How well are EAC-ABET Accredited Civil Engineering Programs Preparing Graduates for the PE Exam?

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How well are EAC-ABET Accredited Civil Engineering Programs Preparing Graduates for the PE Exam?

Abstract

During the past 25 years, there have been many changes to the Principles and Practice (PE Exam) examinations and licensure policies affecting civil engineers. In 2000, the National Council of Examiners for Engineering and Surveying (NCEES) transitioned the PE exam to a multiple-choice format and began allowing PE examinees to choose one of five civil engineering (CE) discipline specific exams instead of a broad problem-based exam. Beginning in 2022, all CE discipline specific PE exams transitioned to computer-based testing (CBT). In 2024, NCEES modified the CE discipline specific PE exams to focus on depth. Another change has involved state boards of registration decoupling the experience requirement from the PE exam. This allows many civil engineering graduates the flexibility to take the PE exam prior to gaining a requisite number of years of experience for licensure. Currently, nearly two thirds of jurisdictions allow graduates of EAC-ABET accredited civil engineering programs to take the Principles and Practice (PE Exam) immediately after graduation.

The changes to the PE exam provide more options and choices for civil engineering graduates from accredited programs. Many examinees will choose to take the examination prior to gaining experiential knowledge. In that case they will rely primarily on knowledge from their undergraduate education. The question is whether graduates have gained sufficient knowledge to pass the PE exam upon graduation. The following study focused on how closely the curriculum from a statistically averaged EAC-ABET accredited civil engineering program aligns with the content on the five new civil engineering specific PE exams.

The average civil engineering curriculum from a study of 87 EAC-ABET accredited programs was compared to the content (232 unique subtopics) on the revised CE discipline specific PE exams. The NCEES topic list for each exam was mapped to course descriptions in undergraduate required and elective courses. The results indicate that 1) the range of civil engineering topics varies significantly in each of the five NCEES civil engineering PE exams, 2) required courses in the average civil engineering curriculum cover 48% to 68% of the topics on each of the five NCEES civil engineering PE exams, and 3) most civil engineering curriculums have the flexibility to cover 82% to 95% of the topics on each discipline specific PE exam if specific electives are included. Students who plan to take the PE exam in their first year after graduation must carefully plan their undergraduate elective courses around the specific topics on the NCEES PE examination of their choice.

Introduction

On April 1, 2024, the National Council of Examiners for Engineering and Surveying (NCEES) eliminated the common breadth format on the Principles and Practice of Engineering examinations (PE exams) in all five civil engineering (CE) disciplines: construction, geotechnical, structural, transportation, and water resources and environmental. The new discipline specific exams were modified to increase the depth of topics in each respective area.

In recent years state policies that mandate when the civil engineering PE exam may be taken have dramatically changed in most jurisdictions. Currently, thirty-three states (66%) allow graduates of EAC-ABET accredited civil engineering programs to take the Principles and Practice (PE Exam) immediately after graduation [1]. In these states, examinees who choose to take the examination early are relying primarily on the depth of knowledge they obtained from their undergraduate civil engineering curriculums. Examinees have little experiential knowledge other than what they obtain through summer internships, PE review manuals and courses, and capstone courses.

The changes to the PE exam have direct impacts on recent civil engineering graduates from accredited programs. Have graduates gained sufficient knowledge from their coursework to pass the depth-based PE exam upon graduation? The following study focused on how closely the curriculum from a statistically averaged EAC-ABET accredited civil engineering program aligns with the content on five new civil engineering specific NCEES PE exams.

Background

Professional Engineering (PE) licensure has been important to the civil engineering profession for many generations and provides an increased level of safety for the public. While there are licensure exemptions that allow some civil engineers to work without a license, many CE graduates aspire to professional positions that require a PE license [2, 3]. Included in this list is the requirement that professors in some jurisdictions have a PE license to teach engineering design courses [4]. In order to obtain a PE license, the most common path to licensure is for candidates to earn an EAC-ABET degree, pass two examinations (the Fundamentals of Engineering (FE) Exam and the PE exam), and obtain 4 years of qualifying experience. The PE exam is a requirement to become a licensed professional engineer in almost every jurisdiction in the United States [5]. Every state, territory, and the District of Columbia constitutes a different jurisdiction, and they each function under different licensure statutes that allow them to vary this process.

