TENNECT

Manual

Index

0. General

The standardized fastening system is built up of a multiplicity of single parts, which can be combined depending on the application. Understandably it is not possible to introduce all feasible detail solution in shortness. Especially the system should not limit the variety of the user solutions, but rather provide the user to realize his agenda.

For the frequently occurring fixation details, for example fixation on top of a column, assembly groups offers an easy manageable solution.

1. Elementary example

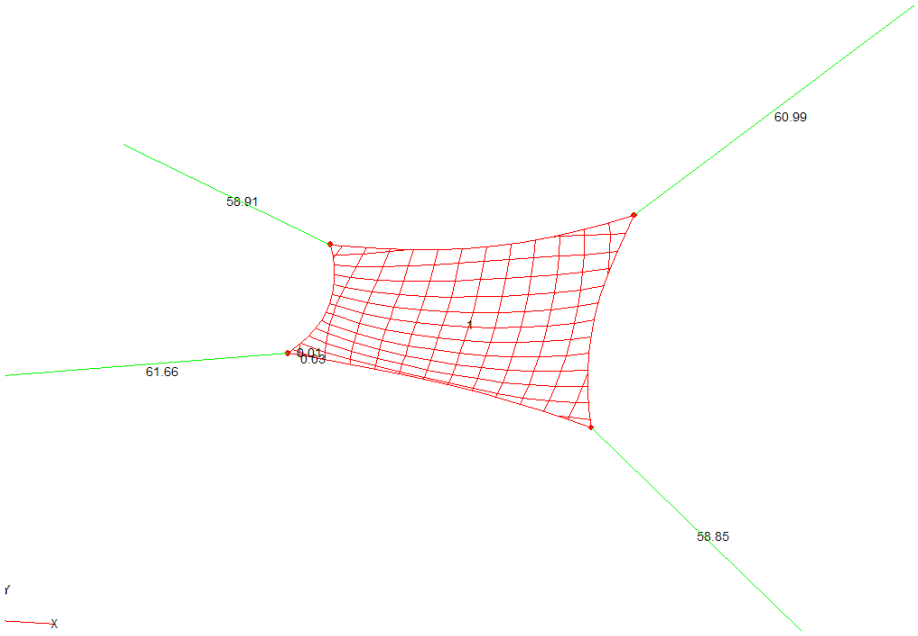
Basis for the sizing of the TENNECT parts should be a membrane shape with a grid space 5m x 5m. The columns are 2,5m respectively 3,5m tall. At each column head the membrane should be connected with a TENNECT element.

Rendering

1.1. Choice of component size

In this simply case the fixation of the membrane is given at all corners. If the membrane is burdened by a snow load, the reaction can directly used for the dimensioning of the TENNECT parts.

Determining for the sizing of the TENNECT elements is the result of the reaction forces, which is the vector of the individual components of the directions x, y and z.



Vectorial output of reaction forces

For the sizing of the TENNECT parts the design value (ULS ultimate limit state) is taken into account. The design value includes the partial safety factors and combination factors according to DIN 1055-100, EC 1 or equal standards.

$N_{Ed} = \gamma * N_{Ek} = 1{,}5 * 61{,}66\ kN = 92{,}5\ kN$

At present the fixation system TENNECT is available in the dimension 25, 100 and 200. The dimension „100“ means that the design resistance of each part is at least 100 kN.

