9 L X 15

Q. A three storyed symmetrical RC school Building situated at Bhuj with the following data.

Plan dimension = 7 X 7 m

storey height = 3.5 m  so total h = 3.5 X 3 = 10.5 m

Total wt of beam in a storey = 130 kN

Total wt of slab in a storey = 260 kN

Total wt of column in a storey = 50 kN

Total wt of walls in a storey = 530 kN

Live load = 130 kN

wt of terrace floor = 655 kN

The structure is resting on hard rock. Determine the total Base shear and lateral loads at each floor level. for 5% Damping using seismic coefficient Method. Assume infill panels are provided.

Soln Determination of Natural Time period

$$T = \frac{0.09h}{\sqrt{d}} = \frac{0.09 \times 10.5}{\sqrt{7}} = 0.3575 \text{ sec}$$

Cl. 7.6.2 P.N-24

Zone factor (Z) = 0.36 Table 2 Cl. 6.4.2 P.N 16

Importance factor I = 1.5 Table 6 Cl. 6.4.2 P.N. 18

for SMRF R = 5 Table 7 Cl 6.4.2 P.N 23

for T = 0.35 & 5% dampingy & hard rock

$\frac{Sa}{g} = 2.5$ fig. 2 P.N. 16

Determination of Design horizontal seismic coffice

$$Ah = \frac{Z}{2}\frac{I}{R}\frac{Sa}{g} \Rightarrow \frac{0.36}{2} \times \frac{1.5}{5} \times 2.5 = 0.135$$

Cl. 6.4.2 P.N 14

Scanned with CamScanner

## Determination of seismic weight

wt. of one storey = wt. of beam + Column + slab + wall + live load.

$\Rightarrow 130 + 250 + 50 + 530 + 130 = 1090\ kN$

hence total wt of 1 & 2 floors $\Rightarrow 2 \times 1090 = 2180\ kN$

wt of Roof / terrace $= 655\ kN$

Total wt of Building $= 2180 + 655 = 2835\ kN$

## Determination of base shear

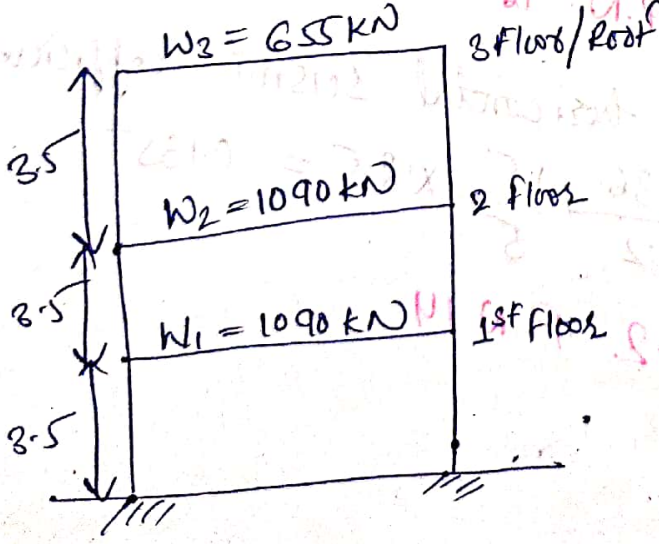
$V_B = A_h W \Rightarrow 0.135 \times 2835 = 382.725\ kN$

Cl. 7.5.3 P.W. 24

## Distribution of equivalent lateral load

$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$

| S.NO. | $W_i$ | $h_i^2$ | $W_i h_i^2$ | $Q_i$ |
|---|---|---|---|---|
| 1 | 1090 | 12.25 | 133525 | 36.77 kN |
| 2 | 1090 | 49 | 53410 | 147.08 kN |
| 3 | 655 | 110.25 | 72213.75 | 198.86 kN |
| | | $\sum W_i h_i^2$ | 1389762.5 | 382.71 kN checked |



Q Calculate Base shears for the seven storey RC Institutional Building located in Ahmedabad.