In 2005, Nevada became the first state to decouple professional experience from the requirements to take the PE exam [6]. Nevada's rationale for the change was to increase the pool of PE applicants who had completed an accredited engineering degree, passed the Fundamentals of Engineering (FE) exam, and passed the PE exam. According to the Nevada Board

> *Anyone who has graduated with a degree in engineering should be able to sit and pass the PE. Having relevant experience is beneficial but not strictly necessary for a successful exam outcome* [6].

Over the next decade other states began to explore this change, and it slowly became a more popular option. NCEES maintains a model law and model rules that are commonly used as guidelines for jurisdictions when they develop their specific laws and rules. In 2014, NCEES modified their Model Law to decouple professional experience from the PE exam requirements [7].

By 2024, thirty-three states had decoupled the professional experience requirement from the PE exam requirement, and this number continues to increase. The majority of engineering graduates of EAC-ABET accredited programs in the U.S. are able to take the PE exam immediately after graduation. Even though removing the professional experience requirement applied to all engineering disciplines, it is especially important to the civil engineering profession and accredited civil engineering programs.

More civil engineers take the PE exam than engineers in other disciplines. In 2024, NCEES offered 23 different computer-based PE exams [1]. During the period January-June, 2024, there were 12,191 first time examinees and 8,162 (67.0%) took one of the five CE PE exams [8]. The second most common category of PE exams was mechanical engineering. There were 1,457 first time examinees who took one of the three mechanical engineering PE exams (12.0%), significantly fewer than the civil engineering PE exam. The NCEES statistics are a clear indicator that the PE exam is a very important career step for many civil engineers.

A close review of ASEE engineering bachelor's degree data indicates that there were 126,270 engineering degrees granted between July 1, 2019 and June 30, 2020 [9]. Approximately 10.9% (13,732) were civil engineering degrees. This number cannot be directly correlated to the 8,162 engineers who took one of the five civil engineering specific PE exams four years later in 2024. However, it does indicate that the number of first-time test takers of CE specific PE exams is a relatively high percentage (most recently 59%) compared to the number of annual civil engineering graduates. Despite civil engineering ranking 3rd among all engineering disciplines in total number of engineering degrees conferred, the civil engineering profession has the highest number of first time PE examinees. The data indicates that the majority of civil engineering graduates will eventually take the PE exam.

NCEES has made several changes to the civil engineering PE exam over the past 25 years. In October 2000, NCEES transitioned the civil engineering PE exam to a multiple-choice exam. The goal was to take bias out of grading, return the results quicker, and save costs. The civil engineering PE exam followed a breadth and depth format. The morning portion covered general breadth topics while the afternoon session covered one of five different civil engineering subject areas [10]. NCEES completed the conversion of all PE exams to computer based tests (CPT) in January 2022 [11]. Today, test takers must go to testing centers. Because PE exams are given year-round, each person's exam is different. The exam consists of multiple choice, point and click, drag and drop, and fill in the bank questions. Although every PE exam is different, they all follow an algorithm designed to give the same number of questions on the same topics at a similar difficulty level [12].

Additional flexibility has also been added to the content in the five CE specific PE exams. Prior to 2024, the five civil engineering PE exams had a common breadth component and a discipline specific depth component. Beginning in 2024, NCEES transitioned the five civil engineering PE exams from breadth and depth exams to depth only exams. The common breadth component of each civil engineering PE exam was either removed or minimized [13].

The current PE CBT test taking rules and format provide an unprecedented number of options. The current level of flexibility with the CBT format allows a recent graduate with an accredited civil engineering degree to take the PE exam weeks after graduation in most jurisdictions. A specific civil engineering discipline must be selected when registering for the exam. Prospective test takers need to take the PE exam in a discipline that most closely focuses on the area in which they practice, or in the case of early test takers, intend to start practicing. Another change from historical PE exam rules is the resources allowed when taking the exam. Only the NCEES PE exam specifications and design standards may be used. The standards for each PE exam are published by NCEES at least 6 months before they become effective. No other resources including design standards, textbooks, review manuals, or additional digital content are allowed when taking the exam [8].

