2.2 Weather Resistance and Surface Coatings

Introduction

It is important to be aware that from August 2011 Clause E2 (External Moisture) of the New Zealand Building Code included an Acceptable Solution (E2/AS3) for weathertight concrete and concrete masonry construction that references the Cement & Concrete Association of New Zealand's – *CP 01, Code of Practice for Weathertight Concrete and Concrete Masonry Construction* in the following referred to as 'CCANZ CP 01'

This Section (2.2) of the *Concrete Masonry Manual* refers to the many relevant details on weathertight concrete and concrete masonry construction contained in 'CCANZ CP 01'.

In choosing any construction system for the external walls of a structure, the designer and builder must exercise great care not only in the selection of materials but also in the supervision of workmanship. Even the most perfect material will not perform to its potential if the design detailing and workmanship are inadequate.

The segmental nature of concrete masonry requires sound masonry units, proper mortar, good detailing and competent workmanship. This is particularly so in single skin walls which are more vulnerable to moisture transmission than are cavity walls in which a drained air space provides an excellent barrier against the passage of water. The following matters have been observed to play a significant role:

1. Design:

    - Inadequate eaves overhang
    - Poor detailing of reveals and sills
    - Lack of adequate flashing details
    - Lack of control joints
    - Failure to specify tooled joints.

2. Materials and Workmanship:

    - Insufficient mortar in joints
    - Failure to recompact joints (tooling) after initial hardening
    - Bond and shrinkage failures between block and mortar
    - Moisture penetration of blocks
    - Failure to drain unfilled cells
    - Failure to reconsolidate grout in filled cells.

Each of the matters listed can readily be resolved by attention to design/specifications and by the use of qualified tradesmen. The tradesmen should be members of the local Blocklayers' Association as well as being a Licensed Building Practitioner in Brick and Blocklaying. Matters of dispute on workmanship can be investigated by an independent and experienced blocklayer should a need ever arise.

Members of Masonry Tradesmen's Associations are well aware of the need to display - by example - competent workmanship for works under construction.

It is worth reiterating that design features such as ample roof overhangs contribute significantly to avoiding incidents of leakage. In addition, while surface coatings are a method of providing a significant degree of weather resistance, they do not necessarily make up for all the design and construction shortcomings.

Specifiers and builders should also be aware of the influence of environment on performance. One type of masonry unit, for example, may be completely satisfactory in its normal applications but exhibit serious moisture problems when employed in a location of greater rainfall and perhaps more wind exposure. This distinction will be emphasised by factors such as lack of roof overhangs in wetter climates.

A major requirement is satisfactory performance, and that may call for a suitable surface coating. If the selection of the masonry unit is based on economics, the comparison of costs should include the price delivered on site, and the cost of any subsequent treatment to ensure satisfactory performance.

If the selection is based on appearance, it must be realised that the apparent advantage of a particular block may be of no consequence should performance demand the application of a coating.

In every case of residential construction, the wall and its external treatment have to comply with the NZBC, either clause E2/AS3 or with an alternative solution.

Mortar

Weathertight joints are dependent on the joint space being completely filled with good quality mortar, correctly tooled to shape and seal its outer surface and to compress it against the face of the masonry unit. Some time after laying the masonry, the mortar

begins to harden. As it does so it will tend to shrink slightly and pull away from the lips of the joint. The firm and proper use of the jointing tool restores intimate contact of the mortar and the masonry units, and also seals any cracks which may have been left when the wall was laid.

The mortar is ready for tooling when it can still be impressed by firm thumb pressure, but without adhering to the thumb.

Proper tooling contributes significantly to the weatherproofing of the wall, but it does require that the joints are already well filled with mortar, particularly the perpends or vertical joints. Mortar may have fallen from these joints as the units were laid, or mortar cracks may have formed during the alignment of the blocks. Additional mortar should be forced into any sparse joints so as to ensure complete filling. This should be done as soon as possible after laying and aligning the masonry units, and definitely before the mortar within the joint has lost its plasticity. Reference should be made to illustration No. 28 in the Blocklaying section of the manual.

Grooved or veed tooled joints, as illustrated in the chapter dealing with Mortar and Mortar Joints, are recommended as the most effective for weatherproofing the wall. Weathered joints are also suitable but the relationship of vertical and horizontal joints is not so easily resolved.

Further details of mortar mixes, joint types, tools and tooling are given in those sections of the manual dealing with Blocklaying, and Mortar and Mortar Joints.

