

**M V ARUNDATHI¹**

¹Assistant Professor, SJB School of
Architecture and Planning

Email ID-
arundathimv@sjbsap.edu.in

She is B.E (CIVIL) with VTU 5th rank, M Tech in Urban and Regional Planning with 5 gold medals, Pursuing Ph.D from Mysore University under the topic “Planning for development of Micro Urban Gardens to increase Green Cover in Urban areas”

**K T SATISHCHANDRA²**

²Associate Professor, SJB School
of Architecture and Planning
Email ID- ktschandra@gmail.com

He is B E (CIVIL in 1983) and M E (Construction Technology in 1985 UVCE Bengaluru). He has been Visiting Professor in many colleges including MVJCE, RVCE, SJCIT Chikballapur. He has been Consulting Structural Engineer since 2010.

TEACHING BUILDING STRUCTURES AS A SUBJECT IN ARCHITECTURE STUDIES

Abstract

A structure is beautiful, when it conveys and serves the purpose for which it is built. This is possible when an architect and structural engineer collaborate in all stages of a construction project for achieving structural stability. This collaboration necessitates the introduction of detailed structural engineering concepts in architectural education. In architecture education, building structures is taught as quantitative and separate entity and its importance is neglected as the time ascends in the course. This happens at the university level, where the studios of architecture studies is designed to concentrate more on architectural skills and with minimal importance on structural detailing of the building. The scheme, syllabus, exam patterns, credit points of building structure in architecture studies has seen a drastic change from time to time. This study focuses on the perception of students and faculty on the importance of structures in architecture studies and opportunities on various methods of teaching structures as a non-quantitative, important subject for UG (B.Arch) architecture students. It looks specifically at the scheme, syllabus and requirement of Visvesvaraya Technological University (VTU) in particular.

Key words: Architectural Education, Building Structures, Scheme, Perception, non-quantitative.

1. Introduction

World famous structures attract common people with their appearance and multi-utility. These are the combined efforts of an architect and a structural engineer. Together they transform the imagination into reality by selecting suitable architectural elements, material and best conjugation of structural elements such that the structure fulfils the purpose for which it is built. These buildings motivate and inspire the students to take up architecture course. A graduated architect, in addition to the architectural skills needs to know the behaviour of a structural element so that the structure is in equilibrium and stable.



Over the period of time, many engineers and architects have developed some misconceptions that their responsibilities mutually excluded each other's concerns and sensibilities. This sensation is also expressed by Tom F. Peters in the book 'Bridging the Gap: Rethinking the Relationship of Architect and Engineer' as follows: While engineering hopes to be moving toward a more comprehensive approach to design and building, and the very nature of the word 'design' in engineering seems to be shifting to mean more 'configuration' than 'dimensioning', architecture is in danger of diversifying into literary and purely graphic pursuits, on occasion so strongly that some architects become mere aesthetic consultants or even abandon building altogether. (Peters 1991)

There is an increment tendency in architects, as structure is a technical subject who's which is left to engineers who would not involve in design and have to work within the boundaries and criteria set by the architects. Engineers, on the other hand, have begun to see architects as just artists whose demands sometimes are in contradiction with the principles of equilibrium and economic structural design. However, both engineers and architects would agree that a building must be of aesthetically beautiful that satisfies both the conditions of serviceability and firmness. Though the main occupation of an architect is to design and hence in the academics of architectural studies the subject interest naturally goes to architectural design studio which is the center of curriculum across the world. Also, a complete design could be achieved with artistic skills, theoretical and scientific knowledge and the activities in design studio becomes most suitable when they are backed up with

supporting technical subjects in the curriculum.

2. Current Architecture Scheme Under Vtu

The undergraduate Architecture education in VTU is mainly spread across full time 5 years. Every year sees a gradual advancement in architectural skills and is a blend of theoretical and practical knowledge for students to learn the art of planning, designing and constructing physical structures of various kind. It consists important subjects like History of architecture, Architecture design (AD), Materials and Methods in Building Construction (MMBC), Building Structures, Building services etc...these subjects increase their level of knowledge and difficulty as the semester moves forward along with few other supporting technical subjects. Each of these subjects are allotted with the credit points depending on their importance of the subject for students. Maximum credit points is given for AD and MMBC.

