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# Stability analysis for an arch supported membrane roof

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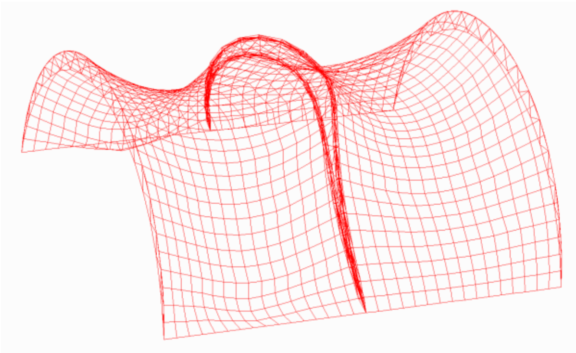
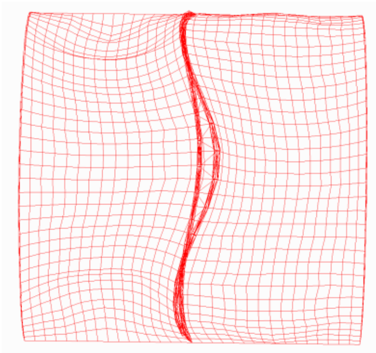
## Abstract

To cover a large span area, a widely used solution is applying textile membrane supported by steel arches. To limit the weight of the arch, slender structural elements must be designed. While steel trusses effectively meet this goal, their loadbearing capacity is limited by stability resistance. As the trusses have large inertia in the plane of the arch, usually the out-of-plane buckling is the more dangerous. The out-of-plane buckling is a complex phenomenon as the membrane restricts the deformation of the arch resulting in an elastic embedded system with a highly nonlinear response.

To get the equilibrium state of the structure Dynamic Relaxation Method is used with 8-node quadrilateral membrane elements [1]. The truss is modelled by straight rods. To get an appropriate model for the out-of-plane behavior of the truss the flanges of the truss are modelled by sub-trusses: four flange 3D trusses are used to represent the proper stiffness of the real bending resistance of a flange. This model fits smoothly into the highly nonlinear DRM algorithm of the membrane structure.





In the equilibrium state of the structure the classical eigenvalue problem is solved [2] to obtain the critical multiplier of the actual load. The elastic and the geometric stiffness of the membrane and the truss elements, respectively, must be selected to safely withstand the destabilizing effects.

The complex stability analysis of the joint system of the membrane and the steel truss gives the chance to get an optimal solution in terms of material usage.

## References

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[2] O. C. Zienkiewich and R. L. Taylor, *The Finite Element Method.* Butterworth-Heinemann, 2000.