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Analysis and Research of Factors Influencing the Design of Prefabricated Buildings

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ABSTRACT- Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. It is a part of structural analysis and a part of structural design where earthquake is prevalent. This technical paper highlights the project work pertaining to the structural analysis and design of a multipurpose auditorium using a computer software, Extended 3D Analysis of building System, abbreviated as STAAD PRO. Shape of the auditorium was linear (rectangular). This includes planning, analysis of loads and designing of structural elements based on different loading conditions. Planning of acoustic and vision point of view were taken from National Building Code, and the limit state method of collapse using respective IS codes. AutoCAD® was used for drawing plan, elevation and section of auditorium. Design and analysis were done manually and the results were verified using STAAD PRO.

KEYWORDS: Structural Analysis, Design, Staad Pro, Auditorium, AutoCAD

I. INTRODUCTION

These are the buildings where groups of people meet or gather for amusement, recreation, social, religious, political, civil, travel, and similar purposes; such as theatres, motion picture houses, marriage halts, town halls, auditoriums, exhibition halls, assembly halls museums. A covered or open enclosure where people can assemble for attending any seminar given on the stage. An Auditorium is a room built to accommodate the audience to sit and watch presentation or any stage performances. An auditorium is a large space that is the move of a multipurpose facility. A auditorium or multi-purposes hall is usually a large space that is built to the needs and specifications of the entertainment. An auditorium may be a various purpose facility where an area built to enable an audience to listen to and watch performances. For movie theatres, the number of auditoria (or auditoriums) is expressed because the quantity of screens. Auditoria are often found in community hall, entertainment venues and theatres, and can be used for presentation, rehearsal, humanities productions, or as a learning space. Each size is exclusive, with specific guidelines governing row size, row spacing, and exit ways. In a continental arrangement, all seats are located during a central section. In order to catch abreast of the greater length of rows allowed, building codes would require wider row spacing, wider aisles, and strategically located exit doors. Various researchers have done work in this area.

OBJECTIVES OF THE PROJECT:

- To design structural and seismic design of assembly buildings.
- Our project involves analysis and design of multipurpose of auditorium using a very popular designing software STAAD Pro.
- To study various codal provisions related to structural and seismic design.
- To study of interface of STAAD PRO software.
- The drafting of auditorium planning by using auto-cadd tool & design of rcc building by using STAAD Pro software.

II. LITERATURE REVIEW

There are three key concepts in seismic design that were fully developed by researchers and engineers.

[1] Analysis and design of auditorium by using STAAD Pro Software

Manoj Nallanathe, Ramesh.bhaskar, B.v.Pavan Kumar (2018), This project deals with the design of a multi-purpose auditorium so as to accommodate 900 persons. The main concept design of auditorium building vision & acoustical purpose. The dimensions auditorium building is 55*22 mts with out include of compound wall & balcony arena. Required area is calculated as per NBC. This includes planning, analysis of loads and designing of structural elements based on the loads coming on them (live loads, dead loads, wind loads as per IS:875 part-1,2,3). The shape of the auditorium is linear (rectangular). Auditorium consists of assembly halls, show off halls, concert halls, auditoriums and theatres. This is so because the plan is based on acoustic and vision point of view, which are taken from NBC part-VIII, for which linear shape is best suitable . The design pattern of seating arrangements, floor height, celing ,stair case & remain parameters necessary for design of auditorium interior part by using ADA code book. The drafting of auditorium planning by using auto-cadd tool & design of rcc building by using Staad Pro software. The building was analyzed & designed using STAAD Pro. The dimensions of column is 0.3*0.8 m & beam 0.3 *1.5 m are challenge think to sustain with an maximum bending moment with an critical section of beam & column . Actually beam design for long span construction should be prefer PT beams instead of R.c.c beam. Normally if we use PT beam is size should be reduce half of the depth of beam size. In this case our project deals R.C.c beam 1.5 m depth of beam but PT beam size is 0.75 m.

The maximum footing size is 4.0*4.0 mts with deep of 1.5 m. STAAD Pro give satisfactory results when checked with manual design also.

Designing is an art of finding out dimensions of a structural member and amount of other materials (reinforcement, prestressing etc.) which will be sufficient to withstand different types of loads and forces applied on that member, at the same time it will be economic and providing serviceability. In other words, “the basic objective in structural analysis and design is to produce a structure capable of resisting all applied loads without failure during its intended life”.

[2] Design and analysis of auditorium using STAAD Pro software

Akshay K. Ghuge, Durgesh H. Tupe, Gajendra R. Gandhe (2021), This project deals with the design and analysis of the auditorium which is located at Aurangabad in Maharashtra State. Auditorium can be used for all types of formal assembly, lectures, seminars, functions, award ceremony, cultural activities like dramatic plays, singing and dancing. The Project is based on limit state concept, the structure is designed to resist and liable to bare all loads liable to act on it. It should be satisfying the requirement of serviceability within the limitation of Deflection and Cracking. The analysis done using STAAD-Pro and Structural Detailing had done using AUTO-CAD. The project was aimed on the analysis and design of an auditorium building located at Aurangabad City in Maharashtra State.

- The construction of auditorium presents a solution of many cultural events programs being held.
- It was analysis using STADD.PRO using generic loading which proved to be premium software of great potential in analysis and design sections of construction industry.
- All the structural components were detailed by using AutoCAD 2016.
- The analysis and design were done according to standard specifications.
- Used IS-456:2000 & SP-16, for the design of the STRUCTURAL MEMBERS. i.e., followed the LIMIT STATE method.
- The various difficulties encountered in the design process and the various constraints faced by the structural engineer while meeting the requirements of architectural drawing were also well.
- Materials used are M20 grade concrete and Fe 415 steel unless mentioned in the particular design elements.

