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Analysis And Design Of G+10 Apartment Building By Using STADPRO

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ABSTRACT

India is a developing country; huge construction projects are yet to come as undeveloped cities are needed to develop since so many years. In current century, many projects all over the world are going on, time delay takes place which in turn affects the growth of the construction of huge projects. The enormous increase in population and scarcity of land makes the people to move from rural areas to urban areas and construction of multi-storied buildings in small areas is being common now-a-days. To avoid time delay and thereby the growth, economic construction methodology should be adopted. Functional designing of the building has become very important and the requirements vary from one building to another. In order to compete in the ever growing competent market it is very important for a Structural Engineer to save time. The main objective of this project is to analyze and design a mutli-storied Apartment building G+10 by using STAAD Pro. First of all, the planning is done and then the Vertical loads and horizontal loads are applied and the design for beams, columns, footing is obtained by STAAD PRO. We conclude that STAAD PRO is a very powerful tool which can save much time and is very accurate in Designs. This project consists of Apartments in G+10 floors with all basic amenities. The code refers for this project are NBC, IS 456-2000. For analyzing the structure, the loads are very important which are calculated by using IS 875. The LIMIT STATE METHOD of design has been adopted in this project.

INTRODUCTION

Structural design is an art and science of designing, with economy and elegance, a safe, serviceable, and a durable structure. The entire process of structural planning and design requires not only imagination and conceptual thinking (which form art of designing) but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and bye-laws, backed up by ample experience, institution and judgment. Here comes the role of civil engineering and more precisely the role of analysis of Structure.
Nowadays the house building is major work of the social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements of the community engineers and architects do the design work, planning and layout, etc, of the buildings. Draughtsman are responsible for doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know This job and should be able to follow the instruction of the engineer and should be able to draw the required drawing of the building, site plans and layout plans etc, as for the requirements.

A building frame consists of number of bays and storey. A multi-storey, multi-paneled frame is a complicated statically intermediate structure. A design of Apartment building of G+10 storey frame work is taken up. The building in plan (15m x 12m) consists of columns built monolithically forming a network.

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The design is made using software on structural analysis design (staad-pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams, columns, slabs etc and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as **per IS 875**. The building is designed as two-dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per **IS 456-2000**. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software.

STATEMENT OF PROJECT:
Salient features:

Utility of building :	APARTMENT BUILDING
No of stories :	G+10
No. of flats:	40
Type of construction :	R.C.C framed structure
Types of walls :	Brick wall
Beam Size	230x300mm
Column Size	300x300mm
Slab thickness	120 mm

Geometric details:

Ground floor:	3m
Floor to floor height:	3m.

Materials:

Concrete grade:	M30
All steel grades:	Fe500 grade

DESIGN OF MULTI STORIED APARTMENT BUILDING:
General:

A structure can be defined as a body which can resist the applied loads without appreciable deformations.

Civil engineering structures are created to serve some specific functions like human habitation ,transportation, bridges ,storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements),beam element ,column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and thee construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system.

The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

- The objective of the design is
- Foundation design
- Column design

- Beam design
- Slab design

Literature Review

- Annop .A, Hussian F, Neeraja R, Chandran Rahul , S Shabina and S Varsha :-Design a multistoried building of G+5 floors, at kalakode,Kerala ,India.the design is done by taking into account standards recommended by IS code , Kerala building and national building rules. And also includes requirements for sesmic and wind load.
- Ibrahim, et al (April 2019): Design and Analysis of Residential Building(G+4):

After analyzing the G+4 storey residential building structure, conducted that the structure is rate in loading like dead load, live load, wind load and seismic loads. Member dimensions are assigned by calculating the load type and its quantity applied on it. Auto CAD gives detailed information at the structural members length, height, depth, size and numbers etc. STAAD.PRO has a capability to calculate the program contains number of parameters which are designed as per IS:456-2000. Beams were designed for flexure, shear and tension and it gives the detail number, position and spacing brief.

- Aman, Nalwadgi M, Vishal T and Gajendra :-Analysis and Design of multi-storey building at Gulbarga city , Karnataka ,India. The study includes design of colums , beams , footings and slabs by well known civil engineeringsoftware named as STAAD-PRO.
- Devi Krishna Chaitanya, et al (January 2017): Analysis and Design of a (G+6) Multi storey Building using STAAD.PRO:
-

They used static Indeterminacy methods to calculate numbers of unknown forces. Distributing known fixed end moments, the condition of compatibility by iteration method, Kani's method was used to distribute moments at successor joints in frame and continues beam for stability of members of building structure. They used to design software STAAD.PRO which reduced a lot of time in design, gives accuracy.

METHODOLOGY

METHODS OF DESIGN OF REINFORCED CONCRETE:

The aim of design is to decide the size of the member and amount of reinforcement required, so that the structure will perform satisfactorily during its life period with minimum cost. The following three methods have been developed for the design of reinforced concrete structures.

a) Working stress method
b) Ultimate load method
c) Limit state method

1.WORKING STRESS METHOD:

Working stress method is based on elastic theory assuming reinforced concrete as elastic material. The stress strain curve of concrete is assumed as linear from zero at the neutral axis to a maximum value at the extreme fiber.

This method adopts permissible stresses which are obtained by dividing ultimate stress by a factor known as factor of safety. For concrete a factor of safety of 3.0 is used and for steel it is 1.78. This factor of safety accounts for any uncertainties in estimation of working loads and variation in material properties. In working stress method, the structural members are designed for working loads such that the stresses developed are within the allowable stresses. Hence, the failure criterion is the stress. This method is simple and reasonably reliable.

The drawbacks of this method are

a) Stress strain curve for concrete is assumed as linear, which is not true.
b) Factor of safety doesn't predict the true margin of safety.

c) The failure criteria assumed is stress but strain criteria is the reliable.
d) The effect of creep and shrinkage of concrete is ignored.
e) This method gives uneconomical sections.

This method has been deleted in IS: 456-2000, but the concept of this method is retained for checking the serviceability states of deflections and cracking. Hence, the knowledge of this method is essential and IS: 456-2000 gives it in the appendix.

2.ULTIMATE LOAD METHOD:

In ultimate load method, structural elements are designed for ultimate loads which are obtained by multiplying the working loads with factor known as load factor. Hence, the designer can able to predict the excess load the structure can carry beyond the working loads without collapse. Hence this method gives the true margin of safety. This method considers the actual stress strain curve of concrete and the failure criteria is assumed as ultimate strain.

This method gives very economical sections. However it leads to excessive deformations and cracking. Thus, this method is failed to satisfy the serviceability and durability requirements. To overcome these drawbacks, the limit state method has been developed to take care of both strength and serviceability requirements.

3. LIMIT STATE METHOD:

In the limit state method, the structural element are designed for ultimate load and checked for serviceability (deflection, cracking etc.) at working loads so that the structure is fit for use throughout its life period. The details of this method are given in article 1.9.

PHILOSOPHY OF LIMIT STATE DESIGN:

A structure may become unfit for use not only when it collapses but when it violates the serviceability requirements such as deflections, cracking etc. The philosophy of limit state method of design is to see that the structure remains fit for use throughout its life period by assuring safety against strength and serviceability requirements i.e. the structure will not reach the limit state in its life time. The acceptable limit for safety against strength and serviceability required before failure occurs is called limit state. All the relevant limit states have to be considering in design. The loads and strength of the material s are to be considered in the design. The loads and strength of materials are to be estimated by probabilistic approach (characteristic values). The design loads and strengths are derived from the characteristic values through the use of partial safety factors.

LIMIT STATES:

The various limit states to be considered in the design are

1. Limit sate of collapse.
2. Limit state of serviceability.

LIMIT STATE OF COLLAPSE:

It is the limit state at which the structure is likely to collapse. The structure may collapse due to rupture of one or more critical sections or loss of overall stability due to buckling or overturning. This limit state may correspond to

a) Flexure
b) Compression
c) Shear
d) Torsion

LIMIT STATE OF SERVICEABILITY:

Limit state of serviceability relate to the performance of the structure at working loads. It is the limit state at which the structure undergone excessive deflection, which adversely affect the finishes causing discomfort to the users and excessive cracking which effects the efficiency or appearance of the structure.

