

A study on the analysis and modeling of multipurpose concert center by the integration of Building information modeling (BIM)

VISHNU VIJAYAN

Assistant Professor and HOD, Basелиos Mathews II College of Engineering, Kerala, India

AMINA S VAHAB

Final Year B.Tech Student Department of Civil Engineering, Basелиos Mathews II College of Engineering, Kerala, India

ELIZABETH M MATHEW

Final Year B.Tech Student Department of Civil Engineering, Basелиos Mathews II College of Engineering, Kerala, India

JYOTHI JOHNSON

Final Year B.Tech Student Department of Civil Engineering, Basелиos Mathews II College of Engineering, Kerala, India

ABSTRACT

In this project we made a sincere attempt to propose a multipurpose auditorium by considering the limitations of existing halls for the same purpose. Our college does not have a separate building for an auditorium. The existing halls have so many limitations such as improper visibility, audibility issues and also in architectural views. An auditorium is a room built to enable the audience to hear and watch various of activities and can also used as an indoor stadium. The project deals with the drafting, modeling, designing, analysis, and estimation using BIM software. BIM (Building Information Modeling) is an intelligent 3d model supported by various software that can be efficiently used for planning, designing, constructing and managing building and infra-structure. Plinth area of proposed auditorium is 8500sqft with a seating capacity of 900nos, Height of the auditorium will be at two levels ,safe bearing capacity of the soil is taken as 200KN/M², Hence the footing is designed as isolated type. All the plans are drawn by using the AUTOCADD 2015.The auditorium is planned as per the guidelines given in the National Building Code (NBC). Design as per IS 456-2000 Plain and reinforced code of practice and the reinforced concrete IS 456-1978 is followed and structural element are done using Staad pro.V8i software ,code of practice for acoustical design of auditorium and cafeteria halls .Telescopic grandstand chairs are introduced for accomplishing the auditorium as multipurpose.

Key Words: *Building information modeling, BIM, Auditorium, Acoustics and architectural consideration, Auto Cad, Revit, Staad pro, Structural design and Analysis etc.*

1. INTRODUCTION

An auditorium could be a room built to enable an audience to listen to and watch performances at venues like theatres. Auditorium will be found in entertainment venues, community halls, and theatres and will be used for rehearsal, presentation, arts and cultural activities or as a learning space.

Auditorium, conference hall are necessary for an Engineering college. In Basелиos Mathews II College of Engineering, there is no special building for Auditorium. In this project we made a sincere attempt to propose a multipurpose auditorium by considering the limitations of existing halls for the same purpose. Our college does not have a separate building for an auditorium. The existing halls have so many limitations such as improper visibility, audibility issues and also in architectural views. We have two facilities for the same purpose, one is the seminar hall at the ground floor and other is main gathering hall at the second floor. While considering the seminar hall it is insufficient for gathering all crowd in our college at once ie, insufficient space. Insight of floor it is made as stepped for which provide proper visibility but inturn it reduces the height of the hall at the rear side which is not the standard minimum. For avoiding the intermediate columns grid beams are used. Grid beams are good for load carrying without columns and fot proper acoustics but there its dept is too large which affects its architectural side.

In case of the main hall at the second floor, the hall is essentially big but there use of intermediate colums affects the visibility. There is also the acoustics issues in which sound make echos. And it is not arranged a stage and proper seating. The floor is flat and while using normal chairs there is a problem of vision. These halls cannot be used for arts functions and we are using temporary stages for the purpose which cause additional expenses. Also our college is conducting so many national and international programs. We thought that the existing facility is not feasible for such programs. We are proposing a concert center in which it is established as a separate building, where all the limitations of the existing halls have given more importance. It can be used for conducting national and international conference, seminars, functions like arts, tech fest, sports or any other celebrations, speeches and so on. We attempted to make it as a multipurpose auditorium by use.

