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Title

Impacts of sealing methods on the reliability of water absorption tests: Investigation of combination of sealing method and building materials

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1. Introduction

Water absorption tests are commonly utilized to assess the liquid-water transport properties of porous building materials. One crucial aspect of these tests is the determination of water absorption coefficients, calculated based on the mass of water absorbed by a specimen per square root of the elapsed time during the tests (ASTM C1585–13, 2013; ASTM C1794-19, 2019; ISO 15148: 2002, 2002). These coefficients are essential for quantifying and comparing the liquid transfer performance of different materials (Ma et al., 2020; Wang et al., 2019). Furthermore, advanced techniques, such as gamma-ray attenuation, X-ray attenuation, and nuclear magnetic resonance spectroscopy (Carmeliet, et al., 2004; Fukui, et al., 2021; Pel, et al., 1995) were employed to measure the evolution of water content distribution in a specimen during water absorption. These methods, along with simplified approaches, such as the ruler method and multi-step method (Evangelides et al., 2018; Ren et al., 2019), help determine the water diffusivity of building materials, a critical hygric property for conducting hygrothermal simulations.

The accuracy of water absorption tests has been debated for decades owing to their significance in evaluating moisture transport in porous materials. While these tests are generally considered reliable compared with sorption or cup tests, interlaboratory errors have been documented in previous studies (Feng et al., 2020; Roels et al., 2004). Factors contributing to these errors include data processing methods, initial water content of specimens, variations in temperatures, differences in test operators, and sealing methods employed for the materials (Bomberg, et al., 2005; Feng, et al., 2020; Roels, et al., 2004; Zelinka, et al., 2016). During the water absorption tests, the side surfaces of the specimens are covered with a vapor-impermeable material, such as wrap, adhesive, resin, or tape. Although international standards (ASTM C1585–13, 2013; ASTM C1794-19, 2019; ISO 15148: 2002, 2002) do not specify suitable types of sealing materials for specific building materials, the choice of sealing methods can impact water transfer within a building material.

It is often stated that certain sealing materials, such as adhesives and resins, can penetrate a specimen's surface during application (Feng, et al., 2020; Zelinka, et al., 2016). Moreover, air entrapment (Hall, 2007) and multidimensional water inflow—resulting from partial exposure of the specimen's sides near the water surface to avoid immersing non-adhesive sealing material (Wilson, et al., 1999)—can affect water absorption behaviors, particularly during the early stages of absorption. These factors can partially hinder water transfer in a material or disrupt the one-dimensionality of water absorption, potentially impacting the accuracy of water absorption test results. The influence of these error factors may vary depending on the characteristics of building and sealing materials, such as water and air transport properties, as well as resin penetrability. While existing studies often mention the effects of sealing methods on water absorption test results, the use of sealing materials likely to influence results, such as penetrating sealants, are not rare even in recent studies (e.g., Feng et al., 2020). In addition, research that primarily addresses sealing methods as potential sources of

error is limited. Consequently, combinations of building and sealing materials have not been fully explored. The significance of different error factors related to sealing application in the water absorption of various building materials must be clarified, and a quantitative dataset should be provided to support the development of more reliable testing methods.

This study investigates the effects of different sealing methods on the water absorption test results of building materials by comparing the impacts of multiple potential error factors and their dependence on the combination of sealing methods and building materials. Water absorption tests were conducted using three common building materials and various sealing materials, including plastic wrap, aluminum tape, and three types of resin. The study compares and discusses the effects of different sealing methods on the test results for each building material based on the test results and characteristics of the building and sealing materials.

2. Materials and methods

2.1. Building and sealing materials utilized in the experiments

The water absorption tests conducted in this study utilized three common building materials: brick, calcium silicate board, and autoclaved aerated concrete (AAC). The density of the used brick, calcium silicate board, and AAC were 1,940, 520, and 410 kg/m³, respectively, and their porosities were 0.246, 0.680, and 0.894, respectively. These materials exhibit a wide range of pore structures, as shown in Fig. 1. Furthermore, the hygric properties of these types of materials have often been examined (Feng and Janssen, 2021; Kumaran, 1996; Kumaran, 2006).

[Insert Figure 1]

The sealing materials utilized in the experiments were non-adhesive plastic wrap, aluminum tape, and resin. Two types of epoxy resins (referred to as Epoxy I and II hereinafter) and an acrylic-modified silicone resin were used on the brick and calcium silicate board specimens. The epoxy I was utilized for sealing the AAC specimen. The plastic wrap utilized was composed of polyvinylidene chloride and had a water vapor transmission rate of 7.3 g/(m²·d), as measured according to ASTM F1249–20 (2020). The viscosity of the resins and time required to reach their practical strength after application, as provided by their respective manufacturers, are listed in Table 1. Additional information from the manufacturers includes:

- Epoxy I begins solidifying approximately 90 min after mixing the two components and requires at least 8 h of fixation at 20 °C. This resin is characterized by superior waterproofing performance.
- Epoxy II starts solidifying 5 min after mixing the two components and requires at least 15 min of fixation at 20 °C.

● The acrylic-modified silicone resin becomes immobile within 2–3 min after application. Based on these data, Epoxy I is characterized by its low viscosity and extended solidification time. Regarding curing time, the acrylic-modified silicone resin offers the best performance among the three types. The aluminum tape utilized in this study was composed of aluminum foil with 0.05 mm thickness and acrylic adhesive.

Table 1. Characteristics of the resins utilized in this study.

Resin	Epoxy I	Epoxy II	Acrylic-modified silicone
Viscosity (Pa·s)	23–43 ^{*1} , 25–45 ^{*2}	200 ^{*3}	76
Duration to reach practical strength	10 h	60 min	15 min
Note	Two-component type		

^{*1} Main agent, ^{*2} Curing agent, ^{*3} Mixture

2.2. Water absorption tests

The bottoms of the AAC specimens were 45 mm × 50 mm, whereas those of the other specimens were 40 mm × 60 mm. The height of the specimens was 100 mm. During testing, the specimens were immersed in water up to 5 mm from their bottoms. The areas on the side surfaces close to the bottom (> 5 mm) of the wrap-sealed specimens were left unsealed to prevent the wrap from coming into contact with the water, as shown in Fig. 2 (a). The top surfaces of specimens were sealed with plastic wrap containing small holes to prevent evaporation. This step was omitted for several brick and calcium silicate board specimens after confirming that evaporation from the top surface had negligible effects on the absorption behavior owing to fast water transport in the two materials.

