STRUCTURAL ANALYSIS OF RESIDENTIAL BUILDING USING ETABS

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Abstract : Structural Analysis involves the determination of behavior of structures in order to predict the response of different structural components due to action of loads. Each structure will be subjected to a combination of loads, such as dead load, live load, earthquake load and wind load. ETABS (Extended Three Dimensional Analysis of Building System) is a software which is programmed with all the major analysis engines such as static, dynamic, Linear and non-linear, etc. is used to analyze and design the buildings. This paper is an attempt to analyze and design a residential building using ETABS. A G+4 storey building Located in Kustagi (Tq) Koppal (Dist) is considered for this study. The Analysis is carried out by static method and design is done as per IS 456:2000 guidelines. Also, the design of all the structural elements are done manually. Drawing and detailing are done using Auto CAD.

IndexTerms **– Structural analysis, ETABS, Residential Building**

I. INTRODUCTION

An engineering structure is an assembly of members or elements transferring the load (or resisting external actions) and providing a form, space, an enclosure and/or a cover to serve the desired function. The structural design is a science and an art, with economy and elegance. A durable structure is one, which can safely carry the forces and can serve the desired function satisfactorily during its service life span without collapse under the most probable loads. The objective of structural design is to plan a structure, which meets the basic requirements such as Serviceability, Safety, Strength, Durability, Economy, Aesthetic beauty, Feasibility, Practicability and Acceptability. A creative sense, imagination, understanding and keen observation of structures, technical know how of the various aspects of structures, understanding of the various structural phenomena on basis of statistical and experimental data, and finally, backed by vast experience from the past, are some of the qualities, required for a structural engineer. So, it is necessary that a structural engineer not having a experience should try to acquire sound knowledge about the basic aspects in engineering a structure and structural design.

II. LITERATURE REVIEW

Abhay Guleria Undergr (2014) [1] analyzed a 15 storey building for structural behavior for different plan configurations like rectangular, C, L and I-shape using ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement were computed and then compared for all the analyzed cases. They concluded that asymmetrical plans undergo more deformation than symmetrical plans.

S Varalakshmi V et.al (2014) [2] analyzed a G+5 storey residential building and designed the various components like beam, slab, column and foundation. The loads namely dead load and live load were calculated as per IS 875(Part I & II)-1987 and HYSD bars i.e. Fe 415 are used as per IS 1986-1985. They concluded that the safety of the reinforced concrete building depends upon the initial architectural and structural configuration of the total building, the quality of the structural analysis, design and reinforcement detailing of the building frame to achieve stability of elements and their ductile performance.

Chandrashekar et.al (2015) [3] analyzed and designed the multi-storeyed building by using ETABS software. A G+5 storey building under the lateral loading effect of wind and earthquake was considered for this study and analysis is done by using ETABS. They have also considered the chances of occurrence of spread of fire and the importance of use of fire proof material up to highest possible standards of performance as well as reliability. They suggested that the wide chances of ETABS software which is very innovative and easier for high rise buildings so that time incurred for designing is reduced.

Balaji.U and Selvarasan M.E (2016) [4] worked on analysis and design of multi-storeyed building under static and dynamic loading conditions using ETABS. In this work a G+13 storey residential building was studied for the earth quake loads using ETABS. They assumed that material property to be linear, static and dynamic analyses were performed. The non-linear analysis was carried out by considering severe seismic zones and the behaviour was assessed by considering type II soil condition. Different results like displacements, base shear were plotted and studied.

Geethu et.al (2016) [5] made a comparative study on analysis and design of multi storied building by STAAD.Pro and ETABS softwares. They provided the details of both residential and commercial building design. The planning was made in accordance with the national building code and drafted using Auto CAD software. They concluded that while comparing both software results, ETABS software shows higher values of bending moment and axial force.

Mohith Y et.al (2017) [6] analyzed a G+3 storey residential building and designed the various components like beam, slab, column and foundation. The loads namely dead load and live load were calculated as per IS 875(Part I & II)-1987 and HYSD bars i.e. Fe 415 are used as per IS 1986-1985. They concluded that the ETABS is the perfect software which can be adopted for analysis and design.

