UNIT-3 (B) WSA

Lateral load: wind load & claculation of wind load on structures (IS: 875 Part 1:3)

Wind:- Motion of air effect

Design step:

STEP. 1

Design wind speed (V_z) ~~(page-53)~~

$$\boxed{V_z = V_b K_1 K_2 K_3}$$ (Page-8, clause 5.3)

V_b = Basic wind speed (page-53)

K_1 = Probability Factor (Risk co-efficient) Table-1 P.11

K_2 = Terrain, height and structure size Factor Table-2 P.12

K_3 = Topography factor clause 5.3.3 P. 12

STEP. 2

Design wind pressure (P_z) (5.4) P. 12

$$\boxed{P_z = 0.6 V_z^2}$$

STEP-3

wind load Calculation (6.2.1) P. 13

$$F = (C_{pe} - C_{pi}) A P_d$$

F = wind load

C_{pe} = ~~Internal~~ external pressure co-efficient

C_{pi} = Internal pressure co-efficient

A = surface area of structural element or cladding unit and

P_d = design wind pressure.

The value of C_{pe} and C_{pi} for different types of roofs, walls of different types of buildings are given in (Table 4 to Table 22)

STEP-4 Equation of Frictional Drag (F') (6.3.1 P.37)

Depending upon the d/h & d/b ratio of rectangular slab building additional drag force given by equ. (i) & (ii)

IF $h \leq b$,

$$F' = C_f' (d - 4h) b P_d + C_f' (d - 4h) 2h P_d$$

If $h \geq b$

$$F' = C_f'(d-4b)bP_d + C_f'(d-4b)2hP_d$$

The value of C_f' are given in (6.3.1) for different surface.

WIND LOAD

Q.1 A rectangular clab building having pitched roof and ~~located in~~ located in a from Givin data physical parameters

Height (h) = 3.5 m
width (w) = 10.0 m (Excluding over hang)
length (L) = 18 m
roof angle (α) = 5°
over hang = 0.5 m
opening on side = 10% of wall area
External surface of walls = smooth
Flate ground, wind zone = 3 (Building situated in jaipur)

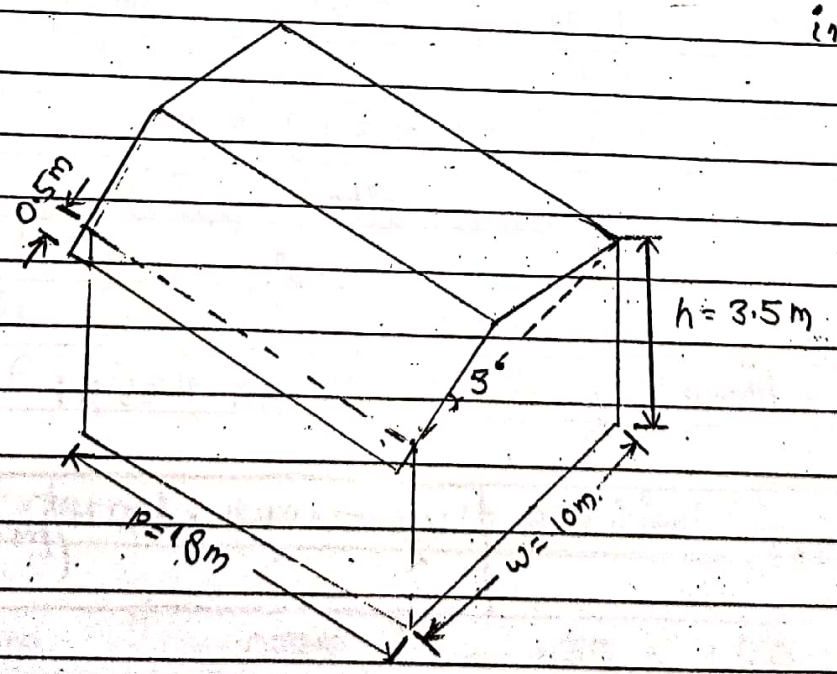


fig. - Isometric view of Rectangular clab building with pitched roof

Sol. STEP. 1 wind data:-

(i) wind zone : 3 (Building situated in raipur)

Basic wind speed V_b = 47 m/s.

