Properly Specifying Steel Deck
How to Get What You Really Want

Thomas Sputo, Ph.D., P.E., S.E.
Technical Director, Steel Deck Institute
Consulting Structural Engineer, Sputo and Lammert Engineering

Mike Antici, Education Chairman, Steel Deck Institute
Design Engineer, Vulcraft

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The Good Way ...
And
the Bad and the Ugly

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Polling Question

- New requirement to earn PDH credits
- Two questions will be asked during the duration of today’s presentation
- The question will appear within the polling section of your GoToWebinar Control Panel to respond
Learning Objectives

• Explain the difference between limits imposed by strength and serviceability

• Identify how to properly specify fire rated deck assemblies

• Identify the proper deck finish for varied environmental exposures
March 20, 2019  “Full Worm Moon”

SDI Mascots
Mr. and Mrs. Mickey
Outline

1. Introduction to resources
2. Design for structural strength and deflection
3. Architectural concerns
4. Design for wind ratings
5. Design for fire ratings
6. Selecting finishes and coatings
7. Acoustical concerns
8. How NOT to specify roof and floor deck
9. Question and answer
What Resources are Available?
What Resources are Available?
What Resources are Available?

**ICC-ES Report**

**ESR-1227**

**DIVISION: 05 00 00—METALS**

**SECTION: 05 31 00—STEEL DECKING**

**EVALUATION REPORT**

**Number: 217**

- **Originally Issued:** 11/09/2011
- **Revised:** 01/06/2017
- **Valid Through:** 11/30/2017

**EVALUATION SUBJECT:**

**STEEL DECKS:**

1.3 Properties assessed:
- Structural
- Fire Resistance
What Resources are Available?
What Resources are Available?

**SDI Diaphragm Interaction Calculator**

- Deck Profile: 1.5 x 6 WR
- Deck Gage: 22
- Deck $F_{y1}$, $F_{u1}$: 33, 45 ksi
- MWFRS: 25 psf
- (-) Uplift, ASCE 7-10 (16)

<table>
<thead>
<tr>
<th>Support Fastener</th>
<th>#12 screw</th>
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</thead>
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<tr>
<td>Support Fastener Pattern</td>
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<td>Sidelap Fastener</td>
<td>#10 screw</td>
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<td>Substrate thickness, $t_2$</td>
<td>CF43 mil (18 gage)</td>
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<td>Substrate $F_{y2}$, $F_{u2}$</td>
<td>33, 45 ksi</td>
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<tr>
<td>Number of Spans</td>
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<td>AISI S-310</td>
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</table>

Various other on-line tools by member companies.
Design for Strength and Serviceability

- Depth and type (profile)
- Design thickness
- Deck material (including yield strength)
- Deck finish
- Fasteners

There are no “Standard” SDI sections.
Sections in SDI RDDM and FDDM are lower bound properties.
Some manufacturers have special proprietary sections
Design for Strength and Serviceability

Design roof deck, using ASD design

- 7’-00” design span
- Deck layout accommodates 3-span construction
- Gravity = 20 psf $L_R$, 15 psf $DL$
- Wind (net) = -40 psf, +20 psf
- MWFRS = 35 psf
- Diaphragm = 300 plf
Design for Strength and Serviceability

\[ 200 \text{ lb maintenance load} \times 1.4 = 280 \text{ lbs} \]

\[ 1.5 \times \text{ WR } 22 = 1.6 \text{ psf} \times 1.2 = 2 \text{ psf} \]

\[ \text{FP} = 280 \text{ lbs} \]

\[ \text{FW deck} = 2 \text{ psf} \]

\[ \Delta = 0.53 \text{ in} = L/160 \]

Check insulation and roofing materials.

\[ L_{\text{max}} = 7.4 \text{ ft} < 7.0 \text{ ft} \]
Design for Strength and Serviceability

Table 4.1 - 1.5 WR ASD Uniform Downward Loads (psf)

<table>
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<tr>
<th>Span Cond.</th>
<th>Gage Number</th>
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<th>6'-00&quot;</th>
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6a) \( D + 0.75L + 0.75(0.6W) + 0.75(L_r or S or R) = 39 \text{ psf} < 61 \text{ psf} \)
Design for Strength and Serviceability

Table 4.2  1.5 WR ASD Uniform Upward Loads (psf)

