Left A ring beam portal frame cantilevers over the entrance, its soffit clad in the characteristic KME Tecu Patina.
Below Verdigris sheeting was also used for internal columns and doors.

It's got to be green

With real copper unlikely to patinate, verdigris copper sheet forms the roof of The Grove hotel's new event space, with single overlaps for delicacy of detailing

It wasn't always as placid at The Grove as it is now. The former country estate of the Earls of Clarendon near Abbot's Langley in Hertfordshire, the 18th century mansion house was called in by Secretary of State John Prescott in 1997 in a landmark green belt test case, when new owners the Ralph Trustees were trying to convert it into a luxury hotel. They eventually won the two-year legal battle and architect Jeremy Blake, now at Purcell, was involved from the outset. He is handling the current programme of increased facilities and improvements at The Grove.

As part of the hotel's ongoing development the client decided in 2014 to create the Cedar Suite, an oval copper-clad structure that would act as a stand-alone wedding and events space for the hotel with its own unique quality and relationship to the garden. Influenced in part by the fact that interior designer Martin Hulbert's Bermondsey office overlooked a church copper roof, the design team decided early on to go for either copper or verdigris sheeting, becoming rapidly aware that with reduced sulphur dioxide levels in the air, real copper was unlikely to patinate. 'It was always going to be green so we looked at alternatives,' recalls Purcell's Kags Alexander-Cahill, 'But copper never left the table and finally we opted for verdigris copper sheet.' The chosen product is KME Tecu Patina supplied by SIG Zinc & Copper.

With engineer Michael Wright of AECOM, the firm developed the idea of a simple Borromini ellipse to form the oval plan of the new structure. 'It looks complicated but it's actually produced from only two arc radii,' explains Alexander-Cahill. 'This meant it was more straightforward to design, allowing us to produce easier to fabricate copper sheet templates and glazed sections.'

From this basic principle the team developed a slim steel structure with a ring beam portal frame cantilevering out over a wide garden entrance area, with 58 secondary 'fins' helping to create a 6m overhanging canopy, clad in SIG's copper sheeting. While the structure is thin, Alexander-Cahill states that, with 3m high full height glazing and doors beneath it, there was no room at all for deflection. That said, some compromises needed to be made as part of the design & build process. While the architect's intent was to have the soffit meet the eaves at a point, advice from contractors Galliford Try and AECOM produced an equally elegant but simpler solution with a small, flat face returning back to the zinc substrate to the extensive green roof.

The copper contractor CEL Ltd collaborated on the design and was keen on having double folded overlaps at sheet interfaces to ensure there would be no billowing of the sheets in the event of high winds, but with the architects wanting to emphasise the delicacy of the detailing, they settled on single overlaps, which creates more discreet joints with copper drainpipes behind structural columns.

There was a real desire to 'bring the outside in' from the project's inception, explains interior designer Martin Hulbert. This resulted in all internal columns and door carcasses in the space being covered in the same verdigris sheeting. While the single lap detail was used on the columns, for doors and wall detailing, sheets are glued and riveted to the substrate. Hulbert notes that copper's inherent pliable quality meant it ran easily around edges and returns. The common material palette has pleased a demanding client, he says: 'Even though the actual oval shape of the new space defined itself as distinct from the main building, we think we created a seamless relationship of interior to exterior.'

Joined up thinking

Stephen Chapman, technical consultant of rolled architectural zinc specialist elZinc, explains how to achieve best practice standing seam roofing

What is standing seam roofing?
Traditional standing seams date back to medieval times when they were originally used on ecclesiastical buildings. Nowadays, standing seam roofs still use malleable metals which are profiled into standing seam trays and then welted in situ either manually or with profiling machines.

Standing seam roofing can be used for any building type and any project where budget constraints aren't too severe. Its main advantages are aesthetic appeal, versatility of use on different roof forms, durability and the use of weathering materials that don't require a painted barrier. Zinc is the most popular material for this roofing, followed by copper, aluminium and stainless steel.