Design procedure for the elements:

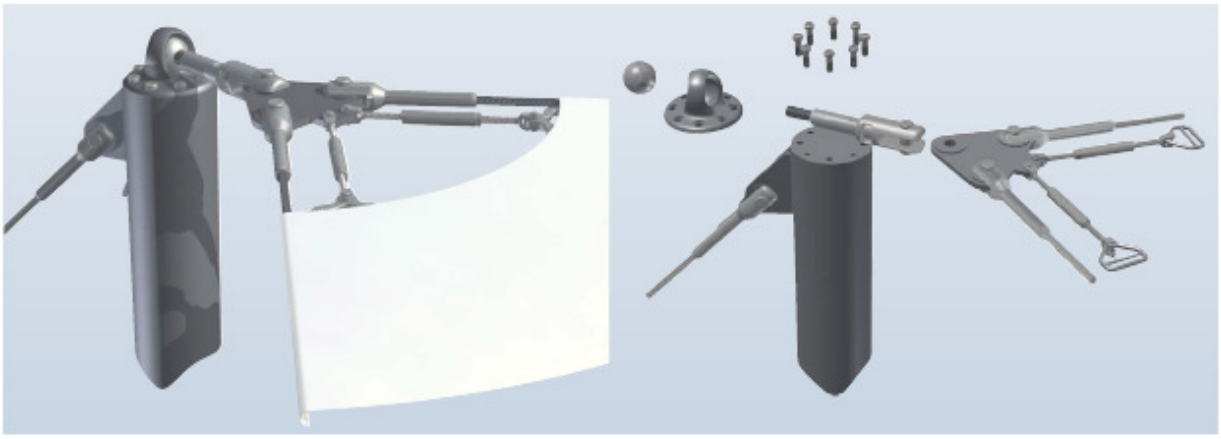
$N_{Ed} = 92{,}5\ kN < 100\ kN = N_{Rd}$

For this example the element size 100 is sufficient.

1.2. Combination of components

The TENNECT system contains single components, which can be assembling to the element size and the individual conditions. In the catalog the nominal size is labeled by color. In order to simplify the usage of the fixation details, the component are graded in assembly groups. These alleviate the positioning of list of parts, price calculation and reduce the danger of non fitting parts. Depending on the kind of fixation, for example fixation on a column or at a wall, different assembly groups are available.

Example: the assembly group PN 100 includes a ball, ball holder, eight socket head screw, a hexagon nut and an adjustable fork.



