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RESPONSE OF R C FRAME STRUCTURES RESTING ON RAFT FOUNDATION USING E-TABS

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ABSTRACT

ETABS stands for Extended hree dimensional Analysis of Building Systems. ETABS is commonly used to analyze: Skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. ETABS was used to create the mathematical model of the Burj Khalifa, designed by Skidmore, Owings and Merrill LLP (SOM). 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. On ETABS we can analyse and design any shape of R.C.C buildings like rectangular. In this project, we mainly emphasizes on structural behaviour of multi-storey building for different plan configurations like T-shape and L-shape. Modelling of 10- storeys R.C.C. framed building is done on the ETABS Software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases.

Keywords: Earthquake, Foundation, Soil Structure Interaction.

I. INTRODUCTION

Over the past 40 years, considerable progress has been made in understanding the nature of earthquakes and how they damage structures, and in improving the seismic performance of the built environment. However, much remains unknown regarding the prevention or mitigation of earthquake damage in worldwide, leaving room for further studies. During past and recent earthquakes, it is realized that the soil-structure interaction (SSI) effects play an important role in determining the behaviour of building structures. The experienced seismic excitation can be considered as function of the fault rupture mechanism, travel path effects, local site effects, and SSI effects. Irrespective of the structure, the local soil conditions can dramatically influence the earthquake motion from the bedrock level to the ground surface, through their dynamic filtering effects. One example is the 1985 Mexico City earthquake where deep soft soils amplified the ground motion and modified the frequency of ground shaking. Similar behaviour was observed during the 1989 Loma Prieta earthquake, in which the sections of the Cypress freeway in Oakland collapsed due to the soil-related motion amplification. The seismic soil structure interaction of multi-story buildings becomes very important after the destruction of recent major earthquakes. For the structure founded on the soil, the motion of the base of the structure will be different from the case of fixed base, because of the coupling of the structure-soil system. It is true that taking the soil into account when calculating the seismic response of the structure does complicate the analysis considerably. It also makes it necessary to estimate additional key parameters, which are difficult to determine, such as the dynamic properties of the soil such as site response, radiation damping and kinematic interaction.

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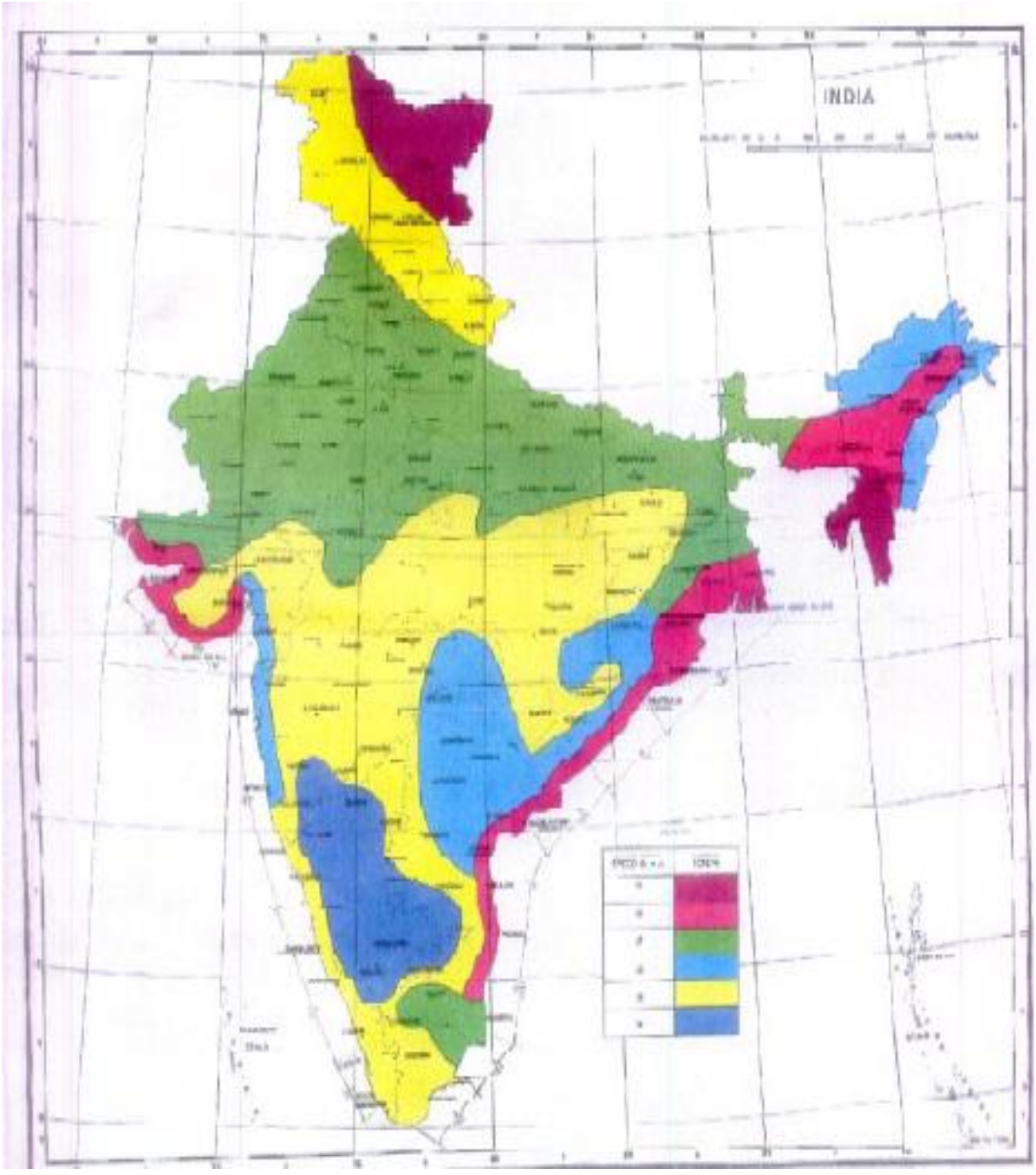
ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, design, and detailing procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviors necessary for Performance based design, making it the tool of choice for structural engineers in the building industry.

