SPRA
Single Ply Roofing Association

TECHNICAL GUIDANCE

WIND LOAD DESIGN REQUIREMENTS FOR SINGLE PLY ROOFING

ENSURING THAT CLIENTS OBTAIN HIGH QUALITY POLYMER-BASED SINGLE PLY ROOFING, THROUGH A PARTNERSHIP OF QUALITY ASSURED MANUFACTURERS AND CONTRACTORS

S11b/17

SPRA TECHNICAL GUIDE SGD09/11
WIND LOAD DESIGN REQUIREMENTS FOR SINGLE PLY ROOFING - PART 2
REQUIREMENTS FOR INSULATION AND MEMBRANE ATTACHMENT

1.0 INTRODUCTION

This report will highlight SPRA best practice guidance with respect to membrane and insulation attachment requirements to provide resistance to wind uplift. It will supplement guidance provided within the 'SPRA Design Guide' [1] and offer references to other appropriate industry documents to ensure that SPRA members are fully informed of the appropriate design and installation requirements.

2.0 SCOPE

The report will focus specifically upon flat roof applications using polymeric single ply membrane fixed using attachment methods including mechanical fasteners, adhesive and ballast. The latter will include green roof applications, where the weight of the substrate above the waterproof membrane and insulation layers may be used for restraint against wind uplift.

3.0 THE IMPORTANCE OF CORRECT INSTALLATION

It is essential that wind load calculations are included as part of the design process to ensure that the method of attachment specified for both insulation and membrane is appropriate to the proposed building and its location. See SPRA document 'Wind load design requirements for flat roofing. Evaluation of the affect of change from BS 6399-2 to the new BS EN 1991-1-4 calculation method' [8] for guidance on the correct provision of wind load calculations for specific constructions.

Incorrect installation of the insulation and membrane restraint requirements can lead to premature failure of the construction. It is therefore essential that the contractor is aware of the required attachment requirements determined by the wind load calculations undertaken.

For membrane installation, the attachment requirements will be specified by the membrane manufacturer and for the insulation either by the appropriate insulation, fastener or adhesive manufacturer / supplier or in some cases

by the membrane manufacturer.It is the responsibility of the person requesting the calculation (roofing contractor / designer or others) to ensure that the information supplied is correct and accurate with respect to the building location, height, dimensions and all other required parameters. Incorrect data could well affect the overall wind load design provision with the consequence of roof failure. (See check list information required for undertaking a wind uplift calculation Annex A).

4.0 RESISTANCE TO WIND USING MECHANICALLY FIXED MEMBRANES

MEMBRANE & INSULATION ATTACHMENT - GENERAL

The attachment of both membrane and insulation should be considered separately. The only exception is field-fixed membrane systems where the membrane is welded/adhered to the insulation securement plate.

4.1.1 MEMBRANE ATTACHMENT

To determine the frequency of membrane fasteners required, a wind uplift calculation in accordance with BS EN 1991-1- 4 should be undertaken to calculate wind load in the corner, perimeter and field areas of the roof. A checklist of the data needed for this to be undertaken is provided in Appendix 1 of SPRA document 'Wind load design requirements for flat roofing. Evaluation of the affect of change from BS 6399-2 to the new BS EN 1991-1-4 calculation method' [8].

The required membrane fastener frequency and fastener design load will be specified by the appropriate SPRA membrane manufacture to contend with the calculated wind load.

Additional fasteners will be required for the corner and perimeter areas due to increased wind loading in these areas. See the 'SPRA Design Guide' [1] for further details.

4.1.2 INSULATION ATTACHMENT

The number of insulation fasteners required is dependent upon board size and type. The SPRA minimum insulation fastener requirements are summarised for each generic insulation type and board size within Appendix A.

For PIR insulation boards, attachment requirements are detailed within the BRUFMA document 'ID/1/2009 Mechanical fixings for Rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes' [2] and the 'SPRA Design Guide' [1]. This requires that where the BRUFMA minimum requirement to secure the boards is proposed, wind load calculations should be undertaken in order to determine insulation fastener requirements at corner, perimeter and field roof areas. These areas should be clearly defined, especially where different numbers of fasteners are required for each section.

