Multi Storied (G + 5) Furniture Showroom Building , Seismic Load Manual Calculation

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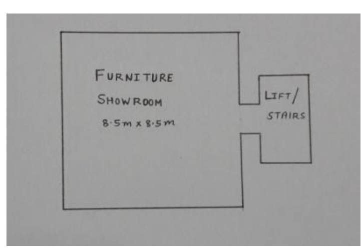
Abstract –The rapid growths of urban population, the high cost of land, the desire to avoid a continuous urban sprawl and the need to preserve important agricultural production have consequent pressure on limited space and these all contributed to drive buildings upward. As the height of building increase, the lateral load resisting system becomes more important than the structural system that resists the gravitational loads. As earthquakes can happen anywhere, some measure of earthquake resistance in the form of reserve ductility and redundancy should be built into the design of all structures to prevent catastrophic failures.

Index terms - *Seismic Analysis, High rise building, Base Shear,*

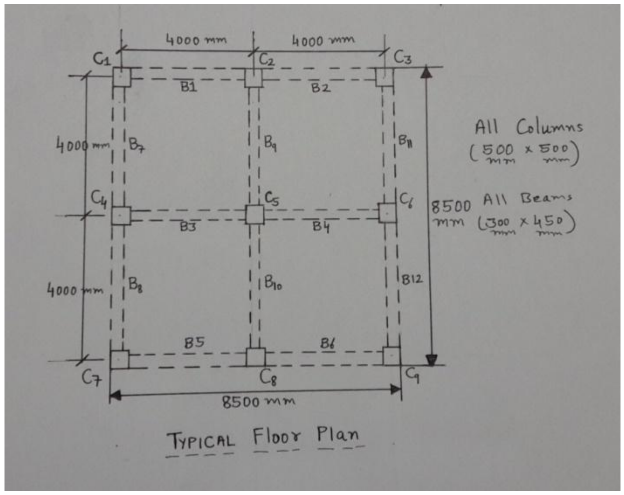
1.INTRODUCTION

The important objective of engineers is to design and build a structure in such a way that damage to the structure and its structural component during the earthquake is minimized. Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner . This G + 5 furniture showroom building is analyzed for earthquake load. In seismic load analysis, we adopt Indian standard code of practice IS-1893 (Part I: 2002) guidelines and methodology. The horizontal forces due to earth quake are assumed to act at each of the floor levels and they induce axial forces in the columns and bending moments in all the members of the frame.

2. PLAN OF G + 5 STRUCTURE



This Showroom building consisting of two blocks, one is functional block (Showroom) and another is service block (Lift / Stairs etc). The Lift / Stairs block is structurally independent of Show room block .



The typical floor plan of G + 5, furniture showroom building of area 72.25 sq.m. proposed in Jaipur is shown above .

3.STRUCTURE ANALYSIS

Our building is situated in Jaipur. Height of each story is taken 3.5 meter. Height of column from plinth beam bottom to footing top is 1mtr. Showroom building rest on medium soil. Slab thickness of each story is 125mm. Brick masonry walls are 230mm thick and plaster thickness including both side is 25mm. As per I.S. 1893(Part –I):2002 the design seismic base shear V_B which is nothing but the total design lateral force along any principal direction shall be determined by $V_B = A_h W$, Where A_h is the design horizontal spectrum value given by $A_h = \frac{ZI}{2R}(\frac{S_a}{g})$. As Jaipur lie in zone II , so zone factor Z= 0.1; Importance factor I for our building is 1. Our building is ordinary RC moment resisting frame building with brick infill panels , thus Response reduction factor R=3 . As per I.S. 1893(Part –I):2002 , the approximate fundamental natural period of vibration (T_a) for our building is given by formula $T_a = \frac{0.09h}{\sqrt{d}}$ = 0.09 * 21.225/ $(8.5)^{1/2}$ = 0.655 sec and $\frac{S_a}{g} = \frac{1.36}{T}$= 2.076. By substituting values in formula ,we get A_h = 0.0346 , thus **V_B = 0.0346 W** .

