SHADESIGN Twister-Sail SHADEONE®: Load ratings (wind test), forces acting on it, permitted loadings, foundations

V1708.1

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Introduction:

The shadesign Twister-Sail SHADEONE is a rollable sun sail. The fabric is fixed to the base by a sail connection rail and several wall brackets. Another 2 fixed mounting points are the tensioning elements in the form of pillars (BASIC+INOX system) or wall tensioners (STRUCTURE system) which are positioned opposite the outer ends of the sail connection rail.

Between them, the fabric shaft furls and unfurls the rolled fabric with a tensioning cable from each pillar running under spring preload to either end of the fabric shaft, reeling and unreeling in contra-rotation to the fabric.

This document illustrates the maximum achievable and permitted tensile forces on the entire system and on the individual components of the Twister-Sail, providing details of the mounting materials (e.g. minimum load-bearing capacities).

It also provides details of the dimensions of mobile foundations.

1. Determining the load capacity of the SHADEONE Twister-Sail with a wind test

Shading products are normally rated by the scale of wind forces defined in DIN EN 13561.

The Twister-Sail was not subjected to any institutional wind classification system

- in part because no test standard exists for sun sails that describe how a test should be conducted (for awnings, there is a standard (DIN EN 13561), i.e. one that applies a wind loading STATICALLY that is 100% repeatable and
- in part because wind classification is not a mandatory requirement for sun sails.

Despite this, and to obtain an assessment of wind force characteristics, the Twister-Sail was subjected to an in-house shadesign wind text equivalent to the awning standard, and conducted with the sail fully deployed (W x A = 6.0 x 5.75 m). During this, the aforementioned standard for awnings (specifically the test for rail-guided back-pull systems) was interpreted and adapted to suit the Twister-Sail.

Photos: shadesign wind test – links: Strain relieved, right: Maximum load (shortly before end of test)

Results of the wind test (in acc. with DIN EN 13561 - rail-guided back-pull systems):

- The Twister-Sail (W x A = 6.0 x 5.75 m) can contend with wind forces up to 8 (up to a wind speed of 62 km/h) stand, which is equivalent to the lower range of force 5 on the Beaufort scale, and with this particular sail size, it equates to a load of 405 kg (=4050N) in the tensioning cable, and 810 kg (=8100N) respectively on the entire connection rail.
- At wind force 7 (from a wind speed of 56 km/h), equivalent to the standards-based safety loading of force 4 on the Beaufort scale and, for this size of sail, to a load of roughly 275 kg (=2750N) in the tensioning cable, and 550 kg (=5500N) respectively on the entire connection rail, only minimal distortion is caused to the pillars.
- At wind force 6 (from a wind speed of 49 km/h), equivalent to the standards-based safety loading of force 3 on the Beaufort scale and, for this size of sail, to a load of roughly 275 kg (=2250N) in the tensioning cable, and 455kg (=4550N) respectively on the entire connection rail, only minimal distortion is caused to the pillars.

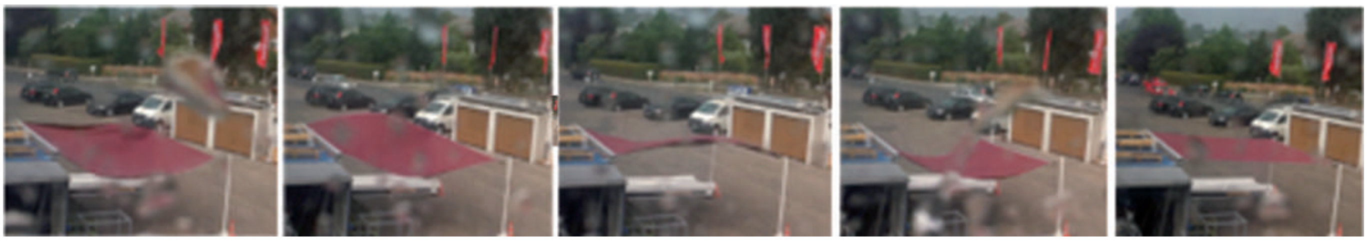
Additional information: The spring elements in the individual tensioning elements are designed for a tensile strain of about 30 kg (300N) after which the spring element is damped and moves to its limit stop (no further elongation and over-stretching of the springs takes place, and no more tensioning cable is released from the tensioning element).

2. Permitted and calculated loadings of the SHADEONE Twister-Sail and its components

Since the shadesign in-house wind test is not based on a standard (there is no standard for sun sails), for reasons to do with insurance legislation, all shadesign documents stipulate that the Twister-Sail should be retracted in windy, rainy or snowy weather, and must not be left unsupervised when it is deployed, i.e. unfurled.