The various combinations of sealing methods and building materials tested are listed in Table 2. The choice of sealing materials can impact several potential error factors. For example, when the wrap-sealed and resin-sealed specimens were compared (Figs. 2(a) and (b), respectively), differences were observed in both the conditions near the bottom surface (whether the side surfaces near the bottom were covered) and the penetration of the sealing material. Therefore, to focus on a single error source, tests combining multiple sealing methods were conducted using the brick specimens, as shown in Figs. 2 (c) and (d). In the case shown in Fig. 2(c), tape or Epoxy I was applied to the area 10 mm from the bottom surface to prevent multidimensional water inflow near the bottom, whereas the remaining area was covered with a wrap. In Fig. 2(d), tape or Epoxy I was applied to the area 90 mm from the top surface, leaving the bottom 10 mm uncovered to allow multidimensional water inflow near the bottom, similar to that of a wrap-sealed specimen. Three duplicated specimens were prepared for brick and AAC, and two specimens were prepared for calcium silicate board for each sealing method, except for cases of combined sealing methods.

Table 2. Combinations of sealing methods and building materials tested in this study.				
Sealing method		Brick	Calcium silicate board	Autoclaved aerated concrete
Plastic wrap		✓	✓	✓
Aluminum Tape		✓	✓	✓
Resin	Epoxy I	✓	✓	✓
	Epoxy II	✓	✓	✓
	Acrylic-modified silicone	✓	✓	
Combination	Bottom 10 mm sealed with aluminum tape (with the top 90 mm sealed with plastic wrap)	✓		
	Bottom 10 mm sealed with Epoxy I (with the top 90 mm sealed with plastic wrap)	✓		
	Top 90 mm sealed with aluminum tape (with the left area uncovered)	✓		
	Top 90 mm sealed with Epoxy I (with the left area uncovered)	✓		

[Insert Figure 2]

Initial tests were conducted on both brick and calcium silicate board using wrap, followed by tests using tape or resin on the same specimen after the wrap was removed. This methodology allowed for a direct comparison of results, eliminating any differences among specimens caused by material heterogeneity. Additional measurements were conducted to ensure measurement repeatability; the test processes, including water absorption and drying, were repeated thrice using the same specimen sealed with wrap. Each building material was tested by a single operator in a controlled laboratory environment at a temperature of 23 °C. During the tests, water absorption was periodically halted, and the specimen was weighed to track the mass of absorbed water over time. The time intervals for weighting were determined depending on the rates of absorption of each material. For brick and calcium silicate board, the first weighting was conducted at the elapsed time of 10 min., followed by weightings approximately every 30 min. For AAC specimens characterized by relatively slow and long absorption, the first weighting was conducted at the elapsed time of 1 h, with subsequent weightings taken every 1 h to several days (longer intervals at later elapsed times). Each sample was weighed within 30 s.

3. Results

3.1. Brick and calcium silicate board

Examples of the time evolution of the water masses absorbed by the brick and calcium silicate board specimens are shown in Fig. 3. Both materials displayed linear relationships between the square root of elapsed time (t) and absorbed water mass before the wetting front reaching at the top surface. The water absorption coefficients A ($\text{kg}/(\text{m}^2 \cdot \text{s}^{1/2})$) of the specimens were determined from the slope of the graph before capillary saturation using the least squares method. Additionally, the water content at capillary saturation w_{cap} (kg/m^3) was determined from the endpoint of the primary absorption stage.

[Insert Figure 3]

Based on the determined water absorption coefficient A and water content at capillary saturation w_{cap} , measurement repeatability was assessed. The maximum differences in A over three repeated tests using the same wrap-sealed specimen were 6% and 3% for the brick and calcium silicate board specimens, respectively. Additionally, the maximum differences in w_{cap} for both types of specimens were negligible ($< 1\%$). These results indicate that the influences of repeated exposure to water and drying on the water transport properties were not significant within at least three repeated tests. The average values of A and relative standard deviation determined using multiple wrap-sealed specimens were $0.227 \text{ kg}/(\text{m}^2 \cdot \text{s}^{1/2})$ and 4.5%, respectively, for eight brick specimens and $0.708 \text{ kg}/(\text{m}^2 \cdot \text{s}^{1/2})$ and 1.8%, respectively, for four calcium silicate board specimens.

The water absorption coefficients A determined for tape- or resin-sealed specimens relative to those sealed with wrap (that is, A_{resin}/A_{wrap} or A_{tape}/A_{wrap} , where A_{wrap} , A_{resin} , and A_{tape} represent the water absorption coefficients when plastic wrap, resin, and aluminum tape were utilized to seal the specimen, respectively) are shown in Fig. 4. To eliminate any differences among specimens caused by material heterogeneity, each value of A was normalized to the value of the same specimen sealed with plastic wrap. When aluminum tape was utilized to seal the materials, the difference in A of both materials compared with that of wrap-sealed specimens was $< 8\%$. Particularly, the changes in A of the brick specimens were minimal, considering the measurement repeatability errors. The impact of resin on water absorption was more pronounced compared with that of tape, resulting in a reduction in A in most cases. Although the changes in A of calcium silicate board specimens owing to the application were $< 7\%$ for all types of resins, the decreases in A of brick specimens were more significant. Notably, the application of Epoxy I to the brick specimen reduced A by 28% compared with the case of plastic wrap.

[Insert Figure 4]

Even when the resin was only partially applied to the sides of brick specimens, A decreased considerably. This decrease was more significant when an area measuring 90 mm from the top surface was sealed (Fig. 2 (d)), compared with sealing the bottom 10 mm (Fig. 2 (c)).

The graph of the water content of the tape- and resin-sealed brick specimens at capillary saturation relative to that of the wrap-sealed specimens is shown in Fig. 5. The water content at capillary saturation decreased significantly when resin, particularly Epoxy I, was utilized to seal the specimens. These differences in the results are important to consider for all types of resins, given the high repeatability of measurements of capillary saturated water content. In contrast, the differences in water content of calcium silicate board at capillary saturation owing to the sealing methods were negligible ($< 1\%$).

[Insert Figure 5]

3.2. Autoclaved aerated concrete

The typical results for AAC specimens are shown in Fig. 6. Unlike brick and calcium silicate board specimens, the AAC specimens exhibited a nonlinear relationship between the square root of time and absorbed water mass. This trend was also observed in previous studies (Feng and Janssen, 2018; Ioannou et al., 2008). The A values could not be directly determined from the slopes of the graphs, leading to the utilization of the following equation to fit the graph (Hall & Tse, 1986):

$$\Delta m = At^{1/2} - Ct, \quad (1)$$

where Δm represents the mass of the absorbed water per unit surface area of the bottom surface (kg/m^2), t represents the elapsed time (s), and C represents an additional constant. The second term in the equation was added to account for the curvature of the graph.

