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Comparison on Soft Storey Effect at Different Level in Multi-Storey Buildings

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Abstract: Nowadays, according to social and functional needs, various types of multi-storey or high rise buildings are the mostly useable buildings in many towns and cities. Among them, some buildings are constructed as soft storey because of the space occupancy considerations. The soft storey has one level that is considerably greater flexible than the storey above and below it. This type of building has no masonry wall in this level or it can also have a greater height than the rest of the floors. Generally, the soft storey usually exists at the ground floor level but it can form any level of a high-rise building to fulfill necessity. In this study, analysis and design of superstructure for twelve-storey reinforced concrete building are presented. Analysis and design of superstructure of the selected building are carried out by using Extended Three Dimensional Analysis of Building Systems software. Firstly, the model is analysed by using software. For the superstructure, storey drift limitation, P-Δ effect, overturning, storey shear and torsional irregularities are carried out from design results. Secondly, the structural designs are made by change of storey height and without change of structural element size, seismic zone, exposure type and soil type. Finally, storey drift of all storey levels and the analysis results of structural performance are compared.

Keywords: multi-storey; soft storey; storey drift; P-Δ effect; overturning; torsional irregularities.

1. INTRODUCTION

All over the world, the multi-storey buildings are widely used due to the rapid growth of the urban population, the high cost of land, and potential of popularity in which the provision of soft storey is a common practice. Generally, the soft storey usually exists at the ground floor level and is known as a soft storey building or an open ground storey building**.** As per Indian standard code of practice, a soft storey has stiffness less than 70 percent of the storey immediately above, or less than 80 percent of the average stiffness of the three storeys above. If the stiffness of the storey meets at least one of above two criteria, the structure is considered to have a soft storey. Nowadays, some space need to be wider open space and higher floor level are considered for the purpose of a large meeting room, a showroom or a banking hall etc. Therefore, soft storey can form any level of a high-rise building. Some buildings are regarded with typical height and designed for same typical floors in structural design. But in practice, height is suddenly increased in one floor and structural elements for this changed height are not designed again. These structures can get soft storey effect and the effect of the seismic loading becomes more severe for heights above this floor level. When the lateral force acts on soft storey building, the building might become failure due to its less stiffness because the seismic force distribution is dependent on the distribution of stiffness and mass along the height. In this study, the structural designs are made by change of storey height and without change of structural element sizes, seismic zone, exposure type and soil type. The structural elements are designed to resist not only gravity forces but also lateral forces including earthquake and wind loads. The mostly failure of soft storey effect on the world are mainly due to the earthquake because the structural members are not strong enough to hold up the building during an earthquake. This indicate that those buildings possess storeys that are significantly weaker or more flexible than adjacent storeys and where deformations and damage tend to be concentrated**.** The Figure.1 is the soft storey failure in M7.4 earthquake, Tukery, August 17, 1999.

Figure.1 Soft storey failure in Tukery

2. METHODOLOGY

In this paper, The 12 multi-storey building will be analysed and designed by using Extended Three Dimensional Analysis of Building Systems (E-tabs) Software. All reinforced concrete members are designed with ultimate strength design using building code of American Concrete Institute (ACI) 318-99. Wind and earthquake loads are considered according to Uniform Building Code (UBC-1997). Exposure type (B) and soil type (D) are considered with design wind velocity

120 mph. Structural system is considered by concrete intermediate moment-resisting frame with over-strength factor 5.5. Firstly, the proposed model is statically analyzed and the structural elements of all storey levels will be compared to know whether or not soft storey effect for proposed buildings. And then, the results are carried out for the superstructure of the proposed model and finally these are compared.

3. TYPE OF STRUCTURE

3.1 Data Preparation

The following Tables describe the design data for five models having different geometrical configurations. Table 1 shows material specifications, Table 2 shows structural configurations, Table 3 shows different cases of five models, Table 4 shows storey heights of different configuration and Table 5 shows structural element sizes.

Table 1 . Material specifications

Concrete compressive strength (f_c')	4 ksi
Reinforcing yield strength (f_y)	50 ksi
Modulus of Elasticity	3605 ksi
Poisson’s ratio	0.2

Table 2. Structural configurations

Number of stories	12
Width of structure	68′-0″
Length of structure	95′-0″
Total height of structure	148′-0″
Number of bay’s along X	8
Number of bay’s along Y	6

Table 3. Different cases of five models

Model-1	Conventional
Model-2	Soft storey at ground floor
Model-3	Soft storey at first floor
Model-4	Soft storey at second floor
Model-5	Soft storey at third floor

Table 4. Storey heights of different configuration

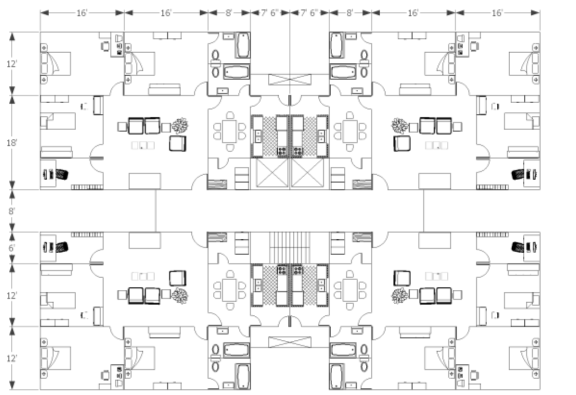
Storey	Height				
	Model M1	Model M2	Model M3	Model M4	Model M5
RT-1	10	10	10	10	10
RT	10	10	10	10	10
11F	10	10	10	10	10
10F	10	10	10	10	10
9F	10	10	10	10	10
8F	11	10	10	10	10
7F	11	10	10	10	10
6F	11	10	10	10	10
5F	11	10	10	10	10
4F	11	10	10	10	18
3F	11	10	10	18	10
2F	11	10	18	10	10
1F	11	18	10	10	10
GF to Base	10	10	10	10	10
Total height	148	148	148	148	148

Table 5. Structural element sizes

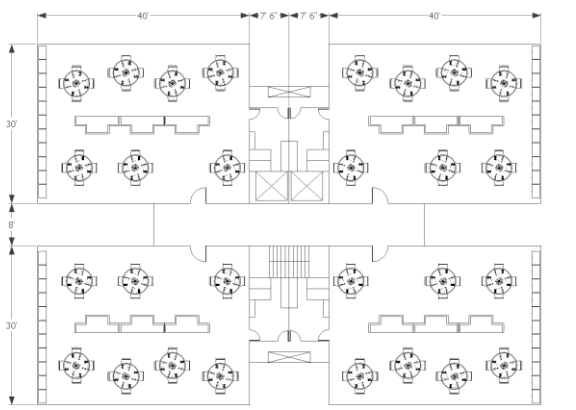
Column sizes	22″x22″, 20″x20″, 18″x18″, 16″x16″
Beam sizes for proposed buildings	18″x20″, 16″x18″ , 14″x18″, 12″x18″, 12″x14″, 10″x12″

3.2 Model Description

The Figure.2 shows the architectural floor plans of proposed buildings. The Figure.3 and Figure.4 show the layout plan of columns and beams of all models respectively.



(i)Typical floor plan



(ii)Soft storey floor plan

Figure.2 Architectural floor plan of proposed buildings

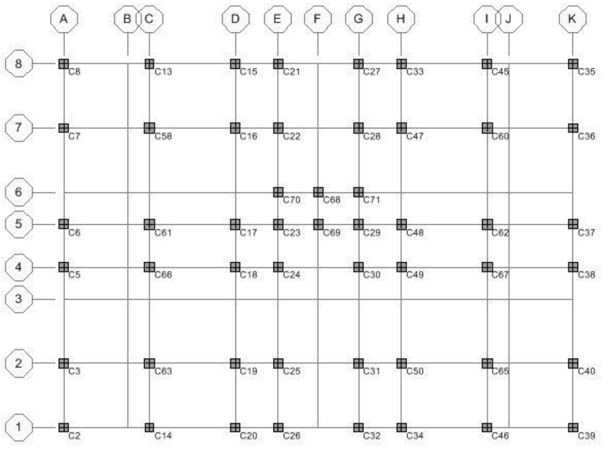


Figure.3 Typical layout plan of columns

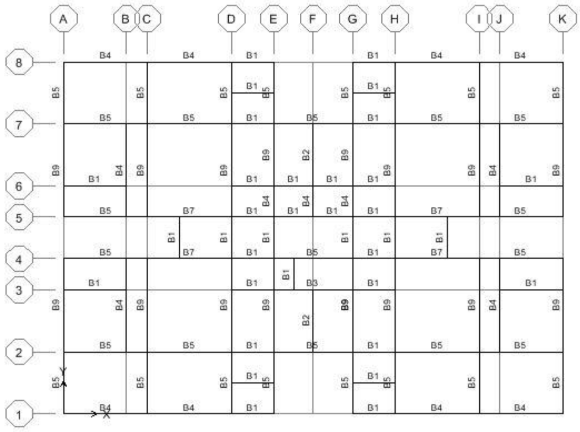


Figure.4 Typical layout plan of beams

4. LOAD COMBINATION

According to ACI (318-99), static design load combinations are as follows in Table 6.

Table 6. Load combination according to ACI (318-99)

1	1.4DL + 1.4SDL
2	1.4DL + 1.4SDL + 1.7LL
3,4	1.05DL + 1.05SDL + 1.275 LL ± 1.275WX
5,6	1.05DL + 1.05SDL + 1.275 LL ± 1.275WY
7,8	0.9DL + 0.9SDL ± 1.3WX
9,10	0.9DL + 0.9SDL ± 1.3WY
11,12	1.05DL + 1.05SDL + 1.28LL ± EQX
13,14	1.05DL + 1.05SDL + 1.28LL ± EQY
15,16	0.9DL + 0.9SDL ± EQX
17,18	0.9DL + 0.9SDL ± EQY
19,20	1.27DL + 1.27SDL + 1.28LL ± EQX
21,22	1.27DL + 1.27SDL + 1.28LL ± EQY
23,24	0.68DL + 0.68SDL ± 1.02EQX
25,26	0.68DL + 0.68SDL ± EQY

5. RESULTS AND DISCUSSIONS

In this section, the results obtained from the analysis of one conventional and four soft storey RC models using ETABS software have been tabulated and compared. The performance of structures on different criteria have been analyzed and discussed as follow.

5.1 Storey Drift

Storey drift is the lateral displacement of one level relative to the level above or below. The figure.5 and figure.6 show comparison of storey drift of five proposed models in x direction and y direction respectively. The storey drifts for models 2, 3, 4 and 5 suddenly increase at soft storey levels. From the following results, it can be seen that the storey drift of model 2 at soft storey level is maximum in both directions, the storey drift of model 3, model 4 and model 5 at that level are nearly equal in both directions and model 1 is minimum. The storey drifts in both direction at each soft storey level are more than drift limit so that the storey drift is significant in soft storey buildings.

