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Report 23-01

Testing of Nu-wall vertical Mono and ZZ profile 200 mm boards in accordance with E2/VM2 (BRANZ EM7) using tests from AS/NZS 4284:2008 'Testing of Building Facades'

Client:	Nu-Wall Aluminium Cladding Limited
Sample designer:	Nu-Wall Aluminium Cladding Limited
Installer:	Nu-Wall Aluminium Cladding Limited
Test dates:	15-16/2/2023
Test Schedule	The tests required by BRANZ EM7 were completed.
Persons present:	Richard Gibbs (Facadelab manager) part time, John Burgess (IANZ authorised signatory), Ray Liebenberg, Matt Cochrane, Glen Tasker (part time)
Test facility:	Facadelab Ltd, 320 Rosedale Rd, Albany, Auckland.

IANZ accredited testing officer: John Burgess

IANZ accreditation number for testing 1091, including AS/NZS 4284 and EM7

Tested by: John Burgess, IANZ Signatory. Checked by: Richard Gibbs

1. Summary

The Nu-wall vertical aluminium weatherboard system was subjected to tests from AS/NZS 4284:2008 as called up by BRANZ EM7 (referenced as E2/VM2 within the NZBC), with the following results.

1.1. Preliminary test

Compliant– to air pressure of ±2.25 kPa

1.2. Air infiltration test 1

Completed

1.3. Seismic testing at serviceability limit state.

Completed to requirements, with 15 cycles of ± 15 mm.

1.4. Air infiltration test 2

Compliant, with less 0.3 L/s.m² air leakage through the specimen following the seismic racking, followed by air leakage standardisation to 0.6 L/s.m².

1.5. Water penetration tests

1.5.1. Static water penetration test

Compliant with water and air pressure at +675 Pa

1.5.2. Cyclic water penetration test

Compliant with air pressure cycling from 338 to 1350 Pa above atmospheric pressure.

1.6. Water management tests

1.6.1. Static water management test

Compliant with water and air pressure at +675 Pa

1.6.2. Cyclic water management test

Compliant, with requirements at stage 1, stage 2 and stage 3 cyclic pressures.

1.7. Wetwall test

Compliant with requirements at 75 Pa above atmospheric pressure.

1.8. ULS test

An additional test (being clause 9.7 from AS/NZS 4284) as allowed in E2/VM2 was performed, showing compliance at +3.3 kPa, and -3.4 kPa.

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4. Test Procedure

This test uses the EM7 BRANZ evaluation method (referenced in the NZBC as E2/VM2) as a means of assessing the weathertightness performance of generic domestic-oriented external wall cladding systems for use on buildings between 10 m and 25 m in height. It expects that a drained and ventilated cavity is used as part of the cladding design.

EM7 applies a series of tests from AS/NZS 4284:2008 *Testing of building facades*, with specific nominated values forming the performance verification. For flexibility, EM7 allows these values to be increased (but not reduced) to allow specific design criteria to be investigated, while maintaining compliance with the test. The aim is to provide a test with a consistent minimum set of parameters for use in weathertight design, verification of compliance with New Zealand Building Code (NZBC) clause E2 *External moisture*, and consenting of claddings for specific mid-rise buildings. The parameters have been developed from research funded by the Building Research Levy and engagement with a variety of industry stakeholders.

A sample of a building façade forms one face of an eternally mounted pressure chamber and is sealed at its perimeter and then successively subjected to tests.

The Facadelab test facility was utilised for this work, located at 320 Rosedale Rd, Albany.

4.1. Preliminary test at SLS pressure

A preconditioning pressure was applied to the external face of the test specimen for a period of 1 minute of positive pressure followed by a period of 1 minute of negative pressure (suction). The pressures of +2.25 kPa and -2.25 kPa (±2%) were applied.

4.2. Air infiltration test 1

Measurements of air leakage were performed in both directions (exfiltration and infiltration) at a pressure difference magnitude of 75 Pa (±2 Pa).

4.2.1. Method for Air infiltration test 1

The volumetric air flow rate at -75 Pa and +75 Pa (±2 Pa) air pressure difference was measured as the total flow through the sample, surrounds and booth.

4.3. Seismic test at SLS displacement

4.3.1. Method for SLS in-plane displacement

The procedure in AS/NZS 4284:2008 clause 8.9 was used to perform 15 cycles of inter-storey movement of span/200 (±10%) in each direction, with a period of around 15 ±5 seconds per cycle.

The specimen was inspected following completion of the cycles.

4.4. Air infiltration test 2

4.4.1. Method for Air infiltration test 2

The air leakage through the total of the sample, surrounds and booth was measured, and then the sample was sealed off with heavy polythene. The difference in these two measurements was calculated.

4.4.2. Criteria for Air infiltration test 2

The magnitude of the specimen air leakage at a pressure difference of 75 Pa must not exceed 0.6 L/s.m² including the measurement uncertainty.

4.4.3. Airtightness standardisation

The specimen air leakage was brought up to 0.60 ±0.04 L/s.m2 at +75 (±2) Pa[1] by drilling holes in the air barrier of 3–6 mm diameter are evenly distributed across the test specimen.

4.5. Water penetration tests – static and cyclic

Water penetration tests were undertaken in accordance with AS/NZS 4284:2008 clauses 8.5 and 8.6.

4.5.1. Static pressure water penetration test

The water penetration test by static pressure was conducted in accordance with AS/NZS 4284:2008 clause 8.5 at a test pressure of 675 ±15 Pa.

4.5.2. Cyclic pressure water penetration test

The water penetration test by cyclic pressure was conducted in accordance with AS/NZS 4284:2008 clause 8.6 using the default multipliers of the positive serviceability pressure of 2.25 kPa. The three stages of the test involved pressures varying from 338–675 Pa, 450–900 Pa and 675–1350 Pa above atmospheric pressure.

This test commenced within 30 minutes of the completion of the static pressure water test.

[1] Where positive pressure refers to the pressure in the booth being higher than atmospheric pressure outside the booth, with the exterior face of the cladding inside the booth.

4.6. Water management tests– static and cyclic

The procedures in section 4.5 were repeated following the closure of the 150 mm inspection ports, restoration of the window air seals and the introduction of 6 mm diameter holes through the wetwall as permitted by AS/NZS 4284:2008 clause 9.9.

These water leakage holes were formed in the following places:

- Through the window/wall joint at three-quarter height of both jambs of the window(s).
- Immediately above the window head flashing(s).
- Through the external sealing of the horizontal and vertical joints – for example, at their ends.
- Through the external and internal corners.
- Through the pipe and duct penetration external seals.
- Above any other wetwall penetration details.

The introduction of defects was checked that they only penetrated to the plane of the back of the wetwall so the water management of the cavity could be assessed.

4.6.1. Criteria for static and cyclic weather tests

See section 4.5.1.

4.7. Wetwall test – airseal degradation

4.7.1. Method for wetwall test

The air seal around the window was removed, and all the inspection ports opened to allow an air pressure of 75 Pa to be established across the wetwall. The air pressure across the air barrier was checked as being only a few Pascals. The static pressure water penetration test (see 4.5.1) was performed with an air pressure of 75 ±2 Pa across the wetwall for 15 minutes.

5. Test sample

5.1. Requirements

The requirements of the BRANZ EM7 method were followed.

5.2. Orientation

The orientation of all elements are recorded in this report as viewed from the outside of the test booth (dry side), being the inside of the façade when constructed. The inside of the test booth has the outside (wet side) of the façade.

5.3. Sample Description

The sample consisted of two similar Nu-wall profiled vertical aluminium cladding board systems constructed on aluminium battens over a fibre-cement rigid wall underlay system on timber studs and dwangs. The two profiles were installed in two panels beside each other as shown in the drawings. A window of 1800 x 800 mm was installed in each of the panels, together with pipes, ducting and a change in plane where the exterior wall was brought outwards through an external and internal corner to return back to its original plane. Allowance for seismic movement was made prior to the seismic tests through the introduction of flexible membranes down the sides of the sample.

The ‘as-built’ drawings are shown in the photos and drawings following.

The infill structure around the sample was constructed of 90 x 45 mm timber framing with James Hardie 7 mm RAB.

The specific details included in the test, as specified, were as follows:

1. typical vertical joint(s) (See Figure 16)
2. typical (vertical) external corner (See Figure 6)
3. typical (vertical) internal corner (See Figure 8)
4. cladding detail at the bottom of the cladding (footer) (See Figure 5)
5. typical inter-storey/tenancy horizontal drainage joint (See Figure 9)
6. typical window head detail (See Figure 13)
7. typical window sill detail (SeeFigure 11)
8. typical window jamb detail (See Figure 12)
9. typical round ventilation pipe of between 140 and 240 mm external diameter (See Figure 15)
10. cladding detail at the top of the cladding (soffit) (See Fig ???)
11. cladding detail at floor level balcony penetration or cladding penetration for balcony support structure (See Figure 17, Figure 18 and Figure 19)
12. typical round plumbing or service pipe penetration of between 10 and 22 mm external diameter (See Figure 14)
13. vertical cladding termination (See Figure 7)

5.4. Drawings

Drawings are attached as appendices at the end of this report.

5.4.1. Modifications to the sample during construction

Minor modifications were made to the sample during construction which are captured in the drawings.

5.4.2. Modifications to the sample during testing

As part of air leakage testing, the sample was blanked off with heavyweight polyethylene sheets, taped together to minimise air leakage.

To allow rapid reduction of the air pressure across the air barrier, as directed in the test, portholes were included through the rigid air barrier during construction. These were opened and closed as required in the test, being covered with sections of rigid plastic sheet as required.

6. Results

6.1. Preliminary Test

The system with face area of 12.3 m² withstood the applied air pressure at ±2.25 kPa.

6.2. Air infiltration test 1 (Pre seismic)

The system was tested to identify and eliminate extraneous air leakage. After sealing peripheral air leaks, the system was found to have the following airtightness.

Airtightness measurements @ 75 Pa ΔP		
	Positive pressure (infiltration) l/s.m²	Negative pressure (exfiltration) l/s.m²
Measured (booth + sample)	0.98 ± 0.05 (k=4.3)	1.02 ± 0.02 (k = 3.2)
Measured (booth)	N/A	N/A
Calculated sample leakage	<1.1	<1.2

Table 1: Initial airtightness measurements at 75 Pa

6.3. Lateral building seismic movement test at SLS

Compliant. The system was subjected to 15 cycles of 15 ± 1 mm movement in each direction at a period of approximately 15 seconds. There were some pauses during the testing as the speed of the ram was adjusted and location of the end points were identified, with three overshoots also noted below.

The positive direction was extension of the ram, while the negative direction was retraction of the ram.

Seismic displacements of sample (mm from central 0 point)																		
Cycle 1				Cycle 2				Cycle 3			Cycle 4				Cycle 5			
0	284	0	315	0	284	0	315	0	284	0	315	0	284	0	315	0	284	0
Cycle 6				Cycle 7				Cycle 8			Cycle 9				Cycle 10			
0	284	0	315	0	284	0	315	0	284	0	315	0	284	0	315	0	284	0
Cycle 11				Cycle 12				Cycle 13			Cycle 14				Cycle 15			
0	284	0	315	0	284	0	315	0	284	0	315	0	284	0	315	0	284	0

Table 2: Seismic displacement cycle movements

6.4. Air infiltration test 2 (Post seismic)

Compliant

Air infiltration was less than 0.6 L/s.m².

The system was tested with the booth and sample together, before blanking off the sample to obtain the air leakage through the sample by itself, and was found to have the following airtightness.

