Digital DNA Vs Manpower DNA in the Field of Structural Designing

Sajad Shabir Shah
M. Tech Student
Department of Civil Engineering
Dr. A.P.J. Abdul Kalam Technical University Lucknow, Lucknow Institute of Technology, India

Abstract— Civil Engineers are facing a great challenge in structural designing. The design must fulfil various parameters which include economical structure, durability and serviceability. But taking these points in mind it becomes very difficult for an Engineer to fulfil all these requirements at a time when a design is performed manually. This dissertation presents a research on digital tools used in civil engineering and comparing their results by taking in mind the requirements of the above points. In this research process a building is taken for analysis and design on two well-known software's STAAD Pro and ETABS. Based on the results taken from these software's some comparison is done with manual analysis. The main aim of this research is to show the exact difference between well-known simulation software's STAAD Pro and ETABS used by structural design engineers nowadays. This study is focussed on the advantages of digital tools in our life to make it easy and reliable for us to perform a daunting task. It is found that ETABS is good for building design and STAAD PRO on the whole deals with RCC Structures as well as Steel Structures but by survey I fund STAAD Pro is mostly used check analysis result. So, in this study I am going to check it out what is the reason, why Engineers are taking analysis result in case of RCC Design why not design result while using STTAD Pro.

Keywords: STAAD Pro, RCC Design, ETABS

I. INTRODUCTION

This research paper is based on the research done to check the essence of STAAD Pro and ETABS for the purpose of designing. An RCC Structure is a structure having concrete members embedded with reinforcing bars. The load can be transferred easily from slabs to beams and then from beams to columns. Finally, from columns to foundation. It is necessary for a stable structure to have monolithic members so as to transfer loading smoothly. The structure consists of beams, columns and slabs. To provide cross section to a member, it needs proper design for given loading.

Design needs to have good hand on numerical problem, to counter different challenges while getting twisted in a design. After complete knowledge of analysis and design one can design any structure but it is not possible for a single person to go through all fields. It is necessary to get a full knowledge in a particular field. Building analysis and design needs complete knowledge of IS Codes and numerical analysis. One must be well versed about loading which are considered in a building. Building can be of various types and can be residential, commercial, industrial and institutional. So, while performing a design we need to go through different design codes. Some of the codes are given below with their description of loading.

- IS- 875 (Part 1) – Design Code for Dead Loads.
- IS- 875 (Part 2) – Design Code for Live Loads.
- IS- 875 (Part 3) – Wind Load Design Code.
- IS- 1893 – Earthquake Design Code.

II. OVERVIEW OF METHODOLOGY

The research consists of various values which are considered by a researcher to know the fact which he/she is searching for. The methodology must be well known and should be of practically applicable. So, in this research I found it suitable to select STAAD Pro and ETABS for my fact-finding process as they are widely used nowadays. Experts are available in case there is any need of assistance while having some technical issue. The brief history of these two software's is given below:

A. STAAD Pro

STAAD pro is an advanced software for analysis and design of structures. In the world market, there are other software packages like this. Currently there is great demand in the market in civil engineering if your specialization is structural engineering. You can follow any software package with little effort depending on where you work and customer requirements. For a variety of packages, you can refer to Google. Basics with which you can pick up any software package, which is customer friendly, are more important in my opinion.

In structural design and analysis are various types of software uses like: -

- STAAD PRO
- ETABS
- SAP
- SAFE
- ANSYS
- STAAD FOUNDATION
- STAAD RCDC

With sophisticated finite element (FEM) functionality and dynamic analysis, STAAD Pro features state-of - the-art user interface, visualization instruments, strong analysis and engine design. STAAD Pro is the first professional option for visualization and verification of outcomes from model generation, analysis and design. Practitioners created STAAD Pro around the globe. It has developed over 20 years and meets the criteria for ISO 9001 accreditation. It provides you all the understanding by using STAAD Pro.

The state-of - the-art user interface, visualization instruments, strong analysis and motor design characteristics sophisticated finite element (FEM) skills and dynamic analysis. STAAD specialist may be a structural analysis and style program with applications mainly in the building and land sectors such as business buildings, bridges and road structures, industrial structures, chemical plant structures, dams, turbine foundations, corridors, other integrated structures, etc.

