



## Determination 2016/016

# Regarding the code-compliance of a zero pitch roof system using a protected liquid-applied membrane

### Summary

The determination considers whether zero pitch protected liquid-applied membrane roofs will comply in regards to weathertightness and durability if constructed as specified by the manufacturer. The determination provides analysis of the evidence in support of the membrane in this use, sets out the design parameters for buildings for which the waterproof membrane would be used, and discusses drainage, resistance to water, and whether there is reliance on other components of the roofing system.

### 1. The matter to be determined

- 1.1 This is a determination under Part 3 Subpart 1 of the *Building Act 2004*<sup>1</sup> (“the Act”) made under due authorisation by me, John Gardiner, Manager Determinations and Assurance, Ministry of Business, Innovation and Employment (“the Ministry”), for and on behalf of the Chief Executive of the Ministry.
- 1.2 The party who applied for the determination, B Gerrard, is a licensed building practitioner (“the applicant”), acting through a building consultant for this determination (“the agent”).
- 1.3 I consider the Manufacturer, Allco Waterproofing Solutions Ltd (“the manufacturer”), is a person with an interest in the matter.
- 1.4 The applicant has applied for a determination on whether zero pitch protected membrane roofs, if constructed as specified by the manufacturer, comply with Clauses B2.3.1(b), B2.3.2(b), E2.3.1, E2.3.2 and E2.3.7(a, b, c). The application is not in respect of building work at a particular site or situation, but considers the specification as supplied by the manufacturer:
  - “Allco Waterproofing Solutions Ltd Zero Pitch Roofing System (PMR) Parts 1 to 6 Issued Version 1.0 dated 3 April 2016”and with the following parameters:
  - buildings that comply with the New Zealand Building Code through design to AS/NZS 1170:2002<sup>2</sup>, and
  - are less than 150m in height, and

<sup>1</sup> The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at [www.building.govt.nz](http://www.building.govt.nz) or by contacting the Ministry on 0800 242 243.

<sup>2</sup> Australian and New Zealand Standard AS/NZS 1170:2002 Structural design actions

- applied to a concrete (structural concrete or lightweight structural concrete) substrate.
- 1.5 The matter for determination under section 177(1)(a) of the Act is whether a roof as described above, would comply with Clauses B2.3.1(b), B2.3.2(b), E2.3.1, E2.3.2 and E2.3.7(a, b, c) of the Building Code (First Schedule, Building Regulations 1992).
- 1.6 In this determination, I refer to the following legislation and Standards, the relevant parts of which are set out in Appendix A.
- The Building Act 2004 with its sections referred to as sections of the Act.
  - Building Code Clause B2 Durability, specifically B2.3.1(b) and B2.3.2(b)
  - Building Code Clause E2 External Moisture, specifically E2.3.1, E2.3.2 and E2.3.7(a, b, c)
  - Acceptable Solution E2/AS1 for New Zealand Building Code Clause E2
- 1.7 In making my decision, I have considered the submissions of the applicant and the other evidence in this matter. I have not considered any other aspects of the Act or of the Building Code.

## **1.8 Limitations on this determination**

- 1.8.1 It is important to note that the validity of this determination remains as long as the conditions in paragraph 1.4 of this determination are maintained, in particular the version of the “specification” referred to.
- 1.8.2 This determination is only valid with respect to the Building Code in force at the date of the determination.

## **2. The background**

- 2.1 An application for determination was received on 12 November 2016. On 26 November 2015 I requested the agent clarify what the relevant building work was and how the applicant was affected by it.
- 2.2 The agent responded by email on 26 November 2015 (in summary): the applicant (being a licensed building practitioner) has specified green roofs in the past with a slope but wishes to be able to specify a green roof with a lesser slope.
- 2.3 On 16 December 2015 I wrote to the applicant setting out proposed matters to be determined.
- 2.4 The agent responded by email on 11 January 2016 with the matter to be determined as being “whether the building work as described by “the specification” complies with the relevant clauses of the Building Code as noted in paragraph 1.5.

## **3. The submissions**

- 3.1 In a covering letter to the application, the agent set out the matter to be considered as “whether the relevant provisions of the building code will be met if the building work described by the Allco Waterproofing Systems Ltd, Zero Pitch Roofing System (PMR) were properly completed in accordance with the plans and specification documentation that accompanies this determination.”

