

Properly Specifying Steel Deck

How to Get What You Really Want

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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”



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?



AMERICAN NATIONAL STANDARDS INSTITUTE/STEEL DECK INSTITUTE
C - 2017 Standard for
Composite Steel Floor Deck-Slabs



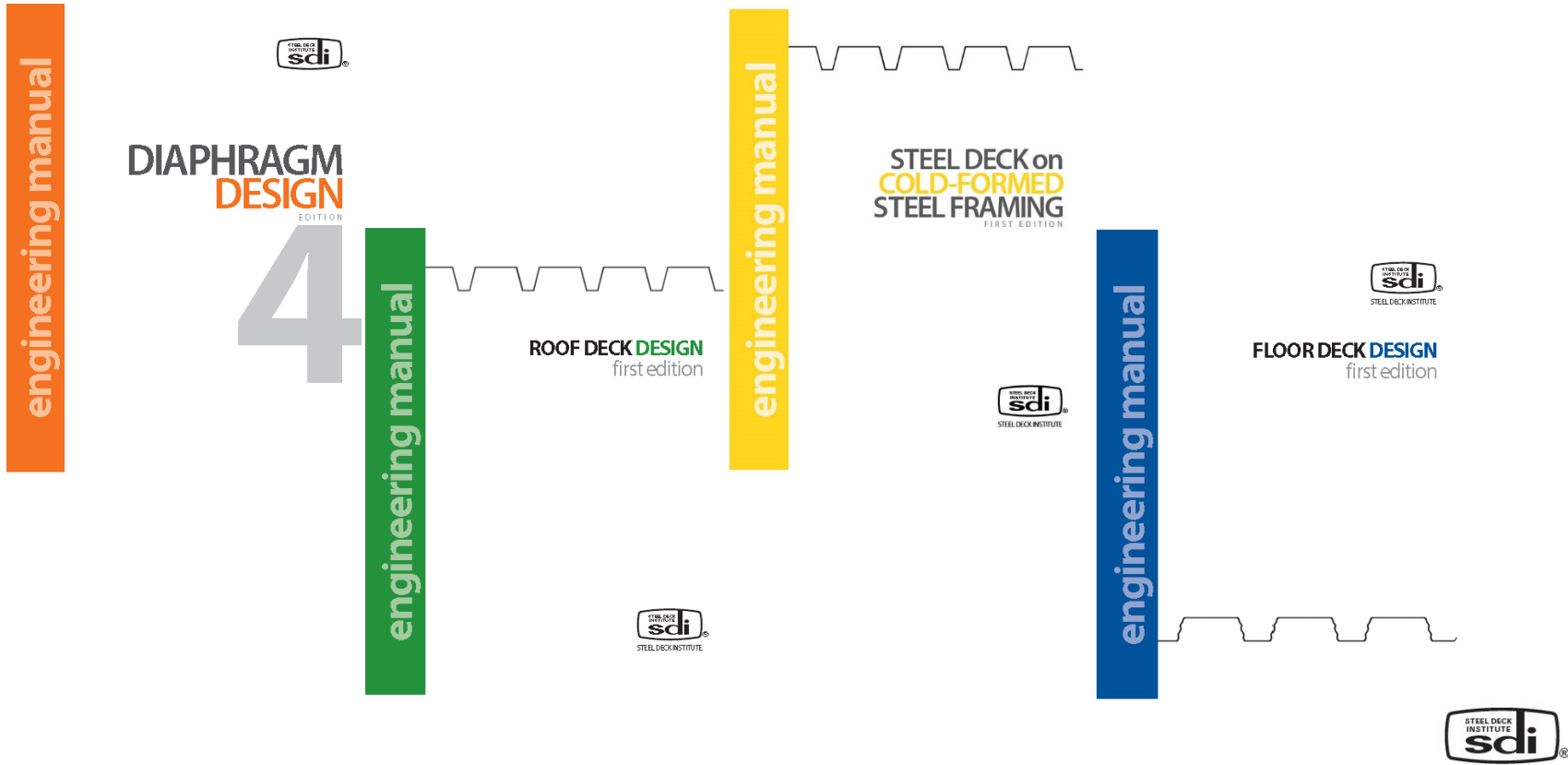
AMERICAN NATIONAL STANDARDS INSTITUTE/STEEL DECK INSTITUTE
NC - 2017 Standard for
Non-Composite Steel Floor Deck



AMERICAN NATIONAL STANDARDS INSTITUTE/STEEL DECK INSTITUTE
RD - 2017 Standard for
Steel Roof Deck



What Resources are Available?





What Resources are Available?

ES ICC EVALUATION SERVICE
In Cooperation with **Innovation** RESEARCH LABS

Most Widely Accepted and Trusted

ICC-ES Report **ESR-1227**
ICC-ES | (800) 423-6587 | (562) 699-0543 | www.icc-es.org
Reissued 12/2016
This report is subject to renewal 12/2017.

DIVISION: 05 00 00—METALS
SECTION: 05 31 00—STEEL DECKING

UES **EVALUATION REPORT** Number: **217**

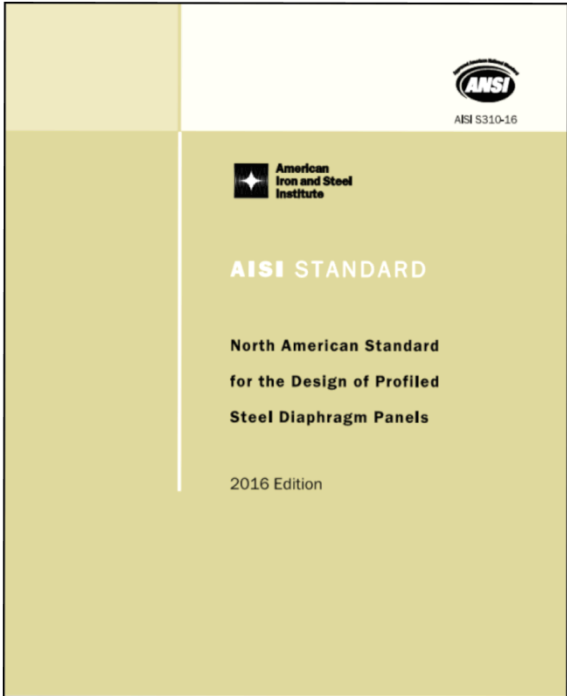
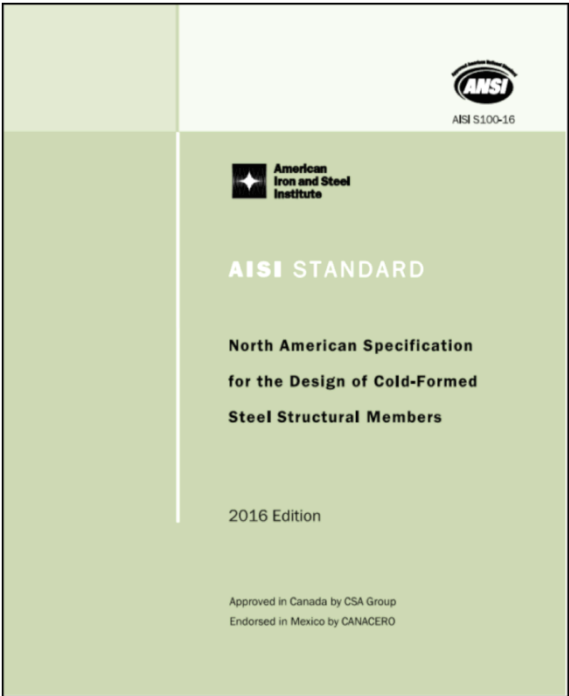
Originally Issued: 11/09/2011 Revised: 01/06/2017 Valid Through: 11/30/2017

