

Classification of Roof Underlay Materials under DUKO

DUKO – Dansk Undertagsklassifikationsordning ApS

This document is a translation of the document *Krav til undertagsmaterialer under DUKO – Dansk Undertagsklassifikationsordning*. In case of inconsistencies the Danish version supersedes this translation.

DUKO classification of roof underlays is based on a combination of material properties, an assessment of the buildability of the product and a documented period of experience with the product.

DUKO divides underlay materials into the following exposure classes: Høj (“High”), MiddelHøj (“Medium High”), MiddelLav (“Medium Low”) and Lav (“Low”). For each of these exposure classes, there are a set of requirements with respect to properties and buildability that the underlay materials in the class must meet. An underlay must fulfil certain specifications if, for example, it is to be categorised as a Class MH underlay material.

Documentation

Before a product can receive a class designation, documentation for certain properties must be submitted. The suppliers’ application form lists the properties and test standards on which the classification is based. If the standard in question does not apply to a certain underlay product, then the standard applicable to the product is indicated, or possibly the fact that there is no relevant standard (e.g. for tear resistance for sheet products).

Material properties

Various material properties of an underlay product determine the exposure classification it receives. The classification is based on the products being divided into rigid underlays and flexible sheets. The two types of materials are so different that it is meaningless to have the same requirements applying to both. Flexible sheet products fastened to boards or panels must meet flexible sheet requirements.

Flexible sheets

Requirements to the material properties of flexible sheets are shown in the table below.

Exposure class	H		MH	ML	L
	Extra	Normal			
Tensile strength, longitudinal and transverse (N/50 mm)	≥ 500	≥ 500	≥ 500	≥ 200	≥ 100
Elongation, longitudinal and transverse (%)	≥ 15	≥ 15	≥ 15	≥ 15	≥ 10
Tear resistance, longitudinal and transverse (N)	≥ 150	≥ 150	≥ 150	≥ 100	≥ 25
Flexibility at low temperature (°C)	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0
Mass per unit area (g/m ²)	≥ 100	≥ 100	≥ 100	≥ 100	≥ 50
Tent effect (g)	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15
Water vapour diffusion resistance (GPa m ² s/kg; only for materials intended to be open to diffusion)	≤ 3	≤ 3	≤ 3	≤ 3	≤ 3
Rigid underlay	Yes	Yes	No	No	No
UV-B resistance	Passed				
Abrasion resistance	Passed				
Peel strength of joints	Passed				

The classification criteria are based on the following test standards

Tensile strength	DS/EN 13859-1
Elongation	DS/EN 13859-1
Tear resistance	DS/EN 13859-1
Flexibility at low temperature	DS/EN 1109
Weight per unit area	DS/EN 1849-2
Tent effect	NT Build 488
Water vapour diffusion resistance	DS/EN ISO 12572
UV-B resistance	Ageing according to ASTM G154-00a: 500 h, UV-B 313 lamps, 32 J/s m ² irradiance, 24 h cycle, 50 °C. Watertight after ageing according to DS/EN 1928; 200 mm water column pressure for 24 hours. < 20 % change in tensile strength according to DS/ EN 12310 after ageing. < 20 % change in tear resistance according to DS/EN 12311 after ageing.
Abrasion resistance, installation	Abrasion testing according to ASTM D4060/EN 438: CS 17 wheel, 0.5 kg load, 5000 cycles on the top side of the product. Watertight after abrasion testing according to DS/EN 1928: 200 mm water column pressure for 24 hours.
Abrasion resistance, use	Test method NT Build 307: Wind load: 2100 N/m ² , underlay is placed on plywood, on the overlaps at every 100 cm 25 x 45 mm chemically treated battens, fixed at every 30 cm, are placed. The underlay must not deflect more than 25 mm above the plywood between 2 battens.
Peel strength of joints	50 mm wide joints fastened and conditioned for 48 hours at 23 °C. Ageing according to DS/EN 13859-1. Peel strength before and after ageing according to DS/EN 12316: 100 m/min and temperature of 23 °C. Initial peel strength = 20 N/5 cm < 20 % change in peel strength after ageing.

Flexible sheets on a rigid underlay

Class MH underlay products can be elevated to Class H if they are laid on a rigid underlay. The rigid underlay must fulfil the following minimum requirements with respect to load-bearing capacity and flexural stiffness.

