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Comparison of Earthquake Load Obtained From Staad-Pro Software in G+3 Model

Patil Aakash Chandrashekhar [1], Mr. Hariram Sahu[2]
[1,2]Department of Civil Engineering
[1,2]School of Engineering Eklavya University, Damoh, (M.P.)

Abstract: *One of the most devastating forces on earth is known to be produced by earthquakes. It has been observed that numerous buildings fell during previous earthquakes. Realistic methods of analysis and design are therefore necessary. The current method for designing earthquake-resistant structures is called performance-based design. It is an effort to forecast how structures will behave in the case of a seismic event. In the current study, the seismic activity of a G+3 multi-story hospital structure located in a separate zone is studied. It entails calculating the load and total. Building seismic weight is determined in a distinct zone based on base shear. Designing with economy, grace, and sturdiness is the art and science of structural planning and analysis. To compete in the highly competitive market, structural designing demands a thorough structural study from which the planning is expected. The present study made an effort to attain this goal. The usage of software can.*

Keywords- Realistic, building, seismic event, earthquake-resistant, structural designing, economy.

Introduction

The results of analysis are utilised to confirm a structure's appropriateness for use. Thus, structural analysis is crucial to the design of structural engineering. A structural engineer must obtain data on structural loads, geometrical parameters, support conditions, and material qualities from several sources in order to conduct a full study. Support responses, strains, and displacements are frequently found as a consequence of this research. The information can then be compared against failure criteria. The beauty of a structural engineer is that he improves humanity's quality of life; it is his line of work to save lives. Structural engineers analyse, design, plan, and research structural components and structural systems to meet design goals and ensure the safety and comfort of occupants. . As a result of such an examination, support reactions, stresses, and displacements are often identified. It is then possible to compare this information to failure criteria. Structural engineers study, design, plan, and research structural components and structural systems to accomplish design goals and assure the safety and comfort of occupants, the beauty of structural engineer is that he makes life better for humanity; it is the business of saving lives.

2. Objective of The Work

1. To create and evaluate the G+3 Staad-pro model
2. A comparison between the manual results and the earthquake load calculated using the Staad-pro programme in the G+3 model.
3. To examine the earthquake loads over four Indian zones.
4. A comparison of the findings of the same building's base shear in various seismic zones.
5. To assess the relative amounts of steel and concrete reinforcement in various seismic zones.

3. Literature Review

Aman et al. (2016) designed and evaluated a current project that was finished in Gulbarga for Unity Builders. Bharat Pride is the name of the initiative. They found that the outcomes of the Staad-pro and Kanis approaches are equivalent. Less than 20 mm is the member's short-term deflection.

Giresh et al. (2017) the seismic analysis and design of a G+ 7 residential structure were displayed using STAAD Pro. Seismic analysis, often known as earthquake analysis, is used to determine the reaction of a structure to seismic stimulation. For the seismic study of the structure, he obtained all necessary seismic information. In this study, the member forces, joint displacement, support reaction, and narrative drift of the structures were assessed in terms of their seismic response.

Adapa (2017) a G+4 multistory building's static analysis has been given. He works with the displacement and static forces at member joints. In his summary, he stated that Staad-pro software is used to do calibrated loadings, and the results are compared to manual analysis, which he judged to be adequate. In addition to static analysis, he said that dynamic analysis, which is calibrated with reference to the Response spectrum and Time History Analysis, should also be utilised to get a thorough understanding of a structure's response to different loads.

Patil et al. (2017) has presented the G+10 multistory residential building's design and analysis. The bending moment, shear force, deflection, and reinforcement were all examined in order to create a cost-effective design. He found that wind had the most bending and shear force. There are more load combinations than there are earthquake load combinations. For practical reasons, structural members' reinforcing details must also be changed. There are more load combinations than there are earthquake load combinations. For practical reasons, structural members' reinforcing details must also be changed.

Satheesh et al. (2020) analysed a G+10 residential building using Staad Pro. According to IS:1893-2002 and IS:875-2015 part 3, they deal with calculating seismic and wind loads for residential structures. They carefully analysed the structure using Kani's approach and then compared their findings to those of Staad-Pro. They concluded that the results of the staad-pro and kanis approaches are essentially the same.

