Research on airtightness durability in Norway

Tore Kolstad Linløkken[1] and Bozena Dorota Hrynyszyn*[1]

[1]Department of Civil and Environmental Engineering, NTNU, NO-7491 Trondheim, Norway

Corresponding author: bozena.d.hrynyszn@ntnu.no

SUMMARY

Achieving adequate airtightness of a building envelope is crucial for preventing moisture-related damages in cold and humid climate zones, such as in Norway. Leaky joints and perforations in air and vapor barriers are often critical points where damaging air leakages arise. Thus, the durability of products, such as adhesive tapes, is crucial to ensure a proper airtightness and performance of critical building details and overall constructions. Having in mind that deterioration of airtightness due to failure of the adhesive systems leads usually to increased heat losses and in turn an increased heat demand, the energy efficiency can be significantly weakened as well. The TightEN competence project carried out in the years 2019-2022 and leaded by one of Europe's largest research institutes, SINTEF, in cooperation with industry and university partners, among others the Norwegian University of Science and Technology (NTNU) in Trondheim, aimed to highlight and strengthen the research on adhesive tapes and develop test methods adequate in the cold climate conditions to ensure a proper durability of sealing solutions over time so that energy efficiency is maintained throughout buildings' lifetime.

KEYWORDS

Airtightness durability, Building envelope, Experimental test method, Durability of joints, Adhesive tapes.

1 INTRODUCTION

In recent years, adhesive tapes have gained popularity as a mean of air-sealing joints and perforations in the building envelope. Early on, these tapes had a reputation for having poor adhesive properties and durability. More recently, along with further product development, adhesive tapes have been recognized for their ability to provide adequate air tightness [1]. The use of tape also allows for innovative solutions, along with a simple and quick application, making it a highly convenient option for air-sealing details.
However, as adhesive tapes represent a relatively recent way of air-sealing buildings, there are concerns and uncertainty regarding the long-term durability of the products and solutions. Current evaluation methods used in the certification of products and systems are primarily based on assessing the mechanical and adhesive properties of products, rather than addressing the airtightness directly.

2 METHOD

In connection to the TightEN competence project, sub-projects were established in cooperation with MSc-students at NTNU to contribute to the development of a new test method to be used for certification and application of adhesive tapes in building skins regarding the Norwegian technical requirements, TEK17 [2]. Based on relevant theoretical background and including

knowledge and experience from established methods for evaluation of tape joints durability, currently being used [3-9], a new testing methodology addressing local, Norwegian, conditions was proposed to evaluate tape products and systems for air-sealing application in buildings with sufficient accuracy, reproducibility, and repeatability regarding their performance in the long-term. The new test method proposed, based on air permeability measurements using a Test Stand (see Figure) made from welded-together steel plates, was further developed, and presented in the MSc thesis, *Development of a Test Method for Evaluating Durability of Adhesive Tapes in Construction*, from 2023 by Tore Kolstad Linløkken [10]. The durability of products is assessed by measuring and comparing permeability rates before and after artificial ageing. The aptness of the method is assessed through a measurement program involving six different material samples, each made by combining an adhesive tape with a substrate material. Two substrate materials were involved, a vapor barrier and a roofing membrane, along with three different adhesive tapes. Parallelly to the air permeability tests, the material samples were tested for peel resistance according to the Norwegian standard NS-EN 12316-2:2013, before and after the same artificial ageing procedures to examine how the two methods compare with regard to durability assessment.

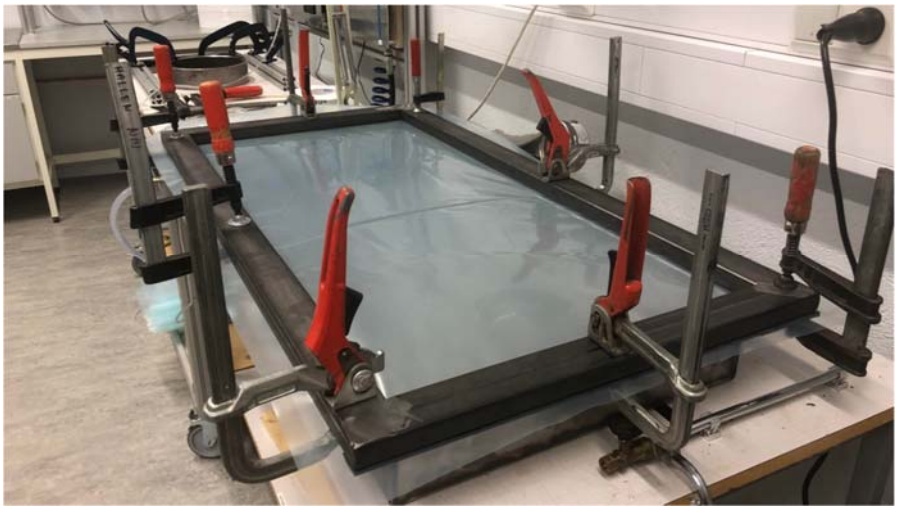

Figure: Test Stand leakage evaluation setup.

