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METAL FABRICATIONS: DESIGN, DETAILING AND INSTALLATION GUIDE

MCRMA Technical Paper No. 11

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For up to date information on metal roof and wall cladding, including downloadable construction details in 3D, visit www.mcrma.co.uk.

1.0 Introduction

The purpose of this design guide is to establish the basic principles behind the successful design, detailing and installation of fabrications in profiled metal roofs and walls.

Much attention is paid in design to the metal roof or wall construction and the basic shape of fabrications however; the vital junctions and fixings etc and the appearance of fabrications can be overlooked and are often left to the experience of the fixer on site. In fact, on many buildings it is the fabrications that the user of the building will notice first, particularly on curved roofs. Complaints to roofing contractors and manufacturers concerning leakage are mainly due to fabrications, either in design or indifferent workmanship.

This guide addresses aspects of steel and aluminium fabrications and workmanship, together with special applications such as GRP soakers or on-site welding. It does not deal with the shape of a fabrication to suit a particular junction but with the jointing and use of the fabrication itself. While aluminium fabrications are referred to throughout the guide, the particular requirements for aluminium are discussed in section 6.0.

As with any engineering problem there is always more than one solution to a fabrication design and a multitude of opinions about the correct methods. MCRMA has endeavoured to present the optimum solutions and the best practice from a wide variety of sources and where there are choices, the merits of each one is discussed.

2.0 Glossary of terms

Note: The following descriptions only apply in the context of metal roofing and cladding

Apron fabrication A wide flat fabrication used to weather from the back of an opening back to a ridge or other interruption in the roof. An apron fabrication is at the same level as the top or crown of the roofing profile.

Bird mouth The gaping of a lap joint.

Butt strap Used to join two fabrications which butt together, usually closure fabrications.

Closed fabrication A shape of fabrication that does not nest and therefore cannot be lapped.

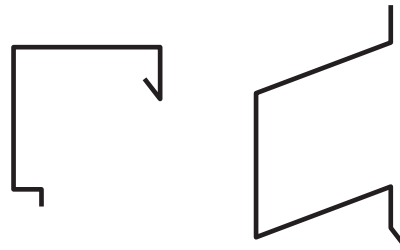


Fig 1 Closed fabrications

Fabrication/trim/closer/closure Any component used to close the roof or wall to a junction or opening.

Gauge Thickness of material.

Girth Developed width of a fabrication.

Lock-form seam A method of jointing material to form a curved fabrication.

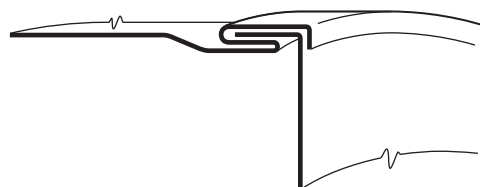


Fig 2 Lock-form seam

Longitudinal edge The long edge of a fabrication.

Oil canning Slight deformation occurring to wide flat fabrication faces

Open fabrication A shape of fabrication that nests.

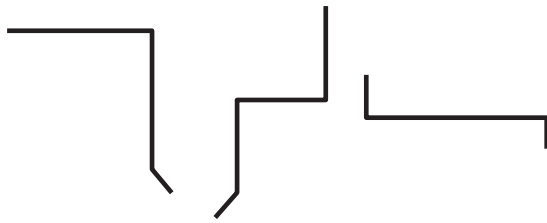


Fig 3 Open fabrications

Pitch Either the slope of a roof, or the spacing of fasteners.

Primary fixings Fixings used to secure the fabrication to the structure or abutting metal sheets.

Rivet - blind sealed A rivet with a closed bulb; can have a neoprene/EPDM seal.

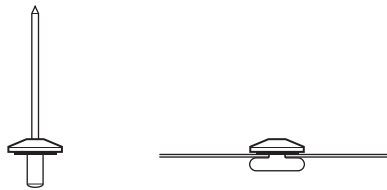


Fig 4 Blind (sealed) rivet

Rivet Bulbtite/TLR. A proprietary type of rivet with expanding legs and a neoprene/EPDM seal.

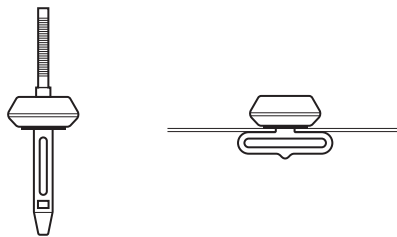


Fig 5 TLR/Bulbtite rivet

Secondary fixings Fixings used across endlaps to compress the seals.

Soaker A fabricated metal or GRP component which forms the transition from the profiled sheet to the opening.

Stitcher screws Fasteners with a specially modified thread designed to fix thin sheets together and incorporating an integral coloured head.

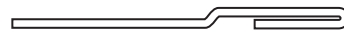
Stiffener A shallow bend within a flat area to stiffen a wide fabrication.

Welt A shape formed into the edge of a sheet to provide a stiffer edge

Fig 6 Different welt shapes



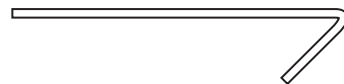
A tight 180° welt.



Lockform welt. One half of form of welt used to lock two sheets of metal together. Can provide a flatter surface on fixing.



Open welt. An open 180° degree welt.



Stiffened edge or lip. Edge angled by 30° or returned on itself by 150°.

3.0 Design and Specification

3.1 Laps/junctions

Lap joints form the simplest joint in open shape flashings. Lap joints in closed shape fabrications that do not nest easily can 'bird mouth'. In these cases, butt straps of 150mm minimum designed to fit within the fabrication are needed. To enable a flashing to lap well, any welt or lip should be trimmed off the length of the lap. Lap joints on sloping flashings for example, verges should be formed to overlap the downslope.

The width of a fabrication should be kept to the minimum that can be achieved practically to reduce the vulnerability to foot traffic and end laps opening.

There are conditions where fabrications can be open jointed provided that they are not required to perform a weathering function. Examples are features or bullnoses installed either outside the building line or over previously weathered components.

Fabrications required to provide weathering should have a double run of sealant applied either side of the line of fasteners or a wide channel shaped seal through which the fastener can be installed. This must be used with care to prevent winding of the sealant around the fastener.

Butt straps should be designed and fabricated to take into account sealant thicknesses.

Low modulus (neutral cure) silicone sealants can be over compressed within joints when fasteners are installed which results in a seal that will not perform in the long term when movement occurs. If such sealants are to be employed, spacers should be used to ensure that a minimum gap of approximately 6mm is achieved. Preferably, these joints should be sealed using an NFRC Class A butyl strip seal.