Terrain Catagory = 1 (because open terrain with few or no obstruction) (5.3.2.1) P-8

Class of structure = A (width is less than 20m) clause (5.3.2.2) P.8

STEP. 2 Design wind speed (V_z)

$V_z = V_b K_1 K_2 K_3$ ⇐ page-8

Here V_b = 47 m/sec. P.52 (Appendiax A)

K_1 = 0.90 (From building) (5.3.1 Table.1) P.11

K_2 = 1.05 [5.3.2.2 Table-2]

K_3 = 1 [5.3.3.1] P. 12 because site upwind slop less then 3°.

Hence V_z = 47 × 0.9 × 1.05 × 1

$$\boxed{V_z = 44.42 \text{ m/sec.}}$$

STEP III wind pressure at 10 m. height

$$P_z = 0.6 V_z^2 \quad \text{(~~Page 54~~)} \quad \{5.4\} \text{ (P. 12)}$$

$$P_{10} = 0.6 (44.42)^2$$

$$\boxed{P_{10} = 1183.88 \ N/m^2}$$

1000

STEP IV wind load Calculation

$$F = (C_{pe} - C_{pi}) A P_d \quad \{6.2.1 \quad P. 13\}$$

Internal pressure co-efficient = C_{pi}

C_{pe} = External pressure co-efficient

A = Surface area of structural element

P_d = design wind pressure

(a) Internal pressure co-efficient (C_{pi}) {page 36-37 6.2.3 and 6.2.3.2

Given opening 10% of wall area is lie between 5 to 20% of wall area then from clause (6.2.3.2)

$$C_{pi} = \pm 0.5$$

The sign will depend on the direction of flow of air relative to the side of opening.

(b) External pressure co-efficient (C_{pe}) {Table-5, P=16}

Here $\frac{h}{w} = \frac{3.5}{10} = .35 < .50$

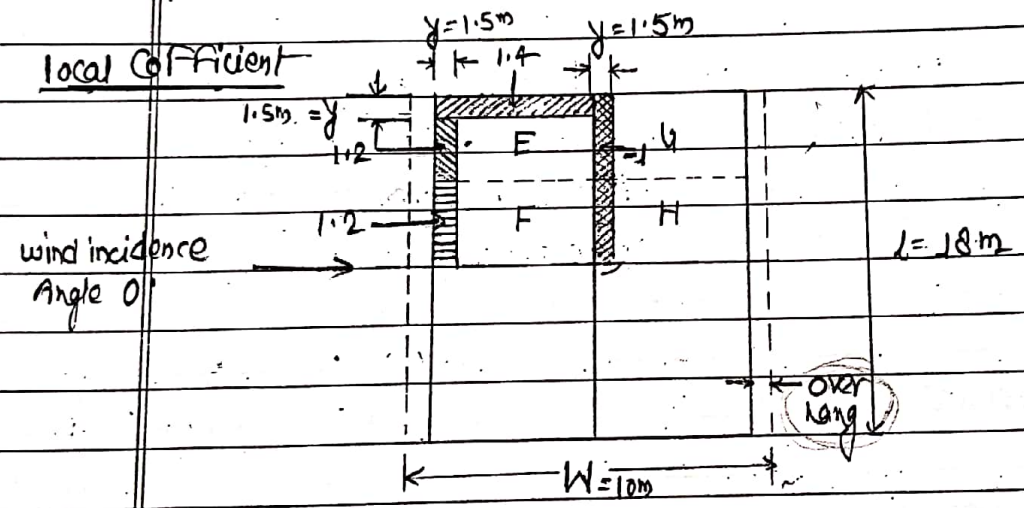
roof angle $\alpha = 5^\circ$

Table-1 Overall external pressure co-efficient

Pitch of roof	wind pressure co-efficient 0	90°
E	-0.9	-0.8
F	-0.9	-0.4
G	-0.4	-0.8
H	-0.4	-0.4

↓ wind incidence Angle 90°

local Cofficient



y = h or 0.15 w which ever is less

= 8.5 or 1.5 so 1.5

$\boxed{y = 1.5\,m}$

(c) External pressure co-efficient for local pressure:-

as show in above fig.

(d) Pressure Co-efficient for over hang {page-27 6.2.2.7

wind ward side of overhang pressure co-efficint $\boxed{C_{pi} = 1.25}$

(Because overhang slope) for overhang portion on side other then the windward side C_{pi} is equal to the C_{pe} of adjoining wall.

