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APIB Test Specification No. 22

Air-inflated cushion structure

01.06.2014 / 22-14en
Version 1.02

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22.1 General information

The test specifications for the "Air-inflated cushion structure" component category includes additional, component-specific provisions for the standard test, which are not governed by the general test specifications.

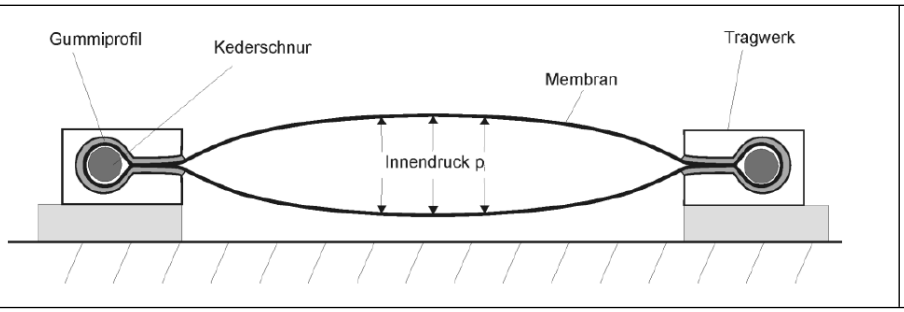
Buildings of this category have a load-bearing system that is either rigid and self-supporting, or flexible (i.e., cable supported). The load bearing system supports air-inflated “cushions” made of thermoplastic polymers (e.g., ETFE). The air-inflated cushions are made of two, three, or more membranes (which are referred to as “foils”). The load transfer at the edges of the cushions is linear, often through components referred to as “rails.” The forces act mainly in-plane of the cushion and are transferred from there to the load bearing building structure. Only limited forces perpendicular to the cushion plane can be sustained, in comparison to in-plane forces.

22.2 Intended use

Air-inflated cushion structures may be used on the façade and on the roof.

22.3 Test specimen

The test specimen consists of a supporting structure, air-inflated cushion, seam and connections to the supporting structure (Fig. 1 and 2). The connections to the supporting structures have to be completed with original accessory components used in practice. The specimen cushion should have a minimum surface area of 1.5m^2. The internal pressure, p_i, must be adjusted by the system supplier for normal and for severe weather conditions.



Translations for Fig. 1:

Gummiprofil = rubber gasket

Kederschnur = cordlike profile

Innendruck= internal pressure

Tragwerk = supporting structure incl. rail

Membran = foil

Figure 1 Cross section of the test specimen (Internal pressure, p_i > external pressure p_a)

22.4 Test set-up

The test specimen with the built-in air cushion is horizontally positioned. The air cushion is inflated to a pressure, p_i + 10%. The pressure deviation may not exceed more than -10%. The bottom foil of the cushion shall not have contact with the substrate underneath it.

22.5 Specimen storage prior to testing (conditioning)

None.