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	Support Fastener	#12 screw	
Deck Gage	22		Support Fastener Pattern	36/4	
Deck F_{y1} , F_{u1}	33, 45	ksi	Sidelap Fastener	#10 screw	
MWFRS			Substrate thickness, t_2	CF43 mil (18 gage)	
(-) Uplift, ASCE 7-10 (16)	25	psf	Substrate F_{y2} , F_{u2}	33, 45	ksi
			Number of Spans	3	
			AISI S-310	2016	

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

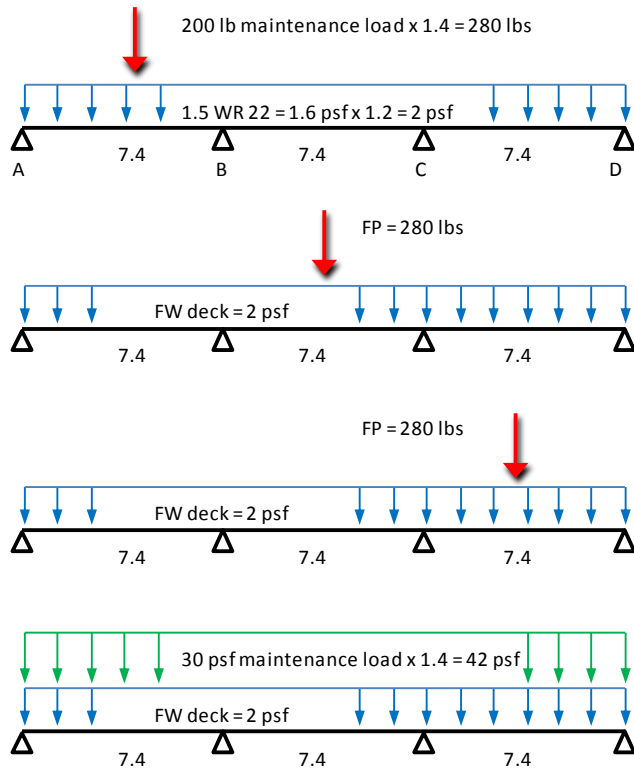


Design for Strength and Serviceability

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



$$L_{\max} = 7.4 \text{ ft} < 7.0 \text{ ft}$$

$\Delta = 0.53 \text{ in} = L/160$
 Check insulation and roofing materials.

Design for Strength and Serviceability

Table 4.1 1.5 WR ASD Uniform Downward Loads (psf)

Span Cond.	Gage Number	5'-00"	5'-06"	6'-00"	6'-06"	7'-00"	7'-06"	8'-00"	8'-06"	9'-00"	9'-06"	10'-00"
Single	22	90	75	63	53	46	40	35	31	28	25	23
	20	112	92	78	66	57	50	44	39	35	31	28
	18	152	126	105	90	78	68	59	53	47	42	38
	16	195	161	135	115	99	87	76	67	60	54	49
Double	22	95	79	66	56	49	42	37	33	29	26	24
	20	118	98	82	70	60	53	46	41	37	33	30
	18	156	129	108	92	80	69	61	54	48	43	39
	16	196	162	136	116	100	87	77	68	61	54	49
Triple	22	119	98	83	70	61	53	46	41	37	33	30
	20	148	122	103	88	76	66	58	51	46	41	37
	18	195	161	136	115	100	87	76	68	60	54	49
	16	245	203	170	145	125	109	96	85	76	68	61

$$6a) D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R) = 39 \text{ psf} < 61 \text{ psf}$$

Design for Strength and Serviceability

Table 4.2 1.5 WR ASD Uniform Upward Loads (psf)

Span Cond.	Gage Number	5'-00"	5'-06"	6'-00"	6'-06"	7'-00"	7'-06"	8'-00"	8'-06"	9'-00"	9'-06"	10'-00"
Single	22	95	79	66	56	49	42	37	33	29	26	24
	20	118	98	82	70	60	53	46	41	37	33	30
	18	156	129	108	92	80	69	61	54	48	43	39
	16	196	162	136	116	100	87	77	68	61	54	49
Double	22	90	75	63	53	46	40	35	31	28	25	23
	20	112	92	78	66	57	50	44	39	35	31	28
	18	152	126	105	90	78	68	59	53	47	42	38
	16	195	161	135	115	99	87	76	67	60	54	49
Triple	22	113	93	78	67	58	50	44	39	35	31	28
	20	140	116	97	83	71	62	55	48	43	39	35
	18	190	157	132	112	97	84	74	66	59	53	47
	16	243	201	169	144	124	108	95	84	75	67	61

$$U_{\text{net}} = 40 \text{ psf} < 58 \text{ psf}$$

Design for Strength and Serviceability


Table 4.5 1.5 WR Uniform Service Load that Causes L/120 Deflection (psf)

