1. INTRODUCTION:

An engineering structure consists of members or elements transferring the load (or resisting external actions) and providing a form, space, enclosure and/or a cover to serve the desired function. The structural design is a science and art of designing a structure 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. The objective of structural design is to plan a structure, which meets all the basic requirements of structural design which are given as follows:

- Serviceability
- Safety
- Durability
- Economy
- Aesthetic beauty
- Feasibility, practicability and acceptability.

1.1 BASIC REQUIREMENTS OF STRUCTURALDESIGN:

A creative sense, imagination, understanding and keen observation of structures in nature, scientific knowledge of various aspects of structures, understanding of the various structural phenomenon on basis of statistical and experimental data, and finally, the backing of vast experience from the past, are some of the qualities required for a structural engineer.

1.2 DESIGN PROCEDURE:

The process of structural design consists of the following phases:

Phase - I: This stage involves the determination of the following:

1.2.1   Type of structure (like RCC /STEEL)

1.2.2   Form of structure (like slab-beam, grid or shell)

1.2.3   Geometry and layout, which include determination of positioning of Columns, beams and slab.

1.2.4   Type of material, particularly grades of steel and concrete, method of construction like R.C.C, Steel, P.S.C, Cast-in-situ, Pre-casted.

Phase – II: This stage involves gathering the necessary information from the client which is as follows:

1.2.5   Function of the structure

1.2.6   Resources available

1.2.7   Importance of the structure and aesthetic requirements

1.2.8   Expected lifespan

1.2.9   Probability of extension in future

1.2.10   Relative weightage between time, economy, resources and soon.

Phase – III: This stage involves the analysis of the structure for the determination of internal design forces (like bending moment, shear force, torsion, axial tension) in the members and behavior of structures under the action of these forces.

Phase – IV: This stage involves the determination of sizes of members, amount and detailing of reinforcement for resisting the design force. This stage forms the core and substance of design.

Phase – V: This stage involves preparation of working drawings, giving sizes of the members, detailing of the reinforcements, preparing bar bending schedules and schedule of quantities giving specifications on material and special instruction, if any.

2. UNICO ASSOCIATES PROFILE

UNICO ASSOCIATES is a Structural Engineering Consultancy firm Started in the year 2013. The Firm has designed the structures with due support of architectural, structural, consultancy since 2 years. The Firm has Credit of giving Total consultancy from beginning to completion of a project.

The Firm had also extended its structural design services to Contractors, Builders in completing Residential.

COMPANY SERVICES
- Architecture
- Interior Design
- Civil Engineering
- Project Consultancy
- Structural design

3. PROJECT

3.1 ABOUT THE PROJECT

Nature of the project   : 28'6"'x39' site Residential Building.

