

# Expanding and Reforming Construction Engineering & Construction Management Education in India

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As a burgeoning industry employing over 31 million people, the Indian construction industry is increasingly drawing focus to itself. While the industry's needs and demands are on a steady rise, the higher education sector is struggling to keep up with it. The field of construction, being varied and complex, calls for several field specific skills that the education system in India is unable to provide as of today. Quality construction education that caters to the requirements of the construction industry is a necessity. This paper draws attention to the existing construction education scenario in India at the undergraduate and graduate levels. The reasons for students leaving the country for education are identified, calling for more and better-informed construction education within India. Drawing parallels from the growth of construction education in the US, introduction of a stand-alone undergraduate construction degree is recommended. The importance of incorporating both engineering and management aspects in construction education curriculum is touched upon. The need to reform graduate level construction curriculum, making it more flexible and interdisciplinary is also addressed.

**Key Words:** Indian, Construction Education, Quality, Flexible, Interdisciplinary

## Introduction

The importance of the building construction industry in India is well recognized. It contributes to 8.1% of the GDP in India (as of 2011), and thus impacts the economic development of the country. It is also the second largest provider of employment, closely following agriculture. In order to ensure that India is well equipped for this large volume of construction, factors that impact construction should be looked into. Education is one such crucial factor. While making provisions for construction education is a challenge in itself due to sheer numbers, the quality of construction education is equally important. There is evidence that India recognizes the need for transformation of the engineering and technology education system to better address industry needs & employment requirements, but this vision has not yet been expanded to the construction sector. Consequently there is a need to increase and better guide construction education in India. Changing requirements of the industry call for more sector specific skills and reforms in the existing construction education curriculum.

The paper does not aim to provide specific curriculum changes but rather makes a statement that calls for the reform of formal construction education in India.

## Engineering Education in India – Call for Educational Reform

Construction education in India falls under the engineering stream of studies. Of the 55 million youth in India (between the ages of 18 and 23) only 15% pursue Engineering education in India (Reddy, 2012). The two main reasons for this are the availability of an opportunity to do so and the existing education curriculum in India. Limited seat availability for engineering, the demand-supply gap in opportunities, the quality of faculty, and the rigid obsolete curriculum all form a part of these two reasons. Only 2-3% of engineering students take up graduate studies at a Master of Science level in India after completing their undergraduate degree. The share of engineering students pursuing PhDs at an Indian university is less than 1%. Nevertheless there is a significant volume of students who go outside the country to study. Numbers exceeded 200,000 in 2010, as reported by the United Nations. This indicates that while there is a growing demand for education within India, large numbers of students opt to study outside the country due to availability of more favorable education options, and the above-mentioned factors.

There is a dynamic momentum in engineering education in India today calling for reforms and unprecedented change (Reddy 2012; Saeki & Imaizumi, 2013). Engineering education strives to keep pace with changes in technology and industry. Promoting professional development, work skills, global outlooks, and sustainability have been identified as core areas that need to be included in engineering education (Parashar, 2012). There is a consensus that in the current status of Indian education the curriculum doesn't have ample relevance to future opportunities, personal skills, and society (Ramanathan, 2006). The need for curriculum reforms in engineering and technology studies has been identified as crucial today. Collaboration in communities and with outside forces has been recognized as one of the key components for curriculum innovation (Parashar, 2012). Interdisciplinary learning and hands-on approaches to engineering and technology education have also been noted as essential to reforms (Ramanathan, 2006). Partnering with industry has also been recognized as important in order to better equip graduates for dealing with market needs and demands. The rapidly changing environment today also calls for flexibility and faster responsiveness of educational institutions. These findings cater to engineering education in general but it can be safely assumed that these are also applicable to construction education.

The "textbook culture" is an underlying factor that plays an important role in curriculum development and the education structure of India. It is embedded in the minds of Indians that textbook knowledge and rote learning are essential to succeeding in exams in the Indian education system. Memorization, rather than understanding, forms the core of this system. In the rat race to survive such an education system, students are not encouraged to assimilate actual understanding of topics, or think outside the box. Staying up to date with trends and changes in the field is not a possibility. Heavy textbook emphasis also makes the curriculum rigid and heavily structured. Textbook focus also excludes soft skill education, experiential learning, and project based learning. Though this may suffice at a primary school level, this static learning process is not practical at higher education levels. The National Knowledge Commission's report in 2008 and the All India Council for Technical Education (AICTE) have identified that the existing rigid education model needs to be made more flexible to cater to the education needs today.