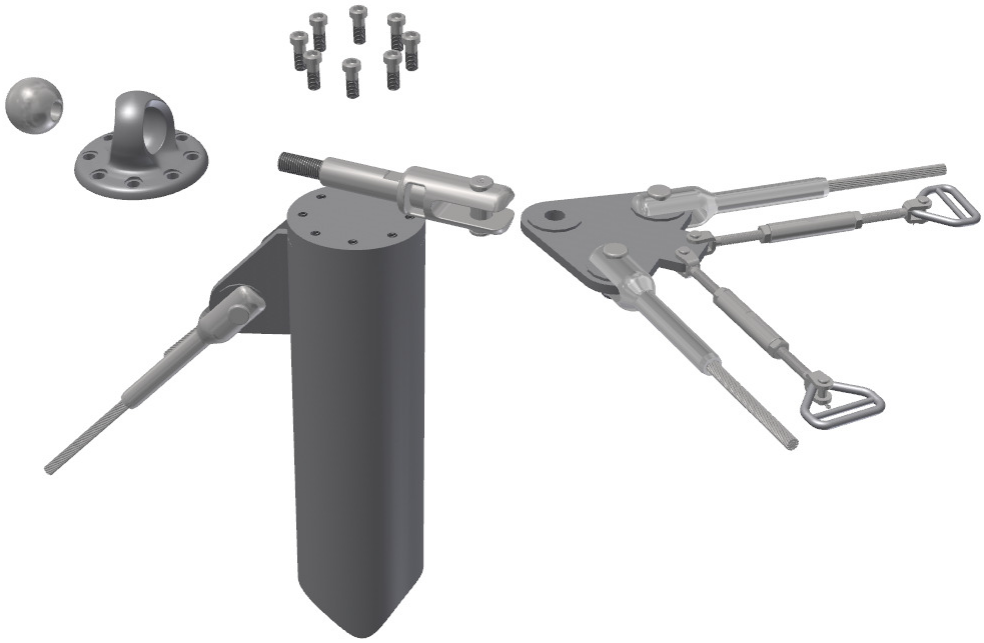
TENNECT PN

	Kugel Ball	Kugelhalter N Ball holder N	Zylinderkopfschrauben Socket head screw	Sechskantmutter Hexagon nut	Gabelkopf, verstellbar Fork, adjustable	Gabelanschlussplatte nach Maß auf Anfrage Customized connection plate on request
Artikelnummer Part number	Abmessungen der Bauteile siehe Seite 9 ff. I Dimensions of the components see page 9 ff.					
PN 25	ISK-K25	ISK-N25	ISK-S0816	I892-1000	ISK-AF25	
PN 100	ISK-K100	ISK-N100	ISK-S1225	I892-2000	ISK-AF100	
PN 200	ISK-K200	ISK-N200	ISK-S2035	I892-2400	ISK-AF200	

Screenshot TENNECT catalog

In this case the membrane should be fixated in every corner on a column. Therefore 4 PN 100 (N_{Rd} = 100 kN) are required.

Alternatively it is possible to order matching fork connection plates, turnbuckle with fork as well as triangle. The fixation system TENNECT offers consequently a complete fixation unit from one source.

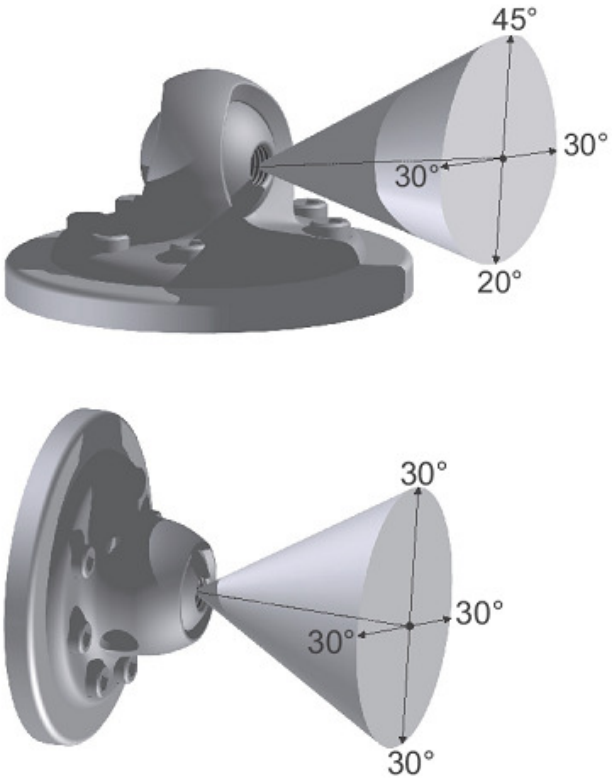


extrusion corner fixation

1.3. Control of angularity

The TENNECT system is made to be used as flexible as possible. The fixation with a ball allows a rotation around the centre point of the ball. In the following graphic the maximum angularity depending on the direction is given.

The actual existing rotation can be taken from the form finding or the structural analysis.



Adjustability of ball holder N and W

2. Matching TENNECT elements – membrane shape

2.1. General

One of the major error sources is the interface between steel trade and the membrane fabrication. Often the responsibility for planning the steel details is in different hands than the pattering of the membrane. The communication between all involved parties is very important, particularly if every detail must be designed for an unique membrane corner. In case of insufficient communication mistakes are unavoidable.