Incorrect placement of the insulation fasteners can reduce resistance to wind load. It is essential that the fastener pattern provides for uniform distribution of the wind load acting upon the insulation layer. The correct fastener distribution pattern as recommended by the SPRA insulation manufacturer or fastener manufacturer must be followed.

4.2 IMPORTANCE OF PULL OUT TESTING

It is a SPRA requirement that pullout testing must be undertaken for all refurbishment projects & new build concrete decks.

See 'Mechanical fasteners for attachment of insulation and membranes - SPRA Quality Standard' [3]. The pullout result is required in order to determine by calculation the fastener design load.

Note that for metal decks, the minimum SPRA fastener design load is 400N.

5.0 RESISTANCE TO WIND LOADING USING ADHESIVELY BONDED MEMBRANES

5.1 ADHESIVE MEMBRANE AND INSULATION ATTACHMENT.

See SPRA Document 'Quality control and use of adhesives for the attachment of vapour control layers, insulation and single ply membrane in flat roofing' [4].

A wind uplift calculation is required to ensure that the selected system including insulation attachment is suitable for the proposed application. Where individual insulation boards are adhered together or to the VCL, the selected adhesive should be tested and approved for use with the appropriate insulation board material.

Note: Whatever the means of attachment it is a SPRA requirement that mechanical restraint is installed at the roof perimeter, at changes of slope and around details. This ensures that any tension in the membrane in the roof field or upstand is not transferred to the other as a peeling action.

5.2 MECHANICALLY FASTENED INSULATION REQUIREMENTS

Where the insulation is mechanically fastened and the membrane adhered, the fastener density required should correspond with the appropriate wind load requirements for corner, perimeter and field areas. In comparison with 4.1.1 and 4.1.2, and minimum insulation fastener requirements detailed in Appendix A, the required number of fasteners will increase for membrane systems bonded to the insulation with adhesive because all of the wind load acting on the membrane is transferred to the insulation fasteners.

As in 4.2, pull out testing must be undertaken to ensure that the correct fastener design load is determined.

It is important that the correct fastener installation pattern is used. (See 4.1.2. Insulation attachment).

Fastener stress plates of minimum size 70x70mm or thermally broken sleeves with washer dimensions of minimum 75mm diameter (Min surface area of 4400mm2) should be used where the insulation is mechanically fastened and the membrane adhered. See Appendix A and the 'SPRA Design Manual' [1].

6.0 REQUIREMENTS FOR GREEN AND BALLASTED ROOFS

6.1 GREEN AND BALLASTED ROOFS - GENERAL

As with all roof constructions, wind load calculations are required for individual buildings in order to ascertain the suitability of the proposed system to resist wind uplift. Calculations must be undertaken to ascertain the wind load provision required for all corner, field and perimeter roof areas.

The resulting wind load values will determine the weight of ballast required to provide for protection against wind uplift. Guidance of minimum ballast requirements can be sought from the appropriate SPRA membrane manufacturer. Additional guidance is provided within FM Approval standard 4477, 'Approval standard for vegetative roof systems' [9], FM Global Loss prevention data sheet 1-35, 'Green roof systems' [10], FM Global loss prevention data sheet 1-29, 'Roof deck securement and above deck components' [6] and The Green Roof Organisation (GRO) Green roof code [13].

6.2 WIND SPEED RESTRICTIONS

The suitability of a green or ballasted roof construction is often determined by its geographical location, specifically the predicted wind load. Wind speed is limited to reduce the likelihood that growth media and/or roof gravel may become wind borne debris. This limitation is also required to reduce the effects of wind scour of growth media and any resulting loss of ballast or potential damage to vegetation above the waterproof membrane.

Consult the appropriate SPRA system supplier with respect to wind speed / wind load restrictions and suitability.

