Earthquack and Wind load:

earthquack (sheet).

↳ (i) Static force method.
(ii) Dynamic "

(i) Static ⟨ Seismic zone (i), (ii) → importance (iv)
Regular under 75 m.
irregular > 20 m.

(ii) Dynamic ⟨ height > 75 m. not in zone 1.
height > 20 m. → zone 3.
→ soil type S_4 → time period > 0.7

Static force method:

$$\text{Base shear } V = \frac{(ZIC)\,W}{R}$$

Z → Seismic zone coefficient table 6.2.22
I → structural importance → table 6.2.23
R → Response modification coefficient 6.2.24
W → total seismic load.

$$C = \frac{1.25\,S}{T^{2/3}} \qquad C \times 2.75$$

$$\frac{C}{R} \not< 0.075$$

S = Site coefficient for soil. → table 6.2.25

T = fundamental period of vibration in second.

Structural period T :

Method A $T = C_t (h_n)^{3/4}$

$C_t = 0.085$ → steel
$= 0.073$ → RC
$= 0.049$ → other.

h_n → height in meters above the base to level n.

Another method of C_t. $C_t = 0.07 / \sqrt{A_c}$.

$A_c = \sum A_e \left(0.2 + \left(\frac{D_e}{h_n}\right)^2\right)$

A_e → combined effective area in sq. m of shear walls in the first story of the building.

A_e → effective horizontal cross section area of shear wall in first story.

D_e → 1st story length of shear wall

$\frac{D_e}{h_n} > 0.9$

Method B: $T = 2\pi \sqrt{\frac{\sum_i^n w_i \delta_i^2}{g \cdot \sum_1^n f_i \cdot \delta_i}}$

Vertical distribution of lateral force:

$$V = F_t + \sum_{i=1}^{n} F_i$$

F_i → lateral force ~~to~~ at storey level;
F_t → Concentrated lateral force at top

$F_t = 0.07 T V \leq 0.25 V$. $T > 0.7$ s.

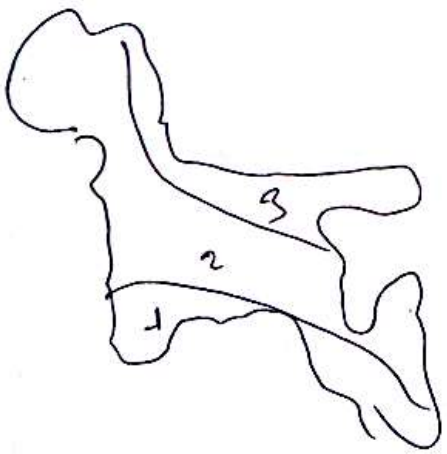
$F_t = 0$. $T \leq 0.7$ s.

Distribution of remaining force: $(V - F_t)$

$$F_x = \frac{(V - F_t) w_x \cdot h_x}{\sum_i^n w_i h_i}$$

→ যে floor এ force বের করতে চাই সে floor এর weight

$\sum_i^n w_i h_i$ → total weight



Zone 1 → $\phi_z = 0.075$
Zone 2 → 0.15
Zone 3 → 0.25

6.2.23

I. essential facilities · $I = 1.25$
II. Hazardous " $I = 1.25$
III Special occupancy structure · $I = 1.$
IV Standard " " $I = 1.$
V low risk structure $I = 1$

6.2.24 $R_w = 4 \sim 12$ (Response mod. coefficient)

6.2.25 Site coefficient S_i

$S_1 \rightarrow 1$
$S_2 \rightarrow 1.2$
$S_3 \rightarrow 1.5$
$S_4 \rightarrow 2$

where soil type not known. S_3 need to be used there.

Location – Dhaka.

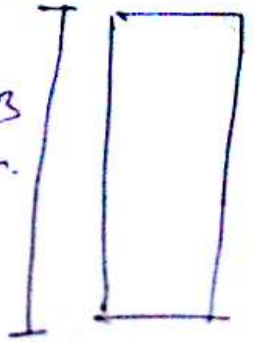
Soil type → Soft medium stiff clay → S3.

