METAL ROOFING FROM A TO ZINC

PART V: Profiles & Profiling Equipment

By Rob Haddock

Editor's note: *This is the fifth article in a multi-part series about metal roofing in today's market. The series provides an in-depth look at materials and their uses, coatings, system designs, and installation techniques. It is reprinted with permission of* Metalmag.

Back to the beginning

The original shapes of metal panel profiles were quite simplistic, as were the tools used in their making. Smiths hammered out small plates of brass, copper, or gold more than 2,000 years ago. They were then folded at their edges and interlocked one-to-the-next to form the "flat-locked" or "flat seam" style roof. The anchoring was accomplished with a small cleat folded into the joint area during installation. This style is believed to be the original metal roof type and is still popular today, especially for irregular shapes like domes and onion domes. With the advent of soldering in the mid-to-late 1800s, these roofs could be used dead flat with soldered "hydrostatic" joints.

At some point in time, more than a thousand years ago, craftsmen learned that they could fold the adjacent edges of a flat plate up at 90° and then fold the top of the upstanding edges together into a tightly formed 360° (or double folded) lock. This all resulted with the joint being raised above the drainage plane of the plate an inch or so—therefore more water resistant. The joint was now standing up in a vertical orientation rather than laying flat—hence "standing seam" was an appropriate designation to differentiate from the earlier "flat seam." Once again, the anchorage was accomplished via a small cleat nailed to the structure and folded into the seam.

When the craft migrated from the Middle East to Europe during the Crusades, metal roofing profiles were adapted to the styles of architecture and the climate that were prevalent in Western Europe and Scandinavia. Steep roof areas and "tiered" architecture (roofs above lower roofs) would dump snow and ice, damaging fragile standing seams below. A strip of wood inserted between the upstands of adjacent plates would support the seam area, increasing the durability of standing seams and creating a new style—the "batten seam," so called because of the wooden batten strip.

A significant nuance was the introduction of a separate joining component—the batten cover that locks into two twin

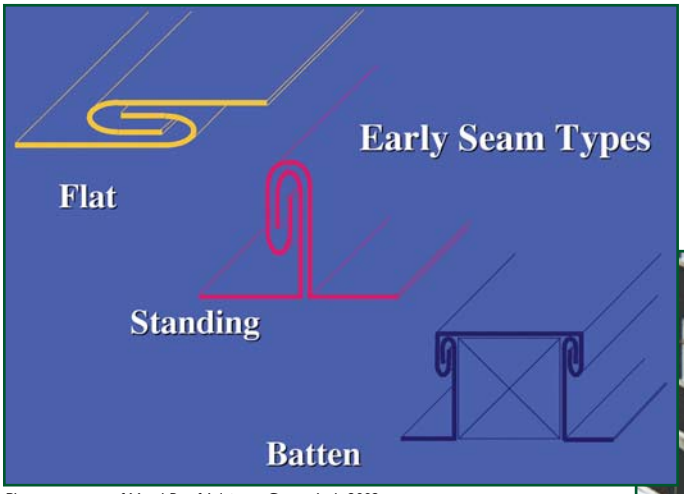

Photo courtesy of Metal Roof Advisory Group, Ltd., 2002

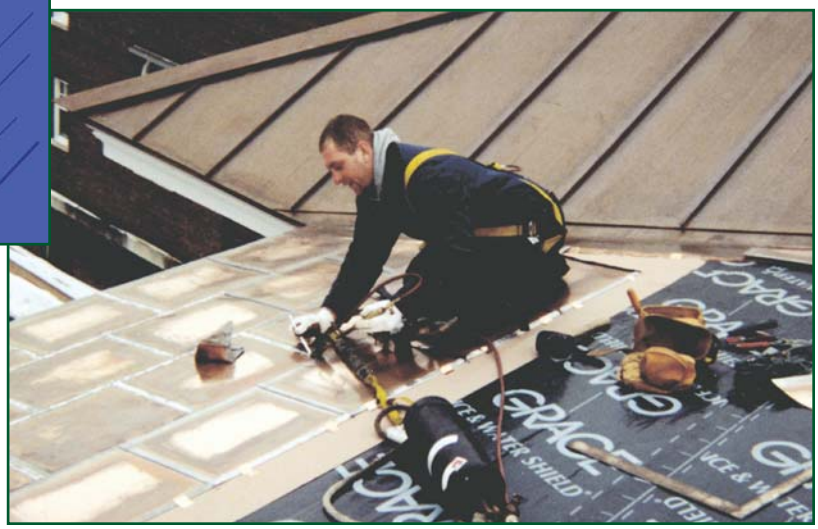

Photo courtesy of Rob Haddock.

