Report from task 2 of MEWS Project: description of 17 large scale wall specimens built for water entry investigation in IRC dynamic wall testing facility

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IMPORTANT NOTICE TO READERS

The main emphasis of the MEWS project was to predict the hygrothermal responses of several wall assemblies that are exposed to North American climate loads, and a range of water leakage loads. Researchers used a method based on both laboratory experimentation and 2-D modeling with IRC's benchmarked model, hygIRC. This method introduced built-in detailing deficiencies that allowed water leakage into the stud cavity - both in the laboratory test specimens and in the virtual (modeling) "specimens"- for the purpose of investigating water entry rates into the stud cavity and the drying potential of the wall assemblies under different climate loads. Since the project was a first step in investigating a range of wall hygrothermal responses in a parametric analysis, no field study of building characteristics was performed to confirm inputs such as water entry rates and outputs such as wall response in a given climate. Rather, ranges from 'no water entry and no response' to 'too much water entry and too wet for too long' were investigated.

Also, for the sake of convenience, the project used the generic cladding systems (e.g., stucco, masonry, EIFS, and wood and vinyl siding) for labeling and reporting the results on all wall assemblies examined in the study. However, when reading the MEWS publications, the reader must bear in mind that the reported results are more closely related to the nature of the deliberately introduced deficiencies (allowing wetting of the stud cavity) and the construction details of the wall systems investigated (allowing wetting/drying of the assembly) than to the generic cladding systems themselves. As a general rule, the reader must assume, unless told otherwise, that the nature of the deficiencies and the water entry rates into the stud cavity were different for each of the seventeen wall specimens tested as well as for each of the four types of wall assemblies investigated in the modeling study. For this reason, simply comparing the order of magnitude of results between different cladding systems would take the results out of context and likely lead to erroneous conclusions.

MEWS PROJECT REPORT T2-02: May 2002

TASK 2 – Field construction

REPORT FROM TASK 2 OF MEWS PROJECT
DESCRIPTION OF 17 LARGE-SCALE WALL SPECIMENS BUILT FOR WATER ENTRY INVESTIGATION IN IRC DYNAMIC WALL TESTING FACILITY

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EXECUTIVE SUMMARY

From late 1999 to early 2001, seventeen large-scale wall specimens were built for water entry investigation in IRC Dynamic Wall Testing facility (DWTF). The specimens consisted of five stucco-clad, five Exterior Insulation and Finish system (EIFS)-clad, four masonry-clad and three siding-clad assemblies (two hardboard and one vinyl). All specimens included a window, a duct and an electrical outlet receptacle. The composition of the specimens is described with wall section drawings and photographic records of their construction.

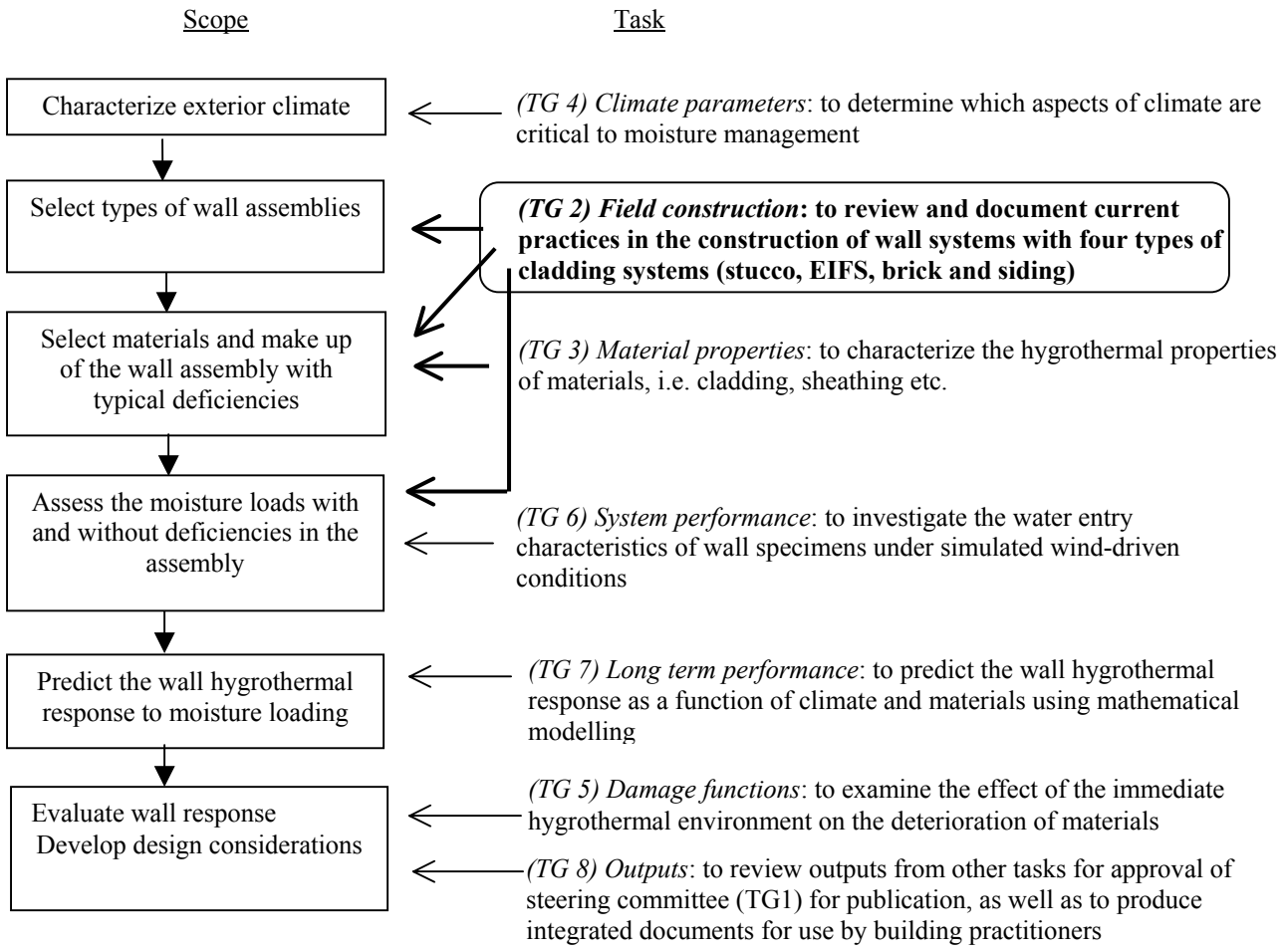
PREAMBLE

The MEWS Consortium Project

In 1998, IRC/NRC initiated a research consortium with industry partners to develop guidelines for moisture management for exterior wall systems (MEWS) in low-rise residential buildings for the wide range of climate zones across North America. It was decided early on that the following four types of cladding systems would be included in the project: stucco, Exterior Insulation and Finish Systems (EIFS), masonry and siding used in wood-frame construction.

The project is broken down into several tasks, from a review of literature on current construction practice to experimental work in the laboratory and mathematical modelling.

The MEWS research project aims at predicting the hygrothermal response of wood-frame walls of residential buildings. The seven tasks of the project form an integrated approach for the development of practical information for durable exterior walls as illustrated in the diagram below.



Schematic of the approach used in the MEWS project

Task Group 2 Objectives

The primary objective of the MEWS Task Group 2 was to gather *sufficient* technical information on exterior moisture management practices used in stucco, EIFS, masonry or siding cladding systems to support other tasks of the project. Indeed this type of information was necessary for the design and construction of 17 large-scale wall specimens to be investigated for water ingress (TG6) using simultaneous air pressure difference and water spray in IRC Dynamic Wall Testing facility.

Task Group 2 Reports

Task Group 2 delivers the following two reports:

1. A collection and review of available technical information about common Canadian and American practices concerning the design and construction of exterior wood-frame walls made with stucco, EIFS, masonry and siding cladding systems. Report T2-01.
2. A detailed description of the 17 large-scale wall specimens built for water entry evaluation in IRC's Dynamic Wall Testing facility (TG6). Report T2-02.

IRC wishes to acknowledge the special collaboration of the following industry members:

- Silvio Plescia, Canada Mortgage and Housing Corporation
- Frank Nunes, Lathing and Plastering Institute of Northern California, for the stucco-clad wall specimens
- John Edgar, EIMA, for the EIFS wall specimens
- Pat Kelly, Canada Brick, and Gary Sturgeon, Masonry Canada, for the masonry wall specimens
- Tom Roe, Louisiana-Pacific and Keith Wilson, Owens-Corning for the siding wall specimens

Content of this Report

This report is divided into four chapters that describe the detailing of each wall specimen at each type of interface. It provides photographic records of the construction of the 17 specimens.

The detailing of these large-scale wall specimens does not constitute a repertory of best practices nor does it completely reflect how cladding systems are actually put in place in practice. Even though every effort was made to get the construction and detailing of the wall specimens consistent with major elements used in practice, some differences were introduced for two reasons:

- Need for placement of the monitoring instrumentation in the specimen. The test wall specimens contain some instrumentation equipment, such as water collection troughs and water deflectors in cavities under penetrating elements (i.e. ducts, outlets, window). As an example of how intrusive some equipment can be, water collection troughs are placed at the window sill and occupy the space usually taken by either insulation materials or pan flashing.
- The need for a relatively uniformly applied testing protocol. For this reason, certain features were introduced in all specimens, even though in practice, these may not be common for all four types of cladding systems. Here are two examples of that. At the window-wall interfaces of all 17 specimens, a 10 mm gap is introduced between the window frame and the edge of the cladding. This gap is sealed with backer rod and a bead of sealant; at given steps in the testing protocol, a portion of the sealant bead is removed to investigate water leakage through a given deficiency. In practice certain cladding systems (e.g. vinyl siding) do not commonly include such a sealed gap at that interface (based on industry partners observations). However, in order to maintain a level of uniformity between wall specimens for comparative purposes, that gap was introduced in all 17 specimens.

  The same situation occurred with the installation procedure for the water-resistive barriers (WRB). One single WRB installation procedure was used for all specimens with a given type of WRB (ex: paper-based or polymeric WRB), even though that procedure may not be typically followed integrally in practice for certain cladding systems (according to observations by some of the industry partners).

CHAPTER 1

CONSTRUCTION AND CURING OF THE FIVE STUCCO-CLAD WALL ASSEMBLIES

This chapter provides the as-built construction details and the curing conditions for the five stucco wall specimens that were investigated for water entry using IRC Dynamic Wall Testing Facility (DWTF).

The construction of the stucco wall specimens took place in November and December 1999. On December 14 and 16, 1999 the scratch and brown coats of the stucco cement plaster were applied by local applicators. Mr. Frank Nunes of the Lathing and Plastering Institute of Northern California was present during the installation of the scratch coat.

1.1 COMPOSITION OF THE STUCCO WALL SPECIMENS

Five different stucco wall assemblies are evaluated for rain entry. Their composition is described in Table 1.1 and illustrated in Figures 1.1 and 1.2.

Table 1.1. Description of the stucco-clad wall assemblies

	WALL COMPOSITION
No. 1	19 mm, lime-cement plaster / self-furring expanded metal lath / cross-woven perforated polyethylene membrane / 11 mm OSB sheathing / 38 mm X 89 mm (2X4) wood framing @ 400 mm o.c.
No. 2*	19 mm, lime-cement plaster / self-furring woven metal lath / 60-minute rated building paper / 11 mm OSB sheathing / 38 mm X 89 mm (2X4) wood framing @ 400 mm o.c.
No. 3	19 mm, lime-cement plaster / self-furring welded wire metal lath / spun-bonded polyolefin membrane (American type) / 11 mm OSB sheathing / 38 mm X 89 mm (2X4) wood framing @ 400 mm o.c.
No. 4	12 mm, fibre-reinforced plaster pre-mix with acrylic finish / self-furring expanded metal lath / two 30-minutes building paper membranes / 11 mm OSB sheathing / 38 mm X 89 mm (2X4) wood framing @ 400 mm o.c.
No. 5	19 mm, 3 coats Portland cement plaster as specified by BC BERC** / “Tilath” 1/8 in. flat rib with offset paper 2.75 lb / 10 mm cavity, PT wood strapping / two 30-minutes building paper membranes / 11 mm OSB / 38 mm X 89 mm (2X4) wood framing @ 400 mm o.c. This is a drained stucco-clad system with vents at top and bottom of the cavity.

* Duplicate specimens of wall assembly No. 2 (2A and 2B) were built but their curing conditions differ.

** As per discussion with Silvio Plescia, CMHC

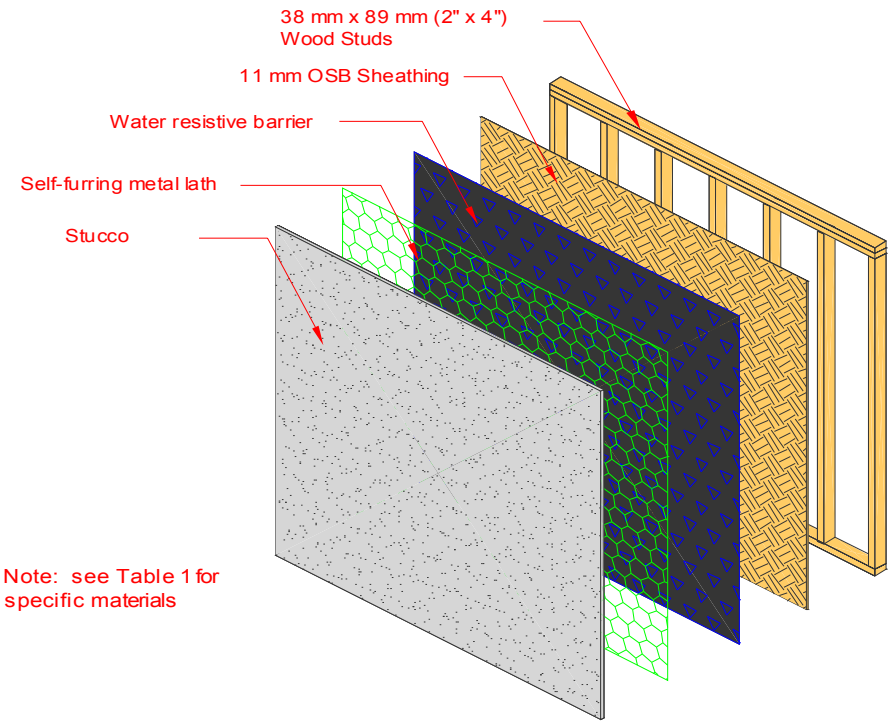


Figure 1.1. Composition of stucco wall specimens No. 1 to No. 4

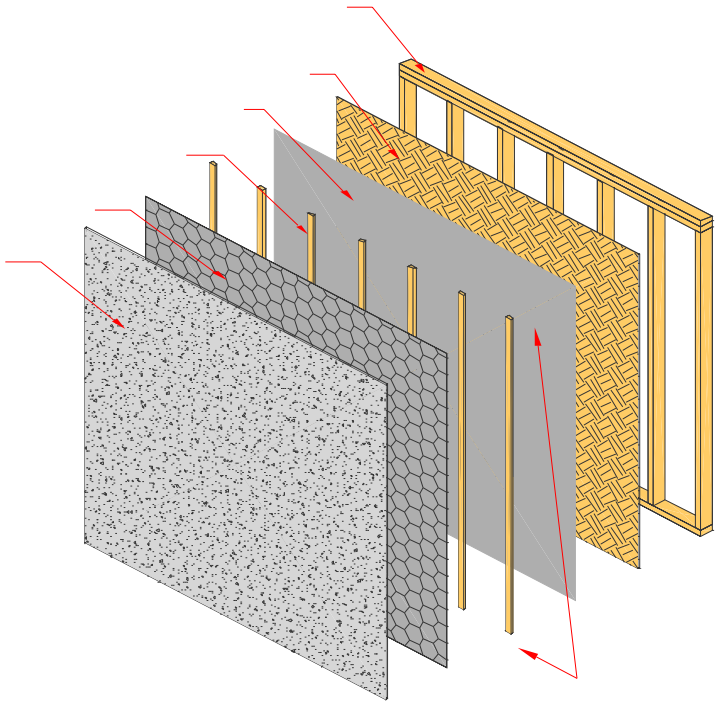


Figure 1.2. Composition of stucco wall specimen No. 5

Four details are included in the stucco-clad wall specimens.

- Window:
  A flange-mounted fixed vinyl (PVC) window measuring 755 mm wide by 755 mm high manufactured by Bonneville Ltd Corporation. The window profile is illustrated in Figure 1.3. The window penetrates through all the layers of materials making up the assembly.
- Duct:
  A circular metal ventilation duct with a 150-mm diameter. The duct penetrates through the first and second lines of defence and the sheathing board.
- Exterior electrical outlet:
  An exterior duplex wall outlet measuring 50 mm wide by 75 mm high by 75 mm deep. The outlet penetrates through the first and second lines of defence and the sheathing board.
- Vertical and horizontal control joints:
  Two vertical and one horizontal control joints (for specimens No. 1 to No. 4) were placed in the stucco plaster. These do not penetrate through the second line of defence. Specimen No. 5 included two vertical control joints only.

The positioning of these details in the wall specimens is shown in Figure 1.4.

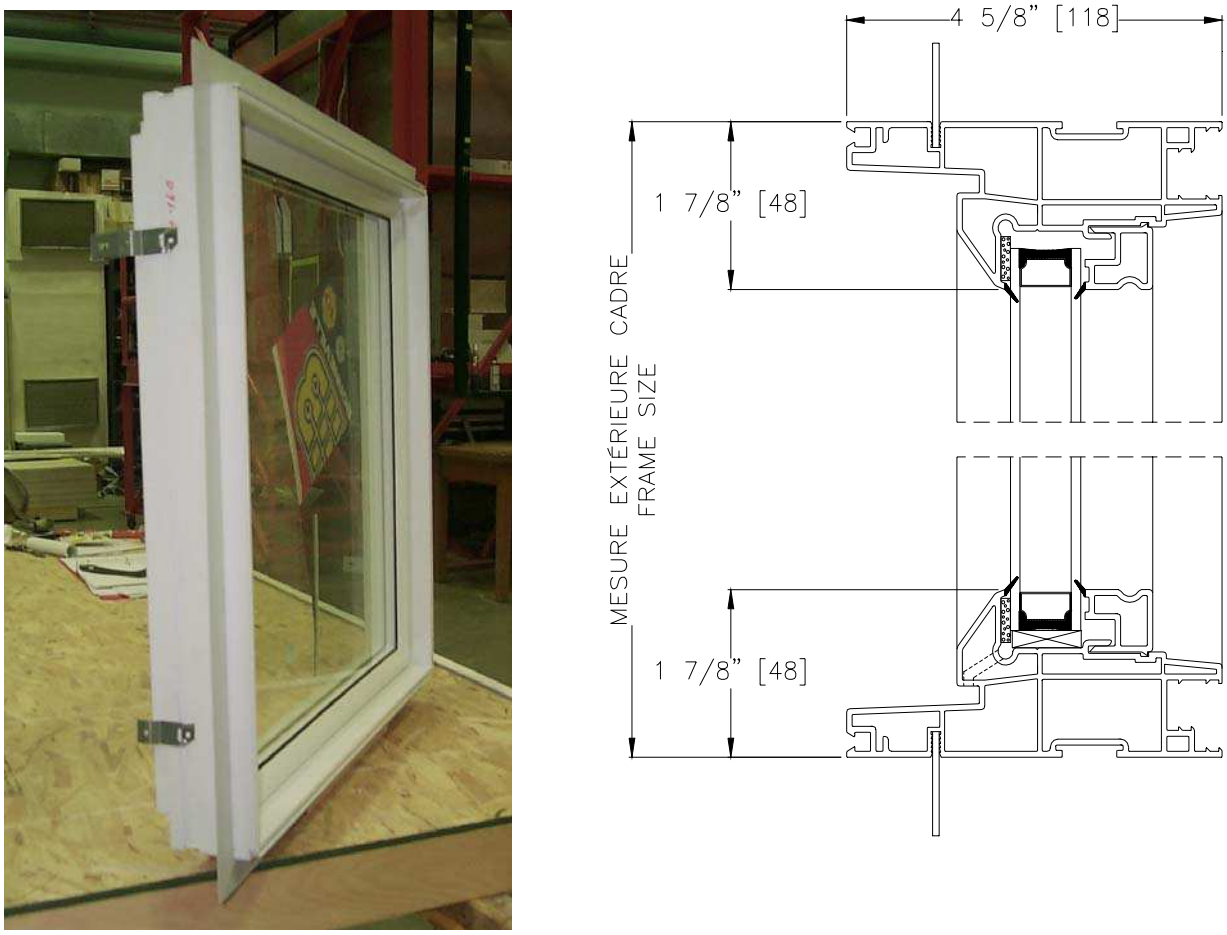


Figure 1.3. Configuration of the window installed in the test specimens

1.2 TYPES OF DEFICIENCIES

Table 1.2 and Figures 1.4 to 1.8 present the deficiencies introduced in the stucco-clad specimens.

Table 1.2. Deficiencies introduced in the stucco-clad wall specimens

Junction	Deficiencies	
	1st line of defence	**2nd line of defence**
Wall-window	• Missing 90 mm of sealant length in the centre of the sill, and at one end of the sill • Missing 90 mm of sealant length at the bottom of one jamb	*For specimens No. 1 and No. 3* (with polymeric water resistive barrier (WRB)) • WRB stapled on top of sill plate • Flashing membrane stapled on rough sill through the WRB • Flashing membrane does not cover the rough sill completely: 6 mm gaps along the junctions with window jambs and a 25 mm gap along the back of the rough sill *For specimens No. 2, No. 4 and No. 5* (with paper-based WRB) • Reverse lap between the inner boundary layer material (WRB) and the flashing at window sill • A 6 mm gap between the WRB and the window flange along the window sill *For specimen No. 5* • No adhesion of a 25 mm continuous strip of self-adhesive flashing membrane to the rough sill and jambs
Wall-ext. electrical outlet	Missing 50 mm of sealant length in the center of the top of the cover plate	• A 18 mm gap between the inner boundary layer material (WRB) and the exterior perimeter of the penetrating element • No flashing in place
Wall- duct	Missing 50 to 90 mm of sealant length in the center of the top of the cover plate	• A 18 mm gap between the inner boundary layer material and the exterior perimeter of the penetrating element • No flashing in place
Two vertical and one horizontal control joints in the cement plaster[1]	Partial bond between the cement plaster and the preformed metal strip used for the control joints	None

Note: Specimen No. 5 contains two vertical control joints.

A sheet of acrylic plastic located on the inside face of the wood framing acts as the air barrier system of the assembly. Deficiencies are introduced in the form of a series of three 4 mm circular holes made in the acrylic sheet at mid-width of every regular stud cavity. All or some of these holes are closed or open depending on the air leakage rate required.

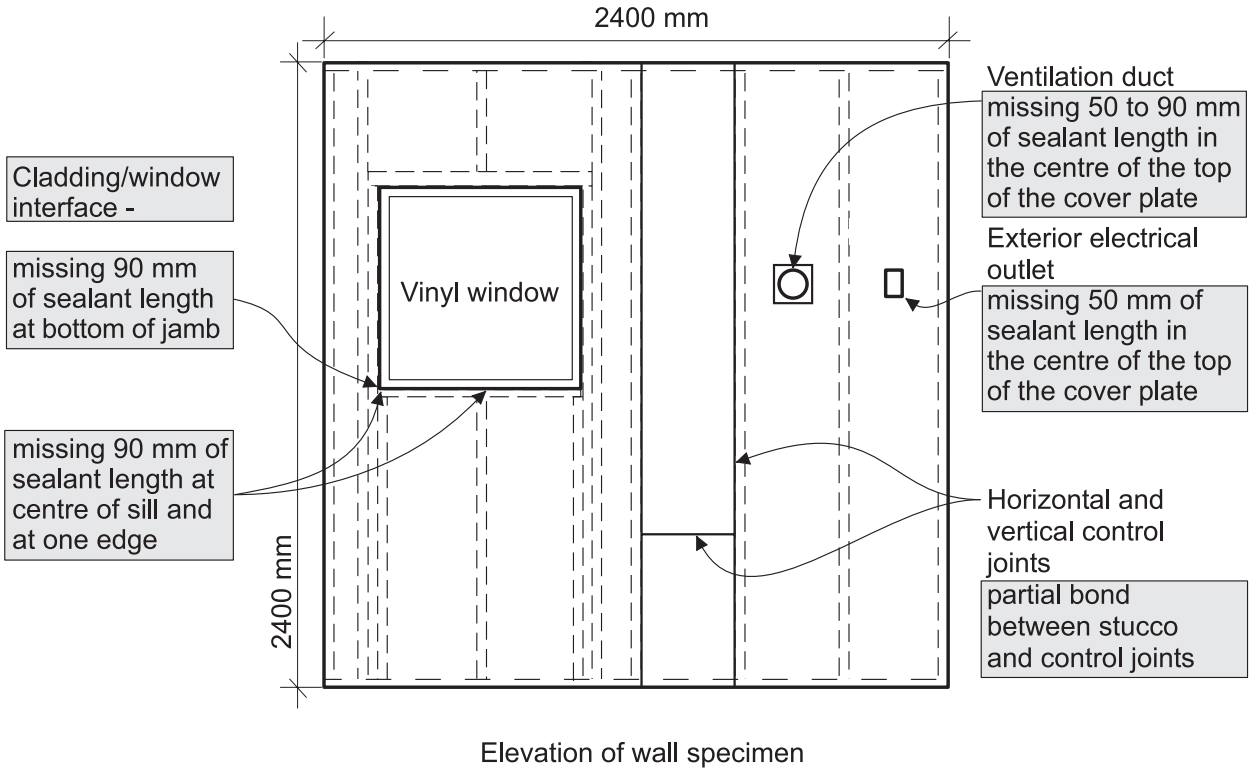


Figure 1.4. Positioning of details on wall specimens and deficiencies in the first line of defence

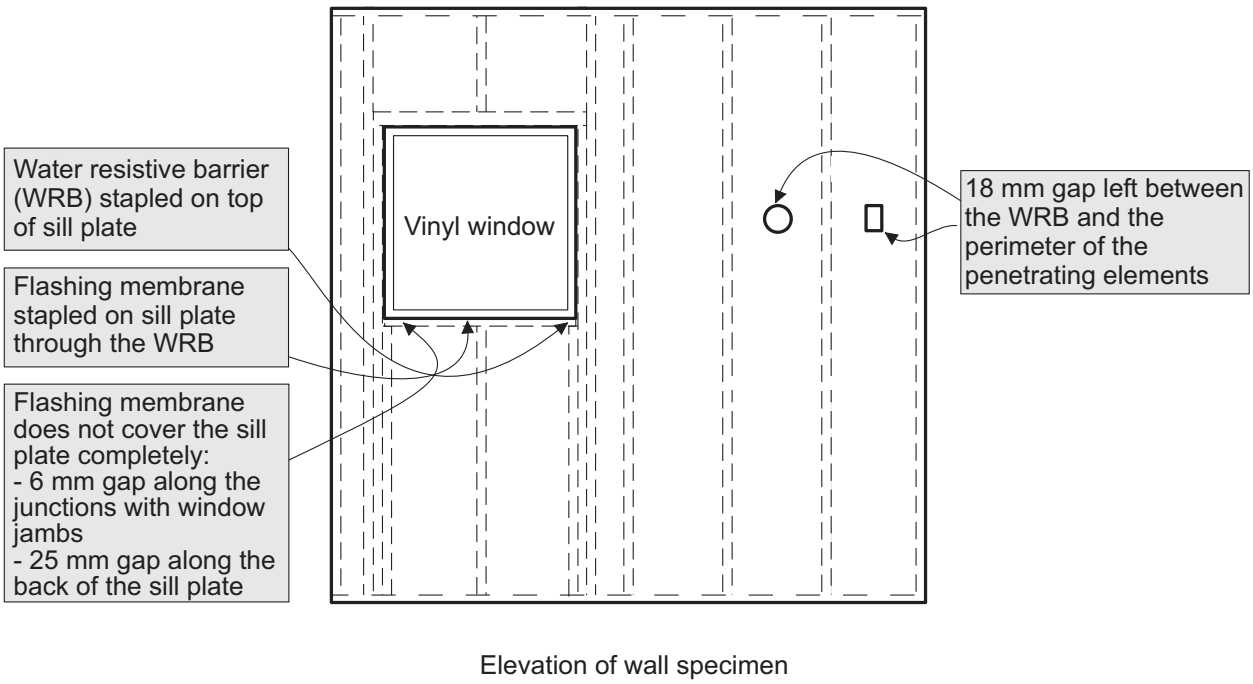


Figure 1.5. Deficiencies in the second line of defence for walls No. 1 and No. 3

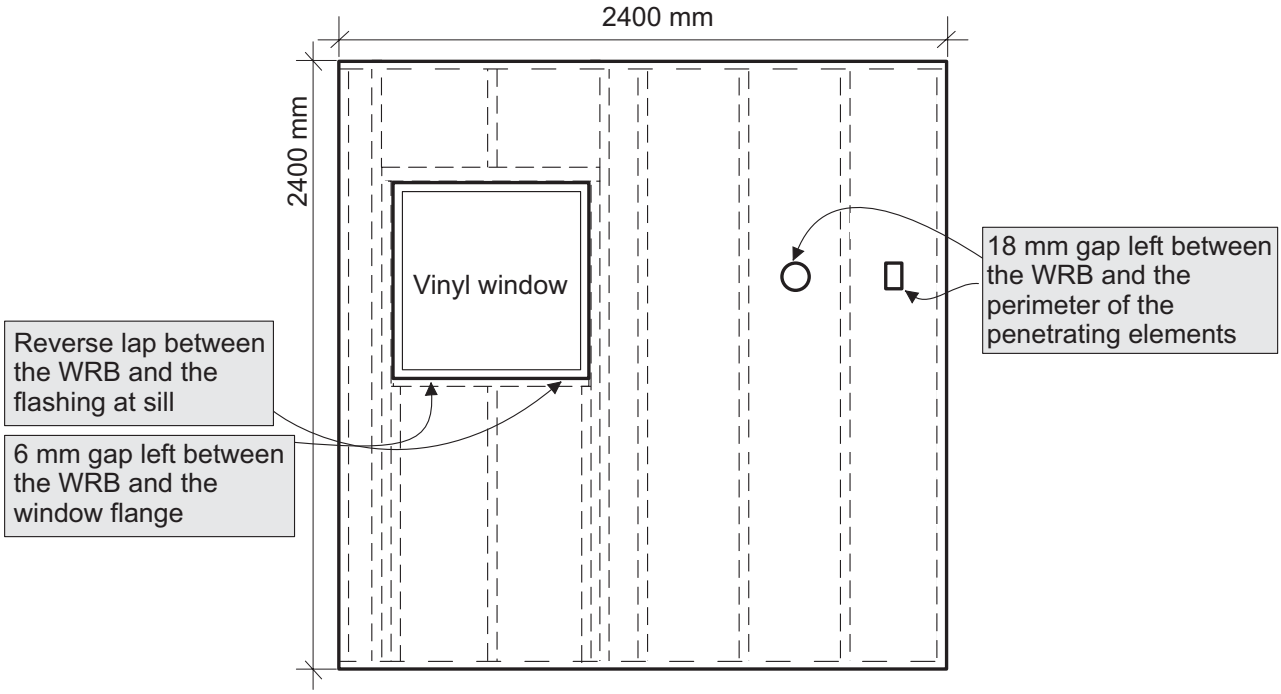


Figure 1.6. Deficiencies in the second line of defence for walls No. 2 and No. 4

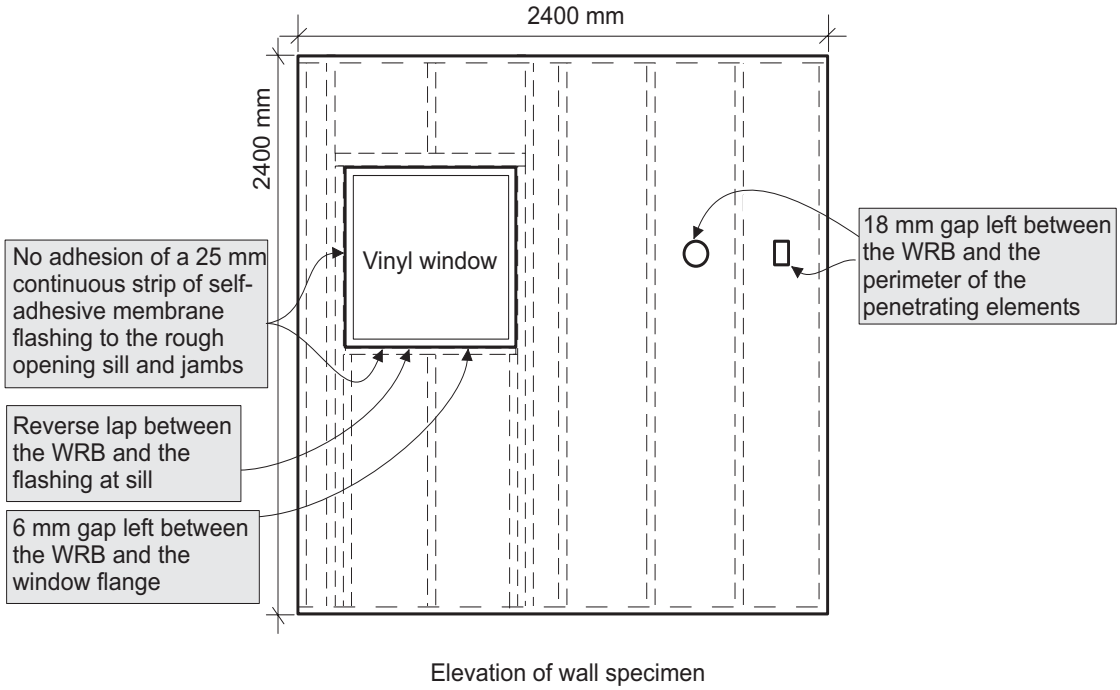


Figure 1.7. Deficiencies in the second line of defence for wall No. 5

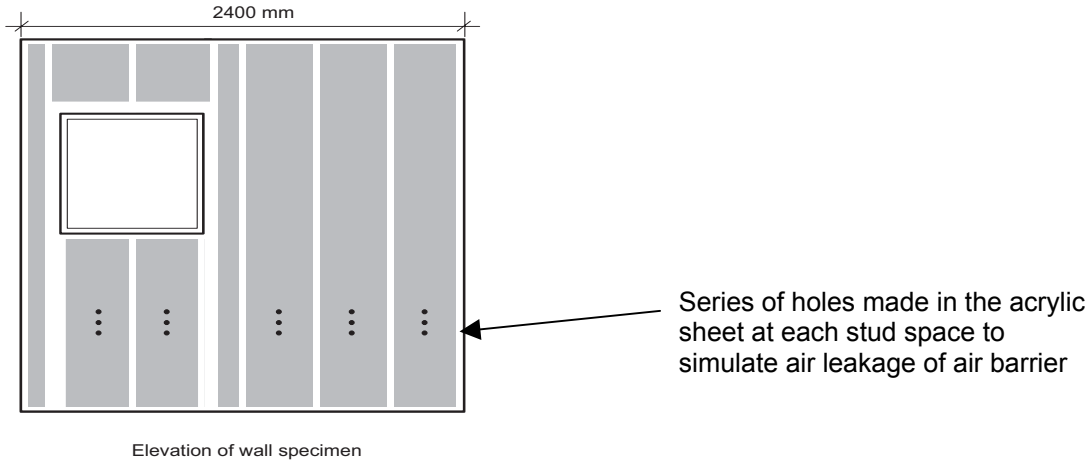


Figure 1.8. Deficiencies in the air barrier system

1.3 CONSTRUCTION OF THE STUCCO-CLAD WALL SPECIMENS NO. 1 TO NO. 4

1.3.1 Wall/window interface for specimens No. 1 and No. 3

Specimens No. 1 and No. 3 both have polymeric water resistive membranes (WRB). Manufacturers of polymeric water resistive barriers recommended that the “modified I cut procedure” be used at window openings. This requires that the window be installed *after* the water resistive barrier and after the flashings at rough sill and jambs are in place. This procedure is illustrated in Figure 1.9. The construction details for the window/wall interface are presented in Figures 1.10 and 1.11.

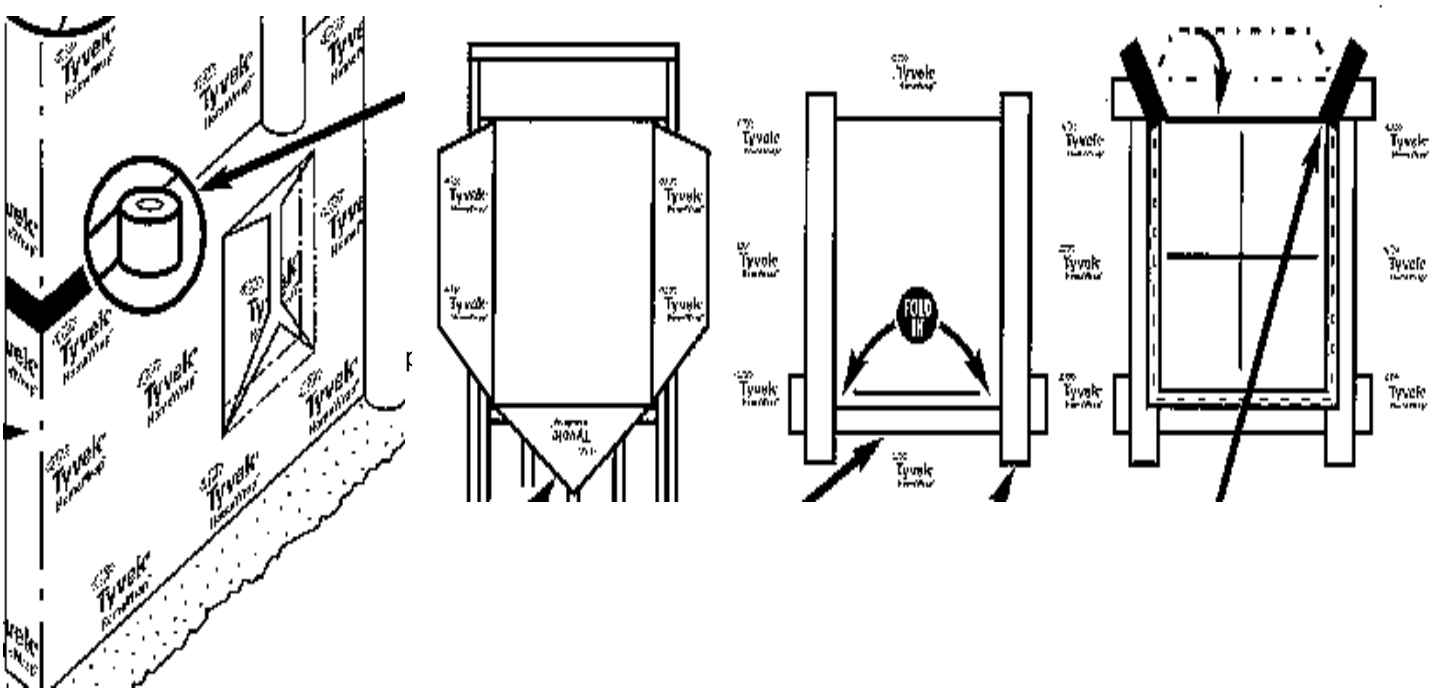


Figure 1.9. The modified I cut procedure for polymeric membrane installation

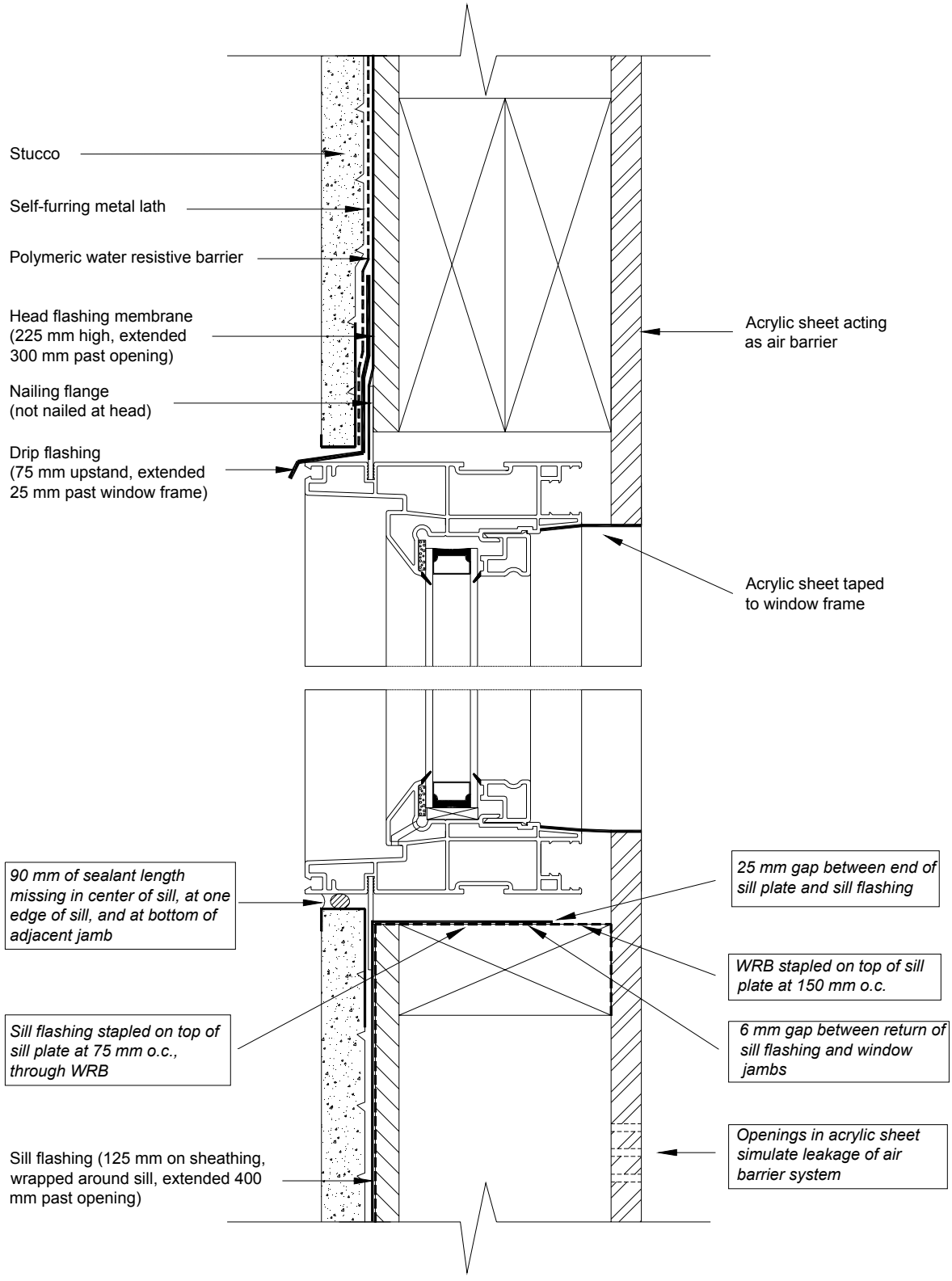


Figure 1.10. Wall/window interface for specimens No. 1 and No. 3 – vertical section

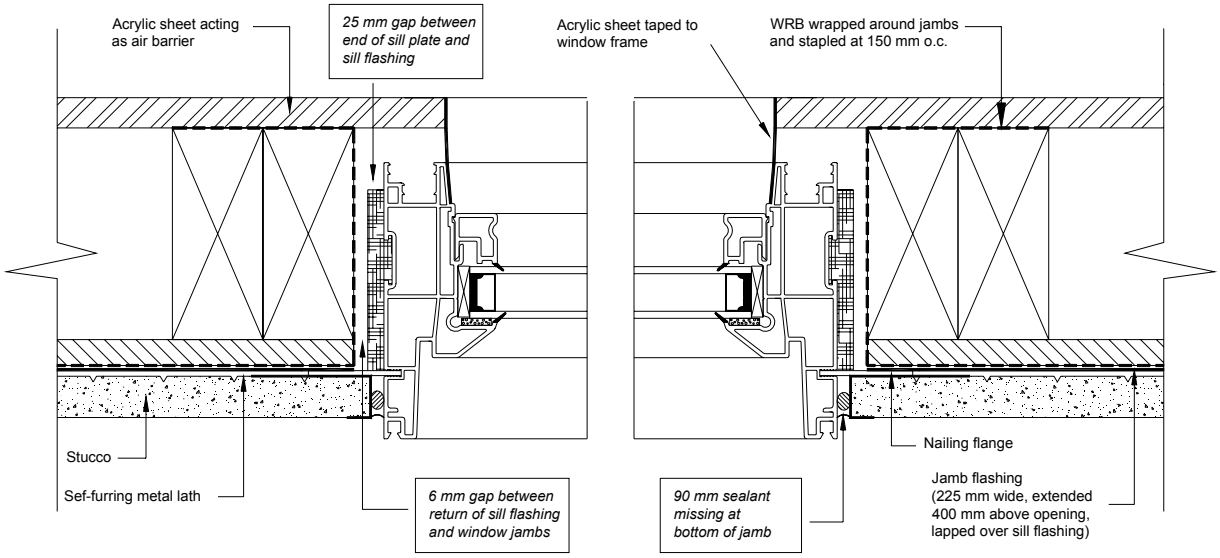


Figure 1.11. Wall/window interface for specimens No. 1 and No. 3 – Horizontal section

Figure 1.12 shows the "modified I cut" procedure for window openings with a polymeric water resistive barrier (WRB), as specified in the manufacturer's literature. One may observe that when the WRB is cut in this way, the sill-jamb junctions are not covered by the water resistive barrier (see Figure 1.13). Therefore, in the two specimens with polymeric WRBs, deficiencies were introduced at the sill-jamb junctions (see Table 1.2). Figure 1.13 shows a 25 mm gap between the sill flashing membrane and the jamb of the window for specimens No. 1 and No. 3. The flashing membrane does not cover entirely the rough sill of the window opening: a strip of rough sill, 25 mm deep and 750 mm wide (the width of the rough opening) was left uncovered. Figures 1.14 and 1.15 show the completed window installation for the two specimens with a polymeric water resistive barrier.

