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An examination of the analysis and research of the factors influencing the design of prefabricated buildings

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Abstract - To comprehend how buildings react to seismic excitations, earthquake engineering uses seismic analysis as a key tool. Where earthquakes are frequent, both structural analysis and design are impacted. This technical report shows project work on a worldwide theater's structural analysis and design utilising STAAD PRO, a computer programme for advanced 3D building systems analysis. The theatre was rectangular in design and was straight. This comprises structural element design, load analysis, and design for various load conditions. The national building code was applied to the design of the acoustic and visual perspectives, and the related IS codes were applied to the collapse limit state technique. The auditorium's design, elevation, and sectional drawings were made utilising. STAAD PRO was used to corroborate the results after manual design and analysis, but when it came to the bottom layer, the absolute displacement was higher for the soft layers than it was for the comparable layers of the traditional structures. Tall buildings have been observed to respond most strongly to low frequency earthquakes because of their low natural frequency. This is true because low natural frequencies in tall structures exposed to low-frequency earthquakes result in resonance and bigger displacements. When a tall structure with a low natural frequency is exposed to a high frequency ground, little displacements happen. Similar to how exposure to low-frequency ground motion causes modest displacements in tall building structures, exposure to high-frequency ground motion causes displacements in low-rise structures.

Keywords :- Structural analysis, Design, Staad Pro, Autocad, Auditorium, IS Code, Natural Frequency

I. INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH.

As part of this project, the auditorium was analyzed and designed using STAAD Pro software and seismic analysis. This project emphasizes work related to the structural design and analysis of a universal theater using the computer program Staad Pro V8i. The National Building Code was used for the design of the visual appearance and acoustics, and Indian Standard Codes were used for the collaplim method. The height, cross-section and floor plan of the auditorium are made with the 2016 version of AutoCAD software. Staad Pro v8i software is used for planning and analysis, and manual methods are used for checking. Places where people congregate for entertainment, recreation, social, religious, political, civil, etc. activities include buildings like theatres, cinemas, wedding chapels, town halls, auditoriums, exhibition halls, meeting halls, and museums. Participants of any stage seminar may congregate in a covered or open area. A room containing audience seating for shows or stage performances is referred to as an auditorium. The auditorium is a sizable room that serves as the hub of a global system. An auditorium or multi-purpose hall is a large space created especially to accommodate the needs and demands of entertainment. The audience can listen to and view performances in the auditorium, which features a variety of activities.

1.2 INSTALLATION BUILDINGS :

A meeting place is a structure that is build for a purpose of assemble for social or other kind of activities. Assembly buildings include theaters, music

halls, ballrooms, playgrounds, gym, classroom, libraries, and houses of worship.

1.2.1 Building types :

Building types can be classified by various factors including size, purpose, structure, etc. divide buildings into several categories according to their functions. . and usage. It makes sense to use the IBC and UBC standards, as they govern the design and construction of buildings. In addition, different types of buildings present varying degrees of risk and danger to the people who live in them and to nearby properties.

1.2.1.1 Construction styles based on IBC and UBC.

The International Building Code classifies buildings into priority groups according to their uses and levels of occupancy to identify inferior buildings in certain types of structures, as mentioned above.

1. Assembly buildings: People congregate in assembly structures to meet and discuss a variety of subjects. For instance, awaiting a vehicle, taking part in religious or social activities, or taking pleasure in food and beverages. Groups A-1, A-2, A-3, A-4, A-5, and A-6 of the International Building Code (IBC 2018) apply to modular buildings. Each category is described in the 2018 International Building Code. Meeting spaces can be compared to a variety of other locations, including theatres, music halls, ballrooms, playgrounds, eateries, community rooms, sports arenas, lecture halls, libraries, and places of worship.

2. Commercial structures: Commercial buildings are used for offices, commercial activities, and other associated services such as account storage, clinics, businesses, etc. are a few examples. These are all illustrations of commercial structures.