2.1 Building Structure as a subject in architecture studies

Over the period of time in architecture curriculum the structures subject is taught as separate entity from the remaining of the architecture subjects. Building structures which consists of important design concepts for creating and building the structure is given minimum credits. In particular, structural design detailing and application is neglected from most of the design studios of the architecture curriculum. Structures education is a combination of physics, linear progression from mathematics rigid body statics, physics, mechanics of behaviour of materials, design and analysis of lateral forces and overall building behavior.



Prof. Keith E. Hedges says that “Many architects believe that mathematics interferes with design learning of structures, which has led to the detachment with the overall architectural design process” .Hedges (2014),.Same like the saying building structures as a subject is losing its importance in architecture studies of VTU. It involves changes in the exam patterns, diluting the syllabus from design of structural elements to only drawing, reduction of credit points and also reduction of number of hours of teaching per week. All these efforts would help the student to somehow pass the exam but would lose his credibility of becoming a complete architect with his no understanding of behavior of the building. Hence, there is a need to develop a new way of approach about this current problem and explore a structures pedagogy that is consistent with the mental framework of architecture students.

2.2 Change in syllabus and scheme of Building Structures

The VTU has revision in their syllabus frequently, from past 10years 4 schemes have come up 2009, 2014, 2015 and currently 2018.

CBCS scheme was introduced in the curriculum from 2015 onwards. Syllabus of building structure subject has seen variations during these years and important one being method of conducting of exam for 3rd ,4th ,5th,6th,7th semester from written exam to viva-vase, from 2014 onwards. This change of pattern has also led to the dilution of syllabus like eliminating designing of the structural elements where students were taught to actually design each and every aspect of the structural element to mere drawing where an already designed data is given and are asked to draw the detailing of the element. Also this has led to the decrease in teaching hours from 4 hours per week to 3 hours per week (1hour instruction + 2 hours of drawing).

The main reason for these changes may be the pass percentage of building structures as a subject in the curriculum. For example, the statics of overall pass percentage of students taking up building structure –V in VTU of various schemes, shows that the pass percentage of this subject has increased drastically from 2018, where the exam pattern had changed from written to viva-vase and also due to the dilution of the syllabus from design to drawing.

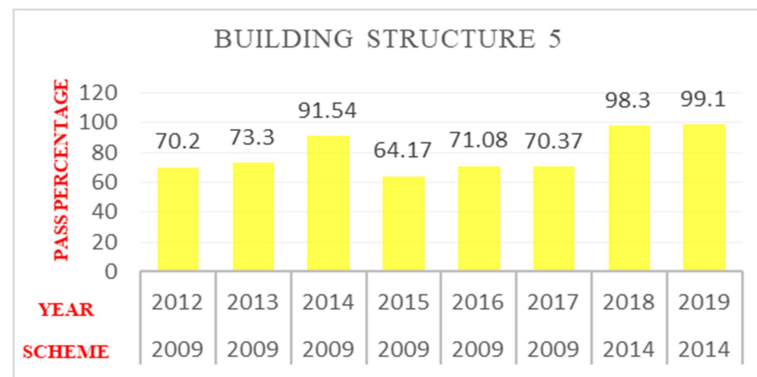


Figure:1 Pass percentage of building structure 5 in vtu

Source: Primary survey by author

3. Results From Primary Survey

A random sample survey was conducted to get the first hand data separately for students of architecture and faculty teaching structures in architecture studies in VTU regarding building structure subject in architecture curriculum. Each survey form consisted of few questions to know their opinion on the subject. Where many faculties and students of 3rd, 5th, 7th, 9th semesters and also few graduated students from various architecture colleges across VTU. From the survey it was found out that student's mindset of taking up architecture in their under graduation mainly depended on their PUC subjects. 63.5% of students had taken up PCMB (Physics, Chemistry, Mathematics, Biology). Many students mentioned that they took architecture as a second choice, first being medical. Also 64.8% students responded that they don't like mathematics as a subject which led them to take up architecture, assuming that it only deals with drawing and sketching and no calculation is involved. However, building structures involves mathematics and calculations which has also led to the ignorance by many students and restrict the subject to mere passing. 53.6 % of the students responded that they study structure for mere passing.