[3] Design and Analysis of Auditorium by Using STAAD Pro

S.Harish, L.Ramaprasad Reddy (2017), The Auditorium allows for huge conferences, displays and performances. Auditorium consists of assembly halls, show off halls, auditoriums and theatres. This thesis is about designing an auditorium using STAAD pro tool. This tool saves time for calculations and studying the structure. Project is primarily based on limit state concept, the structure shall be designed to resist, it must bare all loads liable to act on it at some point of its lifestyles; it shall additionally satisfy the serviceability requirements, including limitations on deflection and cracking. The suited limit for the protection and serviceability necessities before failure happens is known as a ―limit state. The aim of design is to achieve appropriate chances that the structure will not unfit for the use. For which it's indented, that it's going to not attain a limit state. The project is about "Designing and Planning of Auditorium". As this is a prayer hall all the members of the staff assemble here. The total project includes designing of structural members like slab, beams, columns, footings. The designing has been done based on reference of IS code 456:2000 for concrete and SP 16 for steel. The software AutoCAD was used for drawings (plan, section, &elevation) and for drawing reinforcement details of slabs, columns, beams & footings. Various load combinations as per IS code were used, considering seismic load as the major apart from other loads. The structure is stable under various load combinations. This project concludes that the moments and forces appearing in the structure were significantly lower than in case of plane frame under similar loading conditions. Also the project shows that for long spans structures are considerably cost effective than plane frame structures. From the analysis process the values obtained are plotted as bar graph and line graph. Base shear and storey drift are the two parameters which are compared here for medium soil condition and soft soil condition. Base shear is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is high in soft soil condition. The storey displacement is the lateral sway of the story with respect to its base. According to the report the value of storey displacement at 4.5m are maximum in both medium and soft soil conditions.

[4] Structural Analysis and Design of an Auditorium using Extended-3D Analysis of Building System

Ashwini Mareena Sam, Devika J S, Panchami P S, Muhammad Salih N, Rajeev Kumar P (2020), This technical paper highlights the project work pertaining to the structural analysis and design of a multipurpose auditorium using a computer software, Extended3D Analysis of building System, abbreviated as ETABS®. Shape of the auditorium was linear (rectangular). This includes planning, analysis of loads and designing of structural elements based on different loading conditions. Planning of acoustic and vision point of view were taken from National Building Code, and the limit state method of collapse using respective IS codes. Auditoria can be found in entertainment venues, community halls, and theatres, and may be used for rehearsal, presentation, performing arts productions, or as a learning space. Seating arrangements in an auditorium seating layout (or assembly space) are either be identified as "multiple-aisle" or "continental." These terms are commonly found in design standards manuals, building codes, and similar architectural reference documents. Each size is unique, with specific guidelines governing row size, row spacing, and exit ways. Basically, a multiple-aisle arrangement will have a maximum of 14–16 chairs per row with access to an aisle-way at both ends.

In a continental arrangement, all seats are located in a central section. Here the maximum quantity of chairs per row can greatly exceed the limits established in a multiple-aisle arrangement. In order to compensate for the greater length of rows allowed, building codes will require wider row spacing, wider aisles, and strategically located exit doors. Although it would seem like more space is called for, a continental seating plan is often not any less efficient than a multiple-aisle arrangement. In fact, if it is carefully planned, a continental arrangement can frequently accommodate more seating within the same space. This work highlighted the analysis and design of a multipurpose auditorium at Pathanapuram municipality, Kerala state using ETABS® software. Preliminary drawings were done using AutoCAD®. For completeness, a cost estimation for the construction was also carried out and the estimated cost was found as Rs 1,22,00000/-.

[5] Analysis of a Structural and Sesmic Design of an Auditorium

Rupeesh S.and Prabhakaran P. A.(2021), Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. A methodology does not set out to provide solutions. A methodology offers the theoretical underpinning for understanding which method, set of methods, or best practices can be applied to a specific case, for example, to calculate a specific result. With the increasing seismic activities in the recent times an efficient design of the pile foundations to resist the estimated earthquake loads is a major concerned issue.

In this interest, this study deals with the estimation of the seismic loads on a super structure as per the two international codes selected, IS 1893 and EN 1998. Different cases are considered assuming the location of the structure to be in different seismic zones of India and on different ground types (Type C and Type D).

The estimated seismic loads are applied to the SAP2000 model of the structure and analyzed to find the maximum (design) foundation loads. Liquefaction potential was evaluated, before proceeding to the pile design, for the selected soil profiles in the Guwahati region. Then the pile is designed for a selected case of seismic zone V and the ground type

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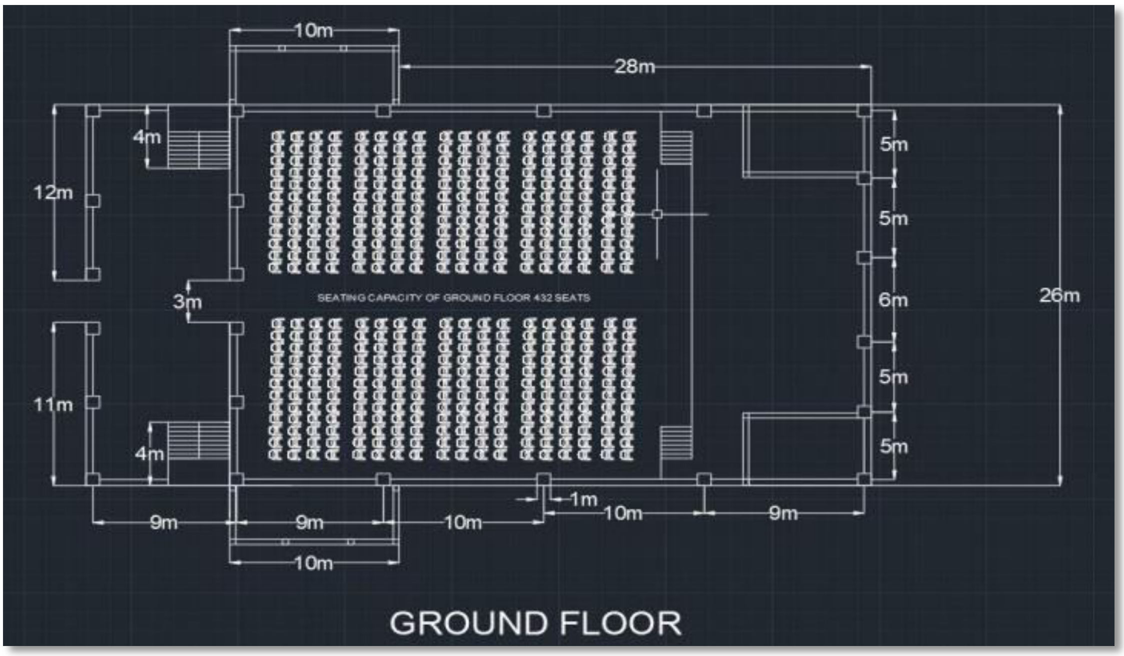
C. The pile is first designed for using the Indian Standard IS 2911. Then the design was checked against lateral deflection and limiting moment capacity of pile for the estimated lateral loads and moments under seismic condition using commonly used method called the Characteristic Load Method. Further the seismic design is revised for both the cases considering the soil profile to be liquefiable.