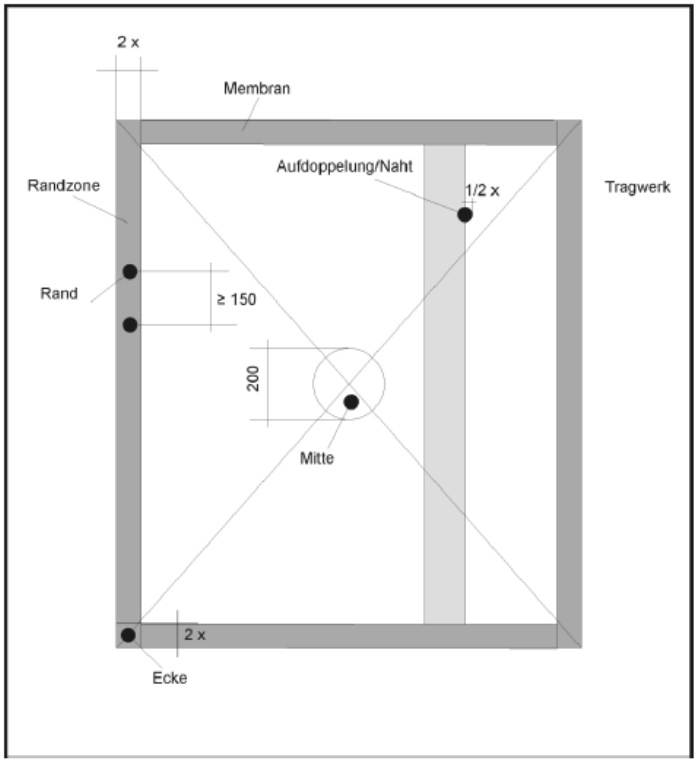
22.6 Specimen treatement before testing

The surface is cooled with ice flakes for 3 minutes before projectiles are fired. The membrane surface is wetted using a sponge three times at intervals of 30 s. Testing must start, at the earliest, one minute after the 3rd wetting, and at the latest, 2 minutes after the 3rd wetting.

22.7 Target area and angle of impact

The test specimen is impacted at the following locations (Fig. 2):

- Centre: in the specimen centre within a circle having a radius of 100 mm.
- Edge: within the edge zone whose maximum width is twice the projectile diameter.
- Corner: within the edge zone. The maximum distance off the free edge is 2 projectile diameters.
- Overlap/seam (if present): The target location lies at the immediate edge of the overlap or seam.



Translations for Fig. 2:

Randzone = Edge zone

Aufdopplung/Naht = Overlap/Seam

Tragwerk = Support structure

Rand = Edge

Mitte = Centre

Ecke = Corner

Figure 2 View of target locations on the inflated cushion in the construction frame (dimensions in millimetres, x = diameter of projectile)

Several tests can be performed on one test specimen, but only if the distance between the impacted locations is at least 150 mm. Any other vulnerabilities must also be tested (refer to part A). The impact angle is 90° in relation to the supporting structure.

22.8 Projectile

In addition to testing with a round projectile, air-inflated membrane structure specimens must also be tested using a projectile simulating an irregular shaped hail stone. Testing and projectile requirements are given in part A.

22.9 Component function

The impacted specimen is tested for watertightness, mechanical performance, and appearance.

22.10 Damage criterion

Watertightness function: The specimen is considered to be watertight as long as no perforations, no cracks, and no delamination of the seams are present.

Mechanical performance function: The specimen is considered to be undamaged, if no material elongation beyond the elastic limit or delamination is visible. If any material elongation beyond the elastic limit or delamination is visible, the specimen is considered to be damaged.

Appearance function: The appearance of the specimen is considered to be undamaged if no indentations greater than 10 mm are visible.

22.11 Measuring methods

Watertightness function: When examined visually, if no perforation, peeling/delamination are visible, the specimen is submerged in water. If bubbles are visible at any target location, the specimen is considered to be damaged.

Appearance function: Appearance is visually checked under all light conditions and at all possible angles at a distance of 5 m from the test specimen.

22.12 Existing standards and regulations (not exhaustive)

- DIN EN 15619: Mit Kautschuk oder Kunststoff beschichtete Textilien - Sicherheit Fliegender Bauten (Zelte) - Spezifikation für beschichtete Textilien für Zelte und zugehörige Bauten; Deutsche Fassung EN 15619:2008+A1:2010, Ausgabedatum: 2010-08
- DIN 18204: Raumabschließende Bauteile aus textilen Flächengebilden und Folien (Zeltplanen) für Hallen und Zelte - Teil 1: PVC-beschichtetes Polyestergewebe, Ausgabedatum: 2007-05
- ASTM D3159-2010: Specification for modified ETFE fluoropolymer molding and extrusion materials
- Literatur: Entwicklung von Ressourcen schonenden Bausystemen mit Membran (G. Grunwald 2007)