Generally large unsupported flat areas over 200mm wide should be avoided if possible unless stiffening folds can be introduced.

Where the appearance of fabrications is important, factory-fabricated corners and junctions should be used. It is also prudent that aesthetically sensitive items should be subject to the architect's approval

of a sample prior to volume manufacture and that the sample be retained on site for future reference. If at all possible the sample should be installed in the building, including a joint, and offered to the design team for comment or approval.

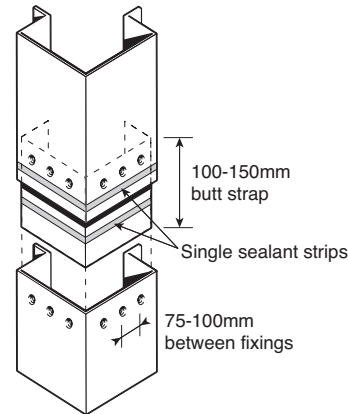


Fig 7 Closed steel fabrication: butt joint, single lines of sealant

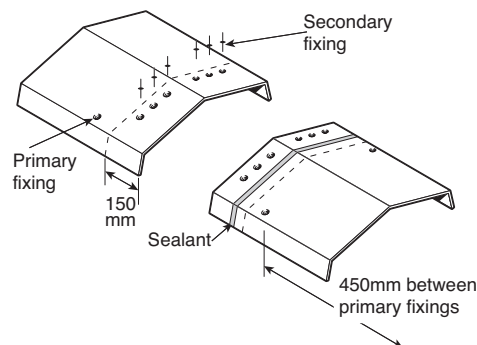


Fig 8 Open steel fabrication: lap joint, single sealant strip (steel)

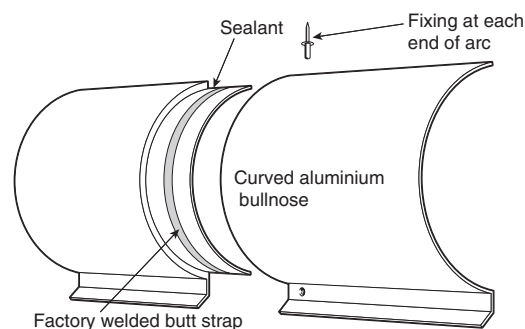


Fig 9 Welded butt strap on aluminium bullnose – show twin seals

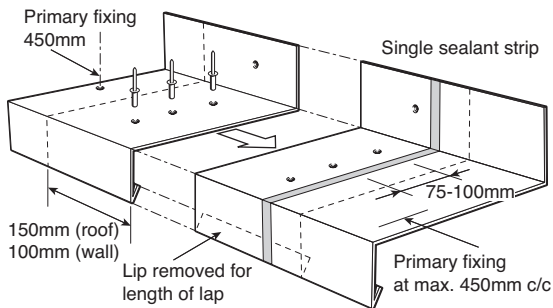


Fig 10 Open steel fabrication: lap joint single line of sealant – show twin seals

Summary

- Minimum lap 150mm on roofs, 100mm on walls
- Only open fabrications that nest should be lapped; use butt straps with closed fabrications
- Minimum butt strap length 150mm
- Butt straps should fit within the fabrication profile with an allowance for sealant thickness
- Stitch laps at 75-100mm centres
- Position the first line of sealant on the weatherside of the joint

Stop fascia fabrication butt straps at the lower shadow line to prevent water tracking around the gap at the butt strap onto the wall. Pointing the gap at a butt strap with clear silicone for example, is not recommended because the silicone can pick up dirt and any smears soon become dirty.

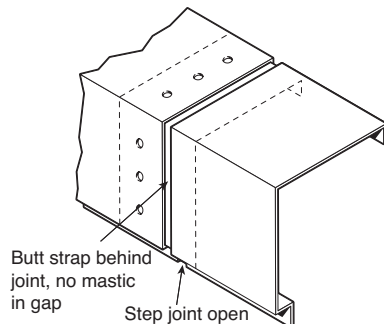
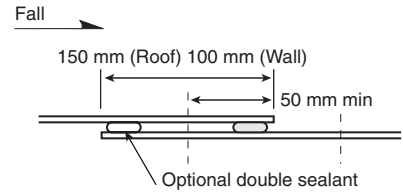
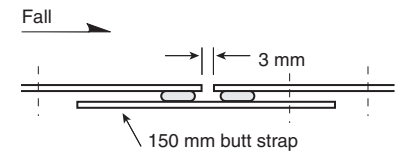
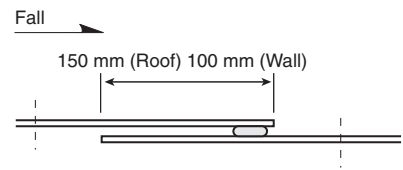


Fig 11 Fascia fabrication butt strap

Fig 12 Lap joints – show double sealant runs



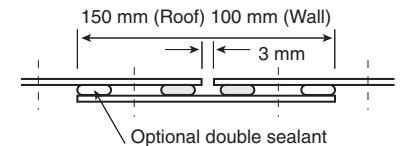
Lap joint, single or double sealant strip(steel)



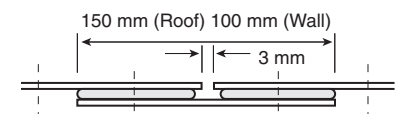
Steel butt joint or unfixed lap with movement allowed at each joint to avoid thermal movement accumulating in a long length. Low modulus neutral cure silicone sealant is one suitable sealant. Fasteners should be stainless steel rivets or screws.



Steel lap joint, wide sealant strip. Some sealant strips can make drilling the hole for the fixing more awkward by binding the drill.



Steel butt strap, single or double sealant strip to each side.



Steel butt strap, single wide sealant strip each side.

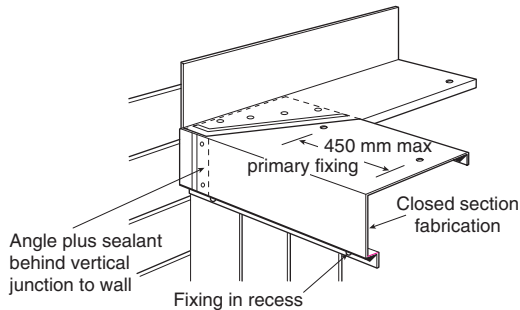


Fig 13 Typical verge/ridge (mono) junction: lap joint, single line of sealant

3.2 Fasteners

3.2.1

Fasteners join two thin materials together and must be purpose-designed for the application. These are generally either self-drilling stitcher screws with bonded sealing washers and integral caps, blind sealed rivets or proprietary Bulbtite/TLR sealed rivets. Colour caps should be avoided as they do not have long-term durability. Where stitcher screws are selected, then the fastener should have a free-spin zone behind the washer to pull the two fabrications together. Stitcher screws in some applications can lead to a bulky appearance.

