e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 6, Issue 6, June 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

International Journal Of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

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Research Analysis of Factors Influencing the Design of Prefabricated Identified Assembly 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, Autocad, Auditorium, AutoCAD

I. INTRODUCTION

In this project analysis and design auditorium by using STAAD Pro Software and also seismic analysis and design of an auditorium. This project highlights the project work pertaining to the structural design and analysis of a multipurpose auditorium using computer software, Staad Pro V8i. Planning of vision point of view and acoustics were taken from National building code, and therefore the limit state method of collapse using Indian Standard Codes. AutoCAD software version 2016 was used for drawing plan, section and elevation of auditorium. Design and analysis is done using Staad Pro. v8i software and verified by manual method.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.

II. LITERATURE REVIEW

[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 mtswith 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.

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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.

[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.

[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.

[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 technicalpaper 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.”

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

III. PROPOSED METHODOLOGY

PLAANNING OF AUDITORIUM

A number of standard codes approved by Indian Standard institutions has specified the following minimum requirements for the construction of the auditoriums:

1. FRONT AND REAR OPEN SPACES: No person shall erect a building unless it is set back at least 6m from the regular line of the street or from the street if no such regular line exists.
2. PLAN AREA: Plan area of the building is to be fixed at an occupant load of range 0.6 to 0.9 m2/member. Drawings were done using AutoCAD.

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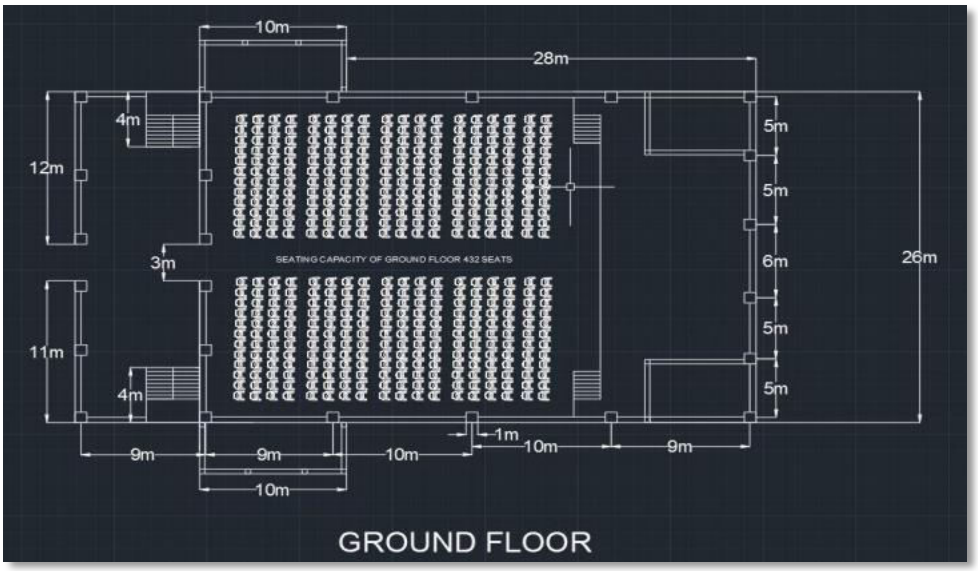
A Structure is often outlined as associate degree assemblage of components. STAAD is capable of analyzing and planning structures consisting of frame, plate/shell and solid components. Virtually any style of structure is often analyzed by STAAD. A SPACE structure, that may be a 3-dimensional framed structure 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.4.1: Ground floor plan]

[Fig.4.2: First floor plan]