II. EARTHQUAKE ZONES



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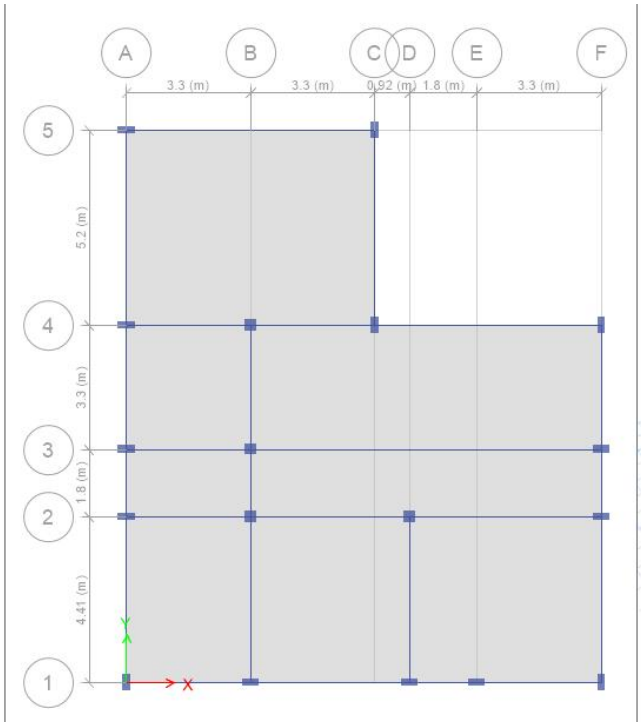

