GalvInfoNote	Useful Galvanized Sheet Metrics
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Introduction

Galvanized sheet is produced in large quantities worldwide. It is ordered to many different combinations of thickness, width, and coating weight [mass]. In most cases, galvanized sheet is sold by weight [mass] and put into use by area, and purchasers continually strive to obtain the maximum number of parts/pieces per coil(s) received. This is usually done by tracking the length of sheet received per coil, and/or the number of pieces obtained. From this information, the actual thickness of the sheet can be calculated and compared to what was ordered, whether that be a minimum or nominal thickness value. In doing this it is important to know the correct weight [mass] per unit area of galvanized sheet.

Another aspect of galvanized sheet is the effect of coating weight [mass] on the cost of the product. Zinc is a world commodity that can fluctuate in price to an extent that can make a significant difference to the price of galvanized sheet. This difference becomes larger the thinner the sheet, as a unit weight [mass] of thinner product has a higher fraction of zinc on it. As an example, the price of thin galvanized sheet increases more that that of thick sheet when zinc prices increase. It is therefore helpful to know the effect of sheet thickness and coating weight on the amount of zinc in a coil.

This GalvInfoNote provides tools for both producers and users to more fully understand the details involved in the above two concepts, so as to help in more effective utilization of galvanized sheet.

Theoretical Weight [Mass] per Unit Area

Because the densities of zinc-based hot-dip coatings are lower than the density of steel, the weight per unit area of coated sheet is less than uncoated sheet of the same thickness. This small difference can be important when large volumes of coated sheet are being consumed. The adjustment in weight [mass] varies as a function of the thickness of the steel substrate, the coating, and the coating type in the case of zinc alloys. For example, 0.013" G90 sheet is about 1.2% lighter than cold rolled sheet of the same thickness. This difference lessens for thicker sheet and/or thinner coatings. Using the densities of steel and the various coatings, plus the actual typical applied coating thickness, a **"Coating Factor (CF)"** can be calculated for each coating type and designation. To arrive at the theoretical weight [mass] per unit area of sheet, the CF is subtracted from the weight [mass] of uncoated steel sheet of the same thickness. The CF is actually the difference in weight [mass] between the coating metal and steel of the same thickness as the coating metal. **Knowing these factors is important in being able to closely track the sheet area obtained per unit weight [mass] of coated sheet product.**

Theoretical Weight

The formula for calculating the Theoretical Weight of galvanized sheet in lb/ft^2 is:

$$TW = t \times 40.833 - CF \qquad (1)$$

Where: TW = Theoretical Weight in lb/ft^2

t = actual sheet thickness in inches

40.833 = weight in lbs of 1 ft^2 of 1" thick steel

CF = Coating Factor in lb/ft^2

For example; galvanized sheet 0.020 inches thick with a G90 coating has a coating factor of 0.006 lb/ft^2, based on the relationship in (1) and a typical actual G90 coating weight of 0.96 oz/ft^2. Therefore:

$$TW = 0.020 \times 40.833 - 0.006 = 0.8107\ lb/ft^2$$

Theoretical Mass

The formula for calculating the Theoretical Mass of galvanized sheet in kg/m^2 is:

$$TM = t \times 7.85 - CF \qquad (2)$$

Where: TM = Theoretical Mass in kg/m^2

t = actual sheet thickness in millimetres

7.85 = mass in kg of 1 m^2 of 1mm thick steel

CF = Coating Factor in kg/m^2

For example; galvanized sheet 0.50 mm thick with a Z275 coating has a coating factor of 0.029 kg/m^2, based on the relationship in (2) and a typical actual Z275 coating mass of 293 g/m^2. Therefore:

$$TM = 0.50 \times 7.85 - 0.029 = 3.896 \text{ kg/m}^2$$

Using the above relationships, Theoretical Weight [Mass] can be calculated for all combinations of sheet thicknesses and coating types/thicknesses. For quick reference, producers of coated sheet usually have tables available for their customers showing this information for the products and thicknesses they sell. The above formulas can be used to interpolate between the thicknesses shown in these tables. If you do not have access to such information, Table 1 shows the coating factors for typically produced coating weights [masses] of most of the commonly ordered coating designations for galvanize, 55% Al-Zn alloy coated sheet, and Zn-5% Al alloy coated sheet.