Control Joints

The weather-resistance of concrete masonry is enhanced by controlling the positions of cracks arising from shrinkage or structural movement, and the proper caulking of those cracks, or control joints as they are more correctly called.

The exact position and spacing of control joints will vary from job to job but should not be larger than 6 m in horizontal direction when using non-specific design standards. Information on methods of forming and sealing control joints is given in the general chapter of the Construction Details section of this manual and also in the section on Veneer Walls.

Further information is given in ‘CCANZ CP 01’, Code of practice for Weathertight Concrete and Concrete Masonry Construction.

Grouting

Structural use of concrete masonry requires a degree of reinforcement and grout filling to an extent that is resulting in an increasing number of fully grouted walls being built. It is very important not to assume that solid filling automatically must produce a weathertight wall. In particular, reconsolidation of grout some time after filling is a vital ingredient to ensure a weathertight solid filled wall. The details of grouting methods are described in the construction section, including the preferred use of gas release type of expanding admixture which automatically compensates for initial volume losses in the grout.

Flashings

The development of chemical sealants and mastics has allowed a reduction in the use of flashings, but it is still prudent design detailing for metal or plastic flashings to be used at parapets, gutters, roof intersections and larger projections.

Materials used for flashings must be moisture-proof, resistant to atmospheric corrosion, resistant to alkali that might be present in the blocks or mortar, resistant to casual puncture or abrasion, easily formed to the required shape and capable of maintaining that shape.

Where a coating is to be applied to the wall, compatibility of flashing material and coating should be confirmed.

Where flashings occur on a building facade, their lower edges should be bent outwards ***at least 20 mm*** and then downwards so as to cause water to drip clear of the facade.

Offsets

It is recommended that concrete masonry sill courses be of the projecting type, in order that water running off same will also drip clear of the facade. The breaking down of rainwater flow in its passage down or across a facade will assist in control of weather staining. The positioning of sill courses and offsets should be considered for that reason at the design stage.

Offsets of approximately 15 mm where concrete masonry meets, say, concrete beams or columns will also assist rainwater flow control and reduce weather staining. Such offsets also provide a rebate against which sealant could be applied by pressure gun, if required.

Table 1: Types of Concrete Masonry Units

	Type 1	Type 2	Type 3	Type 4
Principal Aggregate	Limestone	Scoria	Greywacke	Pumice
Dry Density Kg/m^3	1,794	1,711	2,195	1,701
Dry Density Kg/m^3	208	225	128	166
Permeability Factor (as per AS/NZS 4455.1:2008)	363	24	4	19

Weepholes

Weepholes should be formed in the vertical mortar joints of the outer leaf or skin of a cavity wall immediately above the supporting beam or slab. Refer also to the Veneer walls and Construction Details sections of this manual. Weep holes should also be formed in the bed joints connecting to non-filled masonry cells in partial fill construction.

Masonry Units with Surface Coatings

Although it is not always necessary to provide a coating to concrete masonry, in most cases walls are given some treatment either for decoration or for weatherproofing. Decoration may be desired to provide colour or texture. In some cases, it may be intended to simplify maintenance or perhaps offer protection against the disfigurement of graffiti. Occasionally, specialised coatings will be applied for hygiene reasons, or to offer protection against chemical attack. Paint manufacturers will recommend products suited to these purposes.

The Australian/New Zealand Standard AS/NZS 2311:2009, Guide to Painting of Buildings, Section 3.9.2, contains recommendations for preparing masonry surfaces. In particular attention is drawn to the alkaline nature of concrete, moisture content, surface conditions and efflorescence.

Weathertightness is a more fundamental matter. The New Zealand Concrete Masonry Association has recently commissioned research work by the New Zealand Concrete Research Association and the Building Research Association of New Zealand on the effectiveness of various coatings in restricting moisture movement through masonry walls. This is a complex subject, with several avenues available for further research. The results so far, however, have shown some interesting patterns which form the basis of these recommendations.

Four different types of masonry units were selected to cover a range of aggregates, manufacturing processes, etc. Resistance to moisture movement is only one of several characteristics of the concrete masonry unit. It is therefore not surprising to find that this property varies considerably as different manufacturers programme their productions according to their raw materials, their plant capabilities, and the individual characteristics they wish to emphasise in the product. The four types selected for test are shown in **Table 1**.

The types represent a range of characteristics of masonry products currently in production from four plants. They do not match each individual plant's production. In each area, the manufacturer will be able to advise which of these four most closely represents his product from the point of view of resistance to moisture movement. The most critical characteristic is that of permeability.

