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The Case for a Separate FE Exam for Construction Engineering: Addressing Curriculum Discrepancies and Student Performance

Dr. Nahid Vesali, The Citadel

Dr. Nahid Vesali is an Assistant Professor in the Department of Engineering Leadership and Program Management (ELPM) in the School of Engineering (SOE) at The Citadel. She joined the program in Aug 2020. She teaches project management, technical planning

Dr. Mostafa Batouli, The Citadel

Dr. Mostafa Batouli is an Assistant Professor of Construction Engineering in the department of Civil and Environmental Engineering at The Citadel. Dr. Batouli received his PhD in Civil Engineering from Florida International University. He also holds Master of Public Administration and Graduate Certificate in Homeland Security and Emergency Management from FIU, Master of Science in Civil Engineering/Construction Engineering and Management from IAU, and Bachelor of Science in Civil Engineering/Surveying from University of Tehran. Dr. Batouli is a Professional Engineer (PE) registered in SC. He also holds Project Management Professional (PMP) international certificate. Dr. Batouli teaches diverse range of courses in civil engineering, construction engineering, and construction/project management. As a teacher, he aims to inspire his students to think intensively and critically and to live ethically and morally. Dr. Batouli received Harry Saxe Teaching award in 2022 based on students' votes and students evaluation of instruction. His previous research has resulted in more than 30 referred journal and conference publications as well as five research reports. His past research received major awards and honors including a third-place best poster award from the construction research congress and a Dissertation Year Fellowship from Florida International University in 2016.

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Abstract

Construction Engineering (CONE) has emerged as a distinct discipline within the engineering profession, requiring competencies that differ substantially from traditional Civil Engineering. Despite these differences, CONE graduates must take the FE Civil Exam, which heavily emphasizes Civil Engineering content. This study reviews the curricula of all ABET-accredited Construction programs and maps their coverage of FE Civil Exam topics. The findings highlight significant misalignments between the exam and the curricula of Construction programs, with critical topics like Fluid Mechanics and Environmental Engineering underrepresented. The study argues for a separate FE Construction Exam tailored to the distinct competencies of Construction Engineers. Such an exam would ensure equitable assessment, align with industry requirements, and enhance the professional identity of Construction Engineers.

Introduction and Background

The construction industry is a critical pillar of economic growth and societal development. The construction sector significantly impacts national economies, from shaping urban landscapes to building essential infrastructure. According to the Bureau of Labor Statistics [1], employment in construction-related occupations is projected to grow faster than the average for all fields over the next decade, creating 663,500 annual job openings from industry growth and retirements. This underscores the rising demand for professionals who have both engineering and project management skills.

Construction Engineering (CONE) programs have emerged as a distinct academic discipline to meet this demand, combining traditional engineering principles with a focus on construction management, scheduling, safety, and materials expertise. Despite this distinct focus, CONE graduates are required to take the Fundamentals of Engineering (FE) Civil Exam, which heavily emphasizes traditional Civil Engineering topics. This misalignment has long been recognized as a challenge for CONE graduates.

The FE Civil Exam, administered by the National Council of Examiners for Engineering and Surveying (NCEES), is structured around 14 topics, including Mathematics, Fluid Mechanics, Structural Analysis, and Environmental Engineering. While these topics align well with Civil Engineering curricula, Construction programs emphasize distinct areas such as project controls, cost estimation, and construction safety. As a result, CONE graduates face lower pass rates on the FE Civil Exam compared to their Civil Engineering counterparts.

Recognizing the unique competencies required for construction engineers, the NCEES introduced the Construction Engineering discipline to the Professional Engineer (PE) exams in April 2008. This change was driven by demand from the construction engineering community to better reflect the professional practice and specialized needs of construction engineers. The Construction PE Exam emphasizes knowledge areas such as construction management, scheduling, cost estimation, materials, and safety, allowing construction engineers to have a

more focused and relevant certification pathway distinct from other disciplines such as Civil or Mechanical Engineering. However, Construction graduates are still required to pass the FE Civil Exam as the first step in their licensure pathway, perpetuating a misalignment between their academic training and licensure requirements.

Similarly, Environmental Engineering was introduced as a separate FE discipline by the NCEES in 2011. This addition acknowledged the growing importance of environmental engineering as distinct from Civil Engineering and emphasized specialized knowledge in areas such as water treatment, pollution control, and waste management systems. These changes by the NCEES highlight a precedent for tailoring licensure exams to better align with the unique academic and professional demands of distinct engineering disciplines.