The calculated values of A are shown in Fig. 7. Specimens sealed with Epoxy I exhibited low A , similar to those observed in the other two building materials. Differences in results for specimens sealed with other methods were unclear due to relatively high variability among specimens. Notably, the results indicate a significant increase in water absorption during early stage of absorption ($< 250 \text{ s}^{0.5}$) when aluminum tape was utilized to seal the specimens, as shown in Fig. 6, though the values of A do not differ from those with other sealing methods apparently.

[Insert Figure 6]

[Insert Figure 7]

4. Discussion

4.1. Resin penetration

The test results for the resin-sealed brick and calcium silicate board specimens indicated that the use of resin generally reduced the water absorption of both materials. As the impact of the sealing material on the determined hygric properties may vary depending on the personnel conducting the measurements (Feng, et al., 2017), additional experiments were conducted to assess these differences. Three brick specimens sealed by three different individuals with Epoxy II were tested. To isolate the impact of application methods, procedures other than resin application were performed by a single operator in the same laboratory. A comparison of the test results is shown in Fig. 8, alongside the amount of application by each individual. The normalized values of A regarding those of the same specimen sealed with plastic wrap are shown, similarly with the results reported in the previous section. The findings revealed that A decreased compared with that of the wrap-sealed specimens, regardless of the individual sealing the specimen. Furthermore, A values tended to be smaller with larger application amounts.

[Insert Figure 8]

A similar decrease in A was observed when the area close to the bottom of the specimen was left uncovered, as shown in the top 90 mm sealing case in Fig. 4 (a). This suggests that multidimensional water inflow is not the primary factor contributing to the differences in test results resulting from resin use.

Based on the Lucas–Washburn equation (Washburn, 1921), the penetration depth h (m) of a liquid owing to capillary forces depends on the pore radius r (m), and liquid viscosity η (Pa·s), as follows:

$$h = \sqrt{(r\sigma \cos \theta / 2\eta)t}, \quad (2)$$

where σ and θ denote the surface tension (N/m) and contact angle, respectively. Initial penetration rates of resins (i.e., with sufficient amount of resin to penetrate before consolidation) can be estimated using Equation (2). The peak pore radii for the employed brick, calcium silicate board, and AAC were 4.27, 0.26, and 0.03 μm^1 , respectively, as shown in Fig. 1. Based on these values, resin penetration is expected to have a significant impact on brick owing to its larger pore size. Additionally, Epoxy I is anticipated to penetrate the specimen more easily and prevent water absorption more significantly

¹ AAC has two peak pore sizes. In this study, the peak radius of the finer pores is considered because large aerated pores are inefficient for capillary uptake.

compared with Epoxy II, given its low viscosity and longer curing time. This aligns with the findings from experiments involving brick, indicating that resin penetration is the primary source of measurement errors.

For the calcium silicate board, the acrylic-modified silicone resin reduced the water absorption coefficients more significantly compared with epoxy resins. This suggests that the impacts of resin application on different building materials are influenced by viscosity and curing time, typically provided by manufacturers, and by the components of the resins. Further knowledge should be acquired regarding the influence of resin application on building materials based on their combinations.

4.2. Capillary rise through the gap between the specimen and sealing material

We observed that materials demonstrated faster water absorption when sealed with aluminum tape compared with other sealing materials. The cross-section of an AAC specimen after 3.6 h of water absorption is shown in Fig. 9. Absorption occurred more rapidly near the side surfaces, as indicated by the dotted rectangles, compared with the middle of the specimen. This phenomenon is expected to contribute to the swift water absorption of tape-sealed specimens. One possible explanation for this observation is the limited contact area between the specimen and tape owing to the high porosity, resulting in low adhesive strength and capillary action through the gap between them. Furthermore, the slow water absorption rate of AAC compared with the other materials may accentuate the relatively rapid absorption caused by such phenomena. Given that no other possible mechanism is likely to increase absorption rates in aluminum tape cases, brick and calcium silicate board are also expected to be affected by this phenomenon. Consequently, the impact of the tape on water absorption is anticipated to vary based on the characteristics of the tape and material, and application method employed (such as adhesive strength, pore structure, and surface treatment techniques). When utilizing adhesive tape to seal a specimen with its base in contact with water, careful consideration of these factors is essential.

[Insert Figure 9]

4.3. Multidimensional water inflow and air entrapment

The variations in water absorption between specimens sealed with plastic wrap and aluminum tape were found to be small for both brick and calcium silicate board. This suggests that two potential sources of error do not have a significant impact on the water absorption of these materials: multidimensional water inflow near the water surface when a non-adhesive sealing material is used on a specimen and air entrapment caused by air-impermeable side sealing.

To gain a deeper understanding of the effects of multidimensional water inflow, three-dimensional calculations of water transfer within materials were conducted. The calculation conditions were

designed to replicate the water absorption tests performed on the three building materials conducted in this study. A portion of the side surfaces near the bottom were assumed to be left uncovered with a sealing material and immersed in water. The calculation methods are summarized in the appendix.

The calculated evolutions of the mass of absorbed water as a function of the square root of the elapsed time are shown in Fig. 10. Water absorption processes were compared for different depths of water immersion. The results revealed that materials immersed deeper in water absorbed water more rapidly during the initial stages of absorption. However, as time progressed, the mass of absorbed water increased almost linearly with the square root of the elapsed time until the material reached capillary saturation. Furthermore, the water absorption coefficients A were determined from the slope of the graph during the middle stage of absorption ($> 10 \text{ s}^{1/2}$ and $< 30 \text{ s}^{1/2}$ for brick, $> 10 \text{ s}^{1/2}$ and $< 40 \text{ s}^{1/2}$ for calcium silicate board, and $> 50 \text{ s}^{1/2}$ and $< 150 \text{ s}^{1/2}$ for AAC). The deviation in A resulting from absorption from the unsealed part of the side surfaces was less than 1% when the material was immersed in water up to 10 mm from its bottom. Therefore, with proper data processing procedures (such as excluding data of the initial stage of absorption, which was found to be relatively sensitive to the depth of immersion), the impact of multidimensional water inflow near the bottom surface was considered small.

