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Design and analysis of auditorium using STAAD Pro software

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ABSTRACT

This project deals with the design and analysis of the auditorium which is located at Aurangabad in Maharashtra State. Auditorium can be used for all types of formal assembly, lectures, seminars, functions, award ceremony, cultural activities like dramatic plays, singing and dancing. The Project is based on limit state concept, the structure is designed to resist and liable to bare all loads liable to act on it. It should be satisfying the requirement of serviceability within the limitation of Deflection and Cracking. The analysis done using STAAD-Pro and Structural Detailing had done using AUTO-CAD.

Keywords*— Slab, Beam, Column, Footing, Auditorium, Dead load, Analysis, Design, Structural Detailing, Shear force, Bending moment, STAAD Pro, Auto cad*

1. INTRODUCTION

The auditorium is a central and important space. It is used for all types of formal assembly: lectures, award ceremonies, dramatic plays, musical theatre productions, dance competitions and so on. These varied events place a range of demands on the room. It 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. It also helps for large meetings, presentations, and performances. Auditorium includes assembly halls, exhibit halls, auditoriums, and theaters. An auditorium is a room built to enable an audience to hear and watch performances at venues such as theatres.

1.1 Types of Auditorium

(a) **Arena Theatre:** Arena theatres are large scale auditoria and have a central stage area with audiences on all sides, similar to theatres in-the-round.

(b) **Thrust Theatre**: A theatre within which the stage is extended so the audience surrounds it on 3 sides. The theatre stage could also be backed by an interior proscenium stage, providing an area for background scenery, however audience views into the proscenium opening are usually limited.

(c) **Proscenium Theatre**: Proscenium stages have an architectural frame, known as the proscenium arch, although not always arched in shape. Their stages are deep and sometimes raked, meaning the stage is gently sloped rising away from the audience.

(d) **Thrust and open stage**: Some larger drama theatres take the form of a thrust stage with the audience surrounding 3 sides of the performance platform. The term open stage may be used interchangeably a high seat count within a suitable distance to the stage.

(e) **Flexible theatre**: Flexible theaters could be a generic term for a theatre within which the playing area and audience seating are often designed as desired for every production. the theatre are often configured into the theatre, thrust, and end stage forms described on top of environmental, promenade, black box and studio theatre are different term for this type of space suggesting particular feature or qualities.

2. SPECIFICATIONS

A design of RC building of G+1 storey frame work is taken up. The design is made using software on structural analysis and design (STAAD Pro). The building is subjected to both vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beam, columns, slabs etc and live loads. The building is designed and analysed for the maximum and minimum bending moments and shear forces as per IS 456-2000.The help is taken from software available in institute and computations of loads, moments and shear forces is obtained from this software.

Table 1: Statement of Project

Component	Size
Area of Auditorium	511 Sq.M
No of Stories	G+1
Floor to Floor Height	4.27M

Total Height	10.50M
Shape of the building	Rectangular Shape
Type of construction	R.C.C framed structure
Concrete grade	M25
All steel grades	Fe415 grade
Type of Wall	Brick Wall
Size of Wall	0.23M

2.1 Methods of Design

Reinforced Cement Concrete structures and structural parts could also be manner anybody of the following methods:

- Working Stress method.
- Limit State Method.
- Methods based on Experimental investigations.

2.2 Limit State Methods

In this, the tactic of style supported limit state conception, the structure shall be designed to withstand it shall safety all hundreds prone to act on that throughout its life; it shall conjointly satisfy the serviceability necessities, resembling limitations on deflection and cracking. The appropriate limit for the protection and serviceableness necessities before failure happens is termed a Limit State. The aim of design is to attain acceptable possibilities that the structure will not unfit for the utilization. For which it's meant, that is, that it will not reach a limit state.

2.3 Types of Load

The various loads considered for analysis were:

(a) Dead loads: These are the self-weights of the structure to be designed. The dimensions of the cross section are to be assumed initially which enable to estimate the dead load from the known unit weights of the structure. The values of the unit weights of the materials are specified in IS875:1987(Part-I).

(b) Live loads: They are also known as imposed loads and consist of all loads other than the dead loads of the structure. The values of the imposed loads depend on the functional requirement of the structure. Commercial buildings will have comparatively higher values of the imposed loads than those of the residential buildings. The standard values are stipulated in IS 875:1987(Part-II).