India's rapidly growing economy includes not only manufacturing and production sectors, but also tertiary service sectors (under which construction falls), which call for high-tech or skilled labor. To supply the needs of these growing sectors of the economy, there is now growing demand for higher levels of education for employment (Ramanathan, 2006). These industries have a need for engineers with diverse skills, and industry leaders complain that there is a shortage of adept engineers in India. The National Knowledge Commission reported in 2008 that present day engineering and technology graduates do not have the adequate skills to compete efficiently in the industrial markets. This is resulting in high unemployment numbers for graduates, even though industry requirements and opportunities are many. Pure engineering and technological skills are no longer adequate. Soft skills, business skills, adaptability, and problem solving are also deemed important (Reddy, 2012). Providing engineers suited to the growing Indian economy's needs is a key concern for the Indian Government today (Banerjee, 2008).

## **Construction Education in India**

In India, construction education at the undergraduate level is a part of civil engineering, structural engineering, and architecture programs, falling primarily under the civil engineering stream. Construction is still approached from a purely engineering standpoint. Only at the graduate level do students begin to specialize in construction technology or construction management education. Thus a formal construction degree in India is only found at the graduate level.

### *Demand-Supply gap*

The massive volume of construction work in India has resulted in a huge demand for civil engineers and construction managers. By 2020 the demand for these construction professionals is expected to be at a monumental number of almost 46 million. At the same time the supply is estimated at a mere 778,000, indicating a shortage of 83% (RICS, 2013). Because the construction industry could take a big hit with such a situation, there is a pressing need to increase the number of construction professionals. The first step would be to make construction education more available. While at the undergraduate level universities offer civil engineering, institutions providing a construction degree are few in number. Based on a count of construction management (CM) programs from Target Study and Education and Career Forum, websites having listings of the various CM programs offered in India, the authors conclude that fewer than 25 colleges provide a CM degree in India. Apart from the quantity gap in the

supply of individuals for the construction industry, the quality of construction education is also a concern. All areas of skill preparation concern that apply to general engineering education are applicable to construction professionals as well. Very few studies have been done in the construction education scenario of India. The 2011 RICS (Royal Institution of Chartered Surveyors) research on “Real Estate and Construction Professionals in India by 2020” provides an insight into specific issues as they apply to construction professionals. The report identifies some of the key skill shortages of civil engineers and construction education in the following areas:

1. Construction management
2. Quality control
3. Construction techniques
4. Building control
5. Facilities management

The report by NSDC (National Skill Development Corporation) in 2008 about “Human Resource and Skill requirements in Building, Construction Industry and Real Estate Services” also details some concerns specific to industry professionals. Skill shortages of construction project managers were identified as:

1. Inadequate knowledge of planning and scheduling software
2. Inadequate project management skills
3. Lack of communication and team building skills
4. Insufficient ability to manage multiple contractors and resolve conflicts

### *Undergraduate level studies*

The National Knowledge Commission’s report on engineering education in 2008 states that the undergraduate teaching environment in engineering institutions does not prepare students to relate to industry needs. Curriculum reforms are essential. These reforms needed stem from employment opportunities and market demands. The above-mentioned skill gaps can help provide a guiding direction for reforming construction education. Construction is still not recognized as a separate discipline calling for management, technology, and other skills in combination with some level of traditional civil engineering skills. It is unfortunate that India still doesn’t have an undergraduate degree in construction, even though the demand for construction professionals is growing rapidly.

### *Graduate level studies*

Industry requirements, research needs, and academia have an important connection to graduate level education. Even though India churns out on an average 2 million graduates annually, these graduates do not respond well to market needs and employment requirements (NKC, 2008). As a result, industry professionals still find a dearth of potentially well-groomed graduates. There is a flourishing market for graduates in construction (Nayar, 2011), yet there are very few institutions that offer construction programs in India. These institutions are also relatively new and are not internationally recognized construction programs. When addressing academic concerns, the sheer numbers aside, it is recognized that higher education in India is neither rigorous nor flexible enough to compete with institutions abroad (Nayar, 2011). Good graduate education is a combination of multiple factors which include good faculty and adequate supporting infrastructure (The Hindu, 2013).

