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ANALYSIS AND DESIGN OF MULTISTORIED (G+10) RESIDENTIAL BUILDING BY USING STAAD.PRO

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1. ABSTRACT

Saving time is very important for structural engineers to compete in a constantly evolving competent market. An attempt has been made to analyze and design a high-rise building using the STAAD Pro software package as a sequel.

To analyze a multi-storey building one should consider all the possible loading and see that the structure is safe against all possible loading conditions. There are many methods for analysis of different frames like ear method, cantilever method, portal method, matrix method.

The current project deals with the analysis of G + 10 multi-storey residential buildings. Dead loads and live loads are applied and the design for beams, columns, footings is obtained STAAD Pro and its new features surpass its predecessors and compositors along with other major software like AutoCAD and MS Excel with its data sharing capabilities.

We conclude that the STAAD Pro is a very powerful tool that can save a lot of time and is very accurate in design. It is thus concluded that the STAAD Pro package is suitable for the design of high-rise buildings.

2. INTRODUCTION

Building construction is an engineering deal with the construction of a building, such as a residential building. A simple building can be defined as a space enclosed by a roof, food, clothing, and walls with basic human needs. In ancient times humans lived in caves, under trees or under trees, to protect themselves from wild animals, rain, sun, etc. As time went on humans started living in huts made of wooden twigs. Those old shelters have now evolved into beautiful houses. Wealthy people live in state-of-the-art condition houses.

The buildings are an important indicator of the county's social progress. Every human being wants to have comfortable homes. Security understanding of liability. These are just some of the reasons why a person works so hard and earns a living.

The design is built using software on structural analysis design (staad-pro). The building is subject to both vertical loads as well as horizontal loads. Vertical loads include structural elements such as beams, columns, slabs, etc. and dead loads of live loads. The horizontal load consists of wind forces thus the building is designed for dead load, live load and wind load as per IS 875. The building is designed as a two-dimensional vertical frame and is analyzed by trial for maximum and minimum bending moments and shear force. Error methods according to IS456-2000. The help is taken through the software available in the organization and the load, moments and shear force are calculated and obtained from this software.

3. A BRIEF DESCRIPTION OF SOFTWARE USED

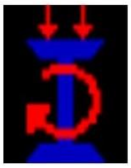
This project is mostly based on software and it is essential to know the details about these software's.

List of software's used

1. Staad pro (v8i)

2. Staad foundations 5(v8i)

3. Auto cad

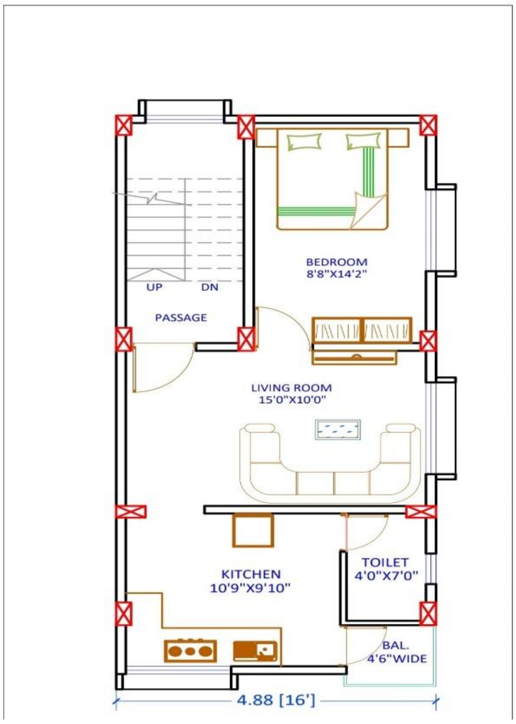


Fig[1]-Staad.p Fig[2]-Staad found. Fig[3]-Auto Cad

3.1 STAAD.PRO STAAD.PRO is a user-friendly software which is used for analysing and designing of structure by the structural engineers. STAAD Pro provides a lot of precise and correct results than manual techniques. It's the foremost computer code for 3D model generation and multimaterial design. The software is fully compatible with all windows operating system but is optimized for windows XP. STAAD.PRO software is used for static or dynamic analysis for structures such as bridges, low rise or high-rise buildings, stadiums, steel structures, etc. First step in STAAD.PRO is to specify the geometry of the structure and then the properties of the members are mentioned. Then the supports are generated and loadings are specified on the structure. Finally, the structure is analysed.