3. Educational hubs : Educational hubs are created for a range of purposes, such as the training, supervision, and care of trainers and students at various developmental stages.
A few examples of educational structures are schools, colleges, training centres, and child care institutions.

4. Factory or large manufacturing Buildings: As the name might imply, factory and industrial buildings are built for processes such as manufacturing, packaging, processing, dismantling, fabricating, finishing, and assembling. It is important to understand that these facilities pose a low level of risk.
For instance, factories, gas and power plants, refineries, offices etc.

5. High-risk Buildings: These structures are designed for the production, processing, creation, or storage of explosive or highly flammable compounds that pose a serious risk to people's bodily and mental health.Fireworks, cyanide, and hydrogen peroxide are a few examples of hazardous substances. The final classification for high-risk structures is H-1, H-2, H-3, H-4, and H-5.

6. Institutional Buildings: Institutional buildings are constructed for a range of uses, such as the care and supervision of individuals who require aid to defend themselves or who are being detained for disciplinary reasons. The subgroups I-1, I-2, I-3, and I-4 are also used to categorise institutional buildings.

A few examples of institutional buildings include psychiatric hospitals, hospitals, nursing homes, and detoxification centres.

7. Mercantile Buildings: Products, including inventories of goods, wares, or things auxiliary to such applications that are accessible to the general public, are shown and sold in these structures.

8. Residential Buildings:- Apartment, homes, hotels etc, are a some examples of residential buildings that are designed and furnished with sleeping space in mind.

9. Storage Buildings: Numerous non-hazardous items, such as bamboo, canvas, and leather, as well as books, paper, boots, shoes, apparel, woollen clothing, and furniture, are kept in these buildings. Garages, warehouses, cold storage facilities, and storage sheds for transportation are a few examples of these buildings.

1.3 AUDITORIUM

A space designed primarily for listening and viewing by an audience is called an auditorium. Auditoriums, which are present in entertainment venues, multifunctional structures, and theatres, can be used to display performing arts. The name "auditorium" comes

from the Latin word "fromauditorius," which means "hearing," and it was first used to describe the ancient Greek theatre, which featured rows of semi-circular seats arranged in wide "zones" for the audience to sit in. Has eleven rows of chairs between, resembling diazomate.

Parts of the auditorium:

1. Beam: Structures with beams can bear loads that are pointed away from their axes. The loads placed on them are typically moved along the length of the structure and passed to the foundation, walls, columns, and other structures at their end points.

2. Column: A vertical structural component intended to support compressive loads is called a column. For instance, a column can support weight from a beam to a foundation or floor, as well as from a beam to a ceiling, floor, or slab. They possess powerful compressive qualities.
3. Slab: a slab is a concrete horizontal flat structural element used for the construction of roofs, ceilings and other horizontal planes. The slab, usually several inches thick, is supported on ground, walls, columns or beams. reinforced concrete slab with flat roof Concrete slabs can either be assembled and placed on the construction site or built on site with formwork.
4. Roof Truss: Supporting inclined, vertical, or horizontal loads is this hinged structure. Plates, loops, channels, corners, and channels make up the grid. This framework supports a roof, bridge, or other structure and is frequently made up of trusses, struts, and brackets.

1.4 PROJECT OBJECTIVES

In our proposal, we estimate and design a multipurpose auditorium using the widely used design application STAAD Pro, which produces seismic and structural plans for prefabricated buildings.
• Explain various code provisions related to seismic and structural design.
• Exploring the user interface of STAAD PRO software
• Auditorium design using automatic CAD tool and STAAD Pro software for RCC building design.

II. LITERATURE REVIEW

The following is a discussion of the terms used in design literature.

[1] Auditorium analysis and design using STAAD Pro software.