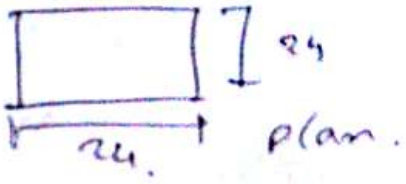
DL → 12 KN/m2

Structure type: STRF in concrete.

↙

6.2.24 → STRI → R = 12





Sol^n.

Dhaka → Zone-2 → Z = 0.15

I = 1.0

$$C = \frac{1.25\,S}{T^{2/3}}.$$

Soil type S3 = 1.5

$$T = C_t \cdot (h_n)^{3/4}.$$

$h_n = 60$ m.

$C_t = 0.073$ (RC) Structure

$$= 0.073 \times 60^{3/4}.$$

$$= 1.57\,S.$$

$S = 1.5$ (soil)

$T = 1.57$.

$$C = \frac{1.25 \times 1.5}{1.57^{2/3}}$$

$$= 1.386$$

$\frac{C}{R} = \frac{1.386}{12} = 0.115$

$C \geq 2.75 \quad C/R \geq 0.075$ (satisfied)

$\therefore C = 1.386$

Seismic dead load

$W = 12\ KN/m^2 \times (24 \times 24)\ m^2 \times 20$ floor

$= 138240\ KN.$

Base shear

$$V = \frac{(ZIC)W}{R}$$

$$= \frac{0.15 \times 1 \times 1.386}{12} \times 138240$$

$$= 2395.028$$

$$= 2395\ KN.$$

Vertical distribution of force:

Concentrated lateral force F_t at top of the building.

$F_t = 0.07TV \leq 0.25V \quad T > 0.7s$

$F_t = 0 \quad T \leq 0.7s.$

$\therefore F_t = 0.07 \times 1.57 \times 2395$

$= 263.2 \simeq 263\ KN.$

$F_t = 0.25V = 0.25 \times 2395 = 598.75$

$\therefore \boxed{F_t < 0.25\,V.}$ OK. $F_t = 263 KN.$

For $\boxed{w_x = 12x}$

$$F_x = \frac{(V - F_t)\, w_x \cdot h_x}{\sum_{i}^{n} w_i h_i}$$ here $w_i = w_x$

$$= \frac{(V - F_t) \cdot h_x}{\sum h_i}$$

$$= \frac{(2395 - 263) \times h_x}{(3 + 6 + 9 + \ldots + 60)}$$

$$= \frac{2132 h_x}{3 \times \frac{20 \times 21}{2}} = 3.38 h_x.$$

$F_x = 3.38 h_x$

Floor level	h_x m	F_x, KN.
20	60	202.8
19	57	192.66
18	54	182.52
17	51	172.38
16	48	162.24
15	45	152.1
14	42	141.96
13	39	131.82
12	36	121.68
11	33	111.54
10	30	101.4
9	27	91.26
8	24	81.12
7	21	70.986
6	18	60.84
5	15	50.7
4	12	40.56
3	9	30.42
2	6	20.28
1	3	10.14

#Same before math. for Khulna city → force above 30 m.

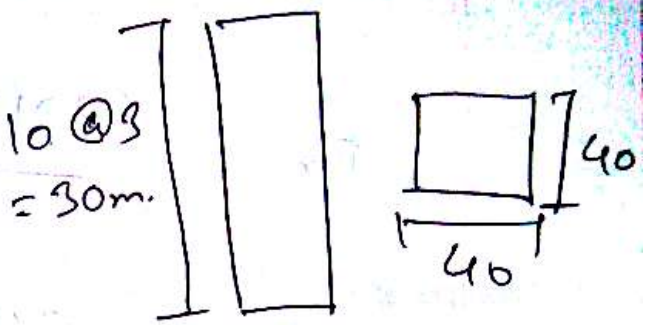
Khulna city.

