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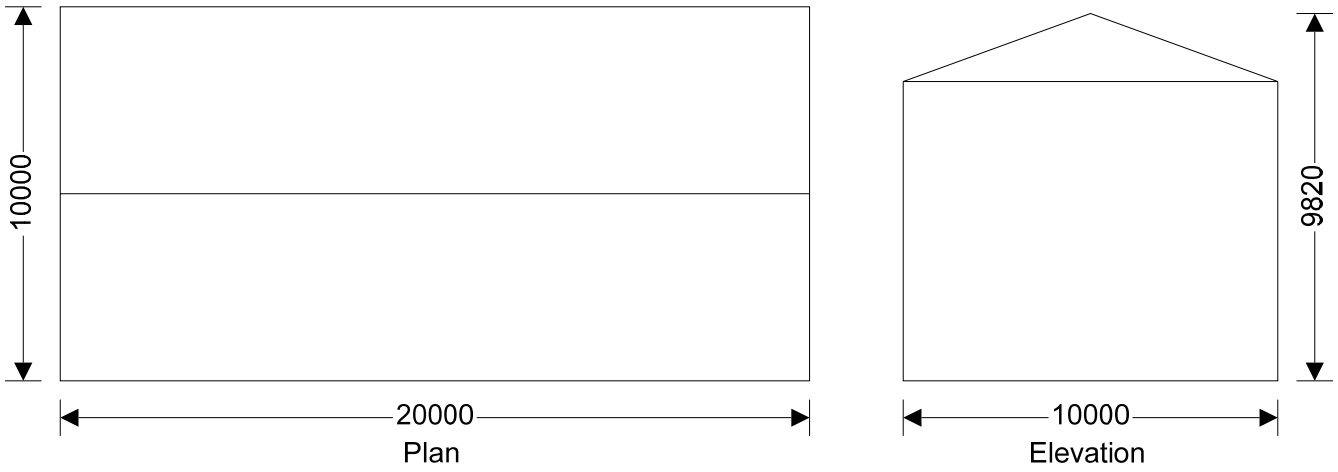
Project: **Architecture & Structures. Wind Loading Analysis & Design for a Duopitch roof example According to EN1991-1-4 with NA=CEN.**				Job Ref. www.geodomisi.com info@geodomisi.com	
Section: Civil & Geotechnical Engineering				Sheet no./rev. 1	
Calc. Dr. C. Sachpazis	Date 07/04/2017	Chk'd by	Date **Error! No**	App'd by	Date

WIND LOADING FOR A DUOPITCH ROOF

In accordance with EN1991-1-4 with NA=CEN and the recommended values.



Building data

Type of roof	Duopitch
Length of building	L = **20000** mm
Width of building	W = **10000** mm
Height to eaves	H = **8000** mm
Pitch of roof	α_0 = **20.0** deg
Total height	h = **9820** mm

Basic values

Fundamental basic wind velocity	$v_{b,0}$ = **25.8** 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)	$v_b = c_{dir} \times c_{season} \times v_{b,0} \times c_{prob}$ = **25.8** m/s
Reference mean velocity pressure	$q_b = 0.5 \times \rho \times v_b^2$ = **0.415** kN/m^2

Orography

Type of feature	Hills and ridges
Actual length of upwind slope in wind direction	L_u = **50000** mm
Actual length downwind slope in wind direction	L_d = **50000** mm
Effective height of feature	Z = **20000** mm
Upwind slope in upwind direction	$\varphi = Z / L_u$ = **0.40**
Effective length of upwind slope (Table A.2)	$L_e = Z / 0.3$ = **66667** mm
Horiz distance of the site from the top of the crest	x = **-5000** mm
Terrain category	II
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 1 part as the height h is less than b (cl.7.2.2)

Peak velocity pressure - windward wall - Wind 0 deg and roof

Reference height (at which q is sought)	z = **8000**mm
Displacement height (sheltering effects excluded)	h_{dis} = **0** mm
Orographic location factor (Figure A.3)	s = **0.63**
Orography factor	$c_o = 1 + 0.6 \times s$ = **1.38**
Roughness length (Table 4.1)	z_0 = **50** mm
Roughness length (Category II)	$z_{0,II}$ = **50** mm
Minimum height (Table 4.1)	z_{min} = **2000** mm
Maximum height	z_{max} = **200000** mm