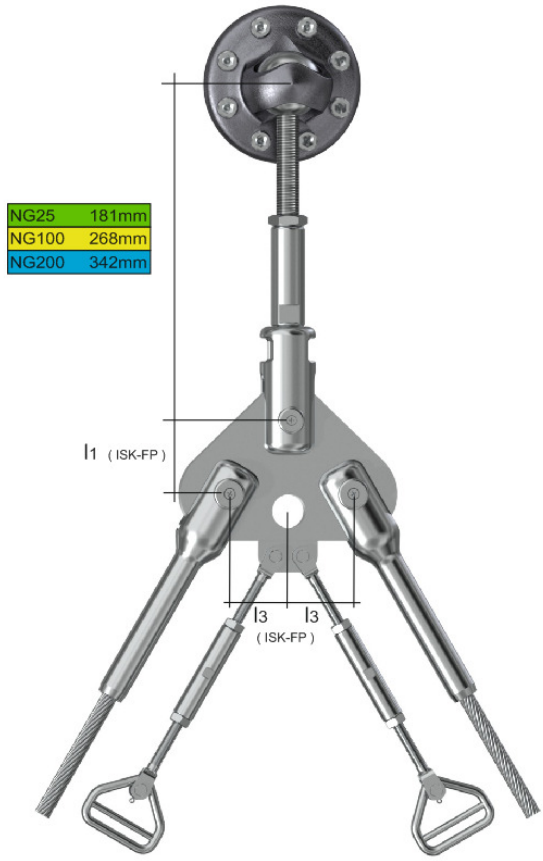
The TENNECT system is a duplicate part whose dimensions are known from TENNECT catalogue. Thereby the interface between steelwork and membrane manufacturing will be much easier, because all involved parties can do planning on the same basis.

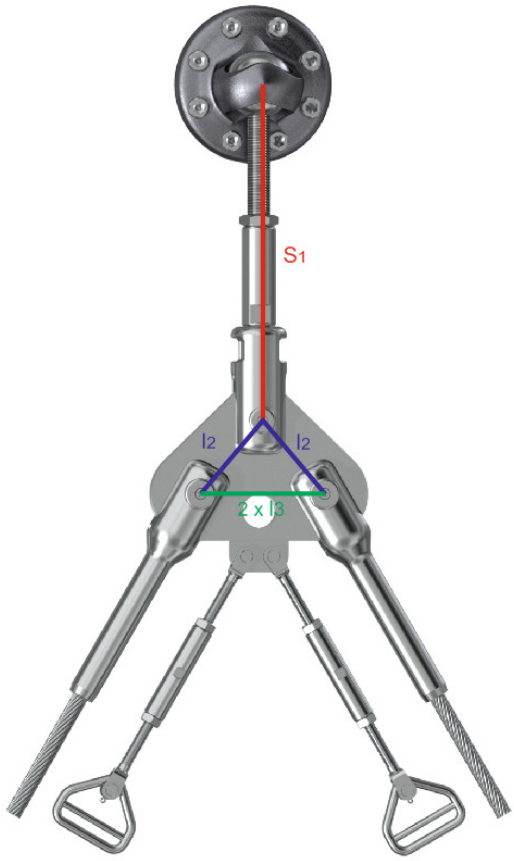
In the following chapter a feasible coordination between steel and membrane parts is shown as it would be work in most of the cases.

2.2. Component dimensions

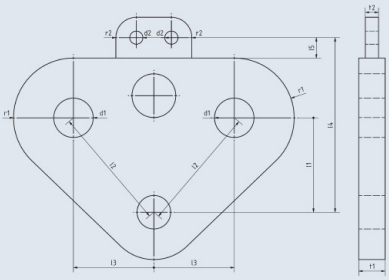
All component dimensions can be taken from the TENNECT catalogue.