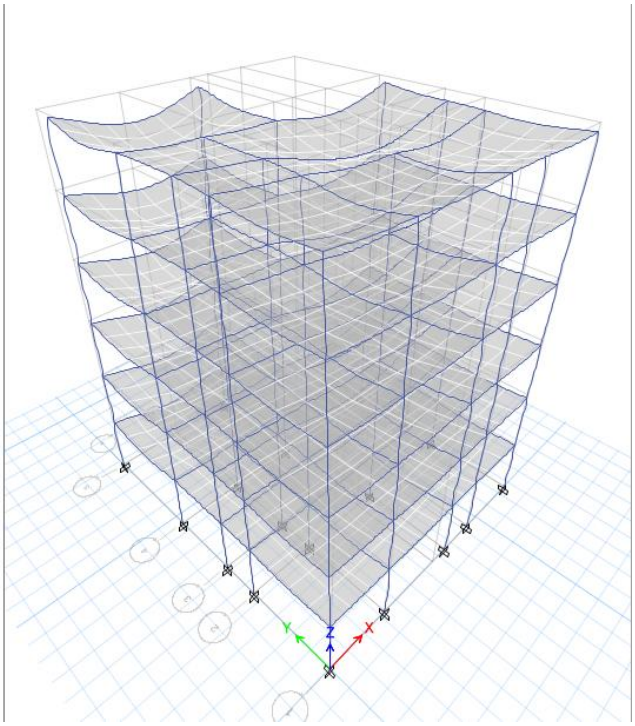

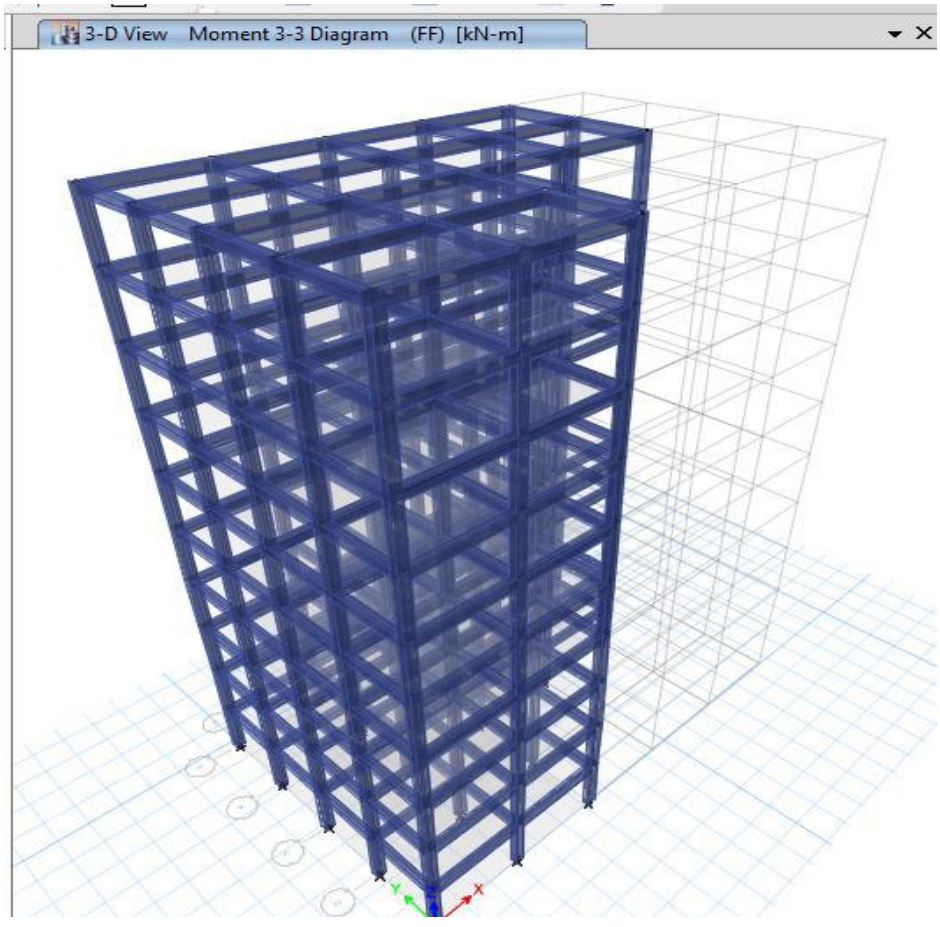

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III. RESULTS

Table 5.3 - Story Forces

Story	Load Case/Combo	Location	P kN	VX kN	VY kN	T kN-m	MX kN-m	MY kN-m
Story6	Dead	Top	690.4354	0	0	0	4385.9762	-3881.0154
Story6	Dead	Bottom	811.8996	0	0	0	5085.947	-4564.1836
Story6	Live	Top	308.6724	0	0	0	1972.5845	-1741.1164
Story6	Live	Bottom	308.6724	0	0	0	1972.5845	-1741.1164
Story6	sdl	Top	1404.8	0	0	0	8531.1136	-7498.704
Story6	sdl	Bottom	1404.8	0	0	0	8531.1136	-7498.704
Story5	Dead	Top	1502.335	0	0	0	9471.9232	-8445.1989
Story5	Dead	Bottom	1623.7991	0	0	0	10171.8939	-9128.3671
Story5	Live	Top	617.3448	0	0	0	3945.1689	-3482.2329
Story5	Live	Bottom	617.3448	0	0	0	3945.1689	-3482.2329
Story5	sdl	Top	2809.6	0	0	0	17062.2272	-14997.408
Story5	sdl	Bottom	2809.6	0	0	0	17062.2272	-14997.408
Story4	Dead	Top	2314.2345	0	0	0	14557.8702	-13009.3825
Story4	Dead	Bottom	2435.6987	0	0	0	15257.8409	-13692.5507
Story4	Live	Top	926.0172	0	0	0	5917.7534	-5223.3493
Story4	Live	Bottom	926.0172	0	0	0	5917.7534	-5223.3493
Story4	sdl	Top	4214.4	0	0	0	25593.3408	-22496.112