3.2 Auto CAD Auto Cad is a designing and drafting software which is used for developing 2-dimensional and 3-dimensional structures, developed and sold by Autodesk, Inc. It is a vector graphics drawing programme. It uses primitive entities- comparable to lines, polylines, circles, arcs and text as the foundation for the complex. Auto CAD's native file format, DWG, and to a lesser extent, its interchange file format, DXFhas become the drawing and detailing works were done by creating use of auto cad 2022.

4. LAYOUT PLAN OF FLOORS



Fig[4]-Layout Plan For Each floor

5. LITERATURE REVIEW

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project STAAD.Pro software is used for analysing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.

Amar Hugar et al., (2016) has been discussed that the Computer Aided Design of Residential Buildinginvolves scrutiny of building using STAAD.Pro and a physical design of the structure. Traditional way of study shows tedious calculations and such tests is a timeconsuming task. Analysis are made quickly by using software's.This project completely deals with scrutiny of the building using the software STAAD.Pro. Finally, the results are compared with physical calculations. The elements are created as per IS:456-2000. Bandipati Anup et al., (2016) this paper deals with evaluate and plan a multi-storeyed building [G + 2 (3-dimensional frame)] adopting STAAD Pro. The technique used in STAAD.Pro is limit state technique. Initially they have created 2-D frames and cross checked with physical calculations. The exact result should be proved. We tested and created a G + 2 storey building [2-D Frame] instantly for all feasible load combinations. The work has been finished with some more multi-storeyed 2-Dimensional and 3-Dimensional frames beneath various load combinations.

Aman et al., (2016) has discussed that the point of the structural engineer is to model a guarded structure. Then the structure is subjected to various types of loading. Mostly the loads put in on the building are considered as static. Finite part analysis that exhibit the result of dynamic load like wind result, earthquake result, etc. The work is conducted using STAAD.Pro software.

Madhurivassavai et al., (2016) he says that the most common problem country facing is the growing population. Because of the less availability of land, multi-storey building can be constructed to serve many people in limited area. Efficient modelling is performed using STAAD.Pro and AutoCAD. Manual International Journal of Pure and Applied Mathematics Special Issue 2798 calculations for more than four floor buildings are tedious and time consuming. STAAD.Pro provides us a quick, efficient and correct platform for analysing and coming up with structures.

Borugadda Raju et al., (2015) has been designed and analysed G+30 multi-storey building adopting STAAD.Pro in limit state methodology. STAAD.Pro contains an easy interface that permits the users to produce the mount and the load values and dimensions are inputted. The members are designed with reinforcement details for RCC frames. The analysis is completed for two dimensional frames and then it is done for more multi-storeyed 2-D and 3-D frames under various load combinations.

Anoop. A, (2016) has explained that the scope of the project is to provide a multi storied building of G+ 5 floors. Revit 2011 and Auto CAD 2014 software is used for developing 3-D models. The structure analysis and design are done using STAAD.Pro. The results are checked for selected members using limit state method of design as per IS 456-2000.

Nasreen. M. Khan (2016) has mentioned that logical data is incredibly necessary and essential talent required by each and every engineer. The project encompasses a shear wall round the elevator pit. During this project the structure is meant and tested with the help of STAAD.Pro and the scheming was done physically. Layout of beam, column, slab, shear wall, stair case, shear wall, tank and an isolated footing are done. Finally, the detailing was done using AutoCAD.

S. Mahesh and Dr. B. Panduranga Rao (2014)

G + 7 is considered a multi-story behaviorConstruct regular and irregular configurationsUnder the earthquake. G + 7 multi-story privateThe building is inspected for seismic tremors and winds Stack using STAAD. Assuming Pro V8i .mPhysical properties and static and dynamicThe exam is done. This is the investigationIs done by thinking about different seismic zones andConduct surveys are conducted for each zoneThree different types of soil are definitely hard , Medium and soft, Kevadkar, Kodag etc. (2013) saw that theSensitive to overwhelming structure parallelPower can be concerned for heavy losses. In thisThey saw that the gravity stack (dead load,Live load) edges can last up to horizontalStacks due to load (vibration, wind, impact, fire)Risks and so much more.) Which can increase high anxiety. For this reason they used shear dividers and steel. The framework for such protests stacking like seismic vibration, wind, impact etc. This has been suggested by the creator in the investigation R.C.C. The building is being demonstrated and inspected As far as STAAD.Pro and results are thought Lateral Displacement, Story Shear and Story Drifts, Base Shear and Demand Capacity (performance).