Location   Bettiah , Bihar

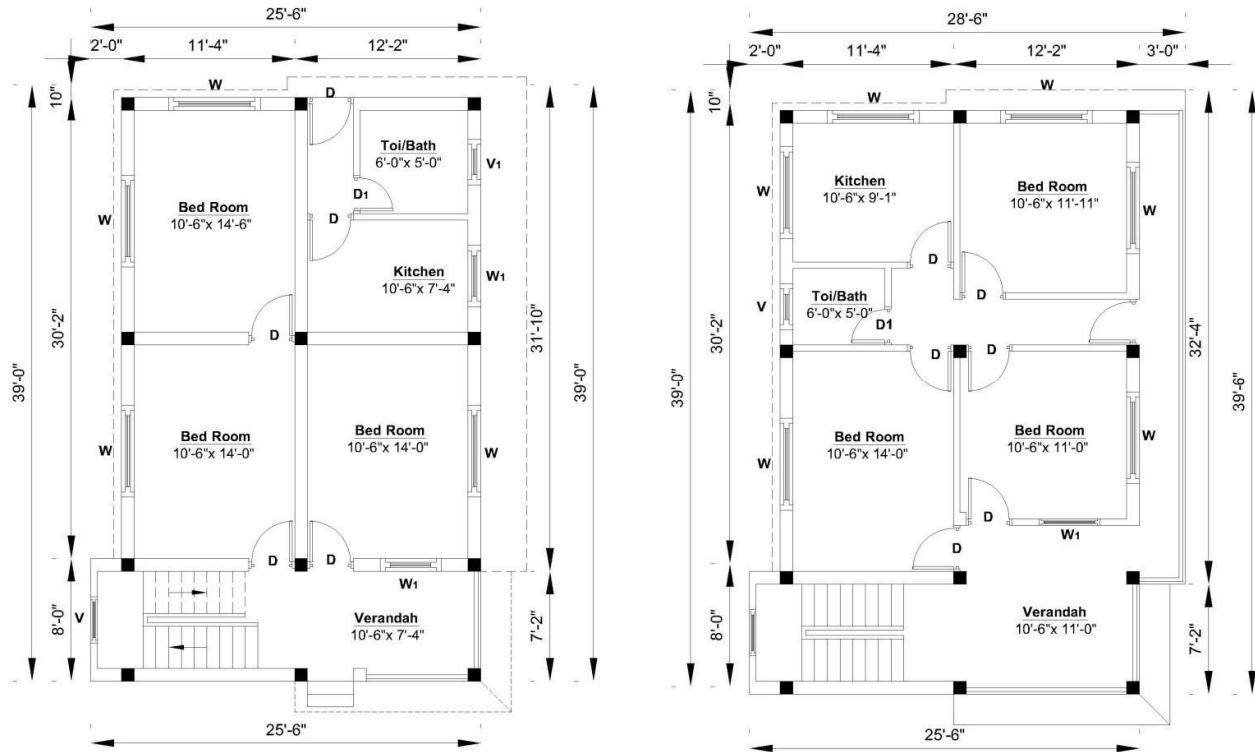Structural Consultants   : UNICO ASSOCIATES

DRAWINGS:

Architectural drawings of

- Ground Floor Plan.
- First Floor Plan.
- Terrace Floor Plan.

4. WORK ASSIGNED
- Plan and Detailing in AUTO CAD Software
- 28'6"'x39' Site planned as per Municipal Bye-law.
- 28'6"'x39' plan Designed as IS CODES.

5. WORK COMPLETED:
- Planning in AUTO CAD.
- Analysis in ETABS

a) Ground Floor Plan   b) First Floor Plan
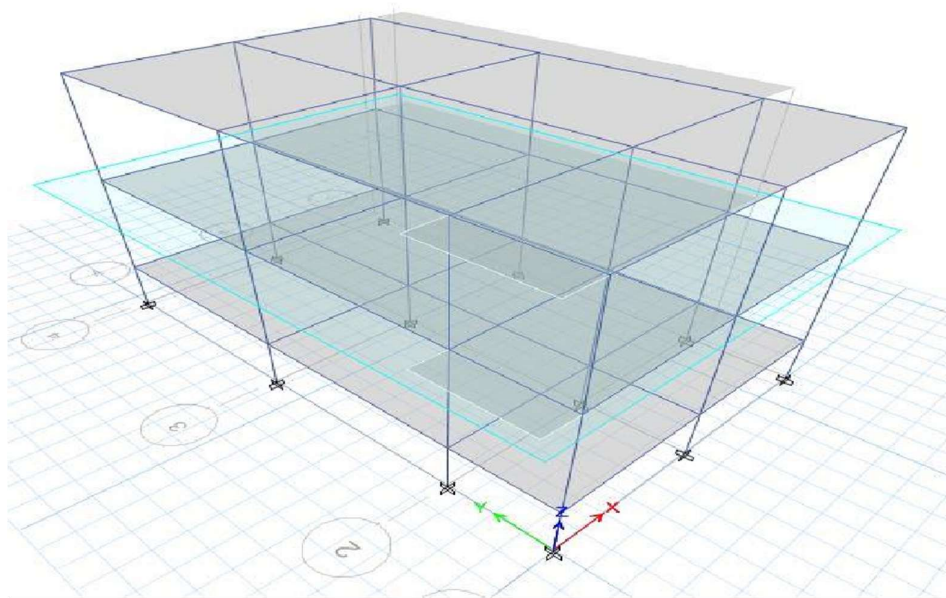
Fig 1: AutoCAD Plan

