Universitat Politecnica De Catalunya, BarcelonaTech
Masters in Computational Mechanics

Course
Computational Structural Mechanics and Dynamics

Resistance to Wind Blows
(Internship @ Szpiniak)

Under Supervision of

External Supervisor: Mr. Nir Szpiniak

Internal Supervisor: Mr. Josep Sarrate

by

KIMEY K WAZARE

A quien corresponda,

El alumno Kimey Kishor Wazare ha completado con éxito las 280 horas de prácticas durante las cuales se le había asignado la siguiente tarea:

- Análisis a través del programa de control numérico la resistencia de materiales en sus puntos de sujeción o anclaje, así como el de los diferentes conectores en momentos de golpes de viento.

La información correspondiente a los materiales del estudio fue proporcionada anteriormente junto con una serie de resultados de laboratorio de éstos a fin de realizar un correcto análisis.

Supervisor: Nir Szpiniak

Szpiniak, S.L.
p.p

Introduction:

The plasticized fabric material manufactured by Szpiniak S.L is use to protect cherry trees in Chile. The tents of fabric material are installed which have a central reinforcement with rings to hang it and side reinforcements to extend it. The main purpose of these tents is to resist the forces of the winds only for 5 months from mid to late winter. The structure is simple and fixed.

The company have performed various test in the laboratory on the fabric material and connectors to measure the strength, failure analysis and resistance test. Drawback were that tested material only reflected the resistance to the traction in a stable speed and could not measure blows of forces.

Figure 1: Installed Tents in Chile

Problem Statement:

Analyze the resistance of the plasticized fabric material in their fastening points in moments of wind blows using numerical technique.

Solutions:

The main concern of the company is to check whether they need to modify the existing design of composite fabric or the connectors at high wind flow. The task is to model and assemble the fabric material and plastic connectors in the CAD software and then performed the analysis in TDYN software to check the failure of the fabric and connector.

Pre Processing:

Analysis is performed on a small domain of composite of dimensions 32*38 cm.

1. **Material:** The composite fabric is made-up of High Density Polyethylene (HDPE) yarn, woven in criss-cross (wrap-weft) manner. The last few centimetres (approx. 10cm) has 50% more fabric folded & welded together. The composite structure is plastic laminated on both the sides for more durability.

Tents are attach to iron strings using connectors like Aluminium eyelet, Galvanized Metal wire and Plastic O-ring.

Mechanical Properties	Direction x	Direction y	Direction z
Young Modulus	1268.0979 N/cm²	1304.1864 N/cm²	0 N/cm²
Shear Modulus	28000 N/cm²	28000 N/cm²	28000 N/cm²
Poisson Ratio	0.46	0.46	0.46

Table 1: Mechanical Properties of HDPE composite fabric

2. **Boundary Conditions:**
   The fabric at upper section is fixed and at lower section is free to move in Y direction. It is constructed using shell technique; boundary pressure load is assign at bottom section in opposite direction.

3. **Meshing:**
   Type of Mesh: Structured & Unstructured mesh
   Element Type: Triangular element

4. **CAD Modelled of Fabric:** Composite fabric is modelled in CATIA, as thickness of each rectangle is different. Circular Hole is meant for assembling aluminium eyelet for connectors.