STEP-IV Design pressure co-efficient on Roof :-

$$C_{p(net)} = C_{pe} - C_{pi}$$

The $C_{p\,net}$ Calculation are summarized on follows

(i) If $C_{pi} = +0.5$, $\theta = 0°$

C_p (for region E & F) $= -.9 - 0.5 = -1.4$

C_p (for a region G & H) $= -0.4 - 0.5 = -0.9$

when $\theta = 90°$

C_p (for region E & G) $= -0.8 - 0.5 = -1.3$

C_p (for region F & H) $= -0.4 - 0.5 = -0.9$

(ii) If $C_{pi} = -0.5$, $\theta = 0°$

C_p (for region E & F) $= -0.9 - (-0.5) = -0.4$

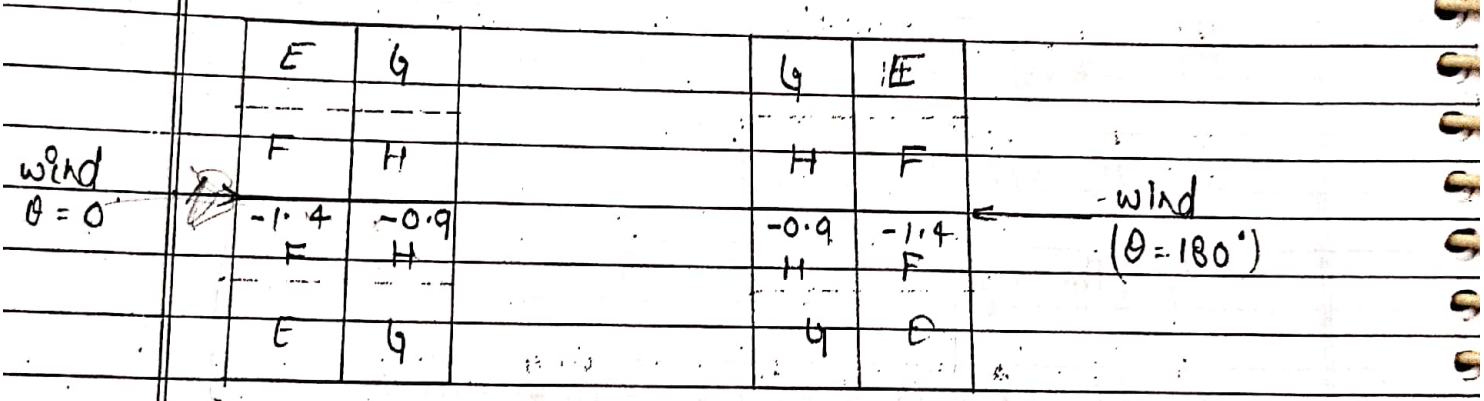
C_p (For region G & H) = $-0.4 - (-0.5) = 0.1$

when $\theta = 90°$

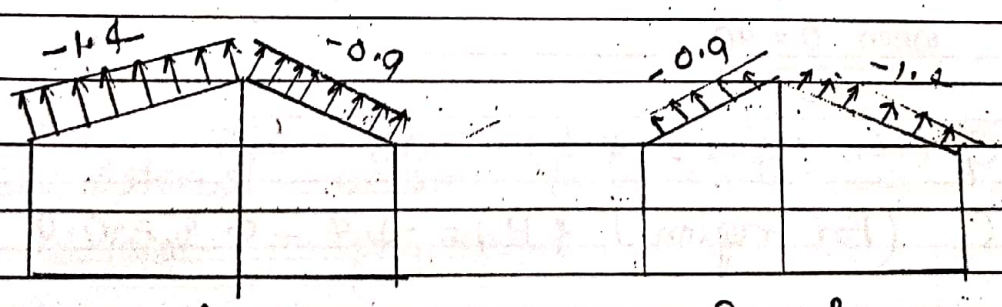
C_p (For region E & G) = $-0.8 - (-0.5) = -0.3$

C_p (For region F & H) = $-0.4 - (-0.5) = +0.1$

The wind may come from either side (direction) and opening may be on any side hence the heighest C_p value for all zone of cladding is considerd as -1.4 outward and $+0.1$ inward Design will have to checked for both these pressure.



