Journal of Physics: Conference Series

Impact of artificial ageing on the performance of acrylic self-adhesive tapes

Impact of artificial ageing on the performance of acrylic self-adhesive tapes

V Dobilaitė[1]*, M Jucienė[1], J Kumžienė[1], K Banionis[1], V Paukštys[1] and A Stonkuvienė[1]

[1]Institute of Architecture and Construction, Kaunas University of Technology, Tunelio st. 60, LT – 44405 Kaunas, Lithuania

*vaida.dobilaite@ktu.lt

Abstract. The use of sealing tapes in creating a continuous envelope to ensure the airtightness of the building is an essential factor. The study aims to investigate the performance properties of single-sided self-adhesive tapes for building applications and to obtain the changes in these properties due to the effects of environmental factors. The tapes were glued to the different substrates. Peel adhesion, tack of the tapes, and the air permeability of sealed elements were determined. The adhesive tape were aged in the laboratory using two different methods, standard (EN 12024) and a new one, during which the test samples were exposed to the cyclic impact of the temperature and humidity of multiple levels. Analysis of the results showed that the substrate has influence on the adhesive behaviour of the self-adhesive tapes. After artificial aging, in most cases, the performance properties of the tapes do not change significantly. The novel approach allowed the comparison of the influence of different aging factors on the change in the performance properties of the tape and contributed to the development of a methodology for testing the durability of sealing tapes. The effect of substrate on tape adhesion was also investigated, which is useful from both a practical and a methodological point of view.

1. Introduction

Self-adhesive tapes are widely used for the installation of a sealed building envelope, along with other sealing materials (plasters, putties, mastics, etc.). The performance of the adhesive tape should ensure that airtightness is maintained during the intended life of the building. However, environmental conditions can significantly worsen the properties of the tapes and their adhesion to the surfaces. Research [1] showed that after 8 months of outdoor aging, some of the exterior air barrier tapes, glued to the outer wall of the barrack hut from plywood panels, completely or largely peeled off from the glued surface, while others showed a change in color, bubbling, or other signs of degradation. A maintaining/losing the sealing purpose of self-adhesive tapes, as well as finding promising solutions to ensure the airtightness of the building are investigated mostly [2-10]. However, very few studies aim to investigate the aging of tapes and the factors influencing the deterioration of tapes' properties.

The conducted research on the artificial aging of tapes reveals the multifaceted situation of the tapes' resistance to climatic effects. It was shown [11] that the properties of the tapes obviously deteriorated, although they passed the durability tests after aging, presumably due to the smaller sample size used in the standardized tests. The cyclic effects of positive and negative temperature and humidity during artificial aging influenced the deterioration of the properties of silicone pressure sensitive adhesive tapes and significantly affected the connection of the tapes with the steel, but the condition of the tapes remained reasonably good even after aging [12]. It was found [13] that after thermal shock (cyclic temperature change from +60 to -40) the mechanical strength of the adhesive joints formed with double-sided adhesive tape increased. It was obtained [14] that UV radiation had the greatest influence on the change in residual compression deformation of tapes made on the basis of precompressed flexible polyurethane foam, and due to the effect of temperature change, resistance to water tightness decreased. Studies [15, 16] have shown that there is a limited increase in air permeability after aging of joints sealed with self-adhesive tapes for exterior air barrier applications under three different aging protocols (heat exposure, heat, rain, cold exposure, UV exposure under high humid conditions). The aforementioned studies were carried out with samples of wood fibre cement boards, but a recommendation is made to expand the scope of the experiment, using combinations of various boards and tapes.

To the best of the authors' knowledge, only a few scientific works can be mentioned that discuss the performance of tapes depending on the structural surface. In the work [17], the PE and PP wind barrier, the PE vapour barrier, the uncoated spruce, the spruce coated with water-based paint, the glass and galvanized steel substrates were selected for the study. Summarizing the results [17], the authors suggest the use of standard substrates rather than actual end-use substrates in the studies and, at the same time, emphasize the need for further analysis to better understand degradation processes when tapes are applied to various surfaces. Investigation [18] of the durability of different tapes glued to substrates commonly used in the construction industry showed that the influence of substrates on resistance to peeling and shearing is less pronounced, and these characteristics were found to be in the same range of values for different substrates. It was found [19] that substrates have a significant influence on the tack of adhesive tapes. Van Linden et al. studied the performance of different tapes (LDPE film with diagonal reinforcement, PET film and PA foil, PP film) to ensure air and water tightness of the joints, found that the substrate affects the airtightness of the sealed joints [20].

