LARO EXPERTS
Ingénieur en Bâtiment/Structure
Conseillers en Construction
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Ingénieur Civil, MBA

INFLATABLE TENTS – CUBE 9X9

CALCULATIONS OF SUPPORTING ANCHORS

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INFORMATION ON THE CONTRACT

PROJECT

Determinations of the number of anchors and their required strengths in order to support wind forces. Self-supporting inflatable tents with rectangular base of 9m x 9m.

20-12-2018

Revision : 2

CLIENT

Party Rental Depot – Att. Todd Shields

SUMMARY

The mandate given to LARO EXPERTS-CONSEIL aims to establish the number of anchors required to withstand wind and snow loads. The tent will be installed in various public places in Canada. To achieve this goal, the inflatable structure was modeled with several simplifications and was evaluated under wind and snow loads. The mandate is thus to ascertain the number of anchors required to withstand wind forces, in addition to the resistance necessary to avoid their pullout.

This document is written based on the technical data provided by INFLATABLE TENT INC- M2B INFLATABLE.

The tent discussed in this report is a self-supporting inflatable structure. Its base is square shaped, and the roof is pyramid-like. Its approximate dimensions are 9x9 meters at its base and 4.5 meters in height.

Based on the data received, our analysis was constructed with wind and snow constraints.

DESCRIPTION OF THE STRUCTURE

INFLATABLE TENT INC- M2B INFLATABLE provided all technical data.

The tent discussed here has a rectangular base whose dimensions are 9x9 meters and its roof forms a pyramid with a square base, bringing the structure to its highest level, 4.47 meters. The structure is a self-supporting inflatable type, and its walls are composed of pressurized air between two flexible membranes.

The wind loads considered in this report are established at gusts of 50 km/h, 70 km/h and 90 km/h.

With an internal pressure of 0.48kPa, the inflatable structure will resist to a 150 mm height of snow load without any important or unsafe deflexion.

As the tent is a temporary installation, the idea here is not to comply with the National Building Code of Canada (NBC) but to determine if the installation can be used while ensuring the safety of users.

WIND LOADS

In this structural analysis, we modeled one case. The wind load was simulated on the X + (Figure 1). We didn't model the case in the Y+ direction because the structure is symmetric.

As an example, this is a wind load of 90 km/h is here modeled by the wind tunnel simulation. The same process was done with 50 km/h and 70 km/h gusts.