While these changes are a major shift for NCEES, they tend to follow trends seen in higher education. The NCEES move to discipline-based testing is similar to the transition many large public universities have made in making their civil engineering curriculum more flexible. Studies in the past decade have shown that civil engineering curriculums in accredited civil engineering programs are very flexible with fewer required courses and more technical electives [14]. The trend shows no sign of abating. Civil engineering programs cover a variety of topics in varying depths. Recent graduates in most programs have made decisions to tailor their degrees to their areas of interest because of this flexibility [14, 15]. The move to increase flexibility with civil engineering curriculums and the PE exam provides more choices, but also places an increased burden on students and young graduates to align their education, experience, and PE testing schedule to what best suites their career.

Research Methods

The objective of this study was to evaluate how undergraduate civil engineering curriculum data maps to the five new civil engineering PE exams. Because 33 states allow graduates of EAC-ABET accredited civil engineering programs to take the PE exam immediately after graduation, many civil engineering graduates will rely on knowledge obtained in their undergraduate courses to pass the discipline specific PE exam of their choosing.

In particular, the study addresses the following research questions.

1. To what extent do the new 2024 civil engineering PE exam topics on each of the five CE exams map to required civil engineering undergraduate courses?
2. What percentage of the new 2024 civil engineering PE exam topics on each of the five exams are covered when the topics are mapped to both required and elective civil engineering undergraduate courses?

The undergraduate civil engineering curriculum data was obtained from a 2024 study of 87 civil engineering EAC-ABET accredited programs [14]. The topics covered on each of the civil engineering PE exams were obtained from published NCEES outlines of the major topics and subtopics [16]. The data from the curriculum study provided a list of required and elective civil engineering courses that was mapped to the new 2024 civil engineering PE exam topics (48 topics and 232 unique subtopics) on the five PE exams.

Detailed course descriptions in undergraduate catalogues were used in the 2024 curriculum study to determine the content in required and elective civil engineering courses. In many cases the course names and descriptions matched the topics and subtopics on the NCEES list. For example, in the Civil Geotechnical PE exam topic list, Soil Mechanics is a topic and is typically covered in a similarly named undergraduate soil mechanics course. In other cases, the list of subtopics mapped to multiple courses and were proportioned between relevant classes. For example, on the Civil Construction PE exam topic list, the statics and stresses subtopic was evenly divided between statics and mechanics of materials courses. Judgment was used to divide the subtopics between courses in a few instances when they did not clearly fit into a course.

Results

As described in the Research Methods section, each of the topics in the five civil engineering PE exams was mapped to required course and elective course statistics derived from the 2024 curriculum study [14]. The results from this study of civil engineering program courses is shown in Table 1. The first column lists subject categories, the second column is the percent of CE programs that require a course on this topic, and the third column is the percent of CE programs that offer a course on this topic (either required or an elective.) It should be noted that included in the list of topics are design and technical electives, broad categories that provide significant flexibility in many programs.

The subsequent sections report the percent of programs that cover each topic on the five CE PE exams. In each case a weighted average is computed for every topic based on the percent of programs that require and offer classes in each subject that corresponds to the subtopics on each CE PE Exam.

Table 1. Percent of Programs offering Required and Elective Courses in Civil Engineering Program Subject Areas [14]

Subject	Required Course (% of programs)	Required and/or Elective Course (% of programs)
Fluid Mechanics	94.3	95.4
Statics	98.9	100.0
Mechanics of Materials	100.0	100.0
Structural Analysis	87.4	100.0
Steel Design	23.0	100.0
Reinforced Concrete	36.8	100.0
Structural Elective	3.4	81.6
Soil Mechanics	87.4	100.0
Foundation Design	18.4	94.3
Pavement Design	1.1	68.9
Geomatics	17.2	35.6
Transportation Engineering	80.5	100.0
Traffic Engineering	8.0	72.4
Hydraulic Engineering	59.8	96.6
Hydrology	29.9	97.7
Environment Engineering	78.2	97.7
Water/Wastewater Engr.	21.8	97.7
Construction/Project Mgt	58.6	91.9
Civil Engineering Materials	79.3	90.8
Surveying	58.6	72.4
Engineering Economics	58.6	73.5
Technical Electives	87.4	87.4
Design Electives	39.1	39.1

Civil-Construction PE CBT Exam

The construction engineering PE CBT exam covers 11 topics and weights them as shown in Table 2. NCEES further divides these topics into 48 subtopics. Each of these subtopics was mapped to civil engineering subjects in Table 1. Table 2 shows the percent of undergraduate CE programs that cover each construction engineering PE CBT exam topic. The mapped subjects that align with the topics on this PE exam are also listed.

