

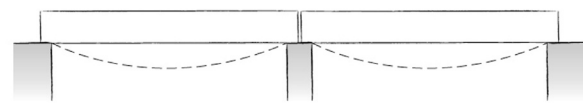
# Gerber Beams



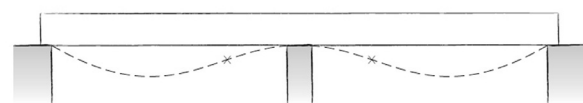
- Continuity in Beams
- Gerber Beams

## Continuous Beams

- Continuous over one or more supports
  - Most common in monolithic concrete
  - Steel: continuous or with moment connections
  - Wood: as continuous beams, e.g. long Glulam spans
- Statically indeterminate
  - Cannot be solved by the three equations of statics alone
  - Internal forces (shear & moment) as well as reactions are affected by movement or settlement of the supports



two spans - simply supported



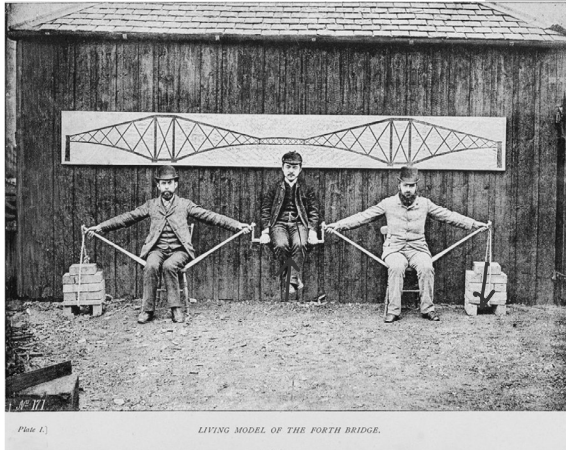
two spans - continuous



# Examples of the Gerber system

Firth of Forth Bridge, 1890

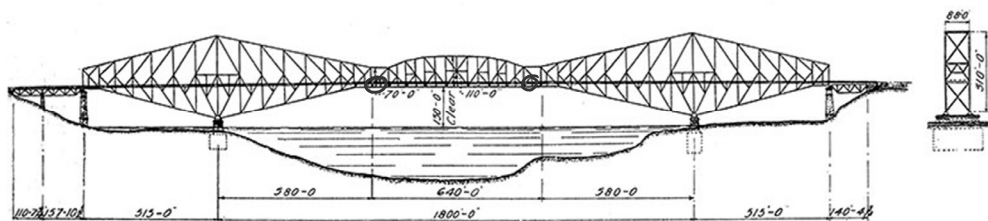
- total length 8094 ft.
- central span 1700 ft.
- Design Fowler & Baker
- Construction 1882 - 1889



Static modeling of the Firth of Forth Bridge by Fowler & Baker



# Quebec Bridge Final Completion 1917



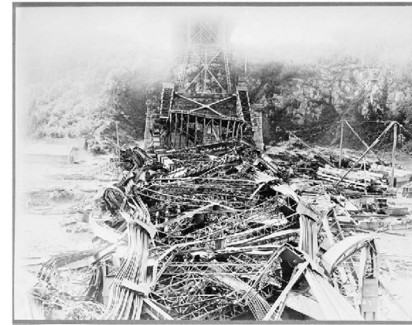
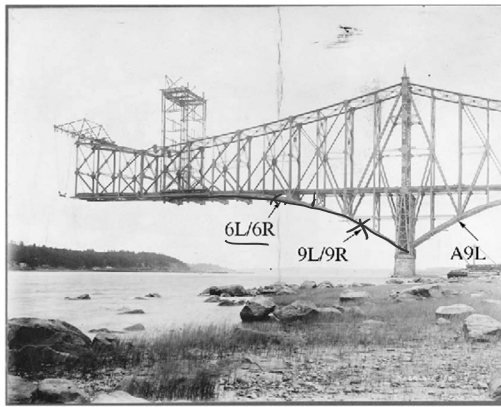
ST. LAWRENCE BRIDGE COMPANY DESIGN AS FINALLY APPROVED AND BUILT