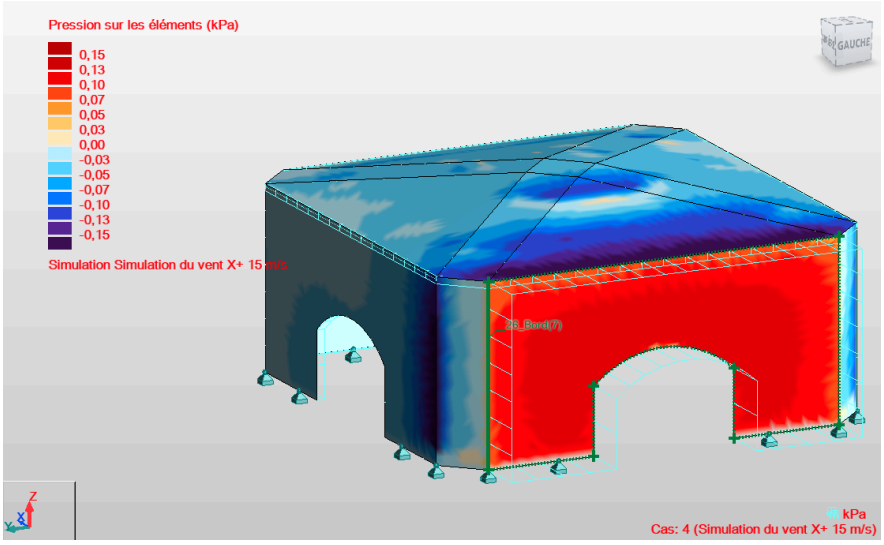


FIGURE 1 : DISTRIBUTION OF THE WIND LOAD ON THE X+ AXIS. AT 50 KM/H WIND GUST

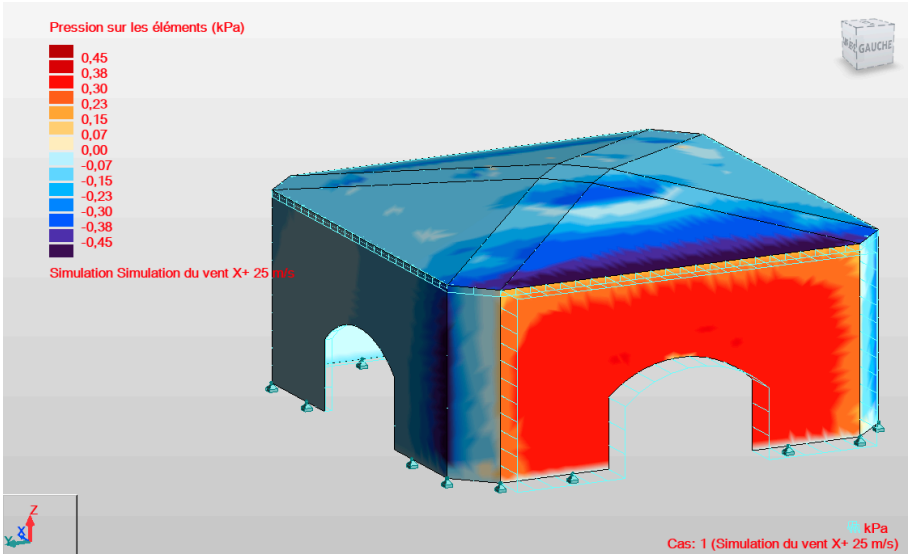


FIGURE 2 : DISTRIBUTION OF THE WIND LOAD ON THE X+ AXIS AT 90KM/H WIND GUST

STANDARD AND SAFETY FACTOR

Since only the wind load is measured in this analysis, a weighting factor of 1.4 is applied for the risk coefficient, taken from 2015 NBC's combined load equations.

MODELIZATION- SIMPLIFIED MODEL

In order to simplify the analysis, only a simplification of the tent reproducing the physical characteristics was used for the modeling. This simplification has a weakening impact on the structure as the weight of the structure itself opposes the critical wind load. By doing so, the reaction values at the supports of the structure are slightly higher than the actual values. This means that the wind resistance is ensured by using ground anchoring and bracing, and not only with the weight of the structure itself.

ANALYSIS

In this analysis, 3 different wind gust speed was evaluated. These speeds affect the number of anchors and/or the pullout resistance required by each anchor as shown in *Table 1 – wind velocity and anchors required.*

There is no maximum number of anchors to stabilize the structure as long as the minimum total pullout resistance is respected. Due to its shape, the vertical reactions are very high at the corners. The shape of this structure struggles to distribute the load to other anchors and the majority of the wind forces are taken by the corners.

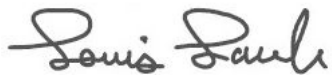
Wind speed (km/h)	Minimum pullout resistance at each corner (4) (lbs)	Minimum total pullout resistance (lbs)	Minimum number of anchors
50	350 (each)	5100	12
70	600 (each)	9300	12
90	900 (each)	15 000	12

TABLE 1 – WIND VELOCITY AND ANCHORS REQUIRED.

CONCLUSION

The results obtained from the analysis of the simplified model of the structure, using the measurements provided by INFLATABLE TENT INC- M2B INFLATABLE, allow a conclusion stating that each anchorage must comply with *Table 1 – wind velocity and anchors required.* Also installations comply with CAN/ULC S109 - NFPA 701 Fire resistance regulations

Louis Larouche, ing.



NOTES OF CALCULATIONS

Project: Inflatables tents - CUBE 9X9m

Prepared by: Alexandre Létourneau
Verified by : Louis Larouche ing.

