Steel-Deck Fastening

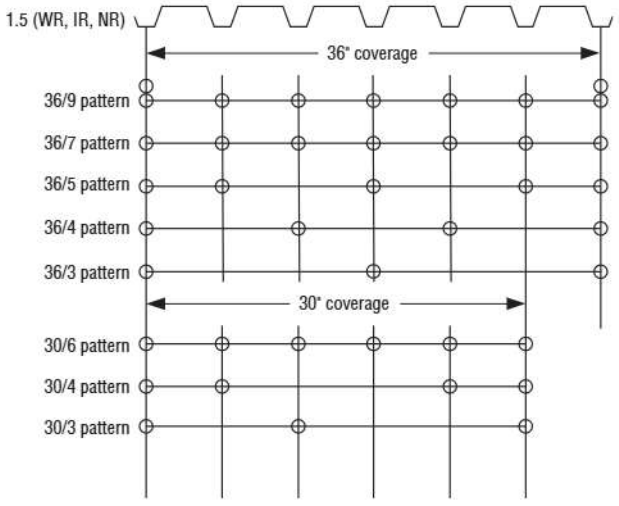
Steel decks may be classified into roof decks, form decks and composite decks. The primary purpose of these decks is to support vertical loads, but they can also be used as a horizontal diaphragm to resist lateral loads from wind or earthquake forces. The strength of the diaphragm can be limited by fastener connection strength, local panel buckling, or even plate buckling of the entire diaphragm.

Steel-deck panels are available in different geometries and thicknesses and steel properties from different manufacturers. Common deck panel profiles are narrow rib (NR, commonly referred to as Type A deck), intermediate rib (IR, commonly referred to as Type F deck) and wide rib (WR, commonly referred to as Type B deck). Illustrations of these can be found in SDI publications. The SDI design recommendations are limited to deck panels that are in the thickness range of 0.014" to 0.064", and panel depths 9⁄16" to 3".

Steel-deck fastening is categorized into two groups — structural fastening and side-lap or stitch fastening. Structural fasteners connect the steel-deck panels to the structural framing, while side-lap fasteners connect the panels together along the free edges between the supports. The most important information for any steel-deck fastener is the connection strength and connection flexibility that is developed using the fastener.

Steel-Deck Fastening

Based on the deck profile, width and the design load, a structural fastening pattern and the number of side-lap fasteners or side-lap spacing can be determined. The fastening pattern provides the number of structural fasteners needed to attach the decking panel to support steel. The structural fastening pattern is given by the deck width followed by the number of fasteners. e.g., 36/7 pattern means 36"-wide panel attached with seven fasteners. The most typical fastener patterns for steel-deck profiles are shown here.



Typical Fastener Layout

The number of side-lap fasteners required at the over-lapping panel edges are per deck span between structural supports. For example, five side laps for a 6' deck span would represent six even spaces with side-lap fasteners at 12" on center. The side-lap fastener spacing can range between 3" and 36" o.c.

Structural fastening can be done with puddle welds, power-actuated pins, or screws. Each type of fastening has its advantages and disadvantages in terms of installation cost, installation effort, capacity, energy dissipation and behavior at ultimate load. All of the fasteners would be called out in a fastener pattern using nomenclature similar to that shown in the figure.

Evaluation Reports and Approvals

Steel-deck diaphragms can be designed and constructed following code-recognized design procedures and provisions. At the same time, the codes provide for alternate design methods and materials to be recognized by the authority having jurisdiction. Some deck and fastener manufacturers have gone the alternate route and in that process have secured evaluation reports that can be used by the engineering design community for design of steel diaphragms and by the local building officials as the basis for approval. ICC-ES and IAPMO UES provide criteria that can be used to secure evaluation reports for steel-diaphragm products.

The insurance industry also has a form of compliance that it uses as the basis for risk management. Factory Mutual (FM) provides an Approval for deck products and systems as well as fasteners used for fastening the deck panels.

Simpson Strong-Tie Steel-Deck Fasteners

Simpson Strong-Tie holds evaluation reports and FM Approvals for all of its steel-deck diaphragm fasteners. These reports and approvals are available online at no cost from the issuing agency or at **strongtie.com**.

The Simpson Strong-Tie self-tapping X metal screws have been qualified for compliance with ASTM C1513 and some of these screws are included in the SDI DDM03, Appendix VII and Appendix IX, and SDI DDM04, Section 12. In those documents, diaphragm design values are provided in tabular format for typical fastening patterns and for a range of common deck thicknesses. The SDI DDM03 and DDM04 manuals are code-referenced documents.