$Z = 0.075$ (Khulna)

$I = 1.25$ (6.23 table)

$S = 1.25$

$C_t = 0.073$. $R = 5$



$$T = C_t (h_n)^{3/4} = 0.073 \times (30)^{3/4} = 0.9357$$

$$C = \frac{1.25 S}{T^{2/3}} = \frac{1.25 \times 1.25}{0.9357} = 1.67 \text{ s}$$

$$W = 6 \times (40 \times 40) \times \text{[illegible]} + 2 \times (40 \times 40) \times 10.$$

↳ [illegible]

$$= 128000 \text{ KN}.$$

$$V = \frac{ZIC}{R} W = \frac{0.075 \times 1.25 \times 1.67 \times 128000}{5}$$

$$= 3912 \text{ KN}.$$

$F_e = 0.07 \times TN$

$= 0.07 \times 0.9397 \times 3912$

$= 256.725$

$$F_x = \frac{(3912 - 256.72)\, w_x h_x}{\Sigma w_i h_i}$$

$$= \frac{3655.275 \times 128000 \times h_x}{128000 \times (3+6+9+\cdots+30)}$$

$$= \frac{3655.275}{3 \times \frac{20 \times 21}{2}} h_x$$

$= 22.153\, h_x$.

$\therefore F_{30} = 22.153 \times 30 = 664.59$ KN.

EQ Loading.

2015-16 → 2

2014-15 → 7

2013-14 → 8.

2012-13 → Windload (8)

11-12 → (9)

2010-11 → no.

9-10 → no.

08-09 → no.

10.

16-17 → must

2011-12 R = 12.

DL = 7 KN/m²

partition wall

= 3 KN/m²

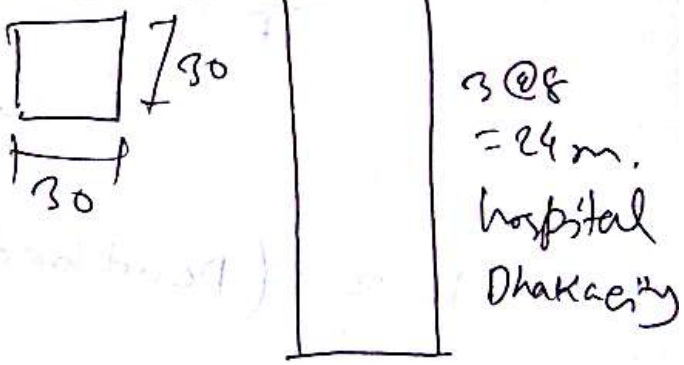
Z = 0.15

I = 1.25

S = 1.5

Cf = 0.083

C < 2.75 and C_t/R > 0.07.



Soln

$T = C_t \cdot (h_n)^{3/4}$ $\quad C_t = 0.083$, $h_n = 24\,m$

$= 0.083 \times 24^{3/4}$

$= 0.899\ s.$

$C = \frac{1.25S}{T^{2/3}}$ $\quad S = 1.5$, $T = 0.899$

$= \frac{1.25 \times 1.5}{0.899^{2/3}}$

$= 2.01 < 2.75$

$\frac{C}{R} = \frac{2.01}{12} = 0.167 > 0.075$

$\therefore C = 2.01$ OK

$W = (\text{Dead load} + \text{partition wall}) \times \text{Area}$

$= (7+3) \times 30 \times 30$

$= 9000\ KN.$ (each floor)

~~Base Shear~~ $V = \frac{ZIC\,W}{R}$

$$W = 9000 \times 8 = 72000 \text{ KN}.$$

Base shear $V = \frac{ZICW}{R}$

$$= \frac{0.15 \times 1.25 \times 2.01 \times 72000}{12}$$

$$= 2261.25 \text{ KN}.$$

$F_t = 0.07TV. \leq 0.25V.$ | $T > 0.75$

$= 0.07 \times 0.899 \times 2261.25 \leq 0.25 \times 2261.25$

$= 142.3 \leq 565.31$ | OK

$F_t = 142.3 \text{ KN}.$

$$F_x = \frac{(V - F_t) \cdot w_x h_x}{\sum w_i h_i} \quad (w_x = w_i)$$

$$= \frac{(V - F_t) \cdot h_x}{\sum h_i}$$

$$= \frac{(2261.25 - 142.3) \times h_x}{(3+6+9+12+---+24)}$$

$\frac{n(n+1)}{2}$

$$= \frac{2114.95}{3 \times \frac{8 \times 9}{2}} h_x =$$

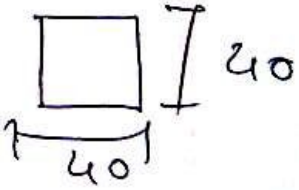
$$= 19.61\ h_x.$$

Floor	h_x m.	$F_x = 19.61\ h_x$.
8	24	470.82
7	21	411.96
6	18	353.1
5	15	294.24
4	12	235.38
3	9	176.49
2	6	117.66
1	3	58.86