Fig 2: ETABS 3D- Modeling

6. PROPERTIES OF STRUCTURAL ELEMENTS:

1) Beam size

       Primary beam =   0.254mx0.3048m

  2) Column size =   0.254mx0.254m

  3) Slab thickness =   0.125m

  4) Grade of concrete =   M20

  5) Grade of steel =   Fe415

  6) Height of floor =   3.1496 m

Loads considered in the Design:

➢ Dead load

- Wall load   = (3.1496-0.125-0.3048)*0.3048x20

  =16.6KN/m

- Self weight of slab = 0.125x1x25 = 3.75 KN/m

- Floor finish   = 1 KN/m

➢ Live load

- Floor load   = 2 KN/m

- Terrace load   =1.5 KN/m

➢ Load combinations (1.5(DL+LL))

7. SAMPLE ANALYSIS RESULTS FOR FRAME ELEMENTS:

Table 1: Column Forces

Story	Column	Load Case/Combo	Station	P	V2	V3	T	M2	M3
			m	kN	kN	kN	kN-m	kN-m	kN-m
Story3	C1	Dead	0	-17.9056	-2.8341	-1.7834	-0.0179	-2.7487	-5.3372
Story3	C1	Dead	1.5748	-15.3664	-2.8341	-1.7834	-0.0179	0.0598	-0.8741
Story3	C1	Dead	3.1496	-12.8272	-2.8341	-1.7834	-0.0179	2.8682	3.5889
Story3	C1	Live	0	-8.0722	-0.5722	-0.5035	-0.0053	-0.6811	-0.8056
Story3	C1	Live	1.5748	-8.0722	-0.5722	-0.5035	-0.0053	0.1119	0.0956
Story3	C1	Live	3.1496	-8.0722	-0.5722	-0.5035	-0.0053	0.9048	0.9967
Story3	C1	Super Dead	0	-1.1115	-0.2558	-0.1712	-0.0045	-0.2543	-0.3621
Story3	C1	Super Dead	1.5748	-1.1115	-0.2558	-0.1712	-0.0045	0.0152	0.0407
Story3	C1	Super Dead	3.1496	-1.1115	-0.2558	-0.1712	-0.0045	0.2848	0.4436
Story3	C1	Roof LIfe	0	-1.4585	-0.2313	-0.1511	-0.0037	-0.23	-0.1981
Story3	C1	Roof LIfe	1.5748	-1.4585	-0.2313	-0.1511	-0.0037	0.0079	0.1661
Story3	C1	Roof LIfe	3.1496	-1.4585	-0.2313	-0.1511	-0.0037	0.2459	0.5302
Story3	C1	DCon1	0	-28.5258	-4.6348	-2.9318	-0.0336	-4.5046	-8.5491
Story3	C1	DCon1	1.5748	-24.7169	-4.6348	-2.9318	-0.0336	0.1125	-1.2501
Story3	C1	DCon1	3.1496	-20.908	-4.6348	-2.9318	-0.0336	4.7295	6.0488
Story3	C1	DCon2	0	-40.6341	-5.4931	-3.6871	-0.0416	-5.5262	-9.7574
Story3	C1	DCon2	1.5748	-36.8252	-5.4931	-3.6871	-0.0416	0.2803	-1.1068
Story3	C1	DCon2	3.1496	-33.0164	-5.4931	-3.6871	-0.0416	6.0867	7.5438