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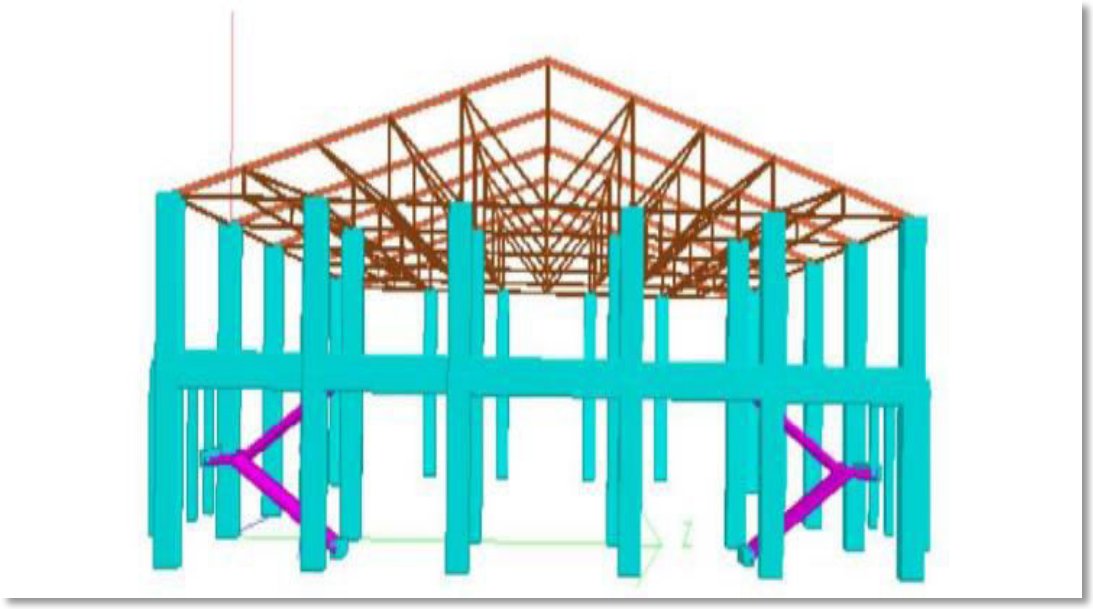

[Fig.4.3: 3D Front view]

STRUCTURAL ANALYSIS

Structural analysis of structure is essential before starting construction work. It provides the details of the size of the foundation, the size of the column and beam, and reinforcement details that are sufficient to carry the load acting on the structure. As discussed in the above sections, structural analysis was done using STAAD PRO Vi8 software. The structural properties used is given in table 4.2 given below.

Table 4.1: 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

Codes Used

- IS 456 : 2000 (Plain and reinforced concrete)
- IS 875 : 1987 (Design loads) ,Part 1 - dead loads -Unit Weights of Building Materials and Stored Materials ,Part 2 – Imposed Loads ,Part 3 – Wind Loads ,Part 5 - Load Combination
- IS 1893(part 1) : 2002(Earthquake resistant design of structures)
- IS 13920 : 1993 (RC Structures subjected to seismic force)
- Design aids for IS 456 (SP16)

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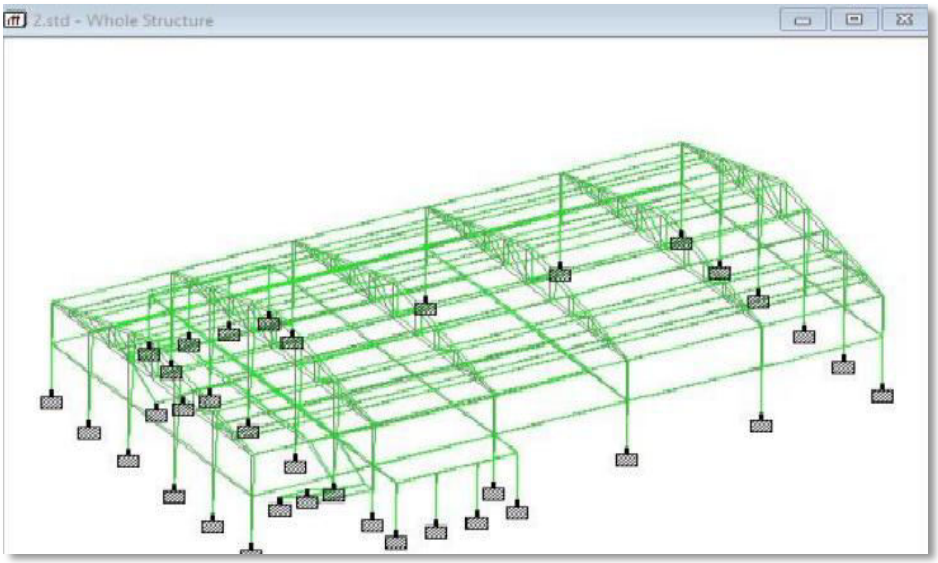
Table 4.2: Concrete Design Parameter

Grade of Concrete	M30
Grade of Main & Secondary Steel	Fe415
Density of Reinforced Concrete	25 KN/m^3
Beam cover	30 mm
Column cover	40 mm
Slab cover	25 mm
Max. size of main reinforcement	60 mm
Max. size of secondary reinforcement	12 mm
Max. percentage of longitudinal reinforcement allowed	6%

