Metal Construction Association

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Guide to Steel Sheet Substrates

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The most commonly used metallic coated sheet steel products in the construction industry are: (1) Galvanized, (2) 55% aluminum-zinc coated, (3) Zinc-5% aluminum coated, and (4) aluminum-coated sheets. These coated sheet steel products provide corrosion protection in a diverse range of applications. They are all made by the continuous hot-dip process. Each product is available with various coating thicknesses, surface finishes and strengths and ductility levels.

Galvanized is an economical, corrosion resistant zinc-coated sheet steel. It provides good overall corrosion resistance and excellent galvanic or sacrificial protection at cut edges and scratches through the coating. It is available in finishes to meet various surface requirements: regular spangle, minimized spangle and temper rolled, extra smooth. Galvanized sheet can be readily factory painted and field painted. It is the standard hot-dip metallic coated sheet product to which all other products are compared.

55% aluminum-zinc alloy-coated steel sheet is coated with an alloy of 55% aluminum-45% zinc. The alloy coating provides excellent long term corrosion resistance like that of aluminum coatings and galvanic protection at cut edges and scratches characteristic of zinc coatings. It is readily formable and available both painted and unpainted. It is widely used unpainted for low slope roofing and painted for architectural roofing and siding panels.

Zinc-5% aluminum coated steel sheet is coated with an alloy of 95% zinc-5% aluminum. For most applications it provides improved performance over galvanized, especially for applications requiring a high degree of coating formability. The high percentage of zinc allows for excellent galvanic protection at cut edges and scratches similar to regular galvanized coatings. It is primarily used painted for building panels.

Aluminum-coated steel sheet has excellent long term corrosion resistance. It provides limited galvanic protection at cut edges and scratches, except in marine environments. It is mostly used unpainted for low slope roofing, although it can be painted and is used for architectural roofing and siding panels.

Hot-Dip Process

The hot dip process involves cleaning, annealing (heat treating), coating and finishing steel coils at speeds up to 600 feet/minute, all in one continuous operation. Figure 1 is a schematic diagram of a typical continuous hot dip coating line.
Coils of cold rolled steel are first uncoiled and welded end-to-end for non-stop processing. The steel is cleaned to remove dirt and oil and then annealed or heat-treated in a furnace. The furnace contains hydrogen gas which eliminates oxides on the sheet and prepares the surface for hot dip coating. The sheet is heated to high temperatures to develop the desired strength and formability levels in the steel.

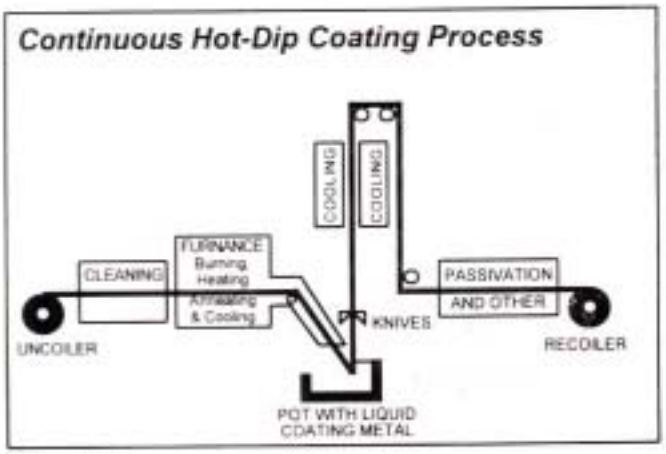

Figure 1

After completing the heat treatment cycle in the furnace, the sheet enters the molten coating bath through a furnace extension to avoid contact with air and reoxidation of the sheet surface. A metallurgical bond forms between the steel and the metal coating in the bath. The metallurgical bond provides the excellent adherence characteristic of hot dip coatings such that the sheet can be formed without flaking or spalling of the coating.

The sheet exits the bath vertically out of the pot, "dragging" or pulling out with it a layer of molten coating. Excess coating is wiped or removed with air knives to achieve the desired coating thickness. The air knives control the coating thickness by impinging a high pressure air stream normal to the

sheet. On modern high speed lines the air knives are computer controlled using feedback from an on-line gage that continuously measures the coating thickness on each side and across the width of the sheet.