Airtightness measurements @ 75 Pa ΔP		
	Positive pressure (infiltration) l/s.m²	Negative pressure (exfiltration) l/s.m²
Pre-seismic (booth + sample)	0.98 ± 0.05 (k = 4.3)	1.02 ± 0.02 (k = 3.2)
Post-seismic (booth + sample)	0.92 ± 0.01 (k = 2.1)	0.98 ± 0.01 (k = 2.1)
Post seismic booth only	0.68 ± 0.02 (k = 2.4)	0.50 ± 0.01 (k = 2.1)
Post seismic sample calculated	0.24 ± 0.02 (k = 2.6)	0.48 ± 0.01 (k = 2.3)
Required air leakage	0.60 ± 0.04	N/A
Extra air - leakage added	0.36 ± 0.03	N/A
Final air leakage	0.60 ± 0.04	

Table 3: Post-seismic airtightness measurements at 75 Pa

The uncertainty in the airflow measurements has been assessed with the facadelab Excel-based 'Expanded Uncertainty Calculator', which varies as noted in the table.

Note that the airtightness measured after the seismic racking was less than the airtightness before racking. (This is not uncommon).

The water penetration testing after this point was all undertaken with the established air leakage of 0.6 l/s.m².

6.5. Water Penetration

Compliant

The results of the static and cyclic water tests, as per clause 8.5 in AS/NZS 4284 are shown below.

6.5.1. Static Pressure Water Penetration

Static water test			
Stage	Air pressure (Pa)	Duration	Result
0	0	5 minutes	Compliant
1	675	15 minutes	Compliant
2	0	5 minutes	Compliant

Table 4: Water penetration static water leakage results

There were no water leaks, meeting the requirement of the assessment method.

6.5.2. Cyclic Pressure Water Penetration

Cyclic water test			
Phase	Air pressure (Pa)	Duration	Result
	0	5 minutes	Compliant
1	338-675	5 minutes	Compliant
2	450 - 900	5 minutes	Compliant
3	675 - 1350	5 minutes	Compliant

Table 5: Water penetration cyclic water test results

There were no water leaks, meeting the requirement of the assessment.

6.6. Water management tests

6.6.1. Static Pressure Water Penetration

Compliant

Following the introduction of defects in the wetwall and the closure of the inspection ports, the following results were found.

Static water test			
Stage	Air pressure (Pa)	Duration	Result
0	0	5 minutes	Compliant
1	675	15 minutes	Compliant
2	0	5 minutes	Compliant

Table 6: Water management static water leakage results

There were no water leaks, meeting the requirement of the assessment method.

6.6.2. Cyclic Pressure Water Penetration

Compliant

Cyclic water test			
Phase	Air pressure (Pa)	Duration	Result
	0	5 minutes	Compliant
1	338-675	5 minutes	Compliant
2	450 - 900	5 minutes	Compliant
3	675 - 1350	5 minutes	Compliant

Table 7: Water management cyclic water test results

There were no water leaks, and the cavity managed any penetrating water, meeting the requirement of the assessment.

6.7. Wetwall test

Compliant

Pressure taps from the cavity were joined to determine an average pressure across the wetwall.

Following the removal of the airseal around the window and opening of sufficient inspection ports to allow establishment of 75 Pa across the wetwall, the following results were obtained.

Static wetwall test			
Stage	Air pressure (Pa)	Duration	Result
0	0	5 minutes	Compliant
1	75	15 minutes	Compliant
2	0	5 minutes	Compliant

Table 8: Wetwall cyclic water test results

Prepared By:

John Burgess (IANZ Signatory)

30 March 2023

Verified By:

Richard Gibbs (Lab Manager)

30 March 2023

7. Appendices

7.1. Drawings

Drawings in this report have been supplied by the client, and have been checked against observations and photos taken during the test. As a result, some modifications have been made to the drawings, however, facadelab takes no responsibility for any potential discrepancies between the details tested and the details drawn.

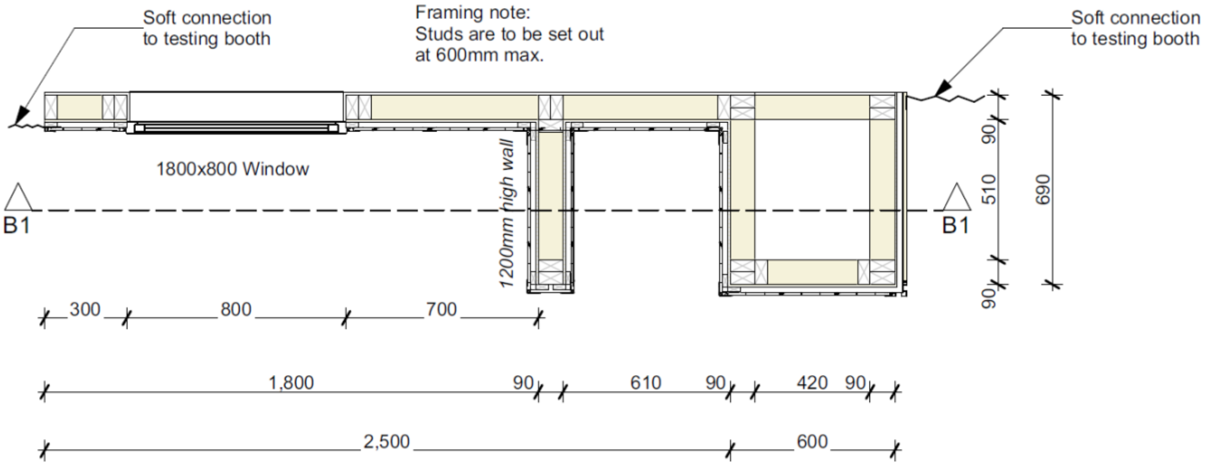
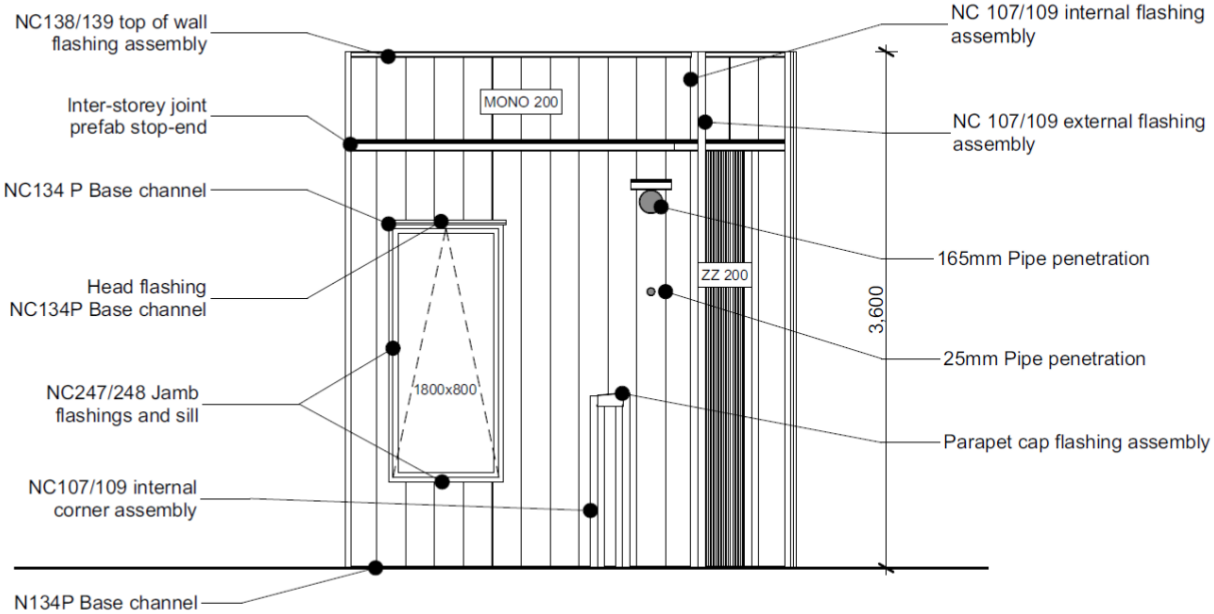


