DESIGN AND ANALYSIS OF MOVIE THEATRE BY USINGSTAADPRO

First A. Donga Gayathri Devi, Second B. K.Jagan MTech (PhD) Asst. Professor, Jr., and Third C.
VISAHKA INSTITUTE OF ENGINEERING & TECHNOLOGY , Member , IEEE

***Abstract*— The design of a modern movie theatre is very complicated and it should be done very methodically keeping in mind the innumerable number of details that it should be attended to. A certain degree of price discrimination can be seen at movie theatres. There is a different and varied price not only for when but also for where one sits in a movie theatre. This is to say that one is charged more for the same movie and the same experience based on from where he or she sits. As by norm, the seats in front are charged lesser than the seats at the back. The comfort of viewing, i.e. physical comfort is the best at the back, and worst in the front, but the last few 'expensive' rows may not be the most 'ideal' place to watch the movie from. In this paper includes the design of an ideal movie theatre such that one can have the best possible angle of vision using STAADD PRO ANALYSIS and LSM.**

In engineering, all types of constructions are made with proper planning and design. The purpose of this project work is to achieve exposure to practical engineering fields. Through this exposure, we would better understand engineering practice in general and a sense of frequent and possible problems. In this project, analysis and design of Multiplex movie theater building have been dealt with keeping in view the stability of the structure. The project involves analysis of Multiplex movie theatre using STAAD.Pro and the structure is designed manually. The plan of all the floors was drawn in the AUTO CAD 2016, the analysis and design of the reinforced concrete structure were done in the leading innovative software STAAD.Pro. The analysis part such as deformed shape, bending moment diagram, shear force diagram is obtained using STAAD.Pro. In addition to the above, manual design and detailing is done for beams, slabs, columns, and footings. Indian standard codes IS 800: 2007, IS 456: 2000, IS 875: 1987-Part II, IS 875: 1987- Part III are referred. From the results, critical sections of the structure were found out.

Keywords: Movie theatre, Beams, Purlins , Footing, STAADD PRO ANALYSIS , LSM.

INTRODUCTION:

Cinema is most popular and cheapest entertainment for the people. For screening the movies to the audience a fully fledged movie theatre is necessary. Hence, though the movie theatre is a commercial entertainment structure, it should provide maximum facilities and comforts to the audience at a reasonable prize. The designer will need many and varied skills – drawing, painting, construction, draftsman-ship, sewing, budgeting, self promotion, communication, are all skills which are needed in various degrees. The designer also needs to have an understanding of the text and of the human figure in space. So the following four principles are Theatre design can be a lifetime study.

- The audience must feel closely linked with the performers and each other
- The audience should be clustered around the performers, within the limits of good sightlines
- The auditorium must be scaled to sustain and enhance the performance.
- The architecture should encourage a sense of excitement and community

STRUCTURE OF A MOVIE THEATRE

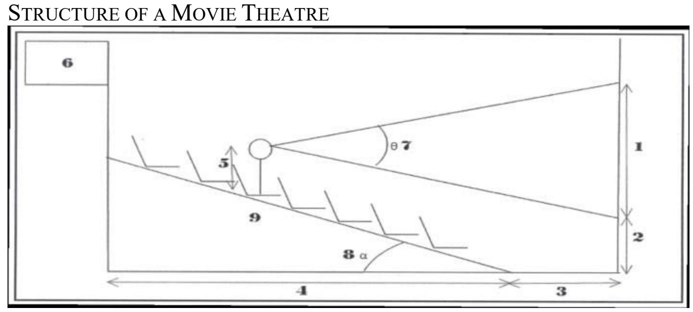


Fig 1. A simplified drawing of movie theatre

the above figure is a drawing representation of a movie theatre which depicts the following:

1. the screen
2. height of the screen above the ground
3. distance between screen and first row
4. horizontal distance between first row and the end of seating area
5. the height of the individual
6. projector room
7. -the angle subtended by screen on individuals eye
8. α- the angle of inclination of the seating area
9. the seating

I. ROOM DESIGN AND ACCOUSTICS

The shape of the room is one of the important factors affecting its acoustical properties. Hence the determination of most desirable shape is a problem that the architect should know how to solve. The optimum ratio of length to width for a room is not a fixed number, but varies with the size and shape of the seating area. For most rooms, ratio of the length to width between 1.2:1 and 2:1 has been more satisfactory.

The inclination starts at a distance of 7.8 m from the screen.Height of last row from the floor near screen = 4.04 m Total height of columns = 3+5.5+0.5 = 9 m

As the breadth of theatre is 19.24 m it will be difficult to provide beams. So roof truss should be designed forthis theatre.