It can use various types of assessment from traditional static analysis of 1st order, analysis of 2nd order P-delta, nonlinear geometric analysis, analysis of Pushover,

or buckling assessment. It can also take benefit of various types of dynamic analysis from modal extraction to time history and assessment of spectrum reaction.

In latest years, it has become component of embedded structural analysis and design solutions, primarily through the use of an exposed API called Open STAAD PRO to access and drive the program using a Visual Basic macro scheme contained within the application or through practicality in apps that embody acceptable programmable macro systems themselves together with Open STAAD professionals. In addition, STAAD Professional has immediate connections to apps such as RAM membership and STAAD Professional Foundation to supply technicians with apps that manage post-processing style that STAAD Pro itself does not manage. Another type of integration endorsed by the STAAD Pro is the standard assessment system for CIM Steel Integration, version 2 frequently referred to as CIS/2 and used for modelling and evaluation by a variety of apps. Make full analysis and design quicker than ever before using the latest STAAD Pro CONNECT Edition for any structure size or type. Simplify your BIM workflow with a physical model STAAD Pro that is automatically transformed into the analytical model for your structural analysis. Share synchronized models with confidence for multidisciplinary team cooperation and, most importantly, provide secure, cost-effective designs.

III. STRUCTURAL DESIGNING

Structural engineers have proper technical knowledge for structural detailing and their analysis. So, they are more experienced to design structures. The structural designing procedures carried out by the structural engineers include calculating the loads and the stresses acting on the building, analysis results for the applied loading, design of sections of structures to sustain the loads, so that the structure designed will withstand the loads predicted safely.

The structural engineers are also involved in the selection of materials best suited for the structure. This will hence ask for good knowledge about the different materials that are used in the construction at the current condition like their economic factors, strength factors and durability factors. The quality factors of different building materials can be analysed by a structural engineer to finalize their suitability in the design of the beams, columns or the foundations.

Another skill of a structural designer is the analysis of structures. This is presently carried out by the software like ETABS, STAAD PRO, SAP etc. As years pass new software are being developed for the analysis of structures at different conditions of loads like wind, earthquake etc.

Most of the structural engineers have to study and work with this software with a knowledge of both the technical details and the programming details. In some organizations, the analysis is carried out by a programmer who may not have the civil engineering graduation but is assisted by a structural engineer.

Whatever be the mode of analysis done, the structural engineer must have the ability to understand and interpret the results from the software to know the validity of the values provided as output. Some organization won't completely rely on the computer results, they conduct a separate man-made calculation for assurance.

Even though structural engineers are the ones that bring and develop the design ideas and detail, he can only see it happen on the site only if the structure is constructed as desired. For this, his interpretation and ideas have to conveyed with the other members of the projects.

The structural engineer has to make coordination and consult other members like the site engineers, other design engineers, geotechnical engineers, landscape architects, architects, project managers etc. Proper knowledge helps in spreading correct information among the group avoiding confusion and errors.

IV. DESCRIPTION OF MODEL TYPE

The structural model is composed of framed structure, with beams and columns being monolithically considered. The model consists of RCC frame with concrete as a base material, the various parameters taken for analysis and design process are mentioned below:
No of Floors = G+4
Height of each Floor = 3m
Beam Size = 300 mm X 200 mm
Column Size = 230mm X 230mm
Slab Thickness = 150 mm
Live load on each floor = 4 KN/M^2
Live Load on Roof = 2 KN/M^2
Type of Soil = Medium
Zone = III
Grade of Concrete used = M30
Grade of Steel = Fe-415
Clear Cover in case of Beams = 25mm
Clear Cover in case of Columns = 40mm

The Plan decided to complete this research was of greater importance. So, accordingly I chose a Plan which can fulfil all the requirement's in the whole analysis process. The Plan taken for modelling of a building is shown below:

V. LOADING

Consideration of loading is the main aspect which must be taken very carefully as the Analysis and Design Process is based on loading conditions. The various codes to finalize the magnitude of loading are mentioned below:
IS-875 (Part 1) _____ Design Code for Dead Loads.
IS-875 (Part 2) _____ Design Code for Live Loads.
IS-875 (Part 3) _____ Wind Load Design Code.
IS-456 :2000 _____ Concrete Design Code.
IS -800: 2007 _____ Steel Design Code.
IS-10262: 2009 _____ Mix Design Code.
IS-1893: 2002 _____ Earthquake Design Code.

