

ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN

ARCH 331

DR. ANNE NICHOLS

SUMMER 2012

lecture
sixteen

steel construction:
trusses, decks & plate girders



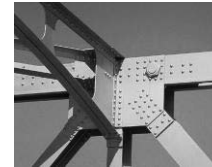
Steel Trusses 1
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Iron & Steel Trusses

- cast iron
 - 18th century
 - chain links
- wrought-iron
- rivets



Steel Trusses 2
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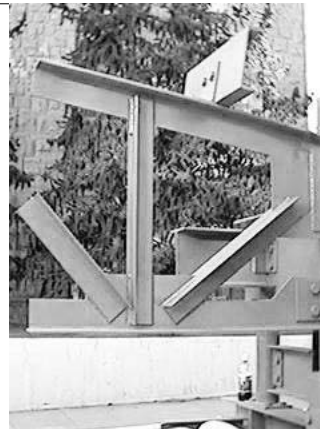
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Truss Connections

- gusset plates
- bolts
- welds



<http://courses.civil.ualberta.ca>

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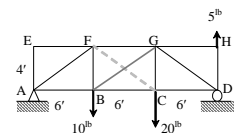
(AISC - Steel Structures of the Everyday)
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Trusses

- require lateral bracing
- consider buckling
- indeterminate trusses
 - extra members
 - diagonal tension counters
 - solvable with statics
 - cables can't hold compression
 - displacement methods
 - elastic elongation
 - too few members, unstable

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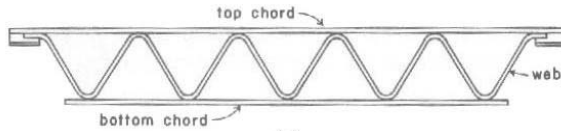
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Manufactured Trusses

- open web joists
- parallel chord



SECTION THRU JOISTS SHOWING FLANGIE TYPES



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Load Tables - w

LRFD

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based On A 50 ksi Maximum Yield Strength - Loads Shown in Pounds Per Linear Foot (plf)

Joist Designation	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (in.)	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
	825	825	825	825	825	825	825	825	825	825	825	825	825	825	825
	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
	537	651	814	825	766	825	825	825	825	825	825	825	825	825	825
	234	344	428	434	475	507	507	507							
	469	570	714	825	672	825	825	825	825	825	825	825	825	825	825
	192	282	351	396	390	467	467	467	550	550	550	550	550	550	550
	415	504	630	825	592	742	825	825	768	825	825	825	825	825	825
	189	334	391	366	324	404	443	443	489	526	526	526	526	526	526
	369	448	561	760	528	661	795	825	684	762	825	825	825	825	825
	134	197	245	317	272	339	397	408	409	455	490	490	490	490	490
	331	402	502	681	472	592	712	825	612	682	820	825	825	825	825
	113	197	207	230	267	336	383	347	396	452	455	455	455	455	455
	298	361	453	613	426	534	642	787	552	615	739	825	825	825	825
	97	142	177	230	197	246	287	347	297	330	386	426	426	426	426
	327	409	555	385	483	582	712	499	556	670	754	822	825	825	825
	123	298	373	505	351	439	529	648	454	505	609	687	747	825	825
	106	132	172	147	184	215	259	222	247	289	323	351	385	385	385
	271	340	462	321	402	483	592	415	462	556	627	682	760	825	825
	93	116	150	128	160	188	226	194	216	252	282	307	339	383	383

load for live load deflection limit (L/360) in RED
total in BLACK

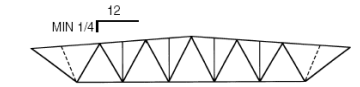
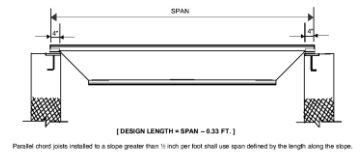
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Open Web Joists