1) Multiplex movie theaters are spaces designed to accommodate large audiences. They have a wide span and multiple stories in order to accommodate seating, sighting, and *acoustical requirements Movie theatres serve extremely good facilities for the people who need entertainment in their leisure time.*

Structural elements such as beam, column, slab, footings, and staircases were designed. The roofing for the theatre is steel truss covered using Asbestos cement sheets. In this work, the limit state method is used for designing the structure. The design has been done adhering to the Indian Standard codes- IS 456:2000 for concrete structure design and IS 800:2007 for the design of truss. It is decided to provide 1 building consisting of all the facilities, decided to plan, model, analyze, and design The aim of the structural design is that the structure should be safe, durable, serviceable, and economical with respect to initial cost and maintenance cost. During analysis, dead loads, live loads, and wind loads were calculated by referring to IS 875:1987 (part1), (part 2), and (part3) and their combinations were applied. The load combinations were taken so as to obtain the maximum design loads, moments, and shear. The design is carried as per IS 456:2000 for the above load combinations. The building was designed for dead loads as per IS 875(Part I)-1987, imposed loads as per IS 875(Part II)-1987, wind load as per IS 875(Part III)-1987. The entire building is analyzed as a 3D system using STAAD.pro.

Statement of project

Utility of building: Movie Theatre
No of stories: G+1

Shape of the building: Rectangular
No of stairs: 1

Type of construction: R.C.C framed structure
Concrete grade: M25

All steel grades: Fe415 grade
Plan area: 2480.32m^2

Seating requirements: 568 persons
Height of building: 12.09 m

An auditorium is a room built to enable an audience to hear and watch performances. For movie theatres, the number of auditoria (or auditoriums) is expressed as the number of screens. Auditoria can be found in entertainment venues, community halls, and theaters, and may be used for rehearsal, presentation, performing arts productions, or as a learning space.

The audience in a modern theatre are usually separated from the performers by the proscenium arch, although other types of stage are common.

The price charged for seats in each part of the auditorium (known in the industry as the house) usually varies according to the quality of the view of the stage. The seating areas can include some or all of the following:

Stalls, orchestra or arena: the lower flat area, usually below or at the same level as the stage.

Balconies or galleries: one or more raised seating platforms towards the rear of the auditorium. In larger theatres, multiple levels are stacked vertically above or behind the stalls. The first level is usually called the dress circle or grand circle. The highest platform, or upper circle is sometimes known as "the gods", especially in large opera houses, where the seats can be very high and a long distance from the stage.

Boxes: generally placed immediately to the front, side and above the level of the stage. They are often separate rooms with an open viewing area which generally seat only a handful of people. These seats are generally considered the most prestigious of the house. A state box or royal box is sometimes provided for dignitaries.

Seating arrangement: Seating arrangements in an auditorium seating layout (or assembly space) will either be identified as "multiple-aisle" or "continental".[1] 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.

An auditorium is a room built to enable an audience to hear and watch performances at venues such as theatres. For movie theatres, the number of auditoriums is expressed as the number of screens. 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. A reinforced concrete construction typically consists of three phases; namely planning, design including analysis and construction. This project deals with planning phase, analysis phrase and the design phase. Any engineering structure should satisfy the functional and structural needs, have a sufficient degree of performance, a reasonable cost and should be aesthetically attractive. The purpose of structural analysis and design is to enable the designers to design the structure with adequate strength, stiffness, and stability. Design is done manually. The analysis is done by using STAAD Pro. The limit state method collapse using IS:456-2000 and SP-16 have been adopted.

LITERATURE REVIEW:

Sullivan and Adler

Designed a tall structure with load-bearing outer walls, and based the exterior appearance partly on the design of H.H. Richardson's Marshall Field Warehouse, another Chicago landmark. The Auditorium is a heavy, impressive structure externally, and was more striking in its day when buildings of its scale were less common. When completed, it was the tallest building in the city and largest building in the United States.

Denver Auditorium Arena

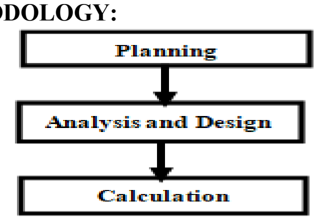
Was an indoor arena located at the corner of 13th and Champak Streets in Denver, Colorado. It was constructed as the Denver Municipal Auditorium in 1908 during the administration of

Denver Mayor Robert W. Speer. The building was opened on July 7, 1908, and was the site of the 1908 Democratic National Convention.