Ramesh Bhaskar, B.V. Pavan Kumar and Manoj Nal Lanathe (2018) This project aims to create a universal auditorium with a capacity of 900 people. The primary design idea and acoustic function of the auditorium Without the balcony arena and partition, the size of the auditorium building is 55 x 22 meters. The required area is determined with the help of NBC. It includes all design, load analysis and design of structural members depending on the load imposed on them (live, dead and wind loads as per IS:875 parts 1, 2 and 3). The auditorium has a straight (rectangular) shape. The term "auditorium" includes meeting rooms, exhibition halls, performance halls, auditoriums and theaters. This is because the plan is based on the acoustic and visual aspects of NBC Part III, which favor linear forms. When designing a theater interior using the ADA codebook, floor height, ceiling height, stairs and other criteria are important. RC building design with Staad Pro software and automatic CAD tool for auditorium design. STAAD Pro was used in the analysis and design of the building. Column dimensions of 0.3 * 0.8 m and beam dimensions of 0.3 * 1.5 m make it difficult to maintain the maximum bending moment in the critical part of both the beam and the column. In fact, PT beams should be chosen over R.C.C. beams in the design of building beams with long intervals. Typically, when using a PT beam, the beam size should be halved. In this case, our project includes a 1.5 meter deep R.C.C. The PT radius is only 0.75 m. The maximum dimensions of the pedestal are 4.0*4.0 meters and the depth is 1.5 meters. STAAD Pro gives acceptable results compared to manual design. Designing is the art of determining the dimensions of a structural part and the amount of additional materials (reinforcement, prestressing, etc.) necessary to ensure the part's resistance to various loads and stresses. is cost effective and functional. The goal of structural

analysis and design is to create a structure that can withstand all applied loads without damage during its lifetime, in other words.

[2] Auditorium design and analysis using STAAD Pro software.

Gajendra R. Gandhe, Durgesh H. Tupe, and Akshay K. Ghuge (2021), The design and study of an auditorium in Aurangabad, Maharashtra, are the subjects of this project. Any formal gathering, lecture, seminar, event, award ceremony, and cultural performances including plays, singing, and dance can take place in the auditorium. The building is built to withstand and carry any weights placed on it because the project is based on the limit state concept. Within the limitations of bending and breaking, it should fulfil the service requirements. STAAD-Pro and AUTO-CAD structural detailing were used for the analysis. The project's main focus was the research and design of an auditorium structure in the Maharashtrian city of Aurangabad. • Building an auditorium is a solution for many organized cultural events.

• Analysis with STADD.PRO using the general download has proven to be state-of-the-art software with great potential in the analysis and design parts of the construction industry.

• All structural parts are described with AutoCAD 2016.

• Analysis and design were carried out according to standard specifications.

• M20 grade concrete and Fe 415 steel are used as materials, unless specified in special design elements.

[3] Audience design and analysis using STAAD Pro.

(2017) S.Harish, L. Ramaprasad Reddy, Large-scale seminars, films, and presentations are possible in auditoriums. There are conference rooms, presentation rooms, auditoriums, and theatres in the auditorium. This thesis discusses the use of the STAAD professional tool for auditorium design. Utilising this tool will cut down on your research and computation time. The project is based primarily on the idea of the limit state; the structure must be built to survive, carrying all possible loads throughout its life, as well as meeting serviceability standards including deflection and crack limitations. The "limit state" is the right level of protection and operational requirements prior to a problem. The objective of design is to provide enough options so that the building may still be used.

[4] Audio structural and seismic design analysis.