The following example illustrates how a consumer of galvanized sheet steel might utilize the above information:

> A roll forming operation orders 1000 tons of 0.020" min thickness x 48" wide in 10 ton coils that will be used for manufacturing wall panels for a large project. The roll former wishes to track how close the supplier came to producing steel to the minimum thickness, realizing that the sheet must be somewhat above the minimum to guarantee there is no material that is under thickness.
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> From Equation (1) above and from Table 1, the weight per square foot of 0.020" thick G90 sheet is 0.8107 lb/ft^2 (if this same thickness of sheet were uncoated it would weigh 0.8167 lb/ft^2 – a difference of 0.74%, which is 7.4 tons on a thousand-ton order). If the entire order were exactly 0.020" thick, at 0.8107 lb/ft^2, it would yield 616,670 feet of 4-foot wide sheet. Since the thickness must be slightly above the minimum, the actual footage obtained is therefore a measure of how close the steel is to minimum gauge. Keep in mind that the actual width must be measured and used in the calculations, since it is always slightly above ordered width. Yield losses at the coil ends must also be accounted for. From the actual usable footage measured on each coil, the actual average thickness received can be calculated. i.e.,

Actual thickness (in) = [Coil wt – yield loss] (lb) x 12 (in/ft) ÷ [40.833 - CF] (lb/ft^2) x width (in) x length (ft)

The above formula calculates the actual average thickness of coils. The results can then be compared to the ordered minimum gauge. This allows tracking of how close the steel is to minimum gauge. The closer steel sheet is to minimum gauge, the higher the number pieces or parts that can be produced per unit weight [mass].

To accurately monitor the actual dimensions of coated sheet, it is apparent that the weight per unit area must be exactly known to be able to obtain accurate results using coil footage measurements. Table 1 shows the Coating Factors for various coating designations, which are for the coating weights [masses] shown, and which are typical of normal production product. Adjusting the weight per unit area of sheet by the coating factor is necessary to avoid incorrect calculations of actual average steel thickness received. If the coating factor were ignored, the calculated thickness would be higher than it actually is.

Table 1 Coating Factors for Zinc-Based Coated Sheet

ASTM Coating Type	Inch-pound			SI (Metric)		
	Designation	Typical Produced Coating Weight (oz/ft^2)	Coating Factor (lb/ft^2)	Designation	Typical Produced Coating Mass (g/m^2)	Coating Factor (kg/m^2)
A653/A653M Galvanize and Galvanneal	G30	0.40	**0.0025**	Z90	120	**0.012**
	G40	0.48	**0.0030**	Z120	144	**0.014**
	G60	0.66	**0.0041**	Z180	198	**0.020**
	G90	0.96	**0.0060**	Z275	293	**0.029**
	G115	1.23	**0.0076**	Z350	375	**0.037**
	G140	1.50	**0.0093**	Z450	482	**0.048**
	G165	1.76	**0.0109**	Z500	533	**0.053**
	G185	1.98	**0.0123**	Z550	588	**0.058**
	G210	2.25	**0.0140**	Z600	643	**0.064**
	G235	2.54	**0.0158**	Z700	756	**0.075**
	G300	3.25	**0.0202**	Z900	975	**0.097**
	G360	3.90	**0.0242**	Z1100	1190	**0.118**
	A25	0.35	**0.0022**	ZF75	105	**0.010**
	A40	0.46	**0.0029**	ZF120	138	**0.014**
	A60	0.66	**0.0041**	ZF180	198	**0.020**
A792/A792M 55% Aluminum-Zinc	AZ50	0.55	**0.0375**	AZM150	165	**0.180**
	AZ55	0.61	**0.0416**	AZM165	180	**0.196**
	AZ60	0.66	**0.0450**	AZM180	198	**0.216**
A875/A875M Zinc-5% Aluminum	GF30	0.40	**0.0047**	ZGF90	120	**0.023**
	GF45	0.51	**0.0060**	ZGF135	153	**0.029**
	GF60	0.66	**0.0078**	ZGF180	198	**0.038**
	GF75	0.82	**0.0097**	ZGF225	245	**0.046**
	GF90	0.96	**0.0114**	ZGF275	293	**0.055**
	GF115	1.23	**0.0146**	ZGF350	375	**0.071**
	GF140	1.50	**0.0177**	ZGF450	482	**0.091**
	GF210	2.25	**0.0266**	ZGF600	643	**0.122**
	GF235	2.54	**0.0301**	ZGF700	756	**0.143**

What Portion of a Galvanized Coil is Zinc?

A coil of 0.012" thick G90 sheet consists of about 12.5% zinc, whereas a coil of 0.050" thick G90 contains about 3% zinc. When the price of zinc changes, it is therefore apparent why it changes more for thin galvanized sheet than for thick. It is useful to know the relationship between the amount of zinc on galvanized sheet as a function of sheet thickness and coating weight. This relationship is shown in Figure 1. It can be helpful when evaluating the cost of a zinc coating versus the corrosion demands that it might be put to, as a function of sheet thickness.

As the fraction of zinc that makes up a coil of galvanize is highest for thinner gauges, only thicknesses from 0.012" through 0.057", plus 0.10", are shown. Note that four common coating weights are shown, plus G140 for the thicker gauges. It is not generally possible to apply G140 to thin gauge. The points for 0.01" thick sheet are given to show that above this thickness, percent zinc as a function of sheet weight becomes small.