In addition, the strength and flexibility of connections with Simpson Strong-Tie X-series screws used in steel decks were evaluated per IAPMO UES Evaluation Criteria EC007 (2021), which is based on AISI S310, North American Standard for the Design of Profiled Steel Panels. The connection strengths and flexibilities can be used to calculate the nominal diaphragm shear strength and diaphragm stiffness per Sections 2 and 3 of SDI DDM03.

The Simpson Strong-Tie steel-deck diaphragm calculator, which is available as a web app, can be used to do the diaphragm strength and stiffness calculations, investigate alternative fastening strategies and ultimately produce the required submission documents.

The available Simpson Strong-Tie fasteners for steel-deck applications are listed on pp. 111–114 and 240–242 of C-F-2023 *Fastening Systems* catalog. They are available in bulk or collated forms. The collated forms are driven using Quik Drive® Systems. For more up-to-date information on steel-deck diaphragm fasteners, evaluation reports, approvals and appropriate Quik Drive tools including some products not found in the print catalog, see **strongtie.com**.

Steel-Deck Diaphragm Calculator

The Steel-Deck Diaphragm Calculator web app offers optimized steel-deck design solutions based on fastener and labor costs for a given shear and uplift. It can provide calculations for any solution generated. Generate diaphragm tables for various roof and floor decks using Simpson Strong-Tie fasteners. The app can also generate a submittal package that includes fastener information, code reports, factory mutual reports, Appendices VII and IX of SDI DDM03 and DDM04, coating information and tools for installation. The app is accessible from any web browser and does not require downloading or installing special software.

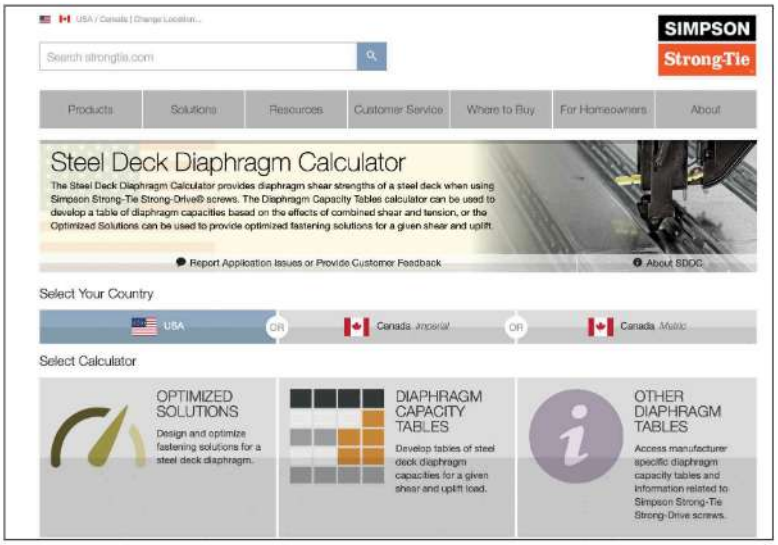
Users can:

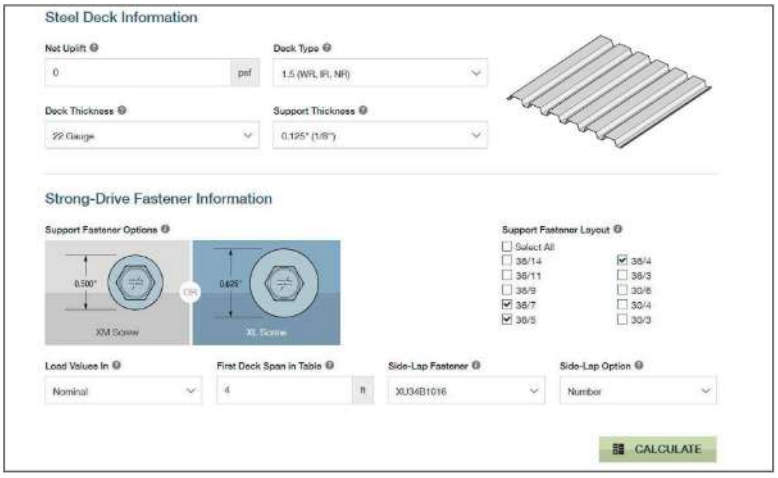
- Design for multiple zones and develop solutions in either ASD or LRFD
- Modify deck properties from the standard properties listed in SDI DDM03 and DDM04
- Generate multiple cost- and labor-optimized solutions with calculations included
- Generate tables in Nominal, ASD Wind, LRFD Wind, ASD Seismic or LRFD Seismic
- Design for loads using the new Strong-Drive® XL Large-Head Metal screw (included in the optimization calculator)
- Design for additional structural patterns not covered in SDI literature
- Access proprietary deck tables with the Strong-Drive XM Medium-Head Metal screw