2.4 Load Combinations

The concept of characteristic loads has been accepted to ensure at least 95 percent of the cases, the characteristic loads considered will be higher than the actual loads on the structure. The characteristic loads are to be calculated on the basis of average/mean load of some logical combinations of all loads mentioned below.

Table 2: Load Combination

Dead Load	Live Load
1.5	1.5
1.2	1.2
0.9	0.9

Load combinations
1. 1.5(DL+LL)
2. 1 (DL+LL)

All these combinations are built in the STAAD.ProV8i. Analysis results from the critical load combinations are used for the design of the structural members.

Note:
DL = dead load
LL = live load

3. MODELLING AND ANALYSIS

The modeling and analysis are done by using STAAD Pro. STAAD Pro stands for Structural Analysis and Designing Program. This Software is most used Software for civil Engineering analysis and designing. In this Software we are working 3 dimensionally. It is very fast method of designing of the structure. It Does not involve any manual calculation and it is Suitable for almost all types material for designing i.e. Concrete, Steel, Aluminum etc.

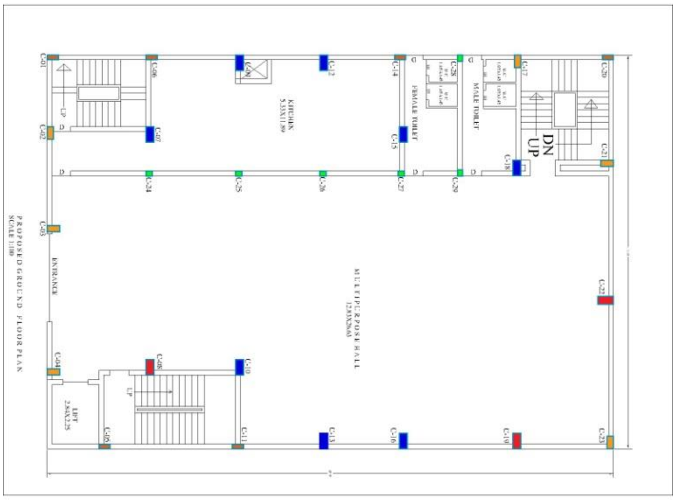

Fig. 1. Ground Floor Plan

Fig. 2. First Floor Plan

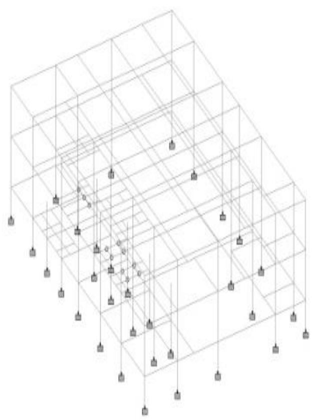

Fig. 3. 3D view of Model

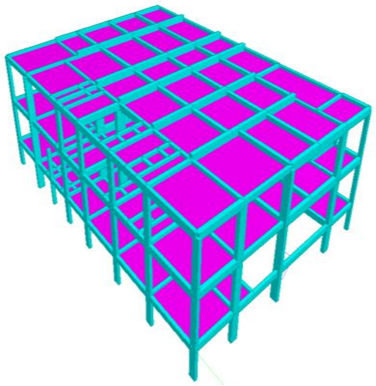

Fig. 4. 3D Rendering View

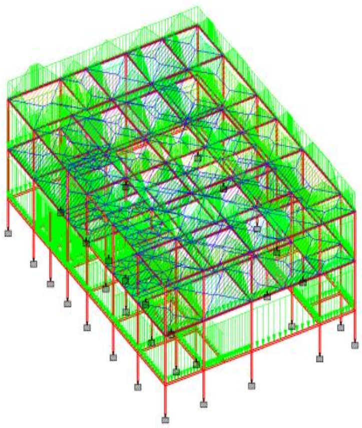