- SJI: www.steeljoist.com
- Vulcraft: www.vulcraft.com
 - K Series (Standard)
 - 8-30" deep, spans 8-50 ft
 - LH Series (Long span)
 - 18-48" deep, spans 25-96 ft
 - DLH (Deep Long Spans)
 - 52-72" deep, spans 89-144 ft
 - SLH (Long spans with high strength steel)
 - pitched top chord
 - 80-120" deep, spans 111-240 ft



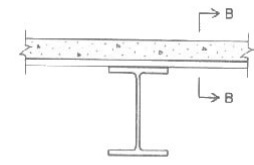
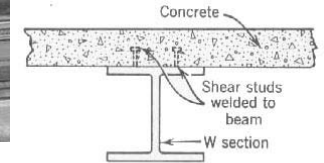
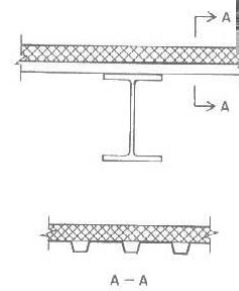
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Decks

- sheet steel
- composite



(c) Composite beam.

(b)

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Light-gage Steel

- sheet metal
 - shaped
 - studs, panels, window frames
 - gage
 - based on weight of 41.82 lb/ft² / inch of thickness
 - 24, 22, 18, 16, i.e.
 - 0.0239, 0.0329, 0.0474, 0.0598 in
 - 0.6, 0.85, 1.0, 1.3, 1.6 mm



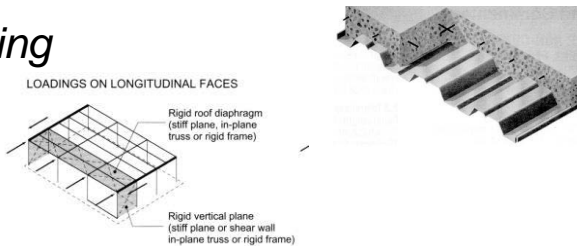
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Steel Decks

- common fire proofing
 - cementitious spray
 - composite concrete
- non-composite
 - concrete is fill
- lateral bracing
- diaphragm action



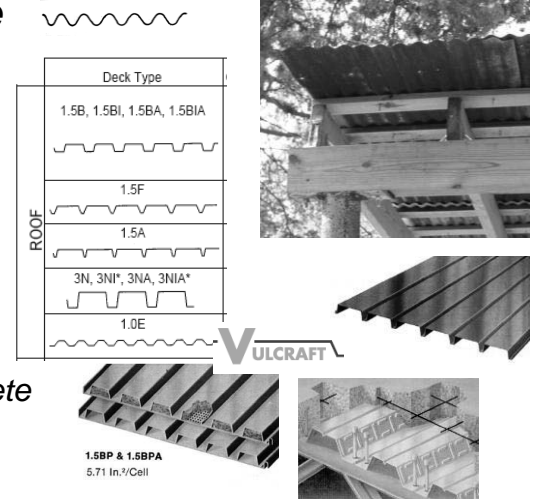
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Steel Decks

- “Texas” style
 - corrugated
- common
 - 1 – 3 spans
 - can be insulated
 - composite
 - with concrete



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Load Tables - w

- live load deflection limit L/240

1.5 B, BI, BA, BIA
Maximum Sheet Length 42'-0" — ICBO Approved (No.3415)
Factory Mutual Approved
Deck type & gauge — Max. deck span
1.5B22, 1.5B22..... 6'-0"
1.5B20, 1.5B20..... 6'-6"
1.5B18, 1.5B18..... 7'-3"
FM Approvals No. OC8A7.AM & OG1A4.AM**