Steel-Deck Diaphragm Load Tables for Interlocking Decks

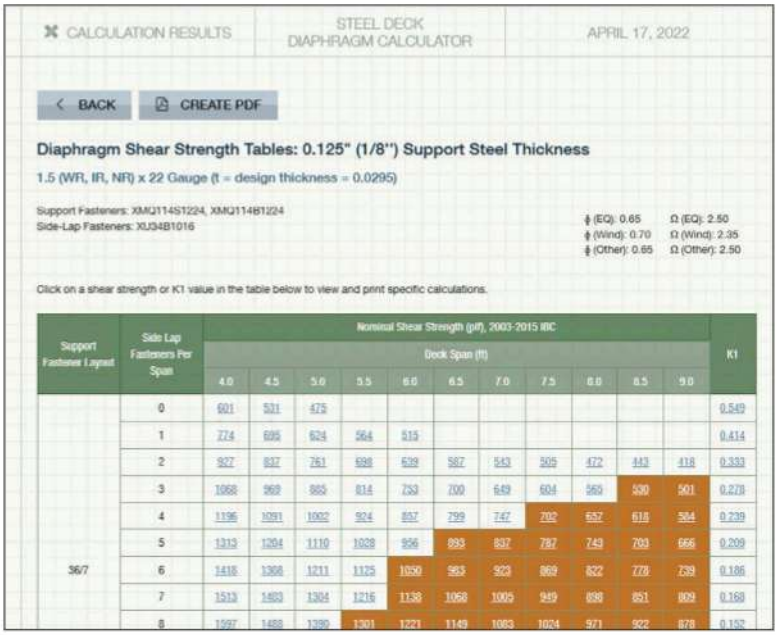
Load tables are available on our website application for using Strong-Drive XM Medium-Head Metal screws on frequently used interlocking decks with proprietary side-lap connections.

For more information regarding Strong-Drive XM Medium-Head Metal screw shear tables, refer to **strongtie.com/diaphragmcalc**.





Example of Steel-Deck Diaphragm Calculator Web Application



Example of Steel-Deck Diaphragm Load Table for Interlocking Decks

Strong-Drive® XL LARGE-HEAD and XM MEDIUM-HEAD METAL Screws

High-Performance Screw Alternative to Welds and Pins

Strong-Drive metal screws are load-tested and code-listed, allowing you to get the maximum load values for installation. Strong-Drive XL Large-Head Metal screws are the perfect choice when high shear or uplift resistance is required. Strong-Drive XM Medium-Head Metal screws, with their ½" washer head, are designed for narrow flutes commonly found on interlocking deck profiles. In high-strength decks (F_y= 50 ksi), these screws are excellent 1-for-1 replacements for pins. These screws are available in bulk or collated for Quik Drive® steel-decking systems.

Simpson Strong-Tie provides a full offering of code-listed fasteners for your next steel-decking job.

