Retrofitting Over Ribbed Metal Building Panels

Roofs – Walls – Fascias

By D.V. McConnohie

ANNUAL SHIPMENT STATISTICS COMPILED BY the Metal Construction Association (MCA) show the metal building reroofing market to be in excess of $900 million annually in materials, labor and accessories and growing at 10% per year ('95-'96 reporting period).

While great emphasis has been directed toward retrofitting sloped metal roofs over existing flat, built-up roofs to eliminate ponding and plugged interior drains and leaks, the problems of retrofitting the large stock of existing metal buildings has been seriously neglected.

Many millions of square feet of metal buildings produced and erected in the 50s through the 70s are now in dire need of replacement. This market commands over 60% of the total industrial-commercial construction of one- and two-story structures (MCA statistics).

The technical challenges of developing a simple, structurally-sound attachment system which meets codes and criteria for attaching the new retrofit panels are many, but standardized solutions have been non-existent or inadequate until recently.

A majority of the retrofits of the past 10 to 15 years have shown that the manufacturers and suppliers have been content to let the erector or contractor use whatever "make-do" attachment system that they devise in the field. Little regard has been exhibited for their own or their buyer's potential liabilities in case of future failures.

Presently there are court cases where just such liability is being passed through to the deeper pockets of the manufacturer/supplier. The legal basis being claimed is that the supplier should have given proper instructions and/or materials that would have assured the buyer and erector/contractor that required code and criteria would be adequately met.

The typical manner in which a retrofit job develops is as follows:

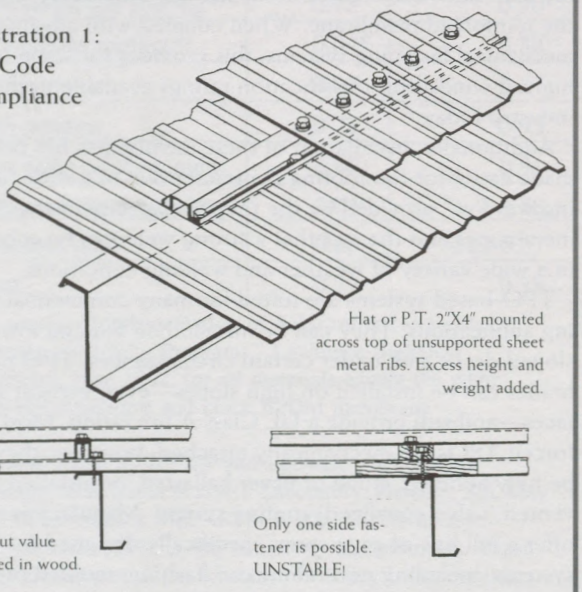
(a) A building owner with continuing and worsening roof leaks decides that a new roof is essential. The existing metal roof is 20 to 40 years old, coated, tarred and caulked beyond its useful life.

(b) The owner calls one or more metal building contractors, erectors or roofing and sheet metal companies to get budget pricing.

(c) Their suggestions and pricing run the gamut:

- Tear off the old roof (and insulation if any) and replace everything (*Illustration 1*).

Illustration 1: No Code Compliance



- Run a light gauge "hat" section across the top of the existing, degraded, 26 ga. ribs.
- Run a pressure-treated 2 x 4 across in the same manner.
- Or, if an architect or engineer has been consulted, run a "hat" channel or 2 x 4 vertically up the "pan" or "valley" of the existing panels fastened through to the underlying structural purlin. Then run a second "hat" channel or 2 x 4 across the pan or valley blocks, fastening it to the blocking to achieve a structural connection.

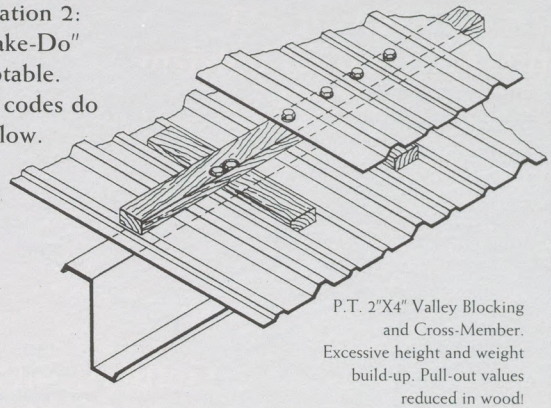
In all cases, the new panels are secured to the top of the new raised surface of that channel or 2 x 4.