Réactions:1 Repère global - Cas: 1 3A6 8 9
Valeurs
1

Repère global - Cas: 1 3A6 8 9

Filtre	Noeud	Cas
Liste complète	1A314 316 317	1A9
Sélection	7 11 46 50 164 1	1 3A6 8 9
Nombre total	1405	9
Nombre sélection	16	7

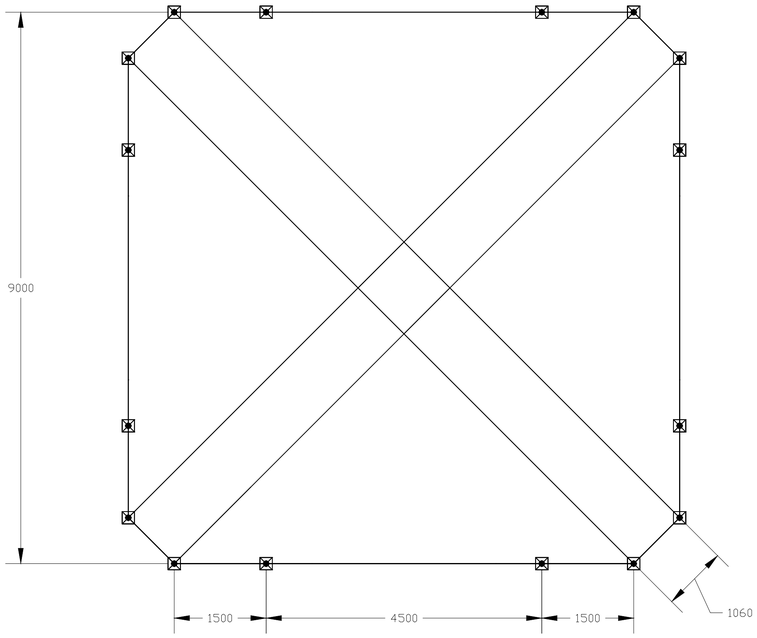
Repère global - Cas: 1 3A6 8 9

Cas/Noeud	FZ [kN]	Nom du cas	Nature
Nom du cas	Simulation du vent X+ 25 m/s		
1/ 7	-1,00	Simulation du vent X+ 25 m/s	vent
1/ 11	0,28	Simulation du vent X+ 25 m/s	vent
1/ 46	0,13	Simulation du vent X+ 25 m/s	vent
1/ 50	-1,71	Simulation du vent X+ 25 m/s	vent
1/ 164	-0,46	Simulation du vent X+ 25 m/s	vent
1/ 168	0,21	Simulation du vent X+ 25 m/s	vent
1/ 203	0,22	Simulation du vent X+ 25 m/s	vent
1/ 207	-0,48	Simulation du vent X+ 25 m/s	vent
1/ 359	-0,99	Simulation du vent X+ 25 m/s	vent
1/ 363	0,28	Simulation du vent X+ 25 m/s	vent
1/ 398	0,14	Simulation du vent X+ 25 m/s	vent
1/ 402	-1,72	Simulation du vent X+ 25 m/s	vent
1/ 548	-2,87	Simulation du vent X+ 25 m/s	vent
1/ 620	0,44	Simulation du vent X+ 25 m/s	vent
1/ 659	-2,87	Simulation du vent X+ 25 m/s	vent
1/ 663	0,46	Simulation du vent X+ 25 m/s	vent
Cas 1	Simulation du vent X+ 25 m/s		
Somme totale	-9,95		
Somme réactions	-9,95		
Somme efforts	9,95		
Vérification	-0,00		
Nom du cas	ELU+		
ELU+/7	-0,44	ELU+	
ELU+/11	0,39	ELU+	
ELU+/46	0,18	ELU+	
ELU+/50	-0,82	ELU+	
ELU+/164	-0,12	ELU+	
ELU+/168	0,30	ELU+	
ELU+/203	0,31	ELU+	
ELU+/207	-0,13	ELU+	
ELU+/359	-0,45	ELU+	
ELU+/363	0,39	ELU+	
ELU+/398	0,20	ELU+	
ELU+/402	-0,82	ELU+	
ELU+/548	-1,40	ELU+	
ELU+/620	0,62	ELU+	