Terrain factor	$k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.19**
Roughness factor	$c_r = k_r \times \ln(z / z_0)$ = **0.96**
Mean wind	$v_m = c_r \times c_o \times v_b$ = **34.2** m/s
Turbulence factor	k_I = **1.0**
Turbulence intensity	$I_v = k_I / (c_o \times \ln(z / z_0))$ = **0.143**
Peak velocity pressure	$q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.46** kN/m^2

Structural factor

Concrete

Structural factor (Annex D)	c_{sCd} = **0.890**

Peak velocity pressure - windward wall - Wind 90 deg and roof

Reference height (at which q is sought)	z = **9820**mm
Displacement height (sheltering effects excluded)	h_{dis} = **0** mm
Orographic location factor (Figure A.3)	s = **0.60**
Orography factor	$c_o = 1 + 0.6 \times s$ = **1.36**
Terrain factor	$k_r = 0.19 \times (z_0 / z_{0,II})^{0.07}$ = **0.19**
Roughness factor	$c_r = k_r \times \ln(z / z_0)$ = **1.00**
Mean wind	$v_m = c_r \times c_o \times v_b$ = **35.1** m/s
Turbulence factor	k_I = **1.0**
Turbulence intensity	$I_v = k_I / (c_o \times \ln(z / z_0))$ = **0.139**
Peak velocity pressure	$q_p = (1 + 7 \times I_v) \times 0.5 \times \rho \times v_m^2$ = **1.52** kN/m^2

Peak velocity pressure for internal pressure

Peak velocity pressure – internal (as roof press.)	$q_{p,i}$ = **1.52** 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 pressu coeff c_{pe}	Peak veloc pressure q_p (kN/m²)	Net pressu element, p_e (kN/m²)	Net pressu structure p_s (kN/m²)	Area A_{ref} (m²)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
F (-ve)	-0.77	1.52	-0.71	-0.54	20.52	-14.58	-11.02
G (-ve)	-0.70	1.52	-0.61	-0.45	21.28	-12.96	-9.59
H (-ve)	-0.27	1.52	0.05	0.11	64.62	3.28	7.18
I (-ve)	-0.40	1.52	-0.15	-0.06	64.62	-9.84	-3.99
J (-ve)	-0.83	1.52	-0.81	-0.62	41.80	-33.94	-26.06

$F_{w,v}$ = **-40.86** kN

rce $F_{w,h}$ = **5.68** kN

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

Zone	Ext pressu coeff c_{pe}	Peak veloc pressure q_p (kN/m²)	Net pressu element, p_e (kN/m²)	Net pressu structure p_s (kN/m²)	Area A_{ref} (m²)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
A	-1.20	1.52	-1.37	-1.08	34.23	-46.91	-37.09
B	-0.80	1.52	-0.76	-0.57	54.87	-41.77	-31.28
D	0.80	1.46	1.62	1.44	160.00	259.77	230.47
E	-0.50	1.46	-0.27	-0.15	160.00	-42.82	-24.64

Overall loading

Equiv leeward net force for overall section $F_l = F_{w,wEs}$ = **-24.6** kN

Net windward force for overall section $F_w = F_{w,wDs}$ = **230.5** kN

Lack of correlation (cl.7.2.2(3) – Note) f_{corr} = **0.85** as h/W is 0.982

Overall loading overall section $F_{w,D} = f_{corr} \times (F_w - F_l) + F_{w,h}$ = **222.5** kN

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

Zone	Ext pressu coeff c_{pe}	Peak veloc pressure q_p (kN/m²)	Net pressu element, p_e (kN/m²)	Net pressu structure p_s (kN/m²)	Area A_{ref} (m²)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
F (-ve)	-1.23	1.52	-1.42	-1.23	5.32	-7.56	-6.55
G (-ve)	-1.33	1.52	-1.57	-1.37	5.32	-8.37	-7.28
H (-ve)	-0.67	1.52	-0.56	-0.46	42.57	-23.76	-19.40
I (-ve)	-0.50	1.52	-0.30	-0.23	159.63	-48.61	-36.33

