



THE IMPACT OF EXTERIOR FINISH VAPOUR RESISTANCE ON THE MOISTURE STATE OF BUILDING WALLS

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Abstract. At present, when the building walls covered with a painted thin render are insulated by the mineral wool slabs from outside, the defects caused by the condensed moisture accumulated in the envelopes become more and more frequent. Water vapour permeability of the exterior finish (ie the paint), if compared with the water vapour permeability of the mineral wool slab, is rather small. That is why the paint coating may become the barrier for the water vapour diffusion and thus create favourable conditions for moisture accumulation in the exterior layers of the envelope during cold seasons. As a rule, to eliminate the defects, the exterior surface is repainted on the former paint coating because the render is thin and mechanically easily damaged. Repainting the thin render surface causes the following: 1) an increase of the exterior coating's vapour resistance; 2) a growth of the condensation intensity in the envelope exterior layers during the of moisture accumulation; 3) a decrease of the durability of the render-paint system. The restrictions for the envelope exterior layer s_d have already been recommended to employ in the European Union. Since moisture accumulation inside the wall is determined by the local climate, it is important to find out whether the recommendations concerning the given s_d value might be applied for the exterior layers of the building walls in Lithuania. To find it out, the calculations of the envelope state and laboratory experiments have been carried out. The paper aims at the analysis of the impact of vapour permeability and its properties in the exterior layers of the wall on the envelope moisture state. It has been determined that the increase of the s_d value is disproportionate to the number of the paint layers or the thickness of the paint coating. It has also been determined that the increase of the s_d value forms the pre-conditions for the increased moisture amount under service conditions caused by water diffusion and condensation. The experiments revealed that, under Lithuanian climatic conditions, in the exploited building walls the s_d value of the exterior layer of the thin render should make $s_d < 0,5$ m and $s_d < 0,6$ m in the paint coating.

Keywords: painted thin render, finish system, water vapour permeability, water vapour resistance factor, water vapour diffusion, equivalent air layer thickness, moisture state.

1. Introduction

A building envelope insulation is popular all over the world. At present, with the use of new, effective materials and products for finishing the buildings, the defects caused by the condensed moisture accumulated in the envelopes become more frequent. This problem is especially relevant to the design of the exterior walls insulated with mineral wool slabs from outside that are finished with the painted thin render. Such constructions are multi-layered and the moisture parameters in the separate layers are varying. It should be stressed that, in comparison with the mineral wool's water permeability, water vapour permeability in the exterior layer (ie the paint) is rather insignificant; that's why the paint coating may become a barrier to water vapour

diffusion and create preconditions for moisture accumulation in the envelope during cold seasons [1]. With the cyclical recurrence of the freezing-warming process, when the envelope is moist, an intensive destruction of the exterior finish may take place.

In most cases, to eliminate the defects the exterior surface is repainted. However, the former coating is preserved because the render is thin and mechanically easily damaged. As Y. Shala claims [2], the restoration of the exterior insulating system which requires a new paint coating should be carried out every 10–15 years. If the average building service period is 70 years [3], then, during the entire building service, the exterior walls may be repainted 8 or more times (one complete paint coating of the building facades

consists of two layers). Therefore each repainting causes the following:

- an increase of the exterior coating's vapour resistance;
- a growth of the condensation in the envelope during moisture accumulation;
- a durability decrease of the rendering-paint system.

As R. Miniotaitė proved by experiments [4, 5], resistance to climatic effects in the coatings made of poliacrilites, silicon solutions obtained with the use of organic solvents or of silicon dispersions depends on vapour permeability.

This permeability is characterised by several moisture parameters, such as relative vapour resistance factor μ or air layer thickness $s_d \cdot \mu$ equivalent to the building material's water vapour permeability is the ratio of the coefficient of outdoor air water vapour permeability and the coating's vapour permeability. The ratio is used to determine the moisture characteristics of homogenic materials. The material's relative vapour resistance μ shows how many times the vapour resistance value of the coating made of this material is higher than that of an immovable air layer of the similar thickness. The higher the quantity μ , the poorer the properties of the material's water vapour permeability. Water vapour permeability of the paint coatings is described by the index s_d . It is the thickness of the air layer (m) equivalent to water vapour diffusion that shows the coating's resistance to water vapour diffusion, ie the drying of the wall. The higher the s_d value of the paint, the poorer the drying conditions for the materials that are under the coating. It means that water vapour may start condensing under the paint pellicle and thus to increase the moisture of the envelope and to decrease its durability.

The designers of the multi-layer building constructions should consider the layer composition in such a way that the layers' vapour resistance increased toward the exterior of the wall, ie the exterior coating should be the most permeable to the vapour stream [6, 7]. This factor has already been considered in the European Standard Project pr EN 13500 [8]. The vapour transfer coefficient of the finish for a day should not be higher than $40 \text{ g}/(\text{m}^2 \cdot \text{d})$. According to DIN 18550 [9], moisture will not accumulate in the envelope if in the exterior layers $w \cdot s_d \leq 0,2 \text{ kg}/(\text{mh}^{0,5})$ where the surface water absorption is $w \leq 0,5 \text{ kg}/(\text{m}^2 \text{h}^{0,5})$ and $s_d \leq 2 \text{ m}$. Today the recommended moisture parameters are: $w \leq 0,1 \text{ kg}/(\text{m}^2 \text{h}^{0,5})$ and $s_d \leq 1 \text{ m}$ [10]. All the mentioned restrictions for the envelope coating's s_d are applied in the EU.