Underlay of boards wider than 1 m

Load-bearing capacity: MK-approved as a "trædesikkert underlag" or a bending moment capacity greater than 250 Nm/m. Stiffness: Flexural stiffness, EI that is greater than 1 kNm²/m

Underlay of boards or solid wood panelling with a width of less than 1 m

Load-bearing capacity: MK-approved as a "trædesikkert underlag" (human step load resistant underlay) or a modulus of rupture greater than 750 Nm/m. Stiffness: Flexural stiffness, EI, that is greater than 3 kNm²/m

Underlays made from boards must have supported joints. However, supported joints are not required if testing for MK approval as a "trædesikkert underlag" (human step load resistant underlay) is documented and passed. Service Class I (fugtklasse I) criteria, short-term duration of load, characteristic strength values and mean values of stiffness, all according to DS 413:2003, are to be used in documenting the strength and stiffness of wood based products.

Flexible sheets must be fastened to the rigid underlay along all joint overlaps using suitable adhesives with a documented durability and water tightness after UV ageing. An acceptable test method could be tent effect testing according to NT Build 488.

Rigid roof underlays without flexible sheeting

Boards or panels used as a roof underlay without flexible sheeting must have a water-repellent surface. The requirements that such boards and panels must meet are shown in the table below.

Exposure class	H	MH	ML	L
Bending moment capacity, longitudinal (M_u , Nm/m see Equation 1 below)	≥ 250	≥ 150	≥ 50	≥ 25
Change in length after humidity change from 30 % to 85 % RH (%)	≤ 0.2	≤ 0.25	≤ 0.3	≤ 0.5
Change in thickness after 24 hours' immersion in water (%)	≤ 2	≤ 10	≤ 25	≤ 30
Flexural stiffness, longitudinal (EI , kN m ² /m, see Equation 2 below)	≥ 1	≥ 0.1	≥ 0.01	≥ 0.01
Tent effect (g)	≤ 15	≤ 15	≤ 15	≤ 15
Water vapour diffusion resistance (GPa m ² s/kg; only for materials intended to be open to diffusion)	≤ 3	≤ 3	≤ 3	≤ 3

Equations:

- $M_u = t^2 f_m / 6$ where f_m is flexural strength and t is thickness.
- $EI = Et^3 / 12$ where E is flexural stiffness and t is thickness.

Calculations and classification requirements are based on the test methods in the following standards:

f_m	DS/EN 14964	Change in length	DS/EN 318
E	DS/EN 14964	Change in thickness	DS/EN 317
Tent effect	NT Build 488	Water vapour diffusion resistance	DS/EN ISO 12572

Practical experience

Before a material can be classified as H Class or MH Class, there must be at least five years of documented practical experience with it under 'Danish conditions'. In other words, practical experience with the material must be obtained in a climate that is similar to the climate in Denmark and under roofing materials corresponding to the open roofing materials and roofing details used in Denmark.

If no five-year period of practical experience with the specific product can be documented, then an insurance policy can be obtained that provides a full product guarantee, i.e. full coverage of materials and labour in case of a failure of the product due to inadequate product characteristics.

Buildability

Buildability is assessed in four categories: identification of the material, roof details, storage and installation, and repair. The requirements for the different exposure classes of materials, both flexible sheets and rigid underlays to be used without flexible sheeting, are stated in the table below:

Exposure class	H	MH	ML	L
Material identification	Acceptable	Acceptable	Acceptable	Acceptable
Roof details	Acceptable	Acceptable	Acceptable	Acceptable
Storage and installation	Acceptable	Acceptable	Acceptable	Poor
Repair	Acceptable	Acceptable	Acceptable	Poor

Quality management

DUKO prefers third party audit of the product quality. This is reflected in the way that DUKO assesses buildability. However, third party audit might, in exposure classes L, ML, MH and H-Normal, be replaced by concurrent fulfillment of the following 4 requirements:

1. Use of underlay raw materials from a supplier with a third party audited ISO 9001 quality management system.
2. Annual third party (competent independent institute) report after audit of the manufacturers own test results that documents that the production in the preceding year fulfils the DUKO classification requirements.
3. Annual testing by third party (competent independent institute) of the following material properties:
 - a. Flexible sheets:
 - i. Tensile strength, longitudinal and transverse
 - ii. Elongation, longitudinal and transverse
 - iii. Tear resistance, longitudinal and transverse
 - iv. Flexibility at low temperature
 - v. Water tightness
 - vi. Water vapour diffusion resistance (only for materials intended to be open to diffusion)
 - b. Rigid roof underlays
 - i. Bending moment capacity
 - ii. Flexural stiffness
 - iii. Change in length in humidity after humidity change from 30 % to 85 % RH
 - iv. Change in thickness after 24 hour immersion in water
 - v. Water vapour diffusion resistance (only for materials intended to be open to diffusion)
4. Unprompted annual submission of the report and the test results no more than 10 workdays before the date for renewal of classification.