PLANNING, ANALYSIS AND DESIGN OF AN AUDITORIUM BUILDING

BADHIRA E.A[1], MUHAMMED MUNDHER K.M[2], MUHSINA M[3], RAHMATH K.A[4], ANILA ANNA SAMSON[5]

[1,2,3,4]B.TECH Student, Department of Engineering, ILM College of Engineering and Technology, Kerala, India
[5]M.TECH, Assistant Professor, ILM College of Engineering and Technology, Kerala, India

---***---

Abstract – *An auditorium is a room built to enable an audience to hear and watch performances at venues such as theatres. Auditorium 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. This project includes planning, analysing and designing an auditorium. Analysis is by using STAAD.pro software. This software saves time for calculations and studying the structure. Project is primarily based on limit state concept, the structure shall be designed to resist, it must bare all loads liable to act on it at some point of its life span; it shall additionally satisfy the serviceability requirements, including limitations on deflection and cracking. The suited limit for the protection and serviceability necessities before failure happens is known as a limit state. The total project includes designing of structural members like slab, beams, columns, footings. 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 used for drawings (planning) and for drawing reinforcement details of slabs, columns, beams, footings, etc.*

***Key Words*: slab, beam, auditorium, dead load, analysis, design, detailing, shear force, bending moment, column, pile, pile cap, grade beam, stair case, Auto cad, Staad Pro.**

1.0 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. For all events, it is essential that everyone in the room hear, clearly and enjoyably, everything that is presented

In this project work we are planning, analysing and designing an auditorium building. We are using limit state method for design of various members. The analysis of the structure is to be done using STAAD Pro software. 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 horizontal load consists of wind forces, thus

building is designed for dead load, live load and wind load as per IS 875.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.

Statement of project

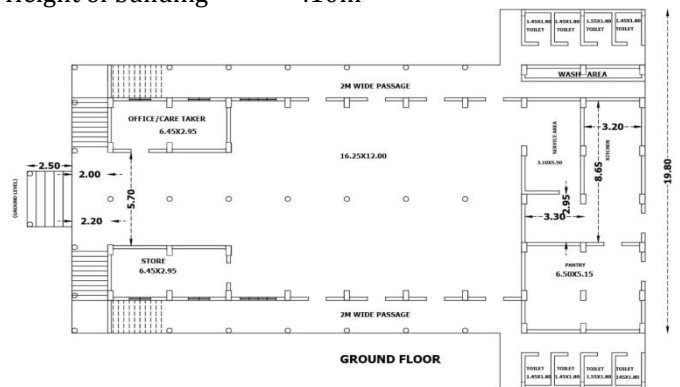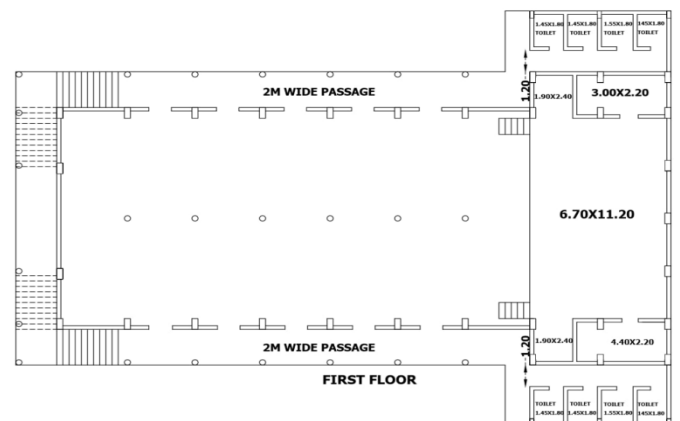|	
Utility of building	:Auditorium
No of stories	:G+1
Shape of the building	:Tee shape
No of stairs	:2
Type of construction	:R.C.C framed structure
Type of wall	:Brick wall
Concrete grade	:M30
All steel grades	:Fe415 grade
Plan area	:1100m²
Seating requirements	:400 persons
Height of building	:10m

Fig 1: Ground floor plan

Fig 2: First floor plan

2.0 OBJECTIVES OF THE PROJECT

- To plan the auditorium building as per the requirements by using software Auto CAD2013.

- To study and practice the analysis of a building using STAAD.Pro software.

- To learn design methodology of various building components.

