Steel Roof Deck design manual

Steel Deck Institute

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STEEL ROOF DECK DESIGN MANUAL

STEEL DECK INSTITUTE

1977
STEEL DECK INSTITUTE

MEMBERS

AIRTHERM MANUFACTURING COMPANY
Box 7039 / St. Louis, Mo. 63177

CONSOLIDATED SYSTEMS, INCORPORATED
Box 1756 / Columbia, S.C. 29202

EPIC METALS CORPORATION
11 Talbot Ave. / Rankin, Pa. 15104

MAC-FAB PRODUCTS COMPANY
Box 13230 / St. Louis, Mo. 63157

MERCO MANUFACTURING, INC.
Box 4110 / Station A / Dallas, Texas 75208

ROLL FORM PRODUCTS, INC.
140 Federal St. / Boston, Mass. 02110

ROOF DECK, INC.
7 Twin Rivers Dr. West / Hightstown, N.J. 08520

UNITED STEEL DECK, INC.
Box 662 / Summit, N.J. 07901

BUILDEX
Division of Illinois Tool Works, Inc.
801 North Hilltop Dr. / Itasca, Ill. 60143

HILTI, INC.
One Cummings Point Road / Stamford, Conn. 06904

PNEUTEK, INC.
202 Boston Road / North Bellerica, Mass. 01862

RAMSET FASTENING SYSTEMS
Specialty Services Group / Olin
Route 139 / Branford, Conn. 06421

PURPOSE

Organized in 1939 by manufacturers of steel roof deck, the Institute insures uniform industry standards for the engineering design, manufacture, and field usage of steel roof deck.

Through the Institute, member companies are continually striving to upgrade the quality of their product, promote good building regulations, disseminate information relative to the proper use of steel roof deck, and engaged in research programs to improve performance.

BENEFITS of steel roof deck

- all-weather construction
- uniform quality
- strong
- durable and attractive
- lightweight
- design flexibility
- fast construction
- economical
- lateral diaphragm
- fire rated

Steel roof deck annually enjoys an ever increasing share of the market it seeks to serve. The acceptability of steel roof deck by the architects and engineers, as attested by the millions of square feet of steel roof deck that are utilized annually in all types of commercial and industrial structures, is a dramatic testimonial summing up the many advantages listed above. Any product, used in such large quantities over a long period of time, must be economically sound, durable, and superior in performance.

SHEAR DIAPHRAGM DESIGN

The Steel Deck Institute with the objective of developing reliable, unbiased standard performance values for steel deck as a diaphragm, based on generic deck profiles, sponsored and completed an extensive independent research program at West Virginia University. This major study was completed in 1972 and resulted in 'Tentative Recommendations for the Design of Steel Deck Diaphragms' with standard shear values for the different deck profiles and variable fastening patterns. The Institute has published this recommendation as publication TD-6 and copies are available at the request of engineers and architects at no charge.

The complete shear diaphragm research report titled 'Strength and Stiffness of Steel Deck Subjected to In-Plane Loading' is available. Upon Request, the S.D.I. office will promptly mail the Institute's LIST OF PUBLICATIONS which includes a convenient order form.

S.D.I. CERTIFICATION PROGRAM

The Steel Deck Institute makes available to deck manufacturers computer engineering analysis of product design by independent consulting engineers, and upon conformance of submitted product will issue certification that it is designed in accordance with S.D.I. Basic Design Specifications and AISI "Specifications for the Design of Cold-Formed Steel Structural Members" and will verify manufacturers' load tables.
SDI CODE OF RECOMMENDED STANDARD PRACTICE

SECTION 1 - GENERAL

1.1 Scope — This code is intended to promote safety and good construction in accordance with good engineering practice. It is designed to assist in the preparation of the sales contract by providing contract details which can be adopted by reference.

1.2 Application — The Code shall govern where building codes, architects' and engineers' plans and specifications, or contracts are not complete or clear. There shall be no conflict between this Code and any legal building regulation; it shall only supplement and amplify such laws.