6. TYPES OF LOADS USED

The loads which are considered for analysis are,

1. Dead Load

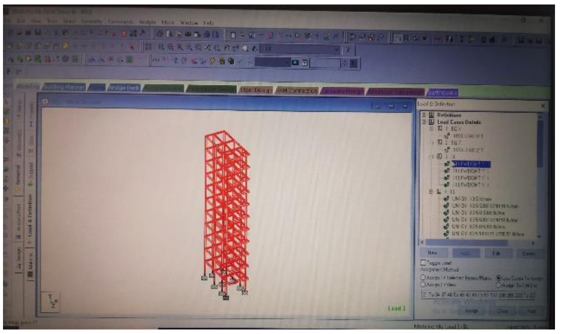
2. Live Load

3. Earthquake Load

4. Wind load

6.1 Dead Load

All permanent loads in the building are considered as dead loads. The dead loads comprise of self-weight of the building, weight of wall, weight of slab, floor finish and permanent materials placed on the building. Dead loads are specified in IS 875 (Part 1).



Fig[5]- Dead Load

6.1.1 SELF WEIGHT

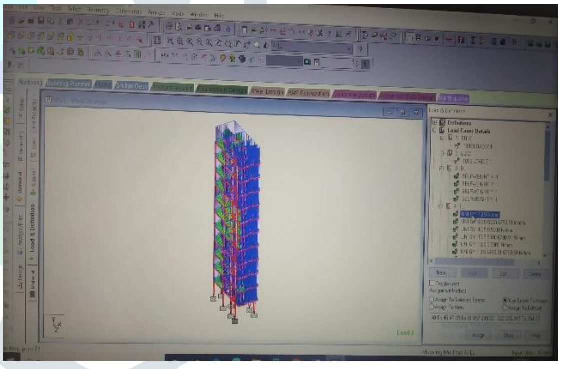
In load case we have option called self- weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure.

6.1.3 INTERNAL WALL LOAD (PARTITION WALL)

Internal wall load = 13.9/2(thickness of partition wall half of the outer wall) Internal wall load = 6.9 kN/m

6.2 Live Loads:

We are taken in live load is floor load Floor load = Thickness X density Floor load = 0.15X25 Floor load = 0.0039N/mm

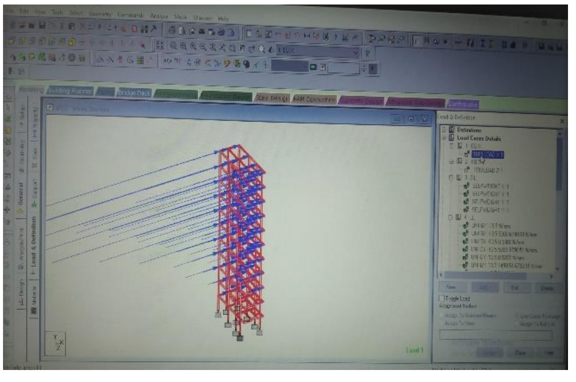


Fig[6]-Live Load

6.3 Earthquake load

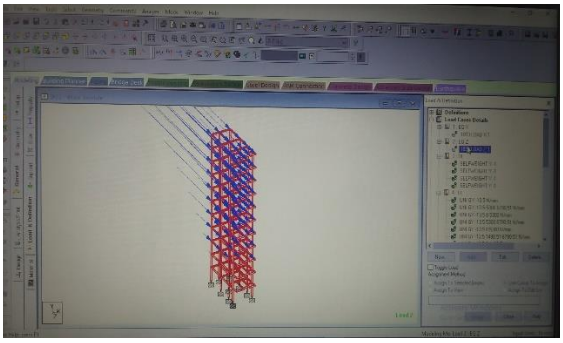
We are taken earthquake load as per IS code 1893-2000