Abhisheck Verma and Gagandeep(2023) A topic of great importance is "Dynamic analysis of multistory irregular building using Staad pro," as most people want to live in metropolitan regions as a result of industrialization and development. To achieve lateral stresses from an earthquake and wind in addition to gravity loads, a building's structural stability must be compromised. Therefore, it is obvious that a structure needs to be strong and stiff enough to resist loads. Due to the accessibility of computers and specialised software, design and analysis are now both practical and economical. The multistory skyscraper was created with the aid of the programme Staad pro v8i. The research analyses three distinct models of asymmetrical multi-story buildings (G+10) with a 3 m floor height. Consideration is given to the response factor of 5, the importance factor of 1.2, the medium soil type, and the structure type 1 with a damping ratio of 5%. The loads utilised in the analysis include seismic load according to IS 1893 Part 1, active load according to IS 875 Part 2, and dead load according to IS 875 Part 1. Software was used to celibately design the beams, columns, and slabs. The outcomes of the three models are then contrasted in terms of base shear, displacement, and storey drift.

4. Methodology

In Civil Engineering, there is a broad range of software available. The amount of software available to support Civil Engineering and design demands is rapidly expanding as a result of technology advancements. The softwares used in civil engineering are describedbelow.

The Auto Cad 2D plan has now been loaded into the Staad-pro program. The plan has now been converted to G+ 3 models. After that, all node points are created as beams in the x and z dimensions, and columns in the y direction. Figure 5.3 shows the Staad- Pro 2 D model and the render view

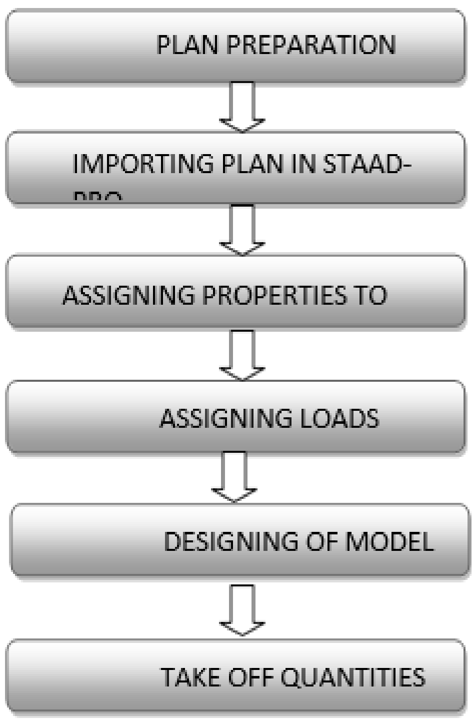

Figure 1: Flow Chart of Methodology.

4.1 Importing plan to Staad-Pro:

The Auto Cad 2D plan has now been loaded into the Staad-pro program. The plan has now been converted to G+ 3 models. After that, all node points are created as beams in the x and z dimensions, and columns in the y direction. Figure 5.3 shows the Staad- Pro 2 D model and the render view

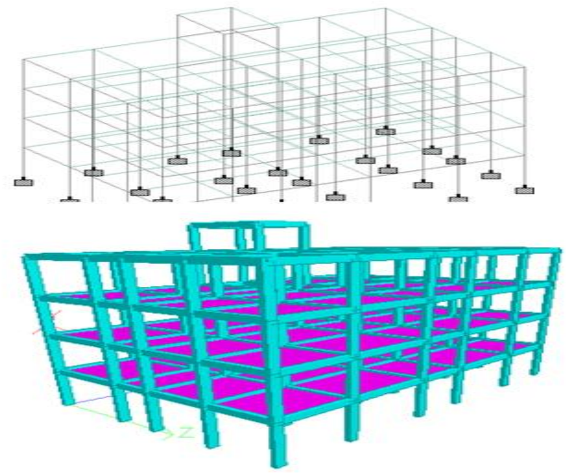

Figure 2: **2D and Render view of Staad-Pro Model.**

4.2 Self-Weight

Self-weight refers to the own weight of body. The permanent load on a structure is the load exerted by the structure's own weight. However, it does not change or modify until the body is modified, such as by altering its cross-section or substance