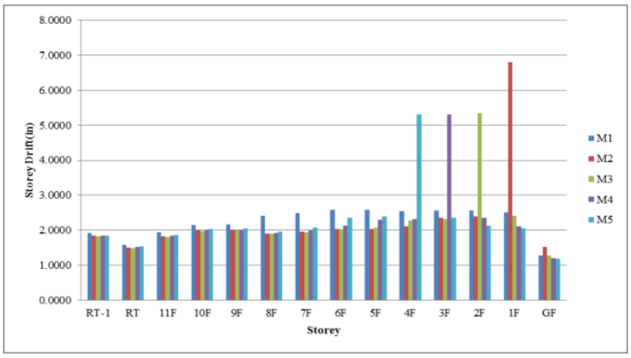


Figure.5 Comparison of storey drift in x direction

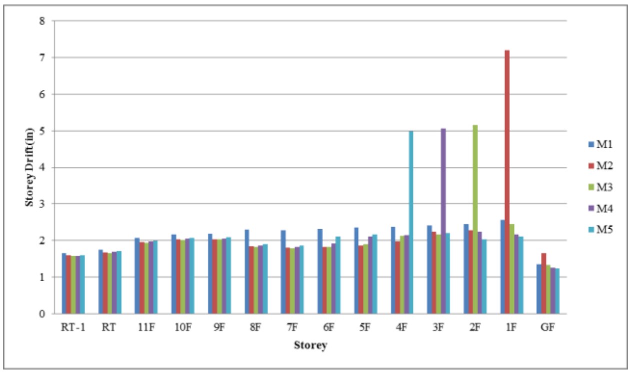


Figure.6 Comparison of storey drift in y direction

5.2 P-Δ Effect

The P-Δ effect results in additional forces and moments of frame members and increases storey displacement and overturning moment .The Figure.7 and Figure.8 show the comparison of P-Δ effect in x-direction and y-direction respectively. In comparison of both directions, the P-Δ effects of models 2, 3, 4 and 5 suddenly increase at soft storey level in which the P-Δ effect at soft storey level of model 2 and 3 in both directions and that of model 4 in X direction are more than limitation. The stability coefficient for x and y direction of model 1 and 5 is smaller than the allowable limit (0.1). Therefore, P-Δ effect is also significant in soft storey at lower level.

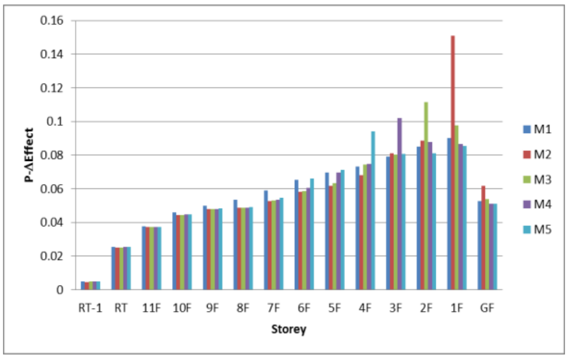


Figure.7 Comparison of P-Δ effect in x direction

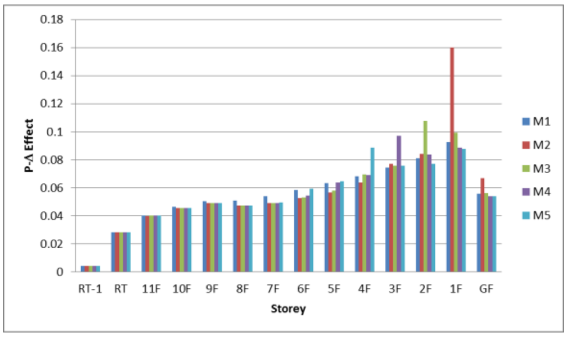


Figure.8 Comparison of P-Δ effect in y direction

5.3 Overturning Moment

The Figure.9 and Figure.10 show the comparison of overturning moment in x direction and y direction. In this comparison, for all models in both directions are nearly similar and it is increasing from top to bottom.

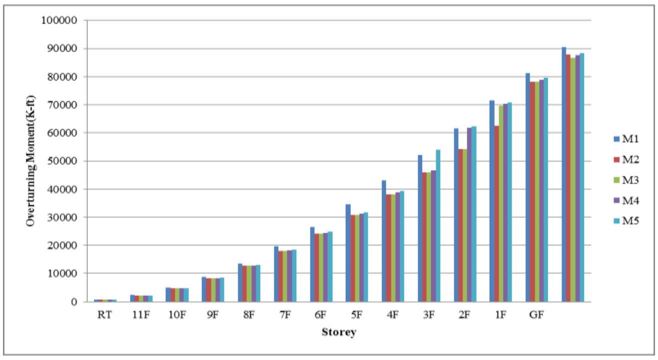


Figure.9 Comparison of overturning moment in x direction

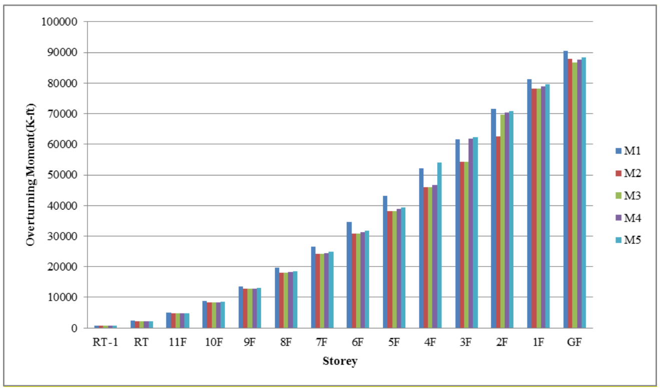


Figure.10 Comparison of overturning moment in y direction

5.4 Storey Shear

Storey shear is the summation of design lateral forces above the storey under consideration. The Figure.11 and Figure.12 show the comparison of storey shear in x direction and y direction. In this comparison, the results of storey shear for all models in x and y directions are nearly similar and it is increasing from top to bottom. Storey shear is the largest in footing and then it declines gradually from footing to top.

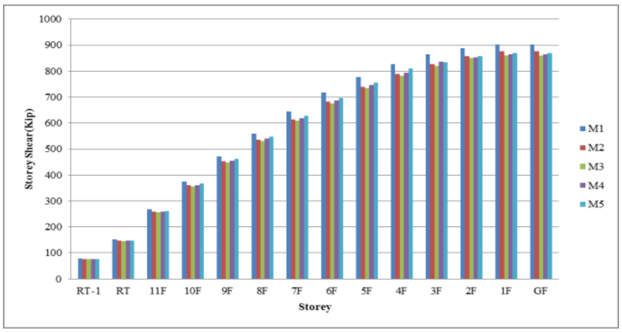


Figure.11 Comparison of storey shear in x direction

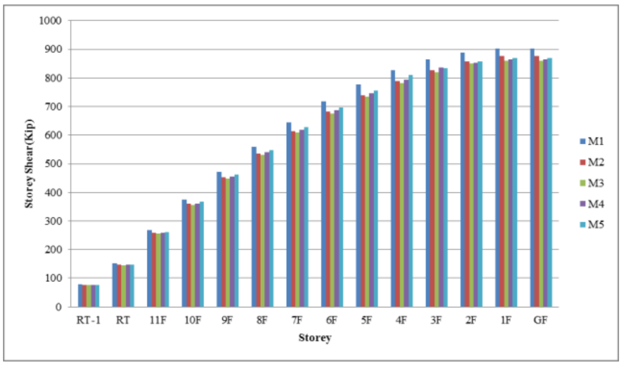


Figure.12 Comparison of storey shear in y direction

5.5 Torsional Iirregularity

The checking of torsional irregularity in both directions for this study is shown in Figure.13 and Figure.14. The torsional irregularity cannot exist as the values of Δmax/Δavg are smaller than the allowable limit (1.2) for all models.

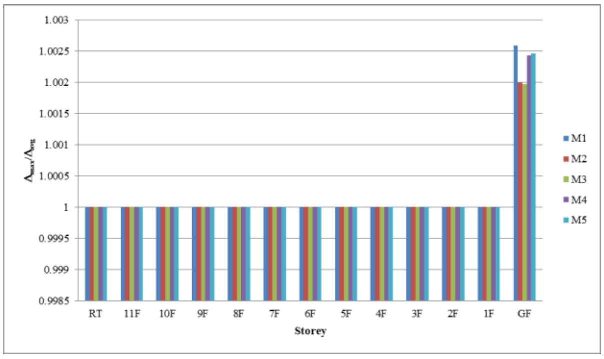


Figure.13 Comparison of $\Delta_{max}/\Delta_{avg}$ for torsional irregularity in x direction

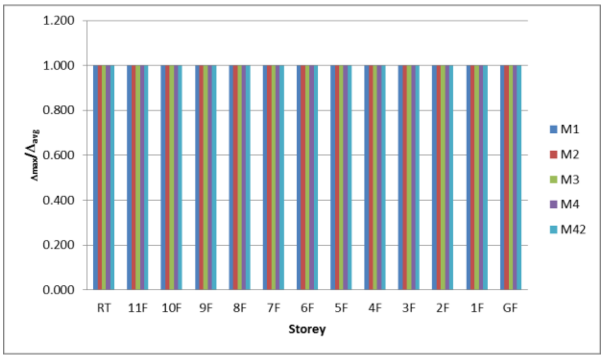


Figure.14 Comparison of $\Delta_{max}/\Delta_{avg}$ for torsional irregularity in y direction

6. CONCLUSION

1. Storey drifts of soft storey models in x-direction and y-direction are more than conventional building. It can be seen that the storey drift of model 2 at soft storey level is maximum in both directions. Storey drift of each soft storey level is more than drift limit and the higher the building, the more displacement will be there. Therefore, storey drift is significant in soft storey buildings.
2. P-Δ effect of model 1 and 4 are more than limitation in both directions. The stability coefficient for x and y direction of model 1 and 5 is smaller than the allowable limit in both directions. Therefore the P-Δ effect is more significant in soft storey models at low level.
3. Overturning moment of proposed models in x-direction and y-direction are nearly similar and it is increasing from top to bottom and these safety factors are less than 1.5.
4. The results of storey shear for all models in x and y directions are nearly similar. It is maximum at ground floor level and is gradually decreasing towards to the top storey of the structure.
5. The torsional irregularity cannot exist as the values of Δmax/Δavg are smaller than the allowable limit for all models.
6. According to study, overturning moment and torsional irregularity have less influence for soft storey level. However, the storey drift of model 2 at soft storey level is maximum in both directions and that of each soft storey level is more than limitation and the P-Δ effect is also significant in soft storey models at low level. Therefore, the structure is found more economical and safe when soft storey is avoided from ground, first and second storey.

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Analysis and design of spun pile Foundation of Sixteenth Storyed Building in cohesion less soil

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Abstract – This aim of the paper is the study on the analysis and design of spun pile foundation in cohesion less soil. This foundation describes the axial force, bending moment, lateral deflection due to seismic load, pile working load and settlement. The pile working load compares the result of pile applying load by analyzing ETAB software. The two results of pile settlement are gained by using Brom:s method and by analyzing ETAB software. To design the foundation, the super structure of sixteenth storeyed R.C building with basement is analyzed by applying E-tab software. According to the result of unfactored load of superstructure, the same number of pile is divided into four groups. Allowable bearing capacity is gained from the soil report of Inya Lake Residence Project in Yangon. The allowable bearing capacity of soil is calculated by Myerhof's and SPT methods. The size of spun pile is used outside diameter 16″ and thickness 3″ slender shape. The pile working load from materials for spun pile is 60 tons. The required length for 60 tons spun pile regard to 85 ft according to calculation of the allowable bearing capacity .The analyzing result and calculations of deflection and settlement is lesser than the allowable limits. The analysis and design of spun pile foundation in cohesion less soil is available for the sixteenth storeyed building.

Keywords – Design of superstructure, spun pie foundation, deflection, settlement and working load.