In the following graphic all required part dimensions are shown:





Dimension TENNECT system



NG	Artikelnummer Part number	d1	d2	l1	l2	l3	l4	l5	r1	r2	t1	t2
25	ISK-FP25-8	13	6	34	45	29	63	10	19	8	10	7
100	ISK-FP100-10	17	7	55	70	45	96	14	28	12	13	9
100	ISK-FP100-12	21	7	55	70	45	96	14	28	12	13	9
100	ISK-FP100-14	24	9	65	85	55	120	14	41	14	18	9
100	ISK-FP100-16	27	9	65	85	55	120	14	41	14	18	9
200	ISK-FP200-16	27	9	65	85	55	124	14	45	14	21	9
200	ISK-FP200-18	30	9	74	95	60	139	14	51	14	25	9
200	ISK-FP200-22	34	13	85	110	70	165	22	58	20	25	12
200	ISK-FP200-26	37	13	85	110	70	176	22	69	20	25	12

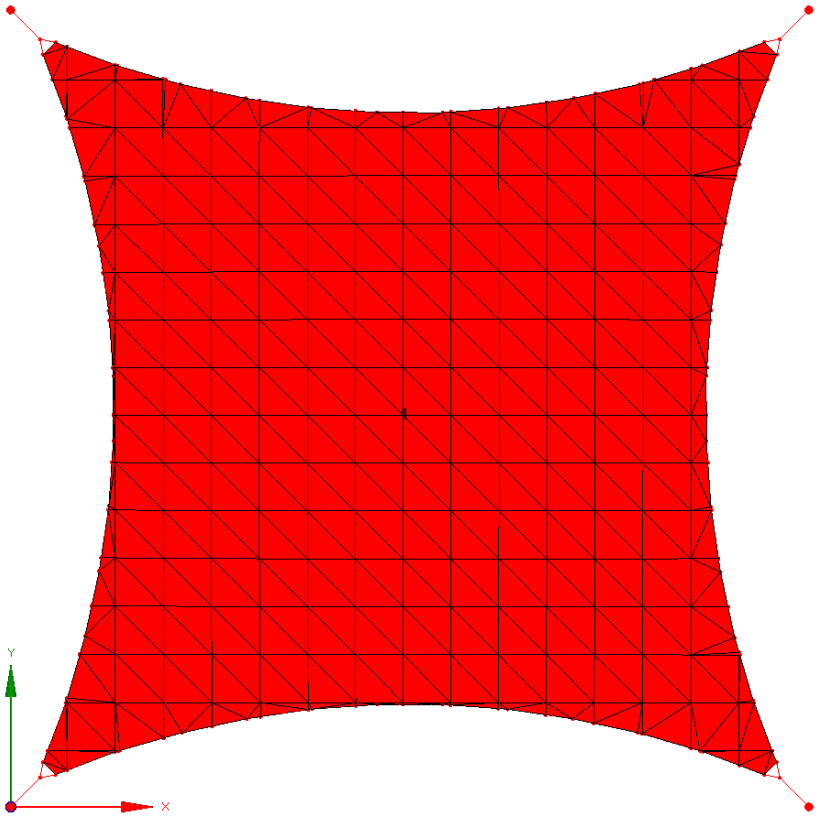
The determined triangle can be used as a strut and tie model for structural analysis or for form finding. After a further iteration or calculation the membrane will arrange with the strut and tie model depending on the level of prestressing. This proceeding offers several advantages:

1. Because of the arrangement of the strut and tie model to the membrane shape refer to the level of prestressing, the real occurring deformation and rotation is known by the result of the calculation. With high probability the fixation detail will work in reality with that knowledge of calculation.

2. The membrane shape is in balance with the border cable and the TENNECT detail. The subsequent cuttern pattering will be much easier, because the place of the fork soll is known as well as the length of cable.

