DESIGN AND ANALYSIS OF AUDITORIUM BY USING STAAD-PRO SOFTWARE

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ABSTRACT

This project deals with the design of a multi-purpose auditorium so as to accommodate 1000 persons. The main concept design of auditorium building vision & acoustical purpose. This includes analysis of loads and designing of structural elements based on the loads coming on them (live loads, dead loads, wind loads as per IS:875 part-1,2,3). The shape of the auditorium is linear (rectangular). Auditorium consists of assembly halls, show off halls, concert halls, auditoriums and theatres .This is so because the plan is based on acoustic and vision point of view, which are taken from NBC part-VIII, for which linear shape is best suitable . The design pattern of seating arrangements, floor height, celing ,stair case & remain parameters necessary for design of auditorium interior part by using ADA code book. The drafting of auditorium planning by using auto-cadd tool & design of rcc building by using Staad Pro software.

Key words:- Concert Halls, Acoustical, ADA(Federal Code Book),Design Of Roof Truss

1. INTRODUCTION

A covered or open enclosure where people can assemble for attending any seminar given on the stage. An Auditorium is a room built to accommodate the audience to sit and watch presentation or any stage performances. An auditorium is a large space that is the move of a multipurpose facility. A auditorium or multipurposes hall is usually a large space that is built to the needs and specifications of the entertainment.

An auditorium is a room built to enable an audience to hear and watch performances. Auditoria can be found in entertainment venues, community halls, and theaters, and may be used for rehearsal, presentation, performing arts productions, or as a space. The term is taken from Latin (from auditorium fromauditorius ("'pertaining to hearing'")); the concept is taken from the Greek auditorium, which had a series of semi-circular seating shelves in the theatre, divided by broad 'belts', called diazomata, with eleven rows of seats between each.

Auditorium, the part of a public building where an audience sits, as distinct from the stage, the area on which the performance or other object of the audience's attention is presented. In a large theatre an auditorium includes a number of floor levels frequently designed as stalls, private boxes, dress circle, balcony or upper circle, and gallery. A sloping floor allows the seats to be arranged to give a clear view of the stage. The walls and ceiling usually contain concealed light and sound equipment and air extracts or inlets and may be highly decorated.The term auditorium is also applied commonly to a large lecture room in a college, to a reception room in a monastery, and, rarely, to the audience area in a religious building. This project deals with planning phase, analysis phrase and the design phase.The purpose of structural analysis and design is to enable the designers to design the structure with adequate strength, stiffness, and stability.

Components of an Auditorium

The typical structural members of an auditorium building are the beam, column, slab, roof truss

Beam Beams are structural elements that resists loads applied laterally to their axis. They typically transfer loads imposed along their length to their end points where the loads are transferred to walls, columns, foundations, and so on.

Column A column is a vertical structural member intended to transfer a compressive load. For example, a column might transfer loads from a ceiling, floor or roof slab or from a beam, to a floor or foundations. They have good compressive strength.

Slab A slab is a structural element, made of concrete, that is used to create flat horizontal surfaces such as floors, roof decks and ceilings. A slab is generally several inches thick and supported by beams, columns, walls, or the ground. A slab of reinforced concrete that serves as a flat roof. Concrete slabs can be prefabricated off-site and lowered into place or may be poured in-situ using formwork.

Roof Truss A joint framed structure that sustained the inclined, vertical or horizontal loads. A truss consist of angles, channels, plates and eye bars. It is a framework, typically consisting of rafters, posts, and struts, supporting a roof, bridge or other structure. They are supporting the roofs of auditoriums, cinema halls, stadiums, railways, stations, airports and others.

2. LITERATURE STUDIES

A.Pavan Kumar Reddy , R.Master Praveen Kumar, et al[1] .,(2017)

From the ancient time we know earthquake is a disaster causing occasion. Up to date days constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. From this study it was concluded that the story drift increases from top story to bottom story in both zone4 and zone5 at story 31 the drift is maximum as compared to other stories. The zone5 has higher value of drift as we compared the drift values in zone4 and zone5.

Narla mohan, A.mounika vardhan, et al (2017)

When a structure is subjected to earthquake, it responds by vibrating. An earthquake force can be resolved into three mutually perpendicular directions- the two horizontal directions (x and y) and the vertical direction (z).

From this study it was concluded that the base shear of structure increases as we go to higher seismic zones. For a similar building the base shear value of ZONE II is 802.6 KN and ZONE V is 2889 KN. This means base shear increases by more than 350% if seismic ZONE changes from II to V.