Table 2. Civil-Construction PE CBT Exam Topics

PE Exam Topic	Percent of the PE Exam	Required Course Coverage (Percent)	Required + Elective Course Coverage (Percent)	Mapped Subjects (Table 1 – Column 1)
Soil Mechanics	8.43%	59.8%	97.7%	Soil Mech, Foundations
Site Layout and Development	7.30%	71.9%	82.0%	Trans Engr, Surveying, Tech Elect
Material Properties	7.30%	81.3%	93.1%	Soil Mech, CE Materials
Estimating Quantities and Costs	8.43%	58.6%	87.3%	Const Mgt, Engr Econ
Project Planning and Scheduling	10.11%	58.6%	91.9%	Const Mgt
Material, Production, and Execution QC	10.11%	67.1%	93.3%	Steel Design, Soil Mech, Const Mgt, CE Materials
Structural Mechanics	10.11%	81.8%	99.2%	Statics, Mech Mat, Struct Analysis, Foundations
Hydraulics and Hydrology	5.62%	39.9%	97.3%	Hyd Engr, Hydrology
Construction Operations and Methods	12.92%	76.9%	88.7%	Foundations, Const Mgt, Tech Electives
Design for Support of Const Loads	14.04%	81.7%	88.0%	Foundations, Tech Electives
Health and Safety	5.62%	46.0%	87.0%	Const Mgt, Traffic Engr
Total	**100%**	**68.4%**	**91.3%**	

More than 50% of the CE programs provide required course coverage in 9 of the 11 Civil-Construction PE exam topics. Two topics, Hydraulics and Hydrology and Health and Safety, are covered in less than half of the CE programs by required courses. Overall, required civil engineering courses cover approximately 68.4% of the Civil-Construction PE exam topics in an average CE program. When elective courses are included, the coverage increases to 91.3% of the Civil-Construction PE exam topics, and every topic is covered by courses in at least 82.0% of the CE programs.

Civil-Geotechnical PE CBT Exam

The geotechnical engineering PE CBT exam covers 10 topics. NCEES divides each topic into a total of 45 subtopics and specifies a percent of questions on the PE exam for each topic. The 45 subtopics were mapped to civil engineering courses in Table 1. Table 3 shows the amount of coverage that each geotechnical engineering PE CBT exam topic receives from undergraduate civil engineering curriculums.

Table 3. Civil-Geotechnical PE CBT Exam Topics

PE Exam Topic	Percent of the PE Exam	Required Course Coverage (Percent)	Required + Elective Course Coverage (Percent)	Mapped Subjects (Table 1 – Column 1)
Site Characterization	11.36%	61.5%	95.1%	Soil Mech, Foundations, Tech Elective
Soil Mechanics, Lab Test, & Analysis	11.36%	87.4%	100.0%	Soil Mechanics
Const Observation, Monitoring, and QA	8.52%	73.0%	89.7%	Const Mgt, Tech Elect
Earthquake Engr and Dynamic Loads	7.39%	87.4%	87.4%	Tech Elect
Earth Struct, Ground Improve-Pavement	13.07%	70.2%	92.0%	Soil Mech, Pavement Design, Tech Elect
Groundwater and Seepage	5.68%	87.4%	87.4%	Tech Elective
Problematic soil and rock conditions	5.68%	70.2%	89.1%	Foundations, Tech Elect
Retaining Structures	14.20%	25.3%	75.9%	Foundations, Design Elect
Shallow Foundations	8.52%	18.4%	94.3%	Foundations
Deep Foundations	14.20%	18.9%	64.4%	Foundations, Design Electives
Total	**100%**	**55.6%**	**86.3%**	

More than 50% of the CE programs provide required course coverage in 7 of 10 Civil-Geotechnical PE exam topics. Three topics, Retaining Structures, Shallow Foundations, and Deep Foundations, are covered by less than half of the CE programs in required coursework. Overall, required civil engineering courses cover approximately 55.6% of the Civil-Construction PE exam topics. When elective courses are included, the coverage increases to 86.3% of the Civil-Geotechnical PE exam topics, and each topic is covered by courses in at least 64.4% of the CE programs.