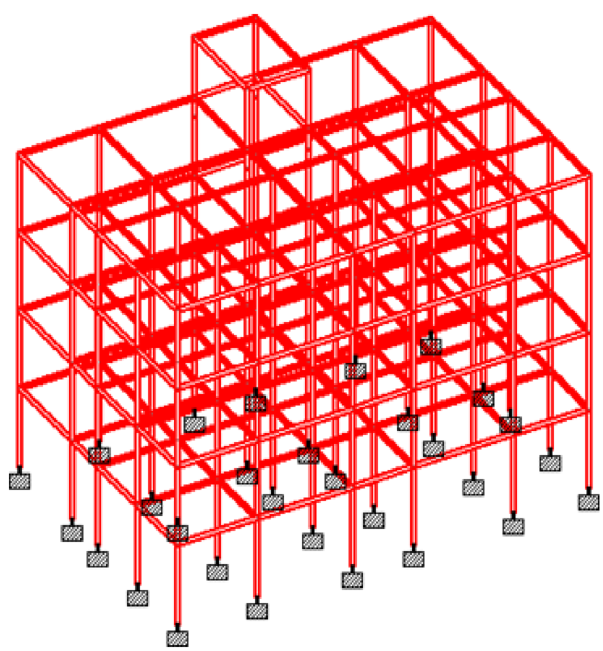

Figure 3: Self Weight of Building Model.

4.3 Member Load

Loads on members can be point, distributed (uniform), moment (concentrated), and temperature loads. It's important to know how the first five sorts of loads will be applied: their orientation, direction, amplitude, point of application, and length. The member load is computed in this project are as follows:

Outer wall load = wall thickness x height x density = 0.23 x 3 x 20 = 13.8KN/m Inner wall load = wall thickness x height x density = 0.115 x 3x 20 = 6.9KN/m

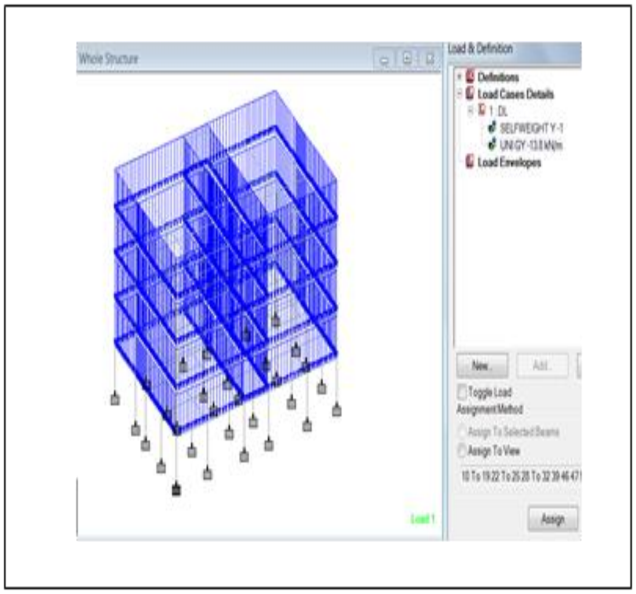

Figure 4: Member load on outer wall.

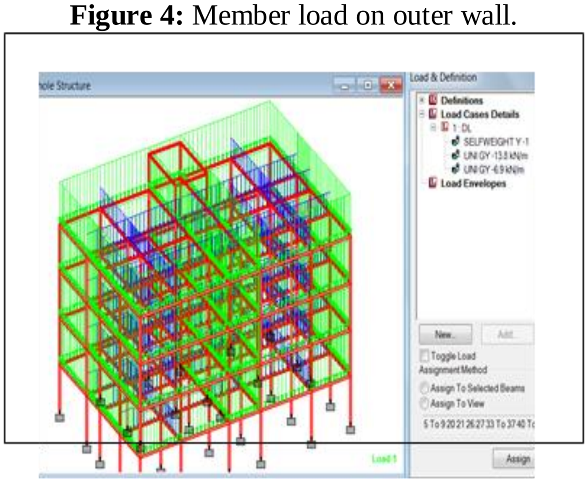

Figure 5: Member load on inner wall.