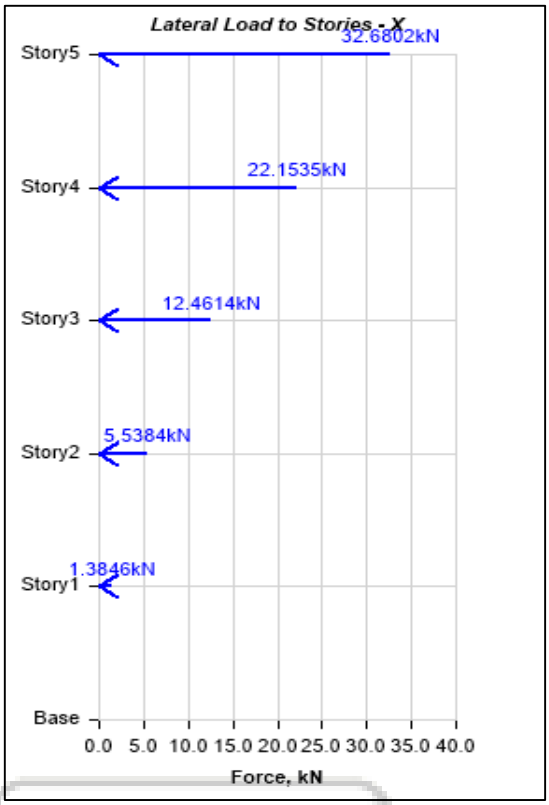

Fig. 1: Earthquake Loading along X+ Direction.

Loads are the main parameters which we must consider while designing to make the final project such that it can resist all loading. The loads variety according to the function of the structure. The residential buildings are considered in general structures whereas institutional or commercial buildings are considered in important structures. The load distribution is same in case of residential and commercial structures as the building blocks are of same properties and mechanism but there is variation in amount of material used only. The loads are distributed from slab to beams. The slabs may distribute load in two ways that is either by one-way distribution or two-way distribution.

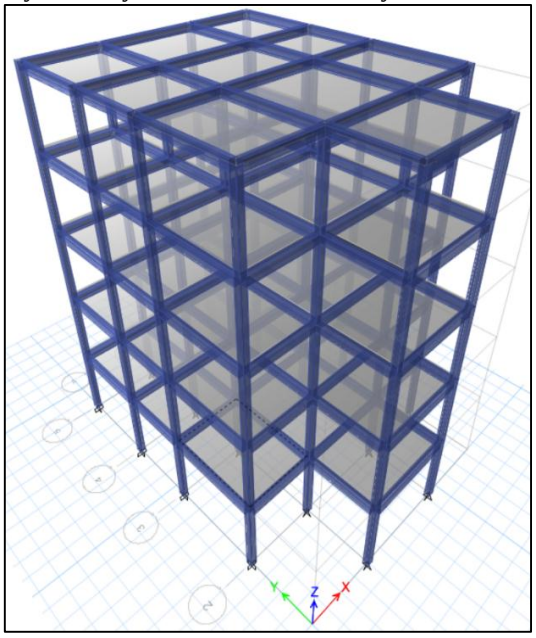

Fig. 2: Solid section of whole. Structure.

In case of one-way distribution, the load is transferred to longer span beams and shorter span beams experience minimum loading which is neglected in calculation process. A slab is said to be One-way slab when the ratio of longer span to shorter span is greater than 2 whereas a slab is said to be Two-Way when the ratio of longer span to shorter span is less or equal to 2.

After the transfer of loads from slab to adjacent beams, the load is transferred to columns and then finally to foundation.

VI. Analysis and Design Result from ETABS

The method used to find out the result was taken as STAAD Pro and ETABS, as these are well known and nowadays used by industries for designing purposes. A Building is being modelled to find out the analysis and design results. In this section I have given all the details and pictures which I have found while analyzing a structure using ETABS. Followed by this I have mentioned the results taken from STAAD Pro using same model and at last I have made some comparison between these software's and the variations which I have found while my whole research process.

VII. Bending Moment

The force applying on a member leads to bending and the detailed study about bending due to applied load can be achieved by Bending Moment. Analytically Bending Moment at a point can be calculated by multiplying the applied force with perpendicular distance. Bending in case of uniformly distributed load is shown parabolically while as in case of point load, it changes linearly. The bending Moment diagram shown below shows the load is uniformly distributed at every horizontal member (Beams), but vertical members show linear change in bending moment diagram which denotes that application of force is of point load.