3. METHODOLOGY USED

The inner powers of the building mass that emerge from the shaking of its base brought about by a seismic unsettling influence are known as earthquake stacking. The translational inertial powers are the essential focal point of earthquake-safe design. These translational inertial pressing factors greaterly affect a construction than vertical or rotational shaking parts. Land sliding, subsidence, and liquefaction of the nearby subgrade because of vibration, for instance, are largely solid earthquake powers. The recurrence of earthquakes is contrarily corresponding to their greatness. Albeit a construction might be designed to withstand the most extreme earthquake without considerable harm, the necessity for such strength all through the task's lifetime would not legitimize the high extra cost.

Two principle procedures are utilized to survey seismic stacking. These strategies consider the construction's qualities just as the district's past earthquake history. The similar parallel power measure is the main strategy. The greatest base shear is determined utilizing an essential computation of the design's crucial period and the normal most extreme ground speed increase, just as other appropriate boundaries.

The subsequent procedure is a modular analysis, which includes dissecting the construction's modular frequencies and consolidating them with earthquake design spectra to decide the greatest modular reaction.

4 SPECIFICATIONS AND MODEL

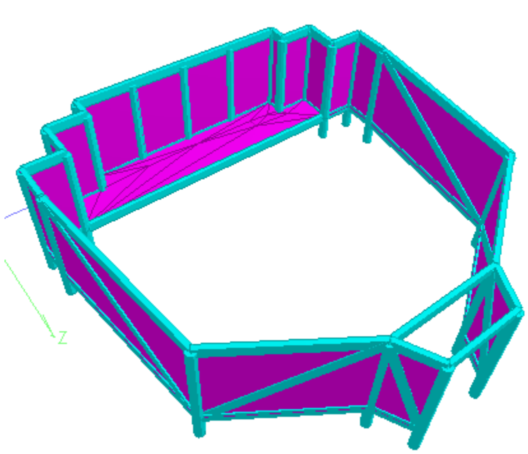
Loads acting on the structure are:

1. Dead Load (DL) and Live load (LL) : As per IS 875 (Part 1) (1987) and IS 875 (Part 2) (1987)
2. Seismic load (SL) : As per IS 1893 (Part 1) (2002) Approach
3. DL : Self weight of the structure, Floor load and Wall loads
4. LL : Live load 3.5 KN/sq.m is considered for floor weight
5. SL : Zone: V (Z=0.36)
6. Rock/ soil type : Medium Rock and Soil site factor : 1
7. Response reduction factor : 5
8. Importance factor : 1
9. Damping : 0.05%

The preliminary data as is taken up for this study

Number of floors	1 story building (G)
Plan size	18mX18m
Size of columns	500mm
Size of beams	450mmX300mm
Shear wall thickness	200mm
Total height	24m
Floor to floor height	3m
Grade of concrete and steel	M30 grade and Fe550
Support condition	Fixed supports