Historical Context and Literature Insights

The development of Construction Engineering as a distinct field highlights the growing complexity of the industry. Historically, Construction Management programs received accreditation from the American Council for Construction Education (ACCE), whereas Construction Engineering programs were overseen by ABET. However, in 2014, ABET expanded its accreditation to include Construction Management programs, recognizing the increasingly overlapping nature of these fields. This change emphasized the necessity for unified curricula to harmonize educational standards across construction-related disciplines [2].

However, beyond curriculum standardization, a more pressing challenge lies in the mismatch between the academic focus of Construction programs and the licensure pathway provided by the FE Civil Exam. While Civil Engineering curricula align closely with the 14 topics outlined in the FE Civil Exam, Construction programs prioritize skills in project management, safety, and scheduling—areas that are minimally represented in the exam. This disparity places Construction graduates at a disadvantage during licensure, raising concerns about fairness and competency evaluation.

Numerous studies have examined the challenges posed by this misalignment between Construction Engineering education and licensure requirements:

- **Swenty and Swenty (2017, 2020)**: Emphasized that the FE Civil Exam's focus on Environmental Engineering and Hydrology fails to evaluate core Construction competencies such as scheduling and safety management [3], [4].
- **Fridley et al. (2016)**: Highlighted the mismatch between the management-oriented nature of Construction Engineering education and the technical design focus of the FE Civil Exam [5].
- **Batouli et al. (2022)**: Provided a comparative analysis of ABET-accredited Construction programs, showing that Civil Engineering programs emphasize Engineering design, while Construction programs focus on materials, methods, and project delivery [2].

These findings highlight the need for a separate FE Exam discipline that is tailored with Construction curricula and better aligns with the academic training and professional demands of Construction graduates.

Study Objectives

This study aims to address the following objectives:

1. Quantify the alignment between the curricula of ABET-accredited Construction programs and the 14 topics outlined in the FE Civil Exam specifications [6].
2. Identify key gaps in curriculum coverage that disadvantage Construction graduates on the FE Civil Exam.
3. Propose evidence-based recommendations for the creation of a dedicated FE Construction discipline to better reflect the academic training and professional competencies of Construction Engineers.

Methodology

Data Collection

This study analyzed the curricula of 59 ABET-accredited programs across multiple construction categories, including Construction Engineering programs, Construction Management programs, Building Construction programs, Civil and Construction Engineering Technology programs, Construction and Facility Management programs, and other related disciplines. Table 1 summarizes the programs studied in this research. Curriculum data were extracted from institutional catalogs and classified based on their coverage of the 14 FE Civil Exam topics as specified by the NCEES. This classification provided a detailed view of topic coverage across these diverse academic programs.

Table 1: Accredited Programs Studies in This Research

Program Title	**Number of Accredited Institutions**
Building Construction	1
Civil Construction Engineering Technology	1
Civil Construction Engineering	1
Construction and Facilities Management	1
Construction Engineering and Management Technology	1
Construction Engineering	17
Construction Engineering and Management	1
Construction Engineering Technology	17
Construction Management and Engineering Technology	2
Construction Management	14
Construction Option in Engineering Technology	1
Engineering Technology in Construction Engineering Technology	1
Structural Design and Construction Engineering Technology	1
Total	**59**

Analysis Framework

The methodology involved two main steps:

1. **Topic Mapping**: Each course listed in the programs was analyzed for its alignment with the FE Civil Exam topics, such as Structural Engineering, Fluid Mechanics, and Construction Management.
2. **Exposure Metric:** A metric was developed to quantify the number of courses in each program that addresses each FE Civil Exam topic, as well as the average exposure levels for each topic across all programs. This comprehensive approach enabled a detailed analysis of the alignment between academic training and licensure requirements, providing nuanced insights into curricular strengths and gaps.

Results and Discussion

Curriculum Misalignment

The analysis reveals substantial discrepancies between the curricula of Construction programs and the FE Civil Exam. As seen in Figure 1, the majority of accredited construction programs do not adequately cover topics such as Mechanics of Materials, Dynamics, Fluid Mechanics, Water Resources and Environmental Engineering, and Transportation Engineering. On the other hand, topics like Mathematics and Statistics, Structural Engineering, and Surveying are well-represented, with over 70% of programs, including related coursework.