Surface Preparation for Coatings

The surface to be coated must be clean and free from any dust or loose particles.

Oil spots and the like must be cleaned off by wiping with a solvent or by scrubbing with a detergent or trisodium phosphate solution. The wall must then be rinsed with water and allowed to dry.

Another condition that may be detrimental to the successful coating of concrete masonry is efflorescence. Efflorescence is not common in concrete masonry but can arise through site conditions or other influences.

Efflorescence usually shows as a whitish bloom of salts on the surface of concrete within which movement of water has carried the salts to the surface. If water continues to enter such concrete, even after coating, efflorescence could continue and cause damage to the coating. Efflorescence on concrete surfaces may be removed by acid brushing but prevention of efflorescence or its recurrence requires the elimination of movement of water into and through the concrete. Such water can come from many sources, some of which are wet soil behind a wall, water vapour condensing in a wall or roof, leakage from rain or surrounding water.

Problems of this sort must be resolved before coatings are applied.

Before applying solvent-based coatings, the surface should be dry for the top 1.5mm. Dry concrete masonry is usually light grey in colour. If in doubt, a moisture meter should be used.

In addition to paying attention to the masonry surfaces, care must also be exercised at adjacent or surrounding elements of the structure such as windows, flashings, services and sealants. Some of the aforementioned preparation methods could be damaging to such other elements if carried out without proper consideration and care.

Synthetic coatings and chemical sealants are in increasing use. In most instances, the coating selected for the masonry will also be applied to any sealants which have been employed, for example, at control joints or around joinery. Information on compatibility of coating and sealant should be requested from the manufacturer of each product. This precaution should be exercised with synthetic flashings or other items where there may be a reaction between the various materials.

Types of Coatings

The range of coating types and the sources of their supply seem to be ever increasing. Within this healthy development there have become known several manufacturers and suppliers with whom detailed selections and specifications for particular applications should be discussed.

Paint formulations can vary considerably, such that - for example - even though two paints may contain the same binding resin, the quality of the paints will be very different if one of those paints is formulated with less resin (consequently greater quantity of filler). A good quality paint, supplied from a reputable manufacturer is recommended.

The following comments are given to assist in providing a base for such discussions. The nature of the subject is such that not all coatings are mentioned, but those in current use are:

1.0 Paints/Coatings

1.1 Acrylic Pigmented Standard or Elastomeric High Build Paint ≥ 180 µm

Concrete walls shall be sufficiently dry to give a relative humidity reading of less than 70% at the time of coating application. The substrate shall be free of contaminates prior to the application of the coating system.

Coatings shall be applied out of direct sunlight and at temperatures between 5°C and 30°C, with the expectation that the temperature will be in that range for the following 12 hours.

Coatings shall not be applied in damp conditions.

Pigmented elastomeric high build acrylic coatings for exterior use shall have a dry film thickness of at least 180 µm. No less than two coats shall be applied.

1.2 Clear Sealer Coating

The coating system shall be supplied by a single supplier who takes responsibility for the system as a whole, encompassing the weathertight coating. The system shall be applied by the coating manufacturer's approved applicator.

Clear coating systems are to be recoated every five years at a minimum or in accordance with the manufacturer's specifications.

The clear coating system shall be designed to prevent water ingress into the pores of the concrete or masonry. The system shall allow the passage of water vapour from the interior to the exterior.

Clear coating systems shall be tested for permeability in accordance with AS/NZS 4456.16. The test shall be conducted on a standard masonry block with a density of between 1,350-1,500 kg/m^3 over a test period of two hours and show a permeability of 1 mm/hr or less.