Figure 1: Test booth setout plan vertical



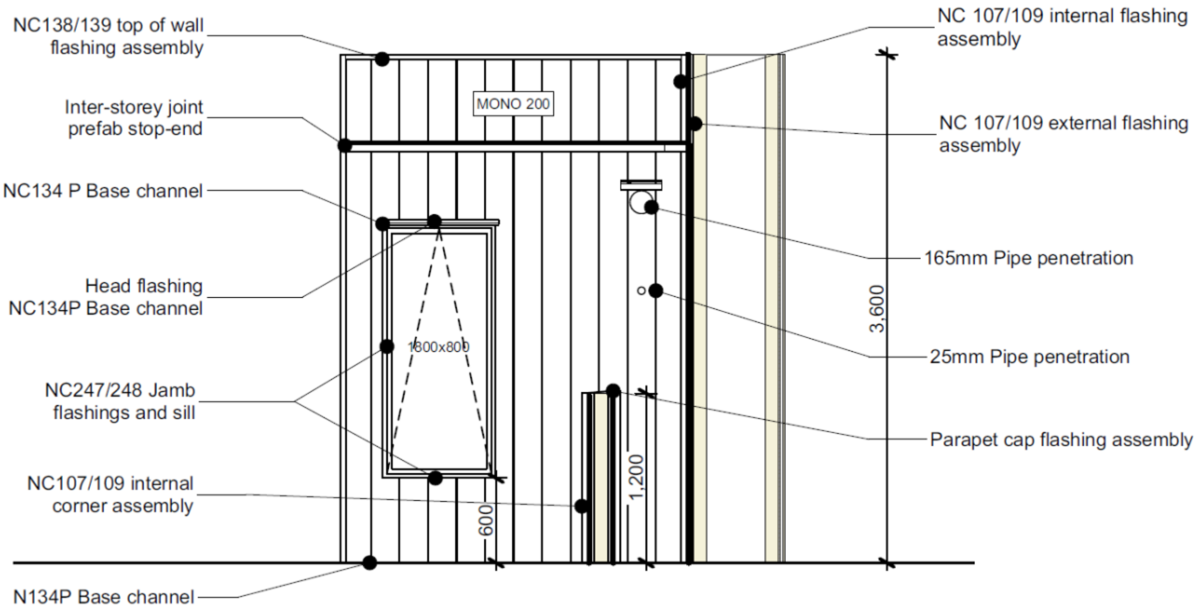


Figure 2: Test booth elevations 1 & 2

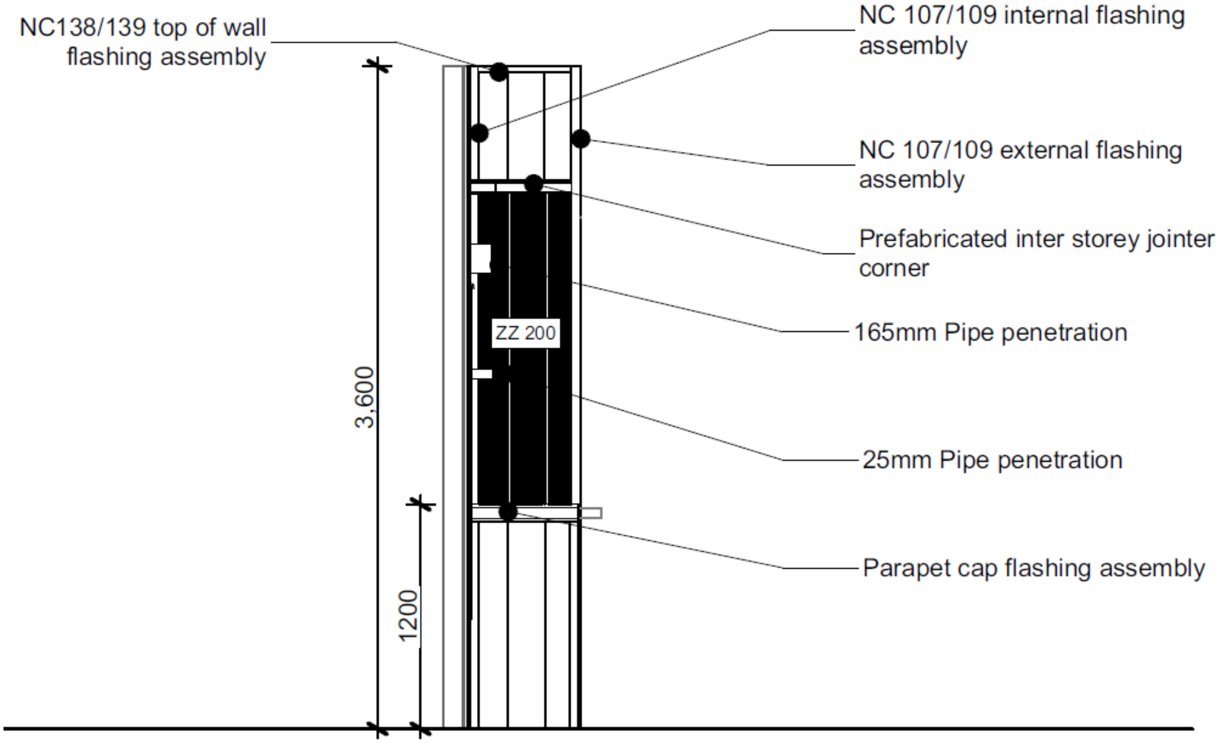


Figure 3: Test booth elevation 3

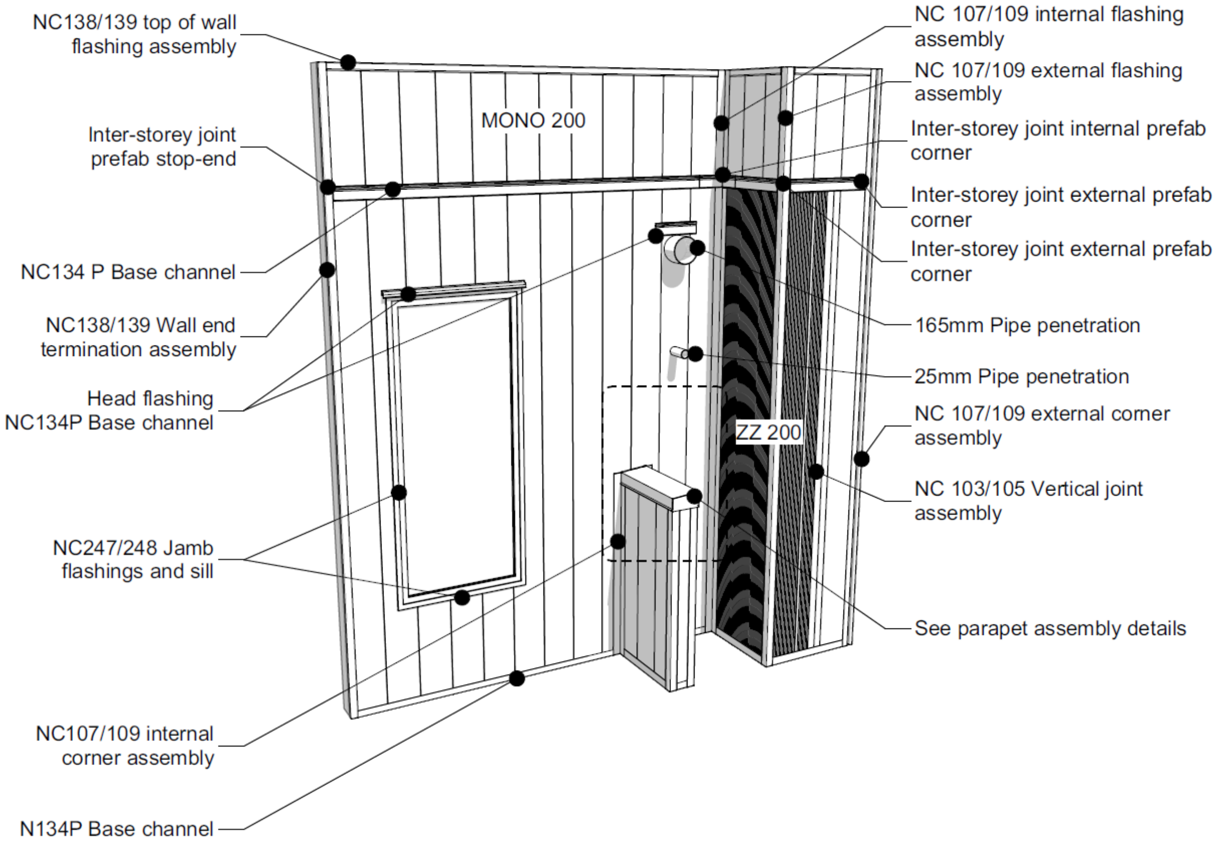


Figure 4: Test booth isometric

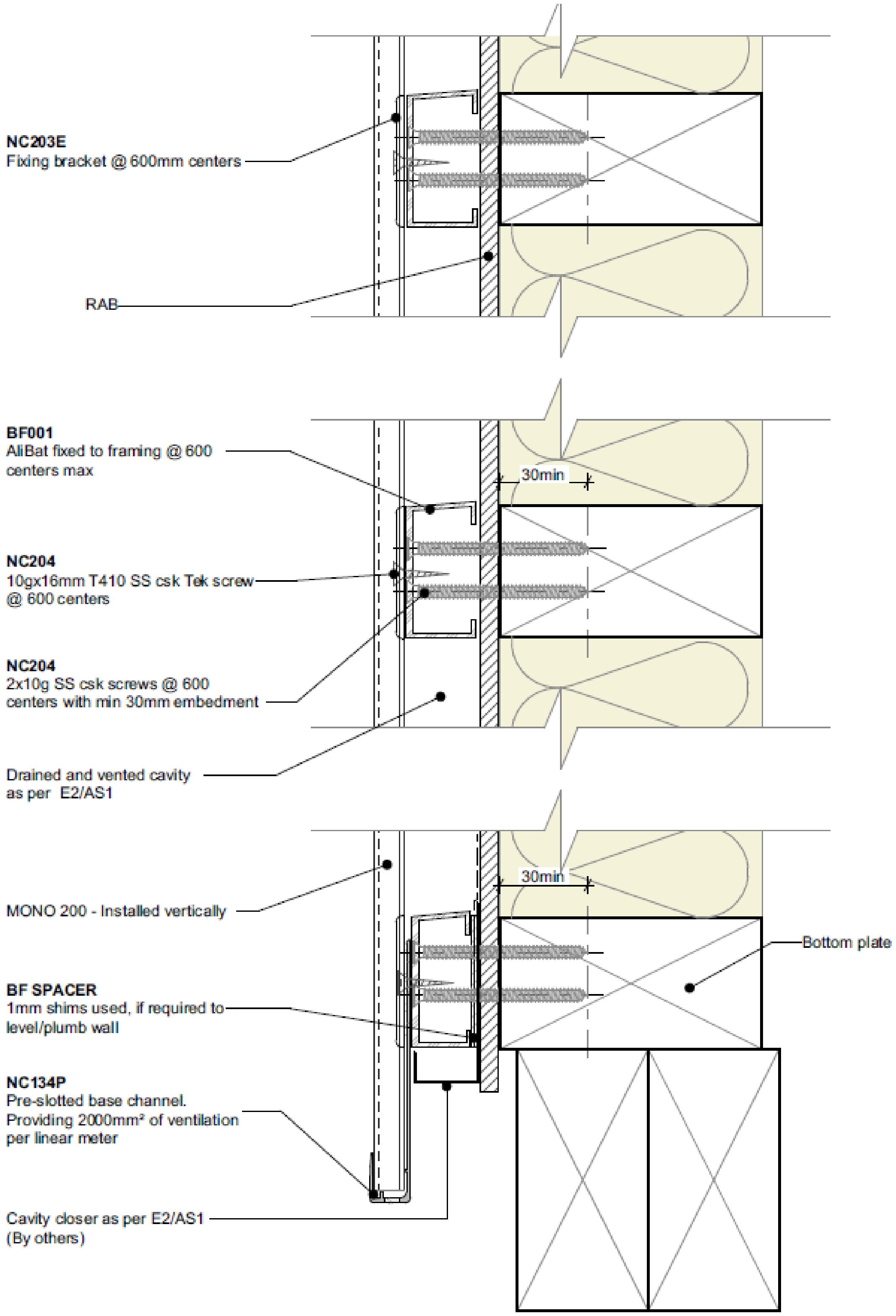


Figure 5: Channel fixings

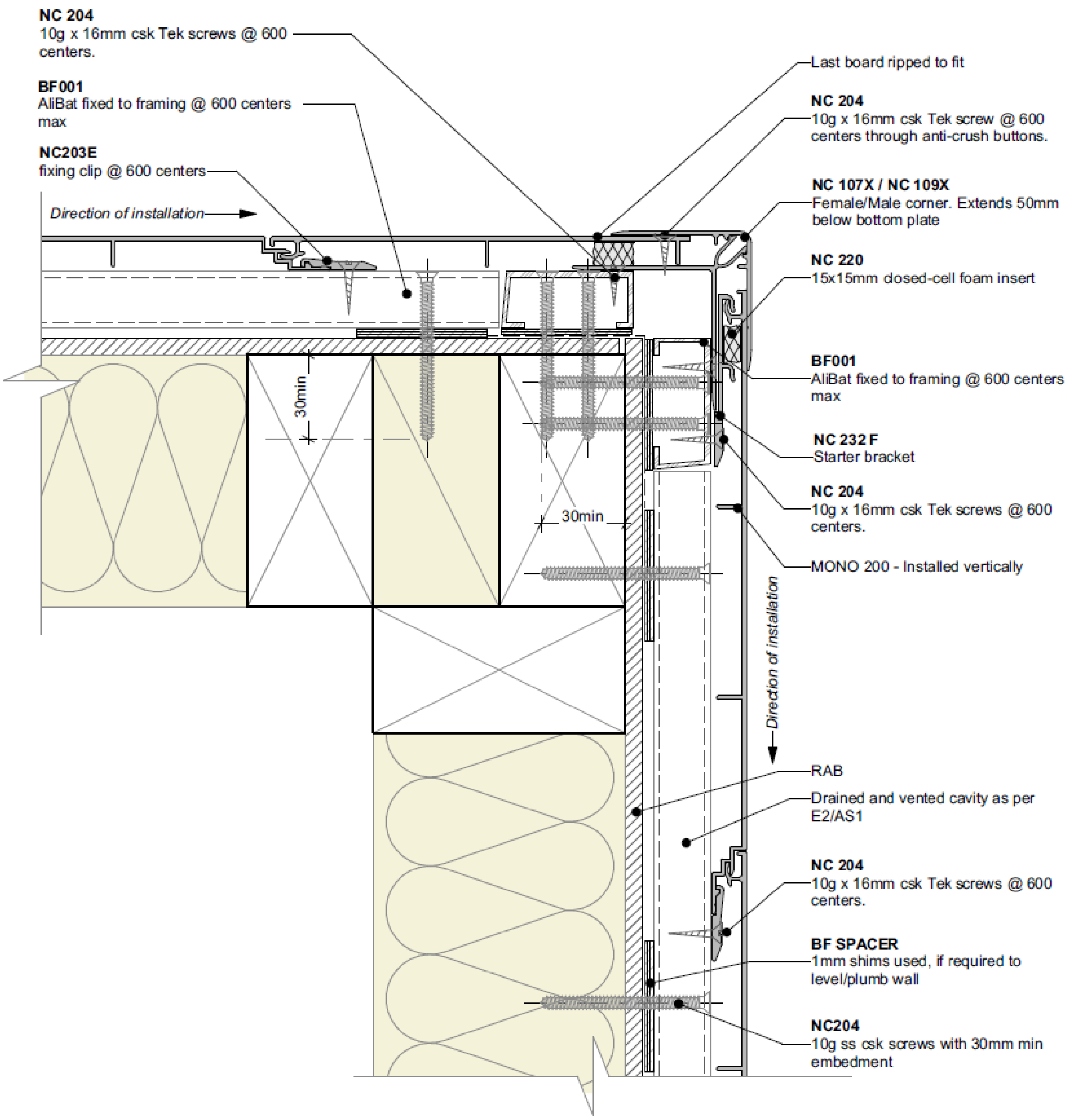


Figure 6: External corner

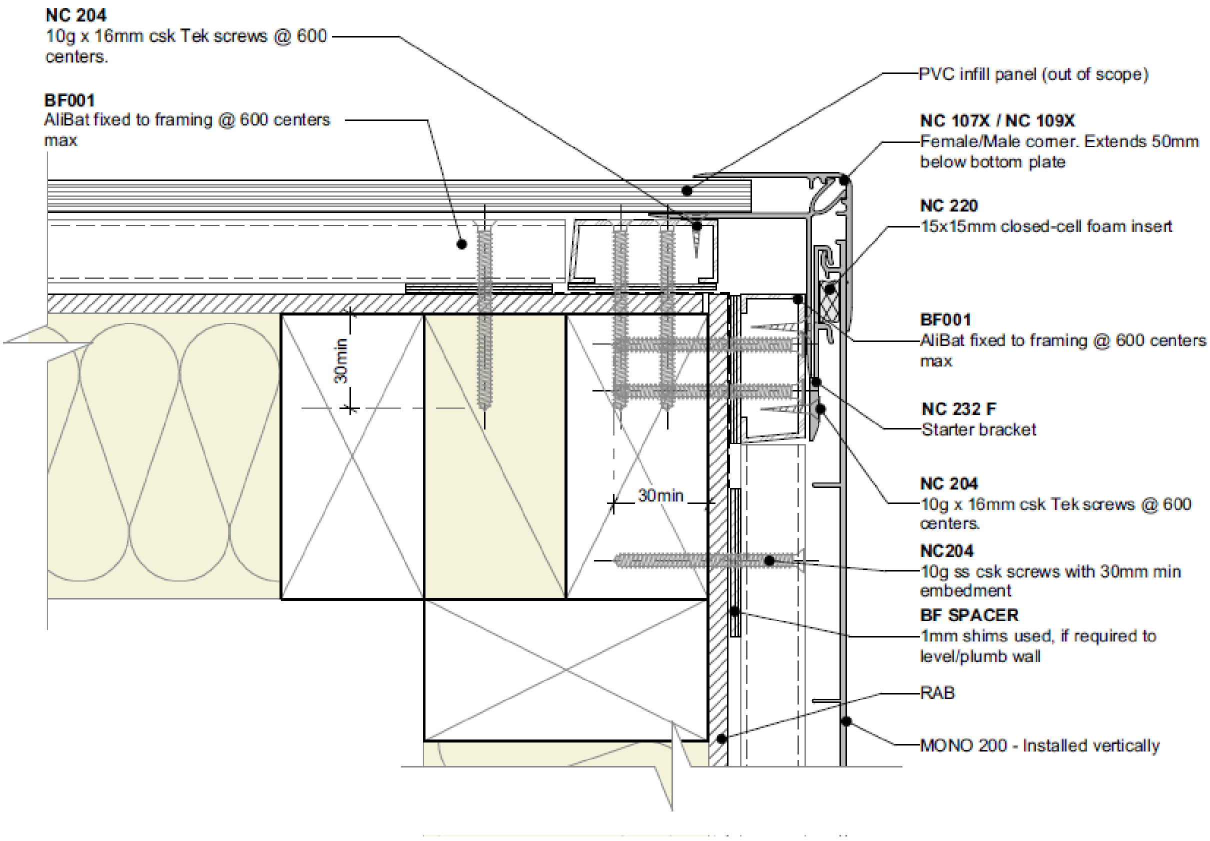


