REMARKS CONCERNING THE PHYSICAL MODELLING OF TEXTILE ROOFS - J.Llorens - ETSAB/UPC - 2014

Form is dependent on:

Membrane: threads, structure, coating (if any).

Orientation of warp and weft.

Geometry and flexibility of supports and boundaries.

Loads and prestress.

Temperature and humidity.

Creep and yielding

Small radius R (great curvatures 1/R) increases the aforementioned dependencies.

Flat surfaces cause difficulties due to high tensions, together with lack of drainage in horizontal position.

Increasing the curvature 1/R (decreasing the radius R) relaxes tensions and improves the drainage.

The warp is stiffer than the weft. so, the sag in the direction of the warp is smaller. Therefore, deformations are smaller if the warf is parallel to the main tensions.

Boundaries affect strongly the equilibrium and shape. They are usually 3D curves, unless rigidity provided by a structural arch, beam or wall, forces them into a plan.

Usual solutions of the boundaries are.

a)   A cable or cord is included in a continuous fabric cuff. Membrane stresses are transferred uniformly from the fabric to the cable and vice versa.

Stretching the corners means stretching uniformly all the surface.

b)   A flexible reinforcement is continuously attached to the edge. Different elongations of the edge and the fabric are not allowed. As a result, the distribution of the tension along the boundary is not uniform, because it concentrates at the ends.

Stretching the corners is not so effective than case a) in order to stretch all the surface. Corners flatten and result over-stressed.

c)   The fabric membrane is attached to a rigid edge, such as a concrete or steel sections. It needs pre-stressing parallel to the boundary to compensate for the differences of elongation. Rigid edges do not follow the fabric deformation.

Stretching the corners do not stretch the surface.

Tension must be applied in all directions. Easiness for adjustability and access is essential.

Three or more forces come into play at a corner. Equilibrium requires that each force is the resultant of the others. Following directly the path of the loads is the best way to save energy and material. When deviations are needed, the influence of angles is significant. Dividing a force into two components depends strongly on the angle of projection.

The model and the full size structure are different in scale. It means much more than a difference in size. There are also the self weight, the rigidity of the materials, the geometry of the connections and the multiplication factor of the loads due to full size deformations and temperature.

2D preliminary sketches and drawings could be misleading because they don't care about equilibrium or simply represent non-feasible surfaces.

The physical model is vulnerable. Tensions relax or not depending on the prestress, temperature, humidity, yield and creep. All measurements have to be done in one session, avoiding alterations. Keeping the model is advisable to check later results or to face alterations. More over, it's worthy to compare it with the results of the computer and the real textile roof.