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Design of Mini Auditorium

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Abstract- This project includes planning, analyzing, designing and estimation of a mini auditorium. The Project is based on renovating a hall, which is already designed and constructed to satisfy the serviceability requirements. The overall project includes planning and designing of seating arrangement, exit and entry routes, stage properties, acoustics, lighting, air conditioning and false ceiling for the mini auditorium. The software AutoCAD is employed for drawings and 3dsmax for 3D modeling.

Keywords: - Absorption; Acoustics; Air conditioning; Diffusion; Reverberation time.

I. INTRODUCTION

An auditorium is a space built to permit audience to listen and watch performances comfortably. This project reports on the planning, analysis, designing and estimation of mini auditorium in mechanical block. The facilities in Mini auditorium will encourage interactive learning and functional relationship. It also Provide comfortable seating with larger work surfaces and a space for conducting seminars and presentations.

Seminar hall rooms generally accommodate smaller numbers of students seated in any number of seating configurations but an Auditorium contain more than 150 seats. When we consider about the design criteria's of the entrance, At-grade access should be provided to the front area of large lecture halls which have sloped or tiered floors to accommodate equipment being moved into and out of the room and to accommodate people who use wheelchairs. Primary entries for large lecture halls should be in the rear section of the room, with doors placed in the sidewalls rather than the rear wall whenever possible.

II. LITERATURE REVIEW

A number of researchers have investigated experimentally, analytically and case studies associated with auditorium and its acoustics. The Signal-to-Noise Ratio of speech intelligibility, an auditorium acoustics design index by Howard G. Latham reports the target design index for predicting speech Intelligibility by Lochner and Burger. Their index provided a measure of useful and detrimental reflected speech energy. It has been necessary to increase the Signal-to Noise Ratio theory to account for the effect of fluctuating ambient background on speech intelligibility [6].

The analysis and design of the Auditorium with special emphasis on Slabs, Beams, Columns, Footing and Stair case. Analysis is done using Substitute Frame Analysis and preliminary analysis of Beams is carried out using Moment Distribution method [1]. Steel used for the RCC members is high yield strength deformed bars of grade Fe415 and concrete mix isM20. Limit State Method is adopted for the design of structural members in the building. Safe bearing capacity of soil is taken as 200kN/m2 and isolated type footing is provided [3].

In the project "Planning, Analysis, Design of an auditorium building", Analysis is by using STAAD.pro software. The designing is mainly based on reference of IS code 456:2000 for concrete and IS code 800:2007 for steel. The software AutoCAD is employed for drawings [7][8]. In Acoustic design for an auditorium using building performance simulation to improve architectural quality, "Odeon 5.0 was used to simulate the reverberation time and sound propagation and diffusion [2].

For a small auditorium, the design recommendation is how to reduce sound absorption and to attain sufficient reverberation. Sound defects were found within the rear wall sand stage outlet [4]. Auditorium acoustics from past to present discuss the transition over time. It will cover how the design began from

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the past to the present. It further discusses some case studies that are from different periods. Some benefits of using acoustics in auditoriums and discuss on the causes poor quality sound within the present auditoriums [5].

Reverberation time improvement of lecture auditorium is a case study of reverberation time of a lecture auditorium. It is found that acoustic performance of the lecture auditorium has improved using curtains and furniture. For more improvement, use carpet on the ground of the auditorium [9].

III. METHODOLOGY

1. Planning:

Design a functioning Auditorium according to the type of performance and the number of the audience.

2. Primary Investigations and AutoCAD Drawings:

The dimension of the auditorium hall is 27m x 10m x 3.5m as measured using a measuring tape. The plan and elevation of the room is shown in Fig 1. The flooring provided is tile flooring. The ceiling and the walls are plain cement painted. There are fourteen numbers of open windows and two doors throughout the auditorium. Doors provided are wooden. Ceiling consist of cross beams, columns are projected inward in one wall. Windows are made of wood and glass. Engineering drawings of the auditorium were produced using AutoCAD software.

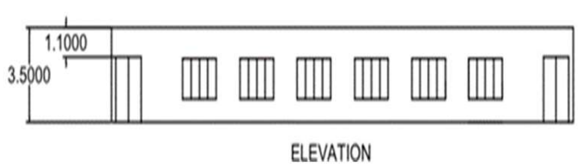

Fig 1. Elevation of the room.

Eliminated by providing highly absorbent materials on the focusing areas.