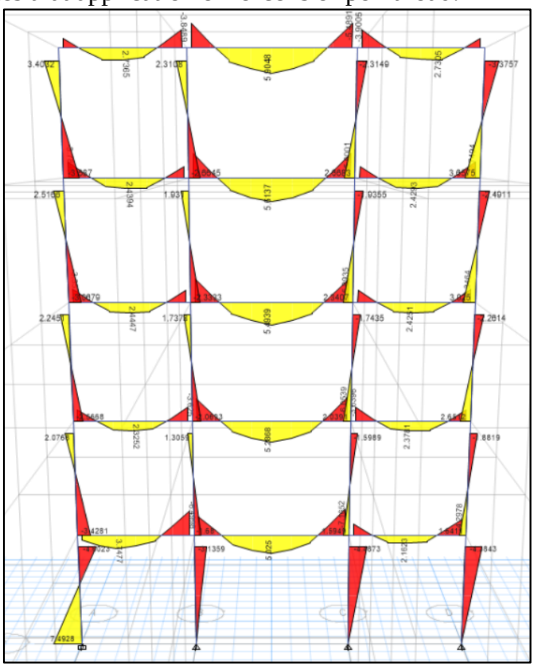

Fig. 3: Bending Moment Diagram.

VIII. SHEAR FORCE

Shear force is the analysis result which shows sharing of surfaces between various layers due to applied load. It is actually algebraic sum of all the vertical forces acting at a particular section. By getting Shear force result we can calculate shear reinforcement to be provided to resist applied load. Shear force diagram of a frame is shown below:

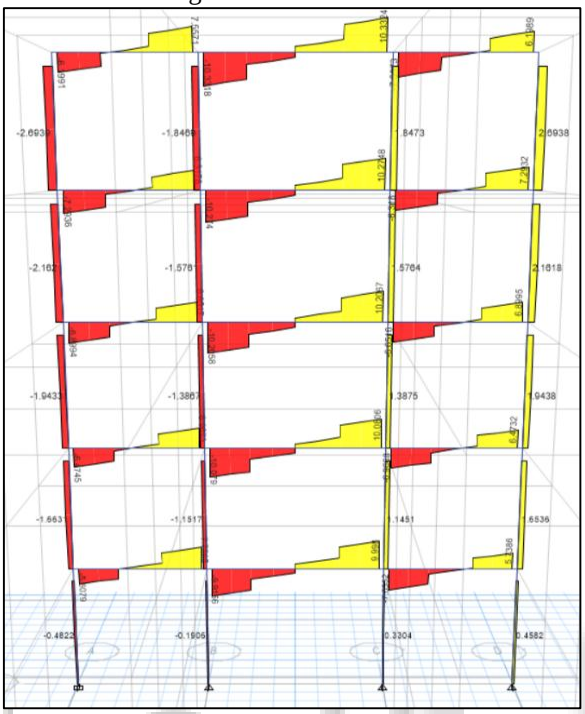

Fig. 4: Shear Force Diagram.

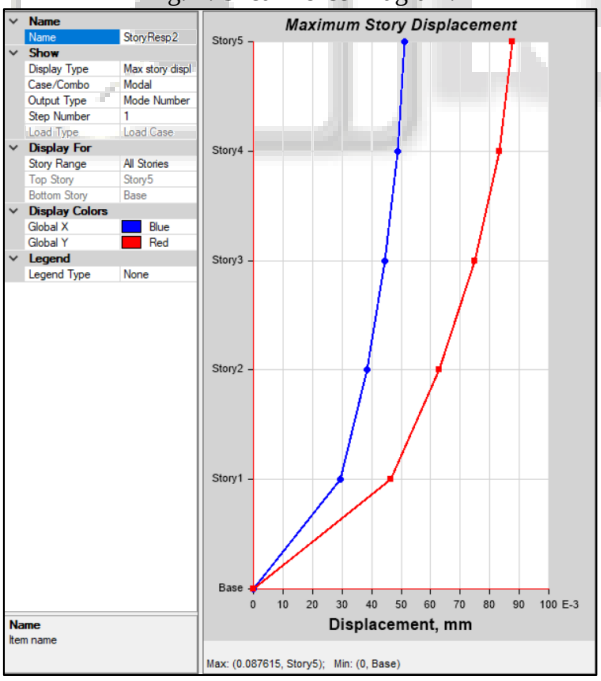

Fig. 5: Graph showing displacement in each storey (Output from ETABS).

