Improving roof reliability: Interim Report from CIB / RILEM Committee

Keith Roberts
BSc  CEng  MICE  MIstructE  MAE

Task Group Chairman

Wednesday 7th September 2011
1. CIB / RILEM previous work
2. The importance of roof reliability
3. International examples
4. Substitution with care
5. Learning through experience
6. Tenets of reliable roofing
1. CIB / RILEM previous work

**CIB**: International Council for Research and Innovation in Building and Construction

**RILEM**: International Union of Testing and Research Laboratories for Materials and Structures

CIB W56 / RILEM Joint Roofing Committee founded in 1983 during NBS / NRCA Conference. The first Chairman was Bill Cullen.
1. CIB / RILEM previous work


- ‘International Index of Codes of Practice Related to Membrane Roofing Systems’ May 1996

1. CIB / RILEM previous work

Representatives drawn from:

<table>
<thead>
<tr>
<th>USA</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>India</td>
</tr>
<tr>
<td>Denmark</td>
<td>Brazil</td>
</tr>
<tr>
<td>Germany</td>
<td>Romania</td>
</tr>
<tr>
<td>Israel</td>
<td>Turkey</td>
</tr>
<tr>
<td>Japan</td>
<td>Italy</td>
</tr>
<tr>
<td>Korea</td>
<td>Portugal</td>
</tr>
<tr>
<td>UK</td>
<td>and more…</td>
</tr>
</tbody>
</table>
1. CIB / RILEM previous work

First meeting of CIB / RILEM Task Group on ‘reliable roofing’

– Phoenix, Arizona, March 2006
2. The importance of roof reliability

Some owners need a high degree of confidence that the building envelope will not leak.

Examples include:

- telephone exchanges, internet server rooms
- hospitals, operating rooms
- civic buildings, court houses
- cathedrals and churches
- nuclear facilities
- electrical power supplies
2. The importance of roof reliability

Industrial building – long valley gutters
2. The importance of roof reliability

Rainwater build up in level gutters
2. The importance of roof reliability

Internal building usage
2. The importance of roof reliability

Experienced roof tradesmen working on trial of over roof system
2. The importance of roof reliability

Over the past thirty years reliability engineering has developed:

- in the aerospace industry: the need to keep commercial airliners flying in the air

- in the car and electronics industries, particularly in Japan in the 1970’s
2. The importance of roof reliability

Defined as:

‘the probability that an item will perform a required function without failure under stated conditions for a stated period of time’

‘assured quality for a given period of time’
2. The importance of roof reliability

Collection buckets and stained ceiling tiles: ‘*not an unusual scene*’
2. The importance of roof reliability
2. The importance of roof reliability

Definitions:

In the construction industry could be measured as

‘the reduction in the number of call backs after completion’
2. The importance of roof reliability

CIB / RILEM Task Group set out to identify specific actions that can improve reliability:

- co-ordination of details and specifications
- the need for competent workmen
- ........
3. International experiences

Committee members asked to share experiences of long lasting roof systems that have given trouble free roofs
3. International experiences

Lecture Hall of the Shizutani School, built in 1666
3. International experiences

Multi layer roof system
3. International experiences

We learn that the multi layer roof system has in-built redundancy.

This has been known for hundreds of years.

We forget what previous generations have learnt!
4. Substitution with care

• Problems often stemmed from the late substitution with alternative products during the construction phase, often to save costs.
• Different approaches in different countries.
• In Israel a formal series of criteria are used for assessing the acceptability of a proposed substitution.
5. Learning through experience

• Constructive feedback after a project has been completed can lead to product development and innovation

• For example:
Reports of intermittent rainwater leakage through laps in metal panel roof systems laid to shallow falls, particularly on long slopes in exposed locations
5. Learning through experience
5. Learning through experience
5. Learning through experience
5. Learning through experience

Appropriate methods of sharing information:

- Manufacturers’ technical information
- Government sponsored publications
- Trade association information sheets
- Contractor in-house advisory services
- Published journals and conferences
5. Learning through experience

**RCI TECHNICAL NOTE: 199**

**Learning from experience**

**Open seals within four way laps**

One of the awkward junctions in metal roof cladding is forming the joints where four sheets come together at the intersection between end and side laps. This RCI Technical Note continues the series sharing feedback from multiple roof investigations, seeking to improve the reliability of the roofs we design and build.