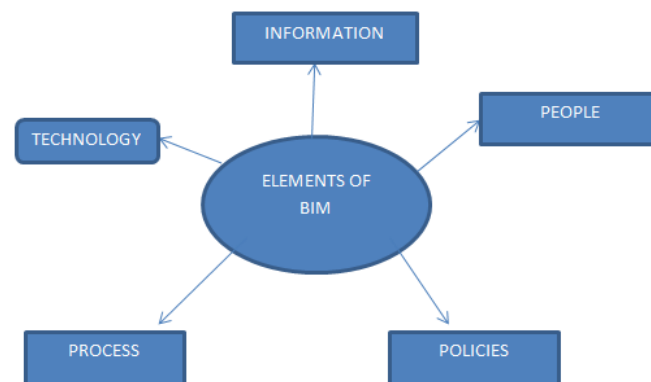
This project reports on the proposal of an auditorium including drafting, analysis, designing and estimation. Analysing and designing all structural components. Isolated footing is adopted for all columns. Safe bearing capacity of soil is taken as 200kN/m².Limit state method is used for structural design. Adopting M20 concrete and Fe415 HYSD bars for the design. Site plan, plan of the building, section of the building, elevation of the building and detailing of reinforcements for Beam, Column, and Footing are also enclosed..

1.1 Building information modeling [BIM]

The idea of BIM was arise in 70's and then it is called Building Description System (BDS).The word Building Model was first used in 1985.In 2002 Autodesk published the paper entitled Building Information Modeling. Building Information Modeling is intelligent 3D software which help in coordination, collaboration, reducing errors at the time of construction, productivity, profitability and motivate during the entire lifecycle of the project such as (plan, design, build operation, and maintenance). Every minute details of the building can be available by using this software. This model can be used to analyse the design and also provide a clear view of the building to the designer and to the client before the construction which may increase the efficiency of the construction procedures Currently BIM software is used in all sectors such as public and private for efficient completing of the project.

Future potentials

- Improve visualization
- Improve collaboration and coordination
- Good relation between designer and client
- Speed and progress of work
- Reduce the cost



1. **Process:** It is the order of work from the starting to the end of the construction; it will provide the output of each stage
2. **Policies:** Policies refer to the measure that should be adopted for each construction process. It may reduce the argument between the client and the designer and which may enhance a good relation between them.
3. **Information:** Information are one of the important element of BIM, there are two type of information system models and documents, models means it is clarifying the objects, roads etc., and they are stored in files and documents are the digital version of the print, drawings etc.
4. **Technology:** Software and hardware tools are used for various stages for BIM.

1.2 Telescopic grandstand chairs

Telescopic seating system is commonly used in different spaces like stadiums , Theatres, and all kinds of public gathering places, advantage of these chair is it is space saving. You will enjoy all the events comfortably in sitting on the telescopic grandstand chairs. It is pulled and extended in a shape of steps. It is retractable and by this way you can save a lot of spaces, and carry out another activities. It is operated in such a way that normally opened and folded manually. The larger set of chairs can be operated by motorised , automatic opening, remote control devices etc are used.

Advantages: Flexibility, Economic, Space saving, Comfort, Perfectly normal structure that can withstand a load of 600kg/sqm , Ideal in education, sports halls or small theatres.

Limitations: Floor must be suitable for structure to be rolled over its on wheels provided, The floor must be able to withstand the stress due to weight of the grandstand



Fig 1.1 Telescopic grandstand chairs

2. OBJECTIVE AND SCOPE

1. To study the modern architectural features of convention Centre.
2. To carry out a investigation on BIM software and its benefits.
3. Use technique skill and modern tools necessary for the construction engineering and management practices.
4. Determine how structural analysis, design and detailing software helps to a project.
5. To study the workflow of the process from design execution.

3. ACOUSTICS AND ARCHITECTURAL CONSIDERATIONS

Acoustics can be defined as the sound produced in a compressed atmosphere. There are some design considerations that must be taken into account for the design of the hall for any public gathering. They are given in code of practice for acoustical design of auditorium and conference halls IS2526-1963. We also consider some of the criteria from the code as possible, following consideration are taken in the design of the proposed auditorium.