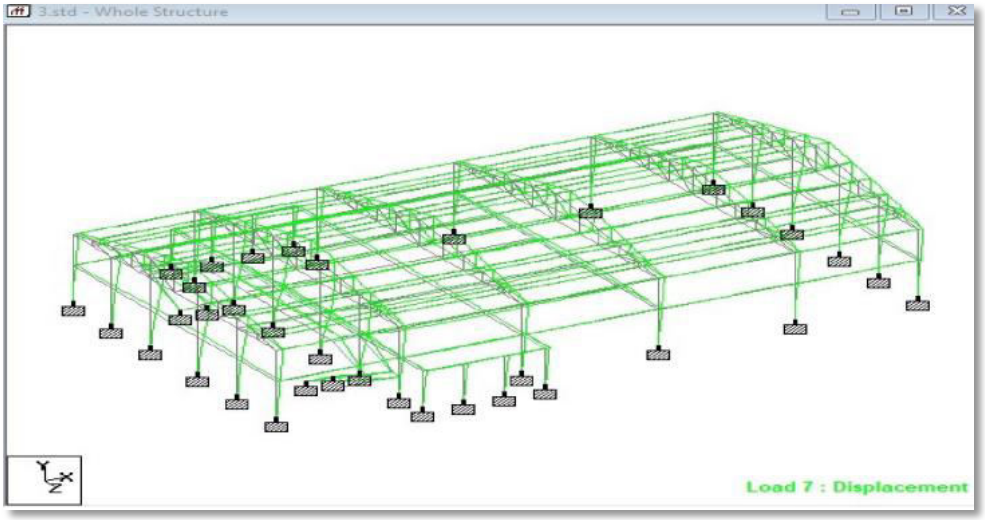
IV. RESULTS

STAAD PRO MODELING

5.1.1 Deflection



[Fig.5.1: Deflection diagram for medium soil]



[Fig.5.2: Deflection diagram for soft soil]

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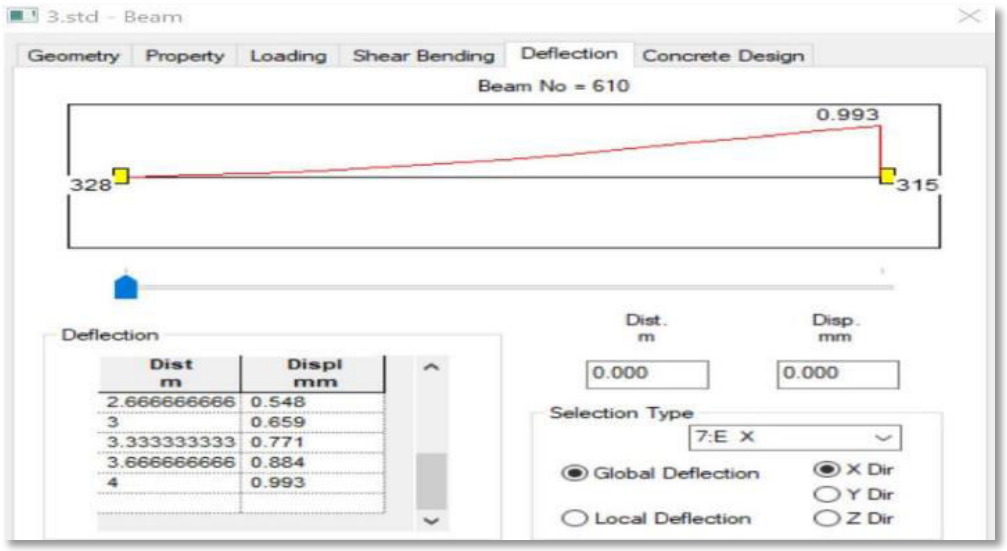
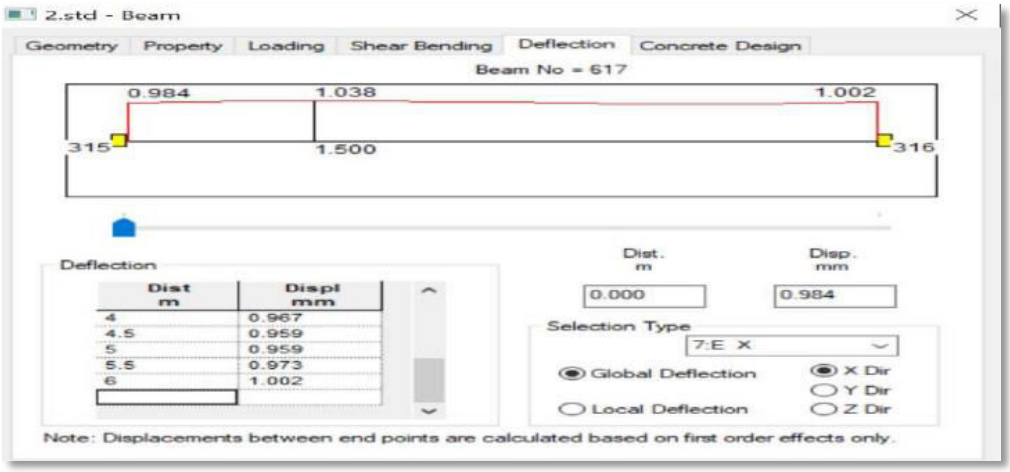
[Fig.5.3: Column deflection for medium soil]