2013-14 (8) 3 @ 10 m = 30 m.

Khulna.

R = 5



DL = 6 KN/m²

Partition = 2 KN/m²

Z = 0.075, I = 1.25, S = 1.2

C_t = 0.073 Same like before.

2014-15

(7) R = 12 □ I 30

3 @ 8 = 24 m 30 hospital.

DL = 7 KN/m²

P.W = 3 KN/m².

Z = 0.15
S = 1.5
Ce = 0.083
I = 1.25

Same like before.

2015-16

(2) Sylhet 3 @ 6 = 18 m.

□ I 20

20.

R = 8

S = 1.2

load = 10 KN/m²

Z = 0.25
Ct = 0.073.
I = 1.25

Same like before.

wind load:

Sustained wind pressure at height z.

$$q_z = 0.00256 C_I C_z V_D^2$$

C_I → structural importance significance.
C_z → height and exposure coefficient

	C_I
essential →	1.25
Hazardous →	1.25
Special →	1.0
Standard →	1.0
low risk →	0.8

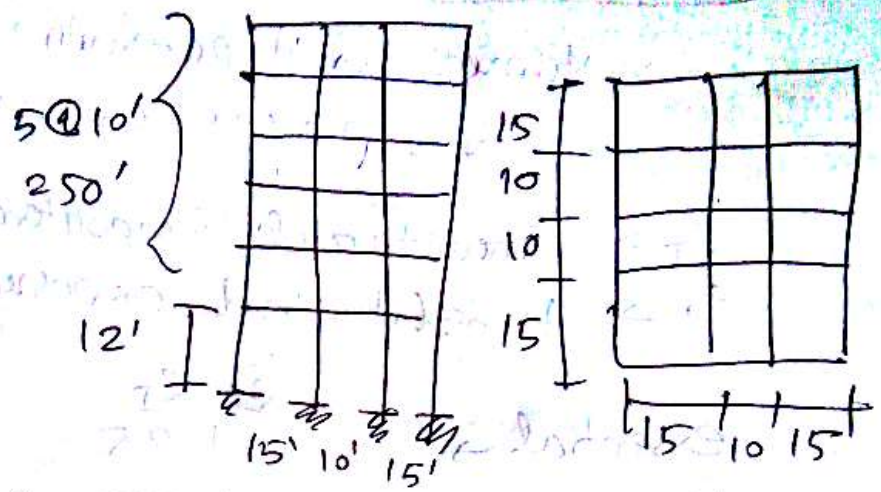
Design wind pressure:

$$P_z = C_{ge} \cdot C_t C_p q_z .$$

C_{ge} → wind gust coefficient
C_t → local topography coefficient
C_p → Pressure coefficient.

#Sheet math:

Dhaka, hospital.



design wind pressure

$$P_z = 0.00256 \cdot C_I C_z \cdot C_{dt} \cdot C_t \cdot C_p \cdot V_b^2$$

basic wind speed $V_b = 130$ mph. (table)

Structural importance $C_I = 1.25$

local topography $C_t = 1.0$

$h = 62' = 12 + 50$

$L = 40'$

$B = 50'$

$\frac{h}{B} = 1.24 \qquad \frac{L}{B} = 0.80.$

$C_p = 1.98$

$\therefore P_z = 0.00256 \times 1.25 \times C_z \times C_{dt} \times 1 \times 1.98 \times 130$

$= 107.08\, C_z \cdot C_{dt}.$

Exposure.

$F_z = B \cdot h_{ext} \cdot P_z$.
$= 50 \cdot h_{ext} \cdot P_z$.