I. INTRODUCTION

Pile foundation is the part of a structure used to carry the applied column load of a super structure to the allowable bearing capacity of the ground surface at the same depth. The common used shape of pile is rectangular and slender which applied the load to the stratum of high bearing capacity. In the case of heavy construction, the bearing capacity of shallow soil will not be satisfactory; the construction should be built on pile foundation. It is used where soil having low bearing capacity respect to loads coming on structure or the stresses developed due to earthquake cannot be accommodated by shallow foundation. To obtain the most economical and durable foundation, the engineers have to consider the super structure loads, the soil condition and desired to tolerable settlement. Pile foundations are convened to construct the multi-storeyed building and work for water, such as jetties as bridge pier. The types of prestressed concrete pile are usually of square, triangular, triangle, circle and octagonal section which are produced in suitable length in one meter interval between 3 and 13 meters. Nowadays, most people use spun pile foundation addition to precast concrete pile to construct most of the buildings and bridges. Spun pile is one of the types of piles are widely used in the world construction. Prestressed concrete cylinder pile is a special type of precast concrete pile with a hollow circular cross section. Advantage of using spun pie are spun pile is less permeable than reinforced concrete pile, thus it has a good performance in marine environment. So the design of two pile foundation can be based on the deflection and settlement due to earthquake.

II. PREPARATION FOR ANALYSIS OF PILE FOUNDATION

Information of structure and material properties are prescribed as follows. Dead load, live load, wind load and earthquake loads are considered in proposed building. The typical beam plans and 3D view of the proposed buildings from ETABs software are shown in Figure 1 and Figure 2.

A. Site location and Profile of structure

Type of Structure	: 16-storeyed R.C Building		
Location	: Seismic zone (4)		
Soil Type	: Silty Sand, S_D		
Type of Occupancy	: Residential		
Shape of Building	: Rectangular shape		
Size of Building	: Length	= 81 ft	
	: Width	= 73 ft	
	: Height	=162 ft	
Height of Building:	Typical story height	= 10 ft	
	: Bottom story height	= 12 ft	

B. Design Codes

Design codes applied for superstructure are ACI (318-99) and UBC-97. There are 26 numbers of Load combinations which are accepted for beam, column, etc.

(1)Material Properties

Analysis property data

Weight per unit volume of concrete	= 150 pcf
Modulus of elasticity	= 3.12 x 10^6
Poisson's ratio	= 0.2

Design property data

Reinforcing yield stress (f_y)	= 50000 psi
Shear reinforcing yield stress (f_y)	= 50000 psi
Concrete cylinder strength (f'_c)	= 3500 psi

C. loading Considerations

The applied loads are dead loads, live loads, earthquake load and wind load.

(1) Gravity Loads: Data for dead loads which are used in structural analysis are as follows;

Unit weight of concrete	= 150 pcf
4½ inches thick wall weight	= 50 psf
9 inches thick wall weight	= 100psf
Light partition weight	= 20 psf
Finishing Weight	= 20 psf
Weight of elevator	= 2 ton

Data for live loads which are used in structural analysis are as follows:

Live load on slab	= 40 psf
Live load on lift	= 100 psf
Live load on stairs	= 100 psf
Live load on corridors	= 60 psf
Live load on roof	= 20 psf
Weight of water	=62.4 pcf

(2)Lateral loads: Data for wind loads which are used in structural analysis are as follows;

Exposure Type	= B
Basic wind velocity	=100mph
Important factor, I_w	= 1.0
Windward Coefficient	= 0.8
Leeward Coefficient	= 0.5

Data for earthquake load are as follows:

Soil profile type	= S_D

Seismic Zone	= 2A
Seismic Zone Factor	= 0.2
Building period coefficient, C_t	= 0.03
Important Factor, I	= 1
Seismic coefficient, C_a	= 0.28
Seismic coefficient, C_v	= 0.4

(3)Lateral Load Combination: According to (ACI 318-99) codes, the design of load combination are as follows:

1. 1.4 DL
2. 1.4 D + 1.7 LL
3. 1.05DL + 1.275LL + 1.275WX
4. 1.05DL + 1.275LL – 1.275 WX
5. 1.05DL + 1.275LL + 1.275 WY
6. 1.05DL + 1.275LL - 1.275 WY
7. 0.9DL + 1.3 WX
8. 0.9DL -1.3 WX
9. 0.9DL + 1.3 WY
10. 0.9DL - 1.3 WY
11. 1.05DL + 1.28LL + EX
12. 1.05DL + 1.28LL - EX
13. 1.05DL + 1.28LL + EY
14. 1.05DL + 1.28LL - EY
15. 0.9DL + 1.02 EX
16. 0.9DL - 1.02 EX
17. 0.9DL + 1.02 EY
18. 0.9DL - 1.02 EY
19. 1.16DL + 1.28 LL + EX
20. 1.16DL + 1.28 LL - EX
21. 1.16DL + 1.28 LL + EY
22. 1.16DL + 1.28 LL – EY
23. 0.79DL + 1.02 EX
24. 0.79DL - 1.02 EX
25. 0.79DL + 1.02 EY
26. 0.79DL - 1.02 EY

III.DESIGN RESULTS OF PROPOSED BUILDING

The design results of beam and column for proposed building are described

TABLE I DESIGN RESULTS FOR COLUMN, BEAM AND SLAB

Section	Size
Column	28″× 28″, 26″×26″, 24″×24″, 22″×22″, 20″×20″, 18″×18″, 16″×16″, 14″×14″, 12″×12″
Beam	9″×9″, 9″×12″, 10″×12″,12″×16″, 12″×18″, 12″×20″,14″×18″,14″×20″
Slab	4″ thick, 4.5″ thick and 5″thick
Wall	12″ thickness and 14″ thickness

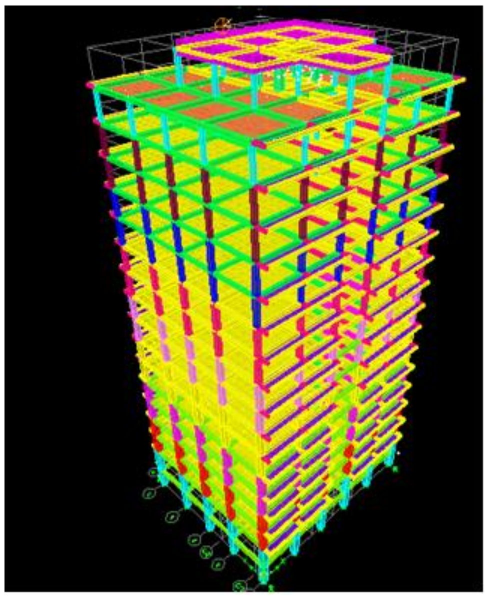


Figure.1 3D Model of Proposed Building

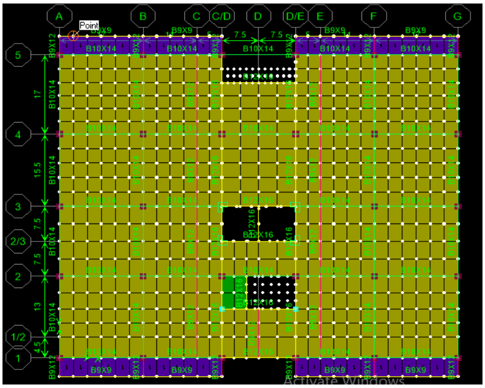


Figure.2 Beam and Column Layout Plan

IV. STABILITY OF THE SUPERSTRUCTURE CHECKING

The design superstructure is checked for

(1) Overturning,
(2) Sliding
(3) Story Drift
(4) Torsional Irregularity
(5) P-Δ Effect

All checking for stability of superstructure are within the limits.

TABLE II STABILITYCHECKING

Checking	X-direction	Y-direction	Limit
Overturning Moment	14.03	11.51	> 1.5
Sliding Resistance	4.81	4.81	> 1.5
Story Drift	0.22	0.26	< 2.4
Torsional Irregularity	1	1	< 1.2
P-Δ Effect	0.001	0.01	< 0.1

The superstructure of sixteenth storeyed building with basement is available by checking five methods.

TABLE III SOIL PROPERTIES

Depth (m)	N (Blow/m)	γ_{sat} (KN/m^2)	N_q	(ϕ') (˚)	σ_{vo} (KN/m^3)
4.50	7	9.95	0	0	44.775
6.00	7	10.53	0	0	60.57
7.50	7	10.98	8	28	77.04
9.00	13	10.48	8	28	92.76
10.50	5	7.98	0	0	104.73
12.00	8	7.98	0	0	116.7
13.50	9	7.98	0	0	128.67
15.00	14	8.65	0	0	141.64
16.50	21	9.76	10	30	156.28
18.00	29	9.76	12	31	170.92
19.50	28	9.76	12	31	185.56
21.00	26	9.76	10	30	200.20
22.50	23	9.76	10	30	214.84
24.00	24	9.76	10	30	229.48
25.5	28	9.76	12	31	244.12
27	10	8.45	0	0	257.55
28.5	23	10.36	10	30	273.09
30	17	10.36	10	30	288.63

The allowable bearing capacity (Qult)all is calculated by Myherhof's method.

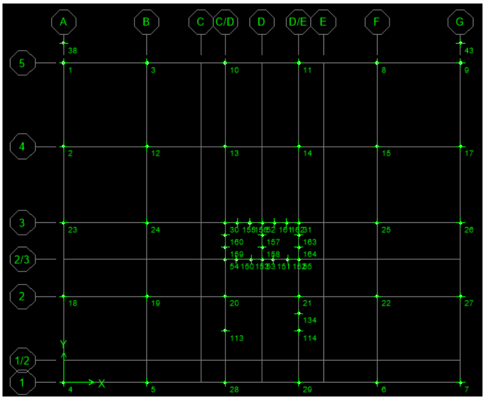


Figure3.Point Levels from load of superstructure

TABLE VI GROUPS OF UNFACTORED COLUMN LOAD

Group of Spun Pile	Points	Range	Maximum Unfactored Load	Control Point
1	113,114	300-500	306.02	4
2	1,4,7,9,20,21	500-700	611.81	36
3	2,3,5,6,8, 10,11,12, 13,14,15, 17,18,19, 23,24,25, 26,27	1007.33	1007.33	207
4	SW	4028.47	4028.47	54

V. Pile working load from Material

(Outside diameter = 16 inches, thickness =3 inches slender pile.)

Shear reinforcing yield stress (fy) = 50000 psi

Concrete cylinder strength (f′c) = 4000 psi

Modulus of elasticity = 3.37×10^6

ϕPT= 0.7 (0.33 f′c Ac + 0.39 fyAst)(ACI318-99)

= 0.7 (0.33 × 4000 × 122+ 0.39 × 50000 × 10 × 0.31)

= 155043 lbs.

= 69 Tons

0.86ϕPT = 0.86 × 69

= 59.34 Tons (Use 60 Tons)

According to CQHP Guideline

Up to 10,000 ft² Area – one bore hole for 2,500 ft²(min) ≥ Two bore hole

For this project,

Project area = 81′-0″ × 73′-0″

= 5913 ft²

Three bore holes are adequate.

The results of unfactored load are received by applying ETAB software. The base point levels of super structure are described in Figure3.