Number of bay in x direction - 6

Number of bay in y direction - 4

Bay width 4m in both directions

Story ht - 3.5m

Slab thickness - 150mm

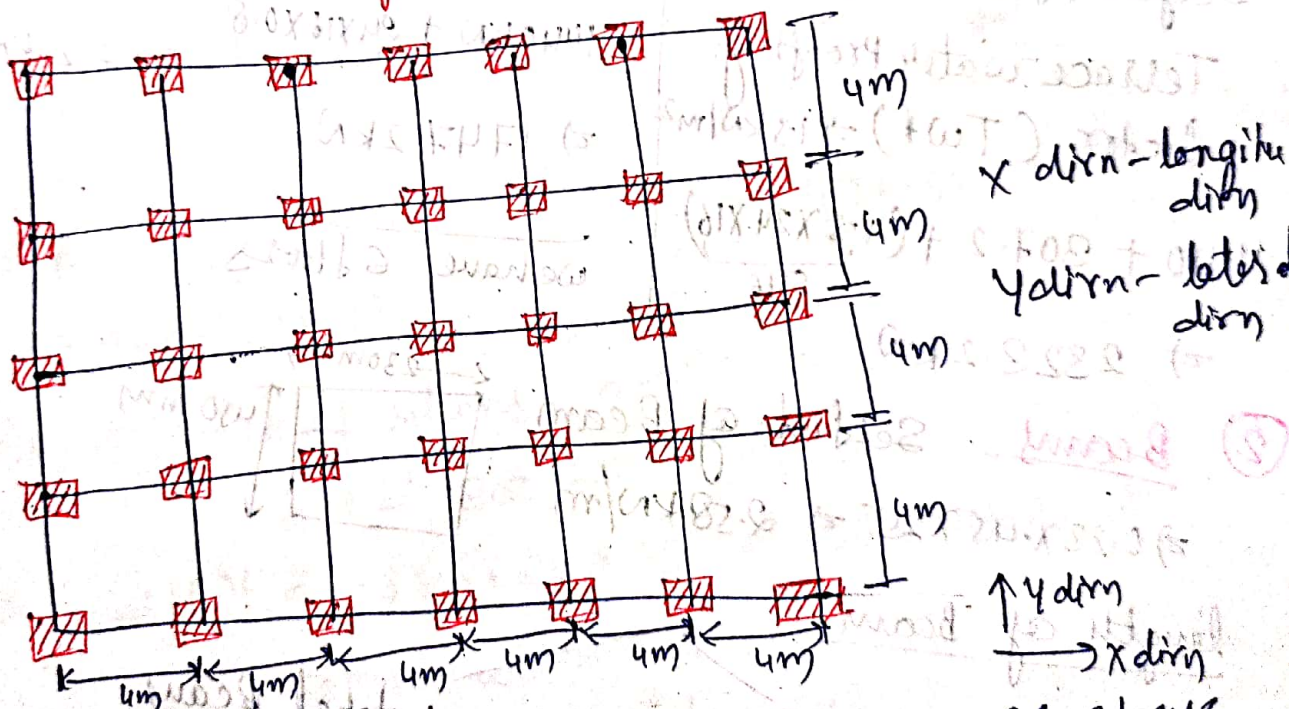
Beam size = 230 x 450mm

Column size = 300 x 600mm

Live load = 4kN/m²

Wall thickness = 230mm

Calculate Base shears & lateral distribution of force on each storey.