One student in the survey stated that "They are unable to understand how the subjects during in the courses relate to studio works and correlate to their future professional life as architects. The student also mentions that they are not able to use the technical knowledge they acquire from other subjects in their project in design studio. They also feel that those technical detailing when they are successful in incorporating in their design studio the weightage of those works are rarely looked into and appreciated". Because of

these reasons they tend to focus on architecture aspects of the design, which will help them fetch more grades and are also appreciated.

The current pattern of exam in VTU which is in viva - vase form requires the student to draw few elements of the structure with the given data. This has led to the lack of understanding of behavior of the element and ultimately understanding the equilibrium of the structure. For ex. A data is given along with the reinforcement details to draw a doubly reinforced beam. Say 350*550 mm. the student however draws the diagram with reinforcement details. Here the important thing is, they fail to understand how these reinforcement numbers were arrived at, like number of bars in compression, number of bars in tension, is the reinforcement safe for bending, why stirrups to be provided, why are these stirrups placed closely near the supports, what is the behavior of these beams when the load is applied, what happens to the beam when it is about to fail or even why double reinforcement is required.

The main problem is the dual identity of a profession of an architect. Frequently architecture is defined as a combination of art and science. However, the question is how much art and how much science? To be more precise, what should be the content of structure courses in the architectural education and more importantly in which manner should this content be transferred to students. Maybe the most critical of the problems is the lack of coordination and the resulting problem of communication between structure courses and design studios. 89.88% of the students and 81% responded that collaboration of design studios and building structures in the curriculum is necessary.



The National Architectural Accreditation Board, Inc. (NAAB), one of the oldest accrediting agency for architectural education in the United States, requires that programs demonstrate satisfactory evidence of student achievement within a discrete structural systems criterion and under a broader design studio situation. The National Council of Architectural Registration Boards, Inc. (NCARB) licensing board for 50 US states defines structural systems as, “The study of the basic structural elements of buildings, their interaction as a support system, the forces that act on and in buildings, and the principles, theory, and appropriate applications of these in design studio systems.” The NCARB approximates that the academy, on average, assign six credit hours to structures exclusive of any prerequisite mathematics and physics coursework.

4. Results And Discussion

From the graph it is evident that bringing up the older syllabus would see more failures. ALI IHSAN U NAY and CENG IZ OZMEN says “Majority of architectural students are visual learners, which means that, they tend to make use of their sensory skills besides their analytical mind. The sensory skills, on the other hand, are all interconnected. The senses of touching, tasting, seeing, hearing and smelling all work as a whole in the process of making the mind aware of the outside world”(2014). The perception level and interpretation of an object depends with the ability of senses that support the absorption of an information related to that object. Based on this, it can be said that actual models will help the students to perceive and interpret in a better way as their senses like seeing, touching and hearing act as primary mediums for learning. Also models help in the

demonstration of theoretical concepts such as displacements, torsion, bending, behaviour of structural element under loading more practically. Hence a concept of model making and drawing combination would be brought up where the behavior of structural element is shown live in the class. 89% of the students and 91% of the faculty members responded that they need a combination of practical knowledge as well as theory for this subject.

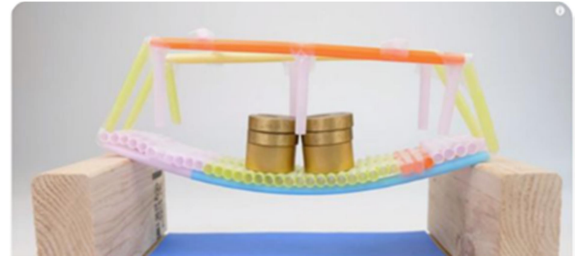


Figure 2 : Demonstration of failing of a normal beam bridge constructed from straws

Source: pinterest.com

Framing of content of syllabus of building structure should laterally run according to the structural details requirement in design studios of the respective semester. Presence of a member with technical knowledge of structures in Board of Studies (BOS) and Board of Examiners (BOE) of the university would be required for the same.