US Patent 9,518,599

For more information, see pp. 111–112, C-F-2023 *Fastening Systems* catalog

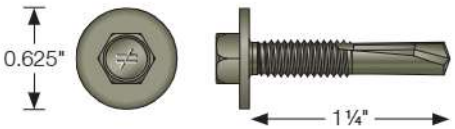
DDM03 APPENDIX VII, IX DDM04

IAPMO UES ER-326

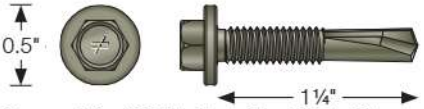
FM APPROVAL #3050714, #3045651

City of L.A. RR26009

State of Florida FL16937



Strong-Drive XL Large-Head Metal Screw

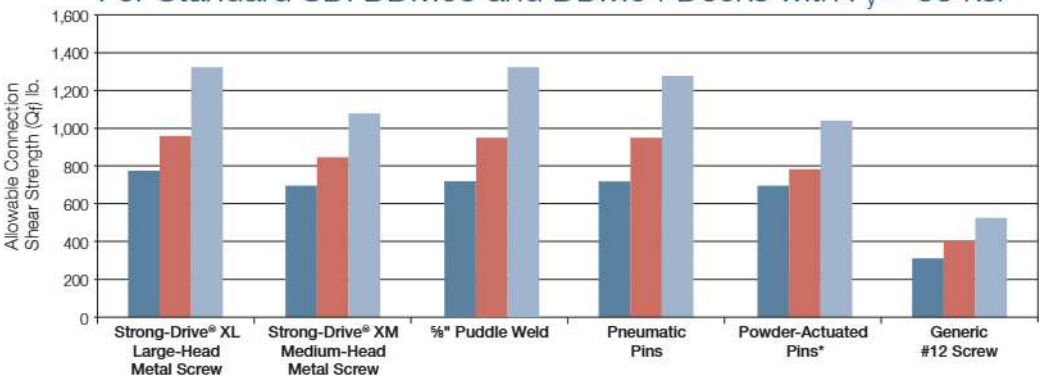


Strong-Drive XM Medium-Head Metal Screw

Strength in Numbers

Comparison testing shows that Strong-Drive XL Large-Head Metal screws and Strong-Drive XM Medium-Head Metal screws are stronger than many alternative fastener types in 33 ksi and 50 ksi steel decking.

For Standard SDI DDM03 and DDM04 Decks with F_y = 33 ksi



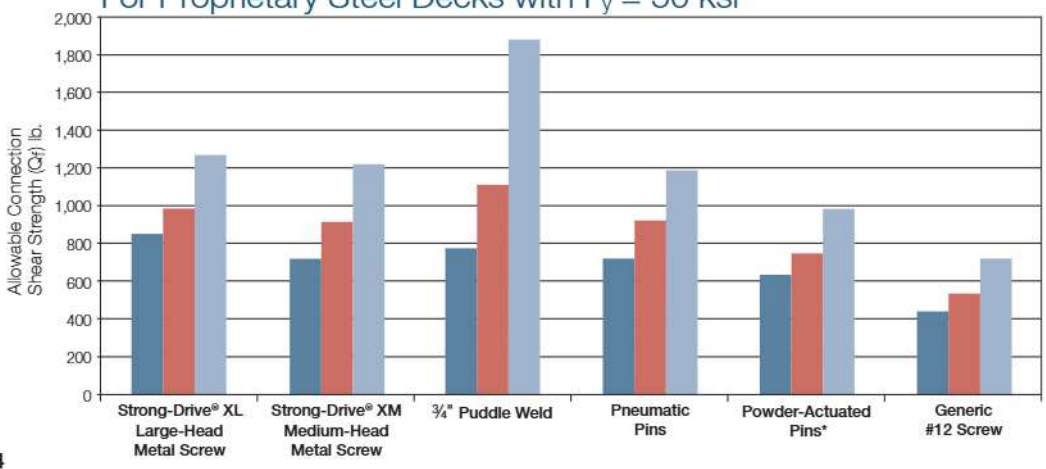
Wind Load

- 22 ga. deck
- 20 ga. deck
- 18 ga. deck

- Standard screw based on AISI Eq.
- PAF values based on SDI DDM03 and DDM04 Manuals
- Values based on ¼" support thickness
- Safety factors per DDM03 and DDM04

*Average

For Proprietary Steel Decks with F_y = 50 ksi



Seismic Load

- 22 ga. deck
- 20 ga. deck
- 18 ga. deck

- Standard screw based on AISI Eq.
- PAF values based on SDI DDM03 and DDM04 Manuals
- Values based on ¼" support thickness
- Safety factors per DDM03 and DDM04

*Average

Strong-Drive® XL LARGE-HEAD and XM MEDIUM-HEAD METAL Screws (cont.)