3.2.2

Fasteners across a lap or butt joint need to clamp and hold the two surfaces together, and also firmly compress the sealant where applicable. This requires them to be installed at 75-100mm centres to avoid opening up under the load. Fabrications must be well secured to the structure or sheeting and maximum centres of 450mm (or alternate profile crowns, whichever is the closer) are recommended – see figure 14.

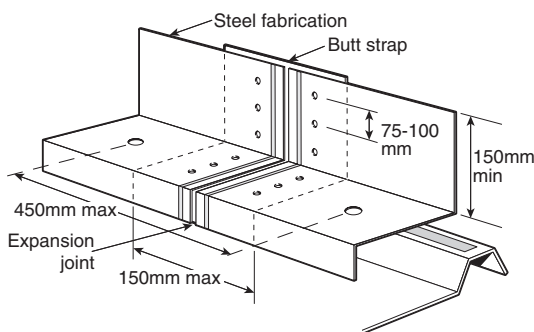


Fig 14 Open joint, butt strap

3.2.3

Where the fastener heads are visible and require colour matching, this may be achieved by stitcher screws with factory-moulded integral colour heads or coloured rivets. Push-on caps do not normally provide a long-term colour match and are prone to becoming detached. The choice of stitcher fixing may be influenced by the final appearance desired as they have larger heads than rivets and are more obtrusive.

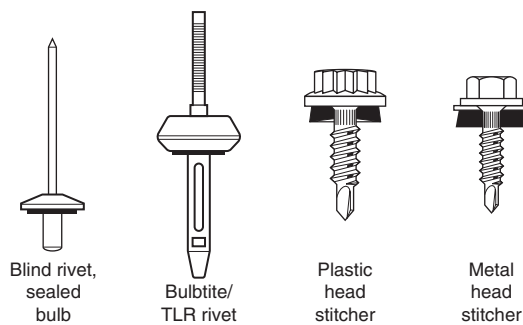


Fig 15 Rivets and fasteners

3.2.4

Fabrications are available in a variety of materials. Self-drilling stitcher screws are available in carbon steel, austenitic stainless steel and aluminium. For coated steel fabrications, the choice between carbon and stainless steel will depend upon the environment (both external and internal) and the desired lifespan. For aluminium fabrications, austenitic stainless steel or aluminium stitchers should be used.

Blind sealed rivets for fabrications are available with aluminium or stainless steel bodies with either aluminium, carbon steel or stainless steel mandrels.

Bulbtite/TLR type rivets are usually all aluminium and their design with the clamping legs provides excellent performance.

Summary

- Refer to section 6.0 for aluminium fabrications
- Blind sealed rivets Bulbrite/TLR sealed rivets or stitcher screws with bonded washers and integral heads if appearance is not paramount
- Lap fixings at 75-100mm centres
- Longitudinal fixings at 450mm centres maximum or to alternate crowns at maximum, whichever is the closer
- Edge distance, 12mm or more
- Open joint, butt strap

3.3. Sealants

Sealants can be readily divided into two types, namely strip sealants and gun grade sealants. Gun grade type of sealants can include silicones, polyurethanes and butyl rubber-based sealants. These have the disadvantage of being readily over-compressed by the fasteners installed at the end laps which reduce the effective thickness and therefore its ability to accommodate movement. By comparison, butyl strip sealants are less readily over-compressed, should be appropriately sized for the joint to be sealed and meet the requirements of an NFRC Class A butyl sealant.

In situations where sealants are to be installed into a varying gap dimension, pre-compressed expanding foam sealants may be considered. They exert a pressure onto the fabrication and require fixings at closer centres to avoid bulging. These sealants require compression to about 20-25 percent of their uncompressed depth to remain watertight. They are generally not recommended for fabrications which are visually important as the expanding tape can induce localised forces which affect the appearance.

The sealant must always be positioned on the weather side of a fixing.

The life of a sealant needs to be considered. The sealants can be the factor that determines the life of the cladding and are not easily replaced.

Care must be taken with sealants on PVDF surfaces as PVDF is virtually non-stick; the long-term bonding of sealants is difficult to achieve.

Sealants must be applied in conditions recommended by the manufacturers, particularly with regard to temperature and they should not be applied in wet conditions or to dirty surfaces.

Summary

- Sealants must be continuous and of consistent quality
- Gun grade sealants require good attention to workmanship
- Compressed foam strips and mastic beads fill gaps but can cause bulging
- Position the sealant on the weather side of the fastener
- Sealants should be applied to dry, non-greasy surfaces

3.4 Insulation, vapour control layer and air seals

Attention needs to be paid in design and installation to ensure that the air sealing, vapour control layer and insulation are made continuous or properly terminated at a fabrication. Every effort must be made to ensure the air and vapour seals are maintained as well as the avoidance of cold bridges due to the omission of insulation. If in doubt, fill the fabrication with quilt insulation, especially horizontal fabrications such as cappings, ridges, penetrations and back fabrications.

If an exact colour match between the fabrications and roof or wall sheet is required, then the fabrications should be manufactured out of the same batch of material as the roof and/or wall. This will mean that the fabrication thickness will be the same as the sheeting and will need to be designed accordingly. Tight folds in harder materials can lead to splitting, generally only a risk with aluminium.

3.5 Materials

The common materials used for fabrications with profiled metal roofs and walls are manufactured from the same materials as the roof and wall cladding that is, coated steel or aluminium. The fabrications can be in the same colour as the area or in a contrasting colour for aesthetic effect. With aluminium, the fabrications can be in a natural, unpainted finish, although painted aluminium is generally more pleasing.