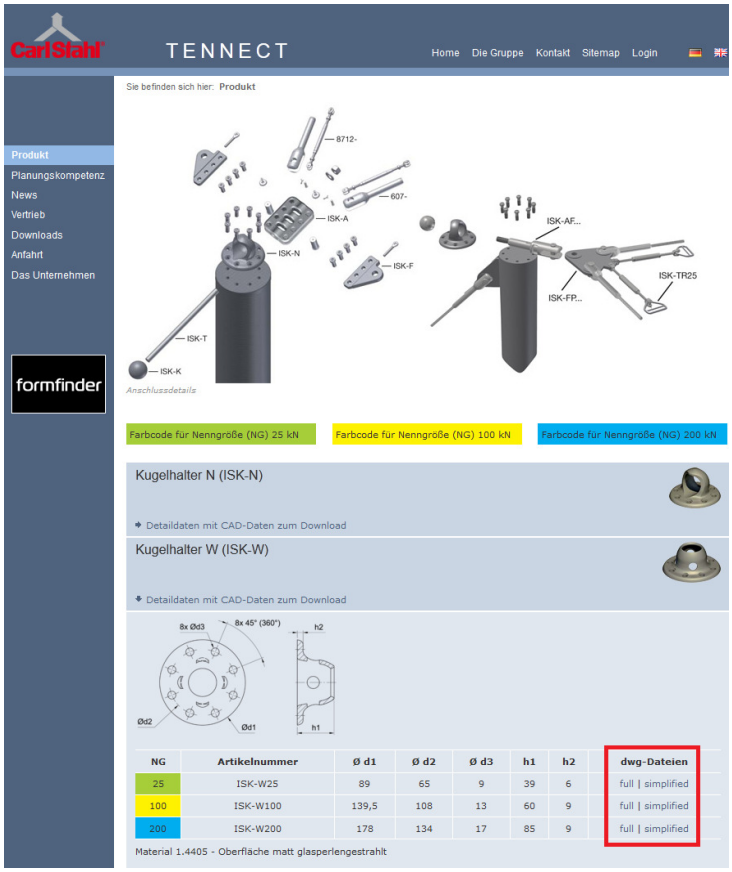
3. The exactitude of shop drawing will get higher

In the following graphic the membrane shape is given after iteration. Noticeable is the new form of the strut and tie model. Thereby that the desired length of the strut and tie model has been adjusted and the system has been spatial straightened, the form of the membrane has changed too. In the area of the fixation details the membrane shape got smaller.

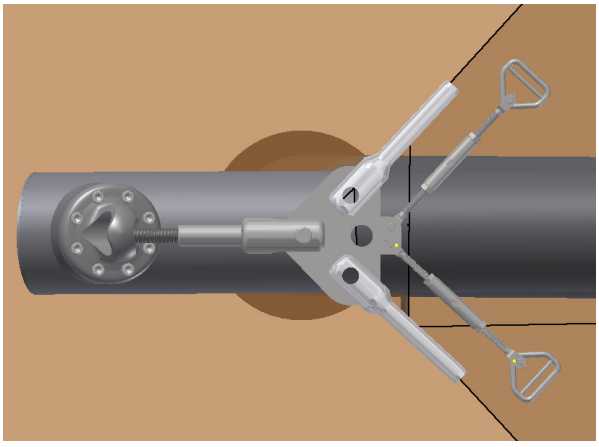


Shape after iteration

Three-dimensional parts can be downloaded from the homepage: www.tennect.com and be imported in the construction program. In this manner the calculated membrane shape and the TENNECT parts can be integrated in the shop drawings.