[Fig.5.4: Column deflection for soft soil]



[Fig.5.5: Beam deflection for medium soil]

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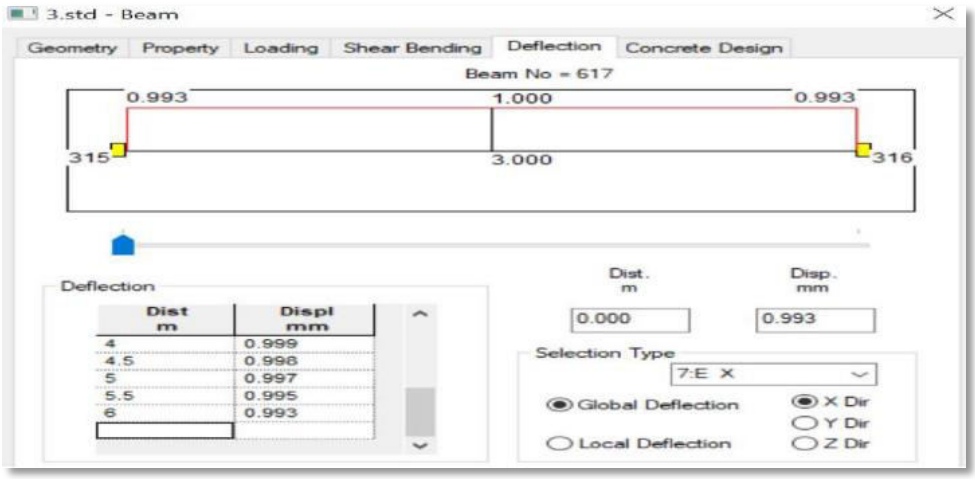
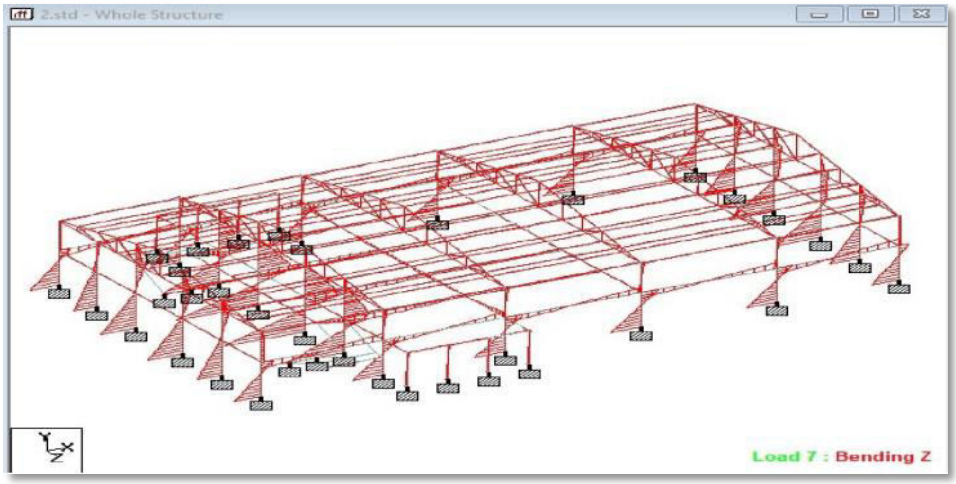
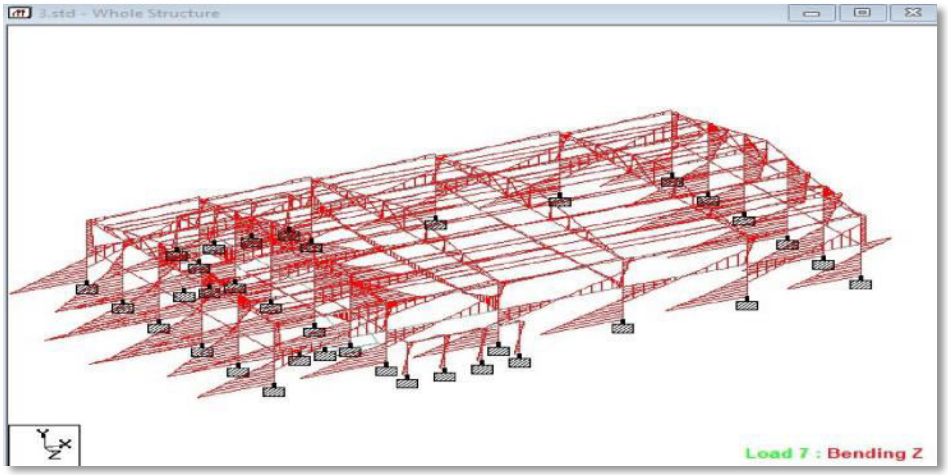