Cas/Noeud	FZ [kN]	Nom du cas	
ELU+/659	-1,41	ELU+	
ELU+/663	0,64	ELU+	
Cas ELU+	**ELU+**		
Somme totale	-2,55		
Somme réactions	-8,96		
Somme efforts	8,96		
Vérification	-0,00		
Nom du cas	**Simulation du vent X+ 15 m/s**		
4/ 7	-0,32	Simulation du vent X+ 15 m/s	vent
4/ 11	0,20	Simulation du vent X+ 15 m/s	vent
4/ 46	0,11	Simulation du vent X+ 15 m/s	vent
4/ 50	-0,58	Simulation du vent X+ 15 m/s	vent
4/ 164	-0,08	Simulation du vent X+ 15 m/s	vent
4/ 168	0,02	Simulation du vent X+ 15 m/s	vent
4/ 203	0,03	Simulation du vent X+ 15 m/s	vent
4/ 207	-0,09	Simulation du vent X+ 15 m/s	vent
4/ 359	-0,32	Simulation du vent X+ 15 m/s	vent
4/ 363	0,22	Simulation du vent X+ 15 m/s	vent
4/ 398	0,13	Simulation du vent X+ 15 m/s	vent
4/ 402	-0,59	Simulation du vent X+ 15 m/s	vent
4/ 548	-1,00	Simulation du vent X+ 15 m/s	vent
4/ 620	0,23	Simulation du vent X+ 15 m/s	vent
4/ 659	-1,00	Simulation du vent X+ 15 m/s	vent
4/ 663	0,23	Simulation du vent X+ 15 m/s	vent
Cas 4	**Simulation du vent X+ 15 m/s**		
Somme totale	-2,82		
Somme réactions	-2,82		
Somme efforts	2,82		
Vérification	-0,00		
Nom du cas	**Simulation du vent X+ 20 m/s**		
5/ 7	-0,64	Simulation du vent X+ 20 m/s	vent
5/ 11	0,17	Simulation du vent X+ 20 m/s	vent
5/ 46	0,08	Simulation du vent X+ 20 m/s	vent
5/ 50	-1,10	Simulation du vent X+ 20 m/s	vent
5/ 164	-0,30	Simulation du vent X+ 20 m/s	vent
5/ 168	0,14	Simulation du vent X+ 20 m/s	vent
5/ 203	0,15	Simulation du vent X+ 20 m/s	vent
5/ 207	-0,31	Simulation du vent X+ 20 m/s	vent
5/ 359	-0,64	Simulation du vent X+ 20 m/s	vent
5/ 363	0,18	Simulation du vent X+ 20 m/s	vent
5/ 398	0,09	Simulation du vent X+ 20 m/s	vent
5/ 402	-1,10	Simulation du vent X+ 20 m/s	vent
5/ 548	-1,83	Simulation du vent X+ 20 m/s	vent
5/ 620	0,28	Simulation du vent X+ 20 m/s	vent
5/ 659	-1,84	Simulation du vent X+ 20 m/s	vent
5/ 663	0,29	Simulation du vent X+ 20 m/s	vent
Cas 5	**Simulation du vent X+ 20 m/s**		
Somme totale	-6,40		

Cas/Noeud	FZ [kN]	Nom du cas
Somme réactions	-6,40	
Somme efforts	6,40	
Vérification	-0,00	
Nom du cas	**ELU-**	
ELU-/ 7	-1,40	ELU-
ELU-/ 11	0,24	ELU-
ELU-/ 46	0,11	ELU-
ELU-/ 50	-2,40	ELU-
ELU-/ 164	-0,65	ELU-
ELU-/ 168	0,03	ELU-
ELU-/ 203	0,04	ELU-
ELU-/ 207	-0,68	ELU-
ELU-/ 359	-1,39	ELU-
ELU-/ 363	0,25	ELU-
ELU-/ 398	0,12	ELU-
ELU-/ 402	-2,41	ELU-
ELU-/ 548	-4,01	ELU-
ELU-/ 620	0,32	ELU-
ELU-/ 659	-4,01	ELU-
ELU-/ 663	0,32	ELU-
Cas ELU-	**ELU-**	
Somme totale	-15,52	
Somme réactions	-8,96	
Somme efforts	8,96	
Vérification	-0,00	
Nom du cas	**ELS+**	
ELS+/7	-0,32	ELS+
ELS+/11	0,28	ELS+
ELS+/46	0,13	ELS+
ELS+/50	-0,58	ELS+
ELS+/164	-0,08	ELS+
ELS+/168	0,21	ELS+
ELS+/203	0,22	ELS+
ELS+/207	-0,09	ELS+
ELS+/359	-0,32	ELS+
ELS+/363	0,28	ELS+
ELS+/398	0,14	ELS+
ELS+/402	-0,59	ELS+
ELS+/548	-1,00	ELS+
ELS+/620	0,44	ELS+
ELS+/659	-1,00	ELS+
ELS+/663	0,46	ELS+
Cas ELS+	**ELS+**	
Somme totale	-1,82	
Somme réactions	-6,40	
Somme efforts	6,40	
Vérification	-0,00	
Nom du cas	**ELS-**	