[Insert Figure 10]

5. Limitations

In this study, we utilized non-adhesive wrap, aluminum tape, and resins to seal the specimens. Other sealing methods, such as paraffin, wax, and paint (Feng, et al., 2017; Huang, et al., 2022; Roels, et al., 2010; Zelinka, et al., 2016) should be examined in future studies. Additionally, the experiments conducted in this study did not reveal any significant impacts of air entrapment from non-air-permeable sealing materials on the results of the water absorption tests. However, further analysis is needed for materials with lower air permeability.

Finally, the experimental results indicate a decrease in the water absorption of the brick when the sides were fully or partially sealed with tape, as shown in Fig. 4 (a). While this decrease may be deemed acceptable in practical measurements (7% of the water absorption coefficient), the exact cause remains unclear. This observation was probably caused by the cumulative effects of various factors, including multidimensional water inflow near the base and air entrapment. Furthermore, factors, such as the inhomogeneity of water transport in surface layers (Gummerson et al., 1971; Hall, 2007) and hydrostatic pressure exerted on material surfaces beneath the water surface, which were not considered in the calculations, could also impact water absorption.

6. Conclusion

Sealing methods are considered potential error sources in water absorption tests, which are essential for evaluating the liquid transport performance of porous building materials. This study investigated the impacts of various sealing methods (such as plastic wrap, adhesive tape, and resins) on the results of water absorption tests conducted on three common building materials. The study compares the effects of the potential error factors caused by various combinations of sealing methods and building materials. The key findings are as follows:

- The penetration of the resin into a specimen can cause significant deviations in both the water absorption coefficients and capillary water content. Materials with large pore sizes, such as bricks, were particularly sensitive to resin penetration. The characteristics of the resin (components, viscosity, and curing time), as well as the expertise of the personnel who conducted the application, also influenced the test results.
- The use of adhesive tape could result in capillary uptake through the gap between the specimen and tape. The significance of excess absorption was likely influenced by the adhesive strength and transport properties of the material, necessitating further clarification on acceptable combinations.
- Compared with the aforementioned factors, the multidimensional water inflow near the water surface and air entrapment caused by the air-impermeable sealing had relatively minor effects on the water absorption of the materials employed in this study.

These findings suggest that the utilization of plastic wrap or tape is the most secure method of sealing among those examined, provided these sealing materials do not come into contact with the water surface, as this could lead to capillary rise through the gap between the specimen and sealing material. Understanding these findings will aid in making informed decisions regarding sealing methods and analyzing the factors contributing to errors in measuring hygric properties across different laboratories or individuals.

Appendix.

Methods of three-dimensional water transfer calculations to examine the effects of multidimensional water inflow near the bottom surface

The three-dimensional water diffusion in the material was calculated as follows:

$$\frac{\partial w}{\partial t} = \nabla \cdot (D_w \nabla w), \quad (\text{A1})$$

where D_w represents the water diffusivity (m^2/s), t represents time (s), and w represents the water content (kg/m^3).

The schematic of the calculation model is shown in Fig. A1, whereas a summary of the water content values utilized for the initial and boundary conditions of the calculations is presented in Table A1. These calculations were based on water absorption tests conducted on three different materials in this study. The material dimensions were assumed to be 40 mm × 60 mm at the base and 100 mm in height, with calculations performed on a quarter of the material volume accounting for symmetric dimensions.

[Insert Figure A1]

Table A1. Water content values utilized as the initial and boundary conditions of the calculations (derived from the data in a previous study (Feng & Janssen, 2021)).

	Brick	Calcium silicate board	Autoclaved aerated concrete
Initial water content in the material (equilibrating with air at 50% relative humidity)	0.49	3.83	9.17
Water content at capillary saturation	209.6	755.8	313.4

The material was expected to absorb water from its bottom surface, leading to saturation of the bottom surface with the water content values corresponding to capillary saturation, as listed in Table 1. The side surfaces near the bottom were left unsealed and immersed in water to replicate multidimensional water inflow, with water content also set to capillary saturation levels. Various calculations were performed with different heights (0, 5, 10, and 30 mm) in this area to assess the impact of water immersion depth on absorption. The water flux through the other areas on the side surfaces was set to 0, as these areas were sealed with moisture-impermeable materials. The water flux at the top surface was set to zero to simplify the calculations.

The material was initially assumed to equilibrate with air at 50% relative humidity. Water content values, as shown in Table A1, were obtained from the database (Feng & Janssen, 2021) and homogeneously distributed throughout the material. Water diffusivity values for the three materials were also sourced from (Feng & Janssen, 2021) and are shown in Fig. A2.

[Insert Figure A2]

Equation (A1) was discretized using the finite difference method, with central and forward differences employed for space and time, respectively. The time and space steps were set to 0.005 s and 0.001 m, respectively.

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Figure legends

Fig. 1. Pore volume distribution of the three materials utilized (Fukui & Takada, 2024).

Fig. 2. Schematics of the sealing methods and covered areas in the water absorption tests.

Fig. 3. Examples of results of water absorption tests using brick and calcium silicate board (wrap-sealed specimens).

Fig. 4. Water absorption coefficients of (a) brick and (b) calcium silicate board specimens relative to those of plastic wrap-sealed specimens.

Fig. 5. Water contents of tape- or resin-sealed brick specimens at capillary saturation relative to those of plastic wrap-sealed specimens.

Fig. 6. Typical results of water absorption test using wrap-, tape-, Epoxy I-, Epoxy-II sealed autoclaved aerated concrete.

Fig. 7. Water absorption coefficients of autoclaved aerated concrete specimens determined based on the methods in (Hall & Tse, 1986).