1. Selection of site

The site should keep distance from major source of noise, that is building should be planned as far as possible from any potential noise such as highways, train tracks, or industrial areas. The auditorium building be isolated from potential noises from other buildings.

2. Volume

The size of the auditorium should remain optimum. The maximum length can be provided is 30m. The main goal while considering the volume of auditorium, is that to reduce the sound energy loss for the audience should be close to the sound source as possible and there by reducing the distance that the sound must travel.

3. Shape and form

For proper acoustics the shape of the hall should be properly selected. The stage to audience distance can be minimized by carefully considering the geometry of the room. The rectangular shoe box type hall with a stage on narrow end may be excellent for proper acoustics and a greater ratio of reverberation sound is desirable. Due to the less availability of space that is due to the less width of the plot we provide a rectangular geometry. However rectangular geometry is only suitable for small halls. The rear walls should be either flat or convex in shape and splayed side walls must be preferable.

4. Use of absorbent

There are so many sound absorbing materials available in the market, such as sound absorbing panels and sound proofing materials that can be used to eliminate sound reflections, some types of sound absorbing materials are

- i. Acoustical foam panels
- ii. Fabric wrapped panels
- iii. Acoustical wall coverings
- iv. Ceiling tiles

5. Sighting

A sight line is a clear line of sight between spectator and the stage, it is one of the most important factor to be considered at the time of construction of an auditorium, conference hall, or a seminar hall, so the designer should check properly the way which seating are to be arranged. These are the grasping and inspecting angles obtained from the viewer's mental perception and inspecting angles for a good look from all sides.

- 30° -no movement
- 60° - Slight movement
- 110°-more eye movement
- 360°-full head and shoulder movement

For good eye sight the consecutive rows of the seats should be elevated over the foregoing one. The elevation being raised on the principle that each viewer shall raised with the person sitting successively of him, so that the viewer head is 0.15m above the way of sound which overlook the head of the person sitting in front of him.

Top of the balcony should not be more than 65feet above the stage to avoid lower path difference and ceiling should be 1/3(larger halls) or 2/3(smaller halls) of average width of the auditorium

4. PLANNING

The plan, section and elevation of the proposed building is drawn by using AutoCAD(2016). Autocad is computer aided design software that helps for creating 2D and 3D drawings.

The proposed plot is in rectangle shape. We measured the plot by using tape. The total area of the plot is 15400sqft. Hence we decided to build a rectangular shaped building which may utilize the size to its maximum.

Table 4.1 Facilities in the auditorium

Facilities Provided	Dimension
Assembly hall	30m x 20m
Green room	3m x 5m (2nos)
Office room	4m x 4m
Guest room	3m x 5m
Technical room	4m x 5.5m
Store room	3m x5m
Toilet & Wash area	0.8m x 1.2m (20nos)
Cafeteria (as a separate unit)	7m x 20m