Figure 7: Edge of booth

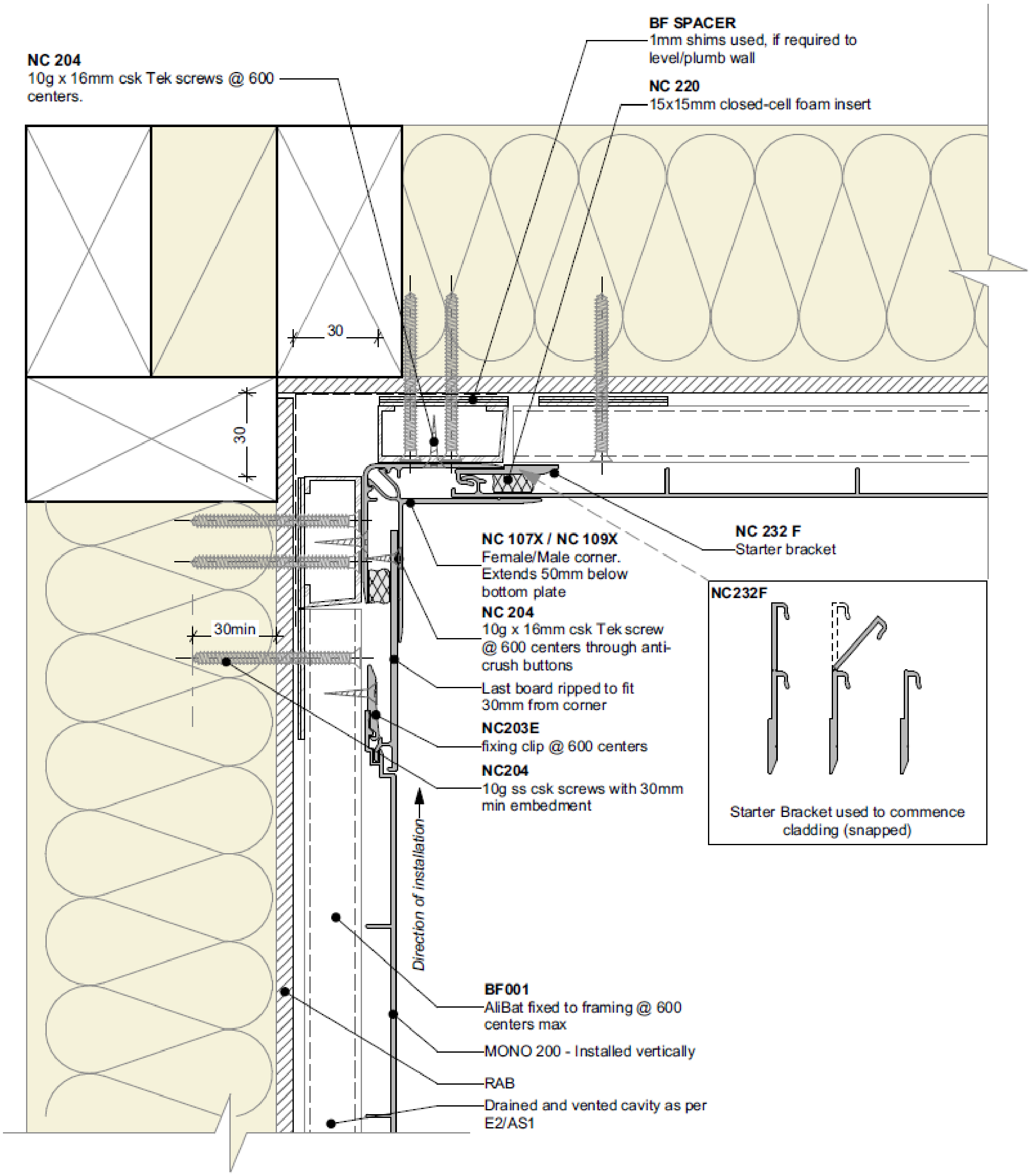


Figure 8: Internal corner using NC107X and NC109X

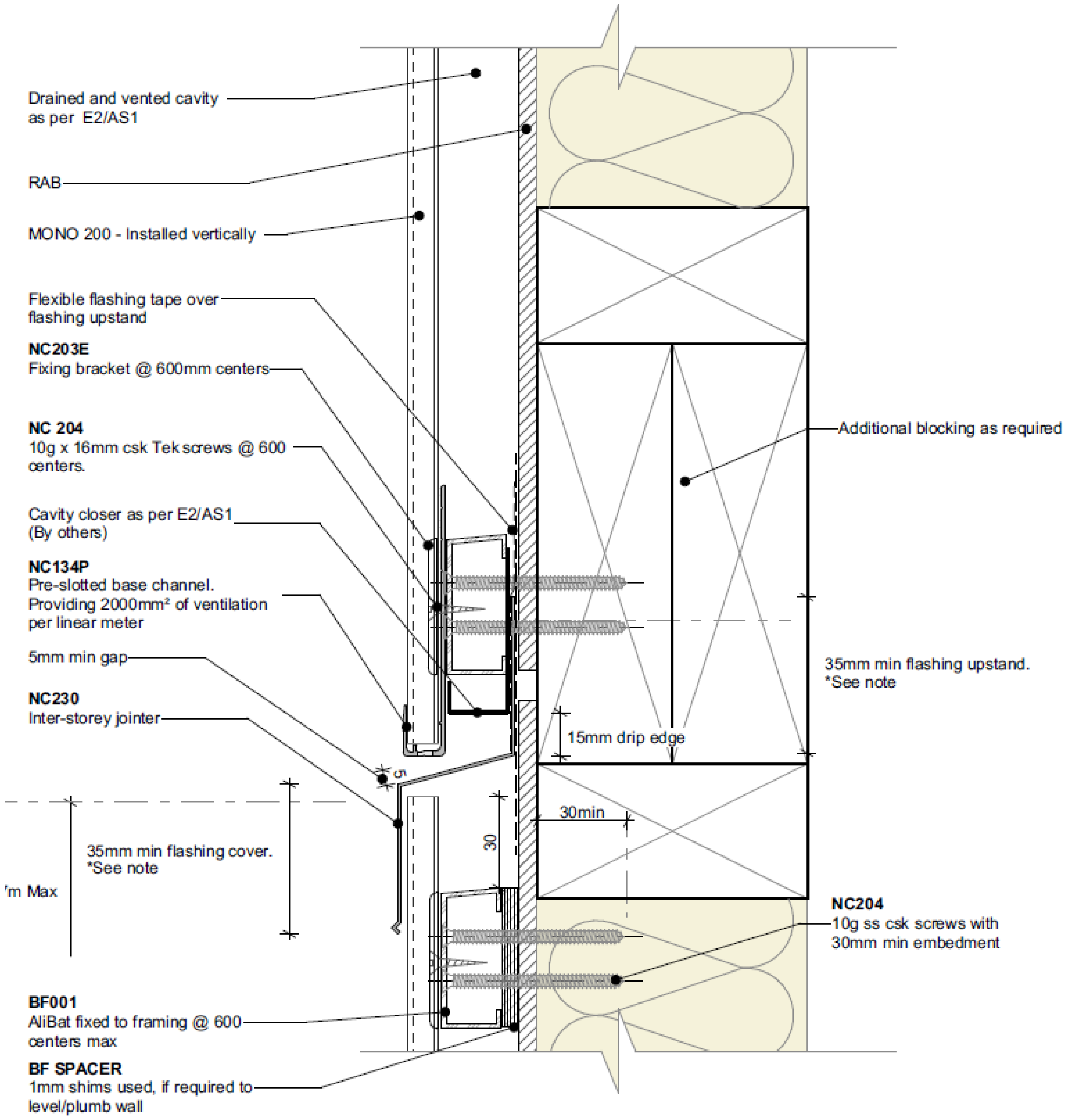


Figure 9: Interstorey joint

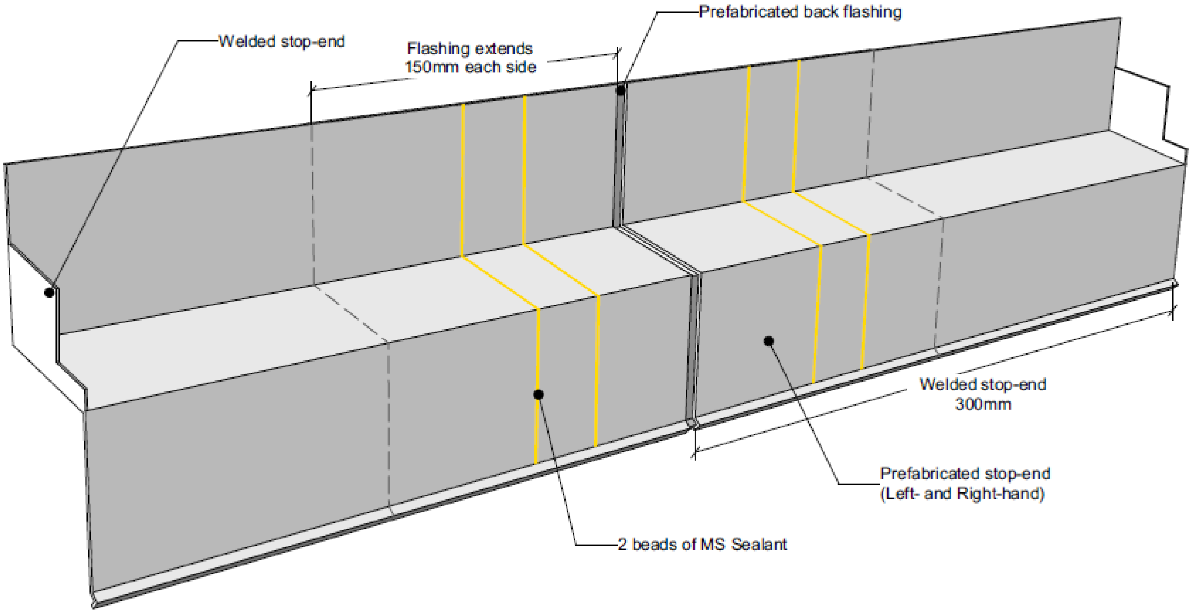


Figure 10: Head flashing and head flashing joint

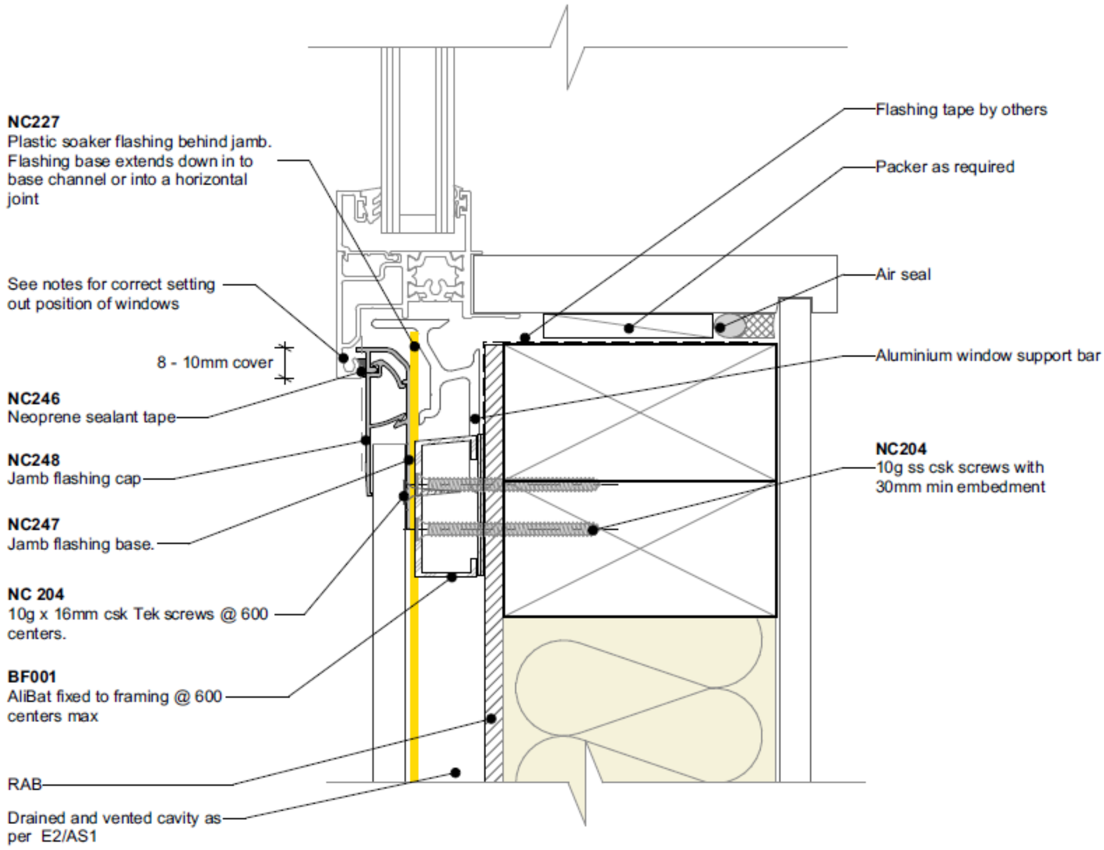


Figure 11: Sill assembly using NC247 and NC248

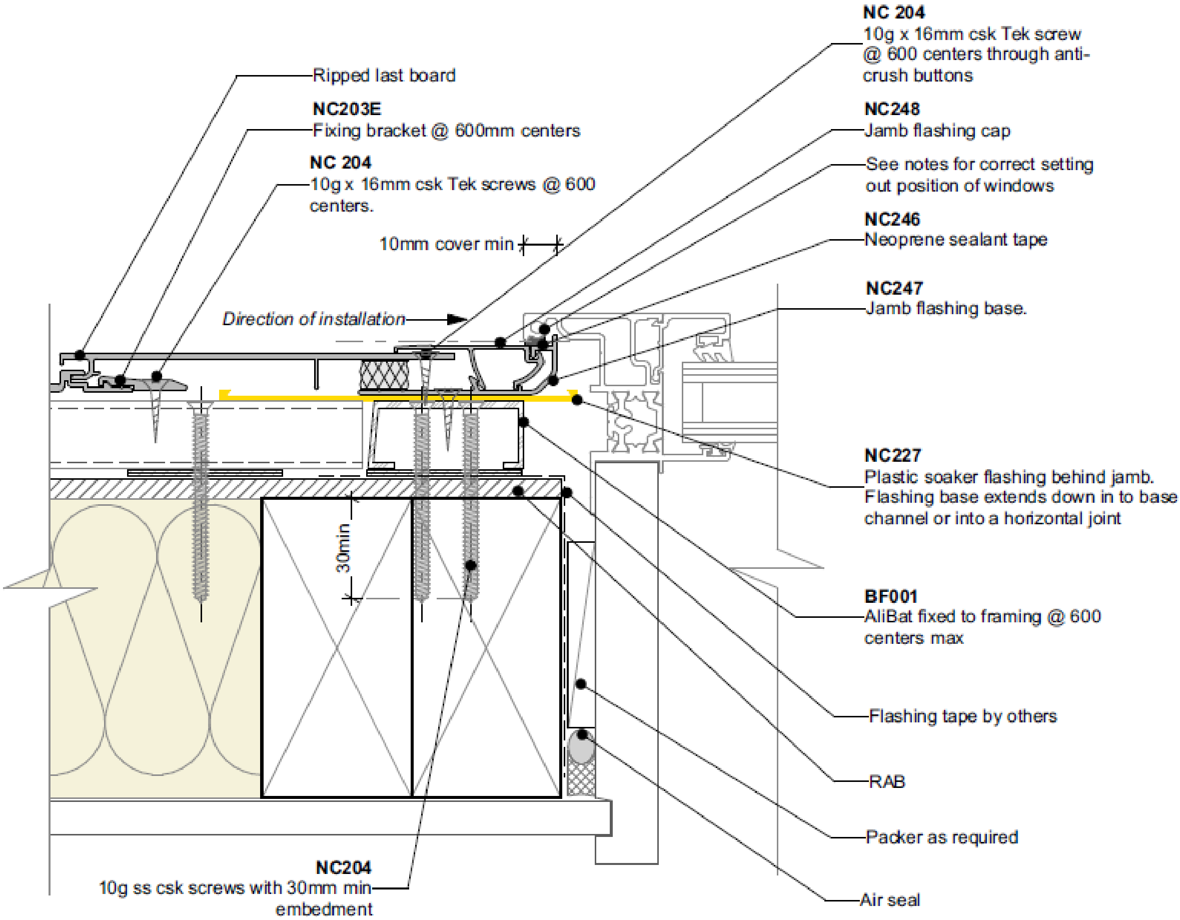


Figure 12: Jamb section using NC247 and NC248 assembly