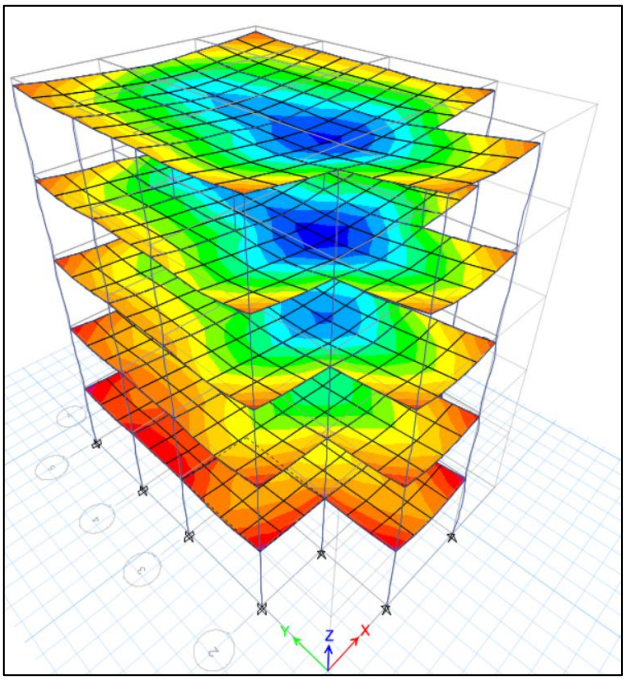

Fig. 6: Contour showing Stresses in Slab.

IX. CONCLUSION

Designing the same building with same configuration on both the software's i.e. STAAD Pro and ETABS, it is clear that ETAB gives best result for reinforcement data but in case of STAAD Pro the reinforcement is greater than the result taken from ETABS. This is the main reason which I found while going through this research. Secondly ETABS gives the reinforcement detailing with drawing in the form of distinct tables, while as STAAD Pro provides an output file through which we can find the design result one by one.

STAAD Pro shows the failure of beams and columns in output file by a tag line as given below:
For failed beams: - "Section fails while designing"
For failed columns: - "Section is not adequate"

But in case of ETABS failed members can be checked simply after design step. "Check failed members" in design section directly select those members and Design Engineer can change the section of those members by taking them in "view selected objects only". In case of STAAD Pro output file is checked page by page to know the beam no or column no which has failed. And then section is changed to those members to make them pass for the given loading. As far as this study is concerned STAAD Pro gives us multiple options for steel designing. STAAD Pro is good for analysis purpose as its workflow is simple and easy as compared to ETABS. ETABS consists of multiple steps to complete a design by assigning each parameter of design, whereas STAAD Pro needs to assign property after modelling and then specifying major factors only to get design output. The main points to know the difference are described below section wise.

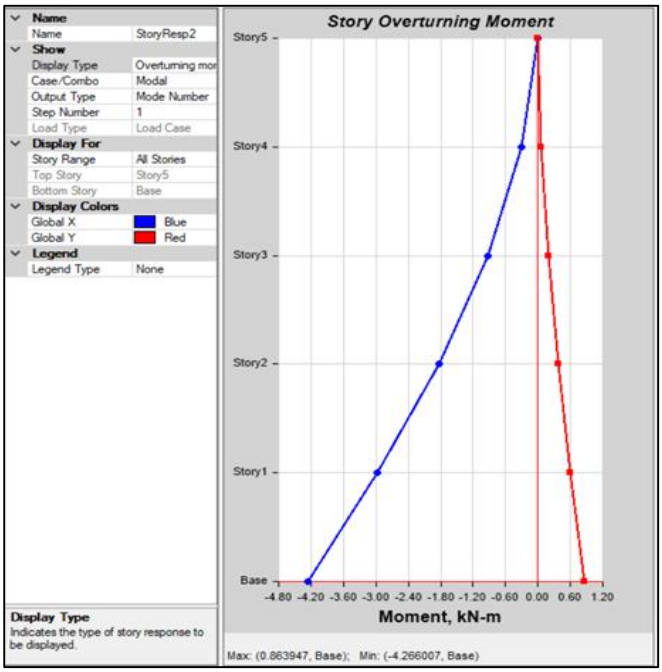

Fig. 7: Story Overturning Moment.