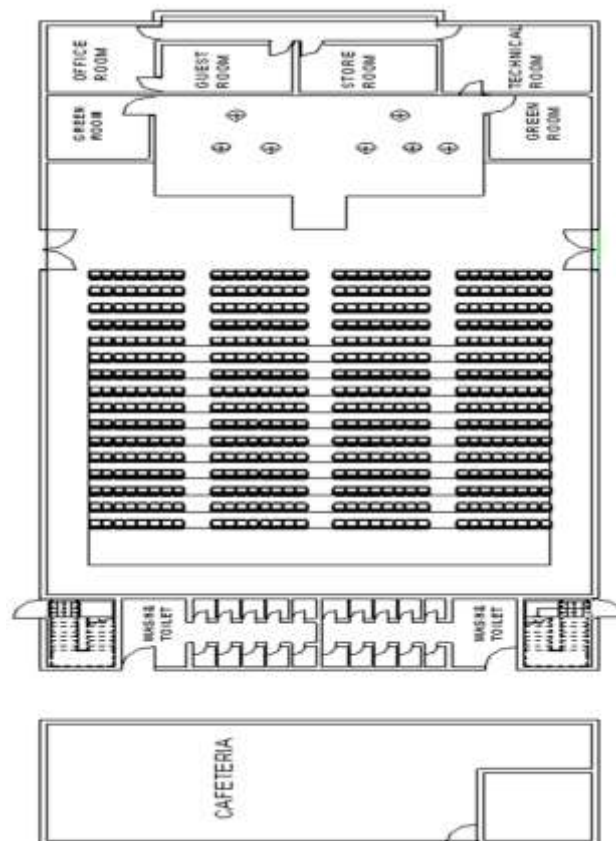


Fig 4.1 Floor Plan

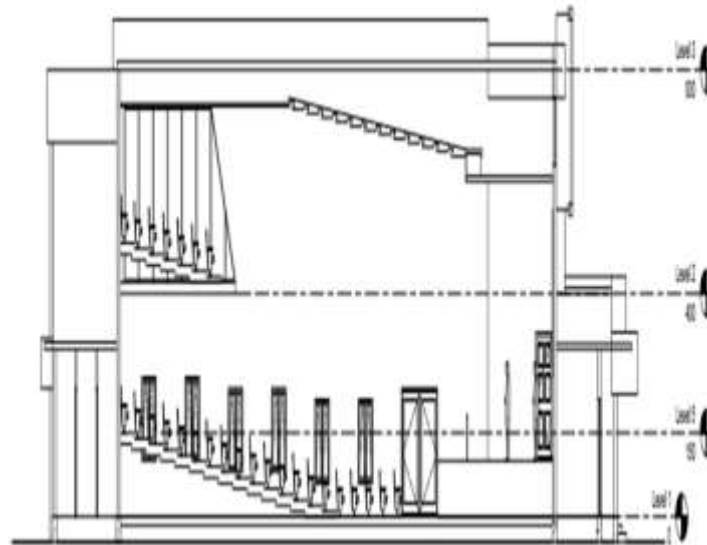


Fig 4.2 Section

5. MODELLING

Modelling is the representation of a structure to understand the design of a building, which may help to understand 3D model and help to communicate with the customers about the building appearance. We use REVIT 2015 software for modelling of our proposed building.



Fig 5.1 Interior view



Fig 5.2 Interior view



Fig 5.3 Exterior view

6. DESIGNING & DETAILING

Design is a concept that pays particular attention to various elements of a building like roof, beams, columns etc. and can be done by the software STADD Pro V8i. The structural design is mainly focused on stability, strength and rigidity of structures. The main aim of the structural design is make the structure capable for withstanding the applied loads. Here we use Limit state method for structural design. Adopting M20 concrete and Fe415 HYSD bars for the design.

6.1 Design of Beams

M30 Fe415 (Main) Fe415 (Sec.)
 Length: 4000.0 mm
 Size: 400.0 mm X 400.0 mm
 Cover: 25.0 mm
 Shear design results at 569.0 mm away from start support
 $VY = 5.41$ $MX = 0.00$ $LD = 1$
 Provide 2 Legged 8 ϕ @ 225 mm c/c
 Shear design results at 569.0 mm away from end support
 $VY = -5.41$ $MX = 0.00$ $LD = 1$
 Provide 2 Legged 8 ϕ @ 225 mm c/c

6.2 Design of column

M30 Fe415 (Main) Fe415 (Sec.)
 Length: 4000.0 mm
 Cross section: 400.0 mm X 400.0 mm
 Cover: 40.0 mm
 Guiding load case: 1 End joint: 1 Tension column
 Reqd. Steel area : 1280.00 Sq.mm.
 Reqd. concrete area: 158720.00 Sq.mm.
 Main reinforcement : Provide 12 - 12 dia. (0.85%, 1357.17 Sq.mm.) (Equally distributed)
 Tie reinforcement : Provide 8 mm dia. rectangular ties @ 190 mm c/c
 Section capacity based on reinforcement required (KNS-MET)
 $Puz : 2541.12$ $Muz1 : 75.65$ $Muy1 : 75.65$
 Interaction ratio: 0.00 (as per Cl. 39.6, IS456:2000)
 Section capacity based on reinforcement provided (KNS-MET)
 Worst load case: 1
 End joint: 2
 $Puz : 2564.10$ $Muz : 79.72$ $Muy : 79.72$ Interaction ratio: 0.00