Figure 1.12. Modified I cut procedure for wall specimen No. 1

Figure 1.13. Deficiency at the sill and jamb levels for specimens No. 1 and No. 3

Figure 1.14. Completed window installation in specimen No. 1

Figure 1.15. Completed window installation in specimen No. 3

1.3.2. Wall/window interface for specimens No. 2 and No. 4.

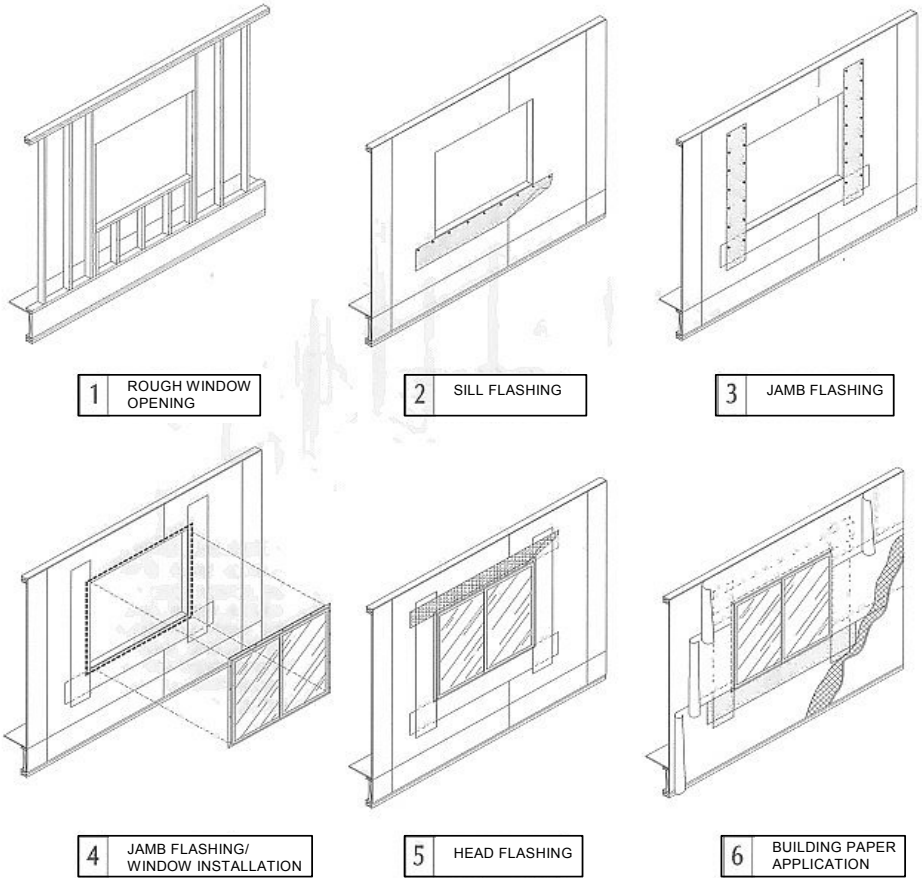


Figure 1.16. Installation procedure taken from the manual entitled *Nail-on Windows Installation & Flashing Procedures for Windows & Sliding Glass Doors* by Robert Bateman, 1995.

Specimens No. 2 and No. 4 both have a paper-based water resistive barrier (WRB). Manufacturers recommended using the “Bateman procedure” for the installation of the WRB at window openings. This procedure is illustrated in Figure 1.16. In this case the window is installed *before* the water resistive barrier is applied onto the wall.
Figures 1.17 and 1.18 provide the detail drawings for the wall/window interface for specimens No. 2 and No. 4.

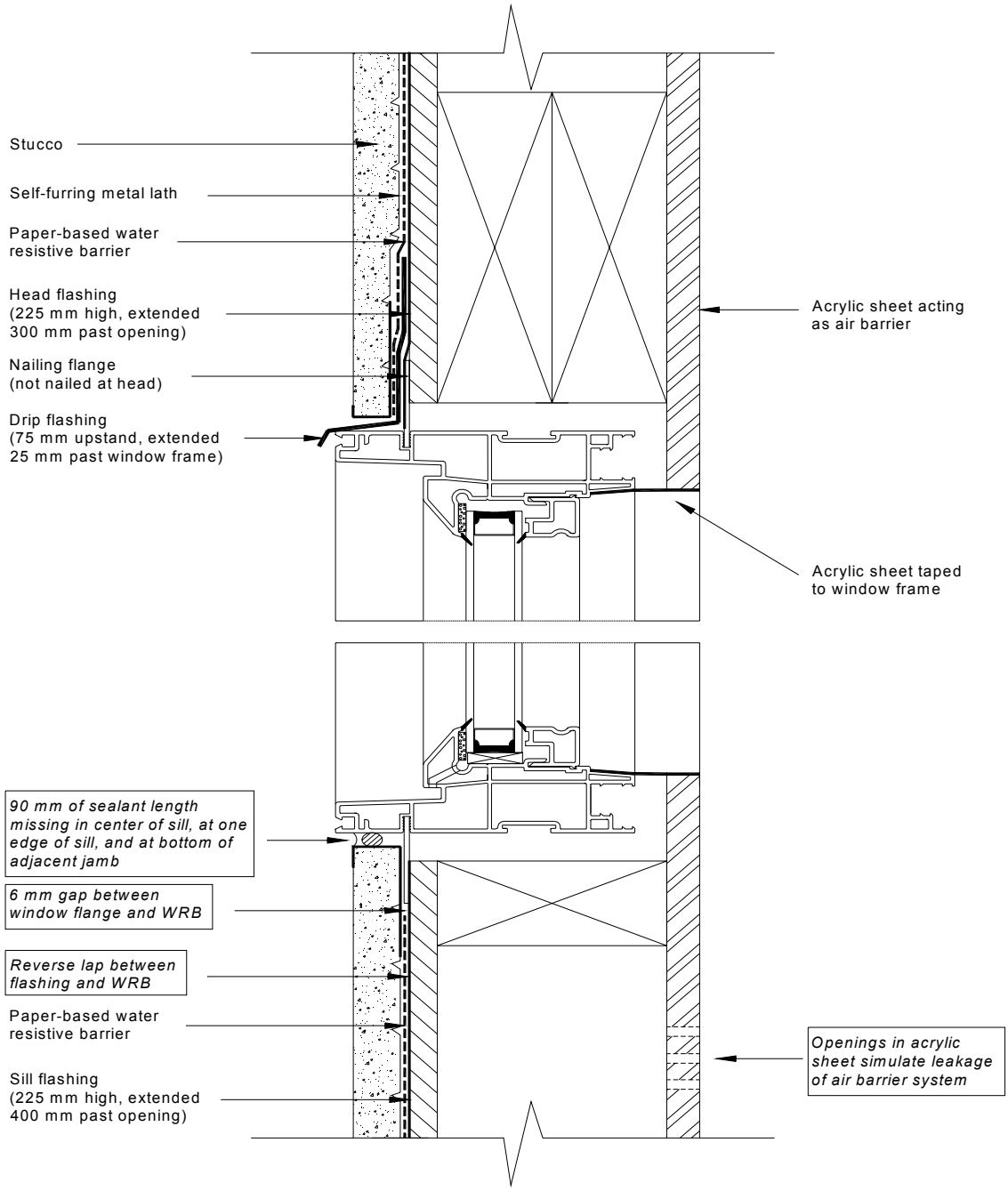


Figure 1.17. Wall/window interface for specimens No. 2 and No. 4 – vertical section

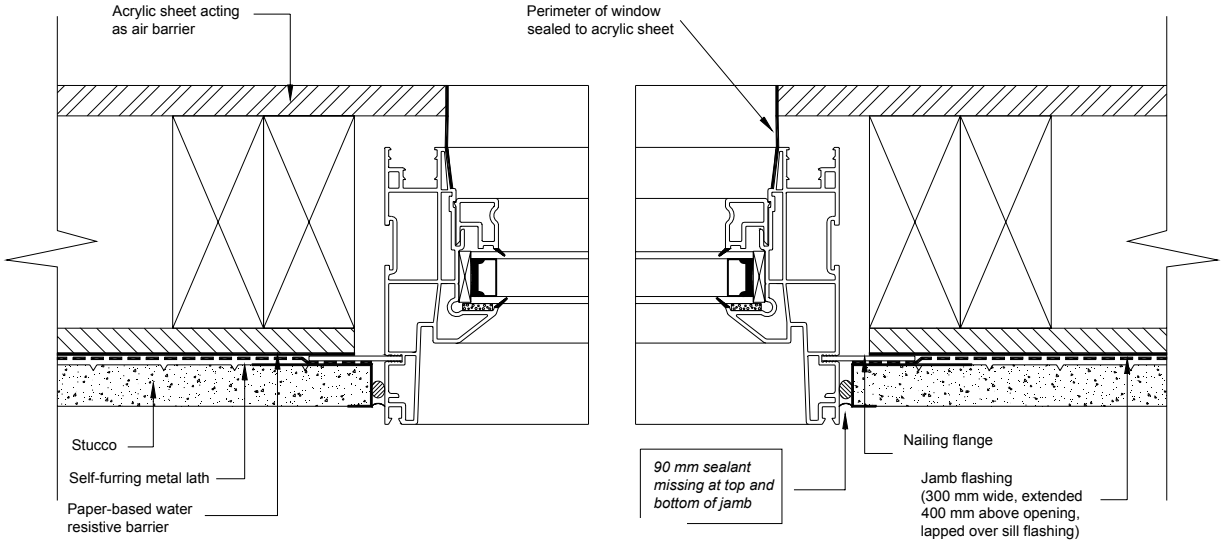


Figure 1.18. Wall/window interface for specimens No. 2 and No. 4- Horizontal section

The sill flashing is first installed, then the jamb flashing, as illustrated in Figure 1.19. The window is to be installed next, followed by the elements for the window head: the head flashing and the metal drip flashing overlapped by the WRB. These elements are shown in Figure 1.20 before they are attached and without the WRB. An example of the completed window installation for specimens with a paper-based WRB is shown in Figure 1.21. One of the deficiencies for the walls with paper-based WRB is also visible in this photograph: the sill flashing is installed behind the WRB while a good practice would be to overlap it over the WRB.

Figure 1.19. Installation of sill and jamb flashing on wall 2b

Figure 1.20. Window head elements in place before the last piece of paper-based water resistive barrier is applied

Figure 1.21. Completed window installation in specimen No. 2a

1.3.3 Wall/duct detail for specimens No. 1 to No. 4

The duct detail with deficiencies is illustrated in Figure 1.22.

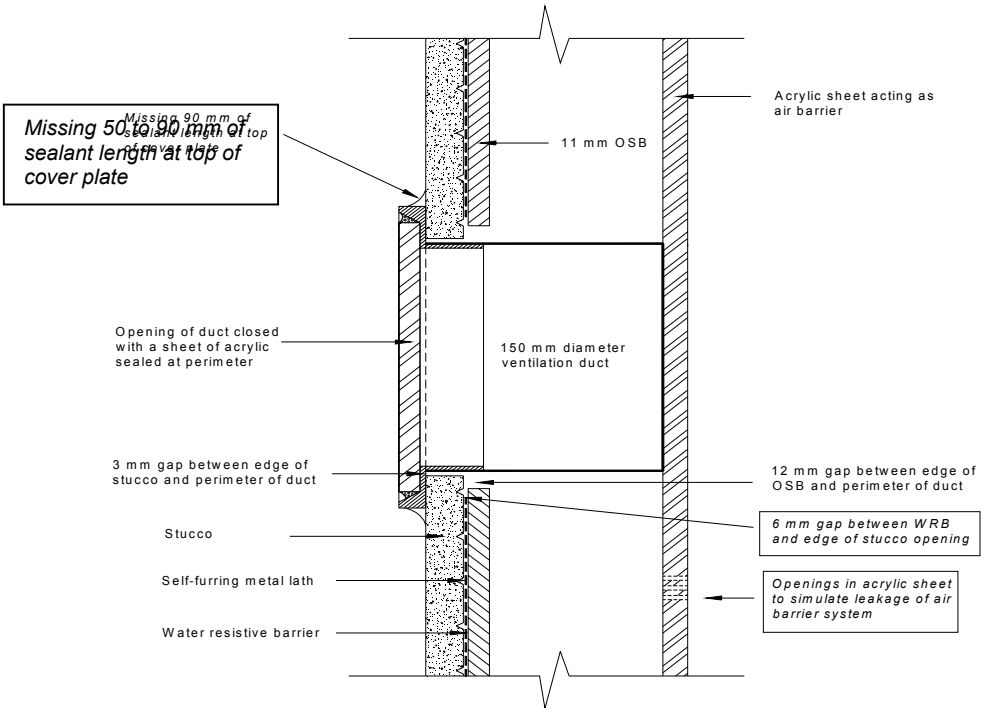


Figure 1.22. Duct detail for specimens No. 1 to No. 4 – vertical section

1.3.4 Wall/electrical outlet detail for specimens No. 1 to No. 4

The electrical outlet detail with deficiencies is illustrated in Figures 1.23 and 1.24.

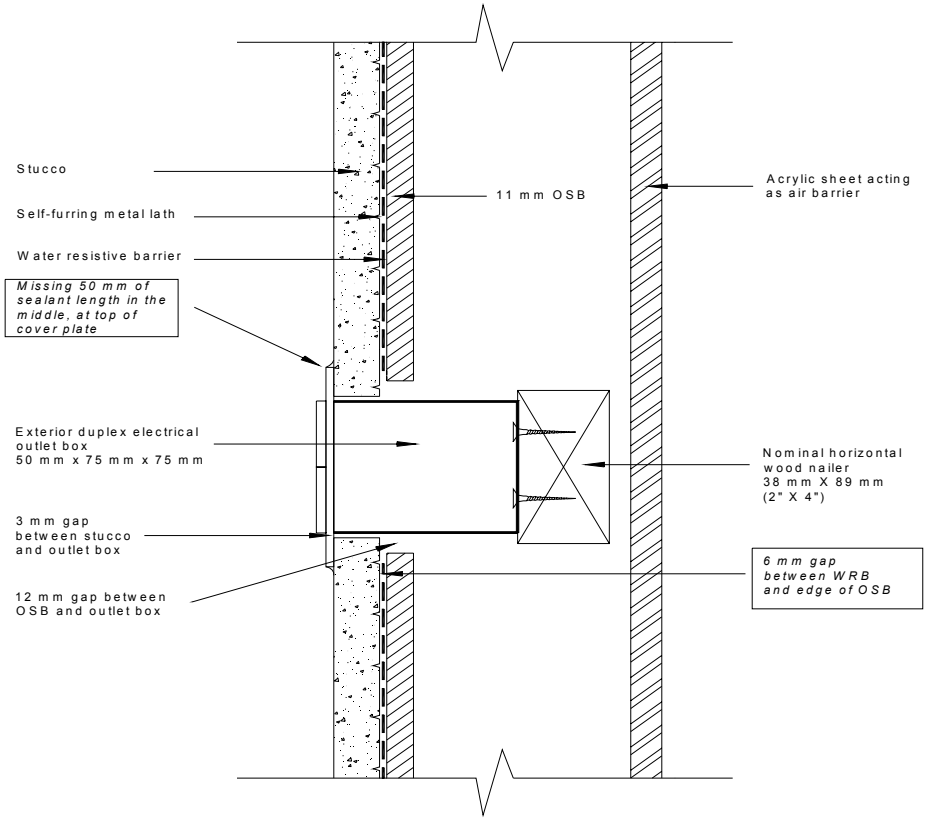


Figure 1.23. Wall/outlet box detail for specimens No. 1 to No. 4. Vertical section

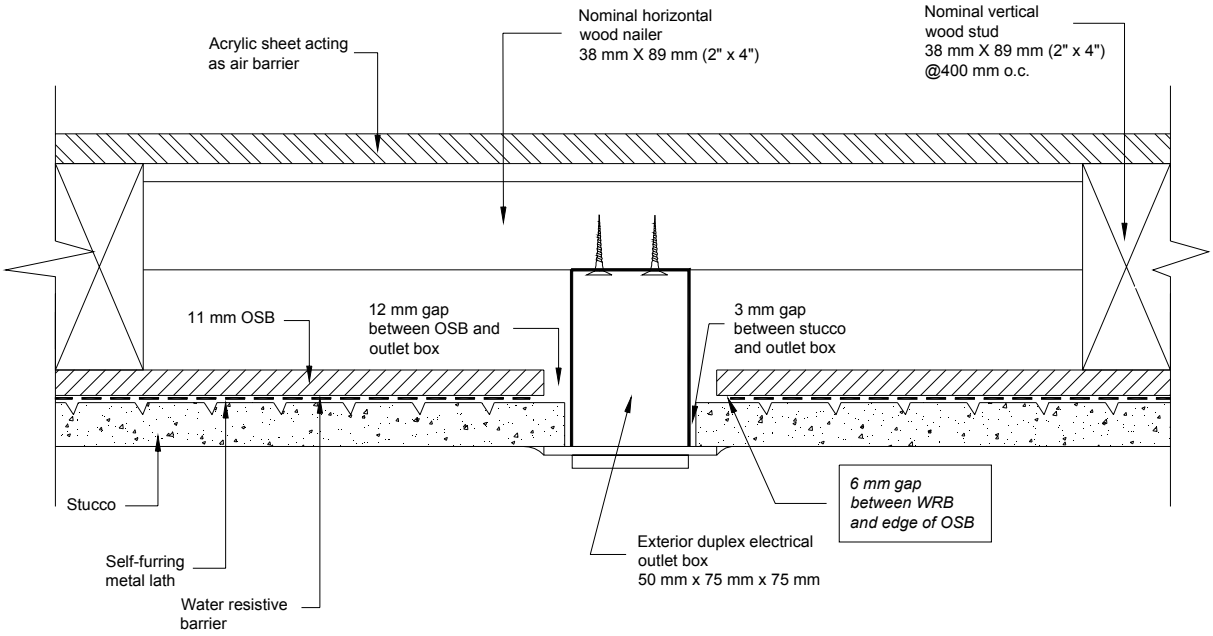


Figure 1.24. Wall/outlet box detail for specimens No. 1-No. 4 Horizontal section

1.3.5 Control joint detail for specimens No. 1 to No. 4

The two vertical control joints detail with deficiencies are illustrated in Figures 1.25 and 1.26.

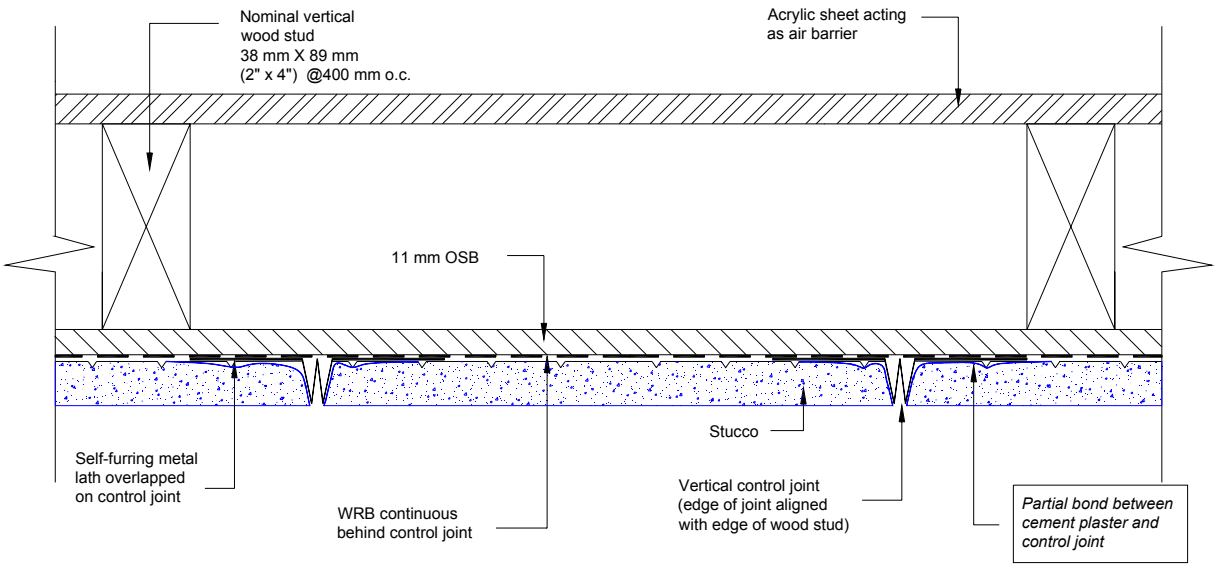


Figure 1.25. Control joint detail for specimens No. 1 to No. 4 - Horizontal section

Figure 1.26. The control joints were covered with tape to reduce bonding of the stucco plaster to the metal control joint profile.

1.3.6 Termination at the bottom of the wall specimens

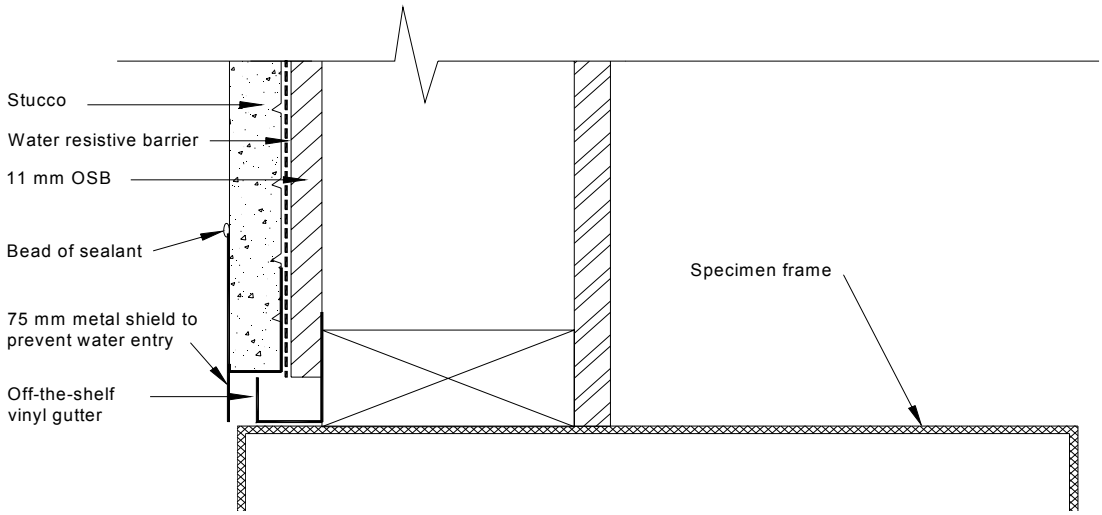


Figure 1.27. Termination at bottom of the specimens No. 1 to 4 – Vertical section

1.3.7 Application of lime-cement plaster

The application of the stucco plaster began on December 14th, 1999 with the application of the scratch coat (Figures 1.28 and 1.29). At that stage, plastic tubes were used to prevent the pressure sensors from being blocked up (Figure 1.30). They were removed on December 16th, 1999,before the application of the brown coat, (Figure 1.31). The brown coat for walls No. 1, No. 2a, No. 2b, and No. 3 was floated using a rigid sponge and water (Figure 1.32). An acrylic premix stucco was used for wall No. 4. It was applied in two 5 mm thick scratch and brown coats but in addition a very thin acrylic finish was applied on this wall on December 17, 1999 (Figure 1.33).

Figure 1.28. Application of the scratch coat on specimen No. 3

Figure 1.29 Application of the scratch coat on specimen No. 2b

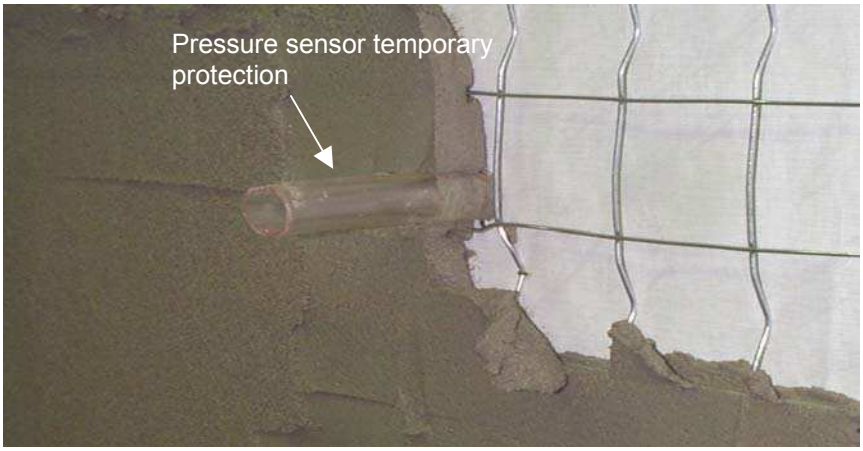


Figure 1.30. Pressure sensor protection during scratch coat application

Figure 1.31. Application of the brown coat on wall specimen No. 2b

Figure 1.32. Floating of the brown coat on specimen No. 3

Figure 1.33. Application of the acrylic finish coat on specimen No. 4

1.4 CONSTRUCTION OF SPECIMEN NO. 5

Specimen No. 5 was built to replicate one of the British Columbia Building Envelope Research Consortium (BCBERC) drying experiments wall specimens. However BCBERC specimens do not include penetrations such as windows and ducts. It was agreed to use Canada Mortgage and Housing Corporation (CMHC) window/wall detailing described in the Best Practice Guide entitled *Wood-frame Envelopes in the Coastal Climate of British Columbia*. The installation of the water-resistive membrane followed the Bateman procedure for paper-based water resistive barrier, as for specimens No. 2 and 4.

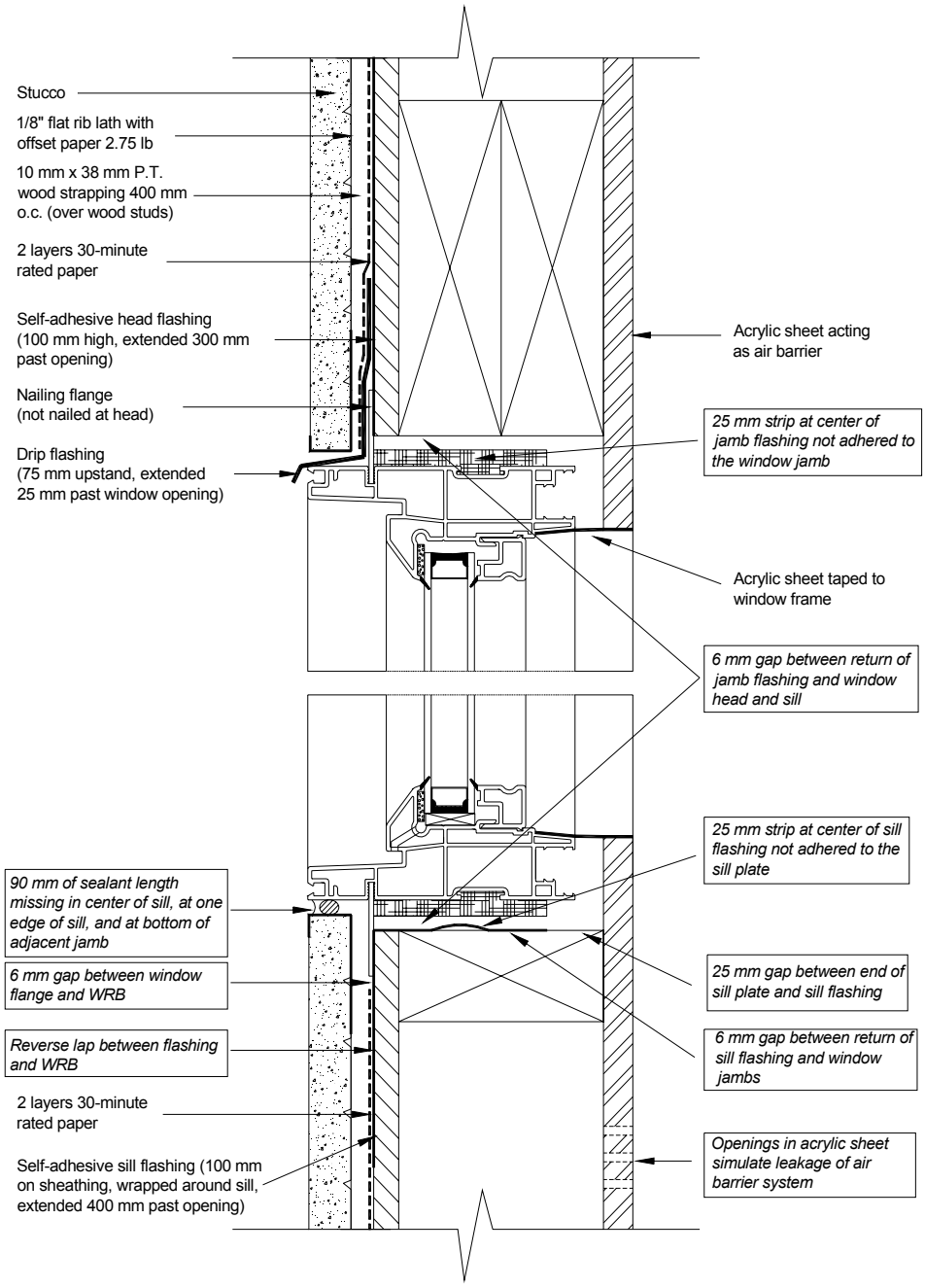


Figure 1.34. Wall/window detail for specimen No. 5 - vertical section

1.4.1 Wall/window interface

Figures 1.34 and 1.35 illustrate the detailing at the wall/window junction for this specimen. A self-adhesive flashing membrane was used at the perimeter of the rough opening for the window. In this case, the sill, jamb and head flashing were installed before the window and the paper-based WRB. The flashed window opening can be seen in Figure 1.36. After the flashing membranes, the WRB and the windows were installed, the control joints and the metal lath were attached. The control joints were covered with tape to prevent the adhesion of the stucco to the joint (as a deficiency).

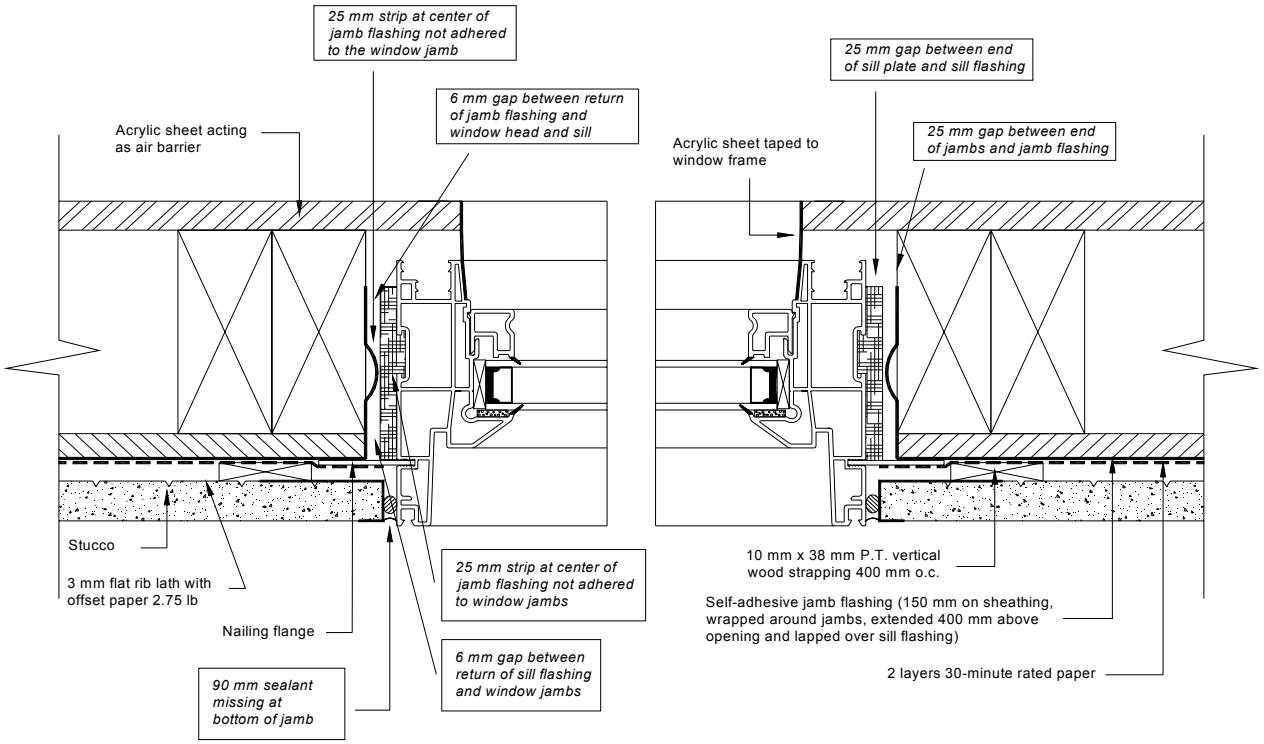


Figure 1.35. Wall/window detail for specimen No. 5 - Horizontal section

Figure 1.36. Self-adhesive flashing installed on wall specimen No. 5

1.4.2 Wall/duct detail

Figure 1.37 describes the wall/duct detail for specimen No. 5.

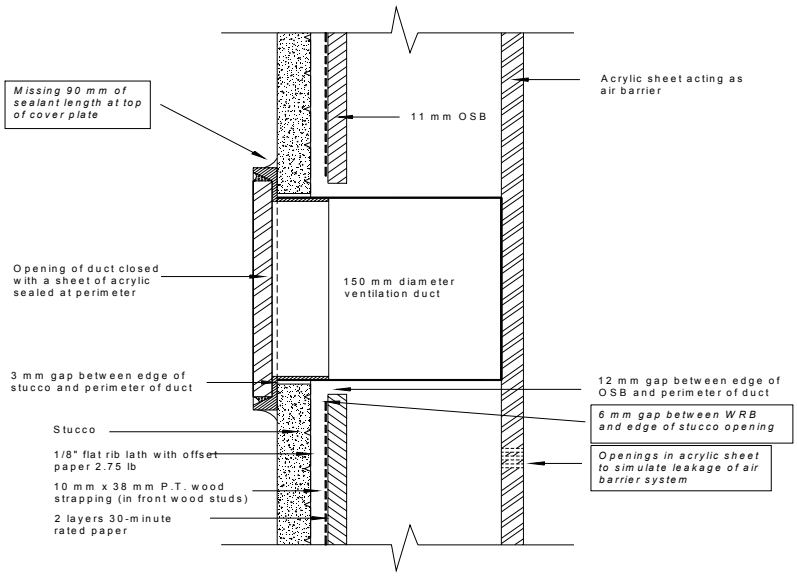


Figure 1.37. Wall/duct detail for specimen No. 5- Vertical section

1.4.3 Wall/outlet detail

Figures 1.38 and 1.39 describe the detailing of the wall/outlet box interface for specimen No. 5.

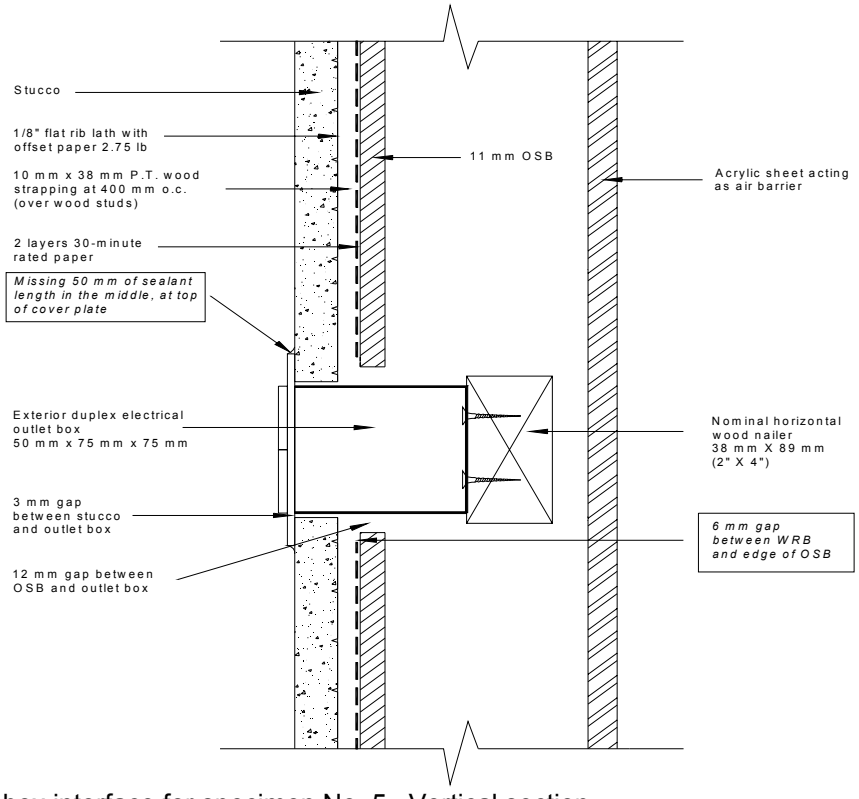


Figure 1.38. Wall/outlet box interface for specimen No. 5 –Vertical section

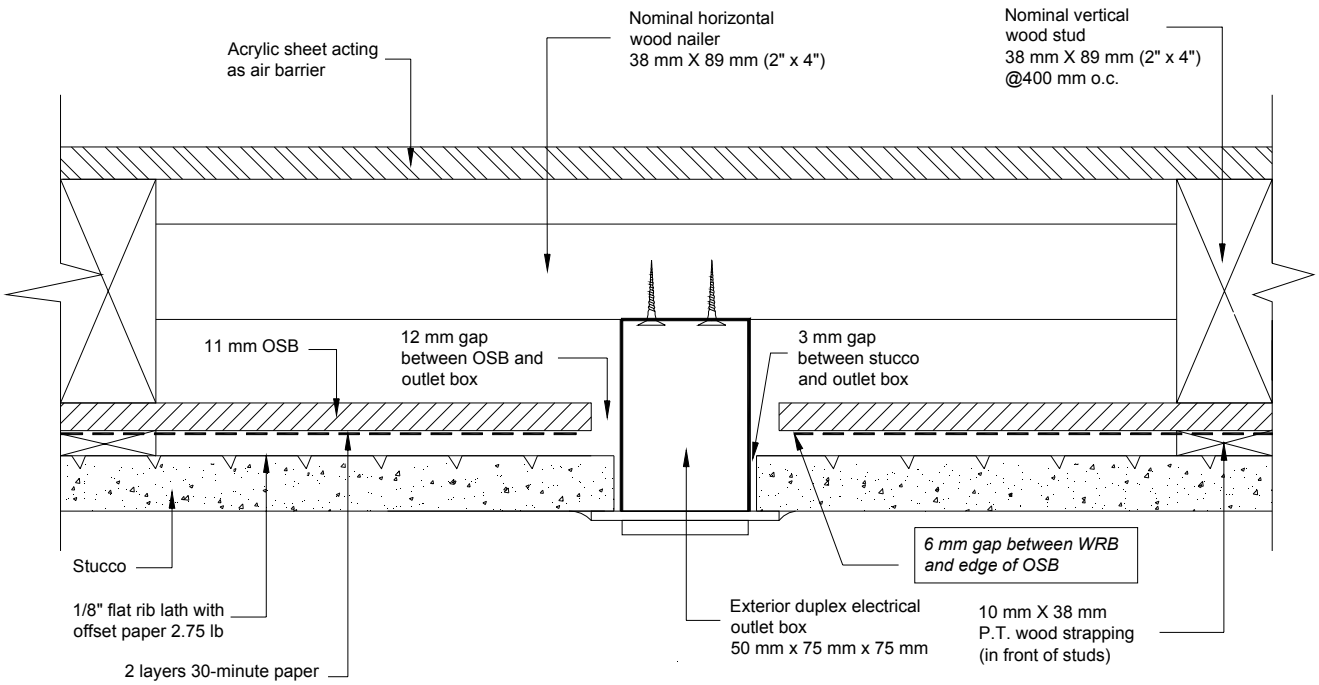


Figure 1.39. Wall/outlet box interface for specimen No. 5 –Horizontal section

1.4.4 Control joint detail

Stucco wall specimen No. 5 only has two vertical control joints because its flashing detail at the bottom of the wall also acts as a horizontal joint. The detail is shown in Figure 1.40.

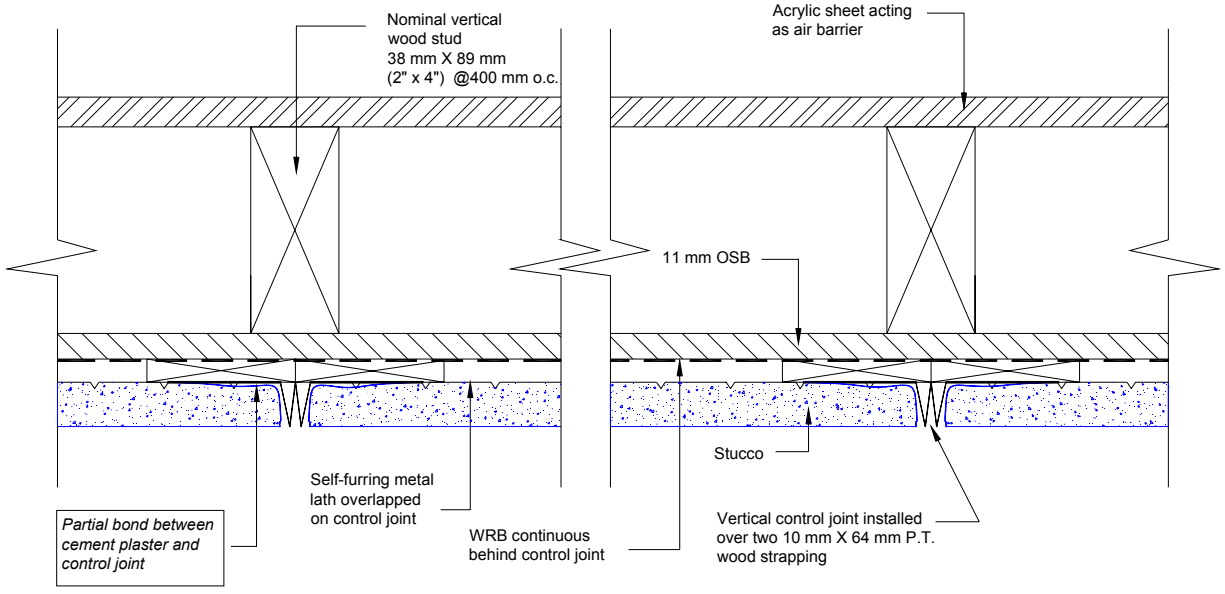


Figure 1.40. Vertical control joints for specimen No. 5- Horizontal section

1.4.5 Termination detail

Specimen No. 5 is vented at the top and bottom. Figure 1.41 shows how the specimen ends at the bottom.

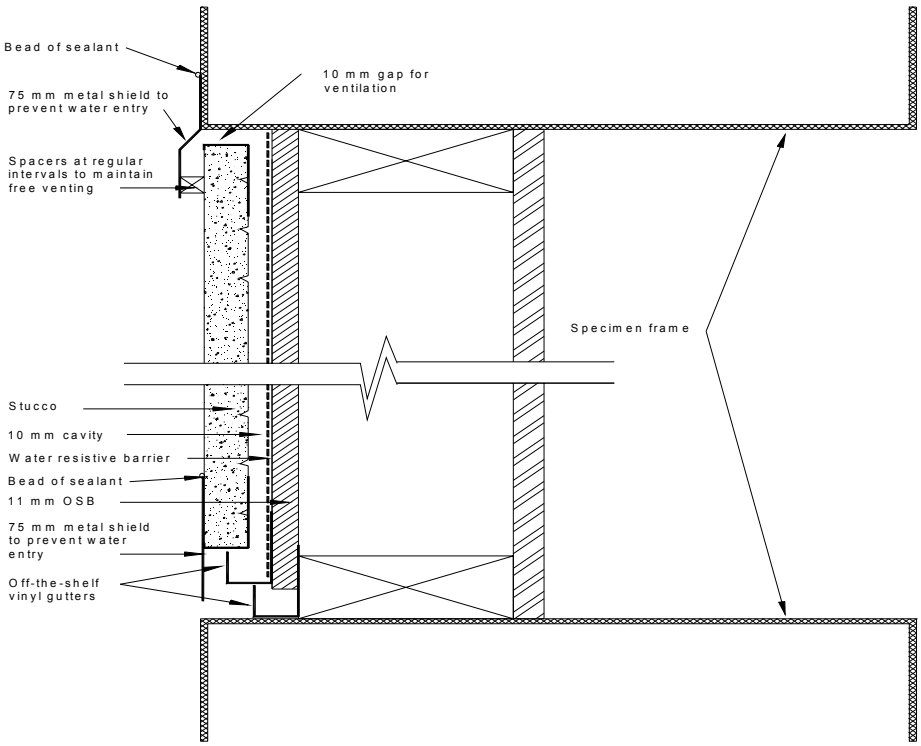


Figure 1.41. Termination detail for specimen No. 5 - Vertical section

1.4.6 Application of stucco cement plaster

This specimen included a three-coat stucco plaster, the third coat consisting of 6 mm thick white cement based stucco mix (Figure 1.42).

Figure 1.42. Application of the finish coat on wall No. 5.

1.5 CURING OF THE WALL SPECIMENS

1.5.1 Curing conditions

The curing conditions of the specimens can affect the cracking of the stucco. Stucco cracking is a type of deficiency specific to that type of cladding systems. Specimens No. 1, 2a, 2b, 3 were subjected to good curing conditions while specimens No. 4 and No. 5 were subjected to poor curing conditions. The curing conditions for the specimens are described below.

