Membranes to meshes: A, E & ν

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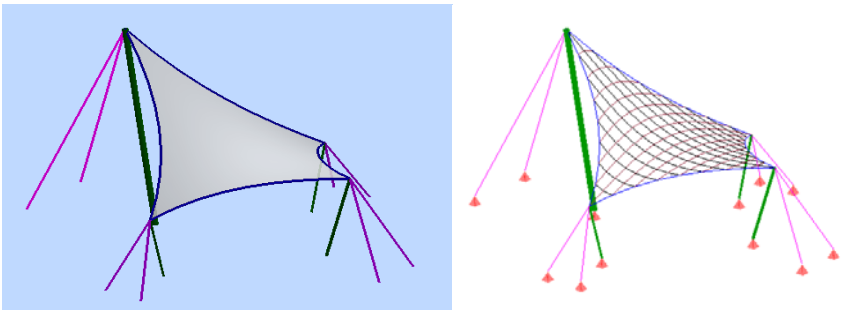
Abstract

Tensile structures, textile structures or membranes structures are terms that are often used as synonyms. However they could be very different things. Nevertheless we usually think about them as a structural element surface. That's why normal units for E, σ or resistance are kN/m or daN/5cm, instead of the usual kN/m^2 or Pa.

Representing membranes graphically can be difficult and it is normal to use a mesh instead (square, triangular, radial…) to represent a membrane. Analyzing a membrane as a structure will require the use of FEM or similar, while analyzing a mesh could be done by using simple bars, which is much easier. If we accept this fact, then why not use meshes instead of membranes?



Behavior of a membrane can be complex. If it is a textile we must distinguish elasticity module E_1 for warp direction and another one E_2 for weft direction. And the same about Poisson's ratio ν. Although many times we use a single ν for both main directions[1]. Trying to establish mechanical properties for diagonal directions is still more difficult, especially if the mesh is not a square mesh, or if the mesh does not follow the warp/weft main direction, like a triangular mesh.

Stiffness of a bar in tension is defined only by their length L, section A and elasticity module E: EA/L. Applying a section (we have already seen that for membranes it is a width) to a bar is relatively easy, but to simulate a membrane behavior we must do it in a way that A, E and ν are simulated at the same time. That is: longitudinal and transversal deformation must be the same when analyzing a membrane or a mesh.

This paper pretends to give some rules so that this similar behavior is achieved, according to the type of mesh used in the simulation.

References

[1] N. Straghöner and J.Uhlemann and 18 alt., *Background for European Structural Design of Tensile Membrane Structures*, CEN/TC 250/WG 5 Membrane Structures Scientific and Policy Report (SaP-Report), 2015

[2] R. Sastre, *Modulus of elasticity of a membrane*, http://www.wintess.com/modulo-de-elasticidad-de-una-membrana, 2012