[Fig.5.6: Beam deflection for soft soil]

5.1.2 Bending Moment and Shear Force



[Fig.5.7: Bending moment diagram for medium soil]



[Fig.5.8: Bending moment diagram for soft soil]

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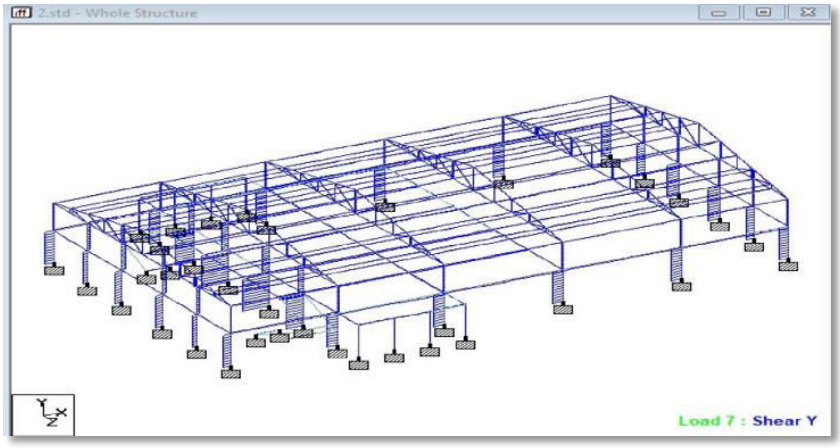
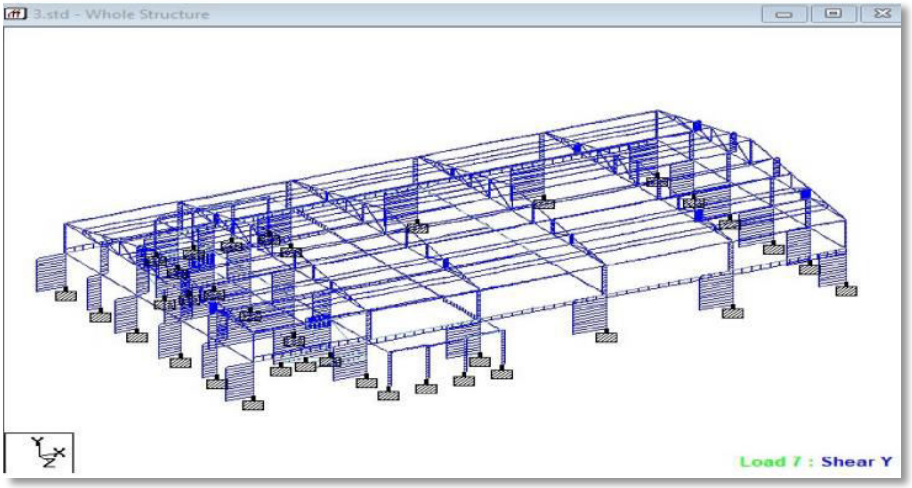
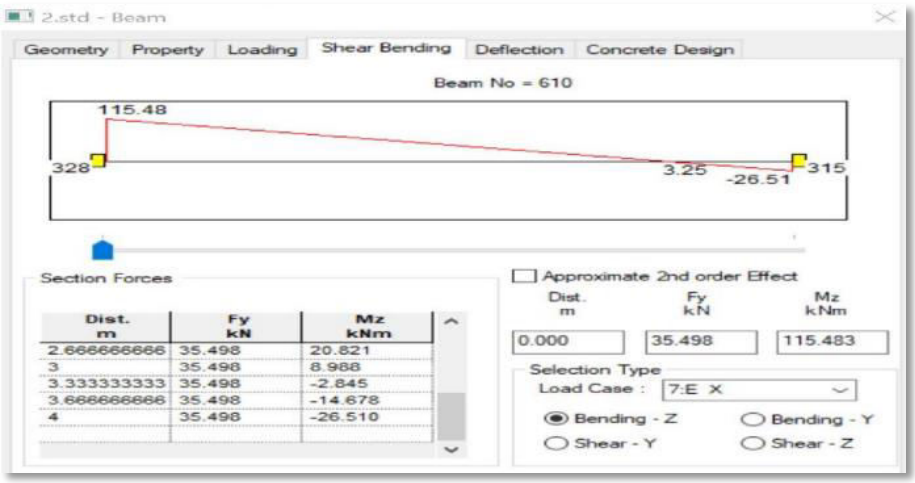