PLAN PLAN



Elevation Elevation

max. C_p ($\theta = 0°$) max. C_p ($\theta = 180°$)

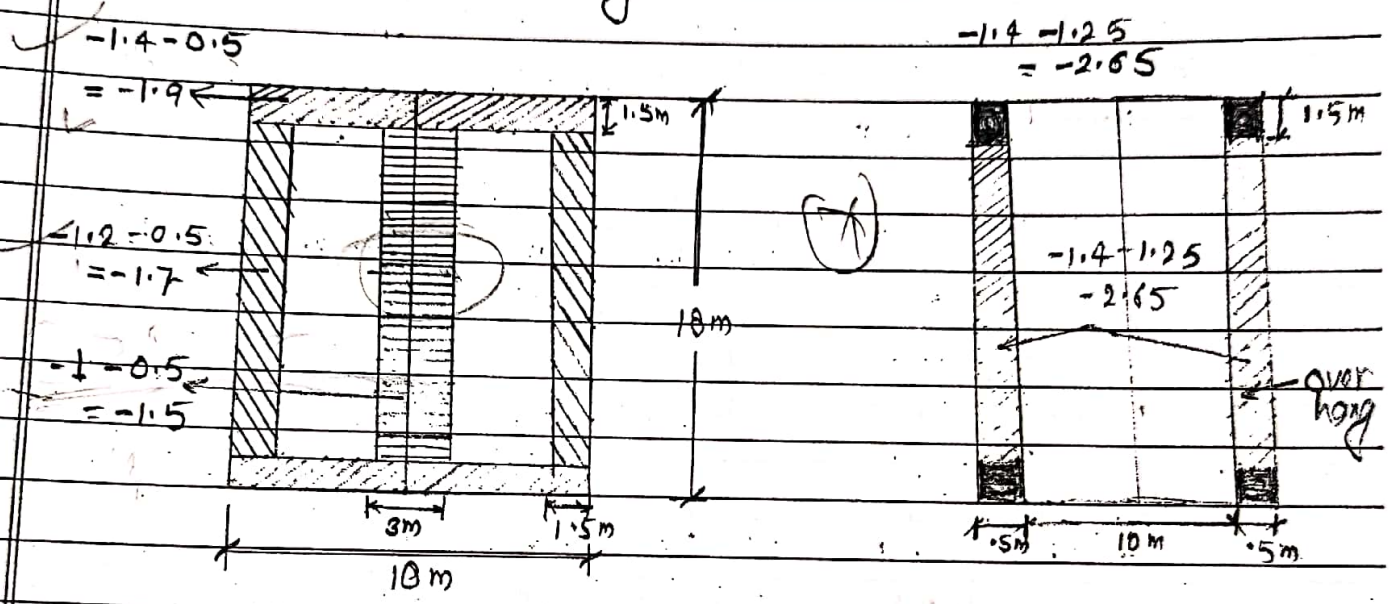
$C_{pi} = +0.5$ $C_{pi} = -0.5$

(a) (b)

r.- C_p for roof

STEP. V Design pressure co-efficient on Roof (Local)

C_p local is negative everywhere depending on wind direction C_{pi} can be +ve or −ve. positive value of C_{pi} will increase $C_{p(net)}$ which is to be considerd for calculation of wind loads The value of C_p are summarized in fig.



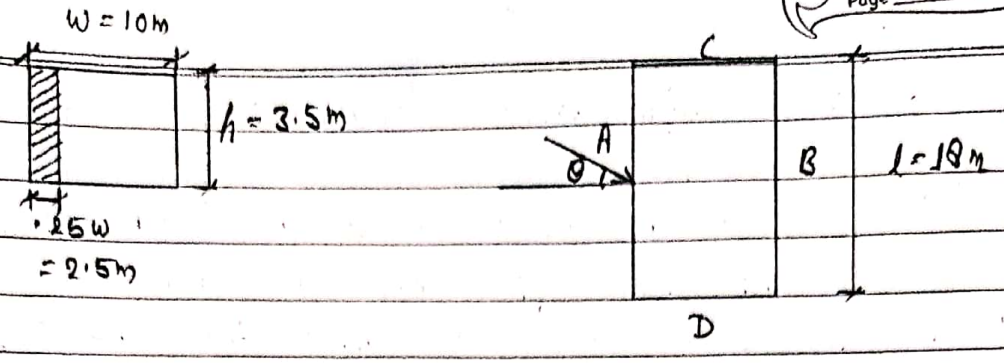
Plan of local C_p Plan of C_p on overhang

Fig :- show C_p local for roof.