This limit state may correspond to

A) Deflection
b) Cracking

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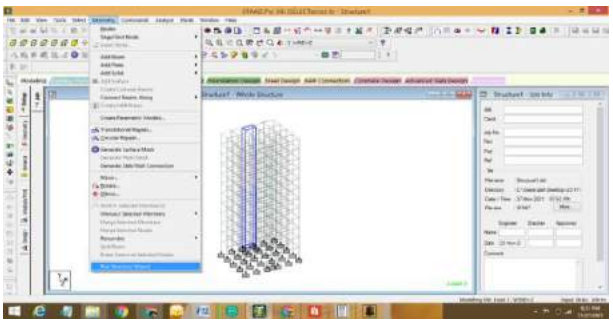
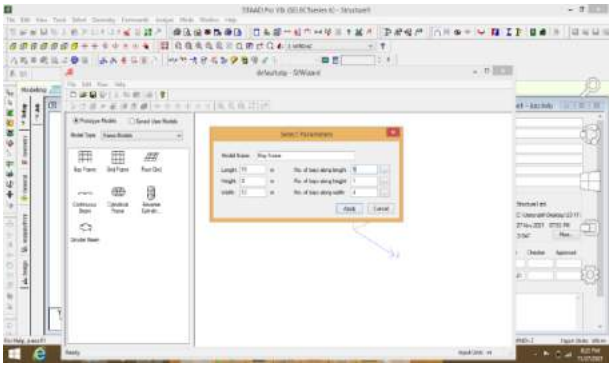
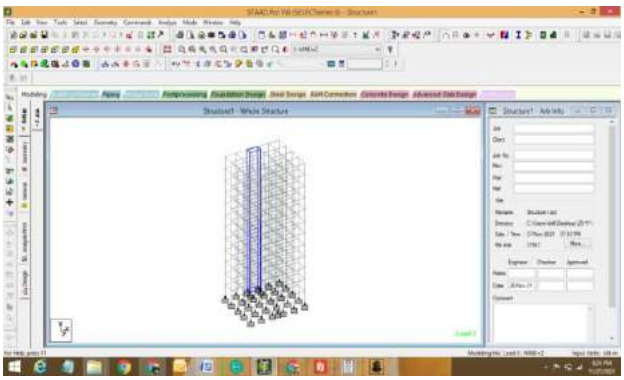
c) Other limit states (Vibrations, Fire resistance, Durability)

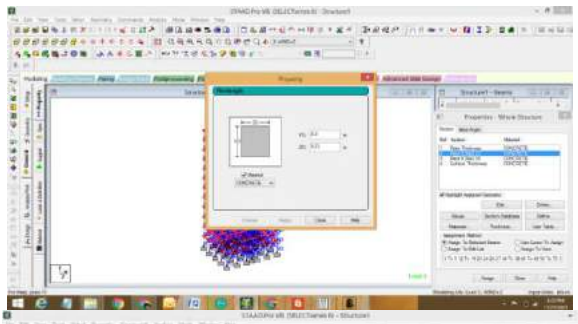
Results obtained from STAAD PRO analysis:

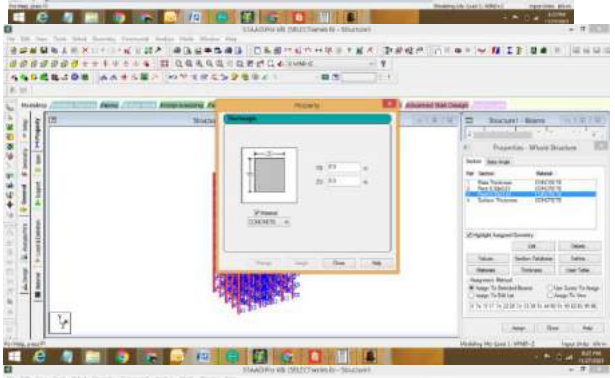
Step 1: Creating The Model

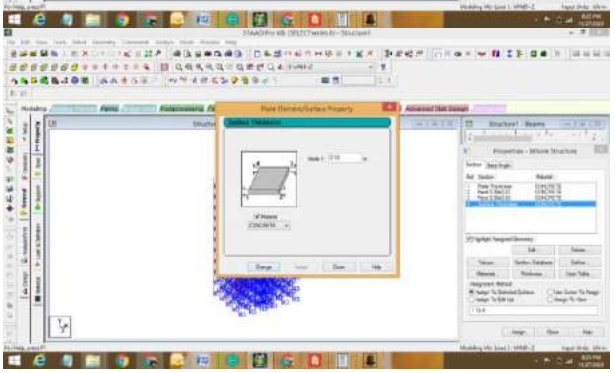




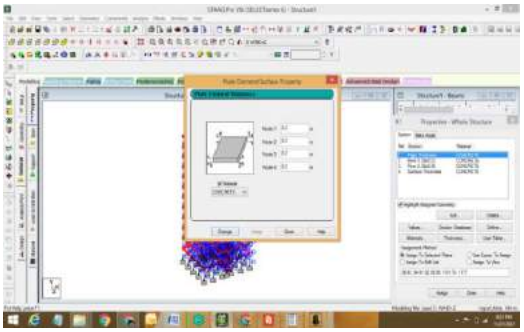




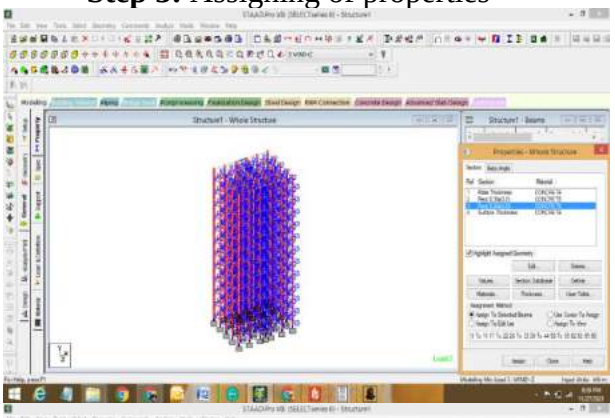


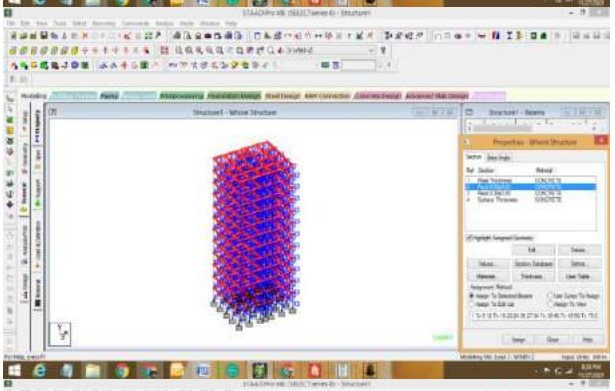


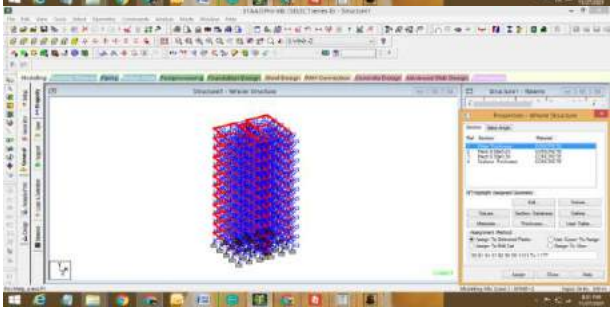
Step 2: Define Property Of Beam,Column And Slab Thickness