To better understand Indian CM programs existing curriculums at IIT-D (Indian Institute of Technology Delhi), IIT-M (Indian Institute of Technology Madras) and NICMAR (National Institute of Construction Management and Research) were reviewed. The curriculum at the top three construction programs in India revealed the following:

1. On an average 70% of the total course credits are predetermined program core credits, 20% are program electives and only 10% are open electives. This points to the rigidity of the curriculum as opposed to what may be found in the US. The ability to tailor courses to suit the interests of specific students is not an option with respect to these curriculums.
2. The core credits touch upon project planning, construction management, construction engineering, materials, project finance, quality, safety, and maintenance management.
3. Missing courses include risk assessment, construction law, sustainability, and software skills.

4. Most of the electives are engineering based, and there is very little room for choice outside of the engineering realm. An engineering focus seems to be an underlying trend in these courses.
5. The communication-leadership aspects of construction management, important areas of skill development for construction managers, are not emphasized in these programs. Greater emphasis on developing people skills is found in US programs.

Source: IIT-D, 2014; IIT-M, 2014; NICMAR, 2014

Although the core subjects found in these Indian construction programs are similar to courses found in US programs, a couple of areas of CM competency appear to be missing. This finding is similar to the gaps in the desired construction skill set as expressed by the RICS and NSDC studies (NSDC, 2008; RICS, 2013). While this is purely from the curriculum content standpoint, based on the primary author's experience traditional lecture based teaching styles, minimal industry involvement, lack of research opportunities and quality of teaching are also differences found in CM education between India and the US.

### **Indian Students Studying Abroad**

*"The US remains the most popular destination for Indian students and is still perceived to provide the most prestigious and valuable credentials of all study abroad destinations."* –IIM Bangalore report, 2009.

While engineering and technological institutions in India are booming in numbers, the number of students going outside the country is also on a steady increase. A look at the past decade shows over a 200% rise in numbers of such students:

Year wise distribution of students studying abroad

2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
203480	198886	179437	157269	141300	141777	129595	114669	96034	70013

Source: UNESCO institute for statistics

A closer look into these numbers and statistics from the UN reveal that over half of the students going outside the country for education go to the United States, followed by Europe. The Institute of International Education recognized the number of Indian students studying in the US in 2011/2012 as 100,270. The main focus of students coming to the US is graduate studies, representing 58.9% of the total.

#### *Why Indian students study abroad*

Academic research on why a large number of Indians chose to study abroad is limited. The Indian media reports that the top two reasons for Indian students leaving the country are the lack of good educational programs and competition for limited seats. Thus the media draws attention to both quantity and quality of education in India. The number of educational institutions is rising slowly but this supply is not at par with the rate of growth of demand. While quantity is increasing, quality needs more attention (RICS, 2011). Other important factors contributing to more students studying outside the country are employability of students with foreign degrees, job opportunities abroad, lack of adequate research in India, and increasing affordability of foreign education. Research by the Wharton Institute reports that while job prospects may appear to be a key factor in Indian students heading to the US for education, only 8% strongly prefer to stay in the US for jobs. High quality teaching and cutting edge research were identified as key factors for choosing graduate studies in the US (Finegold & Kumar, 2011). Thus the historical notion of job prospects being a key motivation for students studying abroad is no longer true. Job opportunities within India are growing lucrative, but the education sector needs immediate attention.

### **Construction Education in the United States**

The inception of construction education in the US as a stand-alone engineering option occurred in the 1920s and gained momentum after World War II (Ledbetter, 1985; Abudayyeh et al., 2000). Providing formal construction education had become increasingly necessary to better address the growing construction industry needs and to address various problems and sector challenges (Russell et al., 2007). Similar to the present Indian scenario, even in

the US, building industry related programs were primarily civil engineering and architecture until the 1920's. The need for more specialized construction education formed the basis for the creation of undergraduate construction engineering programs (Ledbetter, 1985).

Defining construction engineering and teaching methodology were the biggest concerns during the onset of construction education in the US. The process began with setting up a Committee on Construction Engineering which helped guide the complex process of creating an undergraduate degree in construction (Ledbetter, 1985). The difference between civil and construction education was established by the committee. Focus was placed on combining traditional engineering skills with more specific technical skills. Initially, the level of specialization at the undergraduate level was kept at a minimum, in order to avoid the lack of learning of general principles.

The US coped well with construction education because of constant research as well as industry involvement. Regularly updating curriculum and reforming education to stay up to date with industry needs and skills required by employers were identified as being essential for the profession (Bernold, 2005). The multifaceted and constantly changing nature of the construction industry was recognized by the education sector. The imperative need to involve industry with construction education was recognized. Focus was laid on learning as a process, with a goal to be as practical as could be while programs worked to cater to industry needs (Abudayyeh et al., 2000; Bernold, 2005). Fittingly, industry involvement became key to construction education.