STEP- VI Design pressure co-efficient on wall
(6.2.2.1 and Table-4)
P.13 P.14

In this case $\frac{h}{w} = 0.35$, $\frac{l}{w} = \frac{18}{10} = 1.8$

For these values of h/w and l/w [table 4]. The value of C_{pe} as per code provision are given fig.



wind Angle	Cp for surface				Local Cp.
	A	B	C	D	
0	+0.7	-0.25	-0.6	-0.6	-1.0
90°	-0.5	-0.5	+0.7	-0.1	

Now the Cp calculation are summarized blow

If $C_{pi} = +0.5$

when $\theta = 0°$ $\{C_p = C_{pe} - C_{pi}\}$

Cp (for wall A) $= +0.7 - 0.5 = 0.2$

Cp (for wall B) $= -0.25 - 0.5 = -0.75$

Cp (for wall C) $= -0.6 - 0.5 = -1.1$

Cp (for wall D) $= -0.6 - 0.5 = -1.1$

when $\theta = 90°$

Cp (for wall A) $= -0.5 - 0.5 = -1.0$

Cp (for wall B) $= -0.5 - 0.5 = -1.0$

Cp (for wall C) $= +0.7 - 0.5 = +0.2$

Cp (for wall D) $= -0.1 - 0.5 = -0.6$

If $C_{pi} = -0.5$

when $\theta = 0°$

C_p (for wall A) $= 0.7 - (-0.5) = 1.2$
C_p (for wall B) $= -0.25 - (-0.5) = 0.25$
C_p (for wall C) $= -0.6 - (-0.5) = -0.1$
C_p (for wall D) $= -0.6 - (-0.5) = -0.1$

when $\theta = 90°$

C_p (for wall A) $= -0.5 - (-0.5) = 0$
C_p (for wall B) $= -0.5 - (-0.5) = 0$
C_p (for wall C) $= +0.7 - (-0.5) = 1.2$
C_p (for wall D) $= -0.1 + (-0.5) = 0.4$

The above values of C_p for wall are based on wind direction of $\theta = 0°$ and $\theta = 90°$. But with change of angle of attack of wind, position of A-B and C-D get interchanged. Hence max. C_p value for wall A or B = (1.2 and -1.0) and for wall C or D = (1.2 and -1.1) are to be considerd for design of wall.

<u>C_p for local pressure on wall.</u>

~~The corners of wall - ~~ The corners experence more force for when local C_p is specified as under

C_p (corner) $= -1.0 - 0.5 = -1.5$

STEP: VII Final Design pressure and Force calculation

Negative value means that the roof or wall is being ~~pures~~ pushed outward or upward.

Force per unit area for roof when $C_p = -1.4$

$F = C_p \cdot A \cdot P_d$

$= 1.4 \times 1 \times 1183.88$

$F = -1657.43 \ N/m^2$

Force per unit are for longitudinal walls when $C_p = +1.2$

$F = C_p \cdot A \cdot P_d$

$= 1.2 \times 1 \times 1183.88$

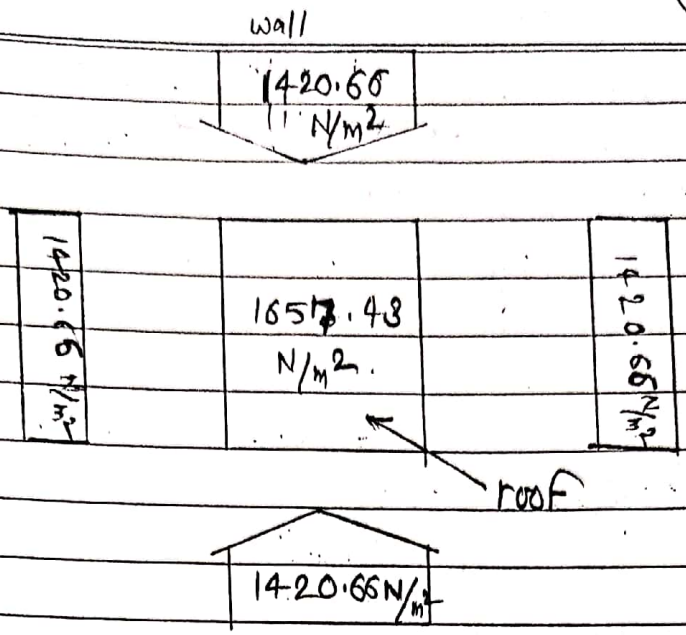
$F = 1420.66 \ N/m^2$

Force per unit area for cross wall when $C_p = +1.2$

$F = C_p \cdot A \cdot P_d$

$= 1.2 \times 1 \times 1183.88$

$F = 1420.66 \ N/m^2$



STEP. VIII **Design Local**