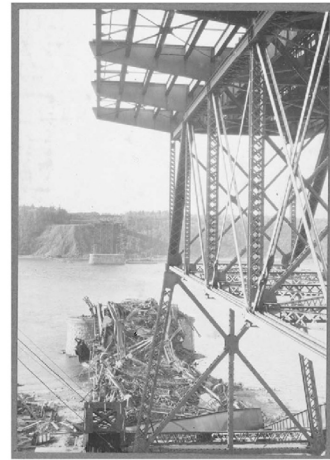
Final successful completion 1917

# Quebec Bridge failure – 1907 and 1916

Compression members that failed in 1907

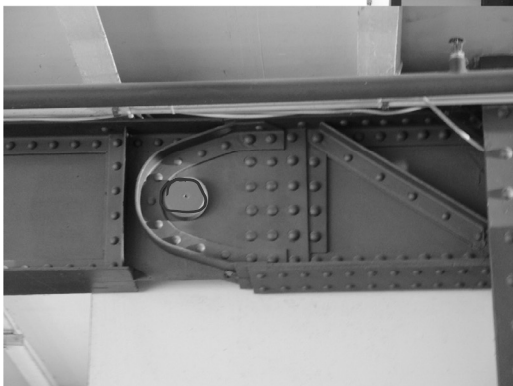


1916 hoisting failure



1907 failure due to miscalculation of the steel strength and dead load.