Gridline - c/c dis. b/w two column, 2 beam or 2 bays

Bay - Area b/w 2 Grid line is bay

Total beam in x dirn - 6 X 5 = 30 Beam

Total beam in y dirn = 7 X 4 = 28 Beam

Total Column - 35

## Base Shear

$V_B = A_h W$ cl. 7.5.3 P.N -24

W = Seismic wt of Building

Slab + Beams + Column + walls

⇒ DL + L.L

① **Slabs** → G floors + 1 Roof

Size = 24 X 16 m

Thickness of slab = 150 mm

Density of RCC = 25 KN/m³

DL of slab = 24 X 16 X .150 X 25 = 1440 KN

**Roof**

Selfwt + floor finish + Terrace water Proofing factor (TWf) ⇒ 1.5 KN/m²

1440 + 307.2 + (1.5 X 24 X 16) (576)

⇒ 2323.2 KN

**Floor**

Selfwt + floor + finish (= 0.8 KN/m²)

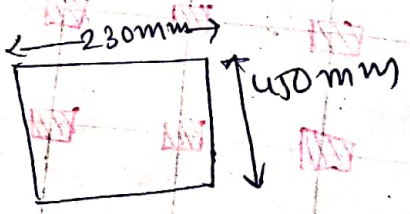
1440 KN + 24 X 16 X 0.8 = 307.2 KN

⇒ 1747.2 KN

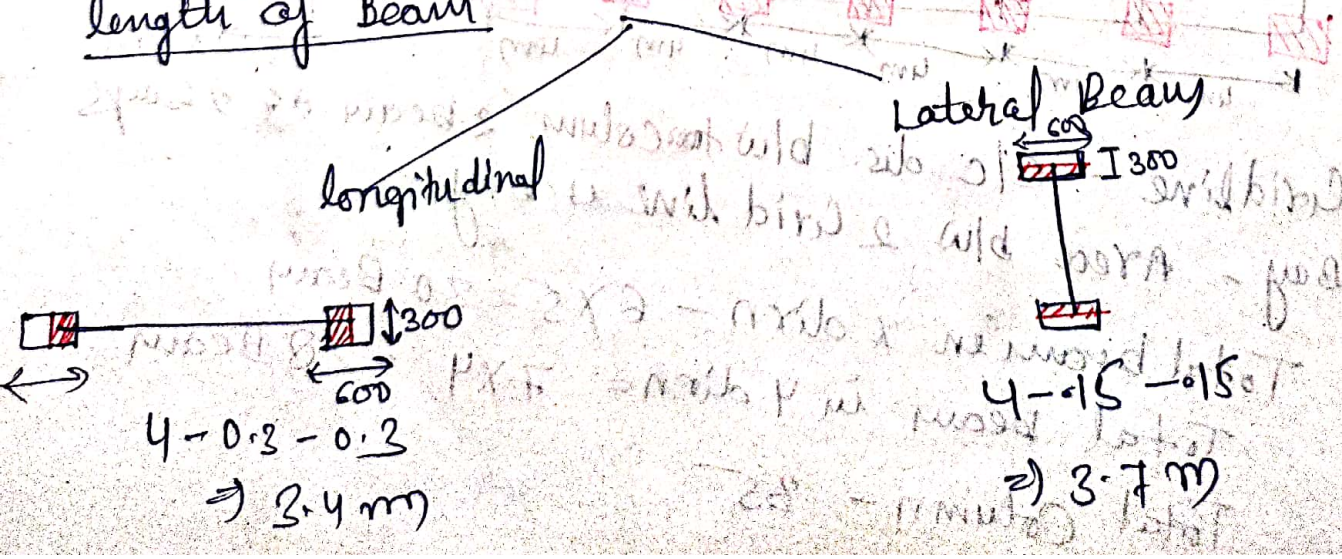
we have 6 floors.

② **Beams** Selfwt of Beam

⇒ 0.23 X .45 X 25 ⇒ 2.58 KN/m




**length of Beam**




longitudinal

Self wt of longitudinal Beam
⇒ 2.58 X 3.4 X 30 ⇒ 263.16 KN
Traverse / longitudinal beam
⇒ 2.58 X 3.7 X 28 ⇒ 267.28 KN

(3) **walls** Self wt of wall
thickness of wall ⇒ 0.23m
Density of Brick masonary = 20KN/m3
So ⇒ Self wt = 0.23 X 20 = 4.6 KN/m²

length of the wall.