2.1 Dead spots: This defect is just the reverse of the previous one. Because of the high concentration of the reflected sound at the sound foci, there is a deficiency of a reflected sound at some points. These points are knows as dead spots and sound level at dead spots are generally in adequate for satisfactory hearing. This defect can be remedied by installation of suitable diffusers to have even distribution of sound in the hall.

2.2 Loudness: This defect is due to lack of reflecting surface at the source of sound and excessive absorption of sound in the hall. The remedies to correct this defect consist of placing hard reflecting surfaces near the source of sound and in adjusting the absorption of the hall to achieve optimum time of reverberation. If the length is more, it is desirable to provide more than one source of sound by installing loud speakers. The location of loudspeakers should be carefully adjusted.

2.3 Exterior Noise: This defect is due to poor sound insulation and hence, the exterior noise enters the seminar hall either through loose doors or windows or through wall or other structural elements having improper sound insulation.

Vehicles, factories, cooling plants etc. the remedy to correct this defect is to provide suitable sound insulation to the various components of the seminar hall, develop the exterior sound. The reverberation time of the room obtained from Sabine formula is 4.12s.

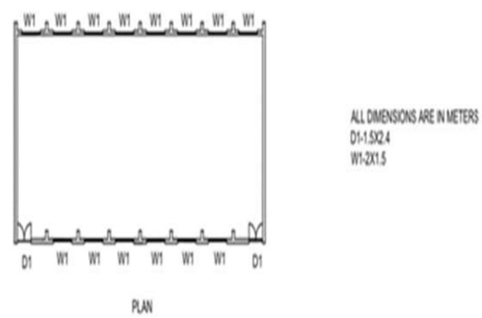

Fig 2. Plan of the model.

3. Acoustics

Sabine Formula:

Wallace Clement Sabine developed a formula that allows planning reverberation time in a room in advance of construction and occupancy.

The Sabine Formula is T=0.049(V/A)

Where,

T = reverberation time or time required in seconds.

Following defects are however are found in most of the seminar halls:

- **Reverberation:** The defect of excessive reverberation is extremely common in many seminar halls. The consequences are that the sound once created prolongs for extended duration leading to the confusion with the sound created next. The remedy of this defect is to correct the time of reverberation by suitably installing absorbent materials.

- **Formation of Echoes:** when the reflecting surfaces are situated at a distance greater than 17 m or so when the form of the seminar hall is unsuitable, the formation of echoes occurs. This defect is often removed by selecting proper shape of seminar hall and by providing rough and porous interior surfaces to disperse the energy of echoes.
- **Sound Foci:** In case of concave reflecting interior surfaces, certain sports are formed where reflected sound waves meet and created a sound of a large intensity.

These spots are knows as the sound foci and they can be;
V = Volume of room in cubic meter.
A = Total square footage of absorption in Sabine.

The room with volume 945 m3 falls under the college auditorium, which have an optimum reverberation, time of 0.8s to 1.2 s from the graph given in fig 3.10. The reverberation time of the room according to Sabine formula is 4.12s, which is very high. In order to reduce the reverberation time acoustical treatment must be provided.

IV. ANALYSIS AND DESIGN

This project is mostly based on software and it is essential to know the details about these software's. List of software's used are:

1. Auto CAD for Drafting:

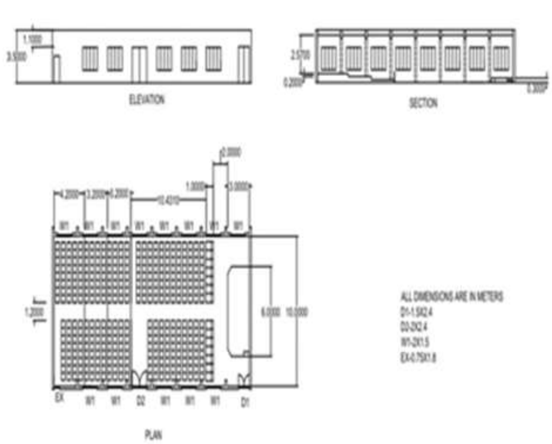

Fig 3. Mini Auditorium With steps.

AutoCAD is a computer-aided design (CAD) and drafting software application that permits architectural designers to draw 3D objects, such as walls, doors, and windows.

The tools generate standard 2D drawings, such as elevations and sections. Similarly, support data-specific objects facilitating standard civil engineering calculations and representations. The plan, elevation and section of the mini auditorium are drawn using AutoCAD 2020. The Fig 2 shows AutoCAD drawing of mini auditorium with steps.

