GEODOMISI Ltd

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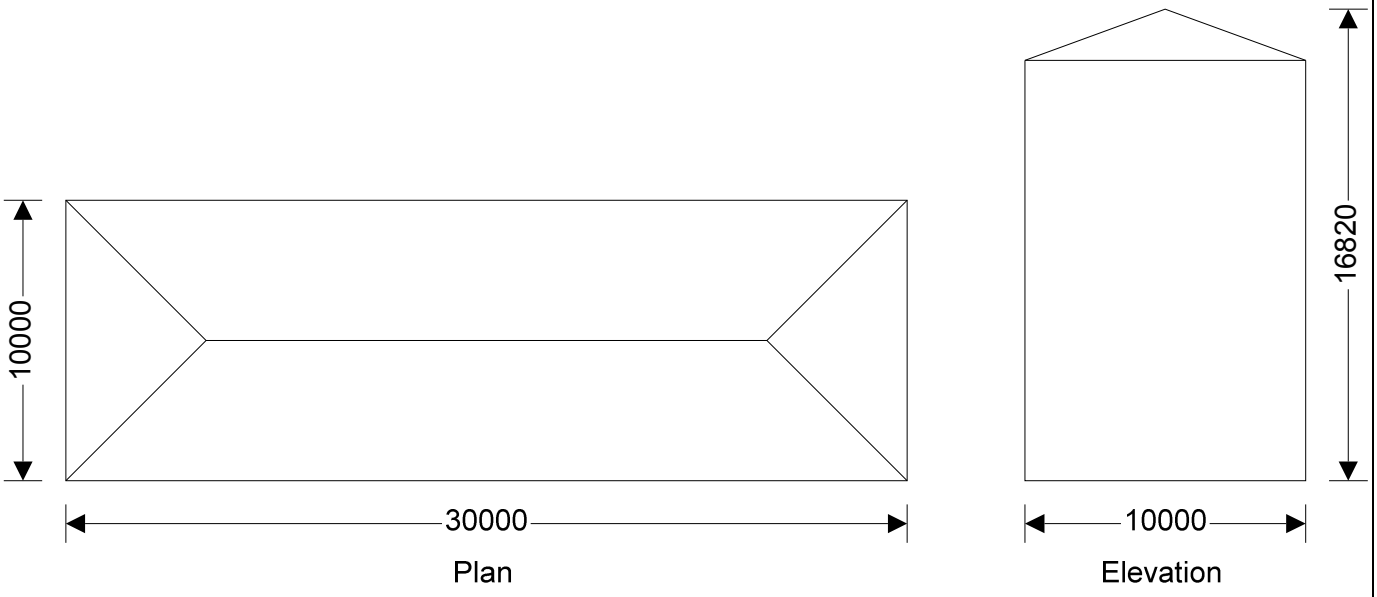
Project: **Wind Loading Analysis & Design for a Hipped Roof example According to EN1991-1-4 with NA=CEN.**				Job Ref. www.geodomisi.com	
Section: Civil & Geotechnical EngineeringCalculations for				Sheet no./rev. 1	
Calc.Made by Dr. C. Sachpazis	Date 08/04/2016	Chk'd by	Date	App'd by	Date

WIND LOADING (EN1991-1-4)



Building data

Type of roof;	Hipped
Length of building;	L = **30000** mm
Width of building;	W = **10000** mm
Height to eaves;	H = **15000** mm
Pitch of main slope;	α_0 = **20.0** deg
Pitch of gable slope;	α_{90} = **20.0** deg
Total height;	h = **16820** mm

Basic values

Fundamental basic wind velocity;	$v_{b,0}$ = **24.2** m/s
Season factor;	c_{season} = **1.00**
Direction factor;	c_{dir} = **1.00**
Shape parameter K;	K = **0.2**
Exponent n;	n = **0.5**
Probability factor;	$c_{prob} = [(1 - K \times \ln(-\ln(1-p)))/(1 - K \times \ln(-\ln(0.98)))]^n$ = **1.00**
Basic wind velocity (Exp. 4.1);	$v_b = c_{dir} \times c_{season} \times v_{b,0} \times c_{prob}$ = **24.2** m/s
Reference mean velocity pressure;	$q_b = 0.5 \times \rho \times v_b^2$ = **0.365** kN/m^2