$F_{w,v}$ = **-65.37** kN

$F_{w,h}$ = **0.00** kN

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

Zone	Ext pressu coeff c_{pe}	Peak veloc pressure q_p (kN/m²)	Net pressu element, p_e (kN/m²)	Net pressu structure p_s (kN/m²)	Area A_{ref} (m²)	Net force element $F_{w,e}$ (kN)	Net force structure $F_{w,s}$ (kN)
A	-1.20	1.46	-1.30	-1.12	16.00	-20.78	-17.94
B	-0.80	1.46	-0.71	-0.60	64.00	-45.67	-38.10
C	-0.50	1.46	-0.27	-0.20	80.00	-21.97	-16.06
D	0.73	1.52	1.57	1.46	89.10	140.01	129.98
E	-0.36	1.52	-0.10	-0.04	89.10	-8.72	-3.73

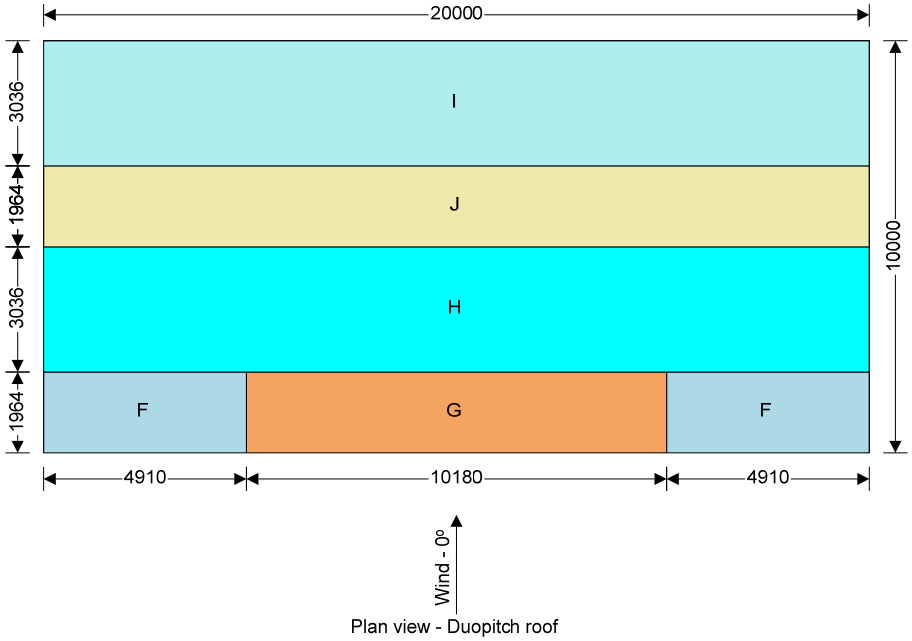
Overall loading

Equiv leeward net force for overall section $F_l = F_{w,wEs}$ = **-3.7** kN

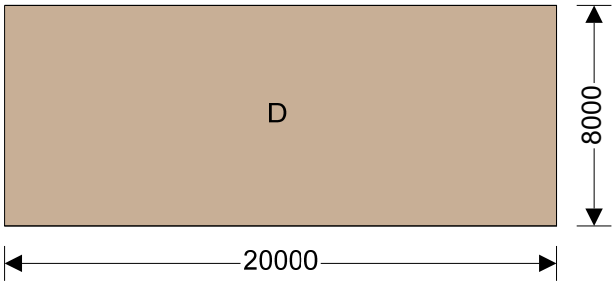
Net windward force for overall section $F_w = F_{w,wDs}$ = **130.0** kN

Lack of correlation (cl.7.2.2(3) – Note) f_{corr} = **0.85** as h/L is 0.491

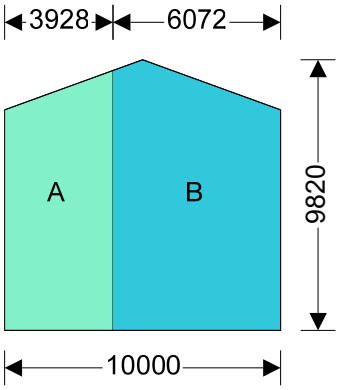
Overall loading overall section $F_{w,D} = f_{corr} \times (F_w - F_l) + F_{w,h}$ = **113.7** kN