Span Cond.	Gage Number	5'-00"	5'-06"	6'-00"	6'-06"	7'-00"	7'-06"	8'-00"	8'-06"	9'-00"	9'-06"	10'-00"
Single	22	155	116	90	70	56	46	38	31	27	23	19
	20	201	151	116	91	73	59	49	41	34	29	25
	18	288	216	167	131	105	85	70	59	49	42	36
	16	371	278	214	169	135	110	90	75	64	54	46
Double	22	373	280	216	170	136	110	91	76	64	54	47
	20	483	363	280	220	176	143	118	98	83	70	60
	18	693	521	401	316	253	205	169	141	119	101	87
	16	892	670	516	406	325	264	218	182	153	130	112
Triple	22	292	219	169	133	106	86	71	59	50	43	36
	20	378	284	219	172	136	112	92	77	65	55	47
	18	543	408	314	247	198	161	132	110	93	79	68
	16	698	525	404	318	254	207	170	142	120	102	87

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

$$L_R = 20 \text{ psf} < 53 \text{ psf} \quad L/240$$

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

<p>Deck Profile</p> <p>Deck Gage</p> <p>Deck Fy1, Fu1</p> <p>MWFRS</p> <p>(-) Uplift, ASCE 7-10 (16)</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: center;">1.5 x 6</td></tr> <tr><td style="text-align: center;">22</td></tr> <tr><td style="text-align: center;">33, 45</td></tr> <tr><td style="text-align: center;">35</td></tr> </table>	1.5 x 6	22	33, 45	35	<p>WR</p> <p>ksi</p> <p>psf</p>	<p>Support Fastener</p> <p>Support Fastener Pattern</p> <p>Sidelap Fastener</p> <p>Substrate thickness, t2</p> <p>Substrate Fy2, Fu2</p> <p>Number of Spans</p> <p>AISI S-310</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: center;">5/8" arc spot</td></tr> <tr><td style="text-align: center;">36/7</td></tr> <tr><td style="text-align: center;">#12 screw</td></tr> <tr><td style="text-align: center;">1/8"</td></tr> <tr><td style="text-align: center;">33, 45</td></tr> <tr><td style="text-align: center;">3</td></tr> <tr><td style="text-align: center;">2016</td></tr> </table>	5/8" arc spot	36/7	#12 screw	1/8"	33, 45	3	2016	<p>ksi</p>
1.5 x 6																
22																
33, 45																
35																
5/8" arc spot																
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1/8"																
33, 45																
3																
2016																

Design for Strength and Serviceability

Uplift = $35 \times 0.6 = 21$ psf

Pnft, kips	1.649	1.639	1.628	1.618	1.606	1.595	1.583	1.571	1.559
Sidelaps per Span	<i>ASD Interactive Allowable Shear Strength, S_n/Ω_d, plf</i>								
	Span, ft								
	7	7.5	8	8.5	9	9.5	10	10.5	11
2	268	247	230	215	202				
3	297	275	256	239	225	212	200	190	180
4	327	303	281	263	248	234	221	209	199
5	356	330	307	288	271	255	242	229	218
6	386	358	333	312	294	277	262	249	236
7	416	385	359	336	317	299	283	268	255
8	444	413	385	361	340	321	304	288	274

$$S_a = 327 \text{ plf} < 300 \text{ plf}$$



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?



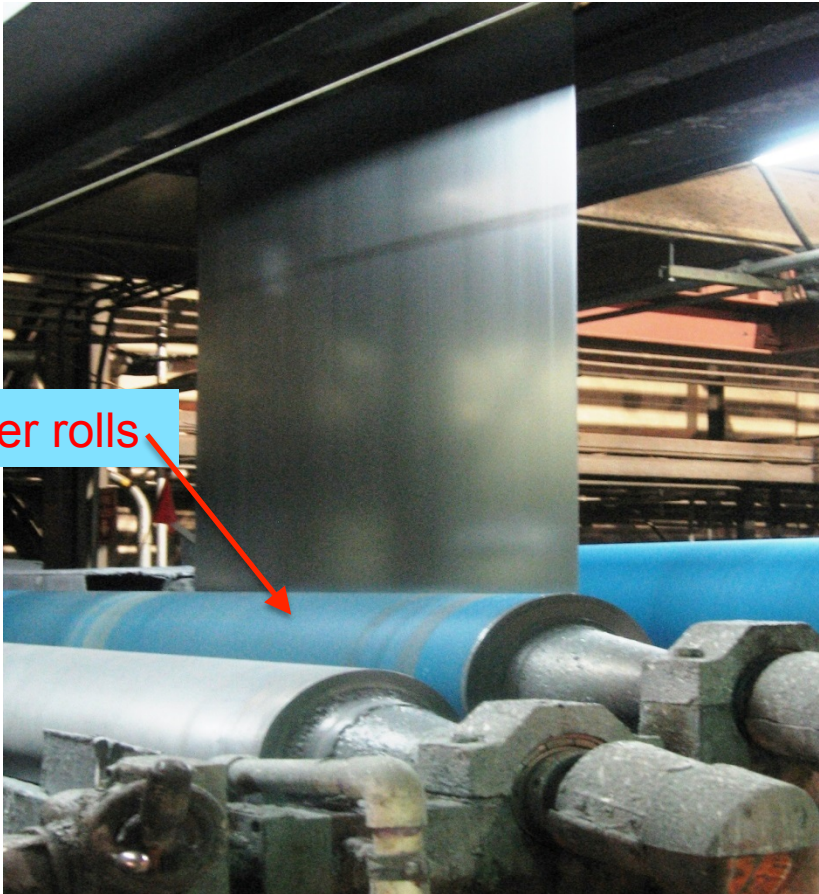
- The Answer
 - The SER is still liable via approvals
 - Design is deferred to GC, not deck supplier
 - Performance specs must be supplied

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

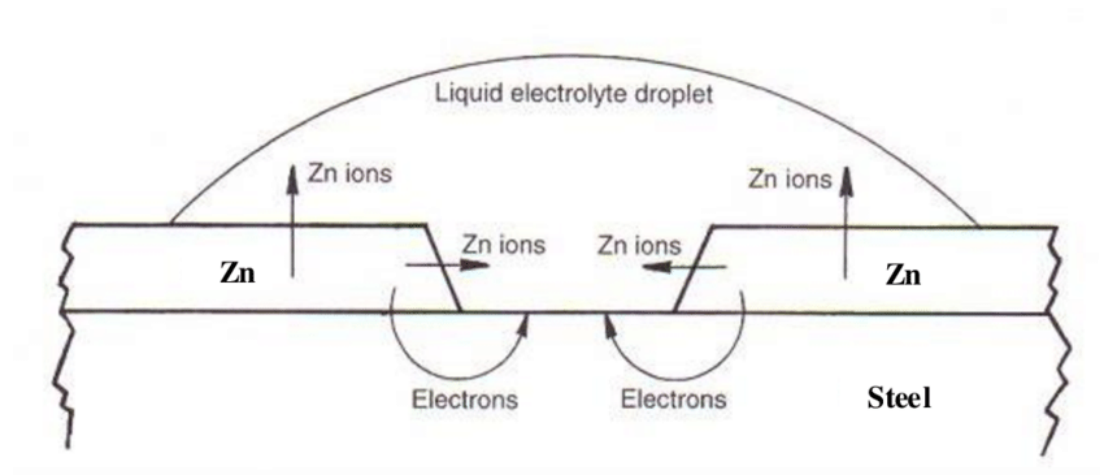


Finish or Coating

Will G+P add protection?