longitudinal wall
4-0.3-0.3
⇒ 3.4m
So 4.6 X 3.4 X 30
⇒ 469.2 KN/m ht

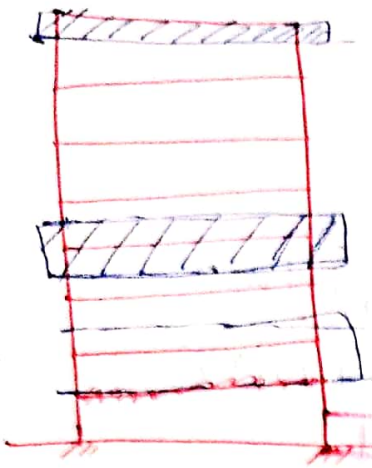
Traverse wall
4-0.15-0.15
⇒ 3.7m
⇒ 4.6 X 3.7 X 28
⇒ 476.56 KN/m ht

**Columns** – No of columns – 35
size = 300 X 600
Self wt = .3 X .6 X 25 X 35 = 157.5 KN/m ht

**live load** Seismic wt = DL + LL
As per Cl-7.3.2 – Live Load on Roof = 0.5 KN/m²
P.W 24 Table-8 consider live load as 50%
So 0.5 X 4 ⇒ 2KN/m² on floors
So live load on floor = 24 X 16 X 2 ⇒ 768KN

## Lumped Mass

We have to assume that wt of particular story to be lumped at centre point



Lets calculate total wt of roof

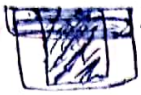
DL + LL

Roof slab + beams + colums + walls

⇒ 2323.2 + 263.16 + 268.05 + 157.5 × $\left(\frac{3.5}{2}\right)$

+ 469.2 $\left[\frac{3.5 - 0.45}{2}\right]$ → depth of beam + 437.92 $\left[\frac{3.5 - 0.45}{2}\right]$

1.525




⇒ 4513.393 kN seismic wt of roof

Seismic wt of floor

⇒ DL + LL

floor slab + beam + colum + walls + L.L

1747.2 + 263.16 + 268.05 kN + 157.5 × 3.5 + 469.2 (3.5 − 0.45) + 760

+ 437.92 (3.5 − 0.45)

3.05

⇒ 6364.3 kN

So total seismic wt

⇒ 6364.3 × 6 + 4513.39 = **42699.64 kN**

Determine $A_h = \frac{Z}{2} \frac{I}{R} \frac{Sa}{g}$ P.N. − 14 Cl 6.4.2

⇒ Annexure E

Z = 0.16

I = 1.5 T = 6 P.N − 18

R = 5 for SMRF

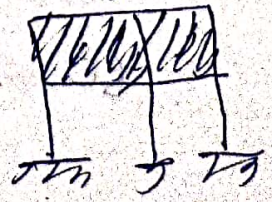
$\frac{Sa}{g}$ = determine Time period in seconds

$T = \frac{0.09h}{\sqrt{d}}$

h = total hdg str. 24.5m

d = dim which is along the dirn of EQ

- RCC frame
- Steel frame
- RC Infill str.



2.11 so d = 24m
24X15

$T \Rightarrow \frac{0.09 \times 24.5}{\sqrt{24}} = 0.45\ sec.$

Type of soil is Medium — assumed.

