Internal Statical Determinacy in Trusses

A planar, externally statically determinate supported truss is also internally statically determinate, if the number of truss members corresponds to double the number of the nodes minus three. The number 3 stands in this equation for the number of equilibrium conditions (that corresponds to the number of support reactions in case of an externally statically determinate system). To shape an internally statically determinate truss, one should follow the triangle rule. Square meshes lead to unstable systems. The inner forces of truss members in statically indeterminate trusses can not be solved with simple methods like graphic statics.

Example: statically indeterminate truss (internally indeterminate, externally determinate static system). The introduction of an additional bar violates the shaping rule. So the truss is statically indeterminate.

Example: Unstable truss. Quadrangular meshes lead to unstable systems, even if the requirements for internal static determinacy are fulfilled.

Calculating the Statical Determinacy of Planar Trusses

\[ S = \text{number of truss members (bars)} \]
\[ K = \text{number of nodes} \]

\[ S = 2K - 3 = \text{statically determinate} \]
\[ S < 2K - 3 = \text{unstable (underdeterminate)} \]
\[ S > 2K - 3 = \text{statically indeterminate (overdeterminate)} \]

Calculation of inner statical determinacy of three-dimensional trusses

\[ S = 3K - 6 = \text{statically determinate} \]