The five wall assemblies on which a traditional scratch coat (all except specimen No. 4) had been applied on December 14th, 1999 were sprayed with water once on the following day until they appeared soaked (a few minutes). On December 16th, their brown coat was applied. On December 17th, wall specimens No. 1, No. 2a, No. 2b and No. 3 were sprayed and covered with burlap and polyethylene plastic film to reduce the drying of the stucco plaster. Walls No. 1, No. 2a, No. 2b and No. 3 were sprayed once a day for five days in the week of December 20th to 24th, 1999 and left covered by burlap and polyethylene plastic film. On January 4th, 2000, i.e. after 15 days of such curing, the burlap and the polyethylene plastic film were removed from the specimen No. 2b. The other three specimens were still protected by the burlap /polyethylene cover until January 17th, 2000 i.e., for a total of 28 days.

As specimen No. 4 (acrylic premix) and specimen No. 5 (three coats of Portland-cement stucco) were subjected to poor curing conditions, these two wall specimens were cured at laboratory ambient conditions (approximately 21°C and 30% RH).

On January 17th, 2000 all cracks were recorded. However a few more cracks appeared before the second inspection on January 24, 2000. Cracks developed where material shrinkage caused excessive stress concentration e.g., corners of the window (Figure 1.43) and between the outlet box opening and the duct opening (Figure 1.44) and between two vertical control joints (Figure 1.45).

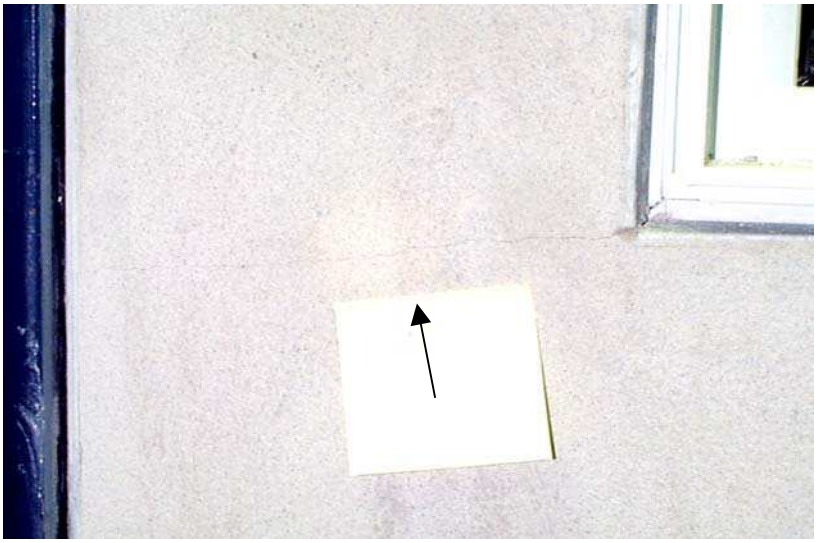


Figure 1.43. Crack at the bottom corner of the window (see arrow on sticker)

1.5.2. Formation of cracks

The formation of cracks is likely to be related to the conditions of curing. To assess the effect of curing conditions, specimens No. 2a and No. 2b (of identical construction) were exposed to different curing conditions, namely, specimen No. 2b was covered with burlap and a polyethylene film for 15 days while specimen No. 2a was covered in the same manner for 28 days. Specimen No. 2b exhibited more cracking than wall No. 2a (Figures 1.44 and 1.45). By January 24th, 2000 specimen No. 2b had developed an additional crack between the outlet penetration and the vertical joint.

Specimens No. 1, No. 2a and No. 3 were exposed to similar curing conditions and showed similar cracking patterns, i.e. one crack at the corner of the window and two at the duct/outlet penetrations. These specimens had a two-coat, Portland cement-lime stucco.

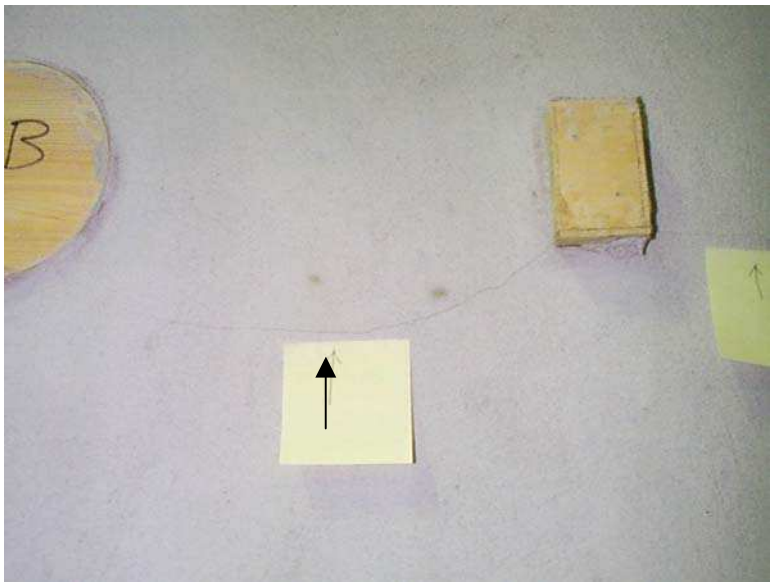


Figure 1.44. Crack between duct and electrical outlet openings (see arrow on sticker)

Figure 1.45. Crack between the vertical control joints (see arrow on sticker)

Figure 1.46. Cracks in specimen No. 2b covered for 15 days

Figure 1.47. Cracks in specimen No. 2a protected for 28 days

It was observed that the curing conditions had an effect on the formation of cracks in the stucco. The specimens protected with burlap and polyethylene for a longer period benefited from a sheltered micro-climate offering better curing conditions; and thus that specimen showed less cracking than the specimen which was protected for a shorter period. These walls all had the same lime-cement stucco mix (Type N). The other two specimens were three-coat applications and each had a different type of the stucco plaster mix: one had an acrylic stucco premix and the other a Portland-cement stucco mix. These were neither sprayed with water nor protected with burlap and polyethylene. Yet, they did not show cracking.

CHAPTER 2

CONSTRUCTION OF THE FIVE EIFS WALL SPECIMENS

This chapter provides the as-built construction details for the five Exterior Insulation and Finish Systems (EIFS) wall specimens built in May and June 2000. These walls were subjected to water entry investigation in the Dynamic Wall Testing facility of IRC as part of the MEWS consortium project.

2.1 COMPOSITION OF THE EIFS WALL SPECIMENS

Five different EIFS wall assemblies were selected in consultation with the EIFS industry. Representatives of the manufacturers were present during the installation of the EIFS on the specimens. The composition of the wall assemblies is described in Table 2.1 and illustrated in Figure 2.1 to Figure 2.5.

Table 2.1. Description of EIFS wall assemblies

No.	Wall type	Drainage mechanism	Insulation attachment	WRB	Sheathing
6	Barrier wall + source drainage at window	Prefabricated sill (source drainage at window)	Latex acrylic adhesive	None	OSB (11 mm)
7	Dual barrier Wall	None	Rust proof fasteners and polypropylene washers	60-min rated building paper, 1 layer	OSB (11 mm)
8	Dual barrier Wall + local drainage at window	Sill drip flashing (local drainage at window)	Polymer cement adhesive	Polymer cement coating	Glass mat gypsum board (12 mm)
9	Drained wall	6 mm X 30 mm vertical grooves @ 300 mm o.c. in EPS insulation	Polymer cement adhesive	Polymer cement coating	Glass mat gypsum board (12 mm)
10	Drained wall	3 mm nylon drainage mat	Rust proof fasteners and polypropylene washers	Non-cementitious moisture barrier coating	OSB (11 mm)

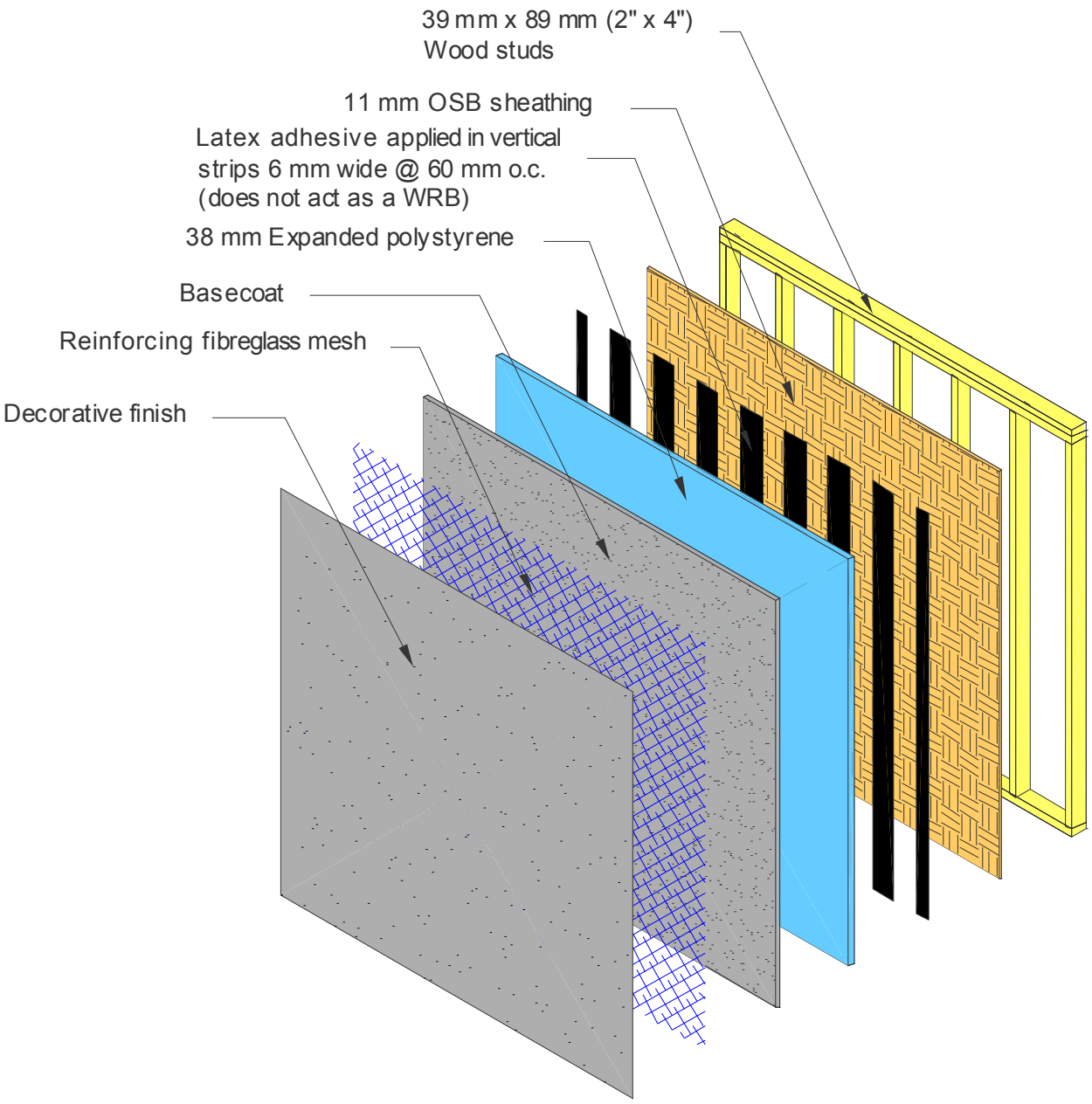


Figure 2.1. Composition of EIFS wall specimen No. 6

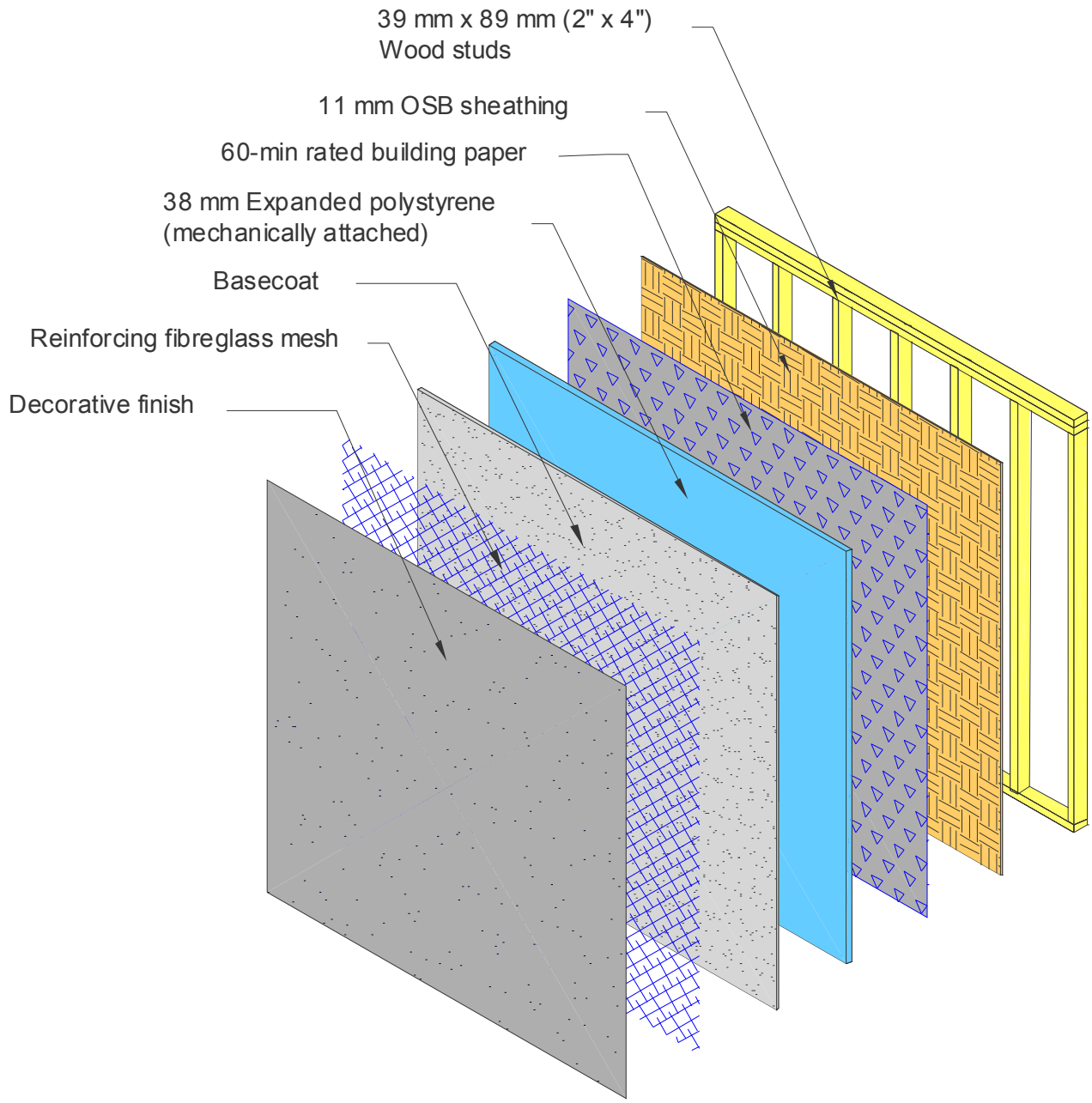


Figure 2.2. Composition of EIFS wall specimen No. 7

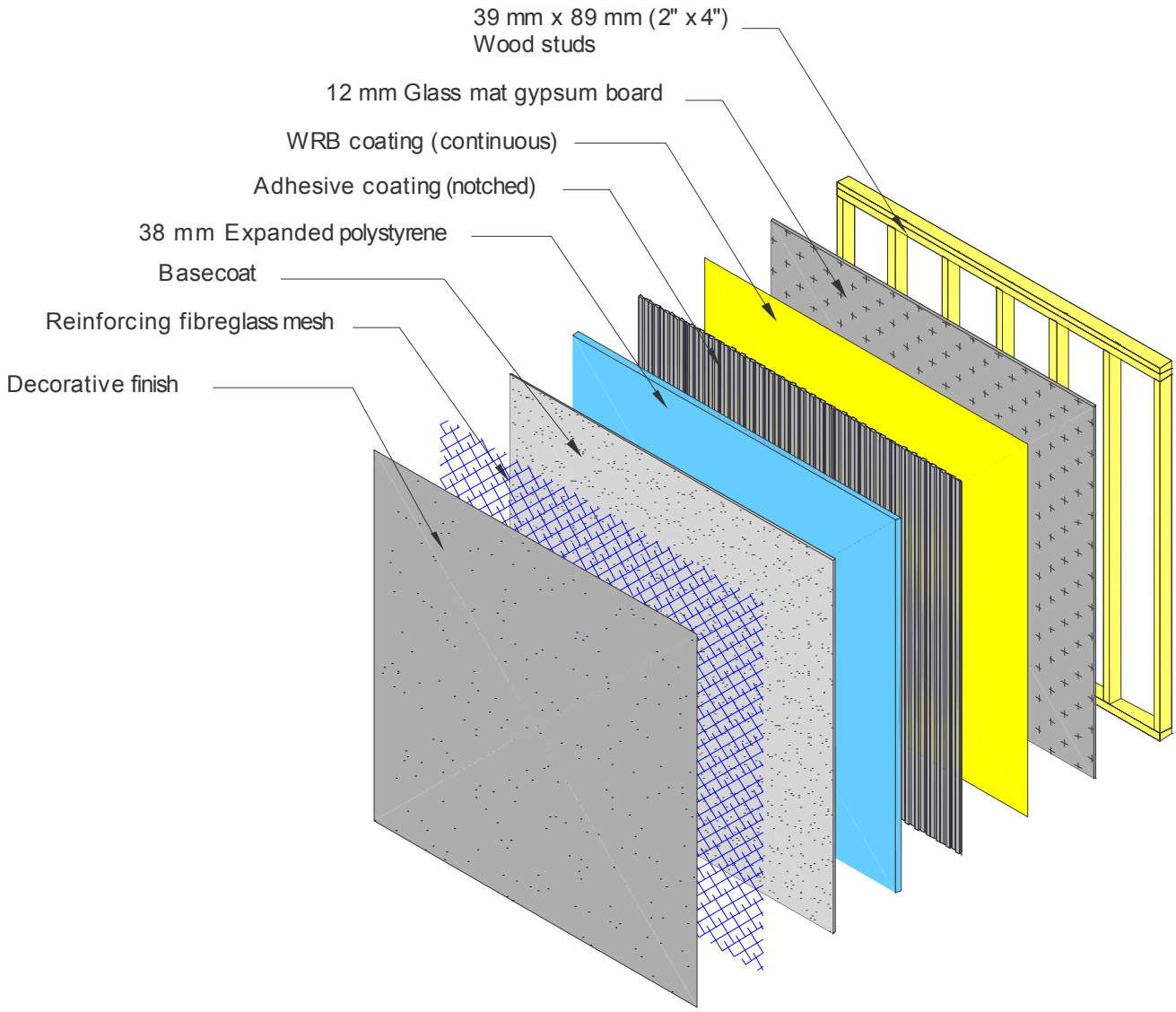


Figure 2.3. Composition of EIFS wall specimen No. 8

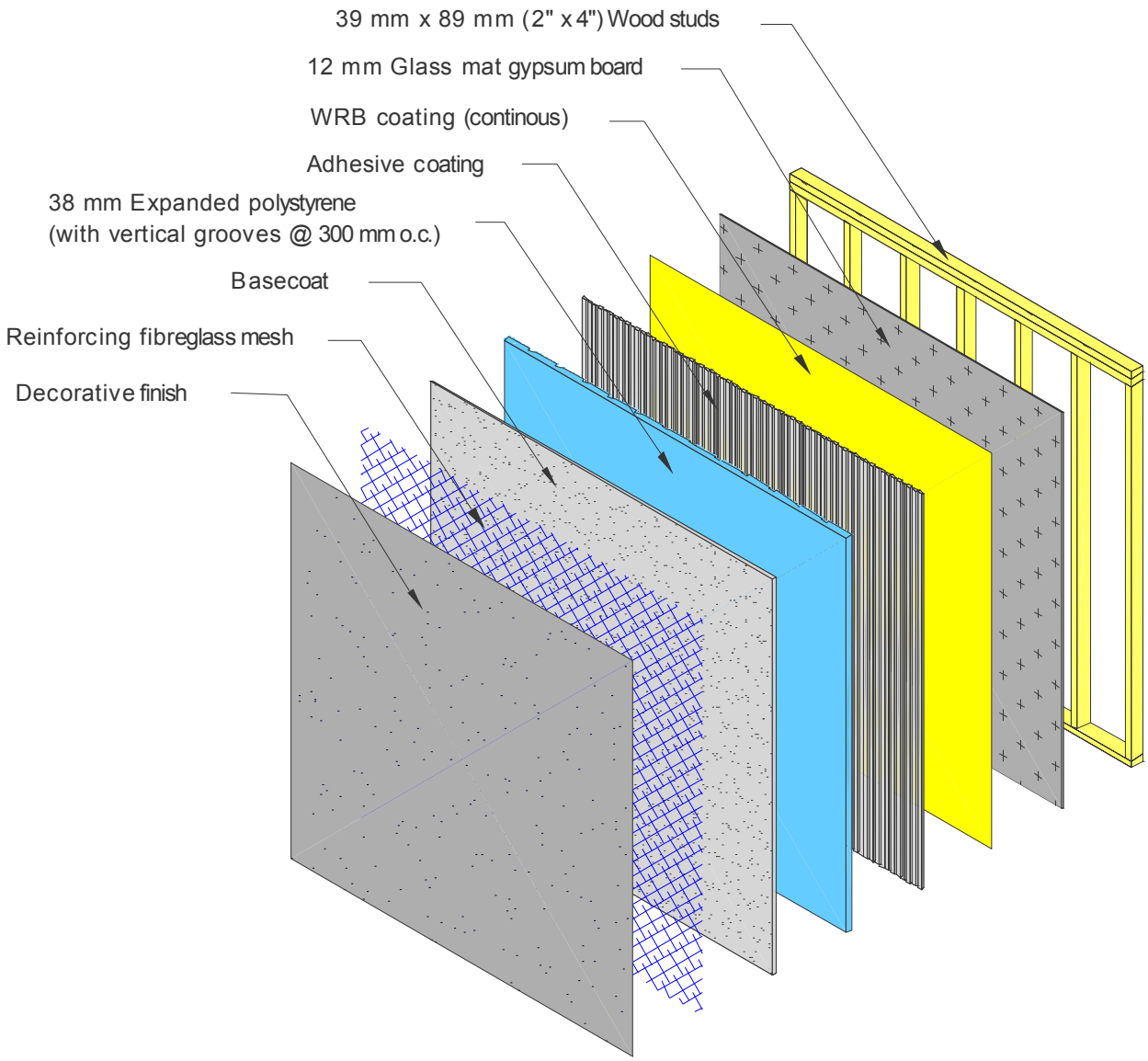


Figure 2.4. Composition of EIFS wall specimen No. 9

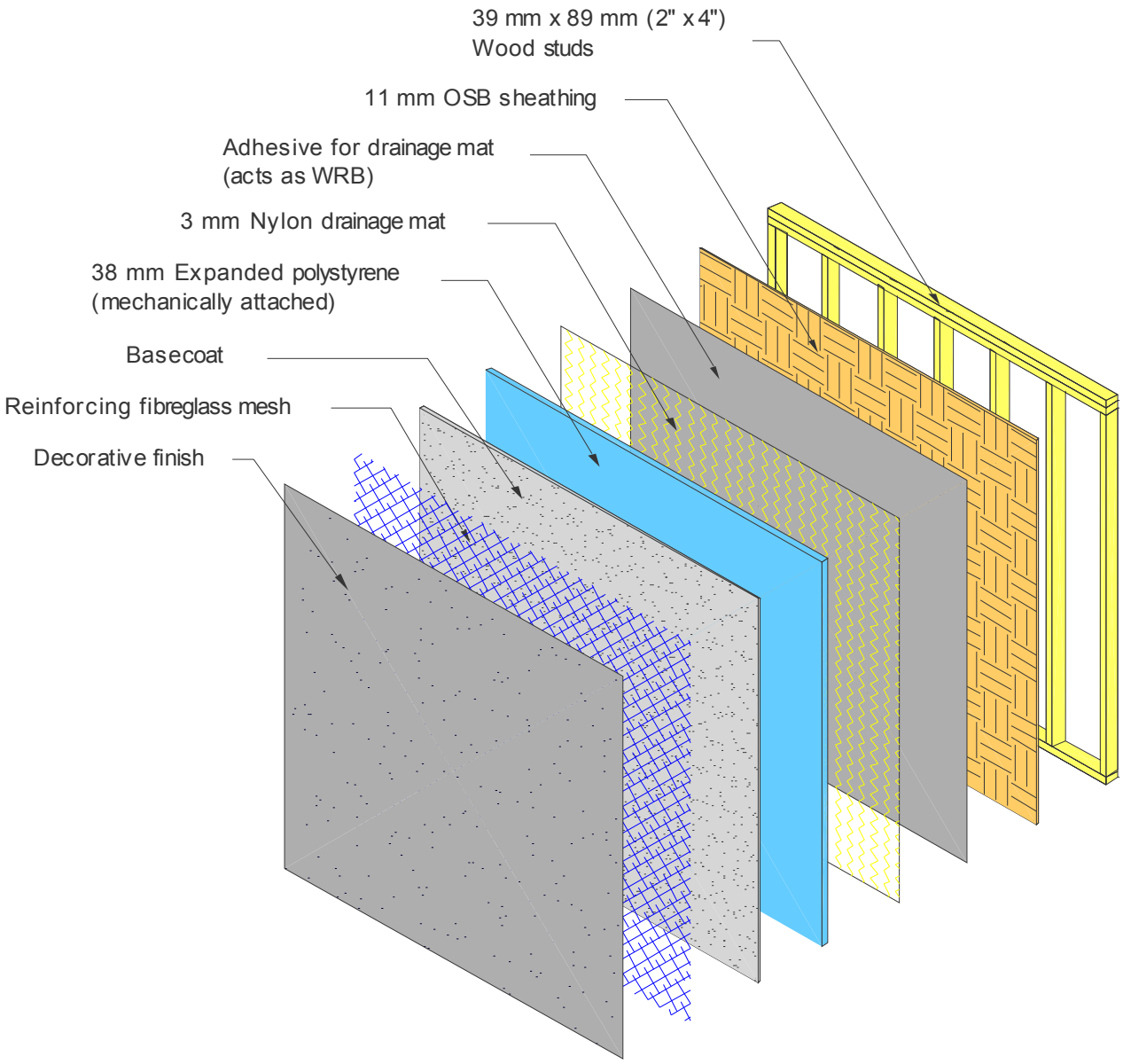


Figure 2.5. Composition of EIFS wall specimen No. 10

2.2 TYPES OF DETAILS

Four types of details are included in each EIFS specimen: window, ventilation duct, electrical outlet and control joint (one horizontal and one vertical). The first three details penetrate through the EIFS lamina, the water-resistive barrier and the sheathing board, while the fourth detail only penetrates through the EIFS lamina and the insulation board.

Window:
A flange-mounted fixed PVC (vinyl) window measuring 755 mm wide by 755 mm high manufactured by Bonneville Ltd Corporation. The window profile is illustrated in Figure 2.6.
The literature from the manufacturer advises against using its nailing flange for permanent mounting of that type of window. The manufacturer highly recommends that the window be fastened to the rough opening with metal brackets snapped into the frame. Because stability of the window is important for specimens subjected to high air pressure differentials, the window is secured to the wall with the brackets provided by the manufacturer. In addition, the nailing flange is in place and contributes to the fastening of the window to the wall.
Duct:
A circular metal ventilation duct with a 150-mm diameter
Exterior electrical outlet:
An exterior duplex wall outlet measuring 50 mm wide by 75 mm high by 75 mm deep
Control joint:
One vertical and one horizontal control joint in the EIFS lamina and foam board

The positioning of these four details in the wall specimens is shown in Figure 2.8.

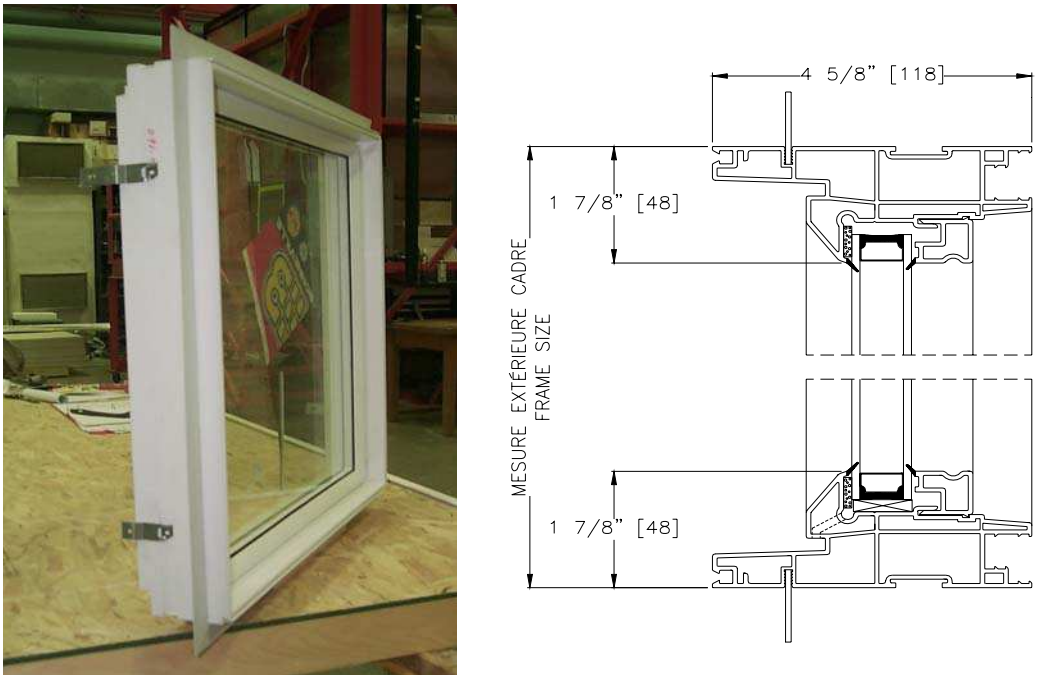


Figure 2.6. Configuration of the window installed in the test specimens

2.3 TYPES OF DEFICIENCIES

Deficiencies are introduced in the EIFS specimens in the 1st and 2nd lines of defence as well as in the air barrier system (Table 2.2 and Figure 2.7 to Figure 2.13).

Table 2.2. Deficiencies introduced in the EIFS wall specimens

Interface/ Junction	Deficiencies	
	1st line of defence	**2nd line of defence**
Wall / Window A fixed vinyl, flange-mounted window, 755 mm X 755 mm	Missing 90 mm of seal length at several locations of the sill and at a sill/jamb junction (see Figure 2.7)	***For specimen No. 6*** • Head drip flashing not extended past window frame • 6 mm gap between jamb flashing membrane and top of rough jambs • 6 mm gap between jamb flashing membrane and prefabricated sill • 25 mm gap between jamb flashing membrane and end of rough jamb • Continuous lack of adhesion of jamb flashing membrane, 25 mm wide, in center of rough jambs • 3 mm high by 90 mm wide gap on indoor side between the prefabricated sill and the window frame and in the center and at a sill/jamb junction ***For specimen No. 7*** • Head drip flashing not extended past window frame • 6 mm gap between jamb flashing membrane and top of rough jambs • 25 mm gap between sill and jamb flashing membranes and end of rough sill and jambs • Continuous lack of adhesion of jamb flashing membrane, 25 mm wide, in center of rough jambs • 6 mm gap between WRB membrane and window flange at sill and jambs ***For specimen No. 8*** • Head drip flashing not extended past window frame • 6 mm gap between jamb flashing membrane and top of rough jambs • 25 mm gap between sill and jamb flashing membranes and end of rough sill and jambs • Continuous lack of adhesion of jamb flashing membrane, 25 mm wide, in center of rough jambs • 6 mm gap between sill drip flashing and window flange ***For specimen No. 9*** • Head drip flashing not extended past window frame • 6 mm gap between jamb flashing membrane and top of rough jambs • 25 mm gap between sill and jamb flashing membranes and end of rough sill and jambs • Continuous lack of adhesion of jamb flashing membrane, 25 mm wide, in center of rough jambs ***For specimen No. 10*** • Head drip flashing not extended past window frame • 6 mm gap between jamb flashing membrane and top of rough jambs • 25 mm gap between sill and jamb flashing membranes and end of rough sill and jambs • Continuous lack of adhesion of jamb flashing membrane, 25 mm wide, in center of rough jambs • 6 mm gap between WRB coating and flashing membrane at sill and jambs

Table 2.2. Deficiencies introduced in the EIFS wall specimens (Cont"d)

Interface/ Junction	Deficiencies	
	1st line of defence	**2nd line of defence**
Wall / Exterior electrical outlet box A 50 mm X 75 mm X 75 mm duplex electrical outlet box	Missing 50 mm of seal length at the top of the cover plate of the outlet	***For specimens No. 6, No. 8 and No. 9*** (adhered EIFS) None[1,2] ***For specimens No. 7 and No. 10 (***mechanically fastened EIFS) 6 mm gap left between the WRB material and the perimeter of the opening in the sheathing
Wall / Ventilation duct A 150-mm diameter circular ventilation duct	Missing 50 mm of seal length at the top of the cover plate of the duct	***For specimens No. 6, No. 8 and No. 9*** None[1,2] ***For specimens No. 7 and No. 10*** 6 mm gap left between the WRB material and the perimeter of the opening in the sheathing ***For all specimens*** 3 mm high by 50 mm wide gap in the sealant between the ventilation duct and the insulation (on the indoor side) at the bottom of the ventilation duct
One vertical and one horizontal control joint in the EIFS	• Missing 50 mm (for specimens No. 6, No. 7 and No. 10), or 90 mm of seal length (for specimens No. 8 and 9) in the horizontal control joint, centered above the window • Missing 50 mm (for specimens No. 6, 7 and 10), or 90 mm of seal length (for specimens No. 8 and 9) seal length in the vertical control joint, at mid-height of the specimen	***For all specimens*** • None[3]

[1] As there is no second line of defence in specimen No. 6, no deficiency can be introduced.
[2] In specimens No. 8 and 9, the mesh used for back-wrapping is applied with an adhesive that covers the window flange and the flashing membrane. The 6 mm gap between the WRB coating and the window flange is therefore omitted because it would be of no effect.
[3] As the control joints do not penetrate past the 1st line of defence, no deficiency is introduced in the second line of defence.

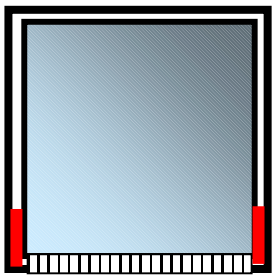
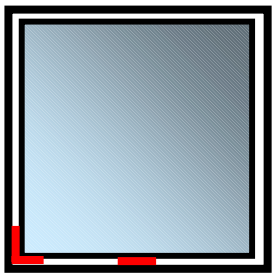
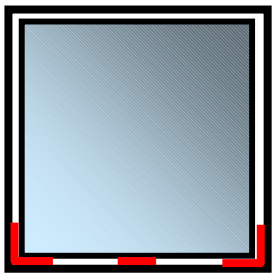
Wall specimen	Deficiency in the first line of defence at window/wall interface (in elevation) (in red)
No. 6	 The engineered sill stays open.
No. 7 No. 9 No. 10	
No. 8	

Figure 2.7 Location of 90 mm missing sealant at the wall/window interface for the 5 EIFS specimens

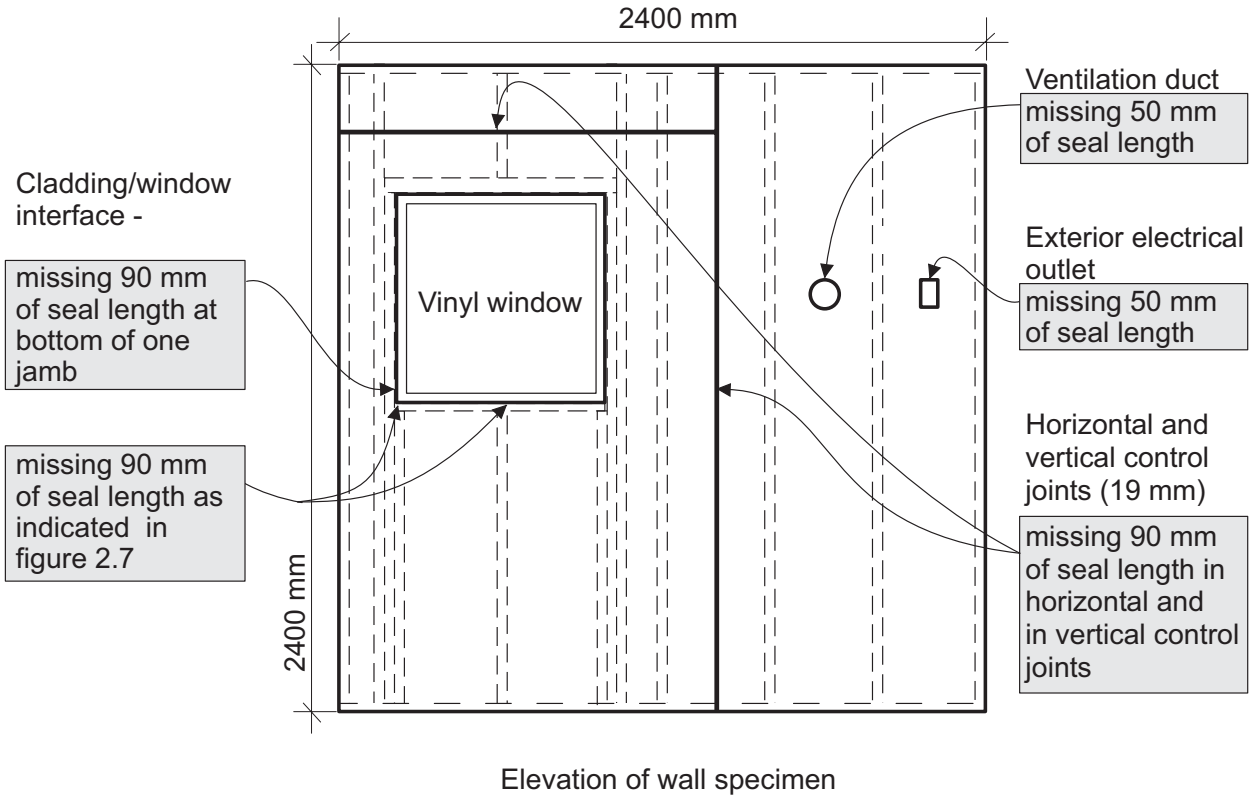


Figure 2.8. Positioning of details and deficiencies in the first line of defence for all specimens