Orography

Orography factor not significant;	c_o = 1.0
Terrain category;	0

Displacement height (sheltering effect excluded); h_{dis} = 0mm

The velocity pressure for the windward face of the building with a 0 degree wind is to be considered as 1 part as the height h is less than b (cl.7.2.2)

The velocity pressure for the windward face of the building with a 90 degree wind is to be considered as 2 parts as the height h is greater than b but less than 2b (cl.7.2.2)

Peak velocity pressure - windward wall - Wind 0 deg

Reference height (at which q is sought); z = **15000**mm

Displacement height (sheltering effects excluded); h_{dis} = **0** mm

Roughness length (Table 4.1); z_0 = **3** mm

Roughness length (Category II); $z_{0,II}$ = **50** mm

Minimum height (Table 4.1); z_{min} = **1000** mm

Maximum height; z_{max} = **200000** mm

Terrain factor; $k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.16**

Roughness factor; $c_r = k_r \times \ln((z - h_{dis}) / z_0)$ = **1.33**

Mean wind; $v_m = c_r \times c_o \times v_b$ = **32.1** m/s

Turbulence factor; k_I = **1.0**

Turbulence intensity; $I_v = k_I / (c_o \times \ln((z - h_{dis}) / z_0))$ = **0.117**

Peak velocity pressure; $q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.18** kN/m^2

Structural factor

Building type; Steel

Structural factor (Annex D); c_{sCd} = **0.893**

Peak velocity pressure - windward wall (lower part) - Wind 90 deg

Reference height (at which q is sought); z = **10000**mm

Displacement height (sheltering effects excluded); h_{dis} = **0** mm

Terrain factor; $k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.16**

Roughness factor; $c_r = k_r \times \ln((z - h_{dis}) / z_0)$ = **1.27**

Mean wind; $v_m = c_r \times c_o \times v_b$ = **30.6** m/s

Turbulence factor; k_I = **1.0**

Turbulence intensity; $I_v = k_I / (c_o \times \ln((z - h_{dis}) / z_0))$ = **0.123**

Peak velocity pressure; $q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.09** kN/m^2

Peak velocity pressure - windward wall (upper part) - Wind 90 deg

Reference height (at which q is sought); z = **15000**mm

Displacement height (sheltering effects excluded); h_{dis} = **0** mm

Terrain factor; $k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.16**

Roughness factor; $c_r = k_r \times \ln((z - h_{dis}) / z_0)$ = **1.33**

Mean wind; $v_m = c_r \times c_o \times v_b$ = **32.1** m/s

Turbulence factor; k_I = **1.0**

Turbulence intensity; $I_v = k_I / (c_o \times \ln((z - h_{dis}) / z_0))$ = **0.117**

Peak velocity pressure; $q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.18** kN/m^2

Peak velocity pressure - roof

Reference height (at which q is sought); z = **16820**mm

Displacement height (sheltering effects excluded); h_{dis} = **0** mm

Terrain factor; $k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.16**

Roughness factor; $c_r = k_r \times \ln((z - h_{dis}) / z_0)$ = **1.35**

Mean wind; $v_m = c_r \times c_o \times v_b$ = **32.6** m/s

Turbulence factor; k_I = **1.0**

Turbulence intensity; $I_v = k_I / (c_o \times \ln((z - h_{dis}) / z_0))$ = **0.116**

Peak velocity pressure; $q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.20** kN/m^2

Peak velocity pressure for internal pressure

Peak velocity pressure – internal (as roof press.); $q_{p,i}$ = **1.20** kN/m^2

Pressures and forces

Net pressure; $p = c_{sCd} \times q_p \times c_{pe} - q_{p,i} \times c_{pi}$;

Net force; $F_w = p_w \times A_{ref}$;