III. OBJECTIVES

From the above literature review the following objectives are made;

1. The main objective of this study is to analyze and design a G+3 commercial building using ETABS software.
2. To design structural components like beam, slab, column and footing manually.
3. Comparison of results obtained from ETABS software with a manual method.
4. To draw and give reinforcement details of structural components by using Auto CAD.

IV. MATERIALS SPECIFICATIONS

Grade of Concrete, fck= 30 N/mm^2
Grade of Steel fy= 415 N/mm^2
Density of Concrete ϒc= 25 kN/m^3
Density of Brick walls considered ϒbrick= 19 kN/m^3

V. METHODOLOGY

To achieve the objectives of the study, that is to analyze and design residential building using ETABS and by manual method, which meets the basic requirements such as safety, durability, economy, aesthetic appearance, feasibility, practicability and acceptability. It has been proposed to follow the following methodology.

5.1 Surveying

Surveying is a basic tool for a Civil engineering science. Before any civil engineering work has to start, surveying has to be done and then we must prepare a plan or map of the area showing topographical details related to design of structure etc.

5.2 Soil Investigation

Good planning and management of a geotechnical site investigation is the key to obtaining sufficient site information for designing a structure in a timely manner and with minimum cost for the effort needed. The engineering properties of soil like water content, density and SBC are calculated by conducting tests in laboratory.

5.3 Structural Planning

This stage involves the determination of the following

a) Type of structure(like load bearing or framed).
b) Form of structure (like slab-beam, grid or shell).
c) Geometry and layout, which include determination of positioning of columns, beams and so on.
d) Type of materials, particularly grades of steel and concrete, method of construction (like RCC, steel, PSC, cast-in-situ, precast).
e) Involves determination of external loads action on the structure and design loads.

Fig.1. Ground floor plan

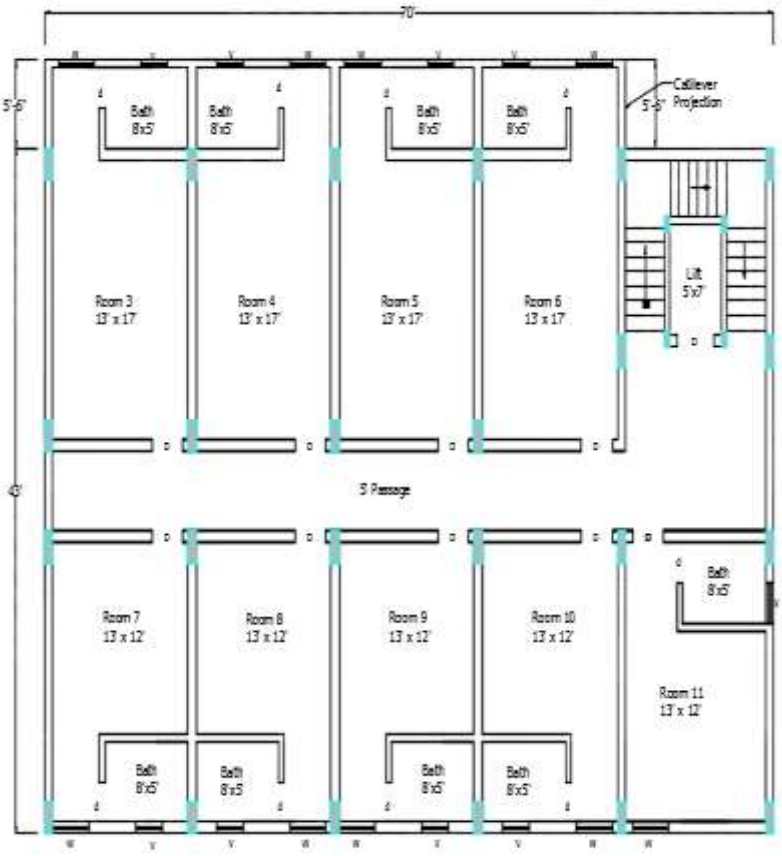

Fig.2. Typical floor plan

5.4 Analysis in ETABS and Manual design

It involves analysis of the structure for the determination of internal member forces (like bending moment and shear forces) in the members and behavior of structures under the action of these forces.This stage also involves the determination of member dimension, quantities and detailing of reinforcement to resist the design forces. This stage forms the core and substance of design.

