Master's of Science in Computational Mechanics

International Center for Numerical Methods in Engineering (CIMNE)

Internship under Szpiniak S.L.

Topic : Resistance to Wind Blow

Main task : Resistance of the fabric attached with elastic cord

External Supervisor: Mr. Nir Szpiniak

Internal Supervisor: Mr. Josep Sarrate

by

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Introduction:

The company Szpiniak S.L. manufacture and distribute a woven waft and wrap in 0 and 90 degree , fabric material of high density polyethylene for the agricultural field. This fabric in the form of tarpaulin is used to protect the vegetation from rains and extreme winds. The tarpaulin of woven fabric is installed in a tent shape, hung from a central wire and bottom two parallel lateral steel cables. The fastening of the tarpaulin is done through plastic connectors at the top and elastic cords and plastic connector at the bottom part.

The several resistance analysis test of the fabric and connector was done by the company in the laboratory. The test could only reflects the resistance to the traction in a stable speed and cannot measure force wind blows.

Fig 1. Real life use of the Tarpaulin of woven fabric and its installation

Given Task:

The objective of the study is to analyze through the program of numerical control the resistance of the fabric at the point of fastening and through the elastic cord in its point of anchoring, in the moments of blowing wind.

Solution:

The company is interested to check the analysis result of the woven fabric in different load conditions and see the test result, so they could modify the material or the installation techniques. The modeling of the connectors and fabric is done in CATIA. The modeled testing fabric structure is imported to TDYN for the analysis in three different pressure load and a hole in the top middle section imitating the real life situation of attachment for connectors through elastic cord.

Technical specification of the material

Tarpaulin: Woven in 0 and 90 degree angle between waft and wrap, laminated both side for rigidity and 50% more thickness in top and bottom part in the last 10cm and again wrapped 4cm, for three variable thickness along the geometry as show in the geometry section

Fabric material: High density Polyethylene,

Laminated Woven fabric: E = 1268.0979 N/cm^2 , ν = 0.46 (as per the Szpiniak S.L. testing)

Plastic connectors and clamp: Groping D4 plastic

Elastic cord: Bungee cord made with natural rubber, 6 mm diameter.

Process:

The small section of 32x38 mm section of the material is modeled and simulation is carried out in TDYN to know the displacement of the fabric in different pressure load conditions and with elastic constrains at the top (bottom section with respect to the Tarpaulin) of the fabric acting as an elastic cord.

Geometry:

Fabric

1) 32x38cm section of fabric material:

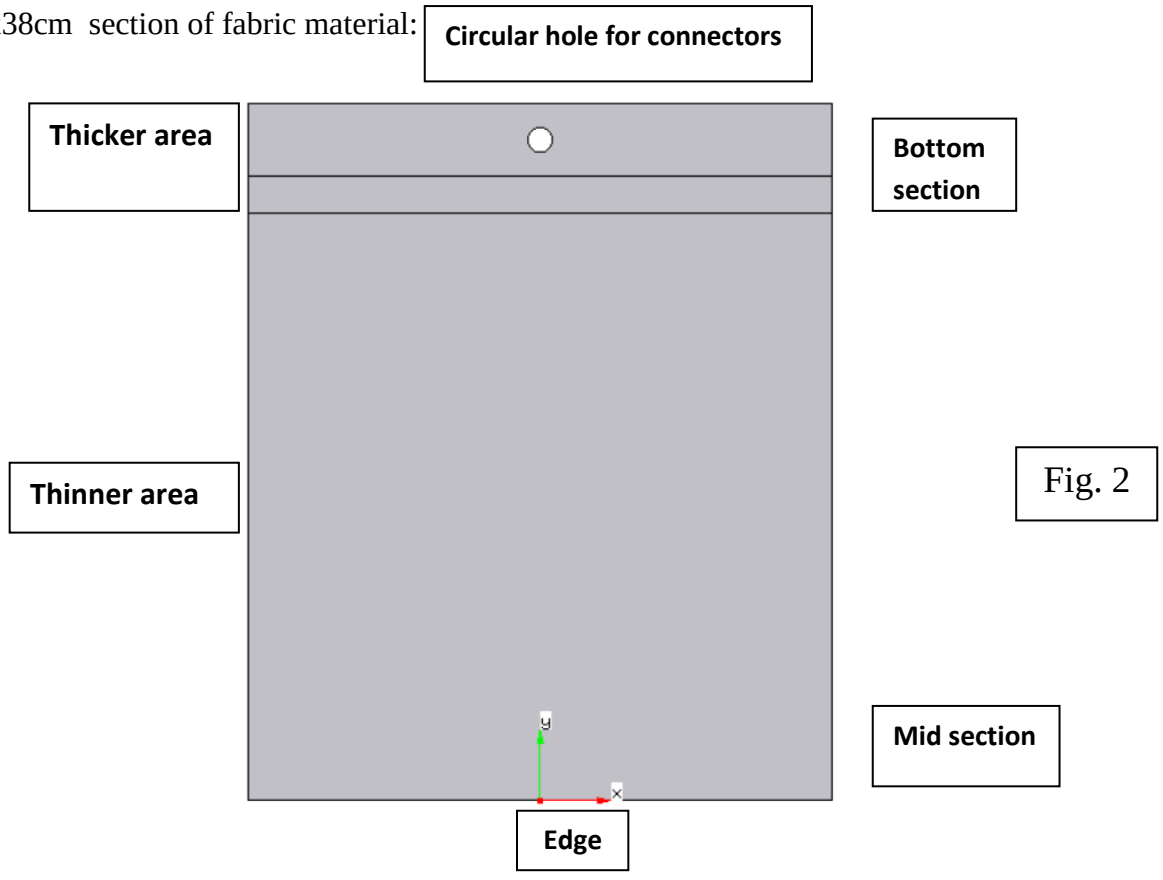


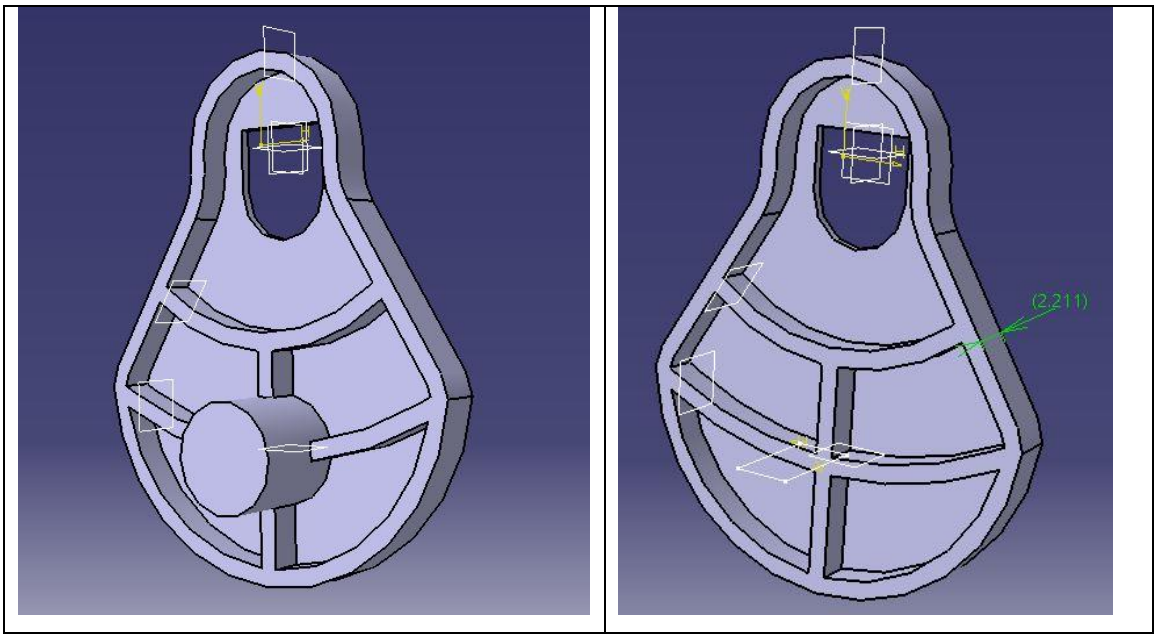
Fig. 2

Connectors

1) Connectors Attachment to the fabric

1) Plastic Clamp:

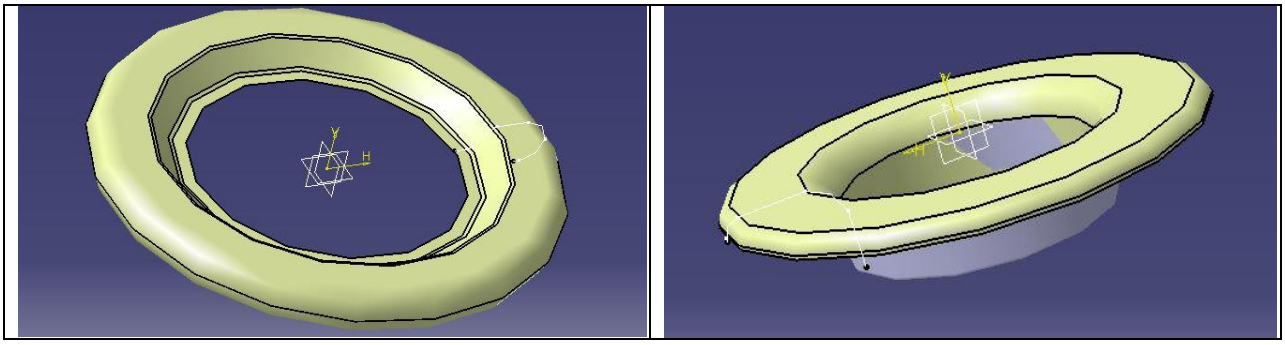
Two parts of the plastic clamp



Front Part Back Part

Fig. 3

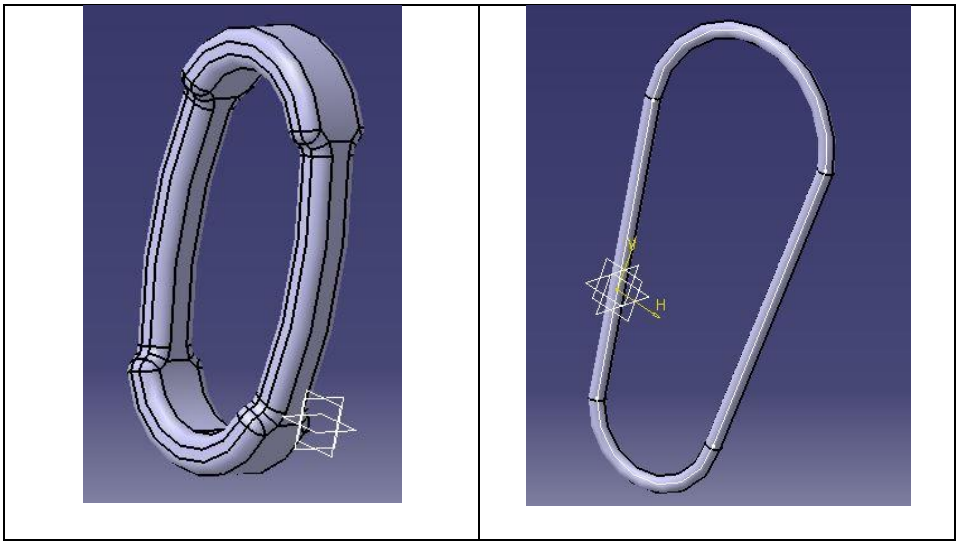
2) Aluminum Eyelet



Cap Lock

Fig. 4

2) Connector used for installation



Plastic Connector Galvanized steel connector

Fig. 5

Analysis Process in TDYN

Details in TDYN :

Steps:

I) Constraints:

1) The geometry of woven fabric of 32x38cm dimension is imported from CATIA in IGES file

2)The elastic constraint in all direction and rotation is assigned at the O ring part of the fabric

3) The fixed constraint in all direction except in Y axis is assigned at the bottom part

II) Materials and properties:

1)Isotropic shell is implemented as we derived the mechanical property of the fabric though testing report done by company.

2) Material specification:

Young's modulus: 1268.0979 N/cm^2

Poisson ratio: 0.46

Specific weight: 0.00951 N/cm^3 are assigned.

III) Loadcases:

1) Shell pressure load of three different values (10 ,50 and 100) is applied in negative Y direction in Newton per centimeter square, throughout the whole surface of the body.

IV) Meshing:

Mesh type: Structured and unstructured mesh

Element type: Triangular element

V) Post processing result

1) Calculation : Calculation is done after the generation of mesh and the post-processing is followed which results in following figures, explains the obtained distribution of displacement at different pressure load.

2) Result: The pressure load is applied throughout the fabric sample in negative Y direction. To check the fabric behavior at different load conditions, three various pressure load i.e.10,50 & 100 N/cm^2 cases are assigned.