A. Analysis Time

Compared to ETABS, STAAD Pro is quite quick, which takes very less time to analyze a structure. Also, ETABS consumes more memory than STAAD Pro and reduces the PC's efficiency. In case of plate meshing STAAD pro takes some time depending on close meshing.

B. User Interface

With distinct display styles, both are fairly simple to work with. They're both simple to work with. STAAD Pro has no choice to storey-wise assign loads and provide storage information. But ETABS offers those that accelerate the job and make understanding easier. Both, however, have the group choice for quicker job. In a building project, structural design engineer performs multiple roles and duties providing technical information for the building site operations to be conducted. Structural engineering is a broader civil engineering discipline. It's a vast subject with endless methods and theories. It is a field that continues to develop with enormous inventions and thoughts. It is therefore of higher significance to be a structural engineer, the roles and duties to be assumed.

REFERENCES

[1] Richa Agarwal1, Prof. Archana Tiwari [2017] ISSN Comparison of Design Result of Multi Story Structure using ETABS and STAAD PRO Software.
[2] Sayyed A. Ahad, Hashmi S Afzal, Pathan Tabrej, Shaikh Ammar, Shaikh Vikhar, Shivaji Bidve [2017] International Journal of Engineering and Computer Science ISSN:2319-7242 Analysis and Design of Multistory Apartment Building Using ETABS.
[3] Tushar R. Agrawal Prof. P. B Kulkarni Nikhil S. Agrawal [2015] International Journal of Engineering and Computer Science Review Paper on Analysis of Multistoried Building with Infill Wall.
[4] Prashanth.P1, Anshuman.S2, Pandey. K3, Arpan Herbert4 [2012] All rights reserved Integrated Publishing services Comparison of design results of a Structure designed using STAAD PRO and ETABS Software.
[5] Ankit Purohit1, Lovish Pamecha [June 2017] SSRG International Journal of Civil Engineering (SSRG-IJCE) Seismic Analysis of G+12 Multistory Building Varying Zone and Soil Type.
[6] Rinkesh R Bhandarkar ,2Utsav M Ratanpara, 3Mohammed Qureshi [2016] International Journal of Engineering and Computer Science Seismic Analysis & Design of Multistory Building Using ETABS.
[7] Seismic Analysis & Design of Multistory Building Using ETABS [Apr-May 2017]] International Journal of Engineering and Computer Science A COMPTABILITY STUDY ON DESIGN AND ANALYSIS OF REINFORCED CONCRETE STRUCTURAL DESIGN USING SOFTWARE.
[8] Suchi Nag Choudhary, Pand Dr. P.S Bokare [June 2017] IJISET - International Journal of Innovative Science, Engineering & Technology, Dynamic Analysis of Multistory Building Using Response Spectrum Method and Seismic Coefficient Method -A Comparison.
[9] Mahesh Suresh Kumawat1* and L G Kalurkar [2014] International Journal of Innovative Science, Engineering & Technology ANALYSIS AND DESIGN OF MULTISTORY BUILDING USING COMPOSITE STRUCTURE.
[10] K. Naga Sai Gopal, N. Lingeshwaran [2017]] International Journal of Innovative Science, Engineering & Technology ANALYSIS AND DESIGN OF G+5 RESIDENTIAL BUILDING BY USING E-TABS.
[11] Sagar R Padol1, Rajashekhar S. Talikoti2 [2015] International Journal of Innovative Science, Engineering & Technology REVIEW PAPER ON SEISMIC RESPONSES OF MULTISTORED RCC BUILDING WITH MASS IRREGULARITY.
[12] Abhay Guleria (2014)Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations. Source:IJERT.
[13] Mahmad saber (2015) COMPARISON DESIGN RESULT OF RCC BUILDING USING STAAD AND ETABS SOFTWARE. Source:IJIRAE.
[14] Amanullah Qureshi, Ummer Farooq Pasha and N S Kumar (2016) COMPARATIVE STUDY ON HIGH-RISE BUILDING DUE TO EFFECT OF LATERAL FORCES USING ETABS. Source: IJARET.
[15] Balaji, Mr. Selvarasan M.E (2016) DESIGN AND ANALYSIS OF MULTISTOREYED BUILDING UNDER STATIC AND DYNAMIC LOADING CONDITIONS USING ETABS. Source: IJTRA.