6.3.1 Earthquake load in x-direction



Fig[7]- Earthquake load

6.3.2 Earthquake Load in z-direction

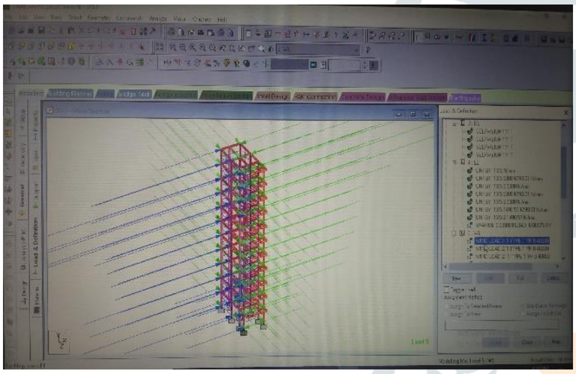


Fig[8]-Earthquake Load

6.4 Wind Load

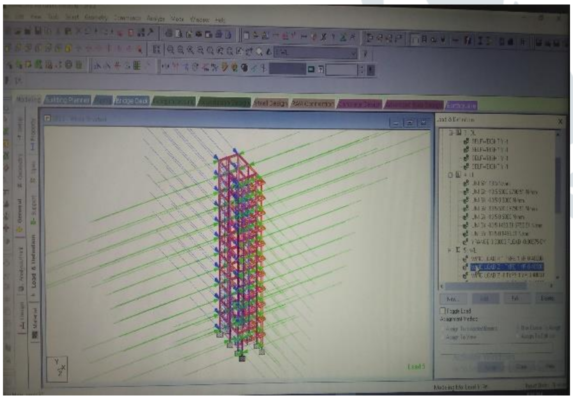
We are taken wind load load as per IS code 1893-2000

6.4.1 Wind Load in x-direction



Fig[9]-Wind load

6.4.2 Wind Load in z-direction



Fig[10]-Wind Load

7. LOAD COMBINATIONS

The different combinations used in the project are

1.5(D.L+L.L.)

1.2(D.L+L.L)

1.2(D.L+L.L+EQX)

1.2(D.L+L.L+EQZ)

1.2(D.L+L.L)-1.2EQX

1.2(D.L+L.L)-1.2EQZ

1.5D.L

1.5(D.L+EQX)

1.5(D.L+EQZ)

1.5D.L-1.5EQX

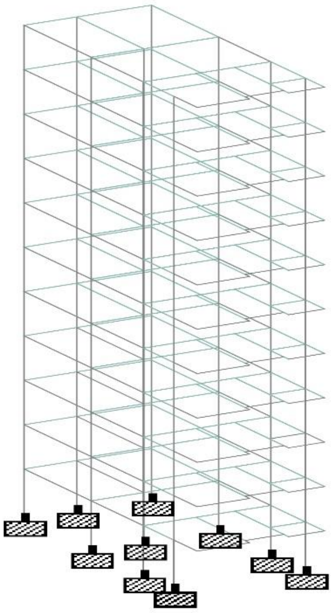
1.5D.L-1.5EQZ

0.9D.L+1.5EQX

0.9D.L+1.5EQZ

0.9D.L-1.5EQX

0.9D.L-1.5EQZ



Fig[11] 3-D view of the model

8. STRUCTURE DESIGN

8.1 Beam design (Beam no.355)

```
===========================================================================
              B E A M   N O.     355   D E S I G N   R E S U L T S

      M30                   Fe415 (Main)              Fe415 (Sec.)

    LENGTH:  5300.0 mm      SIZE:   250.0 mm X  250.0 mm   COVER: 25.0 mm

                     SUMMARY OF REINF. AREA (Sq.mm)
 ---------------------------------------------------------------------------
 SECTION      0.0 mm     1325.0 mm     2650.0 mm     3975.0 mm     5300.0 mm
 ---------------------------------------------------------------------------
  TOP         858.93       117.59        112.65        200.67       1120.41
 REINF.      (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)

 BOTTOM       280.90       181.22        351.03        167.01        391.37
 REINF.      (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)      (Sq. mm)
 ---------------------------------------------------------------------------


                     SUMMARY OF PROVIDED REINF. AREA
 ---------------------------------------------------------------------------
 SECTION      0.0 mm     1325.0 mm     2650.0 mm     3975.0 mm     5300.0 mm
 ---------------------------------------------------------------------------
  TOP        8-12i        2-12i         2-12i         2-12i        10-12i
 REINF.   2 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    2 layer(s)

 BOTTOM      4-10i        3-10i         5-10i         3-10i         5-10i
 REINF.   1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)

 SHEAR   2 legged  8i  2 legged  8i  2 legged  8i  2 legged  8i  2 legged  8i
 REINF.  @ 100 mm c/c  @ 100 mm c/c  @ 100 mm c/c  @ 100 mm c/c  @ 100 mm c/c
 ---------------------------------------------------------------------------

:\SP2.anl

                                                                         Thu
  STAAD SPACE                                              -- PAGE NO.  120


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

 SHEAR DESIGN RESULTS AT   437.2 mm AWAY FROM START SUPPORT
   VY =     36.61 MX =      4.28 LD=     9
   Provide 2 Legged  8i  @ 100 mm c/c

 SHEAR DESIGN RESULTS AT   433.2 mm AWAY FROM END SUPPORT
   VY =     50.52 MX =      4.28 LD=     9
   Provide 2 Legged  8i  @ 100 mm c/c

===========================================================================
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8.2 Column Design (Column no. 376)

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============================================================================

         C O L U M N   N O.   376  D E S I G N   R E S U L T S

      M30                    Fe415 (Main)                Fe415 (Sec.)

LENGTH:  3000.0 mm   CROSS SECTION:  450.0 mm X  230.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:   19  BRACED LONG(Z)  /SHORT(Y)


REQD. STEEL AREA   :     1899.49 Sq.mm.
REQD. CONCRETE AREA:   101600.52 Sq.mm.
MAIN REINFORCEMENT : Provide  12 - 16 dia. (2.33%,   2412.74 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 230 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   1962.82   Muz1 :     62.61   Muy1 :    145.52

INTERACTION RATIO: 1.00 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:    19
Puz :   2115.64   Muz :     71.09   Muy :    171.32   IR: 1.04
============================================================================
```
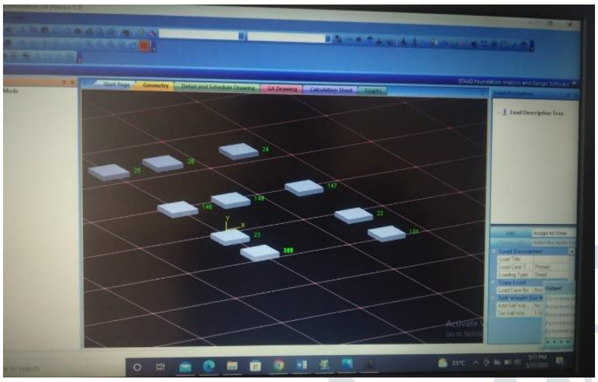