3 RESULTS

The artificial ageing procedures led to significant degradation of air permeability across all material samples. Changes in peel resistance were comparatively small, and three out of six material samples even exhibited increased peel resistance after ageing. Fluctuating system leakage contributed to uncertainty in the permeability measurements and made it difficult to determine what share of air leakage could be attributed to the tape joints themselves. Additionally, as permeability rates seemingly depended on the implementation quality of individual specimens, the method in its current form is not perceived as reliable enough to precisely determine the airtightness inherent to distinctive tape products. However, the method is considered applicable for verifying that permeability rates remain below relevant threshold values after ageing.

The system leakage constitutes a systematic uncertainty when evaluating the air permeability of the test samples. A series of tests have thus been performed in an effort to evaluate the magnitude and variations of the system leakages. Results from these tests are used to assess whether the system leakages vary along with the installation technique, and in turn how the system leakage can be minimized. The Test Stand is considered highly configurable, as it allows

for the specimen layout to be altered, for instance by utilizing solid boards as substrates and including additional components, such as adhesive pipe collars. This versatility makes it possible to perform permeability tests on the same standard substrates already used in the Technical Approval of air and vapor barrier tapes. Furthermore, specimens can be inverted, enabling exposure to both positive and negative pressure differences. The permeability of a specimen as a whole expressed as leakage per unit area, can then be used for comparison against predefined threshold values. In terms of durability evaluation criteria, it is considered more suitable to establish absolute threshold values for permeability before and after ageing, in contrast to current guidelines for peel and shear resistance evaluation, in which durability is evaluated based on the relative change in material properties after artificial ageing.

4 CONCLUSIONS

Although the method in development displays limitations in its current form, it is regarded as a promising concept. Through further development, the method is believed to be suitable for potential integration into wider evaluation programs addressing adhesive tape durability, supplementary to existing methods such as defined in NS-EN 12316-2:2013 [11].

5 ACKNOWLEDGEMENTS

The Research Council of Norway financially supported this research. The authors would like to thank our colleagues from SINTEF, within the research project TightEN (project no. 102020444-2), who provided expertise that assisted the research.

6 REFERENCES

[1] Skogstad, H. B., Kvalvik, M. and Jelle, B. P. (2010), 'Bruk tape med varig heft', https: //www.sintef.no/globalassets/upload/artikkel-10-byggaktuelt.pdf.
[2] Direktoratet for Byggkvalitet (2017), 'Byggteknisk forskrift TEK17', https://dibk.no/ regelverk/byggteknisk-forskrift-tek17/.
[3] Fufa, S. M. et al. (2017), 'Durability evaluation of adhesive tapes for building applications', Construction and Building Materials .
[4] Møller, E. and Rasmussen, T. (2020), 'Testing Joints of Air and Vapour Barriers, Do We Use Relevant Testing Methods?'.
[5] NORDTEST (2000), 'NT BUILD 495: Building materials and components in the vertical positions: Exposure to accelerated climatic strains'.
[6] Sletnes, M. and Frank, S. (2020), 'Performance and durability of adhesive tapes for building applications. from product documentation to scientific knowledge (and back again)', XV International Conference on Durability of Building Materials and Components .
[7] Van den Bossche, N. et al. (2012), 'Airtightness of the window–wall interface in cavity brick walls', Energy and Buildings .
[8] Van Linden, S. and Van den Bossche, N. (2017), 'Airtightness of sealed building joints: Comparison of performance before and after artificial ageing', Building and Environment.
[9] Ylmén, P., Hansén, M. and Romild, J. (2012), 'Beständighet hos lufttäthetslösningar'.
[10] Linløkken T.K., Development of a Test Method for Evaluating Durability of Adhesive Tapes in Construction, NTNU Open, 2023. NTNU Open: Development of a Test Method for Evaluating Durability of Adhesive Tapes in Construction
[11] Standard Norge (2013c), 'NS-EN 12316-2 Flexible sheets for waterproofing Determination of peel resistance of joints Part 2: Plastic and rubber sheets for roof waterproofing'.