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Housing for Generations

Corrosion Performance of Galvanized Steel Framing in Residential Construction

Roger Wildt

For over a century, zinc has enhanced the longevity and performance of steel. Zinc coatings provide the most effective and economical way of protecting steel against corrosion. More recently, steel is finding increased worldwide use as a framing element in new residential construction. This document addresses anticipated long-term performance.

In North America, light-gauge, cold-formed steel was first used in the 1930's and there is no documentation of failure due to corrosion when the building envelope has been maintained in a sound condition. To go beyond this anecdotal history it has been necessary to conduct tests in actual homes with diverse climates and a range of construction practices.

To date all test results, worldwide, indicate that there is little corrosion in residential construction under normal conditions. Minor corrosion, if present, will not adversely affect the anticipated life of a structure. Some conditions of exposure to salt water ions can be more severe than average, but have been noted with recommendations for their mitigation.

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1. The Environment of Building Wall Interiors

Like other construction materials, the durability of galvanized steel framing will depend on its immediate environment. Factors such as water leakage, excessive humidity or condensation will damage any construction material over time and will accelerate the corrosion of zinc coatings that protect steel framing. However, if a building is built to the requirements of a modern building code, properly ventilated and maintained, moisture will not be a concern for galvanized steel framing. The techniques described in various codes include use of vapor barriers and insulation materials that prevent the wall cavity environment from dropping below the local dewpoint for extended periods of time because, under this condition, condensation will occur.

Various techniques are used in North America and Europe for construction with galvanized steel framing, but all fall within two categories:

Cold cavity

In cold cavity construction, insulation is placed on the interior side of the steel framing, leaving the load bearing framing and the wall exterior unheated. The cavity is ventilated to the outside to avoid dewpoint condensation.

Warm cavity

In warm cavity construction, insulation is placed both within the wall framing and on the outside of the framing – immediately beneath the exterior membrane. The cavity is vented to the inside and remains sufficiently warm so that condensation cannot occur.

For all construction

The greatest sources of moisture for most residences are bathrooms and kitchens. As for traditional construction practices, moisture from these rooms should be vented directly to the outside rather than allowed to migrate into wall and ceiling cavities.

The greatest opportunity for the collection (and retention) of condensate moisture is along the bottom track of exterior walls. Moisture collection above the track (inside the trough) can be prevented by eliminating condensation and maintaining the integrity of the exterior membrane. Moisture collection below the track can be prevented by placing either a vapor barrier or sill gasket between the track and the foundation wall.

2. Other Factors Affecting Corrosion

Time of wetness is the most important factor affecting the durability of galvanized steel framing and therefore most attention should be directed toward minimizing wall cavity moisture. The only other residential framing cause of corrosion to zinc is chloride from marine or other salt environments. This situation also has been researched and some conditions will require, for prudence, a heavier coating of zinc.

Roger Wildt is a consultant to International Zinc Association. This brochure is based on information gathered by the International Lead Zinc Research Organisation (ILZRO).

3. Case Studies

Location of North American Test Houses

Location	Environment	Foundation
Miami, Florida	Humid, inland	Slab-on-grade
Leonardtown, Maryland	Semi-marine with humid summers	Crawlspace
Long Beach Island, New Jersey	Marine	Piers with enclosed area under house
Hamilton, Ontario	Industrial with cold winters	Basement

European Exposure Locations and Systems

	Site Characteristics			
Site	Cavity	Loft	Elevation	Other
Edinburgh (UK)	Warm	-	-	Rainscreen, overcladding
Port Talbot (UK)	Cold	-	-	Overcladding
Oxford (UK)	Blockwork-ground floor Brickwork-1st floor	Insulated	-	Floor void under composite floor deck
Lisbon (Portugal)	Cold	Uninsulated, void of timber annex	West	Overcladding
Raahe (Finland)	-	-	West	All are refurbished 3-story block of flats
	-	-	South	
	-	-	North	
	-	Uninsulated	-	
Hameenlinna (Finland)	Loft and west wall	-	South	Lightweight steel frame facing overclad wall

North America

Studies were done with five different coatings (two galvanized, one Galfan® and two Galvalume®) in four different houses representing widely different climatic conditions.

Europe

Studies were done with two different coatings (galvanized and Galfan®) in six different houses/flats in three countries representing both widely different climatic conditions and construction methods.

4. Results

North America

After one year of exposure, 145 samples were retrieved from the four residences. The only sign of corrosion to occur in any of the samples were some incidents of "white rust" on the chords of attic trusses, not considered a sign of sample degradation. At the Canadian residence, some samples had signs of minor rust at cut edges, but all were within 0.01 grams of their pre-exposure weight. At the most severe site (on the ocean front in Maryland), weight losses in the most exposed samples were under 0.04 grams. Comparative measurements with bare steel samples showed that the corrosion loss under a terrace deck was 90 times that of the galvanized samples and the corrosion loss in a crawlspace under the house was 290 times greater than the galvanized samples.

Europe

The European program has been ongoing for over three years, but the results are compatible with those from North America. The extra time of exposure has shown a decline in the rate of coating loss, indicating that some degree of pacification may be occurring. Average loss levels are in the order of 0.037 grams/square meter/month for galvanized and 0.050 for Galfan®. (Note the measurement systems were different between North America and Europe). To put this data in perspective, coating life expectations range from a low of 166 years to well over 450 years.

Another series of tests were conducted in France at a very aggressive location on an island off the coast of Brittany. Again the rates of material loss for bare steel were far higher than for coated steel – up to a factor of 25. By contrast, the galvanized steel had a life expectancy of hundreds of years.

Members of the International Zinc Association have adopted a Sustainability Charter – view their commitment to sustainable development at www.zincworld.org

5. Sustainable Construction

Zinc is natural and fully recyclable. It is an element essential for life and the 17th most common element in the earth's crust. Today, over 80% of the zinc available for recycling is recycled. The presence of zinc coating on steel does not restrict steel's recyclability and all types of zinc-coated products are recyclable, both from the construction phase (job-site scrap) and the demolition phase (end-of-life scrap). Zinc coated steel is recycled along with other steel scrap during the steel production process - the zinc volatilises and is then recovered.

Zinc coating is an energy-efficient process. Zinc residues from the galvanizing process are recycled. Zinc coating extends the life of all steel products and thus improves steel's life-cycle performance and removes the need for regular maintenance normally associated with paint and other coatings. Today's technology enables thinner zinc coatings to provide higher performance. Moreover, as observed in many industrialised countries, zinc coatings now last even longer thanks to decreasing levels of atmospheric sulphur dioxide.

Specifying a zinc coating is in step with today's need for sustainable materials.

6. Summary

Provided that the building envelope is maintained in good condition and water does not enter the wall cavity, a reasonable requirement for all building materials, zinc-coated (galvanized, Galfan® or Galvalume®) steel will maintain its integrity for well over a hundred years – maybe even many hundreds of years. Further, since all test results show some degree of passivity with time, these preliminary figures are likely to be conservative.

The conclusion is very clear – zinc coated steel components of a residential framing system will not be degraded by corrosion during the economic life of a structure.

Need More Information?

The information contained in this leaflet has been drawn from an IZA publication titled "Corrosion Performance of Galvanized Steel Framing in Residential Construction" and represents information gathered by the International Lead and Zinc Research Organization. Single copies of the reference document may be obtained free of charge from International Zinc Association.

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