**Guidance**

When designing and constructing metal clad roof's with four-way laps, the following is offered as good practice to improve the reliability of the roof:

1. Reduce the number of four-way laps by specifying, where practical, longer sheets or panels with no end laps.
2. Discuss with the manufacturer the possibility of staggered adjacent tiers of sheeting to form three-way laps. This is not a common detail and would require more cut sheets at the joints.
3. Use a good quality sealant, Class A to NFRC Technical Bulletin 56, which has a service life of 20 years and good temperature stability. No sealants should be laid at air temperatures of 7°C or less.
4. Install a side lap binder screw to pull the four sheets together.
5. In severely exposed locations install a separate metal capping directly over the four-way lap and continuing over the length of the laps to each side. Lay two layers of expanding foam fillet to the underside of the capping to prevent wind-driven rain being blown up into the side laps.

**Publications**

There is limited guidance currently published about four-way laps. Some manufacturers recommend an additional 150mm length of 6.5mm thick butyl rubber sealant on the top of the third sheet on the side lap, under the end lap of the fourth sheet, and repeated onwards. In addition, a side lap stitching screw is installed 50mm up from the end of the sheet, which would be through the four-way interaction.

The NFRC Technical Bulletin 56 sets out a specification for sealants for use in end laps. This includes a requirement that the sealant should be compressible. Specifically, at 21°C the applied force to compress the sealant by 20% should be less than 1.8kN/m. The Bulletin recognises that in cold conditions greater force is necessary.

**Causation**

With no compression of the sealant there will be gaps along the crown of the side lap where the built up thickness changes from three layers of metal plus two thicknesses of sealant, to two layers of metal plus one thickness of sealant. The greater the thickness of the seal, the larger the gap. The increase in seal thickness from 9.5mm to 6.5mm now recommended requires greater compression to close the gaps.

On exposed shallow pitch and long roofs, wind-driven rain can be blown up and into the side lap construction, allowing small volumes of rainwater to pass into the roof construction and down into the building below.

**Diagram**

1. Plan showing laying sequence
2. Cross section A-A
3. Diagramematic view of a typical four way lap
4. Roof details
5. Side lap end laps

**References**


For further information, contact RCI Technical Note for independent roofing consultancy.
5. Learning through experience

Appropriate methods of sharing information:

- Manufacturers’ technical information
- Government sponsored publications
- Trade association information sheets
- Contractor in-house advisory services
- Published journals and conferences
- Internet discussion groups
6. Tenets of reliable roofing

A summary of common principles or points of best practice written down on single page.

Translated into common languages and widely circulated.
6. Tenets of reliable roofing

A summary of common principles or points of best practice written down on single page.

Translated into common languages and widely circulated.

Seeking to improve the reliability of the roof systems we design build and maintain. Aim to cut down the number of call backs.
6. Tenets of reliable roofing

• #4 Introduce element redundancy
  ‘the fox leaves itself two ways to run’

  Recognize the advantages of a double layer roof system
6. Tenets of reliable roofing

- **#4 Introduce element redundancy**
  
  ‘the fox leaves itself two ways to run’

- **#7 Substitute with care**
  
  follow ‘intelligent caution’ whilst encouraging innovation
6. Tenets of reliable roofing

• #4 Introduce element redundancy
  ‘the fox leaves itself two ways to run’

• #7 Substitute with care
  follow ‘intelligent caution’ whilst encouraging innovation

• #12 Learn from experience
  constructive feedback feeds the virtuous circle, encouraging product development and motivating innovation
By developing appropriate means to share feedback in a constructive way, we can learn from experience and improve the reliability of the roofs we design and build.
The CIB /RILEM Committee thank you for your attention and welcome your support

Keith Roberts  
BSc  CEng  MICE  MIstructE  MAE  
Task Group Chairman