Calculating Panel Compensation

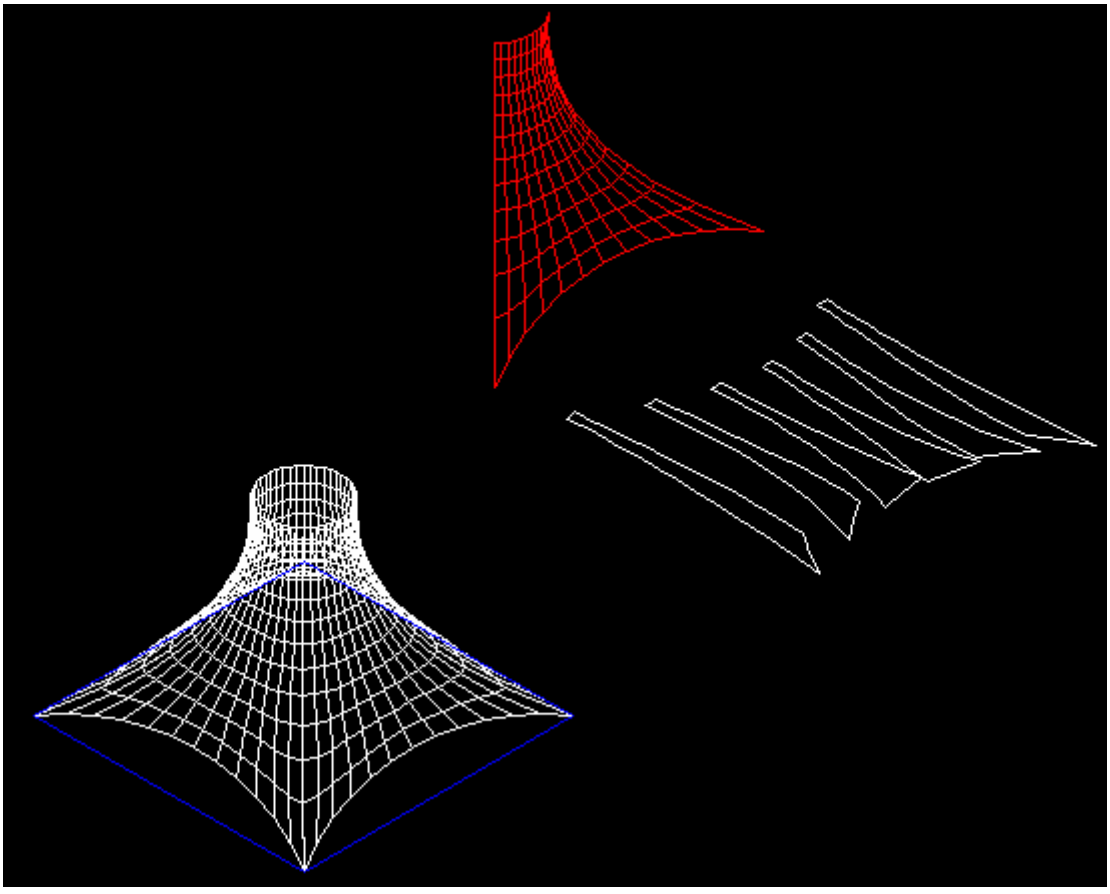
Terminology

Warp…. the direction on the fabric along the roll. Often the strongest and straightest threads in the fabric.

Weft, Fill, Woof…. the direction on the fabric across the roll. American usage is fill, European is weft.

Compensation…. the amount that we need to deliberately shrink the panel, in the warp and weft directions, to create the membrane pre-stress when the panel is then stretched out to full size.

Let's say you have a tensile structure similar to the cone tent shown, designed with a weft/warp tension ratio of 1:2.



That is we have specified in the MPanel model a weft/warp tension ratio of 0.5, and we are paneling with the panel warp in line with the mesh warp. (MPanel uses the names warp and weft in the mesh to indicate the usual direction of paneling)

To determine the compensation to be applied to each panel we need to know:

1 The pre-stress required in the membrane
2 A fabric stretch graph.

Required Pre-Stress.

The pre-stress figure may be part of the job specification. Or it could be derived from a stress estimation of the anticipated wind loads. Or it could be based on previous experience with similar structures.

The higher the pre-stess the more rigid the structure will be, and the less it will deform under wind and snow loading. But this will also mean higher boundary and anchor loads, and a stronger fabric will be needed to accept the loads

In many cases the pre stress will be 5 - 20% of the fabric ultimate tensile strength.