4.4 Floor Load

The loads that can resist by floor of a building know as floor loads. All floor elements must be strong and stiff enough to withstand these stresses. This is generally defined by the maximum permitted deflection of the floor, i.e. how much it will 'bend' under the highest predicted load. Floor load are the sum of slab load, floor finish and load of ceiling plaster

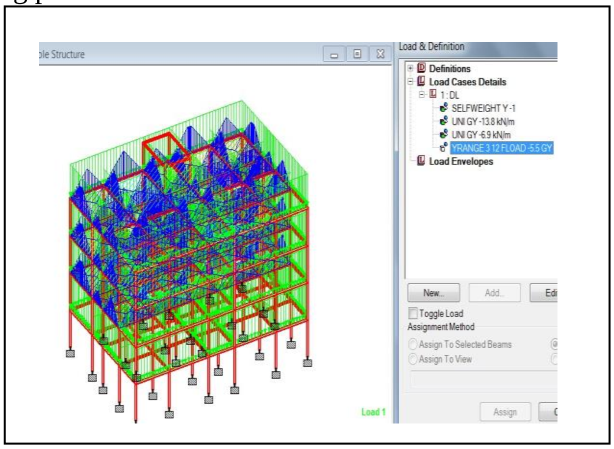

Figure 6: Live Load distribution on model.

4.5 Wind Loads:

Wind load refers to the force exerted on a building's heights as a result of the wind blowing against it. Because of this, the building's structural design must effectively absorb wind pressures and transfer them to the foundation to prevent collapse. It has been shown that wind is the primary load on tall structures when employing wind engineering. As a rule, the structural systems that absorb wind loads are distinct from those that absorb dead weights and other gravity loads generated within the structure. The magnitude of this load increases as we move on the height of structure i.e. taller structure are more effective than the shorter ones. The action of wind in x and z directions are shownin figure

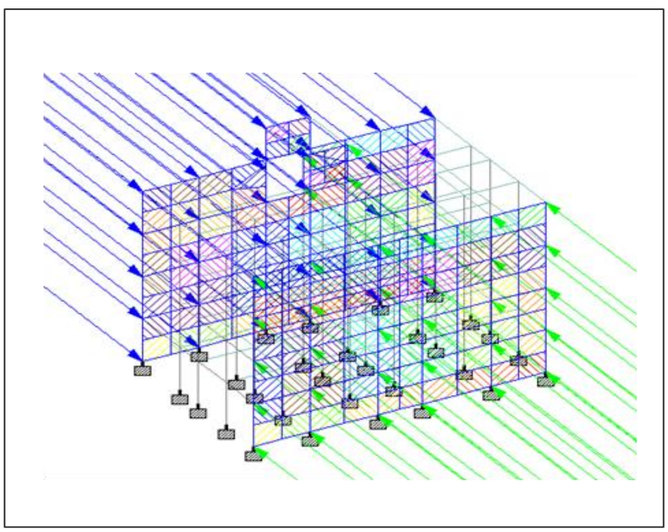

Figure 7: Wind Load on the model in Z (+) Direction.

4.6 Earthquake Loads:

The earthquake load is also known as dynamic load which bring vibration on structures. One of the fundamental concepts in earthquake engineering is seismic load, which refers to the application of an earthquake-generated agitation to a building structure or model.

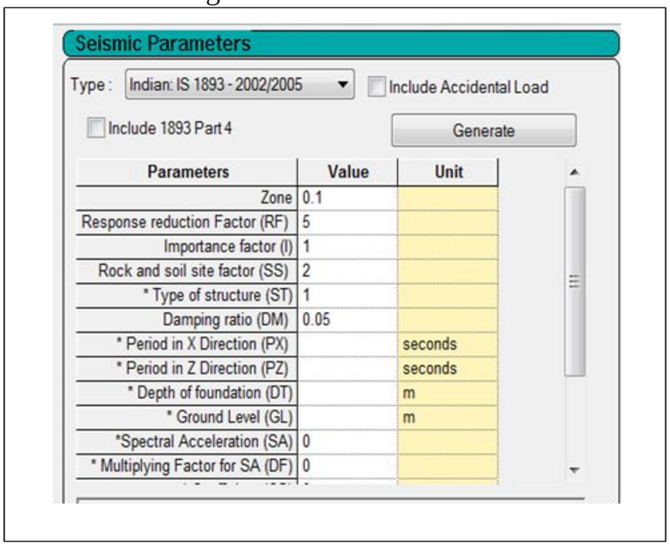

Figure 8: Seismic parameters of Staad-Pro model.