The center line diagram is prepared and imported to ETAB model, and the following step by step procedures are followed:

Step1: Defining of property

New material in the defining material property the concrete of M30 and steel of grade Fe415. For our work the size of structural components (beams, columns, and slabs) are taken as follows.

Beam size: 230mm x 450mm

Column size: 230mm x 600mm, 230mm x 450mm, 150mm x 300mm

Slab Thickness: 150mm

Step2: Assigning of Property

After defining the property we have to draw the structural components and create columns in region for columns.

Step3: Assigning of Supports

By keeping the plan at the base of the structure and selecting all the columns supports fixed supports are assigned.

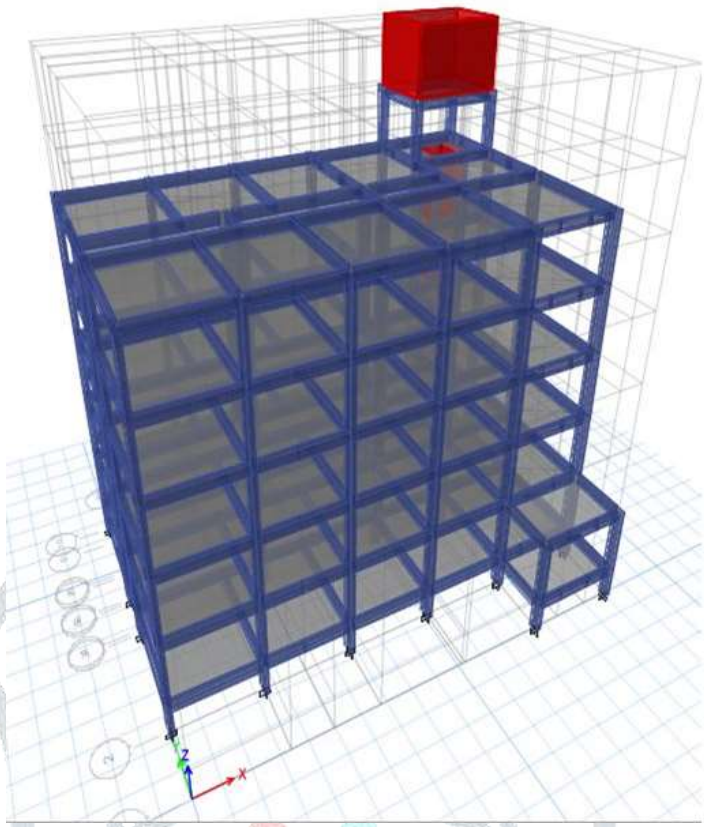

Fig.3. 3D Elevation of Model

Step4: Defining of loads

Dead load of wall (230mm thick) 11.14 kN/m, live load of 4 kN/m^2 and floor finish of 1KN/m^2 was defined.

Step5: Analysis

After the completion of all the above steps analysis was performed and checked for errors.

Step6: Design

Structural components like beam, slab, column and footing are designed manually.

5.5 Verification by manual method

It involves verification of analysis of the structure done by using ETABS by manual methods of analysis.

5.6 Detailing

Drawing, detailing, scheduling and specifications.This stage involves preparation of working drawing, giving sizes of members, detailing of reinforcement, preparing bar bending schedules and schedule of quantities giving specifications of material loads and special instructions, if any.