6.3 Design of footing

Footing Geomtery

Design Type : Calculate Dimension
Footing Thickness (Ft) : 12.000 in
Footing Length - X (Fl) : 40.000 in
Footing Width - Z (Fw) : 40.000 in
Eccentricity along X (Oxd) : 0.000 in
Eccentricity along Z (Ozd) : 0.000 in

Design Parameters

Concrete and Rebar Properties
Unit Weight of Concrete : 150.000 lb/ft³
Strength of Concrete : 4.000 ksi
Yield Strength of Steel : 60.000 ksi
Minimum Bar Size : #3 Maximum Bar Size : #10
Minimum Bar Spacing : 2.000 in
Maximum Bar Spacing : 18.000 in
Pedestal Clear Cover (P, CL) : 3.000 in
Footing Clear Cover (F, CL) : 3.000 in

Soil Properties

Soil Type : UnDrained
Unit Weight : 112.000 lb/ft³
Soil Bearing Capacity : 4.000 kip/ft²
Soil Surcharge : 0.000 kip/in²
Depth of Soil above Footing : 0.000 in
Undrained Shear Strength : 0.000 kip/in²

Design for Flexure about Z Axis (For Reinforcement Parallel to X Axis)
Based on spacing reinforcement increment; provided reinforcement is #3 @ 8.000 in o.c.

Design For Top Reinforcement Parallel to Z Axis
Based on spacing reinforcement increment; provided reinforcement is #3 @ 8.000 in o.c.

Design For Top Reinforcement Parallel to z Axis
Based on spacing reinforcement increment; provided reinforcement is #3 @ 8 in o.c.

Design For Top Reinforcement Parallel to X Axis
Based on spacing reinforcement increment; provided reinforcement is #4 @ 16 in o.c.

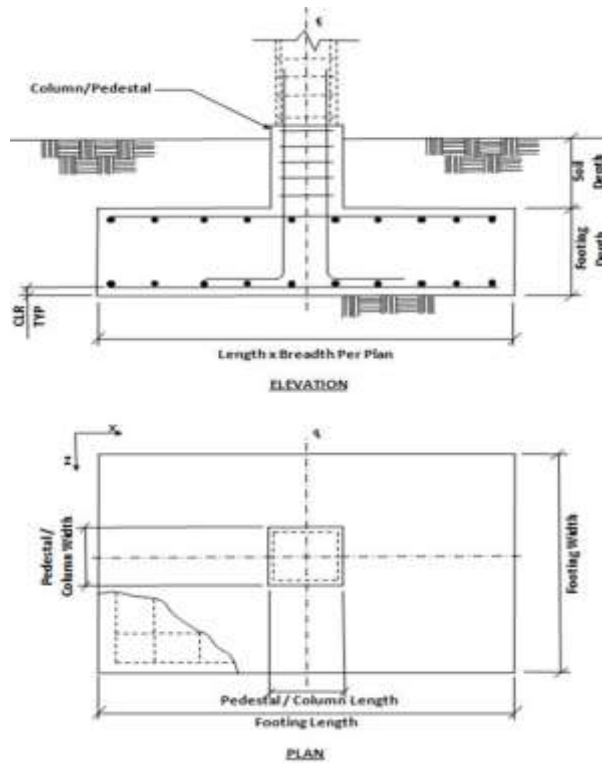


Fig 6.1 Isolated footing

7. STRUCTURAL ANALYSIS

Here we are using STAAD Pro software for analysing the structure, it is the best structural analysis software. In structural analysis we determine the effect of load on the building and structural components. Structural analysis is a method where we are able to find out how a structure behave under certain loads or combination of loads, it is to understand the support reactions, bending moment, shear force, deflection etc.