6.3 SECURING THE INSULATION AND SINGLE PLY WATERPROOFING LAYERS

In ballasted and green roofs applications where the insulation and membrane layers are to be secured by ballast, attachment of the insulation and membrane should be considered carefully.

Should the ballast layer not be installed during the same working day as the insulation, but after an extended period, then the insulation and membrane layers may require to be independently secured using mechanical fixings or by the application of adhesive. Advice should be attained from the appropriate SPRA insulation or membrane manufacturer. For PIR insulation requirements see 'BRUFMA Document ID3/2009 Green Roofs and Ballasted Roofs – Protocol for the securement of Rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes' [5].

6.4 STONE AND GRAVEL BALLASTED ROOFS

Guidance with respect to the minimum ballast weight requirement should be sought from the appropriate SPRA system provider. This must be project specific and relevant to the individual project specification but would not be less than 80kg/m2. See 'BRUFMA Document ID3/2009 Green Roofs and Ballasted Roofs – Protocol for the securement of Rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes' [5]. Further guidance with respect to the minimum ballast requirement can also be obtained from FM Global Loss Prevention Data Sheet 1-29 'Roof Deck Securement and Above Deck Components' [6] pages 21-22. The minimum acceptable ballast weight may increase in accordance with the calculated wind load for each of the corner, perimeter and field roof areas.

Where ballast consists of round stone or gravel, then it is essential to ensure that the threshold wind speeds are below the design wind speed for the building in order to prevent wind scour. Should calculation indicate gravel scour, the size of gravel may be increased or gravel in the vulnerable areas of the roof may be replaced by paving stones. See BRE Digest 311, 'Wind scour of gravel ballast on roofs' [7] for further guidance.

6.5 GREEN ROOFS

The growth media on a green roof system can be prone to scour from wind and water action and therefore may not be a reliable source of uniform ballast for waterproofing components when provided in shallow depths. additionally, growth media typically contains materials that can create a potential source of wind-borne debris. Whilst vegetation will provide a certain amount of wind shelter and plants help anchor the surrounding growth media, it can take several growing seasons for the vegetation to become sufficiently established to protect the growth media from wind action. (See 6.2 Wind speed restrictions). Consideration should be made therefore to allow for more significant wind action in the early stages of growth.

For 'green roof' applications, where the approximate weight of the system is less than 80 Kg/m2 when dry, the insulation and membrane layers must be secured either by supplementary mechanical or adhesive attachment in order to provide for additional wind uplift resistance.

The majority of extensive 'green roof' systems will have a dry weight of less than 80 kg/m2 and therefore will require supplementary mechanical or adhesive attachment for insulation and membrane layers. See 'BRUFMA Document ID3/2009 Green Roofs and Ballasted Roofs – Protocol for the securement of Rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes' [5]. The minimum acceptable ballast weight may increase in accordance with the calculated wind load for each of the corner, perimeter and field roof areas. Consult the appropriate SPRA system manufacturer for guidance.

7.0 SUMMARY

It is essential that the contractor is aware of the required attachment requirements determined by the wind load calculations undertaken. Incorrect specification or installation of the insulation and membrane restraint requirements can potentially lead to premature failure of the construction.

8.0 REFERENCES

[1] SPRA Design Guide 2011

[2] BRUFMA document 'ID/1/2009 Mechanical fixings for rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes'

[3] Mechanical fasteners for attachment of insulation and membranes - SPRA Quality Standard.

[4] SPRA Document 'Quality control and use of adhesives for the attachment of vapour control layers, insulation and single ply membrane in flat roofing'

[5] BRUFMA Document 'ID/3/2009 Green roofs and ballasted roofs – Protocol for the securement of rigid Polyisocyanurate (PIR) and Polyurethane (PUR) roofboards beneath single-ply waterproofing membranes'.

[6] FM Global Loss Prevention Data sheet 1-29 'Roof deck securement and above deck components'. (www.roofnav.com)

[7] Wind scour of gravel ballast on roofs. BRE Digest 311

[8] Wind load design requirements for flat roofing. Evaluation of the affect of change from BS 6399-2 to the new BS EN 1991-1-4 calculation method

[9] FM Approval Standard 4477, 'Approval Standard for Vegetative Roof Systems'. (www.roofnav.com).

