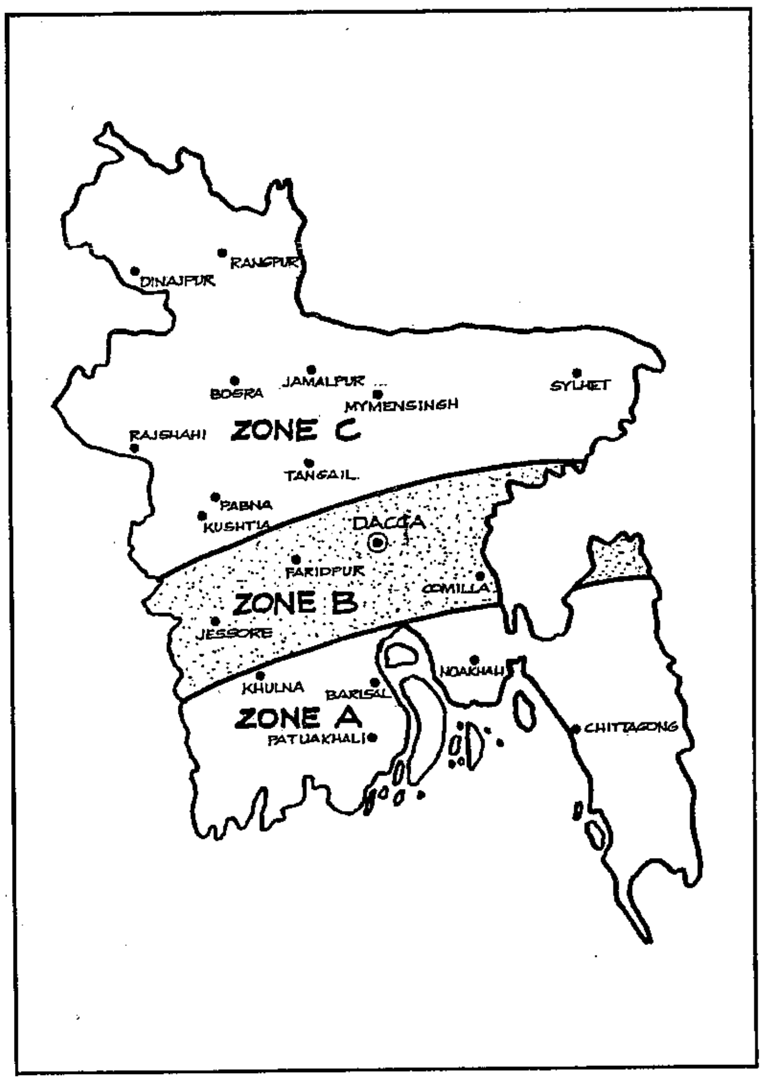
PART B: PROPOSED WIND CODE FOR BANGLADESH



UNESCO, Bangkok, June 1990

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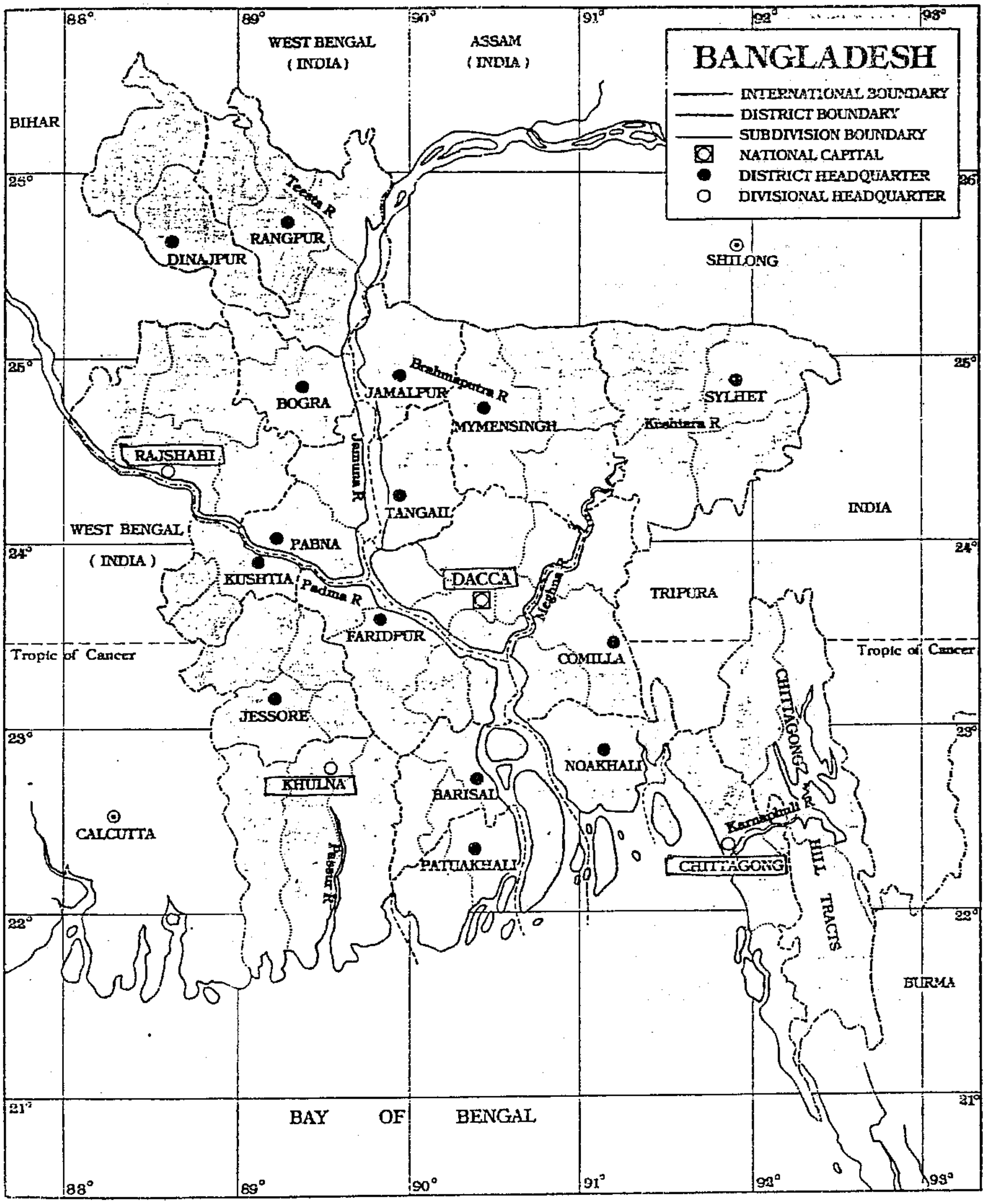
UNESCO MISSION TO BANGLADESH



DISTRICTS IN BANGLADESH - APRIL 1990

CONSIDERATIONS FOR THE DESIGN OF CYCLONE RESISTANT BUILDINGS

This proposal is for a simplified code for low rise buildings to provide design loads for cyclone wind forces.

1.00 BRIEF COMMENTARY ON WIND FORCE EFFECTS

1.01 Windspeed

The wind moves over the ground at a certain speed normally referred to in metres per second (m/sec), kilometres per hour (km/hr), or miles per hour (miles/hr). In a cyclone or typhoon as in all wind environments the wind fluctuates and changes speed rapidly so that in a period of one hour, the forward wind speed is less than the maximum wind speeds which are achieved over periods of a few seconds only. The fastest design wind speed, which is the windspeed used in cyclone wind design, is that which occurs in a three second wind gust. This is referred to as the design wind velocity speed (v). Design windspeeds are normally those which occur at a height of 30'0" (10.0m) above the ground on an open, inland terrain (site terrain category 2) and are based on a 50 year return of the wind event. This is the international datum for wind speed and wind force calculation.

1.02 Height

The wind speed and wind gust varies with height, being slower near ground level where the wind is slowed down by the roughness of the ground, and faster at high altitudes where there is less interference to the wind's forward speed. This effect can be measured at altitude intervals of 30'0" (10.0m) and thus taller buildings are subjected to higher wind speeds than are low buildings. A design factor for different building heights has been established.

