Moving forward with testing

CERAM talks to RCI about thermal expansion of aluminium standing seam roofing. As the company points out: 'Many aluminium standing seam roof installations incorporate sheet lengths of 60 metres or more and consequently, must allow for a movement of 60mm and beyond. Problems frequently arise when a manufacturer is required to demonstrate that their system can cope with this level of movement; there is currently no standard test which will adequately simulate this'

"No one yet has enough understanding of thermal behaviour in standing seam roofs under current climatic conditions"

CERAM, an independent global expert in materials testing, analysis and consultancy for the construction industry, has been involved in structural testing of roofing systems for over 15 years.

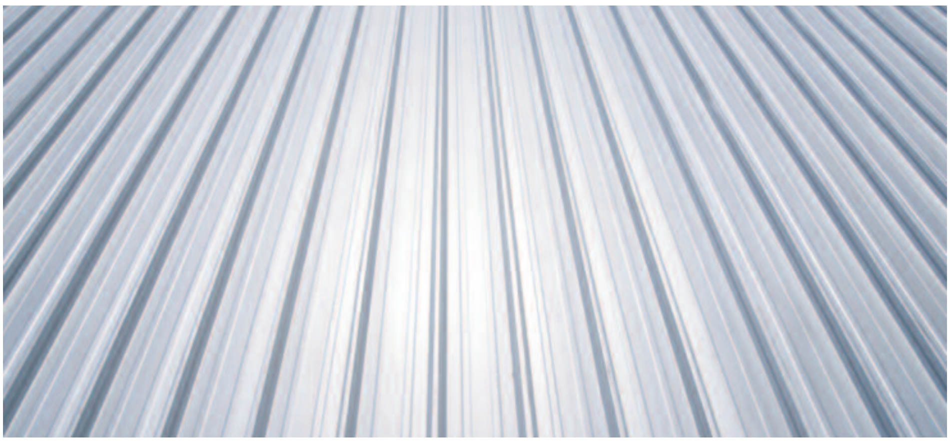
Recently, the thermal expansion of the top sheet of aluminium standing seam roofing has become an issue. As we begin to experience an increase in temperature brought about by climate change, for example, warmer, wetter winters and hotter, drier summers and, in particular, a greater occurrence of extreme events, a greater need to accommodate thermal movement will arise.

Under normal UK weather conditions aluminium can be expected to expand or contract by as much as 1mm per metre, hence the supporting construction must be able to accommodate this. Many aluminium standing seam roof installations incorporate sheet lengths of 60 metres or more, and consequently must allow for a movement of 60mm and beyond. Problems frequently arise when a manufacturer is required to demonstrate that their system can cope with this level of movement; there is currently no standard test which will adequately simulate this. CERAM has worked with several manufacturers and developed a range of tests to measure both the loads and deflections generated from each roof system component whilst applying a 60mm movement to the top sheet.

The first test method that was developed incorporated a mechanical horizontal movement of two short lengths of top sheet (1m) when fixed to a single halter, and gave the expected ratcheting effect of the sheet moving over the rigidly held halter. The movement of the halter was monitored and small loads of less than 1kN were required to move the sheet over the halter. The halter and sheet initially moved together and then the sheet released and slid over the halter head before snagging again and the two processes repeating.

Upscaling the original test

With the incorporation of bar and bracket spacer systems into the roof build-up it was deemed necessary to upscale the original test. The test size was increased to incorporate three roof sheets with a triple span of 1.8m. All elements, including the purlin, brackets, bar, halter and top sheet were monitored throughout the test. All of the tests incorporated a bar and bracket system which prevented any ratcheting of the roof sheet over the halter head. Applying a horizontal load to the top sheet caused the brackets and halter to instantly rotate, and the sheet to lock-in and not move over the halter. Any movement of the top sheet was mirrored in the other elements. This test raised the question of whether mechanical application of movement to the roof sheets (to simulate thermal movement) was actually replicating reality when the thermal expansion can affect the sheet on more than one axis.



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The test was further developed to better simulate the thermal affects through heating top sheets. A 12m span of standing seam sheet was assembled in the laboratory using five top sheets built on a 180mm bar and bracket system at 1.8m, over seven spans. Thermacouples were fixed to the top sheet and one edge of the roof sheets was restrained. The roof sheets were reduced to a temperature of 5ºC and radiant heaters positioned over the top sheets. The underside of the sheets and the three free edges were insulated. Heated over a seven hour period to a top sheet temperature of 125ºC, the roof sheets' expansion was monitored against temperature and time. Deflection of all elements in the construction of the roof was monitored. Surprisingly, the roof sheets showed a maximum movement of 6mm over the temperature rise; 6mm less than expected. The majority of movement occurred in the sheet, with only nominal movement registered by other elements of the build.

In order to measure the load generated by the expansion of the sheets, the test was repeated with both ends of the roof restrained and a load cell placed at one end. A load temperature curve was generated and combined with the load deflection curve to estimate the load, deflection and temperature characteristics of the system. The load generated was less than 1kN for the 6mm sheet movement, although it was greater than the load generated by 6mm of movement under the mechanical loading of the sheets.

In conclusion, it is difficult to test a system for thermal expansion characteristics. The tests performed and developed at CERAM provide a comparative test between systems, however, until a live project is used for installing instrumentation and monitoring over a lengthy period of time to incorporate a number of summers and winters, we will not be able to fully predict how roof systems will behave under true thermal expansion. Whatever the effects of climate change, no one yet has enough understanding of thermal behaviour in standing seam roofs under current climatic conditions.

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