1.3 Design — In the absence of ordainances of specifications to the contrary, design shall be in accordance with the current Basic Design Specifications of the Institute.

1.4 Plans and Specifications for Bidding — shall clearly show details and shall be complete as to extent of Roof Deck and Accessories to be furnished by the Seller.

1.5 Responsibility for Design — When details of design are specified, the Seller shall assume no responsibility other than to furnish materials as specified. When details of design are not specified, the Seller shall furnish all materials required in accordance with Section 1.3 above.

SECTION 2 — BIDDING

2.1 Base Bids — shall include the following items:
   - Steel Roof Deck
   - Ridge and valley plates, and cant strips per architect's plans and specifications
No other accessories will be included unless specified.

2.2 Incomplete Plans and Specifications — will be bid on the basis of the Seller providing material in agreement with the provisions of this Code.

2.3 Special Details — Any materials required to support the steel roof deck shall not be included.

SECTION 3 — DRAWINGS AND SPECIFICATIONS

3.1 Plans Furnished by Buyer — shall include complete architectural plans and specifications, structural steel drawing and purlin placing plans, correctly dimensioned.

3.2 Erection Layouts Furnished by Seller — shall clearly show the location of various sheet lengths and sheet quantities. The seller shall furnish as many prints as may be reasonably necessary, but the tracing shall remain the property of the Seller.

3.3 Discrepancies — The Architect's plans will be assumed to be correct in the absence of written notice from the Buyer to the contrary. When structural steel or purlin placing plans do not agree with the Architect's plans, the structural plans shall be considered as a written notice of change of plans.

3.4 Approval — The erection layouts shall be submitted to the Buyer for approval, unless the Buyer instructs the Seller to submit same directly to the Architect or waives his right of approval. The Buyer (or Architect) shall return one copy marked with his approval or with such corrections as he may deem necessary. The Seller shall not start shop work prior to final approval of his drawings unless such approval is waived.

3.5 Changes by Buyer After Approval — When any changes are made by Buyer after approval or any extra materials are required, the cost of such changes and/or extra materials, shall be paid by the Buyer at a price agreed upon between Buyer and Seller.

SECTION 4 — COLLATERAL MATERIAL

Although certain collateral material, such as insulation, waterproofing, and sheet metal work is not supplied by the steel roof deck manufacturer, it is the desire of this institute to have certain principles followed in the specifying and furnishing of these materials in order to provide a satisfactory insulated steel roof deck construction. This Code is not intended to encroach upon the standard practices of the insulation, roofing, and sheet metal industry, but is to supplement and amplify such specifications.

4.1 Insulation — All steel roof decks shall be covered with a material of sufficient insulating value as to prevent condensation under normal occupancy conditions. Insulation shall be adequately attached to the steel deck by adhesives or mechanical fasteners. Insulation materials shall be protected from the elements at all times during storage and installation.

4.2 Roof Covering — A suitable roof covering shall be applied over the insulation.

4.3 Sheet Metal Work — All closures, flashings, etc. unless otherwise specified, shall be detailed and furnished by the sheet metal contractor.

4.4 Field Painting — Any field painting or touching up of abrasions of the priming coat shall be the responsibility of the Buyer.
SDI Standard No. 1
BASIC DESIGN SPECIFICATIONS

REVISED AUGUST, 1976

1. SCOPE
The requirements of this section shall govern only ribbed steel roof deck construction of varying configurations as produced by steel roof deck manufacturers and used for the support of roofing materials and design live loads. (Suspended ceilings, light fixtures, ducts or other utilities shall not be supported by the steel deck.)