Story4	sdl	Bottom	4214.4	0	0	0	25593.3408	-22496.112
Story3	Dead	Top	3126.1341	0	0	0	19643.8171	-17573.5661
Story3	Dead	Bottom	3247.5982	0	0	0	20343.7879	-18256.7343
Story3	Live	Top	1234.6896	0	0	0	7890.3378	-6964.4658
Story3	Live	Bottom	1234.6896	0	0	0	7890.3378	-6964.4658
Story3	sdl	Top	5619.2	0	0	0	34124.4544	-29994.816
Story3	sdl	Bottom	5619.2	0	0	0	34124.4544	-29994.816
Story2	Dead	Top	3938.0337	0	0	0	24729.7641	-22137.7496
Story2	Dead	Bottom	4059.4978	0	0	0	25429.7348	-22820.9178
Story2	Live	Top	1543.362	0	0	0	9862.9223	-8705.5822
Story2	Live	Bottom	1543.362	0	0	0	9862.9223	-8705.5822
Story2	sdl	Top	7024	0	0	0	42655.568	-37493.52
Story2	sdl	Bottom	7024	0	0	0	42655.568	-37493.52
Story1	Dead	Top	4749.9332	0	0	0	29815.711	-26701.9332
Story1	Dead	Bottom	4871.3973	0	0	0	30515.6818	-27385.1014
Story1	Live	Top	1852.0344	0	0	0	11835.5068	-10446.6987
Story1	Live	Bottom	1852.0344	0	0	0	11835.5068	-10446.6987

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Story	Load Case/Combo	Location	P kN	VX kN	VY kN	T kN-m	MX kN-m	MY kN-m
Story1	sdl	Top	8428.8	0	0	0	51186.6816	-44992.224
Story1	sdl	Bottom	8428.8	0	0	0	51186.6816	-44992.224