Nagarjuna, Shivakumar B. Patil (2015) has studied that the structures are generally constructed on level ground; however, due to scarcity of level grounds the construction activities have been started on sloping grounds. There are two types of configuration of building on sloping ground, the one is step back and the other is step back setback. In this study, G+ 10 storys RCC building and the ground slope varying from 100 to 400have been considered for the analysis. A comparison has been made with the building resting on level ground (setback). The modeling and analysis of the building has been done by using structure analysis tool ETAB, to study the effect of varying height of the column in bottom storey and the effect of shear wall at different position during the earthquake. The results have been compared with the results of the building with and without shear wall. The seismic analysis was done by linear static analysis and the response spectrum analyses have been carried out as per IS:1893 (part 1): 2002. The results were obtained in the form of top storey displacement, drift, base shear and time period. It is observed that short column is affected more during the earthquake. The analyses showed that for construction of the building on slopy ground the step back setback building configuration is suitable, along with shear wall placed at the corner of the building.

- Rahul Manojsingh Pawar, S.B. Sohani (2017) has studied that the buildings situated on hill slopes in earthquake prone areas are generally irregular, torsionally coupled & hence, susceptible to serve damage when affected by earthquake ground motion. These unsymmetrical buildings require great attention in the analysis & design. The various floors of such building steps back towards the hill slope and at the same time buildings may have setbacks also. Buildings situated in hilly areas are much more vulnerable to seismic environment. In this study, 3D analytical model of 10,15 & 20 storied buildings have been generated for symmetric and asymmetric building Models and analyzed using structural analysis tool 'STADD-PRO" to study the effect of varying height of columns in ground stored due to sloping ground and the effect of shear wall at different positions during earthquake.
- Abhishek Verma, Abhishek Gupta, Arun Yadav &Anant Jain In this study, different soil strata are taken and corresponding base shear and storey drift is determined and compared with variation in floors as G+8, G+16 and G+24 and zone as 2, 3, 4 and 5. IS 1893: 2002 "Criteria for Earthquake Resistant Design of Structures" gives response spectrum for different types of soil. A building is modeled in STAAD PRO. This research has immense benefits in the Geotechnical Earthquake Field
- Amer Hassan Shilpa Pal In this paper, nonlinear time history and response spectrum analyses were carried out using software to study the influence of soil condition beneath the isolated base. The effects of soil flexibility are considered in the current study to examine the differences in spectral acceleration, base shear, story displacements, story drifts and story shear obtained following the seismic provisions of Indian standard code. The paper concluded that the hard soil and medium soil are suitable for base isolation building. In addition, analysis and design considerations for base isolated and conventional structures are suggested to enable the designer to get a better understanding at the preliminary design stage
- Mr. Rahul Sawant Dr. M. N. Bajad this study focuses on a review of the influence of soil conditions on the seismic forces in RC buildings. The aim of this study is to gain understanding the effect of the local site conditions on the seismic forces in building. The study helps in creating awareness about the importance of the local site conditions, such as proximity to the source of earthquakes (faults) and the local geological and topographical features in the earthquake resistant design of buildings. The current Indian code of practice for seismic analysis IS 1893:2002, specifies seismic zones to consider different levels of intensity of ground shaking, There are also maps of the principal tectonic features and lithological formations. The is paper shows the soil condition effects studied by the various researchers
- Sayyed O.et al. (2017)concentrated his examination on the impact of infill and mass inconsistency on various floor in RC structures. The outcomes were presumed that the block infill upgrades the seismic execution of the RC structures what's more, poor seismic reactions were appeared by the mass sporadic building, thusly it ought to be maintained a strategic distance from in the seismic defenceless districts.
- Khan et al.(2016) , featured the impact of mass inconsistency on various floor in RCC structures with as Reaction Spectrum investigation utilizing STAAD-Pro V8i programming. In the undertaking work seismic investigation of RCC structures with mass abnormality at various floor levels were done. Models are contrasted and each other for reaction regarding float and redirection.

METHODOLOGY:



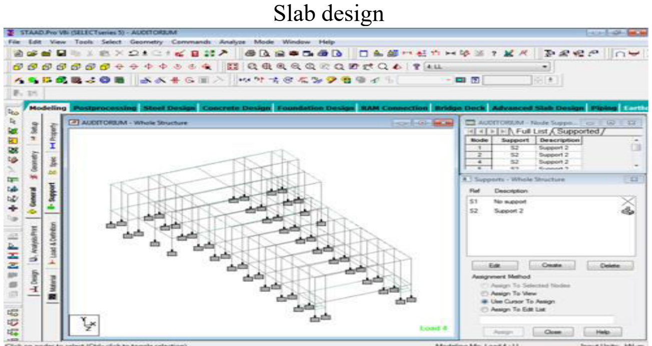
Shows the methodology of the project

A structure can be defined as a body which can resist the applied loads without appreciabledeformations.