We analyze <u>external frame</u> C_1 - C_2- C_3 :

Total seismic weight W for this frame is calculated by summing the seismic weight of concerning columns C_1,C_2 and C_3 . We take live load on all floors is 4KN/m^2 and floor finish load is 1kn/m^2. Thus seismic weights W_1, W_2 and W_3 is calculated by summing full D.L. and only 50% of L.L.

While calculating seismic weights, from simplicity point of view, we take same load at all floors including roof and G.F.

CALCULATION FOR TYPICAL FLOOR :

(A)Load per unit area of terrace slab DL LL

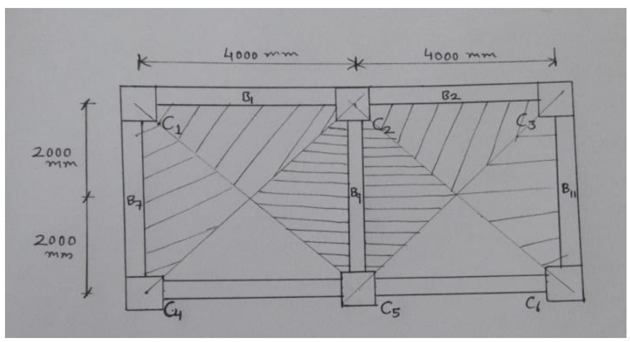
r.c.c. slab self weight [3.125 + 0.0] kn/m^2

{ 25KN/m^3 * 0.125m=3.125 KN/m^2}

floor finish [1.0 + 0.0] kn/m^2

live load [0.0 + 4.0] kn/m^2

Sum = [4.125 + 4.0] kn/m^2



(B) Load taken by Beam B_1(In our case it is same for beam B_2)

DL LL

from slab portion (hatched) [4.125 + 4.0] kn/m

{ 0.5*4*2 [4.125 + 4.0] kn/m^2 }

load per unit length of beam is [4.125 + 4.0]kn/m

from masonry wall with plaster [15.555 + 0.0] kn/m

{ 20kn/m^3 * (3.5-.45)m*(0.23+2*0.0125)m}

Beam self weight [3.375 + 4.0] kn/m

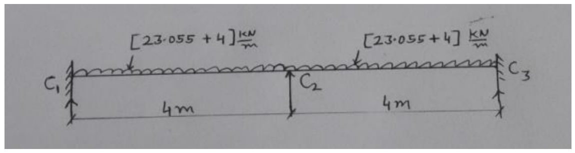
{25kn/m3*0.3m*0.45m }

Sum = [23.055 + 4.0] kn/m

(C) Load taken by Beam B_7 DL LL

(In our case it is same for beam B_{11}) [23.055 + 4.0] kn/m

(D) By beam reaction method



DL LL

Load on C_1 = ½ [[23.055 + 4] kn/m * 4m] [46.11 + 8] kn

Load on C_2 = 2* ½ [[23.055 + 4] kn/m * 4m] [92.22 + 16] kn

Note : Due to similarity of our structure , load transferred to C_1 from beam $B_7$is same as that for beam B_1. Likewise , load transferred to C_3 from beam B_{11} is same as that for beam B_2 .

(E) Load taken by beam B_9

(i) from hatched terrace portion

2* (½ *4*2)m^2 * [4.125 + 4] kn/m^2 DL LL

= [33 + 32]kn [8.25 + 8.0]kn/m

load per unit length of beam is [8.25 + 8.0]kn/m

(ii) from masonry wall with plaster

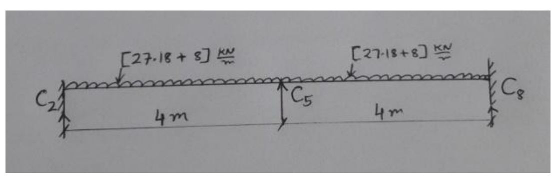
20 kn/m^3* (3.5 – 0.45)m * (0.23 + 2*0.0125)m [15.555 + 0.0] kn/m