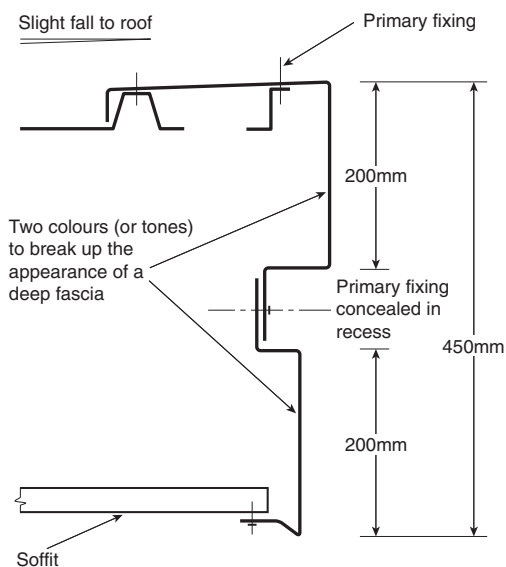


Fig 16 Deep fascia divided into two smaller areas with unobtrusive fixings on the vertical area

Where colour matching is important it is wise not to mix paint types or material types because the paint finishes may age at different rates. Also the orientation of metallic paints can affect appearance, requiring co-ordination between the contractor and flashing supplier. Metallic painted fabrications should come from the same material batch as the area material.

If an exact colour match between the fabrications and roof or wall sheet is required, then the fabrications should be manufactured out of the same batch of material as the roof and/or wall cladding. This will mean that the fabrication thickness will be the same as the sheeting and will need to be designed accordingly.

The minimum material thicknesses for external fabrications generally adopted by the industry are 0.7mm for steel and 0.9mm for aluminium.

Where appearance is important and flatness is essential or where wide girths are being contemplated in aluminium, thicknesses of up to 3mm post-coated or 1.2mm and 1.5mm pre-coated (or natural) are better. Visual flatness is very difficult to achieve and even very minor surface deformations often cause disputes on site.

Samples should be erected on site for comment or approval by the design team.

Flat widths greater than around 200mm require a stiffening bend or backing with a rigid material. Wide girths of steel or aluminium, perhaps on fascias, can be given extra support, for example, by bonding to a ply or insulation board or by bonding on stiffeners to the reverse side. Detailed discussions must take place with the manufacturer to establish that the bonding will be continuous and not leave any unbonded areas which may blister. A reverse side balancing layer may also be needed to ensure that deformation caused by thermal bow will not cause a reduction in performance.

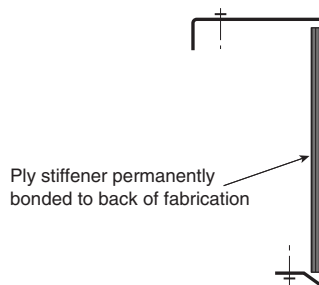


Fig 17 Fully bonded deep fabrication

Large flat unsupported fabrications tend to 'quilt' at fasteners adversely affecting the appearance. Internal fabrications should be a minimum of 0.7mm minimum for steel and aluminium.

To ensure that the fabrication material quality matches that of the wall or roof area sheeting, it is important to specify the coating by name and to ensure that the material is prime material. The reason for this is that the fabrications are often procured from a different source to the area sheet; it is advisable therefore to request proof of the source of manufacture of the fabrications materials.

It is unusual to mix aluminium and steel in roofs and/or walls and fabrications.

Fabrication lengths are generally 3 metres with lengths up to 6 metres being available.

On large radius curved roofing shorter straight lengths of fabrication are commonly used to create a curved appearance by faceting. There can

4.0 Architectural details

be a tendency in doing this for the laps to 'bird mouth' and butt straps shaped to accommodate the faceting can be used to create better flashing junctions.

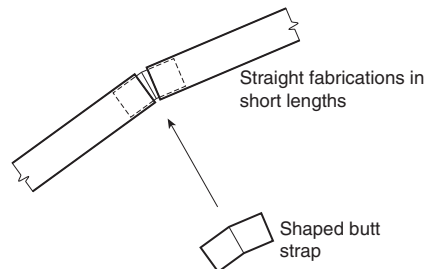


Fig 18 Curved fabrication

Where curved fabrications are needed these are fabricated by the lock-form method or post-coated, welded thick aluminium (2-3mm). The sectional shapes for curved fabrications should be kept as simple as possible with 90° angles.

The verge fabrications to curved roofs are the most prominent and pre-curved fabrications will provide the best appearance. It is a false economy to skimp on the verge fabrications.

The use of lock-form steel/aluminium or welded/post-coated thicker aluminium (2-3mm) will give the best results.

The designer should specify these in the project specification and insist on reference samples for approval before installation.

Summary

- General minimum thickness:

	Internal use	External use
Steel	0.4mm	0.7mm
Aluminium	0.7mm	0.9mm
- Maximum flat width between bends 200-250mm
- Use the same material coating specification as the area material
- Avoid using dissimilar materials and coatings compared to the area material
- Use prime materials and ask for proof of source
- 3 metre common lengths, 6 metre maximum

4.1 Introduction

Architectural fabrications are defined by the fact that they are used on buildings for their visual effect, in addition to any weatherproofing function they may have.

They range in sophistication from two-dimensional bent pre-coated steel fabrications to post-polyester, powder coated welded aluminium complex fabrications. Considerable expertise is required to ensure that these will be compatible with the cladding systems on the building and provide a reliable long-term performance. MCRMA member companies either possess that expertise in-house or are able to recommend reliable supplier companies.

As the photography in this section illustrates, architectural fabrications provide striking visual effects on a building and can on occasions have more effect on the architectural aesthetic than the cladding systems. Some of the major types in common use are illustrated here, however, this is by no means intended to be an exhaustive list.

4.2 Mitred flat panels



These are manufactured from the same panels that make up the wall cladding system of the building. They enable a continuous clean line around a corner which has the effect of making the cladding look as if it is a continuous piece rather than joined together.

4.3 Mitred profile corners



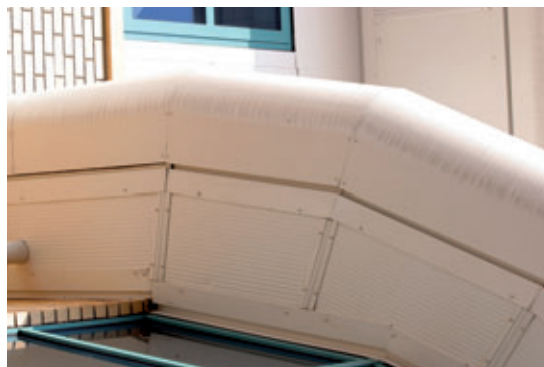
These corners are made to suit both built-up systems and composite panel cladding systems.

4.4 Bull noses



Circular curved fabrications used to create a rounded feature on a building; they are often used on the eaves.