The analysis is done through member structural member properties and support specification and modelling. The dimensions of all the structural members as per the preliminary design and it is assigned. The support specification of assigned.

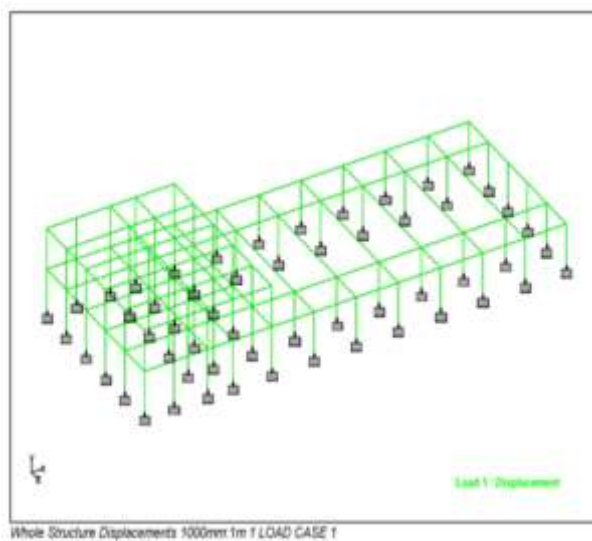


Fig 7.1 Displacement of loadcase 1

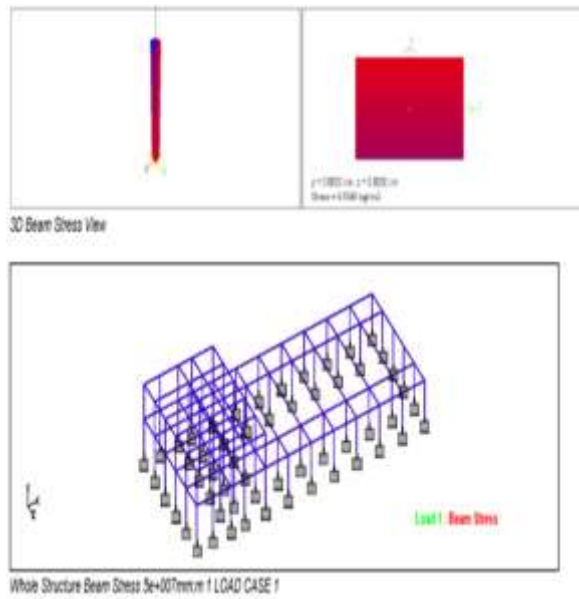


Fig 7.2 Stress details

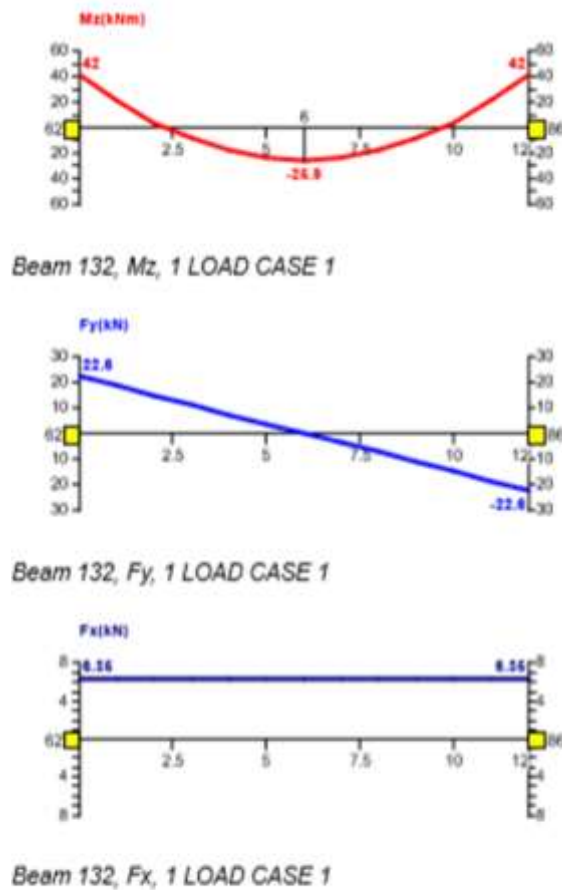


Fig 7.3 Load case details

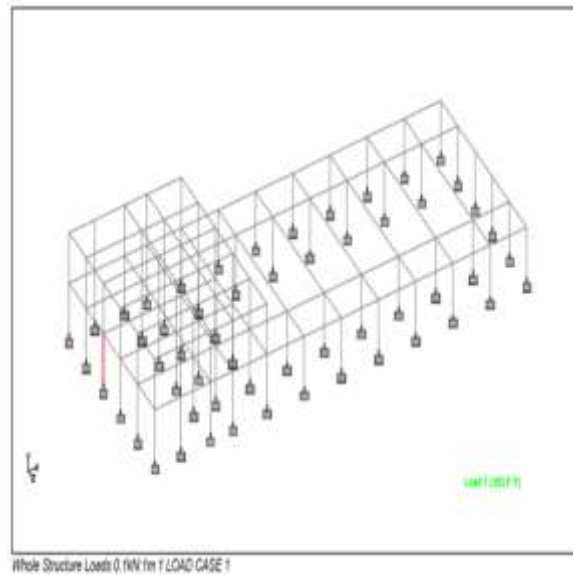


Fig 7.4 Whole structure loads

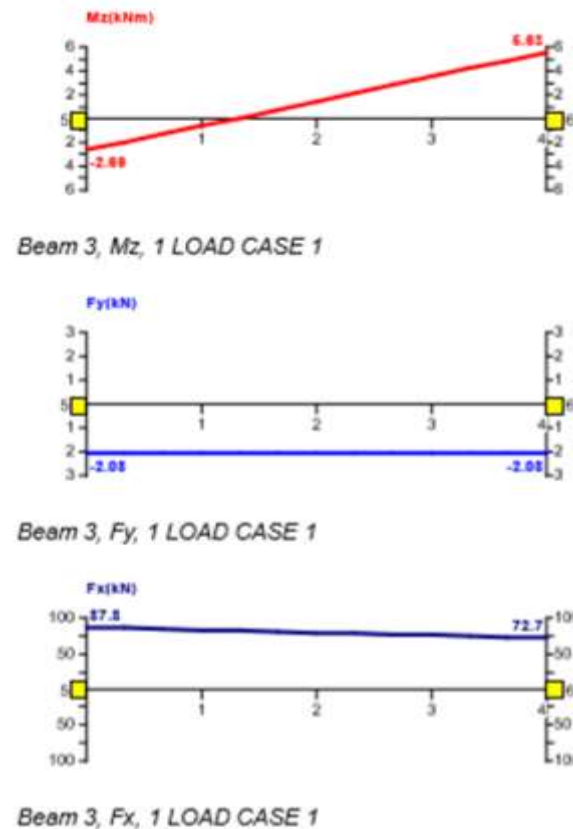


Fig 7.55 Load case

8. ESTIMATION

Estimation is the approximate cost of construction calculated before the construction starting. Estimation is the approximate calculation of the amount, for the construction of the building. If the fund available is less than the estimated cost which may cause delay in the work. For producing an estimate the cost of unit materials should be known. Long wall short wall method is used and estimation is done by manually.

The total cost of the auditorium is **RS.6505282/-**

9. CONCLUSION

Our project was successfully completed by the joint effort of the concerned faculty member and the members of the project. We have completed this project with best of our ability and knowledge and satisfying the requirement of an educational building.