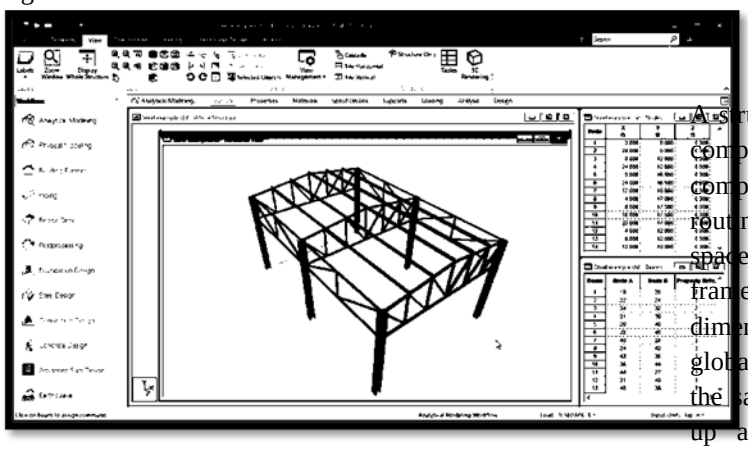
Prabhakaran P. A. and Rupeesh S. (2021), The systematic theoretical analysis of research methodologies is known as methodology. It includes a theoretical analysis of the approaches and guiding ideas in the field of study. The methodology is not intended to offer solutions. The methodology offers a theoretical framework for comprehending which method, set of procedures, or best practises can be used in a particular situation, such as when calculating a particular outcome. The appropriate construction of pile foundations to sustain the expected seismic loads has become a significant issue due to the recent increase in seismic activity. The seismic load assessment of a superstructure in accordance with two chosen international codes, IS 1893 and EN 1998, is the subject of this study.

II. PROPOSED METHODOLOGY

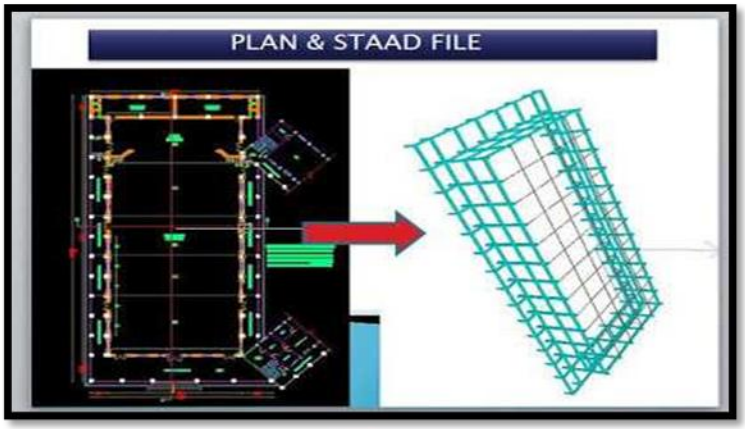
3.1 STAAD PRO

Research Engineers International produced STAAD, also known as STAAD.Pro, the structural designing programme, in 1997. Bentley Systems purchased Research Engineers International in late 2005. then after STAAD.PRO is one of the most well-known software packages for structural analysis and design in the world. Prof. More than 90 international design standards for steel, concrete, wood, and aluminium are supported. It can employ a variety of analytical methods, including traditional static analysis as well as more contemporary methods like p-delta analysis, geometric nonlinear analysis, thrust analysis (static-nonlinear analysis), or bending analysis. It can also make use of a variety of dynamic analytic techniques, such as time history analysis and response spectrum analysis. The accompanying spectrum analysis capabilities enable both user-defined spectra and a number of international code-specific spectra. Programmes that STAAD Pro is compatible with. In the first part of our project, the building loads were calculated, and we also considered earthquakes and

wind loads. Structural analysis includes the physical as well as mathematical interpretations are required to assess and forecast the behaviour of component/structures. In a more abstract sense, structural analysis can be seen as a method that directs engineering style methodology or exhibits style without really using it. For exact result, the structural engineer must validate data such as component's masses, geometry, supports, and material properties. Results from such an Associate in Nursing study frequently involve transitions, stresses, and supportive reactions. The information is then compared to benchmarks that outline failure modes. Advanced structural analysis might examine dynamics, stability, and nonlinear behaviour. The goal of the style is to provide the best conditions for the structures that are being developed. The structure and structural elements should typically be developed using the limit state method. It is necessary to take into account accepted concepts, testing, experience, and sustainable design requirements. Planning, building, and contract operations that are sustainable must be approached holistically. It is crucial to adhere to well specified criteria for the materials, fabrication, execution, maintenance, and use of the building in order to accomplish feasible stylistic goals. How a structure is designed is determined by the fundamental requirements outlined in the Indian Code of Practise. The minimum criteria for the structural safety of buildings are included in the description of expected minimum style (design) loads for dead loads, necessary loads, and other external loads essential for the connection of the structure. The objective is to ensure strict adherence to the load standards outlined in this regulation.