After entering all the seismic parameters in the model, the analysis is done which gives zero error and the representation of earthquake forces in X and Z direction is described below in figure

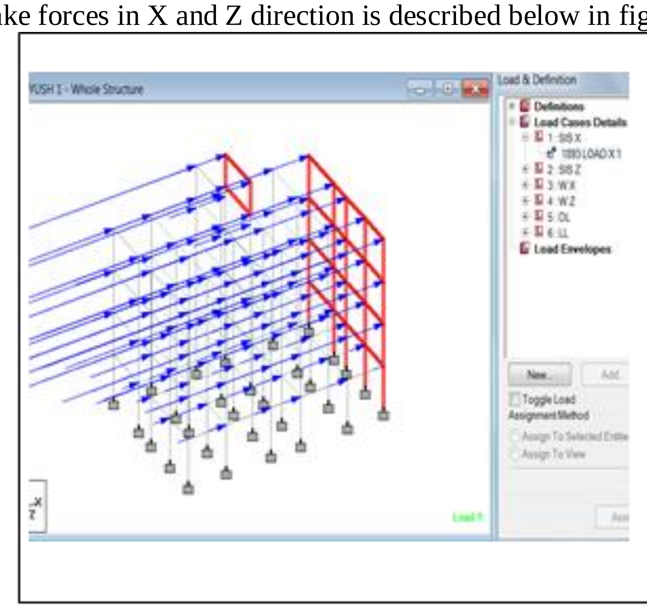

Figure 9: Seismic force in X direction.

5. Design and Analysis

5.1 Beam

A beam is a lateral element that resists loads applied laterally to its axis. Beams can be characterized by their shapes, materials, etc. They are also known, tension members. A beam is a horizontal element that spans an opening and supports a weight, which may be a brick or stone wall above the entrance, in which case the beam is referred to as a lintel. The beam is termed a floor joist or a roof joist depending on whether the weight is a floor or a roof in a structure. Stringers are the lighter longitudinal elements of a bridge deck, whereas floor beams are the heavier transverse members. In this study, the beam dimensions are 0.2 × 0.4 meters, or 200 x 400 mm.

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=============================================================================
               B E A M  N O.   196  D E S I G N  R E S U L T S

      M30                  Fe415 (Main)               Fe415 (Sec.)

    LENGTH:  3350.0 mm    SIZE:   200.0 mm X  400.0 mm   COVER: 25.0 mm


                     SUMMARY OF REINF. AREA (Sq.mm)
-----------------------------------------------------------------------------
SECTION      0.0 mm     837.5 mm    1675.0 mm    2512.5 mm    3350.0 mm
-----------------------------------------------------------------------------
 TOP         158.79      151.57      151.57       151.57       151.57
REINF.      (Sq. mm)    (Sq. mm)    (Sq. mm)     (Sq. mm)     (Sq. mm)

BOTTOM       151.57      151.57      151.57       151.57       151.57
REINF.      (Sq. mm)    (Sq. mm)    (Sq. mm)     (Sq. mm)     (Sq. mm)
-----------------------------------------------------------------------------

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 STAAD SPACE                                            -- PAGE NO.   106
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Figure 10: Design Results of Beam no. 196.

5.2 Column

A column is an axial and mainly vertical member that transmits the load through compression.

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       C O L U M N   N O.   205  D E S I G N   R E S U L T S

     M30                 Fe415 (Main)              Fe415 (Sec.)

 LENGTH:  3000.0 mm   CROSS SECTION:  200.0 mm X  400.0 mm  COVER: 40.0 mm

 ** GUIDING LOAD CASE:    1 END JOINT:   129  TENSION COLUMN


 REQD. STEEL AREA   :       640.00 Sq.mm.
 REQD. CONCRETE AREA:     79360.00 Sq.mm.
 MAIN REINFORCEMENT : Provide   8 - 12 dia. (1.13%,    904.78 Sq.mm.)
                      (Equally distributed)
 TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 190 mm c/c

 SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
 ----------------------------------------------------------
 Puz :   1270.56   Muz1 :     37.92   Muy1 :     17.41