- To design the auditorium building

- To draw the reinforcement detailing of various components.

3.0 TYPES OF LOADS

The various loads considered for analysis were:-

3.1 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).

3.2 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).

4.0 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 -1: Load factor as per IS 456-2000

LIVE LOAD	DEAD 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

4.0 SOFTWARES USED

This project is mostly based on software and it is essential to know the details about these softwares.

List of softwares used are

1. 1.STAAD Pro (V8i)

2. 2.Auto CAD(2013)

4.1 STAAD Pro(V8I)

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 dimensionly. It can make use of various forms of analysis from the traditional static analysis to more recent analysis methods like geometric non-linear analysis, Pushover analysis (Static-Non Linear Analysis) or a buckling analysis. It can also make use of various forms of dynamic analysis methods from time history analysis to response spectrum analysis.

Advantage of using STAAD Pro software:

- Faster method of designing the structure.
- Does not involve any manual calculation.
- Suitable for almost all types material for designing i.e. Concrete, Steel, Aluminium etc.
- Shows accuracy in results.
- Shows result for Number of reinforcement used longitudinally, Shear reinforcement.
- We can design structure for any type of load i.e. Dead load, Live load, wind load, snow load, area load, floor load etc.
- You can import designs from auto CAD to STAAD.

4.2 AUTO CAD 2013

AutoCAD is computer graphics application package developed in 1980 by Autodesk U.S.A. The word Auto itself derives from the corporation of Autodesk while the CAD stands for computer added drafting AutoCAD is an application package cum programming language in their advance version from 1990. As an application package it suited for the engineering purpose designing of almost of the stream of the engineering such as civil, mechanical, electrical etc.

The uses and advantages of AutoCAD:

CAD:- computer added design is basic back bone of the computer added manufacturing . Computer added manufacturing becomes more popular due to its fastest speed automatic process high accuracy least row material wastage. It includes the versions architecture and civil work like buildings, roads etc. AutoCAD provides the features almost used in the field of engineering and architecture engineering. To make a plan projection, interior all the design with the help of AutoCAD. The implementation of a plan used of templates are another advantage of the AutoCAD. Dimensioning and text support increases the efficiency decency of the drawing.

