Crack control

F. Wood 4
1. Beams (i.e., sawn, glued laminated, structural composite/engineered)
2. Columns
3. Bearing walls
4. Trusses
5. Connections (e.g., bolted, nailed, screwed)

G. Masonry 3
1. Flexural members
2. Compression members
3. Flexural-compression members
4. Bearing walls
5. Attachment of elements to masonry

H. Foundations and Retaining Structures 4
1. Use of design pressure coefficients (e.g., active, passive, at rest, bearing, coefficient of friction, cohesion, modulus of sub-grade reaction)
2. Buoyancy effects
3. Retaining walls and abutments
4. Spread footings
5. Combined footings/mat foundations
6. Piles (e.g., concrete, steel, timber)
7. Drilled shafts/drilled piers/caissons
8. Restrained walls (e.g., basement, vault)

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Vertical Forces (Gravity/Other) and Incidental Lateral Component of the Structural Engineering DEPTH Exam Specifications

Effective Beginning with the April 2018 Examination

The 4-hour **Vertical Forces (Gravity/Other) and Incidental Lateral** depth examination is offered on Friday afternoon. The depth modules of the Structural Engineering 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).

The exam uses the US Customary System (USCS) of units.

BUILDINGS

The **Vertical Forces (Gravity/Other) and Incidental Lateral** Structural Engineering 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 4-hour module contains one problem from each of the following areas:

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

All problems are equally weighted. 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 Engineering depth exam in **BRIDGES** covers gravity loads, superstructures, substructures, and lateral loads other than wind and seismic. This 4-hour module contains three problems, one from each of the following areas:

- Concrete superstructure (25% of your score)
- Other elements of bridges (e.g., culverts, abutments, retaining walls) (25% of your score)
- Steel superstructure (50% of your score)

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Lateral Forces (Wind/Earthquake) Component of the Structural Engineering BREADTH Exam Specifications

Effective Beginning with the April 2018 Examination

- The 4-hour **Lateral Forces (Wind/Earthquake)** breadth examination is offered on Saturday morning and focuses on wind/earthquake loads. It contains 40 multiple-choice questions.
- The exam uses the US Customary System (USCS) of units.
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.
- Score results are combined with depth exam results for final score of this component.

	Approximate Number of Questions
I. Analysis of Structures	**15**
A. Generation of Loads	7
1. Horizontal seismic	
2. Vertical seismic	
3. Dynamic seismic lateral earth pressure	
4. Wind loads on buildings—MWFRS (directional procedure)	
5. Wind loads on buildings—MWFRS (envelope procedure)	
6. Wind loads on other structures and building appurtenances—MWFRS	
7. Wind loads—components and cladding (C&C)	
8. Wind loads on bridges	
9. Load combinations	
B. Load Distribution and Analysis Methods	8
1. Statics (e.g., determinate and indeterminate, location of forces and moments, free-body diagrams)	
2. Approximate frame analysis methods	
3. Computer-generated structural analysis techniques (e.g., modeling, interpreting, and verifying results)	
4. Seismic static force procedures	
5. Seismic dynamic force procedures	
6. Seismic irregularities (e.g., horizontal and vertical)	
7. Horizontal torsional moments	
8. Relative rigidity force distribution	
9. Flexible diaphragms	
10. Rigid diaphragms	
11. Wind load distribution	

II. Design and Details of Structures — 25

A. General Structural Considerations — 3
   1. Construction administration (procedures for correcting nonconforming work, testing methods, inspection methods, structural observation)
   2. Serviceability requirements (i.e., deflection, building drift)
   3. Anchorage of a structural system to resist uplift and sliding forces
   4. Components, attachments, and cladding
   5. Seismic coefficients (e.g., response modification factor, redundancy factor, overstrength factor, deflection amplification factor)
   6. Abutment/pier seat width

B. Structural Systems Integration — 2
   1. General structural systems selection based on design criteria (e.g., height limits, foundation considerations)
   2. Specifications, quality controls, and coordination with other disciplines
   3. Constructability
   4. Strengthening existing systems (e.g., details, system compatibility, reinforcing methods)

C. Structural Steel — 5
   1. Braced frames
   2. Moment resisting frames
   3. Dual systems
   4. Cantilever columns
   5. Bridge piers
   6. Bridge bracing elements

D. Cold-Formed Steel — 1
   1. Steel diaphragms
   2. Bearing wall systems (e.g., shear wall systems, flat strap bracing)

E. Concrete — 5
   1. Shear walls
   2. Moment resisting frames
   3. Diaphragms
   4. Bridge piers/abutments
   5. Bridge reinforcement details (e.g., ductile detailing, anchorage)

F. Wood — 3
   1. Diaphragms (e.g., drag struts, chords)
   2. Sub-diaphragms
   3. Shear walls

G. Masonry — 3
   1. Out-of-plane (i.e., slender walls)
   2. Shear walls
   3. Anchorage of walls (e.g., out-of-plane, uplift)
   4. Attachment of elements to masonry

H. Foundations and Retaining Structures — 3
   1. Retaining walls and abutments
   2. Spread footings
   3. Piles (e.g., concrete, steel, timber)
   4. Drilled shafts/drilled piers/caissons

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Lateral Forces (Wind/Earthquake) Component of the Structural Engineering DEPTH Exam Specifications

Effective Beginning with the April 2018 Examination

The 4-hour **Lateral Forces (Wind/Earthquake)** depth examination is offered on Saturday afternoon. The depth modules of the Structural Engineering 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).

The exam uses the US Customary System (USCS) of units.

BUILDINGS

The **Lateral Forces (Wind/Earthquake)** Structural Engineering 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 4-hour module contains one problem from each of 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)

All problems are equally weighted.

At least two problems include seismic content at Seismic Design Category D and above.
At least one problem includes wind content of at least 140 mph.
Problems may include a multistory building.
Problems may include a foundation.

BRIDGES

The **Lateral Forces (Wind/Earthquake)** Structural Engineering depth exam in **BRIDGES** covers gravity loads, superstructures, substructures, and lateral forces (including seismic). This 4-hour module contains three problems, one from each of the following areas:

- Piers or abutments (25% of your score)
- Foundations (25% of your score)
- General analysis of seismic forces (50% of your score)