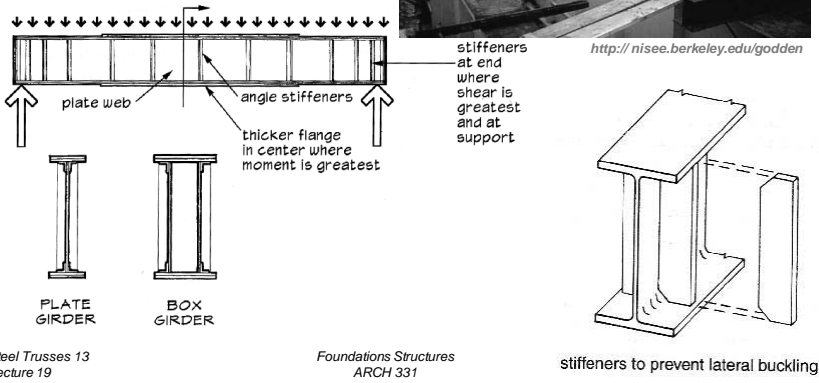
VERTICAL LOADS FOR TYPE 1.5B

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (Dead + Live) Uniform Load (PSF)													
			Span (ft.-in.)													
			5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0			
1	B 24	4'-8	66	52	42	36	30	27	24	21	20					
	B 22	5'-7	91	71	57	47	40	34	30	27	24	22	20			
	B 21	6'-0	104	81	64	53	44	38	33	29	26	24	22			
	B 20	6'-5	115	89	71	58	48	41	36	31	28	25	23			
	B 19	7'-1	139	107	85	69	57	48	41	36	32	29	26			
	B 18	7'-8	162	124	98	79	65	55	47	41	36	32	29			
2	B 24	5'-10	126	104	87	74	64	55	47	41	36	32	29			
	B 22	6'-11	102	85	71	61	52	46	40	35	32	28	26			
	B 21	7'-4	118	97	82	70	60	52	46	41	36	33	29			
	B 20	7'-9	132	109	91	78	67	59	51	46	41	36	33			
	B 19	8'-5	154	127	107	91	79	69	60	53	48	43	39			
	B 18	9'-1	174	144	121	103	89	78	68	60	54	48	44			
3	B 24	5'-10	130	100	79	65	54	45	39	34	31	27	25			
	B 22	6'-11	128	106	89	76	65	57	50	44	39	34	31			
	B 21	7'-4	147	122	102	87	75	65	56	49	42	38	34			
	B 20	7'-9	165	136	114	97	84	72	61	53	46	41	36			
	B 19	8'-5	193	159	134	114	98	84	71	61	53	47	41			
	B 18	9'-1	218	180	151	129	111	96	81	69	60	52	46			
B 16	10'-3	274	226	190	162	140	119	100	85	73	64	56				

Notes: 1. Load tables are calculated using sectional properties based on the steel design thickness shown in the Steel Deck Institute (SDI) Design Manual.
2. Loads shown in the shaded areas are governed by the live load deflection not in excess of 1/240 of the span. A dead load of 10 PSF has been included.
3. ** Acoustical Deck is not covered under Factory Mutual

Plate Girders

- welds
- web stiffeners



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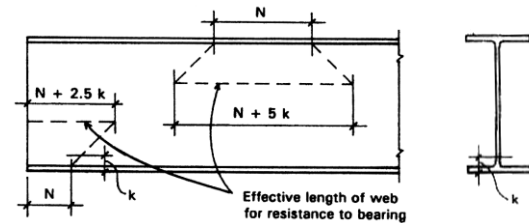
stiffeners to prevent lateral buckling

Web Bearing

- max loads

$$P_{n(\text{max-end})} = (N + 2.5k) F_y t_w$$

$$P_{n(\text{max-interior})} = (N + 5k) F_{yw} t_w$$



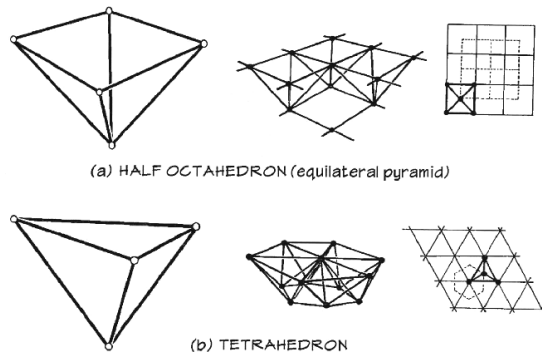
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Space Trusses