5.0 MODELLING AND ANALYSIS

The modeling analysis done in STAAD Pro.
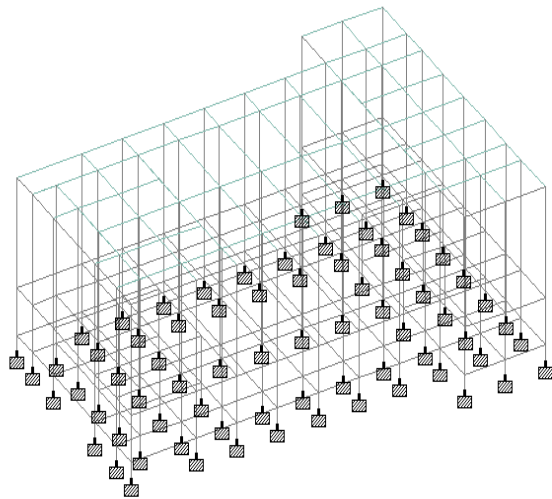
Fig 3: 3D View of the model
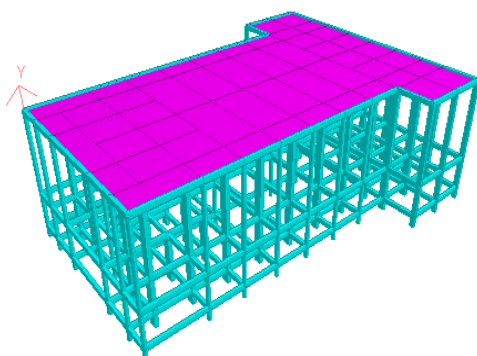
Fig 4: 3D Rendered View of the model
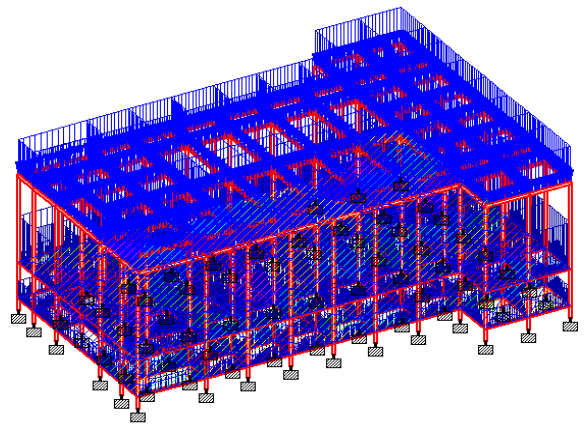
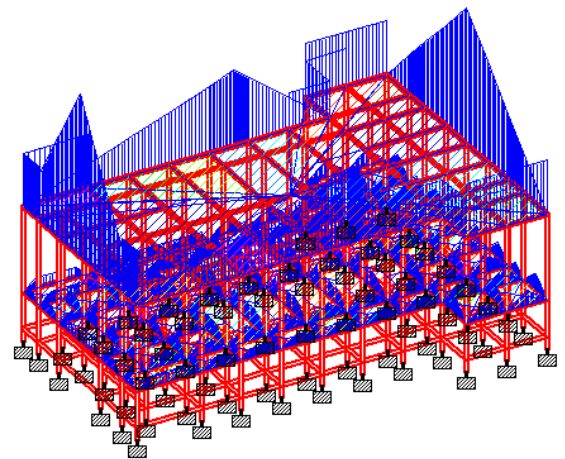Fig 5: TheStructure under Dead Load
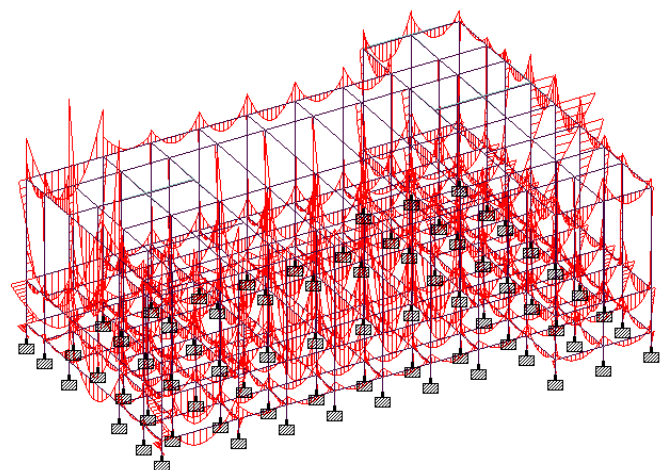

Fig 6: The Structure under Live Load
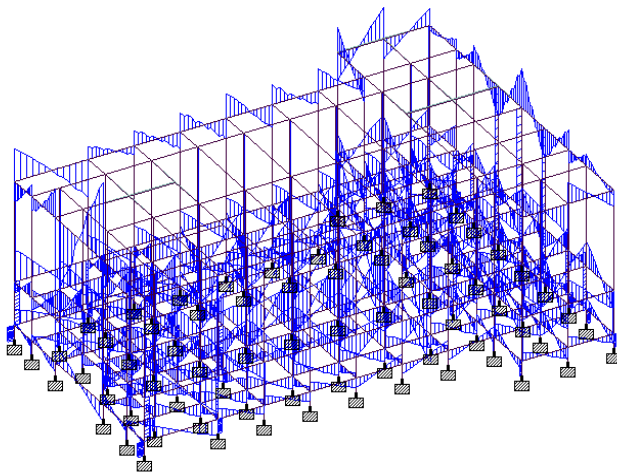

Fig 7: Bending Moment Diagram

Fig 8: Shear Force Diagram

6.0 STRUCTURAL DESIGN

The aim of structural design is to achieve an acceptable probability that the structure being designed will perform the function for which it is created and will safely withstand the influence that will act on it throughout its useful life. These influences are primarily the loads and the other forces to which it will be subjected. The effects due to temperature fluctuations, foundation settlements etc. should be also considered.

The design methods used for the design of reinforced concrete structures are working stress method, ultimate load method and limit state method. Here we have adopted the limit state method of design for slabs, beams, columns, stairs and foundations.