1.03 Wind Zones

Due to various geographical features cyclonic storms occur with predictable frequency in different locations. Cyclones are at their strongest over landfall and once they have travelled up to 30 miles inland lose a substantial part of their force. By reviewing meteorological data of a country subjected to cyclones it is possible to define the zones which will get the strongest winds, strong winds and less strong winds. Wind zones for Bangladesh are shown in Figure 1. These wind zones are labelled A for wind gusts of up to 60m/s, or 134m/hr, B for wind gusts up to 50m/s or, 112 m/hr, and C for winds up to 40m/s, or 90m/hr.

1.04 Site Terrain Category

The smoother the ground surface the less friction there is for the wind and therefore faster wind speeds result at smoother ground levels. Ground roughness characteristics known as terrain categories have been defined. In general these can be ranked as follows from fastest wind speeds to slowest: flat sea coast areas, exposed hills, level open ground, built-up suburban regions, forested areas and densely built-up city areas. A design factor for terrain categories have been developed and is given in Figures 2 and 3.

1.05 Wind Pressure

The wind speed can be converted into the pressures exerted on a plane surface normal to the wind. Table B.2 covers all commonly used units of measure for both wind speed and free stream dynamic pressure. This table may be used for conversion of wind speed into pressures.

1.06 Structural Wind Loads

Winds create both positive and negative pressures on buildings. The windward planes which are tending to be pushed toward the inside of the building are considered to be positive external pressures. Those pressures which are caused by the aerofoil effects of wind blowing around the walls or over the roofs create an external vacuum or a net negative (suction) external pressure which causes the various building planes to be pushed outward.

As well as these external effects, a building can be pressurized with internal pressure (or vacuum) if openings occur in the building envelope.

It is the resultant sum of the positive and negative pressures which determines the total force on any plane of a building's exterior.

1.00 BRIEF COMMENTARY ON WIND FORCE EFFECTS (cont'd)

1.06 Structural Wind Loads (cont'd)

As the external suction forces can become very strong, in high winds buildings tend to "explode". These outward forces are particularly strong on roofs where positive and negative forces combine and under some circumstances create a force stronger than the wind force itself. The Tables on Figures 5 and 6 give the pressures for buildings open on both sides or on one side.

As the wind passes over or around objects such as trees, ridges, fences, buildings, cliffs and valleys, the wind becomes turbulent and causes local increases in air speed and wind pressure. The effect of these air pressures on the edges and perimeters of these obstructions can become much more severe than the normal wind pressure. These effects are catered for by allowing a local pressure factor "K" for critical areas of buildings. Figure 4 shows the affected local areas of a building and gives the "K" factors. These loads are applied only in calculation of the forces on the cladding. See also notes in paragraph 11 hereatfer.

1.07 Other Effects on Wind Speed

The wind speed is also affected by atmospheric pressure, the ambient temperature and air density. However, for this paper, these effects are not taken into account and the factor used is 1.0.

1.08 Return Periods

Selective increases can be made to the design wind forces to cater for the expected life of a building or to give a building a greater factor of safety.

If a building is to remain intact for a once in 100 year event, it should be expected to resist the worst wind speed that could occur in a 100 year period. This wind speed would be higher than the worst wind speed expected in a period of 50 years. Therefore, the 50 year wind and 100 year wind can be referred to as specific events. Since this wind could arrive at any time, it would damage all buildings designed for a lesser event.

A 500 year or 1,000 year event would be described as catastrophic and, since meaningful records are not known for these periods, assumptions of their forces can only be assessed.

1.09 Post Disaster Functions

Important buildings, such as hospitals, police stations, post and telecommunication buildings, electricity generation and control buildings and refuge shelters (such as schools) should be expected to survive severe events such as cyclones so that they are able to serve their "post disaster function" during the recovery period.

Whilst most buildings should be designed for a 50 year event, post disaster buildings should be designed for a 100 year event. The increase in design loads for the 100 year event is approximately 20%.

1.10 Cyclonic Overload On Materials

In considering the ability of building materials and their fixings that resist the cyclone wind loads, it is important to remember that the materials have to resist the maximum design forces only for very short periods of approximately 3-5 seconds. These short term loads may occur many times over the duration of a storm.

Some materials are able to accept short term overload situations with enough flexibility to recover to their normal strength. As timber will flex and recover, an overload allowance of 100% is allowed in the design of timber members for 3-5 second wind gusts. Steel members are permitted on overload factor 33%. Brickwork, on the other hand, will not recover after cracking.

1.00 BRIEF COMMENTARY ON WIND FORCE EFFECTS (cont'd)

1.11 Special Notes on Cladding Loads (See Figure 4)

The building structure has to resist the overall structural wind load applied to the total building and in this situation there is some loadsharing by the total structure as the worst wind loads do not envelope the whole building at one time.

However the wind loads, fluctuating in speed and direction every 3-5 seconds create a dynamic cyclical pressure on the cladding on the buildings' walls and roofs.

These loads are referred to as cladding loads. Dealing with the resistance of wind forces on claddings in low rise buildings is often left to the contractors and tradesmen.

It is only in recent decades that closer attention has been paid to these loads by professional Engineers and Architects.

The wind forces on claddings are most severe at edges and corners such as eaves, barges and ridges, often where inadequate fixings and protection expose weaknesses in cladding fixings.

Cladding loads in these areas can be 50% larger than the overall structural loads applied to the building as a whole.

It is important to design both claddings and their small fixings to resist these wind loads. This involves study and understanding the real cladding loads, the nature and strength of the cladding material, the resistance of individual small fixings (such as nails and screws and bolts) and the batten or rafter spacings which affect the load area and consequent uplift forces.

The tables hereafter offer advice in resolving these wind loads.

2.00 PROCEDURE TO DETERMINE WIND LOADS

The following procedure may be followed to design a building which will be resistant to damages in high winds.

Step 1: Collect the facts

(a) Identify national wind zone
(b) Identify wind speed
(c) Identify height of building and coefficient
(d) Identify terrain category and coefficient
(e) Determine design pressure

Step 2: Determine the wind forces

(a) Identify building dimensions, length, height, width, shape and slope of roof
(b) Determine co-efficients for wall and roof loads, both structural loads and cladding loads, and slope of roof
(c) Calculate structural loads
  - on walls
  - on roof
  - on windows

(d) Calculate cladding loads
  - on walls and on roof

Step 3: Determine wind loads

(a) Work out actual loads
(b) Determine structural lines of forces
(c) Decide on lines of resistance
  - in wall plane
  - in roof plane
  - in floor plane
  - in roof framing

Step 4: Design construction details and connections

(a) Decide on details
(b) Design resistance members
(c) Design fixing details
(d) Decide on materials to be used
(e) Specify workmanship required
(f) Check load areas and overturning moments

2.00 PROCEDURE TO DETERMINE WIND LOADS (cont'd)

Step 5: Check List of Key Points

Some of the important points to be kept in mind as one works their way through this procedure are spelled out below.

(a) The design wind applies to the wind speed at a height of 10m on a terrain category 2 site (eg. at 30'0" [10m] on an airfield) and is based on a 50 year return wind.

(b) If the site is more exposed (beside the sea) the design wind is higher. If the site is more protected (in city areas) the design wind is less.

(c) If the building is higher than 30'0" (10m) the design wind is higher. If the building is lower than 30'0" (10m) the design wind is lower.

(d) The design wind is to be converted to free stream dynamic pressure (eg. kgf/m^2, or pounds force per sq.ft. or kilopascals). This pressure becomes the design pressure.

(e) This design pressure is increased or decreased by co-efficients which provide the actual pressure applied to various parts of the building's walls and roof areas and depends on the wind direction, the disposition of openings in the building and the roof slope.

(f) This pressure or suction force resulting from the design wind and the building shape is to be added to the internal pressure generated inside the building which tends to push the walls and roof outwards. The resulting total pressure is the force to be resisted by the structure of the building and is referred to as the "Structural Load".

