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## NCEES Principles and Practice of Engineering Examination
# CIVIL–GEOTECHNICAL CBT Exam Specifications
**Effective Beginning April 1, 2022**

- The exam topics have not changed since April 2015 when they were originally published.
- The exam is computer-based. It is closed book with electronic references. Design standards applicable to the PE Civil–Geotechnical exam are shown on the last two pages.
- Examinees have 9 hours to complete the exam, which contains 80 questions. The 9-hour time includes a tutorial and an optional scheduled break. Examinees work all questions.
- The exam uses both the International System of units (SI) and the US Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The examples specified in knowledge areas are not exclusive or exhaustive.

| | | Number of Questions |
|---|---|---|
| **1.** | **Project Planning** | **4–6** |
| | A. Quantity take-off methods | |
| | B. Cost estimating | |
| | C. Project schedules | |
| | D. Activity identification and sequencing | |
| **2.** | **Means and Methods** | **3–5** |
| | A. Construction loads | |
| | B. Construction methods | |
| | C. Temporary structures and facilities | |
| **3.** | **Soil Mechanics** | **5–8** |
| | A. Lateral earth pressure | |
| | B. Soil consolidation | |
| | C. Effective and total stresses | |
| | D. Bearing capacity | |
| | E. Foundation settlement | |
| | F. Slope stability | |
| **4.** | **Structural Mechanics** | **5–8** |
| | A. Dead and live loads | |
| | B. Trusses | |
| | C. Bending (e.g., moments and stresses) | |
| | D. Shear (e.g., forces and stresses) | |
| | E. Axial (e.g., forces and stresses) | |
| | F. Combined stresses | |
| | G. Deflection | |
| | H. Beam | |
| | I. Columns | |
| | J. Slabs | |

K. Footings
L. Retaining walls

**5. Hydraulics and Hydrology** **6–9**

A. Open-channel flow
B. Stormwater collection and drainage (e.g., culvert, stormwater inlets, gutter flow, street flow, storm sewer pipes)
C. Storm characteristics (e.g., storm frequency, rainfall measurement and distribution)
D. Runoff analysis (e.g., Rational and SCS/NRCS methods, hydrographic application, runoff time of concentration)
E. Detention/retention ponds
F. Pressure conduit (e.g., single pipe, force mains, Hazen-Williams, Darcy-Weisbach, major and minor losses)
G. Energy and/or continuity equation (e.g., Bernoulli)

**6. Geometrics** **3–5**

A. Basic circular curve elements (e.g., middle ordinate, length, chord, radius)
B. Basic vertical curve elements
C. Traffic volume (e.g., vehicle mix, flow, and speed)

**7. Materials** **5–8**

A. Soil classification and boring log interpretation
B. Soil properties (e.g., strength, permeability, compressibility, phase relationships)
C. Concrete (e.g., nonreinforced, reinforced)
D. Structural steel
E. Material test methods and specification conformance
F. Compaction

**8. Site Development** **4–6**

A. Excavation and embankment (e.g., cut and fill)
B. Construction site layout and control
C. Temporary and permanent soil erosion and sediment control (e.g., construction erosion control and permits, sediment transport, channel/outlet protection)
D. Impact of construction on adjacent facilities
E. Safety (e.g., construction, roadside, work zone)

**9. Site Characterization** **4–6**

A. Interpretation of available existing site data and proposed site development data (e.g., aerial photography, geologic and topographic maps, GIS data, as-built plans, planning studies and reports)
B. Subsurface exploration planning
C. Geophysics (e.g., GPR, resistivity, seismic methods)
D. Drilling techniques (e.g., hollow stem auger, cased boring, mud rotary, air rotary, rock coring, sonic drilling)
E. Sampling techniques (e.g., split-barrel sampling, thin-walled tube sampling, handling and storage)
F. In situ testing (e.g., standard penetration testing, cone penetration testing, pressure meter testing, dilatometer testing, field vane shear)
G. Description and classification of soils (e.g., Burmeister, Unified Soil Classification System, AASHTO, USDA)
H. Rock classification and characterization (e.g., recovery, rock quality designation, RMR, weathering, orientation)
I. Groundwater exploration, sampling, and characterization

**10. Soil Mechanics, Laboratory Testing, and Analysis** **4–6**

A. Index properties and testing
B. Strength testing of soil and rock
C. Stress-strain testing of soil and rock
D. Permeability testing properties of soil and rock
E. Effective and total stresses

**11. Field Materials Testing, Methods, and Safety** **3–5**

A. Excavation and embankment, borrow source studies, laboratory and field compaction
B. Trench and construction safety
C. Geotechnical instrumentation (e.g., inclinometer, settlement plates, piezometer, vibration monitoring)

**12. Earthquake Engineering and Dynamic Loads** **2–4**

A. Liquefaction analysis and mitigation techniques
B. Seismic site characterization, including site classification using ASCE 7
C. Pseudo-static analysis and earthquake loads

**13. Earth Structures** **4–6**

A. Slab on grade
B. Ground improvement (e.g., grouting, soil mixing, preconsolidation/wicks, lightweight materials)
C. Geosynthetic applications (e.g., separation, strength, filtration, drainage, reinforced soil slopes, internal stability of MSE)
D. Slope stability and slope stabilization
E. Earth dams, levees, and embankments
F. Landfills and caps (e.g., interface stability, drainage systems, lining systems)
G. Pavement structures (rigid, flexible, or unpaved), including equivalent single-axle load (ESAL), pavement thickness, subgrade testing, subgrade preparation, maintenance and rehabilitation treatments
H. Settlement