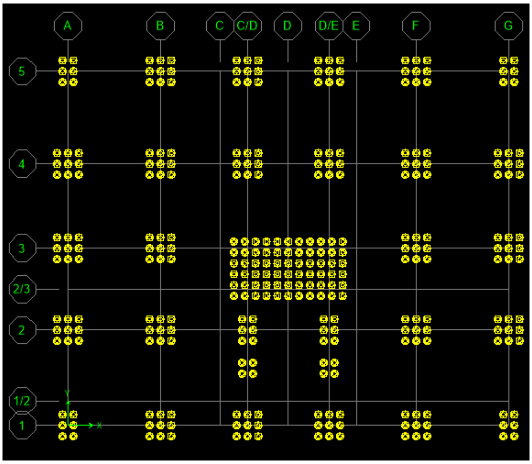
The group 1 is applied in bore 1, Group 2 in bore hole2 And Group 3 in bore hole 3 and Group 3 in bore hole 2.

The allowable bearing capacity Q_{ult} = 618.68 KN (in bore hole 1)

The allowable bearing capacity Q_{ult} = 608.06 KN (in bore hole2)

The allowable bearing capacity Q_{ult} = 633.02 KN (in bore hole 3)

The analysis results of spun pile foundation are described as the pile layout plan in Figure 4.



Figsure4. Spun pile layout plan

VI. Design of Pile Group 1 (Spun concrete pile)

The results of settlement are calculated by Brom's method to compare the software results.

Unfactored load = 611.8 kip

Assume pile cap thickness = 3 ft

B = 6ft

Pile cap weight = 3 × 6 ×4×0.15

= 10.8 kips

Total weight of pile group = 611.81 + 10.8

= 622.61 kips

Load per pile $= \frac{622.61}{6}$

=103.7kip<146kips

(b) Allowable bearing capacity of pile group

The ultimate bearing capacity of the pile group in cohesion less soil is at least equal to the sum of individual pile capacities.

Pile group capacity, $(Q_G)_{ult}$ $= n\times(Q_x)_{ult}$

= 16×410.075

= 2460.45 kips

$(Q_G)_{all}$ $= (Q_G)_{ult}/F.S$

$= \frac{2460.45}{3}$

= 820.15kips

The group capacity is 820.15 kips, which is greater than the loads 622.61 kips on the pile group. Therefore, it is acceptable from a bearing capacity point of view.

(c) Settlement of pile

Semi-empirical method is used. To calculate the settlement

Total load on pile group = 622.61 kips

Q_p = 85.47 kips

Q_{pa} $= \frac{85.47}{3}$ = 28.49 kips

Q_f = 324.6 kips

Q_{fa} $= \frac{324.6}{3}$ = 108.2 kips

Total allowable load, $(Q_v)_{all}$ = 136.69 kips

When actual load on each pile is 103.7 kips.

$$Q_{pat} = Q_{pa} \text{ x } \frac{\text{Load per pile}}{(Q_v)_{all}}$$

$= 28.49\times \frac{103.77}{136.69}$

= 21.63 kips

$$Q_{fa} = Q_{fa} \text{ x } \frac{\text{Load per pile}}{(Q_v)_{all}}$$

= 108.2 × 103.77/136.69

= 82.14 kips

L = 85 ft

$\dot{\alpha}_s$ = 0.55

B = 16 in

A_p = 1.38 ft^2

E_p = 3.37 × 10^6 psi for concrete

C_p = 0.02 (Table)

q_p = Q/A

= 85.47/1.38

= 61.93 k/ft^2

$$C_s = \left[0.93 + 0.16\sqrt{\frac{L}{D}}\right]C_p$$

= 0.066in

$$S_s = \frac{(Q_{pa} + \alpha Q_{fa})L}{A_p E_p}$$

= 0.1in

S_p = $C_s Q_{fa}/Lq_p$ = 0.12

$$S_{ps} = \frac{C_s Q_{fa}}{Lq_p}$$

= 0.01 in

S_t = $S_s + S_p + S_{ps}$

= 0.1+ 0.12 + 0.01

= 0.23 in < 1 in (satisfied)

(ii) Empirical method

S_t $= \frac{B}{100} + \frac{QuaL}{ApEp}$

S_t = 0.31 in

The results obtained from these methods are compared and then higher value 0.2 in is chosen. Therefore, the settlement of pile group is

S_G = $S_t\sqrt{(\bar{b}/B)}$

= 0.31 √(24/10)

= 0.37 < 1 in

TABLE V COMPARISON OF LOAD OF GROUP PILE

Spun Pile	Pile No	$(Q_{uG})_{all}$	Total load on pile group
Group 1	4	413.56	312.43
Group 2	6	820.15	640.61
Group 3	9	1251.71	1028.93
Group 4	54	22530.84	4190.47

TABLE VI COMPARISON OF DESIGN OF PILE CAP

Spun Pile	No of Pile	L (ft.)	B(ft.)	Thickness (ft.)
Group 1	4	4	4	2.67
Group 2	6	6	6	4
Group 3	9	6	6	4
Group 4	54	18	12	5

TABLE VII DESCRIPTION OF DEFLECTION, SETTLEMENT & LOAD

	Deflection		Settlement		Load	
	X	Y	Broom' method	ETAB software	Applied Load	Working load
GP 1	0.13	0.11	0.33	0.04	54.91	60
GP 2	0.15	0.18	0.37	0.5	10	60
GP 3	0.2	0.18	0.41	0.3	51.63	60
GP 4	0.16	0.14	0.41	0.38	54.86	60

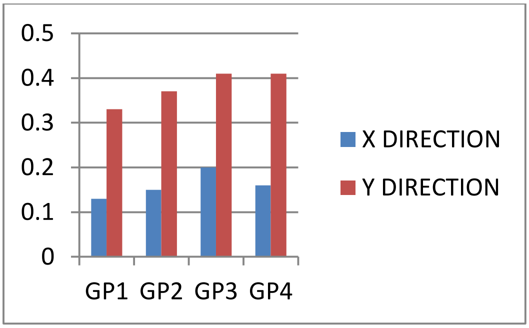


Figure5. Comparison of X & Y direction of spun pile foundation

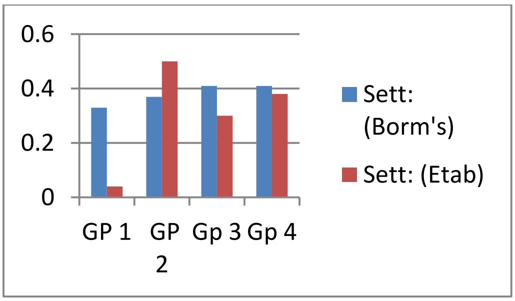


Figure6. Comparison settlement of spun pile foundation

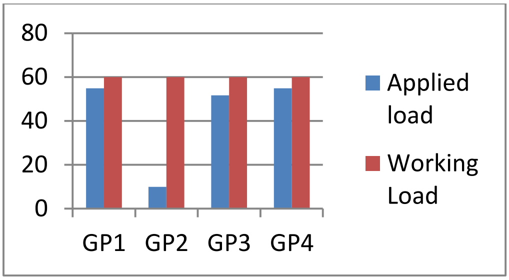


Figure7. Comparison pile working load and applied load of spun pile foundation

VII. DSICUSSION AND CONCLUSION

For the design of spun pile foundation, the required soil parameters are obtained from the soil report on, Yangon. The allowable bearing capacity of the soil is calculated by Tomlinsom, Myerhof in Rules of Thumb and SPT methods. The soil condition of the proposed building at the base of mat foundation is soft soil. The proposed site is located on seismic zone 2A. The superstructure is analyzed and designed by using ETAB software. The lateral load and gravity loads are considered and the design superstructure is checked for sliding resistance, overturning effect, story drift, and torsional irregularity. The sum of critical unfactored loads from superstructure is 29867.01 kip. In design of spun pile foundation the use of the same number of pile divided into four groups. The required pile length for four groups of two pile foundations is 85 Ft. The deflection of two pile foundations is satisfied. The calculated settlement of group1, 3,4 by using Brom's method are greater than ones from ETAB software and group 2 settlement is less than one In comparison two results of settlement for spun pile foundation these are more satisfactory than the Allowable limits. The deflections of two directions are less than the allowable limits. The applied load of spun pile foundation are more responsible than the working load. Finally, the spun pile foundations are accepted to support the proposed sixteenth-storey R.C building with basement.

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Study on Effects of Opening Patterns in Shear wall on Setback building

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Abstract: This article presents the effects of opening on shear wall for thirteen-storeyed U shape RC building, which is situated in seismic zone (4).This structure is setback building. The elevations and plans of this structure are irregularity in shape. Special moment resisting frame is considered in this structure. This structure is analyzed under dead load, live load, wind load, earthquake load and all necessary load combinations are considered by using UBC 97. The modeling and analyzing of each member is done by ETABS 16.0.3. All of structural members are designed by ACI 318-14. Response spectrum analysis is used for dynamic analysis. First, the proposed building is analysed and design by using ETABS software. The shear wall of proposed building is opened with various percentage of opening and three different patterns. There are three types of patterns opening patterns (center 0pening,staggered opening and two vertical opening).The size of openings of shear wall are 13.6%, 25% and 35% of shear wall area. This article include comparative study of storey displacement, storey shear and storey moment under seismic force due to three configurations of openings in shear walls. According to the comparisons of these results, the maximum structural response is occurred at the structure having shear wall is with two vertical opening.

Keywords: seismic zone 4; setback; opening; response spectrum; shear wall

1.INTRODUCTION

We Nowadays,a large number of tall buildings are emerged due to the growth of populations. The highly function of vertical structure elements is to resist not only the gravity loading from the weight of the buildings but also the lateral load such as wind and possible earthquake loads. When these forces are acting on the structure, high shear forces and bending moments in structural members are causing the failure of the structure. Irregularities of plan and elevation give to damage the structural members. Shear wall is a wall column designed to resist the lateral loads.The strength of the shear wall depends on the type, size and use of materials. To attain a structure with sufficient strength and ductility to assure life safety, it is necessary to know about the configuration of opening of shear wall

2. DATA PREPARATION FOR PROPOSED BUILDING

All loadings on superstructure are considered according to UBC-97.Required loads and structural configurations of the proposed building are as follow:

2.1Site Location and Structural Framing System

Type of building : Thirteen-Storeyed RC building

Shape of building : U-shape (Vertical Irregular)

Location : Seismic zone 4

Type of occupancy : Commercial (Hotel)

Size of building :Length =131ft

Width =106.5ft Height of building

Typical storeyed height =12ft

Base to GF Storeyed height =10ft

GF to1st Storeyed height =16ft

1st to2nd storyed height =14ft

Overall height from ground floor =181ft

2.2 Material properties and design property data used for the proposed building

Modulus of elasticity , E_c = 3604 ksi

Poisson's ratio , = 0.2

Coefficient of thermal expansion = 5.5 x 10^{-6} in / in per degree F

Bending reinforcement yield stres (f_y) = 50ksi Shear reinforcement yield stress (f_{ys}) = 50ksi Concrete cylinder strength (f'_c) = 4ksi

2.3. Loading Consideration

Two kind of loads are considered in this study, which is gravity load, that include dead and live load, lateral load that include wind and earthquake load

2.3.1 Dead Load

The weight of all material and fixed equipments incorporated into the building are considered as dead load.

Consideration of dead loads for proposed building are as follows:

4.5" thick brick wall = 55 lb/ft^2
Unit weight of concrete = 150 lb/ft^3
Superimposed dead load = 25 lb/ft

2.3.2 Live load

Live loads are gravity load produced by the used and occupancy of the building and do not include dead loads, construction loads, or environmental loads such as wind and earthquake loadings are based on to UBC-97.