$h_{ext} \rightarrow$ effective height

50 — 1.125
22

Story.	z	G_z.	C_{ez}.	P_z.	F_z.
1	12	0.801			
2	22				
3	32				
4	42				
5	52				
6	62				

অসমাপ্ত

2010-11 ⑤. Chotka.

basic wind speed $V_b = 238$ Km/h.

Exposure category = A.

Sustained wind pressure.

$$q_z = C_c \cdot C_I \cdot C_z V_b^2$$

$C_c = 47.2 \times 10^{-6}$

$C_I = 1.25$ (hospital)

$\therefore q_z = 47.2 \times 10^{-6} \times 1.25 \times C_z \times 238^2$

$= 3.342\, C_z$.

Height $h = \frac{11}{3.28} \times 10 = 33.54$ m.

Design wind pressure

$$P_z = C_{Gc} \cdot C_p \cdot q_z$$

$C_{Gc} = 1.293$. $h = 33.54$ [illegible] / sheet [illegible].

30 - 0.84

pressure coefficient:

$C_p = f\left(\frac{h}{B}, \frac{L}{B}\right)$.

$\frac{h}{B} = \frac{11 \times 10}{60} = 1.83 < 5$

$\frac{L}{B} = \frac{60}{60} = 1.$

$C_p = 1.4$ (table 6.2.15)

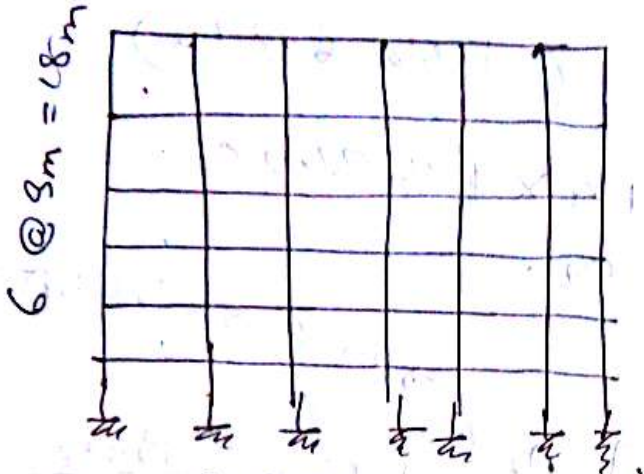
$P_z = 1.293 \times 1.4 \times \frac{1}{2} \times 3.342 C_z.$

$= 1.05 C_z.$

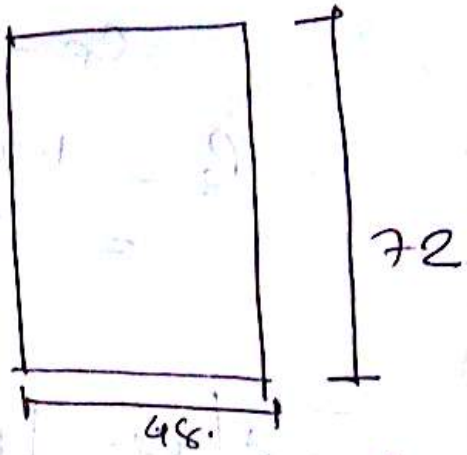
m এ কেন ভাগ হবে?

height m.	C_z.	$P = 6.05 C_z$.	$\frac{A_z}{3.28}$	$F = \frac{\sum P_z \cdot A_z}{3.27}$
33.54	0.891	5.39	$60 \times \frac{3.35}{2}$	541.7
30.18	0.812	4.913	201	987.5
26.83	0.808	4.888	201	982.48
23.48	0.761	4.604	201	925.8
20.12	0.711	4.302	201	864.7
16.72	0.655	3.963	201	796.56
13.41	0.593	3.588	201	724.2
10.06	0.521	3.152	201	633.55
6.71	0.434	2.6257	60 × 3.35	527.8
3.35	0.368	2.2264	60 × 3.35	447.5

Calculate the design wind load at the following building. Rectangular building 72×48m hospital building 6 storyed building. Storey height = 3m. City chittagong.



elevation



plan.

