Section Properties

Section Properties

Section properties are calculated in accordance with the American Iron and Steel Institute Specification for the Design of Cold-Formed Steel Structural Members, AISI S100-2007, Section B. Section properties can be used to develop the bending capacity of the steel deck for out-of-plane loads, which are typically defined by gravity or wind uplift. The section properties can also be used to determine the combined axial and bending capacity of the steel deck for bracing walls or other vertical elements of a building.

The section properties for steel roof deck, like other cold-formed steel members such as Cee, Zee, hat-shaped purlins, studs, and track are based on post-buckling strength. Post-buckling strength is based on the concept that compression flanges and portions of webs will exhibit some local buckling prior to the load capacity of the member being reached. To account for this, the widths of the flat compression elements of the steel deck are reduced for the purpose of determining the section properties, excluding the portion that can no longer effectively carry compression loads. This reduction of the gross section properties results in the effective section properties.

Steel Thickness

The thickness of steel roof deck is typically specified by a gage designation. The design of steel deck is dependent on the specified design base steel thickness in accordance with AISI S100-2007. The base steel thickness should not be confused with the total coated thickness, which is the combined thickness of the base steel, the optional galvanizing thickness, and any factory-applied paint system thickness.

The minimum acceptable base steel thickness to be supplied shall not be less than 95% of the design base steel thickness. This is specified in Section A2.4 Delivered Minimum Thickness of AISI S100-2007.

Some standards reference non-mandatory tables that list the thickness of sheet steel by gage designation. These include the AISC Manual of Steel Construction in the Miscellaneous Information section of the appendix and AWS D1.3 in the Annex. Both references indicate that the values are non-mandatory and are for reference only. The nominal total coated thicknesses listed for each gage in these sources should not be used to determine if the cold-formed steel structural member, including steel deck, meets the minimum thickness requirement for the specified gage.

Effective Section Properties

Effective section properties for a steel deck panel are used to check for the maximum bending and axial load capacities.

The effective properties are determined at the full yield stress of the steel. As the grade of steel increases, the effective section properties decrease. The effective width of the compression elements decreases as the localized plate-like buckling increases. The moment capacity of the deck increases with the increased grade because the increasing yield strength of the steel outpaces the loss of effective compression width of the combined elements. Steel decks cannot be compared based strictly on effective section properties without considering the grade of the steel. The following demonstrates this for B-36 steel deck.

20 Gage B-36 Steel Deck Panel

Yield ksi	I_e^+ (in^4)	I_e^- (in^4)	S_g^+ (in^3)	S_e^- (in^3)	M_n^+ (k-in)
33	0.193	0.237	0.235	0.251	13.95
37	0.187	0.233	0.233	0.247	15.52
38	0.187	0.233	0.233	0.246	15.91
40	0.187	0.233	0.232	0.244	16.69
55	0.177	0.227	0.223	0.233	22.02
80	0.173	0.223	0.218	0.233	23.51

Figure 1.6.1: **EFFECTIVE SECTION PROPERTIES**

Many steel deck panels are not symmetric. In most cases, the top and bottom flange widths are not equivalent. The bending stress and location of the neutral axis is therefore different for positive and negative bending, resulting in different positive and negative section properties.

Gross Section Properties

The gross section properties of the steel deck are based on the entire cross section of the panel. Determination of gross section properties assumes that there are no compression buckling compression flanges or webs elements of the steel deck and that there are no ineffective elements. The gross section properties are used in combination with effective section properties to determine the deflection of the steel deck under uniform out-of-plane loads and for checking axial compression and bending.