The standing seam joint
A typical joint requires 70mm of material to make and is formed by seaming together profiled trays of zinc running longitudinally from ridge to eaves. A small gap at the base forms automatically and allows for lateral thermal expansion. Joints are formed with a double lock that first links the trays horizontally and then folds the seam down to a vertical position. Seam centre dimensions normally range from 430-600mm. Each tray is anchored by a combination of fixed clips and sliding clips that allows longitudinal expansion.

Choosing the right cross joint
Cross joints are needed to introduce expansion joints on large roofs or around details such as chimneys, windows and other roof protuberances. There are several different common joint types (see box right) which vary in terms of complexity. The main factor in determining which detail should be specified is the degree of roof pitch, with different joints nominally considered suitable for different pitches. Another important factor of course is whether the joint needs to function as an expansion joint as not all of them can.

Other site-specific issues are roof orientation and weather conditions in particularly exposed locations – it's always a good idea to look at the installation site with an experienced installer and take all these factors into account when determining joint type. Useful guidance on UK installations is also available from the Federation of Traditional Metal Roofing Contractors.

Fixing
A combination of fixed and sliding clips is used to anchor the roofing trays to the substrate while allowing the zinc to expand and contract. This thermal movement is accommodated by a gap in the detail at the foot and at the head of the trays.

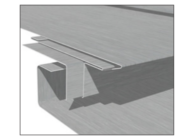
The position of the fixed clip zone depends on the degree of roof pitch. At low pitches such as 3° roofing trays can be anchored in the middle but as the pitch increases they need to be anchored progressively further up. By 30°, for example, they should be hung from a band of fixed clips positioned at the top in order to prevent the trays from buckling when they expand up the roof.

Dealing with wind loading
Properly installed standing seam roofing is suitable for the windiest of sites. As wind loads are transferred from the metal sheeting to the substrate and the structure of the building via the clips within the seams, the heavier the loading the more clips per square metre are needed. In addition, the bay width of the trays needs to be narrowed in windy locations, otherwise an unwelcome fluttering noise can be generated by the movement of the pans of the trays or, at worst, the standing seams can be lifted.

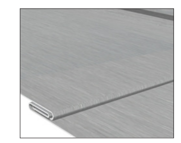
Higher wind loads therefore entail either more clips per linear metre, or a reduction in the distance between the standing seams or both. As windloads are generally heaviest along the edges of the roof and at the corners, these are the areas where more clips are most likely to be needed. In particularly windy sites, it may also be advisable to increase the thickness of the metal itself from a typical 0.65-0.7mm to 0.8mm for zinc.

Avoiding pitfalls
Always consider the implications of the pitch and environmental conditions when specifying the roof details and the thickness of the metal. Architects also need to ensure the roof can drain properly so that problems aren't encountered during installation. A not infrequent issue is low-pitched valley gutters that can cause particular difficulties if no proper provision has been made to recess them into the roof substrate. The correct ventilation of a 'cold' roof, or the proper choice, location and installation of vapour barriers in a 'warm' roof, are also of paramount importance. From a visual point of view, drawings need to set out the position of seams, especially on facades, to make sure these achieve the desired aesthetic effect.

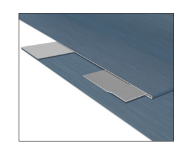
CROSS WELT JOINT TYPES



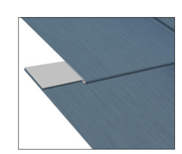
A: Step. Pitch: 3° and above up to about 10°. Height: 60mm. Often used as expansion joint on long, low pitched roofs. The detail introduces a small step in the roof and involves a corresponding step in the wooden substrate, normally using a fillet. The joint incorporates a continuous fixing strip and a T plate with a folded back edge between the two roofing trays that are being joined, as well as creating a 10mm expansion/contraction gap.