The earliest seam styles (above) were simple and fabricated by hand with malleable metals and hand tools. The first profile in history—the "flat seam"—was also the first "hydrostatic" metal profile type when soldering came along. It is still used today (right), as a popular profile for covering irregular shapes like domes.

Over time, tools became more sophisticated. At top, an early wooden brake c. 1860. Center, a variety of early hand tools are shown, including hand shears, spades and malletting anvils. Bottom, an early pan former for lead "batten roll" c. 1840.

Photo courtesy of Rob Haddock.

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upstands and completes the joint. This was a departure from the other profiles that used a "male" and "female" seam edge, which were then interlocked with each other. A modification of the batten seam is the "batten roll." This profile uses a raised "lap seam" (no separate batten cover) and was developed with and for lead roofing to provide more gentle radii for this unique material.

All these styles were fabricated at the point of installation, and with very simplistic tools—mallets, malletting anvils, tongs, and hand and foot brakes, and later, simple pan formers. The metals used were soft, malleable materials and could be meticulously formed, folded, and jointed using these tools, shapes, and techniques. And so the craft of metal roofing was relatively unchanged for centuries, until the Industrial Revolution. A metal roof was the finest and most expensive roof that could be had.

The effects of changing fabrication equipment

With the improvements in mining and milling techniques, as well as innovation in fabrication tools and equipment, new styles of metal roofing began to emerge—and from new materials, as well. The steel industry was making huge strides into the commercialization of sheet goods in the early and mid 1800s, and the harder, less expensive material could be fabricated in a new-fangled thing called a "leaf-brake." It was a device that had a long jaw and a hinged apron that could clamp and fold a perfect, straight bend far more quickly and accurately than the old (and much shorter) hand

Roll forming technology brought on a host of changes and represented real mass production (below). Current trends have made this technology portable with smaller, more mobile equipment (right).

Photo courtesy of Rob Haddock.

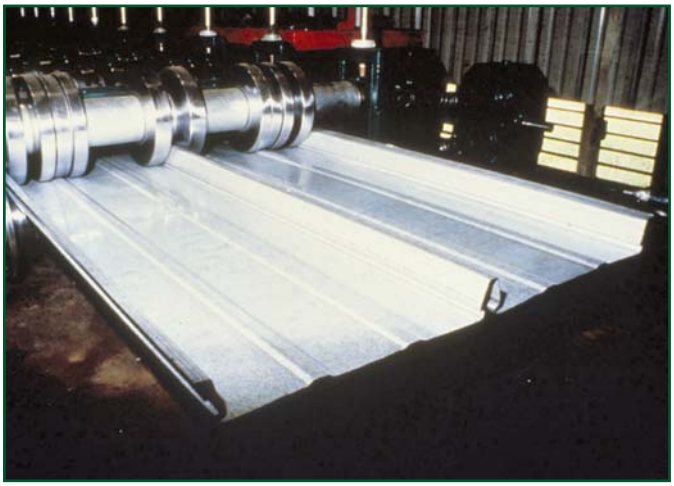

Photo courtesy of Metal Forming Inc.

and foot brakes. This new equipment made any metal roof style more affordable, saving much time by "pre-bending" standing and batten seam profiles in a production environment by less skilled workers.

Corrugating

Another interesting development about the turn of the century was a process called "corrugating." Steel producers found that they could take a very thin sheet of galvanized steel and press lengthwise wrinkles into it by passing it beneath a "corrugating drum." The wrinkles stiffened the sheet such that the metal could now span over open supporting structural members without benefit of a continuous deck. Thus, a "structural" covering would fulfill the function of both deck and roof membrane with one material. The corrugating of steel panels was the first real mass-manufacturing process for metal cladding, and the resulting products made metal an economical roof material for the first time in history. Whereas metal had always been the most expensive roof that could be bought, now it was also the least expensive.

This corrugated metal was attached with exposed fasteners. It was, in other words, "face-fastened" or "through-fastened," meaning that the weathering surface was pierced with nails (and later screws) to secure the product in place. Early applications located the nails in the "high corrugations," but later weather-sealing washered screws came into use as well. Side-seams were joined in overlapping style, as with the earlier "batten roll" methods of roofing.

Roll forming

Innovation continued throughout the next half century, and the leaf brake helped to birth a few new profiles (including another structural panel): the "trapezoidal rib," the integrated batten seam, and the button-punched standing seam. But the most significant advancement in manufacturing did not come along until World War II when "roll forming" technology was invented. This approach to making a profiled sheet was the first departure from a one-at-a-time manufacturing mentality. The progressive roll tooling of such a mill could produce a finished profile in a continuous process rather than step-by-step bending, or sheet corrugating one-by-one.