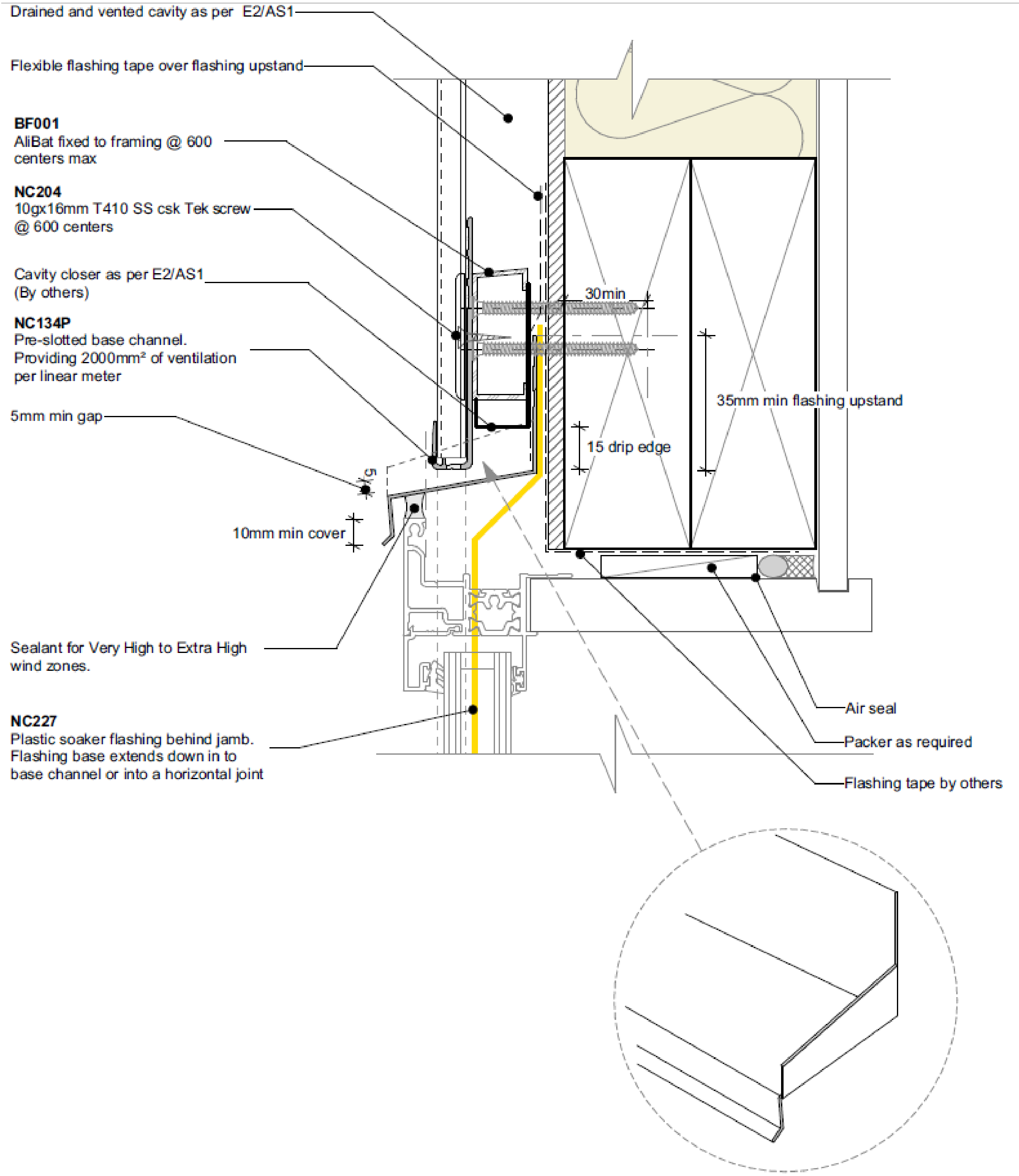


Figure 13: Head section

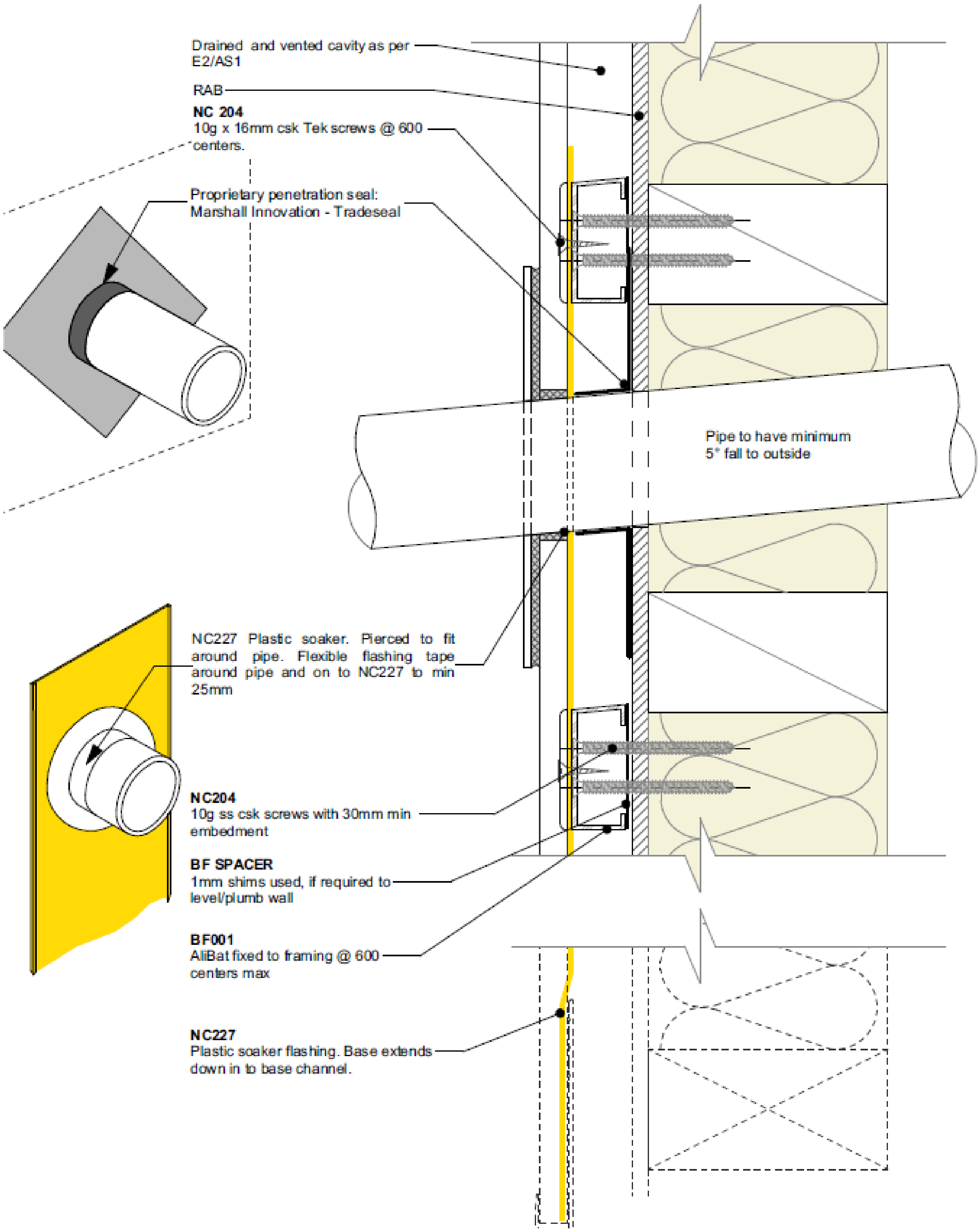


Figure 14: Small pipe penetration

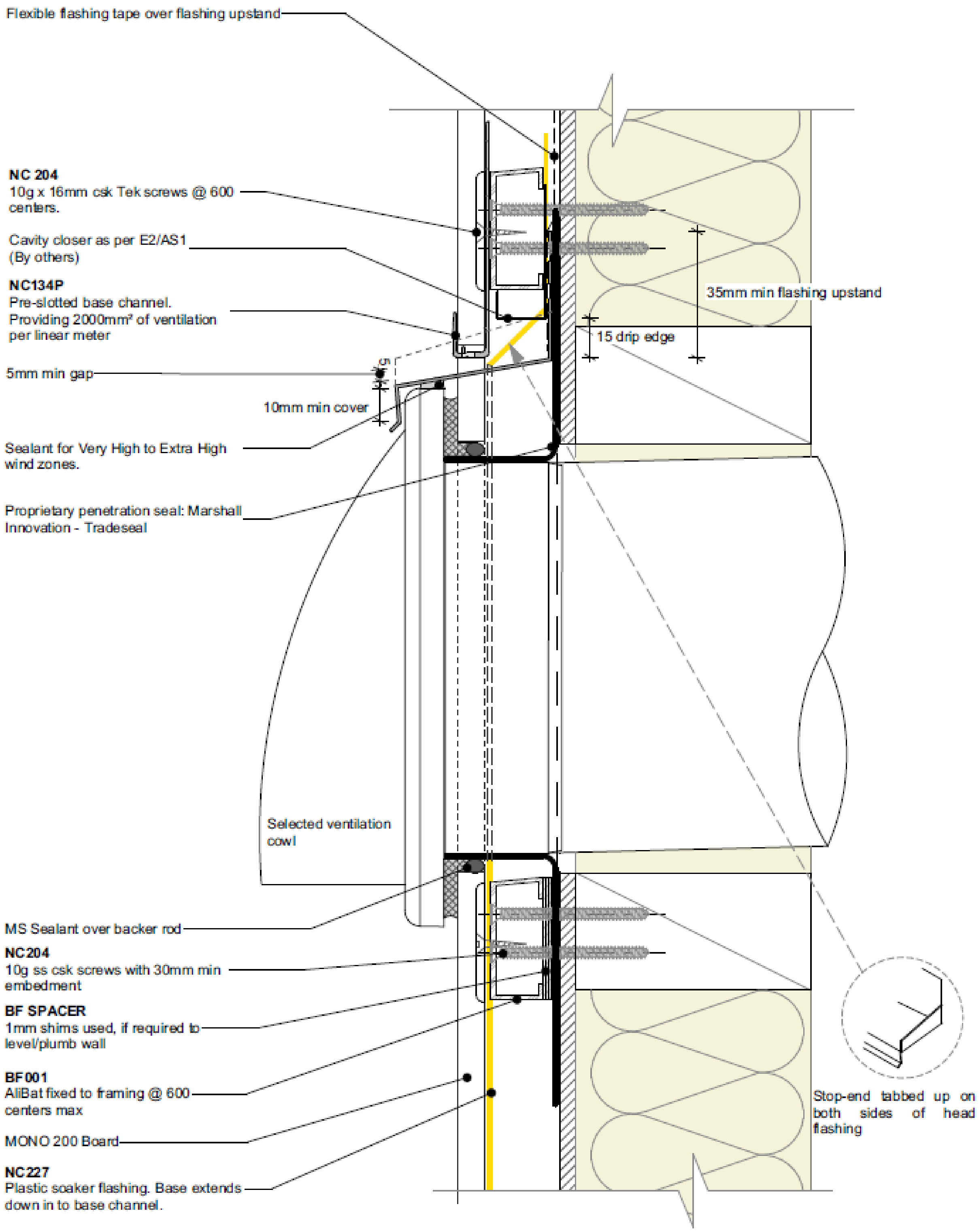


Figure 15: Large cowled pipe penetration

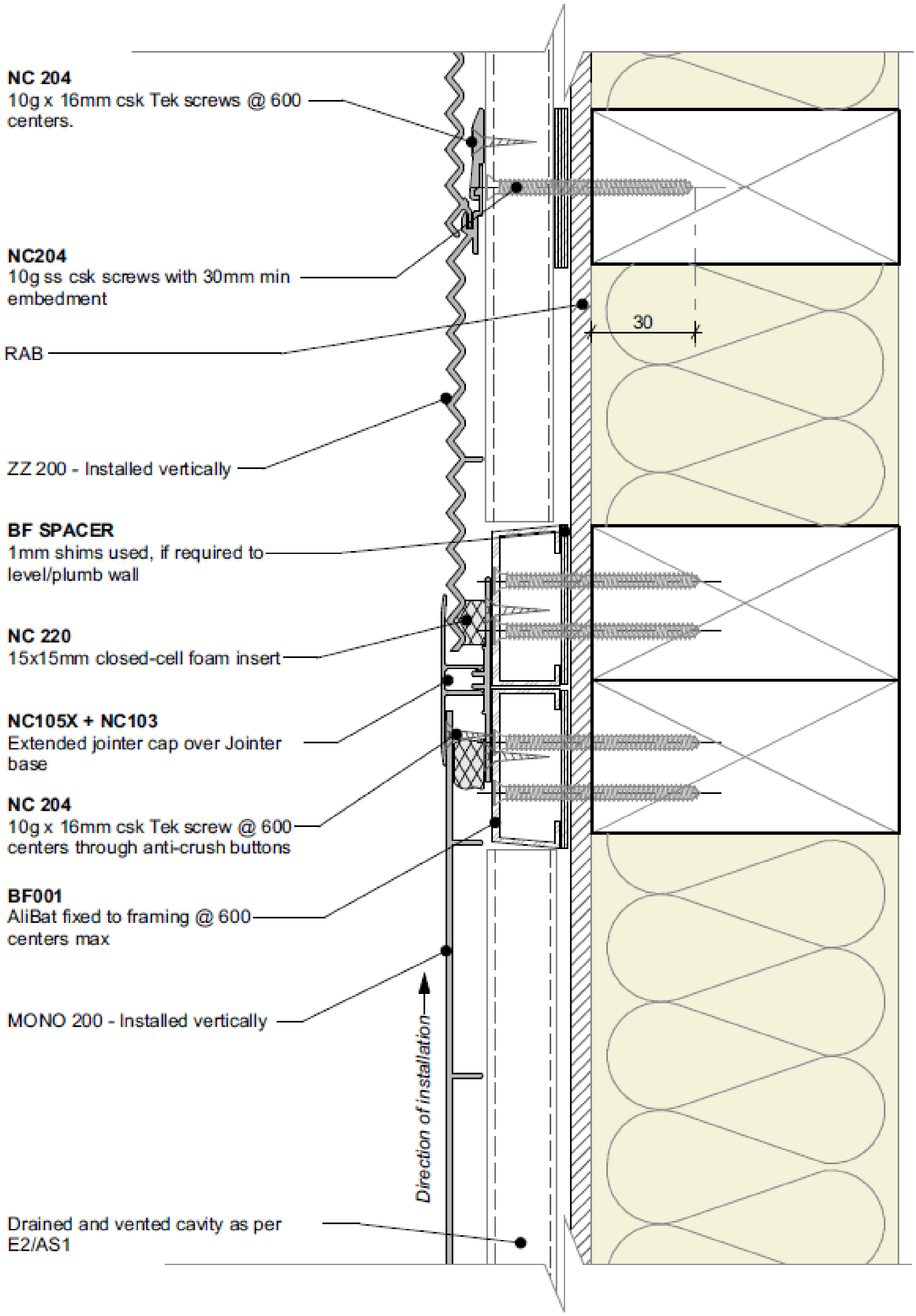


Figure 16: Vertical joint

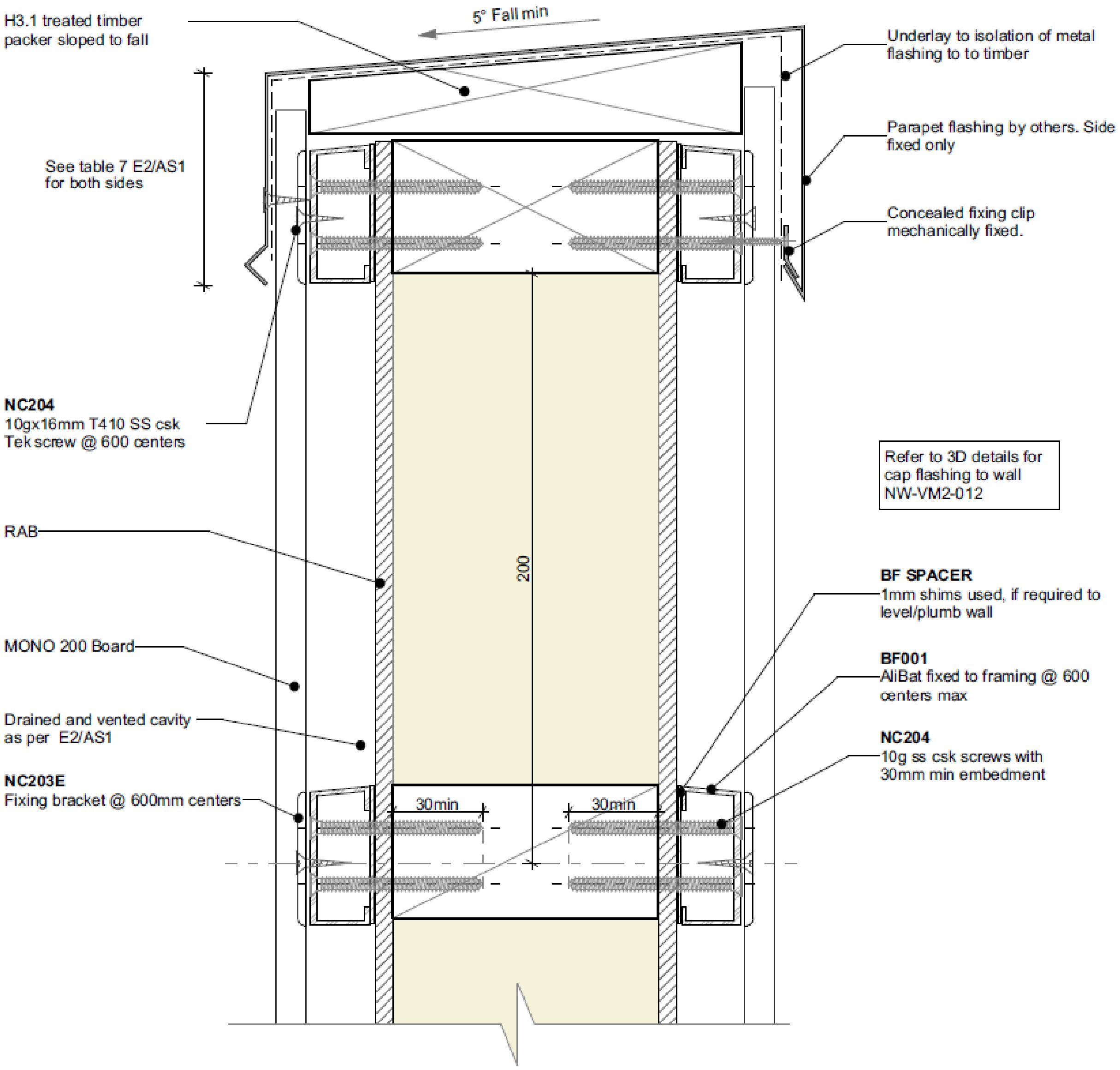


Figure 17: Balustrade/Parapet capping

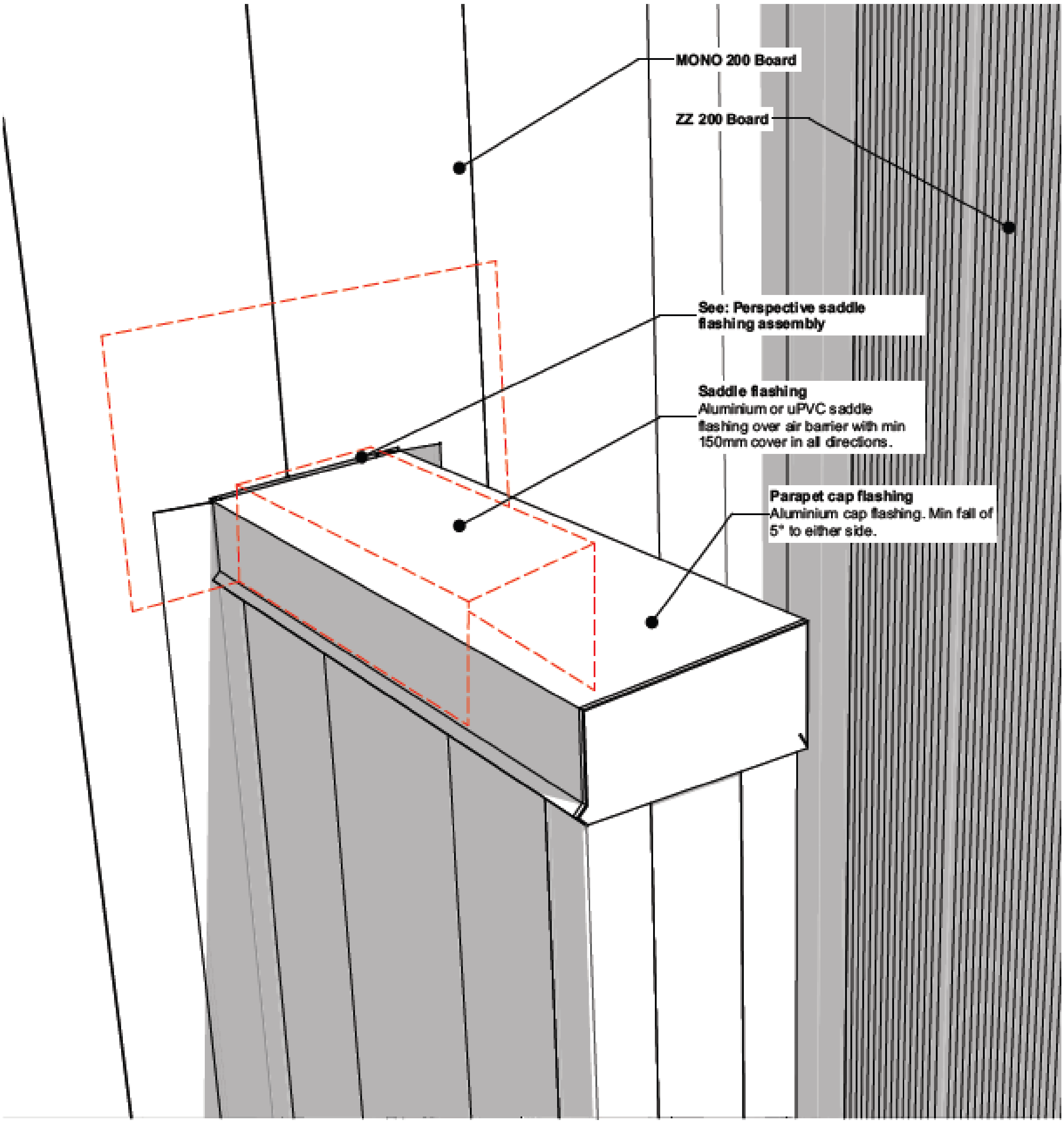