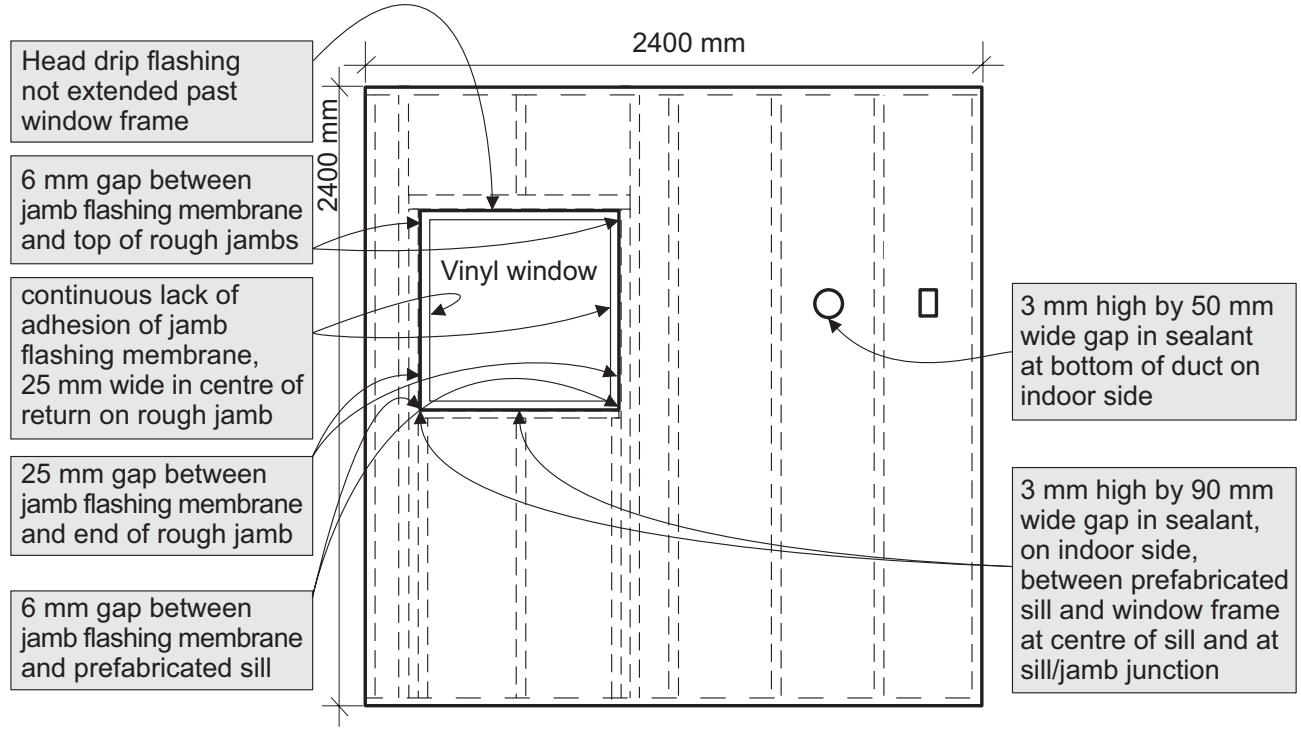


Figure 2.9. Deficiencies in the second line of defence for wall No. 6

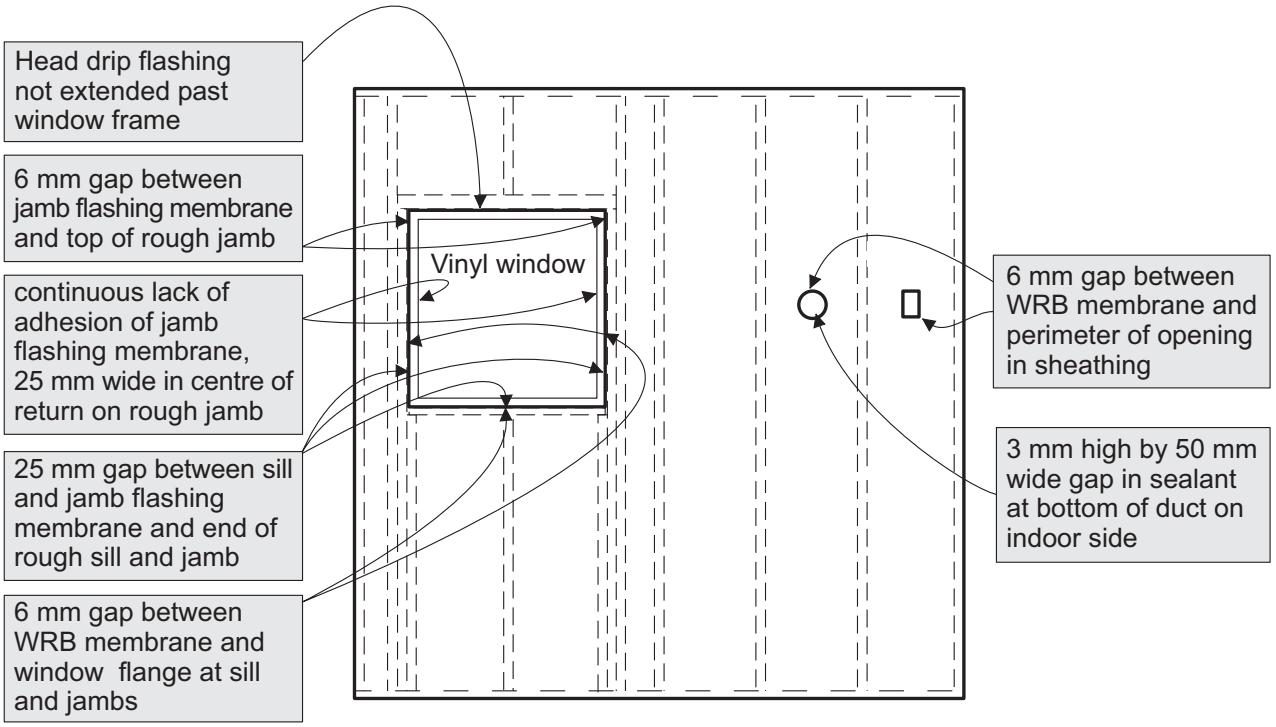


Figure 2.10. Deficiencies in the second line of defence for wall No. 7

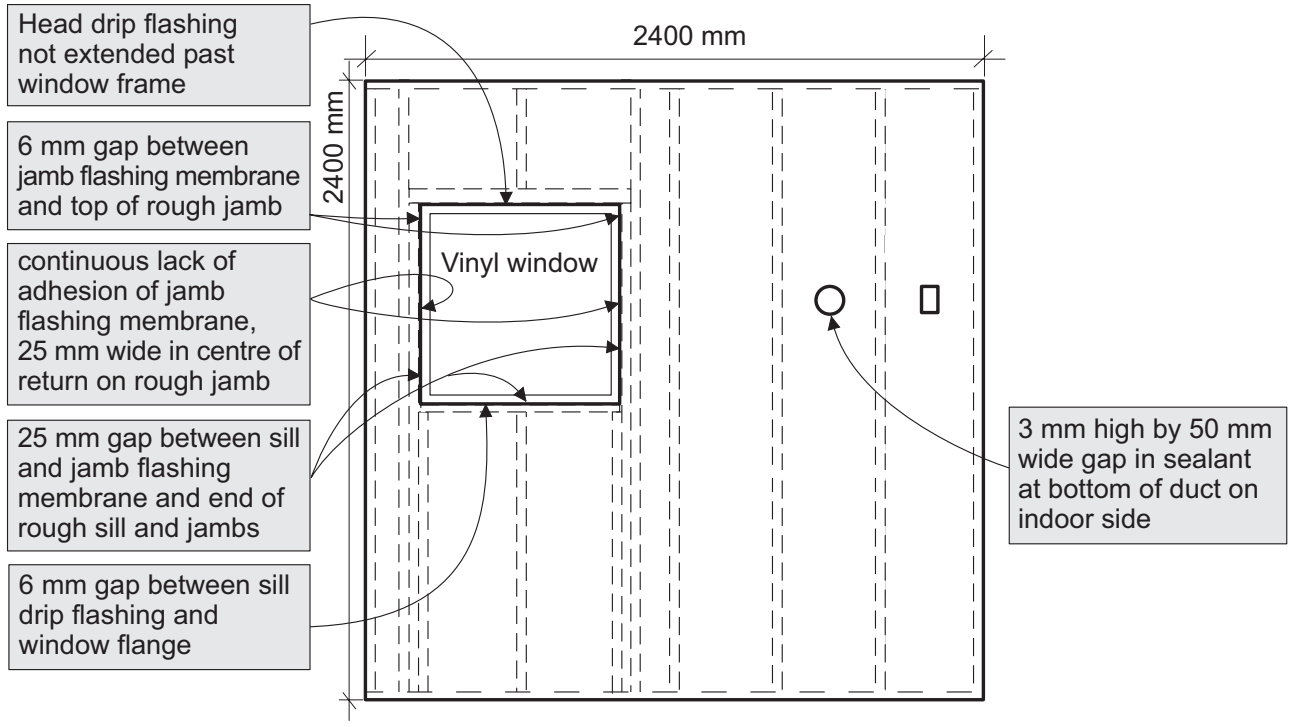


Figure 2.11. Deficiencies in the second line of defence for wall No. 8

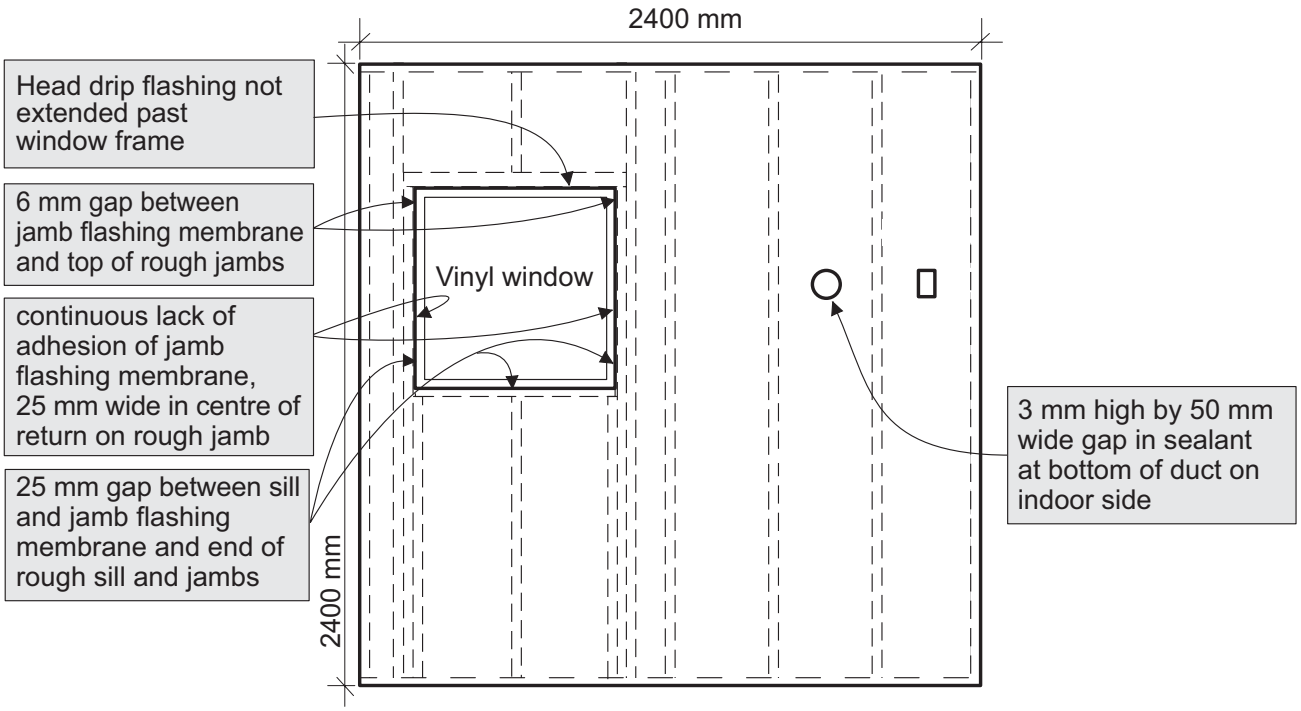


Figure 2.12. Deficiencies in the second line of defence for wall No. 9

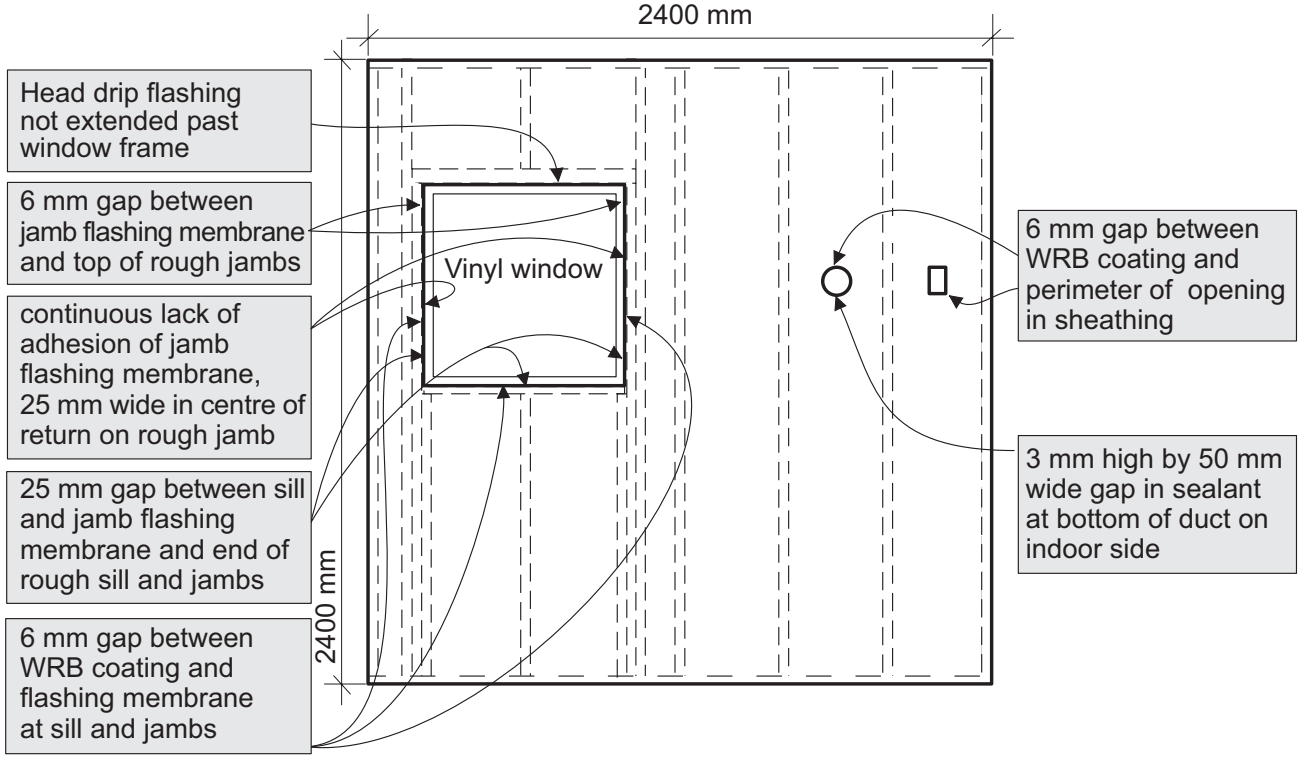


Figure 2.13. Deficiencies in the second line of defence for wall No. 10

2.3.2 Deficiencies in the air barrier system

As shown in Figure 2.14, deficiencies in the air barrier system are provided in each stud space (five in total) by a column of three holes, 4 mm in diameter, drilled in the acrylic sheet. All or some of these holes are closed or open depending on the air leakage rate required.

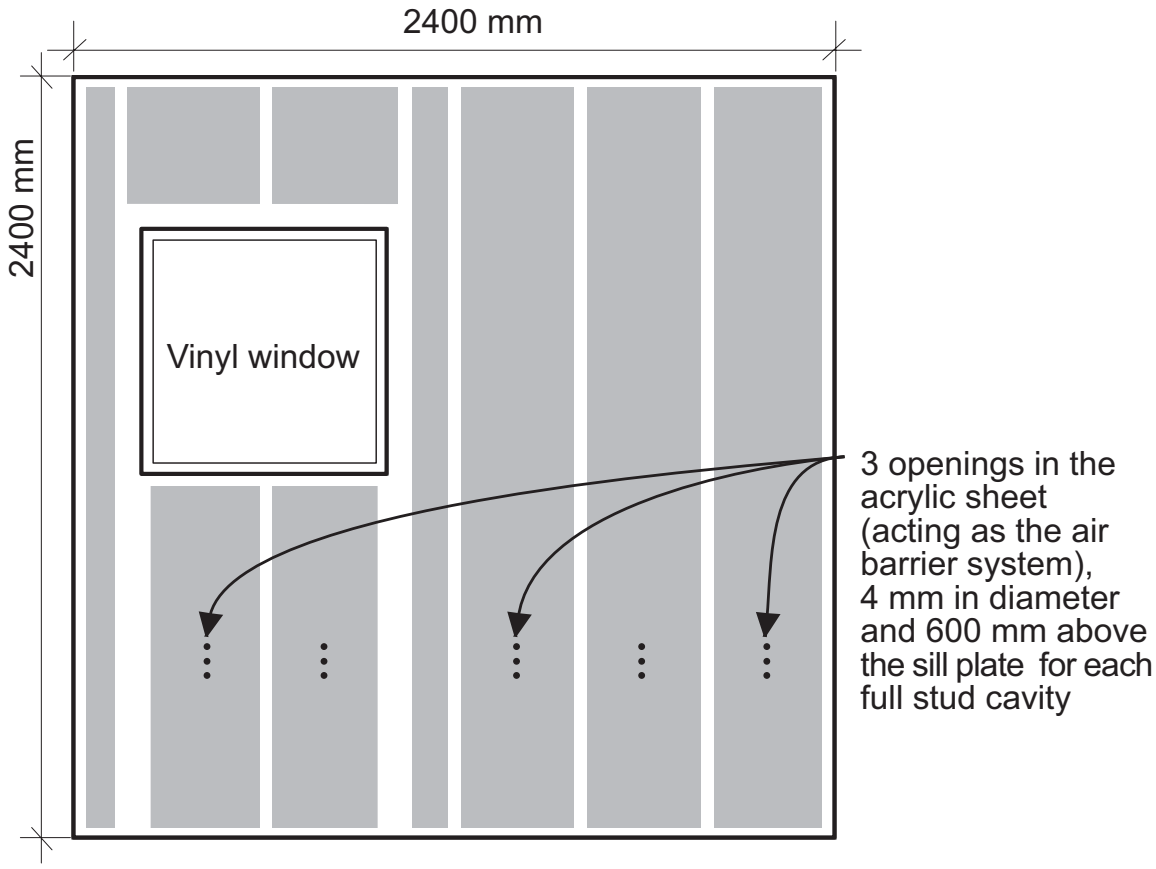


Figure 2.14. Deficiencies in the air barrier system for all specimens

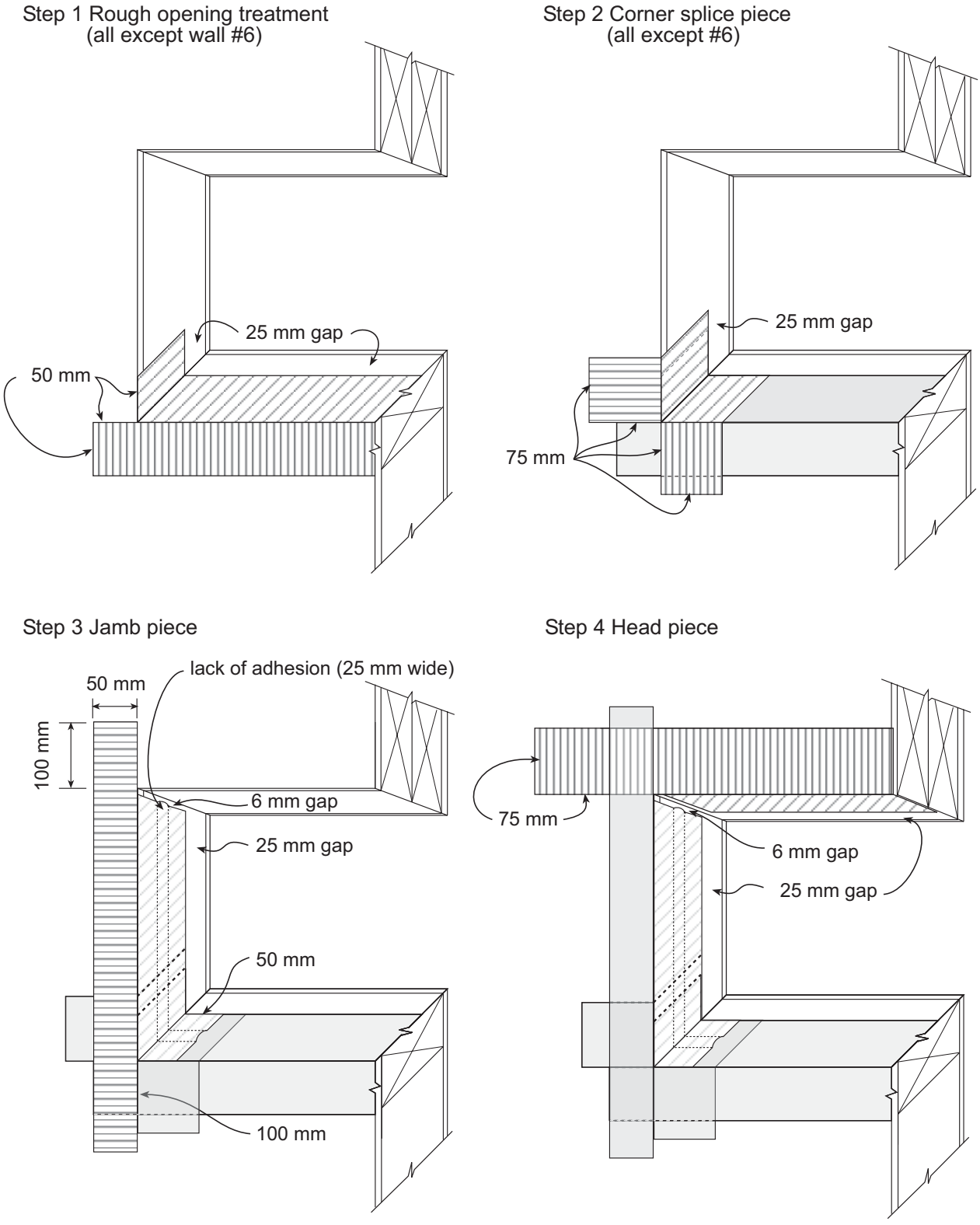
2.4 WALL / WINDOW INTERFACE CONSTRUCTION SEQUENCE AND DETAILS

The window installation procedure is the same for four of the specimens (No. 7, No. 8, No. 9 and No. 10) up to the installation of the WRB. First, the rough opening is covered with a self-adhesive water resistive membrane. The sill piece is first applied, followed by the corner piece and then the jamb piece. The last piece to be installed is the head piece. This flashing membrane installation procedure, with the deficiencies incorporated for this testing program, is illustrated in Figure 2.15 to Figure 2.19. Once the rough opening is protected, the window is installed (*before* the WRB).

For wall No. 7, the head drip flashing is then installed, followed by the paper-based WRB. Construction details for wall No. 7 are found in Figure 2.25 and Figure 2.26. In the case of walls No. 8, 9 and 10, the WRB coating is applied and then the head drip flashing is installed. The construction details for these specimens are shown in Figure 2.29 to Figure 2.38.

Wall No. 6 is a barrier wall with source drainage at the window consisting in a prefabricated sill. This rigid sill is installed over the rough jamb and set in sealant, making the sill and corner flashing membrane pieces unnecessary. The prefabricated sill is wider than the rough opening to catch any water that might leak along the jambs. After the prefabricated sill is put in place, the jamb flashing membrane is installed as described above and shown in Figure 2.14 with the difference that it laps the prefabricated sill instead of the sill flashing. The window is installed, followed by the head drip flashing.

Figure 2.19 and Figure 2.20 illustrate the wall/window detailing for specimen No. 6. Deficiencies, as described in Table 2.2 and Figure 2.6 to 2.12, are included in the execution of the procedures described above for the wall/window interface. Although they may vary to address the specific configuration of the specimens, the deficiencies are intended to be consistent from wall to wall.



(# 6: 6 mm short of prefabricated sill)

Figure 2.15. Installation procedure for the self-adhesive flashing membrane

Figure 2.16. Rough opening treatment - Step 1.

Figure 2.17. Rough opening treatment - Step 2.

Figure 2.18. Rough opening treatment - Step 3.

Figure 2.19. Rough opening treatment - Step 4.

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

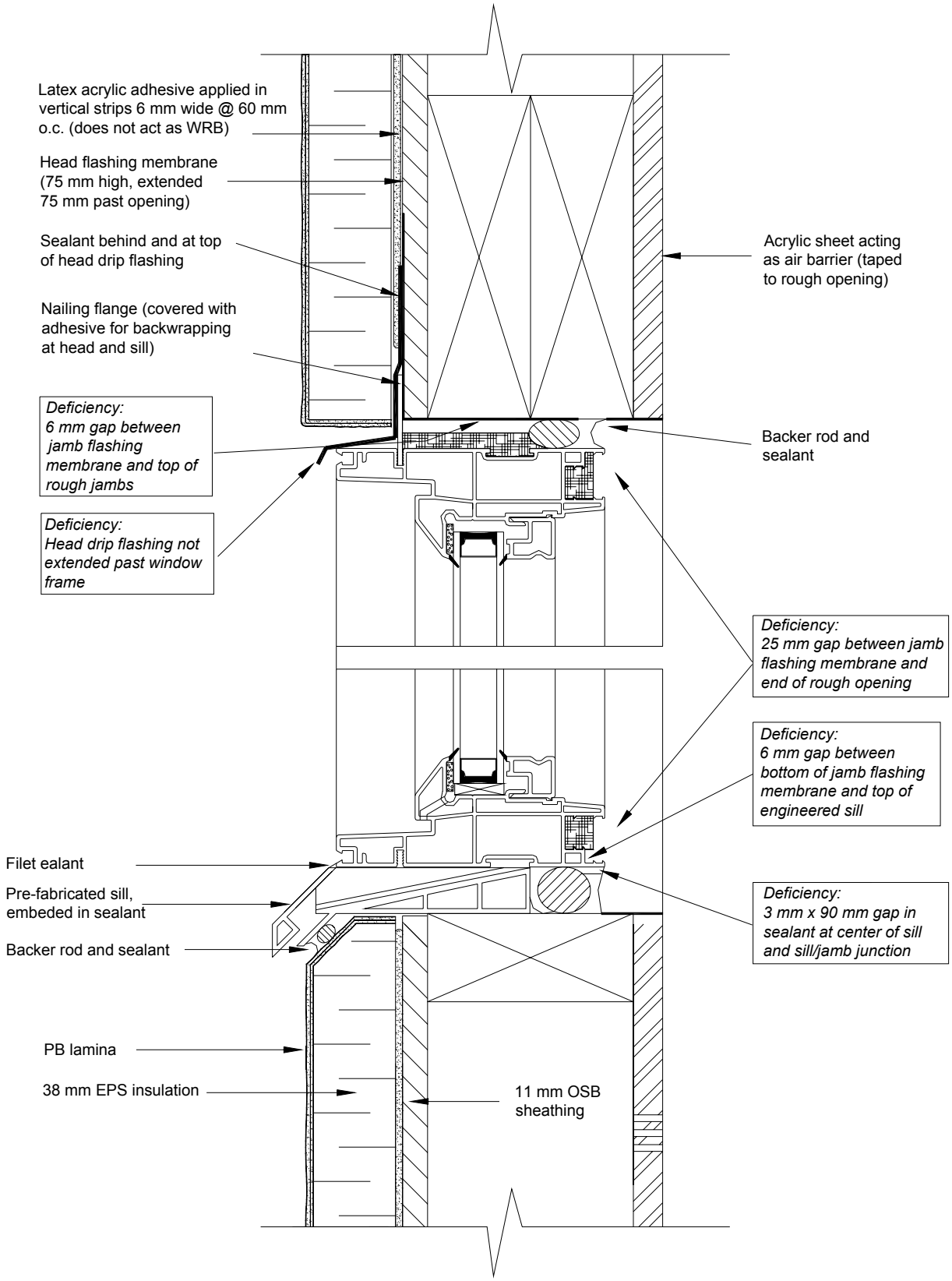


Figure 2.20. Wall/window interface for specimens No. 6 - vertical section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

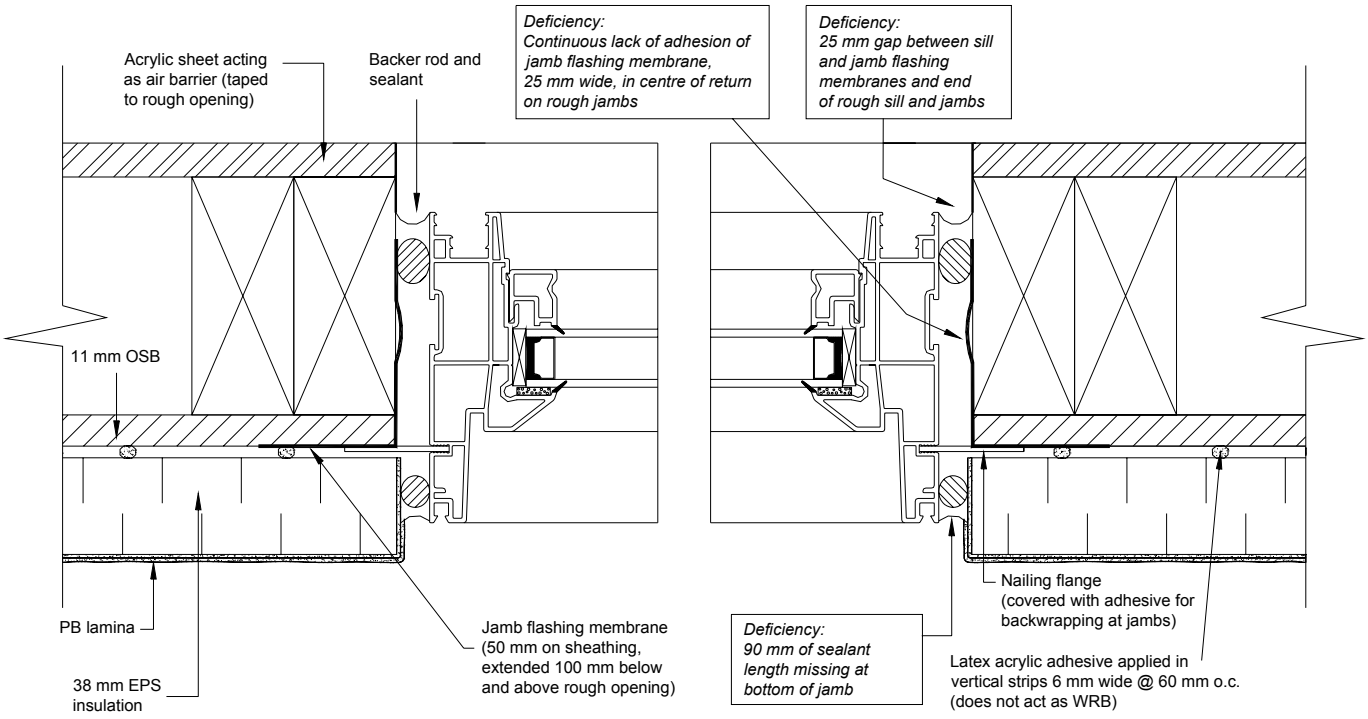


Figure 2.21. Wall/window interface for specimens No. 6 - horizontal section

Figure 2.22. Front of prefabricated sill - Wall No. 6.

Figure 2.23. Prefabricated sill embedded in sealant - Wall No. 6.

Figure 2.24. Sealant at top of jamb - Wall No. 6.

Figure 2.25. Deficiencies at top and bottom of jamb flashing membrane.

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

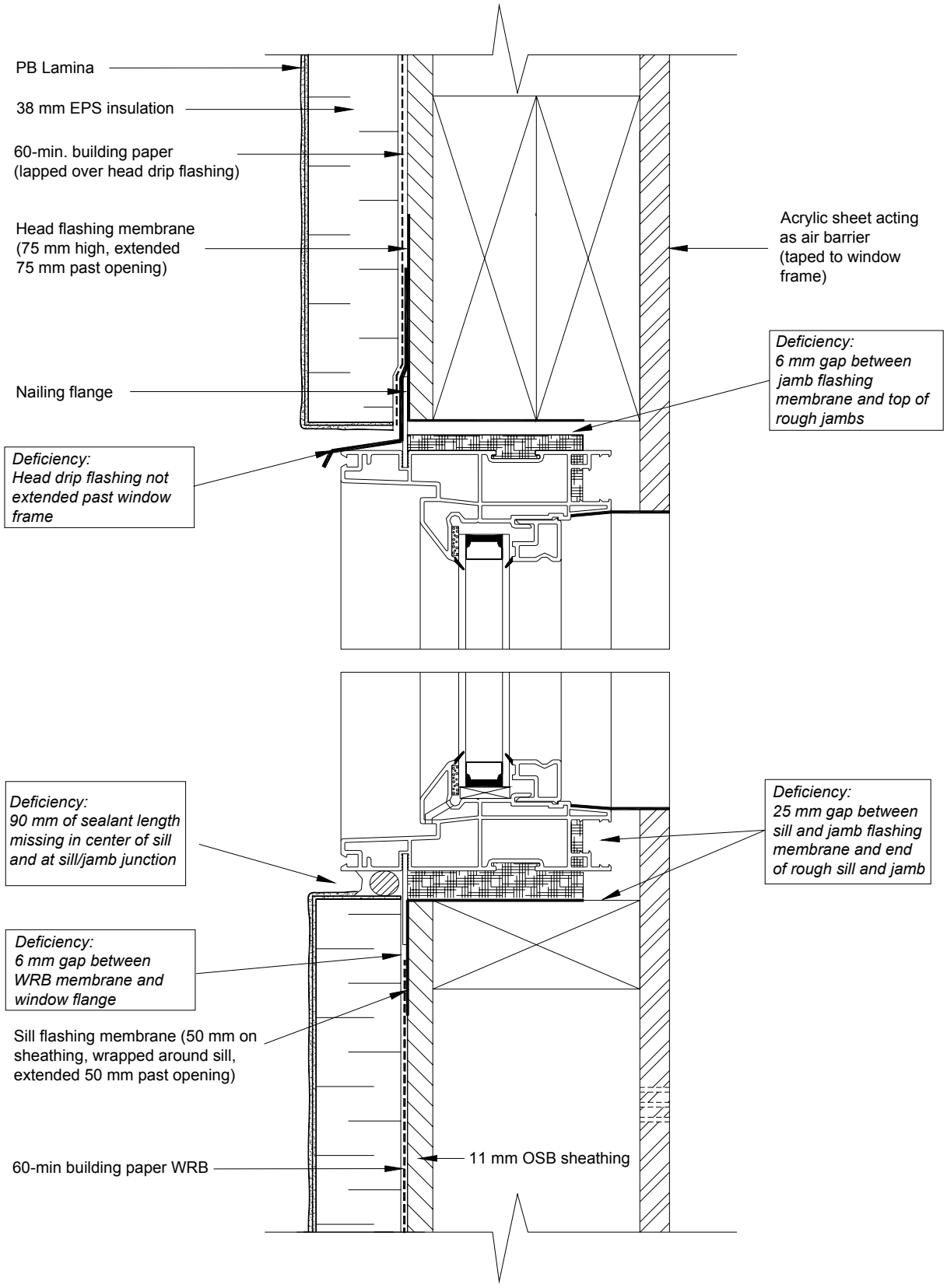


Figure 2.26. Wall/window interface for specimens No. 7 - vertical section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

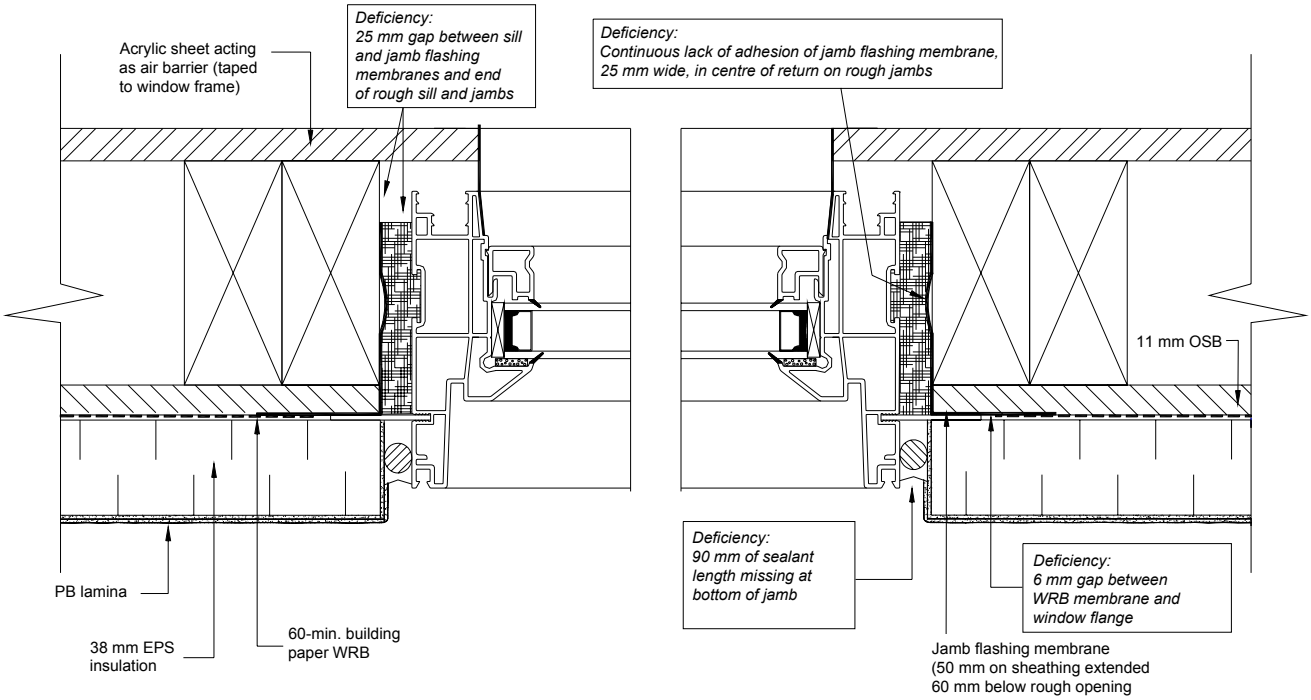
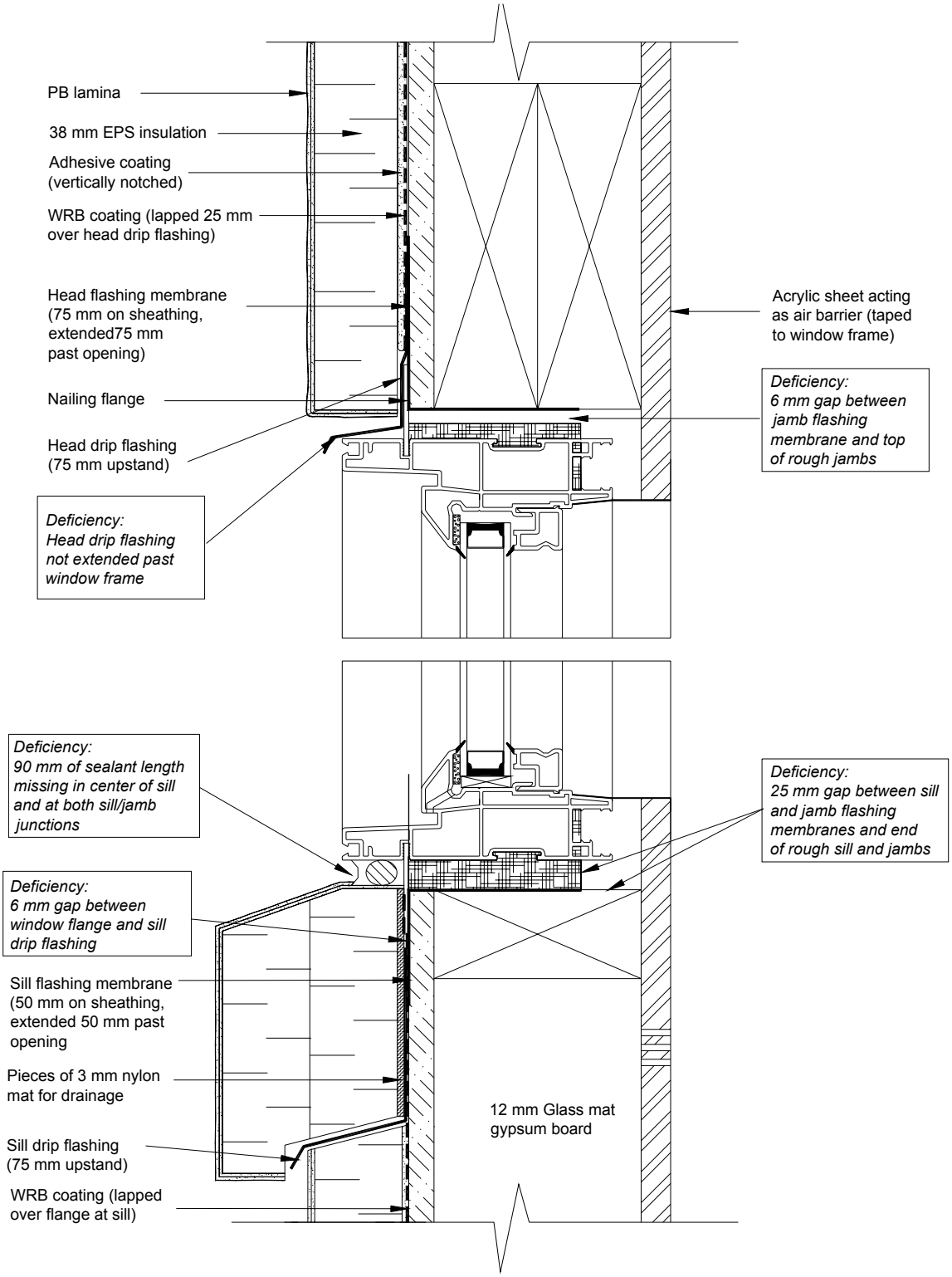


Figure 2.27. Wall/window interface for specimen No. 7 - horizontal section

Figure 2.28. Window installed in wall No. 7.

Figure 2.29. Wall No. 7. Deficiency: 6 mm gap between window flange and paper based WRB



NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

Figure 2.30. Wall/window interface for specimen No. 8 - vertical section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

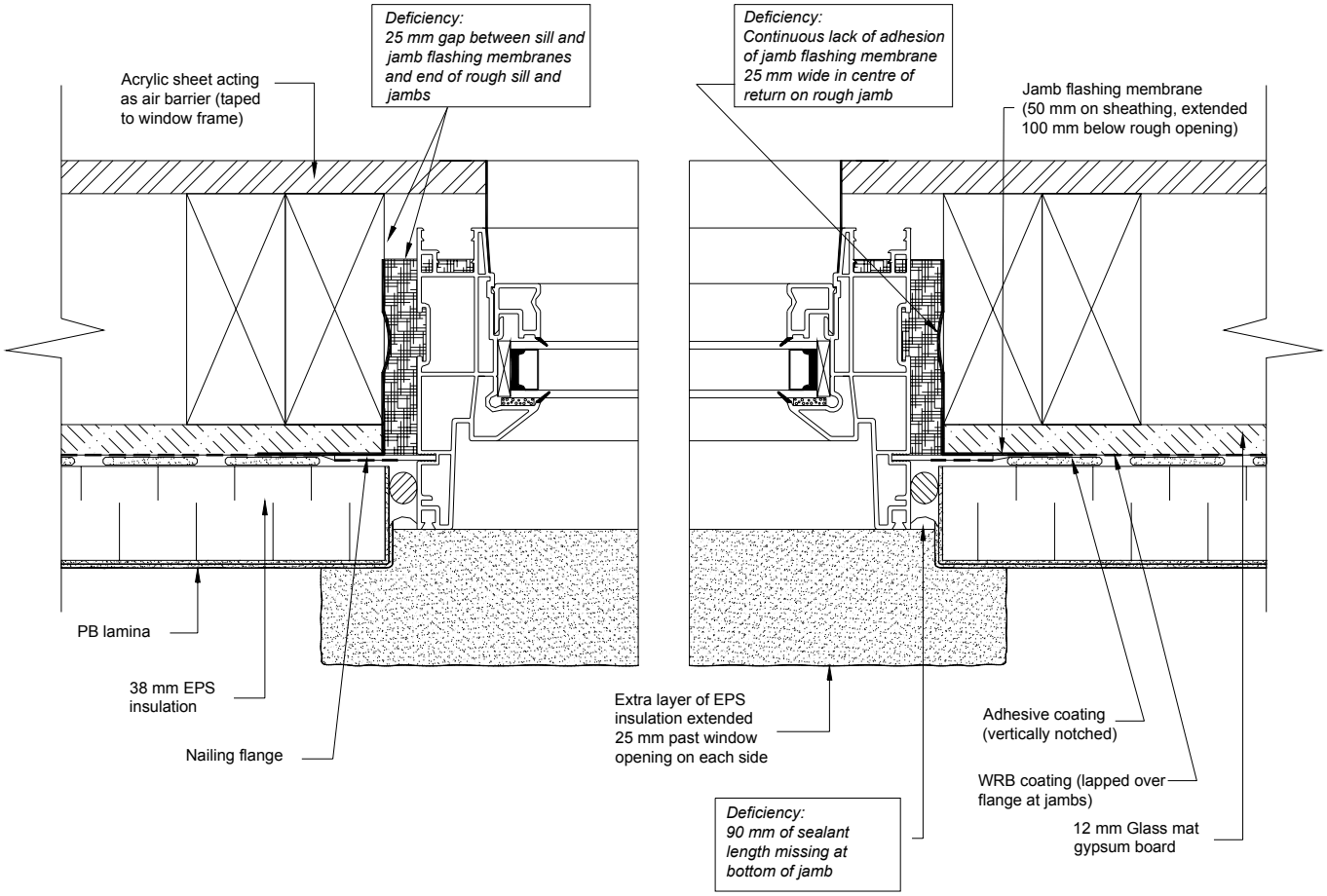


Figure 2.31. Wall/window interface for specimens No. 8 - horizontal section

Figure 2.32. Backwrap for sill piece - Wall No. 8.

Figure 2.33. Sill drip flashing with drainage pieces - Wall No. 8.

Figure 2.34. Sill piece - Wall No. 8.

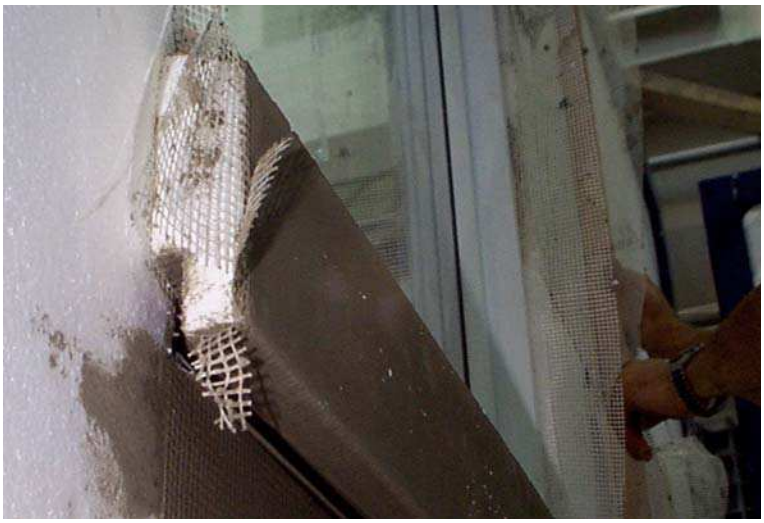


Figure 2.35. Sill piece installed - Wall No. 8.