6.1 Design of slab

Slabs are plate elements having their depth much smaller than other two dimensions. They usually carry a uniformly distributed load from the floors and roof of the building. . Design of reinforced concrete slab was done using **IS 456:2000** and **SP 16:1980**.
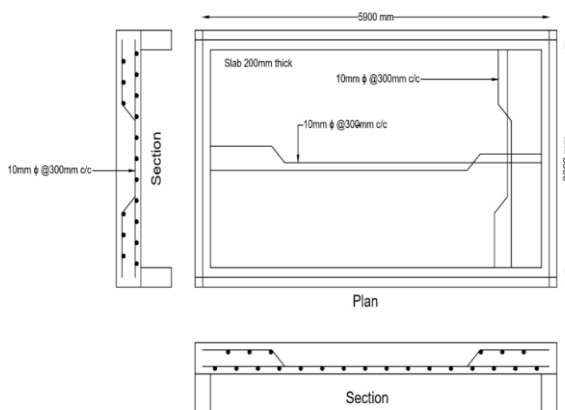

Fig 9: Detailing of slab

6.2 Design of beam

A beam is a structural member subjected to a system of external forces at right angles to the axis. Beams are usually provided for supporting slabs and walls or secondary beams. The beam in which steel reinforcement is provided in the tensile zone only is known as singly reinforced beam. In the case of doubly reinforced beam, reinforcement is provided in compression zone also to carry compressive stresses. Design of beams were done using **IS 456:2000** and **SP 16:1980**. M30 concrete and Fe 415 steel are adopted for beam design.
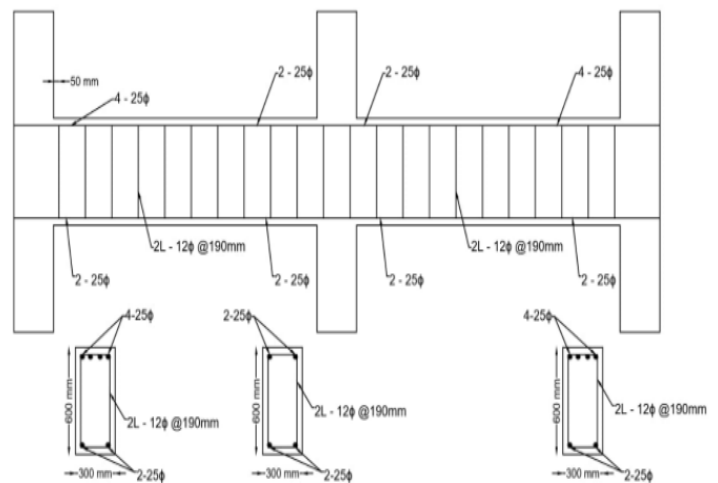

Fig 10: Detailing of beam

Ultimate moment obtained from STAAD Pro.=304.332kNm

Shear force obtained from STAAD Pro.　　= 321.668kN

6.3 Design of column

A column is an important component of RC structure. A column, in general, may be defined as a member carrying direct axial load which causes compressive stresses of such magnitude. Columns are of two types. A column may be considered as short when the slenderness ratios is less than 12, otherwise it is a long column. Design of columns were done using IS 456:2000 and SP 16:198. M30 concrete and Fe 415 steel are adopted for design. The bending moments and axial forces from analysis results are used for the design.

Rectangular column

Design of column were done using IS 456:2000 and SP 16:1980. M20 concrete and Fe415 steel are adopted.
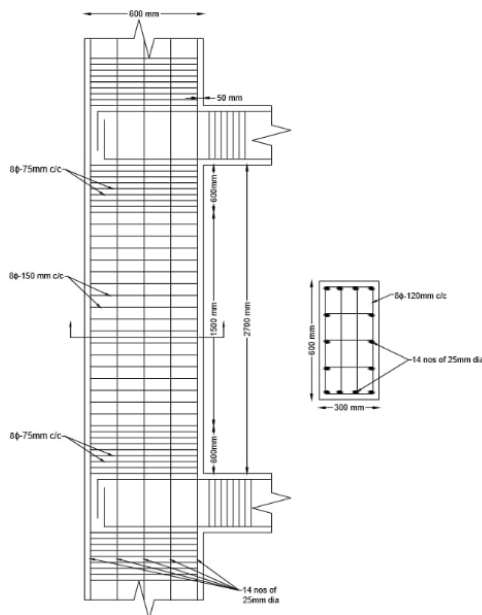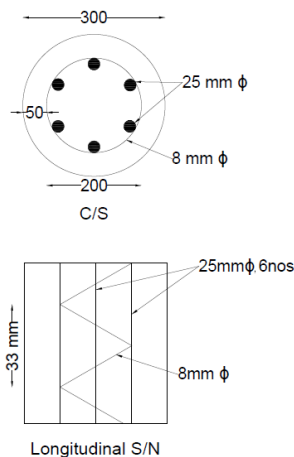
Fig 11: Detailing of rectangular column

Circular column

Fig 12: Detailing of circular column

Result from STAAD Pro.