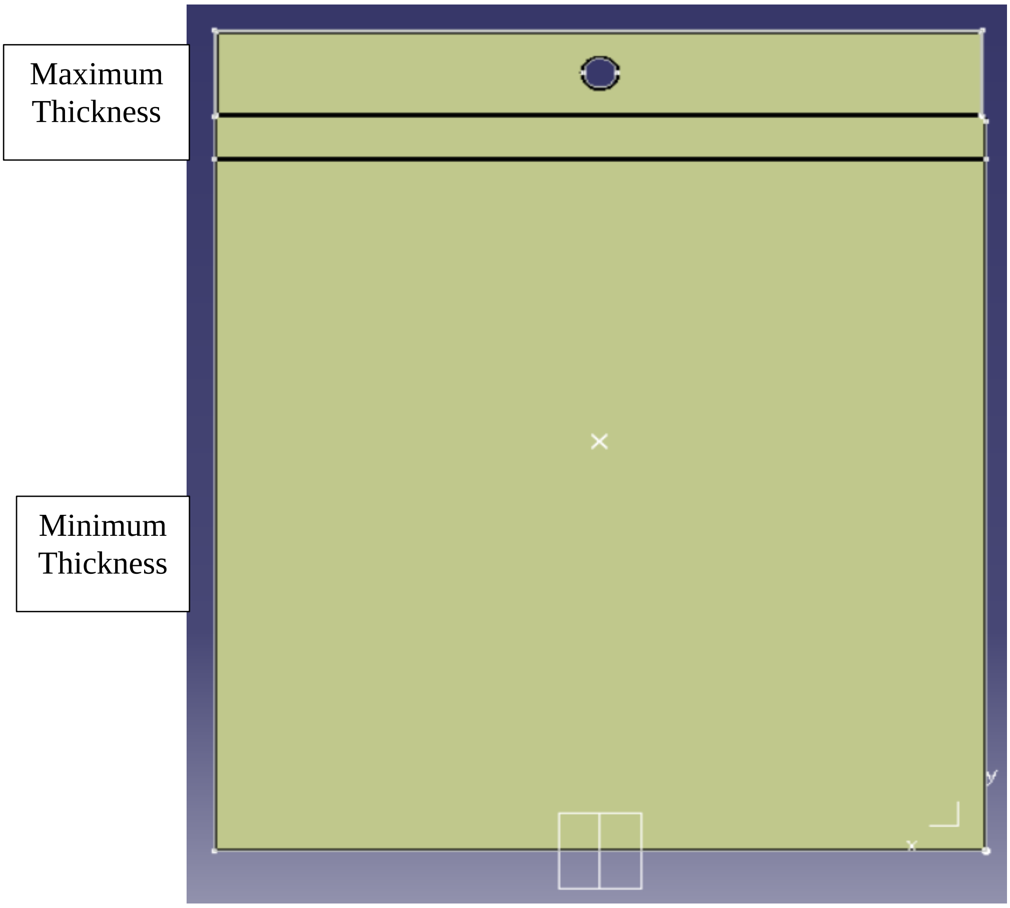

Figure 2: Composite laminated Fabric

Post Processing:

1. **Calculation:** After mesh generation, calculation is done. Post Processing is followed immediately. The following figure shows the obtained distribution of displacements at different pressure load values.

2. **Results:** The load is applied in negative Y direction. To check the durability of the fabric different values of Pressure load are assigned such as 10, 50 & 100 N/cm respectively.