B Double lock cross welt. Pitch: 7° and above. Width: approx 20mm. Doesn't function as an expansion joint. This preformed 'slide-in' version allows for complete rainwater drainage. Cross welt joints should be staggered either side of the standing seam by at least 50mm to avoid too much metal being welted into seam at the same point.

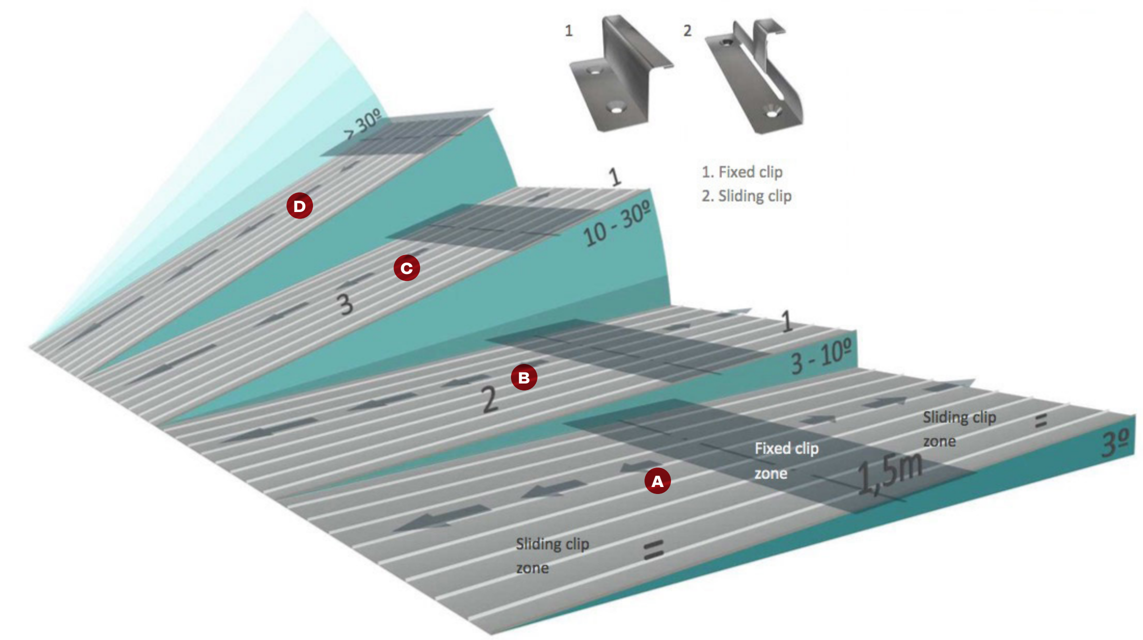


C Lap lock. Pitch: 10° and above. Lap: approx 180mm. Often used as expansion joint for cross welts on longer roofs, it incorporates a soldered continuous cleat between upper and lower roofing trays. Less visually intrusive than the step so above 10° is the preferred method for controlling thermal expansion and contraction.



D Single lock cross welt. Pitch: 25° and above. Width: 40mm fold on lower tray, 30mm on upper. Can be used as expansion joint for steeper pitched, long roofs.

Standing seam zinc roofing, clip fixing distribution according to roof pitch.



Find the real culprit

So-called leaks in flat roofs could well be interstitial condensation. No wonder applying another layer of membrane doesn't work, says SIG Roofing's Ian Dryden

Having worked on refurbishments for many years, I've become increasingly aware that the incidence of interstitial condensation in flat roofs has often been perceived as roof leaks. Generally, we're seeing many instances in warm roof construction of 1960s schools which were overlaid with new roofing in the 1980s – where dampness transpiring between old and new roofs can mean that the whole roof build-up may need to be stripped off.