Factorial Axial Load, p_u = 1144.332 kN

Factorial Moment in X- direction, M_{ux}= 0.007 kNm

Factorial Moment in Y- direction, M_{uy}= 0.027 kNm

6.4 Design of grade beam

Design of columns were done using **IS:2911**, **IS 456:2000**, **SP 16:198.** M30 concrete and Fe 415 steel are adopted for design.
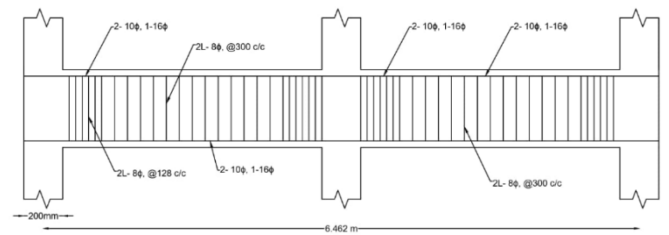

Fig 13: Detailing of grade beam

Ultimate moment obtained.=28.28 kNm

Shear force obtained   = 65.65 kN

6.5 Design of flat slab

M30 grade concrete and HYSD steel bars of grade Fe415 is used. Sixe of the panel is 5.9 ×2 m.
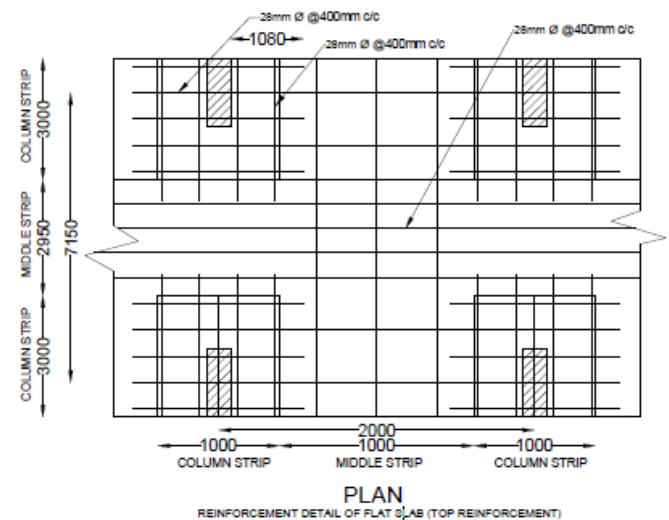

Fig 14: Detailing of flat slab

6.6 Design of stair case

The staircase is provided with as an equivalent slab. The thickness of the slab used for staircase is 200 mm. M30 grade concrete and HYSD steel bars of grade Fe415 is used.

Type of stair: quarter turn wiyh waist slab, tread and riser
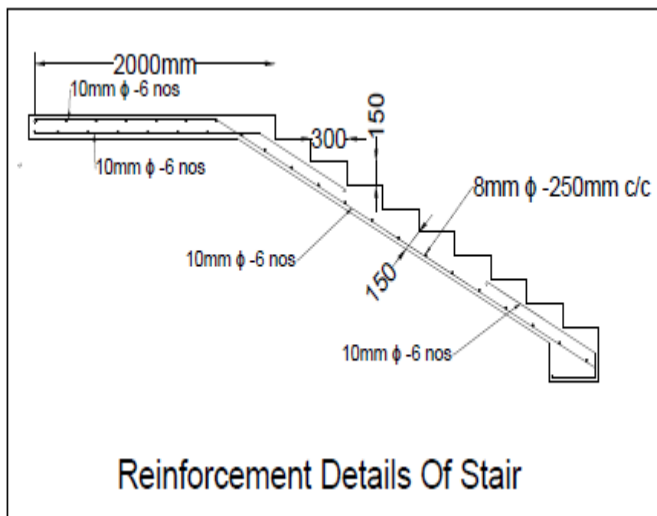
Rise = 150 mm

Tread = 300 mm

Fig 15: Detailing of stair case

6.7 Design of pile

Design of pile were done using IS 456:2000 and SP 16:1980, IS2911(part 1)-1980. M20 concrete and Fe415 steel are adopted. Circular pile with pile diameter 500 mm.