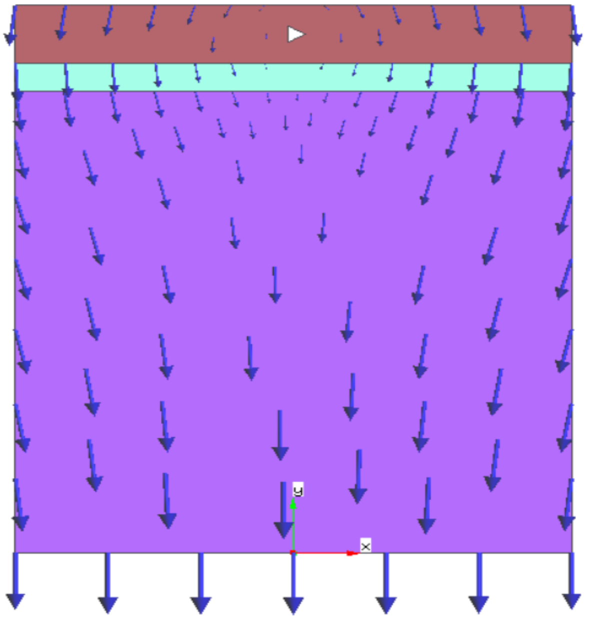

Fig 3.1: Displacement Vector diagram

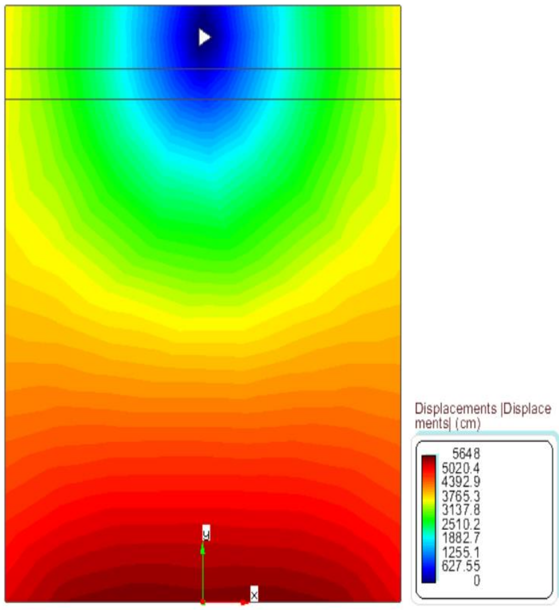

Fig 3.2: Displacement Contour @-10N/cm

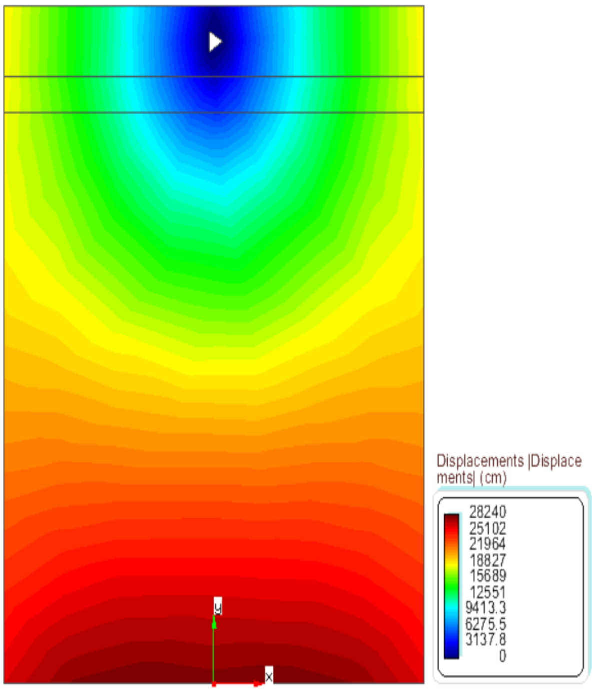

Fig 3.3: Displacement Contour @-50N/cm

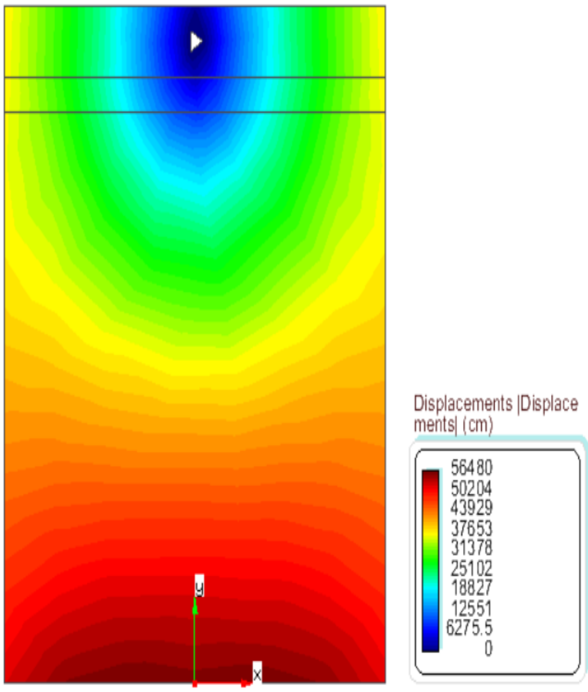

Fig 3.4: Displacement Contour @-100N/cm

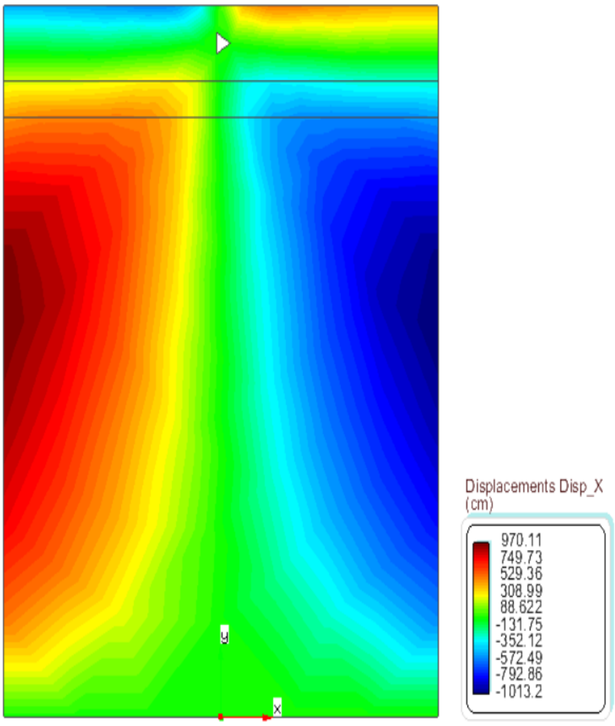

Fig 3.5: X Displacement @-10N/cm

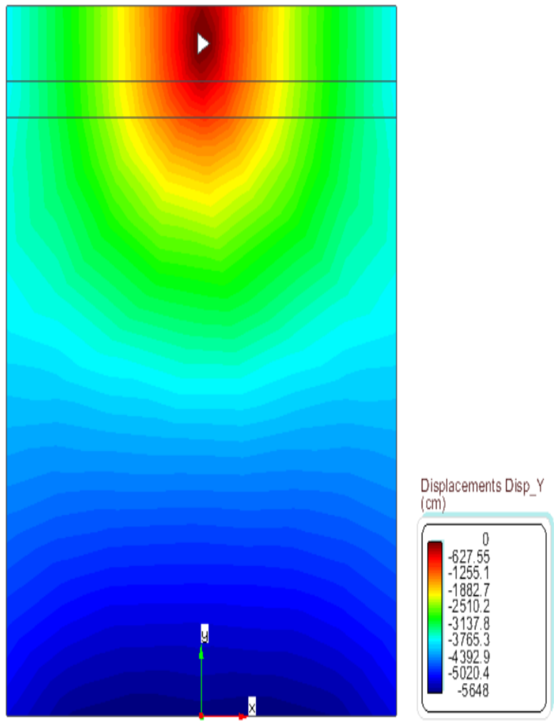

Fig 3.6: Y Displacement @-10N/cm

The maximum displacement is observed at the bottom section of fabric material. As we increase the load value the displacement gets more impacted. It is observe that the upper hinge section of connector is not impacted remains stable as we increases the load.
Therefore, failure is not caused near the connector section. Fabric stretches to its extent and starts breaking, making lower thickness section more weak.

Overcome Problems:

1. Composite Material & Modelling: Woven structure is most complex to define when material is not standard. The company has used HDPE with unknown mechanical properties. So main task was to identify mechanical properties to define the composite in CAD softwares. Standard value of HDPE are defined to model CAD.
   Assigning the values in respective direction is mandatory, slight mistake can generate many errors in simulation. Young Modulus, Poisson ratio etc. are defined in X, Y & Z direction accurately.
2. Boundary Conditions: As both the end sides of fabric are connected to iron string using connectors, then defining small domain is bit complicated. So at bottom section constrain assigning is free to move in Y direction. As wind will impact fabric, stresses will be generated in the Y direction causing it to break at the centre.

Conclusion: (Recommendation)

Development of fabric in different thickness makes it more durable, need to define thickness appropriately. Failure is caused at the bottom section of the fabric as its thickness can't bear that much of instant shock. Bottom thickness should be increased to 20% of existing thickness or woven structure must be redefine.

Future Contribution:

1. Woven structure can be defined with variations in angle and layout.
2. Analysis can be performed to exactly identify the required thickness of all the sections of composite fabric.
3. Algorithm can be define to deal with the woven composite structure with variations in a thickness and layouts.

References:

1. Resistance Traction report, Leitat Laboratory, Szpiniak.
2. Traction Agricover report, Leitat Laboratory, Szpiniak.
3. CATIA Composites, CATIA V5R19 manual.
4. GID and TDYN Ramseries manual.
5. www.textilechapter.com/yarnproperties.