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

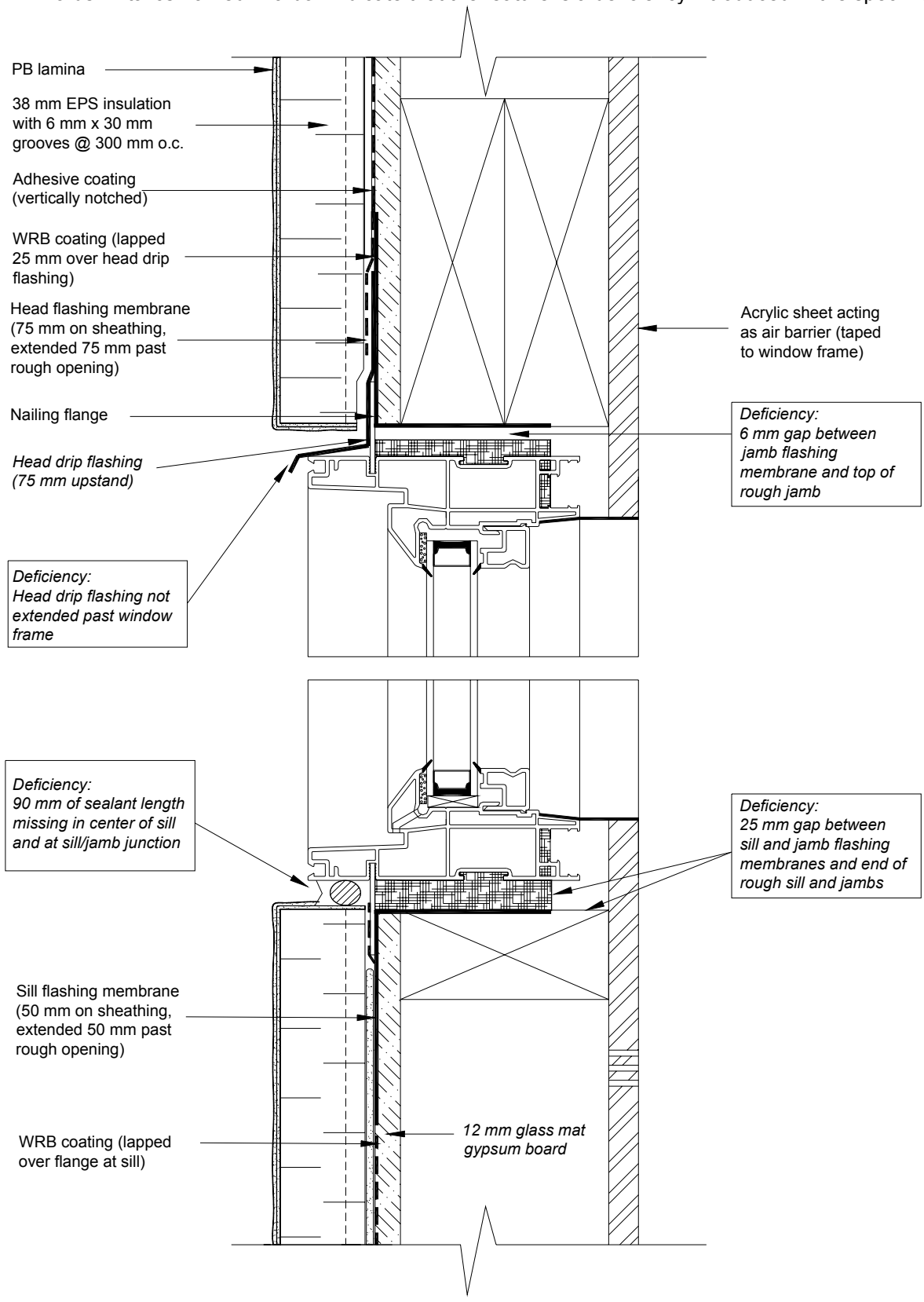


Figure 2.36. Wall/window interface for specimen No. 9 -vertical section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

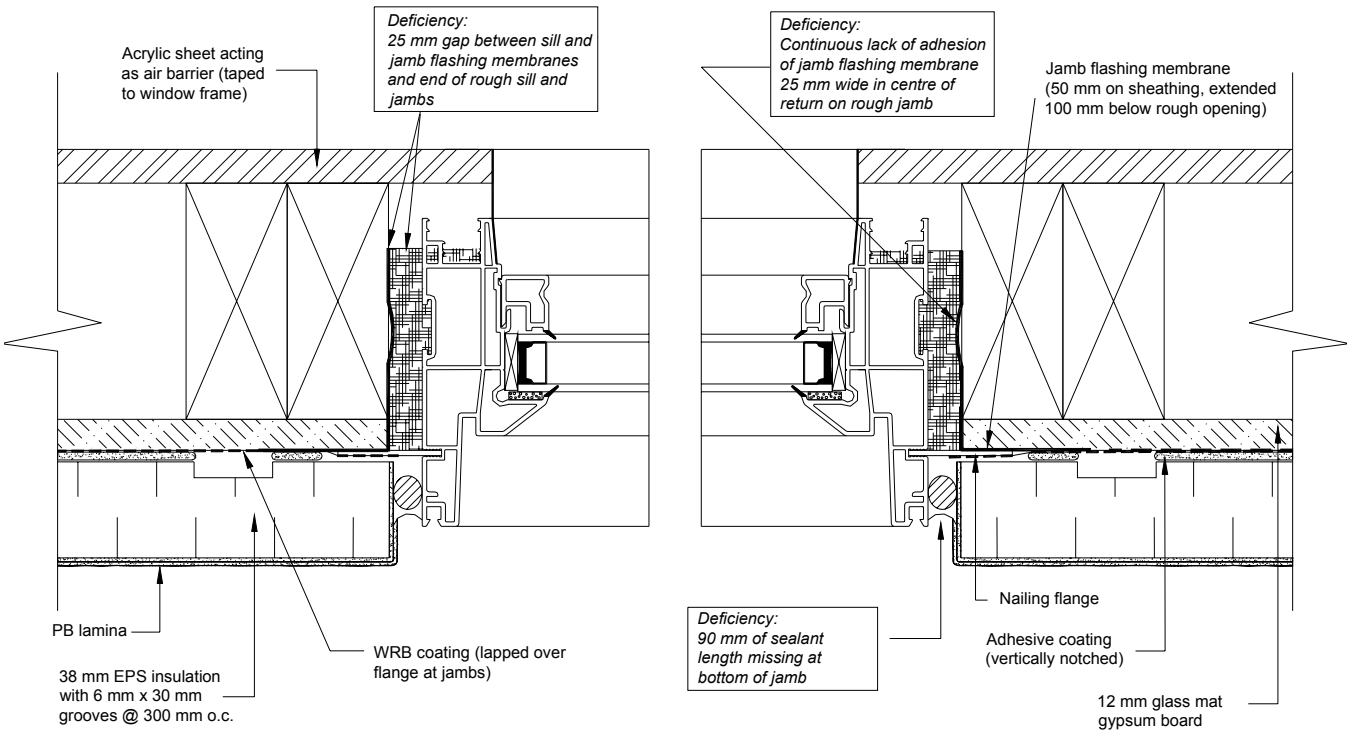


Figure 2.37. Wall/window interface for specimen No. 9 - horizontal section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

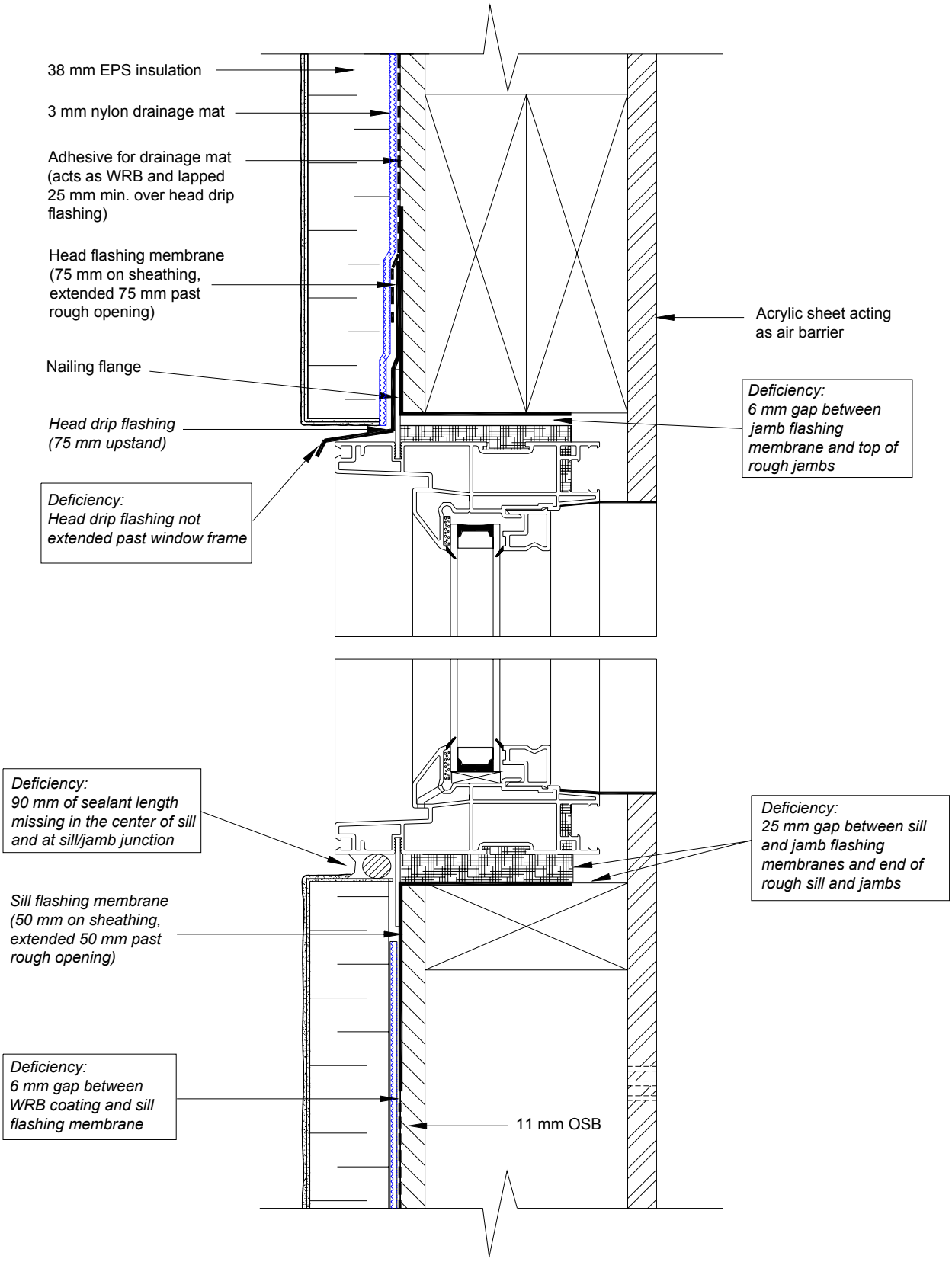


Figure 2.38. Wall/window interface for specimen No. 10 - vertical section

NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

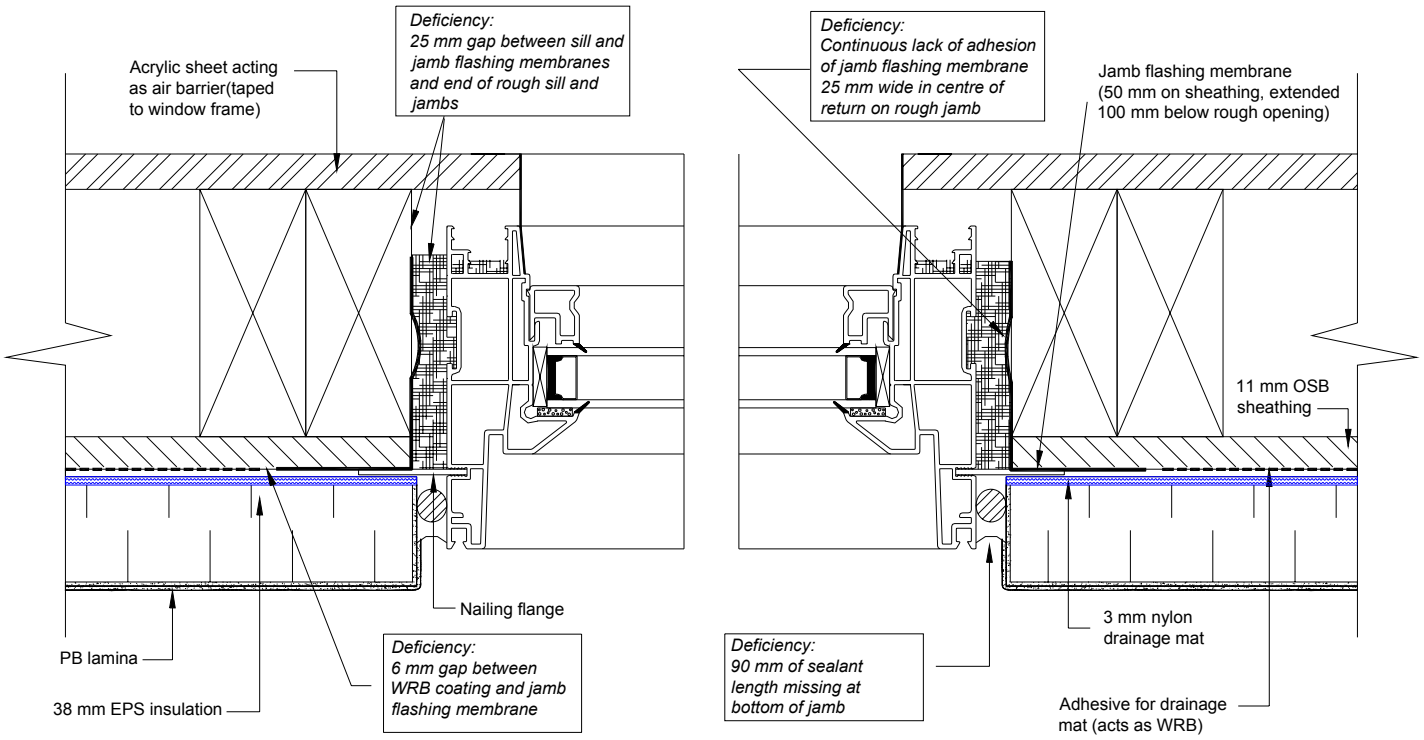
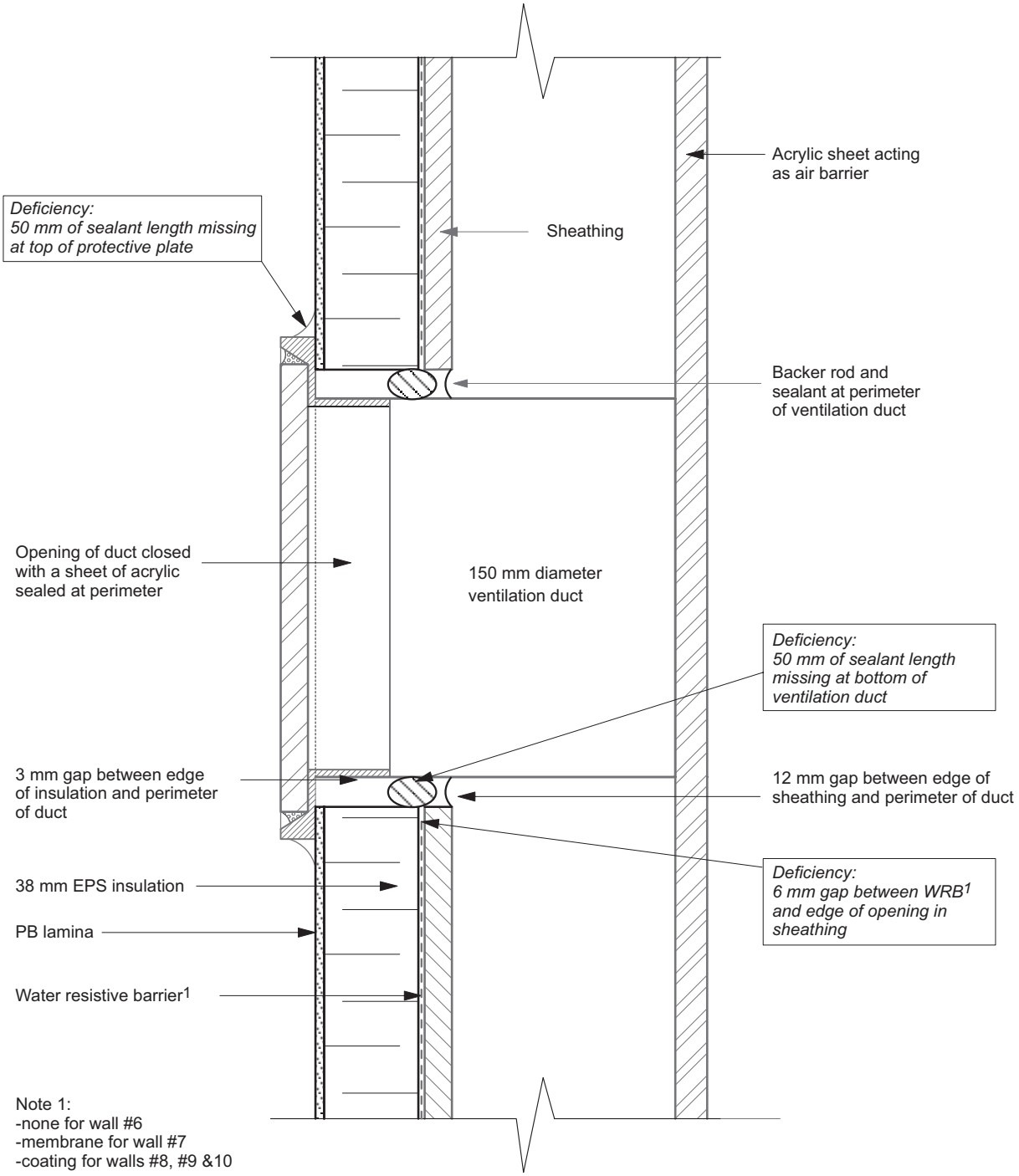


Figure 2.39. Wall/window interface for specimen No. 10 - horizontal section

2.5 WALL / VENTILATION DUCT INTERFACE DETAIL

The duct detail with deficiencies is illustrated in Figure 2.40. The same duct detail applies for all EIFS assemblies, only the materials are changed according to those specified (see Table 2.1 for the composition of the specimens and Table 2.2 for deficiencies).

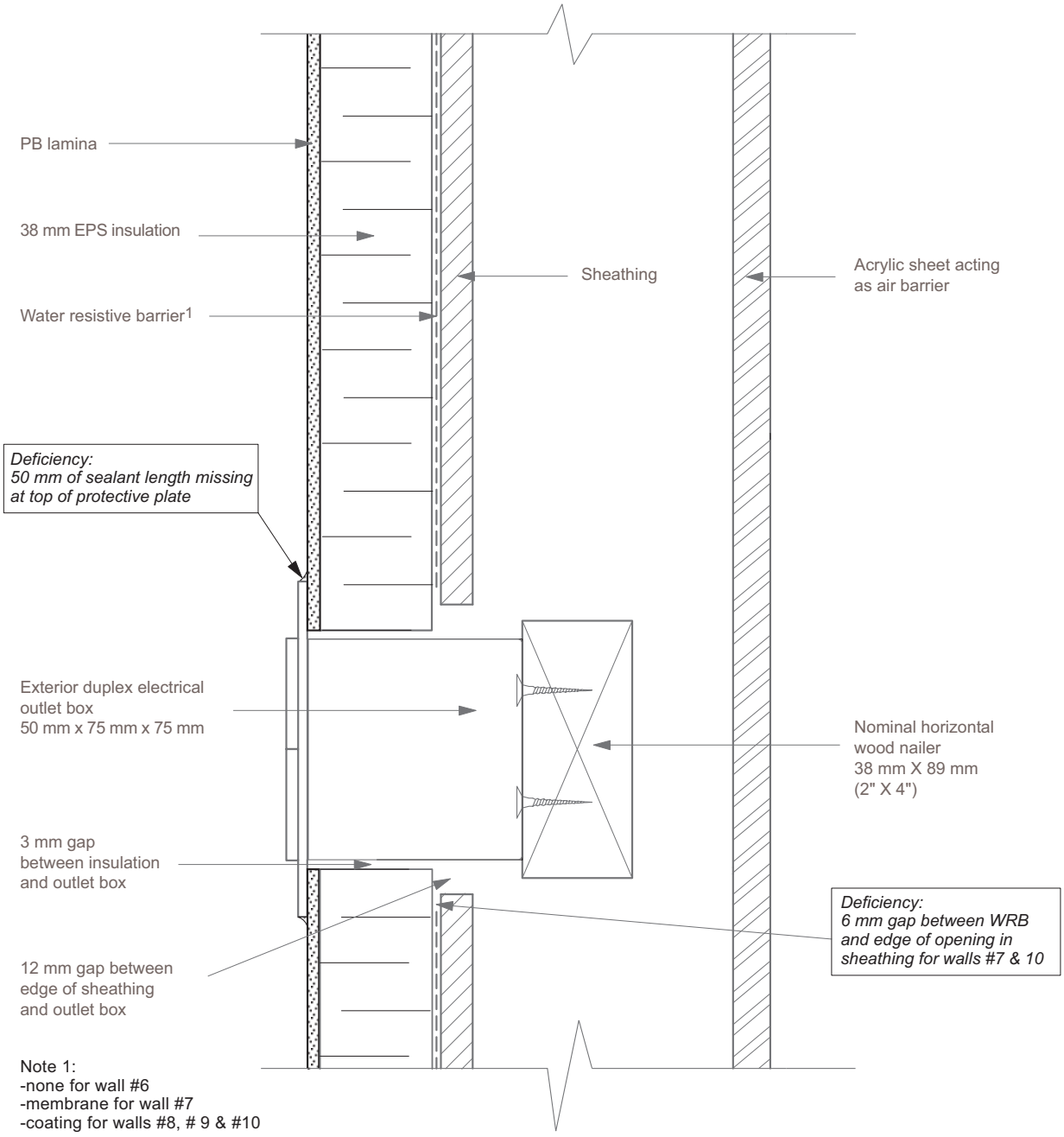


NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

Figure 2.40. Wall/duct interface

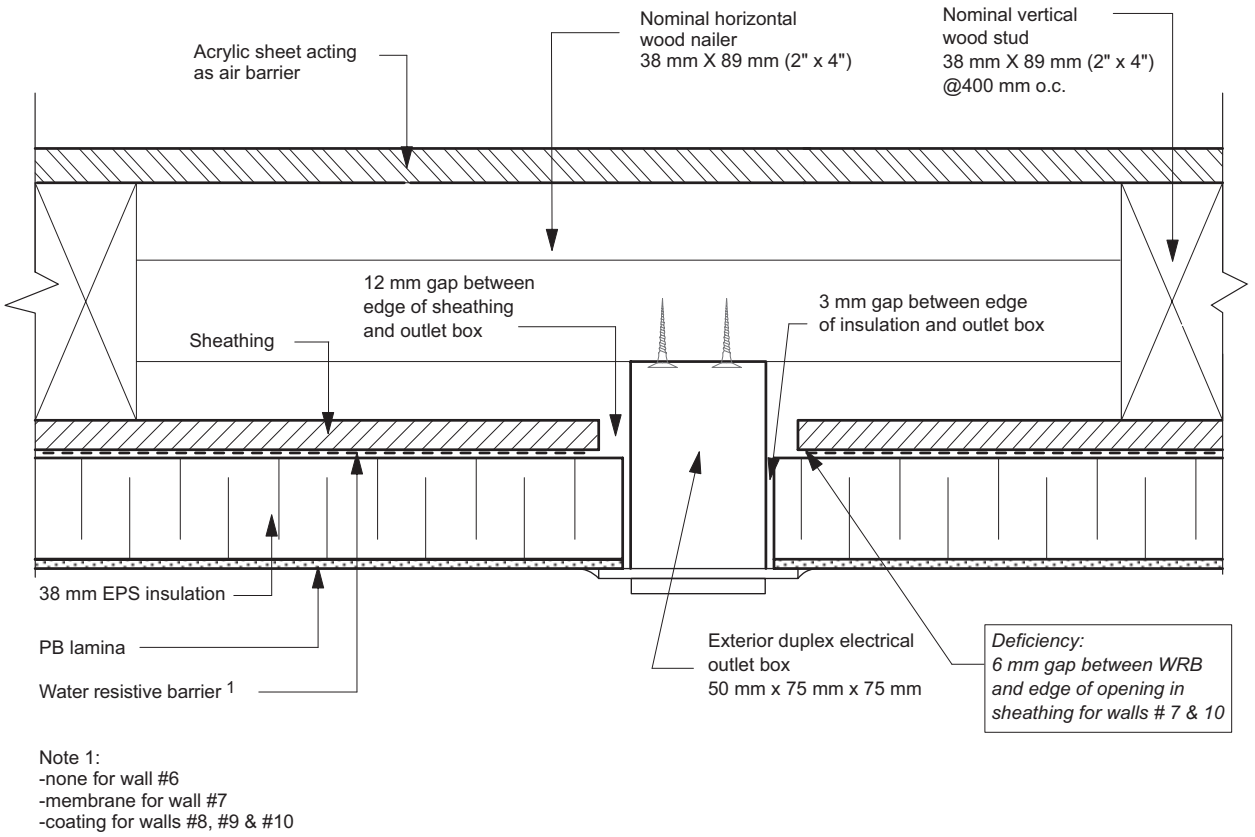
2.6 WALL / ELECTRICAL OUTLET INTERFACE DETAILS

The wall/outlet interface is shown in Figure 2.41 and Figure 2.42. The same electrical outlet penetration detail applies for all EIFS assemblies. The materials are changed according to those specified (see Table 2.1 for the composition of the specimens and Table 2.2 for deficiencies).



NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

Figure 2.41. Wall/outlet box interface - vertical section

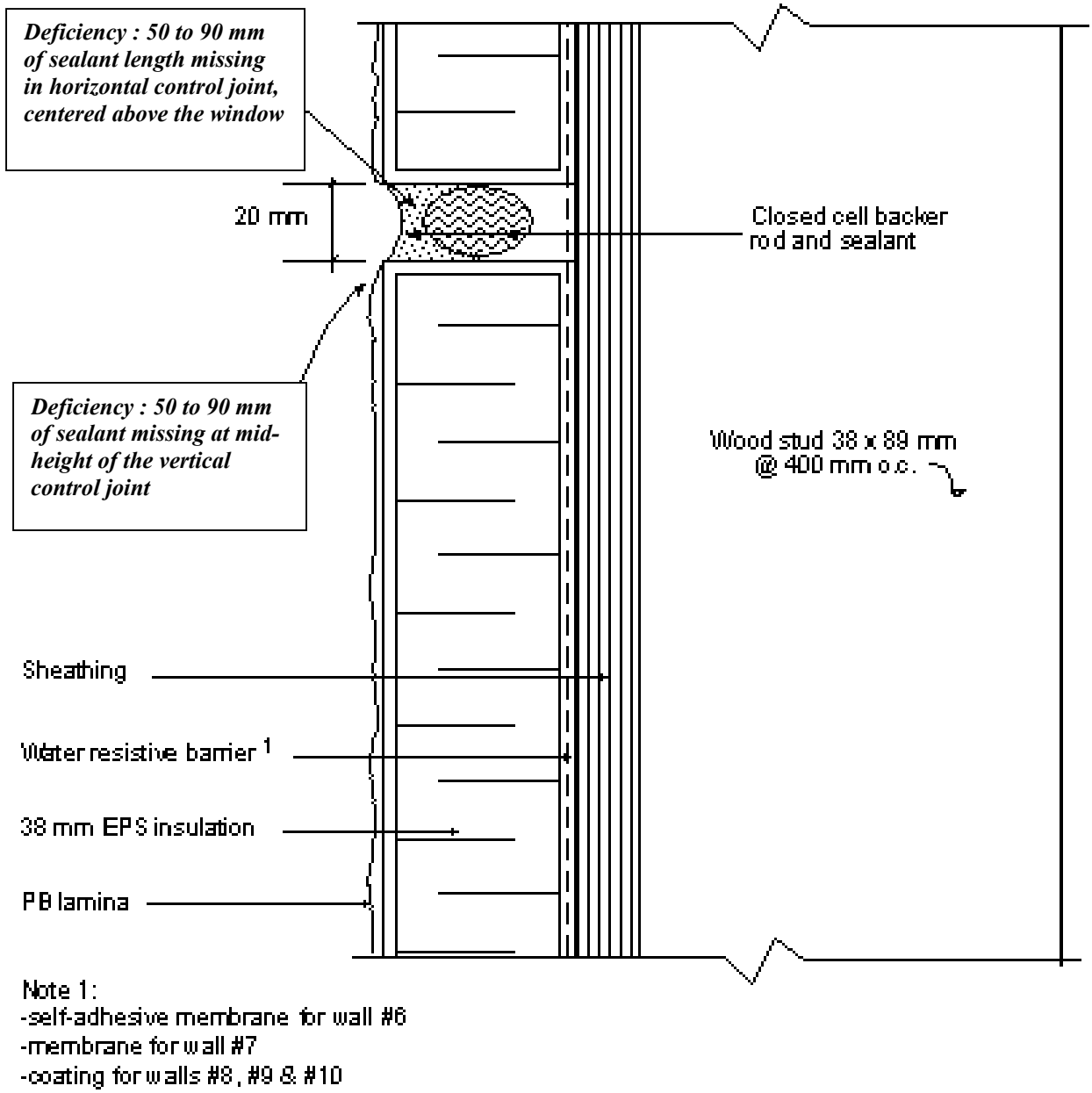


NB. Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

Figure 2.42. Wall/outlet box interface - horizontal section

2.7 CONTROL JOINT CONSTRUCTION DETAIL

All wall specimens have one horizontal control joint located at 300 mm above the window and one vertical control joint centered in the stud cavity that includes no penetration (refer to Figure 2.8 for positioning of control joints). The same control joint detail applies for all EIFS specimens. Only the materials are changed according to those specified (see Table 2.1 for the composition of the specimens). Figure 2.43 shows the detail for the horizontal control joint. The vertical control joint is not shown as it is built inthe same way as the horizontal joint.



NB Words in italics framed in a box indicate that the feature is a deficiency introduced in the specimen

Figure 2.43. Horizontal control joint

2.8 TERMINATION OF THE WALL SPECIMEN DETAILS

Wall specimens No. 6, No. 7 and No. 8 are not drained systems and will have the same termination at the bottom of the wall as presented in Figure 2.44 (refer to Table 2.1 for the exact composition of these specimens). The actual termination of the wall specimen will be adapted to allow for the installation of a water collection system as part of the experimental set-up. Specimens No. 9 and No. 10 are drained at the bottom. Figure 2.45 indicates how these wall specimens end (refer to Table 2.1 for the exact composition of these specimens). The actual termination of the wall specimen is adapted to allow for the installation of a water collection system at the bottom of the wall, as part of the experimental set-up.

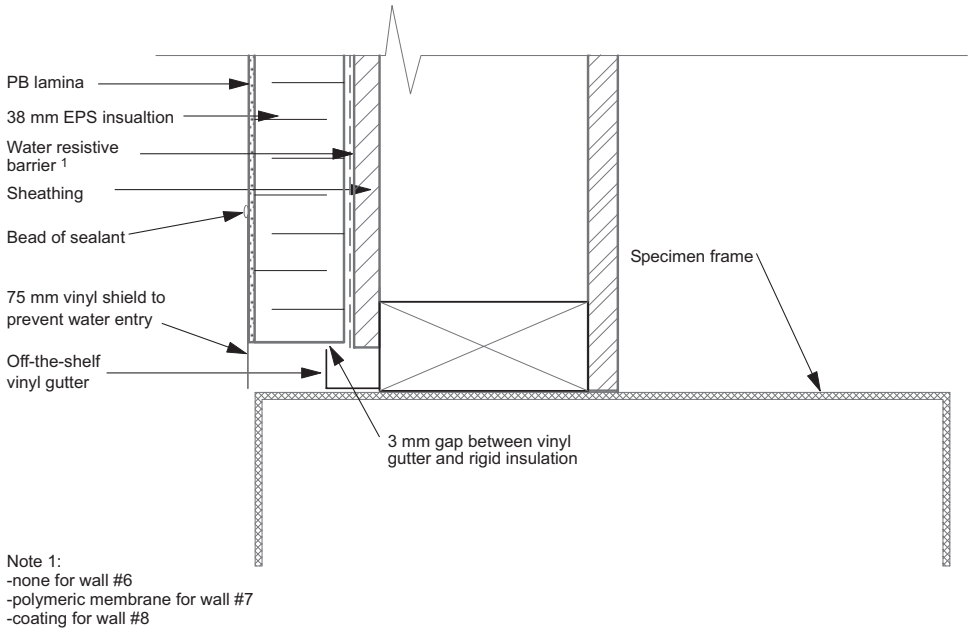


Figure 2.44. Termination detail at the bottom of the wall for specimens No. 6, No. 7 and No. 8

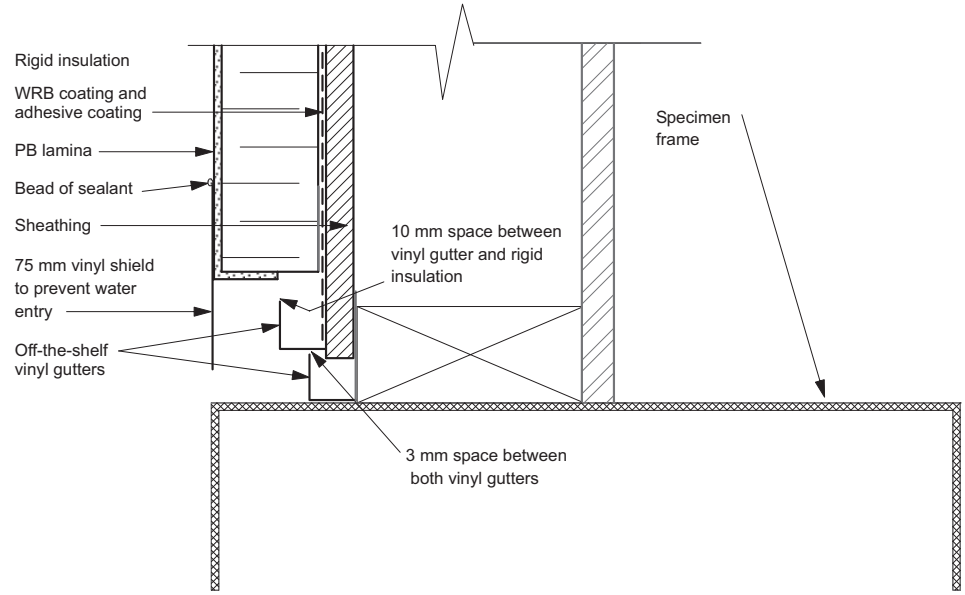


Figure 2.45. Termination details for specimens No. 9 and No. 10

APPENDIX 2.1. PHOTOGRAPHIC RECORDS OF EIFS INSTALLATION ON THE SPECIMENS

In this section, photographic records taken at the time of the EIFS installation are presented to illustrate the procedure for the various systems.

Figure 2.46. Wall No. 6. Self-adhesive membrane behind control joints and backwrapping of penetrations

Figure 2.47. Wall No. 6. Application of adhesive to the back of the EPS insulation

Figure 2.48. Wall No. 6. Installation of EPS insulation

Figure 2.49. Wall No. 6. Backwrapping of EPS insulation

Figure 2.50. Wall No. 6. Application of mesh and base-coat

Figure 2.51. Wall No. 6. Application of finish coat

Figure 2.52. Wall No. 7. WRB membrane with water sensitive paper strips

Figure 2.53. Wall No. 7. Backwrapping of vertical joint and insulation installation

Figure 2.54. Wall No. 7. Insulation mechanically attached

Figure 2.55. Wall No. 7. Spotting of fasteners and backwrapping completed

Figure 2.56. Wall No. 7. Application of base-coat and mesh

Figure 2.57. Wall No. 7. Application of finish coat

Figure 2.58. Wall No. 8. Application of WRB coating

Figure 2.59. Wall No. 8. Backwrapping and installation of adhered EPS insulation

Figure 2.60. Wall No. 8. Application of base-coat and mesh

Figure 2.61. Wall No. 8. Application of finish coat

Figure 2.62. Wall No. 9. Application of WRB coating

Figure 2.63. Wall No. 9. Backwrapping around openings

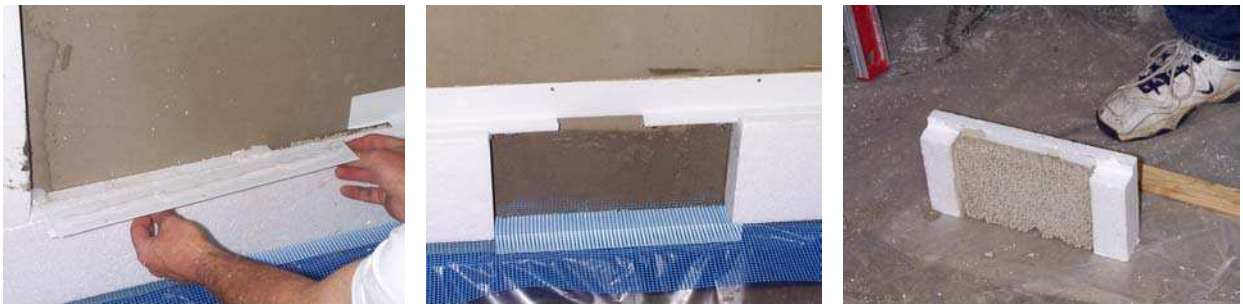


Figure 2.64. Wall No. 9. Drainage system components

Figure 2.65. Wall No. 9. EPS insulation with vertical grooves, application of adhesive behind the insulation

Figure 2.66. Wall No. 9. Installation of EPS installation

Figure 2.67. Wall No. 9. Sanding of EPS insulation

Figure 2.68. Wall No. 9. Application of finish coat

Figure 2.69. Wall No. 10. Application of WRB coating and nylon drainage mat

Figure 2.70. Wall No. 10. Installation of mechanically attached EPS insulation

Figure 2.71. Wall No. 10. Rust proof fasteners and backwrapping over insulation

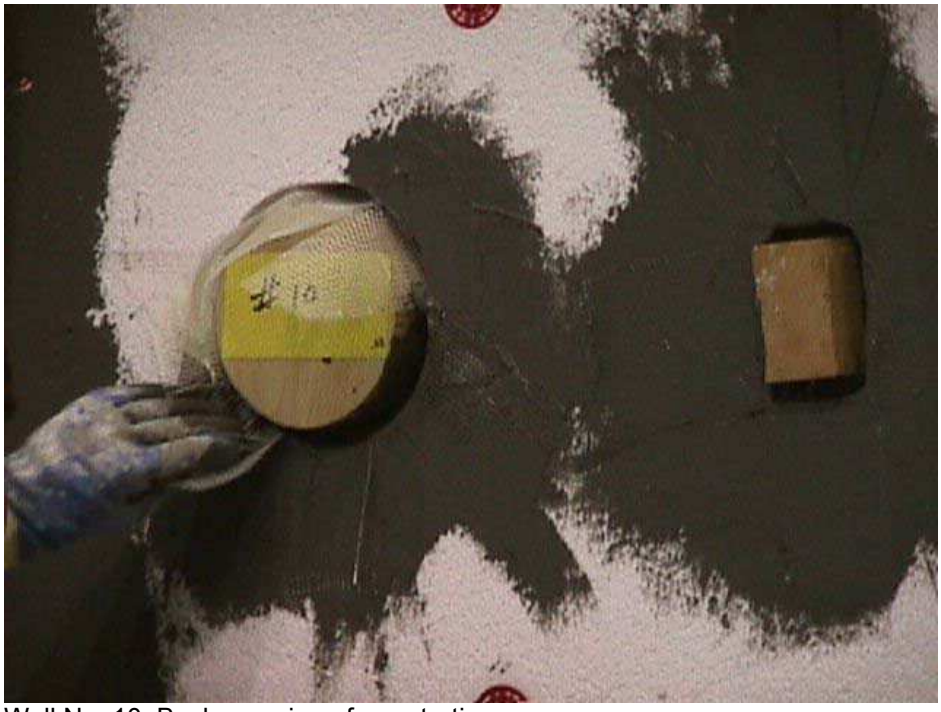


Figure 2.72. Wall No. 10. Backwrapping of penetrations

Figure 2.73. Wall No. 10. Installation of base-coat and mesh

Figure 2.74. Wall No. 10. Application of finish coat

CHAPTER 3

CONSTRUCTION OF THE FOUR MASONRY WALL SPECIMENS

This chapter provides the as-built construction details for the four masonry wall specimens and related penetration and interface details. These specimens were investigated for water entry using the Dynamic Wall Testing Facility (DWTF) as part of the MEWS consortium project.

3.1 COMPOSITION OF MASONRY SPECIMENS

Four different masonry wall assemblies were selected in consultation with the masonry industry representatives participating in the MEWS project. The composition of the wall assemblies is described in Table 3.1 and illustrated in Figures 3.1 to 3.4.

Table 3.1. Description of masonry wall assemblies

No.	Brick type	Cavity size	WRB	Sheathing	Type of window	Type of sill
11	Clay brick (190 mm X 57 mm X 90 mm depth) Type N masonry cement mortar Concave 10 mm joints Corrugated metal ties with Brick veneer Tie system (BVTS)	25 mm	None	25 mm XPS foam board (ship lap joints)	Box	Stone
12	Same as No. 11, without the BVTS	25 mm	1 layer 30-min paper	11 mm OSB	Flanged	Rowlock
13	Same as No. 12	25 mm	1 layer 30-min paper	11 mm asphalt impregnated fiberboard	Box	Rowlock
14	Same as No. 12	50 mm	1-layer cross-woven perforated polyethylene	12 mm glass mat gypsum board	Flanged	Stone

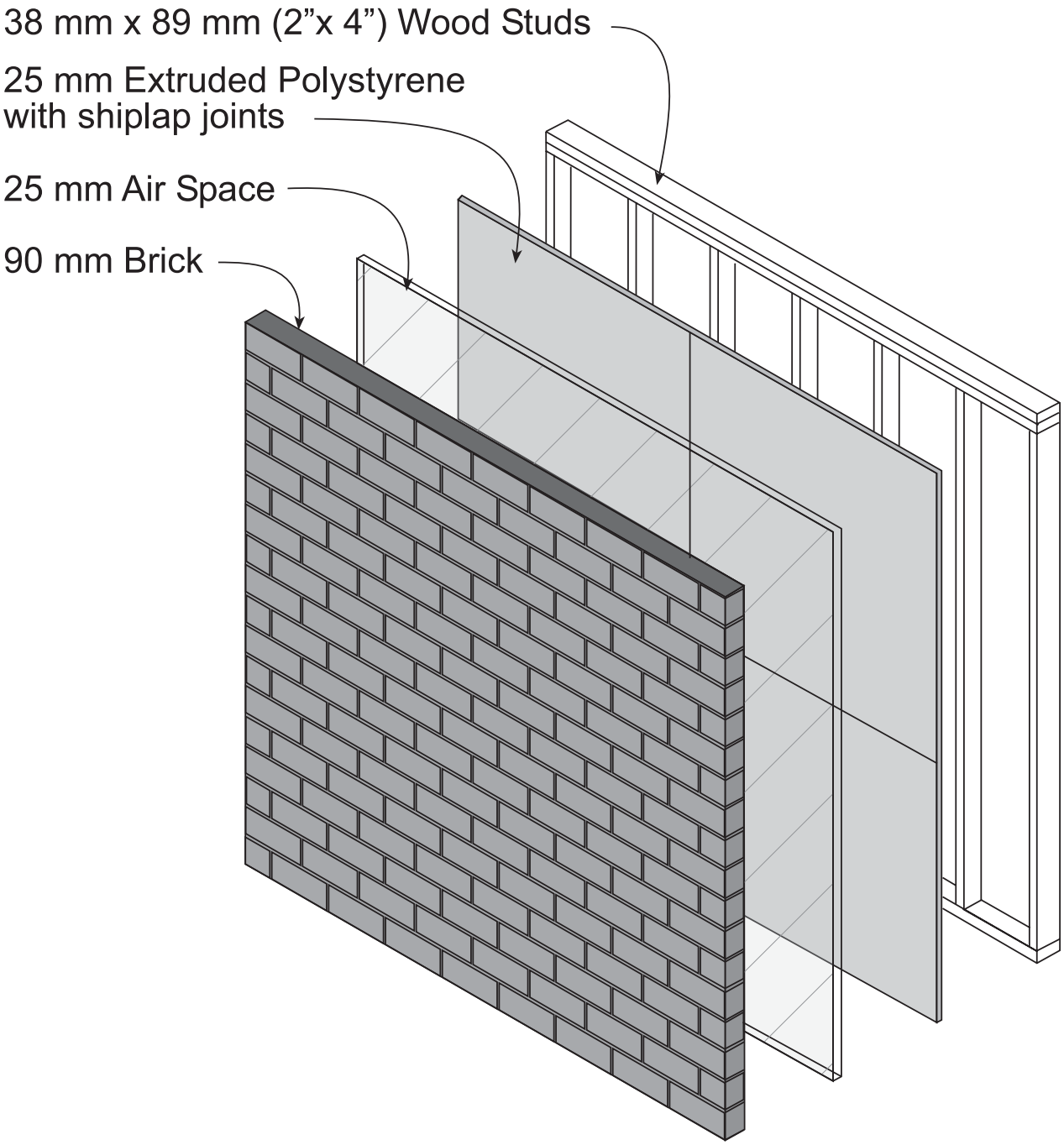


Figure 3.1. Composition of masonry wall specimen No. 11

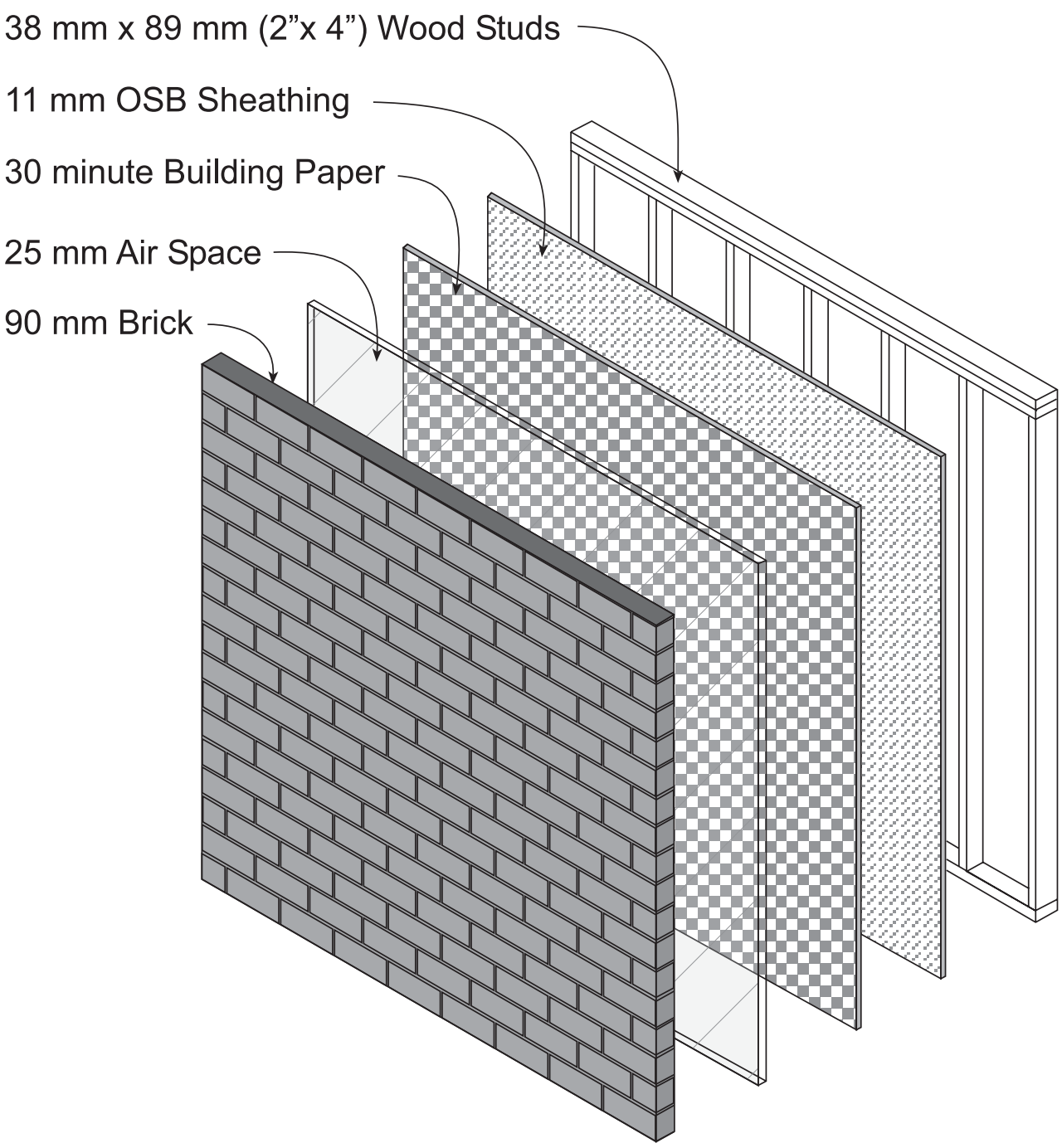


Figure 3.2. Composition of masonry wall specimen No. 12

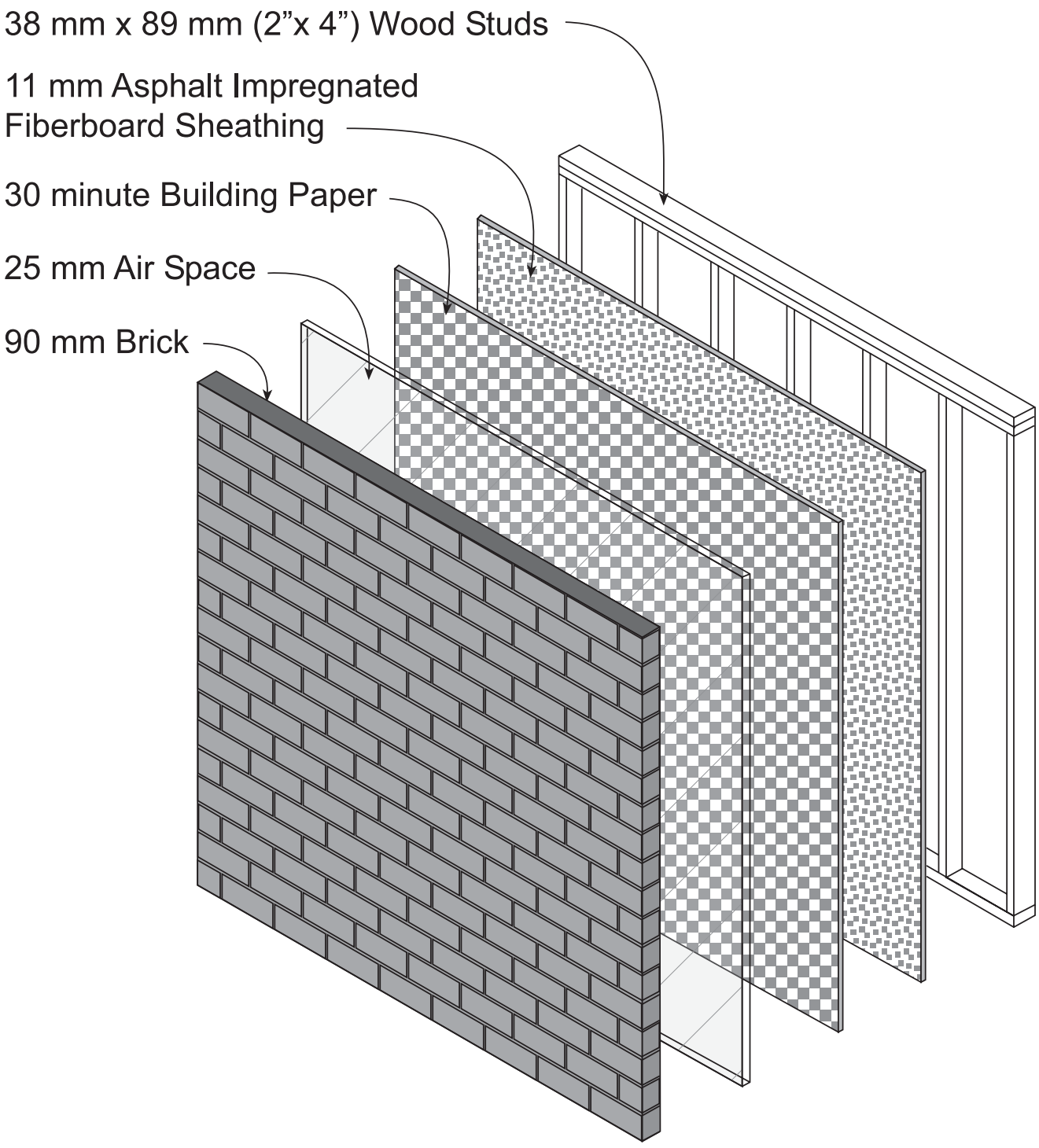


Figure 3.3. Composition of masonry wall specimen No. 13

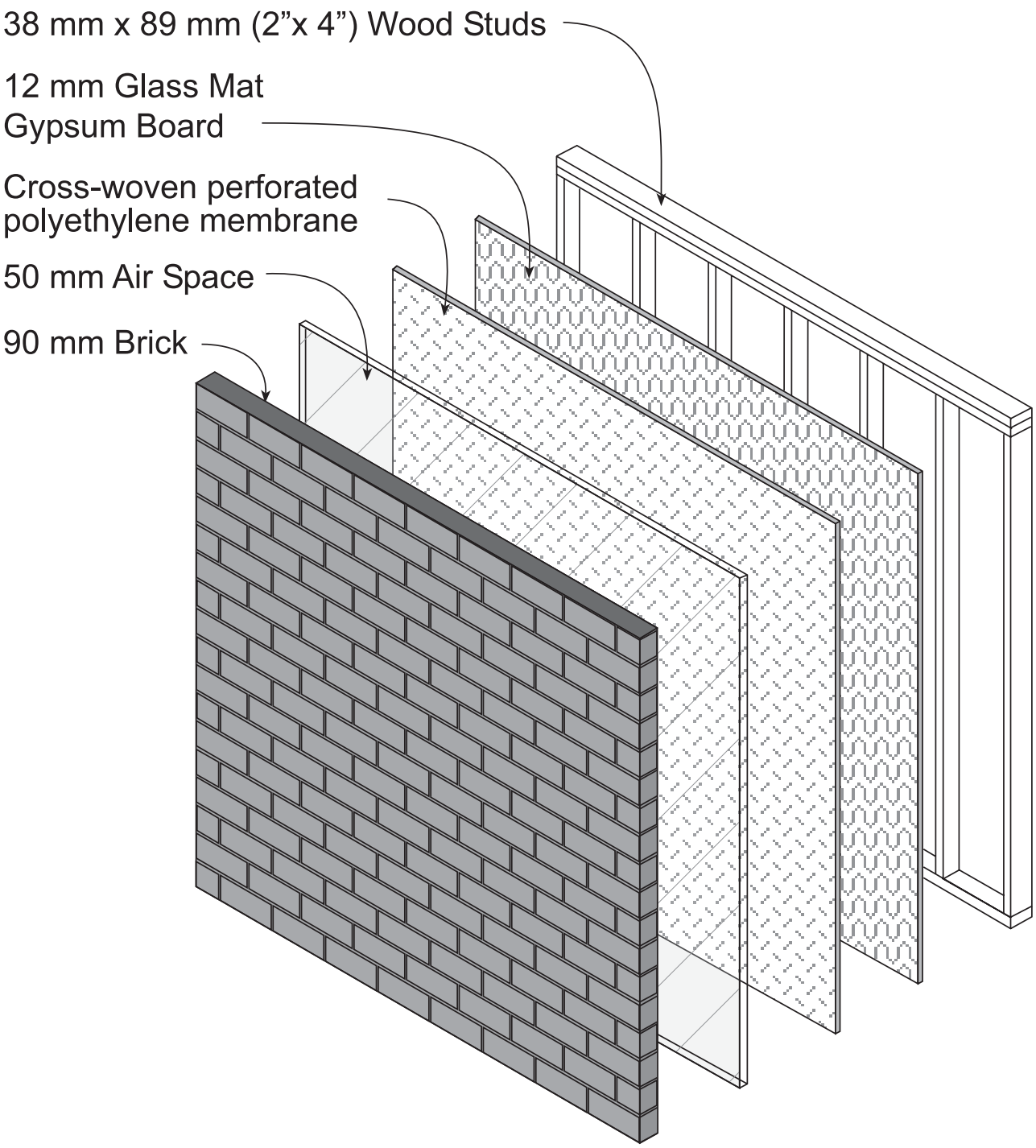


Figure 3.4. Composition of masonry wall specimen No. 14

3.2 TYPES OF DETAILS

Three types of details are included in each masonry specimen: window, ventilation duct and electrical outlet. No control joint was included in masonry walls; in practice masonry walls built in low-rise residential buildings rarely include a full storey vertical control joint. Note that both the window and the vent duct penetrate through the masonry veneer, the water-resistive barrier and the sheathing board, whereas the electrical outlet receptacle only penetrates through the brick veneer. The positioning of these three details in the wall specimens is shown in Figure 3.5.