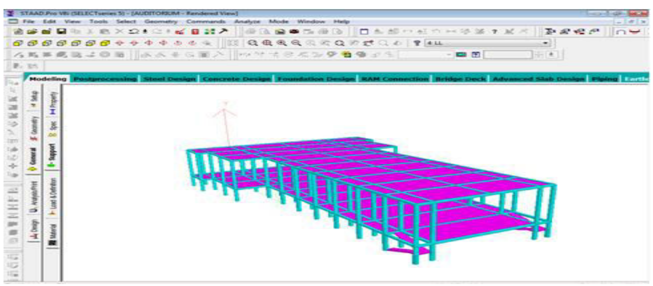
Civil engineering structures are created to serve some specific functions like human habitation ,transportation, bridges ,storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements),beam element ,column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and thee construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the componentsthat make up the structural system.

The main object of reinforced concrete design is to achieve a structure that will result in a safeeconomical solution.The objective of the design is

1. Foundation design
2. Column design
3. Beam design
4. Slab design



Above figure represents the skeletal structure of the building which is used to carry out theanalysis of our building.



3D VIEW

All the loadings are acted on this skeletal structure to carry out the analysis of our building.This is not the actual structure but just represents the outline of the building in staad pro.

A mesh is automatically created for the analysis of these building.

Load Conditions and Structural System Response:

The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. as shown in table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classifications ofloads are described in the following sections.

Types of loads on a hypothetical building are as follows.

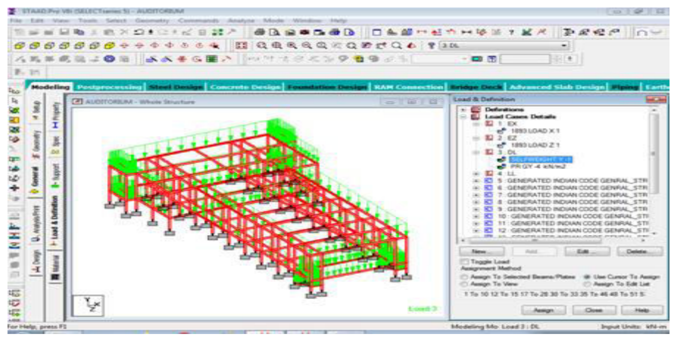
- Dead Load: self-weight As per IS 875 (part-1)-1987
- Live Load: As per IS 875 (part-2)-1987
- Wind Load: As per IS 875 (part-3)-1987
- Seismic Load: As per IS 1893 (part-1)-1984
- Load Combinations: As per IS 875 (part-5)-1987

2) *Dead Loads:*

Dead loads consist of the permanent construction material loads compressing the roof, floor, wall, and foundation systems, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc.

In staad pro assignment of dead load is automatically done by giving the property of the member.

In load case we have option called self weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure looksred in color as shown in the figure.



Dead load

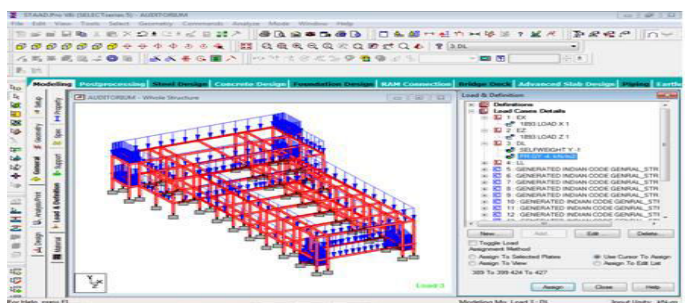
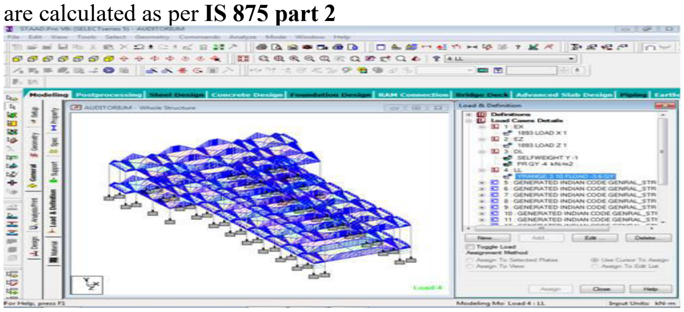


plate load

Live Loads: Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should b e located or directed to give the maximum load effect possible in end- use conditions. For example. The stair load of 300 pounds should be applied to the center of thestair tread between supports.

In staad we assign live load in terms of U.D.L .we has to create a load case for live load and select all the beams to carry such load. After the assignment of the live load the structure appears as shown below.