Another benefit attributable to this new manufacturing method was the precision with which panels could be formed. One end of the panel would be dimensionally consistent with the other—within thousandths of an inch! This had never been possible with leaf braking. The roll-forming process also opened the spectrum of available metal panel profiles, allowing intricate shapes, lines, and bends never before possible or affordable. This equipment today can operate at line speeds of up to 600 feet per minute, automatically measuring and cutting panels to length with amazing accuracy at the same time.

The concept of continuous manufacturing – dealing with an endless strip of material – now pervades almost every aspect of production and fabrication, including painting, profiling, curving, seam closing, slitting, leveling, and even sealant injection.

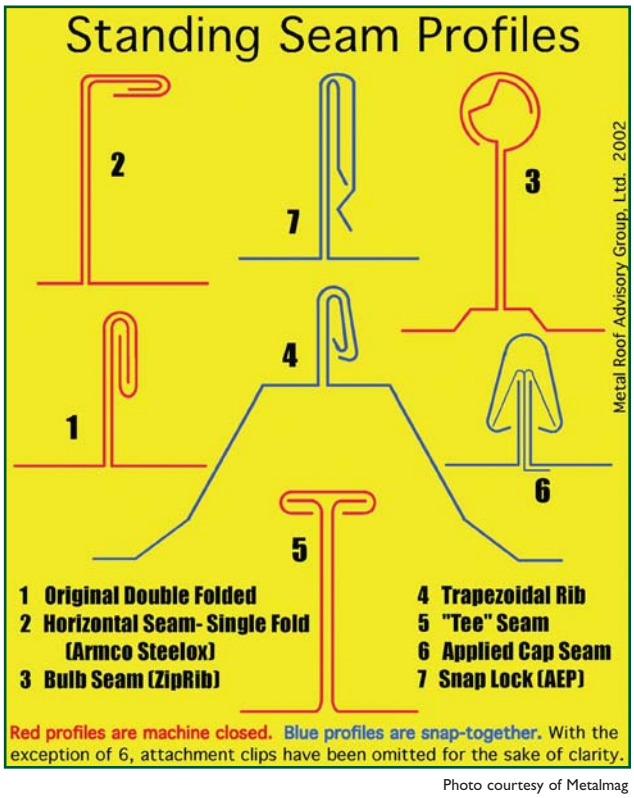

Photo courtesy of Metalmag

In this sample of shapes, 5 and 6 utilize twin male components with a female cap. The others are male-female interlocks. Many variations of all these profiles are available. For instance, combine a 1 seam type with a 4 rib geometry – you have Butler's "MR24," or MBCI's "Double Lok," or VP's "SSR." Combine a 6 seam type with a 4 rib geometry for Behlen's standing seam. Add a small hook to the 2 seam type for McElroy's "Maxima."

Right: Butler introduced "MR24" in the late 1960s. It utilized the original double-folded standing seam profile (see standing seam profile #1 on page 6) atop a trapezoidal rib shape, and closed the seam with an electric machine—in essence a miniature 4-stage roll former.

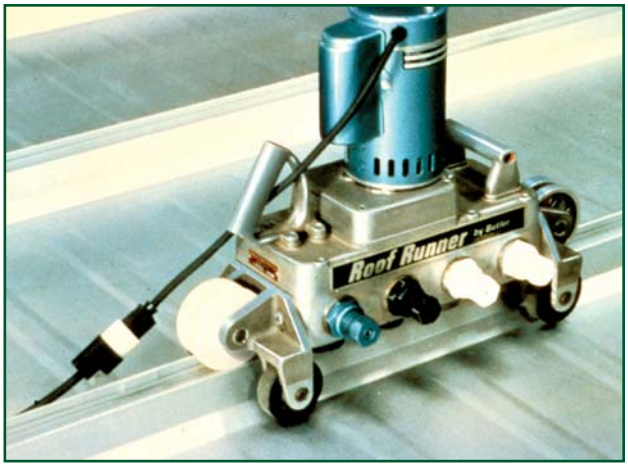

Photo courtesy of Rob Haddock.

The roll forming process has found its way from large in-plant mills to smaller, portable "site-forming" machines and electric seam-folding machines as well. Whenever long, parallel bend lines are found on metal panels, it is a reasonable assumption that the profile was made by roll forming.