[Fig.5.9: Shear force diagram for medium soil]



[Fig.5.10: Shear force diagram for soft soil]



[Fig.5.11: Column shear bending diagram for medium soil]

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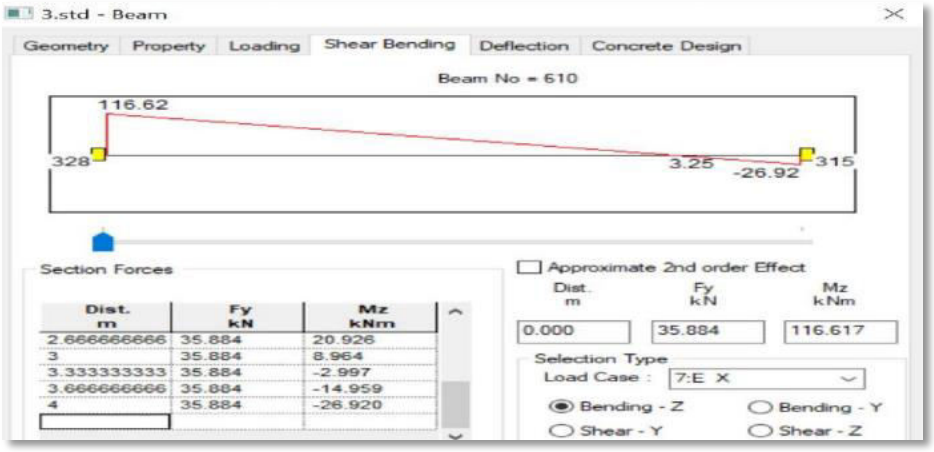
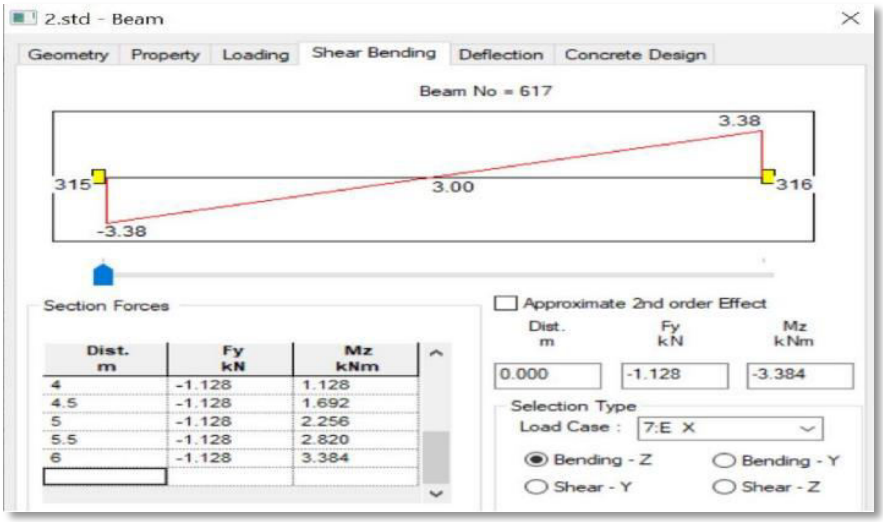
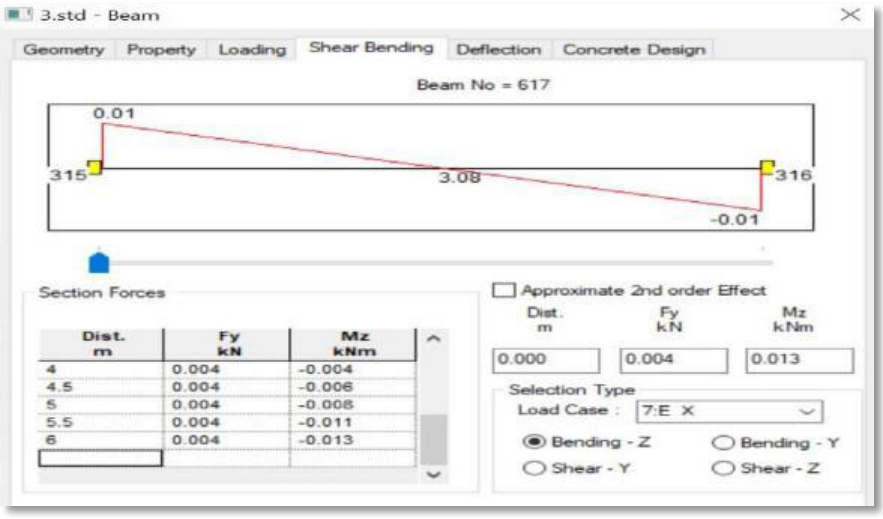