3.2 This was subsequently amended to “whether the building work as described by the “specification” complies with

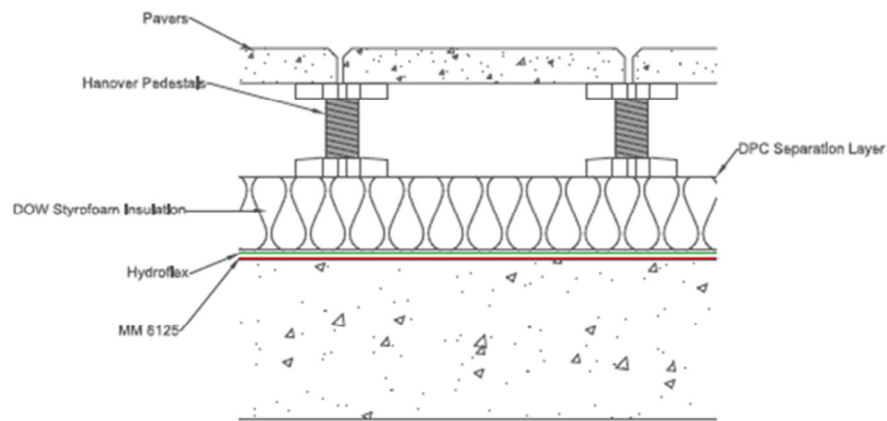
- E2.3.1
- E2.3.2
- E2.3.7(a, b, c) and
- B2.3.1(b) and B2.3.2(b)

3.3 The applicant provided copies of the manufacturer’s specification, datasheets and independent assessments. The specification relates to the design of the system within the parameters set out in paragraph 1.4 of this determination. The system described in the specification consists of:

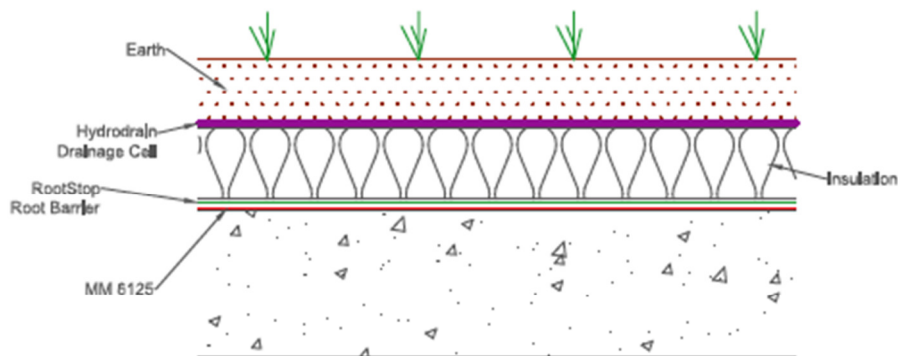
**Table 1**

<b>Element</b>	<b>Function</b>
Hydrotech MM6125 system	Provides waterproofing layer
Electronic Field Vector Mapping (EFVM)	Detects breaches or any construction related damage to the Hydrotech MM6125 layer
Dow Styrofoam (Roofmate SL-X)	Provides the insulation layer as well as water resistance/moisture shedding
DPC Water Control layer	An optional DPC layer included to mitigate the risk of “cold rain phenomenon”, used where concrete pavers or stone/gravel ballast is installed.
Hydrotech root stop, or Casali Eradix	For use with a green roof to prevent roof penetration and ensure durability of the membrane
Filter fabric	An optional protective layer that protects the Insulation layer from exposure to the sun, prevents the stone ballast from falling between the insulation panels
Drainage mat Hydrodrain 300 or Aquadrain	Provides an additional drainage layer and is used in conjunction with a green roof installation
Ballast	Ensures that the insulation remains in place. Ballast can be: <ul style="list-style-type: none"> <li>• Pavers and associated feet or pedestals</li> <li>• Gravel stop</li> <li>• Stone crushed</li> <li>• Soil medium/green roof</li> </ul>

3.4 The system is shown in the following figures:



**Figure 1: The roofing system with pavers as ballast (nts)**



**Figure 2: The roofing system with a green roof as ballast (nts)**

3.5 The items noted in Table 1 above as being optional have no effect on Building Code compliance with respect to external moisture and are not part of the specification for the purpose of this Determination. I have considered those items to the extent that the waterproofing layer may rely on them for durability.

3.6 I have therefore considered the following elements as making up the system that is subject to this determination:

- A hot applied rubberised monolithic membrane that is fully adhered to a structural concrete roof deck (Hydrotech MM6125 membrane system). I refer to this as “the waterproof membrane” in this determination.
- A layer of extruded polystyrene insulation (Roofmate SL-X).
- A protective layer (dependant on ballast).
- Ballast (concrete pavers, stone, or soil).