Point Results

Table 5.4 - Joint Reactions

Story	Joint Label	Unique Name	Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Base	1	9	Dead	6.108	-2.1275	266.9519	2.259	5.2993	0.0216
Base	1	9	Live	2.9392	-1.0493	97.1617	1.1146	2.5112	0.0113
Base	1	9	sdl	10.5674	-3.4441	562.1689	3.6263	9.2864	0.0274
Base	2	14	Dead	-3.3546	-3.7054	259.6216	3.8846	-3.4606	0.0247
Base	2	14	Live	-1.6329	-1.8023	93.7205	1.8847	-1.6915	0.0127
Base	2	14	sdl	-5.8134	-6.2118	538.9002	6.4422	-5.9743	0.0349
Base	3	19	Dead	0.4446	0.1352	430.4639	0.1469	0.3831	0.0253
Base	3	19	Live	0.0803	-0.1692	182.4556	0.2943	0.046	0.0129
Base	3	19	sdl	2.6006	5.4183	550.9258	-4.8495	2.4835	0.0355
Base	4	24	Dead	-2.4429	-1.4604	196.5145	1.2386	-2.4908	0.027
Base	4	24	Live	-1.0794	-0.6964	61.7661	0.5727	-1.1084	0.0137
Base	4	24	sdl	-4.826	-1.4448	407.277	1.1723	-4.904	0.0404
Base	5	29	Dead	-0.4957	2.5894	155.6266	-2.7049	-0.4142	0.029
Base	5	29	Live	-0.2504	1.2184	45.3185	-1.2923	-0.2124	0.0147
Base	5	29	sdl	-0.8741	5.1511	355.7823	-5.239	-0.7809	0.0413
Base	6	34	Dead	0.7031	1.617	154.3588	-0.8319	0.7771	0.0257
Base	6	34	Live	0.3213	0.6784	42.3658	-0.2923	0.3557	0.0133
Base	6	34	sdl	1.3613	4.0924	375.2358	-2.9386	1.4397	0.0335
Base	7	39	Dead	2.1911	0.7214	270.4104	-0.5718	1.8408	0.0248
Base	7	39	Live	1.2249	0.3624	100.0989	-0.2882	1.024	0.0128
Base	7	39	sdl	1.6718	1.1267	557.3542	-0.9153	1.1177	0.0338
Base	8	44	Dead	1.1321	-0.1637	162.0195	0.3088	1.0485	0.0258
Base	8	44	Live	0.5335	-0.0966	46.1719	0.1684	0.4734	0.0132
Base	8	44	sdl	2.2846	-0.0435	396.7359	0.249	2.0382	0.0356
Base	9	49	Dead	1.6908	-0.7331	192.1974	0.8746	1.7197	0.0262
Base	9	49	Live	0.8373	-0.3345	60.0591	0.4049	0.8342	0.0134
Base	9	49	sdl	2.562	-1.439	455.6642	1.6357	2.4882	0.0363
Base	10	54	Dead	0.9734	1.5578	253.2471	-1.4492	1.3387	0.0262
Base	10	54	Live	0.4632	0.8275	91.2196	-0.7741	0.6328	0.0135

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Story	Joint Label	Unique Name	Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Base	10	54	sdl	1.4976	1.9895	556.843	-1.8364	1.8895	0.0357
Base	12	64	Dead	-0.6693	1.7809	219.9137	-1.7319	-0.254	0.0266
Base	12	64	Live	-0.2402	0.9582	79.8339	-0.9353	-0.0493	0.0137
Base	12	64	sdl	-2.6203	2.2709	445.0038	-2.1994	-2.1022	0.0356
Base	13	69	Dead	1.0834	1.383	187.4447	-1.363	1.4441	0.028
Base	13	69	Live	0.5044	0.8056	67.4304	-0.7972	0.672	0.0143
Base	13	69	sdl	1.6307	0.9904	345.567	-0.963	2.018	0.0382
Base	14	74	Dead	-4.7911	-0.3313	267.5713	0.2924	-4.5878	0.0272
Base	14	74	Live	-2.4587	-0.1493	99.7751	0.1272	-2.3729	0.0139
Base	14	74	sdl	-4.9035	-1.1572	462.7172	1.1047	-4.7701	0.0365
Base	15	79	Dead	-6.4075	0.3768	261.0665	-0.4102	-6.2886	0.0265
Base	15	79	Live	-3.2004	0.1836	96.453	-0.2031	-3.1605	0.0135
Base	15	79	sdl	-2.8594	0.4642	349.2766	-0.506	-2.9701	0.0368
Base	16	84	Dead	1.0535	-1.7652	355.1049	1.9649	1.0732	0.0344
Base	16	84	Live	0.5321	-0.9219	145.8805	1.0186	0.534	0.0176
Base	16	84	sdl	0.5069	-2.9971	597.0771	3.2747	0.5003	0.0471
Base	17	89	Dead	1.8829	0.2087	329.7807	0.019	1.8331	0.034
Base	17	89	Live	0.9449	0.1213	132.3661	-0.0098	0.9113	0.0174
Base	17	89	sdl	-1.0669	-0.4075	453.3232	0.722	-1.1319	0.047
Base	18	94	Dead	-0.0841	0.3894	383.3832	-0.1589	-0.2105	0.0329
Base	18	94	Live	-0.015	0.3887	174.1671	-0.2735	-0.0884	0.0168
Base	18	94	sdl	-2.3417	-1.0697	382.1317	1.3757	-2.533	0.0457
Base	19	99	Dead	0.9823	-0.473	525.7206	0.5538	0.9988	0.0354
Base	19	99	Live	0.4959	-0.3248	235.7906	0.3597	0.4962	0.0181
Base	19	99	sdl	0.6225	-3.2889	636.816	3.3748	0.6101	0.0483