Window:
A fixed PVC (vinyl) window measuring 755 mm wide by 755 mm high and 118 mm in depth (Bonneville Ltd Corporation) will be used for all brick veneer specimens. For wall specimens No. 12 and No. 14, a nailing flange is used, as provided in the window profile illustration shown in Figure 3.6. Vinyl frame extension trims (supplied by the window manufacturer) are mounted on the front end of the main window frame thus extending the depth to accommodate the different combinations of cavity depth and sheathing board thickness. This permits the edge of the window frame to extend to the masonry assembly thereby providing an adequate interface between components, as shown in Figures 3.8 to 3.11. Sealant is used to prevent water entry at this junction.

Advice offered in the manufacturer's literature suggests not using the nailing flange as a permanent mounting for that window. The manufacturer highly recommends that the window be fastened to the rough opening using metal brackets that fit in a groove in the PVC frame (Figure 3.6). Because stability of the window is important for specimens subjected to high air pressure differentials, windows will be secured to the wall with the brackets provided by the manufacturer. Hence, for two of the specimens, the nailing flange will also contribute to the fastening of the window to the wall in addition to the brackets.

Duct:
A circular metal ventilation duct having a 150-mm diameter

Exterior electrical outlet:
An exterior duplex wall outlet measuring 50 mm wide by 75 mm high by 75 mm deep

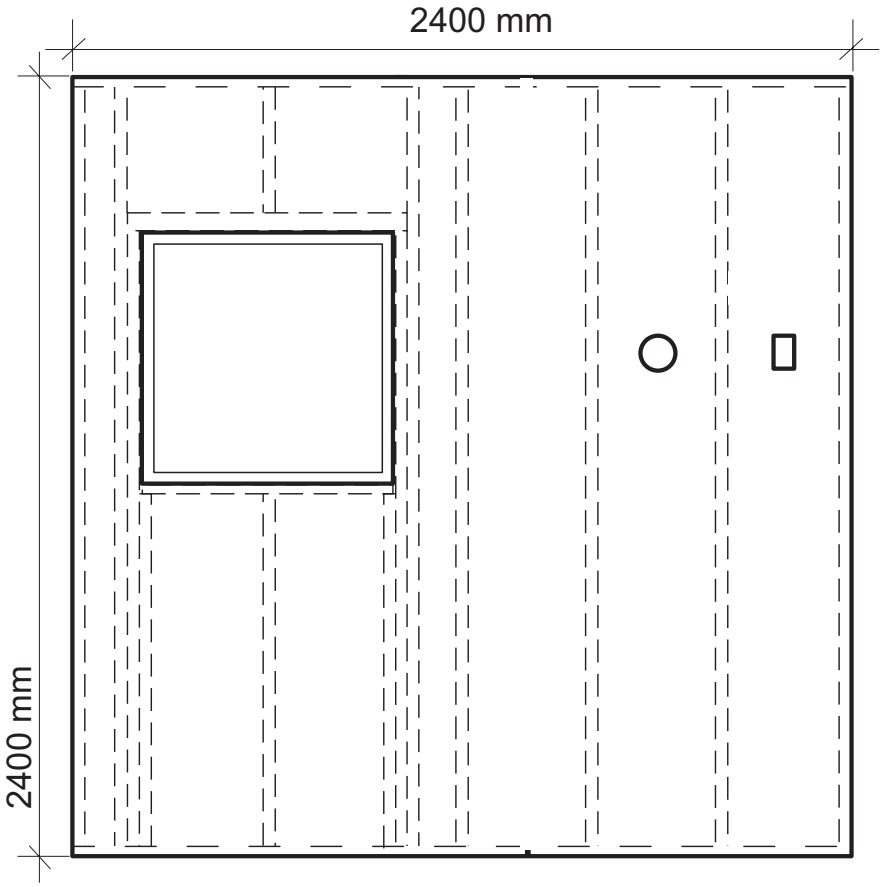


Figure 3.5. Positioning of details in brick veneer specimens.

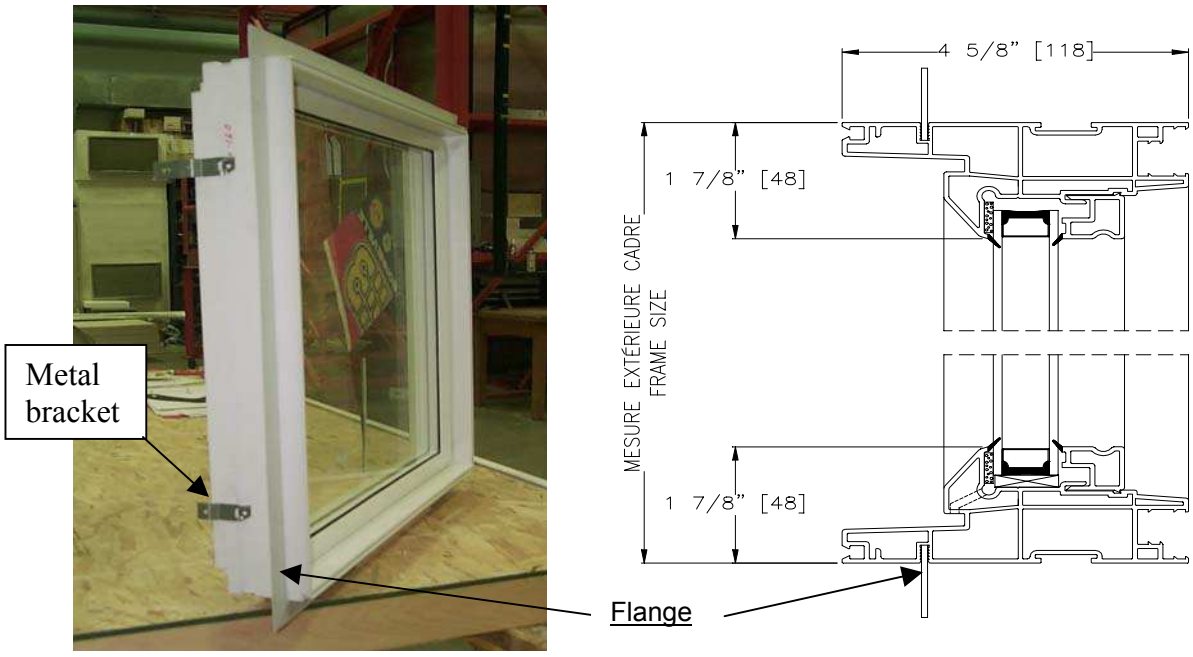


Figure 3.6. Configuration of the window installed in the test specimens

3.3 TYPES OF DEFICIENCIES

Deficiencies are introduced in the masonry specimens in the 1st and 2nd lines of defence as well as in the air barrier system.

The set of deficiencies in the first line of defence, i.e. the cladding, is the same for all the wall specimens. It consists of a missing length of sealant at specific interfaces.

For the second line of defence, i.e. the water resistive barrier (e.g. membrane, coating or foam board) with or without a clear cavity, the deficiencies cannot be reproduced systematically for all the specimens. The actual detailing for each assembly affects what can realistically go wrong, and hence, the deficiencies vary from specimen to specimen. The deficiencies in the 2nd line of defence of the brick veneer walls at penetrations are described in Figures 3.8 to 3.19.

Deficiencies in the air barrier system (acrylic sheet placed on the inside face of the studs (Figure 3.7) are provided for each stud space (five in total) by a series of three 4-mm diameter holes that perforate the air barrier. All or some of these holes are closed or open depending on the air leakage rate required.

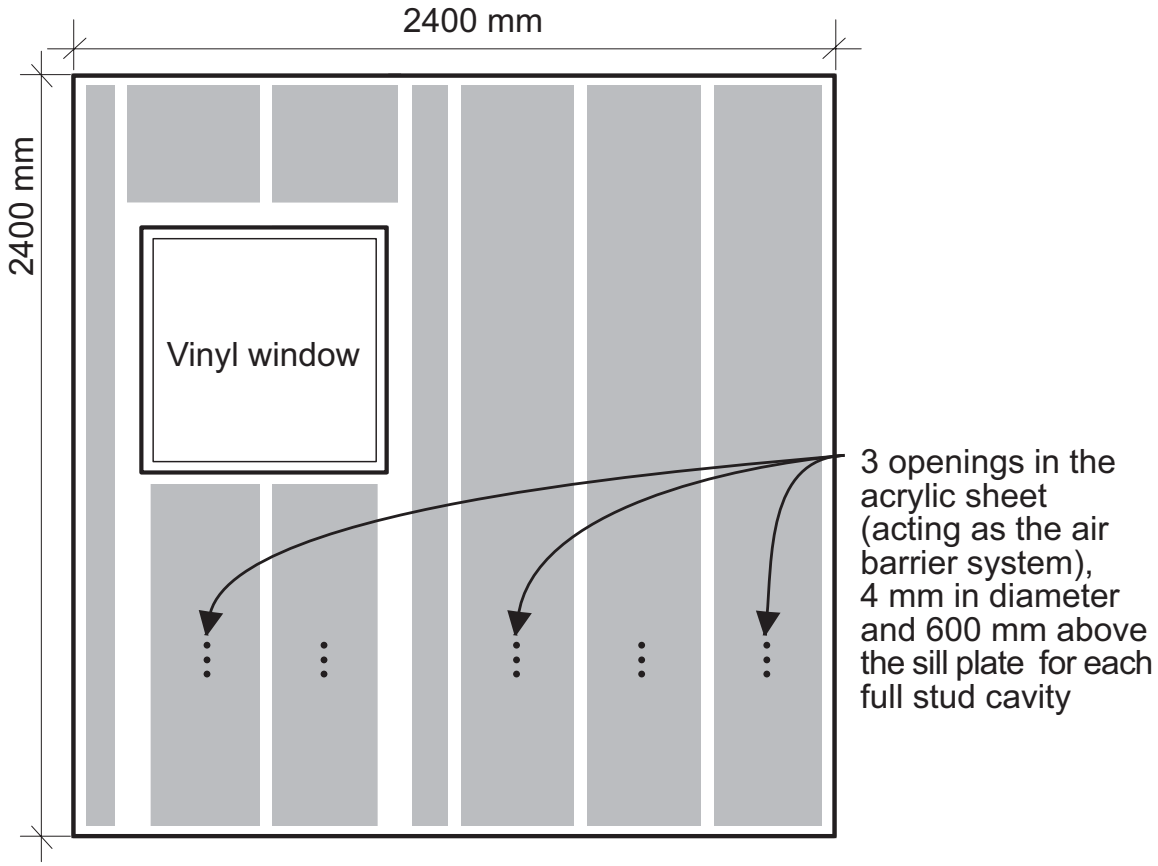


Figure 3.7. Deficiencies in the air barrier system for all specimens

3.4 WALL / WINDOW INTERFACE DETAILS

Figures 3.8 to 3.11 illustrate the detail for the wall/window interface of specimens No. 11 to No. 14.

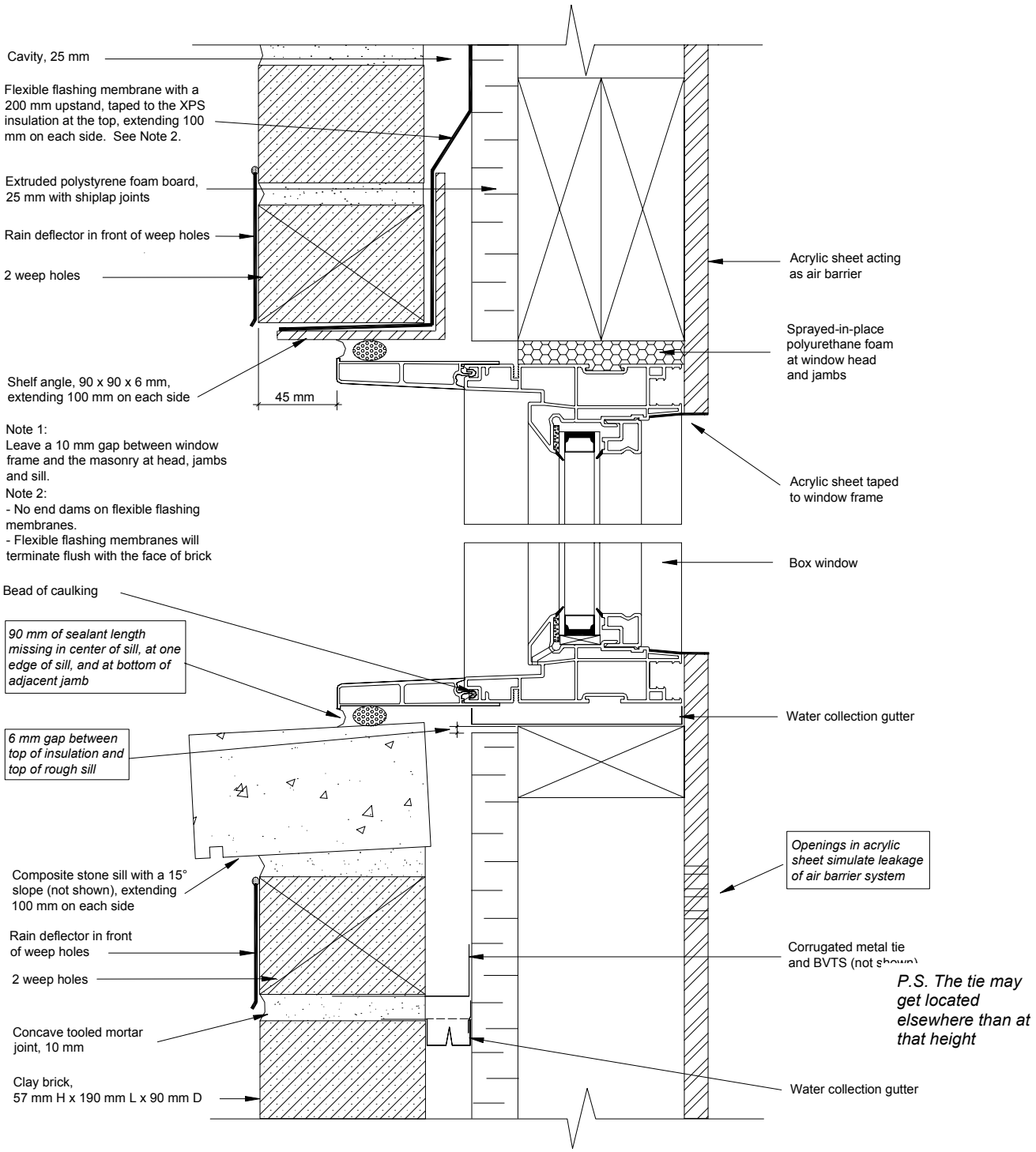


Figure 3.8. Wall/window interface for specimen No. 11 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

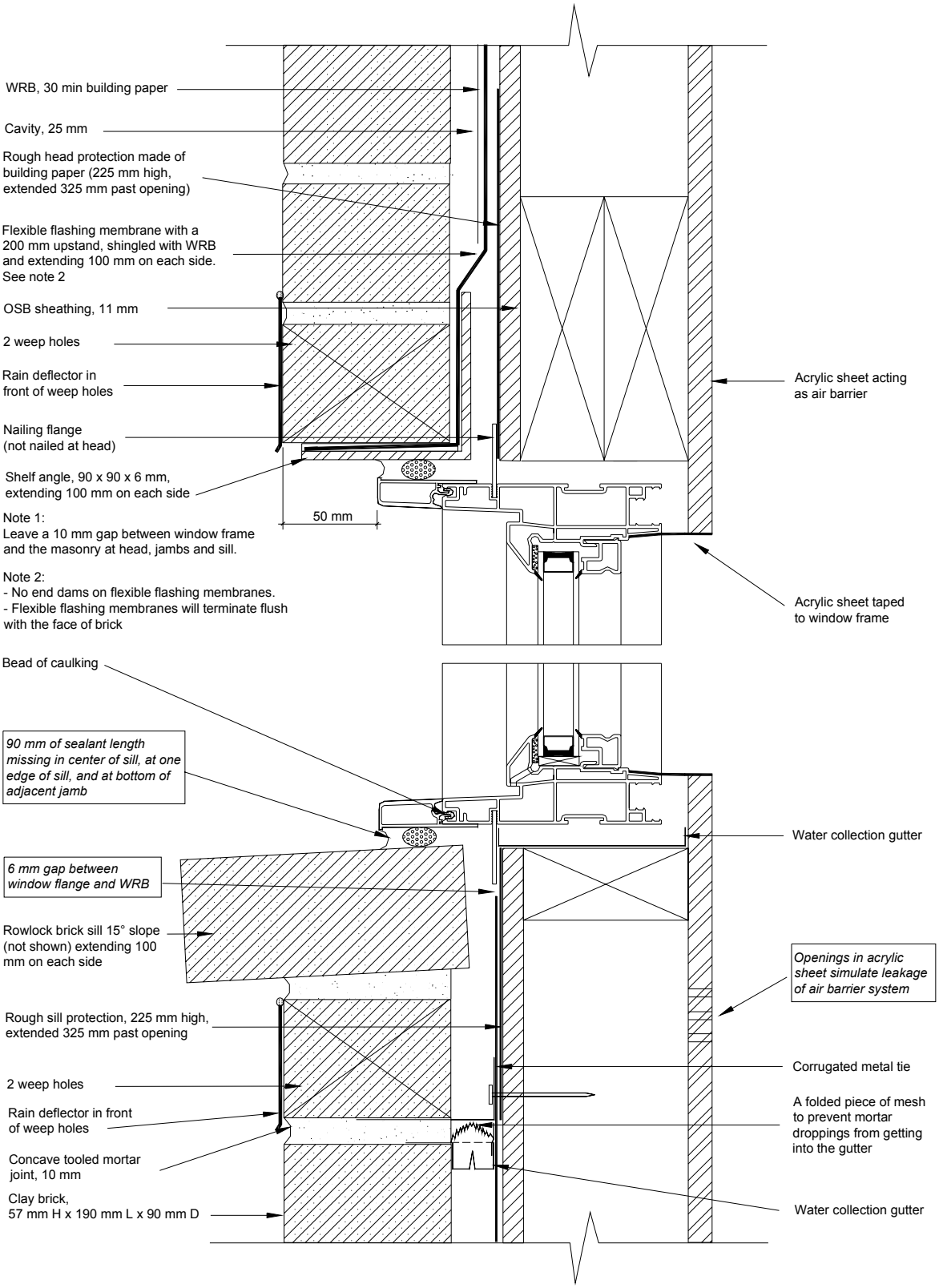


Figure 3.9. Wall/window interface for specimen No. 12 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

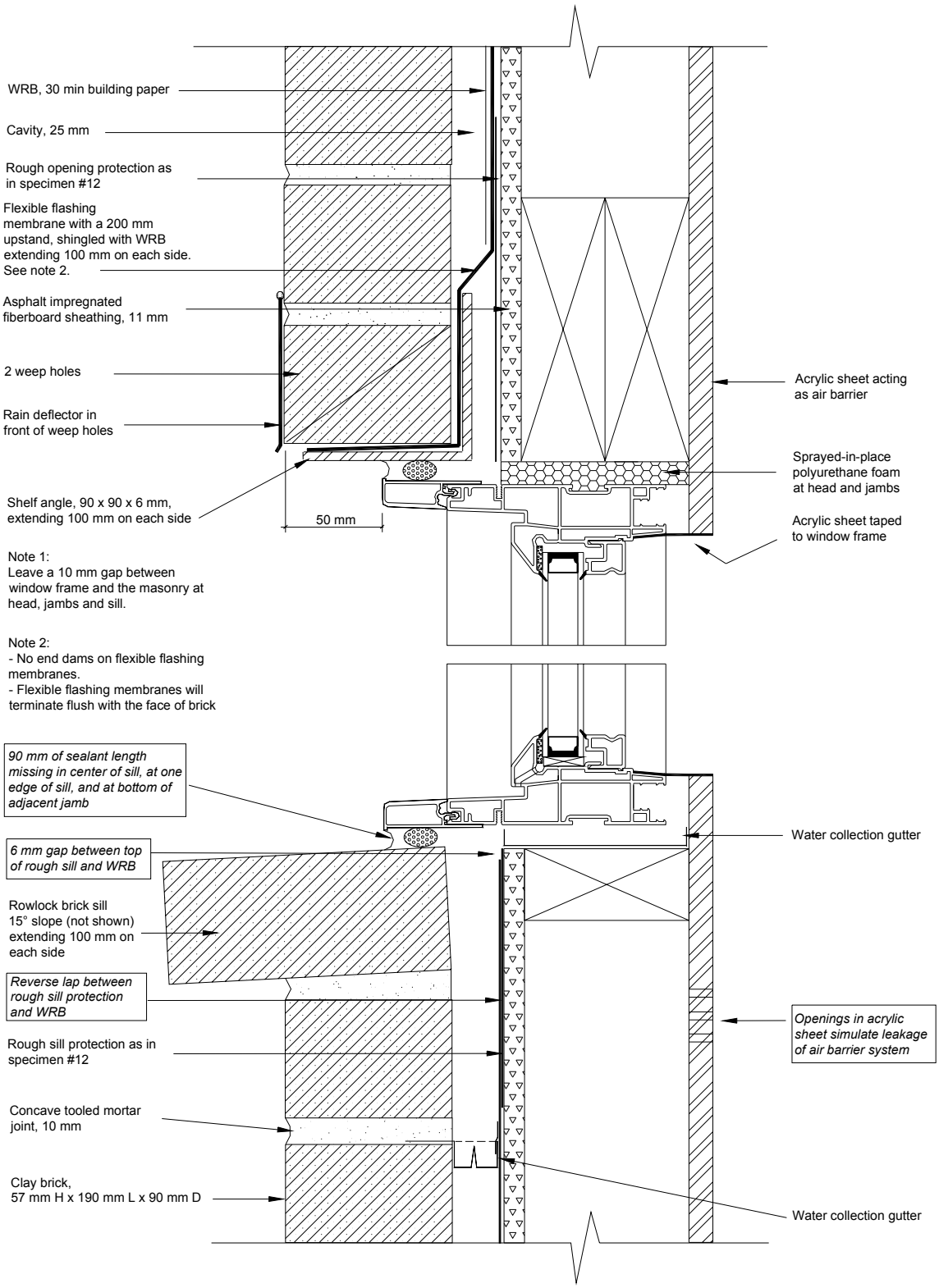


Figure 3.10. Wall/window interface for specimen No. 13 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

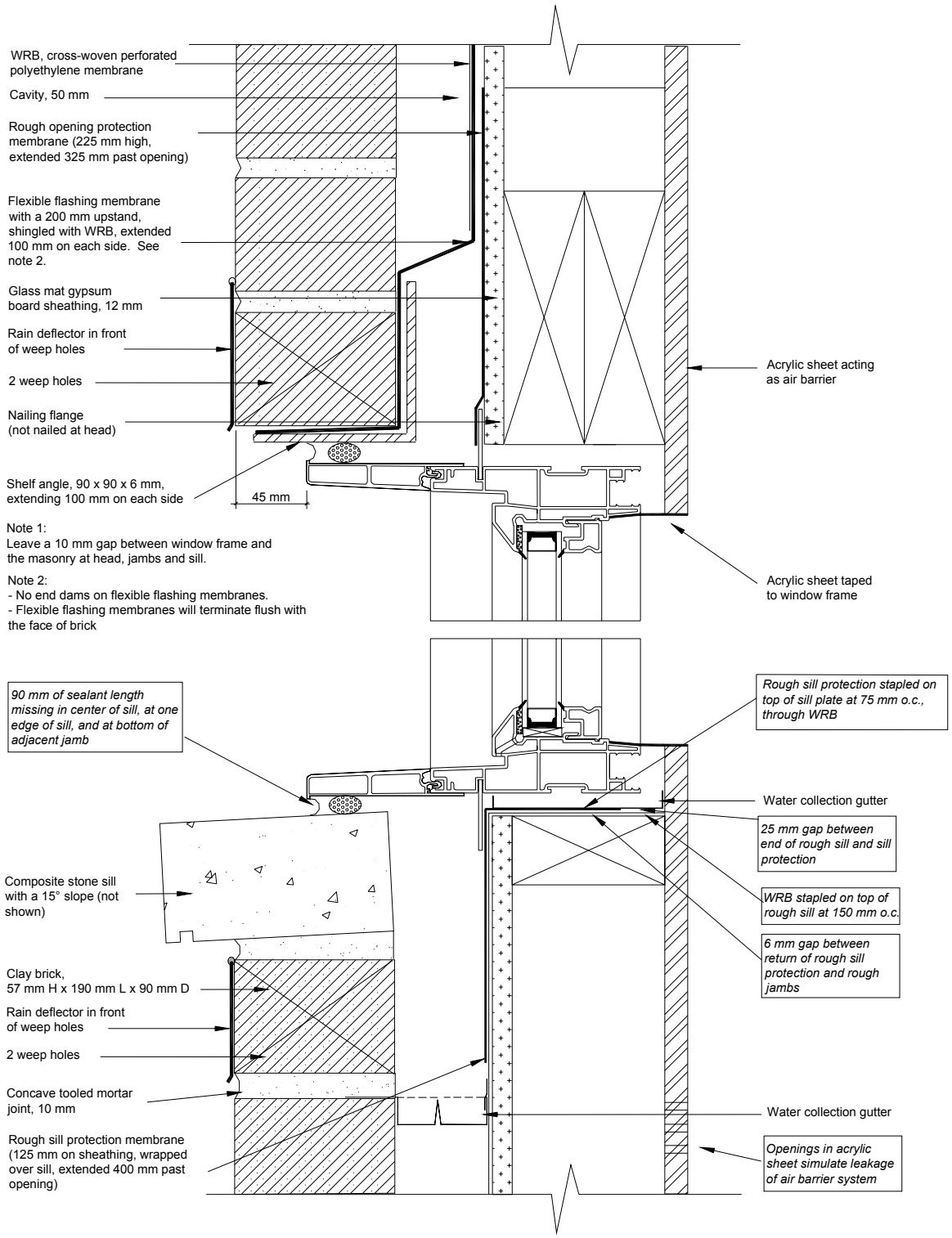
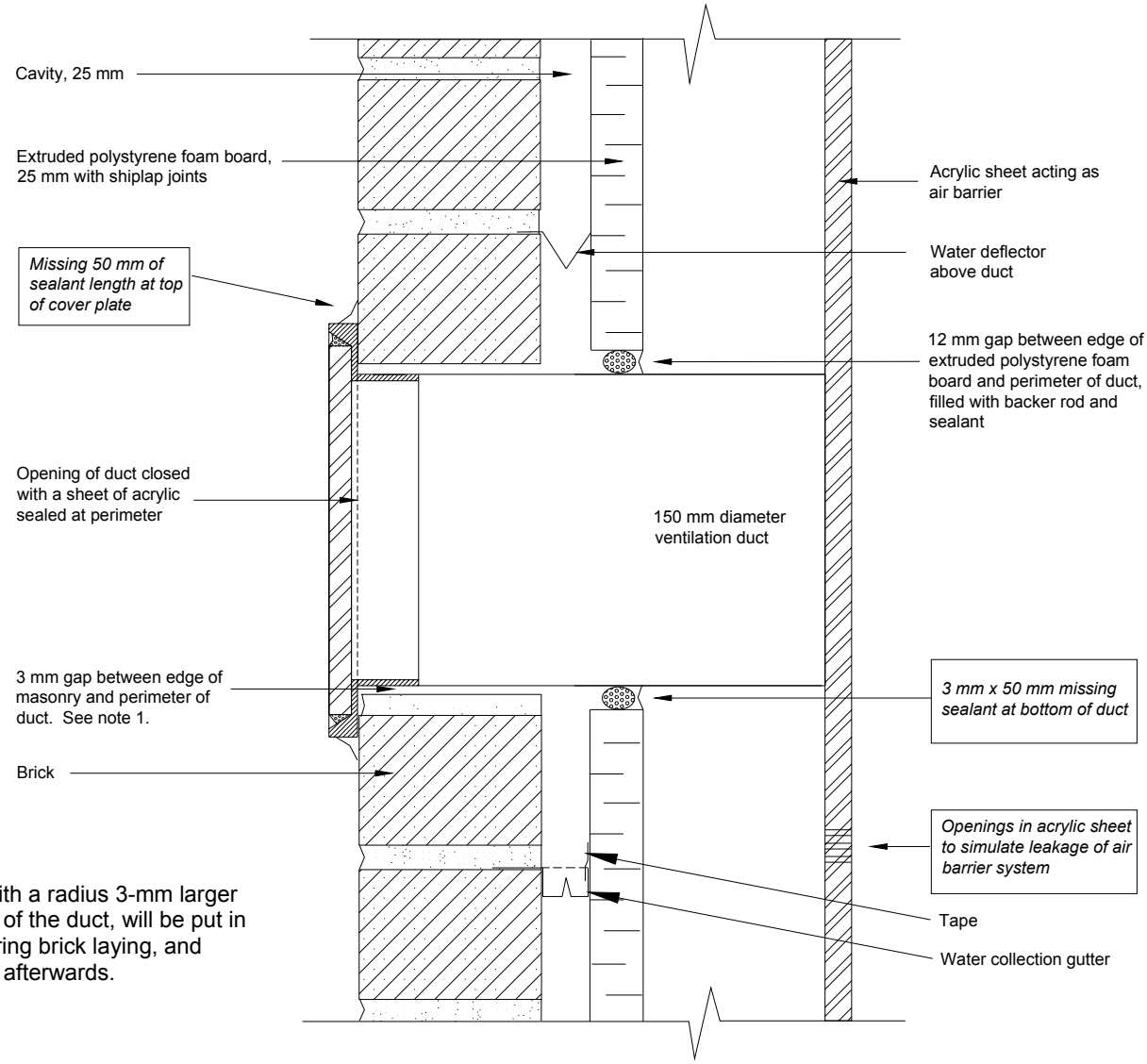


Figure 3.11. Wall/window interface for specimen No. 14 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

3.5 WALL/VENTILATION DUCT INTERFACE DETAIL

Figures 3.12 to 3.15 describe the proposed detailing of that interface for the four specimens.



Note 1.
A form with a radius 3-mm larger than that of the duct, will be put in place during brick laying, and removed afterwards.

Figure 3.12. Wall/ventilation duct interface for specimen No. 11 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

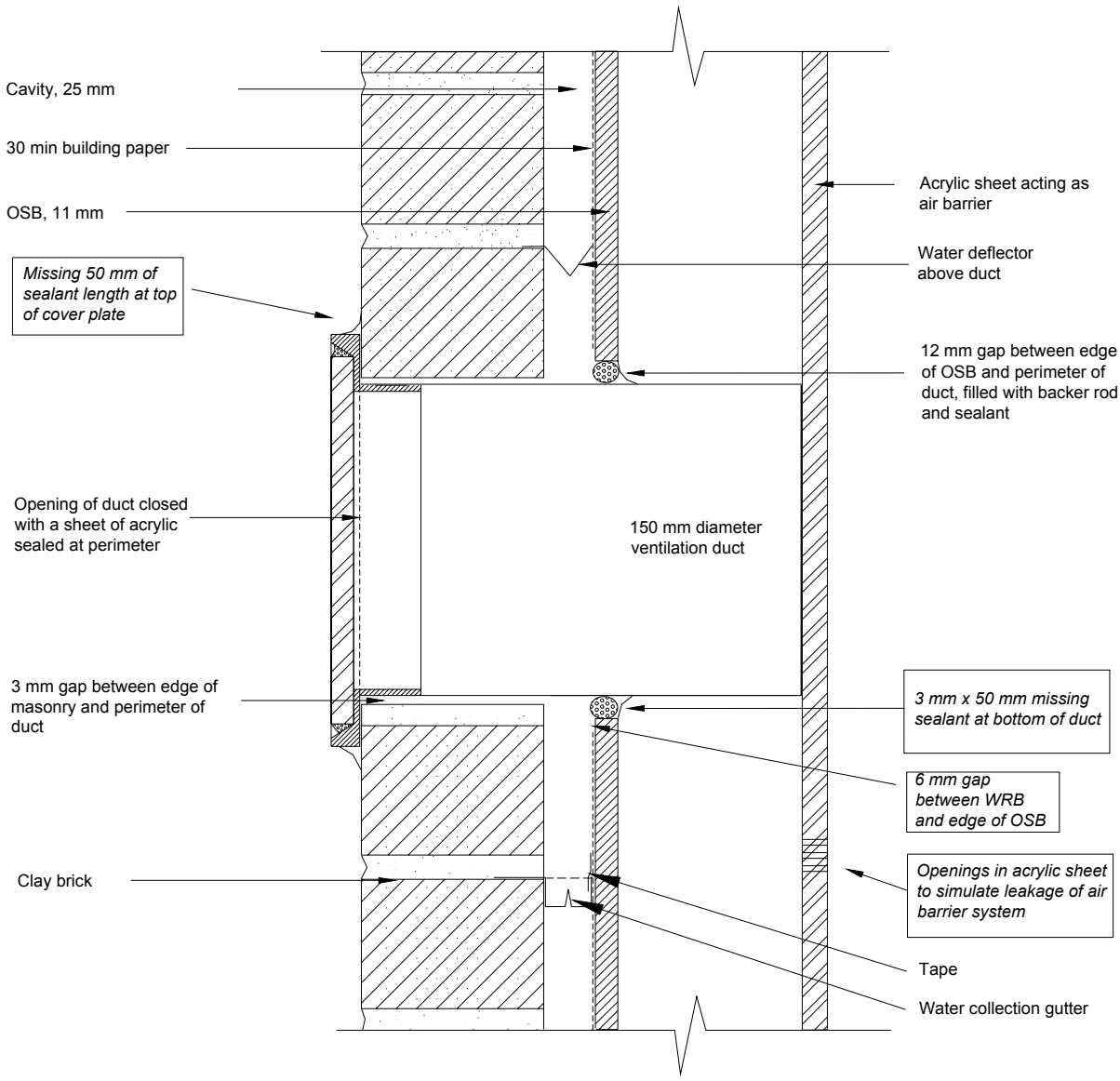


Figure 3.13. Wall/ventilation duct interface for specimen No. 12 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

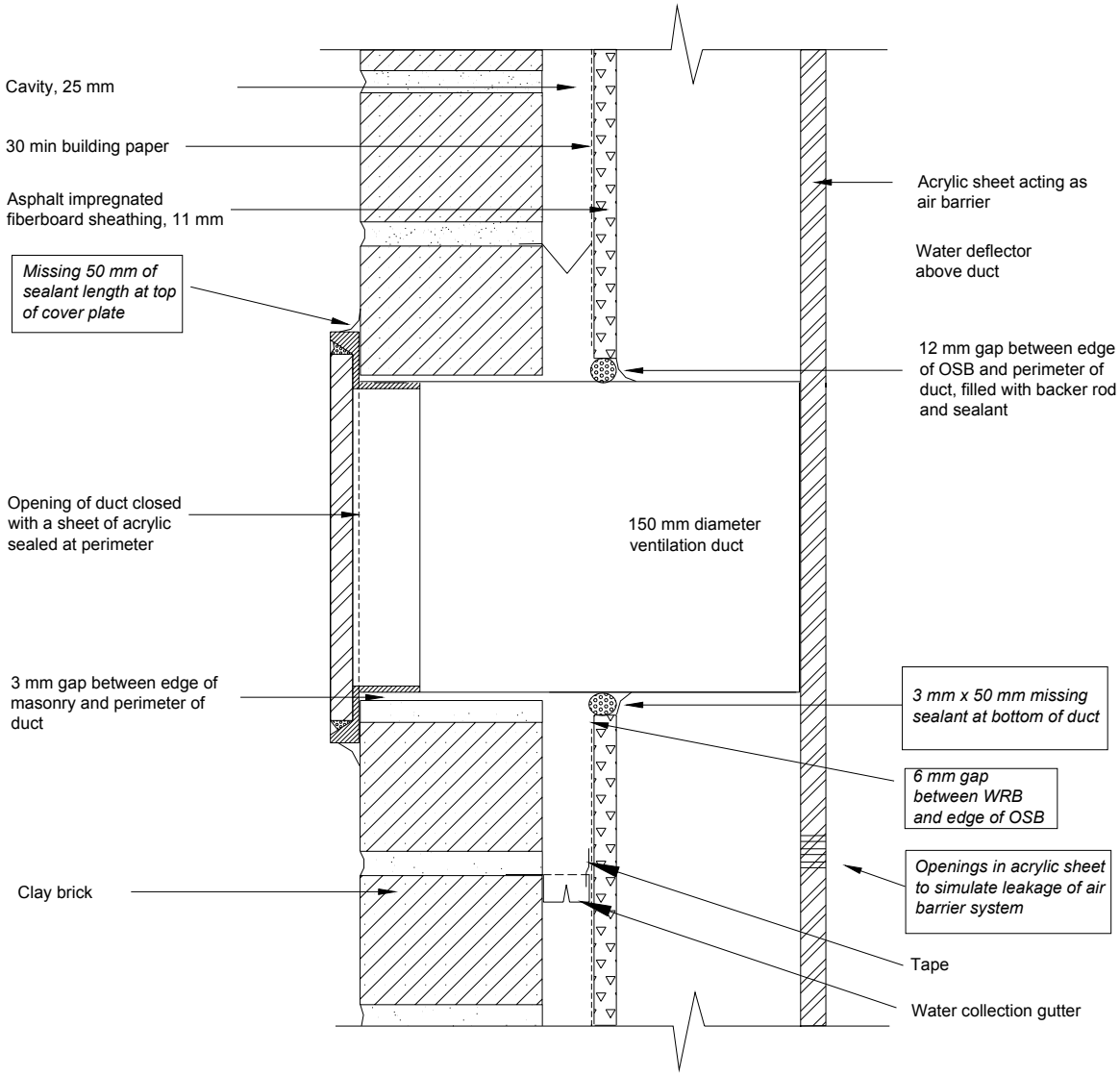


Figure 3.14. Wall/ventilation duct interface for specimen No. 13 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

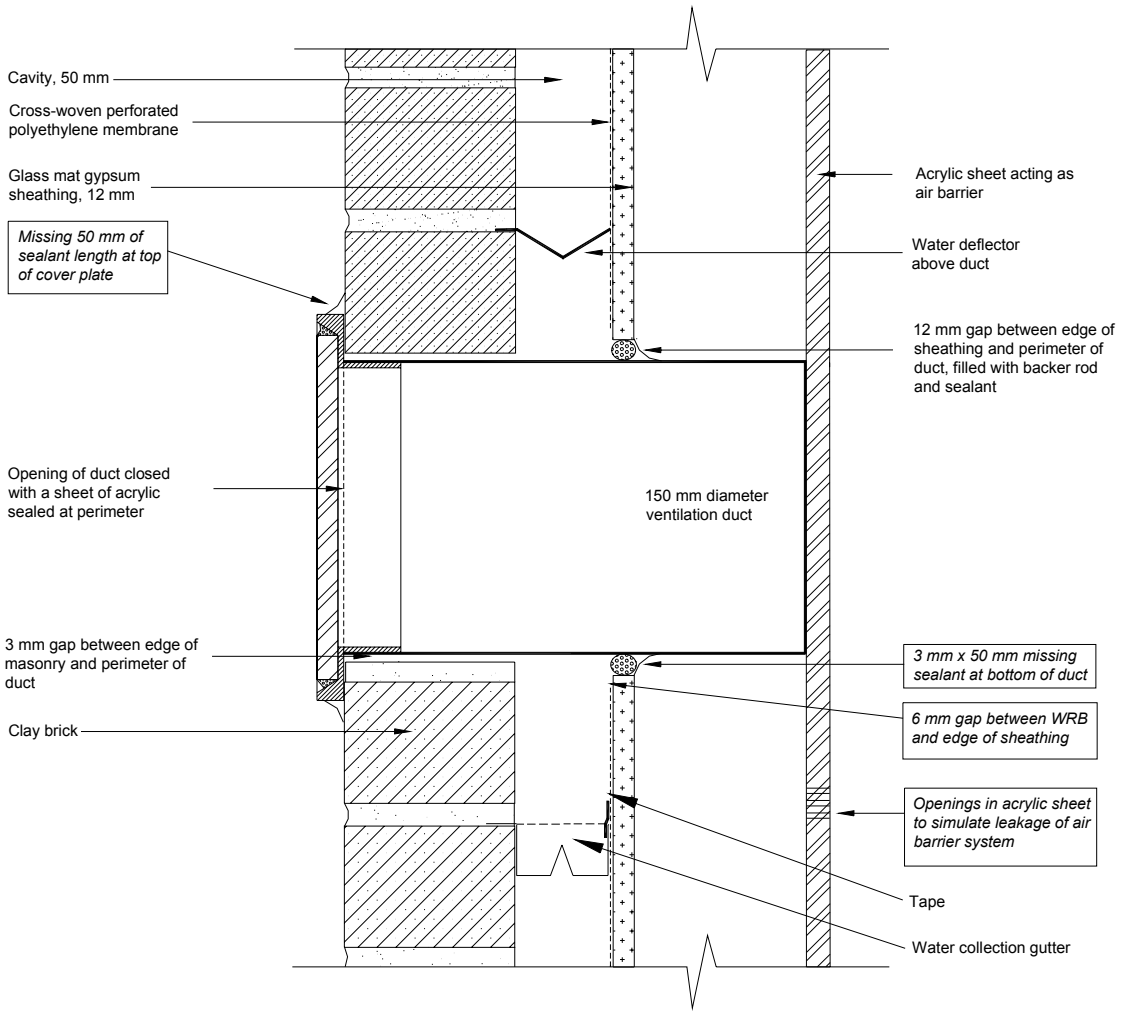


Figure 3.15. Wall/ventilation duct interface for specimen No. 14 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

3.6 WALL/ ELECTRICAL OUTLET INTERFACE DETAIL

Figures 3.16 to 3.19 describe the proposed detailing of that interface for the four specimens.

