International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 09 Issue 10 ǁ 2021 ǁ PP. 69-76

Analysis and Design of Commercial Building by Using E-TABS 2021

SANATH KUMAR K P
(Student at dept of Structural engineering, NCET Bangalore)

Manohar D R
(Associate Professor at dept of civil engineering, NCET Bangalore)

Abstract
In every aspect of human civilization we need building structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it is made for. Here comes the role of civil engineering and more precisely the role of analysis of structure. The present design consists of G+6commercial building. The floor to floor distance is 3.6m. There are many classical methods to solve the design problems and with time new softwares are also coming into play. Here in this project work based on software named "ETABS", design and analysis of multistoried G+6 building using RCC structure are carried out.
ETABS are the effective software's which are used for the purpose of analysis and design of structure by the structural engineers. These software's give more precise and accurate results than manual techniques.
ETABS was used to create the mathematical model of the BurjKhalifa(UAE). The input, output and numerical solution techniques of ETABS are specifically designed to take advantage of the unique physical and numerical characteristics associated with building type structures. ETABS provides both static and dynamic analysis for wide range of gravity, thermal and lateral loads.
In this project I analyse and design the multi-storey building using ETABS. Comparing results obtained by softwares and justifying economical one or to decide best software to adopt for design and to increase the number of storey of the structure.

Date of Submission: 28-09-2021 Date of acceptance: 11-10-2021

I. INTRODUCTION

The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design is used to produce a structure capable of resisting all applied loads without failure during its intended life. Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation. A geotechnical site investigation is the process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation for a structure. Structural engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. Now days various software packages are available in market for analyzing and designing practically all types of structures.

1.1OBJECTIVES:

1. The main objective of this study is to analyze and design a G+1 residential building using ETABS software
2. Creating structural plan
3. Modeling
4. Loading
5. Analysis
6. To design structural components like beam, slab, column and footing manually
7. To draw and give reinforcement details of structural components by using Auto CAD.
8. Design by using IS-456

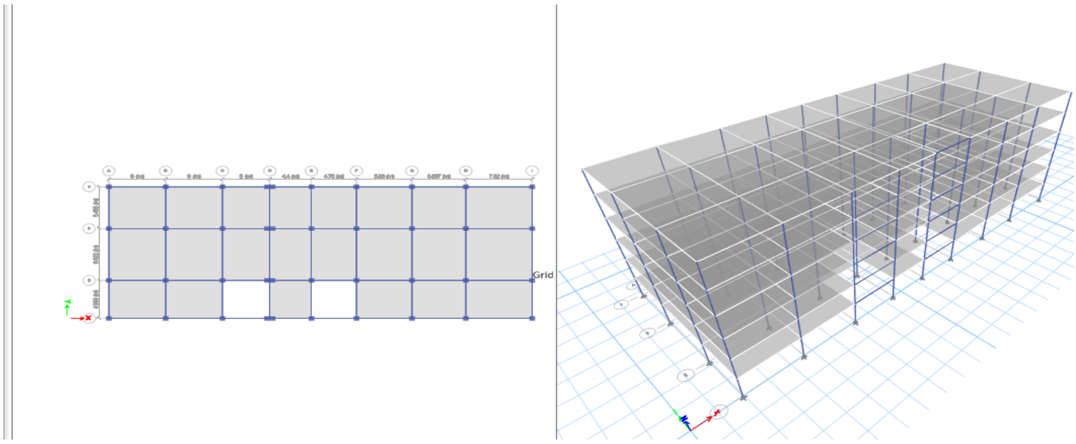
1.2 SCOPE:

- Modelling of the building using ETABS

II. METHODOLOGY:

The process of structural design involves the following stages.

I Structural planning.
II. Estimation of Loads
III. Analysis of structure
IV. Member design
V. Drawing, detailing and preparation of schedule



1.3 Structural Planning:

This involves determination of the form of the structure, the material for the same, the structural system, the layout of its components, the method of analysis and the philosophy of structural designs.