2. DESIGN AND MATERIAL
A. MATERIAL
Steel deck shall be manufactured from steel conforming to ASTM Designation A611 Grade C, D, or E or A446 Grade A, B, C, D, E or F or equal having a minimum yield strength of 33,000 psi. The unit design stress shall in no case exceed the minimum yield strength of the steel divided by 1.65 for specific design uniform loads. The unit design stress shall be increased 33⅓% per cent for temporary concentrated loads provided the deck thus required is not less than that required for the specific design uniform loads. The maximum working stress shall not exceed 20,000 pounds per square inch.

The thickness of steel before coating with paint or metal shall be in conformance with the following table:

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Design Thickness, in.</th>
<th>Minimum Thickness, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>0.0295</td>
<td>0.028</td>
</tr>
<tr>
<td>20</td>
<td>0.0358</td>
<td>0.034</td>
</tr>
<tr>
<td>18</td>
<td>0.0474</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Standard tolerance for ordered lengths is ±1/₂''.

B. SECTION PROPERTIES
Structural adequacy of deck sections shall be established by the determination of Section Modulus and Moment of Inertia, computations for which shall be in accordance with conventional methods of structural design. Such computations shall reflect the concept of "effective compression flange width" as limited by the appropriate provisions of the latest Edition of the A.I.S.I. "Specification for the Design of Cold-Formed Steel Structural Members".

Arbitrarily assumed effective compression flange widths shall not be allowed. Testing shall not be used in lieu of the above in determination of vertical load carrying capacity of steel deck.

C. MOMENT AND DEFLECTION COEFFICIENTS
A moment coefficient of 1/8 shall be used for simple and dual spans and a moment coefficient of 1/10 shall be used for 3 or more spans. A deflection coefficient of 3/384 shall be used for all except simple spans for which the deflection coefficient of 5/384 shall be used.

D. MAXIMUM DEFLECTIONS
Deflection of the deck shall not exceed 1/240 of the span under the uniformly distributed design live load or when subjected to a 200 pound temporary concentrated load applied to a 1 foot width of the deck when placed at the midpoint of the end span. All spans are to be considered center to center of supports.*

E. ANCHORAGE
Steel deck units shall be anchored to the supporting framework to resist the following gross uplifts:

45 pounds per square foot for eave overhang
30 pounds per square foot for all other roof areas

The dead load of the roof deck construction shall be deducted from the above uplift forces.

For welded installations, welds shall be proportioned so that the unit shear stress shall not exceed 13,600 psi on the throat of the fillet or plug welds as specified by The American Iron & Steel Institute's "Specification for the Design of Cold Formed Steel Structural Members", Section 4.2.1.

F. PROTECTION
All steel roof deck shall be free of oil, grease and dirt, and given a shop coat of priming paint or metal. This prime coat is intended to protect the steel for only a short period of exposure in ordinary atmospheric conditions and must be considered an impermanent and provisional coating.

* See CONSTRUCTION LOAD TABLES on page 6
### SDI Standard No. 2

**LOAD TABLES**  
REVISED NOVEMBER, 1976

**NOTES:**

1. Load tables are calculated using Sectional Properties based on the steel design thicknesses shown in this SDI Design Manual.

2. Loads shown in tables are uniformly distributed total (dead plus live) loads in PSF. Loads in shaded areas are governed by live load deflection not in excess of 1/240 x span. The dead load included is 10 PSF. All other loads are governed by the allowable flexural stress limit of 20,000 psi for a 33,000 psi minimum yield. Where heavy construction loads or other unusual concentrated loads are anticipated during the lifetime of the deck, the specified live load must be increased to offset the effects of the abnormal concentrated loading.

3. The rib width limitations shown are taken at the theoretical intersection points of the flange and web projections.

4. Span length assumes center-to-center spacing of supports. Tabulated loads shall not be increased by assuming clear span dimensions.