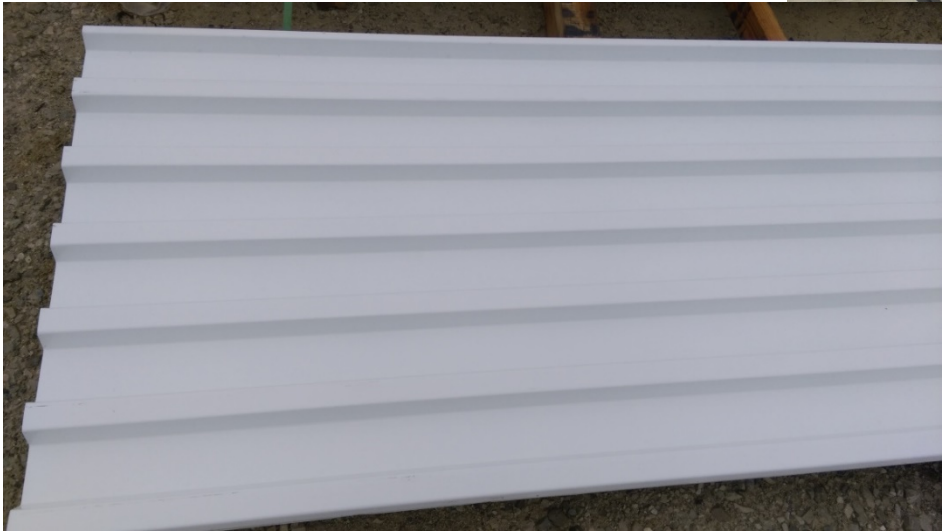
Galvanized Finish

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



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



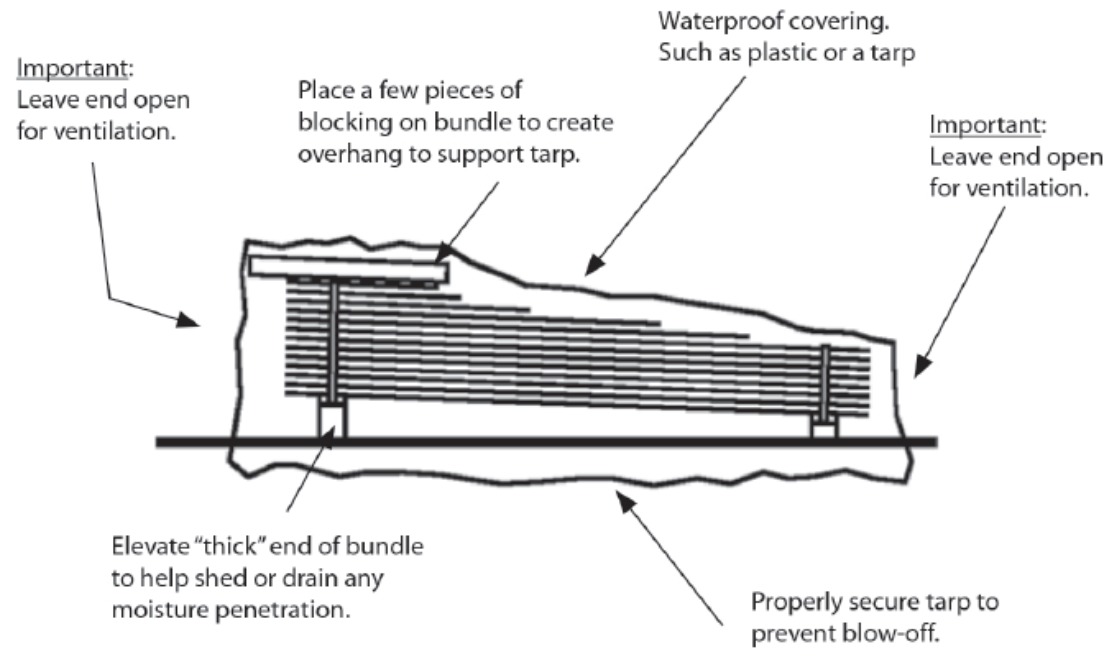
One way to breach a barrier,
Bangalore

UGLY Finish or Coating

**MANUAL OF
CONSTRUCTION
WITH STEEL DECK**
THIRD EDITION

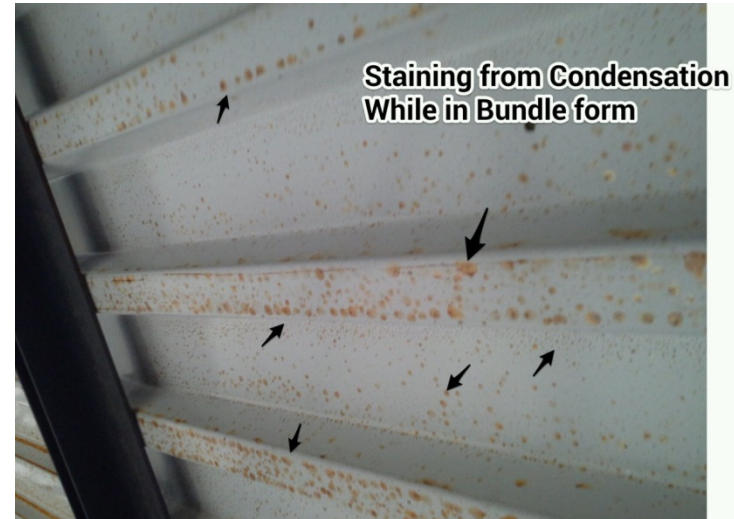
MOC3-2016

**FIGURE 3
RECOMMENDATION FOR PROTECTING DECK BUNDLES AT JOB SITE**



UGLY Finish or Coating

Shop Prime Coat



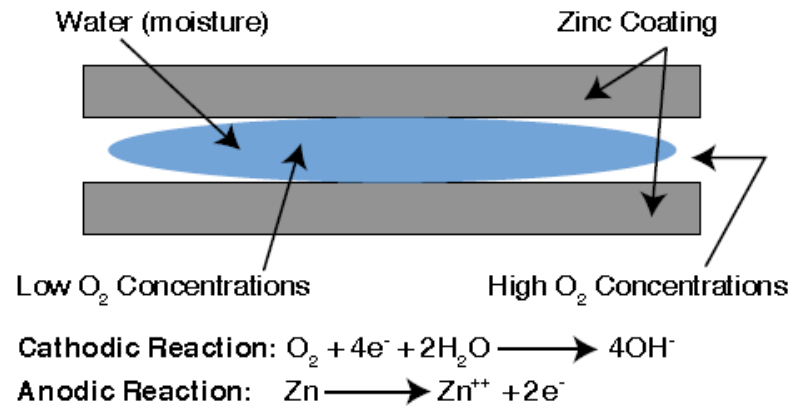
UGLY Finish or Coating

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



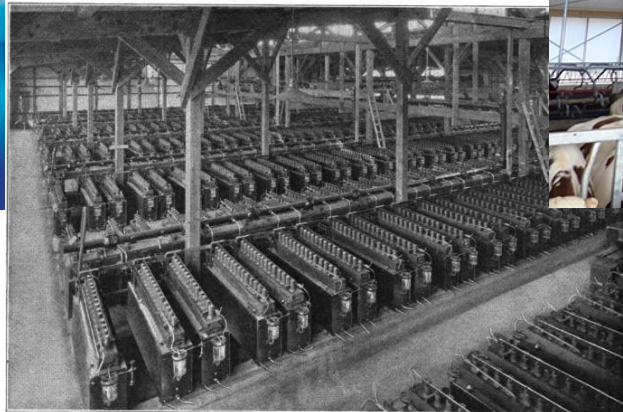
Source: American Galvanizers Association

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.**



Finish or Coating: SDI Code of Standard Practice

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.



Excluded: SDI Code of Standard Practice

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.