3.7 A draft determination was issued to the applicant and the manufacturer for comment on 26 February 2016.

3.8 The applicant was broadly in agreement with the draft determination but requested a hearing which was held on 9 March 2016

3.9 The applicant made submissions about the following:

- The importance of Electronic Field Vector Mapping (EFVM) for detecting defects in the membrane.
- The specification of wind speeds for design purposes.

3.10 The applicant provided a revised specification reflecting the scope described in paragraph 1.5 on 13 April 2016. Further clarification of the specification was received on 26 April 2016.

## 4. Discussion

### 4.1 The legislation

4.1.1 The relevant clauses of the Building Code are: E2.3.1, E2.3.2 and E2.3.7(a, b, c), which set out the performance requirements for providing adequate resistance to penetration by and accumulation of water from the outside; and B2.3.1(b) and B2.3.2(b) which sets the durability performance requirements that the building elements must comply with.

4.1.2 Section 19 of the Act provides various means as establishing compliance with the Building Code, including but not limited to compliance with the relevant Acceptable Solution(s). The waterproof membrane and the specified concrete roof structure are outside the scope of the Acceptable Solution and must be assessed as an alternative solution.

### 4.2 External Moisture E2

4.2.1 The Building Code has two key performance requirements with regard to external moisture – that external moisture is shed from roofs and walls, and that roofs and external walls prevent the penetration of water that could cause undue dampness, damage to building elements, or both.

#### **Clause E2.3.1 – Roofs must shed precipitated moisture. In locations subject to snowfalls, roofs must also shed melted snow.**

4.2.2 The agent has expressed the view that BCAs are reluctant to grant a building consent where the roofing system is being used on roof with a gradient less than 2 degrees, and argues that E2.3.1 can be satisfied by a roof with zero gradient.

4.2.3 Acceptable Solution E2/AS1 specifies a minimum roof pitch for several common roof claddings. However it does not apply to the building work described in this determination in at least two respects: being a liquid applied membrane, the waterproof membrane is outside the scope of the Acceptable Solution; and the specified concrete roof structure is outside the scope of buildings to which E2/AS1 applies.

4.2.4 In this case it is the Code of Practice for Torch-on Membrane Systems for Roofs and Decks<sup>3</sup> (“the Code of Practice”) that provides a more relevant basis on which to make an assessment of compliance. The Code of Practice states:

... While torch-on membranes will keep water out where there is no fall, it is well recognised that providing adequate fall to the roof area enhances the serviceable life of the membrane system, and minimises ponding and the risk of moisture ingress into the structure.

This Code of Practice requires the following falls:

<sup>3</sup> Membrane Group New Zealand Inc., *Code of practice for torch-on membrane systems for roofs and decks: for the selection, design and installation of reinforced modified, bituminous materials*, (Oct. 2008)

- The minimum fall for a roof is 1.50, which is equivalent to 1:40
  - The minimum fall for a deck is 1.00, which is equivalent to 1:60
- 4.2.5 However, the Code of Practice also states that situations outside those above are subject to specific design, and can be readily resolved with dialogue between the designer and supplier. In other words, the limits of fall are not absolute.
- 4.2.6 Drainage of the roof system must properly take into account likely rainfall intensity, the location and capacity of drainage points from the roof, and the movement of rainwater through the ballast or other material over the insulation layer.
- 4.2.7 The specification provides design information for ballast and soil overburden, and addresses drainage through those materials. The specification also provides for a drainage mat to facilitate drainage in a green roof.
- 4.2.8 It is possible, and realistic to expect, that a notionally flat roof structure could in practice have low points in which water would pond. The question is whether this would constitute a failure of the performance requirement to “shed precipitated water”. I consider that such low points reflect construction tolerances, and accordingly I have taken the view that this is appropriately considered as a matter for compliance with E2.3.7(b).
- 4.2.9 I am satisfied that the specification provides for precipitated water to be shed, in compliance with E2.3.1.

**Clause E2.3.2 – Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to building elements, or both.**

- 4.2.10 The applicant has provided evidence of certification by the British Board of Agrément (BBA) for the waterproof membrane system, used with a range of reinforcement membranes and protection sheets to form a waterproofing layer for flat and completely flat roofs, podiums, green roofs and roof gardens. The certificate includes consideration of its use as a protected waterproofing layer on flat roofs (including completely flat).
- 4.2.11 I am satisfied that the BBA certification of the waterproof membrane system is reasonable evidence of compliance with E2.3.1 for construction that is in accordance with the specification.
- 4.2.12 I am of the view that the waterproof membrane system will comply with Clause E2.3.2 without relying on contribution from other components of the system described in the specification.