5. Bending Moment formulae used for flexural stress limitation are:
   - Simple & Two Span \( M = \frac{wL^2}{8} \)
   - Three Span or more \( M = \frac{wL^2}{10} \)

6. Deflection formula for deflection limitation are:
   - Simple Span \( \Delta = \frac{5wL^4}{384EI} \)
   - Two & Three Span \( \Delta = \frac{3wL^4}{384EI} \)

7. Normal installations covered by these tables do not require midspan fasteners for spans of 5 ft. or less.

8. The manufacturer guarantees that the product identified as complying with a Standard Load Table conforms to the Basic Design Specifications of the Steel Deck Institute and to the dimensional parameters established for that load table.

<table>
<thead>
<tr>
<th>DECK TYPE</th>
<th>SPAN</th>
<th>DESIGN THICKNESS</th>
<th>Uniform Total (Dead &amp; Live) Load in Pounds Per Sq. Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR 22</td>
<td>4-0</td>
<td>0.0295</td>
<td>74 58 47</td>
</tr>
<tr>
<td>NR 20</td>
<td>5-0</td>
<td>0.0358</td>
<td>90 72 58 48 40</td>
</tr>
<tr>
<td>NR 18</td>
<td>5-6</td>
<td>0.0474</td>
<td>121 95 77 64 54 46</td>
</tr>
<tr>
<td>IR 22</td>
<td>5-0</td>
<td>0.0295</td>
<td>74 58 47</td>
</tr>
<tr>
<td>IR 20</td>
<td>5-6</td>
<td>0.0358</td>
<td>90 72 58 48 40</td>
</tr>
<tr>
<td>IR 18</td>
<td>6-0</td>
<td>0.0474</td>
<td>121 95 77 64 54 46</td>
</tr>
<tr>
<td>WR 22</td>
<td>5-0</td>
<td>0.0295</td>
<td>74 58 47</td>
</tr>
<tr>
<td>WR 20</td>
<td>5-6</td>
<td>0.0358</td>
<td>90 72 58 48 40</td>
</tr>
<tr>
<td>WR 18</td>
<td>6-0</td>
<td>0.0474</td>
<td>121 95 77 64 54 46</td>
</tr>
<tr>
<td>WR 22</td>
<td>6-6</td>
<td>0.0295</td>
<td>98 68 58 50 42</td>
</tr>
<tr>
<td>WR 20</td>
<td>7-0</td>
<td>0.0358</td>
<td>122 101 85 70 56 49 42</td>
</tr>
<tr>
<td>WR 18</td>
<td>7-6</td>
<td>0.0474</td>
<td>165 136 115 98 84 73 64 57 51 45 40</td>
</tr>
<tr>
<td>WR 22</td>
<td>8-6</td>
<td>0.0295</td>
<td>98 68 58 50 42</td>
</tr>
<tr>
<td>WR 20</td>
<td>9-0</td>
<td>0.0358</td>
<td>122 101 85 70 56 49 42</td>
</tr>
<tr>
<td>WR 18</td>
<td>9-6</td>
<td>0.0474</td>
<td>207 171 143 120 98 81 69 59 51 45 40</td>
</tr>
</tbody>
</table>

Steel decks, other than the standard configurations above, are available from member companies in 1 1/2, 3, 4 1/2, 6 and 7 1/2 inch depths and 6, 8, 9 and 12 inch centers.
SITE STORAGE and ERECTION

SITE STORAGE
Steel decking is generally supplied with a prime coat of paint which is not intended to assure protection for extended periods of time when exposed to the elements. Steel decking should be stored off the ground with one end elevated to provide drainage and should be protected from the elements with a waterproof covering, ventilated to avoid condensation.

ERECTION
Deck sheets should be placed in accordance with approved erection layout drawings supplied by the deck manufacturer or in conformance with the deck manufacturer’s standards. Roofs having a slope of ½ inch or more in 12 inches should be erected beginning at the low side to insure that end laps are shingle fashion. End laps of sheets should be a minimum of 2 inches and should occur over supports.

Care should be exercised to avoid overloading the supporting structural elements when placing bundles of steel deck or other construction loads on the roof.