2. 3Ds Max for 3D Modeling:

3D Studio Max is 3D computer graphics programs developed by Autodesk. Architectural visualization studios frequently use it. The latest version of 3ds Max also features shedders, normal map creation and a customizable user interface, new icons, rendering, global illumination, and its own scripting language. 3Ds MAX is used for the interior designing of the mini auditorium.

3. Detailing:

The dimension of the auditorium hall is 27m x 10m x 3.5m as measured using a measuring tape. The flooring provided is tile flooring. The ceiling and the walls are plain cement painted.

There are fourteen numbers of open windows and two doors throughout the auditorium. Doors provided are wooden. Ceiling consists of cross beams. Columns are projected inward in one wall. Windows are made of wood and glass. Engineering drawings of the auditorium were produced using AutoCAD software. The first row of the designed mini auditorium consists of movable seating and others are fixed. Auditorium fixed seat width to be at 0.6 unless restricted by row curve. Seminar halls should be sized in the width to length ratio 2:3 or 3:4 .The aisles in a lecture hall should be arranged to provide the maximum prime viewing locations for the audience. The screen is having a 4:3aspect ratio.

In the mini auditorium, folding projector screens and ceiling- mounted projectors are provided. End Stage is well suited to lecture, film, or slide presentations. The defect of excessive reverberation is very common in many seminar halls. Reverberation time is the time required for sound to decay 60 dB after source has stopped. The effects are that the sound once created prolongs for longer duration resulting in the confusion with the sound created next. The remedy of this defect is to correct the time of reverberation by suitably installing absorbent materials. The reverberation time of the room obtained from Sabine formula is 4.12s.

The most common material plywood, which is used in multilayer in interiors, to make it sound proof. Steel is one of the best materials for sound insulation. The plan, elevation and section of the mini auditorium is drawn using AutoCAD 2020. 3Ds MAX is used for interior designing of the mini auditorium.

Main seminar hall lighting, Instruction area, Non-projection white board, Projection whiteboard, Instructor workstation are the five functional lighting zones. For acoustical value, walls in the lecture hall should have a rough or textured surface. Sidewalls should be angled away to focus sound toward the audience and the back of the room. The back wall is covered with acoustical absorption materials. To enhance the instructor's voice projection, the ceiling should be hard surfaced nearest the instructor.

Carpet is used in the front, rear, and aisles of lecture halls and tile under the seating area. Resilient, non-skid vinyl or rubber tile is a good choice of floor covering for lecture halls. In the mini auditorium two exits are provided. It is provided to reduce congestion, to allow free movement and to reduce disturbances for performer. HVAC systems are designed to provide a comfortable environment for learning. An emergency exit is provided for a safe way to evacuate in case of a disaster.

4. Detailed Estimate:

The estimation of mini auditorium with steps is done by considering all the expenses during the renovation work. The demolition work is done near the center window to fix the door and masonry work at the back to close the extra space after fitting the emergency exit. The steps and stage are constructed using steel to reduce dead load. The fixed seating is the most costly in the whole estimate but in order to ensure comfortable seating they are necessary. Carpets and curtains are provided for aesthetics and acoustics.

The acoustics treatment is done by providing absorbing panels and treating the wall accordingly. Total cost for constructing mini auditorium with steps is Rs.20, 23,560. This include the charges for labour work of demolition and masonry and the cost for stone, cement, sand, steel, painting charges, interior works, HVAC, electrical equipments and safety equipments This design is optimum for unobstructed view.

V. ANALYTICAL RESULTS

The interior of the room is composed of many objects and details modeled as separate elements. There are many elements with different details on them and all of them should be modelled. This modelling stage highlights the details of the interior. Most of the objects in the interior are modelled with the same techniques as exterior.

The materials describe how an object reflects or transmits the light. They are data that are applied on the surface of an object and they are shown in a particular way when the scene is rendered. Creation of materials can take a long time and for faster results, plug-in called V-Ray Material Presets Pro issued for applying materials on the mini auditorium. This plug-in contains many types of materials and with a little editing of these materials, the desired results are obtained.

Depending on the desired results, it can be often encountered with material that needs to reduce reflection, reflection glossiness, bumpiness and opacity. All these settings and many others can be changed in material editor window. Most of the materials containing a texture, when applied on very small or big objects do not look realistic. To solve this problem, the UVW Map modifier is used. It is a mathematical technique for coordinating textures. It includes the possibility of adjusting the size of texture in three dimensions to give additional flexibility to get the desired results.