*Figure 18:*Isometric *balustrade/Parapet capping*

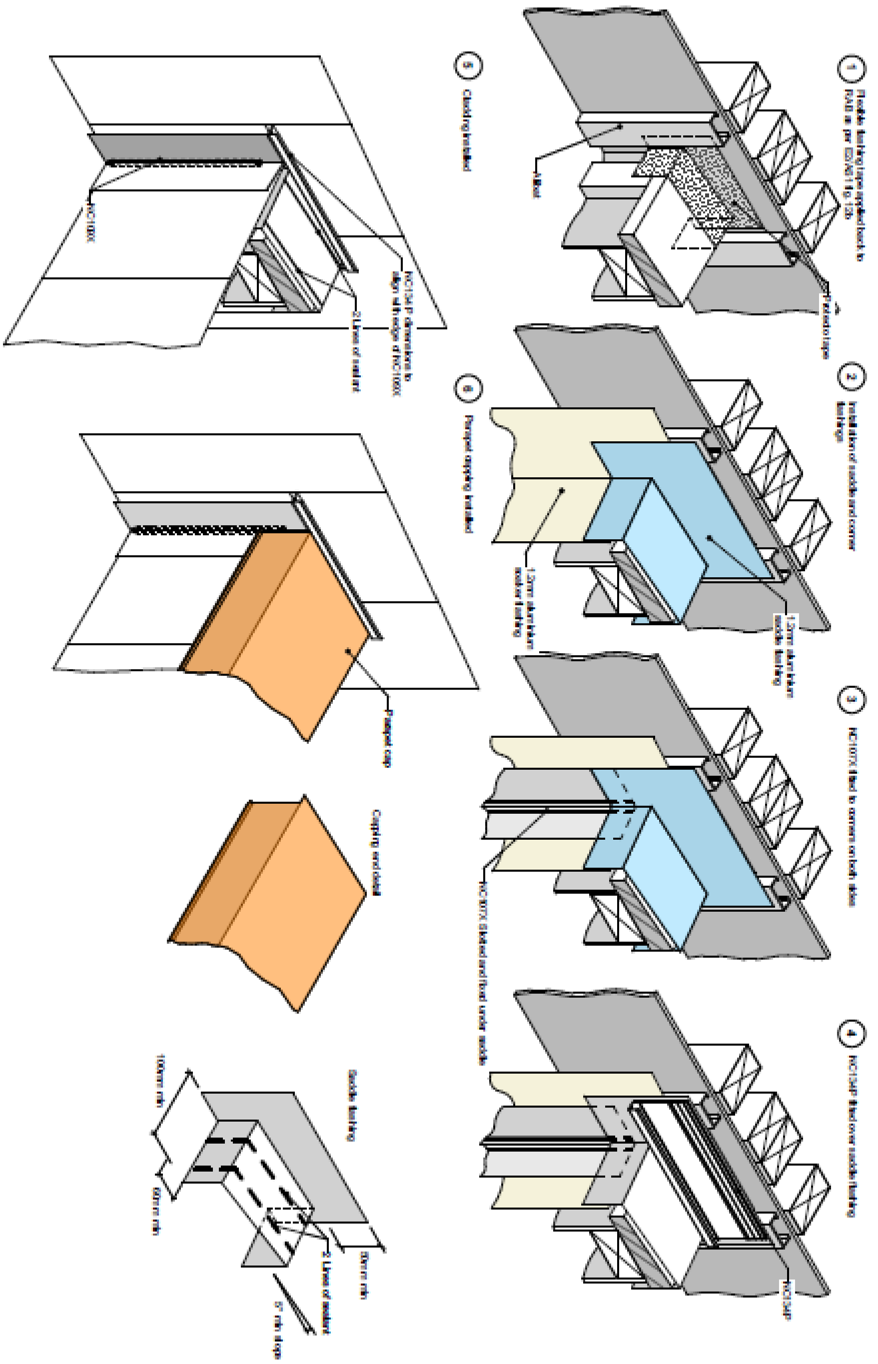


Figure 19: Saddle flashing construction isometric views

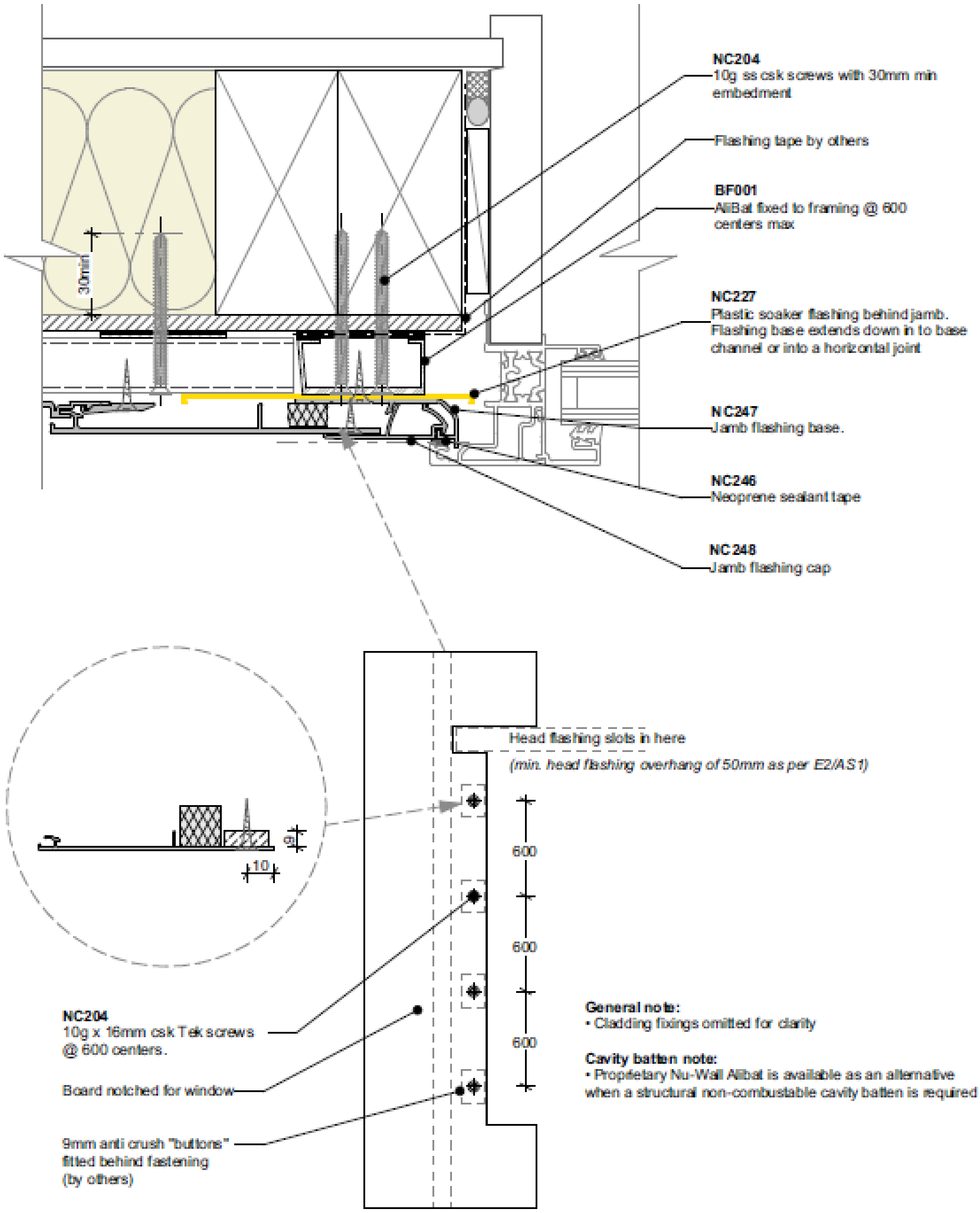


Figure 20: Board notching around window jamb

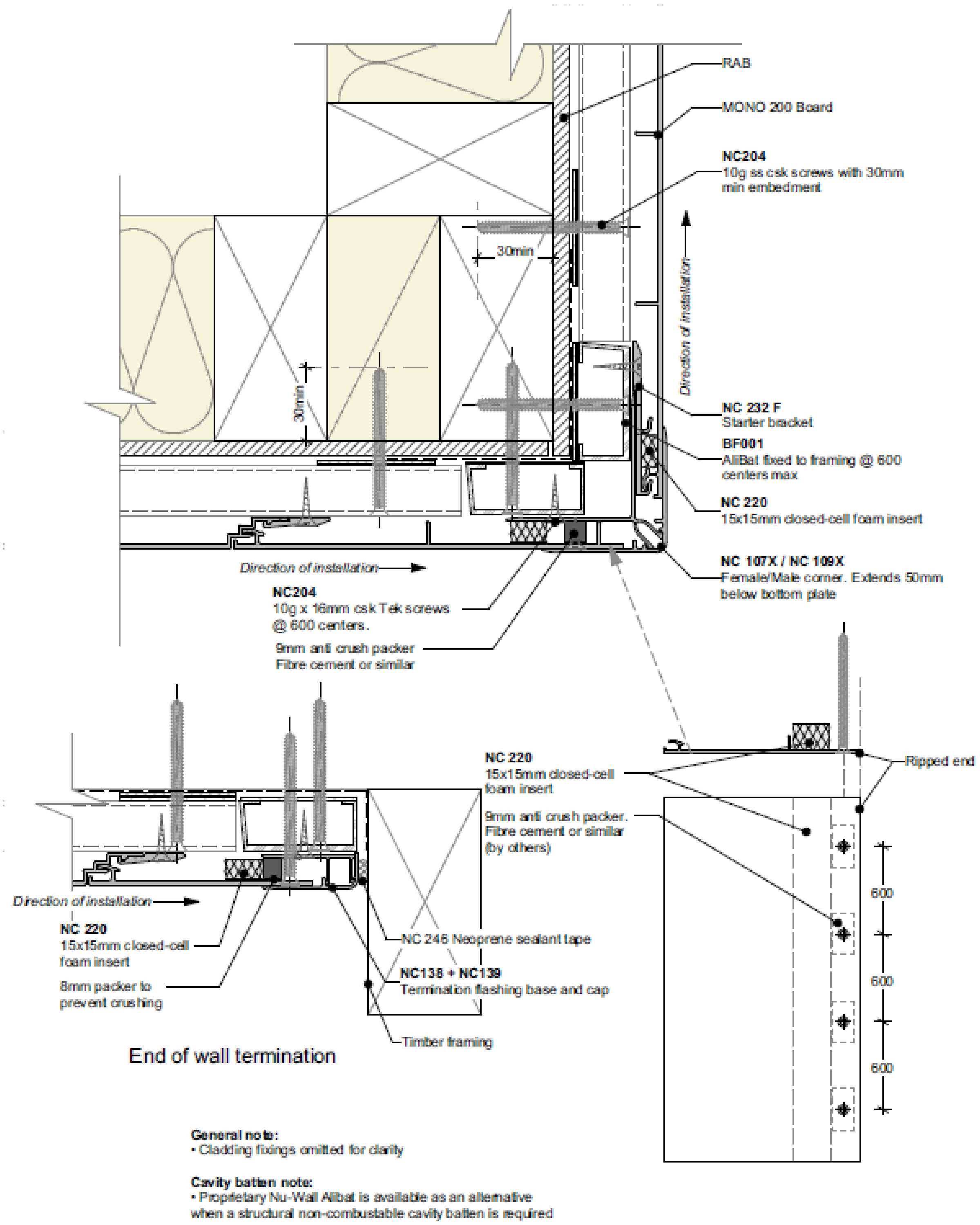


Figure 21: Ripped board to end of wall junction, End of wall.

7.2. Photos

Figure 22: Dry side of sample under test.

Figure 23: Wet face of sample prior to test

Figure 24: Window drainage