Sometimes press forming is used in tandem with roll forming to produce still different effects like some of the popular tile facsimiles available in the marketplace, or for "crimp curving" or to break a profiled (roll-formed) sheet over the ridge area. Press forming is also used for the manufacturing of individual shingles or tiles and other textured shapes that are not characterized by long panels with parallel bend lines.

Of course, roll-forming technology has made a host of new profiles possible, and the manufacturing of the old ones much more cost effective. Another new concept to come along in panel profiling within the last few decades was the creation of snap-together seams and snap-on caps, using the spring action of harder and higher yield metals, along with the dimensional consistency of modern roll-forming equipment, to develop locks and joints that do not require field folding or crimping.

Profiles and joints for "structural" panels

The use of standing seam joints and profiles on structural steel and aluminum panels is a trend that started with Armco Steel pre-1950. The concept was boosted with Kaiser's introduction of a product called "Zip Rib" in the '60s. This was a "bulb seam" design held in place with concealed clips, and it was popularized worldwide. Then about 1970, Butler Manufacturing introduced MR24 in the United States, the first standing seam joint used in conjunction with a trapezoidal rib panel profile. It was a curious blend of old and new: a thousand-year-old joint on a relatively new material and profile, then used atop pre-engineered metal buildings. This revolutionized the metal building industry, and since then, every major U.S. manufacturer of pre-engineered steel buildings now offers a structural standing seam alternative.

There seem to have emerged from within the metal building industry two panel geometries: the flat pan and the trapezoidal rib. There have also emerged two different types of joints: male-female interlock, or applied cap. With applied cap profiles, the cap is the female component of the assem-

Right and below: The concept of roll-tooling and continuous feed are also utlized by other material handling equipment, including levelers (that stretch and flatten material), cut-to-length lines, slitters, and curving machines.

Photo courtesy of Rob Haddock.

Photo courtesy of Rob Haddock.

bly, and the panel edges are mirrored male components. Additionally, either of these joint types (interlock or applied cap) may be snap-together or mechanically crimped or folded. It seems that recent trends are more toward mechanically folded seams, probably because, generally speaking, they are more durable with respect to wind resistance. Clearly, snap-together type seams are less labor intensive to install, and for that reason will always remain popular.

Which is best?

There is no clear answer to the question, "Which seam and profile is the best?" Everyone has biases, and there are pros and cons to any profile and seam type. My personal favorites are generally profiles that involve no void area within the seam. Trapezoidal ribs are cumbersome shapes to deal with at panel termination points—especially when those points are skewed, like at hips or valleys. But on the other hand, if the job does not involve such conditions, the trapezoidal profile may offer cost efficiencies not enjoyed by other profiles.

All things considered, it is hard to beat the original double-folded standing seam. It has been around for more than a thousand years and is sure to be around for a very long time to come.

New technology brings new challenges

Prior to the advent of roll forming, panel lengths were generally limited to 8 or 10 feet — the length of a traditional leaf brake. With the roll-forming process, panel lengths grew longer and longer, not being limited by fabrication equipment, but only by transportation restrictions. This makes sense, as longer panel lengths mean fewer end-to-end joints that are expensive to execute and can be problematic. As the panel lengths increased, however, we also began to experience roof failures associated with thermal effects. With increasing panel lengths, panel attachment methods had to gain sophistication in order to accommodate the increased effects of thermal cycling. In the next segment, we will explore thermal cycling characteristics of metal panel systems.

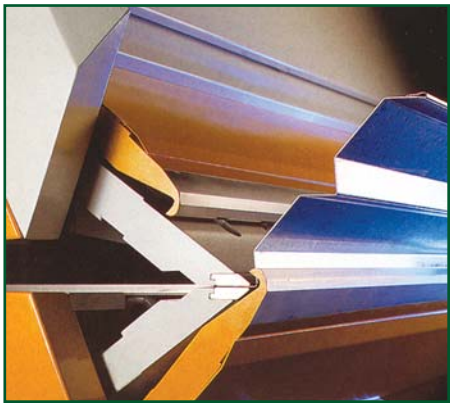

Photo courtesy of RAS.

Above right and right: Modern, state-of-the-art sheet metal brakes can handle hard metals and are veritable fabrication centers with computerized controls and automated processing.

Photo courtesy of Roper Whitney.

Rob Haddock

Rob Haddock is president of the Metal Roof Advisory Group, Ltd. and a well recognized authority on metal roofing. He is a consultant, technical writer, training curriculum author, inventor, and educator. He is a member of NRCA, ASTM, SBA, and MCA, and has taught RCI's metal roofing classes. He is a past recipient of RCI's Horowitz Award for outstanding contribution to *Interface* journal.