The literature analysis showed that there is a lack of objective knowledge on the ability of self-adhesive tapes to form a reliable bonding with the substrates to which they are adhered, the dependence of the performance of tapes on various factors, and the change of adhesive properties over time. The study aims to investigate the performance of single-sided self-adhesive tapes for building applications when they are glued to different substrates and to obtain changes in these properties as a result of the effects of environmental factors. This is relevant considering the need for a methodology for artificial aging testing of adhesive tapes for a reliable prediction of the tape's service life. Furthermore, the results could be useful in the development of sealing materials and technical solutions to seal the building envelope.

2. Materials and Methods

Commercial single faced acrylic self-adhesive tapes with different backings, which can be used inside and outside the building, were chosen for the study (Table 1). According to the manufacturers, the T1 tape (the backing is paper) is air- and water-impermeable, and the acrylic adhesive ensures strong and durable adhesion to all surfaces. T2 tape (the backing is nonwoven material) can be glued to nonwoven materials, plastic, laminated films, wood, or concrete structures. T3 tape (the backing is a film and reinforcing threads) to seal the joints between the vapour barrier film and skylights, pipes, roof structures.

Table 1. Main characteristics of self-adhesive tapes.

	Backing	Total thickness, μm	Breaking strength±SD, N/24 mm	Elongation at break±SD, %
		EN 1942	EN ISO 29864	
T1	paper	380	176 ± 8	14±2
T2	nonwoven	570	89 ± 3	21±2
T3	film/mesh	370	53 ± 5	69±3

A Mitutoyo micrometer with a division value of 1 μm, was used to measure the thickness of the adhesive tapes. The breaking force and the corresponding relative elongation of the strip specimens (24 mm wide) were obtained with a universal test machine BTI-FB050TN (Zwick/Roell, Germany, force measurement accuracy ±1%). The initial distance between the clamps was 100 mm, and the clamp movement speed was 5 mm/s, the number of specimens is five.

The principle scheme for testing the performance of self-adhesive sealing tapes is presented in Figure 1. Research included measurements of the thickness of the tape and its adhesion characteristics (tack, peel adhesion) before and after aging. In addition, an air permeability test of unaged tapes and tapes subjected to cyclic aging was carried out in order to perform a reliability analysis of the tapes' sealing abilities when they are adhered to different structural surfaces.