= 15.555 kn/m

(iii) beam self weight

25*0.3 * 0.45=3.375 kn/m [3.375 + 0.0] kn/m

Sum = [27.18 + 8.0] kn/m



(F) Load on column C_2 from beam B_9

½ [27.18 + 8.0] kn/m * 4m = [54.36 + 16.0] kn

Load calculation for column C_1 , C_2 & C_3 of one story

Col. C_1	Load from hori. grid beam B_1 DL LL [46.11 + 8.0] kn	Load from vert. grid beam B_7 DL LL [46.11 + 8.0] kn	Col. Self weight 25*.5*.5*(3.5-0.45) DL LL [19.06 + 0.0] kn	Total Load DL LL **[111.28 + 16.0]**
Col. C_2	Load from hori. grid beam B_1 DL LL [92.22 + 16.0] kn	Load from vert. grid beam B_7 DL LL [54.36 + 16.0] kn	Col. Self weight 25*.5*.5*(3.5-0.45) DL LL [19.06 + 0.0] kn	Total Load DL LL **[165.64 + 32.0]**
Col. C_3	Load from hori. grid beam B_1 DL LL [46.11 + 8.0] kn	Load from vert. grid beam B_7 DL LL [46.11 + 8.0] kn	Col. Self weight 25*.5*.5*(3.5-0.45) DL LL [19.06 + 0.0] kn	Total Load DL LL **[111.28 + 16.0]**

Axial load on **column C_1 and C_3** due to DL & LL for load combination (DL +LL +EL)

Floor	Loads in KN		TL	Cumulative		
	DL	50% of LL		DL	LL	TL
5^{th}	111.28	8	119.28	111.28	8	119.28
4^{th}	111.28	8	119.28	222.56	16	238.56
3^{rd}	111.28	8	119.28	333.84	24	357.84
2^{nd}	111.28	8	119.28	445.12	32	477.12
1^{st}	111.28	8	119.28	556.40	40	596.40
G.F.	111.28	8	119.28	667.68	48	715.68
Foundation	19.75	0	19.75	687.42	48	**735.43**

Note : Loads on columns between GF and footing include self weight of ground beams and self weight of column from ground beam to the top of footing. Ground floor use for parking so no walls.

Axial load on **column C_2** due to DL and LL for combination (DL +LL+EL)

Floor	Loads in KN		TL	Cumulative		
	DL	50% of LL		DL	LL	TL
5^{th}	165.64	16	181.64	165.64	16	181.64
4^{th}	165.64	16	181.64	331.28	32	363.28
3^{rd}	165.64	16	181.64	496.92	48	544.92
2^{nd}	165.64	16	181.64	662.56	64	726.56
1^{st}	165.64	16	181.64	828.20	80	908.20
G.F.	165.64	16	181.64	993.84	96	1089.84
Foundation	26.50	0	26.50	1020.34	96	**1116.34**