So $\frac{Sa}{g} = 2.5$

So $A_h = \frac{0.16}{2} \times \frac{1.5}{5} \times 2.5 \Rightarrow 0.06$

So $V_B = A_h \times W$

$\Rightarrow 0.06 \times 42699.64 = 2561.97 kN$

## Distribution of Design forces

cl. 7.7

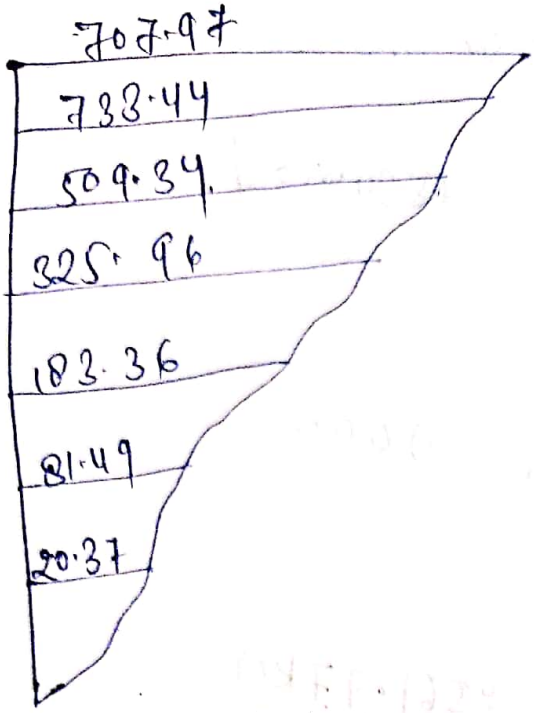
$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$

| Floor | $W_i$ (kN) | $h_i^2$ | $W_i h_i^2$ | $Q_i$ | $V_i$ (story shear / cumulative shear) |
|---|---|---|---|---|---|
| 7th Roof | 4513.39 | 600.25 | 2709162.34 | 707.97 | 707.97 |
| 6 | 6364.3 | 441 | 2806656.3 | 733.44 | 1441.41 |
| 5 | 6364.3 | 306.25 | 1949066.87 | 509.34 | 1950.75 |
| 4 | 6364.3 | 196 | 1247402.8 | 325.96 | 2276.71 |
| 3 | 6364.3 | 110.25 | 701664.07 | 183.36 | 2460.07 |
| 2 | 6364.3 | 49 | 311850.7 | 81.49 | 2541.56 |
| 1 | 6364.3 | 12.25 | 77962.67 | 20.37 | 2561.93 |