(g) In addition, the cladding materials (roof sheeting and wall materials) are subjected to local pressures tending to pull off the cladding. These forces effect the cladding only and do not affect the structure.

(h) The cladding of the central wall and roof areas carry the same loads as the actual pressure. However, perimeters of walls and roof areas carry a greater suction (50% greater). While the corners of the roof and sharp ridges and projections carry an even greater suction (100% greater). These forces are pressures affect the fixing of the claddings to their immediate supporting members and are referred to as "Cladding Load".

Table B.1 gives a listing of the force of aerofoil effect at different wind speeds.

3.00

Table B.1

AEROFOIL EFFECT : WHEN ROOFS FLY

VELOCITY	TYPICAL MOVEMENT	VELOCITY
0.00 m/sec	Dead calm - birds fly	
0.23 m/sec	Leaf moves	0.50 m/hr
0.50 m/sec	Leaf flies	1.15 m/hr
0.75 m/sec	Paper flies	1.80 m/hr
0 - 5 m/sec		0 - 11 m/hr
5 - 10 m/sec	Loose aluminium sheets fly	11 - 22 m/hr
10 - 15 m/sec	Loose galvanised iron sheets fly	22 - 33 m/hr
15 - 20 m/sec	Loose fibre cement sheets fly	33 - 45 m/hr
20 - 25 m/sec		45 - 56 m/hr
25 - 30 m/sec	Loose concrete and clay files fly	56 - 67 m/hr
30 - 35 m/sec	Roof sheets fixed to battens fly	67 - 78 m/hr
35 - 40 m/sec	DC3 aircraft take off speed	78 - 90 m/hr
40 - 45 m/sec	Roof tiles nailed to battens fly	90 - 100 m/hr
45 - 50 m/sec	Garden walls blow over	100 - 112 m/hr
50 - 55 m/sec	Unreinforced brick walls fail	112 - 123 m/hr
55 - 60 m/sec	Major damage from flying debris	123 - 134 m/hr
60 - 65 m/sec		134 - 145 m/hr
65 - 70 m/sec	100mm thick concrete slabs fly	145 - 156 m/hr
70 - 75 m/sec		156 - 168 m/hr
75 - 80 m/sec	150mm thick concrete slabs fly	168 - 179 m/hr
80 - 85 m/sec		179 - 190 m/hr
85 - 90 m/sec		190 - 201 m/hr
90 - 95 m/sec		201 - 212 m/hr
95 - 100 m/sec	200mm thick concrete slabs fly	212 - 224 m/hr

Table B.2

CONVERSION OF WIND SPEED TO FREE STREAM DYNAMIC PRESSURE

SPEED				FREE STREAM DYNAMIC PRESSURE			
m/sec	Knots	miles/hr	km/hr	lbf/ft^2	kgf/m^2	N/m^2 Pa	kPa
0.278	0.540	0.621	1.000	0.001	0.005	0.047	0.00005
0.447	0.868	1.000	1.609	0.003	0.012	0.122	0.0001
0.514	1.000	1.150	1.850	0.003	0.016	0.162	0.0002
1.000	1.942	2.237	3.600	0.013	0.063	0.613	0.0006
1.277	2.480	2.856	4.597	0.021	0.102	1.000	0.001
4.000	7.770	8.947	14.40	0.205	1.000	9.808	0.010
8.835	17.162	19.762	31.81	1.000	4.883	47.85	0.048
10.000	19.425	22.368	36.00	1.282	6.255	61.30	0.061
20.0	38.85	44.74	72.02	5.124	25.02	245.2	0.245
30.0	58.28	67.10	108.0	11.53	56.29	551.7	0.552
35.0	67.98	78.29	128.0	15.69	76.63	750.9	0.751
40.0	77.70	89.47	144.0	20.50	100.0	980.8	0.981
40.3	78.28	90.14	145.1	20.81	102.1	1000.	1.000
45.0	87.41	100.66	162.0	25.94	126.7	1241.	1.241
50.0	97.12	111.84	180.0	32.03	156.4	1532.	1.532
55.0	106.84	123.02	198.0	38.75	189.2	1854.	1.854
60.0	116.55	134.21	216.0	46.12	225.2	2207.	2.207
65.0	126.26	145.39	234.0	54.13	264.3	2589.	2.589
70.0	135.98	156.57	252.0	62.73	306.5	3004.	3.004
75.0	145.69	167.76	270.0	72.06	351.8	3448.	3.448
80.0	155.40	178.94	288.0	81.99	400.3	3923.	3.923
85.0	165.11	190.13	306.0	92.55	451.9	4429.	4.429
90.0	174.83	201.31	324.0	103.80	506.7	4965.	4.965
95.0	184.54	212.50	342.0	115.60	564.5	5532.	5.532
100.0	194.25	223.68	360.0	128.10	625.5	6130.	6.130

Formulae:

$P = 0.613V^2$ N/m^2 (Pa) for V in m/sec

$P = 0.0625V^2$ kgf/m^2 for V in m/sec

$P = 0.00256V^2$ lbf/ft^2 for V in miles/hr

4.00 COMPARISON OF INTERNATIONAL WIND CODES

To compare the wind codes of various countries, the wind forces created by a 50 m/sec (111.84 m/hr) wind at 10m above ground in Site Category 2 on a 50 year return period have been calculated in these codes as follows:

	Sri Lanka	141.6 kgf/m^2	29.0 lbf/ft^2
	Australia	153.4 kgf/m^2	31.5 lbf/ft^2
	USA	156.0 kgf/m^2	32.0 lbf/ft^2
	Britain	156.25 kgf/m^2	32.0 lbf/ft^2
Proposal for	Bangladesh	156.25 kgf/m^2	32.0 lbf/ft^2

For your reference, the formulas of the various codes used by other countries are given below along the calculations.

CALCULATIONS OF INTERNATIONAL WIND CODES

Calculations at 50 m/sec Velocity (111.84 miles/hr)

United States of America

$Q_{30} = 0.00256\ V^2_{30}$ lb/ft^2

$= 32$ lbf/ft^2

$= 156$ kgf/m^2

where:
Q_{30} = wind pressure at 30 ft
V_{30} = wind speed at 30 ft

Australia

$Q_z = 0.6V^2z \times 10^{-3}$ kpa

$= 1.5$ kpa
$= 31.4$ lbf/ft^2
$= 153.4$ kgf/m^2

where:
V_z = wind speed at 10.0 m
Q_z = wind pressure kpa

Sri Lanka

$q = KV^{\circ}{}_2{}^{2'}$ lbf/ft^2

$= 0.00232 \times 111.84^2$ lbf/ft^2

$= 29$ lbf/ft^2

$= 141.6$ kgf/m^2

where:
V_2 = design wind speed
K = constant, zone 1-0.00232
q = dynamic pressure

British Standards

$q = KV^2s$

$= 0.0625 \times 502$ kgf/m^2
$= 32.0$ lbf/ft^2
$= 156.25$ kgf/m^2

where:
Vs = wind speed
K = 0.00256 lbf/ft^2
K = 0.0625 kgf/m^2

PART B PROPOSAL FOR BANGLADESH WIND CODE

PROPOSAL FOR WIND ZONES • BANGLADESH

SUGGESTION FOR DEVELOPMENT

DATUM • HEIGHT – 30'0 • SITE – AIRPORT • RETURN PERIOD – 50 YEARS

PROPOSED DESIGN LOADS FOR BUILDINGS TO RESIST CYCLONES

	WIND ZONE	WIND SPEED	WIND PRESSURE	STRUCTURAL LOADS		CLADDING LOADS	
				WALL	ROOF	WALL	ROOF
60 m/s	A	134 MPH	46 PSF	64 PSF	79 PSF	64-92 PSF	79-120 PSF
50 m/s	B	112 MPH	32 PSF	45 PSF	54 PSF	45-64 PSF	54-83 PSF
40 m/s	C	90 MPH	21 PSF	29 PSF	35 PSF	29-42 PSF	35-55 PSF
$V^2 \times 0.00256$ PSF			P	1.4P	1.7P	1.4-2.0P	1.7-2.6P