[Fig.5.12: Column shear bending diagram for soft soil]



[Fig.5.13: Beam shear bending diagram for medium soil]



[Fig.5.14: Beam shear bending diagram for soft soil]

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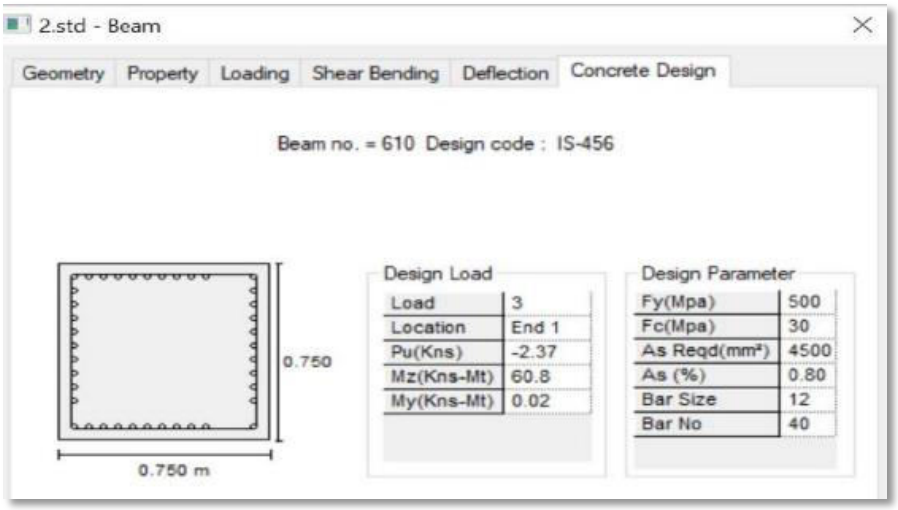
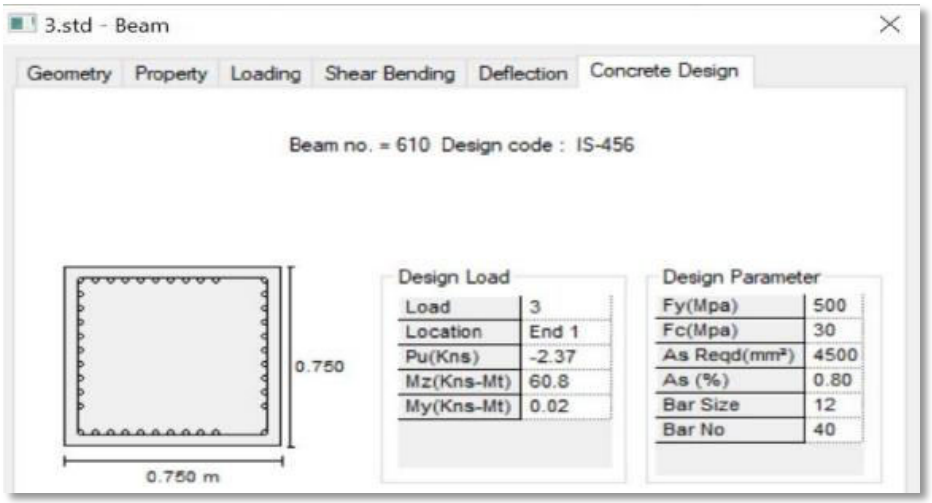
V.DESIGN

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". As soon as the analysis of structure is completed results of analysis such as bending moment, shear force, deflection etc. are viewed followed by design phase thus the design parameters listed in below table are inputted to the software and assigned to structure now the structure is once again analysed with the input parameters and checked for any errors, since we don't get any errors the design details of each and every member in the structure is thrown out by STAAD.Pro. Some of the structural elements are designed satisfying the structural property and the analysis made using the software are listed below.