Civil-Structural PE CBT Exam

The structural engineering PE CBT exam covers 5 topics. NCEES divides each topic into subtopics and specifies a percent of the questions for each topic. Each of the 36 subtopics was mapped to Table 1 civil engineering course statistics. Table 4 shows the amount of coverage that each structural engineering PE CBT exam topic receives from undergraduate civil engineering curriculums.

Table 4. Civil-Structural PE CBT Exam Topics

PE Exam Topic	Percent of the PE Exam	Required Course Coverage (Percent)	Required + Elective Course Coverage (Percent)	Mapped Subjects (Table 1 – Column 1)
Analysis of Structures-Loads & Load App	17.05%	53.7%	93.1%	Struct Anal, Struct Elect, Soil Mech, Foundations
Analysis of Structures-Forces & Load Eff	24.43%	88.4%	98.5%	Statics, Mech of Mat, Struct Anal, Struct Elect
Temp Structures & Other topics	7.39%	84.5%	87.9%	Const Mgt, Tech Elect
Design and Details of Structures-Materials and Material Properties	14.20%	50.8%	78.2%	Steel Design, Reinf Conc, Soil Mech, CE Materials, Design Elect
Design and Details of Structures-Component Design and Detailing	36.93%	26.3%	88.9%	Steel Design, Reinf Conc, Foundation, Design Elect
Total	**100%**	**53.9%**	**90.3%**	

More than 50% of the CE programs provide required course coverage in 4 of 5 Civil-Structural PE exam topics. One topic, Design and Details of Structures-Component Design and Detailing, was covered in less than half of the CE programs by required courses. Overall, required courses in CE programs cover approximately half (53.9%) of the Civil-Structural PE exam topics. When elective courses are included, the coverage increases to 90.3% of the Civil-Structural PE exam topics, and each topic is covered by at least 78.2% of the CE programs

Civil-Transportation PE CBT Exam

The transportation engineering PE CBT exam covers 10 topics. NCEES divides each topic into subtopics and specifies a percent of questions for each topic. Each of the 35 subtopics was mapped to civil engineering courses in the 2024 curriculum study from Table 1. Table 5 shows the amount of coverage that each transportation engineering PE CBT exam topic receives from undergraduate civil engineering curriculums.

Table 5. Civil-Transportation PE CBT Exam Topics

PE Exam Topic	Percent of the PE Exam	Required Course Coverage (Percent)	Required + Elective Course Coverage (Percent)	Mapped Subjects (Table 1 – Column 1)
Project Management	8.47%	58.6%	85.8%	Const Mgt, Engr Econ
Traffic Engineering	14.13%	36.5%	80.4%	Trans Engr, Traffic Engr, Tech Elective
Roadside and Cross Section Design	10.17%	84.8%	92.1%	Trans Engr, Tech Elect
Horizontal Design	11.30%	48.9%	67.8%	Geomatics, Trans Engr
Vertical Design	11.30%	48.9%	67.8%	Geomatics, Trans Engr
Intersection Geometry	10.17%	64.1%	90.0%	Trans Engr, Traffic Engr, Tech Elective
Traffic Signals	7.34%	8.0%	72.4%	Traffic Engr
Traffic Control Design	7.34%	8.0%	72.4%	Traffic Engr
Geotechnical and Pavement	8.47%	58.1%	92.0%	Soil Mech, Foundations, Pave Degn, Traffic Engr
Drainage	11.30%	44.9%	97.2%	Hyd Engr, Hydrology
Total	**100%**	**47.5%**	**81.9%**	

More than 50% of the CE programs provide required course coverage in 4 of the 10 Civil-Transportation PE exam topics. Six topics, Traffic Engineering, Horizontal Design, Vertical Design, Traffic Signals, Traffic Control Design, and Drainage, are covered by required courses in less than half of the CE programs. Overall, required civil engineering courses cover less than half (47.5%) of the Civil-Transportation PE exam topics. When elective courses are included, the coverage increases to 81.9% of the Civil-Transportation PE exam topics. However, four of the topics are covered by 72.4% or less of the CE programs.

Civil-Water Resources and Environmental PE CBT Exam

The water resources and environmental PE CBT exam covers 12 topics. NCEES divides each topic into subtopics and specifies a percent of questions for each topic. Each of the 68 subtopics was mapped to civil engineering courses in the 2024 curriculum study from Table 1. Table 6 shows the amount of coverage that each water resources and environmental engineering PE CBT exam topic receives from undergraduate civil engineering curriculums.