Roof load case 1 - Wind 0, c_{pi} -0.30, - c_{pe}

Zone	Ext pressure coeff c_{pe}	Peak velocity pressure q_p (kN/m^2)	Net pressure element, p_e (kN/m^2)	Net pressure structure p_s (kN/m^2)	Area A_{ref} (m^2)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
F (-ve)	-0.77	1.20	-0.56	-0.37	38.31	-21.47	-14.22
G (-ve)	-0.70	1.20	-0.48	-0.31	47.89	-23.00	-14.73
H (-ve)	-0.27	1.20	0.04	0.11	46.82	1.87	4.96
I (-ve)	-0.47	1.20	-0.20	-0.08	76.35	-15.28	-6.49
J (-ve)	-0.90	1.20	-0.72	-0.50	22.35	-16.10	-11.14
K (-ve)	-0.97	1.20	-0.80	-0.56	34.32	-27.47	-19.28
L (-ve)	-1.40	1.20	-1.32	-0.98	27.14	-35.84	-26.46
M (-ve)	-0.67	1.20	-0.44	-0.28	26.07	-11.48	-7.19

Total vertical net force; $F_{w,v}$ = **-88.85** kN

Total horizontal net force; $F_{w,h}$ = **4.42** kN

Walls load case 1 - Wind 0, c_{pi} -0.30, - c_{pe}

Zone	Ext pressure coeff c_{pe}	Peak velocity pressure q_p (kN/m^2)	Net pressure element, p_e (kN/m^2)	Net pressure structure p_s (kN/m^2)	Area A_{ref} (m^2)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
A	-1.20	1.18	-1.05	-0.76	90.00	-94.59	-68.26
B	-0.80	1.18	-0.58	-0.39	60.00	-34.84	-23.13
D	0.80	1.18	1.30	1.11	450.00	585.46	497.66
E	-0.53	1.18	-0.27	-0.14	450.00	-120.57	-61.95

Overall loading

Equiv leeward net force for overall section; $F_l = F_{w,wEs}$ = **-62.0** kN

Net windward force for overall section; $F_w = F_{w,wDs}$ = **497.7** kN

Lack of correlation (cl.7.2.2(3) – Note); f_{corr} = **0.88**; as h/W is 1.682

Overall loading overall section; $F_{w,D} = f_{corr} \times (F_w - F_l) + F_{w,h}$ = **494.4** kN

Roof load case 2 - Wind 90, c_{pi} -0.30, - c_{pe}

Zone	Ext pressure coeff c_{pe}	Peak velocity pressure q_p (kN/m^2)	Net pressure element, p_e (kN/m^2)	Net pressure structure p_s (kN/m^2)	Area A_{ref} (m^2)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
F (-ve)	-0.77	1.20	-0.56	-0.43	4.26	-2.39	-1.82
G (-ve)	-0.70	1.20	-0.48	-0.36	5.32	-2.56	-1.91
H (-ve)	-0.27	1.20	0.04	0.09	17.03	0.68	1.47
I (-ve)	-0.47	1.20	-0.20	-0.12	17.03	-3.41	-2.03
J (-ve)	-0.90	1.20	-0.72	-0.56	9.58	-6.90	-5.41
L (-ve)	-1.40	1.20	-1.32	-1.08	10.64	-14.05	-11.48
M (-ve)	-0.67	1.20	-0.44	-0.32	17.03	-7.50	-5.53
N (-ve)	-0.27	1.20	0.04	0.09	238.38	9.54	20.55

Total vertical net force; $F_{w,v}$ = **-5.79** kN

Total horizontal net force; $F_{w,h}$ = **1.77** kN

Walls load case 2 - Wind 90, c_{pi} -0.30, - c_{pe}

Zone	Ext pressure coeff c_{pe}	Peak velocity pressure q_p (kN/m^2)	Net pressure element, p_e (kN/m^2)	Net pressure structure p_s (kN/m^2)	Area A_{ref} (m^2)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
A	-1.20	1.18	-1.05	-0.90	30.00	-31.53	-26.96
B	-0.80	1.18	-0.58	-0.48	120.00	-69.68	-57.49
C	-0.50	1.18	-0.23	-0.16	300.00	-68.35	-49.31
D_b	0.74	1.09	1.17	1.06	100.00	116.89	106.49
D_u	0.74	1.18	1.23	1.14	50.00	61.61	56.90
E	-0.38	1.18	-0.09	-0.04	150.00	-13.51	-6.22