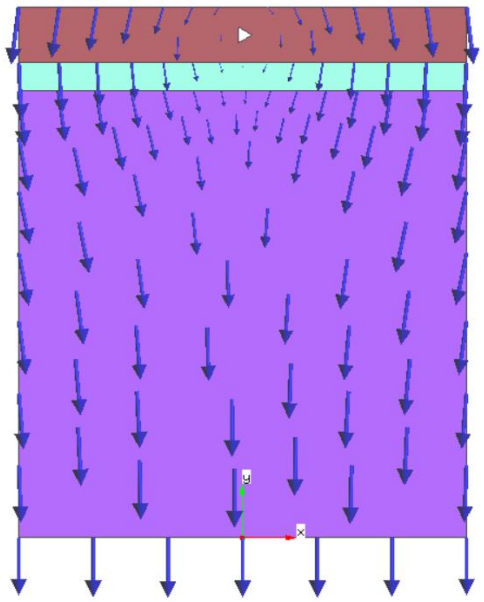


Fig.6: Displacement Vector diagram

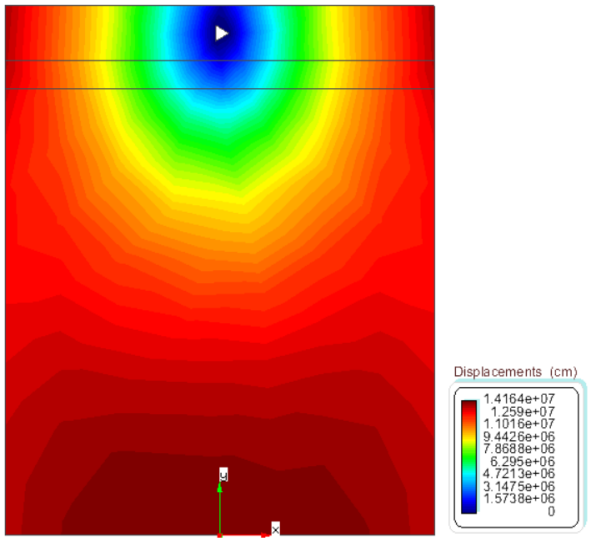


Fig.7: Displacement Contour @-10N/cm^2

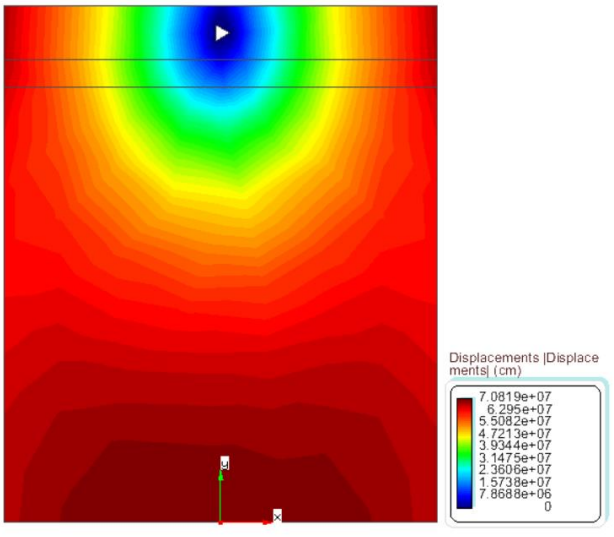


Fig.8: Displacement Contour @-50N/cm^2

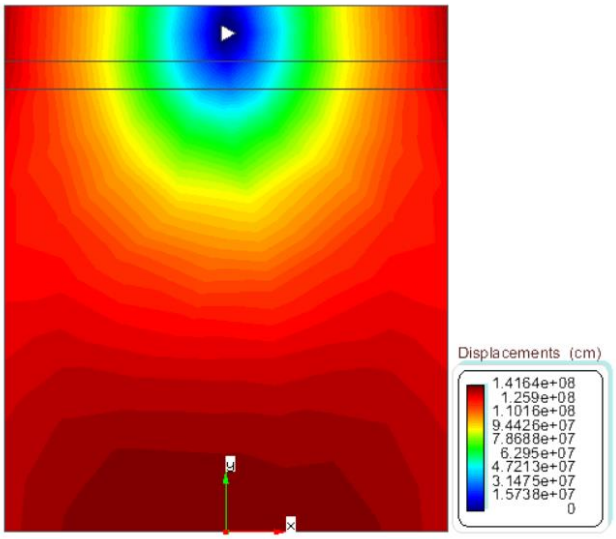


Fig.9: Displacement Contour @-100N/cm^2

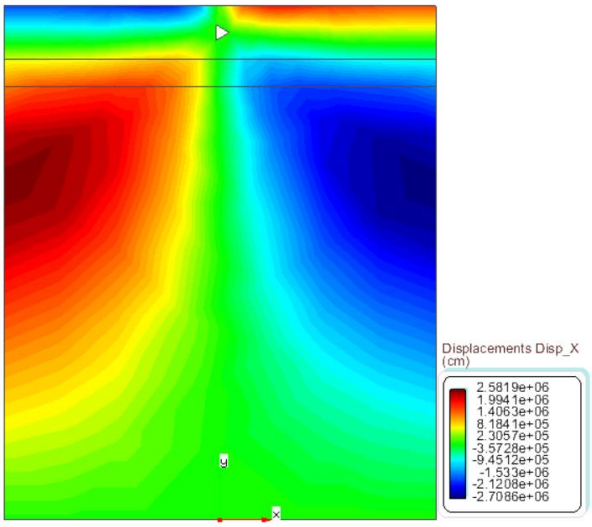


Fig.10: X Displacement @-10N/cm^2

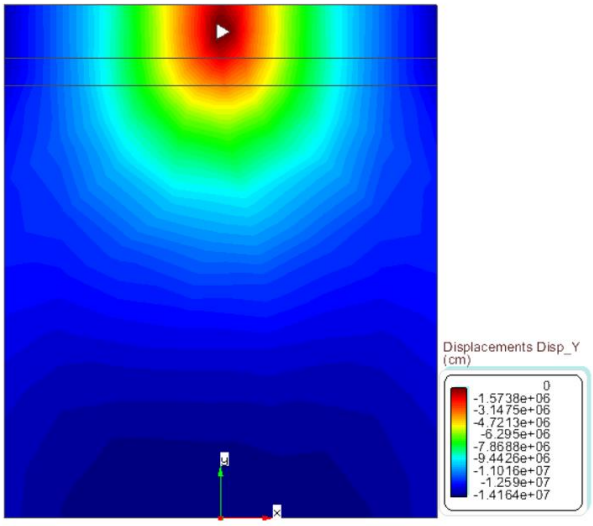


Fig.11: Y Displacement @-10N/cm^2

As we can see in the result, the vector magnitude is increasing in negative y direction while moving away from the constraint and becomes constant at the edge of the material this shows that the maximum displacement is away from the connector connecting point, this is true for all the three pressure loads. Also there is relative displace of the fabric from the lateral sides as seen in X-displacement @-10 N/cm^2.

Conclusion and Suggestion

As maximum displace is near the region of the edges, the material failure will occur around that region. The lateral stiffener can be used to make it laterally stiff

Problems

1) Modeling of woven structure.

2) Meshing

2) Inflexibility of TDYN for a pre custom settings to assign the physical property of the woven fabric or a composite material which curb us to acquire the accurate result.

Prospective of future research

1) The future research and analysis can be carried out in different angle of woven fabric deciding which woven angle is best for the physical properties for a particular fiber.

2) Prospective of continuing research in detail for Master's thesis using all the modeled connectors and their assembled simulation of the real life model with tent shape structure introducing an aerodynamic effect at different wind speed.

References

1) Analysis of woven fabric strengths: Prediction of fabric strength under uniaxial and biaxial extensions, Ning pan, Division of Textiles and clothing, Biological and Agricultural engineering department, University of Califonia, USA

2)Mechanical Properties of Polymers

3) Analysis of woven and braided fabric reinforced composites, Rajiv A, Naik, Analytical Service and material, Inc, Hampton, Virginia

4) CATIA v5 manual

5) Ramseries manual

6) Determination of tensile properties, Ref Agricover provided by Szpiniak, SL, Leitat Technological Center,

7) Geosynthetics- Traction test strip wide, Ref . Agricover provied by Szpiniak, SL, Leitat Technological Center,

8)Determination of mass per unit area of small samples, Ref . Agricover provied by Szpiniak, SL, Leitat Technological Center,

A quien corresponda,

El alumno Sumit Maharjan 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 del tejido y el cordel elástico en sus puntos de sujeción o anclaje 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.
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