IV. MODAL RESULTS

Table 5.5 - Modal Periods and Frequencies

Case	Mode	Period sec	Frequency cyc/sec	Circular Frequency rad/sec	Eigenvalue rad^2/sec^2
Modal	1	0.912	1.097	6.8916	47.4947
Modal	2	0.887	1.127	7.0806	50.1349
Modal	3	0.69	1.449	9.1026	82.8567
Modal	4	0.299	3.342	20.9985	440.9372
Modal	5	0.288	3.474	21.8298	476.5387

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Case	Mode	Period sec	Frequency cyc/sec	Circular Frequency rad/sec	Eigenvalue rad²/sec²
Modal	6	0.226	4.422	27.7855	772.0314
Modal	7	0.175	5.72	35.9388	1291.5954
Modal	8	0.165	6.075	38.1723	1457.1212
Modal	9	0.132	7.592	47.7043	2275.7018
Modal	10	0.123	8.12	51.0202	2603.0563
Modal	11	0.113	8.834	55.506	3080.9128
Modal	12	0.097	10.348	65.0159	4227.0681

Table 5.6 - Modal Participating Mass Ratios (Part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY	Sum UZ
Modal	1	0.912	0.0327	0.7765	0	0.0327	0.7765	0
Modal	2	0.887	0.4902	0.0591	0	0.523	0.8356	0
Modal	3	0.69	0.3066	0.0004	0	0.8295	0.836	0
Modal	4	0.299	0.0047	0.0914	0	0.8342	0.9274	0
Modal	5	0.288	0.0611	0.0085	0	0.8953	0.9359	0
Modal	6	0.226	0.0387	0.0001	0	0.934	0.936	0
Modal	7	0.175	0.0017	0.0322	0	0.9357	0.9682	0
Modal	8	0.165	0.0214	0.0035	0	0.9571	0.9717	0
Modal	9	0.132	0.0137	3.546E-05	0	0.9708	0.9718	0
Modal	10	0.123	0.0011	0.0155	0	0.9718	0.9873	0
Modal	11	0.113	0.0108	0.0019	0	0.9826	0.9892	0
Modal	12	0.097	0.0001	0.007	0	0.9827	0.9962	0

V. CONCLUSION

From our results obtained from the analyses outputs, the elements are in accordance to our objectives of the study which are:

1. The dead, live and floor finish loads obtained by the ETABS are similar to the manually calculated values

2. Analysis of the structural integrity of these buildings in withstanding the design earthquake loadings was conducted and was judged to be safe.

3. The way forward will be to conduct studies on different shapes and geometrical configurations and to see the variations as the study we conducted only included irregular L shape, and T shape configurations.

4. Various important results like bending moments, shear force, and deflection results are compared for the irregular configurations.

5. In this project along with the analysis results, the design values are included for both the unsymmetrical configurations.

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By, GOLAKOTI SURYA KARTEEK

BIOGRAPHAICAL DATA

Prof. Mahadeva M is working as assistant professor in civil engineering department form last 2 years and he also worked as assistant professor in k s institute of technology. He is **national advisory board member for international conference** and he secured a ***"Active Young Researcher Award"*** from AR Research Publication and Conference World for your continuous contribution in the research field for shaping up the new era and He received is **B E in civil engineering and M.Tech** with specialization in **CAD structures** from visvesvaraya technological university. His research interest is in the field of soil structure interaction, structural engineering, earth quake engineering.

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