Any construction live loads during erection and roofing should be distributed by appropriate means to prevent damage to the previously installed components.

CONSTRUCTION LOADS TABLE
STANDARD 1 ½” ROOF DECKS

<table>
<thead>
<tr>
<th>Type</th>
<th>Span Condition</th>
<th>Span Ft.-in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NARROW RIB DECK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR 22</td>
<td>1</td>
<td>3’ 10&quot;</td>
</tr>
<tr>
<td>NR 22</td>
<td>2 or more</td>
<td>4’ 9&quot;</td>
</tr>
<tr>
<td>NR 20</td>
<td>1</td>
<td>4’ 10&quot;</td>
</tr>
<tr>
<td>NR 20</td>
<td>2 or more</td>
<td>5’ 11&quot;</td>
</tr>
<tr>
<td>NR 18</td>
<td>1</td>
<td>5’ 11&quot;</td>
</tr>
<tr>
<td>NR 18</td>
<td>2 or more</td>
<td>6’ 11&quot;</td>
</tr>
<tr>
<td>INTERMEDIATE RIB DECK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR 22</td>
<td>1</td>
<td>4’ 6&quot;</td>
</tr>
<tr>
<td>IR 22</td>
<td>2 or more</td>
<td>5’ 6&quot;</td>
</tr>
<tr>
<td>IR 20</td>
<td>1</td>
<td>5’ 3&quot;</td>
</tr>
<tr>
<td>IR 20</td>
<td>2 or more</td>
<td>6’ 3&quot;</td>
</tr>
<tr>
<td>IR 18</td>
<td>1</td>
<td>6’ 2&quot;</td>
</tr>
<tr>
<td>IR 18</td>
<td>2 or more</td>
<td>7’ 4&quot;</td>
</tr>
<tr>
<td>WIDE RIB DECK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WR 22</td>
<td>1</td>
<td>5’ 6&quot;</td>
</tr>
<tr>
<td>WR 22</td>
<td>2 or more</td>
<td>6’ 6&quot;</td>
</tr>
<tr>
<td>WR 20</td>
<td>1</td>
<td>6’ 3&quot;</td>
</tr>
<tr>
<td>WR 20</td>
<td>2 or more</td>
<td>7’ 5&quot;</td>
</tr>
<tr>
<td>WR 18</td>
<td>1</td>
<td>7’ 6&quot;</td>
</tr>
<tr>
<td>WR 18</td>
<td>2 or more</td>
<td>8’ 10&quot;</td>
</tr>
</tbody>
</table>

*Note: Spans governed by a maximum stress of 26,600 psi and maximum deflection of 1/240 with a 200 pounds concentrated load at midspan on a 1’-0” width section of deck.

The deck erector normally cuts all openings in the roof deck which are shown on the erection drawings and which are less than 16 square feet in area, as well as skew cuts which are shown on the drawings. Openings not shown on the erection diagrams, such as those required for stacks, conduits, plumbing vents, etc., are cut (and reinforced, if necessary) by the trade requiring the openings.

ATTACHMENT OF DECK TO SUPPORTING MEMBERS
The attachment spacings are based on providing 30 pounds per square foot gross up-lift and providing lateral stability to the top flange of the supporting structural members.

Welding—Care should be exercised in the selection of electrodes and amperage to provide positive welds and prevent high amperage blow-holes. (The welding rod selection and the amperage are left to the preference of the individual welder.) Welds are made from the top side of the deck with the welder following close behind the placement crew. Welding washers are not necessary for steel deck with design thickness of 0.0295 or heavier.

Puddle welds shall be at least ½ inch in diameter or an elongated weld having an equal perimeter. Fillet welds when used shall be approximately 1 inch long. Weld metal shall penetrate all layers of deck material at end laps and side joints and have good fusion to the supporting members.

Screws—The allowable load value per screw used to determine maximum fastener spacing for either self drilling or standard metal type is based on minimum size 12 and structural support thickness of .06 inches.