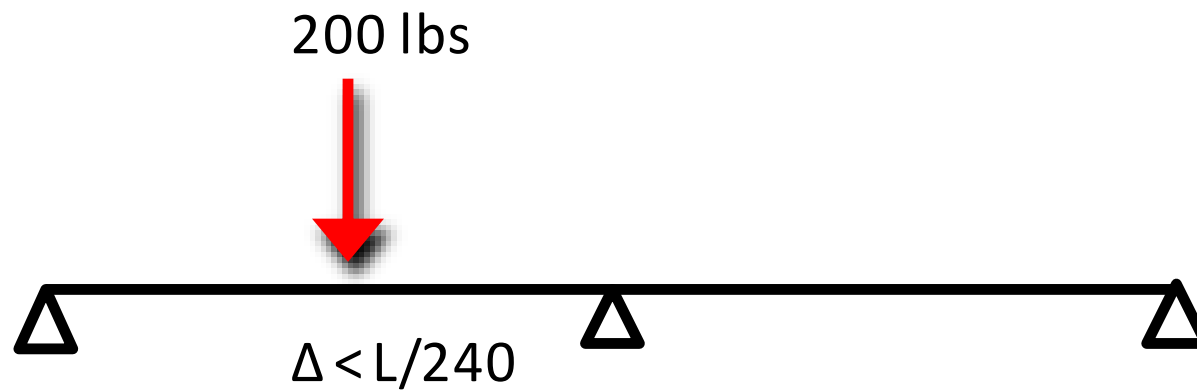
Wind Rated Assemblies

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

Class Number 4451

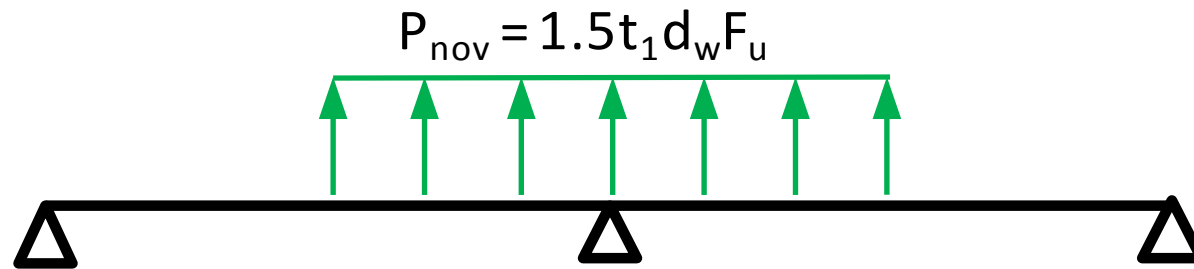


Wind Rated Assemblies



FM 4451/4.1 *and* SDI RD-2017/2.4.1

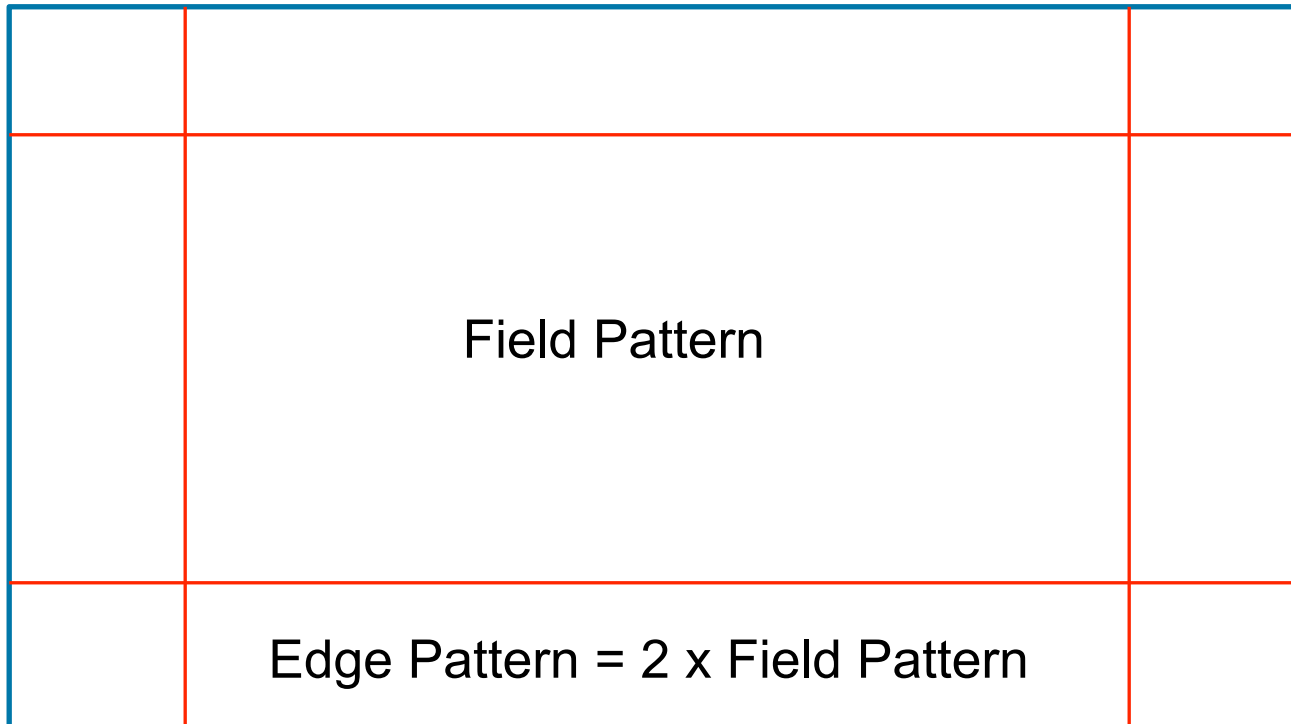
Wind Rated Assemblies



FM 4451/4.3.1.2 *and* AISI S100/J4.4.2-1

Wind Rated Assemblies

Corner Pattern =
2.5 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 FARID ALFAWAKHIRI, P.E., 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 **Farid Alfawakhiri** (falfawakhiri@steel.org) is the senior engineer, Construction Codes and Standards, for the American Iron and Steel Institute.

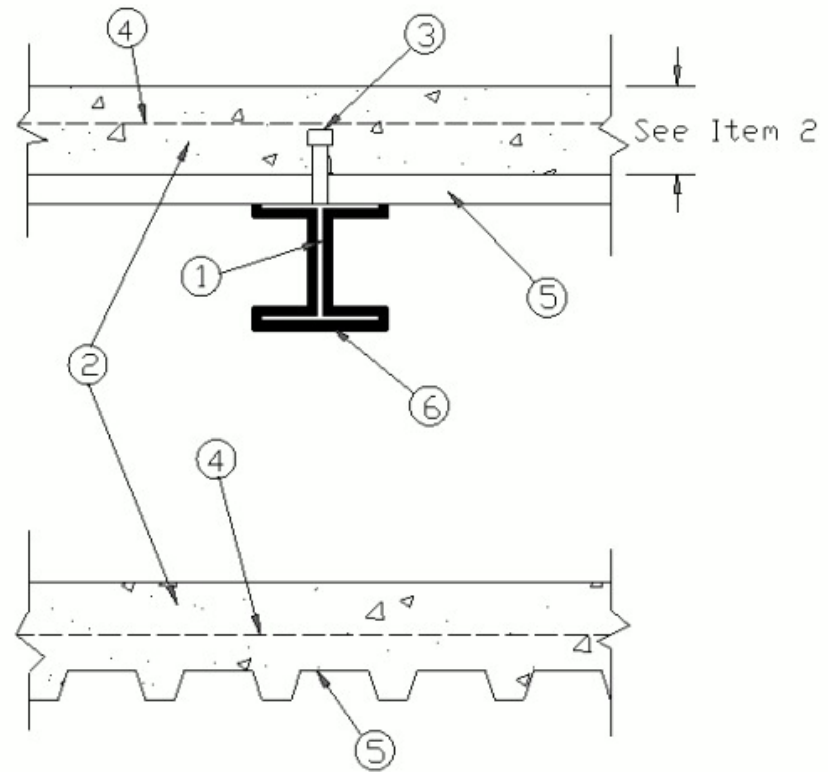