Simultaneously importance of construction management as a core also developed. The engineering, technology, and management aspects all came to be recognized as being important to construction education (Russell et al., 2007). The need to maintain a balance between engineering and management, both essential to construction, were also recognized. The core elements of construction engineering were established as technical fundamentals, materials, construction resources, and field operations (Tatum, 2010). Defining study areas and setting standards for construction education became important. ABET (Accreditation Board for Engineering and Technology) and ASC (Associated Schools of Construction) were established, directing attention towards construction industry needs and construction education respectively. These institutions helped guide the process of construction education and curriculum formation. Graduate construction education developed as the means of acquiring more specialized knowledge in construction. Graduate programs also help to keep up with the latest innovative technologies and business aspects of the industry. Interdisciplinary courses and flexible curriculums became inherent to graduate education. These conditions hold true even today. Some other areas identified as essential to graduate education are globalization, communication, leadership, and technology adoption (Becker et al., 2011). In recent years, sustainability has also been recognized an important component to studying construction (Tatum, 2010).

## **Recommendations for Construction Education in India**

Construction education is a necessity to support the construction industry in India today and developing it is key to the growth of the nation. The number of programs pertaining to construction education should be increased. The present focus on education in fields like IT, computer science, and electrical engineering should be expanded to construction sectors as well. Literature supports the call for immediate attention towards several aspects of construction education. These include:

1. Curriculum reforms
2. Collaboration with community and outside forces
3. Interdisciplinary approaches & hands-on learning
4. Industry involvement
5. A flexible education model
6. Equipping construction students with soft skills, business skills, adaptability, and problem solving skills

Drawing parallels from the evolution of construction education in the US, it follows that the first step towards developing construction education in India could be the introduction of a dedicated, stand-alone construction engineering or construction management undergraduate degree. The main focus of this could be the introduction of construction specific study areas (technology, materials and usage, processes, management, construction law, finance etc.) in addition to traditional civil engineering knowledge. The importance of blending engineering and management skills in the curriculum established has been demonstrated by the success of construction programs in

the US. All areas identified by the 2011 RICS report as skill shortages of civil engineers, should find a place in the new construction education degree. Courses should touch upon topics that deal with such general areas as:

1. Management techniques
2. Project management software
3. Cost estimation and related software knowledge
4. Quality control and quality assurance
5. Project tendering process
6. Facilities management
7. Sustainability and energy efficiency

As established in the US, during the introduction of construction education, it is important to have a regulatory education committee dedicated towards establishing the new degree. In India this role can be taken up by the AICTE (All India Council for Technical Education). The AICTE already serves to monitor and provide guidelines for education in sectors of architecture, information technology as well as town and country planning, and hotel management and vocational training. The need for setting up a new construction education division can easily be justified. The AICTE can also be charged with the duty of accrediting the newly created programs and thus help maintain quality of education.

At the graduate level, the existing construction management programs need to be reformed. The main focus should be to increase the flexibility and rigor in education curriculum to better-fit individual needs and industry requirements. Incorporating interdisciplinary courses in the curriculum is important for professional development. India also lags behind in technology studies because of lack of involvement with industry. More industry involvement, as exists in the US, should be emphasized. This could be done by encouraging more guest lectures, conducting site visits, having more career fairs, and emphasizing the importance of internships or cooperative education experiences. Graduate education should also include topics of present day needs such as globalization, latest technologies, business models, and sustainability. The education model should also drastically shift from the inherent 'textbook culture' to a more practical approach that fits the needs of the construction industry. Finding the right faculty to teach construction is also an important concern. Distance education and online courses could also be looked into as a possibility for expanding construction education within India.

## Conclusion

Though the need for education reform has been identified in India and India appears to be in the middle of an educational renaissance, there is much to be done in the field of construction education. Construction is a dynamic applied field. Professional construction education should have a good balance of theory and practice. The textbook driven model of education does not fit the construction field. Tackling the growing need for construction education should include introduction of a construction undergraduate degree and a re-examination of the existing education curriculum at the graduate level. Staying current with technological knowledge is essential to becoming competitive at a global level. These changes can help capture the flourishing market for construction professionals and support the growing construction industry in India. Without these changes, Indian higher education will be providing little support for the future economic growth of the nation at large.

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