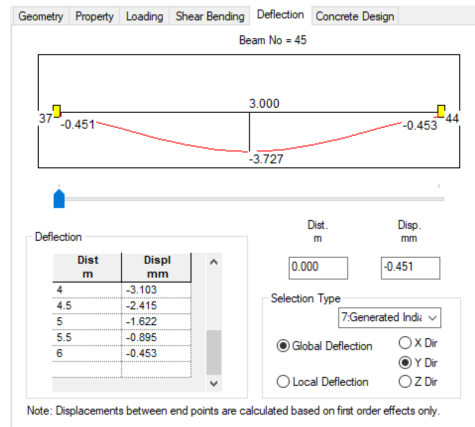
STAAD Model



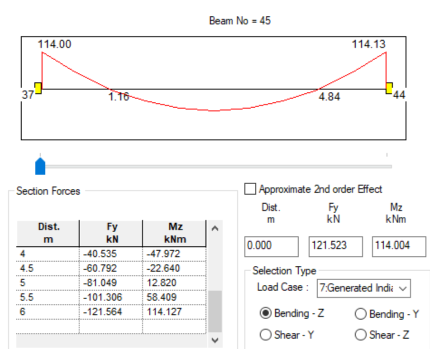
5. RESULTS AND ANALYSIS

Entrance Beams

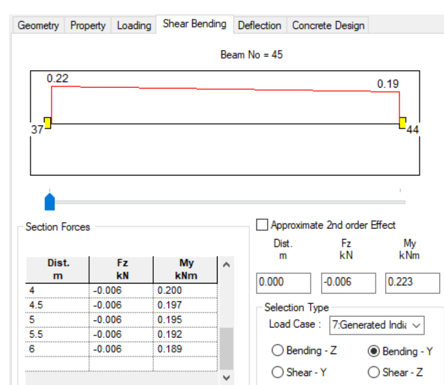
Deflection



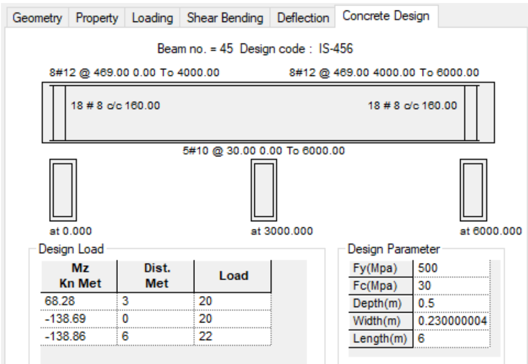
Shear in Y direction and Bending in Z direction



Shear in Z direction and Bending in Y direction



Entry Beam design



Entry Beam design output

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B E A M N O. 45 D E S I G N R E S U L T S

M30 Fe500 (Main) Fe500 (Sec.)

LENGTH: 6000.0 mm SIZE: 230.0 mm X 500.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION 0.0 mm 1500.0 mm 3000.0 mm 4500.0 mm 6000.0 mm

TOP 811.76 183.77 183.77 183.77 813.04

REINF. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)

BOTTOM 183.77 188.77 366.66 188.62 183.77

REINF. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)

STAAD SPACE --

PAGE NO. 61

SUMMARY OF PROVIDED REINF. AREA

SECTION 0.0 mm 1500.0 mm 3000.0 mm 4500.0 mm 6000.0 mm

TOP 8-12í 3-12í 3-12í 3-12í 8-12í

REINF. 2 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 2 layer(s)

BOTTOM 3-10í 3-10í 5-10í 3-10í 3-10í

REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)

SHEAR 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í

REINF. @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c

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OUTPUT FOR BAR COMBINATION

| M A I N R E I N F O R C E M E N T |

SECTION | 0.0- 1500.0 | 1500.0- 4500.0 | 4500.0- 6000.0 |

| mm | mm | mm |

TOP | 9-10í + 1-12í | 2-10í + 1-12í | 9-10í + 1-12í |

| in 2 layer(s) | in 1 layer(s) | in 2 layer(s) |

Ast Reqd| 811.76 | 183.77 | 813.04 |

Prov| 820.29 | 270.29 | 820.29 |

Ld (mm) | 543.8 | 543.8 | 453.1 |

BOTTOM | 2-12í | 2-10í + 2-12í | 2-12í |

| in 1 layer(s) | in 1 layer(s) | in 1 layer(s) |

Ast Reqd| 188.77 | 366.66 | 188.62 |

Prov| 226.29 | 383.43 | 226.29 |

Ld (mm) | 543.8 | 543.8 | 453.1 |

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 708.9 mm AWAY FROM START SUPPORT
VY = 100.79 MX = -1.28 LD= 20
Provide 2 Legged 8í @ 160 mm c/c
SHEAR DESIGN RESULTS AT 708.9 mm AWAY FROM END SUPPORT
VY = -100.83 MX = 1.29 LD= 22
Provide 2 Legged 8í @ 160 mm c/c

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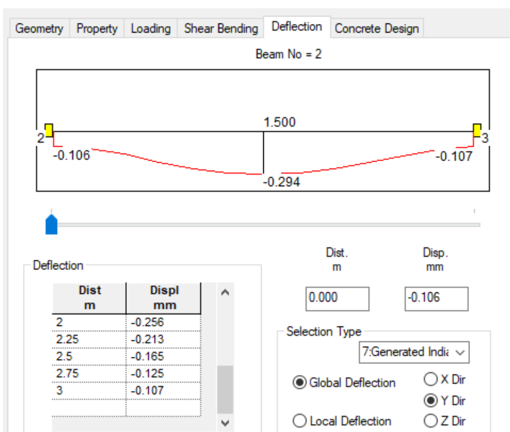
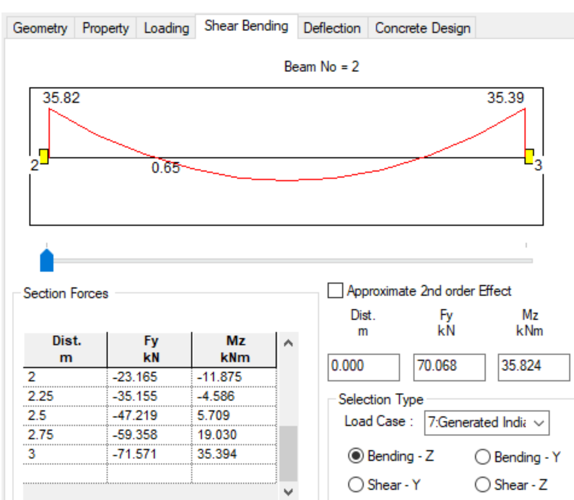
Staging beam design