Table 6. Civil-Water Resources and Environmental PE CBT Exam Topics

PE Exam Topic	Percent of the PE Exam	Required Course Coverage (Percent)	Required + Elective Course Coverage (Percent)	Mapped Subjects (Table 1 – Column 1)
Project Planning	5.62%	81.6%	87.1%	Soil Mech, Engr Econ, Tech Elect
Soil Mechanics	4.49%	59.8%	97.7%	Soil Mech, Foundations
Materials	5.62%	75.6%	93.9%	Soil Mech, Foundations, CE Materials
Analysis and Design	8.43%	73.6%	97.4%	Hydr Engr, Env Engr
Hydraulics-Close Conduits	10.11%	72.7%	96.2%	Fluid Mech, Hydr Engr
Hydraulics-Open Channel	10.11%	59.8%	96.6%	Hydraulic Engr
Hydrology	11.24%	29.9%	97.7%	Hydrology
Groundwater and Wells	5.62%	29.9%	97.7%	Hydrology
Surface Water and Groundwater Quality	7.30%	78.2%	97.7%	Environmental Engr
Drinking water Distribution and Treat	8.43%	21.8%	97.7%	Water/Wastewater Dsgn
Wastewater collection and treatment	10.11%	51.0%	93.1%	Water/Wastewater, Tech Elect
Project Sitework	12.92%	86.6%	90.2%	
Total	**100%**	**60.1%**	**95.2%**	

More than 50% of the CE programs provide required course coverage in 9 of 12 Civil-Water Resources and Environmental PE exam topics. Three topics, Hydrology, Groundwater and Wells, and Drinking Water Distribution and Treatment, are covered by less than half of the CE Programs with required coursework. Overall, required civil engineering courses cover approximately 60.1% of the Civil-Water Resources and Environmental PE exam topics. When elective courses are included, the coverage increases to 95.2% of the Civil-Water Resources and Environmental PE exam topics and each topic is covered by courses in at least 87.1% of the programs.

The amount of Civil PE exam topic coverage increases on every PE CE exam when elective courses are included. Figure 1 summarizes the results for all five civil engineering PE CBT exams. For each exam, there is a noticeable increase in PE exam topic coverage if elective courses are taken in the topic areas that are either not covered or sparsely covered by required courses.