Unit weight of water = 62.4 lb/ft^3

Live load on floor area = 40 lb/ft^2

Live load on roof = 20 lb/ft^2

Live load on stair case = 100 lb/ft^2

Live load on lift = 100 lb/ft^2

2.3.3 Wind Load

The wind pressure on a structure depends on the wind response of the structure. Required Data in designing for wind load:

Exposure type = Type B
Basic wind velocity = 80 mph
Total height of building = 181 ft
Windward coefficient = 0.8
Leeward coefficient = 0.5
Importance Factor = 1.0

2.3.4 Earthquake Load

The purpose of seismic design is to proportion the structures so that they can withstand the displacements and forces induced by the ground motion.

Seismic zone = 4

Seismic Source Type = A

Soil Type = S_D

Structure =Special Moment Resisting Frame

Seismic Response Coefficient, Ca = 0.44 Na

Seismic Response Coefficient, Cv = 0.64 Nv

Near Source factor, Na = 1

Near Source factor, Nv = 1

Zone Factor = 0.4

Importance Factor, I = 1.0

Response Modification Factor, R = 8.5

C_T value = 0.03

2.4. Modeling of Proposed Building

Architectural view for ground floor plans, fifth to sixth floor plan, seventh to nine floor plan, tenth to twelve floor view and three dimensional view (3D) of proposed building are shown in Figure 1, 2, 3, 4, and 5 respectively. Figure 6 ,7 and 8shows the sample opening pattern of the shear wall.

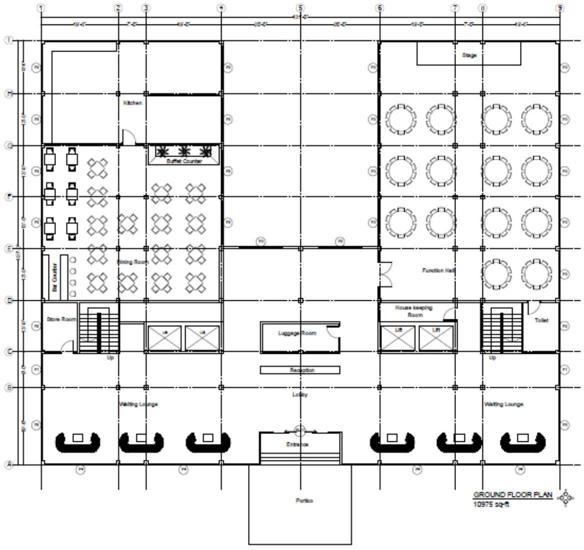

Figure 1. Architectural View for Ground Floor Plan

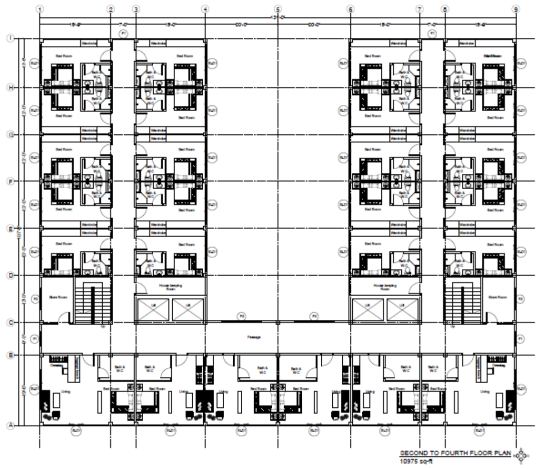

Figure 2. Architectural View for 1st to 4th Floor Plan

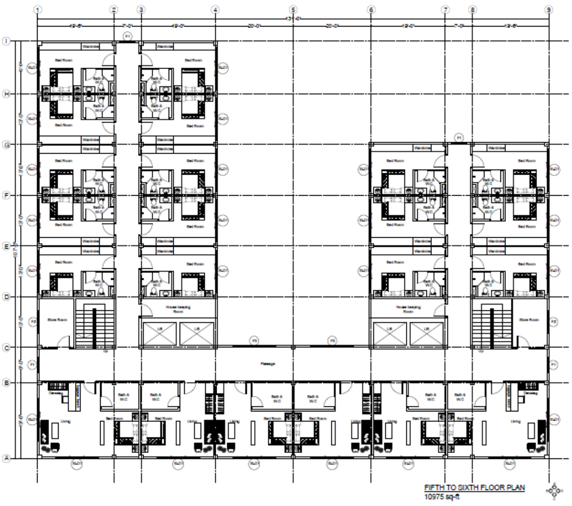

Figure 3. Architectural View for 5st to 6th Floor Plan

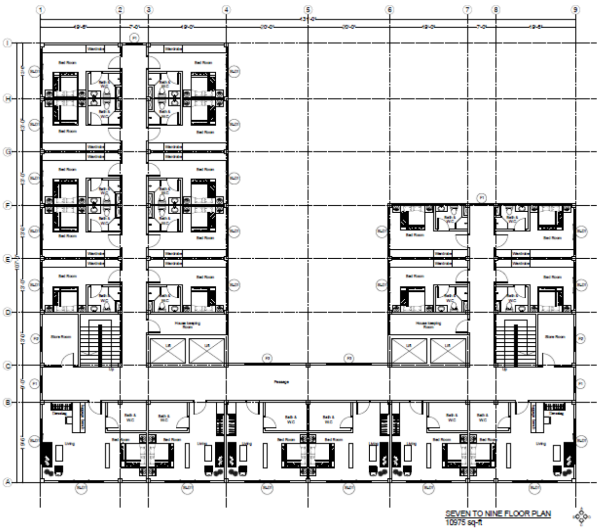

Figure 4. Architectural View for 7st to 9th Floor Plan

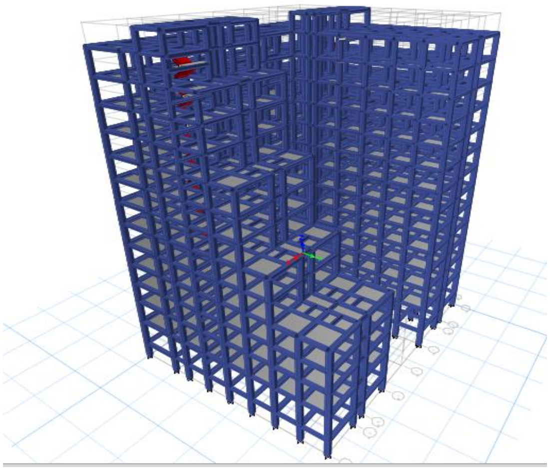

Figure 5. 3D View of Proposed Building

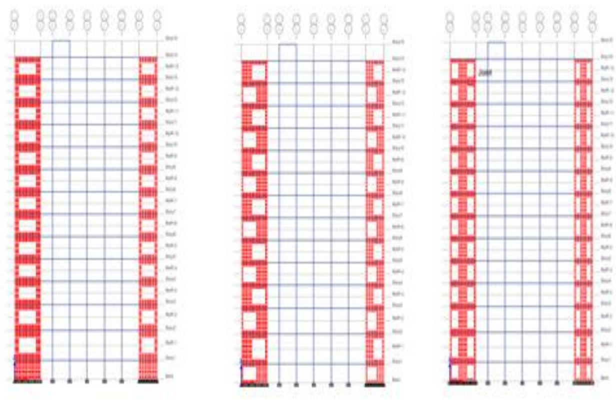

Figure 6. opening patterns of Propose Building(35%)

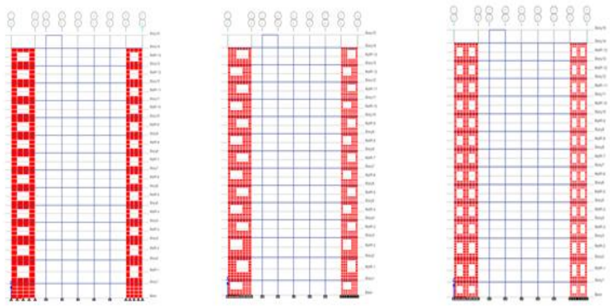

Figure 7. opening patterns of Propose Building(25%)

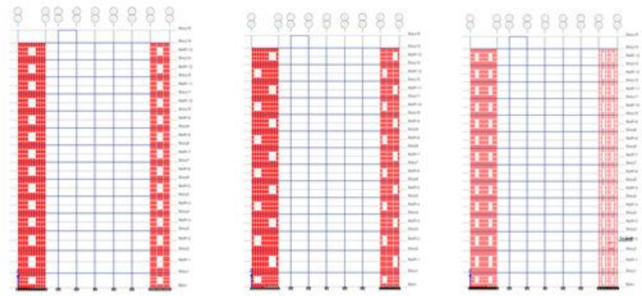

Figure 8. opening patterns of Propose Building(15%)

3. LOAD COMBINATIONS

According to ACI 318-14 and UBC- 97, static design load combinations and dynamic design load combinations (Response Spectrum analysis) for zone (4) are as follows:

1. 1.4DL
2. 1.2DL+1.0LL
3. 1.2DL+1.6LL
4 1.2DL+0.5Wx
5 1.2DL-0.5Wx
6 1.2DL+0.5Wy
7 1.2DL-0.5Wy
8. 1.2DL+1.0LL+1.0Wx

9. 1.2DL+1.0LL-1.0Wx
10. 1.2DL+1.0LL+1.0Wy
11. 1.2DL+1.0LL-1.0Wy
12. 0.9DL+1.0Wx
13. 0.9DL-1.0Wx
14. 0.9DL+1.0Wy
15. 0.9DL-1.0Wy
16. 1.2DL+1.0LL+1.0EQX
17. 1.2DL+1.0LL-1.0EQX
18 1.2DL+1.0LL+1.0EQY
19 1.2DL+1.0LL-1.0EQY
20 0.9DL+1.0EQX
21 0.9DL-1.0EQX
22 0.9DL+1.0EQY
23 0.9DL-1.0EQY

4. Modeling the Structure with Static Analysis

The column section, beam sections and shear wall sizes of the proposed building with static analysis are shown in Table 1 and 2. Layout plan for beam, and location of shear walls of the proposed building are shown in Fig 6, 7, 8,9, 10, 11, 12,and 13 respectively

Table 1 Design Section of Columns

Beam Name	Type	Section (in × in)
B1	Main Beam	14 × 20
B2	Main Beam	12 × 15
B3	Main Beam	10 × 12
B4	Main Beam	9× 12
SB	Secondary Beam	9 × 12

Table 2 Design Section of beams

Column Name	Storey Level	Section (in × in)
C1	Base to Story 6	20 × 20
	Story 7 to Story 11	18 × 18
	Story 12 to Roof	16 × 16
C2	Base to Roof	16×16

Shear wall thickness is 12 in from base to level 13. The thickness of slab is 6 in for all room and 7 in for landing.Function of column C 1 is not only exterior column but also interior column for all room. Column C2 is only for lift room.