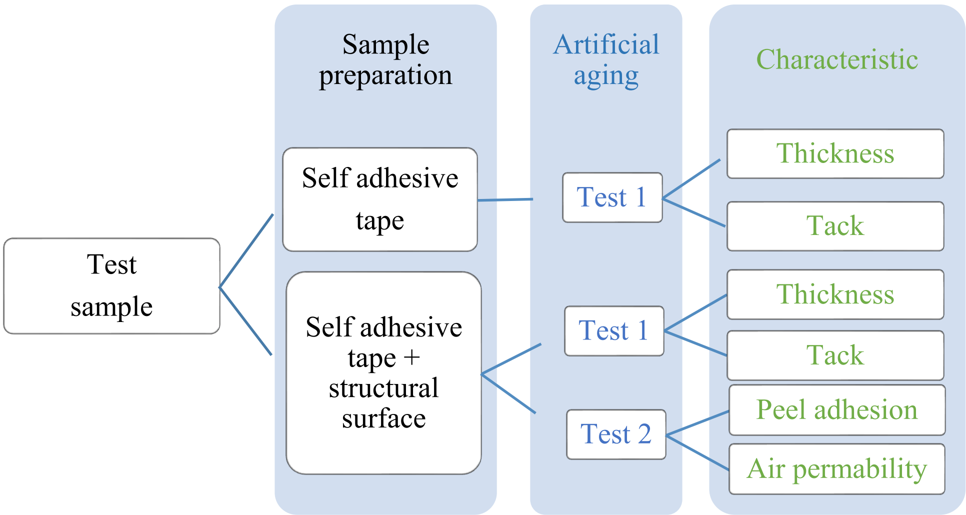

Figure 1. Flow chart for the tests

The adhesion between the adhesive tape and the substrate can be characterized by peel adhesion and tack. Peel adhesion of the tapes was determined according to the methodology of the EN ISO 29862 standard, Method 1. According to this method, the tape is removed at an angle of 180 degrees from a stainless steel pane; during the test, the self-adhesive tapes were removed from different structural surfaces such as OSB, plasterboard, cement-sawdust board, and plastic. The tape sample with a width of 24 mm was adhered to the surface in a section of 150 mm (contact area 3600 mm^2). All other test conditions were ensured as specified in the standard. The test was carried out with a universal test machine BTI-FB050TN, the movement speed of the clamps was 5 mm/s, the peeling took place along the entire length of the adhered tape, the result of the peeling force was evaluated by subtracting 25 mm from the start and ends of the peeling.

The tack of self-adhesive tapes was determined by the rolling ball method. The core of the method is that a ball with a diameter of 9.5 mm and a mass of 3.5 g after rolling from a plane inclined at an angle of 15°, rolls freely on the adhesive surface of the sealing tape lying in a horizontal position and stops after rolling a certain distance. The tack is measured by the distance, from the point where the ball comes into contact with the adhesive tape glue to the top of the ball that has rolled a certain way.

The peel adhesion test of the unaged tape is performed immediately after the tape sample is adhered to the test surface; the tack test is performed when the release coating is removed from the adhesive tape. Before all tests, the tapes and surfaces were conditioned for at least 1 day at a temperature of (23±1) °C and (50±5) % relative humidity, these conditions were also maintained during peel adhesion and tack tests. When the tape was adhered to structural surfaces, a 2 kg roller was used to ensure uniform pressing conditions, the time of cutting and pressing the sample to the surface did not exceed 30 s, and the surface was cleaned with acetone before gluing.

The air permeability test was performed according to the EN 9053-1 standard. Air flow passing through the samples was measured with the Veri-Flow 500 electronic flow meter (accuracy ±2%) by gradually increasing the pressure to 50, 100 and 200 Pa with the Retrotec DM32 gauge (pressure reading accuracy ±1%). The test was carried out under laboratory conditions (20 °C, 50% RH) before and after sample conditioning. Two similar test setups have been applied. Unwanted air leaks through the perimeter joints between the specimen and the airtight boxes have been avoided by using closed cell ethylene propylene rubber (EPDM) with a thickness of 2 cm on both sides of the specimen to seal the specimen airtight with a metal frame against the airtight box.

The adhesive tapes were artificially aged in two different ways (Table 2). Aging test 1 (Test 1) was performed according to the EN 12024 standard, which specifies the method for determining the behavior of adhesive tape at elevated temperature and high humidity. Aging test 2 (Test 2, or cyclic exposure) was carried out including the effects of moisture, heat, and cold. The aging parameters were selected and the sequence of cyclic effects was determined, taking into account air humidity, average rain duration, and number of sunny days, temperature changes in warm and cold years [21]. The evaluation of the statistical climatological data of the climate zone of the middle latitude is a new aspect in the studies of the development of the aging methodology for self-adhesive tapes.

Table 2. Summary of artificial aging test conditions.

Test series	Type	Exposure time, h	Number of cycles	Conditions of 1 cycle
Test 1	Elevated temperature, humidity	24	7	40 °C and 85% RH
Test 2	Cyclic impact of multilevel temperature, humidity	48	20	Step 1: 7h (+5°C and (96 -100) % RH) Step 2: 5 h -10°C (+0.5 repose) Step 3: 18h (+31°C and (45 – 50) % RH) Step 4: 10h (+39°C and (25 – 30) % RH) Step 5: 7.5h (+49°C and (15 – 20) % RH)

In Test 2, the tape – surface system was aged, that is, samples of 24 mm width tapes were glued on structural surfaces selected for the study, i.e. OSB, plasterboard, cement-sawdust board, and plastic. In both cases, artificial aging was carried out in a Feutron 3423/16 climate chamber, with controlled environmental conditions. The peeling adhesion test was performed after 5, 10, 15, and 20 cycles.