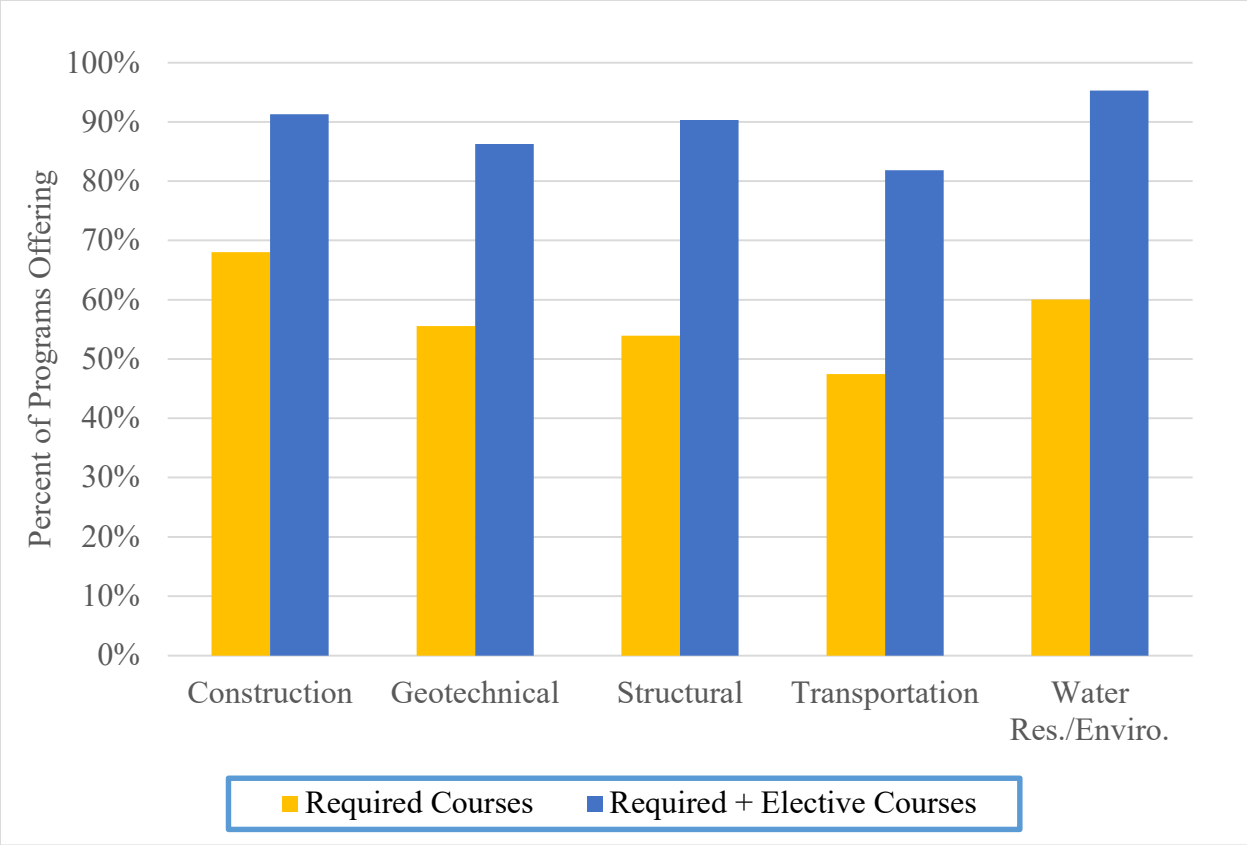

Figure 1. Coverage of Civil Engineering PE Topics by Required and Elective Undergraduate Courses listed in Table 1.

Discussion of Results

Each of the five civil engineering PE CBT exams was modified in 2024 to include more depth, but the amount of breadth that remains varies. The new Civil-Structural PE exam and the new Civil-Geotechnical PE exam have the greatest amount of discipline depth. The 2024 Civil-Construction PE exam has the greatest amount of breadth. Of the 11 topics on the civil engineering-construction PE exam, four topics require a depth of knowledge in other areas of civil engineering:

- Soil Mechanics
- Material Properties
- Structural Mechanics
- Hydraulics and Hydrology

For students specializing in construction engineering, it is important for them to take a number of civil engineering technical elective courses outside their specialty. Examinees who take this exam are faced with a requirement that they be knowledgeable in 5 different civil engineering disciplines. There are total of 48 subtopics on the Civil-Construction PE exam. Because there is a

substantial amount of breadth on the Civil-Construction PE exam, required courses in undergraduate civil engineering curriculums provide the highest amount of coverage of topics for this exam, 68.4%. It is interesting to note that the Civil-Construction PE exam had a lower first time pass rate than the other four civil engineering PE exams in 2024 [8].

Most of the 10 Civil-Geotechnical PE exam topics map directly to undergraduate geotechnical engineering courses. Only two topics did not map directly to geotechnical engineering required courses or technical electives. Many of the Civil-Geotechnical PE exam topics mapped directly to content in a first Foundation Engineering course, yet a Foundations course is only required in about 18% of civil engineering programs. It is helpful if students specializing in geotechnical engineering take technical electives in construction engineering and pavement design as well as advanced geotechnical engineering topics.

The new Civil-Structural PE exam was condensed to five topics. Most of the topics map directly to engineering mechanics, structural engineering, and foundation engineering courses. Required undergraduate courses cover slightly more than half (53.9%) of the Civil-Structural PE exam topics. This is the second lowest coverage percent of the five civil engineering PE exams and is attributed to the fact that steel design, reinforced concrete, and foundation engineering courses are all three required by fewer than 37% of civil engineering programs.

The new Civil-Transportation PE exam retained a degree of breadth. Approximately 28% of the exam covers topics in construction management, geotechnical engineering, hydraulic engineering and hydrology. An equal amount of content covers topics in traffic engineering which is a required course in few civil engineering programs. Required undergraduate courses cover slightly less than half of the Civil-Transportation PE exam topics. The 47.5% coverage of PE exam topics by required courses was the lowest of the five civil engineering PE exams. Transportation is also the topic with the lowest coverage even when electives are considered.

