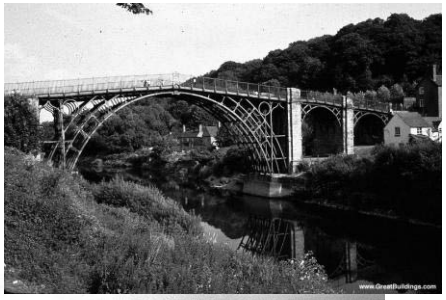
ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN
ARCH 331
DR. ANNE NICHOLS
FALL 2013

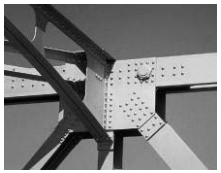
lecture
nineteen

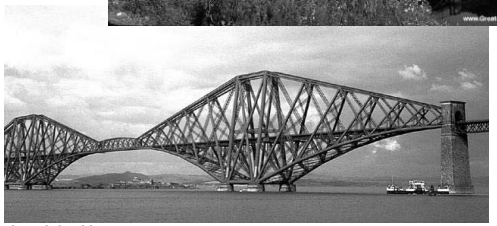
steel construction:
trusses, decks & plate girders

Iron & Steel Trusses

- cast iron
  - 18^{th} century
  - chain links
- wrought-iron
- rivets





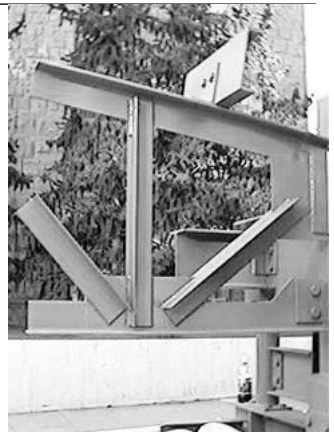


http:// nisee.berkeley.edu/godden

Truss Connections

- gusset plates
- bolts
- welds

(AISC - Steel Structures of the Everyday)



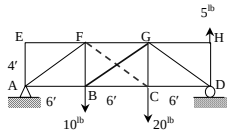
http://courses.civil.ualberta.ca

Trusses

http:// nisee.berkeley.edu/godden

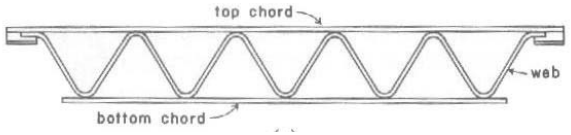
- require lateral bracing
- consider buckling
- indeterminate trusses
  - extra members
    - diagonal tension counters
  - solvable with statics
    - cables can't hold compression
  - displacement methods
    - elastic elongation
  - too few members, unstable

One Maritime Plaza, SOM 1964



Manufactured Trusses

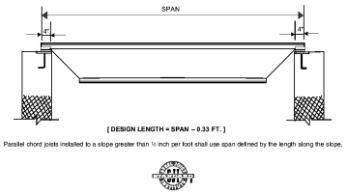
- *open web joists*
- *parallel chord*

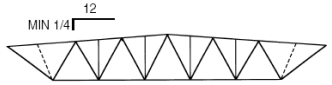


(c) SECTION THRU JOISTS SHOWING FLANGE TYPES

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*





Load Tables - w

LRFD

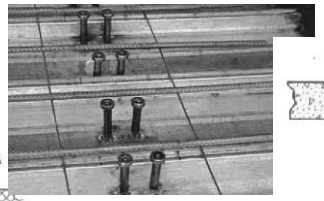
STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based On A 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