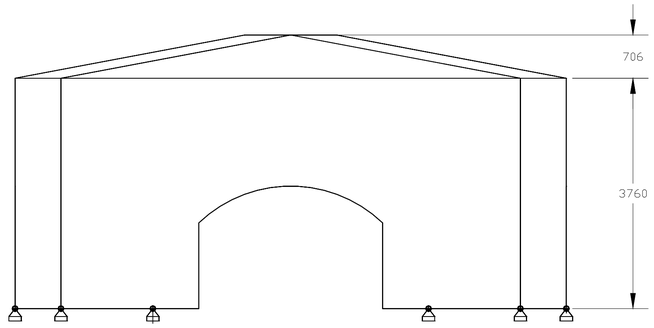
Cas/Noeud	FZ [kN]	Nom du cas
ELS-/ 7	-1,00	ELS-
ELS-/ 11	0,17	ELS-
ELS-/ 46	0,08	ELS-
ELS-/ 50	-1,71	ELS-
ELS-/ 164	-0,46	ELS-
ELS-/ 168	0,02	ELS-
ELS-/ 203	0,03	ELS-
ELS-/ 207	-0,48	ELS-
ELS-/ 359	-0,99	ELS-
ELS-/ 363	0,18	ELS-
ELS-/ 398	0,09	ELS-
ELS-/ 402	-1,72	ELS-
ELS-/ 548	-2,87	ELS-
ELS-/ 620	0,23	ELS-
ELS-/ 659	-2,87	ELS-
ELS-/ 663	0,23	ELS-
Cas ELS-	**ELS-**	
Somme totale	-11,09	
Somme réactions	-6,40	
Somme efforts	6,40	
Vérification	-0,00	



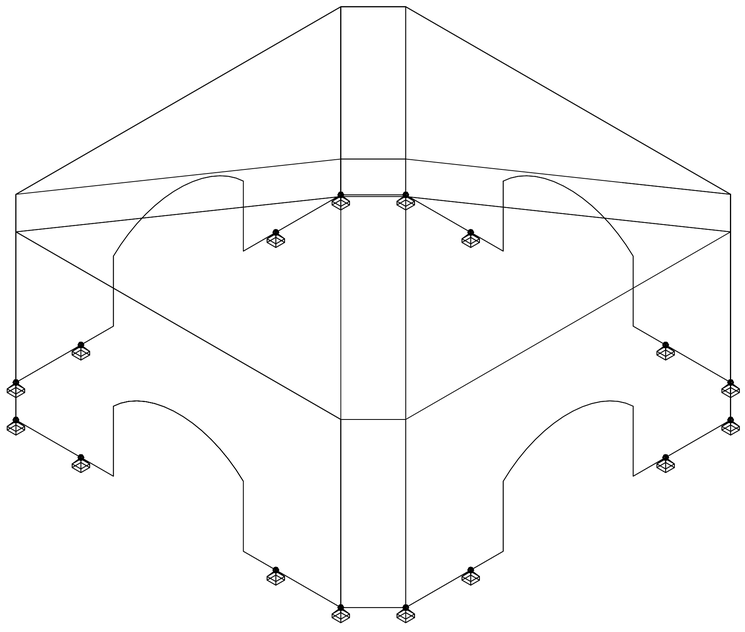
PLAN VIEW
1:50

NOTES

- EACH ANCHORS MUST COMPLY WITH TABLE 1 AT PAGE 6 OF THIS PRESENT REPORT.



ELEVATION VIEW
1:50



VUE ISOMÉTRIQUE

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No	Description	Date
1	Localisation des ancrages	10-10-18
2	Localisation des ancrages	20-12-18

Client
PARTY RENTAL DEPOT

Projet
Inflatable Tent - cube 9X9

Titre du Dessin
Localisation des ancrages au sol

Numéro de projet A18-ME 1403

Date 20/12/18

Dessiné par Alexandre Létourneau

Vérifié par Louis Larouche

S-01

Echelle Indiquée