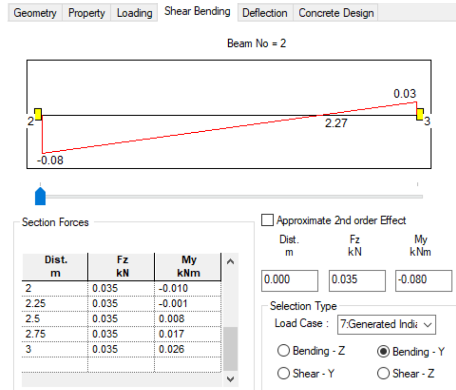
Deflection



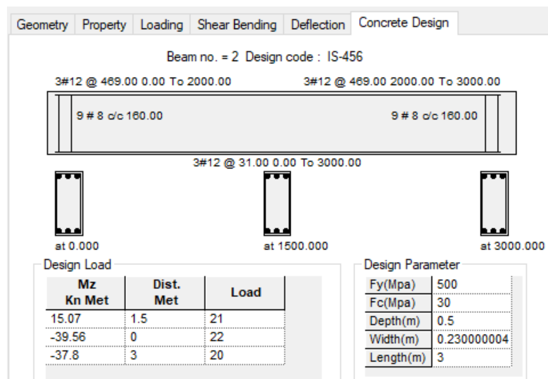
Shear in Y direction and Bending in Z direction



Shear in Z direction and Bending in Y direction



Staging beam design



Staging output for beams

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B E A M N O. 2 D E S I G N R E S U L T S
M30 Fe500 (Main) Fe500 (Sec.)
LENGTH: 3000.0 mm SIZE: 230.0 mm X 500.0 mm COVER: 25.0 mm
STAAD SPACE --
PAGE NO. 9
SUMMARY OF REINF. AREA (Sq.mm)

SECTION 0.0 mm 750.0 mm 1500.0 mm 2250.0 mm 3000.0 mm

TOP 200.28 183.38 0.00 183.38 191.22
REINF. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)

BOTTOM 183.38 183.38 183.38 183.38 0.00

REINF. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION 0.0 mm 750.0 mm 1500.0 mm 2250.0 mm 3000.0 mm

TOP 3-12í 3-12í 2-12í 3-12í 3-12í

REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)

BOTTOM 3-12í 3-12í 3-12í 3-12í 2-12í

REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)

SHEAR 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í

REINF. @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c @ 160 mm c/c

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OUTPUT FOR BAR COMBINATION

| M A I N R E I N F O R C E M E N T |

SECTION | 0.0- 750.0 | 750.0- 2250.0 | 2250.0- 3000.0 |

| mm | mm | mm |

TOP | 1-10í + 2-12í | 2-12í | 1-10í + 2-12í |

| in 1 layer(s) | in 1 layer(s) | in 1 layer(s) |

Ast Reqd| 200.28 | 183.38 | 191.22 |

Prov| 304.86 | 226.29 | 304.86 |

Ld (mm) | 543.8 | 543.8 | 0.0 |

BOTTOM | 2-12í | 2-12í | 2-12í |

| in 1 layer(s) | in 1 layer(s) | in 1 layer(s) |

Ast Reqd| 183.38 | 183.38 | 183.38 |

Prov| 226.29 | 226.29 | 226.29 |

Ld (mm) | 543.8 | 543.8 | 0.0 |

STAAD SPACE -- PAGE NO. 10

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 719.0 mm AWAY FROM START SUPPORT