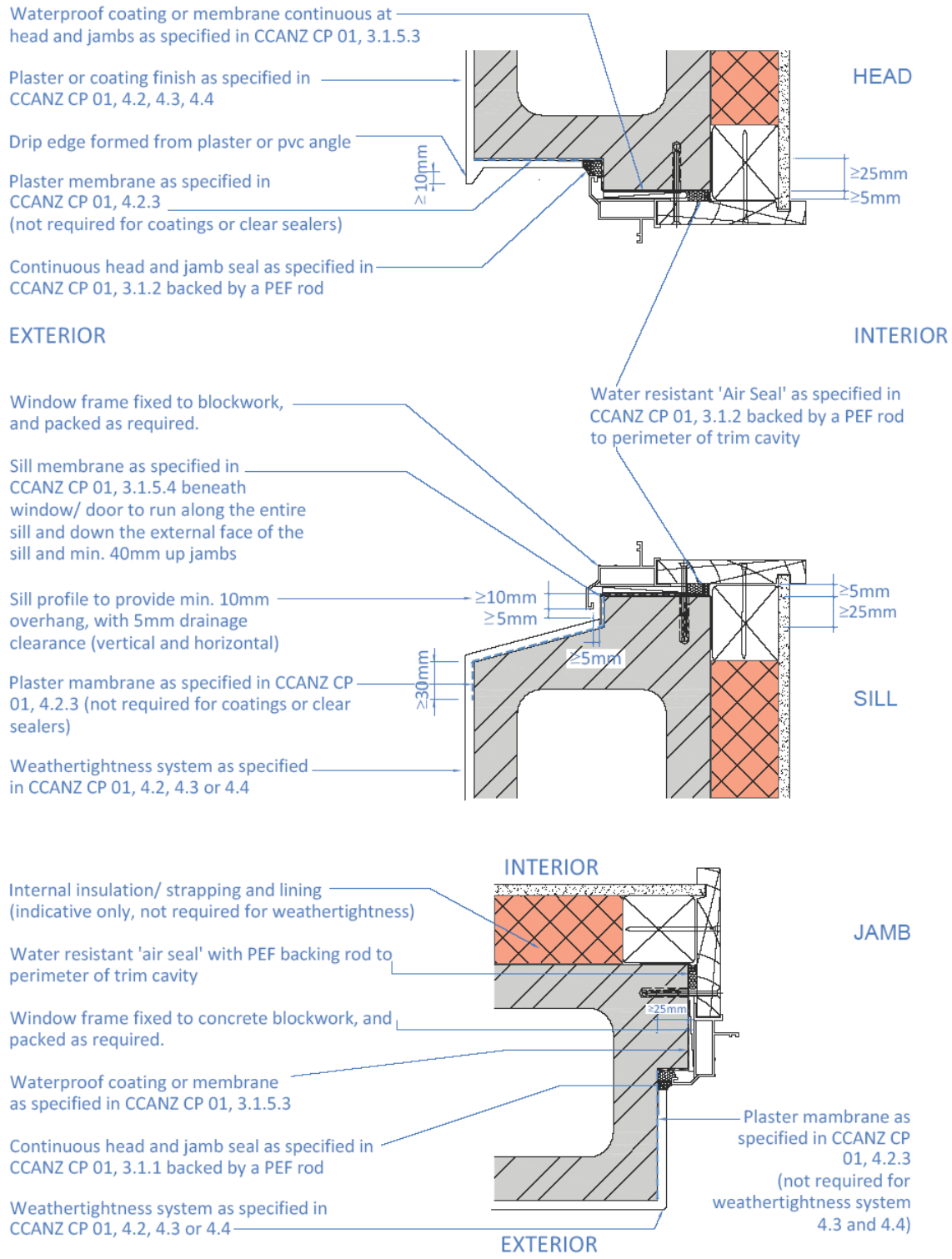
When building with a low permeability block, the tested permeability shall be 3 mm/hr or less. Low permeability blocks are blocks with a permeability of less than 10 mm/hr when tested in accordance with AS/NZS 4456.16.

1.3 Clear Coat Impregnations

Clear coat impregnations shall comply with EN 1504 part 2.

Detail 1 (page 5) shows typical window joints in coated and plastered concrete masonry walls.

Further construction details are given in 'CCANZ CP 01' with details 3b, 8, 19, 23, 27, 34a, 34b, 54, 58a, 62 and 66.



Comment 1: Structural layout is indicative only and subject to individual project design.
Comment 2: Thermal insulation is not required for weathertightness.

Detail 1

(not to scale)

Window - Head, Sill and Jamb

Weathertightness system: external coating or plaster

2.0 Plaster Systems

The substrate shall be free of contaminates prior to the application of the base coat.

Plaster shall be applied out of direct sunlight at temperatures between 5°C and 30°C, with the expectation that the temperature will be within that range for the following 24 hours.

2.1 Polymer Based Plaster System

Polymer based plaster systems comprise of a base coat with:

(i) Plaster of at least 3 mm thickness to form a flat plane surface,

(ii) Reinforcing with an alkali-resistant fibreglass mesh as specified in section 2.5.3.2,

(iii) Cover to the mesh of at least 1.0 mm of plaster, and a

(iv) Minimum bond strength of 0.1 MPa to the concrete or concrete masonry substrate, and a

(v) Polymer modified cement-based plaster finish coat with a standard acrylic coating of no less than 80 µm dry film thickness.