- The base shear increases significantly as the soil condition changes from medium soil to soft soil.
- In our case the base shear increased by 35.95%
- The storey drift is also affected due to the change in the soil conditions, it increases as the soil stiffness decreases.
- In our case the storey drift increased in the range of 8% to 14%.

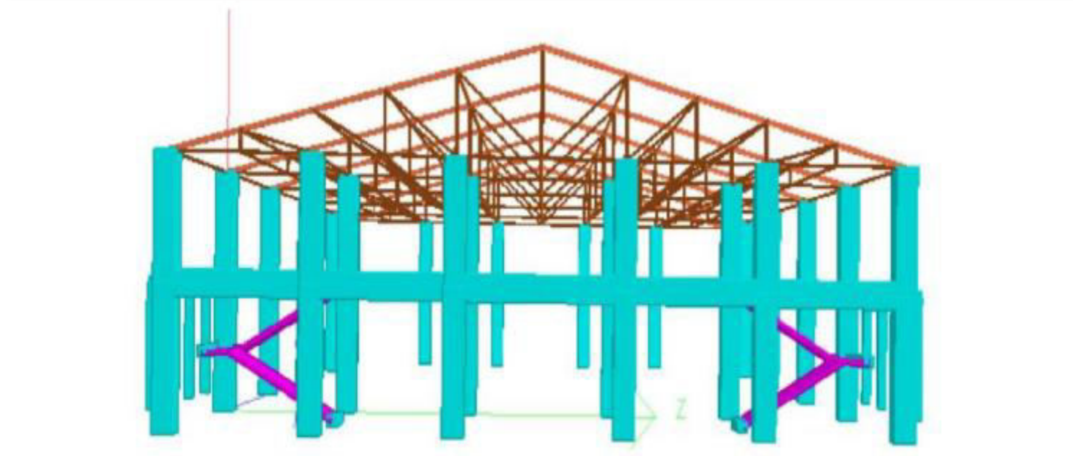
III. PROPOSED METHODOLOGY

A Structure is often outlined as associate degree assemblage of components. STAAD is capable of analyzing and planning structures consisting of frame, plate/shell and solid components. Virtually any style of structure is often analyzed by STAAD. A SPACE structure, that may be a 3-dimensional framed structure with hundreds applied in any plane, is that the most general. A PLANE structure is sure by a worldwide X-Y frame of reference with hundreds within the same plane. A TRUSS structure consists of truss members who might have solely axial member forces and no bending within the members. A FLOOR structure may be a 2 or 3-dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ & MY square measure restrained at each joint]. The ground framing (in worldwide X-Z plane) of a building is a perfect example of a FLOOR structure. Columns also can be sculptural with the ground during a FLOOR structure as long because the structure has no horizontal loading. If there's any horizontal load, it should be analyzed as an area structure. The graphical user interface (or user) communicates with the STAAD analysis engine thought the STAAD INPUT file. That computer file could be a document consisting of a series of commands that square measure dead consecutive. The commands contain either directions or knowledge concerning analysis and/or design (style). The STAAD computer file may be created through a text editor or the graphical user interface modeling facility. In general, any text editor is also utilized to edit/create the STAAD computer file. The graphical user interface modeling facility creates the computer file through Associate in nursing interactive menu-driven graphics homeward-bound procedure.

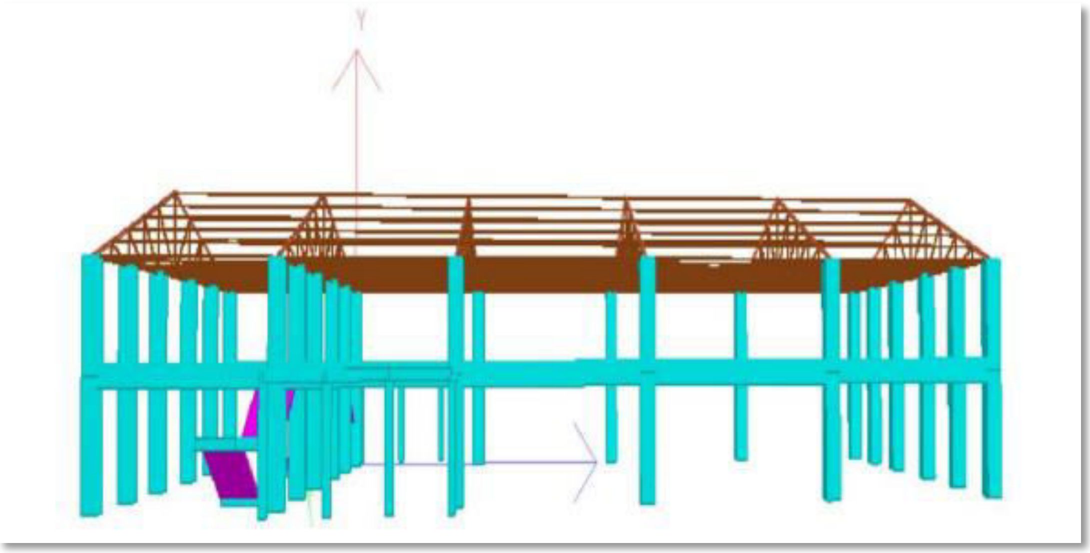


[Fig.3.1: Ground floor plan]