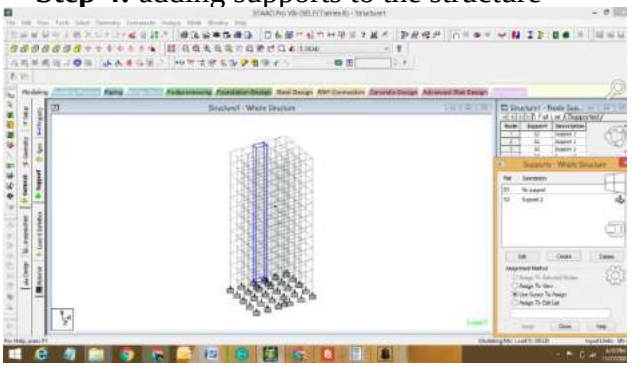
Step 3: Assigning of properties



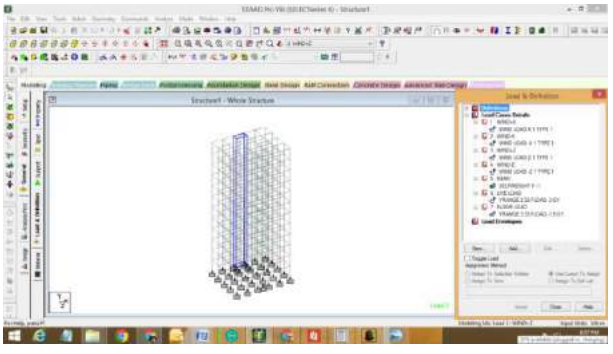




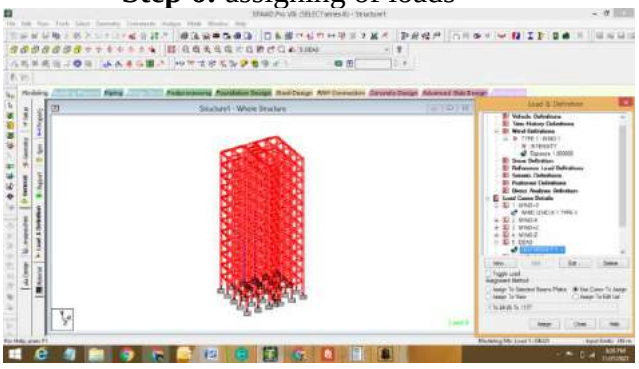
Step 4: adding supports to the structure

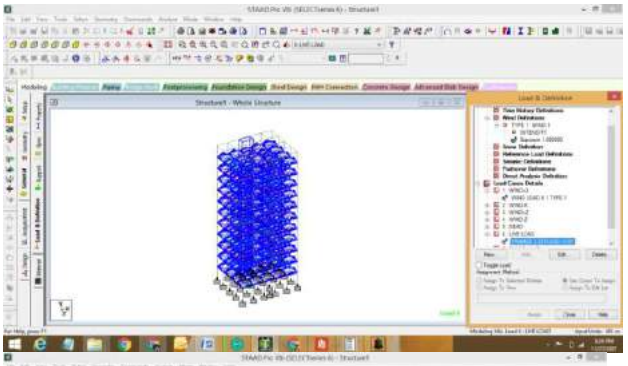


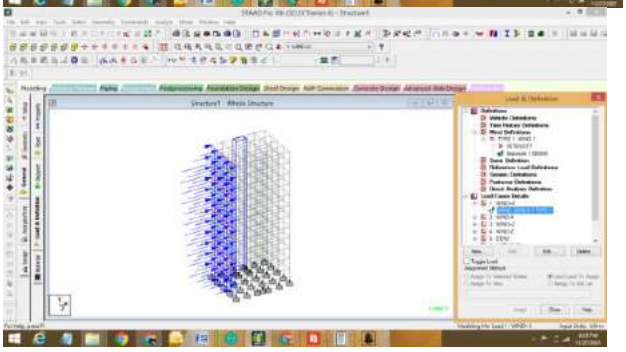
Step 5: Adding of loads

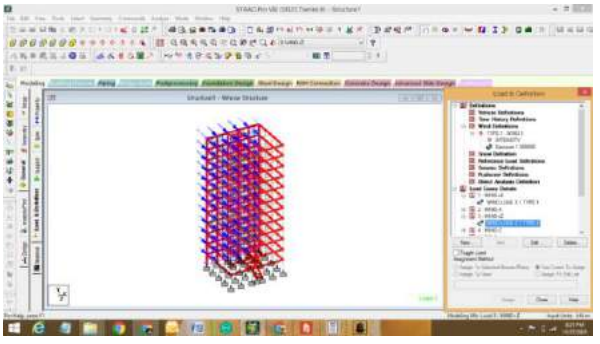


Step 6: assigning of loads

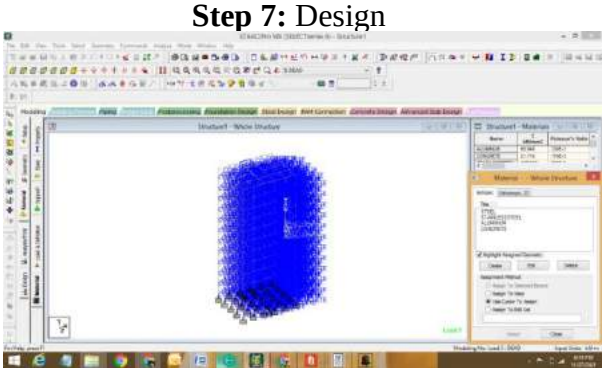








Step 7: Design



Step 8: Assign parameters

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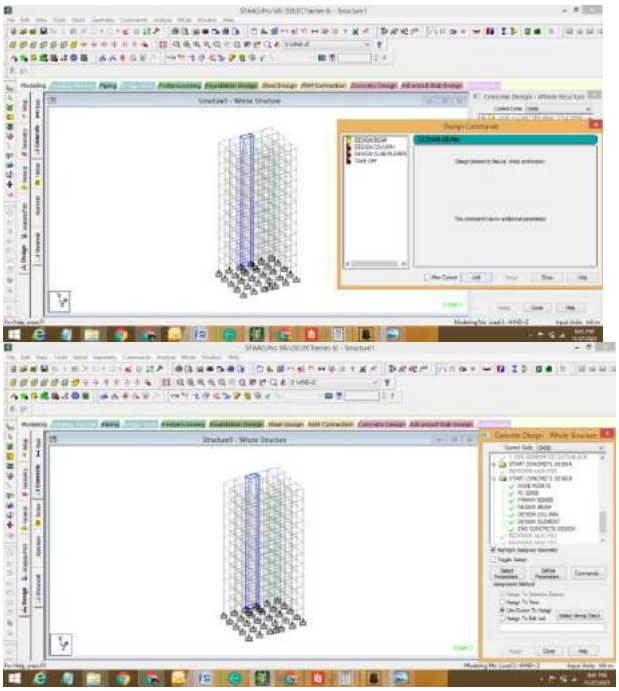
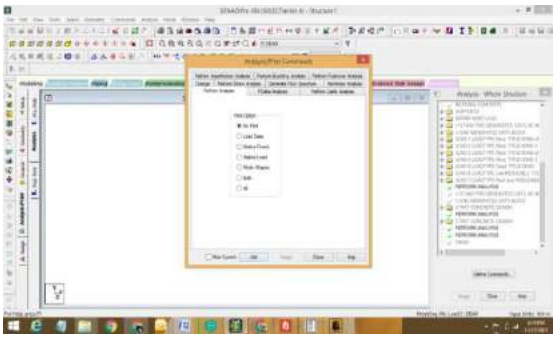
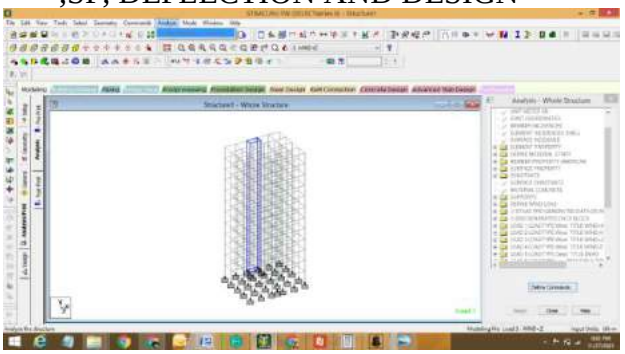