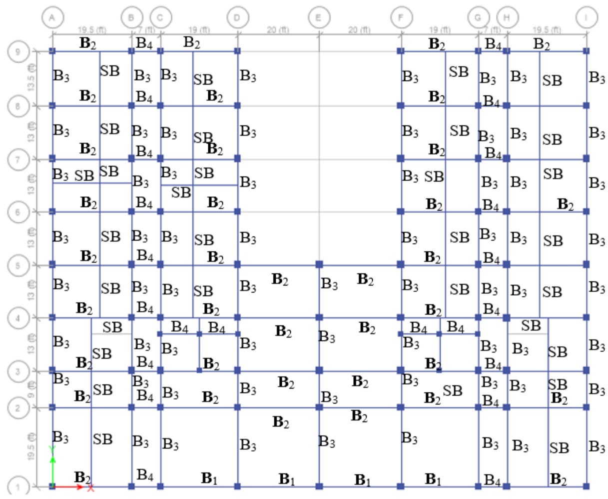

Figure 9. Beam layout plan

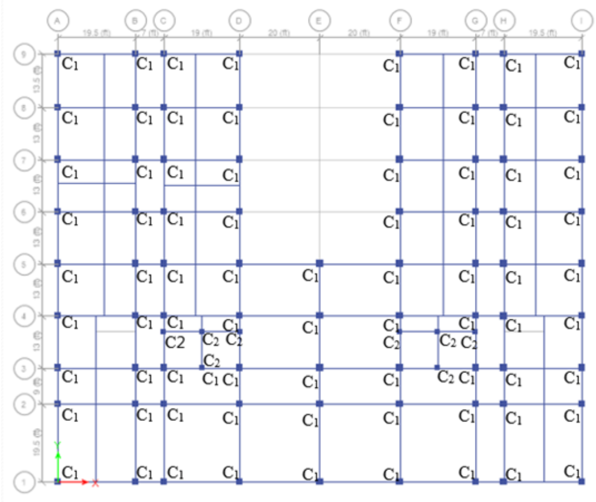

Figure10. Column layout plan

5. Comparing the Results

The results of openings are compared form the following figures.Figure,11,12,13,14,15 and 16 are the comparing results of 13.6% opening in storey displacement, shear and moment.

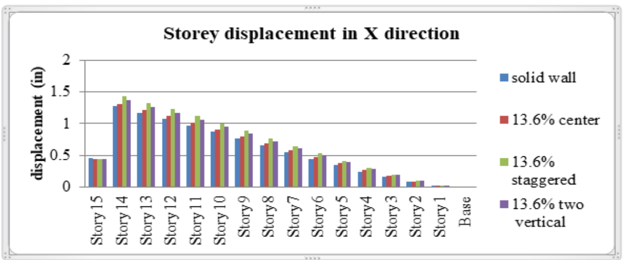

Figure11. Comparing the results of storey displacement in X direction with 13.6% opening

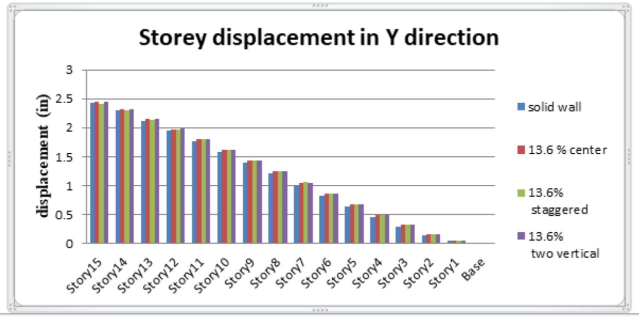

Figure12. Comparing the results of storey displacement in Y direction with 13.6% opening

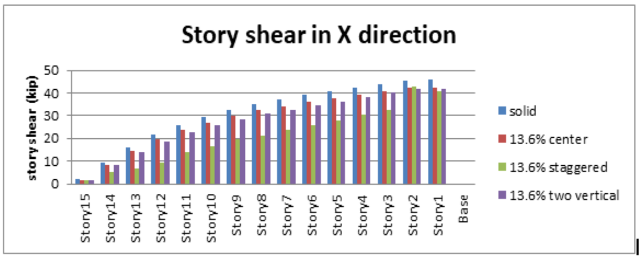

Figure13. Comparing the results of storey shear in X direction with 13.6% opening

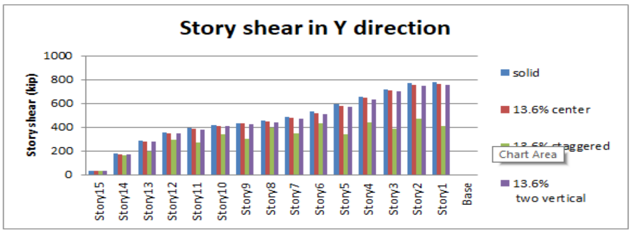

Figure14. Comparing the results of storey shear in Y direction with 13.6% opening

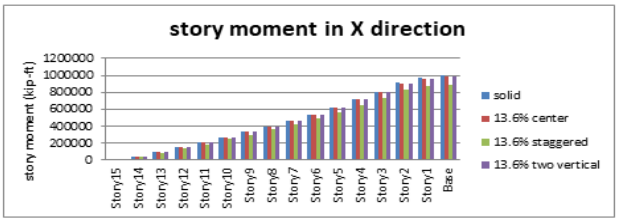

Figure15. Comparing the results of storey moment in X direction with 13.6% opening

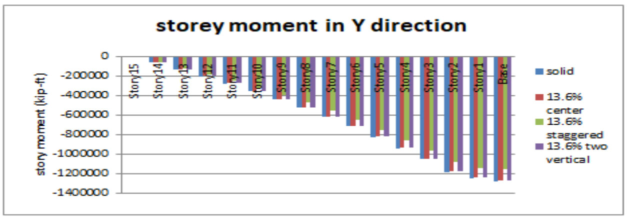

Figure16. Comparing the results of storey moment in Y direction with 13.6% opening

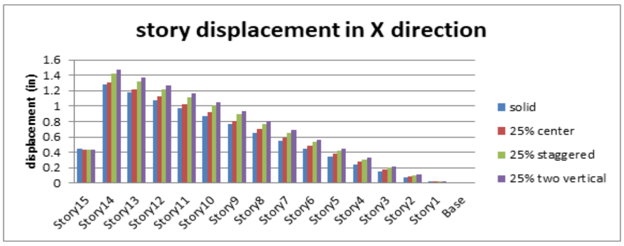

Figure17. Comparing the results of storey displacement in X direction with 25% opening

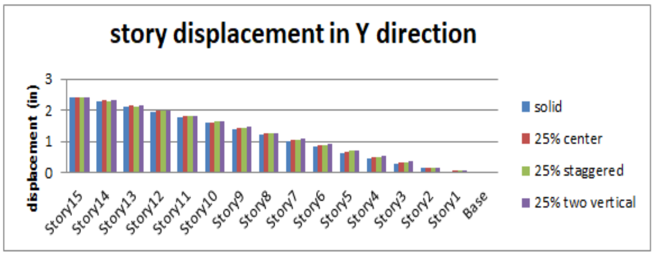

Figure18. Comparing the results of storey displacement in Y direction with 25% opening

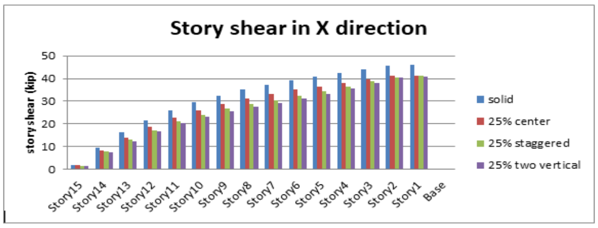

Figure19. Comparing the results of storey shear in X direction with 25% opening

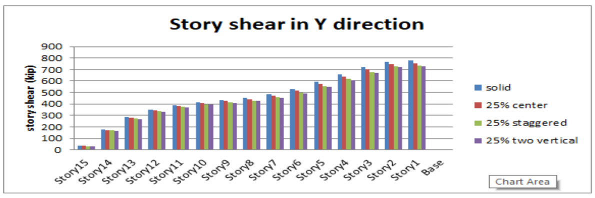

Figure20. Comparing the results of storey shear in Y direction with 25% opening

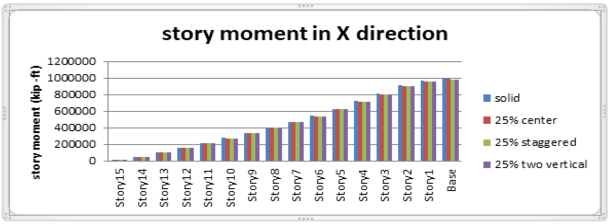

Figure21. Comparing the results of storey moment in X direction with 25% opening

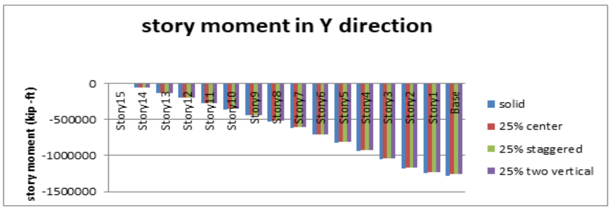

Figure22. Comparing the results of storey moment in Y direction with 25% opening

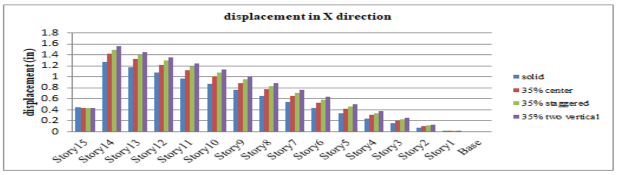

Figure23. Comparing the results of storey displacement in X direction with 35% opening

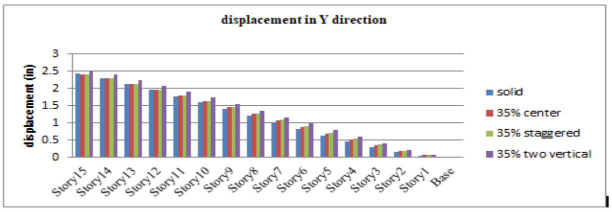

Figure24. Comparing the results of storey displacement in Y direction with 35% opening

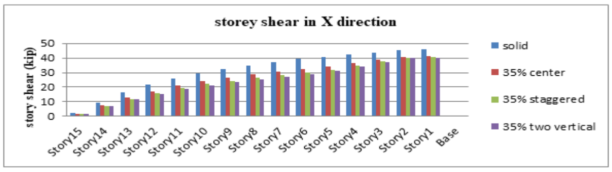

Figure25. Comparing the results of storey shear in X direction with 35% opening

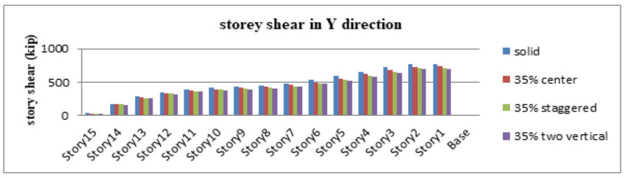

Figure26. Comparing the results of storey shear in Y direction with 35% opening

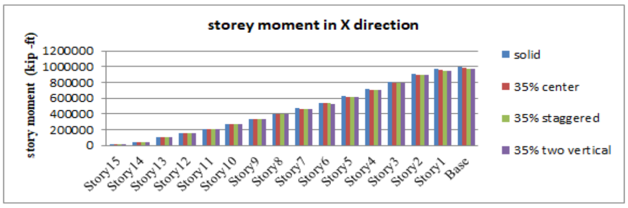

Figure27. Comparing the results of storey moment in X direction with 35% opening

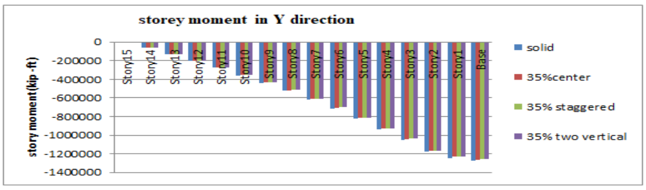

Figure28. Comparing the results of storey moment in Y direction with 35% opening

from the above figures, figure17,18,19.20,21 and 22 are the comparing results of 25% opening in storey displacement, shear and moment .And,figure,23,24,25,26,27 and28 are the comparing results of 35% opening in storey displacement, shear and moment.