As the sheet continues vertically after the air knives, the coating is cooled and solidified. The solidification process can also be controlled at this location to impart selective surface finishes, such as minimized spangle.

Processing through a tension leveler takes place to flatten the sheet and through a temper or rolling mill to control the surface finish after cooling. Then, as a final step before coiling, a chemical treatment is applied to protect the sheet from transit and storage corrosion.

Fabrication

Galvanized, 55% aluminum-zinc coated, zinc-5% aluminum coated, and aluminum coated sheet lend themselves to most fabrication processes; they can be roll formed, brake formed or lock seamed; they can be welded, by various methods, riveted, and in some cases soldered, and generally handled and processed much the same as uncoated flat-rolled sheet. As a result, the designer and materials specifier have a range of practical choices for matching specific coated products to meet the requirements for the end use, such as strength and ductility, corrosion resistance, and surface finish.

Mechanical Properties

These coated-sheet products are available in a number of metallurgical qualities, providing different degrees of formability and strength to the base sheet. The most common quality types are:

1) Commercial Quality (CQ)
2) Lock Forming Quality (LFQ)
3) Drawing Quality (DQ)
4) Drawing Quality Special Killed (DQSK)
5) Deep Drawing Quality Special Killed - Fully Stabilized
6) Structural Quality (SQ)

The most common quality types used in the construction industry are CQ, LFQ, and SQ. Most steel products used for construction applications are designed in accordance with the AISI *"SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS"* which requires the use of steel of structural quality. Other quality types are typically used for accessories, flashing and other non-structural applications when formability or economics are considerations. These types may be used for structural applications when *AISI Specification* criteria governing their use are met. The strengths levels for SQ as defined in ASTM specifications, A 653-95 for galvanized, A 792-94 for 55% aluminum-zinc coated, A 875-94 for zinc-5% aluminum coated, and A 463-95 for aluminum coated are listed in the following table:

Mechanical Property Requirements for ASTM Structural Quality Grades (Minimum Values)

Grade	Yield Strength (ksi)	Tensile Strength (ksi)	Elongation (%)
33	33	45	20
37	37	52	18
40	40	55	16
50	50	65	12
Class 1 50			
Class 2	50	None Specified	12
80	80	82	None Specified

NOTE: A 463-95 SQ is available in Grade 33 only.

Coating Weight

Coating thickness (measured as coating weight in ounces per square foot or grams per square meter) is important in controlling corrosion resistance and influencing coating ductility during fabrication. The coating weight should be chosen carefully, by considering the fabrication method and type of environment in which the sheet will be expected to serve. In general, thick or heavy coatings will provide better corrosion resistance and longer life than thin or light coatings. Conversely, the adherence of the coating generally is inversely proportional to the thickness; therefore, a thin coating is more desirable for applications involving severe forming. Coating weight may also affect the weldability of some products. Conversely, the welding process can limit the selection of coating weight.

Common coating weights used in the construction industry for galvanized include the following:

ASTM A 653-95 Coating Designation	Approximate Thickness (Mils*)		Minimum Coating Weight (oz/sq ft)	
	Both Sides	Each Side	Triple-Spot Test Total Both Sides	Single-Spot Test Total Both Sides
G165	2.8	1.4	1.65	1.40
G115	1.9	1.0	1.15	1.00
G 90	1.5	0.8	0.90	0.80
G 60	1.0	0.5	0.60	0.50
G 40	0.7	0.3	0.40	0.30

*1 Mil - 0.001 inch

For 55% aluminum-zinc coated sheet, the most common coating categories are:

ASTM A 792-94 Coating Designation	Approximate Thickness (Mils*)		Minimum Coating Weight (oz/sq ft)	
	Both Sides	Each Side	Triple-Spot Test Total Both Sides	Single-Spot Test Total Both Sides
AZ 50	1.6	0.8	0.50	0.43
AZ 55	1.8	0.9	0.55	0.50
AZ 60	1.9	1.0	0.60	0.52

*1 Mil - 0.001 inch

For zinc-5% aluminum coated sheet, the most common coating categories are:

ASTM A 875-94 Coating Designation	Approximate Thickness (Mils*)		Minimum Coating Weight (oz/sq ft)	
	Both Sides	Each Side	Triple-Spot Test Total Both Sides	Single-Spot Test Total Both Sides
GF90	1.6	0.8	0.90	0.80
GF75	1.3	0.7	0.75	0.65
GF60	1.0	0.5	0.60	0.50
GF45	0.8	0.4	0.45	0.35

*1 Mil - 0.001 inch

Aluminum-coated Type 2 sheet is used in construction applications. It is coated with commercially pure aluminum and has the following coating designations:

ASTM A 463-95 Coating Designation	Approximate Thickness (Mils*)		Minimum Coating Weight (oz/sq ft)	
	Both Sides	Each Side	Triple-Spot Test Total Both Sides	Single-Spot Test Total Both Sides
T2 65	2.4	1.2	0.65	0.60
T2 100	3.7	1.9	1.00	0.90

*1 Mil - 0.001 inch

Chemical Treatment

All four coated sheet products are available with a chemical or passivation treatment. The chemical treatment, applied on the coating line, inhibits light surface corrosion, such as "white rust" on galvanized during transit and storage of coils and sheets. This staining or "white rust" is the product of zinc corroding in the presence of moisture when sheets are tightly stacked. The chemical treatment also maintains brightness and delays the onset of darkening (graying) of sheet surfaces upon exposure to the atmosphere.

Painting

Galvanized, 55% aluminum-zinc coated, zinc-5% aluminum coated, and aluminum coated sheet can be readily painted either before or after fabrication. Paint provides obvious aesthetic benefits as well as increased corrosion protection. When the surface is properly pretreated and the appropriate paint system is selected, the pretreatment forms an adherent bond between the paint and the metallic coating. A key to good performance is selection and use of a pretreatment and primer specifically designed for each weight and type of underlying metallic coating.

Many types of paint can be used on coated-steel sheet. The choice depends on the ultimate service requirements of the product. For example, some types will maximize weather resistance, while others will provide a high-gloss surface. Consultation with paint suppliers is strongly recommended to obtain maximum performance.

For more information contact **The Metal Construction Association's Technical Consultant, Frederick J. Palmer, at (412) 221-8926.**

GLOSSARY:

Annealing—The general process involving a thermal application of controlled heating and cooling of steel sheet to induce softening and alter mechanical properties.

Brake forming—A bending operation in which steel sheet is plastically deformed along single, straight line surface contours.

Cold-reduction—The operation of passing unheated steel sheet through rolls for the purpose of reducing its thickness; producing a smooth, dense surface; and producing controlled mechanical properties.

Ductility—The property which permits steel sheet to sustain plastic deformation without rupture.

Lock Seam—An interlocking folded connection of the free edges of steel sheets to join the pieces together forming a continuous surface.

Roll forming—A continuous bending operation most often done at room temperature in which steel sheet is plastically deformed along a line or axis. Tandem sets of rolls shape the sheet in a series of progressive stages until the desired cross sectional shape is obtained.

Spangle—The pattern of the crystalline structure of the outer layer of a hot-dipped galvanized coating. Spangle size, shape and general pattern are largely influenced by the composition of the galvanized coating. Also referred to as "frost-flower".

Sheet steel quality:

Commercial quality (CQ) sheet—Steel sheet intended for applications where the product is subjected to bending or moderate forming.

Drawing quality (DQ) sheet—Steel sheet intended for fabrication of an identified part where drawing or severe forming is involved.

Drawing quality, special killed (DQSK) sheet—Steel sheet intended for fabrication of an identified part where drawing or severe forming may be involved or where the product is to be essentially free from significant changes in mechanical properties over a period of time.

Lock-forming quality (LFQ) sheet—Steel sheet intended for applications where the product is subjected to machine lock forming, which imposes requirements on both the base metal and the coating that are in excess of the formability requirements of commercial quality steel sheet.

Structural quality (SQ) sheet—Steel sheet intended for applications where the mechanical properties are specified; such properties are evaluated by commonly accepted mechanical tests such as tension and hardness.