Fig. 5. Structure under Dead Load

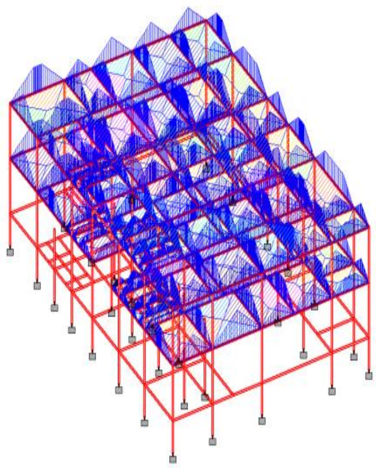

Fig. 6. Structure under Live Load

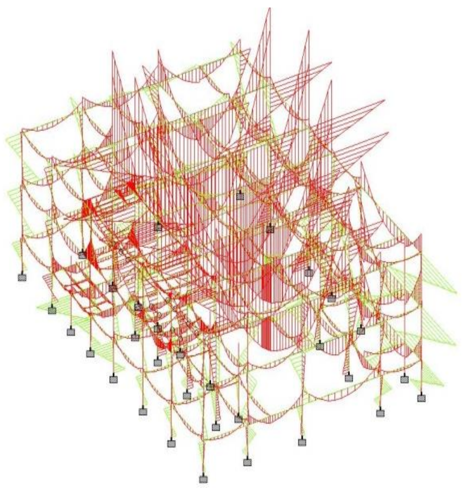

Fig. 7. Bending Moment in Z and Y Direction

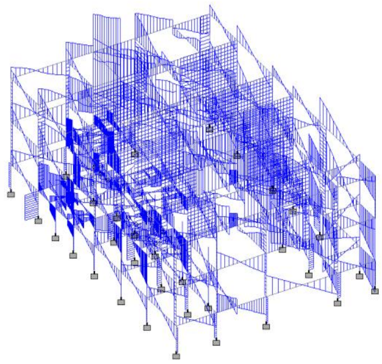

Fig. 8. Shear force Diagram

4 RESULTS

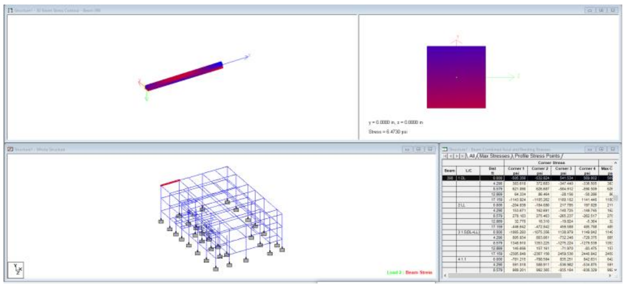

Fig. 9. Beam Stress Contour

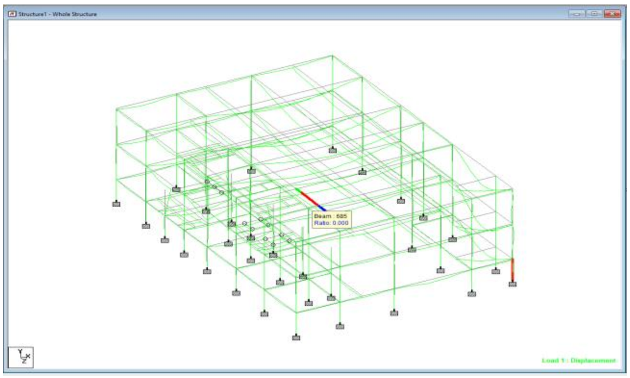

Fig. 10. Deflection in Structure

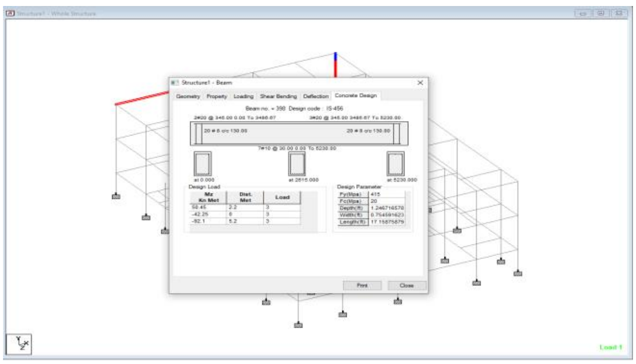

Fig. 11. Detail Design of Beam

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kip	Fy kip	Fz kip	Mx kip-in	My kip-in	Mz kip-in
Max Fx	58	3 1.5(DL+LL)	17.602	206.615	-0.472	-4.158	2.355	-662.225
Min Fx	34	3 1.5(DL+LL)	**-24.150**	354.040	-3.905	-132.361	4.033	1787.756
Max Fy	59	3 1.5(DL+LL)	6.640	**460.395**	-2.557	-62.210	18.404	-865.738
Min Fy	53	2 LL	0.199	**-0.283**	0.031	1.073	-0.470	-10.011
Max Fz	62	3 1.5(DL+LL)	0.848	286.110	**13.613**	1085.265	-4.297	-27.628
Min Fz	33	3 1.5(DL+LL)	-0.838	146.310	**-10.361**	-285.980	0.895	23.117
Max Mx	62	3 1.5(DL+LL)	0.848	286.110	13.613	**1085.265**	-4.297	-27.628
Min Mx	41	3 1.5(DL+LL)	1.289	211.615	-4.242	**-334.821**	2.695	-33.977
Max My	59	3 1.5(DL+LL)	6.640	460.395	-2.557	-62.210	**18.404**	-865.738
Min My	60	3 1.5(DL+LL)	-21.636	350.444	0.710	-0.916	**-19.455**	1644.290
Max Mz	34	3 1.5(DL+LL)	-24.150	354.040	-3.905	-132.361	4.033	**1787.756**
Min Mz	54	3 1.5(DL+LL)	12.123	452.646	1.922	-47.541	-2.521	**-1209.864**