FOR HEIGHT ABOVE GROUND

0-15'0"	-7%	0.93
15-30'0"	DATUM 1.00	1.00
30-45'0"	+3%	1.03

FOR 100 YEAR RETURN PERIOD ADD 20% (FOR POST DISASTER)

FOR SITE CATEGORY LOCATIONS (SCL)

SCL 1	SEASIDE	1.09	ADD 20%	TO RESULTANT LOAD ON ELEMENT (APPROX.)
SCL 2	AIRPORT	DATUM 1.00	DATUM	
SCL 3	URBAN	0.85	DEDUCT 30%	
SCL 4	CITY CENTRE	0.70	DEDUCT 50%	

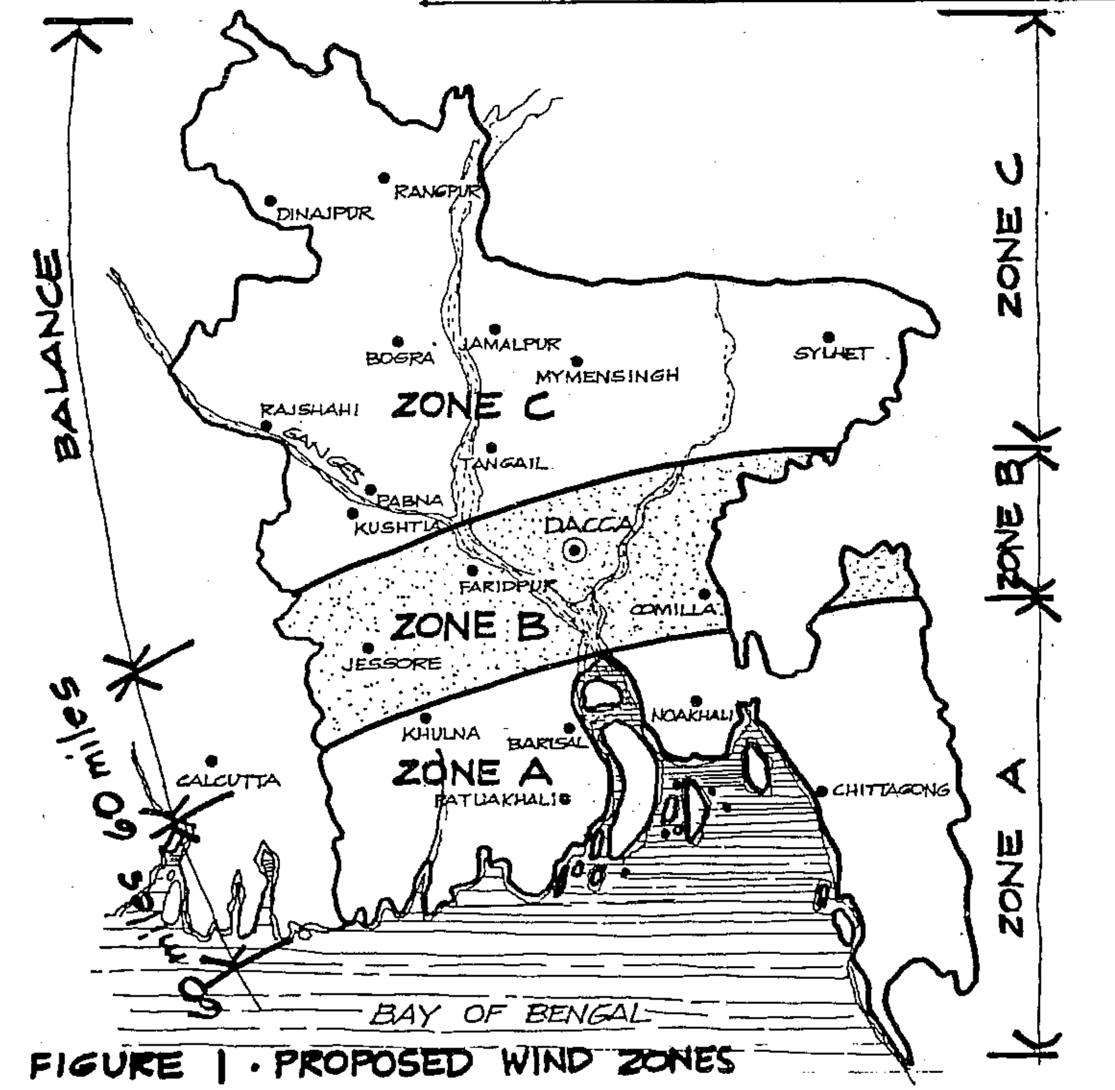


FIGURE 1 • PROPOSED WIND ZONES

6.00 FORMULAE AND CO-EFFICIENTS FOR CALCULATING WIND FORCES

For easy reference by the reader, the formulae and the coefficients used in this chapter are summarized and presented together.

1. To convert wind speed to dynamic pressure

$Qz = C\,V^2z$

Qz	= Dynamic wind pressure
C	= Coefficient
Vz	= Dynamic wind velocity

Qz	$= 0.613\,V^2$	N/m^2 (pascals)	for V in m/sec
Qz	$= 0.0625V^2$	kgf/m^2	for V in m/sec
Qz	$= 0.00256V^2$	lbf/ft^2	for V in miles/hr

2. Design wind pressure on a surface

$Pz = C_P\,Qz$

Pz	= Design wind pressure
C_P	= Coefficient of pressure

The coefficient varies according to location of the surface and direction of wind.

3. Co-efficient for height

The datum of 1.00 refers to a height of 10m on terrain category 2. Co-efficients for other heights are:

0 - 15 ft high	-	0.93
15 - 30 ft high	-	1.00 - datum
30 - 45 ft high	-	1.03

4. Co-efficients for terrain categories

Refer also to diagrams for degree of site exposure to wind. The datum is 1.00 at a height of 10m on terrain category 2.

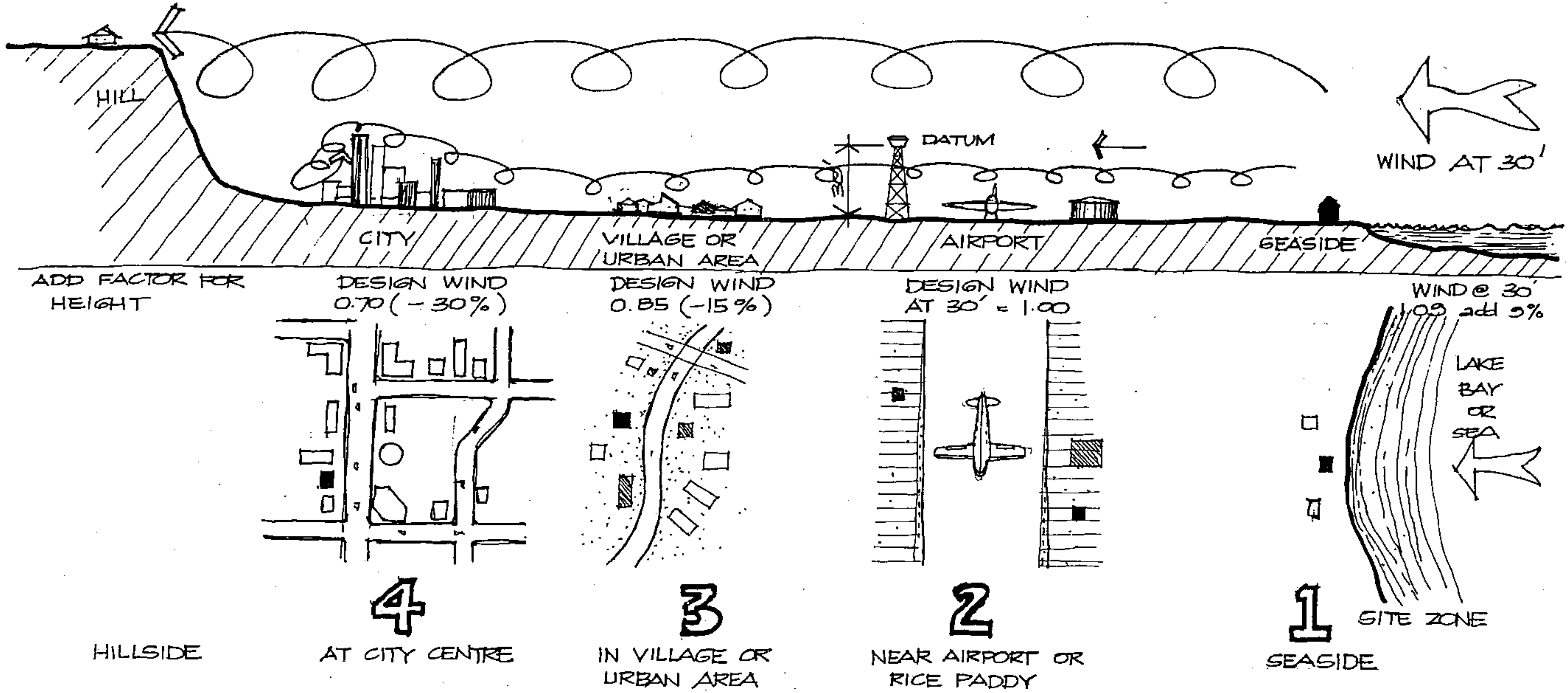
Terrain category 1	- 1.09	eg.	-	at seaside
Terrain category 2	- 1.00 - datum		-	open country eg. airport
Terrain category 3	- 0.85		-	urban or village
Terrain category 4	- 0.70		-	city centre