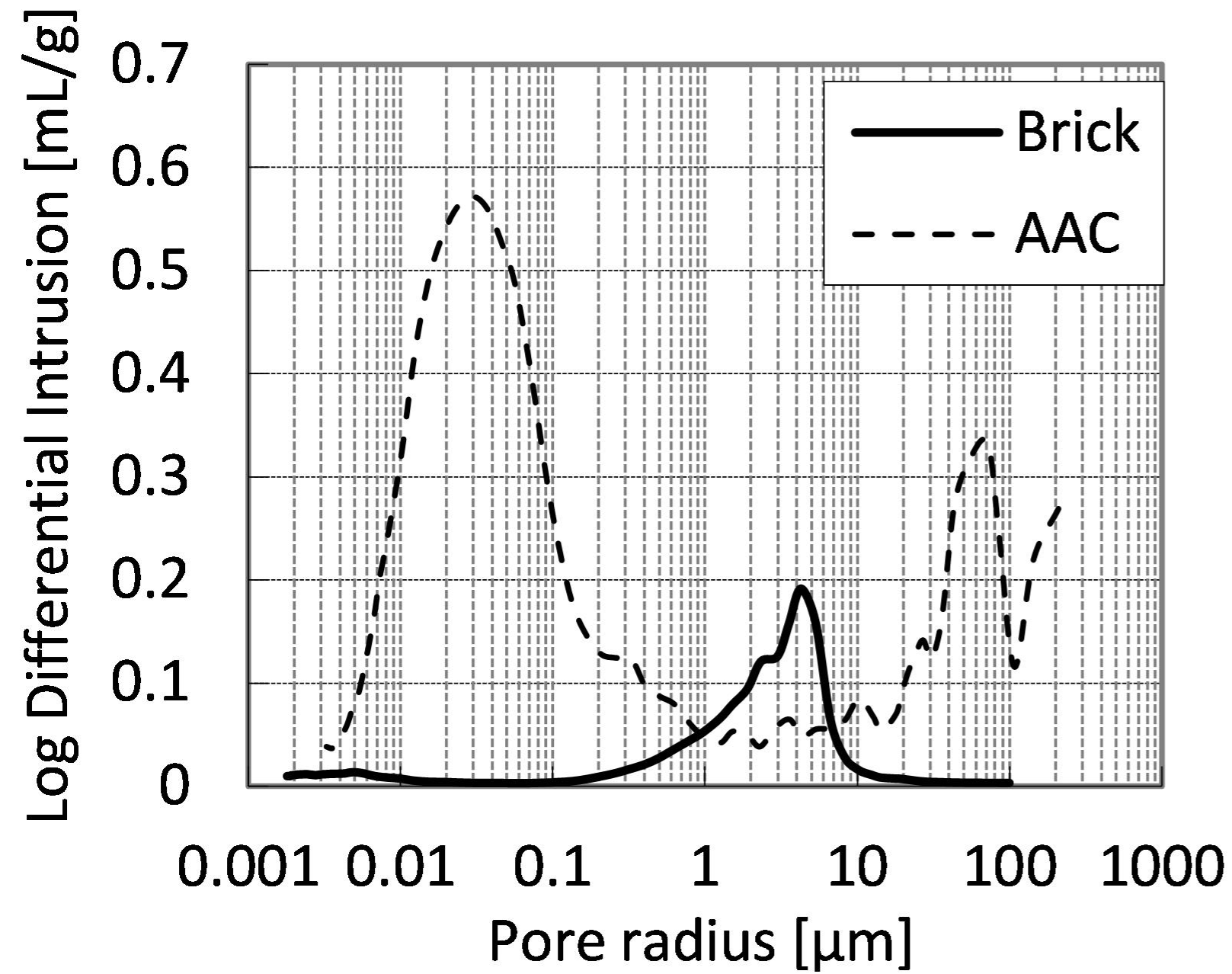
Fig. 8. Comparison of the impacts of resin penetration on water absorption coefficients and amount of application based on the individuals applying the resin.

Fig. 9. Cross-section of an autoclaved aerated concrete specimen during water absorption.

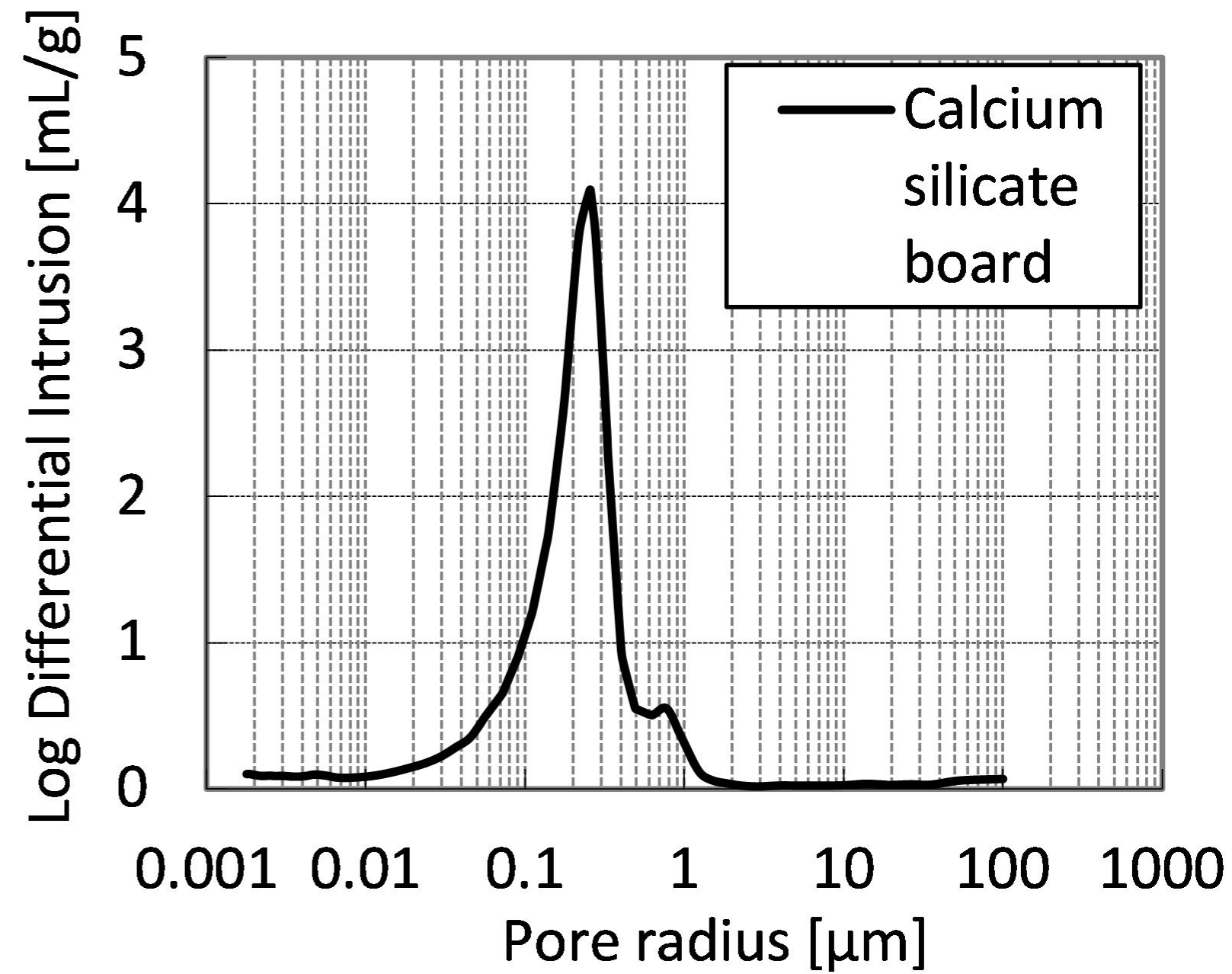
Fig. 10. Results of the three-dimensional calculations of water transfer in (a) brick, (b) calcium silicate board, and (c) autoclaved aerated concrete, considering multidimensional water inflow from the unsealed area near the bottom surface.