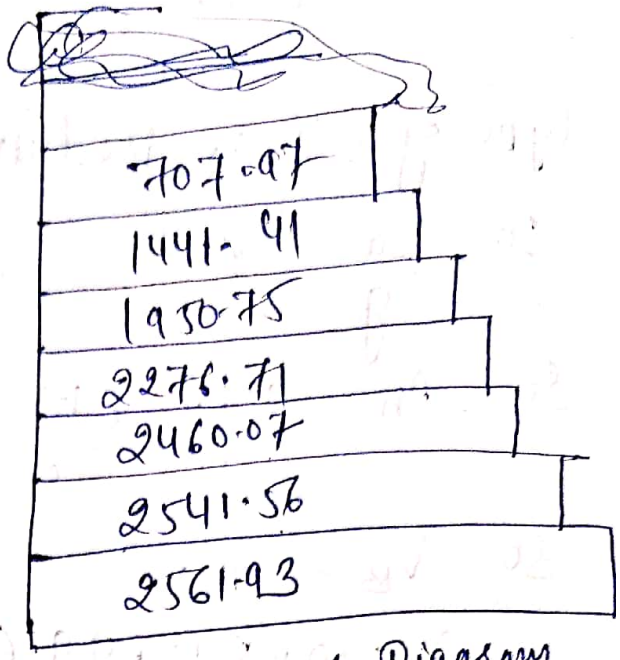
9803765.75

≈ 9803766

Check = 2561.93 kN

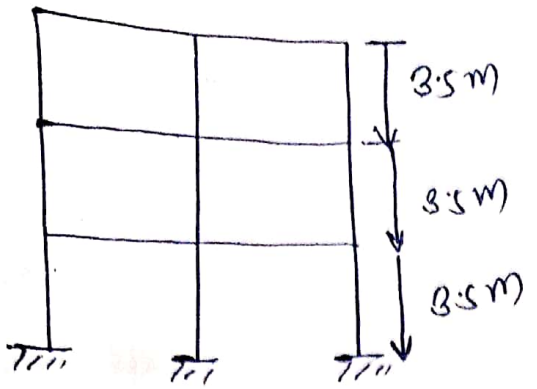


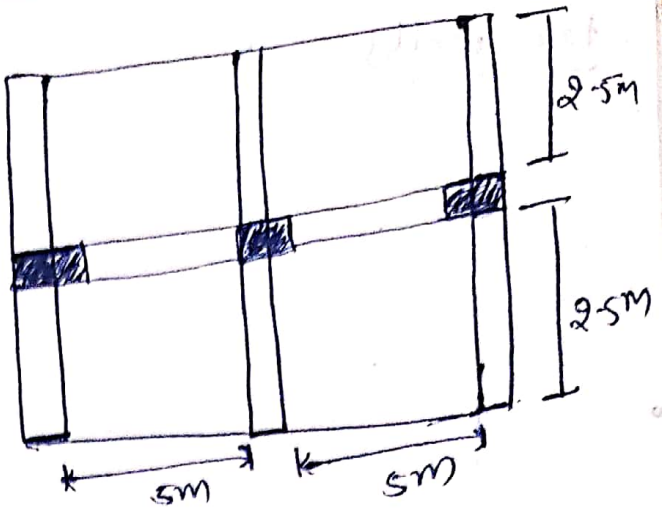

Lateral load distribution




storey shear Diagram

Q.