The principle elements of a R.C. C building frame are as follows:

i. Slabs to cover large area
ii. Beams to support slabs and walls
iii. Columns to support beams
iv. Footings to distribute concentrated column loads over a large area of the supporting soil

After getting an architectural plan of the building, the structural planning of the building frame is done. This involves determination of the following.

a) Column position
b) Beam locations
c) Spanning of slabs
d) Layout and planning of stairs
e) Type of footing

a) Positioning of columns:

Following are some of the guiding principle which helps in deciding the column positions. Columns should preferably be located at or near the corners of a building and at the intersection of walls, because basically the function of column is to supports beams which are normally placed under the walls to support them. There can however, be an exception in case of columns in walls on the property line. Since column footing requires certain area beyond the column, the column may be shifted inside along across wall to make room for accommodating the footing within the property.

Orientation of Column:

Normally, columns provided in a building are rectangular with width of column not less that the width of the supported beam for effective load transfer. As far as possible the width of column is also not exceed the thickness of the wall to avoid offsets. Restriction on the width of column necessitates the other sides of columns to be larger to get the desired load carrying capacity.

b) Positioning of Beams:

Following are some of the guiding principles for positioning of beams:

1. Beams shall normally be provided under the walls or below a heavy concentrated load to avoid these loads directly coming on slabs. Basic principle in deciding the layout of component members is that heavy load should be transferred to the foundation along the shortest path.
2. Since beams are primarily provided to support slabs, its spacing shall be decided by the maximum span of slabs. Slab requires the max. volume of concrete to carry a given load (i.e. its volume / load ratio is very high compare to other components). Therefore the thickness of slab is required should be kept minimum. The max practical thickness for residential / office / public buildings is 200mm, while the minimum is 100mm. The max and min. spans of slabs which decide the spacing of beams are governed by loading and limiting thickness is given above.

C) Spanning of Slabs:

This is decided by positions of supporting beams or walls. While the supports are only on opposite side or only in one direction then the slab acts as a one-way supported slab. When the slab is supported into two perpendicular directions it acts as a two-way supported slab. However, the two action of slab does not depend only on the manner in which it is supported but also on the aspect ratio Ly / Lx (the ratio of long span Ly to short span Lx), the ratio of reinforcement in the two directions (A_{stx}/A_{sty} or M_{ux} / M_{uy}), and the boundary conditions. Therefore, designer is free to decide as to whether the boundary conditions. Therefore, designer is free to decide as to whether the slab should be designed as one-way or two-way. This decision may be taken considering the following points.

1. A slab acts as a two-way slab when the aspect ratio Ly/Lx less than 2, slab with Ly/Lx > 2 is designed as a one-way.
2. A two-way slab is generally economical compare to one-way slab because steel along both the span acts as main steel and transfers the load to all the four supports, while in one way slab main steel is provided along the short span only and the load is transferred to two opposite supports only. The steel along the long span just act as distribution steel and is not designed for transferring the load.
3. A slab having supports on all sides but have Ly/Lx < 2 can be made to act as a one-way slab spanning across the short span by providing main steel along the short span and only distribution steel along the long span in such case provision of more steel in one direction increases the stiffness of the slab in that direction.

d) Layout of Stairs

The type of stairs and its layout is governed essentially by the available size of staircase room and the positions of beams and columns along the boundary of the staircase. Following are some useful guidelines in deciding the layout of stairs.

1. The stair slab in general are heavy compare to floor slabs because of (i) heavy dead load due to inclined length of slab acting over horizontal span, and due to additional weigh to steps (ii) greater live load on stairs than that on floors. Therefore longer span for the flights be avoided as far as possible.
2. Stair flights shall preferably be supported on beams or walls. Supporting the flight on landing slabs should be voided as far as possible. Especially when the span of landing slabs exceeds twice the width of stair, because this causes stress concentrations in the supporting landing slab at their junction.

e) Choice of Footing Type:

The type of footing depends upon the load carried by the column and the bearing capacity of the supporting soil. For framed structure under study, isolated column footings are normally preferred except in case of soil with low bearing capacities. If such soil or black cotton soil exists for greater depth pile foundation can be an appropriate choice. If columns are very closely spaced and bearing capacity of soil is low raft foundation can also be an alternative solution.

1.4. Marking of Frame Components:

Before starting the structural design of R.C. Frame components it is always necessary to mark or designate them first to facilitate identification, listing and scheduling. The different schemes adopted for marking or identification, listing, and scheduling recommended by SP-34 Code of practice.