[Fig.3.1: STAAD PRO working Interface on Auditorium]



[Fig.3.2 : Working interface of STAAD Pro]

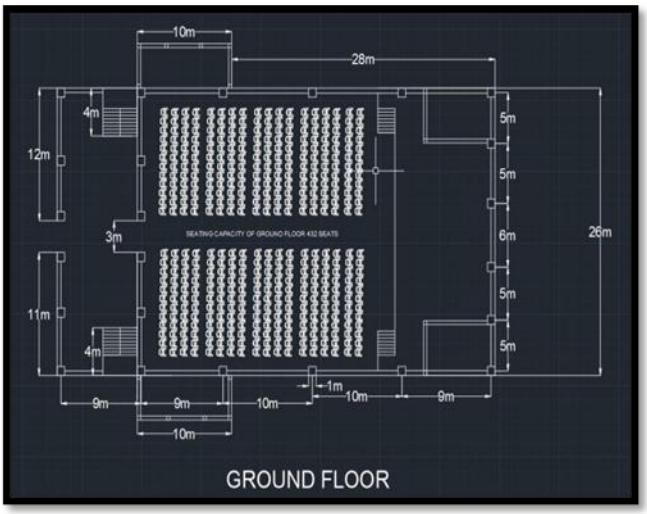
3.2 PLANNING OF AUDITORIUM

The following minimal requirements are for the building of the auditoriums and are established in a variety of standard codes that have been approved by Indian Standard institutions:

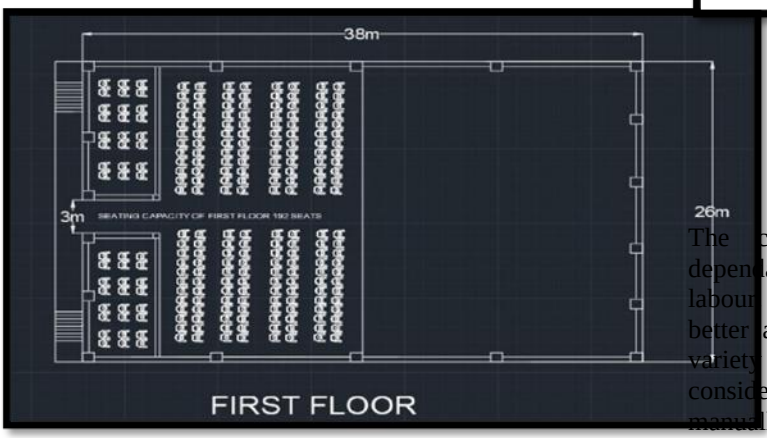
- FRONT AND REAR OPEN SPACES: No building may be erected unless it is set back a minimum of 6 metres from the street's normal line, or from the street if there is no such regular line.
- PLAN AREA: The building's plan area should be set at 0.6 to 0.9 m2/member of occupant load. The drawings were created with AutoCAD.