The new Civil-Water Resources and Environmental PE exam covers more topics (12) and subtopics (68) than any other civil engineering PE exam. Most of the topics map directly to hydraulic engineering, hydrology, and environmental engineering courses, yet some topics map to construction management, geotechnical engineering, and civil engineering materials courses. Required undergraduate courses cover approximately 60% of the Civil-Water Resources and Environmental PE exam topics, the second highest of the five civil engineering PE exams. When elective and required courses are included, they produce the highest level of coverage (95.2%) of any of the five PE exams.

The study results indicate that the increased depth that NCEES has included in the new 2024 civil engineering PE exams requires examinees to have specialized knowledge. In all 5 exam options, courses are required in less than 70% of the topics. As previously noted, CE programs have significant flexibility in their course offerings. This translates to programs offering electives that cover at least 81% of topics for every PE exam. It should be noted that these results are based on an average CE program. No attempt was made to map the PE exam topics to individual programs. Understandably, some programs may cover all topics in a category, while others may cover fewer topics.

Because 66% of states allow graduates of accredited civil engineering programs to take the PE exam immediately after graduation, many examinees will rely on their undergraduate courses to prepare them for the PE exam topics. In many cases students will need to decide which specific CE PE exam they want to take early in their undergraduate curriculum in order to take more electives that cover their exam topics. Without these courses, graduates face the challenge of taking an exam that includes a significant amount of material they may not have learned. In effect, graduates with broad undergraduate course work will need time to acquire specialized knowledge through either additional coursework, independent study (lifelong learning), or the traditional method of gaining knowledge through experience. It would be prudent for civil engineering programs to begin discussing licensure requirements with students in freshmen level introduction to engineering courses rather than senior seminars.

Conclusions

This study reviewed the topics and subtopics on the five recently updated civil engineering PE CBT exams. For each PE exam, the topics were mapped to subject areas covered in required and elective courses in EAC-ABET accredited programs. The results support several conclusions.

- Based on ASEE civil engineering graduation data and NCEES PE exam data, professional licensure is more important to the civil engineering profession than it is to any other engineering discipline. More first-time attempts are made on the civil engineering PE exams than the other 18 PE exams combined. The number of first-time civil engineering PE examinees in 2024 was approximately 59% of the total number of civil engineering graduates in 2020.
- Since Nevada first decoupled experience from the PE exam requirements in 2005, thirty-two other states have followed suit. This change allows graduates of accredited civil engineering programs who have passed the FE exam to take the PE exam immediately after graduation in most jurisdictions.
- Civil engineering graduates who take the PE exam early will increasingly rely on their undergraduate civil engineering courses or independent study to prepare them for the PE exam. Most jurisdictions no longer assume that experience is necessary to take and pass the PE exam.
- Study results indicate that required civil engineering courses best prepare graduates for the Civil-Construction PE exam and provide the least preparation for the Civil-Transportation PE exam.
- Required and elective civil engineering courses best prepare civil engineering graduates for the Civil-Water Resources and Environmental PE exam, provided graduates take specific technical electives. Graduates are least prepared for the Civil-Transportation PE exam even when taking into account elective options.
- EAC-ABET accredited program momentum to transition civil engineering curriculums to increased specialization is supported by the results of this study. Most civil engineering students are allowed to customize their undergraduate education to include more specialization which would significantly help them pass any of the five civil engineering PE CBT exams. Required courses in an average CE program would not cover more than 68% of the topics on any of the civil engineering PE exams, but by selecting the right

technical electives, a specialized undergraduate program can cover over 81% of the topics on any of the five civil engineering PE exams.
- The move by CE programs toward specialization is supported by industry input through the recent changes by NCEES on the PE exam.

The average civil engineering curriculum requires 127.8 credit hours to graduate and 18.9 credit hours of engineering electives [14]. NCEES modified all five civil engineering PE exams in 2024 to test depth of civil engineering discipline knowledge rather than breadth and depth [16]. Because most graduates of accredited civil engineering programs are no longer required to obtain 4 years of professional experience prior to taking the PE exam, more PE examinees will rely on knowledge obtained from their undergraduate curriculum to prepare them for the PE exam. This places more emphasis on sophomore, junior and senior civil engineering students making engineering elective course choices that align with the discipline specific PE exam they intend to take after graduation. This has advising ramifications for all accredited civil engineering programs.

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