Step 9: analysis and print

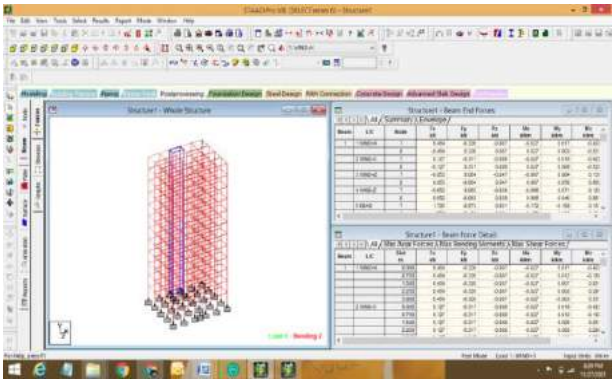


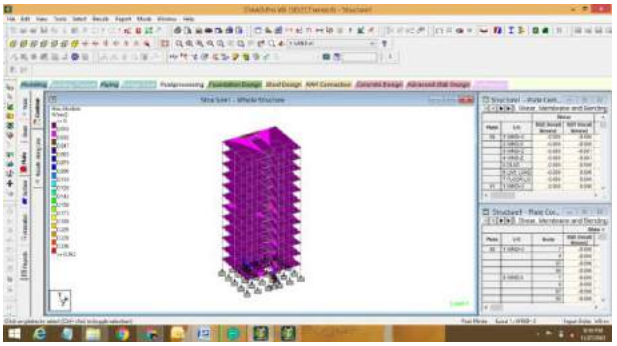
STEP 10 CHECK FOR RESULTS OF BM ,SF, DEFLECTION AND DESIGN

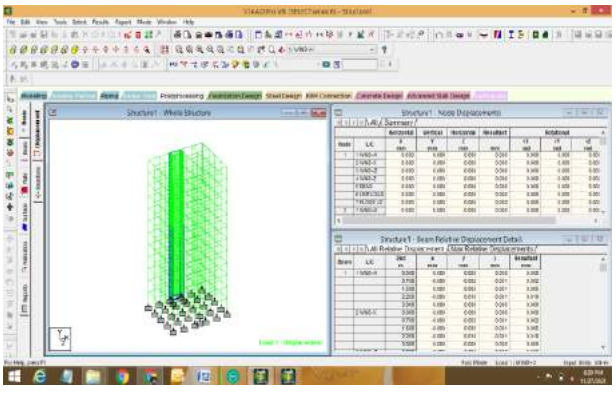


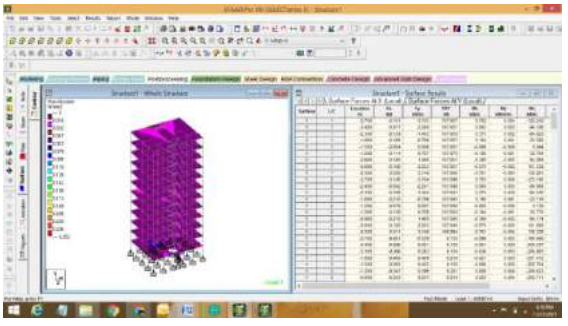
RESULTS AND DISCUSSIONS

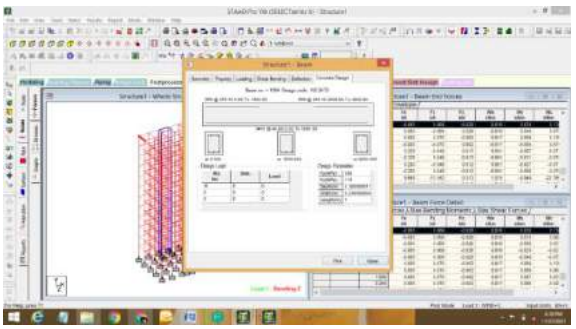
From the analysis procedure with STAAD.Pro, the design for concrete and steel reinforcement is shown below