Only in those jobs where a roof consultant, architect or engineer has been brought into the design has ample consideration been given to certify compliance to wind load uplift codes.

Many, if not most first-time retrofitters have not seen an engineered or approved method for accomplishing attachment of the new panels, and certainly the owner/buyer is unaware of the differences as quoted. The supplier's field salespeople seldom feel qualified enough to suggest attachment methods.

This is the point where the abuse and neglect begin to

Illustration 2:
A "Make-Do"
Acceptable.
Some codes do
not allow.



P.T. 2"X4" Valley Blocking and Cross-Member. Excessive height and weight build-up. Pull-out values reduced in wood!

Note: Requires two fasteners each, blocking, stringer and new sheet valleys at each purlin line.

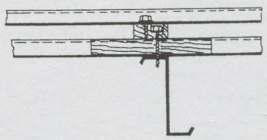
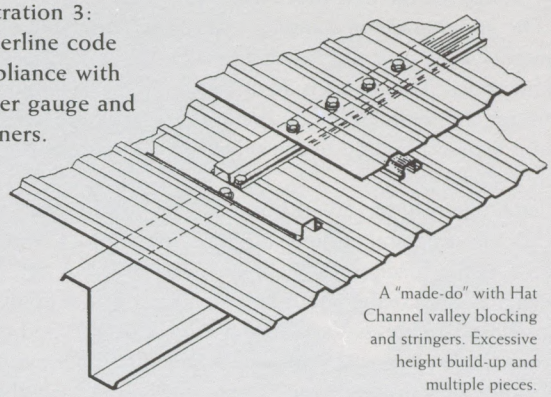
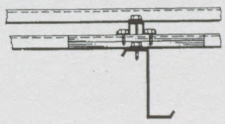


Illustration 3:
Borderline code
compliance with
proper gauge and
fasteners.



A "made-do" with Hat Channel valley blocking and stringers. Excessive height build-up and multiple pieces.

Note: Requires two fasteners each, blocking and stringer and one or two each valley of new sheet for wind code.



show up, not by any intent but because of a lack of knowledge and recognized, engineered system in place to assure code compliance and MCA standards of quality.

Under those circumstances, the owner/buyer generally opts for the least expensive proposal. That usually means he gets the most common method of a hat section laid directly on and across the existing high ribs.

The erector then attempts to "find" the underlying purlin with a two- to three-inch long screw from one side of the hat channel rails. (The required two fasteners are impossible because the two rails of the hat channel are farther apart than the width of the purlin top flange).

The results of this fiasco are as follows: (1) it meets no uplift code requirements; (2) when torquing down the one long screw-to-purlin, the channel rail often "cripples" the support rib; (3) the other channel rail is "stitched down" with a screw (if at all) into only the 26-gauge metal; (4) heavy foot traffic on the new panels during the erection similarly may cripple the ribs at the point of impact of the narrow channel rail resting on the rib.

The end product is a no-code, non-engineered, "loose" roof, presenting sobering liabilities to all concerned. Degraded 26-gauge panel ribs have no practical value as the sole support for the new retrofit panels and certainly no significant restraint against wind load uplift and shear factors when attached with stitch screws.

Other serious concerns with all of the "make-do" methods previously mentioned are: excessive imposed dead loads when using pressure treated 2 x 4s and reduced fastener pull-out values in wood; excessive height build-up when using either hat channels or 2 x 4s over the top of existing ribs.

Higher elevations of the new roof panel over the existing structural system invite "shear" loads when the upper panel diaphragm is subjected to maximum horizontal wind loads.

Such shear loads are exacerbated by intermittent gusts which cause the elevated diaphragm to move somewhat independently from the structurally-attached underlying existing diaphragm. The further the separation, the larger the leverage in shear.