Moisture inside the wall is determined by the local climate. In Lithuania, the climate is colder than in Western Europe. Here the average temperature in January and February is often about $-10 \text{ }^\circ\text{C}$ and lower. Therefore the above-mentioned s_d value restrictions cannot be applied for the wall's exterior layers of the buildings in Lithuania. Neither

can the given s_d value restriction [8–10] be recommended for the buildings' exterior walls during the design or in the initial period of the building service: the Standard Project does not consider the alteration of the s_d values of the wall's exterior finish during the building service. Therefore it is important to determine the possible boundaries of the vapour resistance alteration in the walls of the buildings in Lithuania.

2. Method of investigation

The Standards EN ISO 13788 [11] and STR 2.05.01:2005 [12] provide the calculation method that allows the determination of the annual moisture amount balance and the greatest amount of accumulated moisture (kg/m^2) caused by the condensation inside the envelopes. In order to calculate the vapour resistance of the wall's exterior finish it is necessary to find out the values of the coating's water vapour permeability. The majority of the producers do not indicate the water vapour permeability parameters of the building materials used for finish, since they are included into the list of the indices not obligatory to be declared. Moreover, various scientific sources define different values of moisture quantities [12, 13]. It is also important to point out that no investigations have been carried out to determine the dependence of the coating's vapour resistance on the number of the coated paint layers during service and therefore the following questions arise: how much does this dependence alter with different paints used; whether the vapour resistance increases in all sorts of paint and what effect does it have on the moisture state of the entire envelope. Therefore, in order to prognosticate the envelope moisture state, it is urgent to determine the values of vapour permeability in various sorts of paint by taking into consideration the number and thickness of the paint coatings.

2.1. Determination of vapour resistance in the double-layer coating-base system by the number of paint coatings

Having analysed the producer-indicated properties of the paint's water vapour permeability, the authors selected the most popular paints in Lithuania, ie acrylic, silicate, poluretanic and silicon ones. The moisture characteristics of these paints indicated by the producers [14–19] are in Table 1.

For determining the moisture parameters for each sort of paint, 12 samples of the system paint-thin render have been treated. In each group, three samples were coated with the paint layers of different thickness obtained by the following number of the paint layers coated on the sample's base: 2, 4, 6, 8. Three samples were left unpainted, just

covered with a thin render. All the samples were of 100 mm in diameter and of about 10 mm thickness (Fig 1).

Water vapour permeability was determined in the environment of 23°C, as it is required by the LST EN ISO 12572:2001 Standard [20]. The difference of the water vapour pressures on the different sides of the sample was worked out and the density of the water vapour stream passing through the sample was measured. Vapour resistance Z , ($m^2 \cdot s \cdot Pa/kg$) was calculated in the following way:

$$Z = \frac{p_{1,sat} - p_2}{q} - \frac{d_o}{\delta_p^{air}}, \quad (1)$$

where: $p_{1,sat}$ – points to the partial pressure of the saturated water vapour, Pa, p_2 – the partial pressure of water vapour above the sample, Pa, d_o – the thickness of the air layer from the water surface in the cup to the bottom of the sample after the latest weighing, m; δ_p^{air} – the coefficient of water vapour diffusion in the air equal to $2 \cdot 10^{-10} \text{ kg}/(m \cdot s \cdot Pa)$.

In the double-layer system of the coating (ie paint), vapour resistance was calculated as follows:

$$Z = Z_p - Z_b, \quad (2)$$

where: Z_b – vapour resistance of the thin render sample, [$m^2 \cdot s \cdot Pa/kg$]; Z_p – vapour resistance of the sample representing the paint-thin render system, [$m^2 \cdot s \cdot Pa/kg$].

Accordingly, s_d was obtained:

$$s_d = Z \cdot \delta_p^{air}. \quad (3)$$

2.2. Determination of vapour resistance in the double-layer coating-base by the paint coating thickness

When the thin render is covered with several paint coatings without paint utilisation control, it is difficult to determine the real thickness of the coating. Therefore, with the use of the method of the water vapour permeability determination described in Part 2.1, an additional experiment was carried out during which, in the preparation of the samples, the paint utilisation was controlled and the thickness of the paint coating determined.

For this experiment the paint sorts presented in Table 1 were selected and they were coated on the thin render samples (100 mm in diameter; ≈ 10 mm thick). The amount of the paints to be covered on the base and, accordingly, the obtained thickness of the paint was calculated due to remains of the dry material. The calculation results are in Table 2. The thin render samples were covered with adequate paint coatings whose thickness was 0,08, 0,16 and 0,24 mm.