2.2 Polymer Modified Cement-based Plaster System

Polymer modified cement-based plaster systems comprise of a base coat with:

(i) Plaster of at least 3 mm thickness to form a flat plane surface,

(ii) Reinforcing with an alkali-resistant fibreglass mesh as specified in section 2.5.3.2,

(iii) Cover to the mesh of at least 1.0 mm of plaster and a

(iv) Minimum bond strength of 0.1 MPa to the concrete or concrete masonry substrate, and a

(v) Polymer modified cement-based plaster finish coat with a standard acrylic coating of no less than 80 µm dry film thickness.

2.3 Solid Plaster System

Solid plaster systems comprise of a base coat with:

(i) Bond or scratch coat 3 to 4 mm thick, reinforced with an alkali-resistant fibreglass mesh as specified in section 2.5.3.2, and

(ii) Flanking coat 9 to 15 mm thick in accordance with NZS 4251, and a

(iii) Solid plaster finish coat, 2-3 mm thick, applied in accordance with NZS 4251.

2.4 Three Coat Cement Solid Plaster

Three coat cement-based solid plaster in accordance with NZS 4251 Section 3: *Plaster system for concrete masonry walls.*

Detail 1 (page 5) shows typical window joints in plastered concrete masonry walls.

Further construction details are given in 'CCANZ CP 01' with details 3a, 8, 19, 23, 27, 34a, 34b, 54, 58a, 62 and 66.

3.0 Exterior Insulation Finish System (EIFS)

3.1 Limitations

EIFS shall be:

(a) Designed and tested as a total system, to meet NZBC E2,

(b) Supplied by a single supplier who takes responsibility for the system as a whole encompassing the durability, weathertight detailing and overall weathertightness, and

(c) Not fixed:

(i) so as to form a horizontal surface, or

(ii) in such a way as to allow water to pond.

3.2 General

COMMENT: *It is recommended that installation and finishing of EIFS is carried out by trained applicators who are approved by the New Zealand supplier of the system.*

3.3 Materials

EIFS shall comprise:

(a) A polystyrene rigid insulation board,

(b) A polymer-modified cement-based base plaster or a polymer-based base plaster, reinforced with fibreglass mesh, and

(c) A polymer-modified cement finishing plaster system or polymer-based finishing plaster system in one or more coats.

3.3.1 Polystyrene Board

Polystyrene boards shall be either:

(a) Expanded polystyrene (EPS) complying with AS 1366: Part 3, Class H or Class S, or

(b) Extruded polystyrene (XPS) that complies with AS 1366: Part 4.

COMMENT: *The minimum board thickness will be determined by structural and thermal requirements. For some EIFS, polystyrene boards are available with the base coat plaster factory-applied.*

The polystyrene boards shall be mechanically fixed at no greater than 600 mm centres and adhered to the wall using a cement-based mineral adhesive coat, tested for bond strength between polystyrene and concrete or masonry substrate, in accordance with ASTM E2134-01(2006).

The concrete or masonry wall shall be free of contaminates prior to application of the adhesive.

3.3.2 Fibreglass Reinforcing Mesh

The entire exterior surface of the polystyrene sheet (including corners) shall be continuously reinforced with an alkali-resistant fibreglass mesh, which shall:

(a) Weigh no less than 150 grams per m^2,

(b) Have an aperture size from a minimum 3 mm x 3 mm to a maximum of 6 mm x 6 mm square,

(c) Comply with the requirements of EIMA 101.91 test No. 6.3 and ASTM E2098,

(d) Be tested for alkali resistance by 28 days immersion in 5% sodium hydroxide with no visual degradation at the end of the test, and

(e) Overlap at mesh to mesh joints for at least 75 mm.

3.3.3 Base Coat Plaster

The base coat plaster shall:

(a) Be at least 3 mm thick and form a flat plane surface and be either:

(i) polymer-modified cement-based plaster, or

(ii) polymer based plaster,

(b) Be reinforced with an alkali-resistant fibreglass mesh as specified in section 4.1.3.2 of 'CCANZ CP 01',

(c) Cover the mesh by at least 1.0 mm,

(d) Be applied out of direct sunlight at temperatures between 5°C and 30°C, and with the expectation that the temperature will be within that range for the following 24 hours, and

(e) Have a bond strength with the polystyrene board tested in accordance with ASTM E2134-01(2006).