6. Conclusion

In this study, the proposed building is vertical irregularities (setback) U-shape building. The shear wall is situated in Y direction of the structure .So the results of the structure is clearly different in X direction and the results of the structure in Y direction is nearly the same.

In comparison of analysis of results, the maximum value of storey displacement and minimum value of storey shear and moment at the two vertical opening of the structure.And minimum value of storey displacement and maximum value of storey shear and moment are occurred at center opening .

So it can be considered that the center opening is more suitable than the other opening pattern (staggered and two vertical). And two vertical opening is not suitable for the opening in shear wall structure.

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IoT Concept for Animal Detection Using ANN to Prevent Animal Vehicle Collision on Highways

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Abstract: Being in a world where wildlife animals are becoming extinct and remaining getting run over by vehicles while crossing through the roads, this paper proposes an IoT concept to prevent animal-vehicle collision on highways and roads in reserve areas. Electric fencing being a huge threat to animal's life our paper brings in a great replacement of this electric fencing by giving alerts through smart phones and huge LED displays placed across the major places where animals are found to cross the roads. This paper uses two major algorithms such as the motion detection algorithm with the sensors and object recognition algorithm using artificial neural networks. In this paper we have used the motion detection PIR sensor to detect the animal movement near roads and the ANN for object recognition. Once the motion is detected the object recognition algorithm recognizes whether the motion detected was due to an animal movement or any other factors. If it is because of an animal movement it sends alerts through the LED signage boards and to the android application which uses Google maps to show alerts on the corresponding area through MQTT. This paper achieves object recognition accuracy of up to 91%.

Keywords: ANN (Artificial Neural Networks), IoT, PIR, MQTT, Object recognition

1. INTRODUCTION

As the world is evolving towards 'smart' technologies approaching anything with smart technology is the smartest way. This paper proposes an IoT concept to prevent animal-vehicle collison by using various sensors and image processing algorithms. In certain highways and in roads that go through the reserve areas various wildlife animals are present and they tend to cross the roads. Animals are unaware of the vehicle movement so does the vehicle drivers. Each year thousands of animals get hit by vehicles and die. Hence we developed an approach to prevent this from happenning or atleast the numbers can be reduced to a huge amount.

On various bench marking analysis we have proposed that PIR (Passive Infrared) sensors can be used for motion detection. Which helps us to find any movement in that premises. In order to confirm that movement is due to an animal and not any external factors we use the IP cameras which uses image recognition algorithm to confirm that it is an animal.

Having confirmed the presence of animals a message is sent through huge LED displays and alerts through google maps who are using it on the premises.

2. ANALYSIS OF ANIMAL VEHICLE COLLISION

Our paper proposal was initiated with the depth analysis of animal vehicle collision across the world. Various statistical data was analysed and based on the results the we have included certain additional algorithms to our approach in order to prevent the animal vehicle collision to the maximum. Folllowing are few of the statistics that has been analyzed.

The below table gives the detailed data with the number animals killed each year from 2014 to 2018 month wise. It is found that each year hudreds of animals are being killed due animal vehicle collison. The statistics also provides the rare type of animals which are being killed.

BY MONTH	2014	2015	2016	2017	2018
JAN	9	5	11	22	-
FEB	11	2	9	17	-
MAR	7	8	17	17	-
APR	4	18	9	24	18
MAY	5	21	46	33	35
JUN	35	60	83	52	71
JUL	28	43	61	82	33
AUG	32	73	38	42	31
SEP	34	39	29	23	39
OCT	27	27	49	29	24
NOV	27	26	51	46	44
DEC	20	16	22	28	23
UNKNOWN	0	0	1	0	0
TOTAL	239	338	425	416	318

Table.2.1 *Animals killed record*

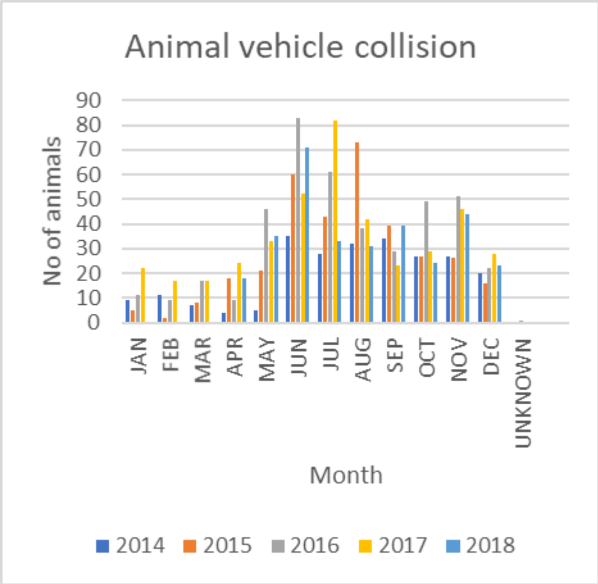

Fig.2.1 *Animal Vehicle collision chart*

TYPE OF ANIMAL	NUMBER OF ANIMALS	YEAR
Bear	4	2018
Bighorn	1	
Cat	2	
Coyote	3	
Deer	220	
Dog	1	
Elk	31	
Fox	2	
Lion	4	
Moose	3	
Pheasant	1	
Rabbit	1	
Raccoon	4	
Skunk	2	
UNK	39	

Table2.2 *Type of animal dead by animal-vehicle collision*

Based on the above statistics we infer huge number of animals become victims of animal-vehicle collision. Hence our paper proposes the method to reduce the number of deaths caused by animal-vehicle collision to the maximum and preserve the nature with a technical and smart approach.

To implement this approach specific locations which are considered as animal crossing zone are chosen.

The Fig.2.2(a) shows the alert signage boards on highways denoting moose crossing for next 5 kms. Zones similar to this are chosen across all states in a country and the project can be implemented.

(a)

(b)

Fig.2.2 (a) *Animal crossing alert displays,* ***(b)*** *Deer in a highway*

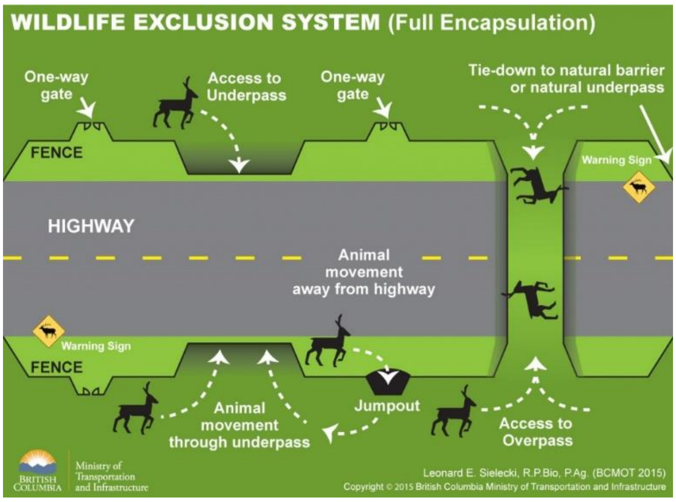

Fig.2.3 *Wildlife exclusion system*

The British Columbia ministry of transportation and infrastructure has released a detailed picture of the animal crossing in highways. This picture also explains the ways in which the animal jumps out of the fence and a method to encapsulate by building an underpass for animals and the warning signs kept on highways.

3. SYSTEM ARCHITECTURE

3.1 SYSTEM ARCHITECTURE

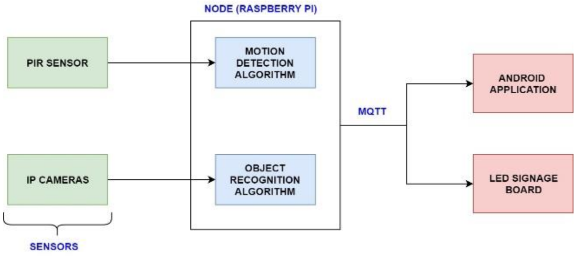

Fig.3.1 *Proposed system architecture*

The above block diagram illustrates the overview of the alerting system. There are two major sensors that is being used in this system they are the PIR sensor and the cameras. Detailed description of the sensors are explained in the below sections.

3.1.1 PIR Sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensors are commonly used in security alarms and automatic lighting applications. PIR sensors detect general movement, but do not give information on who or what moved. For that purpose, an active IR sensor is required.

Fig.3.2 *PIR Sensor*

PIR sensors are commonly called simply "PIR", or sometimes "PID", for "passive infrared detector". The term passive refers to the fact that PIR devices do not radiate energy for detection purposes. They work entirely by detecting infrared radiation (radiant heat) emitted by or reflected from objects. This PIR sensor is used in our application to detect the movement of animals.

3.1.2 IP CAMERAS

An Internet Protocol camera, or IP camera, is a type of digital video camera that receives control data and sends image data via the Internet. They are commonly used for surveillance. Unlike analog closed-circuit television (CCTV) cameras, they require no local recording device, but only a local area network. Most IP cameras are webcams, but the term IP camera or netcam usually applies only to those used for surveillance that can be directly accessed over a network connection.

3.1.3 LED SIGNAGE BOARD

The LED signage board is used to show alert message when an animal motion is detected. In this paper we use RS-232 communication port to send message to the board and display the messages published through MQTT.

3.1.4 NODE

The node here refers to the controller that has been used on the premises to process the data received from the sensor and sends alerts to LED signage boards and android applications. In this paper we are using an ARM based contoller. Following are the specifications of the ARM based controller.

SoC: Broadcom BCM2837

CPU: 4× ARM Cortex-A53, 1.2GHz

GPU: Broadcom VideoCore IV

RAM: 1GB LPDDR2 (900 MHz)

Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless

Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy

Storage: microSD

GPIO: 40-pin header, populated

Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI).

Fig.3.3 *ARM based controller*

There can be multiple nodes across the country. Each node can be named as Node-1, Node-2, Node-3 etc., each node sends alerts to the LED signage boards and android application through the common communication protocol i.e., MQTT.

3.1.5 MQTT

MQTT is a machine-to-machine (M2M)/"Internet of Things" connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport. It is useful for connections with remote locations where a small code footprint is required and/or network bandwidth is at a premium. For example, it has been used in sensors communicating to a broker via satellite link, over occasional dial-up connections with healthcare providers, and in a range of home automation and small device scenarios. It is also ideal for mobile applications because of its small size, low power usage, minimised data packets, and efficient distribution of information to one or many receivers.[2]

3.1.6 NODE ARCHITECTURE

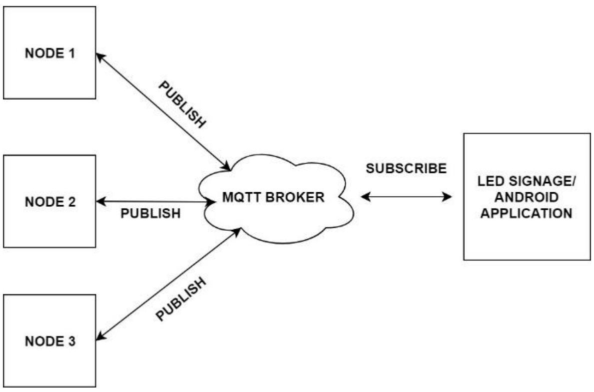

Fig.3.4. *Node architecture*

The fig.3.4 describes the common communication protocol. Unlike HTTP this protocol communicates with the publish subscribe basis. The user end subscribes to the particular URL from where the data has to be received. The node acts the publisher which publishes the message to the broker this broker in turn sends the message to the end user who has subscribed to the node.