Fig. A1. Schematic of the calculation model.

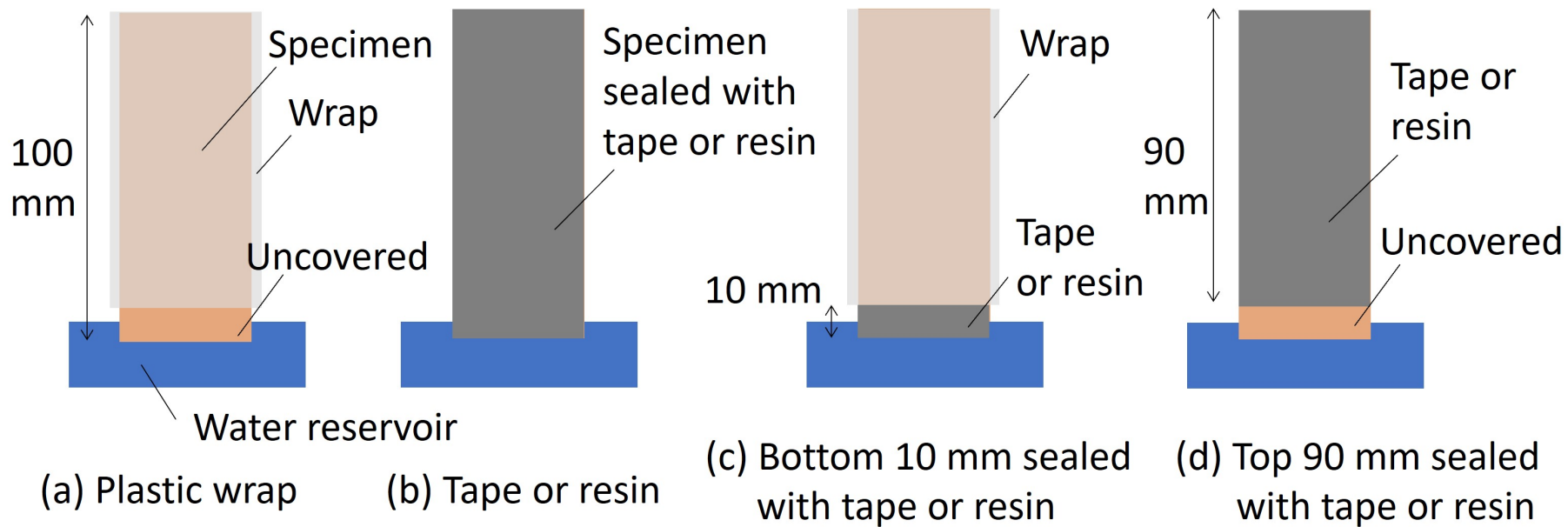
Fig. A2. Water diffusivity D_w (m^2/s) employed in the calculations (sourced from (Feng & Janssen, 2021)).



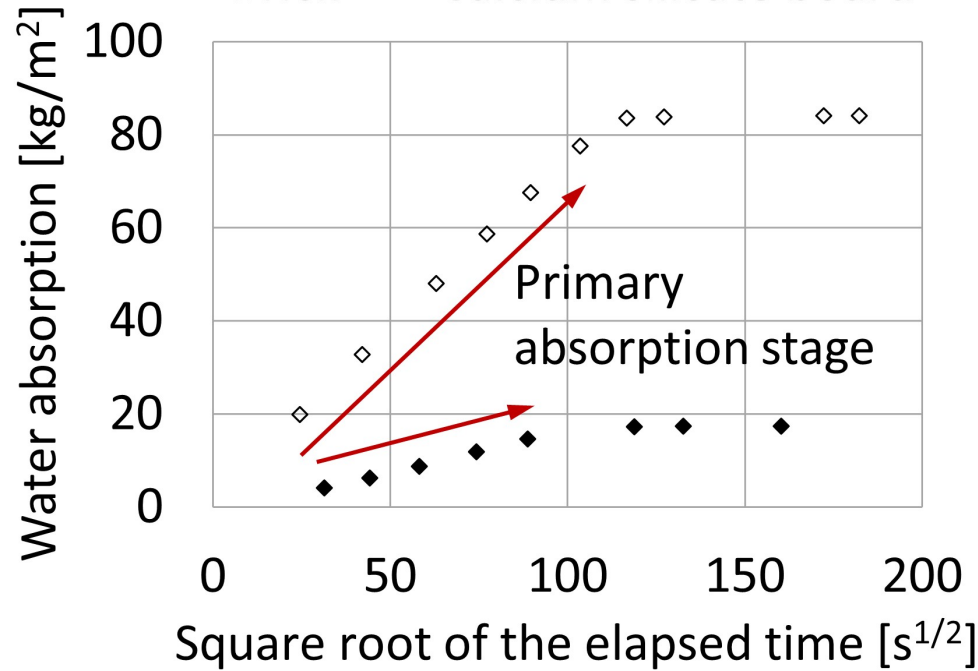
(a)

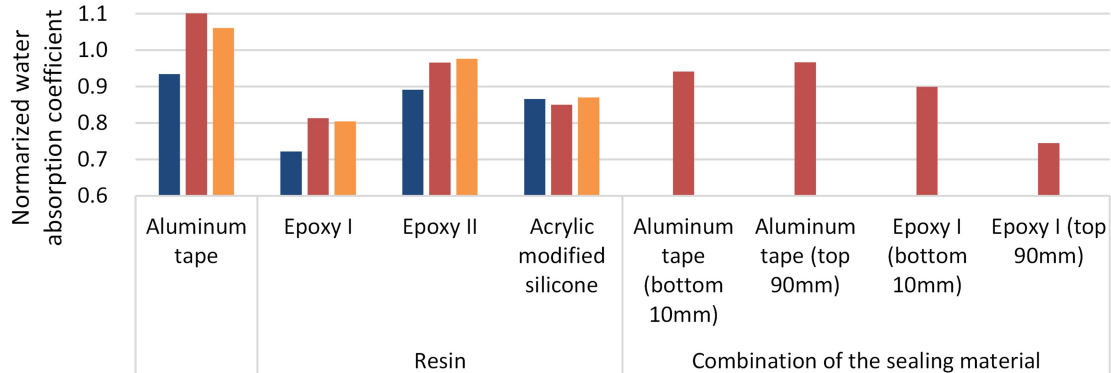


(b)