4.5 Bull nose corners



Where two bull nose fabrications meet, a pre-fabricated bull nose corner provides a neat pre-engineered detail.

4.6 Wings, fins and aerofoils



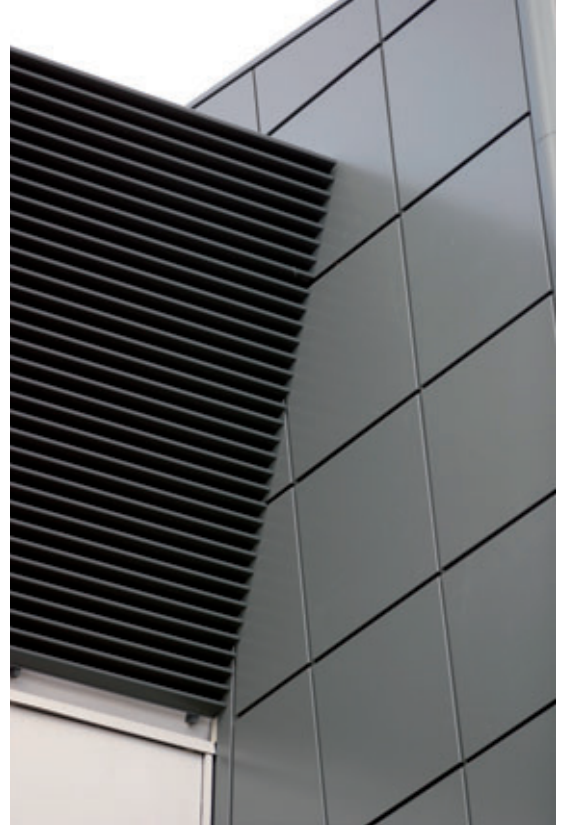
These describe variations of bull nose fabrications which instead of containing simple circular radii, have variations for different visual effects.

4.7 Window surrounds



Window surrounds manage the interface between cladding and window frames. They can be used for purely functional purposes but also can provide a striking visual feature.

4.8 Louvre systems



This is another example of form following function and then taking it over. The function of louvres is to provide ventilation, however they also give what could otherwise be rather dull looking planar buildings a more interesting presentation.

4.9 Curved fabrications



These are used, for example, to provide the end detail to a curved roof. The range of applications is extremely wide, however the curved fabrication almost inevitably makes a strong aesthetic statement.

4.10 Fascia and soffit systems



Fascias are used on vertical faces and soffits for the underside of horizontal faces. These items can be considered as either cladding and fabrications, however they are mentioned here because they are often used to create architectural features to complement or contrast with the main cladding system used.

5.0 Manufacture

Before any fabrication manufacture can be undertaken the manufacturer must have agreed clear working details giving the following information:

- 1 Girth
- 2 Length
- 3 Quantity
- 4 Thickness
- 5 Metal specification
- 6 Colour coating
- 7 Packing instructions (ie batching, if needed)
- 8 Sketch showing profile shape, dimensions and angles, colour-coated surfaces, welts
- 9 Butt straps
- 10 Any special instructions for example, tapering in length, dressing of welds.
- 11 Radius, if applicable

While the bulk of fabrication dimensions can be pre-planned by the sub-contractor at the working drawing stage, there will always be some fabrications that have to rely on site-measured dimensions before manufacture.

The designer needs to be aware of the restrictions concerning minimum dimensions of fabrications to be pressed or folded. Such dimensions vary from machine to machine and fabricator to fabricator.

At the moment, standard tolerances on fabrication dimensions at the manufacturing stage do not exist. Also it is rare for the buyer to state what tolerances will be acceptable to his company. The following can be used as a guide:

Girth of fabrications in flat form prior to folding	± 2mm
Dimension between folds (external or internal dimensions must be specified)	± 1mm
Fold angle	± 2°
Length	+0/-5mm

Fold radii are another aspect which must be considered especially when dealing with thick materials such as copings etc. The thicker the material, the greater the internal radii.

Whether or not detailed or specified, it is good practice to include a fold or welt to the longitudinal edge of fabrications.

Summary

- Provide the fabricator with a complete specification
- Stiffen edges
- Be aware of minimum fabrication dimensions generally, and minimum radii for aluminium

6.0 Special requirements for aluminium

The primary reasons for differentiating between steel and aluminium fabrications is thermal movement. The expansion and contraction rate of aluminium is about twice that of steel and can lead to the rupturing of fasteners and joints. Movement should be assumed to occur and allowed for in design and fixing.

6.1 Allowance for expansion

A rule of thumb for thermal movement in aluminium is 1mm per metre of length. For dark colours this should be increased to 1.5mm per metre. For example, a 3 metre flashing not in dark colours needs an allowance of $3 \times 1 = 3\text{mm}$ at each end for movement.

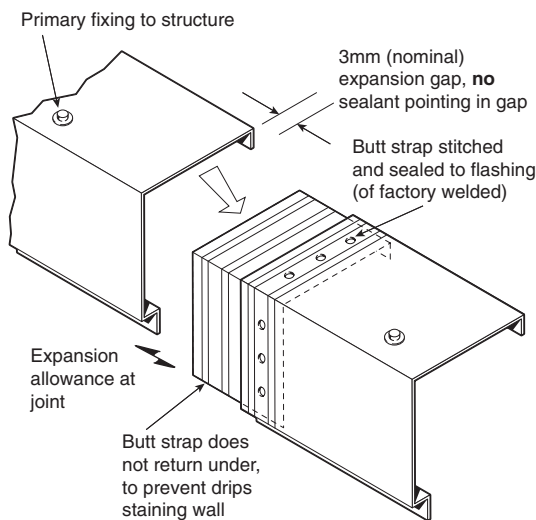


Fig 19 Allowances for movement in aluminium closed section fabrications

If expansion joints are not used and joints are rigidly fixed, the fabrication will act like a very long section amplifying the movement. For example, four 3 metre sections fixed rigidly together will act like a 12 metre fabrication with $12 \times 1 = 12\text{mm}$ of expansion/contraction trying to happen in a stiff material.

If the expansion/contraction is not allowed to happen, temperature variations will cause thinner fabrications to ripple and buckle, laps and fasteners could weaken and leaks occur. Ultimately, fabrications could detach. In extreme cases, it has been known for rigidly fixed aluminium fabrications to fracture.

A 3m fabrication will tend to expand from its centre slotting fixing holes slightly and taking up slack. The expansion gap at each end allows the 1.5mm or so movement to take place at each end of the fabrication.