[Fig.3.2: First floor plan]



[Fig.3.1: 3D Front view]



[Fig.3.4: 3D Side view]

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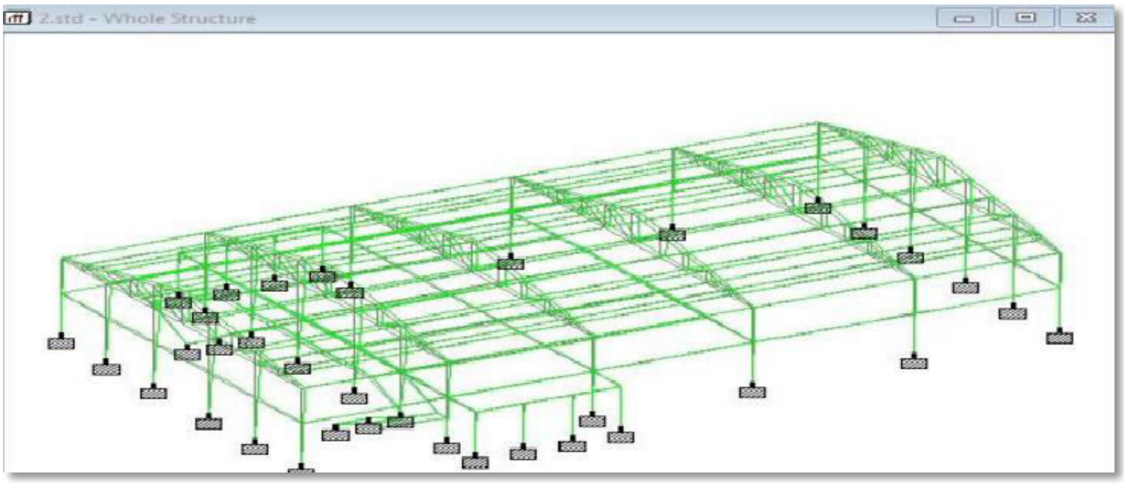
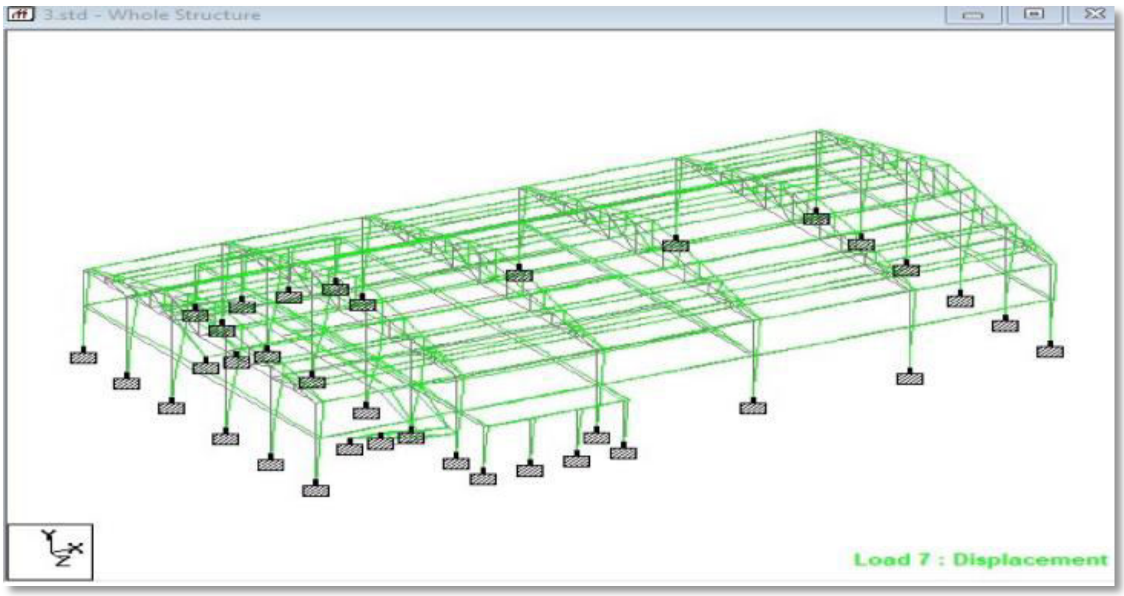
Table 3.1: Structural Property

PARTICULAR OF ITEMS	PROPERTIES
Type of support	Fixed
Number Of Stories	G+1
Total Height of Structure	13.5
Floor Height 1	5.5
Floor Height 2	3.5
Main Beam Size	750mm*450mm
Secondary Beam Size	350mm*350mm
Main Column Size	750mm*750mm
Secondary Column Size	350mm*350mm
Slab/Plate Thickness	150 mm

IV. RESLUTS & DISCUSSION



[Fig.4.1: Deflection diagram for medium soil]



[Fig.4.2: Deflection diagram for soft soil]