Total Seismic weight $W = W_1 + W_2 + W_3$

W = **735.43+1116.34+735.43**

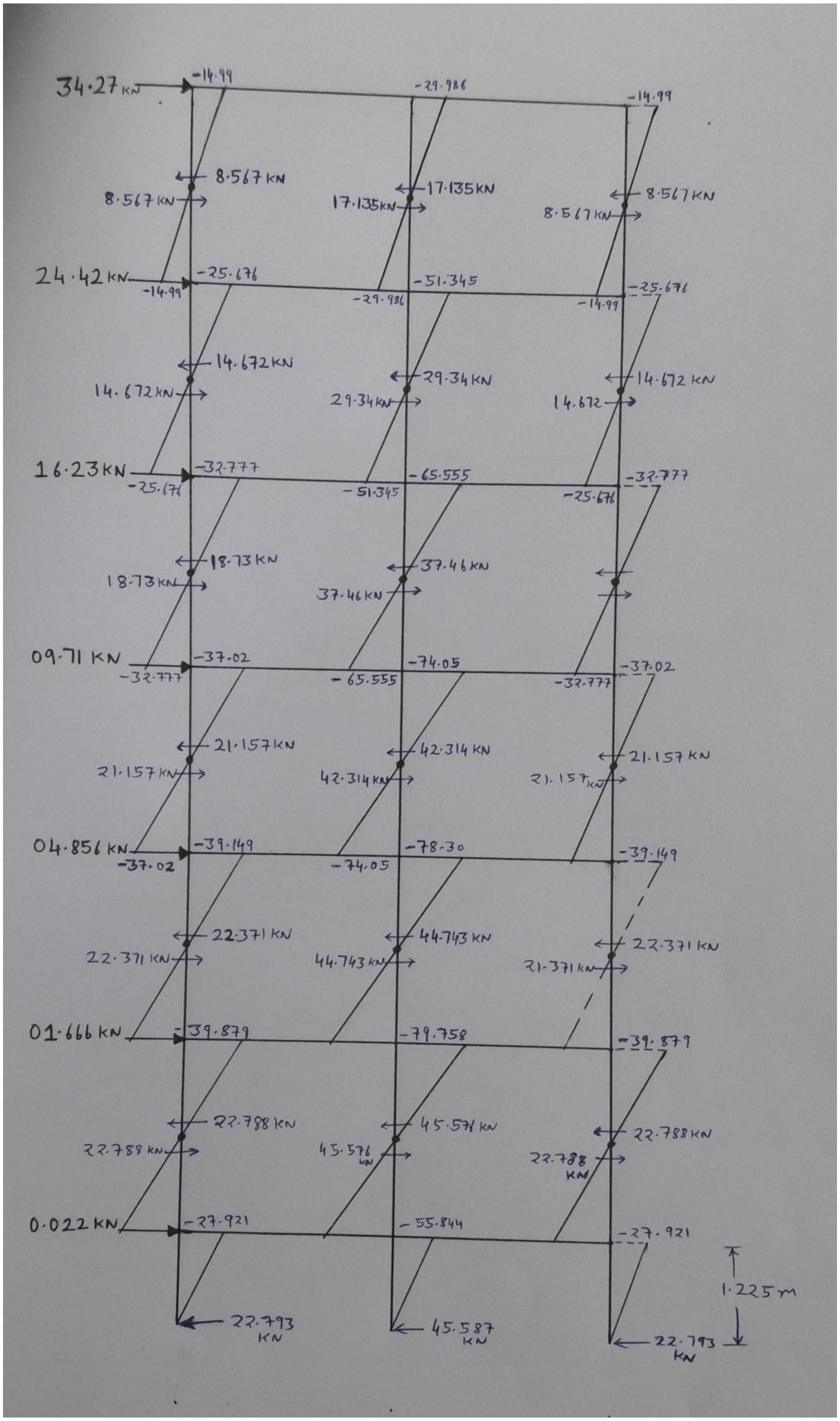
W = **2587.2KN**

As **V_B = 0.0346 W** , thus $V_B = 0.0346 * 2587.2 = 89.517$ KN

The base shear V_B will be now distributed at each storey . The calculations are tabulated in table below .

Level	W_i	h_i	$W_i h_i^2$	$Q_i = V_B \frac{Wih_i^2}{\sum Wih_i^2} = 89.517 * \frac{Wih_i^2}{\sum Wih_i^2}$
Roof	420.20	22.45	211.781×10^3	Q_{6-6} = 34.274 kn
5^{th} floor	420.20	18.95	150.895×10^3	Q_{5-5} = 24.42 kn
4^{th} floor	420.20	15.45	100.302×10^3	Q_{4-4} = 16.23 kn
3^{rd} floor	420.20	11.95	60.005×10^3	Q_{3-3} = 9.71 kn
2^{nd} floor	420.20	8.45	30.003×10^3	Q_{2-2} = 4.856 kn
1^{st} floor	420.20	4.95	10.296×10^3	Q_{1-1} = 1.666 kn
G.F.	66.00	1.45	0.1388×10^3	Q_{g-g} =0.022kn

Nodes are considered at the centre of beam – column joint .