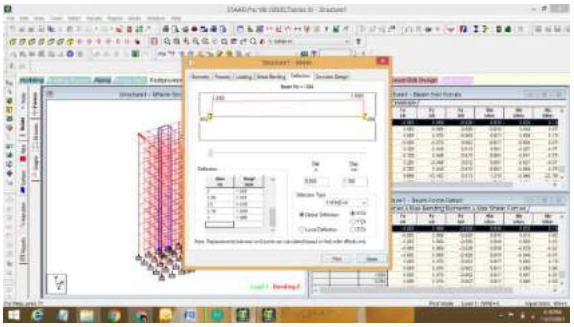


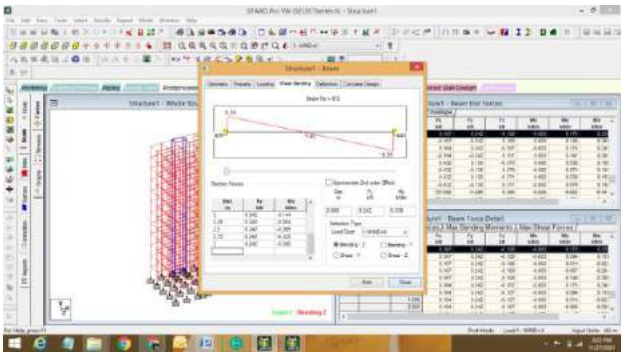


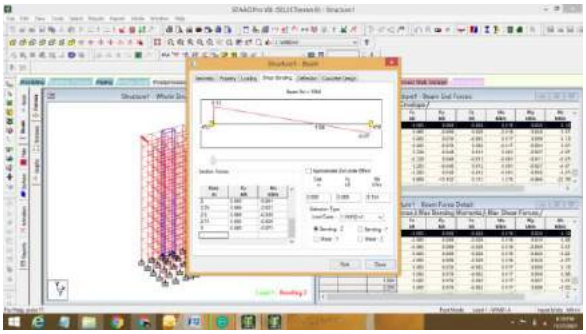


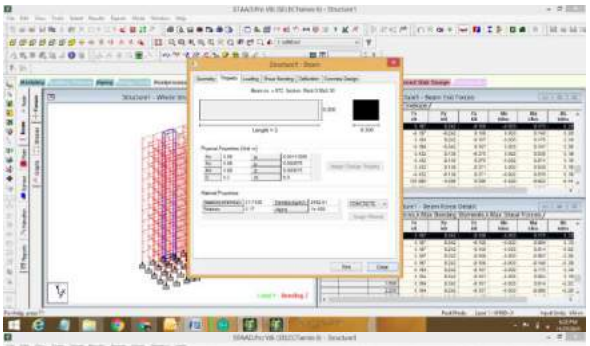


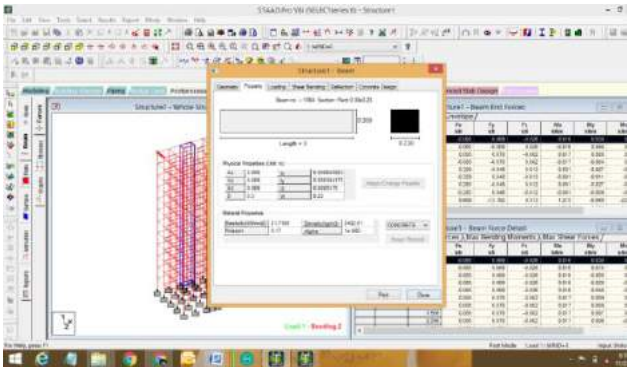


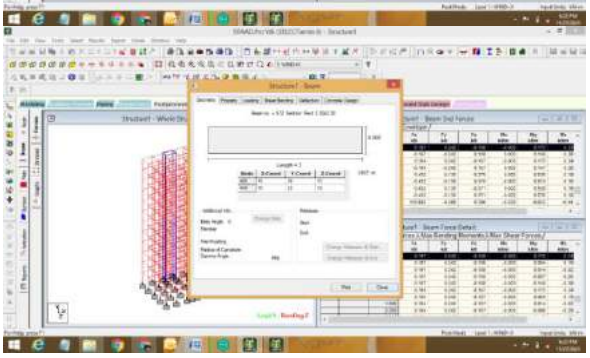


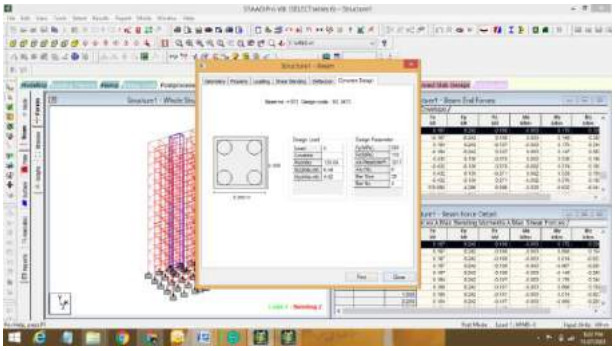


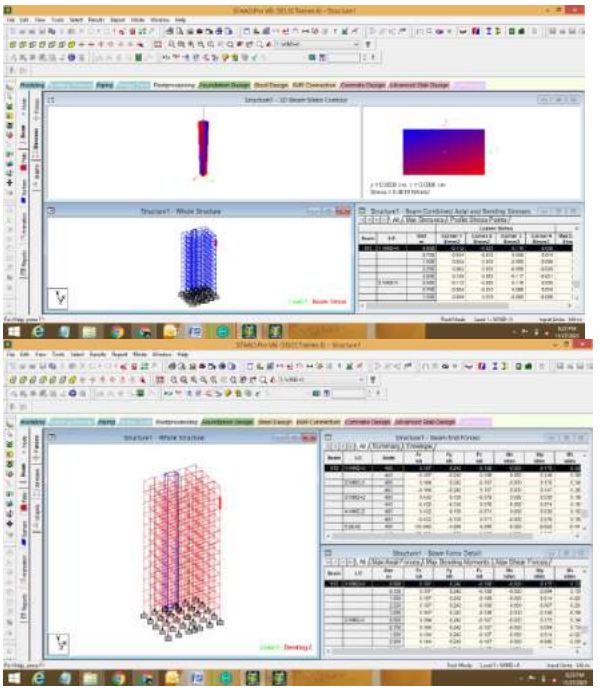


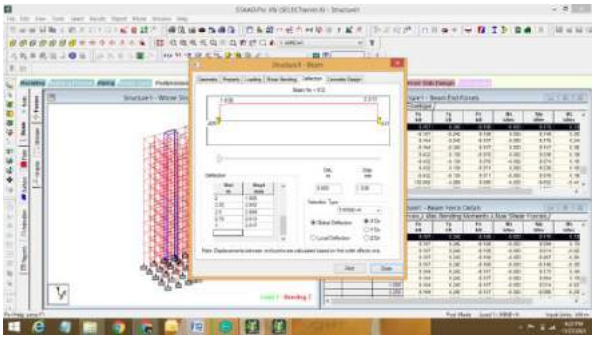


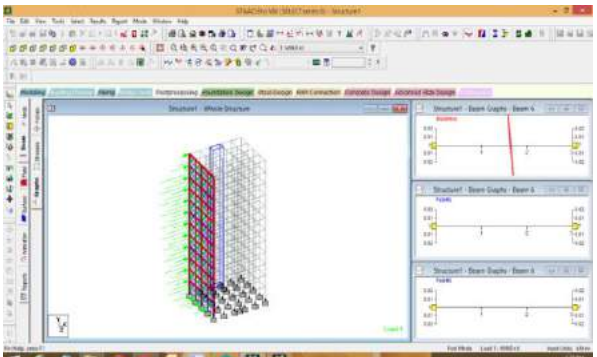
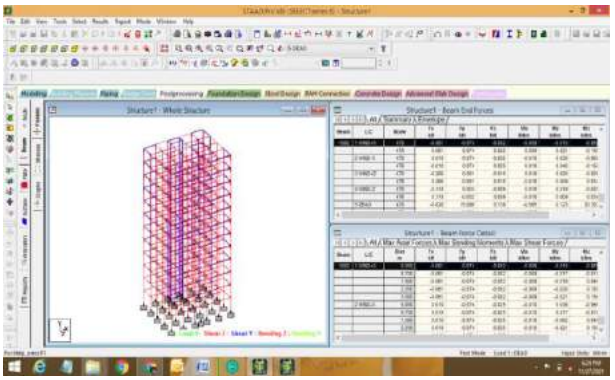
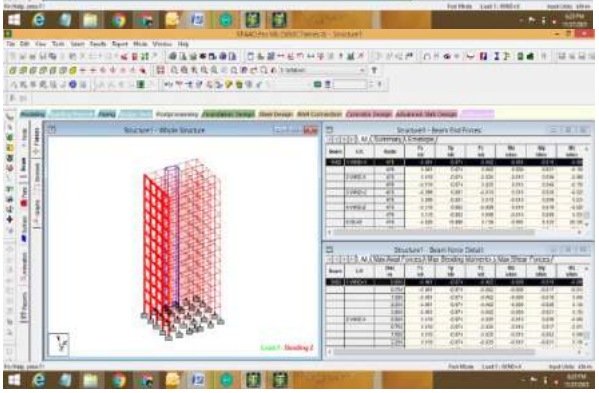
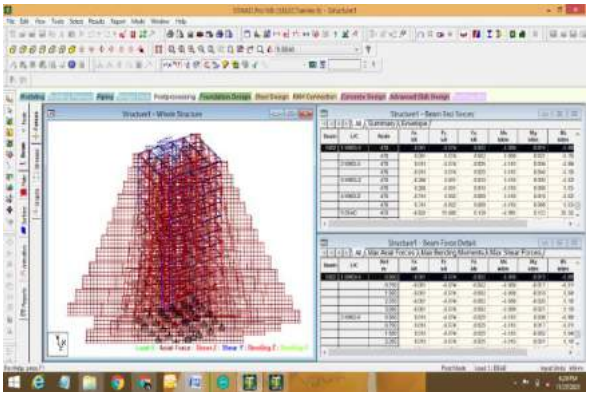
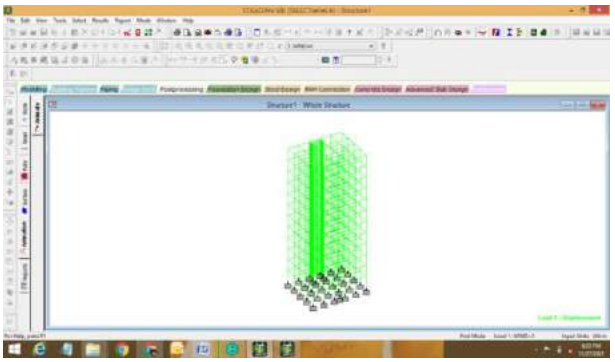
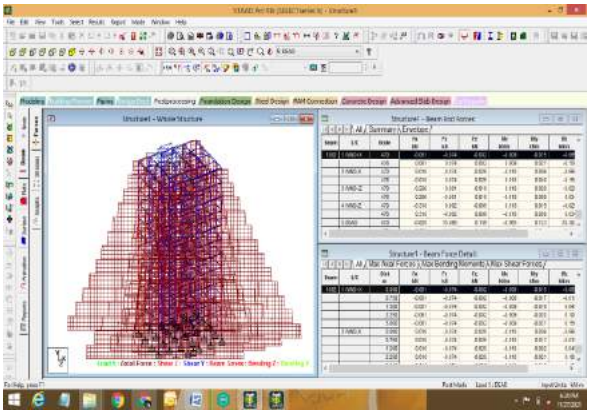
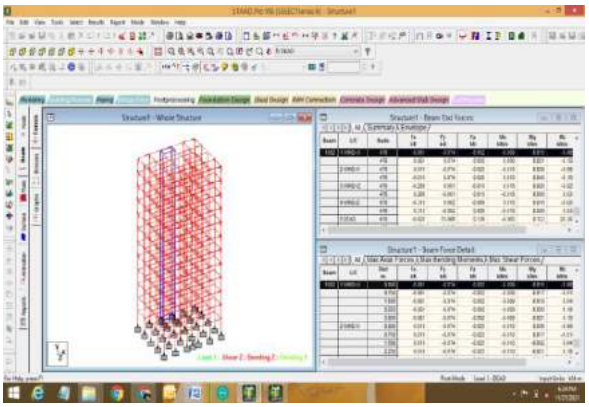
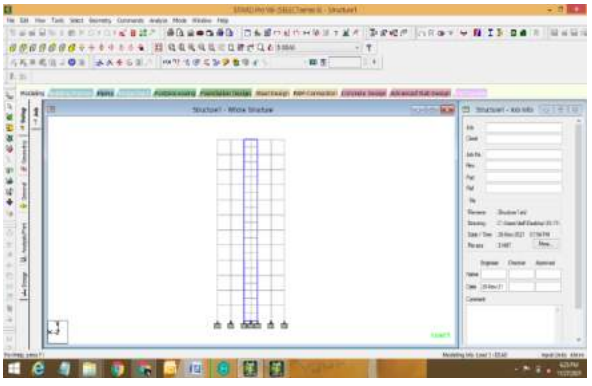