**E2.3.7 Building elements must be constructed in a way that makes due allowance for the following:**

- (a) the consequences of failure:
  - (b) the effects of uncertainties resulting from construction or from the sequence in which different aspects of construction occur:
  - (c) variation in the properties of materials and in the characteristics of the site.
- 4.2.13 I consider that the waterproof membrane being fully adherent to the underlying concrete roof substrate minimises the passage of moisture should the membrane itself fail to resist penetration by moisture.
- 4.2.14 I also note that inspection of the integrity of the membrane by electronic field vector mapping (EFVM) to ensure that the membrane has been applied without defects is a critical part of the specification.

- 4.2.15 I am therefore satisfied that the specification satisfies E2.3.7(a).
- 4.2.16 In considering E2.3.7(b) I have assumed there is a likelihood of unintended ponding of water at low points on a nominally flat concrete roof as a consequence of normal construction tolerances.
- 4.2.17 I have considered the functional requirement (Clause E2.2) to provide adequate resistance to penetration and the accumulation of moisture from the outside.
- 4.2.18 I take the view that provided the integrity of the membrane with respect to water resistance is not compromised then the functional requirement does not depend absolutely on precipitated water being shed.
- 4.2.19 The applicant has provided evidence of certification by the British Board of Agrément (BBA) for the waterproof membrane system for use as a protected membrane for above- and below-ground waterproofing within a structure of concrete, brickwork or blockwork, or as a damp-proof membrane for solid floors.
- 4.2.20 I am satisfied that the membrane would provide sufficient resistance to water that might pond in local low points, and therefore I am satisfied that the specification satisfies E2.3.7(b).
- 4.2.21 This of course requires the structural capacity of the roof to be sufficient to carry the weight of water that might have been retained. The structural design of the roof should recognise and allow for the weight of retained water.
- 4.2.22 I am satisfied that the specification, which includes installation procedures, provides for site specific conditions of the substrate to be evaluated and treated to be suitable for application of the membrane, and that when installed in accordance with the specification the water proof membrane satisfies E2.3.7(c).

### **4.3 B2 Durability**

#### **Clauses B2.3.1(b) and B2.3.2(b)**

- 4.3.1 The waterproof membrane system has been in use in Canada since 1963 and in the UK since 1988. The generic inverted roof system has been widely used internationally.
- 4.3.2 I note that the BBA certification for the waterproof membrane system is with respect to a protected waterproofing layer. I have considered whether other components of the system specification are relied upon for code compliance with respect to durability of the membrane. I have not considered whether they attract Building Code requirements in their own right.
- 4.3.3 In considering the durability requirements for this system, I note that the application is in respect of clause B2.3.1(b), which requires a fifteen year durability for those building elements (including the building envelope) that are moderately difficult to access or replace, or where failure would go undetected during normal use but would be easily detected during normal maintenance.
- 4.3.4 It is my view that the membrane, covered by insulation, other protective membranes, and ballast (concrete pavers, stone, or soil) is more than “moderately difficult to access and replace”, and that the failure would not be easily detected during normal maintenance and would go undetected during normal use. Accordingly it is clause B2.3.1(a) that is the appropriate requirement, which necessitates 50 years durability.
- 4.3.5 The BBA certification for the waterproof membrane system states that “the system, when fully protected and subjected to normal service conditions, will provide an

effective barrier to the transmission of moisture for the design service life of the structure in which it is located”.

- 4.3.6 I am satisfied that this encompasses the 50 year durability required for compliance with B2.3.1(a).
- 4.3.7 I have not explicitly considered the thermal performance of the Roofmate SL-X roof insulation material, but I have considered its durability as it provides physical protection to the waterproof membrane.
- 4.3.8 I note that the BBA agrément certificate for Roofmate SL-X certifies its use on flat roofs, which the certificate defines as roofs having a minimum fall of 1:80 (0.72 degrees). In this regard the BBA agrément certificate would not fully address the use of the insulation on a zero pitch roof. No submission was made regarding the use of the insulation material on a zero pitch roof at a gradient less than that covered by the BB agrément certificate.
- 4.3.9 I have made an assumption that the BBA agrément certificate caveat relates not to the durability of the insulation, but to the thermal insulation performance and its lesser efficiency should water be present under the insulation. I consider the caveat in the BBA certificate for Roofmate SL-X is not relevant to the consideration of compliance with respect to external moisture, and therefore does not disqualify the use of Roofmate SL-X on a completely flat roof above the waterproof membrane. Compliance with H1 Energy Efficiency is not a matter of this determination; the energy efficiency performance would be a matter for specific consideration by a BCA when considering an application for building consent.
- 4.3.10 I note that the insulation material is itself fully protected from UV radiation by a protective layer and then ballast of stone, concrete pavers or soil placed to prevent uplift by wind forces or buoyancy forces.
- 4.3.11 Notwithstanding that ballast or pavers, if used, are likely to have a durability greater than the waterproofing membrane, I consider them to be designed for removal and replacement. I am satisfied that the specification satisfies B2.3.2(b).