Table. 1 Paint properties and their dependence on the sort of paint

Sorts of paint	s_d , m	Moisture resistance	Durability
Acrylic	0,3–1	++	–
Silicate	0,06–0,3	+	+
Poluretanic	0,2–1,2	–	–
Silicon	0,12–0,3	++	++

++ – good; + – normal; — no data.

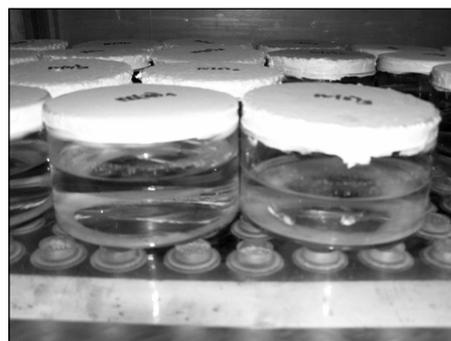


Fig 1. The samples used for determining the water vapour permeability in the paint-thin rendering system

2.3. The moisture state of the wall

With the exact s_d values of the paints it is possible to forecast the envelope's moisture state during service, at the same time estimating vapour resistances of the paint coatings. Such calculations will help determine whether without additional moisturing the wall's exterior finish does not prevent the moisture transfer from inside and whether moisture does not accumulate inside the wall. They will also help finding out what effect the increase of the finish vapour resistance makes on the wall's moisture and to estimate the critical values of vapour resistance in the wall's exterior finish.

The standards [11–12] provide the calculation method that allows to determine the annual moisture amount balance and the greatest amount of accumulated moisture (kg/m^2) caused by the condensation occurring inside the envelopes. These methods may also provide the comparison of the moisture state of different constructions. Since the transfer of water vapour is rather slow and durable the values of the average monthly temperature and relative air moisture should be taken for calculation. Such precision is satisfactory for determining of the conditions under which water vapour condensation is possible as well as of its place and amounts of condensation and evaporation (ie drying).

On the basis of the discussed standard method, the calculations of the moisture state have been carried out (Fig 2) for the envelope. The physical parameters of the layers are presented in Table 3. They confirm the stationary conditions for the Kaunas city during January when the characteristics of water vapour permeability in the exterior walls finish differ.

The microclimatic parameters in the interior premises were: 20 °C and 60 % relative air humidity. In all calculations equal indoor and outdoor air temperature and relative air humidity were accepted.

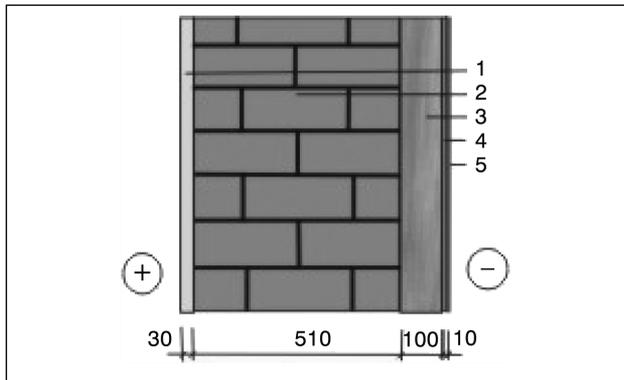


Fig 2. Wall construction: 1 – mineral render from inside; 2 – ceramic brick wall; 3 – mineral wool; 4 – thin mineral render; 5 – paint

3. Results and discussion

3.1. Dependence of the exterior finish vapour resistance on its thickness and the number of coatings

The results of investigation are presented in Tables 4–6. With the help of the value of the thin render's vapour resistance Z_b and the value of the thin render-paint coating system's vapour resistance Z_p the paint coating's vapour resistance Z (according to formula (2)) and the thickness of the air layer s_d equivalent to the building material's water vapour permeability (according to formula (3)) were calculated.

The results of determining the air layer thickness s_d show that, with an increase of the number of paint coatings or the thickness of the coating, the paint coatings s_d also increases. The degree of the increase of the s_d value depends on the sort of paint, ie the pigment, the polarity of film formation and the binder.

Table 2. Estimation of the paint amount necessary for determining the adequate paint coating's thickness

Paint coating	Paint mark	Dry remains, %	Paint density (20 °C) kg/m ³	Thickness of dry coating, mm	Area that requires 1l of paint for 1/m ²	Required paint amount, l	Paint amount required for sample coating, g
Acrylic	3F	60	0,00140	0,08	7,5	0,001	1,47
				0,16	2,8	0,002	2,93
				0,24	2,5	0,003	4,40
Acrylic	7S	40	0,00130	0,08	5,0	0,002	2,04
				0,16	2,5	0,003	4,08
				0,24	1,7	0,005	6,13
Siloxan-acrylic	5L	60	0,00144	0,08	7,5	0,001	1,51
				0,16	3,8	0,002	3,02
				0,24	2,5	0,003	4,52
Silicate	6U	61	0,00150	0,08	7,6	0,001	1,54
				0,16	3,8	0,002	3,09
				0,24	2,5	0,003	4,64
Poluretanic	4P	66	0,00150	0,08	8,3	0,001	1,43
				0,16	4,1	0,002	2,85
				0,24	2,8	0,003	4,28