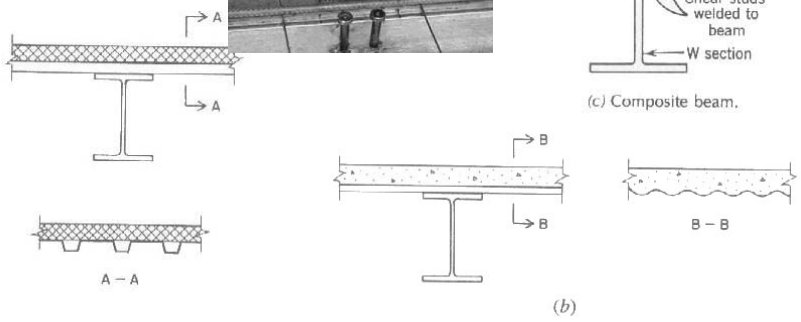
Joist Designation	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (in.)	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.) ↓															
10	825 550														
11	825 542														
12	825 455	825 550	825 550	825 550											
13	718 363	825 510	825 510	825 510											
14	618 289	750 425	825 463	825 463	825 550	825 550	550	550							
15	537 234	651 344	814 428	825 434	766 475	825 507	825 507	825 507							
16	469 192	570 282	714 351	825 396	672 390	825 467	825 467	825 467	825 550	825 550	825 550	825 550	825 550	825 550	825 550
17	415 159	504 234	630 291	825 366	592 324	742 404	825 443	825 443	768 488	825 526	825 526	825 526	825 526	825 526	825 526
18	369 134	448 197	561 245	760 317	528 272	661 339	795 397	825 408	684 409	762 456	825 490	825 490	825 490	825 490	825 490
19	331 113	402 167	502 207	681 269	472 230	592 287	712 336	825 383	612 347	682 386	820 452	825 455	825 455	825 455	825 455
20	298 97	361 142	453 177	613 230	426 197	534 246	642 287	787 347	552 297	615 330	739 386	825 426	825 426	825 426	825 426
21		327 123	409 153	555 198	385 170	483 212	582 248	712 299	499 255	556 285	670 333	754 373	822 405	825 406	825 406
22		298 106	373 132	505 172	351 147	439 184	529 215	648 259	454 222	505 247	609 289	687 323	747 351	825 385	825 385
23		271 93	340 116	462 150	321 128	402 160	483 188	592 226	415 194	462 216	556 252	627 282	682 307	760 339	825 363

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

Decks

- *sheet steel*
- *composite*



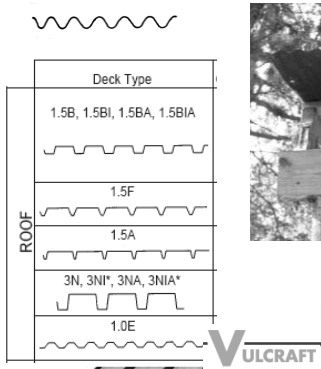


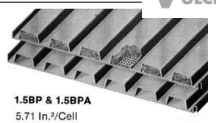
Light-gage Steel

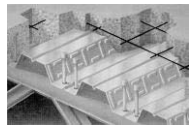
- *sheet metal*
  - *shaped*
  - *studs, panels, window frames*
  - *gage*
    - *based on weight of 41.82 lb/ft² / inch of thickness*
    - *24, 22, 18, 16, i.e.*
    - *0.0239, 0.0329, 0.0474, 0.0598 in*
    - *0.6, 0.85, 1.0, 1.3, 1.6 mm*

Steel Decks

- *"Texas" style*
  - *corrugated*
- *common*
  - *1 – 3 spans*
  - *can be insulated*
  - *composite*
    - *with concrete*

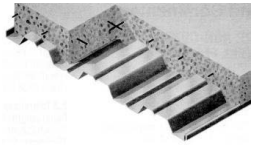


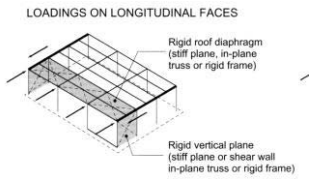




Steel Decks

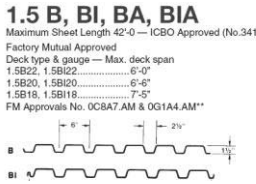
- *common fire proofing*
  - *cementitious spray*
  - *composite concrete*
- *non-composite*
  - *concrete is fill*
- *lateral bracing*
- *diaphragm action*

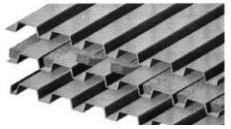




Load Tables - w

- *live load deflection limit L/240*





ROOF

VERTICAL LOADS FOR TYPE 1.5B

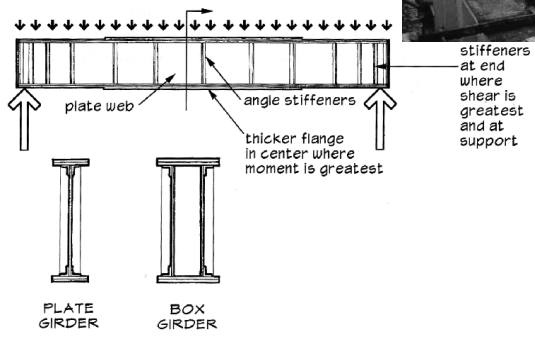
No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (Dead + Live) Uniform Load (PSF) Span (ft.-in.) C. to C. of Support 5'-0	5'-6	6'-0	6'-6	7'-0	7'-6	8'-0	8'-6	9'-0	9'-6	10'-0
1	B 24	4'-8	66	52	42	36	30	27	24	21	20		
	B 22	5'-7	91	71	57	47	40	34	30	27	24	22	20
	B 21	6'-0	104	81	64	53	44	38	33	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
	B 16	8'-8	206	157	123	99	81	68	58	50	44	39	34
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
	B 16	10'-3	219	181	152	130	112	97	86	76	68	61	55
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