3.3.4 Finish Coat

The finish coat shall comprise either:

(a) A polymer-modified cement-based plaster or a polymer-based plaster, finished in both cases with a paint coating, or

(b) Either a pre-coloured polymer-modified cement-based plaster, or a pre-coloured polymer-based plaster with the top coat applied as a decorative plaster that is sealed or glazed.

COMMENT: *Dark colours cause* finishes *to reach higher temperatures, which results in more thermal expansion and a greater risk of cracking. Coating manufacturers can supply reflectance values.*

3.3.5 Openings and Penetrations

(a) All window/door openings shall have waterproof membranes as specified in section 3.1.5.2 of 'CCANZ CP 01',

(b) All wall recesses shall have waterproof membranes as specified in section 3.1.5.2 of 'CCANZ CP 01',

(c) All window/ door openings, wall recesses and penetrations shall have sealant, or air seals as detailed in sections 3.1.1 to 3.1.2 of 'CCANZ CP 01', and

(d) Openings and penetrations in EIFS shall be completed as shown in Detail 2 (page 9) and Details 53, 57a and 57b of 'CCANZ CP 01'.

COMMENT: *This is the minimum standard, and additional elements required by the system supplier should not be excluded on the basis of this Code of Practice.*

3.3.6 Decorative Mouldings

Decorative mouldings formed from polystyrene shall be glued onto the base coat plaster and in addition meshed on at the top edge. The adhesive bond strength shall be tested in accordance with ASTM E2134-01(2006). Control joints shall be reflected through the mouldings.

COMMENT: *Decorative mouldings formed from other materials are available, but due to unknown weight and rigidity of the mouldings specific design of the fixing is required.*

3.4 Movement Joints

Control joints shall be provided to coincide with the control joints in the masonry or concrete substrate. The joint shall be 8 to 15 mm wide as shown in Detail 69a of 'CCANZ CP 01'.

The front of the joint shall use either a sealant as specified in section 3.1.1 of 'CCANZ CP 01'or an EIFS joint profile as per Detail 69a of 'CCANZ CP 01'. The sealant shall have a width to depth ratio of 2:1.

At junctions between concrete walls and timber or metal frame walls, a control joint and back flashing as shown in Details 61 to 64 shall be provided.

3.5 EIFS/Floor Slab Junction

The bottom of the EIFS shall run at least 100 mm into ground as shown in Details 1 and 2 of 'CCANZ CP 01' and incorporate a waterproofing capillary break in the insulation.

The capillary break shall be formed by a continuous cut through the insulation board. The bottom section of the insulation board shall be made watertight by applying a membrane as specified in 4.2.3 of 'CCANZ CP 01'and as shown in Details 1 and 2 of 'CCANZ CP 01'.

COMMENT: *If the EIFS terminates above ground, no capillary break is required but the bottom edge of the EIFS should be finished using a PVC cap incorporating a drip profile.*

3.6 Parapets and Balustrades

Parapets and balustrades shall comply with section 6.11 of 'CCANZ CP 01'. Balustrades shall use the same weathertightness details and specifications as for parapets.