1.5 Common Building Components are:

1. Super structure
2. Sub structure

1. Super Structure:

The superstructure is that part of the building which is above the ground and which serves the purpose of building's intended use. It includes

1. Plinth
2. Wall and columns
3. Beams
4. Arches
5. Roofs and slabs
6. Lintel and arches
7. Chajjas
8. Parapet
9. Steps and stairs

Loads on superstructure: The various loads considered acting on the structure are as follows:

a) Dead load & super imposed dead load (IS875 Part-I)
b) Live load (IS875 Part-II)

Besides dead load and live load, the wind load can be required to be considered in building design, since for building up to G+3storey's wind load is not considered.

2. Substructure:

The substructure is the lower portion of the building, whichislocatedbelowgroundlevelwhichtransmitstheloadofthesuperstructuretothesubsoil, and itincludes

Foundation: Requirements of foundation are as follows:

1. Foundation should be sufficiently strong to prevent excessive settlement as well as unequal settlement.
2. The code has rightly warned that the structure shall not be constructed on such loose soils which will subsidies during an earth quake resulting in large differential settlement.
3. For designing the foundation, bearing capacity of supporting soil is required.

In case of black cotton soil, loose fine sand and expensive clay use of raft foundation or pile foundation may be adopted.

III. RESULTS AND DISCUSSIONS:

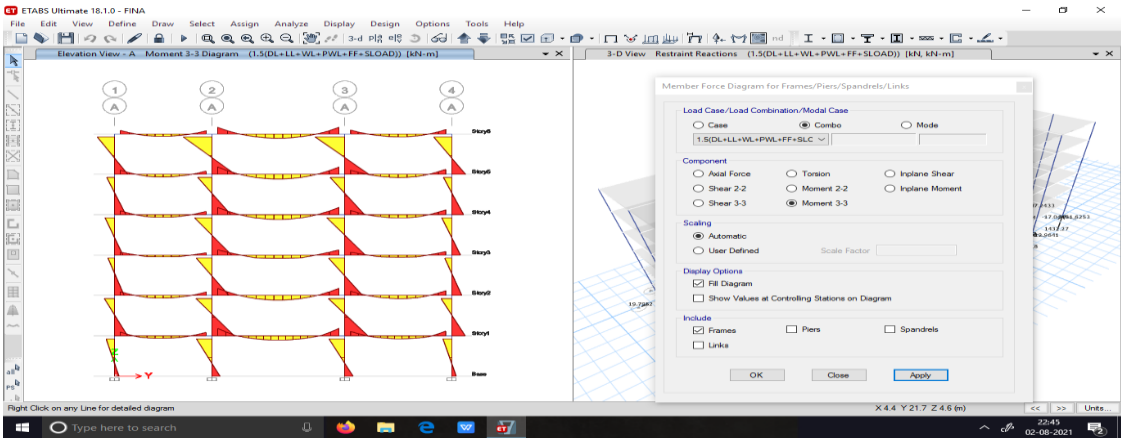


Fig. BENDING MOMENT DIAGRAM

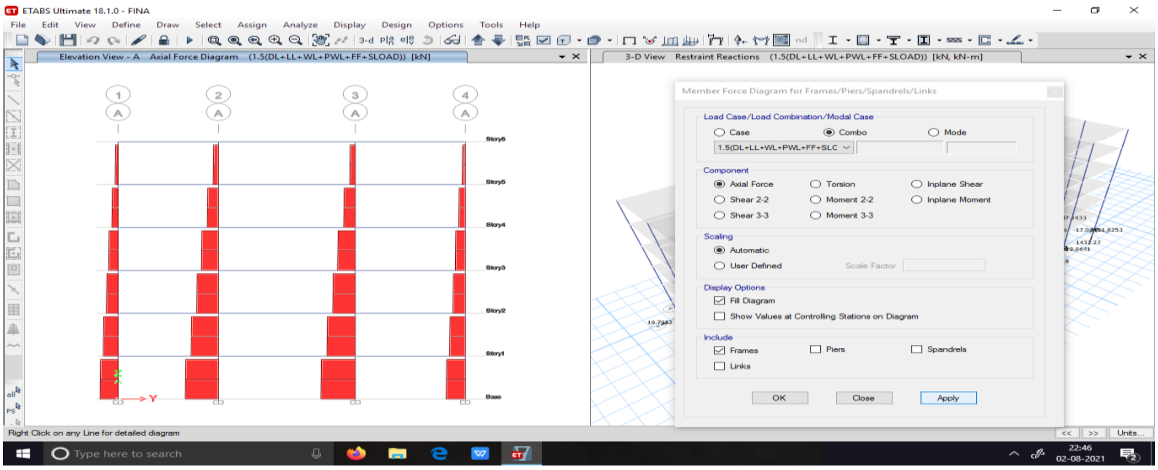


Fig 4.4 AXIAL FORCE DIAGRAM

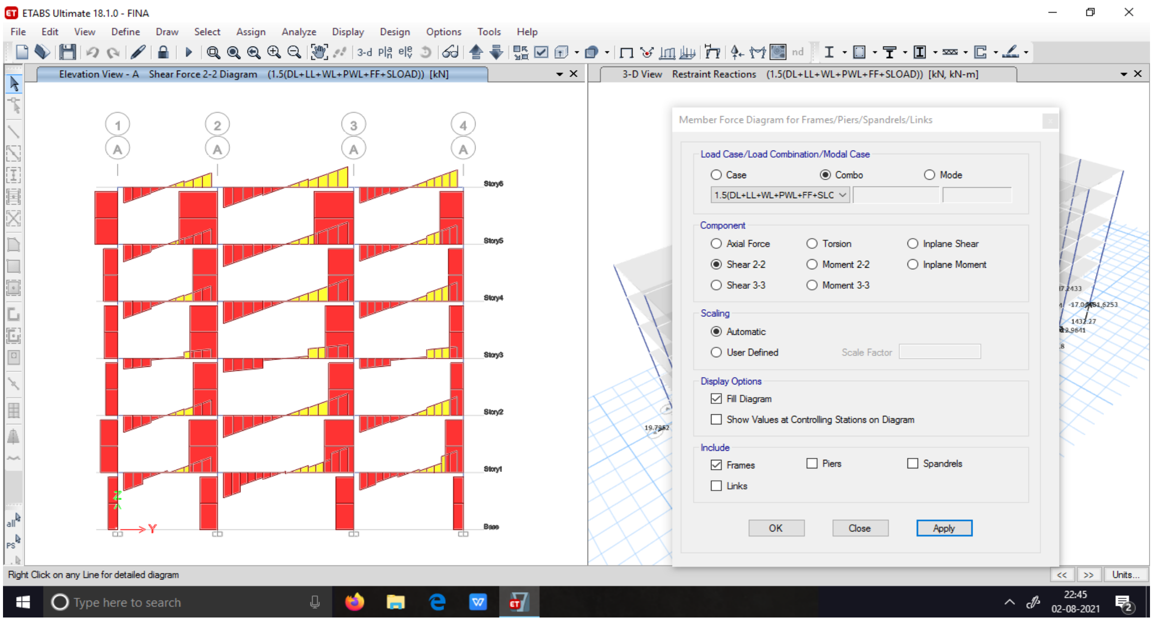


Fig 4.5Shear force diagram

COLUMN & BEAM FORCES

Story	Column	P	V2	V3	T	M2	M3
Story3	C1	-163.5494	40.5379	17.6343	-0.0763	24.4556	52.9695
Story3	C1	-159.3055	40.5379	17.6343	-0.0763	1.3106	-0.2365
Story3	C1	-155.0617	40.5379	17.6343	-0.0763	-21.8345	-53.4425
Story3	C2	-231.5116	-19.4702	24.5703	-0.0292	34.219	-25.0739
Story3	C2	-227.2678	-19.4702	24.5703	-0.0292	1.9704	0.4808
Story3	C2	-223.0239	-19.4702	24.5703	-0.0292	-30.2781	26.0355
Story3	C3	-182.6886	22.9306	13.1536	-0.0402	18.3086	30.5249
Story3	C3	-178.4447	22.9306	13.1536	-0.0402	1.0445	0.4285
Story3	C3	-174.2009	22.9306	13.1536	-0.0402	-16.2195	-29.6679
Story3	C4	-116.1542	-25.8063	6.1971	-0.0033	8.6046	-32.0538
Story3	C4	-111.9104	-25.8063	6.1971	-0.0033	0.471	1.8169
Story3	C4	-107.6665	-25.8063	6.1971	-0.0033	-7.6627	35.6876
Story3	C5	-284.7115	47.5869	-4.251	-0.0326	-5.9777	65.3456