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\[ U_{\text{net}} = 40 \text{ psf} < 58 \text{ psf} \]
Table 4.5  1.5 WR Uniform Service Load that Causes L/120 Deflection (psf)

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\[ L_R = 20 \text{ psf} < 106 \text{ psf} \quad L/120 \]

\[ L_R = 20 \text{ psf} < 53 \text{ psf} \quad L/240 \]
Design for Strength and Serviceability

### SDI Diaphragm Interaction Calculator V1

**Last Revision 3/21/2018**

Per AISI S-100-16, AISI S-310-16, AISI S-310-13, SDI DDM04

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<th>WR</th>
<th>Support Fastener</th>
<th>Support Fastener Pattern</th>
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<tr>
<td>Deck Fy1, Fu1</td>
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- **5/8" arc spot**
  - 36/7
  - #12 screw
  - 1/8
**Design for Strength and Serviceability**

<table>
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<tr>
<th>Sidelaps per Span</th>
<th>Pnft, kips</th>
<th>( S_{a} )</th>
<th>ASD Interactive Allowable Shear Strength, ( S_{nf}/\Omega_{d}, \text{ plf} )</th>
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Uplift = 35 x 0.6 = 21 psf

\( S_{a} = 327 \text{ plf} < 300 \text{ plf} \)
Design for Strength and Serviceability

- Depth and Type (profile)
  - 1-1/2” Wide Rib (Type B) Roof Deck
- Design thickness
  - 22 gage
- Deck material (including yield strength)
  - 33 ksi minimum yield … do not specify ASTM grade
- Deck finish
  - G 60 galvanized
Design for Strength and Serviceability

- Support fasteners
  - 5/8” visible arc spot welds
- Support fastener pattern
  - 36/7 or 6” on center
- Sidelap fasteners
  - Four #12 self-drilling screws per span
- Edge fasteners
  - 5/8” visible arc spot welds at 6” on center
Polling Question 1

Applicable steel deck resources are:

A. AWS D1.1
B. AISI S100 and S310
C. ASCE Manual of Steel Construction
D. NDS for Wood Construction
Design for Strength and Serviceability

To Delegate or Not?
That is the Question?

• The Answer . . . .
  • The SER is still liable via approvals
  • Design is deferred to GC, not deck supplier
  • Performance specs must be supplied
Design for Strength and Serviceability

- If Delegated, what are performance specs?
  - Profile depth
  - Concrete depth, f’c, WWR if applicable
  - Construction loads, w_c and P_c
  - Superimposed Service loads, w_d, w_l and w_w
  - S_n, S_a or S_u min
  - G’ or F min
  - NRC, IIC, STC if applicable
  - Finish
Finish or Coating

- Bare … aka “black”
- Galvanized … G30 / G60 / G90 (or higher)
- Prime painted … “phosphatized/painted” or “phos/painted” … One side or both
- Prime paint over galvanized
- Other coatings
Coatings

Prime painted (grey, white).

Note: Primer is applied “before” forming.

Does finish affect U.L. rating?
Finish or Coating

   Roof Deck
      Galvanized, primed painted, bare

   Form Deck
      Galvanized, primed painted, bare

   Composite Deck
      Galvanized, bare, bottom prime painted.
      Do not have primed surface in contact with concrete.

Paint? Primer? Shop Coat?
Finish or Coating

Bare Deck

Remember your chemistry class … remove the moisture and the rusting stops.
Finish or Coating

Galvanized Finish
- G30 = 0.15 oz/sf per side
- G60 = 0.30 oz/sf per side
- G90 = 0.45 oz/sf per side
- Greater may be available
Finish or Coating

Galvanized Finish

- Works by galvanic protection … zinc sacrifices itself for steel
- “Touch up” of welds and nicks NOT NECESSARY

Will G+P add protection?
Finish or Coating

Shop Coat
Finish or Coating

Paint is a Barrier

- “Shop Coat” is a **provisional**, impermanent prime coating
  - “Touch up” of welds and nicks NOT NECESSARY
- Additional finish paint (if required) should be field applied
  - Not by deck installer … add to painting contracts
- Think about spray on fireproofing requirements

One way to breach a barrier, *Bangalore*
UGLY Finish or Coating

FIGURE 3
RECOMMENDATION FOR PROTECTING DECK BUNDLES AT JOB SITE

Important: Leave end open for ventilation.