Table 2: Beam Forces

Story	Beam	Load Case/Combo	Station	P	V2	V3	T	M2	M3
			m	kN	kN	kN	kN-m	kN-m	kN-m
Story3	B1	Dead	0	0	-3.9254	0	0.5314	0	-1.9157
Story3	B1	Dead	0.3641	0	-3.221	0	0.5314	0	-0.6148
Story3	B1	Dead	0.7281	0	-2.5165	0	0.5314	0	0.4296
Story3	B1	Dead	1.0922	0	-1.8121	0	0.5314	0	1.2176
Story3	B1	Dead	1.0922	0	2.4115	0	0.4885	0	1.2122
Story3	B1	Dead	1.4563	0	3.116	0	0.4885	0	0.206
Story3	B1	Dead	1.8203	0	3.8204	0	0.4885	0	-1.0567
Story3	B1	Dead	2.1844	0	4.5249	0	0.4885	0	-2.5758
Story3	B1	Live	0	0	-2.1392	0	-0.0945	0	-0.4837
Story3	B1	Live	0.3641	0	-2.1392	0	-0.0945	0	0.2951
Story3	B1	Live	0.7281	0	-2.1392	0	-0.0945	0	1.0739
Story3	B1	Live	1.0922	0	-2.1392	0	-0.0945	0	1.8527
Story3	B1	Live	1.0922	0	2.0386	0	0.0257	0	1.8512
Story3	B1	Live	1.4563	0	2.0386	0	0.0257	0	1.109
Story3	B1	Live	1.8203	0	2.0386	0	0.0257	0	0.3668
Story3	B1	Live	2.1844	0	2.0386	0	0.0257	0	-0.3754