Story3	C5	-280.7101	47.5869	-4.251	-0.0326	-0.7171	6.4568
Story3	C5	-276.7088	47.5869	-4.251	-0.0326	4.5436	-52.432
Story3	C6	-177.2976	-39.1743	0.1525	-0.0234	0.2536	-48.7163
Story3	C6	-173.0537	-39.1743	0.1525	-0.0234	0.0534	2.6999
Story3	C6	-168.8098	-39.1743	0.1525	-0.0234	-0.1468	54.1162
Story3	C7	-154.4684	41.3041	-9.4815	-0.0327	-13.1532	54.1275
Story3	C7	-150.2245	41.3041	-9.4815	-0.0327	-0.7088	-0.0841
Story3	C7	-145.9806	41.3041	-9.4815	-0.0327	11.7357	-54.2957
Story3	C8	-229.0551	-9.0783	-15.5721	0.0089	-21.8117	-11.5043
Story3	C8	-224.8112	-9.0783	-15.5721	0.0089	-1.3734	0.411
Story3	C8	-220.5673	-9.0783	-15.5721	0.0089	19.065	12.3262
Story3	C9	-120.3716	-6.4537	-17.8829	-0.1807	-24.6449	-8.4674
Story3	C9	-116.1278	-6.4537	-17.8829	-0.1807	-1.1735	0.0031
Story3	C9	-111.8839	-6.4537	-17.8829	-0.1807	22.2979	8.4736
Story3	C10	-420.1852	10.9013	-8.6052	-0.0751	-11.9695	14.6189
Story3	C10	-416.1839	10.9013	-8.6052	-0.0751	-1.3206	1.1285
Story3	C10	-412.1825	10.9013	-8.6052	-0.0751	9.3283	-12.3618
Story3	C11	-249.3018	-1.5605	-4.0043	0.00001942	-5.6737	-1.9135
Story3	C11	-245.0579	-1.5605	-4.0043	0.00001942	-0.418	0.1347
Story3	C11	-240.8141	-1.5605	-4.0043	0.00001942	4.8377	2.1829
Story3	C12	-126.7379	-39.7672	-5.1795	0.032	-7.2426	-48.1598
Story3	C12	-122.494	-39.7672	-5.1795	0.032	-0.4445	4.0346
Story3	C12	-118.2501	-39.7672	-5.1795	0.032	6.3536	56.2291
Story2	C1	-333.9328	19.5563	10.0505	-0.0021	13.0426	28.0352
Story2	C1	-329.6889	19.5563	10.0505	-0.0021	-0.1487	2.3675
Story2	C1	-325.4451	19.5563	10.0505	-0.0021	-13.3399	-23.3002
Story2	C2	-465.681	-8.8099	14.7238	-0.0297	19.6402	-9.6559
Story2	C2	-461.4371	-8.8099	14.7238	-0.0297	0.3152	1.9071
Story2	C2	-457.1932	-8.8099	14.7238	-0.0297	-19.0099	13.47
Story2	C3	-367.5474	12.1442	7.8254	-0.0065	10.4873	18.5857
Story2	C3	-363.3035	12.1442	7.8254	-0.0065	0.2165	2.6464
Story2	C3	-359.0597	12.1442	7.8254	-0.0065	-10.0544	-13.2929
Story2	C4	-236.5355	-14.0411	4.0912	-0.024	5.8018	-19.1737
Story2	C4	-232.2916	-14.0411	4.0912	-0.024	0.432	-0.7448
Story2	C4	-228.0478	-14.0411	4.0912	-0.024	-4.9377	17.6841
Story2	C5	-568.4508	24.7306	-1.4995	-0.0021	-1.3903	33.0082
Story2	C5	-564.4494	24.7306	-1.4995	-0.0021	0.4653	2.404
Story2	C5	-560.4481	24.7306	-1.4995	-0.0021	2.3208	-28.2001
Story2	C6	-352.0897	-17.5253	0.1075	-0.0564	0.1706	-22.5069
Story2	C6	-347.8458	-17.5253	0.1075	-0.0564	0.0296	0.495
Story2	C6	-343.6019	-17.5253	0.1075	-0.0564	-0.1115	23.4969
Story2	C7	-316.9492	20.9732	-6.5345	-0.0014	-9.505	29.9158
Story2	C7	-312.7054	20.9732	-6.5345	-0.0014	-0.9285	2.3884