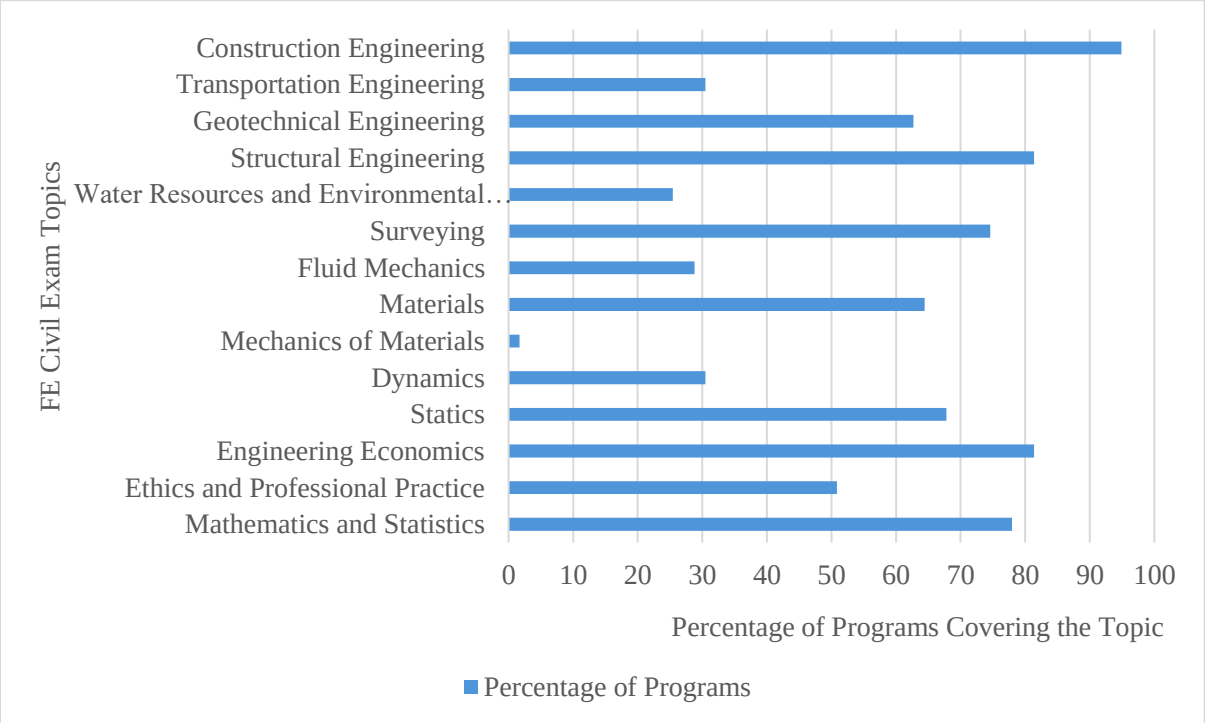

Figure 1: Percentage of Accredited Construction Programs Covering Each FE Civil Topic

Next, we calculated the average number of exposures a student receives to each FE Civil Exam topic throughout their program. To achieve this, each course in the curricula of the 59 programs was analyzed and categorized under one or multiple FE Civil Exam topics based on its relevance. For instance, the University of North Florida's Building Construction program includes a course titled "Construction Drawing," which was labeled as relevant to the "Construction Engineering" FE Civil Exam topic. Similarly, the course "Construction Materials" in the same program was labeled as relevant to both the "Construction Engineering" and "Materials" topics. General education courses, foundational science courses, and other courses not directly related to any FE Civil Exam topics were excluded from the analysis.

Figure 2 presents the analysis results, emphasizing the disparity in student exposure to various FE Civil Exam topics. Notably, exposure to the "Construction Engineering" topic constitutes 41% of the total student exposure to FE Civil Exam topics, underscoring its dominance in construction-related curricula. In stark contrast, technical topics such as "Transportation Engineering" and "Dynamics" receive minimal attention, with fewer than five exposures on average across the programs.