The project was focused on the planning, design, analysis of an concert hall in our college, by using an intelligent 3-d software Building Information Modeling (BIM). The project consists of designing of structural members like beams, columns, footings etc., Design by AutoCAD 2015 design and analysis by Stadd pro V8i. BIM improve its design quality and collaborate in real time to support project delivery process. The design and analysis are done by the IS specifications. This project helps us to study work flow process from design execution, and to study the modern architectural features of convention Centre, to carry out research on BIM technology. We also learned that the success of an auditorium depend on architectural and acoustics considerations, acoustics plays an important role in enhancing the desirable sounds and eliminating the unwanted noise and architectural for the proper vision. The final estimated cost for the completion of the project is RS.6505282/-

We made this proposal according to the requirements so, we hope that the proposal will be accepted and implemented by the concerned authorities and it should be asset for our Civil Engineering Department.

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REFERENCES

1. A.Q Saraireh, Ibrahim Moh'd and Haron, Ahmad Tarmizi, "Understanding the Conceptual of Building Information Modeling", International journal of Academic research in business and social science, 8(1),957-963, 2018
2. Miss. Irin Ann Isaac and Dr. Anoop CK, "Analysis of BIM and scope of BIM in India", IJERT, Vol 08, issue 11, 2019
3. C.R Vigneshwar, "Planning, Analysis, Designing and Estimation of an auditorium", isjournals, Vol 03, issue 01, 2018
4. Ch. Pratysha, V. Vijaya Kumar, "Analysis and Design of Auditorium", International journal for technical research in engineering, Vol 04, issue 12, 2017
5. Vijayan, Vishnu and V, ACHU and Riyana, M. S. and Jayakrishnan, R., Time-Cost-Risk Optimization in Construction Work by using Ant Colony Algorithm (April 4, 2018). International Research Journal of Engineering and Technology, Volume: 05 Issue: 04 | Apr-2018. Available at SSRN: <https://ssrn.com/abstract=3570079>
6. Vijayan, Vishnu, A Comparative Study on Sustainable Building Construction with Conventional Residential Building (April 20, 2018). International journal of current engineering and scientific research (ijcesr), 2018. Available at SSRN: <https://ssrn.com/abstract=3591429>
7. Vijayan, Vishnu, A Study on Flyover Construction with Eco Technical Road System (June 2, 2018). International Journal of Emerging Technologies and Innovative Research, 2018. Available at SSRN: <https://ssrn.com/abstract=3591306>
8. Vijayan, Vishnu and V, ACHU and M. S., Riyana, Mechanical Strength of Concrete using Bottom Ash as Fine Aggregate (April 5, 2018). International Journal of Current Engineering and Scientific Research Volume 5-issue-4-2018. Available at SSRN: <https://ssrn.com/abstract=3570084>
9. C.M.F Pangu, M.S Prawirasasra, Abrar Ismardi, "Measurement of acoustics performance of an auditorium", IOP publishing, 2017
10. Kabiru Maishanu and Dr Halil Zafer Alibaba, "Auditorium acoustics from past to present", Int journal of engineering research and application, vol 07, issue 01, 2017
11. zhonghua gou, Acoustic Design for an Auditorium Project Using Building Performance Simulation to Enhance Architectural Quality, 2017
12. Vijayan, Vishnu and M. S., Riyana, A Study About the Status of Implementation on Safety Standards and Legal Requirements Pertaining to Construction Safety (April 4, 2018). Journal of Emerging Technologies and Innovative Research, April 2018, Volume 5, Issue 4. Available at SSRN: <https://ssrn.com/abstract=3496217>
13. Vijayan, Vishnu, An Experimental Study on Chitosan for Water Treatment (May 28, 2018). Available at SSRN: <https://ssrn.com/abstract=3591432> or <http://dx.doi.org/10.2139/ssrn.3591432>
14. Vijayan, Vishnu and Jasna Jamal. "A Study on Strengthening of Bubble Deck Slab with Elliptical Balls by using GFRP Sheets." International Journal for Scientific Research and Development 6.1 (2018): 659-663
15. Vijayan, Vishnu, et al. "a study on sustainable and cost effective building construction in housing sector." (2019). International Journal of Current Engineering And Scientific Research vol.6, issue 6,
16. Vijayan, Jasna Jamal Vishnu. "A Study on Strengthening of Bubble Deck Slab with Elliptical Balls by using GFRP Sheets."