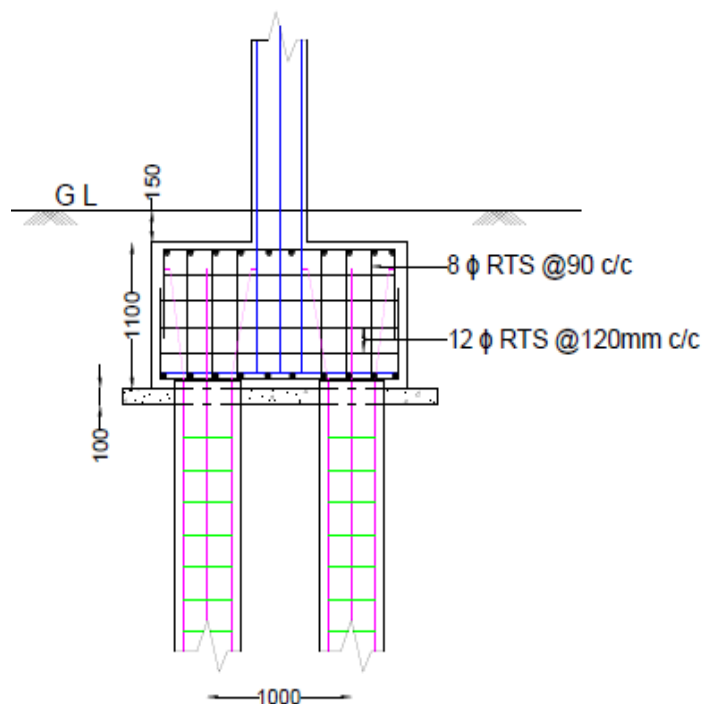M30 grade concrete and HYSD steel bars of grade Fe415 is used.

Fig 16: Detailing of pile

Breadth of the pile cap = 1800 mm
Width of the pile cap   = 800 mm
Depth of the pile cap   = 1100 mm

7.1 CONCLUSION

The project was aimed on the analysis and design of an auditorium building located at Kozhikode. This project gave an example exposure to various field practice in the analysis and design of multi storied building. The analysis was done using the software package STAAD Pro V8i, which proved to be premium software of great potential in analysis and design sections of construction industry. All the structural components were designed manually and detailed using AutoCAD 2013. The analysis and design were done according to standard specifications. 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

REFERENCES

1. **Manoj.Nallanathelet.al** (2018), Analysis & Design Of Auditorium By Using Staad Pro Software, *International Journal of Pure and Applied Mathematics*, 2855-2860.

2. **Ch. Pratyusha, et.al** 2017), Planning, Analysis And Design Of Auditorium, *International Journal For Technological Research in Engineering*,vol.4, 2719-2725.

3. **ShitalA.Navghareet.al** (2017),Analysis of RCC Framed Structure for Column with Modelling Irregularities, *International Journal of Innovative Research Science, Engineering and Technology* , vol.6, 217–224.

4. **S.Harish,et.al** (2017), "Design and Analysis of Auditorium by Using STAAD Pro",*International Journal of Innovative Research Science,Engineering and Technology* , vol.6, 14034–14050.

5. **KabiruMaishanuet.al** (2017),"Auditorium Acoustics From Past to Present", *"Int. Journal of Engineering Research and Application"* ,Vol. 7

6. **D. S. Bhoite et.al** (2017),"Design Of College Auditorium For PES College Of Engineering, Phaltan", "*International Journal of Informative & Futuristic Research*",vol 4

7. **V. Aishwaryalakshmiet.al** (2017), "Design and analysis of an institutional building", "*International e-Journal For Technology And Research*"

8. **V.Varalakshmi et.al** (2014),"Analysis and Design of G+5 Residential Building", "*IOSR Journal of Mechanical and Civil Engineering*"

9. **IS456:2000**, "Plain and Reinforced Concrete-Code of Practice" ,*Bureau of Indian Standards*.New Delhi. **SP16:1980,** "Design Aids for Reinforced Concrete to IS:456-1987" , ,*Bureau of Indian Standards*.New Delhi.

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

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

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