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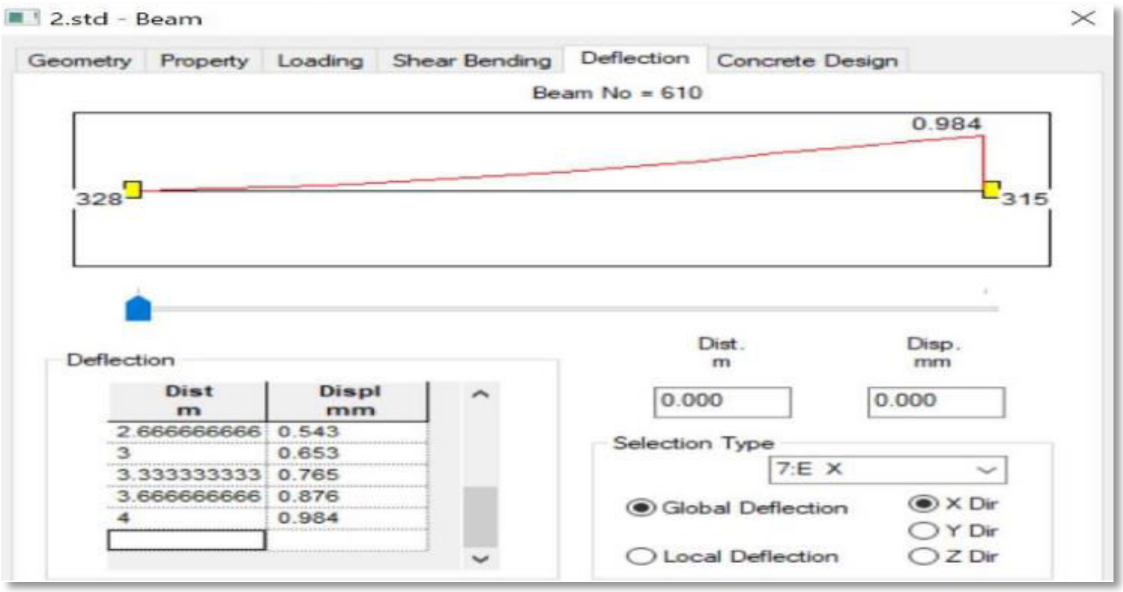
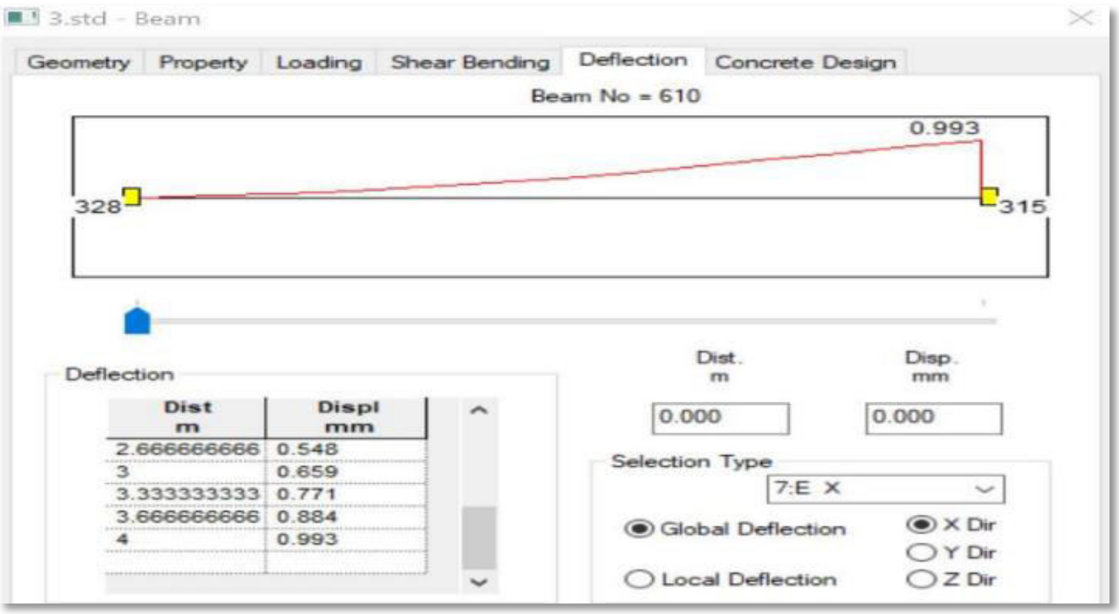


[Fig.4.3: Column deflection for medium soil]



[Fig.4.4: Column deflection for soft soil]