5. Local pressure factors to walls and roofs (K)

Refer to diagrams for typical areas affected.

General surface areas	A - 1.0
Perimeter areas	B - 1.5
Corners and gable ends	C - 2.0

The local pressure factor is multiplied by the external suction on a roof or wall and affects the cladding and its supporting framework and fittings only. It must not be used to determine total forces on a building.



SITE CATEGORY LOCATIONS (S.C.L.) – FOR CYCLONE WINDS

SCL 4	SCL 3	SCL 2	SCL 1	WIND PRESSURE	WIND SPEED		
23 PSF	33 PSF	46 PSF	55 PSF	46 PSF	134 MPH	ZONE A	60 m/s
16 PSF	23 PSF	32 PSF	38 PSF	32 PSF	112 MPH	ZONE B	50 m/s
10 PSF	15 PSF	21 PSF	25 PSF	21 PSF	90 MPH	ZONE C	40 m/s
0.70P	0.85P	1.0P	1.09P	P	← COEFFICIENTS		

FIGURE 2 · SITE CATEGORY LOCATIONS

PROPOSED WIND FORCES FOR
TERRAIN CATEGORIES - ROUGHNESS OF SITE

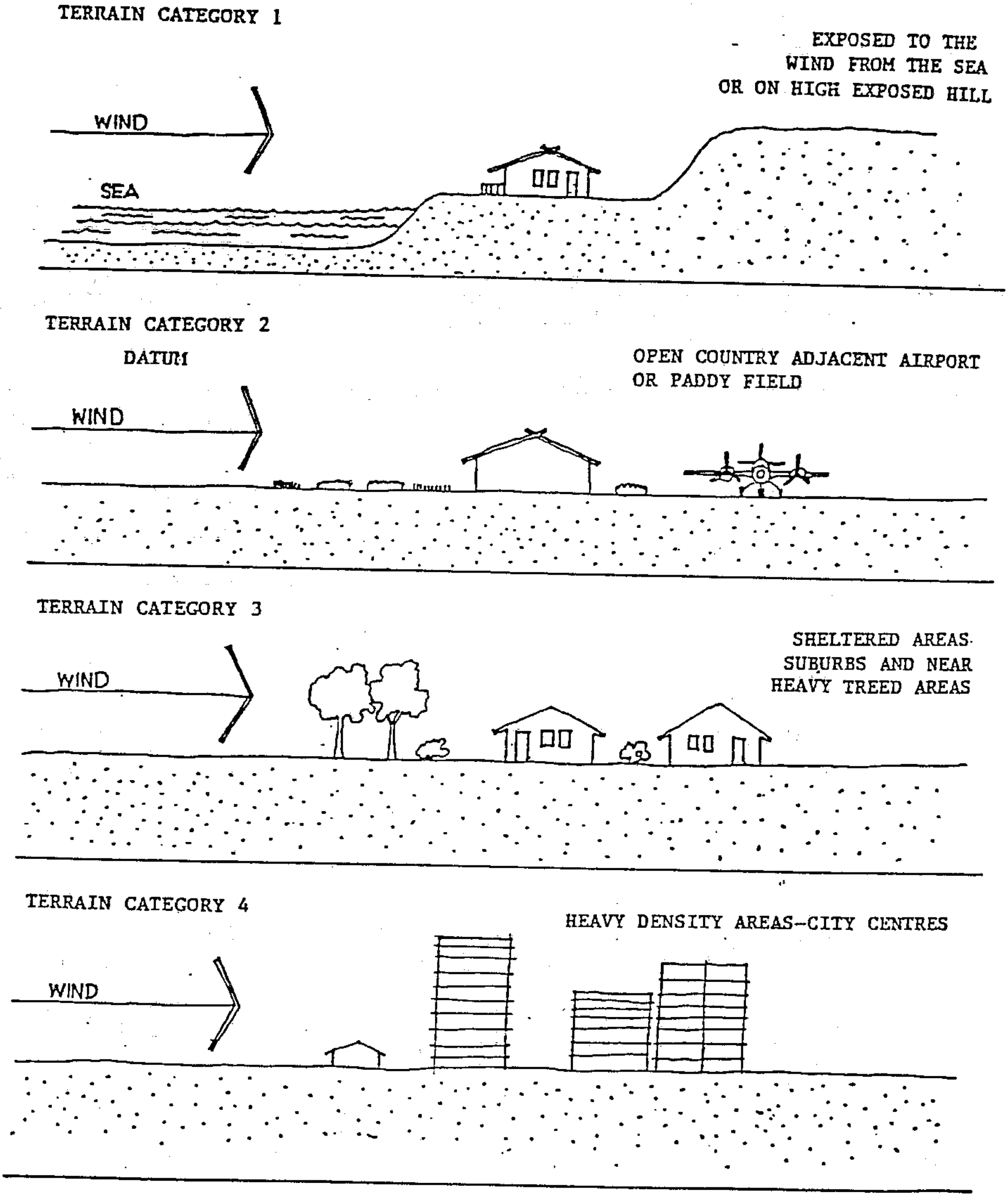
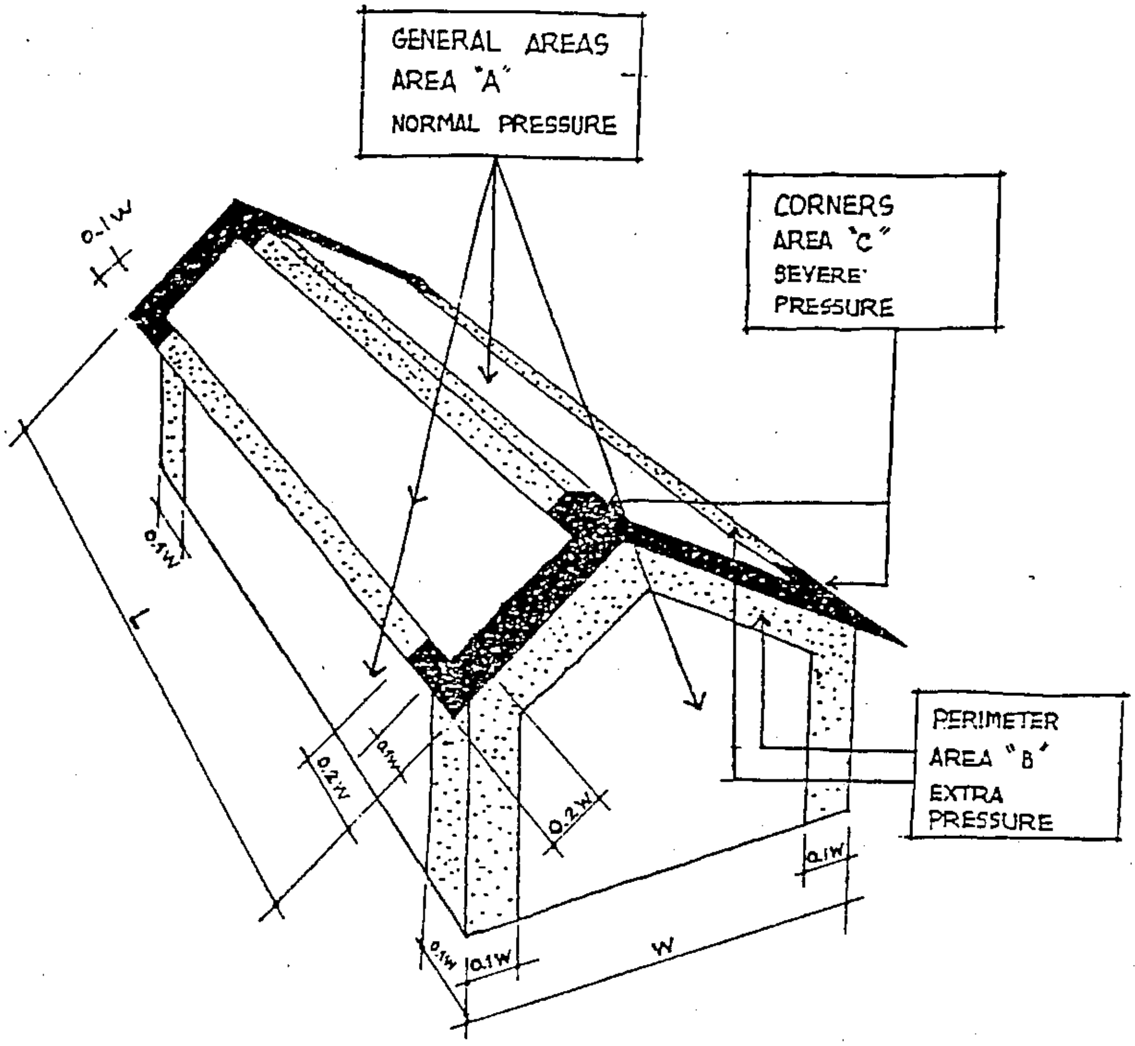