4. IMPLEMENTATIONS

4.1 FLOW CHART

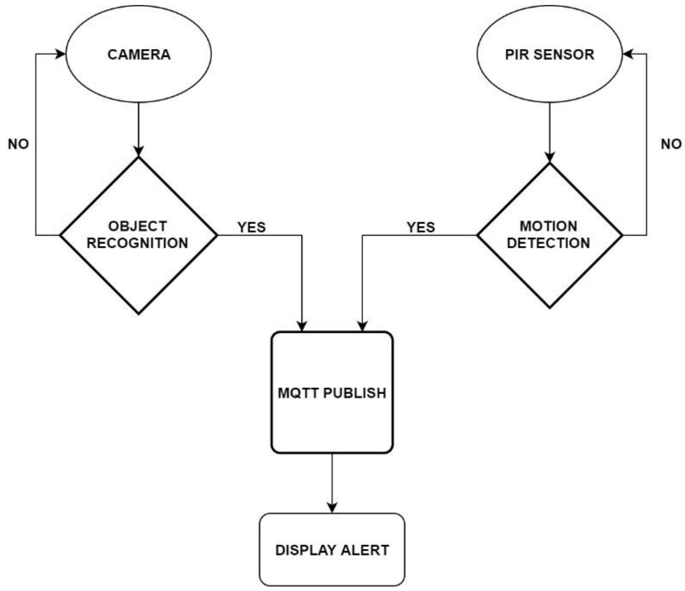

Fig.4.1 Flow Chart

The Fig.4.1 describes the flow chart of the whole system. Firstly the PIR sensor detects any motion on its premises, if yes it sends the alert to MQTT broker. Similarly the camera detects if the movement is because of animal movement or any other external factor. If it recognises animal then it sends alert to the MQTT broker. This broker in turn publishes the alert to the LED signage boards and mobile application.

4.2 OBJECT RECOGNITION TECHNIQUE

In this paper we use the object recognition technique to identify the prescence of animal each and every time when motion is detected in the premises, an alert is sent to LED signage board & android application.

In this paper we use the Artificial Neural networks technique for object rocognition. The neural network is trained with the data sets of animals and produce result with more than 90% accuracy. Neural network uses the backpropagation algorithm to train the datasets.

4.3 MQTT SETUP

In this paper MQTT is used as the common communication protocol between the user and the end devices/sensors. The following images describes how to establish a MQTT connection and publish messages on the subscribed URL.

MQTT FX is the testing tool that is being used to check publish and subscribe operations.

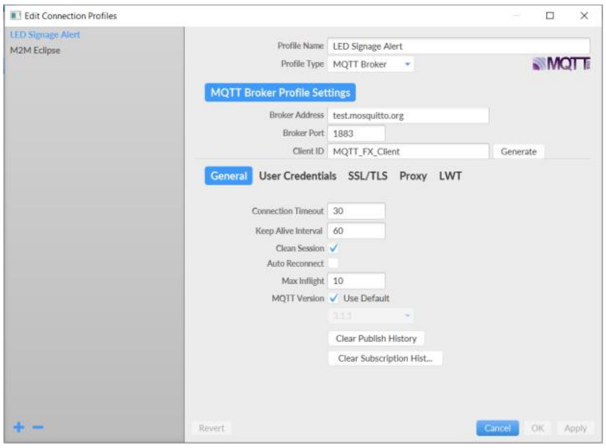

Fig.4.1 *MQTT settings*

After installing MQTT FX open the connection settings page. In the settings page we enter the profile name, profile type, the broker address and the broker port. In this paper we are using the mosquitto broker. MQTT always uses port 1883 to listen.

After applying the changes, we connect to the broker. Once it is connected to the broker the status changes to green color on top right of the window as shown in Fig.4.2. This denotes that the broker is listening and its active. When the connection is lost it turns into red color.

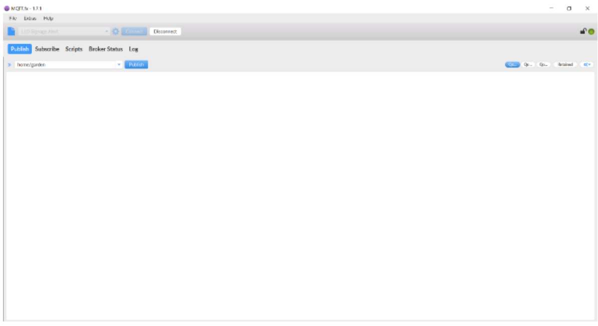

Fig.4.2 *MQTT Connection*

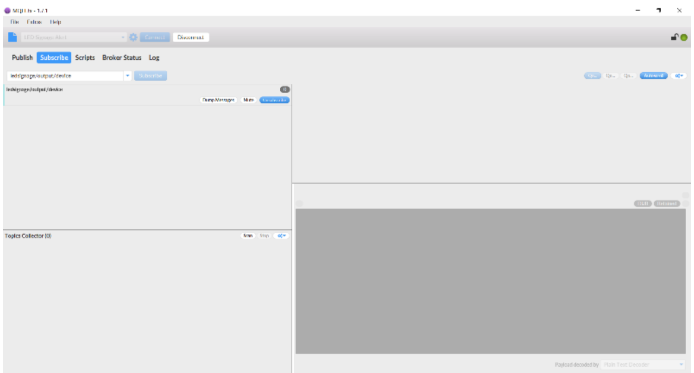

Fig.4.3 *MQTT Subscribe*

In Fig.4.3 you see how to subscribe to a particular url. The url has to be entered and the subscribe button is clicked. Once it is subscribed the publish tab is used to publish the messages to the end device.

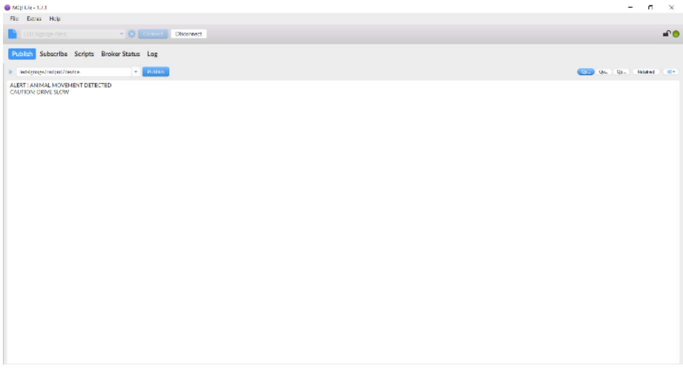

Fig4.4 *MQTT Publish*

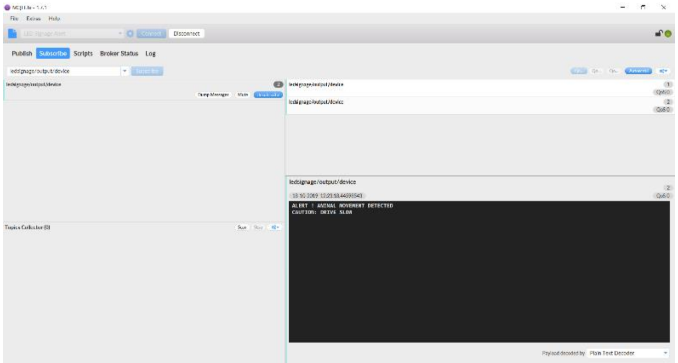

Fig.4.5 *MQTT Message published*

The published message can be seen in the fig.4.5.Which shows

"ALERT ! ANIMAL MOVEMENT DETECTED CAUTION : DRIVE SLOWLY"

5. RESULTS AND DISCUSSIONS

The results obtained from object detection & MQTT message publish to the LED signage boards are as shown below. In Fig.5.3 you can see the accuracy is 0.9158 which is 91.58 %. And the total network error is diplayed in Fig.5.2

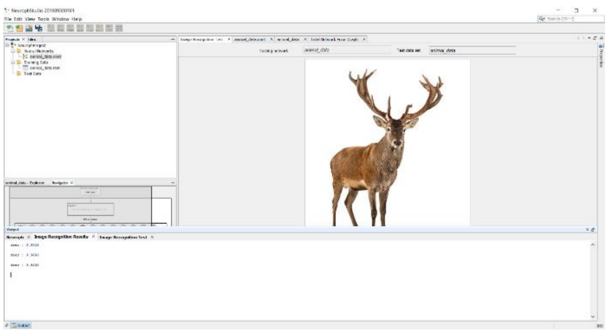

Fig. 5.1 *Objet recognition output*

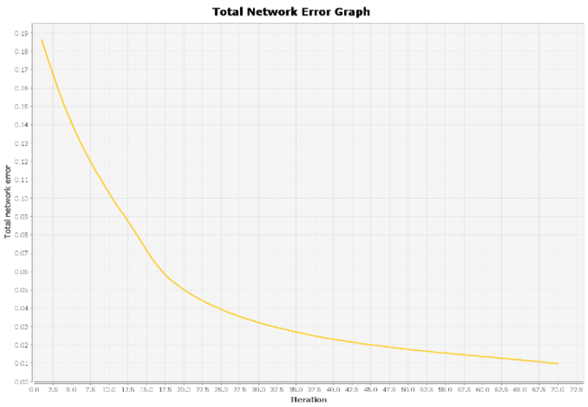

Fig.5.2 *Network error graph*

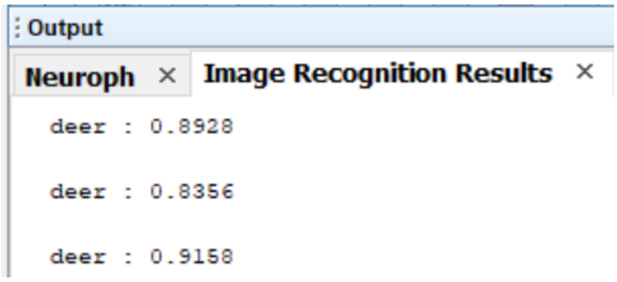

Fig.5.3 *Image recognition result (Accuracy)*

6. CONCLUSION

In this paper we have deeply analyzed the animal vehicle collision happening across the world. We have derived at a solution to prevent animal vehicle collision using IoT. We have used sensors such as the PIR sensor to detect motion and IP cameras to recognize the movement of animal. These sensors having satisfied with the condition sends message to the MQTT broker which in turn publishes the message to the LED signage boards placed across the roads which are animal crossing zone. Our paper uses the MQTT broker in cloud. The entire client server communication happens through the node.

7. FUTURE SCOPE

Our future scopeis to involve with the development of an adroid application which comes with maps and shows alert directly on the maps when the user is moving along the location. Also when the user crosses one zone to the other zone MQTT has to be unsubscribed from the current zone and be subscribed to the next zone, MQTT handoff is one biggest challenge which has to be addressed in future. Once the above two objective are developed the entire system has to be deployed in real time environment.

8. ACKNOWLEDGEMENT

Our thanks to all experts who have contributed to our research work.

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