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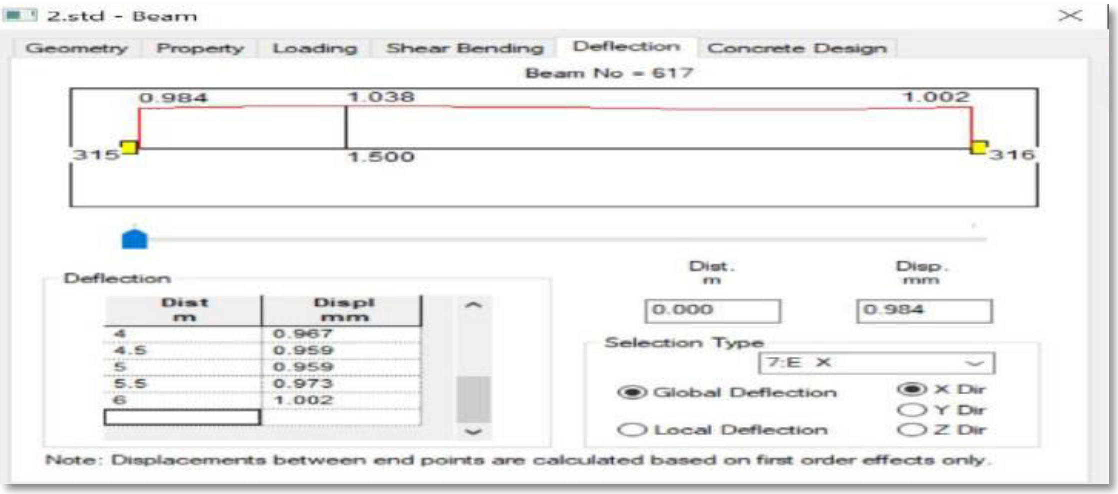
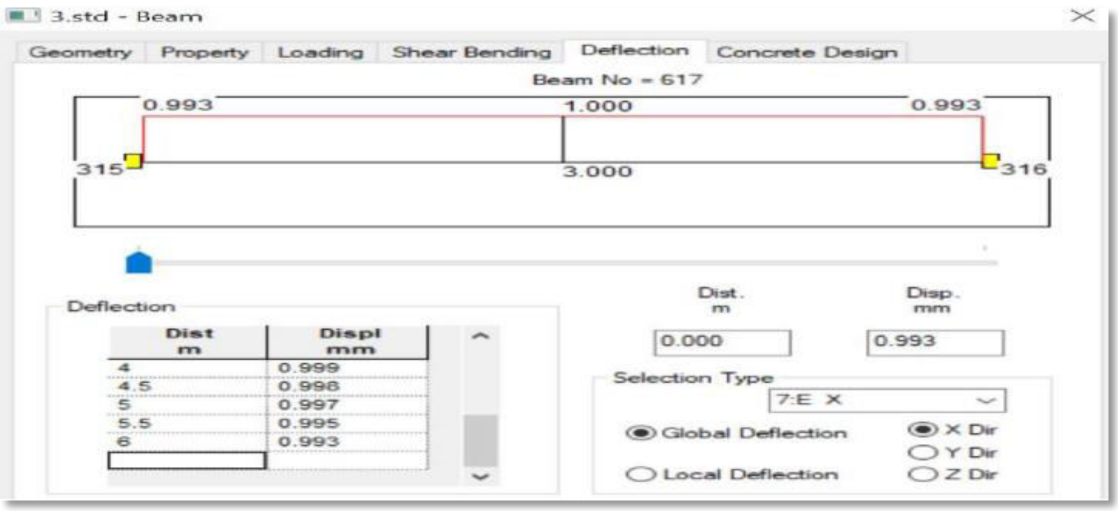
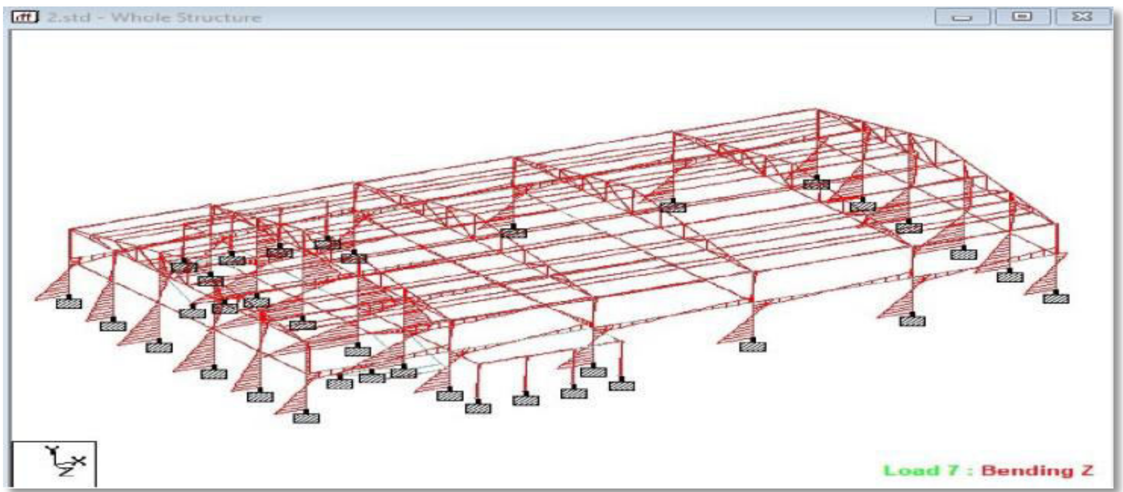


[Fig.4.5: Beam deflection for medium soil]



[Fig.4.6: Beam deflection for soft soil]



[Fig.4.7: Bending moment diagram for medium soil]