Overall loading

Equiv leeward net force for upper section; $F_l = F_{w,wEs} / A_{ref,wE} \times A_{ref,wu}$ = **-2.1** kN

Net windward force for upper section; $F_w = F_{w,wus}$ = **56.9** kN

Lack of correlation (cl.7.2.2(3) – Note); f_{corr} = **0.85**; as h/L is 0.561

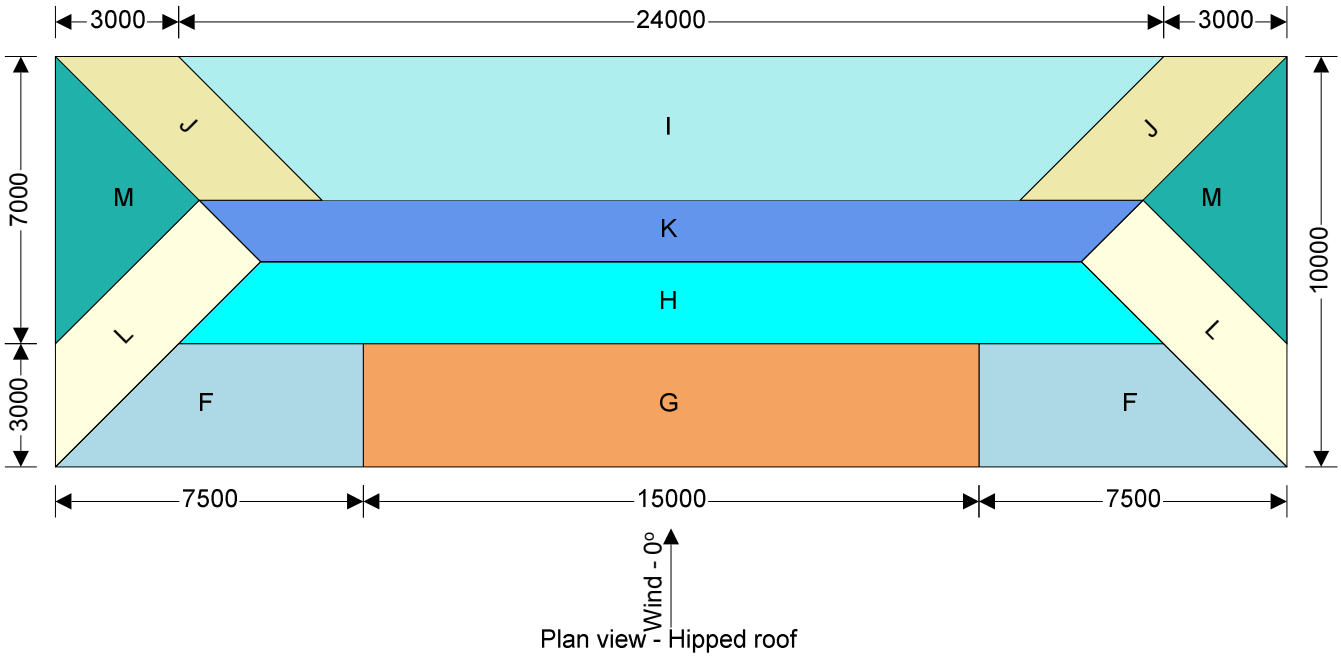
Overall loading upper section; $F_{w,u} = f_{corr} \times (F_w - F_l) + F_{w,h}$ = **51.9** kN

Equiv leeward net force for bottom section; $F_l = F_{w,wEs} / A_{ref,wE} \times A_{ref,wb}$ = **-4.1** kN