Fig. 12. Bending Moment and Support Reaction

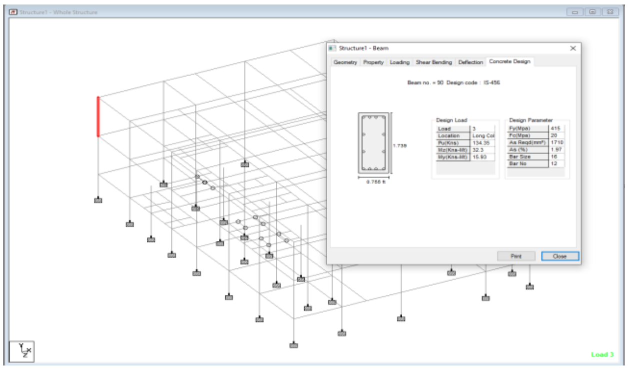

Fig. 13. Detail Design of Column

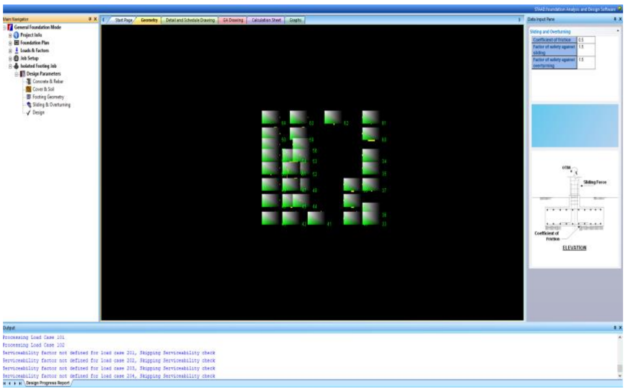

Fig. 14. Detail Design of Footing

5. CONCLUSIONS

- The project was aimed on the analysis and design of an auditorium building located at Aurangabad City in Maharashtra State.
- The construction of auditorium presents a solution of many cultural events programs being held.
- It was analysis using STADD.PRO using generic loading which proved to be premium software of great potential in analysis and design sections of construction industry.
- All the structural components were detailed by using AutoCAD 2016.
- The analysis and design were done according to standard specifications.
- Used IS-456:2000 & SP-16, for the design of the STRUCTURAL MEMBERS. i.e., followed the LIMIT STATE method.
- The various difficulties encountered in the design process and the various constraints faced by the structural engineer while meeting the requirements of architectural drawing were also well.
- Materials used are M20 grade concrete and Fe 415 steel unless mentioned in the particular design elements.
- The structure is stable under various load combinations.
- STAAD Pro gives satisfactory results when checked with manual design and it gives 15%-20% less Reinforcement.

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