Story2	C7	-308.4615	20.9732	-6.5345	-0.0014	7.648	-25.1389
Story2	C8	-455.4308	-3.2454	-8.8584	-0.0282	-11.4579	-2.3863
Story2	C8	-451.187	-3.2454	-8.8584	-0.0282	0.1687	1.8733
Story2	C8	-446.9431	-3.2454	-8.8584	-0.0282	11.7953	6.1329
Story2	C9	-248.2835	-4.3493	-11.8273	0.2181	-16.7176	-4.9824
Story2	C9	-244.0396	-4.3493	-11.8273	0.2181	-1.1943	0.7261
Story2	C9	-239.7958	-4.3493	-11.8273	0.2181	14.329	6.4346
Story2	C10	-820.1691	6.2783	-4.3106	0.0194	-4.47	8.8113
Story2	C10	-816.1677	6.2783	-4.3106	0.0194	0.8644	1.0419
Story2	C10	-812.1663	6.2783	-4.3106	0.0194	6.1987	-6.7274
Story2	C11	-489.4629	-1.7783	-3.5779	-0.0641	-4.6347	-3.3833
Story2	C11	-485.219	-1.7783	-3.5779	-0.0641	0.0614	-1.0493
Story2	C11	-480.9751	-1.7783	-3.5779	-0.0641	4.7574	1.2847
Story2	C12	-257.5332	-21.545	-3.5789	-0.0879	-5.0324	-31.0656
Story2	C12	-253.2894	-21.545	-3.5789	-0.0879	-0.3351	-2.7879
Story2	C12	-249.0455	-21.545	-3.5789	-0.0879	4.3622	25.4899
Story1	C1	-442.7016	23.3705	11.829	0.0233	5.8733	13.6684
Story1	C1	-440.8828	23.3705	11.829	0.0233	-0.7805	0.5225
Story1	C1	-439.064	23.3705	11.829	0.0233	-7.4344	-12.6234
Story1	C2	-639.42	-9.427	18.5719	0.0504	9.0003	-1.0765
Story1	C2	-637.6012	-9.427	18.5719	0.0504	-1.4464	4.2262
Story1	C2	-635.7824	-9.427	18.5719	0.0504	-11.8931	9.5289
Story1	C3	-514.2574	17.3324	10.1457	0.0107	4.9818	11.2089
Story1	C3	-512.4386	17.3324	10.1457	0.0107	-0.7252	1.4594
Story1	C3	-510.6198	17.3324	10.1457	0.0107	-6.4321	-8.2901
Story1	C4	-336.0667	-22.047	6.2057	0.0216	3.0471	-6.3025
Story1	C4	-334.2479	-22.047	6.2057	0.0216	-0.4436	6.099
Story1	C4	-332.4291	-22.047	6.2057	0.0216	-3.9343	18.5004
Story1	C5	-748.3985	26.4713	0.8079	-0.006	0.5761	15.8556
Story1	C5	-746.8222	26.4713	0.8079	-0.006	0.1822	2.9508
Story1	C5	-745.2459	26.4713	0.8079	-0.006	-0.2117	-9.954
Story1	C6	-479.8171	-19.1612	0.0287	0.0985	0.088	-4.4086
Story1	C6	-477.9983	-19.1612	0.0287	0.0985	0.0719	6.3695
Story1	C6	-476.1795	-19.1612	0.0287	0.0985	0.0558	17.1477
Story1	C7	-434.7869	25.2102	-10.6123	-0.0004	-4.8791	14.5365
Story1	C7	-432.9681	25.2102	-10.6123	-0.0004	1.0904	0.3558
Story1	C7	-431.1493	25.2102	-10.6123	-0.0004	7.0598	-13.8249
Story1	C8	-607.4294	-2.9836	-9.9734	0.022	-4.7157	1.9074
Story1	C8	-605.6106	-2.9836	-9.9734	0.022	0.8944	3.5857
Story1	C8	-603.7918	-2.9836	-9.9734	0.022	6.5044	5.264
Story1	C9	-354.2557	-7.3646	-18.0906	-0.3515	-8.522	0.0814
Story1	C9	-352.4369	-7.3646	-18.0906	-0.3515	1.654	4.224
Story1	C9	-350.6181	-7.3646	-18.0906	-0.3515	11.83	8.3665