6.2 Design and installation

The minimum aluminium thickness for fabrications is 0.9mm. Where appearance is of prime importance for example, on fascias, then consider thicker aluminium (2-3mm, for example) and post-painting to match, if necessary. Curved fascias may need to be 3mm, welded, welds dressed and post-painted. This tends to give a tidier appearance than lock-formed thinner materials.

As a general guide, the unstiffened or unsupported widths and material gauges in the table below can be used. The lower limit should be adopted where high aesthetic standards are required and the upper limit where appearance is not critical (behind parapets, for example). The mid range should be suitable for most building purposes.

Gauge mm	Unstiffened width mm
0.9	125-250
1.2	175-350
1.6	225-450
2.0	275-550
3.0	325-650

The maximum individual fabrications length should generally be 3 metres and the widest visible face flat between 125 and 250mm without a stiffening bend (in 0.9mm aluminium). Aluminium fabrications in 6 metre lengths can be used, but for light colours only. For wider ridge fabrications consider introducing additional bends (see fig 20).

Isolate aluminium fabrications from galvanised steel supports using suitable self-adhesive PVC tape.

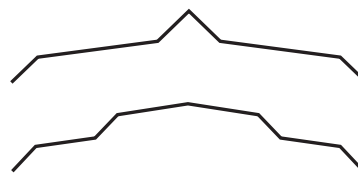


Fig 20 Wide ridge fabrications

Natural mill or stucco aluminium can give aesthetically poor results with the slightest undulation or imperfection appearing prominent. Solid colours such as light grey work better and match well with stucco roofs although there is a variation, especially at first.

Note that metallic silver can also show undulations and imperfections and that whilst light grey can be considered with stucco, it does not work with metallic silver.

Joints in open section fabrications should be lapped. In closed section fabrications that do not nest, joints should be butt strapped. Typical joint details are shown below:

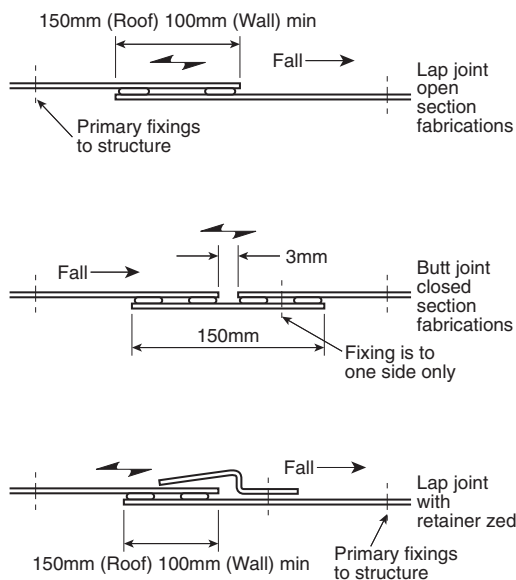


Fig 21 Open section fabrications

6.3 Sealants

Sealants can be readily divided into two types, namely strip seals and gun grade sealants. Gun grade sealants can include silicones, polyurethanes and butyl rubber-based sealants. These have the disadvantage of being readily over-compressed by the fasteners installed at the end laps which reduces the effective thickness and therefore its ability to accommodate movement. By comparison, butyl strip sealants are less readily over-compressed, should be appropriately sized for the joint to be sealed and meet the requirements of an NFRC Class A butyl sealant.

6.4 Welding

One of the advantages of using aluminium is its ability to be welded either in the factory or on site. Welding may be by TIG, MIG, gas brazing or soldering; TIG is currently the favoured method. Welding is a specialist trade and must be undertaken by fully trained and coded welders.

Complex intersections should be welded. These form fixed points; ensure sufficient allowance has been made for expansion between fixed points.

Ensure that there is no risk of fire if welding is to be carried out on site that is, no backing paper, loose vapour control layer or combustible material concealed behind the weld area.

All operatives must stay clear of any welding in progress because of the associated hazards of welding glare, fume fever etc.

Note that aluminium does not change colour when heated!

If the aluminium is pre-painted, the paint must be removed at least 25mm away from the welded area on both sides of the material. Also, any cutting must be done by proper cutting tools and not grinders. Failure to do this may lead to weld inclusions and premature failure.

Welds must be visually checked for stop/start worm holes, cold lap or inclusions which may lead to premature failure and/or leaks. Non-destructive testing may be carried out by trained people using the dye penetration test or similar.

6.5 Fasteners

To fix aluminium to thin flexible materials, aluminium body rivets with stainless steel mandrels or all stainless steel rivets are suitable. Do not oversize holes, the correct pilot hole size is important even with 'Bulbtite' or TLR type rivets.

When fixing fabrications to a rigid substrate with screws, the holes in the aluminium should be oversized by at least 2mm and large washers used to allow flexure in the flashing length.

7.0 Penetrations

Stainless steel rather than carbon steel screws must be used with aluminium fabrications. Fix fabrications at 450mm maximum centres, or to every rib, along their length.

6.6 Aesthetics

Where aluminium fabrications are used and the appearance is crucial, the architect's approval of a sample is prudent before the volume manufacture of expensive welded/post-coated items. This can be of the component or of the made-up fabrication and intersection.

Penetrations in metal roofs create particular design questions for their fabrications and there are a variety of solutions.

7.1 Pipe fabrications

Vent pipes and other relatively small penetrations can be weathered using pre-formed EPDM or silicone rubber pipe fabrications.

These contain a pliable aluminium strip around their base which can be worked around the shape of the roofing profile. The edge is bedded in a gun grade sealant such as silicone and fixed with sealed rivets or stitcher screws. The fixing kits must be obtained from the pipe fabrication manufacturer.

The rubber soakers are adaptable to most profile shapes and provide a good solution if applied well. The pipe fabrications should be installed so that they do not block any flutes of the roof sheet, as this allows water to remain on the coating causing premature deterioration and it unnecessarily tests the sealants. Large diameter pipes should either be installed on a flat back-lashing or specialised soaker pipe fabrications are available.

Any back fabrications should extend to the ridge and under no circumstances should laps other than endlaps be used. Longitudinal laps in these fabrications are not a satisfactory solution.

The collar should be in contact with the pipe by 25mm and any spiral welds etc should have sealant applied.

7.2 Profiled soakers

In trapezoidal profiles, factory-made GRP or aluminium soakers which provide a transition from the profile shape to a flat leading to the upstand can be used. These lap into the profile, with laps being sealed as with normal end and side laps. These are generally only suitable on pitches greater than 5°.