VY = 32.49 MX = 2.18 LD= 23

Provide 2 Legged 8í @ 160 mm c/c

SHEAR DESIGN RESULTS AT 719.0 mm AWAY FROM END SUPPORT

VY = -31.52 MX = -2.21 LD= 21

Provide 2 Legged 8í @ 160 mm c/c

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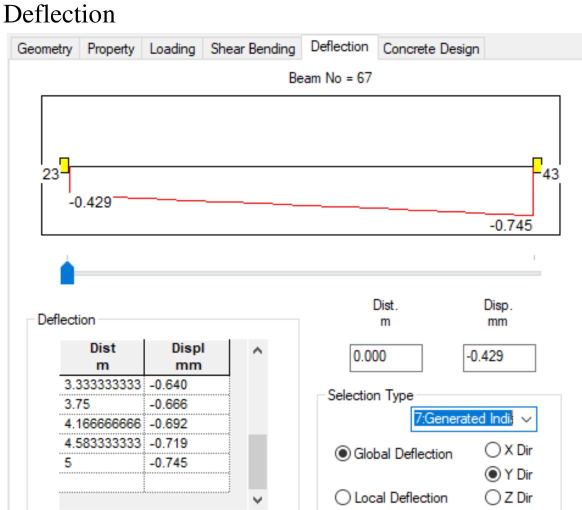
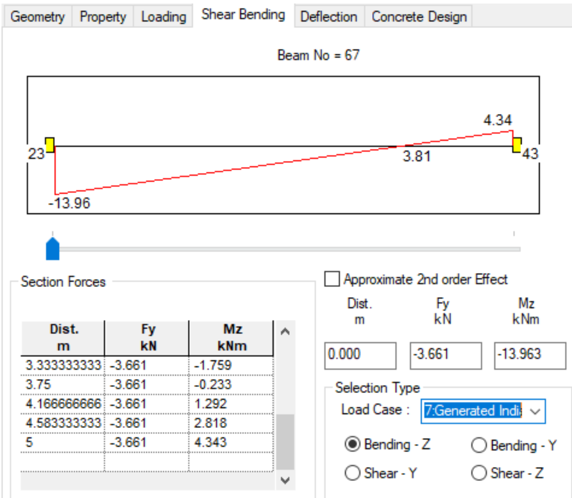
Column design

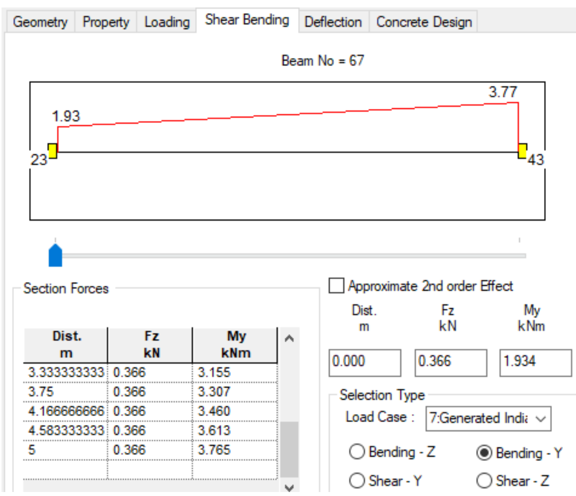
Deflection



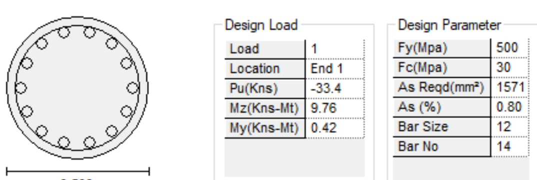
Shear in Y direction and Bending in Z direction



Shear in Z direction and Bending in Y direction



Column design



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COLUMN NO. 49 DESIGN RESULTS

M30 Fe500 (Main) Fe500 (Sec.)

LENGTH: 5000.0 mm CROSS SECTION: 500.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 1 TENSION COLUMN

REQD. STEEL AREA : 1570.80 Sq.mm.

REQD. CONCRETE AREA: 194778.75 Sq.mm.

MAIN REINFORCEMENT : Provide 14 - 12 dia. (0.81%, 1583.36 Sq.mm.) (Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 3218.56 Muz1 : 123.74 Muy1 : 123.74

INTERACTION RATIO: 0.04 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE: 20

END JOINT: 1 Puz : 3223.10 Muz : 144.55 Muy : 144.87 IR: 0.10

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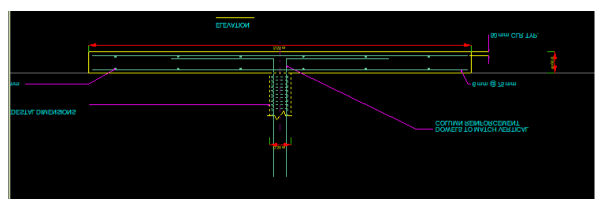
FOUNDATION DESIGN



6. CONCLUSIONS

The project is about "Designing and Planning of Auditorium". 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.

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