Table 3. Physical parameters of the envelope layers

Type of the envelope layers	Thickness of the building material's layer d , mm	Density ρ , kg/m ³	Building material's thermal conductivity coefficient λ , W/(m·K)	Relative water vapour resistance μ	s_d , m
1. Interior render	30	1 700	0,8	6	0,12
2. Brick masonry	510	1 400	0,64	10	5,1
3. Mineral wool	100	80	0,04	1	0,1
4. Thin render	10	1 700	0,9	6	0,06
5. Paint	0.1	–	1	–	According to paint coating number and thickness

Table 4. Values of vapour permeability of the mineral thin render-paint coating system by considering the number of coatings

Paint mark	Paint coating	Number of paint layers	Relative vapour resistance μ	Vapour resistance $Z_{p'}$ (m·h·Pa)/mg	$s_{d'}$ m
1E	Silicate 1	2	0,014	0,730	0,444
		4	0,012	0,856	0,521
		6	0,010	0,862	0,524
		8	0,010	0,942	0,572
2SF	Siloxan	2	0,024	0,447	0,272
		4	0,020	0,456	0,277
		6	0,021	0,498	0,302
		8	0,020	0,549	0,334
3F	Acrylic 1	2	0,010	0,926	0,563
		4	0,008	1,369	0,832
		6	0,008	1,369	0,904
		8	0,006	1,486	0,993
4P	Poluretanic	2	0,023	0,364	0,221
		4	0,020	0,430	0,261
		6	0,019	0,511	0,310
		8	0,016	0,526	0,319
5L	Siloxan-acrylic	2	0,023	0,441	0,268
		4	0,020	0,500	0,304
		6	0,018	0,562	0,341
		8	0,016	0,632	0,384
6U	Silicate 2	2	0,027	0,344	0,209
		4	0,025	0,376	0,228
		6	0,024	0,397	0,241
		8	0,022	0,433	0,263
7S	Acrylic 2	2	0,012	0,894	0,544
		4	0,009	0,959	0,583
		6	0,008	1,224	0,744
		8	0,006	1,399	0,870

Table 5. Values of the water vapour permeability parameters of the mineral thin render

Vapour permeability coefficient $\delta_{p'}$ kg/(m·s·Pa)	Vapour resistance $Z_{b'}$ (m·s·Pa)/kg	Relative vapour resistance μ	$s_{d'}$ m
0,036	0,178	16,2	0,157

Table 6. Values of vapour permeability of the mineral thin render-paint coating system when considering the paint coatings thickness

Paint mark	Paint coating	Thickness of paint layers, mm	Vapour resistance $Z_{p'}$ (m·h·Pa)/mg	Relative vapour resistance μ	$s_{d'}$ m
3F	Acrylic 1	0,08	1,210	71,0	0,733
		0,16	1,280	88,4	0,780
		0,24	1,400	95,1	0,851
4P	Poluretanic	0,08	0,381	27,6	0,232
		0,16	0,446	28,9	0,268
		0,24	0,453	36,5	0,275
5L	Siloxan-acrylic	0,08	0,430	26,0	0,264
		0,16	0,470	26,7	0,288
		0,24	0,542	31,7	0,329
6U	Silicate 2	0,08	0,348	22,1	0,212
		0,16	0,362	23,3	0,220
		0,24	0,466	24,4	0,283
7S	Acrylic 2	0,08	1,337	62,0	0,753
		0,16	1,423	84,4	0,812
		0,24	1,540	89,3	0,864

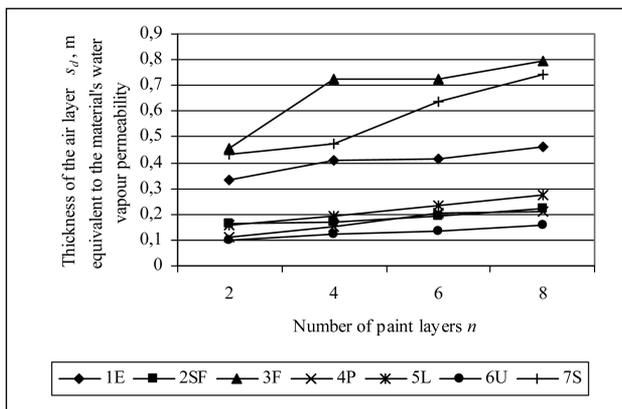


Fig 3. Dependence of the air layer thickness s_d equivalent to the building material's water vapour permeability on the number of the paint layers

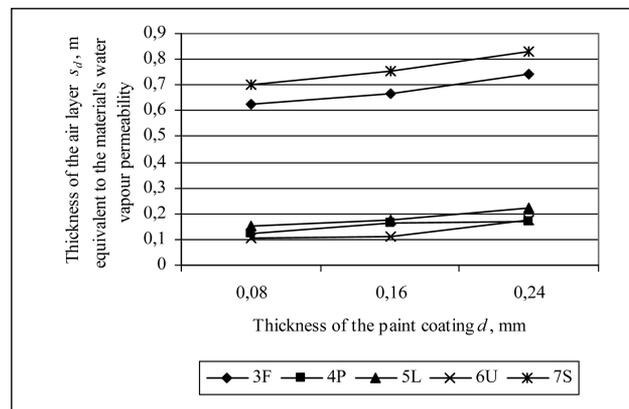


Fig 4. Dependence of the air layer thickness s_d equivalent to the building material's water vapour permeability on the thickness of the paint layer