Profiled soakers, if not manufactured from the same material and paint finish as the roof, will cease to have the same appearance after time due to differential fade and ageing. This may not be critical.

7.3 Back fabrications

These flat sheets installed over the crown of the roof sheet profile and laid over the roof sheet, provide a convenient method of weathering openings particularly with secret fix profiles at very low slopes. The endlap between back fabrications should be sealed with twin lines of sealant and stitched with sealed rivets or screws at 75-100mm centres. Longitudinal laps should not be used. The back fabrications edges should be turned down over the profile ribs.

On wide flute profiles, the use of appropriately fire rated insulation board in the profile pans, between the apron and roof profile, will help support the apron and resist accidental damage.

A quilt insulation should be used in narrow flute profiles and installed under the back flashing to reduce the amount of condensation forming on the underside of it.

7.4 On site welding

A very effective method of introducing openings on aluminium roof sheeting is to weld in an aluminium soaker on-site. This can be used with painted or natural aluminium with equal success.

On-site welding is a specialist operation and the advice of a welding expert should be sought and heeded. In particular, the designer needs to consider thermal movement, weld edge support by means of rigid rock fibre insulation, fire safety and drainage from behind the soaker.

It is feasible to introduce penetrations by the use of on-site welding after the general roof area has been installed. The specialist welder will normally cut the opening, take fire precautions, seal vapour control layers and ensure continuity of insulation, as well as installing kerbs, trimmers and soakers and welding the soaker in.

7.5 On site GRP

A method with similar attributes to the on-site welding of aluminium is the use of site-applied GRP on steel roofing to weather an opening. This is another specialist operation in which the advice of an expert applicator should be sought and

heeded. Corus has carried out investigations into site-applied GRP used with Colorcoat HPS200 and is satisfied with regard to material compatibility.

The designer will need to consider drainage around the opening, the long term durability of GRP, support to the bond area and differential colour ageing.

As with welding, it is feasible to introduce openings after the general area of roofing has been installed. Again, the complete procedure is carried out by the specialist.

7.6 General

With all methods of weathering openings, the early planning of opening positions will allow the best detailing. Structural trimmers need to be introduced, the vapour control layer needs to be made continuous (that is, sealed to the opening surrounds). Openings are ideally positioned as close to the ridge as possible, in line upslope (or not placed in the roof at all!).

Penetrations installed after completion of the roof area will need a trimmer to provide support to the surrounding roof and continuity of seal of the vapour control layer.

Attention should be paid to the prevention of cold bridging and to the continuity of insulation.

8.0 Workmanship

8.1 Good housekeeping

Materials must be stored off the ground preferably undercover and secured against the wind.

Protect against trapped moisture and do not store near to access ways.

Avoid impact damage during fixing, especially from riveting tools.

Do not twist fabrications and avoid dragging sections over each other.

Ensure that the correct section is in the correct place and take care in handling sharp edges. Do not force sections into shape especially at folds or weld lines.

Butt straps can be fitted at ground level where they can be well supported to avoid distortion when drilling and riveting. This is especially applicable to aluminium fabrications.

Do not walk on fabrications, either in storage or when fixed, and store away from lines of foot traffic.

Notify the main contractor that walking or standing on finished fabrications is to be avoided.

When working on a fabrication on an aluminium roof, work from a board to avoid over-deflecting the roof sheet or damaging coatings.

Provide boarding for foot traffic in work areas, provide edge protection and provide signs that is, warning signs around fragile areas, rooflights etc.

Clear drill swarf and rivet mandrels as work progresses, do not allow steel swarf to get wet.

Do not store cardboard boxes of fasteners on roofs and only have enough fasteners for the job in the work area.

Dispose of any fabrication off-cuts, clear work area as work progresses and protect work from any follow-on trades, especially wet trades.

Store tools safely when not in use.

8.2 Tools

There are five sets of tools necessary to carry out fabrications work:

Cutting saw, nibbler, shear head snips etc

Hole forming drill, punch etc

Measuring tape, rule, set square, pencil

Fastening lazy tongs, riveter, screw gun etc

Shaping hammer, wide nosed pliers etc

Where electrical tools are used, they must be suitable for 110V site systems and fitted with safety plugs. All electrical tools must be regularly checked and tagged in accordance with the Electrical Regulations. Repairs to electrical equipments must be carried out by trained personnel only.

Certain tools, especially cutting and hole forming tools, require the use of adequate personal protection equipment such as goggles or face mask, ear defenders, gloves etc.

Obviously, the range of tools available is enormous. The type of tools will depend generally on the preference of the user. Certain tasks may mean that special proprietary tools must be used. Whatever the case, the tool must be fit for purpose; the misuse of tools can be both costly and dangerous.

When cutting and drilling, it is good and safe practice to remove sharp edges and burrs. Grinding tools used for cutting tend to produce greater burrs and coating damage than shears or cutting blades and are not to be used.

With power cutting, the operator should consider the problem of noise and ensure that he and others in close proximity use ear protection.

When drilling, it is good practice to use a neoprene sealed washer at the chuck face of the drill to avoid drill damage to the fabrication. Care must be taken when applying force to a drill as sudden penetration may result in fabrication indentations. It is also good practice to pre-punch drill holes to prevent the drill bit slipping across paint faces, and the

materials should be well supported. Swarf must always be removed from the roof.

Cutting tools should be guided along straight edges for the best finish. Cables must be clear of any cutting areas. A good cut can be achieved by cutting bulk waste away with power tools and finishing the work with hand snips, gilbows or similar. Hand snips can be left or right-handed depending on which side the waste is being removed. Screw guns operate in the same manner as a drill.

Care must be taken not to over-tighten fasteners or drive them home too fast, thus stripping the thread (use a depth stop). As with a drill, too much pressure at the wrong time may lead to fabrication indentations.

Rivets are installed by either lazy tongs or lever arm riveting tools. Lazy tongs work by an operator 'punching' action, which can lead to fabrication indentation if misused. It is normally good practice to start pulling the head of the rivet gun away from the rivet prior to the fracture of the rivet mandrel. No matter what the tool used, the sudden fracture of a rivet mandrel can have disastrous results on the finished appearance of a fabrication.

8.3 Fasteners

The choice of fastener is between screws and rivets; the choice being based upon function, strength and desired appearance.