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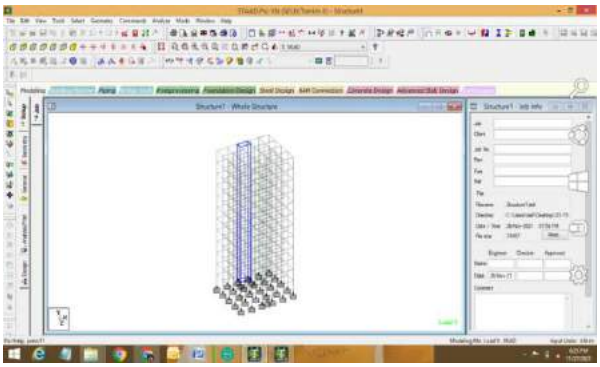

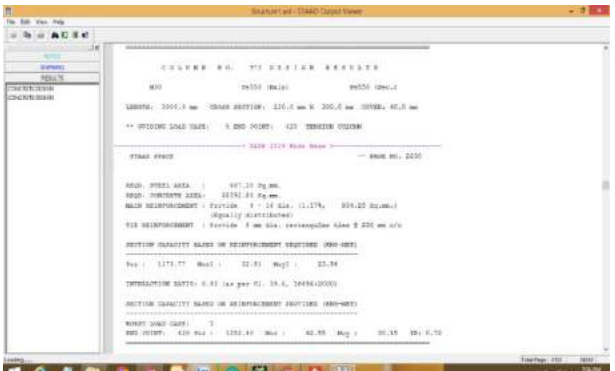

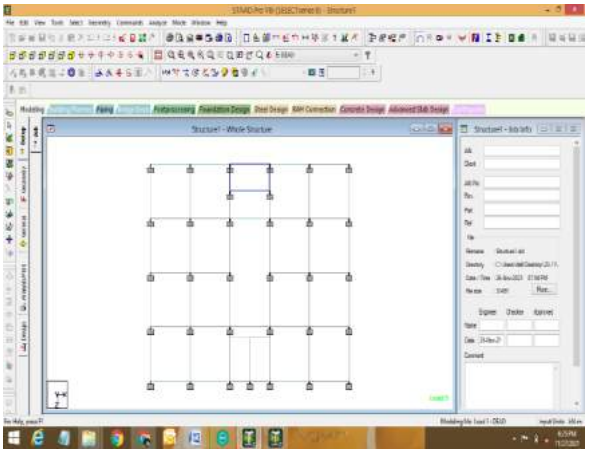

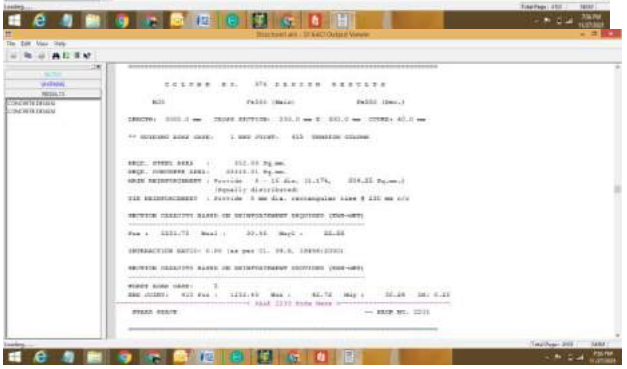

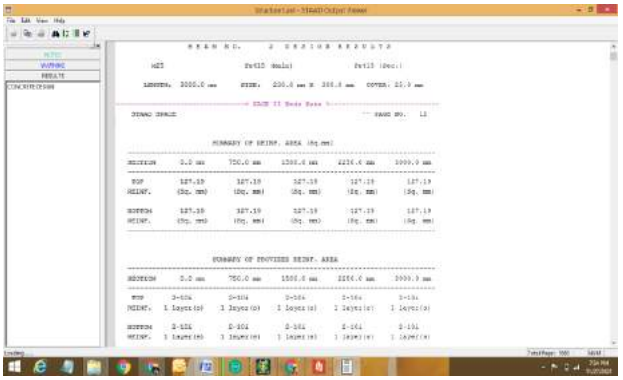

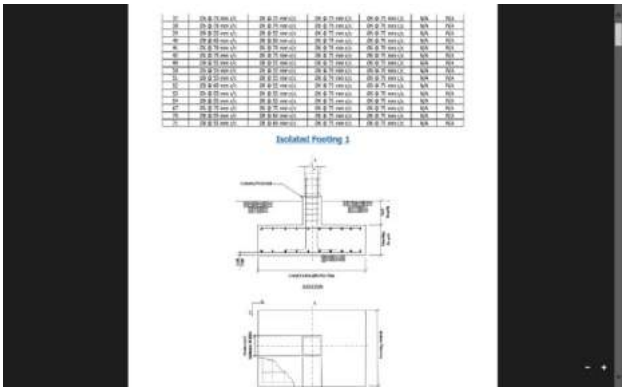

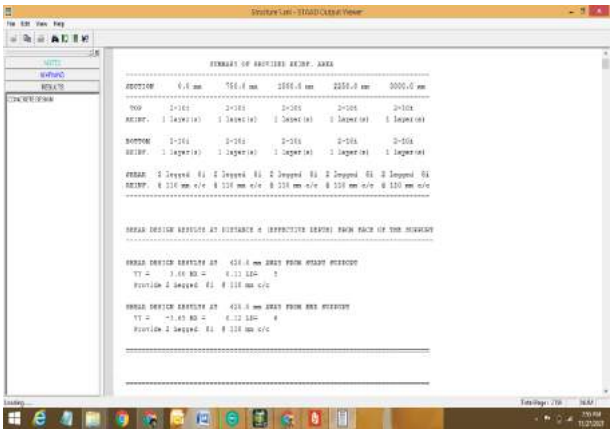

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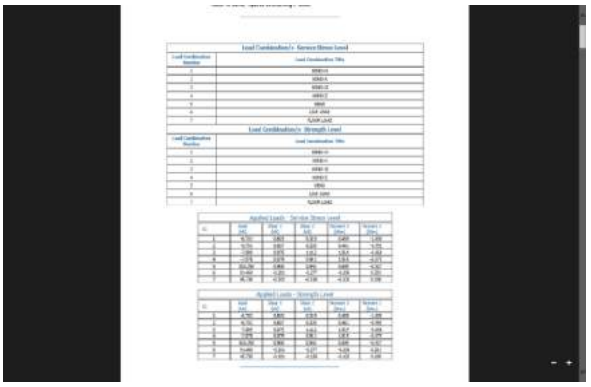