Figs 3, Fig 4 illustrate well that the first two coverings of the paint coatings indicate the main vapour characteristics of the paint sort. In deeper coatings they are more distinct. When the number of the coatings grows from 2 to 8, s_d of the silicate paints (1E; 6U) increases by 1,5 times; s_d of the siloxan paints (2SF; 5L) increases 1,4–1,7 times and s_d of the poluretanic (4P) and acrylic (3F; 7S) paints – up to 1,8 times. It shows that the increase of the s_d value is not proportional to the number of the paint coatings, ie the thickness of the whole paint coating. The s_d value of the acrylic paint (3F and 7S) is considerably higher than those of other sorts of paint examined.

In order to estimate the finish coating's water vapour transfer coefficient ($W = 40 \text{ g/m}^2\cdot\text{d}$) in the insulation system introduced in the European Standard Project where the mineral wool slabs are presented as an insulating material, the authors recalculated the coefficient into the value of relative vapour resistance, the result making $\mu = 44$. Then s_d of the exterior 1 cm thick coating makes $s_d = 0,44 \text{ m}$. The thickness of the paint coatings calculated, it is possible to recalculate the μ value recommended by the European Standard into the s_d value of an adequate paint coating's thickness. Thus, according to the prEN 13500:2002, the s_d of the paint coating of 0,08 mm thickness should be $s_d < 0,0035 \text{ m}$; of 0,16 mm thickness $s_d < 0,007 \text{ m}$ and of 0,24 mm thickness $s_d < 0,01 \text{ m}$. Figs 3, 4 demonstrate that the paint coatings of all sorts do not meet the requirements concerning the limiting values of vapour permeability of the exterior coatings presented in the European Standard Project. It encouraged the authors to carry out the calculations of the envelope moisture (Fig 2) and estimate the real (ie obtained during the investigation) vapour resistances of the paint coating under the climatic conditions characteristic of Lithuania. With the application of the discussed calculation method, it is possible to determine the limiting values of vapour resistance of the exterior coatings used in the buildings exploited in Lithuania.

3.2. The impact of the thin renders vapour resistance on the moisture state of the entire wall

The results of the experiments carried out in the Laboratory of Thermal Physics at the Institute of Architecture and Construction (Lithuania) demonstrate that, if compared to the mineral wool slab's water vapour permeability coefficient $\delta_p \approx 0,5 \text{ mg}/(\text{m}\cdot\text{h}\cdot\text{Pa})$, the water vapour permeability coefficients of the tested render samples are 10 times lower [21]. It allows for the conclusion that the drying conditions of the mineral wool will be complicated. Table 7 presents the values of the parameters describing water vapour permeability of several sorts of thin render finish [12]. The calculation of the moisture state of the envelope presented in Fig 2 was carried out with the use of the standard method discussed in Part 2.3.

The calculation results (Fig 5) demonstrate that moisture distribution in the envelope's cross-section in case of any thin render finish with various values of vapour parameters is similar. The zone of condensation is possible to appear between the thin render finish and the mineral wool slabs.

The dynamics of moisture accumulation and drying in the envelope was determined by the same calculation method (Fig 2). The condensation is most expected to occur between the mineral wool layer and the thin render in the course of the year. Fig 6 displays that when s_d thickness of the air layer equivalent to the building material's water vapour permeability in the thin render finish makes less than 0,5 m, moisture does not accumulate in the envelope. However, with the increase of the s_d value of the exterior thin render finish, the possibility arises for the accumulation of the greater moisture amount in the insulation layer. When the amount of moisture increases, the probability for its drying out during the warm seasons becomes smaller.

Table 5 presented the s_d value of the mineral thin render investigated in the given paper, which is 0,157 m. It is lower

than the critical s_d value of the exterior coating (0,5 m). Therefore, when analysing the water vapour transfer in the entire structure of the insulated wall, it should be considered that, with the absence of an additional moisturing of

the insulated material, the mineral render with the s_d value 0,157 will be satisfactory to guarantee the normal moisture state of the exterior walls of the buildings exploited in Lithuania.

Table 7. Parameters describing water vapour permeability of the thin render layers

Type of render	μ	Thickness d , mm	$\mu \times d = s_d$, m
Polymeric render of low permeability	300	10	3
Polymeric render, permeable	100	10	1
Polymeric render of high permeability	50	10	0,5
Mineral render	6	10	0,06