Fire Rated Assemblies

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.





Fire Rated Assemblies

4. **Welded Wire Fabric — 6 by 6 — W1.4 x W1.4.**

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.**

Fire Rated Assemblies

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.



Fire Rated Assemblies, NW or LW

“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 Rated Assemblies, Composite or Form

“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 **al-**lowed, 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

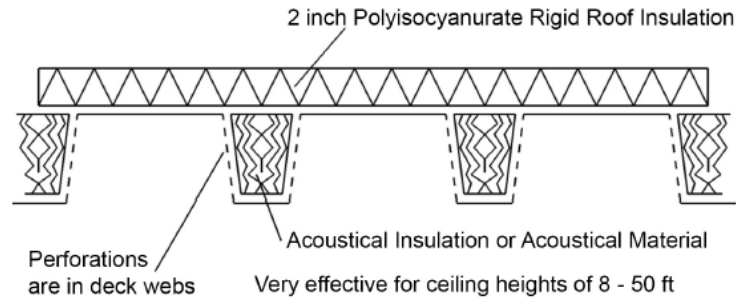
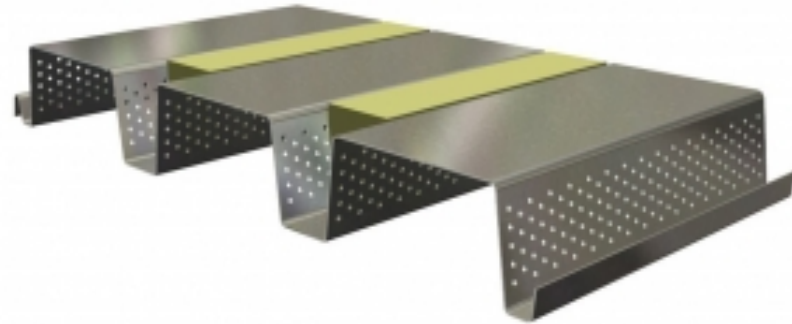
UGLY Fire Rated Assemblies

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.