Basic wind speed $V_b = 260$ km/h

Exposure Catagory – A.

Sustained wind pressure. $q_z = C_c C_I \cdot C_z \cdot V_b^2$

$C_c = 47.2 \times 10^{-6}$

$C_I = 1.25$

$q_z = 47.2 \times 10^{-6} \times 1.25 \times 260^2 \times C_z = 3.988 C_z$.

Design wind pressure $P_z = C_{pe} \cdot C_p \cdot q_z$.

for not slender building.

$C_{ce} = C_{eH}$.

for $h = 18m$. $C_{eH} = 1.3886$ (table 6.2.11)

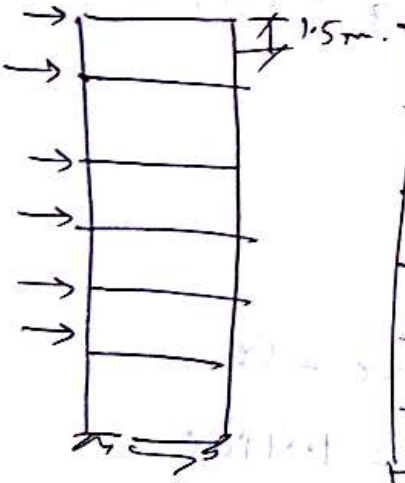
$\frac{h}{B} = \frac{18}{72} = 0.25 < 5$

$\frac{L}{B} = \frac{48}{72} = 0.67$

$C_p = 1.542$ (table 6.2.15) (theoretical)

$P_z = 1.3886 \times 1.542 \times 3.988\, C_z$.

$= 8.532\, C_z$ - KN/m²

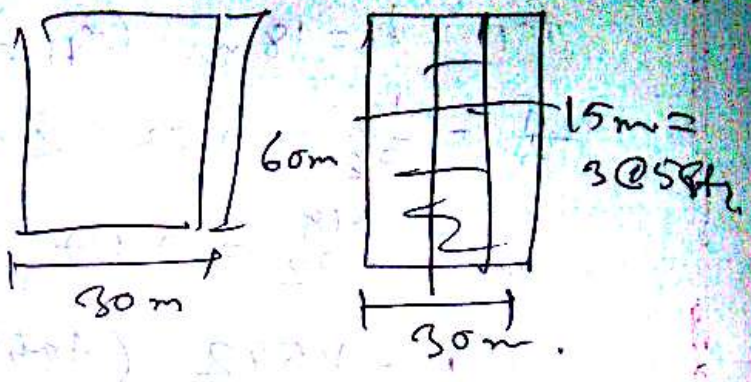


height	C_z.	P_z	A	$F = \Sigma P_z . A_z$.
18	0.677	5.776	1.5x8 = 12	69.312
15	0.624	5.324	3x8 = 24	127.776
12	0.565	4.821	24	115.704
9	0.497	4.240	24	101.76
6	0.415	3.541	24	84.984
3	0.368	3.139	24	75.336

table 6.2.10

2012-13

(8)



$V_b = 210 Kph$.

$C_I = 1.25$

exposure A.

$C_c = 47.2 \times 10^{-6} m$.

$q_z = C_c . C_I C_z V_b^2$

$= 47.2 \times 10^{-6} \times 1.25 \times C_z \times 210^2$

$= 2.6019 C_z$.

$P_z = C_p . C_{ge} . q_z$.

non circular building. $C_{ge} = C_{en}$.

For 15m. $C_{ge} = C_{en} = 1.418$.

$\frac{h}{B} = \frac{15}{60} = 0.25$

$\frac{L}{B} = \frac{30}{60} = 0.5$

$C_p = 1.45$ table 6.2.15

$P_z = 1.45 \times 1.416 \times 2.6019\, C_z$.

$= 5.432\, C_z$.

story	height	P_z.	A_z.	$F_z = \sum P_z A_z$
5	15	80.133	1.5×60	7211.97
4	12	64.1066	3×60	11539.188
3	9	46.08	3×60	8654.4
2	6	32.059	3×60	5769.54
1	3	16.03	3×60	2885.4