Figure 25: Window head

Figure 26: Cladding vertical joint between profiles and footer

Figure 27: Parapet saddle flashing

Figure 28: Balustrade/parapet, large pipe cowl, and small pipe flange

Figure 29: Vented cavity closure at foot, and internal corner in ZZ board

Figure 30: Flexible membrane connections at head of sample allowing seismic movement

Figure 31: Airtightness testing with sample sealed.

Figure 32: Hole formed above parapet saddle flashing joint

Figure 33: Holes formed for assessing cavity drainage above cowl, through corners and inter-storey joint

Figure 34: Hole formed about window head

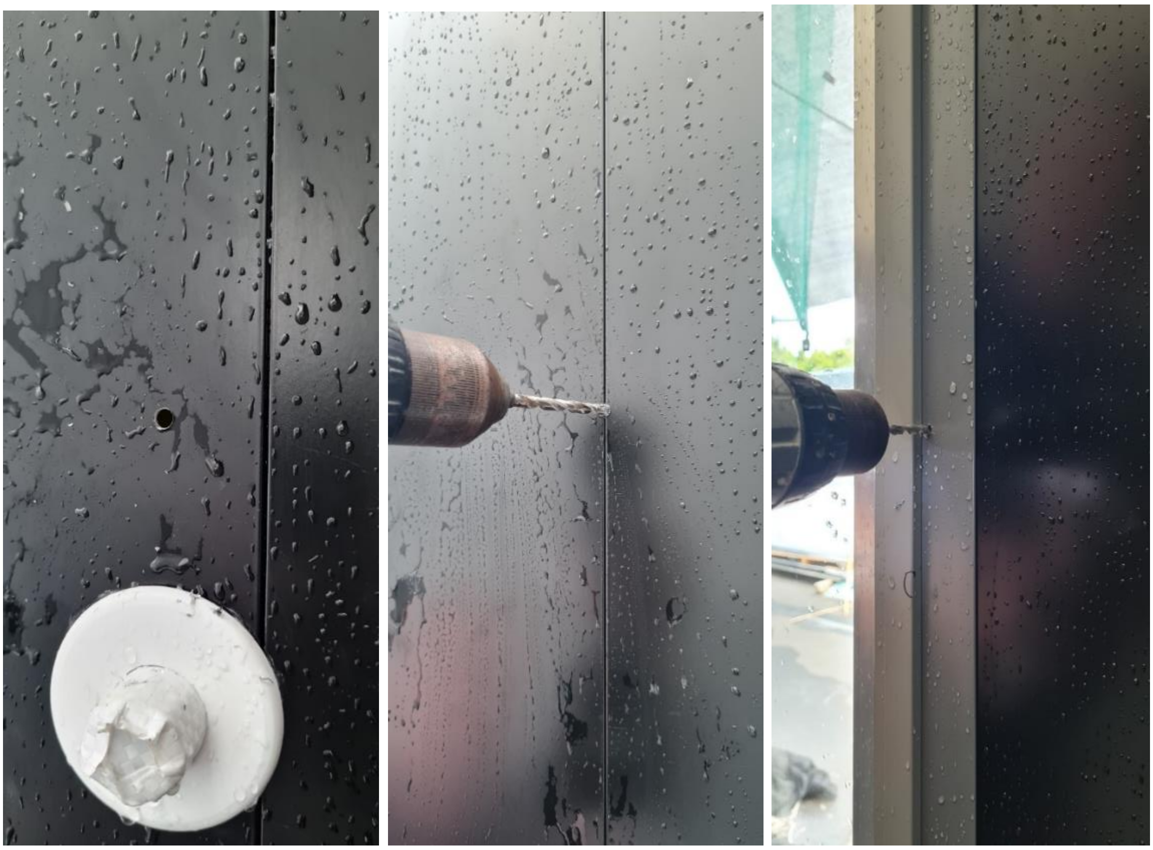


Figure 35: Holes with 6 mm drill formed above small pipe flange, through vertical joint and window jamb

Figure 36: Holes formed through window jamb and vertical board jointer

Figure 37: 'Port-holes' in rigid wall underlay to allow access and pressure manipulation