Powder Actuated Fasteners—The allowable load values per fastener used to determine the maximum fastener spacing are based on a minimum structural support thickness of not less than ½ inch and the fastener providing a ½ inch diameter bearing surface.

Fastener Spacing—Standard style deck sheets are available in widths of 18, 24, 30 and 36 inch depending on the manufacturer. The location and number of fasteners required for satisfactory attachment of standard deck to supporting structural members are as follows: All edge ribs plus a sufficient number of interior ribs to limit the spacing between adjacent points of attachment to 18 inches. Side laps of individual sheets must be fastened together between supports not exceeding 3 feet on center for spans greater than 5 feet.

INSULATION
Insulation board should have sufficient strength and thickness to permit unsupported spans and edges over the deck’s rib openings. Cementsitious insulating fills should be poured only over galvanized deck and must be adequately vented. In all cases the recommendations of the insulation manufacturer should be followed.
FIRE RESISTANCE RATINGS

2 HR. RATING
WITH
DIRECT-APPLIED
INSULATION

Illustration refers to UL Design P801 using a sprayed mineral fiber insulation. See also UL Designs P701 (1 hr.) and P703 (1 1/2 hr.), using sprayed vermiculite plaster.

2 HR. RATING
WITH
METAL LATH
AND
PLASTER CEILING

Illustration refers to UL Design P404. See also UL Design P409.

OTHER 2 HR. FIRE RATINGS

Although standard roof deck shapes were not used for the following tests, it is the opinion of persons knowledgeable with fire test procedures that steel roof decking, 1 1/2 in. minimum rib height and minimum 22 MSG, galvanized, can be used without decreasing the fire resistance of the assembly. In each case the assembly was tested using either a steel form unit, 3/8 in. min., or a steel floor deck essentially identical to products marketed as roof deck. The authorities having jurisdiction should be consulted before substituting steel roof decking in the following assemblies:

UL Designs P215 and P219: acoustical ceiling systems;
2 in. vermiculite concrete or special roof topping mixture on steel deck.

1 HR. RATING
WITH SUSPENDED ACOUSTICAL CEILING

Illustration refers to UL Design P201.
See also UL Design P202, P204, P205, P206, P208, P209, P210, P211, P214 and Factory Mutual Roof-Ceiling Construction 3-1 hr.

Note: UL Design refers to listings in Fire Resistance Index of Underwriters Laboratories Inc.
SUGGESTED ARCHITECTS’ ROOF DECK SPECIFICATIONS

1. SCOPE This section shall include all materials, equipment and labor necessary for the installation of steel roof decking, complete, in accordance with this specification and drawings. Requirements for deck supports, field painting, sumps, flashings, drains, collars, gutters, downspouts, or other miscellaneous items are specified elsewhere as needed.

2. DECKING The steel roof deck shall be (narrow) (intermediate) (wide) rib configuration, . . . in. rib height, as manufactured by . . . . . . . . . . . . . and shall be designed in accordance with the "Basic Design Specifications" as adopted by the Steel Deck Institute.

3. LOADS The deck shall be capable of supporting a uniformly distributed live load of . . . . . . . . pounds per square foot without live load deflection exceeding 1/240 of the span length, c. to c. of supports and a uniformly distributed load of . . . . . . . . pounds per square foot without exceeding a unit stress of 20,000 psi.

4. ACCESSORIES Ridge and valley plates and steel cant strips attached directly to the steel deck as shown on the plans to provide a finished surface for the application of insulation and roofing, shall be furnished by the deck manufacturer.

5. INSTALLATION Steel deck shall be erected and fastened in accordance with the manufacturer's specifications and erection layouts. Cutting openings through the deck less than 16 square feet in area, and all skew cutting, shall be performed in the field.

6. FINISH Roof deck shall receive one prime coat of manufacturer's standard paint, or shall be zinc coated.