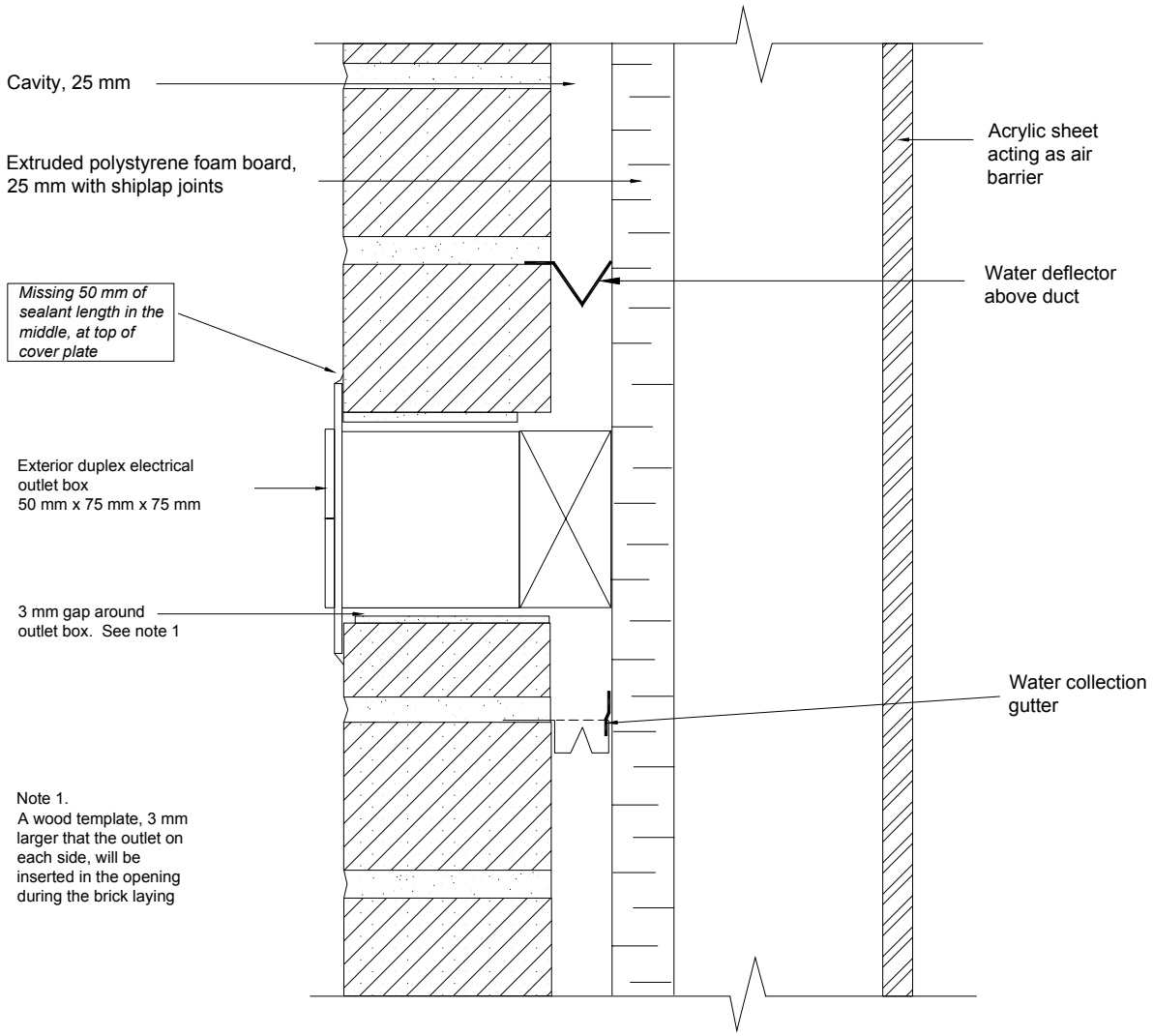


Figure 3.16. Wall/electrical outlet interface for specimen No. 11 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

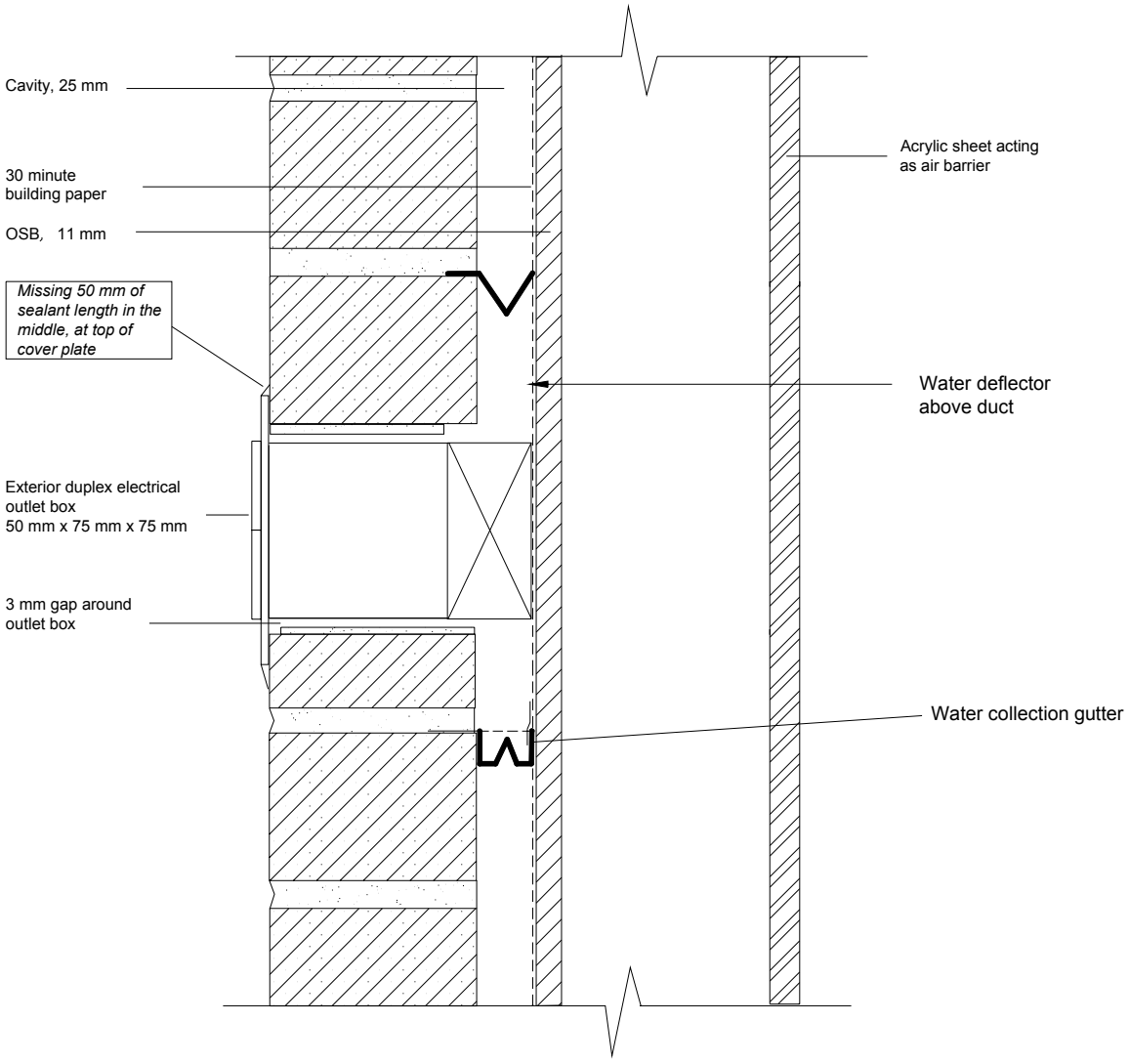


Figure 3.17. Wall/electrical outlet interface for specimen No. 12 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

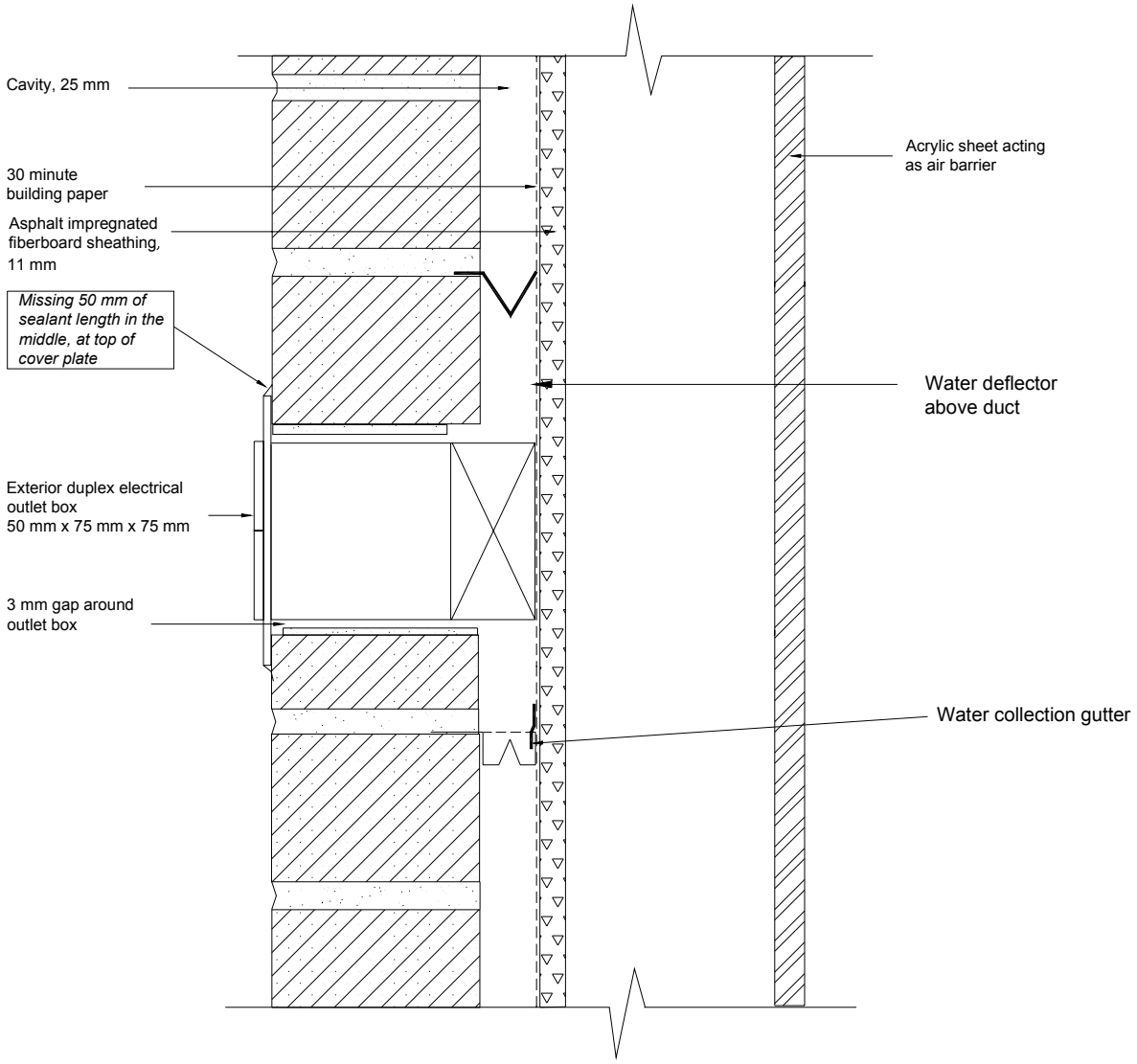


Figure 3.18. Wall/electrical outlet interface for specimen No. 13 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

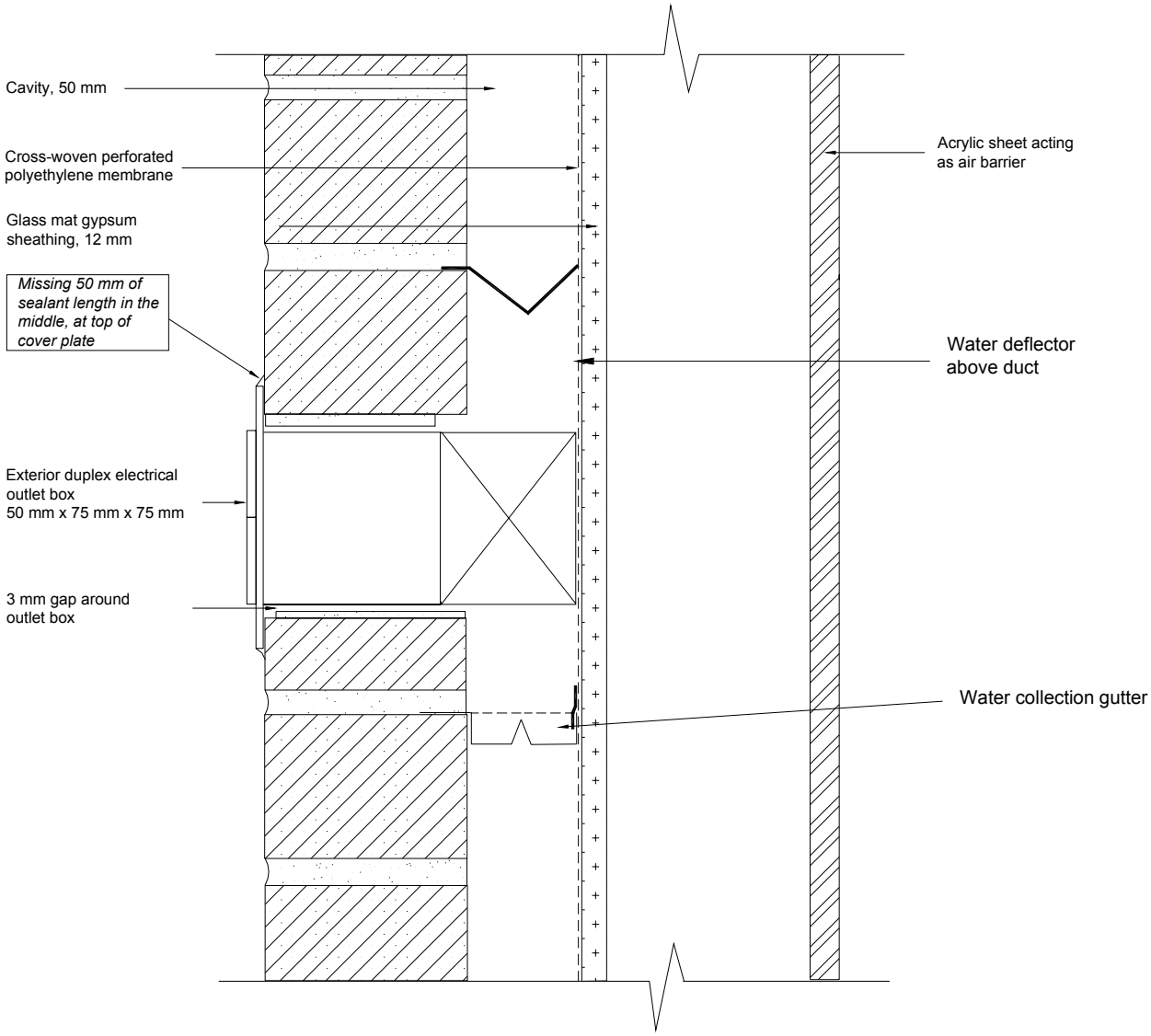


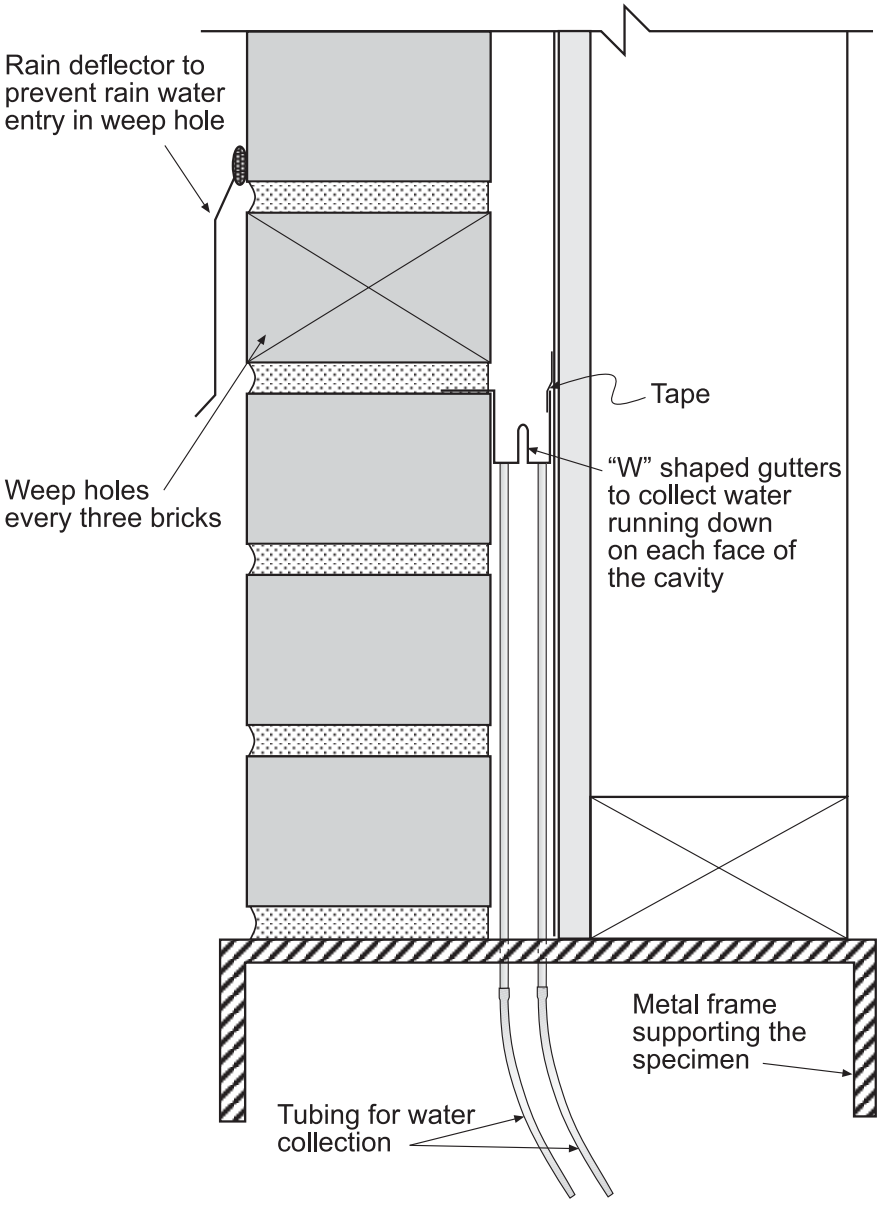
Figure 3.19. Wall/electrical outlet interface for specimen No. 14 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

3.7 TERMINATION OF THE WALL DETAIL

A generic representation of the termination of the wall at the bottom is presented in Figure 3.20.

The objective is to collect water draining to the bottom of the cavity and to quantify the amount of water that bridges the inside face of the cavity. To accomplish this, a W-shaped gutter is installed at the bottom of the wall. This collects water flowing along either face of the cavity once it reaches the base of the wall. As was the case for the EIFS and stucco-clad test specimens, typical flashing details are not in place since the objective of the test is not to evaluate the effectiveness of flashing details but rather to estimate the quantity of water collected in the cavity under several simulated wind-driven rain scenarios.

Figure 3.20. Bottom of the wall - vertical section



APPENDIX 3.1 PHOTOGRAPHIC RECORDS OF THE CONSTRUCTION OF THE SPECIMENS

Figure A3.1 Installation of the foam sheathing on specimen No. 11

Figure A3.2 Installation of the flashing membrane at the window head of specimen No. 11

Figure A3.3 Specimen No. 11. Foaming at the window head and jambs (rough sill is left clear to place the water collection gutter)

Figure A3.4 Moving specimen No. 11 from Building M-24 to Building M-20 at IRC

Figure A3.5 The four specimens were installed in Building M-20 for the brick laying stage.

Figure A3.6 Specimen No. 11. Brick laying by a local masonry company

Figure A 3.7 Profile of a water collection trough to be placed in the cavity

Figure A3.8 Window frame extension and installation of the water collection through in the cavity behind the brick veneer

Figure A3.9 Specimen No. 11 at the form that will be used for the ventilation duct later on

Figure A3.10 Specimen No. 12 at window head showing the shelf angle and the flashing membrane

Figure A3.11 Rowlock window sill for specimen No. 12

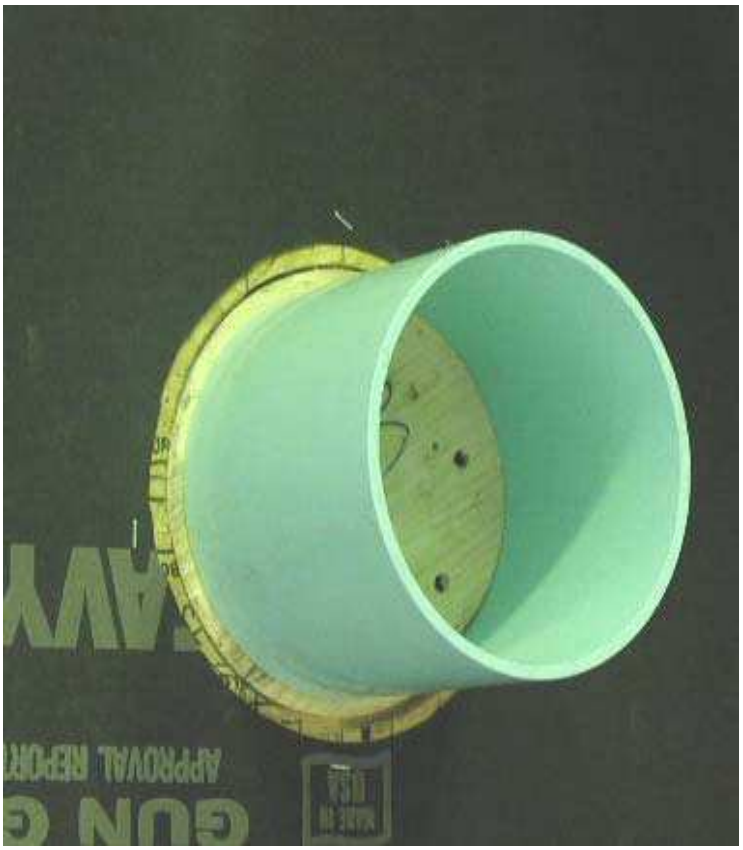


Figure A3.12 Deficiency in the WRB membrane around the duct of specimen No. 12

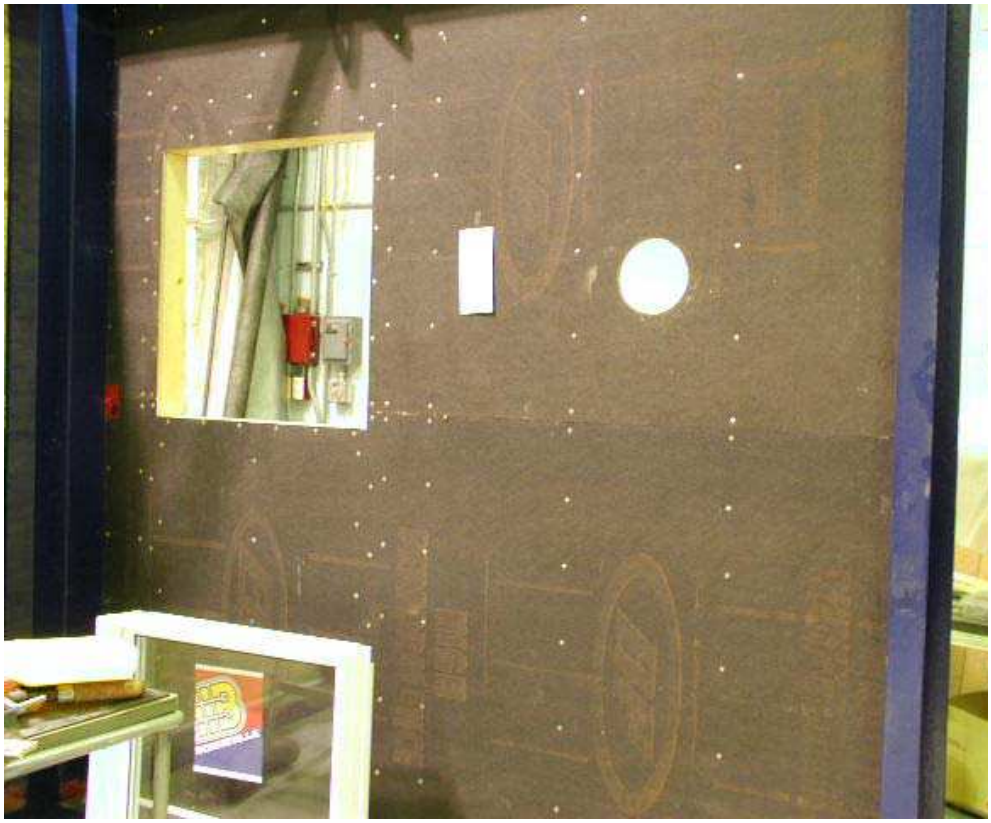


Figure A3.13 Installation of the sheathing board on specimen No. 13

Figure A3.14 Descending view of the brick veneer. Mortar Maze was installed in the cavity to reduce the occurrence of mortar droppings in the water collection troughs.

Figure A3.15 Brick laying in progress. Weepholes are placed every three bricks.

Figure A3.16 Specimen No. 13 almost completed

Figure A3.17 Window of specimen No. 13

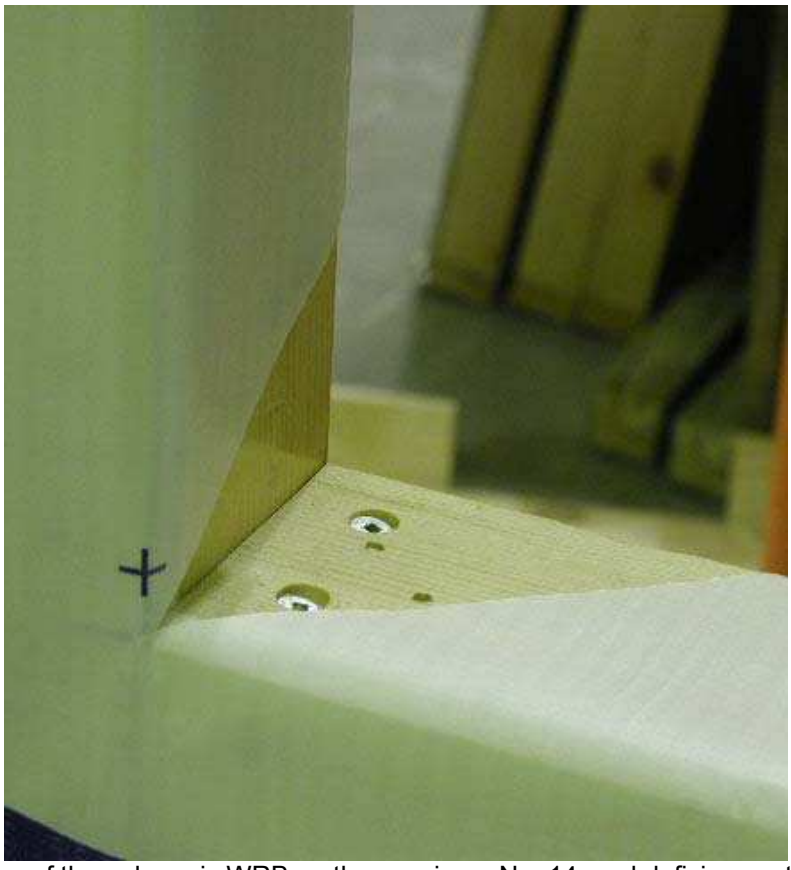


Figure A3.18 Installation of the polymeric WRB on the specimen No. 14, and deficiency at the corner

Figure A3.19 Installation of the window on specimen No. 14. Dupont procedure was followed.

Figure A3.20 Installation of the water collection roughs at the bottom of the specimen No. 14

Figure A3.21 Forms were removed for the installation of the ventilation duct and electrical outlet

CHAPTER 4

CONSTRUCTION OF THE THREE SIDING WALL SPECIMENS

This chapter provides general specifications for the assembly of siding wall specimens and related penetration and interface details. These specimens were investigated for water entry using the Dynamic Wall Testing Facility (DWTF) as part of the MEWS consortium project. The specimens were built in the spring 2001.

4.1 COMPOSITION OF THE THREE SIDING SPECIMENS

Three different siding wall assemblies were selected in consultation with the siding industry representatives participating in the MEWS project. The composition of the wall assemblies is described in Table 4.1 and illustrated in Figures 4.1 to 4.3.

Table 4.1. Description of siding-clad wall assemblies

	Composition
No.15	Hardboard lap siding / cross-woven perforated polyethylene membrane / 11 mm asphalt impregnated fiberboard sheathing
No.16	Hardboard lap siding / 19 mm cavity, vertical PT wood strapping / 2 layers 30-min building paper / 12 mm glass mat gypsum board sheathing
No.17	Horizontal vinyl siding / 36 mm extruded polystyrene with ship-lap joints (acts as WRB and sheathing)

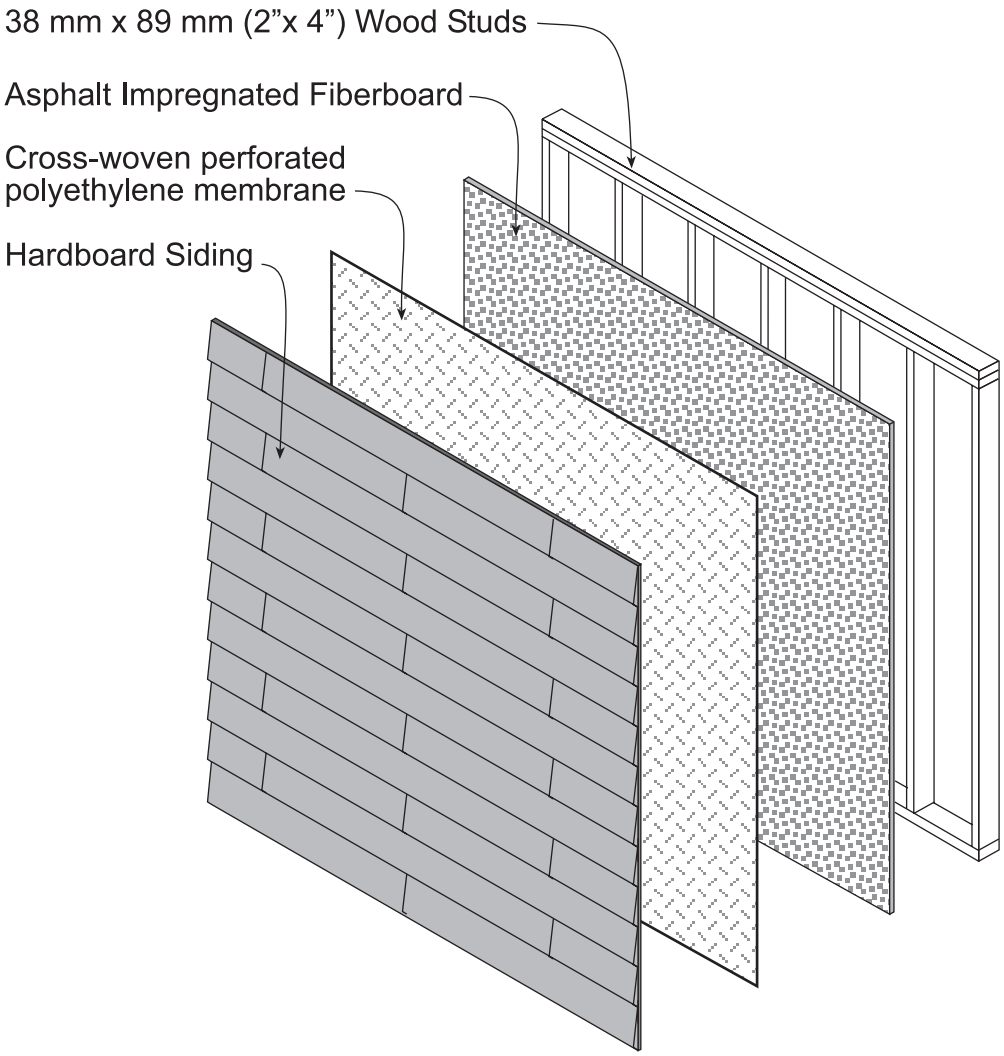


Figure 4.1. Composition of hardboard siding wall specimen No. 15

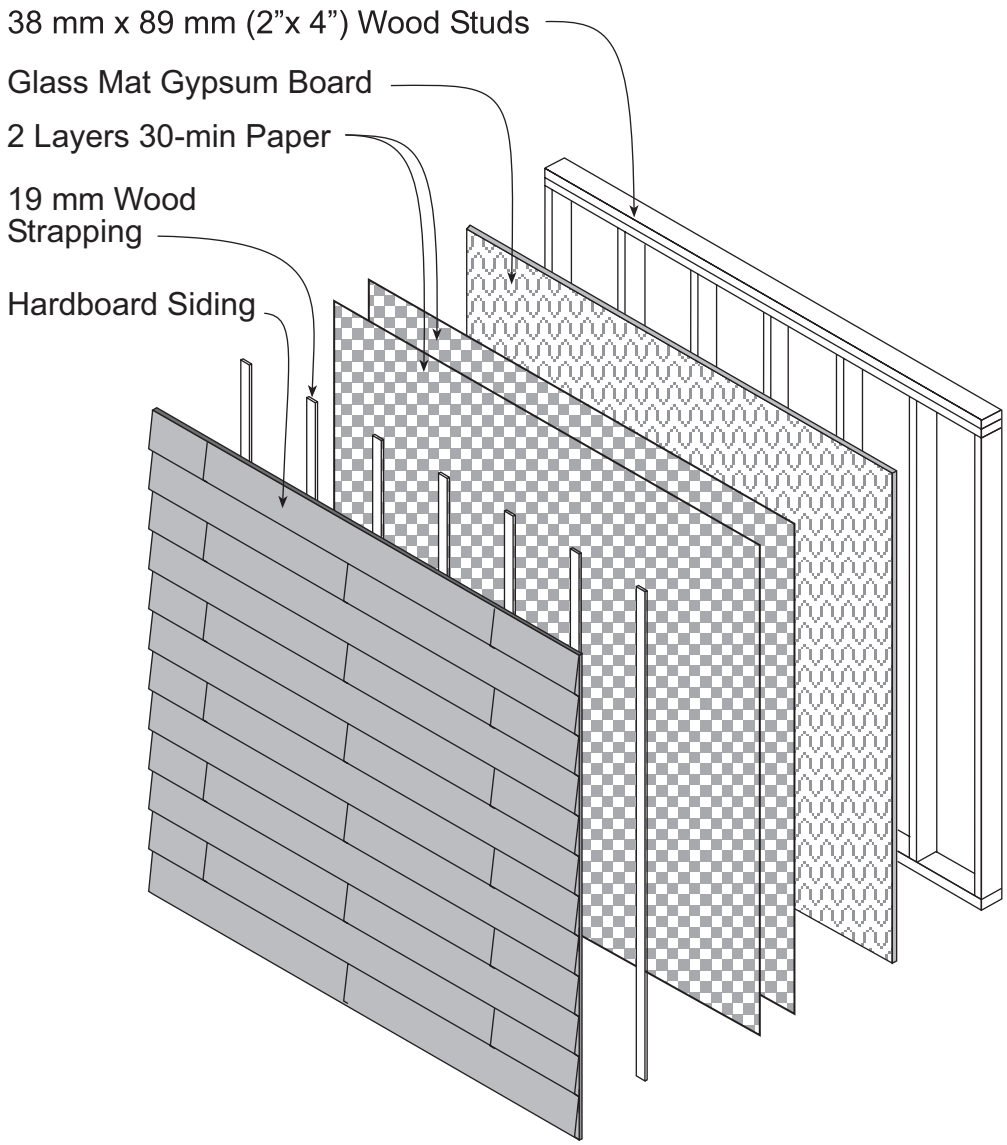


Figure 4.2. Composition of hardboard siding wall specimen No. 16

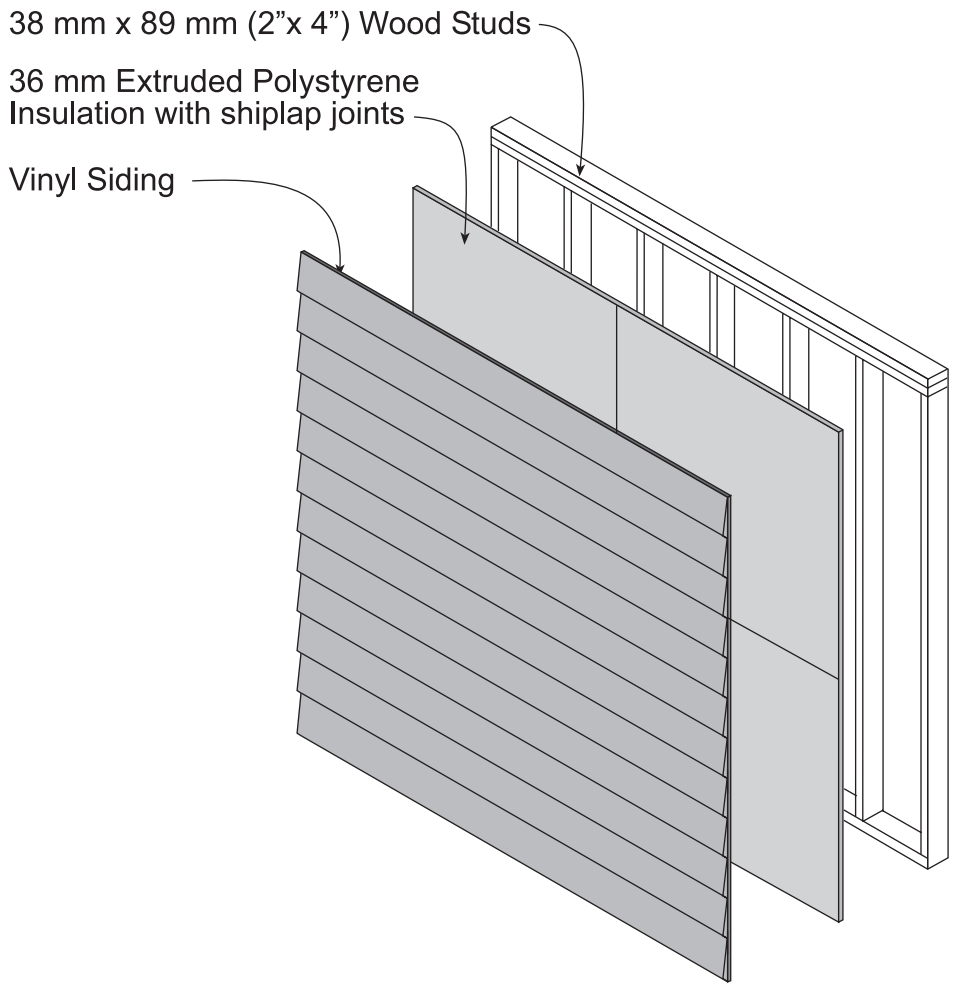


Figure 4.3. Composition of vinyl siding wall specimen No. 17

4.2 TYPES OF DETAILS

Three types of details are included in each siding wall specimen: window, ventilation duct and electrical outlet. Similarly to the masonry test specimens, no control joint is included in siding test walls. Note that the window, the electrical outlet and the vent duct penetrate through the siding, the water-resistive barrier as well as the sheathing board. The positioning of these three details in the wall specimens is shown in Figure 4.4.

Window:
A flange-mounted fixed PVC (vinyl) window measuring 755 mm wide by 755 mm high manufactured by Bonneville Ltd Corporation will be used. The window profile is illustrated in Figure 4.5.

Advice offered in the manufacturer's literature recommend not using the nailing flange as a permanent mounting for that window. The manufacturer highly recommends that the window be fastened to the rough opening using metal brackets that are themselves secured to the frame. Because stability of the window is important for specimens subjected to high air pressure differentials, windows will be secured to the wall with the brackets provided by the manufacturer. Hence, the nailing flange will also contribute to fastening the window to the wall in addition to that provided by the brackets.

Duct:
A circular metal ventilation duct having a 150-mm diameter

Exterior electrical outlet:
An exterior duplex wall outlet measuring 50 mm wide by 75 mm high by 75 mm deep

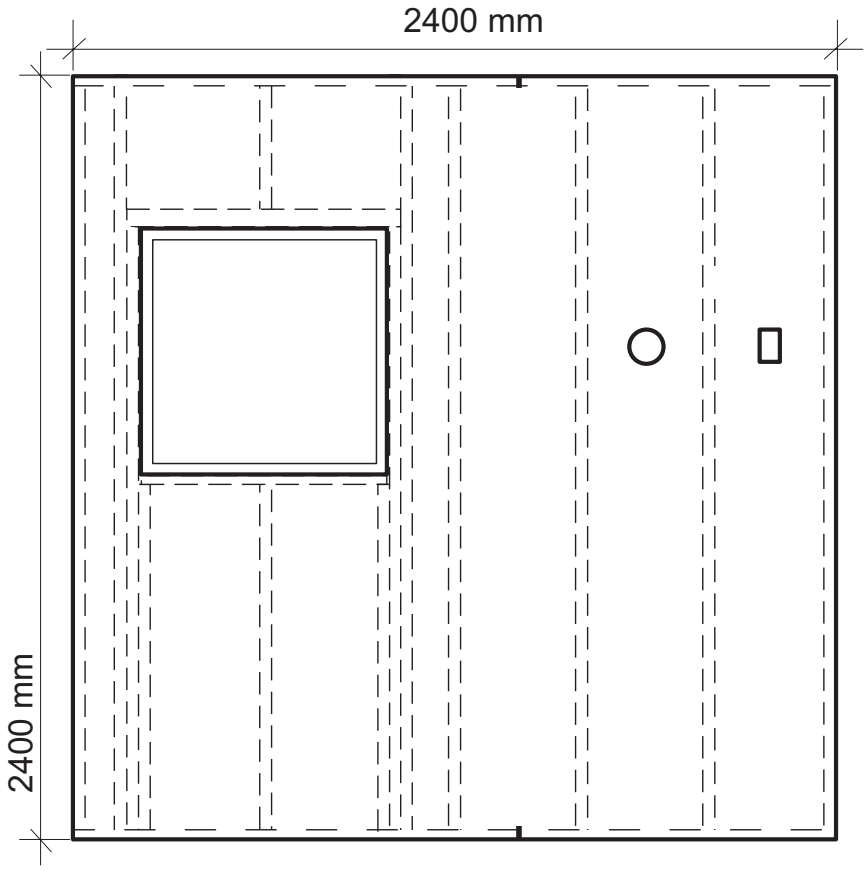


Figure 4.4. Positioning of details in siding-clad specimens (in elevation).