**14. Groundwater and Seepage** **3–5**

A. Seepage analysis/groundwater flow
B. Dewatering design, methods, and impact on nearby structures
C. Drainage design/infiltration
D. Grouting and other methods of reducing seepage

**15. Problematic Soil and Rock Conditions** **3–5**

A. Karst; collapsible, expansive, and sensitive soils
B. Reactive/corrosive soils
C. Frost susceptibility

**16. Earth Retaining Structures (ASD or LRFD)** **4–6**

A. Lateral earth pressure
B. Load distribution
C. Rigid retaining wall stability analysis (e.g., CIP, gravity, external stability of MSE, crib, bin)
D. Flexible retaining wall stability analysis (e.g., soldier pile and lagging, sheet pile, secant pile, tangent pile, diaphragm walls, temporary support of excavation, braced and anchored walls)
E. Cofferdams

F. Underpinning (e.g., effects on adjacent construction)
G. Ground anchors, tie-backs, soil nails, and rock anchors for foundations and slopes

**17. Shallow Foundations (ASD or LRFD)** **4–6**

A. Bearing capacity
B. Settlement, including vertical stress distribution

**18. Deep Foundations (ASD or LRFD)** **4–6**

A. Single-element axial capacity (e.g., driven pile, drilled shaft, micropile, helical screw piles, auger cast piles)
B. Lateral load and deformation analysis
C. Single-element settlement
D. Downdrag
E. Group effects (e.g., axial capacity, settlement, lateral deflection)
F. Installation methods/hammer selection
G. Pile dynamics (e.g., wave equation, high-strain dynamic testing, signal matching)
H. Pile and drilled-shaft load testing
I. Integrity testing methods (e.g., low-strain impact integrity testing, ultrasonic cross-hole testing, coring, thermal integrity testing)

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## NCEES Principles and Practice of Engineering Examination
## GEOTECHNICAL Design Standards

**Effective Beginning with the April 2022 Examinations**

In addition to the *PE Civil Reference Handbook*, the following codes and standards will be supplied to examinees on exam day as a searchable, electronic pdf file with linked chapters for easy navigation. Solutions to exam questions that reference a standard of practice are scored based on this list and the revision year shown. Solutions based on other standards will not receive credit. NCEES does not sell printed copies of the handbook or design standards. Design standards are available through the publisher.

| ABBREVIATION | DESIGN STANDARD TITLE |
|---|---|
| **ACI 360R-10** | *Guide to Design of Slabs-on-Ground*, 2010, American Concrete Institute, Farmington Hills, MI, www.concrete.org. |
| **ASCE 7-10** | *Minimum Design Loads for Buildings and Other Structures,* 3rd printing, 2010, American Society of Civil Engineers, Reston, VA, www.asce.org. |
| **EM 1110-2-1902** | *USACE Engineering and Design: Slope Stability*, 2003, US Army Corp of Engineers, Washington D.C., www.publications.usace.army.mil. |
| **FHWA NHI-05-037** | *FHWA Geotechnical Aspects of Pavements*, 2006, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA NHI-06-088** | *FHWA Soils and Foundations Reference Manual – Volume I*, 2006, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA NHI-06-089** | *FHWA Soils and Foundations Reference Manual – Volume II*, 2006, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA-NHI-11-032 GEC No. 3** | *FHWA LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual*, 2011, Geotechnical Engineering Circulars, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA NHI-16-009 GEC No. 12** | *FHWA Design and Construction of Driven Pile Foundations – Volume I*, 2016, Geotechnical Engineering Circulars, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA NHI-16-010 GEC No. 12** | *FHWA Design and Construction of Driven Pile Foundations – Volume II*, 2016, Geotechnical Engineering Circulars, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **FHWA NHI-16-072 GEC No. 5** | *FHWA Geotechnical Site Characterization,* 2017, Geotechnical Engineering Circulars, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |

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| **FHWA NHI-18-024**<br>**GEC No. 10** | *FHWA Drilled Shafts: Construction Procedures and Design Methods,* 2018, Geotechnical Engineering Circulars, US Department of Transportation, Federal Highway Administration, Washington, D.C., www.fhwa.dot.gov. |
| **NAVFAC DM-7.02** | *Foundations & Earth Structures, Design Manual 7.02*, 1986, US Army Corps of Engineers, Naval Facilities Engineering Command |
| **CFR TITLE 29**<br>**Part 1926** | U.S. Department of Labor, Washington, D.C., July 2020.<br>Safety and Health Regulations for Construction<br>• Subpart CC, Cranes and Derricks in Construction, Part 1926:1400–1926:1442 with Appendix A–Appendix C<br>• Subpart E, Personal Protective and Life Saving Equipment, Part 1926.95–1926.107<br>• Subpart M, Fall Protection, 1926.500–1926.503 with Appendix A–Appendix E<br>• Subpart P, Excavations, 1926.650–1926.652 with Appendix A–Appendix F |
| **UFC 3-220-01** | *Unified Facilities Criteria (UFC): Geotechnical Engineering*, 2012, US Army Corps of Engineers, Naval Facilities Engineering Command, Air Force Civil Engineer Center, Washington D.C. |
| **UFC 3-220-05** | *Unified Facilities Criteria (UFC): Dewatering and Groundwater Control*, 2004, US Army Corps of Engineers, Naval Facilities Engineering Command, Air Force Civil Engineer Center, Washington D.C. |
| **UFC 3-220-10N** | *Unified Facilities Criteria (UFC): Soil Mechanics*, 2005, US Army Corps of Engineers, Naval Facilities Engineering Command, Air Force Civil Engineer Center, Washington D.C. |