Place a few pieces of blocking on bundle to create overhang to support tarp.

Waterproof covering. Such as plastic or a tarp

Important: Leave end open for ventilation.

Elevate "thick" end of bundle to help shed or drain any moisture penetration.

Properly secure tarp to prevent blow-off.
UGLY Finish or Coating

Shop Prime Coat
**UGLY Finish or Coating**

Galvanized Finish with ‘White Rust’

“Wet Storage Stain” … formation of zinc hydroxide

“White Rust” is a different process than “Wet Storage Stain” and you should speak with your electrochemist friends for an explanation

Source: American Galvanizers Association
Deck in Corrosive Environments
Deck in Corrosive Environments

Special Barrier Coatings for Corrosive Environments

Ventilation is key
Deck in Corrosive Environments

Chemicals
- Chlorine
- Acids
- Ammonia (agricultural)
- High humidity

Solutions
- Isolate from chemicals with barrier / coatings
- Stainless Steel (stain-less)

Fundamentals of Corrosion and Their Application to Steel Deck
July 2015
Finish or Coating: SDI Code of Standard Practice

2.2 Paint: When required by the Contract Documents, a shop coat of primer shall be provided by the manufacturer. The primer shall be permitted to be shop applied or provided as prepainted steel coils, at the manufacturer’s option.

3.5 Field Painting: Neither the seller, manufacturer, nor installer shall be responsible for field painting, either as a full finish coat or as “touch-up.” Field painting is the sole responsibility of the ORC to assure that the surface is properly prepared and that the coating is properly applied. Neither the seller, manufacturer nor installer will accept responsibility for adhesion or compatibility of the field coating or for other causes leading to unsatisfactory painting results.
3.4 **Fireproofing:** Neither the seller, manufacturer, nor installer shall be responsible for ensuring the bonding of fireproofing materials.  

Rx: Properly specify coating

3.6 **Repair of Deck Finish at Welds:** Unless otherwise required by the Contract Documents, where deck welds are not directly exposed to a corrosive environment, it shall not be required to repair painted or galvanized finishes. Neither the seller, manufacturer, nor installer will accept responsibility for repair of deck finish at weld areas.
Excluded: SDI Code of Standard Practice

4.3 Excluded Materials: Unless otherwise specified, the following materials are excluded from the bid.

- Shear Connectors: Shear connectors and related placement plans and details are not the responsibility of the seller or manufacturer.
- Touch-up Paint: Paint used in field to touch-up painted or galvanized deck surfaces.
5.6 **Calculations:** Neither the seller nor manufacturer shall be responsible for providing design calculations, test reports, nor other acceptance reports, with or without a professional seal; however ……

Rx: COSP lists what is provided

5.7 **As Built Drawings:** Neither the seller, manufacturer, nor installer shall be responsible for “as built” drawings.
Wind Rated Assemblies

Approval Standard for Profiled Steel Panels for Use as Decking in Class 1 Insulated Roof Construction

Class Number 4451
Wind Rated Assemblies

200 lbs

Δ < L/240

FM 4451/4.1 and SDI RD-2017/2.4.1
Wind Rated Assemblies

\[ P_{nov} = 1.5t_1d_wF_u \]

FM 4451/4.3.1.2 and AISI S100/J4.4.2-1
Wind Rated Assemblies

Corner Pattern = 2.5 x Field Pattern

Field Pattern

Edge Pattern = 2 x Field Pattern
Polling Question 2

What type of finish is NEVER acceptable on the top side of composite deck?

A. Zinc
B. Rust
C. Prime paint
Fire Rated Assemblies

Now you can choose
either one and get the same fire protection thickness.

Restrained or Unrestrained?

BY CHARLES J. CARTER, S.E., P.E., PH.D. AND FARED ALFAWAKHIRI, P.ENG., PH.D.

HAVE YOU EVER been caught up in a debate about whether restrained conditions or unrestrained conditions should be used with fire resistance ratings in the Underwriters Laboratories (UL) Fire Resistance Directory?

If you have, we’re happy to report that this tired old argument is now dead. Thanks to recent tests of unrestrained specimens at UL, we now know the answer is that it doesn’t matter. The fire protection required will be the same—at least for the floor construction described in the new UL Design No. D982.