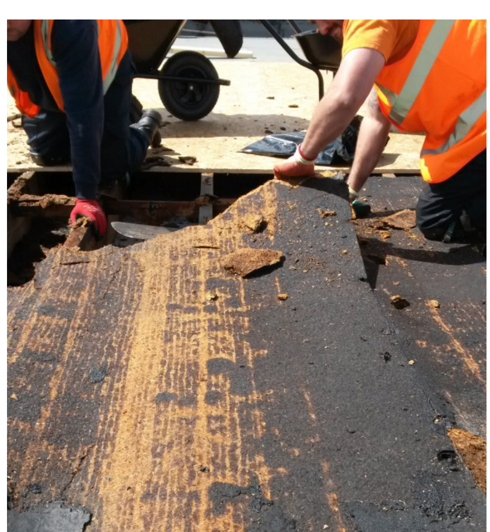
Interstitial condensation can also be found in cold roofs – ones with no vapour control layer above the suspended ceiling. This scenario is generally caused due to insufficient ventilation to the void and can result in the insulation becoming saturated with moisture that has passed up through the lower layers. With cold roofs, the best way to solve this is to introduce or increase ventilation in the void. However, this can create conflict, especially when you are trying to achieve a thermal performance of 0.18 U-value, so ventilation may not be feasible. If so, removing the insulation above the ceiling and converting to warm roof construction maybe the only course of action.

Interstitial condensation has also become apparent in newer warm roof designs where a contractor has installed a ceiling with insulation above and an unvented void exists between the underside of the warm roof and the ceiling. Moisture can build up in the void and appear as staining on the ceiling. This is often misdiagnosed as a roof leak.

One Glasgow project is a prime example of this specific condensation problem. It was constructed in the 1980s over an unsealed metal deck and 'leaks' were noticed 16 years ago. To try to solve this, the contractor overlaid a new waterproofing system on the existing. When the 'leak' persisted, they didn't investigate further but just kept reapplying new roofing membranes around the area of the leaks. Incredibly, there were up to 13 layers of repair membrane in places.

Where water ingress or ceiling staining occurs, the first thing is to ascertain is whether the roof is actually leaking or if it's suffering from interstitial condensation. With flat roofs, water can track through the layers of roof's build-up, so it can be very difficult to identify the cause without cutting a hole in the roof. It's imperative to check if there's a vapour control layer in the roof build-up; if not, it's almost certain that interstitial condensation is occurring – especially if it's a warm roof.

Interstitial condensation is especially likely to be the cause if the building is used as a manufacturing plant, school or swimming pool, as there's a high internal moisture load that may be passing up into the ceiling void and roofing system.



Bottom A school roof refurbishment in Glasgow: over 90% of the roof was damaged.
Below Condensation between layers causing delamination.

If you're adding extra insulation to upgrade a roof's thermal performance as well as reroofing it, you have to ensure you are not creating a dew point within the build-up where moisture will condense. An interstitial condensation risk analysis should always be carried out before finalising any overlay design.

While every situation is unique, a general rule of thumb is that if the insulation to be installed on the top of the existing build-up has a better thermal performance than the existing one, interstitial condensation is less likely.

Technological developments have helped improve diagnosis. Drones can conduct visual roof surveys safely and thermal camera imagery can prove useful in helping to identify where leaks are tracking from. But ultimately a thermal camera won't tell you if you have a vapour control layer installed or the actual build-up of the roof. Core samples need to be taken to determine the actual roof build up.

Is the issue endemic in the UK's flat roofs? Maybe not, but at the moment interstitial condensation is the culprit in six of every hundred projects that I've surveyed. So, if you extrapolate that figure to the whole of the UK, how many roofs could that be? If architects are working on projects where this problem might occur, SIG has a free roof surveying service. This will not only help to diagnose the issues but will recommend a cost-effective solution using one of a range of certified waterproofing systems installed by our network of accredited installers and backed up with robust warranties. Interstitial condensation might be a problem – but it is solvable! ●

Ian Dryden is SIG Roofing's business development manager, specification.