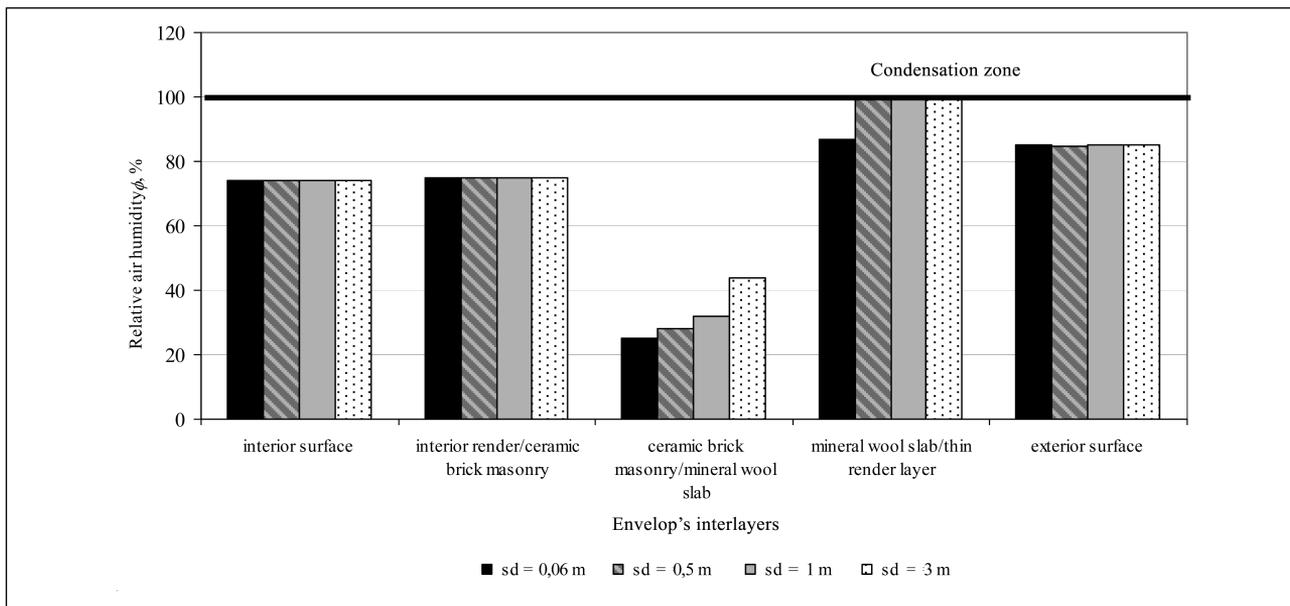


Fig 5. The impact of the thin render finish with different moisture characteristics on the moisture state of the insulated envelope

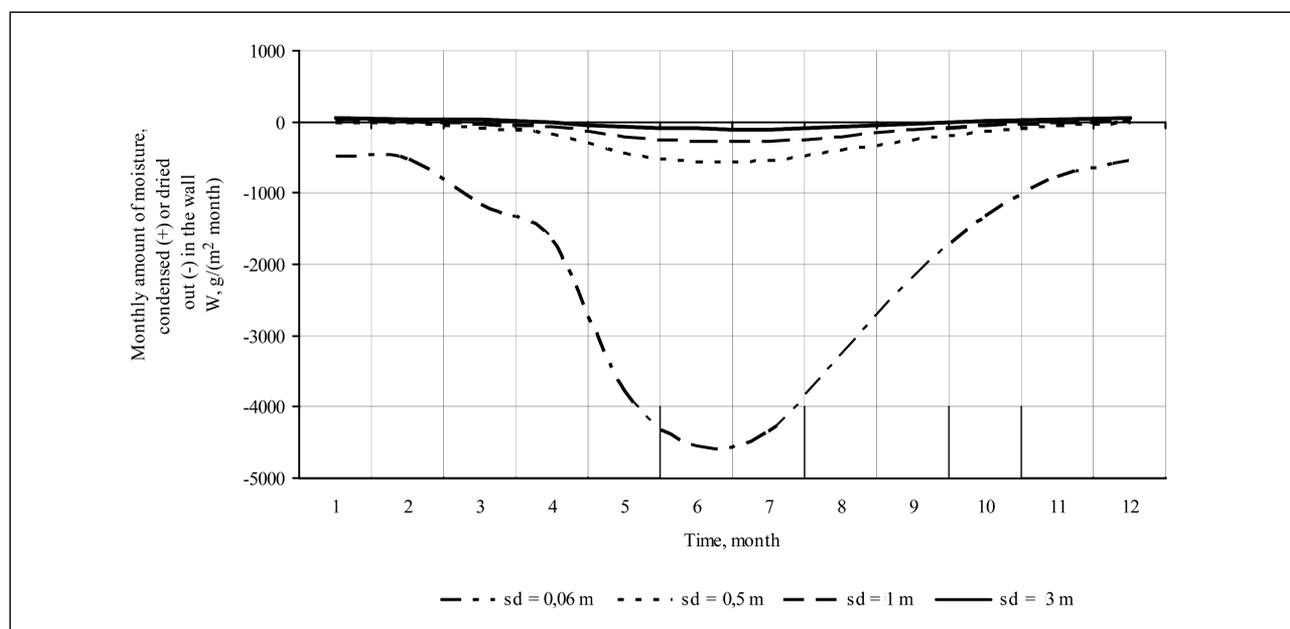


Fig 6. Annual dynamics of moisture alteration in the wall in its possible zone of condensation when the thickness of the air layer equivalent to the material’s water vapour permeability s_d varies

3.3. The impact of the coating's vapour resistance on the moisture state of the entire wall

Part 3.2 presented the analysis of the mineral thin render under the climatic conditions typical of Lithuania, thereby concluding that the mineral thin render will not make any difficulty for the movement of water vapour and thus will not damage the moisture state of the entire wall. Yet the question arises whether the wall moisture state will change when the vapour resistance of the discussed exterior layer becomes higher, ie when the thin render finish is painted from outside.