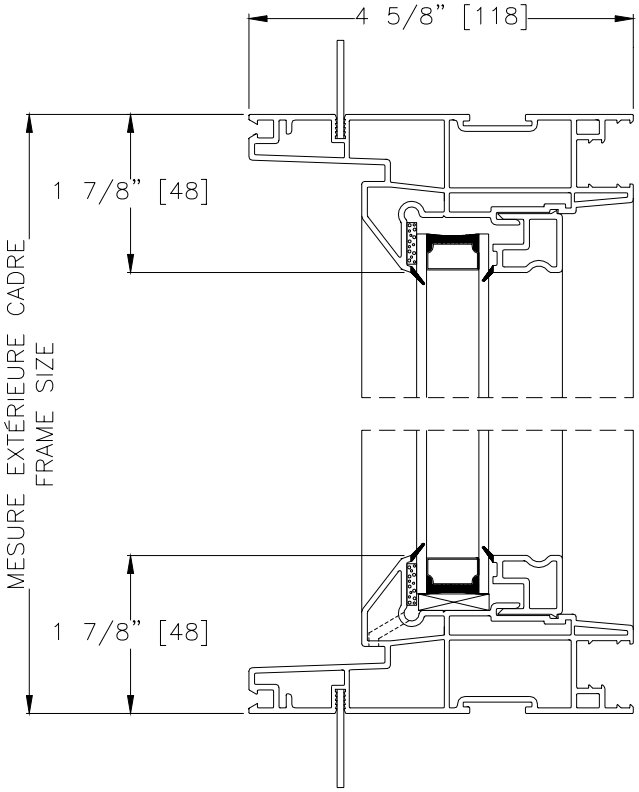


Figure 4.5. Configuration of the window installed in the test specimens

4.3 TYPES OF DEFICIENCIES

Deficiencies are introduced in the 1st and 2nd lines of defence, as well as in the air barrier system.

The set of deficiencies in the first line of defence, i.e. the cladding, is the same for all the wall specimens. It consists of a missing length of sealant at specific interfaces.

For the second line of defence, i.e. the water-resistive barrier (a membrane, a coating or a foam board), the same deficiencies cannot be replicated in all specimens. The actual detailing for each assembly affects what can realistically go wrong, and hence, the deficiencies vary from specimen to specimen. Note that the deficiencies are listed on the drawings of sections 4.5, 4.6 and 4.7 in italic and in a box.

Deficiencies in the air barrier system are provided for each stud space (five in total) by a series of three 4 mm diameter holes in an acrylic sheet placed on the inside face of the studs (Figure 4.6). All or some of these holes are closed or open depending on the air leakage rate required.

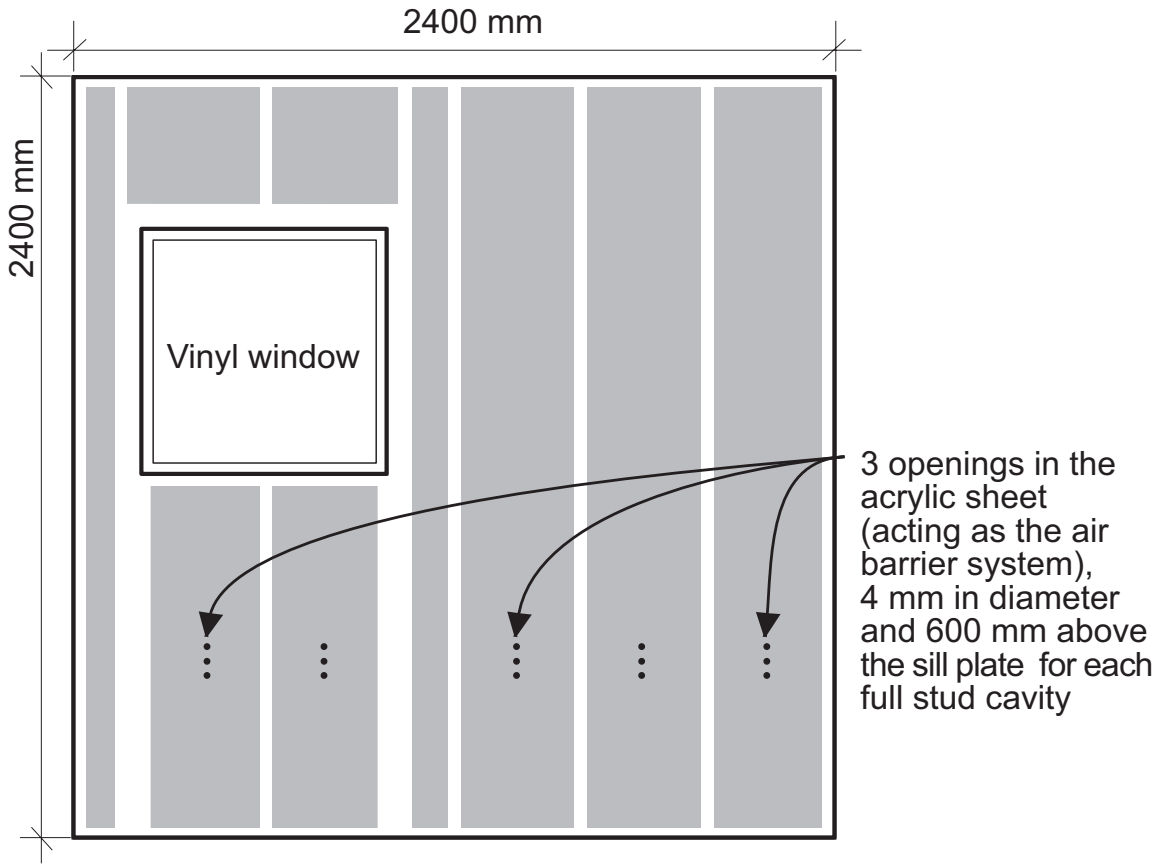


Figure 4.6. Deficiencies in the air barrier system for all specimens

4.4 WALL / WINDOW INTERFACE DETAILS

Figures 4.7 to 4.9 illustrate the detail for the wall/window interface of specimens No. 15 to No.17.

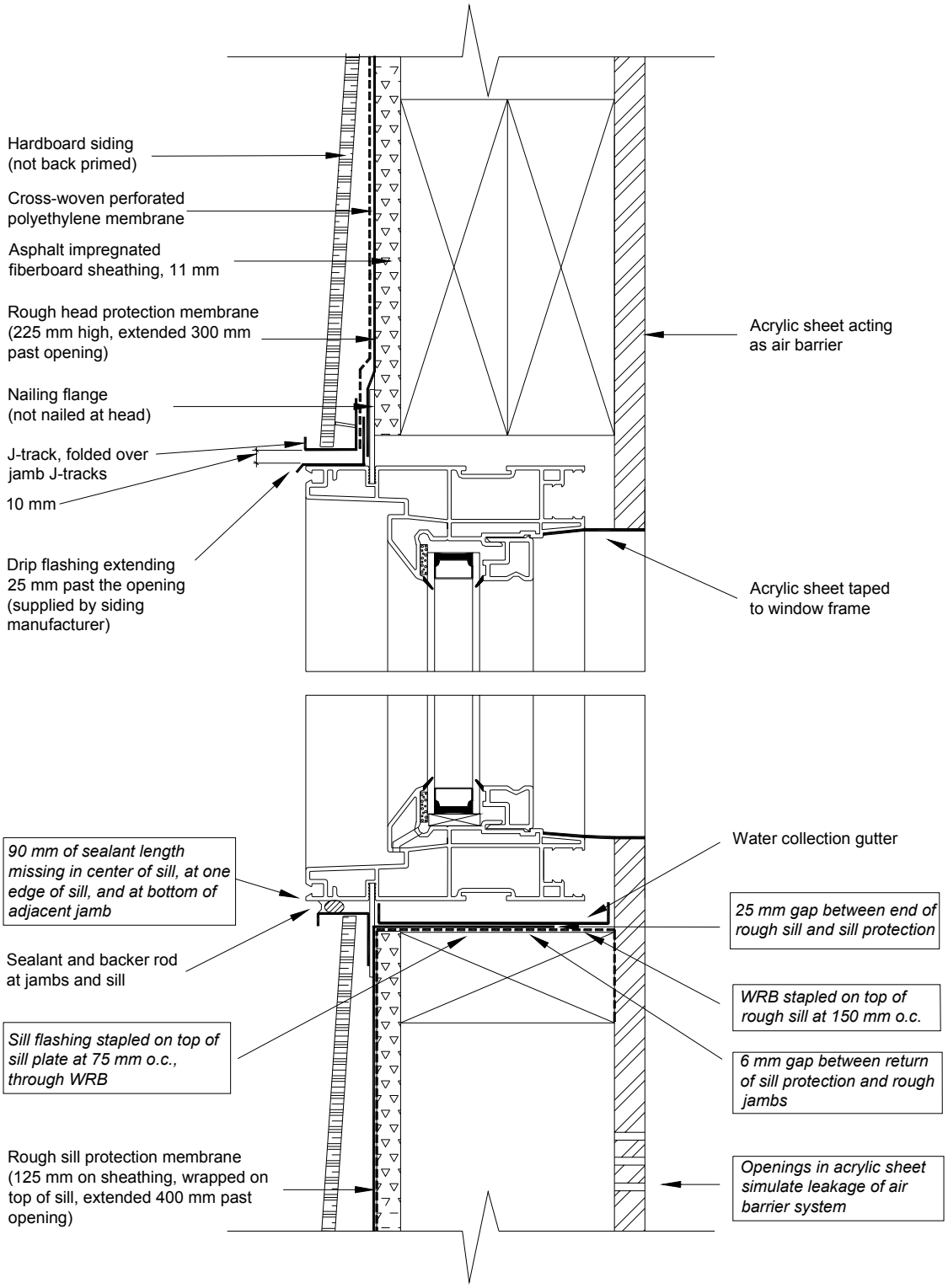


Figure 4.7. Wall/window interface for specimen No. 15 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

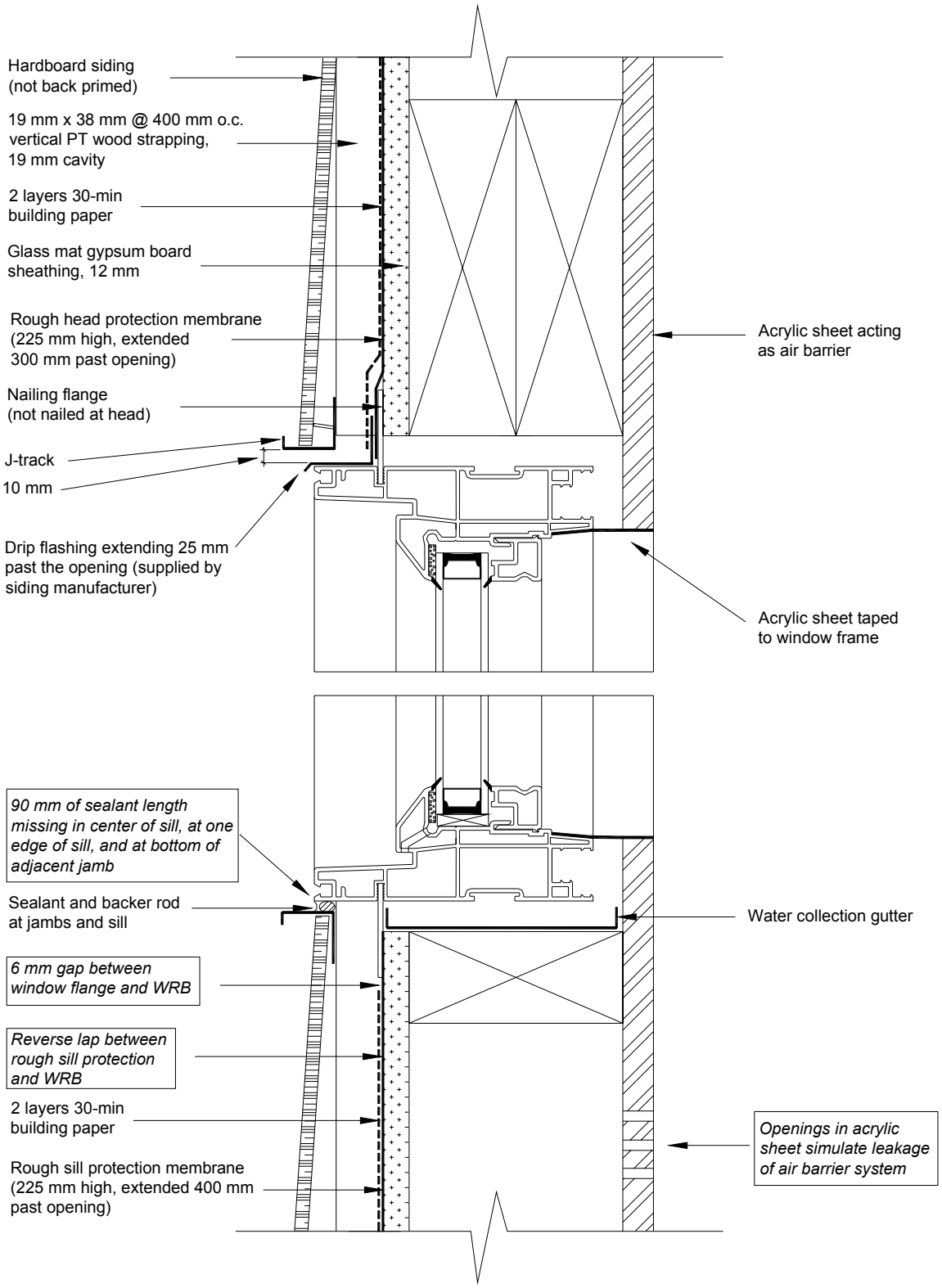


Figure 4.8. Wall/window interface for specimen No. 16 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

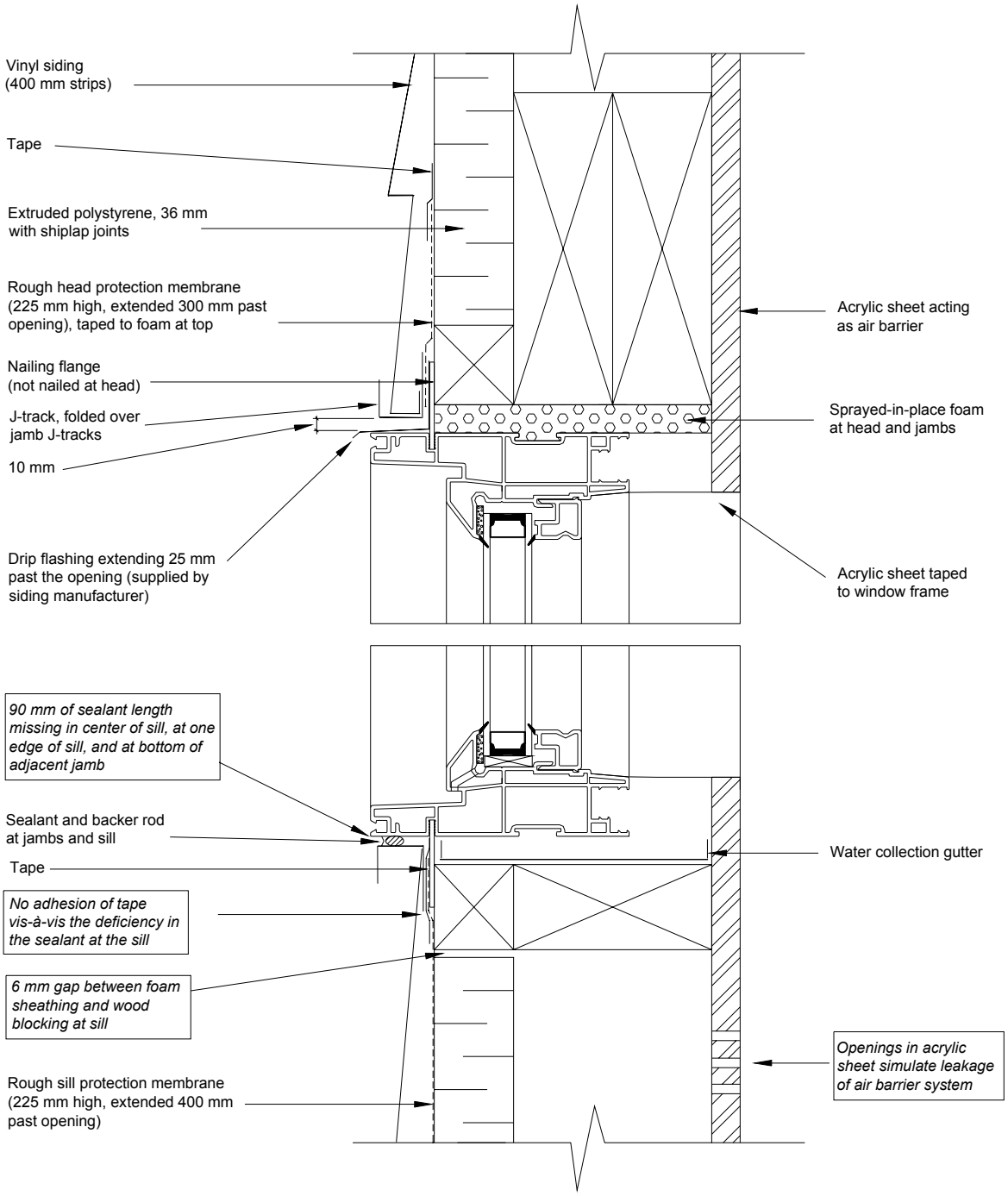


Figure 4.9. Wall/window interface for specimen No.17 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

4.5 WALL/VENTILATION DUCT INTERFACE DETAIL

Figures 4.10 to 4.12 describe the detailing of that interface for the three specimens.

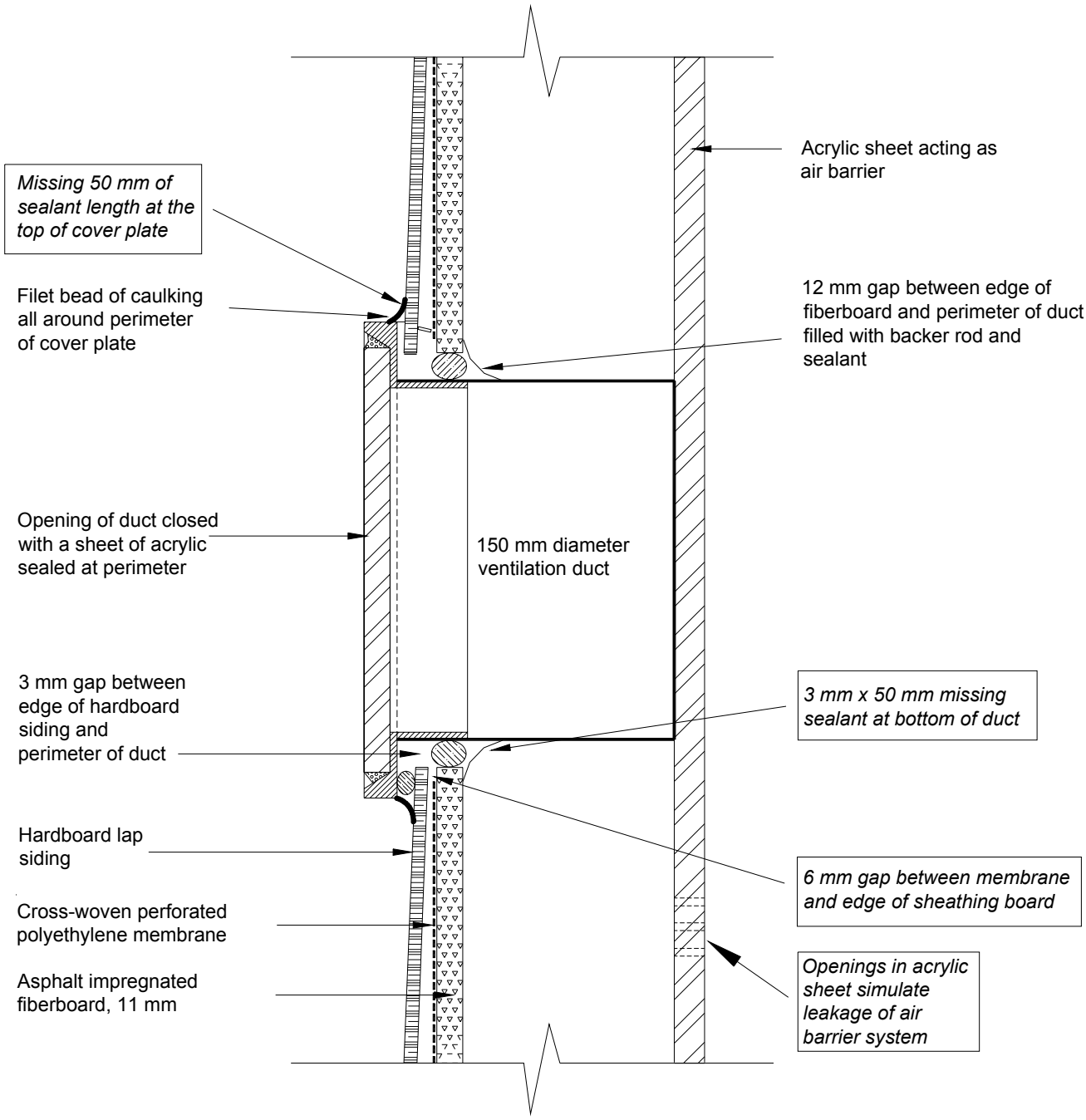


Figure 4.10. Wall/ventilation duct interface for specimen No. 15 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

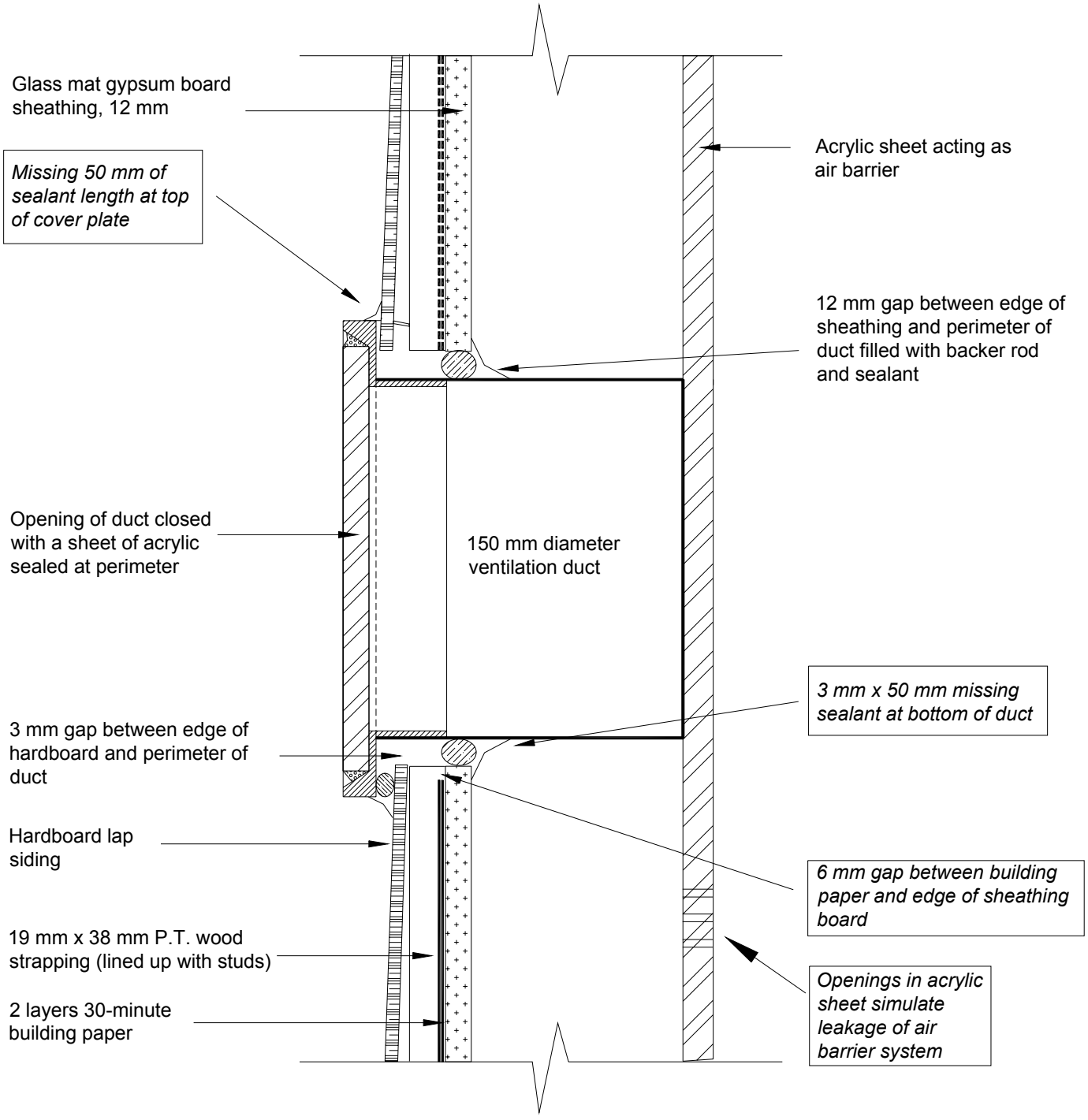


Figure 4.11. Wall/ventilation duct interface for specimen No. 16 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

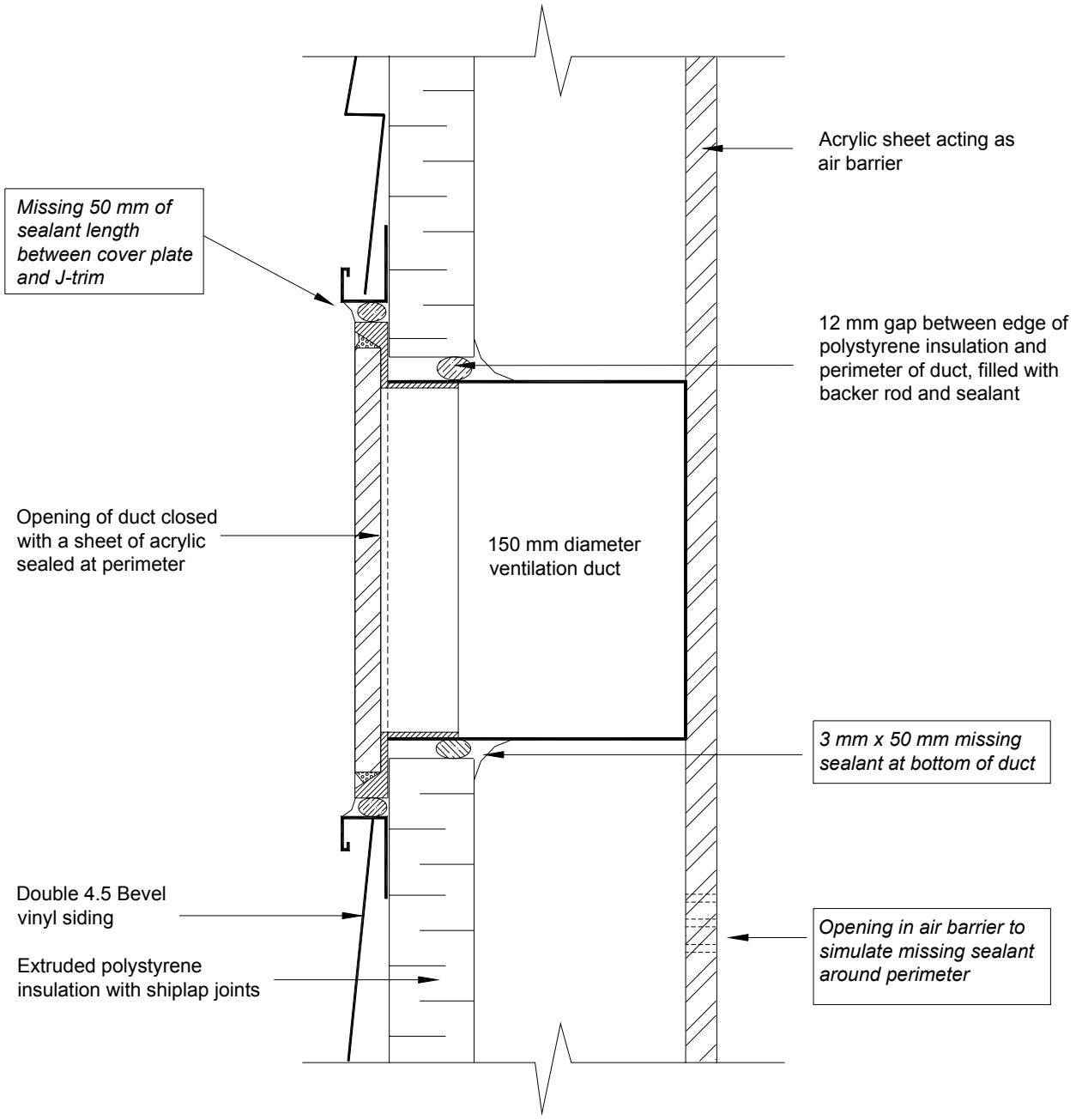


Figure 4.12. Wall/ventilation duct interface for specimen No. 17 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

4.6 WALL/ ELECTRICAL OUTLET INTERFACE DETAIL

Figures 4.13 to 4.15 describe the proposed detailing of that interface for the three specimens.

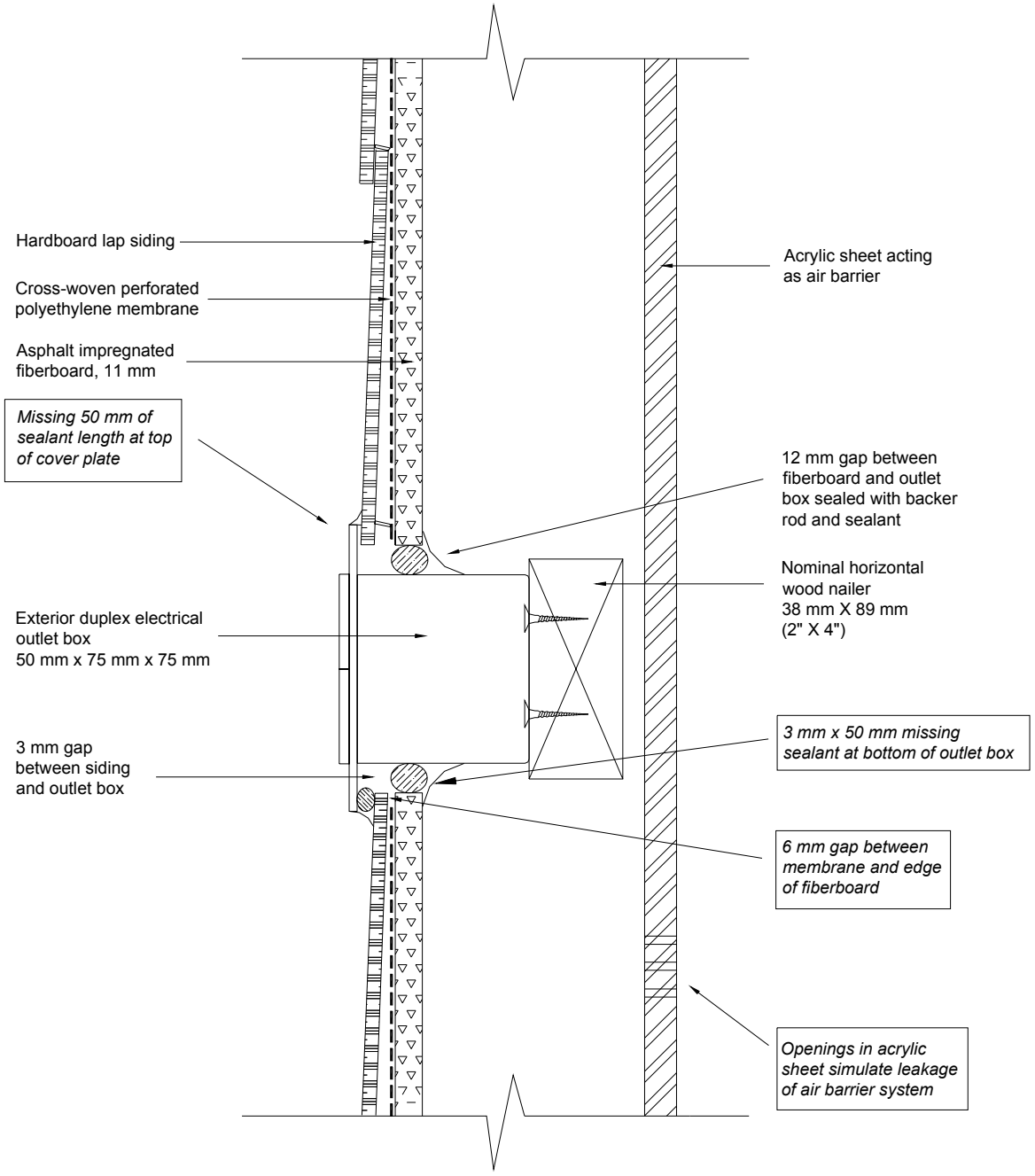


Figure 4.13. Wall/electrical outlet interface for specimen No. 15 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

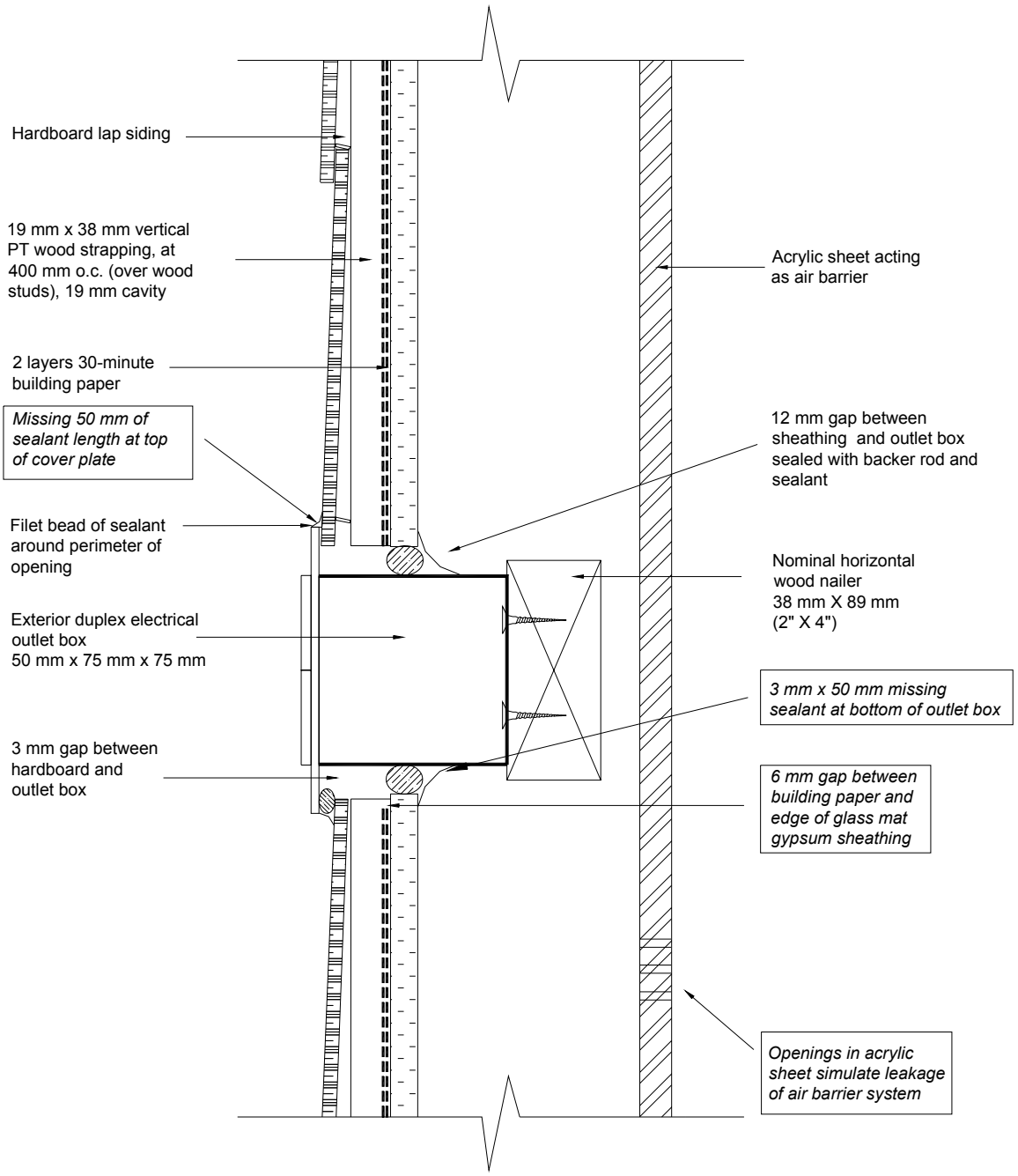


Figure 4.14. Wall/electrical outlet interface for specimen No. 16 - vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

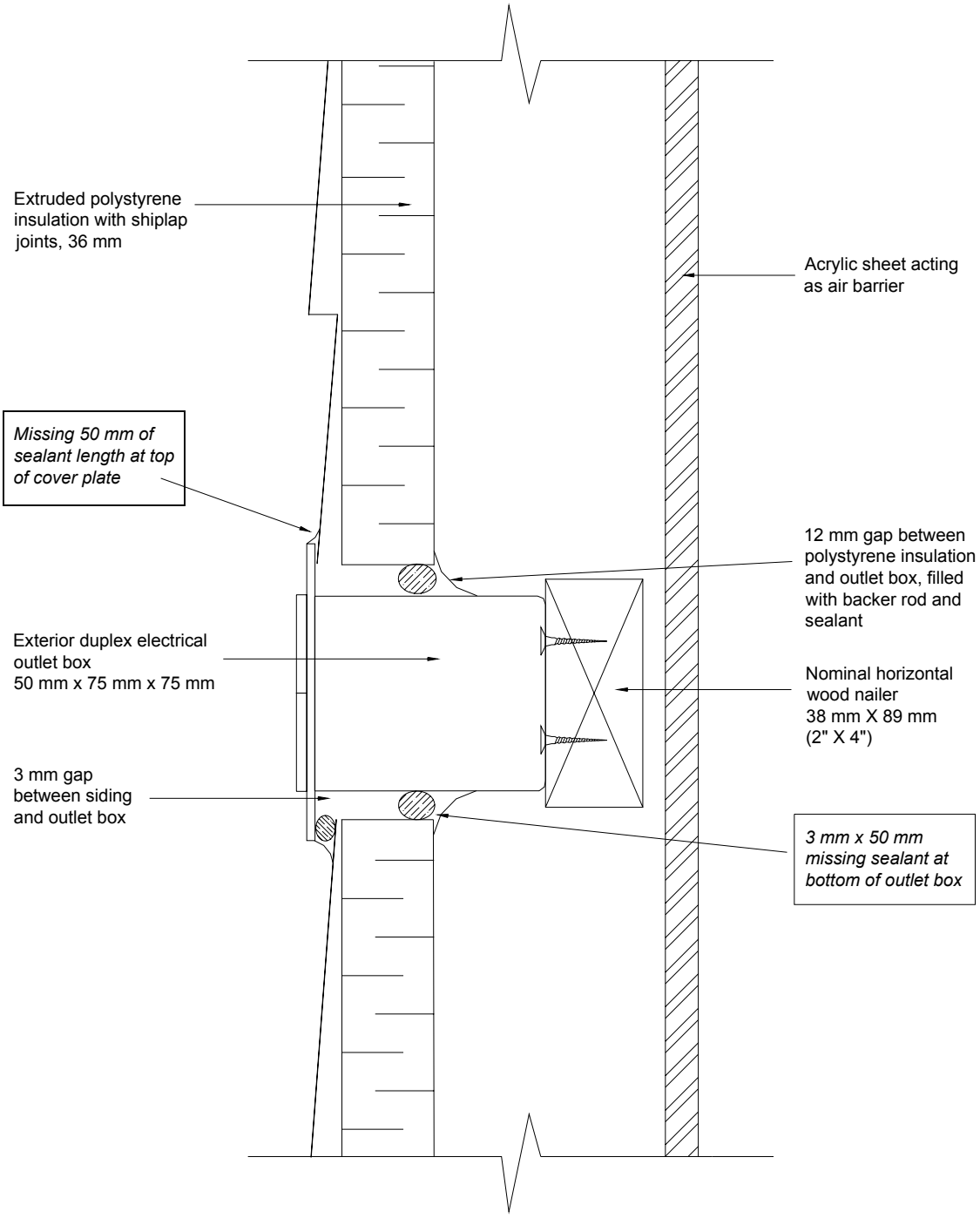


Figure 4.15. Wall/electrical outlet interface for specimen No. 17- vertical section
NB. Words in italic framed in a box indicate that the feature is a deficiency introduced in the specimen

APPENDIX 4.1 PHOTOGRAPHIC RECORDS OF THE CONSTRUCTION OF THE SPECIMENS

Figure A.4.1 Specimen No.15 at window sill

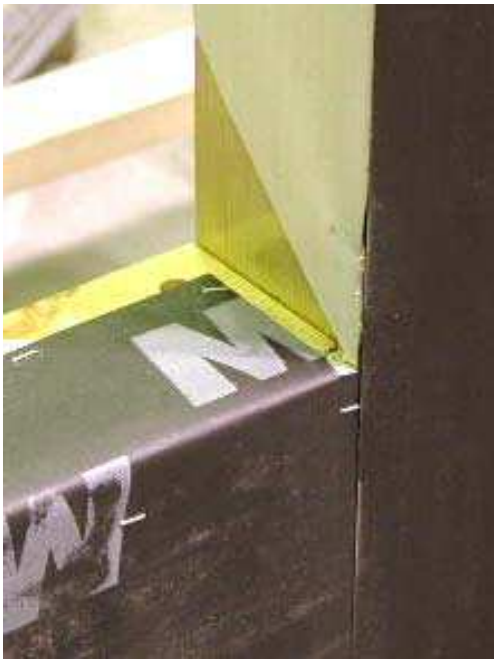


Figure A4.2 Specimen No.15.Close-up on the deficiencies at the rough sill

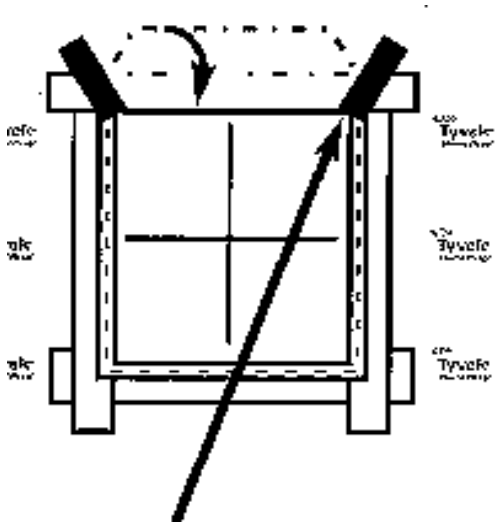


Figure A4.3 Specimen No.15. Front view of the membranes installed around the window (left) according to Dupont procedure (right)

Figure A4.4. Specimen No. 15 Placement of J-trim around window

Figure A4.5 specimen No.15 Installation of the hardboard siding

Figure A4.6 Specimen No.15. Deficiency in the installation of the WRB at the duct opening

Figure A4.7 Specimen No.15. Location of the joints in the siding (same location for all 3 specimens)

Figure A4.8 Specimen No.16. Detailing around the window of, showing the furring strips, J-trim and deflector at head

Figure A4.9 Specimen No.16. Zoom on the detailing at the window head

Figure A4.10 Specimen No.16. Detailing at the ventilation duct and outlet, showing the gutter system placed for water collection

Figure A4.11 Specimen No. 16. Placement of furring strips and water collection system at the bottom of each cavity

Figure A4.12 Specimen No. 16. Zoom on the water collection device at the bottom of each cavity

Figure A4.13 Specimen No 16 completed

Figure A4.14 Specimen No.17. Placement of membranes around the window frame

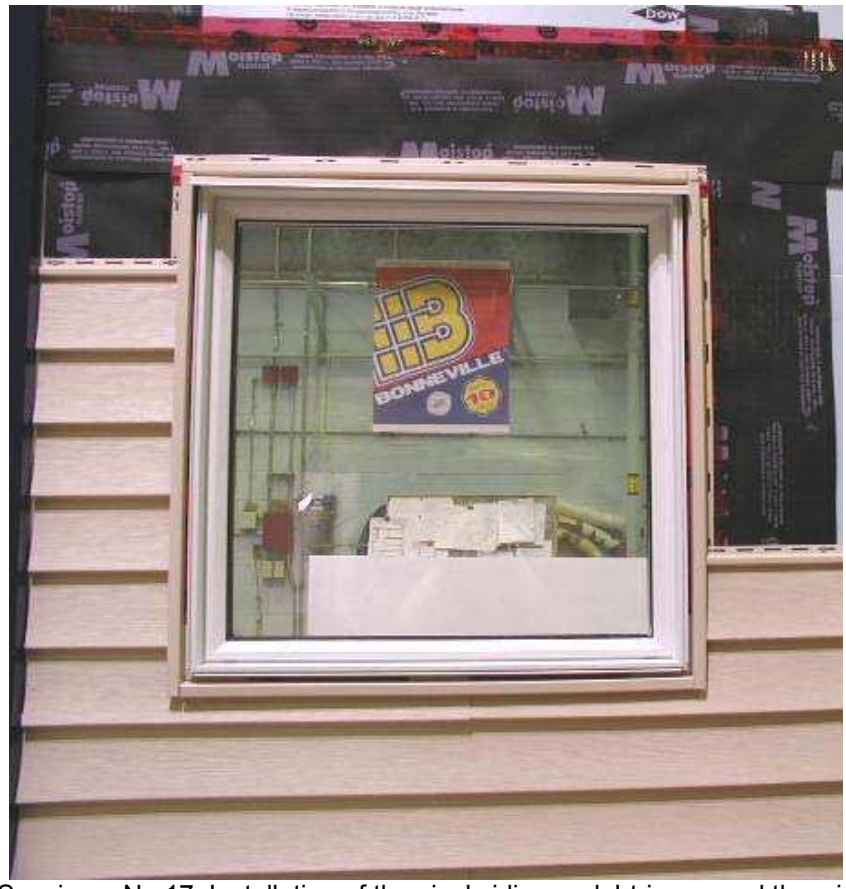


Figure A4.15 Specimen No.17. Installation of the vinyl siding and J-trim around the window frame

Figure A4.16 Specimen No. 17. Installation of J-trim all around the ventilation duct, to provide similar detail as a flanged accessory would have done (flanged accessory was not available for 150mm diameter duct)

Figure A4.17 Specimen No 17. Installation of the electrical outlet

Figure A4.18 Specimen no 17. Installation of vinyl siding completed