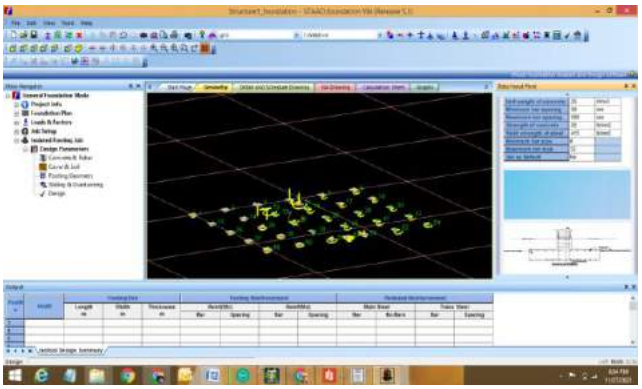

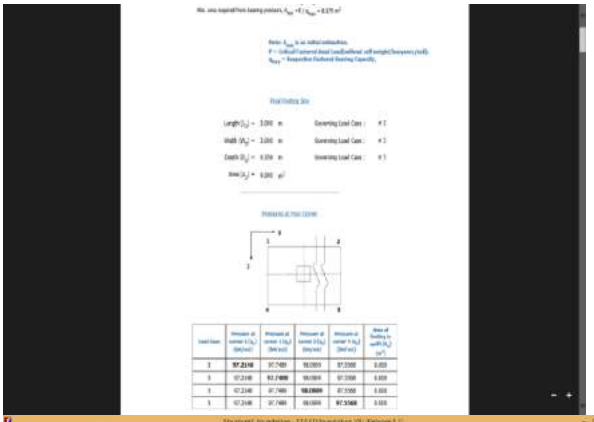

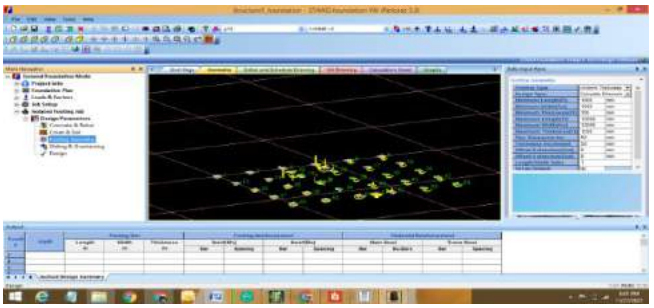

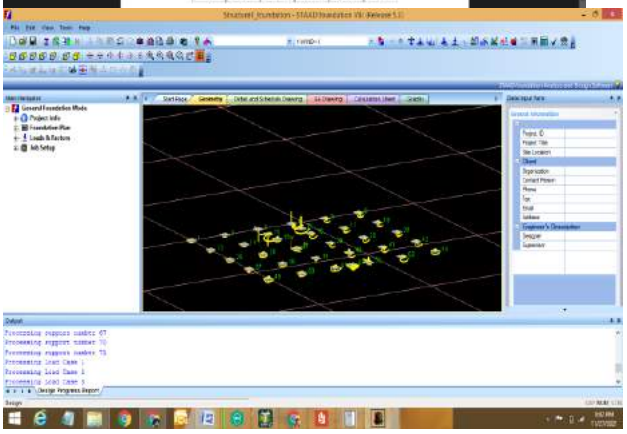

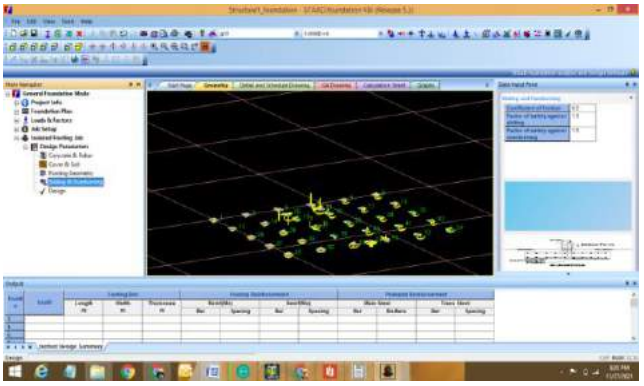

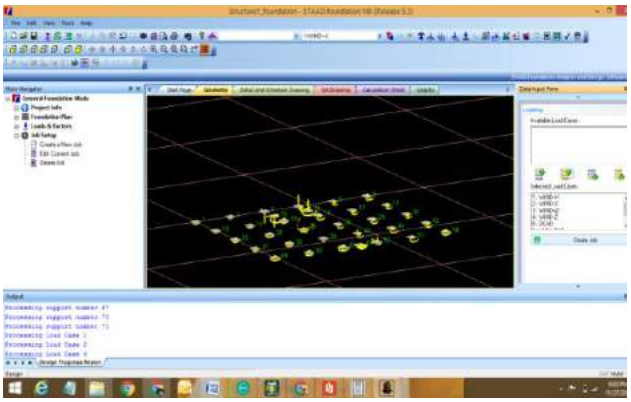

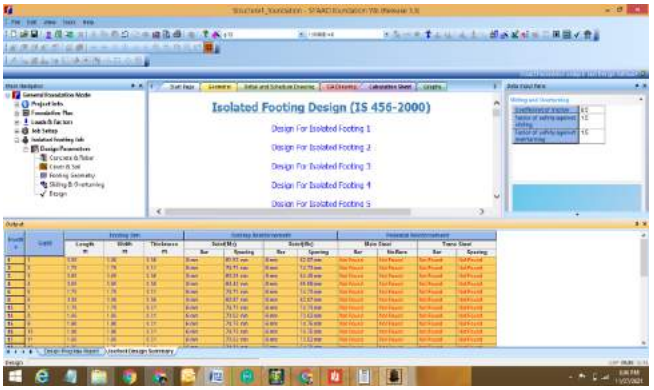

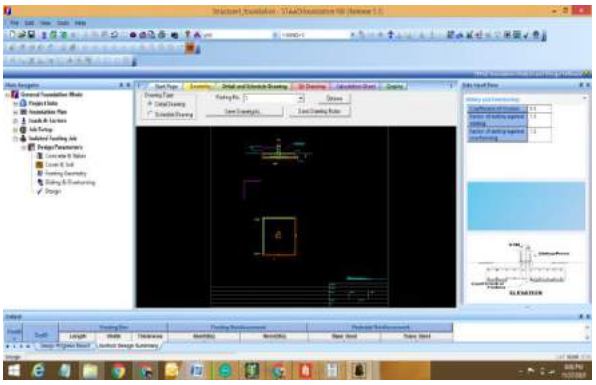

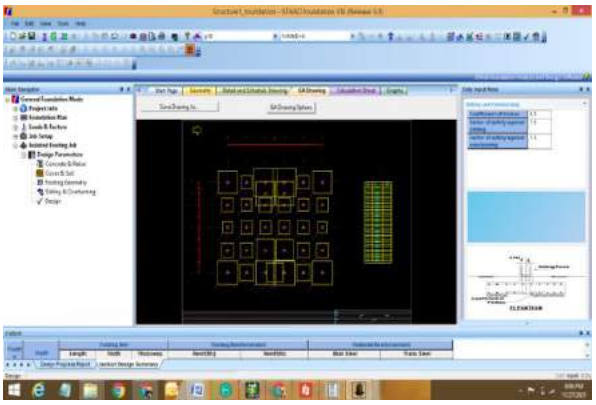

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ELEMENT INCIDENCES SHELL

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SURFACE INCIDENCE
70 488 489 71 SURFACE 1
70 3 454 488 SURFACE 2
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3 454 455 4 SURFACE 4
ELEMENT PROPERTY
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DEFINE MATERIAL START
ISOTROPIC CONCRETE
E 2.17185e+007
POISSON 0.17
DENSITY 23.5616
ALPHA 1e-005
DAMP 0.05
TYPE CONCRETE
STRENGTH FCU 27579
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MEMBER PROPERTY AMERICAN
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101 TO 104 111 TO 115 122 TO 125 132 TO 136 143 TO 147 154 TO 177 180 TO 187 -
190 TO 195 202 TO 206 213 TO 216 223 TO 227 234 TO 238 245 TO 268 -
271 TO 278 281 TO 286 293 TO 297 304 TO 307 314 TO 318 325 TO 329 -
336 TO 359 362 TO 369 372 TO 377 384 TO 388 395 TO 398 405 TO 409 -
416 TO 420 427 TO 450 453 TO 460 463 TO 468 475 TO 479 486 TO 489 -
496 TO 500 507 TO 511 518 TO 541 544 TO 551 554 TO 559 566 TO 570 -
577 TO 580 587 TO 591 598 TO 602 609 TO 632 635 TO 642 645 TO 650 -
657 TO 661 668 TO 671 678 TO 682 689 TO 693 700 TO 723 726 TO 733 -
736 TO 741 748 TO 752 759 TO 762 769 TO 773 780 TO 784 791 TO 814 -
817 TO 824 827 TO 832 839 TO 843 850 TO 853 860 TO 864 871 TO 875 -
882 TO 905 908 TO 915 918 TO 923 930 TO 934 941 TO 944 951 TO 955 -
962 TO 966 973 TO 996 999 TO 1006 1009 TO 1014 1021 TO 1025 1032 TO 1035 -
1042 TO 1046 1053 TO 1057 1064 TO 1087 1090 TO 1097 -
1100 PRIS YD 0.3 ZD 0.23
6 TO 11 17 TO 22 28 TO 33 39 TO 44 50 TO 55 82 83 95 96 105 TO 110 -
116 TO 121 126 TO 131 137 TO 142 148 TO 153 178 179 188 189 196 TO 201 207 -
208 TO 212 217 TO 222 228 TO 233 239 TO 244 269 270 279 280 287 TO 292 298 -
299 TO 303 308 TO 313 319 TO 324 330 TO 335 360 361 370 371 378 TO 383 389 -
390 TO 394 399 TO 404 410 TO 415 421 TO 426 451 452 461 462 469 TO 474 480 -
481 TO 485 490 TO 495 501 TO 506 512 TO 517 542 543 552 553 560 TO 565 571 -
572 TO 576 581 TO 586 592 TO 597 603 TO 608 633 634 643 644 651 TO 656 662 -
663 TO 667 672 TO 677 683 TO 688 694 TO 699 724 725 734 735 742 TO 747 753 -
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845 TO 849 854 TO 859 865 TO 870 876 TO 881 906 907 916 917 924 TO 929 935 -
936 TO 940 945 TO 950 956 TO 961 967 TO 972 997 998 1007 1008 1015 TO 1020 -
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SURFACE PROPERTY
1 TO 4 THICKNESS 0.12
CONSTANTS
MATERIAL CONCRETE MEMB 1 TO 24 26 TO 1177
SURFACE CONSTANTS
MATERIAL CONCRETE ALL
SUPPORTS
1 TO 6 13 TO 18 25 TO 30 37 TO 42 49 TO 54 67 70 71 FIXED
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ASCE-7-2010:PARAMS 45.000 KMPH 0 1 3 0 0.000 FT 0.000 FT 0.000 FT 1 -
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 0.112129 0.113118 0.114068 0.114983 0.115866 HEIG  0  4.572  6.096  7.62 -
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 24.384  25.908  27.432  28.956  30.48  32.004
EXP 1 JOINT 1 TO 489
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WIND LOAD X 1 TYPE 1
LOAD 2 LOADTYPE Wind  TITLE WIND-X
WIND LOAD -X 1 TYPE 1
LOAD 3 LOADTYPE Wind  TITLE WIND+Z
WIND LOAD Z 1 TYPE 1
LOAD 4 LOADTYPE Wind  TITLE WIND-Z
WIND LOAD -Z 1 TYPE 1
LOAD 5 LOADTYPE Dead  TITLE DEAD
SELFWEIGHT Y -1 LIST 1 TO 24 26 TO 1177
LOAD 6 LOADTYPE Live REDUCIBLE TITLE LIVE LOAD
FLOOR LOAD
YRANGE 3 33 FLOAD -3 GY
LOAD 7 LOADTYPE Roof Live REDUCIBLE TITLE FLOOR LOAD
FLOOR LOAD
YRANGE 3 33 FLOAD -1.5 GY