The s_d values (Table 1) of various paint sorts presented by the producers fluctuate within the interval from 0,02 m

to 1 m. Therefore, according to the STR 2.01.05:2005 [12], the calculations were made to show whether with the absence of additional moisturing the wall's exterior finish would not affect the moisture migration from inside and whether the moisture would not accumulate inside the wall. The calculations demonstrate that, after the painting of the facade of the building insulated from outside with the mineral wool slabs that were finished with thin render, two planes of condensation would appear in the envelope, ie between the mineral wool slab and thin mineral render and between thin mineral render and the paint coating (Fig 7).

The dynamics of the annual moisture accumulation and drying in the envelope (ie between the thin mineral render

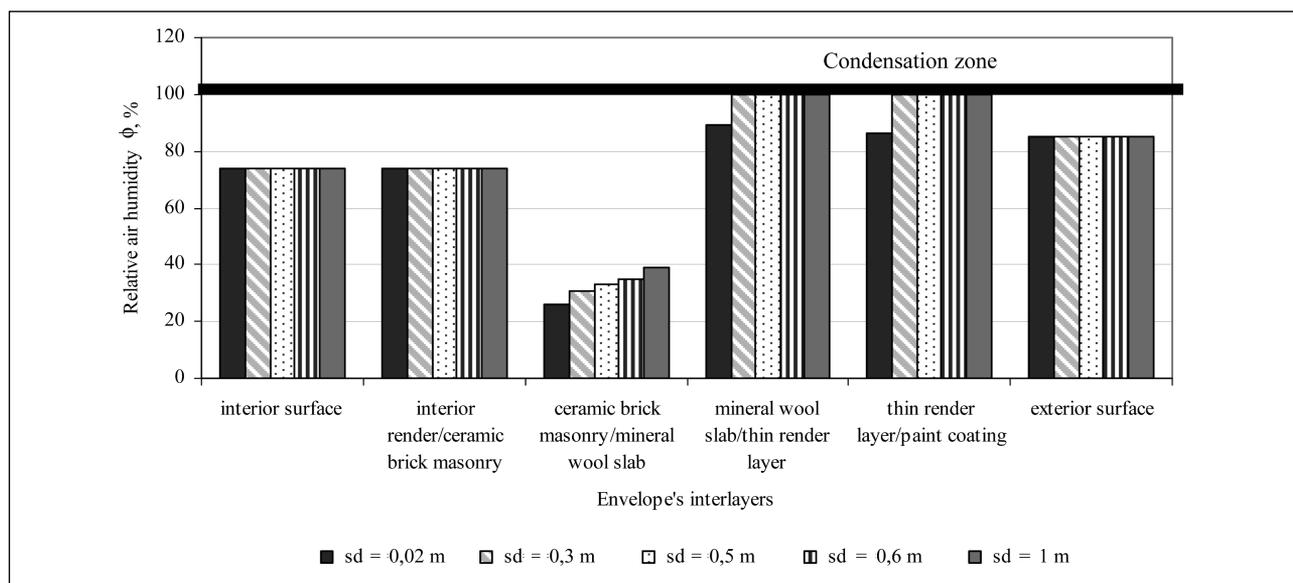


Fig 7. Dependence of the paint coating with various moisture characteristics on the moisture state of the insulated wall