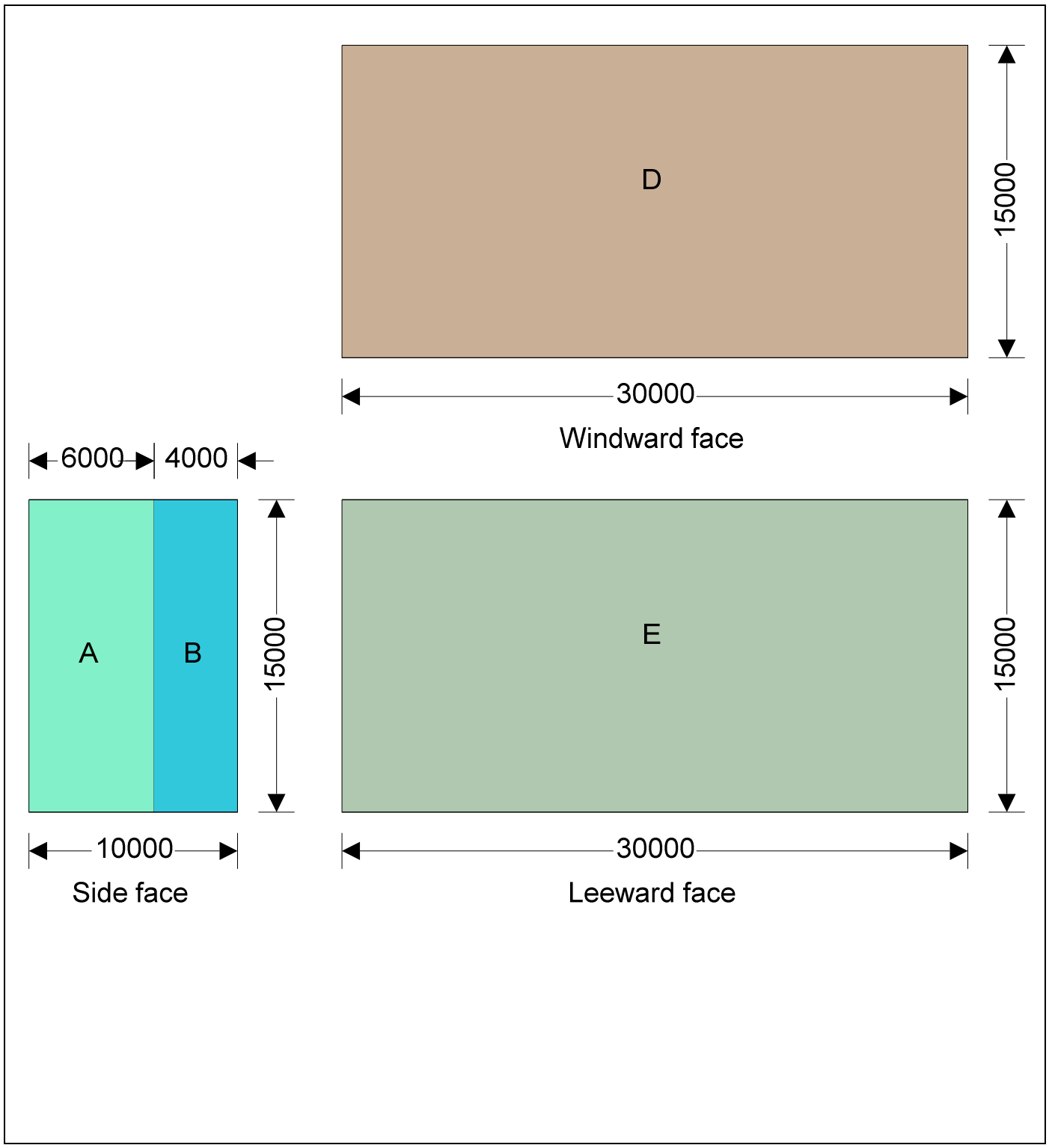
Net windward force for bottom section; $F_w = F_{w,wbs}$ = **106.5** kN