Screw Shear and Tension Strengths

Size-TPI x Length	Model (Model No.)	Factor	Support Thickness (in.)	Nominal Shear (lb.)	Nominal Tension (lb.)	Reference Connection Shear Strength, Qf (lb.), and Flexibility, Sf (in./kip)							
						GR33 / GR40				GR50			
						Deck Thickness, ga. (in.)				Deck Thickness, ga. (in.)			
				P_{ss}	P_{ts}	22 (0.0295)	20 (0.0358)	18 (0.0474)	16 (0.0598)	22 (0.0295)	20 (0.0358)	18 (0.0474)	16 (0.0598)
#12-24 x 1¼	XL Large-Head Metal Screw (XLQ114T1224, XLQ114B1224)	Qf	0.375	3,110	4,985	1,985	2,410	3,110	—	2,030	2,465	3,110	3,110
			0.25			1,870	2,270	3,005	3,110	2,465	2,465	3,110	3,110
			0.1875			1,790	2,170	2,875	3,110	1,945	2,360	3,110	3,110
			0.125			1,685	2,045	2,705	3,110	1,830	2,220	2,940	3,110
		Sf	0.125–0.375			0.0076	0.0069	0.006	0.0053	0.0076	0.0069	0.006	0.0053
#12-24 x 1¼	XM Medium-Head Metal Screw (XMQ114S1224, XMQ114B1224)	Qf	0.375			1,565	1,895	2,510	3,110	1,780	2,200	2,995	3,110
			0.25			1,565	1,895	2,510	3,110	1,780	2,200	2,995	3,110
			0.1875			1,215	1,625	2,475	3,110	1,655	2,050	2,790	3,110
			0.125			1,215	1,625	2,475	3,110	1,495	1,850	2,520	3,110
		Sf	0.125–0.375			0.0076	0.0069	0.006	0.0053	0.0076	0.0069	0.006	0.0053

1. P_{ss} and P_{ts} are nominal shear strength and nominal tension strength for the screw itself, respectively, and are the average (ultimate) value of all tests determined by independent laboratory testing.
2. The ASD and LRFD loads for tension are calculated using a safety factor Ω of 3.0 and the resistance factor ϕ of 0.5, respectively.
3. For tension connection: the smallest of the screw tension strength, pullover strength and pullout strength shall be used for design.

Structural Screw Pullover Strength with Steel Minimum Yield Strength F_y = 33 ksi

Size-TPI x Length	Model (Model No.)	Design Basis	Reference Pullover Loads (lb.)							
			GR33				GR40 / GR50			
			Deck Thickness, ga. (in.)				Deck Thickness, ga. (in.)			
			22 (0.0295)	20 (0.0358)	18 (0.0474)	16 (0.0598)	22 (0.0295)	20 (0.0358)	18 (0.0474)	16 (0.0598)
#12-24 x 1¼	XL Large-Head Metal Screw[2] (XLQ114T1224, XLQ114B1224)	Nominal	1,295	1,705	2,490	2,775	1,575	1,990	2,820	3,075
		LRFD	840	1,100	1,625	1,810	1,020	1,285	1,840	2,005
		ASD	525	690	1,015	1,135	635	800	1,150	1,255
#12-24 x 1¼	XM Medium-Head Metal Screw[2] (XLM114S1224, XLM114B1224)	Nominal	750	1,020	1,400	1,930	910	1,190	1,590	2,135
		LRFD	485	655	915	1,260	595	775	1,035	1,395
		ASD	305	415	570	790	370	485	650	870

1. Values are based on steel members with a minimum yield strength of F_y = 33 ksi and tensile strength of F_u = 45 ksi.
2. The values for 16 ga., 18 ga., 20 ga. and 22 ga. are based on tests per AISI Standard Test Method S905.
3. The safety factor Ω and resistance factor Φ used to determine the ASD and LRFD strengths are based on AISI S100.
4. The values for 16 ga., 18 ga., 20 ga. and 22 ga. are based on the calculations per AISI S100.
5. For tension connection: the smallest of the screw tension strength, pullover strength and pullout strength shall be used for design.

Structural Screw Pullout Strength

Size-TPI x Length	Model (Model No.)	Design Basis	Reference Pullout Loads (lb.)			
			Support Thickness			
			⅛"	3/16"	¼"	⅜"
#12-24 x 1¼	XL Large-Head Metal Screw (XLQ114T1224, XLQ114B1224) XM Medium-Head Metal Screw (XMQ114S1224, XMQ114B1224)	Minimum Tensile Strength of Steel, F_u = 65 ksi				
		Nominal	1,490	2,240	2,985	4,475
		LRFD	745	1,120	1,490	2,240
		ASD	495	745	995	1,490
		Minimum Tensile Strength of Steel, F_u = 50 ksi				
		Nominal	1,150	1,720	2,295	3,445
		LRFD	575	860	1,150	1,720
		ASD	385	575	765	1,150

1. Values are based on calculations per AISI S100.
2. The tabulated ASD and LRFD loads are based upon a safety factor Ω of 3.0 and the resistance factor ϕ of 0.5.
3. For tension connection: the smallest of the screw tension strength, pullover strength and pullout strength shall be used for design.

For more information regarding these tables, please refer to IAPMO UES ER-326.