Story	Beam	Load Case/Combo	Station	P	V2	V3	T	M2	M3
			m	kN	kN	kN	kN-m	kN-m	kN-m
Story3	B1	Super Dead	0	0	-0.1228	0	0.2048	0	-0.0922
Story3	B1	Super Dead	0.3641	0	-0.1228	0	0.2048	0	-0.0475
Story3	B1	Super Dead	0.7281	0	-0.1228	0	0.2048	0	-0.0028
Story3	B1	Super Dead	1.0922	0	-0.1228	0	0.2048	0	0.0419
Story3	B1	Super Dead	1.0922	0	0.6713	0	0.0988	0	0.0409
Story3	B1	Super Dead	1.4563	0	0.6713	0	0.0988	0	-0.2035
Story3	B1	Super Dead	1.8203	0	0.6713	0	0.0988	0	-0.4479
Story3	B1	Super Dead	2.1844	0	0.6713	0	0.0988	0	-0.6923
Story3	B1	Roof LIfe	0	0	-0.0556	0	0.2861	0	-0.0259
Story3	B1	Roof LIfe	0.3641	0	-0.0556	0	0.2861	0	-0.0056
Story3	B1	Roof LIfe	0.7281	0	-0.0556	0	0.2861	0	0.0146
Story3	B1	Roof LIfe	1.0922	0	-0.0556	0	0.2861	0	0.0349
Story3	B1	Roof LIfe	1.0922	0	1.1298	0	0.1573	0	0.0339
Story3	B1	Roof LIfe	1.4563	0	1.1298	0	0.1573	0	-0.3774
Story3	B1	Roof LIfe	1.8203	0	1.1298	0	0.1573	0	-0.7887
Story3	B1	Roof LIfe	2.1844	0	1.1298	0	0.1573	0	-1.2
Story3	B1	DCon1	0	0	-6.0722	0	1.1043	0	-3.0118
Story3	B1	DCon1	0.3641	0	-5.0156	0	1.1043	0	-0.9935
Story3	B1	DCon1	0.7281	0	-3.9589	0	1.1043	0	0.6402
Story3	B1	DCon1	1.0922	0	-2.9023	0	1.1043	0	1.8891
Story3	B1	DCon1	1.0922	0	4.6243	0	0.8809	0	1.8797
Story3	B1	DCon1	1.4563	0	5.681	0	0.8809	0	0.0038
Story3	B1	DCon1	1.8203	0	6.7376	0	0.8809	0	-2.2568
Story3	B1	DCon1	2.1844	0	7.7943	0	0.8809	0	-4.9021
Story3	B1	DCon2	0	0	-9.281	0	0.9625	0	-3.7374
Story3	B1	DCon2	0.3641	0	-8.2244	0	0.9625	0	-0.5509
Story3	B1	DCon2	0.7281	0	-7.1677	0	0.9625	0	2.251
Story3	B1	DCon2	1.0922	0	-6.1111	0	0.9625	0	4.6682
Story3	B1	DCon2	1.0922	0	7.6822	0	0.9195	0	4.6565
Story3	B1	DCon2	1.4563	0	8.7389	0	0.9195	0	1.6673
Story3	B1	DCon2	1.8203	0	9.7955	0	0.9195	0	-1.7066
Story3	B1	DCon2	2.1844	0	10.8522	0	0.9195	0	-5.4652
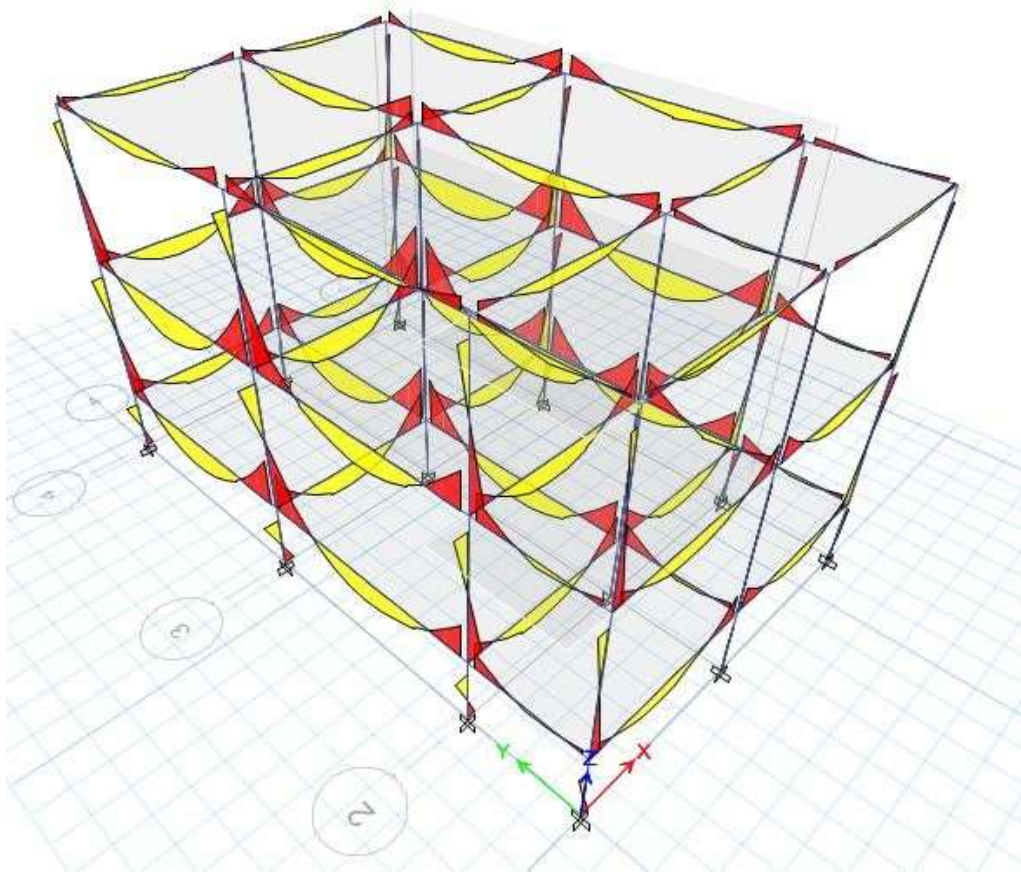
Fig 3: Bending Moment Diagram in 3D view