#### **4.4 Consideration of the scope of the system**

- 4.4.1 I have considered to what extent the parameters specified in paragraph 1.4 are relevant to the matters that I have considered for determination. The parameters regarding structural competence and nature of the roof substrate are clearly applicable to providing a suitable substrate for the application of the waterproof membrane.
- 4.4.2 Having said that, it would be more accurate to express that parameter regarding structural competence as “Buildings that meet the Building Code requirements for structural performance having been designed in accordance with AS/NZS 1170:2002”
- 4.4.3 The parameter that limits the scope to buildings less than 150m in height is relevant to the design of ballast, in order to resist uplift forces on the insulation layer, but does not affect the compliance with respect to external moisture or durability of the waterproof membrane.



- 4.4.4 The parameter regarding wind exposure zones as defined in NZS3604:2011<sup>4</sup> can only apply to buildings with an eave height no greater than 8m. Wind uplift forces acting on buildings higher than this must be assessed by specific design.

## **5. The decision**

- 5.1 In accordance with section 188 of the Building Act 2004, subject to the limitations described in paragraph 1.8.1 and 1.4 of this determination, I hereby determine that zero pitch protected membrane roofs if constructed as specified by “Allco Waterproofing Solutions Ltd Zero Pitch Roofing System (PMR) Parts 1 to 6 Issued Version 1.0 dated 3 April 2016” comply with Clauses B2.3.1(a), B2.3.2(b), E2.3.1, E2.3.2 and E2.3.7(a, b, c).

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 29 April 2016.

John Gardiner  
**Manager Determinations and Assurance**

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<sup>4</sup> New Zealand Standard NZS 3604:2001 Timber framed buildings

## Appendix A: The legislation

A1. The relevant sections of the Act:

### **19 How compliance with building code is established**

(1) A building consent authority must accept any or all of the following as establishing compliance with the building code:

- (a) compliance with regulations referred to in section 20:
- (b) compliance with an acceptable solution:
- (ba) compliance with a verification method:

A2. The relevant clauses of the Building Code:

**B2.3.1** Building elements must, with only normal maintenance, continue to satisfy the performance requirements of this code for the lesser of the specified intended life of the building, if stated, or:

- (a) the life of the building, being not less than 50 years, if:
  - (i) those building elements (including floors, walls, and fixings) provide structural stability to the building, or
  - (ii) those building elements are difficult to access or replace, or
  - (iii) failure of those building elements to comply with the building code would go undetected during both normal use and maintenance of the building.
- (b) 15 years if:
  - (i) those building elements (including the building envelope, exposed plumbing in the subfloor space, and in-built chimneys and flues) are moderately difficult to access or replace, or
  - (ii) failure of those building elements to comply with the building code would go undetected during normal use of the building, but would be easily detected during normal maintenance.
- (c) 5 years if:
  - (i) the building elements (including services, linings, renewable protective coatings, and fixtures) are easy to access and replace, and
  - (ii) failure of those building elements to comply with the building code would be easily detected during normal use of the building.

**B2.3.2** Individual building elements which are components of a building system and are difficult to access or replace must either:

- (a) all have the same durability, or
- (b) be installed in a manner that permits the replacement of building elements of lesser durability without removing building elements that have greater durability and are not specifically designed for removal and replacement.

**E2.3.1** Roofs must shed precipitated moisture. In locations subject to snowfalls, roofs must also shed melted snow.

**E2.3.2** Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to building elements, or both.

**E2.3.7** Building elements must be constructed in a way that makes due allowance for the following:

- (a) the consequences of failure:

(b) the effects of uncertainties resulting from construction or from the sequence in which different aspects of construction occur:

(c) variation in the properties of materials and in the characteristics of the site.