After artificial aging, the peel adhesion and tack characteristics were determined. A group of 5 samples was prepared for each test to determine the adhesion characteristics with the structural surface before and after aging, for thickness - three samples, for air permeability - 3.

After aging, the change in the thickness of the tapes was determined as the difference between the initial and aged thicknesses of the tape without the release coating. The latter characteristics are obtained by measuring the thickness of the release coating and subtracting it from the total thickness of the tape determined according to the EN 1942 standard. Samples prepared for the peel adhesion test were used in thickness change studies. The research results were processed statistically. The percentage was calculated between the characteristics of the aged and unaged samples.

3. Results and Discussion

The airtightness of the building is ensured by sealing the structures and their connections and covering the air-permeable materials with additional coatings, thus creating a continuous, air-tight envelope inside or outside the building. When self-adhesive tape is used to ensure the tightness of the building, they must adhere reliably to the structural surface to which it is glued and the formed bond did not lose its adhesive properties over time. This connection can be characterized by peel adhesion and tack. From an exploitation point of view, it is relevant that adhesive tapes are resistant to the effects of environmental factors (moisture, temperature changes, etc.).

It is known [22] that the adhesion of the adhesive tape to the substrate depends on the thickness of the adhesive, so the change in thickness was evaluated at the beginning of the analysis of the results. It was found that aging in a humid environment (Test 1) did not change thickness (Table 3). The results obtained according to Method 2 showed that cyclic aging did not significantly affect thickness. The thickness of the T1 tape varied within 30 µm, but no clear trend was found depending on the number of cycles. The thickness of the T2 tape at different number of cycles changed within 20 - 30 µm, but the number of cycles did not lead to a clear change. The thickness of the T3 tape at different numbers of aging cycles remained unchanged, the thickness was set the same all the time.

Table 3. Results of the thickness of adhesive tapes without release coating µm, before and after aging

Code	Initial thickness, µm	Thickness after aging, µm				
		Test 1	Test 2			
			Number of cycles			
			5	10	15	20
T1	310±0	300±8	280±12	290±0	290±10	290±12
T2	500±6	490±7	510±0	500±6	510±6	520±0
T3	290±6	290±7	290±0	290±0	290±0	290±0

The results of artificial aging on the tack of self-adhesive tapes show that, in principle, the adhesive tapes T1 and T2 did not change or changed slightly (Table 4) after the aging of the tapes at elevated temperature and high humidity. The tack of tape T3 decreased significantly, the rolling path of the ball increased by almost 1.5 cm after aging under the same conditions as tape T1, T2. Such a decrease could be caused by the fact that after aging according to Test 1, the release coating of this tape shrunk a little, and the adhesive layer opened in places, which could dry out their surface and reduce the tape's tack. Very similar results were obtained after cyclic aging. The T3 tape was found to be the most sticky of the adhesive tapes tested. The impact of 20 cycles reduced the tack of this tape by a small margin. The tape T2 has less tack than T3. Slightly different results were obtained with the T1 tape. This tape had the longest ball rolling path, which means that its tack is the lowest of all the tested tapes. After 20 cycles, the rolling path of the ball has decreased, i.e., the tack of the adhesive tape has improved.

Table 4. Results of the self-adhesive tape tack, cm before and after aging

Code	Initial tack, cm	Tack after aging, cm				
		Test 1	Test 2			
			Number of cycles			
			5	10	15	20
T1	4.7±0.2	4.0±0.6	5.4±0.7	4.7±0.8	5.7±0.9	3.5±0.5
T2	2.8±0.7	2.6±0.4	2.9±0.3	2.7±0.4	2.7±0.2	2.6±0.4
T3	1.8±0.2	3.2±0.4	1.9±0.2	2.0±0.1	1.9±0.3	2.1±0.3

The results of peel adhesion after aging according to Test 1 are presented in Figure 2. It can be seen that after 7 days of aging at 40 °C and 85% humidity, the peel adhesion of the T2 tape did not change, the T3 tape only changed when glued to the OSB (the resistance increased by a third). The peel adhesion of T1 tape increased when it was glued to plasterboard and decreased when it was glued to plastic.