Collaboration of subjects like MMBC and building structures. MMBC which also deals with the materials and detailing of structural elements but does not concentrate on understanding the behavior of the structural element, is given second most credit in the exams. Since, these two subjects are similar in their objective, a syllabus could be formed in such a way that at every semester these two subjects could go laterally. For example a design of certain element could be done in building structures class while the same drawing could be done



in MMBC. In such a manner deeper knowledge of the structure could be achieved in both the subjects. The behavior of the element could be studied in Building structures class while the suitable material for the element could be analyzed in MMBC class. It is required to give equal credits for both the subjects.

A new system has to be brought up by developing a studio that is multidisciplinary in nature by including faculty from different technical disciplines. Where along with architectural design faculty, one common faculty with knowledge of structural design and occasionally a mechanical engineer to be present. Also considering structural element of the design as critical part for evaluation. This would create a sense of interest and enthusiasm students to learn the design parameters in depth and ultimately overall architectural

skill development of the students. Such a method is also followed in Hence, one of the major step in improving the method of education of building structure would be to increase the appropriate staff specialized in structures in design studios of the curriculum.. Council of Architecture (COA) considers faculty teaching structures as well as artistic skills as allied faculties and not core faculties.

Hence, in most of the cases tenure faculties and visiting faculties are hired to teach building structures and not the core faculties. Also professor post for a faculty teaching structure is absent. 71.9% of the faculty teaching building structures replied that they would not continue to teach in architecture if they are not promoted to professor post in spite of having adequate qualification. This would lead to decrease in the interest among the faculty members to teach the subject.

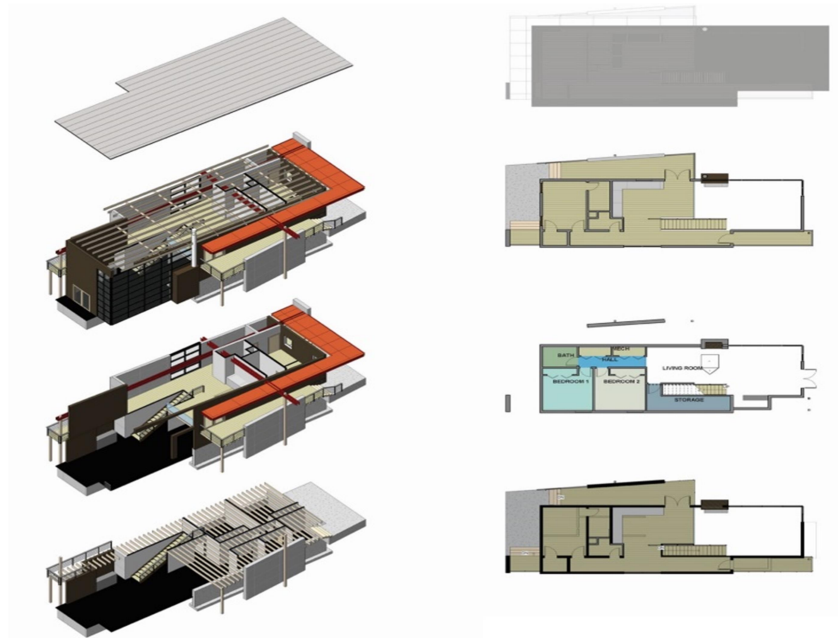


Figure 3: Isometric structural diagram of a design studio project to illustrate the relationship between structure and architectural space. Detailing of every element of the structure is shown.

Source: Prof. Keith E.Hedges, Drury University

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5. Conclusion

Conjugation of architectural skills and structural skills is possible from an appropriate form of architectural education. Teaching building structures should have more of hands- on activities along with the soft method of teaching with lot of options for trial and error method, which makes the students to get the hang of concept easily. Small scale lab experiment where the behavior of the element could be observed under loading, where failures of a structural element could be understood. Collaboration of subjects like MMBC and building structures could help give equal importance to both the subjects. Considering structural detailing as also important criteria in design studios for marking could help the students to take up building structures seriously and implement in their design.

It is the responsibility of schools of architecture and universities that take up the

task of future generations who pursue architecture with the skills and knowledge of building future buildings. It should be remembered that building structures design not only makes the building firm but when skillfully designed it becomes one of the key elements that decides the spatial functions, serviceability and aesthetic quality of a building. Architecture and structures cannot mutually exclude each other, if done, its like building a structure without foundation.

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