Table 3: Base Reaction

Load Case/Combo	FX	FY	FZ	MX	MY	MZ	X	Y	Z
	kN	kN	kN	kN-m	kN-m	kN-m	m	m	m
Dead	0	0	3363.1481	18386.8186	-11804.0069	0	0	0	0
Live	0	0	372.5205	1956.241	-1269.7482	0	0	0	0
Super Dead	0	0	254.0666	1465.4336	-949.5983	0	0	0	0
Roof Life	0	0	131.5875	763.6024	-508.5188	0	0	0	0
DCon1	0	0	5425.8221	29778.3782	-19130.4078	0	0	0	0
DCon2	0	0	5984.6029	32712.7398	-21035.0301	0	0	0	0
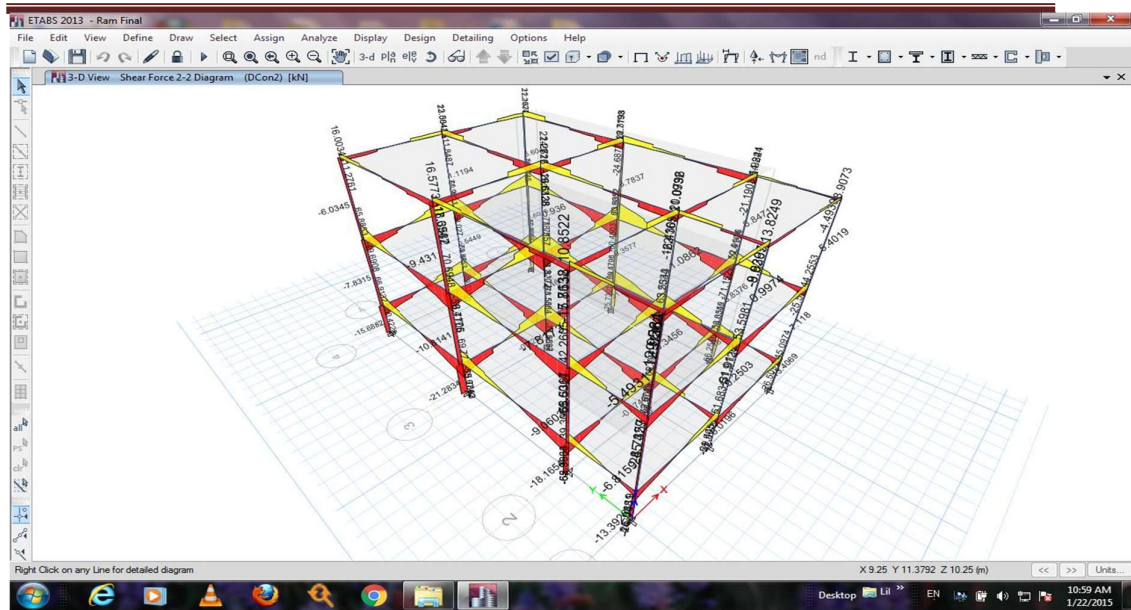
Fig 4: Shear Force Diagram in 3D- view