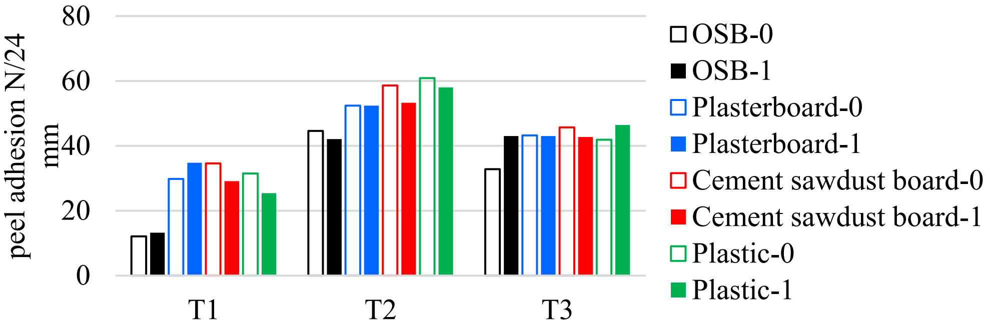

Figure 2. Peel adhesion results before (0) and after (1) aging according to Test 1

Figure 3 shows the changes trends in peel adhesion of the tapes due to artificial cyclic aging. The results reveal how peel adhesion changes differently depending on changing environmental conditions. The biggest change, when the peel adhesion increases by 3 times with the increase in the number of cycles, was obtained for the case where the T1 tape is glued to the OSB surface. The adhesive bond between the unaged tape T1 and the OSB surface is the weakest; the change after climatic aging occurs very quickly; after 5 cycles the peel adhesion almost doubles. After exposure to artificial cyclic aging, the peel adhesion of T1 tape also increases when glued to plasterboard and plastic, only to a lesser extent, 27% and 19%, respectively, and this change occurs only at the highest number of cycles tested. The positive effect of aging has been established in the work of other authors [13]. Tendencies of increasing resistance to peeling have also been determined for T3 tape, the most from the OSB surface (79%), from other surfaces in the range of 24-32%. It should be noted that when T3 tape was removed from the cement-sawdust board, the nature of the tape peel was different compared to other surfaces. Two clear force zones were formed, the maximum force, when the adhesive bond between the tape and the surface is destroyed due to the load, and the minimum force, when the backing of the tape is already broken and displacement is due only to the strength of the reinforcing threads. As a result, the minimum adhesion values of the peel adhesion of the T3 tape from the cement-sawdust board were distinguished, the latter not included in the analysis of the results. The peel adhesion of T2 tape (nonwoven base) after artificial aging according to climatic parameters was either unchanged (OSB, plasterboard) or decreased by 23%, 31% when peeling from cement-sawdust and plastic surfaces, respectively.

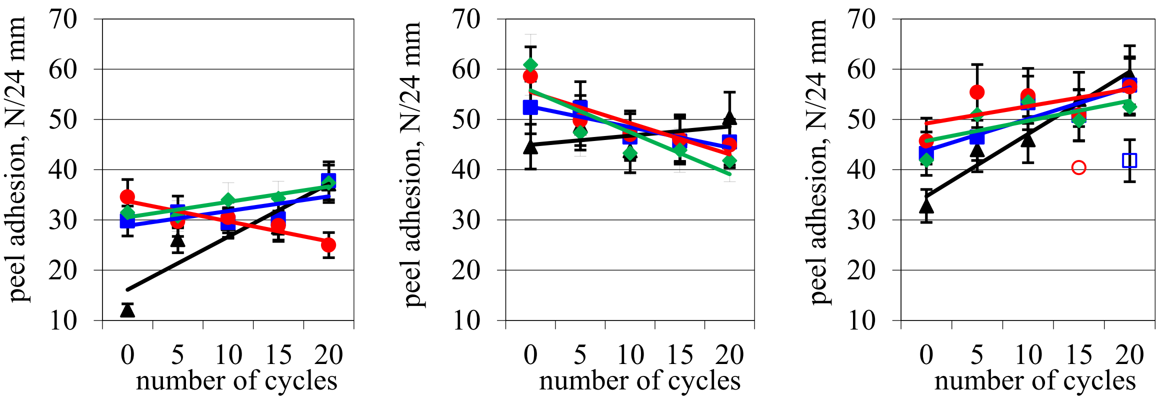

Figure 3. Relationship between peel adhesion of the tapes T1 (a), T2 (b), T3 (c) and climatic exposure cycles, where ▲ ▬ OSB, ▬ ■ (□ F_{min}) plasterboard, ▬ ● (○ F_{min}) cement-sawdust board, ▬ ◆ plastic.