[Fig.5.15: Main column design for medium soil]



[Fig.5.16: Main column design for soft soil]

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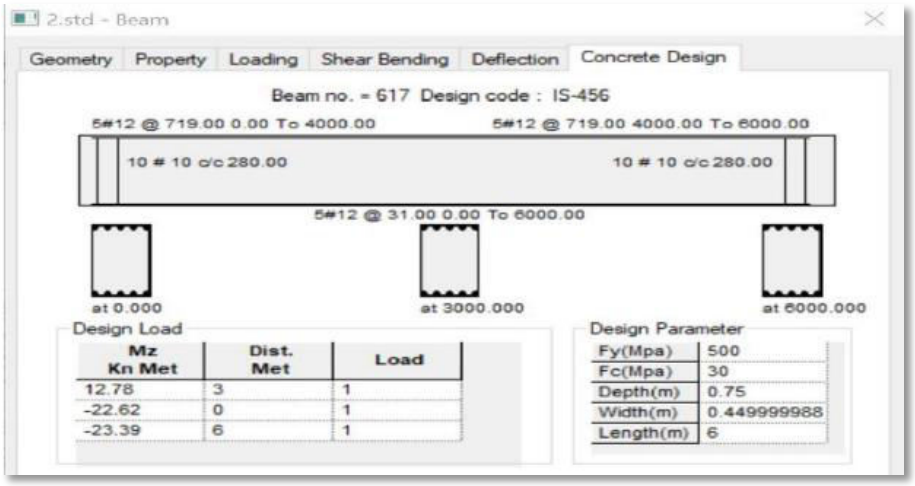
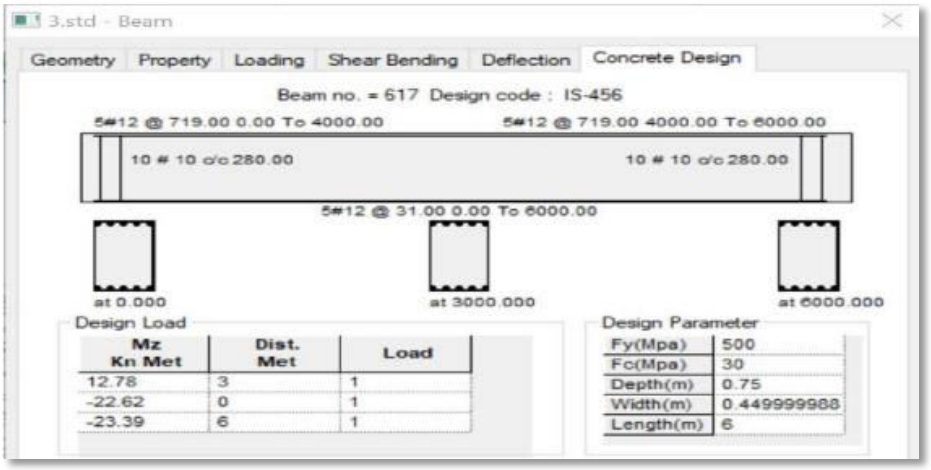


[Fig.5.17: Main beam design for medium soil]



[Fig.5.18: Main beam design for soft soil]

BASE SHEAR AND STOREY DRIFT

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.

The auditorium was analysed and designed for seismic loads under medium and soft soil conditions.

- The base shear for the given auditorium in medium soil was found to be - 1597.08 KN
- The base shear for the given auditorium in soft soil was found to be - 2171.29KN
- The maximum storey drift in the auditorium under medium soil condition was found to be - 0.087 cm
- The maximum storey drift in the auditorium under soft soil condition was found to be - 0.0948 cm

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VI.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%.

VII.ACKNOWLEDGMENTS

The authors would like to express an acknowledgement to the Faculty of Civil Engineering Department and management of V.M Institute of Engineering and Technology, Nagpur, Maharashtra, India, for providing the facilities such as the Structural laboratory and advanced Structural laboratory to accomplish this study. The author also wishes to acknowledge cooperation given by laboratory technician from Faculty of Civil Engineering, V.M Institute of Engineering and Technology, Nagpur, Maharashtra, India, to complete this study.

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