<u>Diagram showing columns shear and moment for external frame C_1 - C_2- C_3</u>

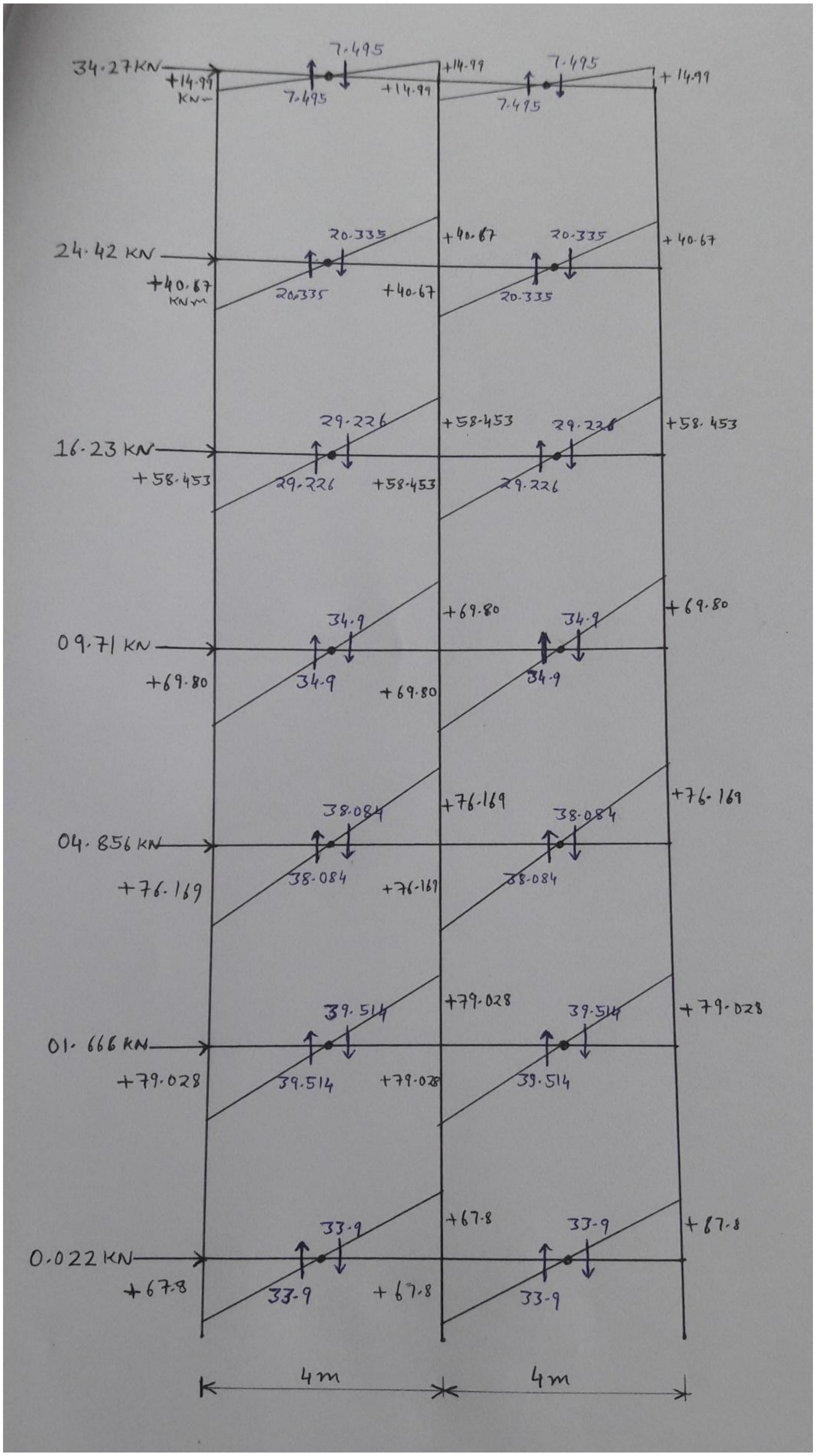


Diagram showing girders moment and shear for external frame $\underline{C_1 - C_2 - C_3}$

5.CONCLUSION

We have done seismic analysis manually. By Analyzing this building , we have gained clarity and knowledge about the earth quake effects . Actually while doing manual calculations, we have gained more knowledge than analyzing using software. By doing this project we have become more familiar with standard codes . We have felt the real engineering practice in this work .

6.ACKNOWLEDGEMENT

My sincere thanks to my department colleagues for their constraint help during my research .

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