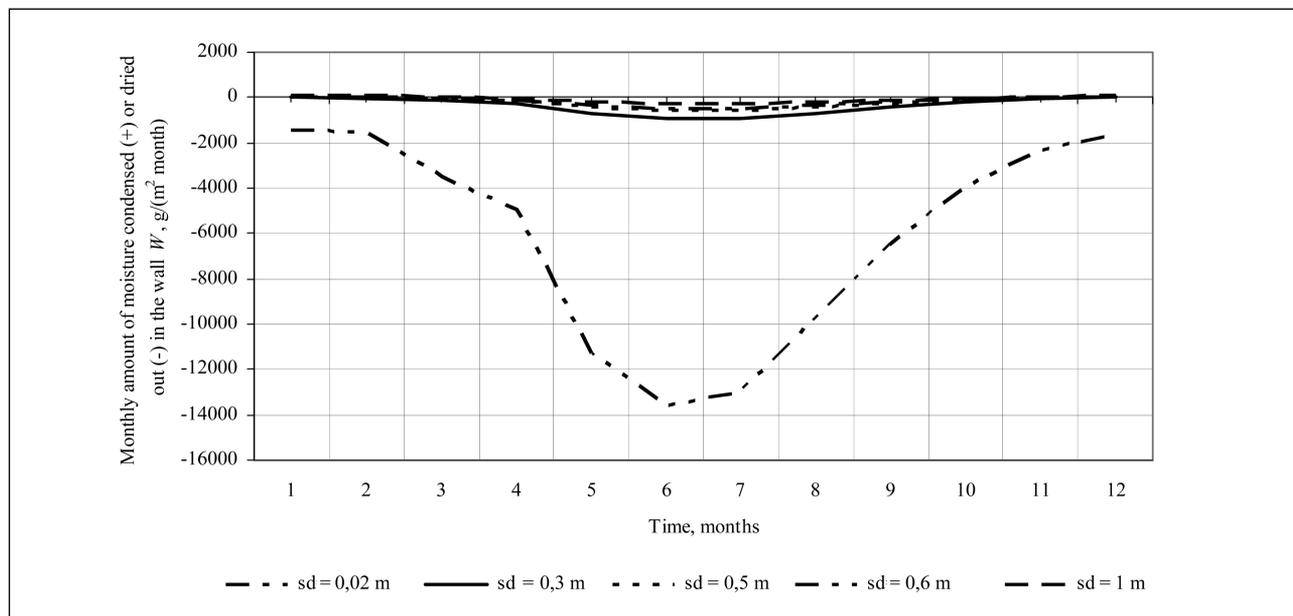


Fig 8. Annual dynamics of moisture alteration in the wall in its possible zone of condensation when the thickness of the air layer equivalent to the material's water vapour permeability s_d varies

and paint coating) demonstrates that, when in the paint coating the thickness s_d of the air layer equivalent to the building material's water vapour permeability is higher than 0,6 m, the moisture will accumulate in the envelope (Fig 8).

The results of the paint's water permeability determination show that, under service conditions, the acrylic paint creates the preconditions for the decreased moisture in the walls caused by water vapour diffusion and the condensation factors.

4. Conclusions

1. Under local climatic conditions, the s_d value of the thin render layer in the walls of the buildings exploited in Lithuania should be $s_d < 0,5$ m and that of the paint coating should be $s_d < 0,6$ m.

2. The increase of the s_d value depends on the number of the paint layers, ie on the thickness of the entire paint coating.

3. The raise of the acrylic paint s_d value creates the possibility for the increased moisture in the buildings when under service conditions which may be caused by water vapour diffusion and the condensation factors.

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IŠORINĖS APDAILOS GARINĖS VARŽOS ĮTAKA PASTATŲ SIENŲ DRĖGNUMUI

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Santrauka

Pastaruojų metu projektuojant iš išorės mineralinės vatos plokštėmis apšiltintas sienas su dažyto plonasluoksnio tinko apdaila, vis dažniau atsiranda defektų dėl atitvarose susikaupiančios kondensacinės drėgmės. Išorinės apdailos (dažų) vandens garų laidumas, palyginti su mineralinės vatos plokštės vandens garų laidumu, yra mažas, todėl dažų sluoksnis gali tapti barjeru vandens garų difuzijai ir sudaryti prielaidas drėgmei kauptis išoriniuose atitvaros sluoksniuose šaltuoju metų laiku. Bandant pašalinti atsiradusius defektus,

paprastai išorės paviršius yra perdažomas, paliekant senų dažų sluoksnį, nes tinkas yra plonas ir mechaniškai lengvai pažeidžiamas. Dėl šios priežasties plonasluoksnio tinko paviršiaus perdažymas yra susijęs su: 1) paviršinio sluoksnio garinės varžos didinimu; 2) kondensacijos intensyvumo padidėjimu išoriniuose atitvaros sluoksniuose drėgmės kaupimo laikotarpiu; 3) sistemos tinku – dažais ilgaamžiškumui mažinti. Jau išorinio atitvaros sluoksnio s_d apribojimai rekomenduojami taikyti Europos Sąjungos valstybėse. Drėgmę kauptis sienos viduje skatina vietovės klimatas, todėl reikia nustatyti, ar šios s_d verčių rekomendacijos tinka Lietuvoje eksploatuojamų pastatų sienų išoriniams sluoksniams. Tam buvo atlikti atitvaros drėgminės būklės skaičiavimai ir laboratoriniai tyrimai. Šiame darbe išanalizuota išorinių sienos sluoksnių garų laidumo savybių įtaka atitvaros drėgnumui. Nustatyta, kad šios s_d vertės didėjimas neproporcingas dažų sluoksnių skaičiui ar dažų dangos storiumi. Taip pat nustatyta, kad išorinių apdailos sluoksnių s_d vertės didinimas sudaro prielaidas šių sluoksnių padidintam drėgniui eksploatacijos sąlygomis atsirasti dėl vandens garų difuzijos ir kondensacijos reiškinių. Atlikus tyrimus nustatyta, kad Lietuvos klimato sąlygomis eksploatuojamų pastatų sienų plonasluoksnio tinko sluoksnio s_d vertė turi būti $s_d < 0,5$ m, o dažų dangos $s_d < 0,6$ m.

Reikšminiai žodžiai: dažytas plonasluoksnis tinkas, išorinio apšiltinimo sistemos, vandens garų laidumas, santykinė garinė sluoksnio varža, lygiavertis medžiagos vandens garų laidumui oro sluoksnio storis, drėgnumas.

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