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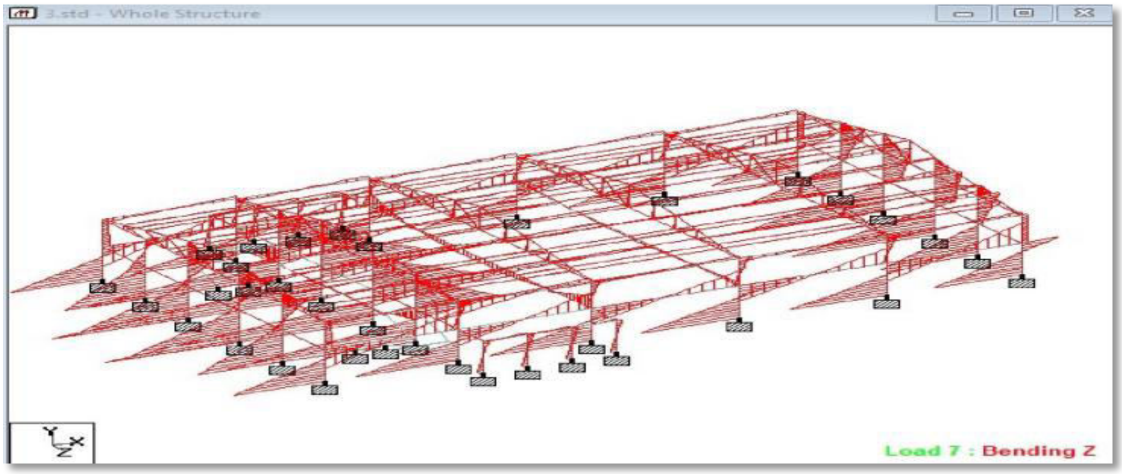
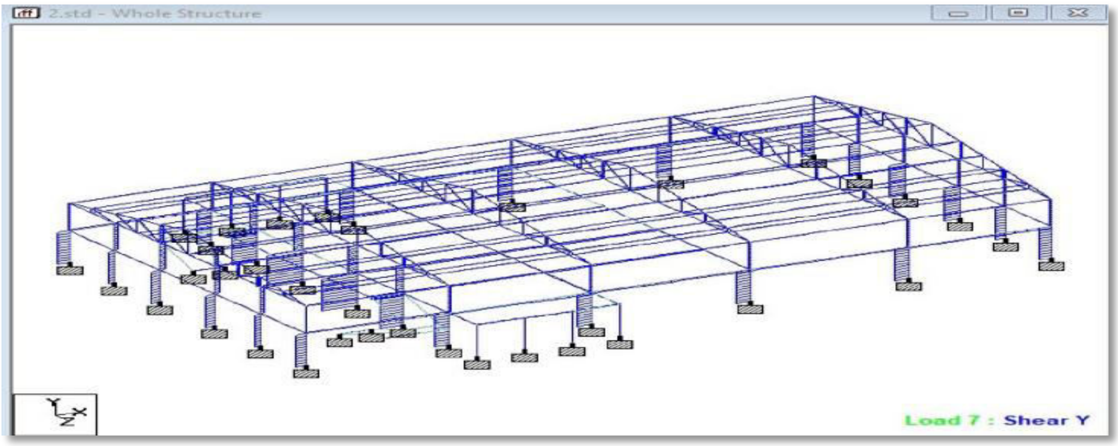
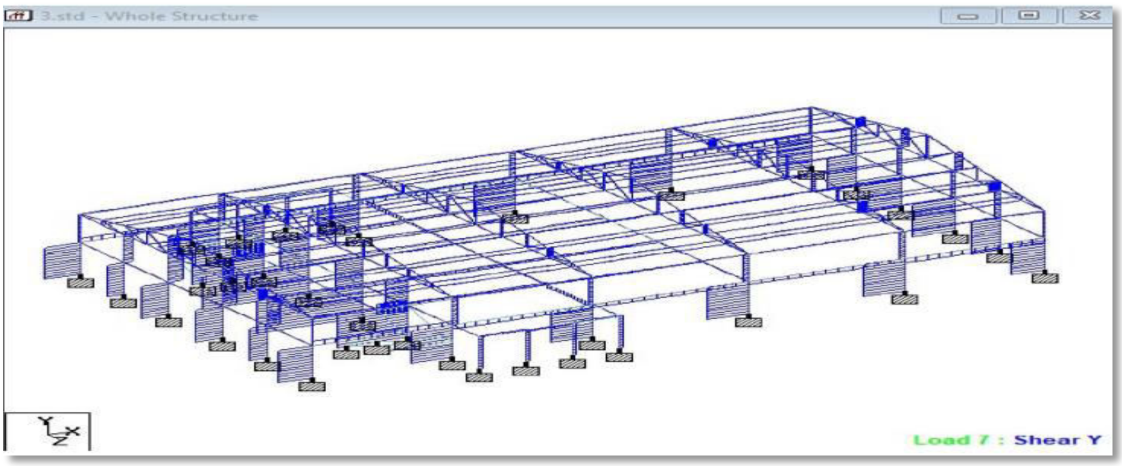


[Fig.4.8: Bending moment diagram for soft soil]



[Fig.4.9: Shear force diagram for medium soil]



[Fig.4.10: Shear force diagram for soft soil]

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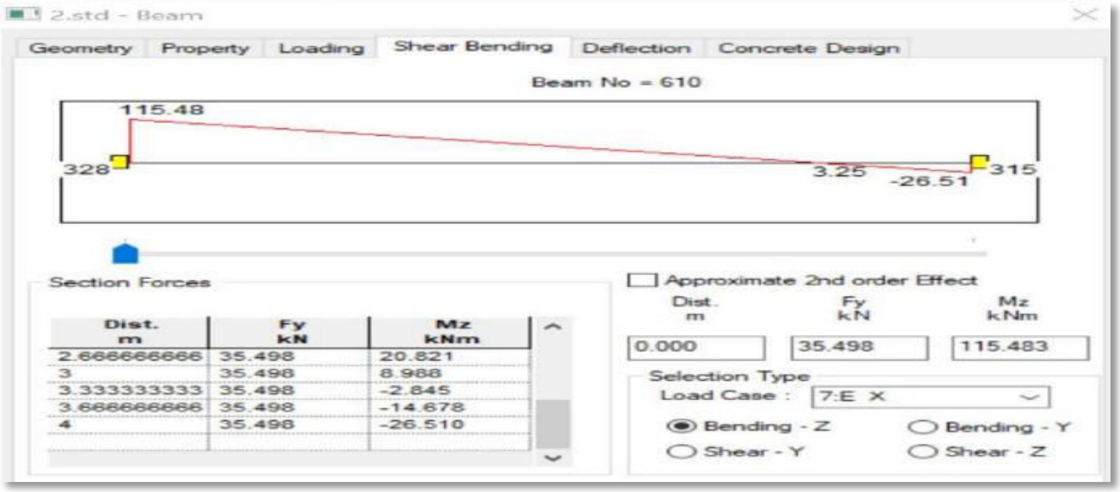
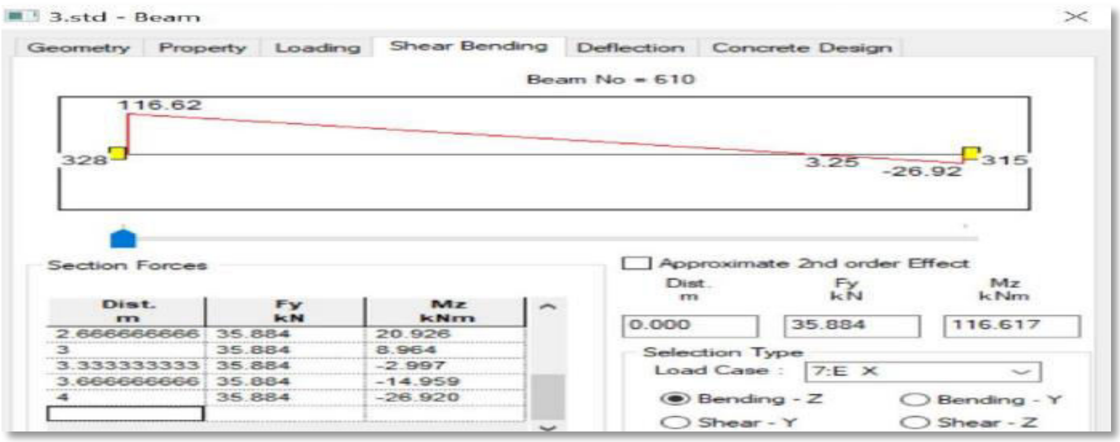
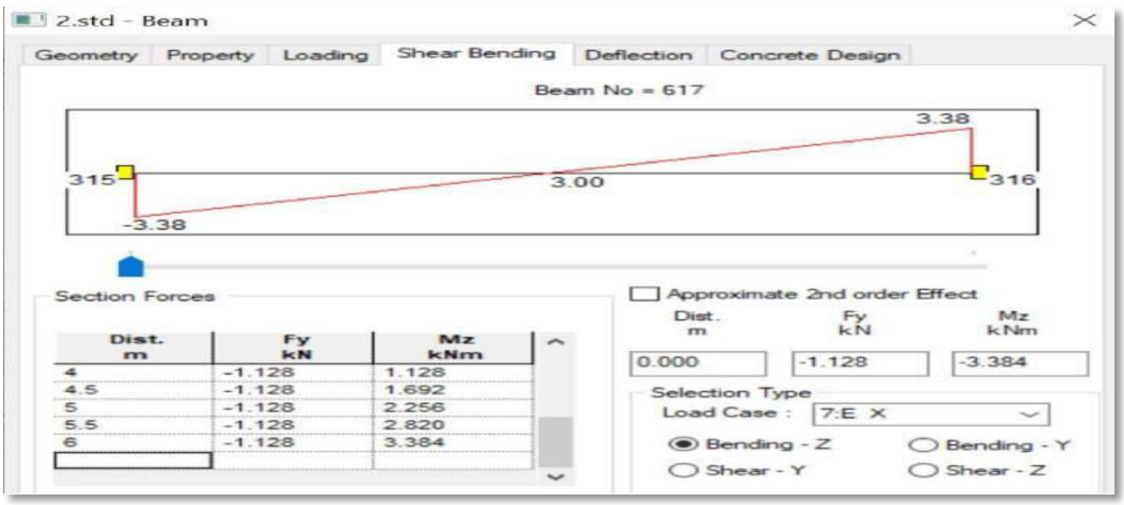