Figure 3 DIAGRAM OF TERRAIN CATEGORIES



ISOMETRIC OF BUILDING

IP. INTERNAL PRESSURE MAXIMUM - 0.8 x Force

EP. EXTERNAL PRESSURE MAXIMUM - 0.9 x Force

"K" FACTORS ARE CLADDING ONLY

1.0 GENERAL AREA A x EP. + IP.

1.5 PERIMETER AREA B x EP. + IP.

2.0 CORNER AREA C x EP. + IP.

Figure 4 LOCAL PRESSURE FACTORS
- To be applied to cladding loads only

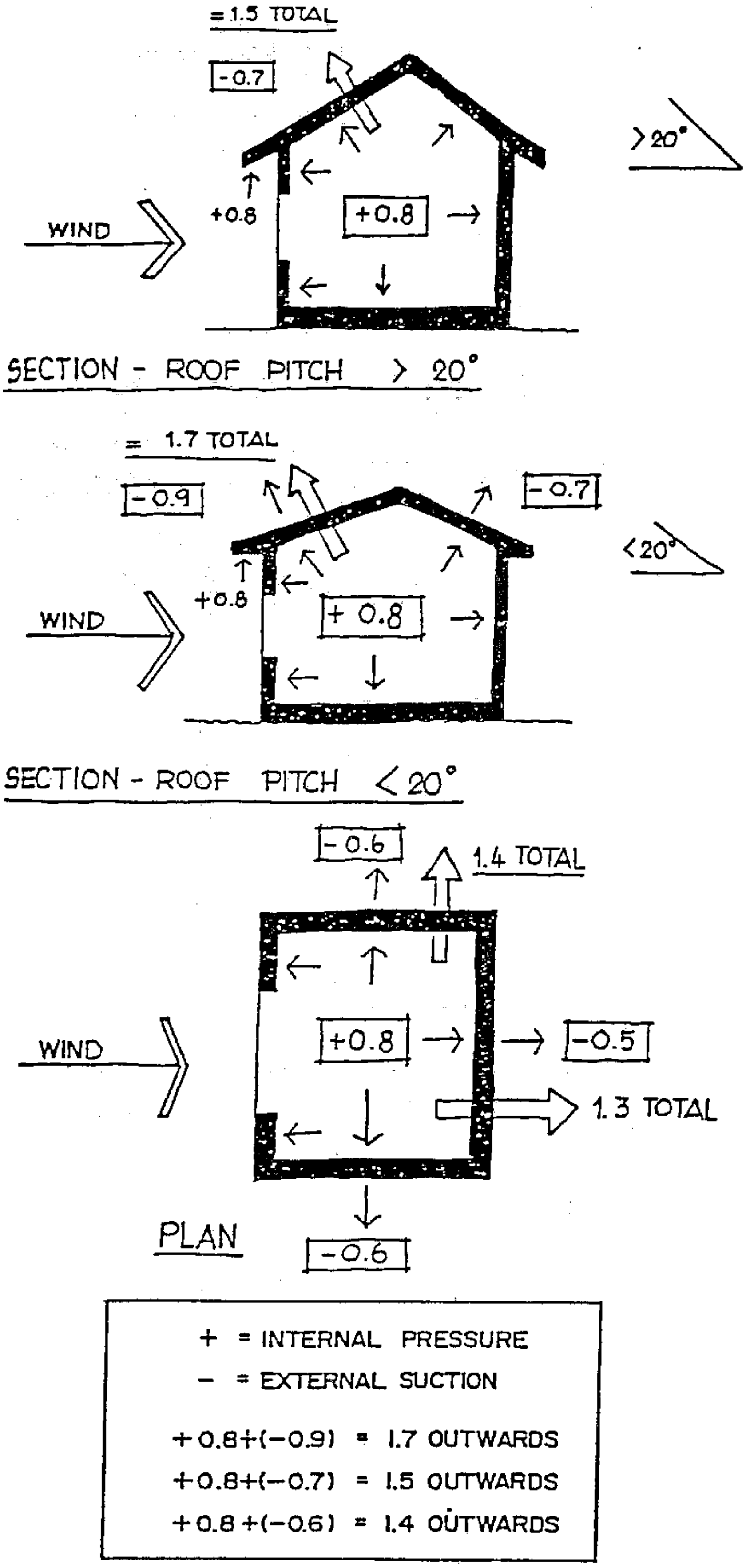
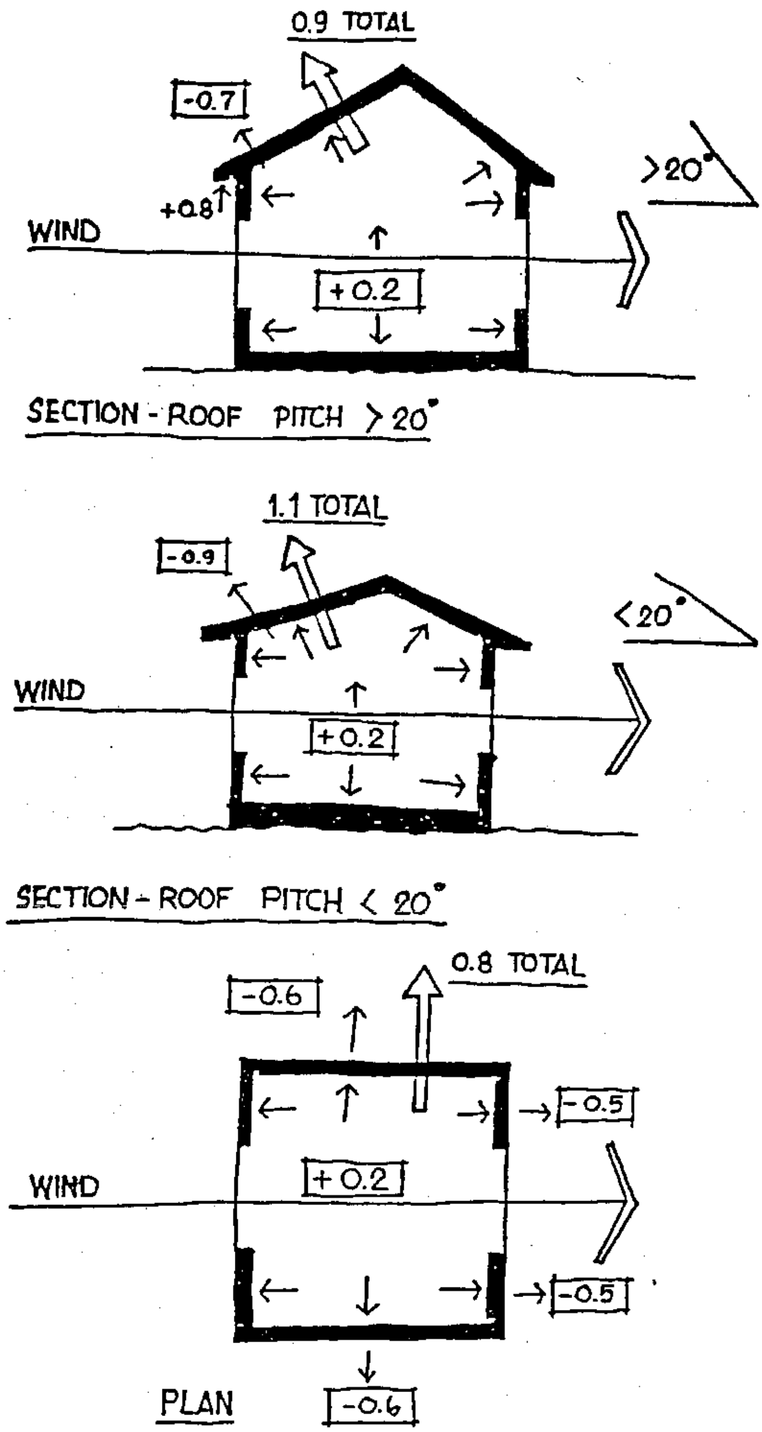