PERFORM ANALYSIS
<! STAAD PRO GENERATED DATA DO NOT MODIFY !!!
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CODE INDIAN
FC 25000 MEMB 1 TO 24 26 TO 1177
FYMAIN 415000 MEMB 1 TO 24 26 TO 1177
FYSEC 415000 ALL
DESIGN BEAM 1 TO 5 12 TO 16 23 24 26 27 34 TO 38 45 TO 49 56 TO 79 85 TO 90 -
93 94 97 100 TO 104 111 TO 115 122 TO 125 132 TO 136 143 TO 147 154 TO 177 -
180 TO 187 190 TO 195 202 TO 206 213 TO 216 223 TO 227 234 TO 238 -
245 TO 268 271 TO 278 281 TO 286 293 TO 297 304 TO 307 314 TO 318 -
325 TO 329 336 TO 359 362 TO 369 372 TO 377 384 TO 388 395 TO 398 -
405 TO 409 416 TO 420 427 TO 450 453 TO 460 463 TO 468 475 TO 479 -
486 TO 489 496 TO 500 507 TO 511 518 TO 541 544 TO 551 554 TO 559 -
566 TO 570 577 TO 580 587 TO 591 598 TO 602 609 TO 632 635 TO 642 -
645 TO 650 657 TO 661 668 TO 671 678 TO 682 689 TO 693 700 TO 723 -
726 TO 733 736 TO 741 748 TO 752 759 TO 762 769 TO 773 780 TO 784 -
791 TO 814 817 TO 824 827 TO 832 839 TO 843 850 TO 853 860 TO 864 -
871 TO 875 882 TO 905 908 TO 915 918 TO 923 930 TO 934 941 TO 944 -
951 TO 955 962 TO 966 973 TO 996 999 TO 1006 1009 TO 1014 1021 TO 1025 1032 -
1033 TO 1035 1042 TO 1046 1053 TO 1057 1064 TO 1087 1090 TO 1097 1100
DESIGN COLUMN 6 TO 11 17 TO 22 28 TO 33 39 TO 44 50 TO 55 82 83 95 96 105 -
106 TO 110 116 TO 121 126 TO 131 137 TO 142 148 TO 153 178 179 188 189 196 -
197 TO 201 207 TO 212 217 TO 222 228 TO 233 239 TO 244 269 270 279 280 287 -
288 TO 292 298 TO 303 308 TO 313 319 TO 324 330 TO 335 360 361 370 371 378 -
379 TO 383 389 TO 394 399 TO 404 410 TO 415 421 TO 426 451 452 461 462 469 -
470 TO 474 480 TO 485 490 TO 495 501 TO 506 512 TO 517 542 543 552 553 560 -
561 TO 565 571 TO 576 581 TO 586 592 TO 597 603 TO 608 633 634 643 644 651 -
652 TO 656 662 TO 667 672 TO 677 683 TO 688 694 TO 699 724 725 734 735 742 -
743 TO 747 753 TO 758 763 TO 768 774 TO 779 785 TO 790 815 816 825 826 833 -
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DESIGN ELEMENT 80 81 84 91 92 98 99 1101 TO 1177
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CONCRETE TAKE
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FYMAIN 550000 MEMB 1 TO 24 26 TO 1177
FYSEC 550000 ALL
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DESIGN COLUMN 1 TO 24 26 TO 79 82 83 85 TO 90 93 TO 97 100 TO 1100
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CONCRETE TAKE
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PERFORM ANALYSIS
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743 TO 747 753 TO 758 763 TO 768 774 TO 779 785 TO 790 815 816 825 826 833 -
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925 TO 929 935 TO 940 945 TO 950 956 TO 961 967 TO 972 997 998 1007 1008 1015 -
1016 TO 1020 1026 TO 1031 1036 TO 1041 1047 TO 1052 1058 TO 1063 1088 1089 -
1098 1099
DESIGN ELEMENT 80 81 84 91 92 98 99 1101 TO 1577
END CONCRETE DESIGN
PERFORM ANALYSIS
FINISH
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CONCLUSIONS

- STAAD PRO has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed as per IS: 456(2000). Beams are designed for flexure, shear and torsion.
- *Design for Flexure:*

Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging (creating tensile stress at the top face) moments are calculated for all active load cases at each of the above mentioned sections. Each of these sections are designed to resist both of these critical sagging and hogging moments. Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried.

- *Design for Shear:*

Shear reinforcement is calculated to resist both shear forces and torsional moments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

- *Beam Design Output:*

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

- *Column Design:*

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

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