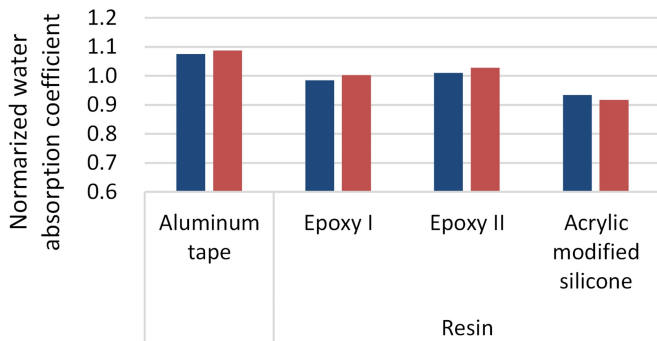


◆ Brick ◇ Calcium silicate board

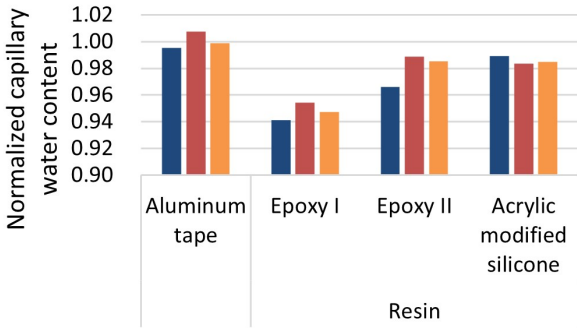


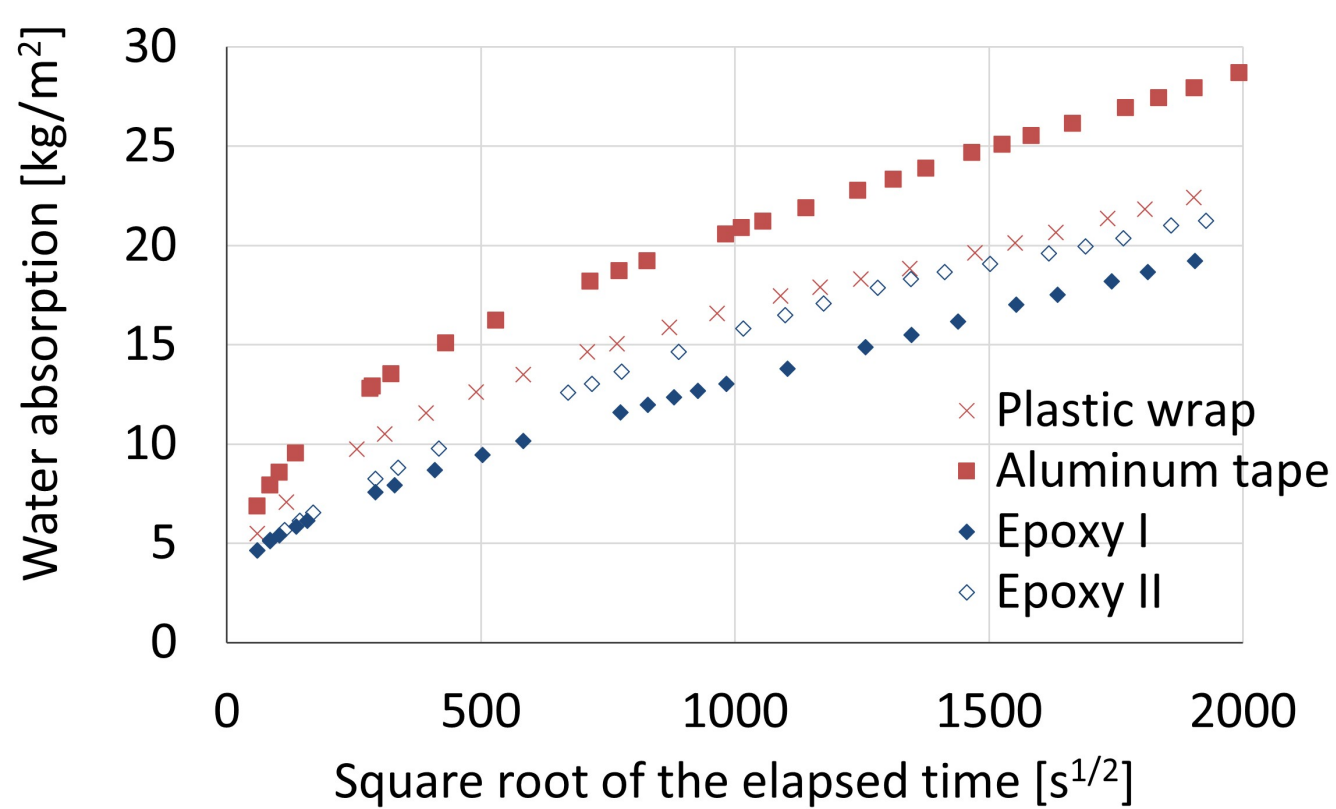


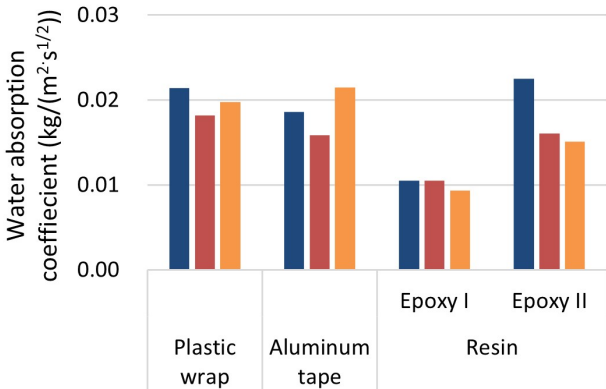
(a)

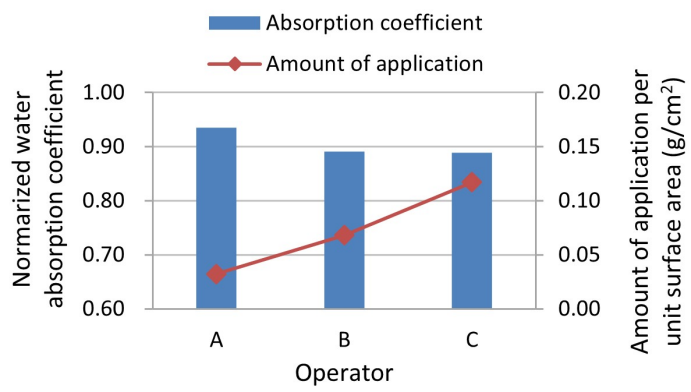


(b)