Several years of experience in field tests with the Twister-Sail in all weathers support the results from the shadesign in-house wind tests, demonstrating that the SHADEONE Twister-Sail is very stable indeed in windy conditions (please look at the video example in our Dropbox area for specialist retailers) and that the sail can remain unfurled, i.e. extended, for the same length of time as people find it pleasant and bearable to sit outside (during storms, no-one would normally wish to remain under the sun sail). In keeping with any other sun protection product, wind imposes a load on the system and influences the service life of the product.

Series of photos: Video clips of the Twister-Sail in stormy conditions



Since the Twister-Sail has been found to be resistant to high wind speeds, tension loadings of wind force 0 to wind force 3 are quoted (depending on design).

Tensile loads on the tensioning element (on the cable reversal unit):

Wind force 0:	45kg (=450N)
Wind force 1:	2.5kg x sail surface area [m2], but at least 45 kg (N = kg x 10)
Wind force 2:	4.2kg x sail surface area [m2], but at least 45 kg (N = kg x 10)
Wind force 3:	6.7kg x sail surface area [m2], but at least 45 kg (N = kg x 10)

Example 1.1: Sail surface area = 5 m2, Wind force 2 » tensile strain 45 kg (=450N)
Example 1.2: Sail surface area = 25 m2, Wind force 1 » tensile strain 62,5 kg (=625N)

Tensile loads on the two outer wall consoles:

Wind force 0: 45kg (=450N)
Wind force 1: 2.5kg x sail surface area [m2], but at least 45 kg (N = kg x 10)
Wind force 2: 4.2kg x sail surface area [m2], but at least 45 kg (N = kg x 10)
Wind force 3: 6.7kg x sail surface area [m2], but at least 45 kg (N = kg x 10)

Example 2.1: Sail surface area = 5 m2, Wind force 2 » tensile strain 45 kg (=450N)
Example 2.2: Sail surface area = 25 m2, Wind force 1 » tensile strain 62,5 kg (=625N)

Tensile loads on the inner wall consoles:

Wind force 0: 30kg (=300N)
Wind force 1: 1.0 kg x sail surface area [m2], but at least 30 kg (N = kg x 10)
Wind force 2: 1.5 kg x sail surface area [m2], but at least 30 kg (N = kg x 10)
Wind force 3: 2.0 kg x sail surface area [m2], but at least 30 kg (N = kg x 10)

Example 3.1: Sail surface area = 5 m2, Wind force 2 » tensile strain 30kg (=300N)
Example 3.2: Sail surface area = 25 m2, Wind force 3 » tensile strain 50kg (=500N)

The retaining material (screws, dowels etc.) must be selected to suit the substrate and be dimensioned in accordance with the above load details plus the standards-based safety factor.

The line of application can vary by up to max. +/-30° from the direct line between sail connection rail and the tensioning element on the cable reversal unit.

3. Mobile foundation (e.g. filled wood trough) for pillars (tensioning element BASIC + INOX):

For a support surface under the foundation trough (width W min. 0.7 m, depth D = 1m), depending on the wind class design, the total weight of a trough is calculated as follows (basis for calculation: Centre of gravity of the trough is roughly equivalent to the tilting edge near the sail. If the centre of gravity is located centrally in the trough, the weight of the trough doubles):

Wind force 0: Trough weight (T=1m) = 45 kg x pillar length [m]
Wind force 1: Trough weight (T=1m) = 2.5 kg x pillar length [m] x sail surface area [m2], but a minimum of 45 kg x pillar length [m]
Wind force 2: Trough weight (T=1m) = 4.2kg x pillar length [m] x sail surface area [m2], but a minimum of 45 kg x pillar length [m]
Wind force 3: Trough weight (T=1m) = 6.7kg x pillar length [m] x sail surface area [m2], but a minimum of 45 kg x pillar length [m]

Example 4.1:
Pillar length =3m, sail surface area = 5 m2, Wind force 2
» Trough weight (T=1m) = 135 kg (centre of gravity opposite the tilting edge of the trough)
» Trough weight (T=1m) = 270 kg (centre of gravity in centre of trough)

Example 4.2:
Pillar length =2.4m, sail surface area = 25 m2, wind force 1
» Trough weight (T=1m) = 150 kg (centre of gravity opposite the tilting edge of the trough)
» Trough weight (T=1m) = 300 kg (centre of gravity in centre of trough)

If the depth of the trough T is changed, the total weight of the trough then needs to be recalculated, as follows:
Trough weight (trough depth_new [m]) = trough weight (T=1m])/trough depth_new[m])

Example 4.3 (same as Example 4.1):
Pillar length =3 m, sail surface area = 5 m2, wind force 2, trough depth_new=0.75 m
» Trough weight (T=0.75 m) = 180 kg (centre of gravity opposite the tilting edge of the trough)
» Trough weight (T=0.75 m) = 360 kg (centre of gravity in centre of trough)

Presentation of mobile foundation + concepts