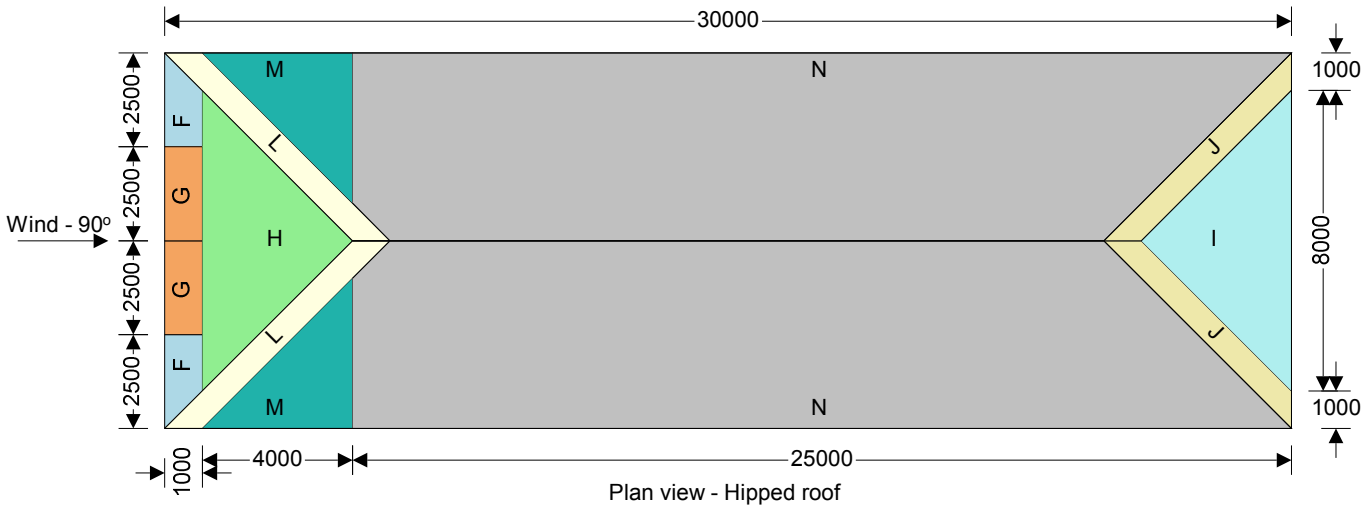
Lack of correlation (cl.7.2.2(3) – Note); f_{corr} = **0.85**; as h/L is 0.561

Overall loading bottom section; $F_{w,b} = f_{corr} \times (F_w - F_l)$ = **94.0** kN

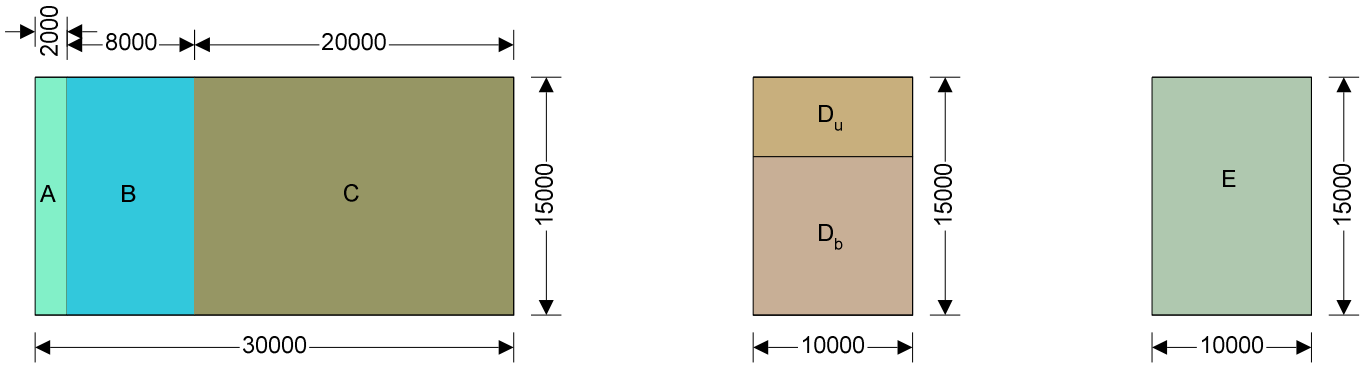


Plan view - Hipped roof


D
15000
30000
Windward face
6000
4000
A
B
15000
10000
Side face
E
15000
30000
Leeward face



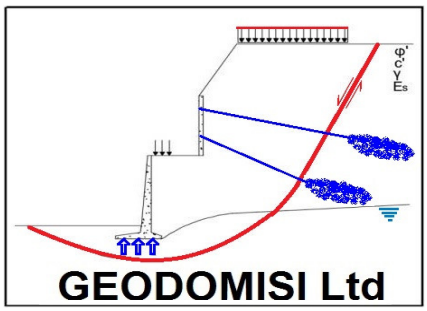
Plan view - Hipped roof



Side face

Windward face

Leeward face



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