Peel resistance is also reduced for T1 tape when glued to a cement-sawdust surface (28%). Thus, the effects of climate aging include both deterioration and improvement in peel adhesion, and may also have no effect.

The performance of the tapes was evaluated by their ability to form a tight connection and maintain this connection, regardless of the effects of environmental factors. The results with uncertainties of 7 x 10^{-6} m^3/h in the case of min value and 12 x 10^{-3} m^3/h in the case of max value are given in Figure 4. Analyzing the influence of cyclic aging on air permeability, it was found that aging changes air permeability, and this change depends on the adhesive tapes and the structural surface. The paper backing tape T1 was characterized by low air permeability. In all investigated cases, aging cycles were found to increase air permeability. The increase is not significant, but the trends in the results suggest that with longer aging times, the properties of the adhesive tapes deteriorate and the air permeability increases. Analyzing the results obtained during the tests with T2 adhesive tape, it was found that this adhesive tape provides sufficient vapor barrier for plasterboard, cement-sawdust, and plastic surfaces, and aging increases the air permeability within small limits.

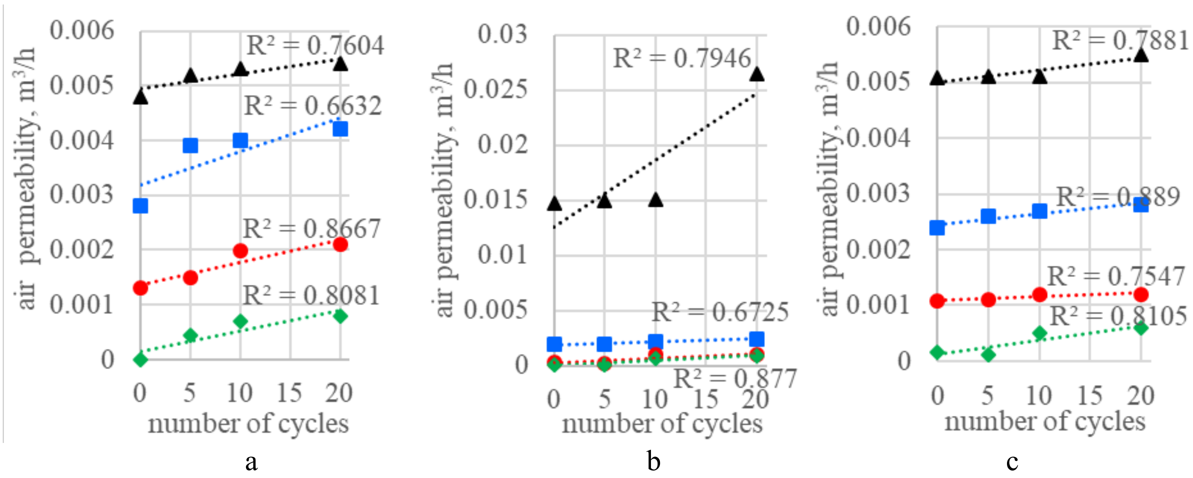

Figure 4. Influence of cyclic aging on airtightness of tapes T1 (a), T2 (b) and T3 (c), where ▲ – OSB, ■– plasterboard, ● – cement-sawdust board, ◆– plastic

Somewhat different results were obtained on the OSB board. In this case, air permeability was several times higher, and a significant increase in air permeability after aging was also observed. Therefore, to ensure sufficient sealing of the structure, it is not recommended to use this tape on OSB surfaces; in this case it is recommended to choose another sealing tape. When testing the T3 adhesive tape, the results were similar to those of T1. On all investigated surfaces, air permeability was found to increase during aging, although within negligible limits. In all cases the highest permeability was obtained on the OSB surface. The air permeability of the T2 tape on this surface is ~5 times higher than that of the other two tapes tested. On plasterboard there is a slightly lower air permeability. In all investigated cases, it turned out to be similar, so all investigated tapes seal the plasterboard surface in building structures sufficiently well. The best impermeability was obtained on the plastic surface. In all investigated cases, the plastic surfaces showed good air impermeability, judging by the aging cycles as well.