Screws are generally used to fix elements back to supports however, some screws are available that 'stitch' sheets or fabrications together. Sticher screws are not as common as rivets for fixing sheet materials together because of their appearance above the cladding materials.

In all cases, the manufacturer's information regarding pilot hole size (where needed), material compatibility and strength should be consulted prior to specification. Sometimes it is necessary to oversize holes for screw fasteners in the items to be secured, especially in aluminium fabrications to allow for expansion. It must be noted that oversizing of rivet holes is not permissible even when using Bulbtite or TLR type rivets.

When using screw fasteners on fabrications, sealed washers should be used to give a weathertight fixing. For the washer to work properly, it must not be over or under compressed.

The most common type of fastener is a blind sealed rivet. These offer a durable weathertight finish when installed correctly. Bulbtite or TLR rivets are popular since they tend to be more efficient at clamping materials.

For aesthetic purposes, most fasteners can be fitted with plastic caps although the site-fitted caps do not tend to last very long. Alternatively, rivets are now available factory-coated to match adjacent fabrications, or screws with integral plastic heads can be used provided that they are acceptable to the design team.

Take care not to dimple a fabrication while drilling. Pre-punching the hole is useful to avoid skid of the drill bit. Care is also needed during pulling a rivet not to dimple the fabrication when the mandrel breaks. Support the butt strap and fabrication while drilling and riveting to avoid distortion – this may mean attaching butt straps at ground level.

8.4 Site measurement and setting out

Site-measured fabrications and components such as intersections offer the best appearance but take time which is not always available.

Fabrications are usually delivered to site as part of the materials package and are often made to fit regardless.

Fabrications that offer greater flexibility in installation tend to be the favoured type whereas close tolerance products are unforgiving if the structure is out of line.

There is no substitute for preparing and setting out the job properly. The quality of the finish is directly proportional to the amount of time spent on achieving the right finish. Badly fixed fabrications will detract from the overall appearance of a project and could cause leakage. Therefore, it is essential that fabrications are lined in with a string line and squared up using a level.

9.0 Problem-solving

Symmetrically set out fabrications give a better appearance. Three 2.5m lengths look better than two 3m lengths plus a 1.5 make-up piece. Short lengths of 1.5m or less used to finish a run of fabrications seem not to lie flush and can therefore mar the finished effect.

Where the appearance of a fabrication is important to the success of a building, the specifier should make it clear in his preliminaries that the installer is responsible for the design and installation of the fabrication to the satisfaction of the specifier. If the appearance of the fabrications are considered to be of prime importance, then the specifier should also request and approve samples of the fabrications and joints prior to manufacture, perhaps installed on a reference mock-up on site.

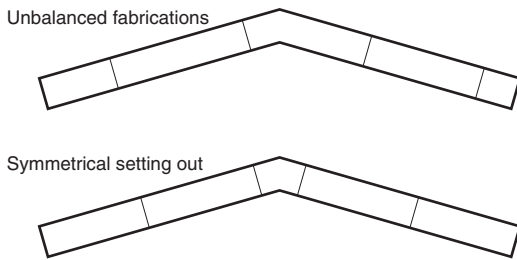


Fig 22 Setting out of fabrications

Packs or shims are not common but their use may be considered in areas where the supports are misaligned.

It is always advisable to check the supports prior to fixing any fabrication to determine high and low points. If the points are found to be in excess of 5mm from the string line for example, shims or packers should be considered at fixing points.

Intersections and corners can be specially fabricated on site or in the factory with short leg lengths. Where appearance is important factory-made corners and end closers are the best choice, as it can be difficult to achieve a professional finish with site-made corners, unless made skilfully.

Since most complaints of water ingress or poor appearance can be traced back to fabrications, the more common causes are listed below:

Sealant	<ul style="list-style-type: none"> - too little - too much - incomplete - incorrectly positioned - wrong type
Fastening	<ul style="list-style-type: none"> - too few - leakage at fixing - thermal movement at fixing - poorly installed - part installed rivets - too close to edge - spacing
Foot traffic	<ul style="list-style-type: none"> - deformation of fabrication - joints/fixings ruptured
Repairs	<ul style="list-style-type: none"> - fixing holes not plugged
Appearance	<ul style="list-style-type: none"> - architect/designer not satisfied with appearance - oil canning - water staining - poor corner detailing
Stiffeners	<ul style="list-style-type: none"> - lack of stiffened edges or turn downs - too large a flat area without stiffening
Joints	<ul style="list-style-type: none"> - lapped joints 'bird mouth' - no allowance for thermal movement
Material	<ul style="list-style-type: none"> - too thin/thick - paint finish different to main areas resulting in colour variation - poor post-painting (lack of etch priming etc)
Cut edges	<ul style="list-style-type: none"> - sheet edges cut with angle grinder
Roof	<ul style="list-style-type: none"> - ends/edges of low pitch roof sheets under fabrications not turned up, or fillers missing

Most, if not, all of these faults can be avoided by the following:

- Appropriate fixer training
- Improved design
- Detailing
- Supervision
- Ensuring that design information gets to the supervisor and fixer on site.



Fig 23 examples of good practice



MCRMA technical papers

- No 1 Recommended good practice for daylighting in metal clad buildings
- No 2 Curved sheeting manual
- No 3 Secret fix roofing design guide
- No 4 Fire and external steel-clad walls: guidance notes to the revised Building Regulations, 1992 (*out of print*)
- No 5 Metal wall systems design guide
- No 6 Profiled metal roofing design guide
- No 7 Fire design of steel-clad external walls for building: construction, performance standards and design
- No 8 Acoustic design guide for metal roof and wall cladding
- No 9 Composite roof and wall cladding panel design guide
- No 10 Profiled metal cladding for roof and walls: guidance notes on revised Building Regulations 1995 parts L & F (*out of print*)
- No 11 Flashings for metal roof and walls: design, detailing and installation guide
- No 12 Fasteners for metal roof and wall cladding: design detailing and installation guide
- No 13 Composite slabs and beams using steel decking: best practice for design and construction
- No 14 Guidance for the design of metal roofing and cladding to comply with Approved Document L2: 2001
- No 15 New Applications: composite construction
- No 16 Guidance for the effective sealing of end lap details in metal roofing constructions.
- No 18 Conventions for calculating U-values, f-values and Ψ -values for metal cladding systems using two- and three-dimensional thermal calculations.

Please note: Publications can be downloaded from the MCRMA web site at www.mcrma.co.uk

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The diagrams of typical constructions in this publication are illustrative only.



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