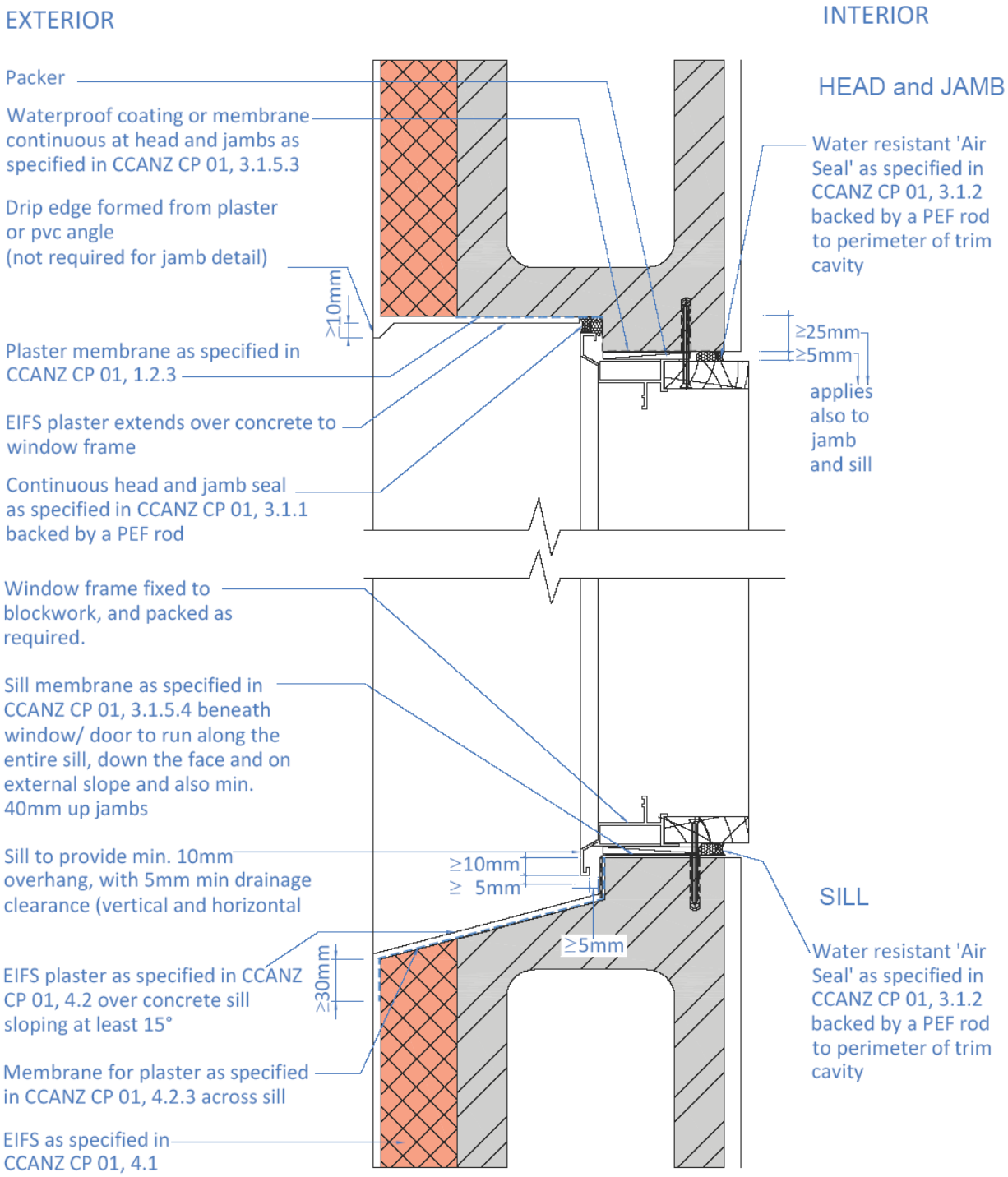
3.7 Fixings

Fixings of downpipes brackets, garden taps and other outside fittings shall be in accordance with NZBC E2/AS1 Paragraph 9.9.4.4.

Designs of fixing brackets for connecting items carrying substantial loads such as stringers for decks are outside the scope of this Concrete Masonry Manual and will require specific design.

The types of coatings available for the finishing of concrete masonry surfaces are so numerous and diverse that in all cases reference should be made to reputable manufacturers before finally deciding what system to use.

When appropriate, the paint coatings were applied in different ways to the masonry specimens using brush, roller or spray techniques.



Comment 1: Structural layout is indicative only and subject to individual project design.

Detail 2
Window - Head, Sill and Jamb
Weathertightness system: EIFS

(not to scale)

Summary

The properties of concrete masonry can vary significantly from one plant to another but with appropriate care there need be no problem with regard to weatherproofing. The manufacturer can provide information on his product and recommend the most appropriate surface coatings for any given situation.

Surface coatings should not be regarded as compensation for poor design detail or construction techniques. It is important that the established practices as outlined in other sections of this manual should be conscientiously applied.

Care in the preparation of the surface prior to application of a coating is important. The normal precautions recommended for any paint application should be followed but particular attention should be given to the possible presence of efflorescence materials. Possible chemical reactions between coating materials and sealants or flashings, etc. should be considered.

Special care should be exercised in the selection of coatings in those areas which are prone to heavier rainfalls at frequent intervals or high wind.

References

In order to evaluate the methods of weathertightness requirements reference should be made to 'CCANZ CP 01', a free download is provided online at: www.ccanz.org.nz/images/document/CCANZ-CP%2001%202011.pdf.

