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Various Factors of Water Entry and Penetration Through Water Proofing Layer in Wooden Wall Assembly

Hiroaki Saito [1] and Masashi Miyamura [2]

[1] Ashikaga University, Ashikaga, Japan 3268558,
Phone +81 284 22 5674, Fax +81 284 62 0976, hsaito@ashitech.ac.jp

[2] National Institute for Land and Infrastructure Management, Tsukuba, Japan 3050802,
Phone +81 29 864 4339, Fax +81 29 864 6774, miyamura-m92ta@mlit.go.jp

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1 Introduction

Global warming has a significant impact on exposure conditions related to the long-term durability of building envelopes. Based on the trends in meteorological data issued by Japan Meteorological Agency, the annual number of days with heavy rain of more than 200 mm per day increased by 1.5 times in the past decade in comparison with the rate of increase 40 years ago (Japan Meteorological Agency, 2019). To examine proper boundary condition to assess service life of building envelopes, this paper describes an experimental study regarding water penetration through primary and secondary waterproofing layers in wooden wall assemblies.

As a first step, water spray tests using airtight box were implemented to compare watertightness of exterior systems using ceramic sidings (Figure 1). The ceramic sidings of six products (Sp1 ~Sp6) with similar specification were selected. The sprayed water was uniformly applied at a rate of 4 L/[m^{2}min] across the exterior of the specimens. Static pressure differences through the siding panel were increased stepwise by 150 Pa, 240 Pa, 350 Pa, and 470 Pa, with static loading. Water penetrating the inner plane through the shiplap joints was collected at the bottom of the specimen, and weighed to quantify the overall penetration rate.

The quantity of penetrating water are shown in Figure 1. The quantity of the penetrating water in Sp1 and Sp2 exceeded 0.3 L/min m^2 in the range beyond 240 Pa. This value is approximately equivalent to 8% of the sprayed water. These values of the other specimens were less than 0.1 L/min m^2 and 3%. This result indicates that dispersion of the water entry in siding products cannot be neglected in determining the proper configuration of vented cavity.

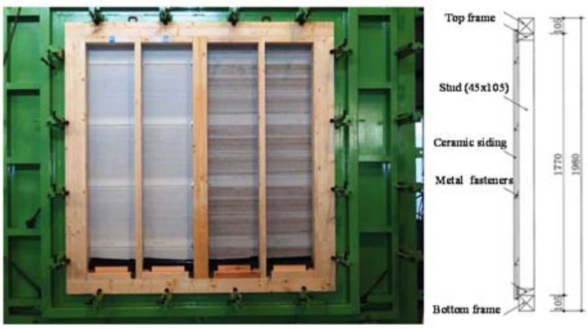

Figure 1. Specimens fixed to airtight box.

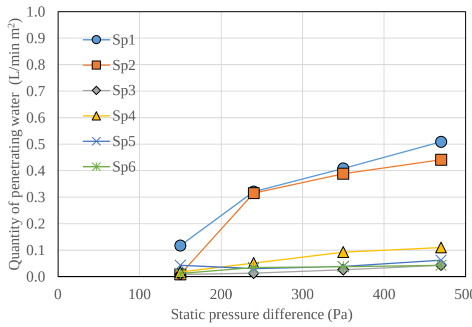

Figure 2. Quantity of penetrating water in Case 1.

As for secondary waterproofing layer, water penetration tests at fastner interface were conducted for representative products. Seven products of asphalt impregnated felt (AF), two products of modified asphalt impregnated felt (MF), and three products of permeable polymer housewrap (HS) for secondary waterproofing material of wall assembly were selected as the test samples in Case1. Water column containers were placed on the fasteners of the specimen, and colored water was injected into them. Water penetration was confirmed by visual observation of the colored water leaking after 24 hours.

Water leakage was observed at 30 mm of the water level in HS, and all points of HS allowed water penetration through the fastener interface (Figure 3). Contrarily, AF and MF indicated higher performance for watertightness. However, water leakage in AF and MF was detected from 50 mm of water level. Water penetration tests in Case 2 were performed in three products of HS and one product each of AF and MF. To consider the impact of an actual construction site, fastened samples on substrate were exposed to an outdoor environment on a 30-degree angle from the horizontal. Although water penetration was detected on AF and HS, MF secured watertightness on all spots of the fastener interface even after the outdoor exposure (Table 1). The differing results between Case 1 and Case 2 suggested not only vulnerability in AF but also durability in MF, taking into account the construction schedule.

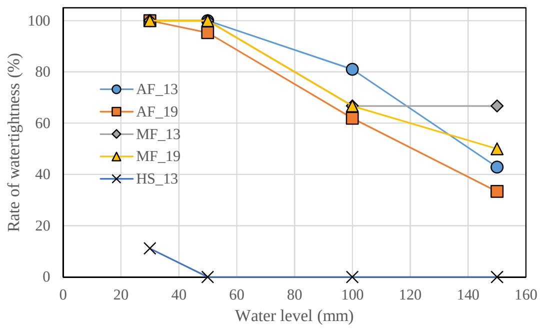

Figure 3. Rate of fastener interface securing watertightness in Case 1.

Table 1. Rate of watertightness in Case2.

Waterproofing material	Rate of watertightness (%)
AF	0 [0/9]
MF	100 [9/9]
HS	0 (0/9)

2 Conclusions

In conclusion, aforementioned experimental results suggest that various factors have significant impact on the water leakage. Lately, consideration of rain penetration in hygrothermal analysis has been recommended in evaluation methods such as the ASHRAE Standard 160 (ASHRAE 2009). However, findings in this paper suggest that rain penetration rate should be examined in consideration of various factors, in order to assess the service life of building envelopes.

ORCID

Hiroaki Saito: https://orcid.org/0000-0003-3633-7679
Masashi Miyamura: https://orcid.org/0000-0002-5606-9117

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