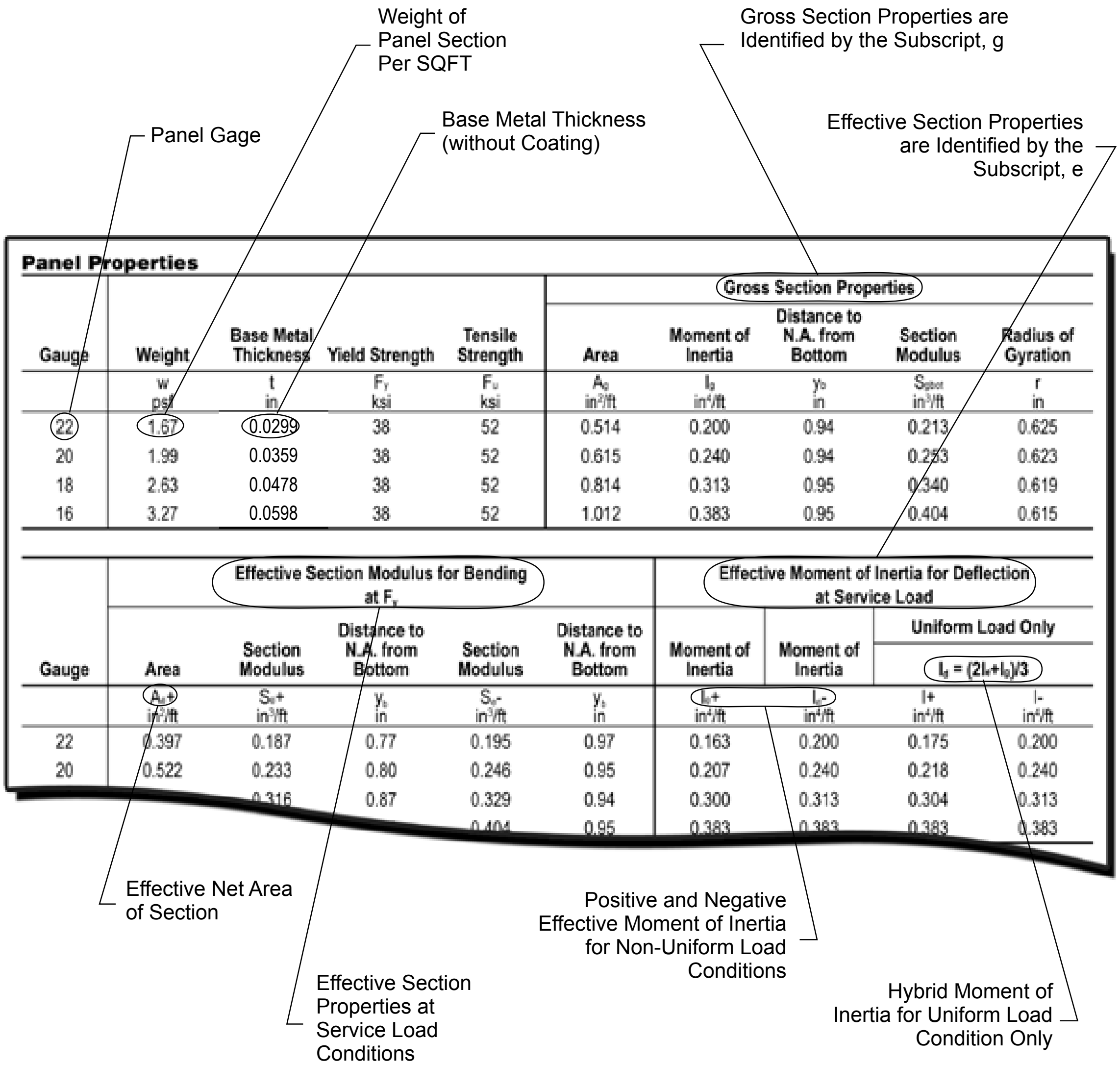
Service Load Section Properties

The service load moment of inertia is used to determine the deflection of the steel deck for out-of-plane loads. The calculated moments of inertia are determined at a working stress level of 0.6Fy. Following accepted practice, the hybrid moment of inertia is based on the sum of two times the effective moment of inertia and the gross moment of inertia divided by three, as follows.

$$I_d = \frac{2I_e + I_g}{3}$$

This deflection equation for uniformly distributed loads takes into account that, throughout the length of the span, portions of the steel deck will have low bending stress below the onset of localized compression buckling in which the gross section properties would be valid and the other portions of the span will have bending stresses high enough to push beyond the onset of localized compression buckling in which effective section properties would be appropriate.

How to Read Section Properties Table



Panel Properties

Gauge	Weight	Base Metal Thickness	Yield Strength	Tensile Strength	Gross Section Properties: Area	Moment of Inertia	Distance to N.A. from Bottom	Section Modulus	Radius of Gyration
	w psf	t in	F_y ksi	F_u ksi	A_g in²/ft	I_g in⁴/ft	y_b in	S_{gbot} in³/ft	r in
22	1.67	0.0299	38	52	0.514	0.200	0.94	0.213	0.625
20	1.99	0.0359	38	52	0.615	0.240	0.94	0.253	0.623
18	2.63	0.0478	38	52	0.814	0.313	0.95	0.340	0.619
16	3.27	0.0598	38	52	1.012	0.383	0.95	0.404	0.615

Gauge	Effective Section Modulus for Bending at F_y: Area	Section Modulus	Distance to N.A. from Bottom	Section Modulus	Distance to N.A. from Bottom	Effective Moment of Inertia for Deflection at Service Load: Moment of Inertia	Moment of Inertia	Uniform Load Only $I_d = (2I_e+I_g)/3$	
	A_e+ in²/ft	S_e+ in³/ft	y_b in	S_e- in³/ft	y_b in	I_e+ in⁴/ft	I_e- in⁴/ft	I+ in⁴/ft	I- in⁴/ft
22	0.397	0.187	0.77	0.195	0.97	0.163	0.200	0.175	0.200
20	0.522	0.233	0.80	0.246	0.95	0.207	0.240	0.218	0.240
		0.316	0.87	0.329	0.94	0.300	0.313	0.304	0.313
				0.404	0.95	0.383	0.383	0.383	0.383

Figure 1.6.2: **SAMPLE OF B-36 PANEL PROPERTIES TABLE**