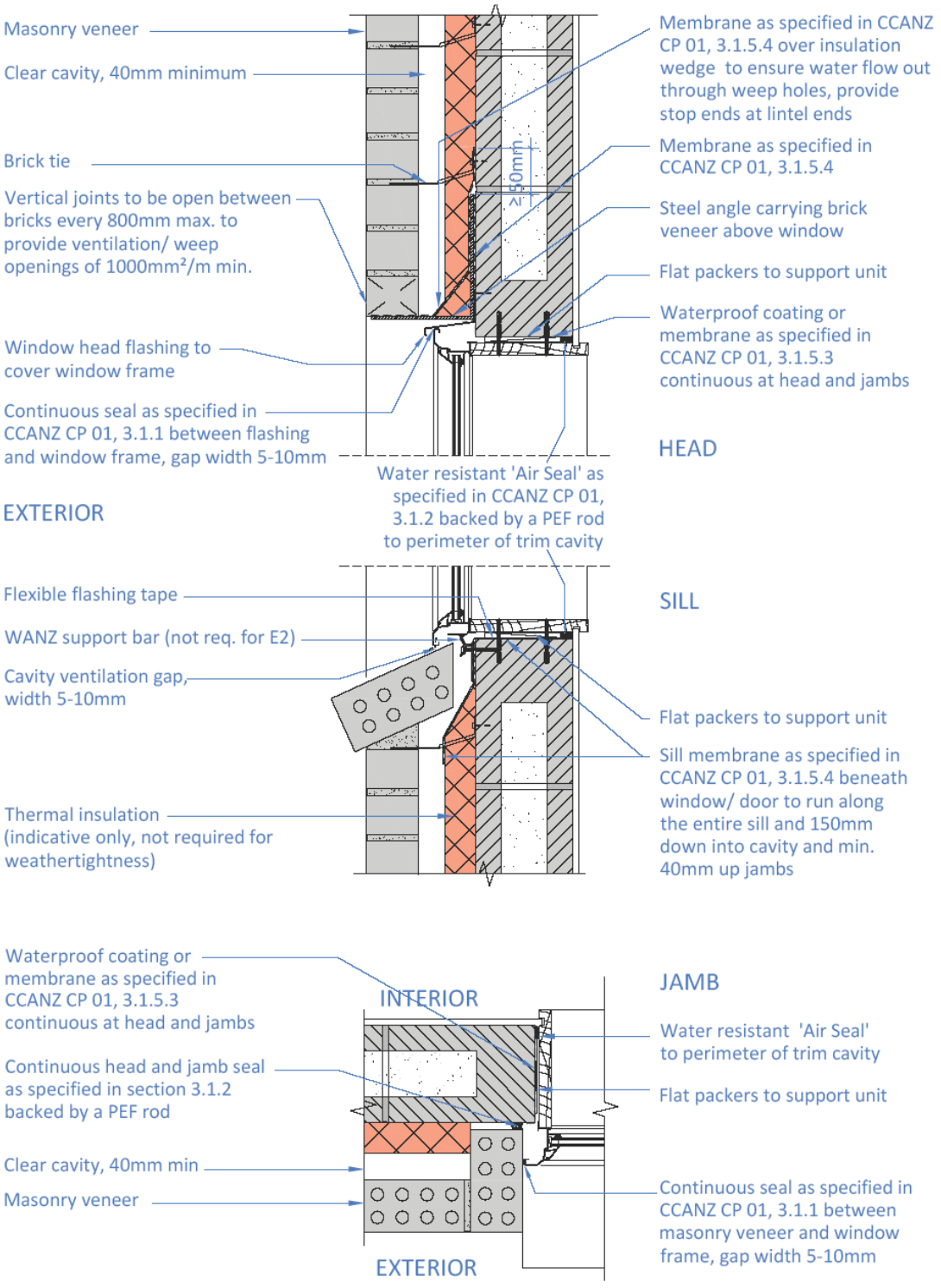
Veneer Section

The basic requirements for veneer construction are contained in Section 5 of the Masonry Manual.

This section has recently been revised to take into account the latest revisions to E2/AS1, E2/AS3 and NZS 4229:2013 Appendix E.

E2/AS1 deals with construction using timber frame as a structural wall support. E2/AS3 deals with construction using concrete or masonry as a structural wall support, which also appears as Appendix E of NZS 4229:2003.

The weatherproofing aspects are illustrated in Detail 3 on page 11. More details are shown in Section 5 of the Masonry Manual.



Comment 1: Structural layout is indicative only and subject to individual project design.
Comment 2: Thermal insulation is not required for weathertightness.

Detail 3

(not to scale)

Window - Head, Sill and Jamb

Weathertightness system: brick veneer with drained cavity