Table 4: Story Drift

Story	Load Case/Combo	Label	Item	Drift	X	Y	Z
					m	m	m
Story3	Dead	4	Max Drift X	0.000052	7.8994	11.3792	7.7492
Story3	Dead	4	Max Drift Y	0.000088	7.8994	2.1844	7.7492
Story3	Live	4	Max Drift X	0.000015	7.8994	11.3792	7.7492
Story3	Live	4	Max Drift Y	0.000012	7.8994	11.3792	7.7492
Story3	Super Dead	4	Max Drift X	0.000016	7.8994	11.3792	7.7492
Story3	Super Dead	4	Max Drift Y	0.000015	7.8994	11.3792	7.7492
Story3	Roof LIfe	4	Max Drift X	0.000013	7.8994	11.3792	7.7492
Story3	Roof LIfe	4	Max Drift Y	0.000014	7.8994	2.1844	7.7492
Story3	DCon1	4	Max Drift X	0.000103	7.8994	11.3792	7.7492
Story3	DCon1	4	Max Drift Y	0.000156	7.8994	11.3792	7.7492
Story3	DCon2	4	Max Drift X	0.000125	7.8994	11.3792	7.7492
Story3	DCon2	4	Max Drift Y	0.000173	7.8994	11.3792	7.7492
Story2	Dead	3	Max Drift X	0.000026	6.9088	11.3792	4.5996
Story2	Dead	3	Max Drift Y	0.000127	6.9088	11.3792	4.5996

Story	Load Case/Combo	Label	Item	Drift	X	Y	Z
Story2	Live	3	Max Drift X	0.000014	6.9088	11.3792	4.5996
Story2	Live	3	Max Drift Y	0.000028	6.9088	11.3792	4.5996
Story2	Super Dead	3	Max Drift X	0.000008	6.9088	11.3792	4.5996
Story2	Super Dead	3	Max Drift Y	0.00001	6.9088	11.3792	4.5996
Story2	Roof LIfe	3	Max Drift X	0.000001	6.9088	11.3792	4.5996
Story2	Roof LIfe	1	Max Drift Y	0.000004	0	11.3792	4.5996
Story2	DCon1	3	Max Drift X	0.00005	6.9088	11.3792	4.5996
Story2	DCon1	3	Max Drift Y	0.000206	6.9088	11.3792	4.5996
Story2	DCon2	3	Max Drift X	0.000071	6.9088	11.3792	4.5996

Story	Load Case/Combo	Label	Item	Drift	X	Y	Z
					m	m	m
Story2	DCon2	3	Max Drift Y	0.000247	6.9088	11.3792	4.5996
Story1	Dead	3	Max Drift X	0.000002	6.9088	11.3792	1.45
Story1	Dead	3	Max Drift Y	0.000059	6.9088	11.3792	1.45
Story1	Live	3	Max Drift X	4.558E-07	6.9088	11.3792	1.45
Story1	Live	3	Max Drift Y	0.00001	6.9088	11.3792	1.45
Story1	Super Dead	3	Max Drift X	0.000001	6.9088	11.3792	1.45
Story1	Super Dead	3	Max Drift Y	0.000004	6.9088	11.3792	1.45
Story1	Roof LIfe	3	Max Drift X	3.559E-07	6.9088	11.3792	1.45
Story1	Roof LIfe	1	Max Drift Y	0.000001	0	11.3792	1.45
Story1	DCon1	3	Max Drift X	0.000003	6.9088	11.3792	1.45
Story1	DCon1	3	Max Drift Y	0.000095	6.9088	11.3792	1.45
Story1	DCon2	3	Max Drift X	0.000004	6.9088	11.3792	1.45
Story1	DCon2	3	Max Drift Y	0.00011	6.9088	11.3792	1.45

8. CONCLUSIONS:

My training at **"UNICO ASSOCIATES** has been an eye-opening as well as an enriching experience for me. I gained an in-depth and thorough knowledge on the Structural Engineering Practices exercised by Engineers in India. It is important that a prospective engineer such as me to develop a strong understanding in the basics of structural elementdesign.

- Knowledge about visualization of structure isobtained.

- All the design requirements were checked for codal provisions.

- Knowledge about preparation of structural design report is obtained and

  learned to apply our engineering knowledge to practicalfield.

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One Month Training Report on Etabs Software

BACHELOR OF TECHNOLOGY
(Civil Engineering)

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