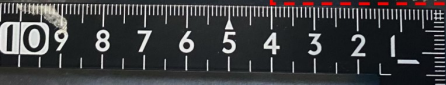






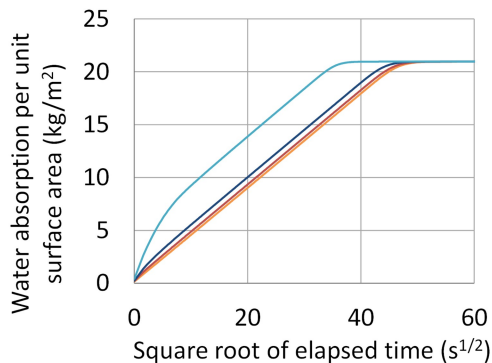


Direction of
water absorption

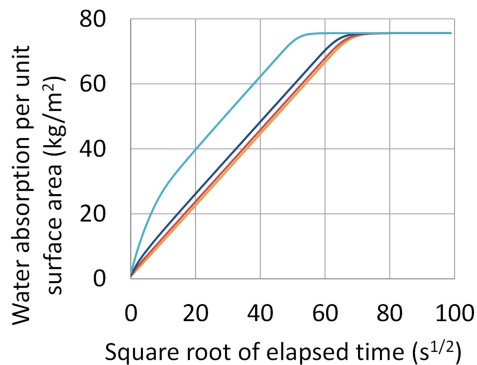


Depth of the immersion of side surfaces into water [mm]

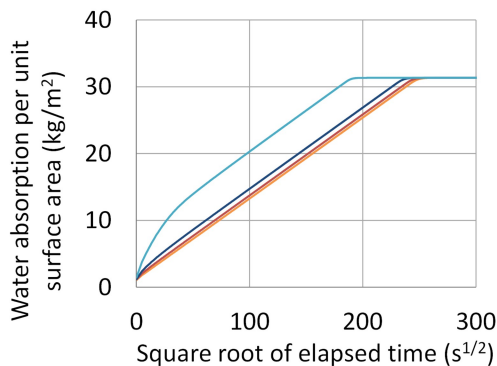
— 0 — 5 — 10 — 30



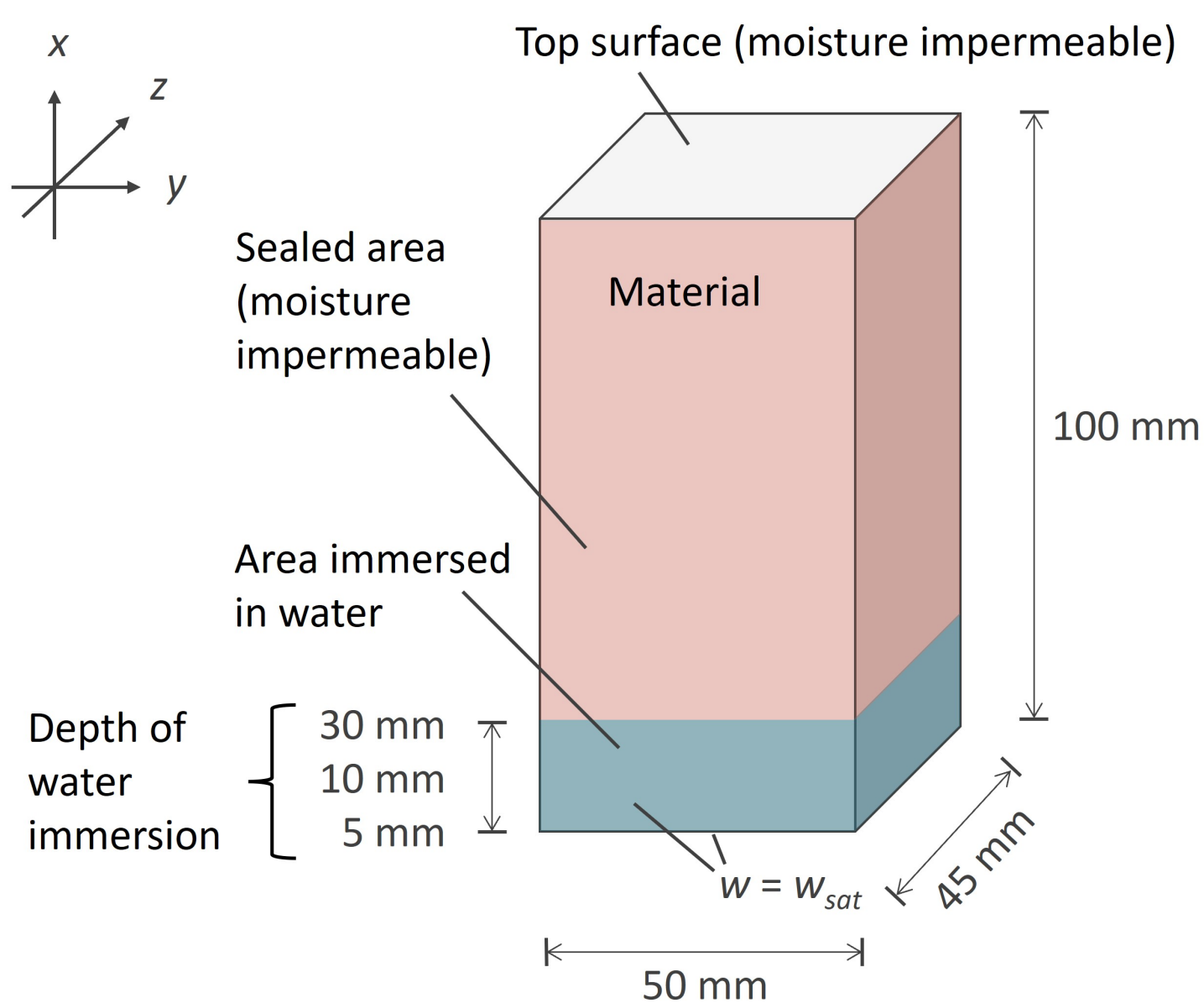
(a)



(b)



(c)



— Brick — Calsium silicate board — Aerated concrete