1. Rendering Interiors in 3ds Max:

The rendering interiors of a room in 3D impeccably with 3DS Max. The process of interior rendering in 3DS max starts with conceptualizing the model, creating it, enhancing the scene with the right lighting and strategic texturing, and getting the scene rendered.

2. Working with .dwg Files:

The .dwg format is widely used for storing elevation drawings encoded from line diagrams. The DWG file uses a single view for displaying top, left and front

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elevations along with additional information. To render 3D interiors, you have to import the DWG file carrying the needful imprints into 3DS. Prior to that, invoke AutoCAD for opening the DWG file and eliminating redundant details except for the fundamental layout of the building. You do not need to import trivial drawings related to furniture, household items, plants etc., into 3DS. Trimmed down DWG file is easy to work with as the absence of an excessive number of shapes keep the Max viewport optimally functional. You can drag the pruned DWG file and drop on the viewport.

3. Setting up 3DS Max Interface:
To streamline the workflow in Max, the system units should be set in millimeters. Navigate to „Customize Menu‟ and click on „Units Setup‟ to accomplish this. The Display Units can be set as per your convenience and turn on „Use Real- World Texture Coordinates‟ from „Customize Menu‟ under „General Preferences‟ for using commonly used measurement options for defining texture dimensions.

4. Modeling using 3DS Max:
Within a simple 3D box, you can set back an area in the rear for window and then add it. Further, the furniture to be placed within the room are mostly box shaped and are represented in straight-lined manner. The complexity arises when you have to place different furniture and object in perspective across the room. 3DS Max provides tools for creating complex models and can use Boolean and lofting tools for making provisions for undulated shapes in trim. Revolve profile tools have to be used for creating complicated profiles for spindles. Other tools need to be used for creating different shapes of varying complexities.

5. Building the Scene:
To build the scene, strategically deploy procured models across the room. The models have to be scaled and put in appropriate place prior to texturing. To apply appealing and suitable textures to the models, import pixel-based pictures that have been retouched in Photoshop for mapping to the models.

The tile image is rendered suitable for floor texturing using flat projection map or "planar" surface. For shapes that are non planar, you can apply the texture maps in cylindrical or spherical modes. Procedural application of textures is an alternative method for mapping them on models. The procedures stand for patterns, which the 3DS generates on its own. The textures can be modified largely using attributes, which can be tweaked to accomplish the desired look and feel. The procedural patterns enjoy a distinctive advantage over pixel-based textures as the former can be animated for striking results. 3DS comes loaded with standard textures of wood, marble etc.

6. Room Lighting:
Once you set proper lighting for the room, the bulk of scene building activity would be over. You can better master the intricacies of lighting in 3DS using various illuminating perspectives and shading. Major lighting types you can work with are sun or directional lighting, point lighting as achieved through bulbs that can be accompanied by lampshades, fluorescent lighting, and other illumination modes. The lighting positions are shown in Fig 4.

Fig 4. Lighting Positions.

7. Rendering Process:
When you give the command for rendering, what actually happens is that all the custom 3D modeling and scene building decisions you have taken until now are spontaneously actuated. The accumulated information base is used for creating the eventual rendering. This step can be repeated until the flaws are fixed and the perfect look is pulled off. We used rendering option V-ray engines.

8. Finalizing the Production:
In the post-production phase, swiftly fix any discrepancies in the final versions which would be delivered for publishing. Still, images are refined through Photoshop. The efficiency of computer graphics can be optimally tapped into with limitless DOF (Depth of Field) which allows for shaper and

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crisper images. Your final image would look more realistic with carefully rendered depth map pass. The finalization of the mini auditorium is shown in the figure 5, 6, 7, 8.

Fig 5. Side View.

Fig 6. Stage.

Fig 7. Front View.

Fig 8. Windows and Ceiling.

Fig 9. Back View.

VI. CONCLUSIONS

The project was aimed on the planning, design, analysis and estimation of a mini auditorium. The drawing and detailing was done using the software AutoCAD, which proved to be premium software with great potential in construction industry. The 3D modelling is done using 3ds max.

The acoustics of the room were considered and treatment was planned according to it. The plan of the mini auditorium with steps was made with a seating capacity of 400 seats.

The detailed estimation of mini auditorium was conducted. The optimum choice will be stepped mini auditorium because it provides unobstructed view and good acoustics. The analysis and design of mini auditorium is done according to standard specifications.

Development on this project is essential part of the education; the better hall we provided to students will result in better scores and understanding in them.

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