Thus, the results obtained confirm that it is relevant to evaluate the airtightness of building structures by evaluating tapes of different structures and different surfaces, as well as analyzing the influence of aging on the quality of building structures. A summary of tape performance and air permeability results is presented in the table 5 when system aging is performed according to the Test 2 methodology. The threshold for good evaluation was as follows air tightness ≥0.005 m3/h, peel adhesion ≥30.The complex results presented allow to fully reveal the situation related to the use of adhesive tapes on different structural surfaces. The results show the problematic nature of the OSB board in places where sealing is required. In this case, the T1 and T3 tapes, which remain sufficiently well adhered to the OSB surface after aging and ensure adequate tightness, fully meet all requirements, but in this case, the tested tape T2 does not ensure sufficient tightness.

Table 5. Summary of tape properties and air tightness results

Surface / Tape	OSB	plasterboard	cement-sawdust board	plastic
T1				
T2				
T3				

after aging:
the adhesiveness of the tape with the surface is quite good, but the air permeability is increased
air tightness is good enough, but adhesion to the surface is not good enough
good adhesion to the surface and reasonably good air tightness.

After examining the results obtained on plasterboard and plastic panels, we can see that for these panels all the tested tapes met the airtightness and strength requirements after aging. Adhesive tape T1 provided a good seal in all cases, but the system with cement sawdust board did not provide sufficient adhesion strength after aging.

4. Conclusions

The results of the research revealed that the self-adhesive tapes selected for investigation have sufficient good adhesion to the structural surface and reasonably good air tightness. It was found that the adhesive thickness of the tapes did not change after aging, neither when they were aged in a humid environment nor when they were subjected to cyclic exposure to heat, cold, and humidity. Analysis of the effect of artificial aging on the tack of the adhesive tapes showed that the tack either did not change or changed slightly. A slightly different situation is with peel adhesion; it was found that depending on the surface to which the tape is applied, it may increase, decrease, or remain unchanged after artificial aging.

The results of the air permeability of the adhesive tapes showed that the intensity of air flow through the samples mainly depends on the surface on which the sealing materials are glued. Since the air permeability of the samples with plastic plate and sealing materials was close to zero, it can be stated that the tape ensured air flow impermeability through the artificially formed gap.

When comparing the new method with EN 12024, it should be emphasized that the proposed method includes more aging parameters and also takes into account the influence of the substrate. Moreover, the merit of the proposed ageing protocol is that the aging parameters are based on studies of the weathering in which the buildings are operated; they correspond to the climatic conditions of mid-latitudes. All these factors are important and contribute to the development of a methodology for testing the durability of self-adhesive tape for building application.

5. References

[1] Kreiger M, Pagan-Vazquez A, Alvey J, Chu D 2015 Environmental degradation effect on airtightness of pressure-sensitive adhesive exterior housing tapes on plywood *ASHRAE Transactions* **121**(2) 130-140.
[2] Kalbe K, Piikov H, Kalamees T 2020 Moisture dry-out capability of steel-faced mineral wool insulated sandwich panels *Sustainability* **12**(21) 9020.
[3] Kukk V, Bella A, Kers J, Kalamees T 2021Airtightness of cross-laminated timber envelopes: Influence of moisture content, indoor humidity, orientation, and assembly *J. Build. Eng.* **44** 102610.
[4] Kölsch P, Zirkelbach D, Nusser B, Wagner R, Zegowitz A, Hünzel H 2016 Airflow through lightweight wall assemblies - influence of size and location of leakages. *Thermal Performance of the Exterior Envelopes of Whole Buildings XIII International Conference.* Clearwater Beach, Florida. Oak Ridge National Laboratory, pp. 459-484.
[5] Bracke W, Van Den Bossche N, Janssens A 2014 Airtightness of building penetrations: Air sealing solutions, durability effects and measurement uncertainty. 35th AIVC Conference