Figure 5 STRUCTURAL LOAD COEFFICIENTS, INTERNAL AND EXTERNAL PRESSURE - Dominant opening on windward side - internal pressure + 0.8



\+ = INTERNAL PRESSURE
\- = EXTERNAL SUCTION

+0.2+(-0.7) = 0.9 OUTWARDS
+0.2+(-0.9) = 1.1 OUTWARDS
+0.2+(-0.6) = 0.8 OUTWARDS

Figure 6 STRUCTURAL LOAD COEFFICIENTS, INTERNAL AND EXTERNAL PRESSURE - Openings on opposite walls - internal pressure + 0.2

8.00 Wind Pressure Tables for Bangladesh

Taking into account the above factors it is possible to generate tables which are suited for a specific country. This has been done for Bangladesh. Table B.3 gives the design pressures for different wind zones in the country and with adjustments for each of the four terrain categories. Table B.4 to B.9 give Design Loads on roofs for each terrain category in the three zones. Separate tables are provided for roofs under 20° pitch and those over 20°.

Table B.3

PROPOSED WIND PRESSURES (Qz) FOR ZONES A, B & C
DYNAMIC WIND PRESSURE - FOR SITE AND HEIGHT

Return period 50 years - 3 sec. gust in cyclone wind.
$P = 0.0625V^2$ kgf/m^2 for V in m/sec or $P = 0.00256\ V^2$ lbf/ft^2 or V in miles/hr.
Assessed adjustments made to wind speed to suit site roughness and height.

Terrain Category (Site roughness)	Height (feet)	Velocity Multiplier	Wind Speed (mph)			Free Stream Dynamic Pressure (lbf/ft^2)		
			Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
1. Seaside	30'0"	1.09	146	122	98	55	38	25
	15'0"	1.02	137	114	92	48	33	21
2. Rural Open	30'0"	1.00	134	112	90	46	32	21
	15'0"	0.93	125	104	84	40	28	18
3. Urban	30'0"	0.85	114	95	77	33	23	15
	15'0"	0.79	106	88	71	29	20	13
4. City	30'0"	0.70	94	78	63	23	16	10
	15'0"	0.65	87	73	59	20	14	9

Notes: Most sites fall in Terrain Categories 2 and 3.
For post disaster buildings which should survive to serve the community immediately after a disaster (eg. Hospitals, police station, telecommunication buildings and perhaps schools if used as refuge centres), add 20% to all forces.

TABLE B4 - ROOF LOADS

DESIGN LOADS - ZONE A - PITCH < 20°

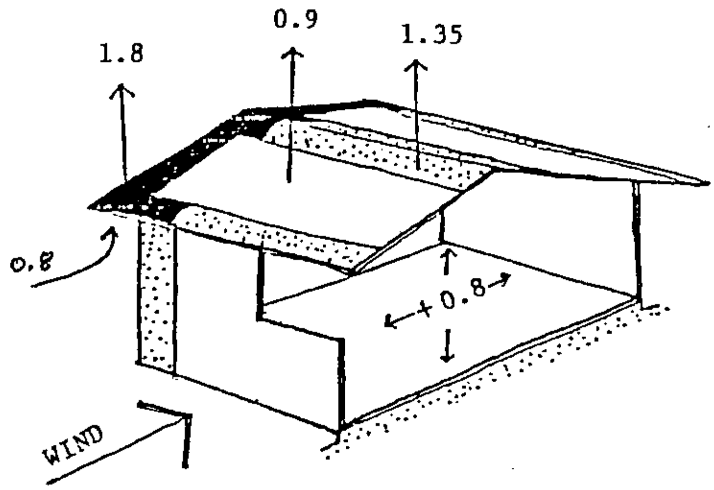


DIAGRAM OF PRESSURE COEFFICIENTS
(to be multiplied by Q_z)

K = CLADDING COEFFICIENT

- AREA A - $P_s + P_I$
- AREA B - $1.5P_s + P_I$
- AREA C - $2.0P_s + P_I$

Q_z = STATIC WIND PRESSURE
P_z = DESIGN PRESSURE
P_I = INTERNAL PRESSURE
P_s = EXTERNAL SUCTION

STRUCTURAL LOAD $P_z = Q_z (P_I + P_s)$

CLADDING LOADS $P_z = Q_z (K \times P_s + P_I)$

TERRAIN CATEGORY	HEIGHT	PRESSURE Q_z	DESIGN LOADS - lbf/ft² AREA A 1.7 x Q_z	AREA B 2.15 x Q_z	AREA C 2.6 x Q_z	WIND SPEED m/hr
1	30'0"	55	93	118	142	146
	15'0"	48	82	103	125	137
2	30'0"	46	79	99	120	134
	15'0"	40	68	86	104	125
3	30'0"	33	56	71	86	114
	15'0"	29	49	62	75	106
4	30'0"	23	38	49	59	94
	15'0"	20	33	42	51	87
			STRUCTURAL LOAD	CLADDING LOADS*		

ROOF LOADS - DOMINANT OPENING IN WINDWARD WALL

* Local pressure factors must not be used in the determination of the total forces on a structure or a surface such as a wall or roof.