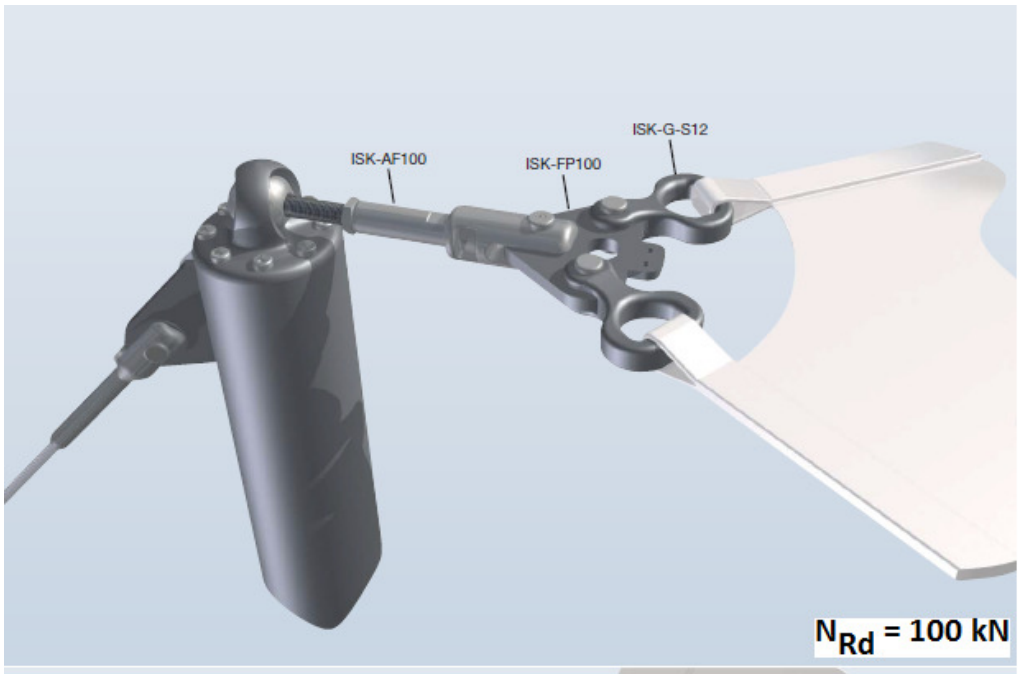
Screenshot homepage

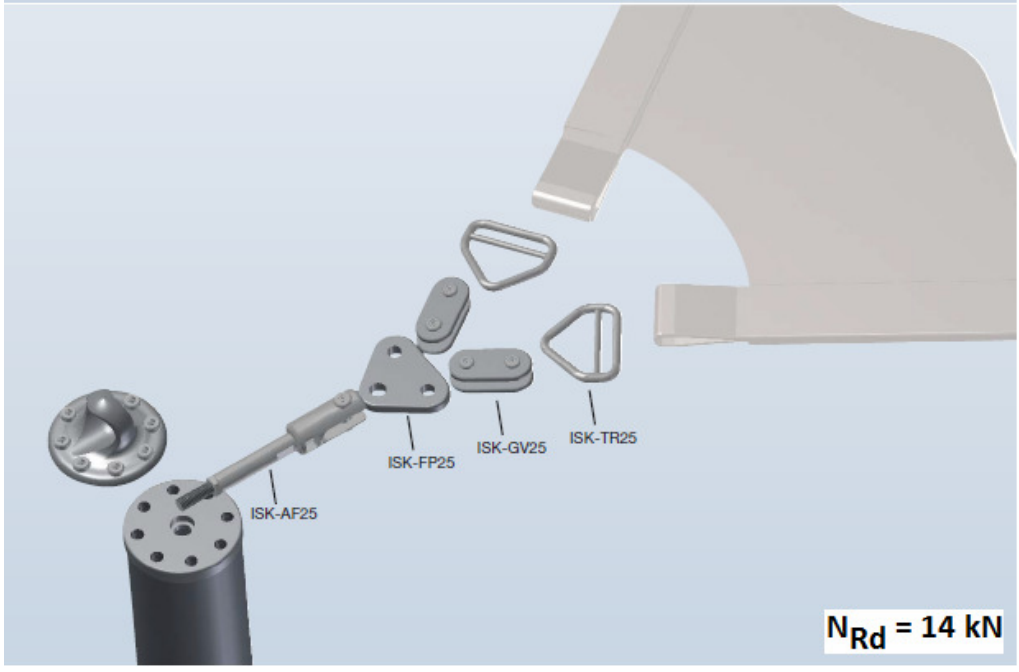


Screenshot construction program

3. Connecting a belt

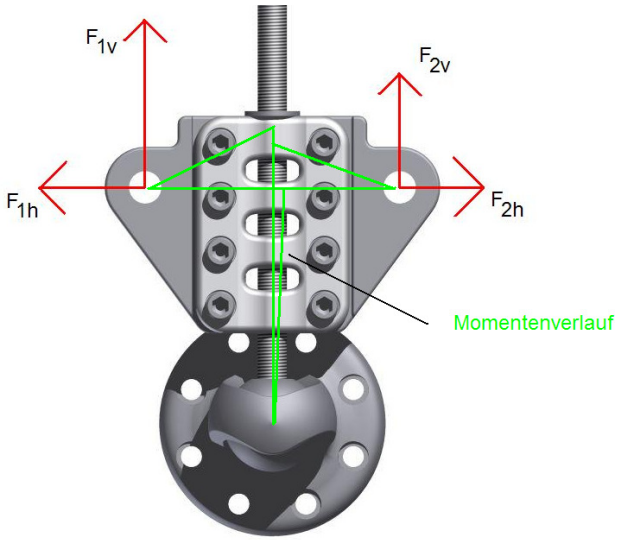
In principle the approach is similar to the fixation of border cables. The system TENNECT offers two different fixation details. The triangle can be used for maximum load N_{Rd} = 14 kN. Using higher loads the belt holder S12 must be used, which is compatible to the fork connection plate ISK-FP100-14.





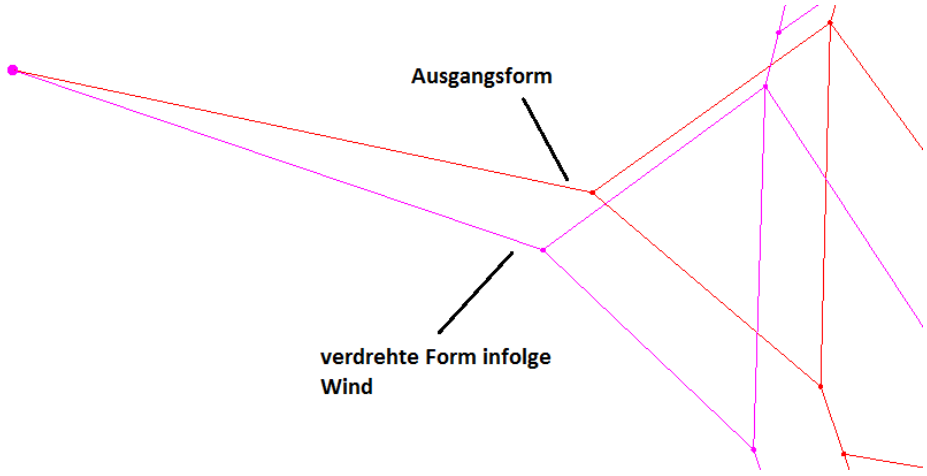
4. Why adjustable fork?

If two cables with different normal forces in case of wind, snow etc. are connected at the ball holder, the result is a jump of bending moment at the axis of the threaded road which must be taken up by the treaded road. The moment of inertia of the threaded rod is in most cases not designed for it. A failure will occur.



Assembly of TENNECT system with unequal border cable forces

In the following graphic the initial position of membrane corner (red marked) is given as well as the deformed strut and tie model. The system has been twisted at the intersection between adjustable fork and fork connection plate. Using a rigid system the threaded rod would have got a bending load.



Screenshot from calculation

5. Care instructions

During and after installation the surface can be polluted by tramp iron. The combination of different materials can cause contact corrosion.

To protect the surface we advise to clean all TENNECT components after assembly with suitable cleaning agent and to make an additional surface coating. The procedure should be repeated regularly.

Suitable cleaning agents and surface protection see TENNECT catalog page 19.

Further details concerning characteristics, cleaning and care instructions of stainless steel see:

www.edelstahl-rostfrei.de

www.euro-inox.org