 INTERACTION RATIO: 0.22 (as per Cl. 39.6, IS456:2000)
```

Figure 11: Design Results of Column no.205.

The weight of the above structure is transmitted to the lower one and then finally to the foundation. Hence a column is also said to be a compression member. Structural columns are often constructed from high-strength materials such as stone, brick, and concrete. The type of column used in construction is rectangular column, circular column, axially loaded column, reinforced concrete column, steel column etc. Types of column are shown below in figure 4.24. In this study, the beam dimensions are 0.2 × 0.4 meters, or 200 x 400 mm.

5.3 Take off Details

For each member, Staad-pro software estimates how much material is needed to support it. The whole concrete volume and the total reinforcing details make up the takeoff details. It takes 83.6 cubic metres of concrete and 73489N of steel to build this structure.

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STAAD SPACE                                              -- PAGE NO.   301

      **************  CONCRETE  TAKE OFF  **************
            (FOR BEAMS, COLUMNS AND PLATES DESIGNED ABOVE)
 NOTE: CONCRETE QUANTITY REPRESENTS VOLUME OF CONCRETE IN BEAMS, COLUMNS, A
       REINFORCING STEEL QUANTITY REPRESENTS REINFORCING STEEL IN BEAMS AND
       REINFORCING STEEL IN PLATES IS NOT INCLUDED IN THE REPORTED QUANTITY.

      TOTAL VOLUME OF CONCRETE =        83.6 CU.METER

                     BAR DIA         WEIGHT
                     (in mm)        (in New)
                    --------        --------
                        8              27352
                       10              11507
                       12              32771
                       16               1858
                                ------------
                       *** TOTAL=      73489
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Figure 12: Take off quantities of concrete and steel.

5.4 Running Analysis

The analysis window is run and the analysis results are obtained with zero error, no warning and two notes after assigning properties to the members, applying loads and completing the design.

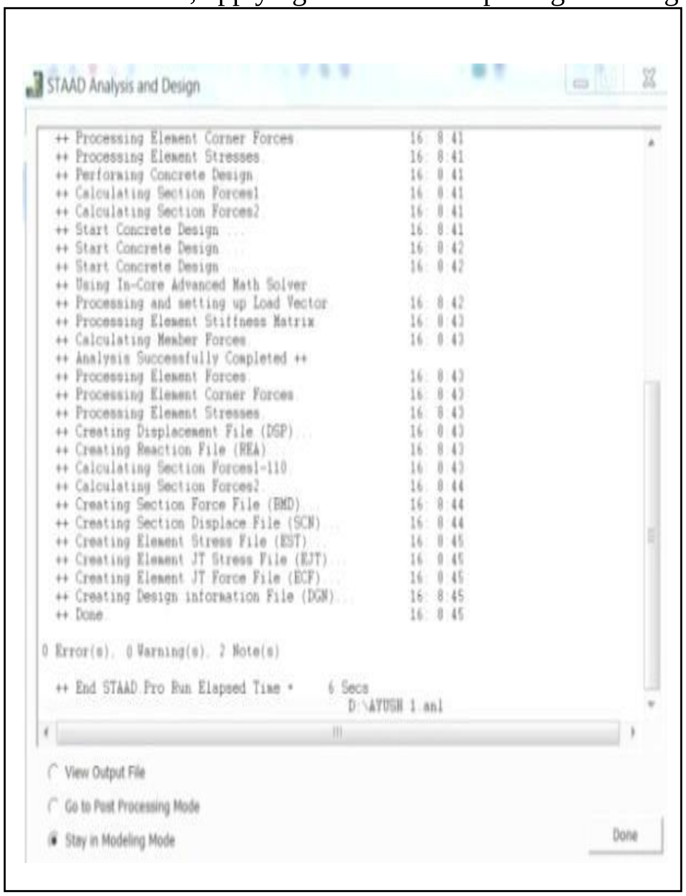

Figure 13: Running analysis window.

6. Conclusions

- The base shear levels differ significantly across different regions of India when seismic characteristics are analysed. Zones II and III each have a value of 226.85 KN, while Zones IV and V each have a value of 544.44 KN. Zone V has a value of 816.66 KN.
- The average increment is nearly 18%. As a result, when compared to manual results, Staad pro results are almost as accurate. In addition Staad pro provides reinforcement details of all its members, as well as take-off quantities of concrete and steel.
- Different amounts of steel are also purchased in other zones, including 51383 N in zone II, 54104 N in zone III, 65835 N in zone IV, and 75484 N in zone V.

- As a consequence, we draw the conclusion that a structure with the same seismic weight, dead load, and live load will have variable base shear and steel values depending on the seismic zone.

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