Beam Size = 250 x 400 mm

Column Size = 250 x 450 mm

Slab thickness = 150 mm

Infill wall - 250 mm longitudinal wall
- 150 mm transverse wall

RCC - 25 kN/m3

Brick Masonary - 20 kN/m3

Soil type - Hard Rock

R = 5, I = 1, Z = 0.36

Seismic wt of Building = Roof + 2 floors

Slab + Beam + column + wall + live load

Slab Base dimension

Xdirn ⇒ 5 + 5 + 0.3 x .25 ⇒ 10.75 m

Ydirn ⇒ 2.5 + 2.5 + .25 = 5.25 m

Dead load = 10.75 x 5.25 x .150 x 25 = 211.64 kN

FF = 0.8 kN/m2

TWF = 1.05 kN/m2

Floor

211.64 + 45.15

⇒ 256.79 kN

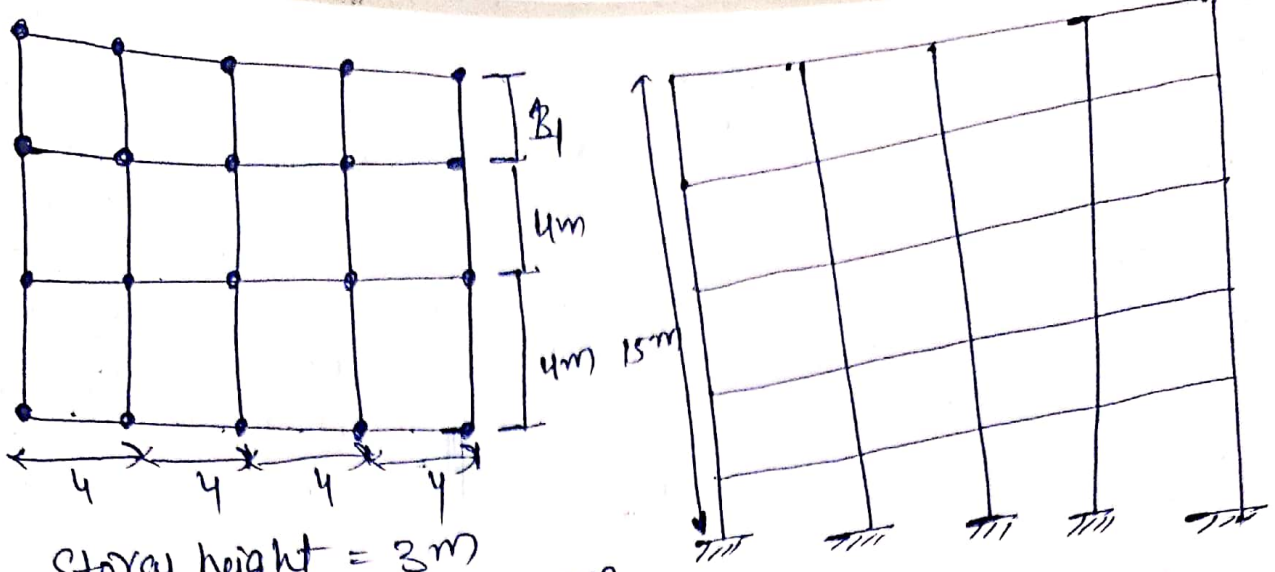
Roof

211.64 + 45.15 + 84.65

⇒ 341.44 kN

FF = 45.15 kN

TWF = 84.65




Storey height = 3m

Total height = 5 × 3 = 15m

Beam size = 400 × 500mm

Column size = 600 × 600 mm

Slab thickness = 150mm

Brick wall - 230mm

Soil type = Medium

Rcc unit wt = 25kN/m3

Brick Masonary = 20kN/m3

Residential Building located in Delhi

live load - 2kN/m²

## Seismic forces -

Base shear = $V_B = A_h W$

where $A_h = \frac{Z}{2} \frac{I}{R} \frac{S_a}{g}$

here $Z = 0.24$, $I = 1$, $R = 5$

for $\frac{S_a}{g}$, $T_a = \frac{0.09h}{\sqrt{d}} = \frac{0.09 \times 15}{\sqrt{16}} = 0.33$ sec

$\frac{S_a}{g} = 2.5$

so $A_h = \frac{0.24}{2} \times \frac{1}{5} \times 2.5 = 0.06$

# for seismic weight of building

4 floors + 1 Roof

① Slab $16 \times 12 \times 0.15 \times 25 = 720\ kN$

FF = 0.8 kN/m²
TWF = 1.5 kN/m²

Floors : DL + FF
720 + 153.6
⇒ 873.6 kN

Roof : DL + FF + TWF
720 + 153.6 + 288 ⇒ 1161.6 kN

② Beam length of Beam = 4 − 0.3 − 0.3 ⇒ 3.4 m
⇒ $31 \times 0.4 \times 0.5 \times 3.4 \times 25 = 527\ kN$

③ Column
⇒ $20 \times 0.6 \times 0.6 \times 3 \times 25 =$ ~~540 kN~~ 180 kN/m

④ Walls
$31 \times 3.4 \times 0.23 \times 20$ ⇒ 484.84/m

⑤ Live load = $2 \times 0.25 = 0.5$
⇒ $0.5 \times 16 \times 12 = 96\ kN$

Roof ⇒ $1161.6 + 527 + 180 \times \left(\frac{3}{2}\right) + 484.84\left(\frac{3-0.5}{2}\right)$
⇒ 2564.65 kN

floors = $873.6 + 527 + 180 \times 3 + 484.84 \times (3 - 0.5)$
$+ 96$ ⇒ 3248.7 N

all 4 floors = ~~19492.2 kN~~ 12994.8

Total seismic W = ~~19492.2 + 2564.65~~ ⇒ ~~22056.85~~

W = 15559.45 kN

Base Shear $V_B = A_h W$

$\Rightarrow 0.06 \times$ ~~22056.85~~ 15559.45 $\Rightarrow$ ~~1323.41 kN~~ 933.57 kN

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

| Storey | $W_i$ | $h_i^2$ | $W_i h_i^2$ | $Q_i$ | $V_i$ |
|---|---|---|---|---|---|
| Roof | 2564.65 | 225 | 577046.2 | 370.45 | 370.45 |
| 4 | 3248.7 | 144 | 467812.8 | 300.32 | 670.77 |
| 3 | 3248.7 | 81 | 263144.7 | 168.93 | 839.7 |
| 2 | 3248.7 | 36 | 116953.2 | 75.08 | 914.78 |
| 1 | 3248.7 | 9 | 29238.3 | 18.77 | 933.55 |
| | | $\Sigma = 1454195.25$ | | | |