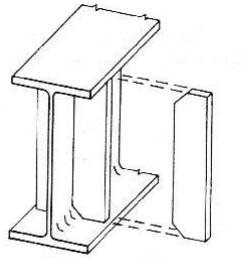
Notes: 1. Load tables are calculated using sectional properties based on the steel design thickness shown in the Steel Deck Institute (SDI) Design Manual.
2. Loads shown in the shaded areas are governed by the live load deflection not in excess of 1/240 of the span. A dead load of 10 PSF has been included.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

Plate Girders

- *welds*
- *web stiffeners*

http:// nisee.berkeley.edu/godden





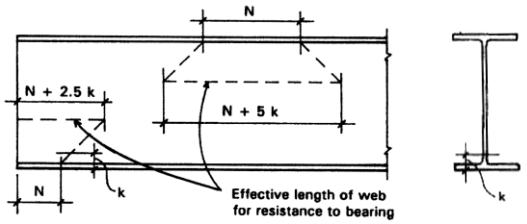
stiffeners to prevent lateral buckling

Web Bearing

- *max loads*

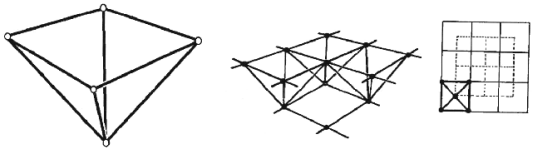
$$P_{n(max-end)} = (N + 2.5k)F_y t_w$$

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

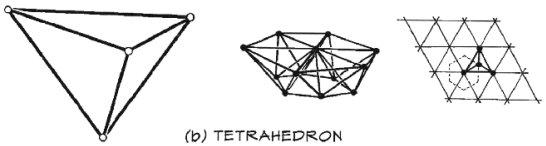


Space Trusses

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



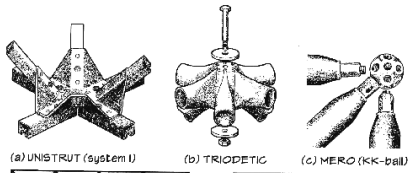
(a) HALF OCTAHEDRON (equilateral pyramid)

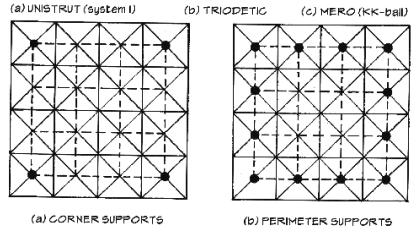


(b) TETRAHEDRON

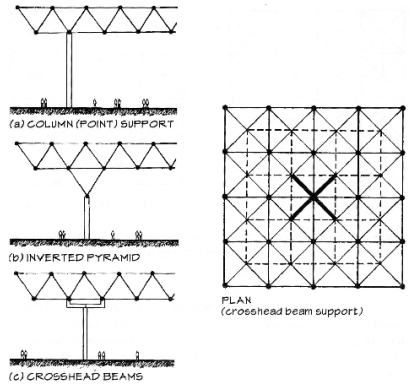
Space Trusses

- *connections*





- *supports*



Space Trusses

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Space Trusses

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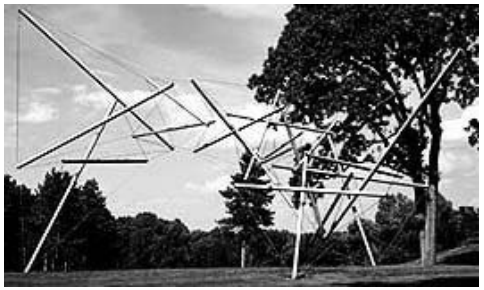
Tensegrities

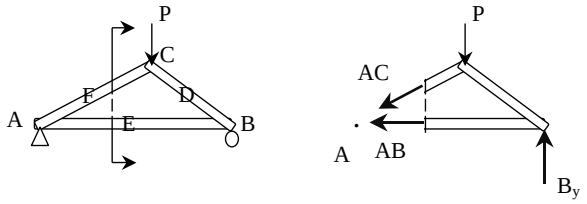
- *3D frame*
- *discontinuous struts*
- *continuous cables*



Free Ride Home – Kenneth Snelson

Method of Sections

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



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*