9. FOOTING CALCULATIONS

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
22	1	3.550 m	3.550 m	0.306 m
23	2	9.050 m	9.050 m	0.307 m
24	3	5.900 m	5.900 m	0.306 m
25	4	6.750 m	6.750 m	0.306 m
28	5	6.400 m	6.400 m	0.306 m
139	6	0.000 m	0.000 m	0.000 m
146	7	7.900 m	7.900 m	0.357 m
147	8	3.500 m	3.500 m	0.406 m
148	9	2.700 m	2.700 m	0.306 m
151	10	3.650 m	3.650 m	0.407 m
339	11	0.000 m	0.000 m	0.000 m
341	12	0.000 m	0.000 m	0.000 m
343	13	0.000 m	0.000 m	0.000 m
345	14	0.000 m	0.000 m	0.000 m
347	15	0.000 m	0.000 m	0.000 m
349	16	0.000 m	0.000 m	0.000 m
351	17	0.000 m	0.000 m	0.000 m
353	18	0.000 m	0.000 m	0.000 m
355	19	0.000 m	0.000 m	0.000 m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
22	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
23	Ø10 @ 70 mm c/c	Ø10 @ 70 mm c/c	Ø6 @ 75 mm c/c	Ø8 @ 50 mm c/c	N/A	N/A
24	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
25	Ø8 @ 55 mm c/c	Ø8 @ 55 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 55 mm c/c	N/A	N/A
28	Ø8 @ 75 mm c/c	Ø8 @ 80 mm c/c	Ø6 @ 65 mm c/c	Ø6 @ 60 mm c/c	N/A	N/A
139	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
146	Ø10 @ 70 mm c/c	Ø10 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø8 @ 70 mm c/c	N/A	N/A
147	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
148	Ø8 @ 70 mm c/c	Ø8 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A

151	Ø10 @ 75 mm c/c	Ø8 @ 50 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
339	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
341	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
343	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
345	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
347	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
349	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
351	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
353	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
355	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	N/A	N/A
357	Ø10 @ 70 mm c/c	Ø8 @ 50 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A



Fig[12]-Foundation Layout

10. CONCLUSION

Planning, analysis and design of G+10 multi-storey residential building was done. It's a G+10 storied building with parking in the basement and the rest of the floors are occupied with apartments. All the structural components were designed in detailed using AutoCAD. The analysis and design were done according to standard 8 specifications using STAAD.PRO. The dimensions of structural members are specified and the loads such as dead load, live load, floor load and earthquake load are applied. Deflection and shear tests are checked for beams, columns and slabs. The tests proved to be safe. Theoretical work has been done. Hence, I conclude that we can gain more knowledge in software in civil engineering basically STAAD.PRO.

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