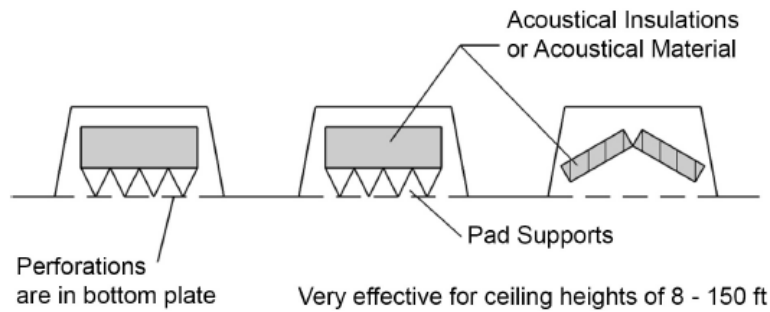
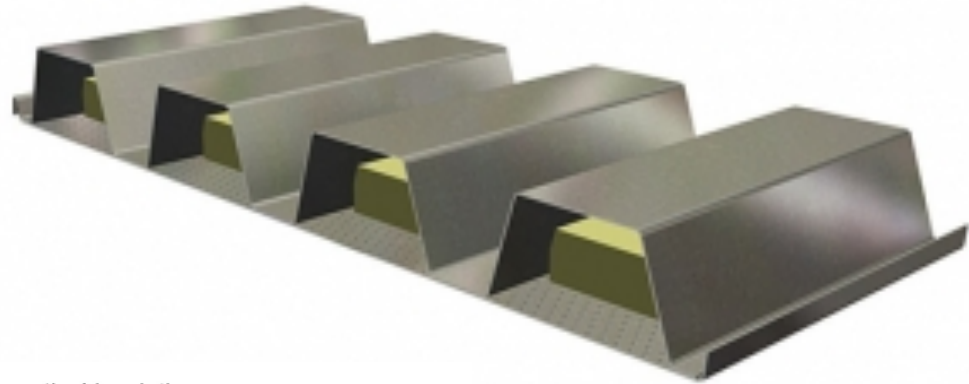


Acoustical Deck



		Sound Absorption Coefficients (Frequency)						NRC
		125	250	500	1000	2000	4000	
1.5 inch	Acoustic Deck	0.11	0.18	0.66	1.02	0.61	0.33	0.60
3 inch	Acoustic Deck	0.18	0.39	0.88	0.93	0.58	0.39	0.70

Cellular Deck



Panel	Sound Absorption Coefficients (Frequency)						NRC
	125	250	500	1000	2000	4000	
3 inch Deep Cell	0.47	0.57	0.95	0.98	0.82	0.69	0.85

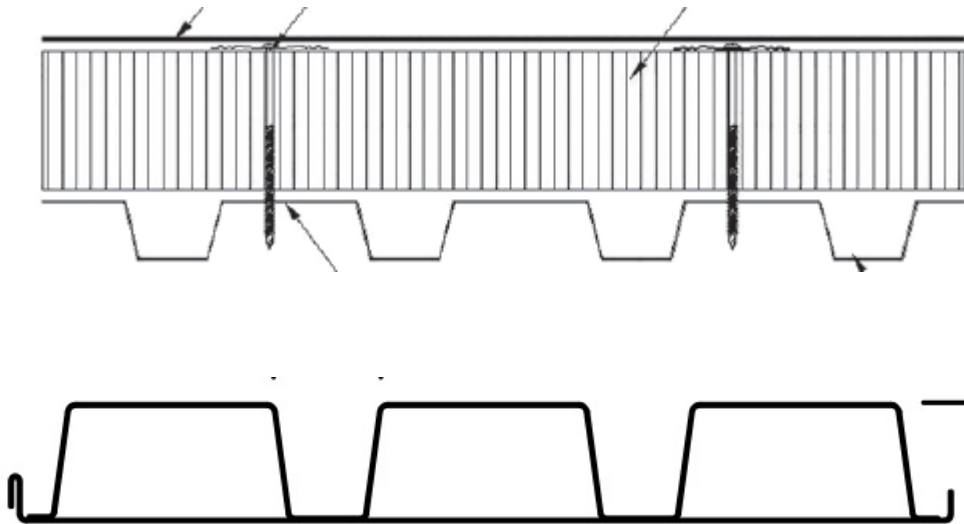
UGLY Acoustical Deck

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

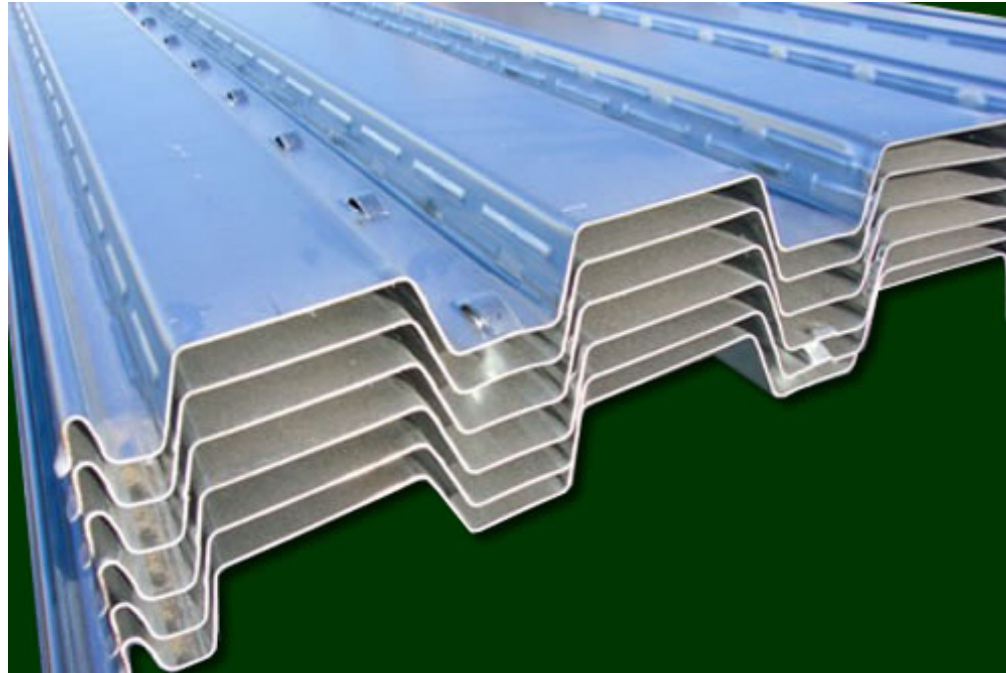
1. Specify cellular deck
2. Control screw length

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'..
 - ESCSI – Lightweight Concrete Drying Study, 1/31/2011. Available from <http://www.escsi.org>