Story1	C10	-1060.9944	9.0872	-2.0138	-0.0202	0.4845	3.9008
Story1	C10	-1059.4181	9.0872	-2.0138	-0.0202	1.4663	-0.5292
Story1	C10	-1057.8418	9.0872	-2.0138	-0.0202	2.448	-4.9592
Story1	C11	-661.3282	-5.8422	-5.0001	0.1007	-0.8989	-2.969
Story1	C11	-659.5094	-5.8422	-5.0001	0.1007	1.9137	0.3173
Story1	C11	-657.6906	-5.8422	-5.0001	0.1007	4.7262	3.6035
Story1	C12	-362.8314	-24.3872	-5.6676	0.1322	-2.6389	-4.377
Story1	C12	-361.0126	-24.3872	-5.6676	0.1322	0.5491	9.3408
Story1	C12	-359.1938	-24.3872	-5.6676	0.1322	3.7371	23.0586

IV. CONCLUSION

1. This project is mainly concentrated with the analysis and design of multi-storied residential building with all possible cases of the loadings using ETAB software Meeting the design challenges are described in conceptual way.
2. Short term deflection of all horizontal members is within 20mm.
3. The structural components of the building are safe in shear and flexure.
4. Maximum size of column and beam required is 230mmx375mm.
5. Maximum thickness of slab provided is 125mm.
6. There is no such large difference in analysis results of Etabs and Kanis method.
7. Proposed sizes of the elements can be used in the construction of this building.
8. Usage of ETABS software minimizes the time required for analysis and design

REFFERENCES:

Journals

[1]. Varalakshmi V,G shivakumar and R S Sarma (2014) “Designed and d G+5 residential building by ETABS”, International Conference on Advance in Engineering and Technology.

[2]. Chandrashekar and Rajashekar (2015), “Analysis and Design of Multi Storied Building by Using ETABS Software”, International journals of scientific and research vol.4: issue.7: ISSN no. 2277-8179.

[3]. Balaji and Selvarasan (2016), “Design and Analysis of multi-storeyed building under static and dynamic loading conditions using ETABS”, International Journal of Technical Research and Applications e-ISSN: 2320-8163, www.ijtra.com Volume 4, Issue 4, PP. 1-5

[4]. Geethu S N, Depthi M, Abdul Nasir N A and Izzudeen K M(2016) “Comparative study on design and analysis of multi storied building by STAAD.Pro and ETABS softwares”.

[5]. Aman, Manjunath Nalwadgi, Vishal, Gajendra Analysis And Design Of Multi-Storey Building By Using STAAD Prointernational Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 06 | June-2016

[6]. C.V.S. Lavanya, Emily.P.Pailey, Md. Mansha Sabreen and U.P.B.C. Sekhar, Analysis and Design of G+4 Residential Building Using ETABS. InternationalJournal of Civil Engineering and Technology, 8(4), 2017, pp. 1845-1850.

[7]. Mounika.Pallapolu, Aquila Angel. Pilli and K. Prasanthi, Analysisand Design of Commercial Building. International Journal of Civil Engineering andTechnology, 8(4), 2017, pp. 1445–1451.

[8]. IS: 1893-2002, Part 1, “Criteria for Earthquake Resistant Design of Structures –General Provisions and Buildings”, Bureau of Indian Standards, New Delhi, India.

[9]. IS: 875 (Part 1), “Indian Standard Code of Practice for design loads for building and structures, Dead Loads” Bureau of Indian Standards, New Delhi.

[10]. IS: 875 (Part 2), “Indian Standard Code of Practice for design loads for building and structures, Live Loads” Bureau of Indian Standards, New Delhi.

[11]. IS: 875 (Part 3), “Indian Standard Code of Practice for design loads (Other than earthquake) for building and structures, Wind Loads” Bureau of Indian Standards, NewDelhi.

[12]. IS 456:2000, “Indian Standard plain and reinforced concrete-Code of Practice”, Bureau of Indian Standards, New Delhi, 2000.

[13]. Indian standards code of practice for design SP-16 and detailing SP-34. ss