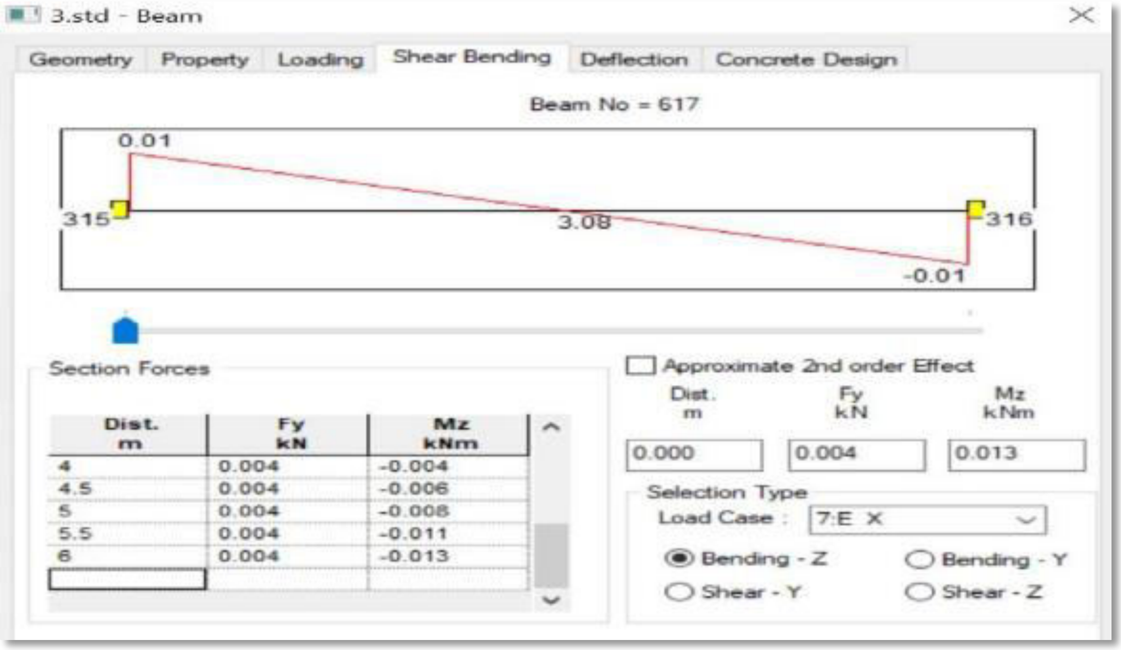
[Fig.4.11: Column shear bending diagram for medium soil]



[Fig.4.12: Column shear bending diagram for soft soil]



[Fig.4.13: Beam shear bending diagram for medium soil]



[Fig.4.14: Beam shear bending diagram for soft soil]

III. CONCLUSION

It concludes that the reliability and efficiency of this software in the field of designing is better to that of the manual work. It is seen that the software generated results were more economical and efficient which included the various different conditions which are difficult to consider while doing manually. This project concerns the feasibility of construction of an auditorium building with economical ways.

- The base shear increases significantly as the soil condition changes from medium soil to soft soil.
- In our case the base shear increased by 35.95%
- The storey drift is also affected due to the change in the soil conditions, it increases as the soil stiffness decreases.
- In our case the storey drift increased in the range of 8% to 14%.

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