For our structure live load is taken as **25 N/mm** for design.Live loads are calculated as per **IS 875 part 2**



live load

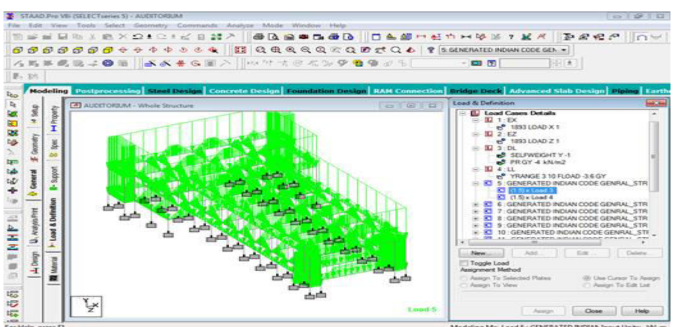
Load combinations:

All the load cases are tested by taking load factors and analyzing the building in differentload combination as per **IS456** and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design

Load factors as per **IS456-2000**

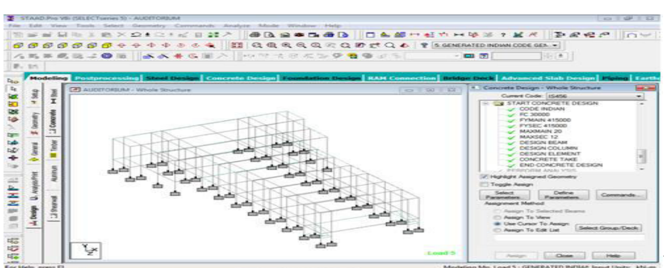
LIVE LOAD	DEAD LOAD
1.5	1.5
1.2	1.2
0.9	0.9

When the building is designed for both wind and seismic loads maximum of both is taken.Because wind and seismic do not come at same time as per code.



Load combination

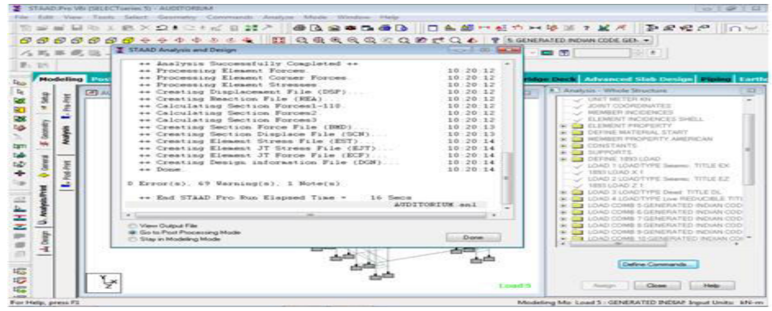
Structure is analyzed by taking all the above combinations.



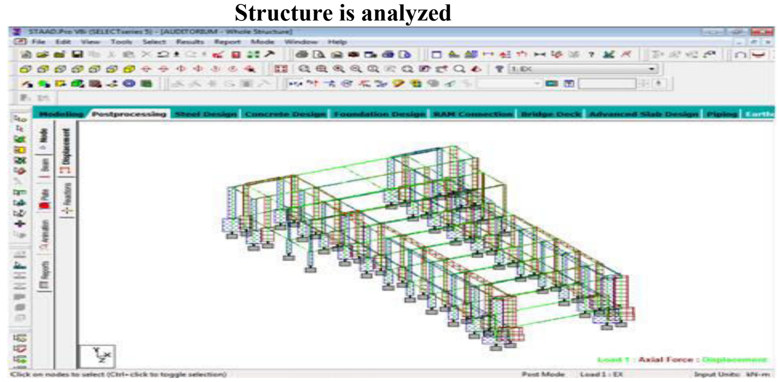
D

esign parameters

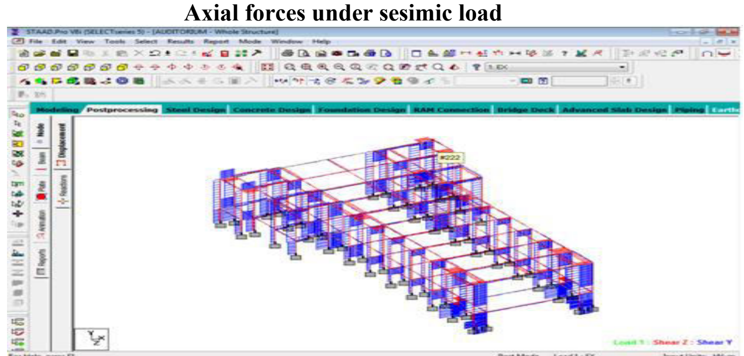
RESULT:



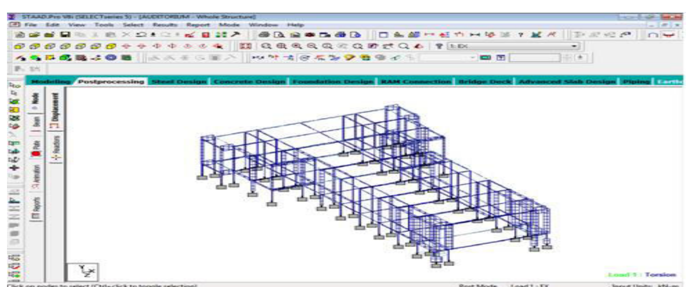
Structure is analyzed



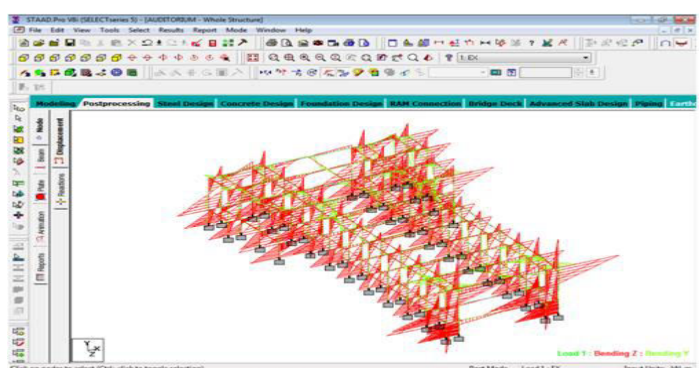
Axial forces under sesimic load



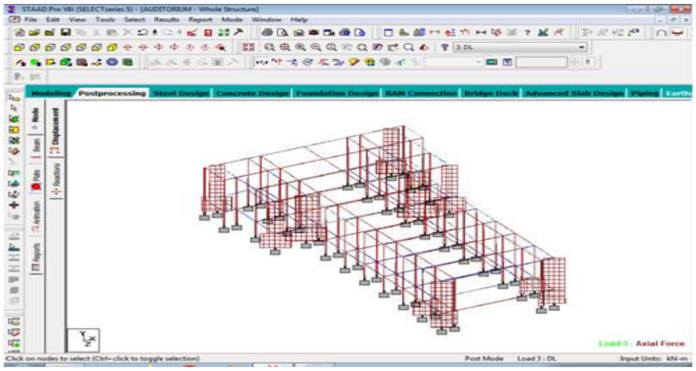
SF-Y,Z under sesimic load



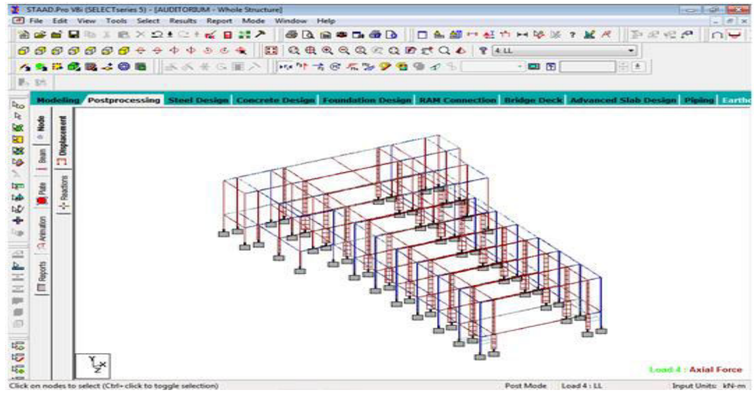
TORSION under sesimic load



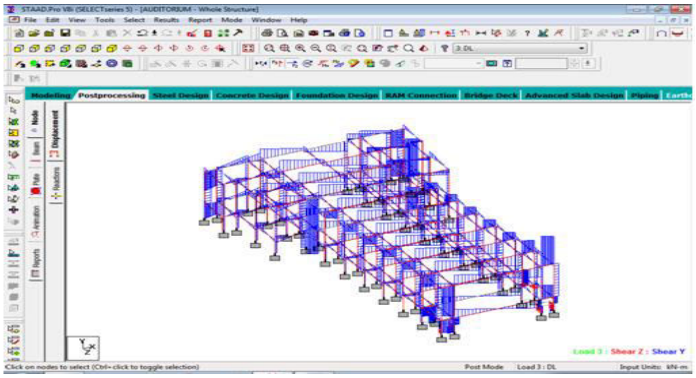
BM-Y,Z Under sesimic load



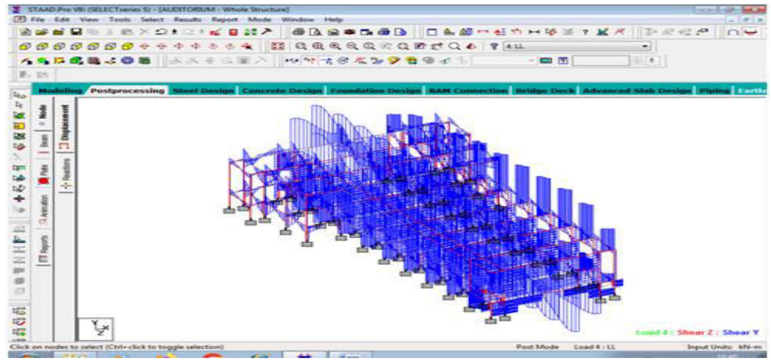
Axial forces under dead load



AXIAL FORCE under live load

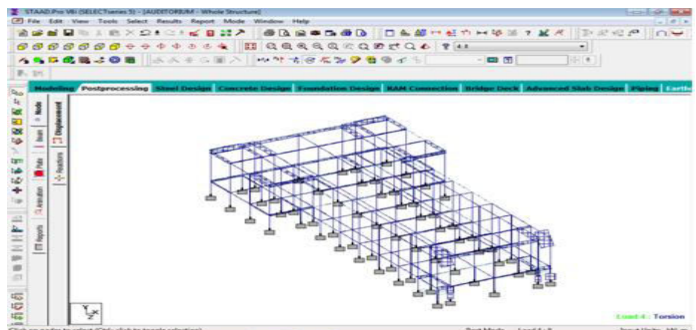


SF-y,z under dead load

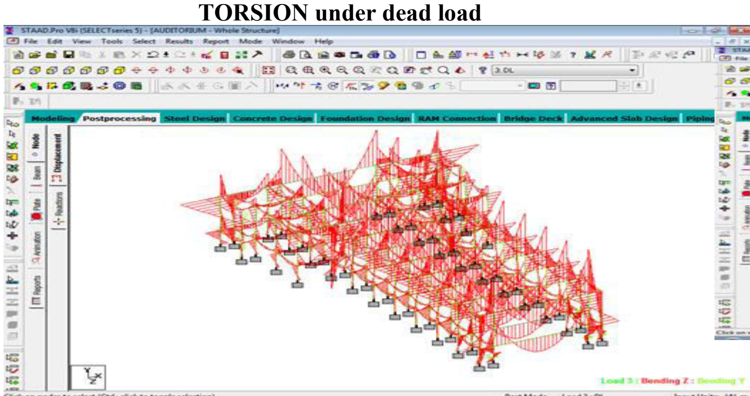


SF-Y,Z under live load

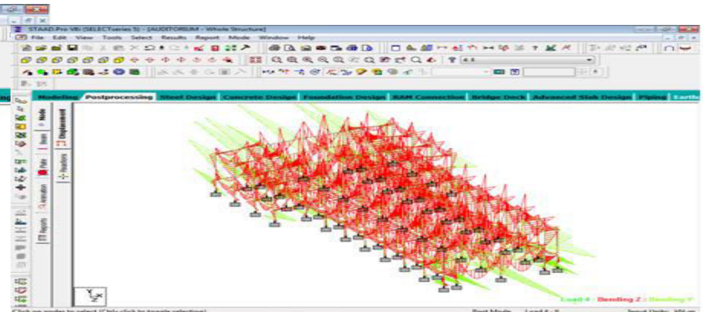
TORSION under dead load



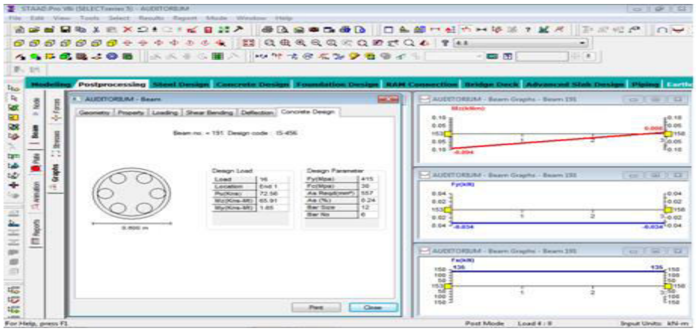
TORSION under live load



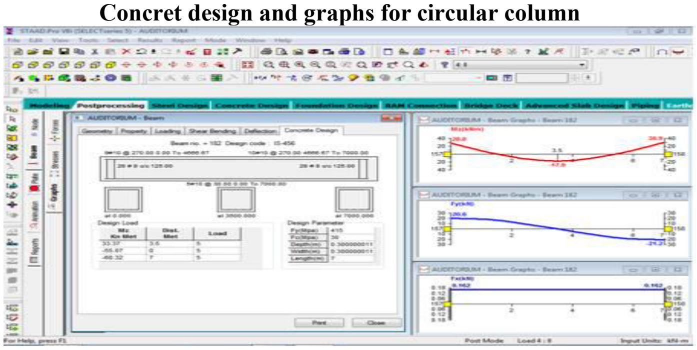
BM-Y,Z under dead load



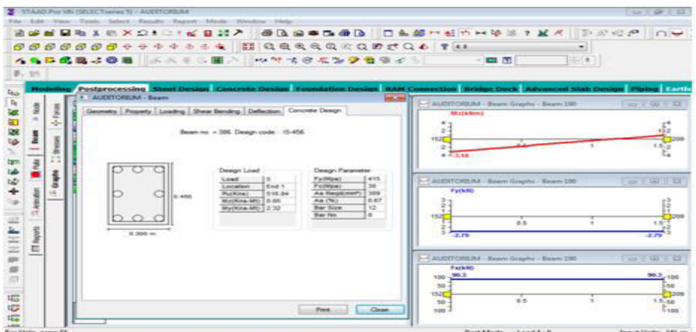
BM-Y,Z under live load



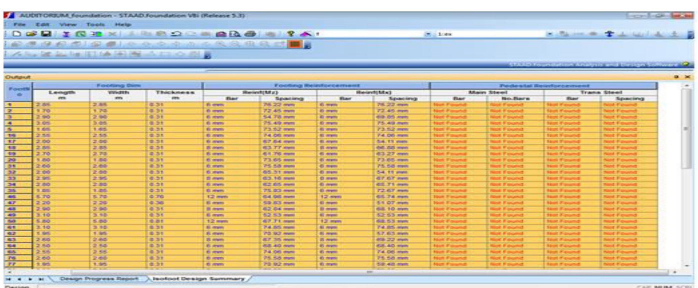
Concrete design and graphs for circular column

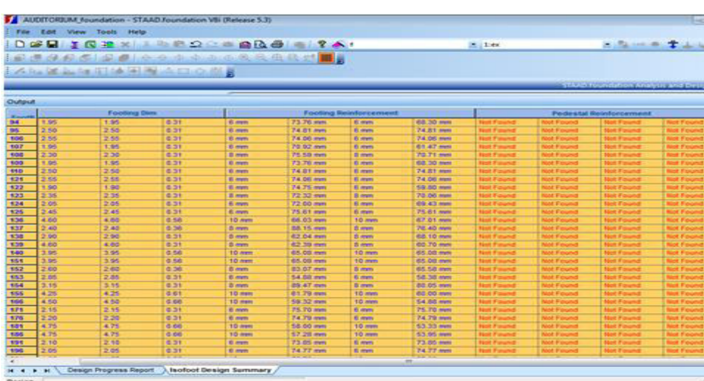


Concrete design and graphs for rectangular beam



Concrete design and graphs for rectangular column





Footing design

CONCLUSION:

The project is about "Designing and Planning of movie theatre". 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.

The RC structure was modeled and analyzed using the software STAAD.Pro. All the structural components were designed manually and detailed using AutoCAD software. The manual design was adopted as STAAD takes values on the safer side than manual work. The project helped us to gain ample exposure to various field practices in the analysis and design of the multi-storied building. Various constraints faced by the structural engineer during design and architectural drawing were revealed.

REFRENCE:

IS: 456:2000 Indian Standard "Plain and reinforced concrete – Code of practice" Bureau of Indian Standards,
New Delhi

IS:875(Part-III)-1987, "Indian Standard Code of Practice for Design Loads (other than earthquake) for Building and Structures", Bureau of Indian Standard, New Delhi,1997.

SP16: 1980, Design Aids for Reinforced Concrete to IS: 456-1978 Bureau of Indian Standard, New Delhi,1997

Kerala Municipal Building Rules – Government of Kerala, Trivandrum 2019

IS 800:2007 "General Construction in Steel – Code of Practice", Bureau of Indian Standard, New Delhi,2007

P. Yella Reddy and B. Rama Bhupal Reddy, Design of Movie Theatre by STAAD Pro Analysis and LSM - A Study IOSR Journal of Mathematics Volume 12, Issue 6 Ver. I (Nov. - Dec.2016), PP 09-27

Shankar Saj T K Sachin Saj T K, PLANNING, ANALYSIS AND DESIGN OF AN AUDITORIUM IJRAR June 2019,Volume 6, Issue 2

Jean-Bernard Bluntzera, Egon Ostrosia, Jérémy Niezb Design for Materials: Anew integrated approach in Computer Aided Design.

Roly Gjestland , How to design a Cinema Auditorium, International Union of Cinemas, Version: 24.10.2019

Young-Seo Park, Sungil Ham, Spatial Analysis of Various Multiplex Cinema Types, Science Direct, 3 November 2015 Issue 5

Bill Chew, Projection Room Design in Multiplexes, BKSTS journal Cinema Technology, December 2002, p.1

IS 800-1984, code of practise for general construction in steel.

IS 456-2000, code of practise for plain & reinforced concrete.

. "Theory of structures" by S.Ramamrutham.

"Strength of materials & Theory of structures" by B C Punmia.

. "SP-16" Design aids for reinforced concrete COLUMNS.

"Reinforced concrete design" by S.Unnikrishna Pillai & Menon.

. "R.C.C. Designs" by B C Punmia, A K Jain & A K Jain.