Ventilation and Airtightness in Transforming the Building Stock to High Performance. Poznań, Poland, 24-25 September pp. 85-97.
[6] Kopecky P, Stanek K, Tywoniak J 2020 Hygro-thermal performance of wooden beam ends: experimental investigations of uninsulated and internally insulated brick wall. *12th Nordic Symposium on Building Physics (NSB 2020).* Kurnitski, J. et al. EDP Sciences 172 01009.
[7] Van Linden S, Van Den Bossche N 2021 Comparative study on the feasibility of watertight face-sealed building joints under simulated wind-driven rain conditions *Build. Res. Informat.* **49**(7) 748-762.
[8] Kalamees T, Alev Ü, Pärnalaas M 2017 Air leakage levels in timber frame building envelope joints *Build. Environ.* **116** 121-129.
[9] Herms J 2020 Achieving airtightness and weather protection of CLT buildings. *12th Nordic Symposium on Building Physics (NSB 2020).* Kurnitski, J. et al. EDP Sciences 172 10011.
[10] Johnsen I, Andenæs E, Gullbrekken L, Kvande T 2022 Vapour resistance of wind barrier tape: laboratory measurements and hygrothermal performance implications *J. Build Phys.* **46**(1) 923-940.
[11] Ylmén P, Hansén M, Romild J 2014 Durability of air tightness solutions for buildings. 35th AIVC Conference "Ventilation and Airtightness in Transforming the Building Stock to High Performance", Poznań, Poland 268-278
[12] Antosik K, Weisbrodt M, Mozelewska K, Czech Z, Piątek-Hnat M 2020 Impact of environmental conditions on silicone pressure-sensitive adhesives *Polym. Bull.* **77**(12) 6625-6639.
[13] Rudawska M, Wahab A 2021 Mechanical properties of adhesive joints made with pressure-sensitive adhesives *Strojniški Vestnik - Journal of Mechanical Engineering* **67**(7-8) 380-388.
[14] Francke B, Sudol E 2019 Durability of joint sealing tapes on the basis of a pre-compressed polyurethane foam. IOP Conference Series: Materials Science and Engineering, **473** 012022.
[15] Langmans J, Desta T Z, Alderweireldt L, Roels S 2017 Durability of self-adhesive tapes for exterior air barrier applications: a laboratory investigation *Int. J. Vent.* **16**(1) 30-41.
[16] Langmans J, Desta T Z, Alderweireldt L, Roels S 2015 Laboratory investigation on the durability of taped joints in exterior air barrier applications. 36th AIVC Conference *Effective Ventilation in High Performance Buildings*. Madrid, Spain, 23-24 September pp. 615-623.
[17] Fufa S M, Labonnote N, Frank S, Bjørn P R, Jelle P 2018 Durability evaluation of adhesive tapes for building applications *Constr. Build. Mater.* **161** 528–538.
[18] Sletnes M, 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 DBMC 2020. Barcelona, Catalonia, October, 20-23, pp. 269 – 276.
[19] Jucienė M, Dobilaitė V 2021 Impact of climatic effects and various surfaces on the tack of adhesive tapes for building & construction, *J. Build. Eng.* **42** 102825.
[20] Linden S, Maroy K, Steeman M, Bossche N V 2017 Tape as a means to ensure air- and watertightness of building joints: experimental assessment. 14th International Conference on Durability of Building Materials and Components, Ghent University, Belgium 29-31 May RILEM Publications.
[21] Norvaišienė R, Burlingis A, Stankevičius V 2006 Impact of acidic precipitation to ageing of painted facades' rendering: Monograph, Technologija, Kaunas (in Lithuania).
[22] Akhmedgoraeva A R, Stytsenkov A A, Galimzyanova R Y, Khakimullin Y N 2019The influence of thickness and reinforcement on the properties of sealing tapes of incongealable type on the basis of butyl rubber depending on the nature of the glued substrate, *Polym. Sci. Series D*, **12**(2) 137-141.