TABLE B5 - ROOF LOADS
DESIGN LOADS - ZONE A - PITCH > 20°

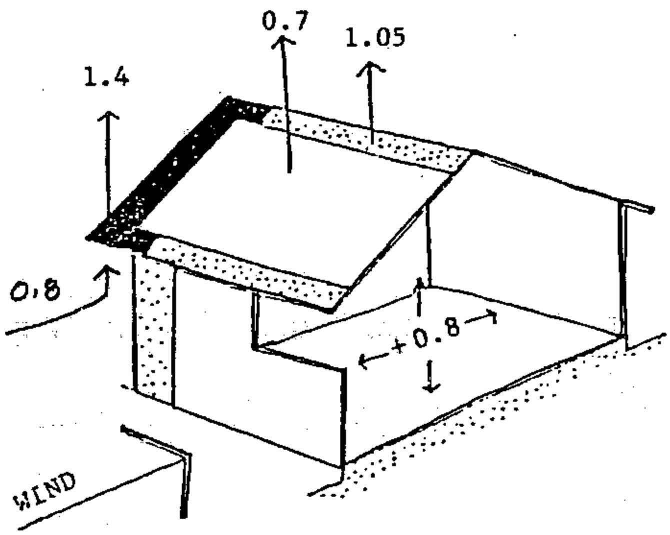


DIAGRAM OF PRESSURE COEFFICIENTS
(to be multiplied by Q_Z)

K = COEFFICIENTS FOR CLADDING

- AREA A - $P_s + P_I$
- AREA B - $1.5P_s + P_I$
- AREA C - $2.0P_s + P_I$

Q_Z = STATIC WIND PRESSURE
P_Z = DESIGN PRESSURE
P_I = INTERNAL PRESSURE
P_S = EXTERNAL SUCTION
K = CLADDING

STRUCTURAL LOAD $P_z = Q_z (P_I + P_S)$

CLADDING LOADS $P_z = Q_z (K \times P_S + P_I)$

			DESIGN LOADS - lbf/ft^2			
TERRAIN CATEGORY	HEIGHT	PRESSURE Q_z	AREA A $1.5 \times Q_z$	AREA B $1.85 \times Q_z$	AREA C $2.2 \times Q_z$	WIND SPEED m/hr
1	30'0"	55	82	101	120	146
	15'0"	48	72	89	106	137
2	30'0"	46	69	85	102	134
	15'0"	40	60	74	88	125
3	30'0"	33	50	62	73	114
	15'0"	29	43	53	63	106
4	30'0"	23	34	42	50	94
	15'0"	20	29	36	43	87
			STRUCTURAL LOAD	CLADDING LOADS*		

ROOF LOADS - DOMINANT OPENING IN WINDWARD WALL

* Local pressure factors must not be used in the determination of the total forces on a structure or a surface such as a wall or roof.

TABLE B6 - WIND LOADS

DESIGN LOADS - ZONE B - PITCH <20°

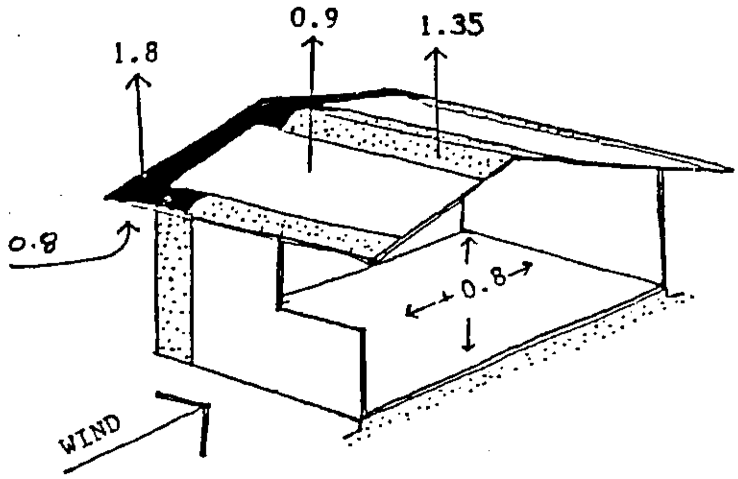


DIAGRAM OF PRESSURE COEFFICIENTS
(to be multiplied by Q_z)

K = CLADDING COEFFICIENT

- AREA A - $P_S + P_I$
- AREA B - $1.5P_S + P_I$
- AREA C - $2.0P_S + P_I$

Q_z = STATIC WIND PRESSURE
P_z = DESIGN PRESSURE
P_I = INTERNAL PRESSURE
P_S = EXTERNAL SUCTION

STRUCTURAL LOAD $P_z = Q_z (P_I + P_S)$

CLADDING LOADS $P_z = Q_z (K \times P_S + P_I)$

			DESIGN LOADS - lbf/ft²			
TERRAIN CATEGORY	HEIGHT	PRESSURE Q_z	AREA A $1.7 \times Q_z$	AREA B $2.15 \times Q_z$	AREA C $2.6 \times Q_z$	WIND SPEED
1	30'0"	38	65	82	99	122
	15'0"	33	56	71	86	114
2	30'0"	32	54	69	83	112
	15'0"	28	47	60	72	104
3	30'0"	23	39	50	60	95
	15'0"	20	34	43	52	88
4	30'0"	16	27	34	41	78
	15'0"	14	23	29	35	73
			STRUCTURAL LOAD	CLADDING LOADS*		

ROOF LOADS - DOMINANT OPENING IN WINDWARD WALL

* Local pressure factors must not be used in the determination of the total forces on a structure or a surface such as a wall or roof.

TABLE B7 - WIND LOADS

DESIGN LOADS - ZONE B - PITCH $> 20°$

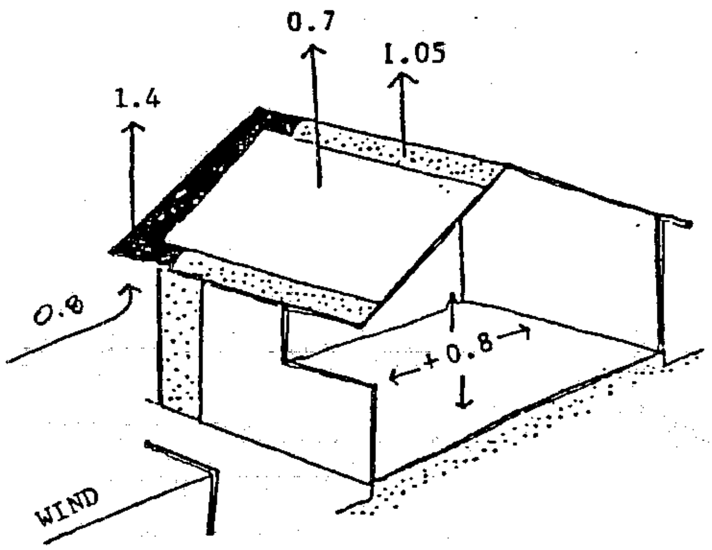


DIAGRAM OF PRESSURE COEFFICIENTS
(to be multiplied by Q_z)

K = CLADDING COEFFICIENT

AREA A - $P_s + P_I$

AREA B - $1.5P_s + P_I$

AREA C - $2.0P_s + P_I$

Q_z = STATIC WIND PRESSURE

P_z = DESIGN PRESSURE

P_I = INTERNAL PRESSURE

P_s = EXTERNAL SUCTION

STRUCTURAL LOAD $P_z = Q_z (P_I + P_s)$

CLADDING LOADS $P_z = Q_z (K \times P_s + P_I)$

			DESIGN LOADS - lbf/ft^2			
TERRAIN CATEGORY	HEIGHT	PRESSURE Q_z	AREA A $1.5 \times Q_z$	AREA B $1.85 \times Q_z$	AREA C $2.2 \times Q_z$	WIND SPEED
1	30'0"	38	57	71	84	122
	15'0"	33	50	62	73	114
2	30'0"	32	48	59	70	112
	15'0"	28	42	51	61	104
3	30'0"	23	35	43	51	95
	15'0"	20	30	37	44	88
4	30'0"	16	23	29	34	78
	15'0"	14	20	25	30	73
			STRUCTURAL LOAD	CLADDING LOADS*		

ROOF LOADS - DOMINANT OPENING IN WINDWARD WALL

* Local pressure factors must not be used in the determination of the total forces on a structure or a surface such as a wall or roof.