A structure is frequently referred to as a collection of components. STAAD can study and plan solid component, plate/shell, and frame structures. STAAD routinely examines buildings in virtually any style. A space structure is the most general type; it can be a 3D framed building with numbers of applications in any dimension. The structure of a plane is guaranteed by a global X-Y frame of several points contained inside the same plane. Each of the truss members that make up a truss construction is only permitted to be susceptible to axial member forces and not to internal bending. A floor structure is a two- or three-dimensional building that is limited at each joint so that there is no global (horizontal) X or Z mobility. If there

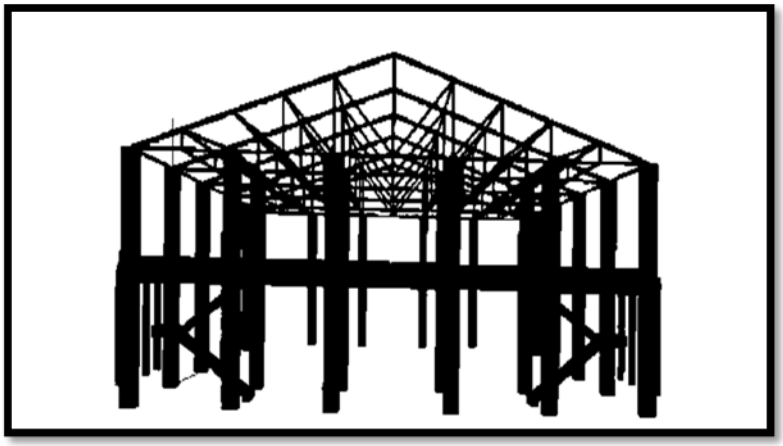
is any horizontal load, an area structure analysis should be performed. That computer file could be composed of a series of commands that are executed in exact order. The instructions regarding styling are provided by the orders. The graphical user interface modelling capability builds the computer file using an interactive menu-driven graphics approach.



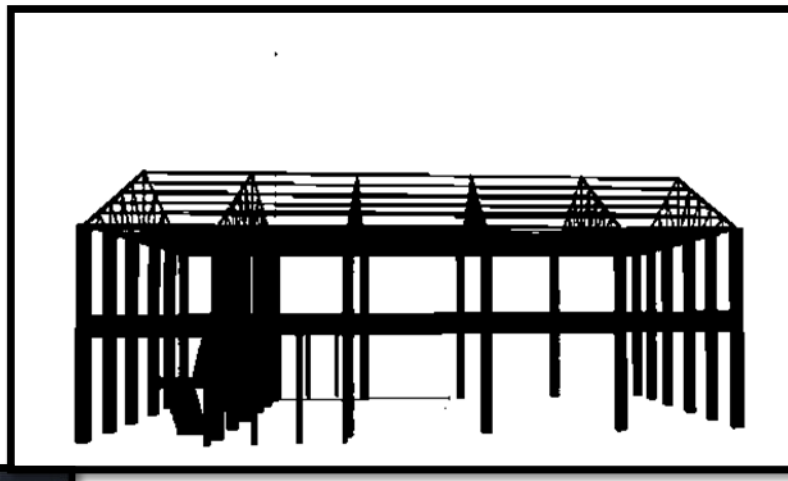
[Fig.3.3: Ground floor plan]



[Fig.3.4: First floor plan]



[Fig.3.5: 3D Front view]



[Fig.3.6: 3D Side view]

CONCLUSION

The conclusion is that this software's design dependability and efficiency outperform manual labour. It is obvious that the program's results were better and more efficient because they considered a variety of factors that are challenging to take into consideration when carrying out the operation manually. If the theatre can be constructed using economically sound techniques will be determined by this study.

SCOPE OF THE FUTURE

- STADD. Pro is a versatile software that is used to determine the required reinforcement of any reinforced member depending on the load and nodal deflection against forces acting laterally.
- STADD.PRO and ETABS (version 2017) give almost no difference in outputs compared to manually calculated outputs.
- The non-uniform shape of the building is much sensitive to vibrational loads than buildings with a normal shape.
- Variations with vibrating forces, wind forces acting on building, SF and BM along the height are directly co-related.
- The responses of building during an earthquake depends significantly on dimensions and geometry, as well as how the seismic waves were transmitted to ground.
- STADD.PRO helps to meet the rules for planning.
- STADD.PRO is a very easy to operate and can give accurate readings as compared to manual calculation. .

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