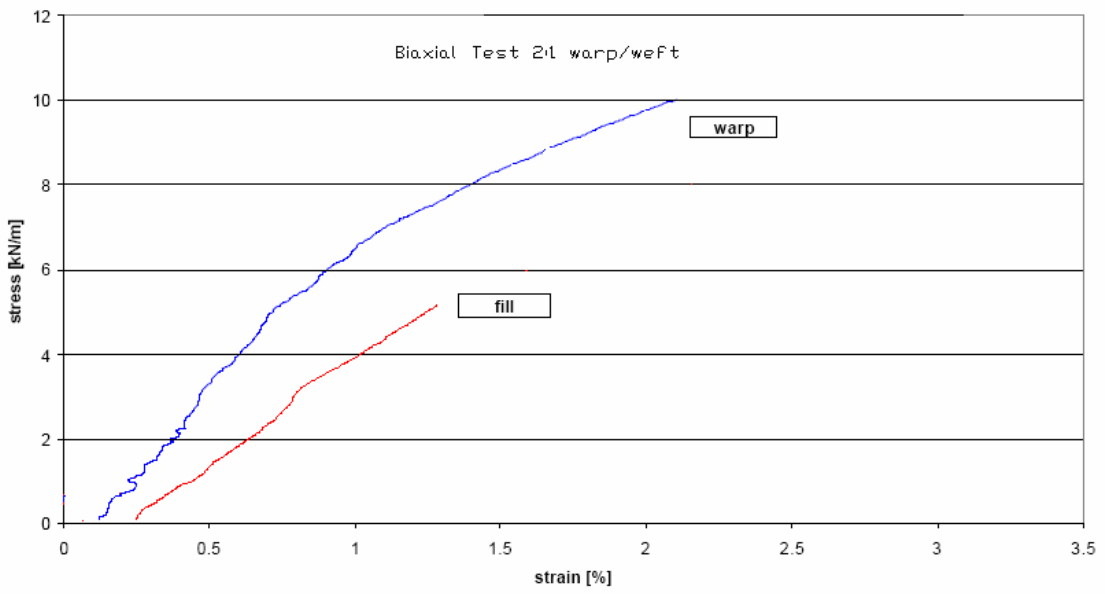
The pre- stress will need to be quoted in the same units as the fabric manufacture uses, often KN/M.

An example pre-stress value for an architectural fabric could be 3 KN/M.
That is roughly 300 Kgf / M, or 180 lbf / foot.

So in warp direction we will pre-stress to 3 KN/M, in the weft direction we will pre-stress to 1.5 KN/M

Fabric Stretch graph

Here is an example fabric stretch graph from a biaxial test at 2:1 warp/weft ratio

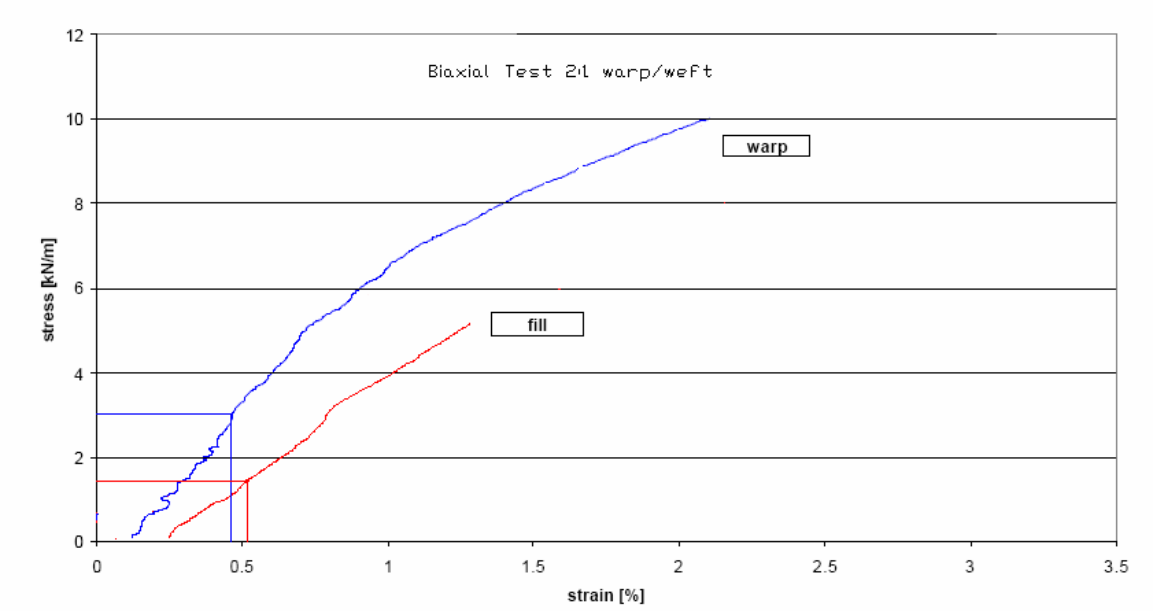


This graph would be obtained from the fabric manufacturer, from independent testing, or from a test jig in your production department.

It may be difficult to obtain a biaxial test graph at the tension ratio you require. And this is an idealized graph… a real graph will be more complicated, including effects such as time dependence, hysteresis, recovery, etc.

This is the graph after a few stretch cycles, so it includes some initial settling stretch, as shown by the strain at zero stress.

Now we look up the required pre-stress values, and translate then into strains.



You can see how we have converted:
3KN/M warp stress into 0.45 % warp strain
1.5 KN/M weft stress into 0.55% weft strain

These are the figures that we would use to compensate the panels:

Warp compensation 0.45%
Weft compensation 0.55%

You can also see, given the fabric data that we have to work with, there is no sense in being very accurate with these figures. A different test method on the fabric, a different fabric batch, or a different interpretation of the results, would give rather different figures.