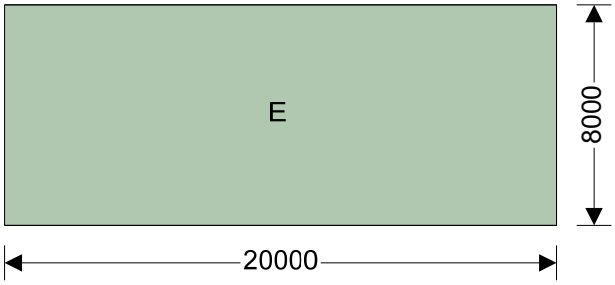
Plan view - Duopitch roof



Windward face



Side face



Leeward face

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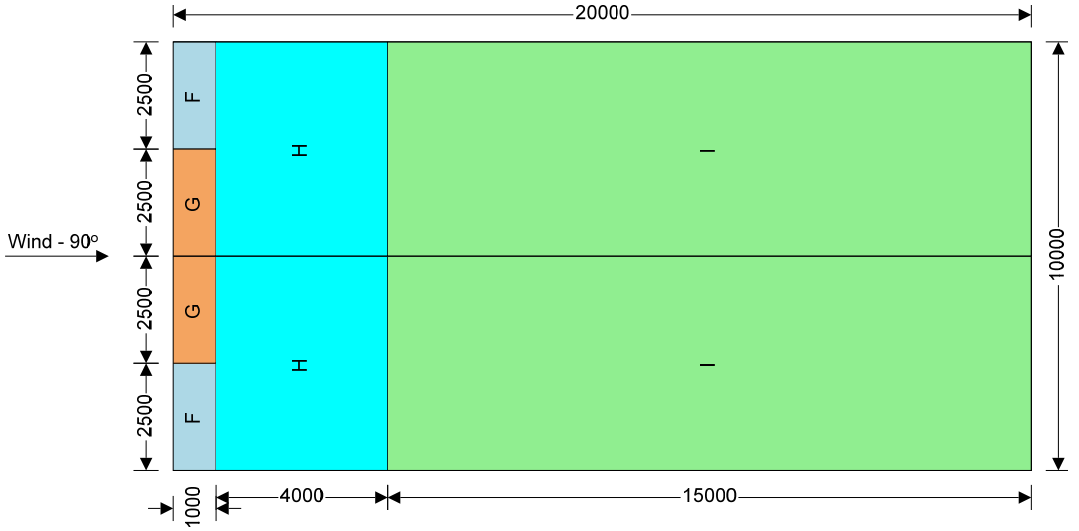
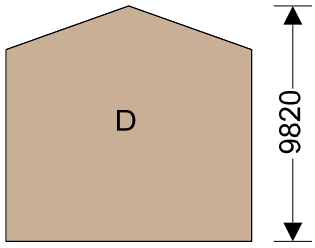
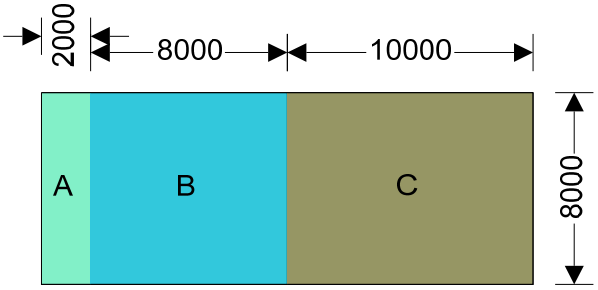


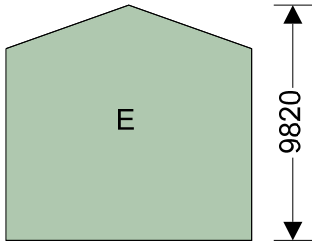
Plan view - Duopitch roof



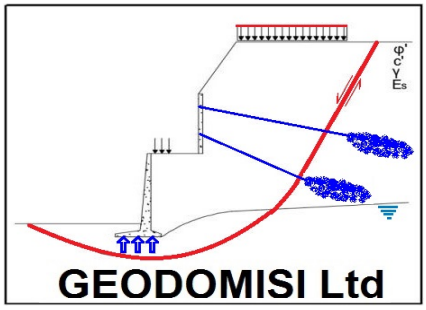
Windward face



Side face



Leeward face



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