Charles J. Carter (carter@aisc.org) is a vice president and the chief structural engineer for AISC and Fared Alfawakhirı (alfawakhirı@steel.org) is the senior engineer, Construction Codes and Standards, for the American Iron and Steel Institute.
Fire Rated Assemblies

UL Design No. D982

Restrained Assembly Rating - 2 Hr.
Unrestrained Assembly Rating - 2 Hr.
Unrestrained Beam Rating - 1 Hr.
Fire Rated Assemblies

2. Normal Weight or Lightweight Concrete — Compressive strength 3500 psi. Normal weight concrete, carbonate or siliceous aggregate, 150 ± 3 pcf unit weight. Min. thickness 4-1/2 inches. Lightweight concrete, expanded shale, clay or slate aggregate by rotary-kiln method, 110 +/- 3 pcf unit weight. Min. thickness 3-1/4 inches.

..... Thickness is above top of deck

3. Shear Connectors (optional) — Studs, max. 3/4 in. diam, headed type or equivalent, designed in accordance with the specification of the American Institute of Steel Construction. Welded to top flange of beam through steel floor or form units.

5. Steel Floor and Form Units* — Composite or non-composite. Min. 1-1/2 in. deep, max 3 in. deep, galv or phosphatized/painted fluted units. Min gauge 22 MSG. Welded to supports approx 12 in. OC. Total live and dead load shall not exceed 200 psf.
6. **Spray-Applied Fire Resistive Materials** — Applied by mixing with water and spraying in one or more coats to steel beam surfaces which are free of dirt, loose scale and oil. Application shall be in accordance manufacturer's instructions and applicable UL Design. Coating thickness shall be sufficient to provide a 1 hr Unrestrained Beam Rating on the size of wide flanged beam utilized. See D900, N700 and N800 series designs for specific coatings and coating thickness requirements. When selecting a design, note the wide flanged beams size and the design's capacity for heat dissipation. Refer to BXUV guide information for additional information regarding beam substitution and thickness adjustments.
If normal-weight concrete (145 to 155 pcf) is specified, the use of lightweight (90 to 120 pcf) is not recommended because its greater insulating properties could cause higher temperatures on supporting members. When lightweight concrete is specified, the use of normal-weight concrete is not recommended because its lower insulating properties could cause higher unexposed surface temperatures.
Fire tests have generally shown that composite slabs deflect more than similar noncomposite slabs. Therefore, the ratings developed with composite units would not be jeopardized if noncomposite units of the same profile are used provided the loading is based on the section modulus of the noncomposite units.”
Fire Rated Assemblies

Spray-Applied Fire Resistive Materials
Paint must be compatible with any spray on materials

*Painted Decking*

Fireproofing can only be applied directly to painted floor and roof decking if the specific decking, with the specific paint, has been fire-tested and is then specifically listed in the design in the UL Fire Resistance Directory. Painted decking must be supplied by the decking manufacturer to the jobsite with the paint pre-applied during the manufacturing process. There are no paints or decking approvals which allow the application of paint on the jobsite. Galvanized decking is the default in all designs in the UL Fire Resistance Directory. Where painted decking is allowed, the design lists the specific deck type and then uses the designation “Types XX, XXX etc. ptd/ptd or phos/ptd may be used” (the ptd/ptd and phos/ptd refer to the coatings on the top and
**UGLY** Fire Rated Assemblies

Bad: Structural Engineer leaves all fire rated assemblies to the Architect.

Good: Structural Engineer and Architect (and Fire Protection Engineer, if any) coordinate efforts early.
Acoustical Deck

2 inch Polyisocyanurate Rigid Roof Insulation
Perforations are in deck webs
Acoustical Insulation or Acoustical Material
Very effective for ceiling heights of 8-50 ft

<table>
<thead>
<tr>
<th>Sound Absorption Coefficients (Frequency)</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 inch Acoustic Deck</td>
<td></td>
</tr>
<tr>
<td>0.11 125</td>
<td></td>
</tr>
<tr>
<td>0.18 250</td>
<td></td>
</tr>
<tr>
<td>0.66 500</td>
<td></td>
</tr>
<tr>
<td>1.62 1000</td>
<td></td>
</tr>
<tr>
<td>0.61 2000</td>
<td></td>
</tr>
<tr>
<td>0.93 4000</td>
<td></td>
</tr>
<tr>
<td>0.93 NRC</td>
<td></td>
</tr>
</tbody>
</table>

| 3 inch Acoustic Deck                     |     |
| 0.18 125                                 |     |
| 0.39 250                                 |     |
| 0.88 500                                 |     |
| 0.93 1000                                |     |
| 0.58 2000                                |     |
| 0.39 4000                                |     |
| 0.70 NRC                                 |     |
Cellular Deck