How **NOT** to Specify Steel Deck

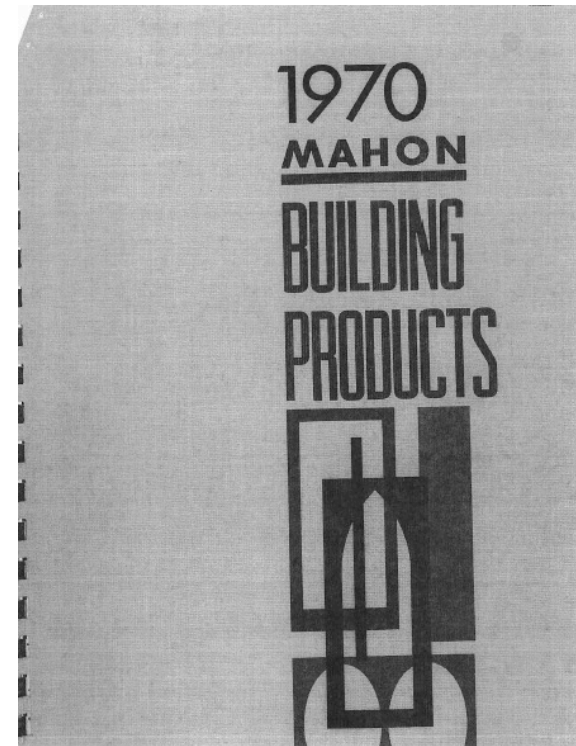


UGLY Specification of Steel Deck

“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:

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

Deck type	Design thickness in.	W psf	Section Properties			
			I_p in ⁴ /ft	S_p in ³ /ft	I_n in ⁴ /ft	S_n in ³ /ft
B24	0.0239	1.46	0.107	0.120	0.135	0.131
B22	0.0295	1.78	0.155	0.186	0.183	0.192

Problems:

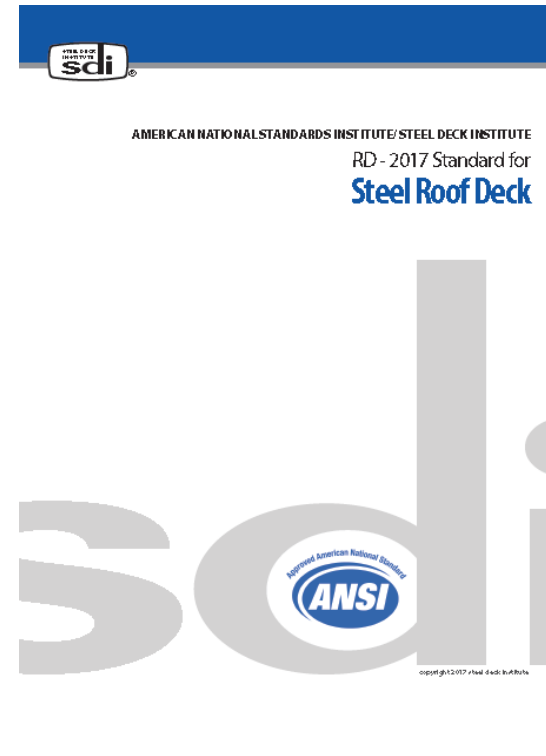
- Section modulus is meaningless without a specified steel yield strength
- Looks like you pulled this from a specific manufacturer's catalogue ... but is this what you REALLY need?

UGLY Specification of Steel Deck

“Comply with SDI Design Manual #21”

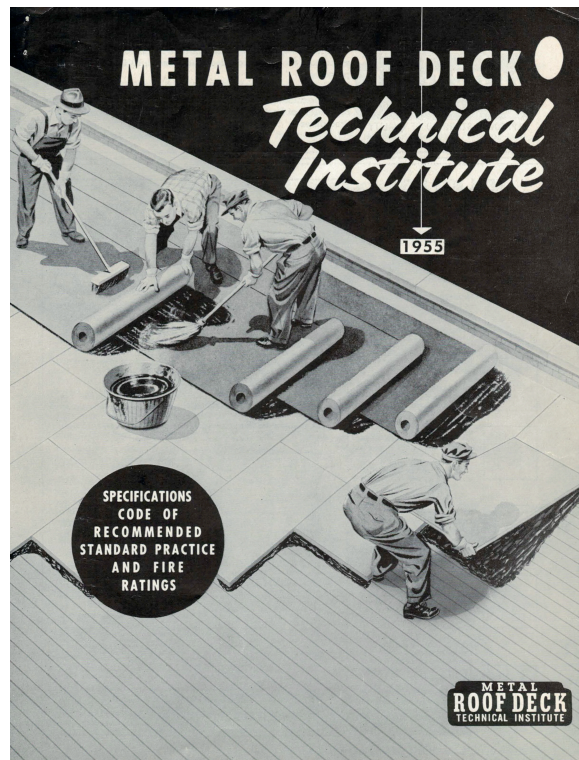


“Comply with ANSI/SDI RD-2017 Standard”

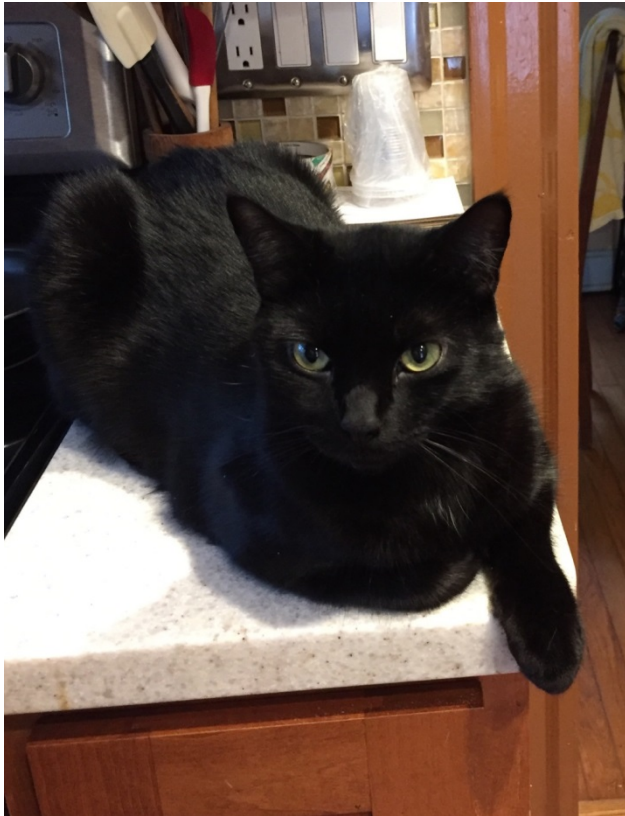


UGLY Specification of Steel Deck

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



Steel Deck Institute Spokes-Cat



Mickey says:

**Build
With
Steel
Deck**

Questions?



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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



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