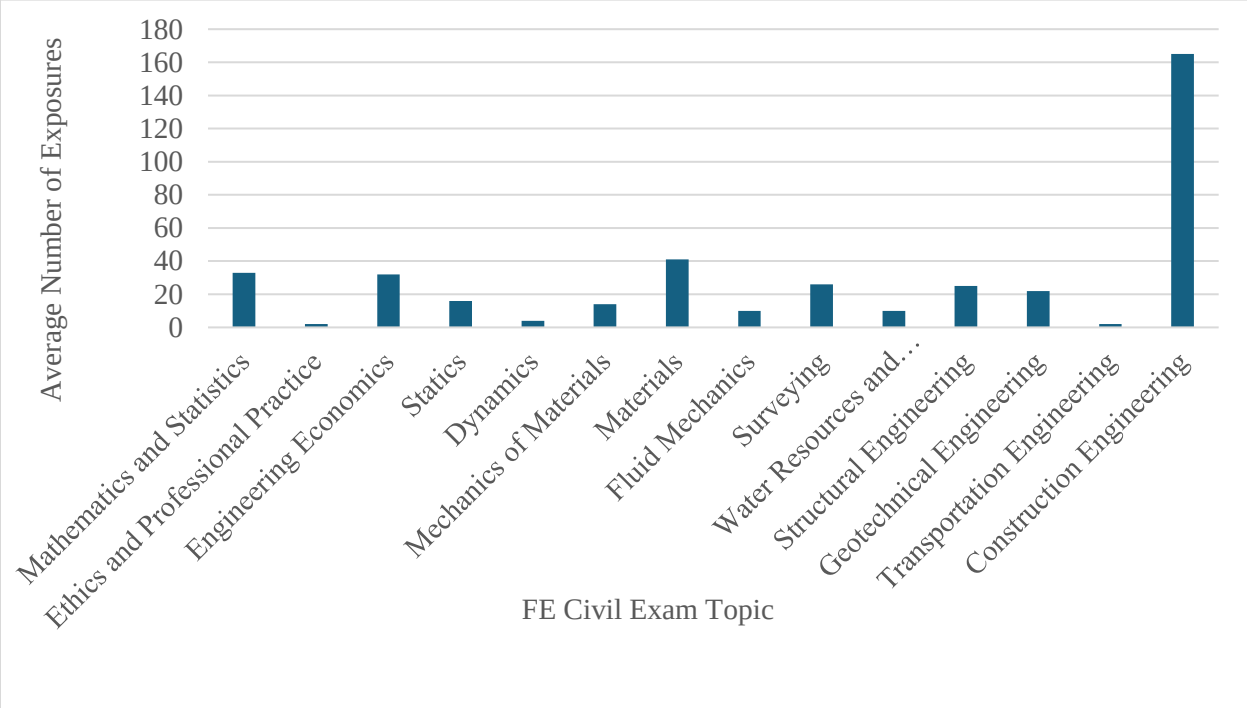

Figure 2: Average Number of Exposures to Different FE Civil Exam Topics

Challenges of Misalignment

The lack of alignment between Construction curricula and the FE Civil Exam has far-reaching implications:

- Topics like **Fluid Mechanics**, and **Environmental Engineering** are underrepresented in Construction programs, with fewer than 30% of programs including relevant coursework.

- Conversely, topics prioritized in Construction programs, such as **Construction Management**, **Scheduling**, and **Safety**, are minimally represented in the FE Civil Exam.

The curriculum misalignment affects pass rates and raises concerns about the fairness of licensure pathways for Construction graduates. This disparity emphasizes the need for a dedicated FE Construction Exam, which would better reflect the competencies required by Construction professionals and align with their academic training.

Conclusion

This study highlights the significant misalignment between the curricula of Construction programs and the FE Civil Exam, which is primarily tailored to Civil Engineering graduates. The findings reveal that critical topics such as Fluid Mechanics, Environmental Engineering, and Dynamics are included in fewer than 30% of Construction programs, placing graduates at a disadvantage when attempting the exam. Conversely, Construction programs strongly emphasize on areas like Project Management, Scheduling, and Safety, which are minimally represented in the FE Civil Exam. Furthermore, exposure to the "Construction Engineering" topic accounts for 41% of the total student exposure to FE Civil Exam topics, illustrating a curriculum imbalance that underscores the need for a tailored exam.

While this study provides valuable insights, it has some limitations. The list of accredited programs was obtained from the ABET website in 2022 and may not include the most recently accredited programs. Additionally, mapping courses to FE Civil Exam topics relied on course titles and short descriptions available on institutional websites. The absence of detailed syllabus reviews means that nuanced topic coverage within courses might have yet to be fully captured. Addressing these limitations in future research would strengthen the findings and provide a more comprehensive understanding of curriculum-exam alignment.

Future work should include a similar analysis of Civil Engineering programs to better quantify the differences and overlaps between Civil and Construction curricula as they relate to the FE Civil Exam. This would provide deeper insights into the gaps that Construction graduates face. Additionally, studies are needed to determine the topics that should be included in a proposed FE Construction Exam or the changes required in Construction Engineering (CONE) program curricula to better align them with the existing FE Civil Exam. NCEES, academia, and industry stakeholders should conduct such studies collaboratively to ensure any proposed changes reflect both academic preparation and industry needs.

Developing a dedicated FE Construction Exam that aligns with the core competencies emphasized in Construction programs would ensure a fairer licensure process for graduates. Revisiting curriculum design to integrate foundational topics like Fluid Mechanics and Environmental Engineering, which are critical for licensure and industry success, would further bridge the gap between academic preparation and licensure requirements.

Addressing these challenges would improve licensure pathways for Construction graduates and strengthen the professional identity of Construction Engineering as a distinct discipline. By

tailoring the licensure process and curricula to reflect particular skills and knowledge required in the field, the construction industry will be better equipped to meet its growing demands.

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