Perforations are in bottom plate

Pad Supports

Acoustical Insulations or Acoustical Material

Very effective for ceiling heights of 8 - 150 ft

<table>
<thead>
<tr>
<th>Panel</th>
<th>Sound Absorption Coefficients (Frequency)</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>3 inch Deep Cell</td>
<td>0.47</td>
<td>0.57</td>
</tr>
</tbody>
</table>
UGLY Acoustical Deck

Bad: Pick STC ratings that are not available.

Good: Refer to manufacturer’s or SDI literature for STC ratings.
Insulation / Roofing Screws

If screws are visually objectionable

1. Specify cellular deck
2. Control screw length
Vented or Not?

Roof (1.5WR)

Floor (2” Composite)
Vented or Not? – Roof Version

- Roof with Lightweight Insulating Concrete (LWIC)
  - Vermiculite Expanded Aggregate Concrete – 0.75% to 1.5% open area
  - Cellular Concrete – No venting required
  - Building code may (most likely) require galvanized surface

- Lesson
  - Coordinate with Architect and beware of “Value Engineering”* during construction.

* “Value Engineering” has nothing to do with either Value or Engineering. It is the process of substituting pasteurized processed cheese food product for real cheese.
Vented or Not? – Floor Version

• Composite or Non-Composite Floor Deck
  • Venting is NOT NECESSARY
  • Venting DOES NOT cause the slab to dry quicker.*

• Fick’s Law states that 'the rate of diffusion is proportional to both the surface area and concentration difference and is inversely proportional to the thickness of the membrane'.
How **NOT** to Specify Steel Deck
**UGLY** Specification of Steel Deck

“Provide 22 gage minimum Mahon Section 200 steel roof deck, or equal.”

Problems:
- Mahon disappeared in the 1970’s
- Do you want a proprietary section? (It is OK if that is your intention).
- What is “equal”? 
UGLY Specification of Steel Deck

What is “equal”?

How about:
- Your specified profile has a capacity of 200 psf
- What is submitted has a capacity of 190 psf
- While you only need 100 psf

What are you going to do?
**UGLY** Specification of Steel Deck

Provide 1-1/2” steel roof deck with minimum section properties as follows:

- \( S_p = 0.186 \text{ in}^3/\text{ft} \)
- \( S_n = 0.192 \text{ in}^3/\text{ft} \)
- \( I_p = 0.155 \text{ in}^4/\text{ft} \)
- \( I_n = 0.183 \text{ in}^4/\text{ft} \)

Problems:

- Section modulus is meaningless without a specified steel yield strength
- Looks like you pulled this from a specific manufacturer’s catalogue … but is this what you REALLY need?

<table>
<thead>
<tr>
<th>Deck type</th>
<th>Design thickness in</th>
<th>w psf</th>
<th>Section Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in (^{2}/\text{ft} )</td>
<td></td>
<td>J (_p)</td>
</tr>
<tr>
<td>A54</td>
<td>0.109/16</td>
<td>1.47</td>
<td>0.167</td>
</tr>
<tr>
<td>B122</td>
<td>0.0296</td>
<td>1.78</td>
<td>0.156</td>
</tr>
</tbody>
</table>
UGLY Specification of Steel Deck

“Comply with SDI Design Manual #21”
“Comply with ANSI/SDI RD-2017 Standard”
UGLY Specification of Steel Deck

“Comply with the requirements of the Metal Roof Deck Technical Institute”
Mickey says:

Build With Steel Deck
Questions?
Polling Question Answers

1. Applicable steel deck resources are:
   A. AWS D1.1
   B. AISI S100 and S310
   C. ASCE Manual of Steel Construction
   D. NDS for Wood Construction

2. What type of finish is NEVER acceptable on the top side of composite deck?
   A. Zinc
   B. Rust
   C. Prime paint
THANK YOU