VI. RESULTS AND DISSCUSSIONS

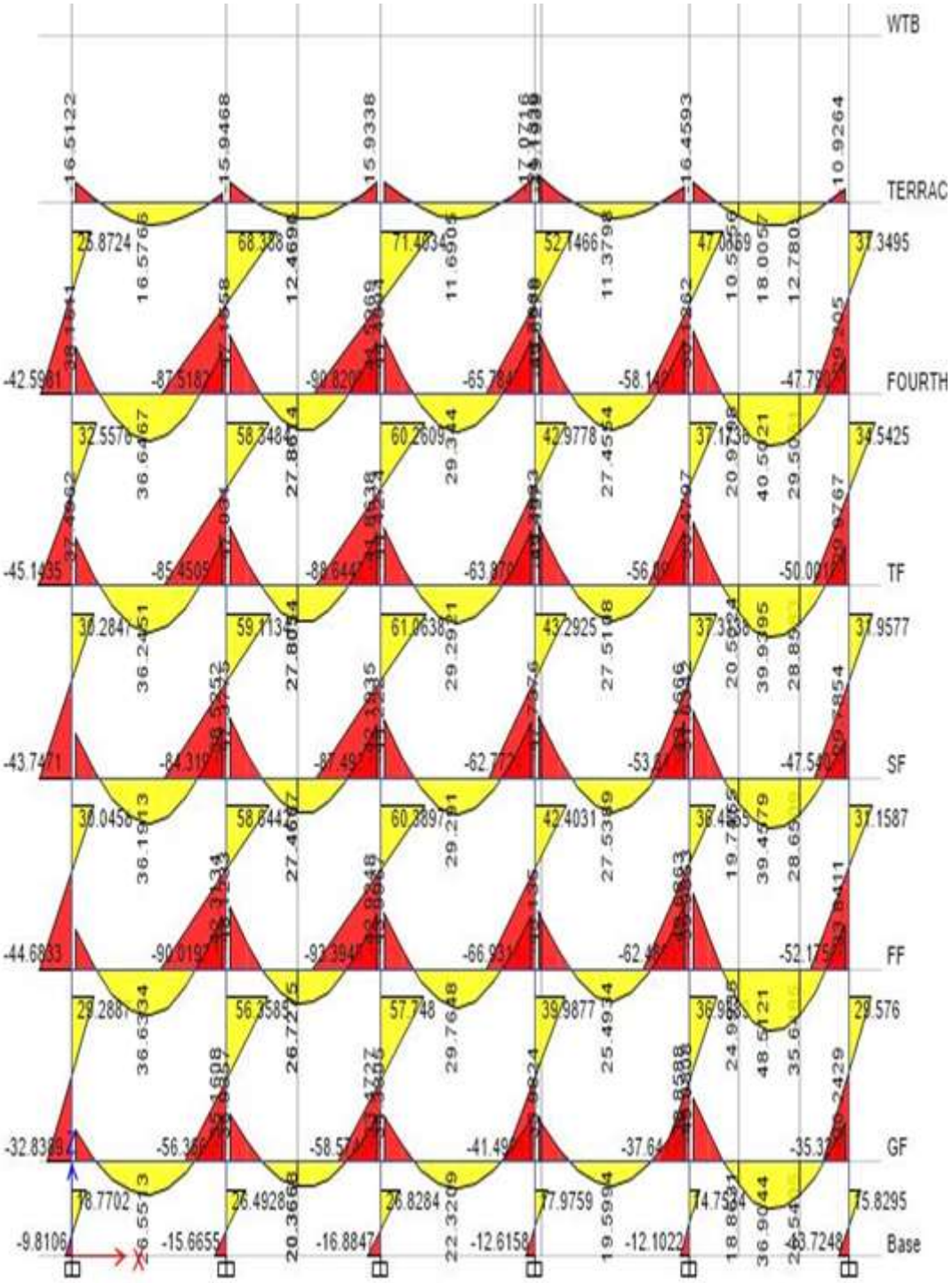

Fig.4. Bending moment Diagram

Maximum support moment = 59.95 kN – m
Maximum Mid span moment =48.513 kN – m

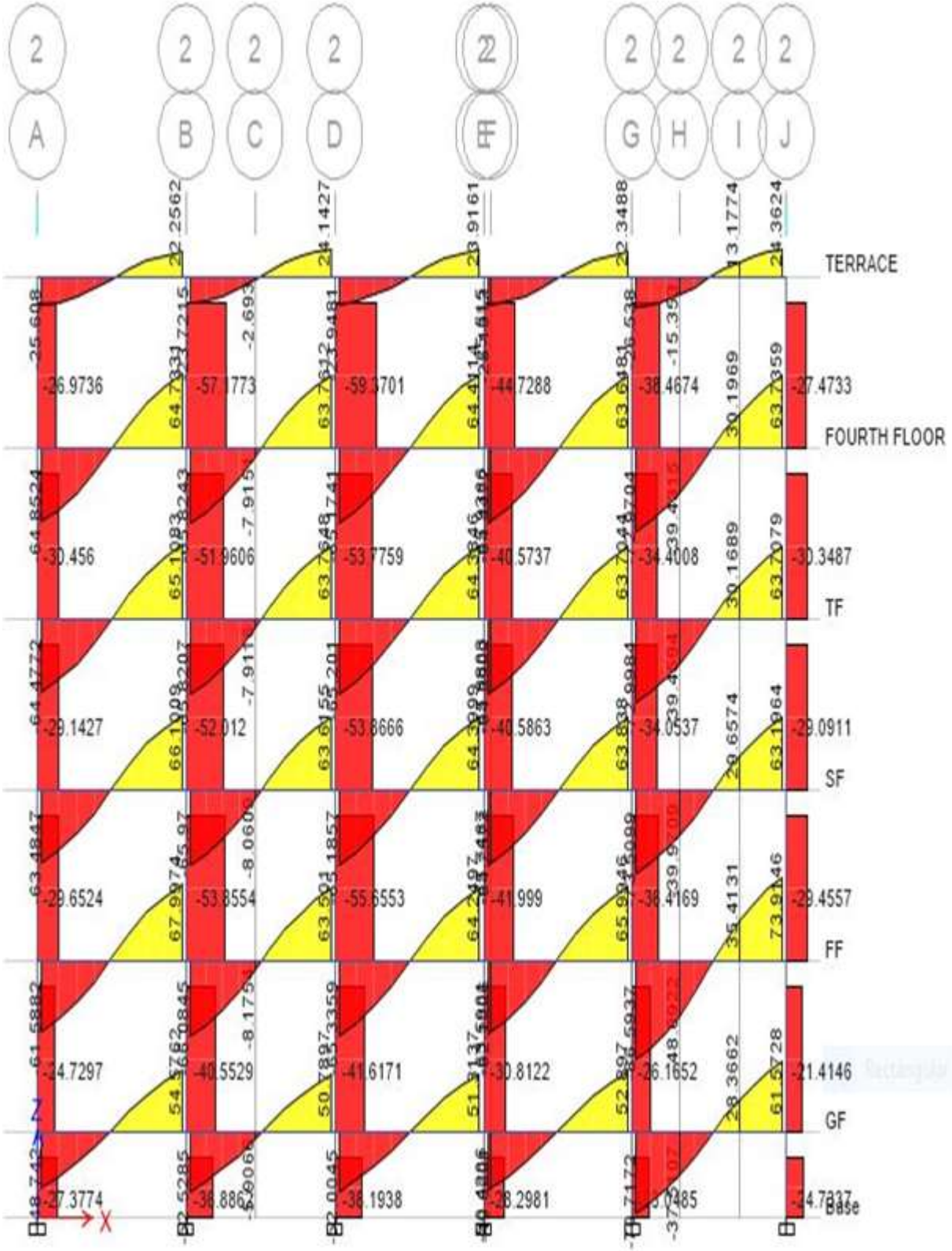

Fig.5. Shear Force Diagram

Maximum Shear Force = 48.10 kN

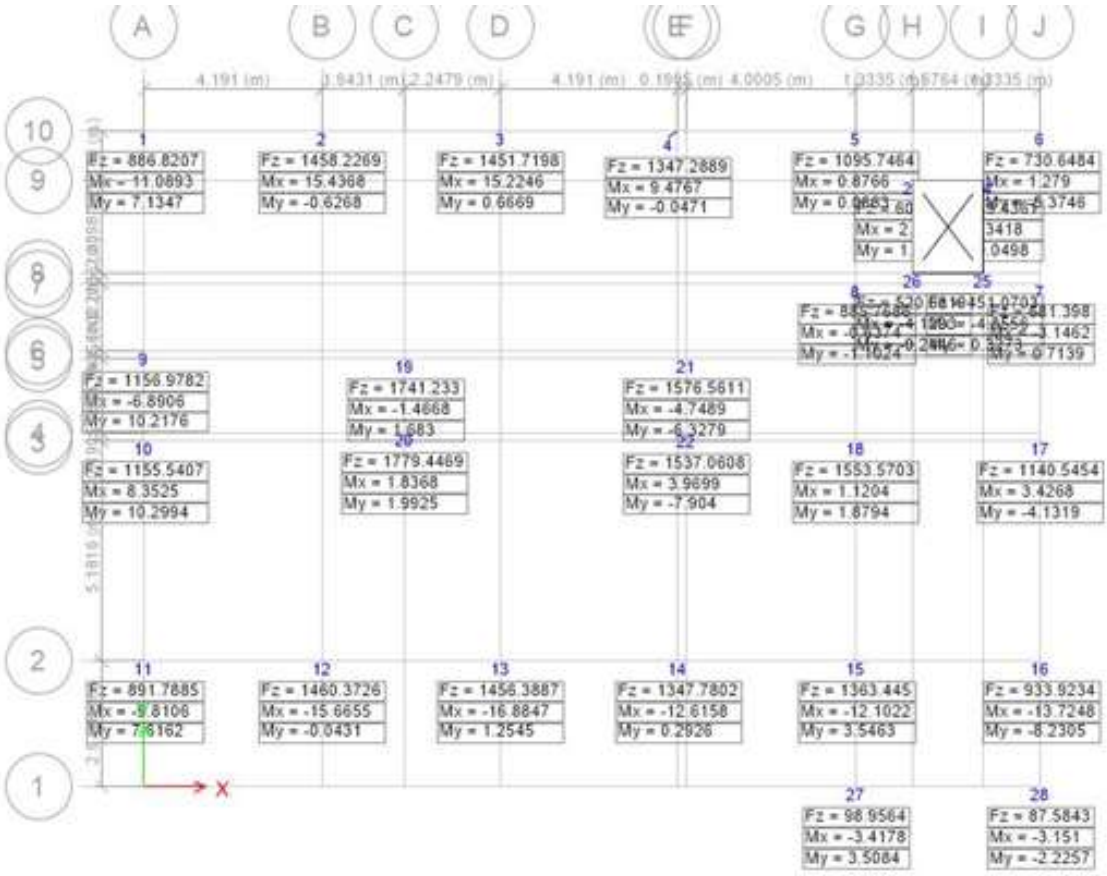

Fig.6. Support Reactions

Column size: 230mm x 600mm

Column Load= 1779.45 kN
Column Moment = 37.34 kN-m

Column size:230mm x 450mm

Column Load= 98.956 kN
Column Moment = 3.306kN-m

Column size:150mm x 300mm

Column Load= 608.63 kN
Column Moment = 1.225 kN-m

VII. CONCLUSIONS

From the data revealed by the manual design as well as software analysis for the structures following conclusions are drawn:

1. Analysis was done by using ETABS software and successfully verified manually as per IS456:2000.
2. Calculation by both manual work as well as software analysis gives almost same result.
3. Sizes of the beams provided is 230mmX450mm and Columns provided are 230mmX600 mm, 230mmX450 mm and 150mm x 300mm which comes under economic.
4. There is a gradual increase in the value of lateral forces from bottom floor to top floor in software analysis.
5. Maximum Shear force is 48.1 kN and Maximum Bending Moment value is 59.95kN-m,Maximum load for which columns and footings designed are 1779.45 kN .
6. Usage of ETABS software minimizes the time required for analysis and design.

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