[10] FM Global Loss Prevention Data Sheet 1-35, 'Green Roof Systems'. (Available free at www.roofnav.com).

[11] FM Global Loss Prevention Data Sheet 1-28, 'Wind Design'. (Available free at www.roofnav.com).

[12] FM Global Loss Prevention Data Sheet 1-28R/1-29R, Roof Systems, (available free at www.roofnav.com)

[13] The GRO Green Roof Code. Green Roof Code of Best Practice for the UK 2011

TABLE 1: MINIMUM NUMBER OF INSULATION FASTENERS AND THEIR LAYOUT

Thermal Insulation	Minimum size of fastener stress plate	Minimum number of fasteners per board	Position of fasteners
UR / PIR (see note 1)	***Mechanically fastened waterproof membrane:*** Minimum 50 x 50mm or 50mm dia. (based on minimum surface area of 1963mm^2) ***Adhered waterproof membrane:*** Minimum 70 x 70mm or 75mm dia. (based on minimum surface area of 4400mm^2)	4 per 0.6 x 1.2m board (5.55 fixings/m^2) (see note 1) 4 per 1.2 x 1.2m board (2.77 fixings/m^2) (see note 1) 6 per 2.4 x 1.2m board (2.08 fixings/m^2) (see note 1) 8 per 3.0 x 1.2m board (2.22 fixings/m^2) (see note 1)	Pattern to be as per BRUFMA guide (See reference 2)
	Minimum 70 x 70mm or 75mm dia. (based on minimum surface area of 4400mm^2)	4 or 5 per board for most board sizes - consult manufacturer 1.2 x 2.4m require min 6 per board or above - consult manufacturer (see note 1)	One per corner (fifth in centre, if required)
	Minimum 70 x 70mm or 75mm dia. (based on minimum surface area of 4400mm^2)	4 per 0.6 x 1.25m board (see note 1)	One per corne
	Minimum 70 x 70mm or 75mm dia. (based on minimum surface area of 4400mm^2)	1 per 1.2 x 1.0m board 1 per 1.8 x 0.6m board (see note 2)	Centre of board

Notes:

1) The required number of fasteners shown is the minimum only. Regardless of the membrane attachment method, wind load calculations should be undertaken in order to determine actual fastener requirements in corner, perimeter and field roof areas. These areas should be clearly defined, especially where different numbers of fasteners are required for each zone. The required number of fasteners may increase for membrane systems bonded to the insulation with adhesive because wind loading acting on the membrane is transferred to the insulation fasteners.

2) The number of fasteners required for mineral wool products is subject to individual membrane manufacturer approval, which should be based on wind uplift testing undertaken by the same. The required number of fasteners may increase for membrane systems bonded to the insulation with adhesive because wind loading acting on the membrane is transferred to the insulation fasteners.

3) Appendix A does not meet the requirements of FM Global. To meet FM Global requirements for insulation attachment, the guidance within FM Global Loss Prevention Data Sheet 1-29 Roof 'Deck Securement and above deck Roof Components' [6] shall be followed with respect to the provision of insulation fasteners. This states within 2.2.2.2 that where the membrane is mechanically fixed and a vapour control layer (or vapour retarder) is installed below the insulation layer the insulation shall be fastened at a rate of 1 fastener per 0.19m2 for the entire roof area. See 1-29 for full details and fastener placement required by FM. This FM requirement is applicable for all types of insulation boards. For metal deck installations where the membrane is adhered to the insulation, FM Global additionally require the insulation to be mechanically attached.

BUILDUK
Leading the Construction Industry

RIBA

member of cpa construction products association

SPRA
Single Ply Roofing Association

SINGLE PLY ROOFING ASSOCIATION
Roofing House, 31 Worship Street, London EC2A 2DY
t: 0845 1547188 • e: enquiries@spra.co.uk • www.spra.co.uk