- 3D with 2 force bodies and pins
 - pyramid
 - tetrahedron
- “frames” have fixed joints
- layers
- 40's



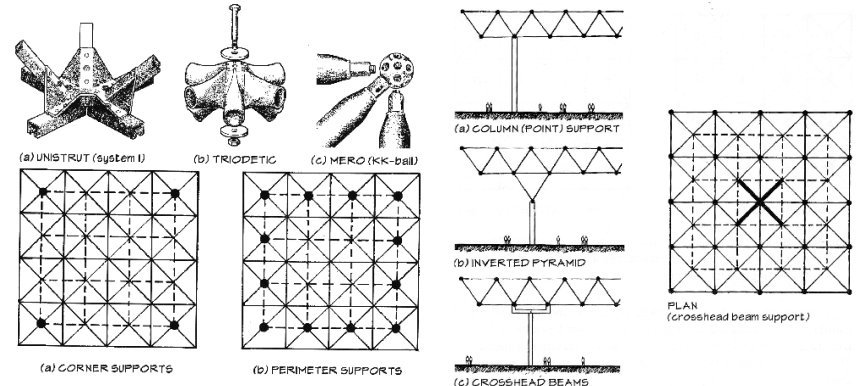
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Space Trusses

- connections
- supports



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Space Trusses



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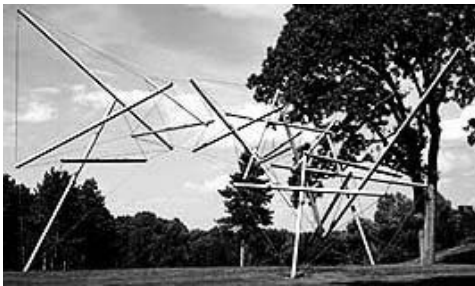


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Tensegrities

- 3D frame
- discontinuous struts
- continuous cables



Free Ride Home – Kenneth Snelson

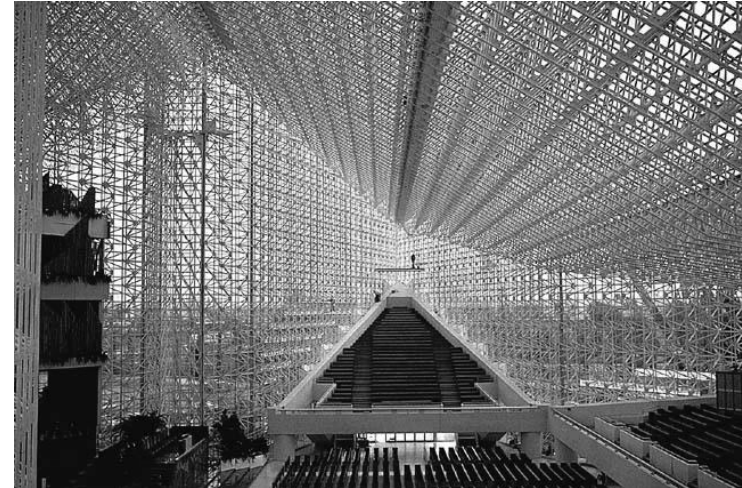


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Space Trusses



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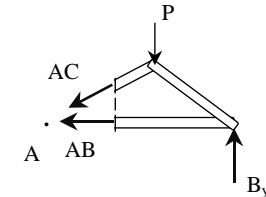
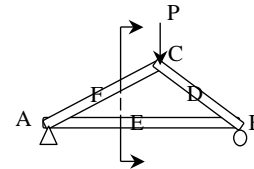
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Method of Sections

- relies on internal forces being in equilibrium on a section
- cut to expose 3 or less members
- coplanar forces $\rightarrow \sum M = 0$ too



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Method of Sections

- joints on or off the section are good to sum moments
- quick for few members
- not always obvious where to cut or sum