It does not require great imagination to visualize and forecast the breaking off and/or "wallowing" at tip and head points of the fasteners holding both the channels and new panels in place when significant shear force is applied to the upper diaphragm attached as described. Even when structural valley blocking and cross members are utilized and properly attached, the height and weight build-up remains, and a new problem is created. That problem is the rigidity of the hat channel connection under thermal expansion and contraction.

We have seen and are currently seeing where this system has caused fasteners to "back out." Visual inspection of the edges of the sheet around the fastener penetration hole shows some trauma. In one case of a long roof run, the lower portion fasteners have been reset or replaced three times so far (per Dale Nelson of APCO Building Systems).

To overcome these multiple deficiencies in retrofit attachment system design, Roof Hugger, Inc., embraced the premise that a Zee section was essential in replicating the desirable "roll-and flex" of the original structural system. Such a section tolerates thermal movement quite well and absorbs wind loads.

Secondly, the Zee shape must allow a "nesting" into the pans or valleys of the existing ribbed panels to achieve a nearly direct structural connection with no dependence on the existing panel ribs for either support or uplift resistance.

Third, the lowest possible silhouette must be attained to minimize the leverage of horizontal wind shear forces.

The result has been the one-piece Roof Hugger sub-purlin. This galvanized (G-90) Zee section "nests" into existing profiles, attaches to the structurals through pre-punched pilot holes and requires only standard fasteners, tools and techniques.

The company supplies wind load uplift engineering data and manufactures sections in 12 gauge through 18 gauge to meet various code requirements or special situations.

Most of the previous and about one-half of the current retrofit jobs have used screw-down, 12" on center by 1-1/4" to

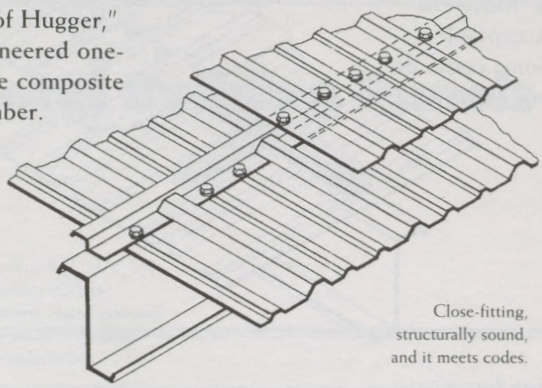
1-1/2" ribs for the new roof material.

The growing use of standing seam panels mounted on clips presents some new and variable problems in calculating wind uplift codes. These panels are manufactured in widths of 12" through 30", with 24" being the norm. The clips present a point load as opposed to the spread of loads when using the screw-down type.

Each clip restrains an area of roof equal to the panel width times the structural purlin spacing. Assuming a 24" wide panel and 5' purlin spacing, each clip restrains 10 s. f. A 110-MPH wind velocity creates about 34 pounds per s. f. of uplift on one-story structures. Variations occur for heights and roof slopes. This equates to 340 pounds per clip in our example. Thus the selection of proper gauges becomes essential for the attachment system to meet required criteria.

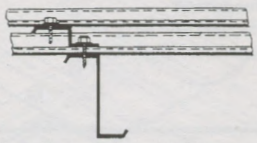
While the Roof Hugger has only been available for a short time, the company has furnished its system for jobs ranging from Guam, Hawaii, Alaska, Canada, Mexico through the Caribbean Islands with customers such as the U.S. Air Force, Navy, Corps. of Engineers and on many state and local government jobs. Several major manufacturers of metal buildings and components have used the product in retrofitting their own facilities.

Illustration 4: The "Roof Hugger," engineered one-piece composite member.



Close-fitting, structurally sound, and it meets codes.

Note: Requires two fasteners in bottom flange and one to two fasteners in the new sheet for wind code.



About The Author

D.V. "Red" McConnohie *attended Western Michigan University and studied mechanical and hydraulic engineering under the G. I. Bill immediately following discharge from the 8th A.F. in WWII. He joined American Building Company in 1959 and was district manager for Florida until 1966. Over 37 years, he developed three industrial parks, sold and built structures in the U.S., Central America, the Caribbean Islands and Europe. He has been a featured speaker before thousands of industry professionals across the U.S. and overseas. Red is currently Chairman of Roof Hugger, Inc.*