# Gerber system in building frames

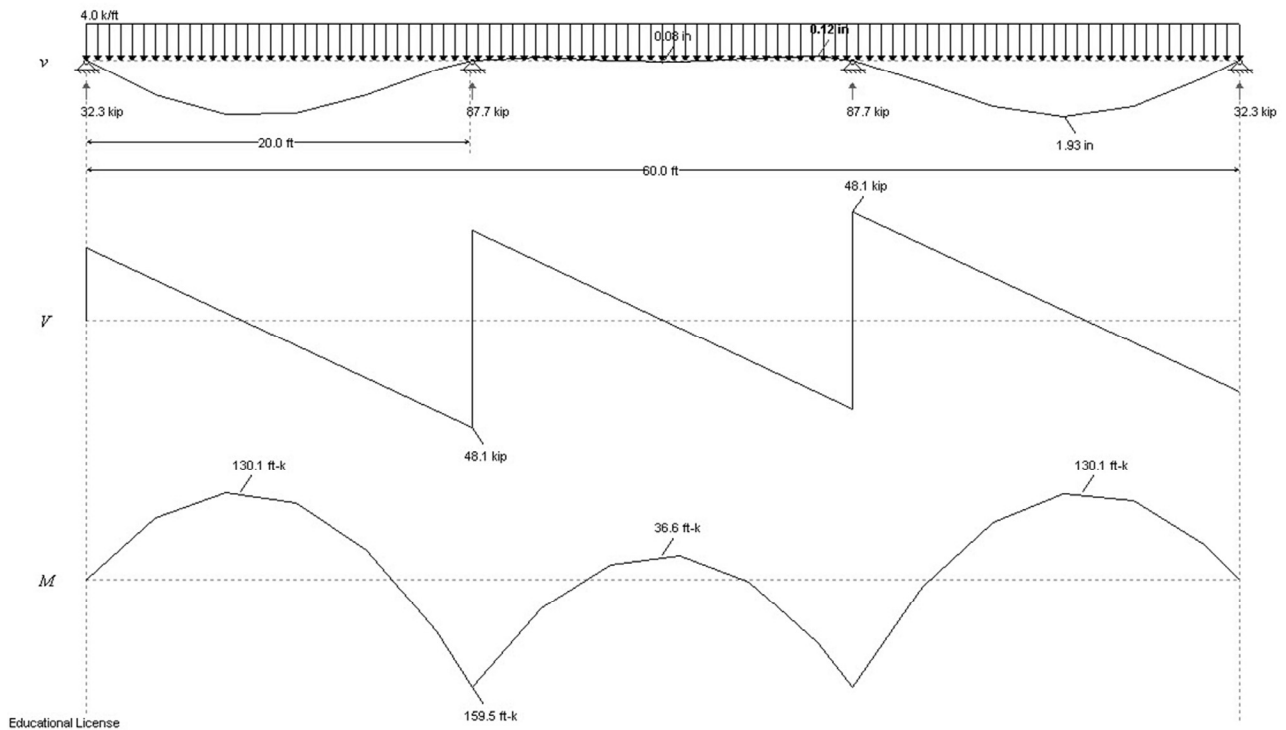


Speicherstadt Hamburg Kaffeerösterei  
1888

# Gerber Beams in Detroit

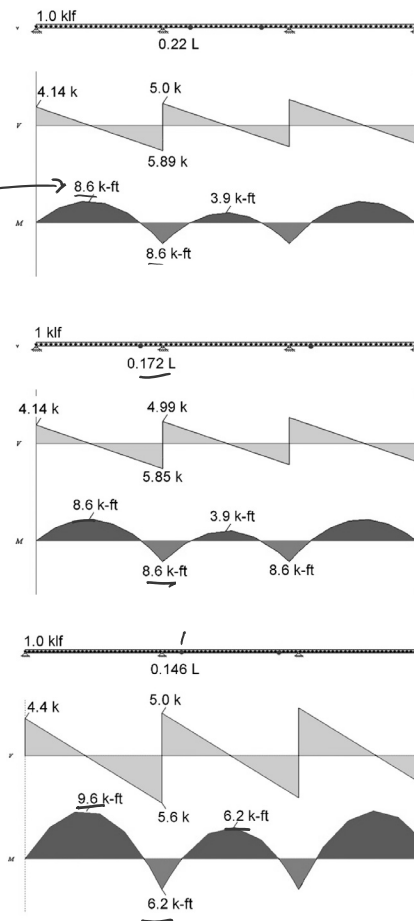
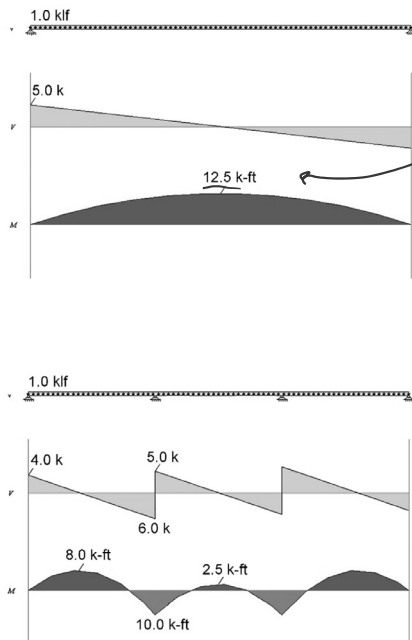


## Moment control in beams



# Moment control in beams

Spans = 10 ft



## Example Problem

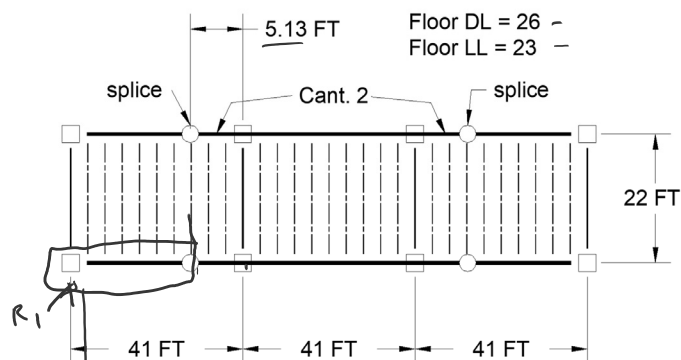
Given:

Span and loading

- D + L = 49 psf
- 49 psf x 11 ft = 539 plf

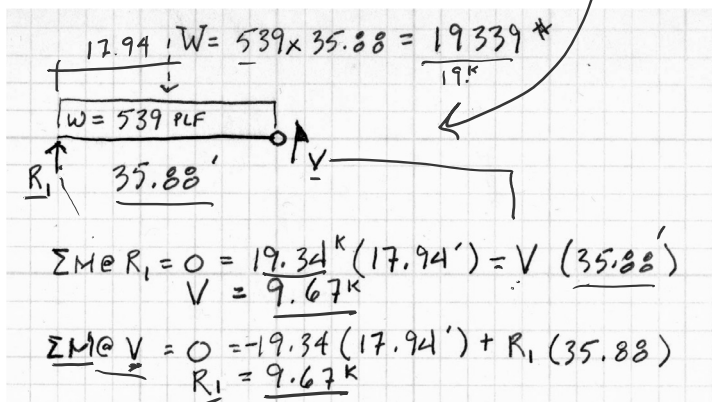
Find:

shear and moment  
beam section



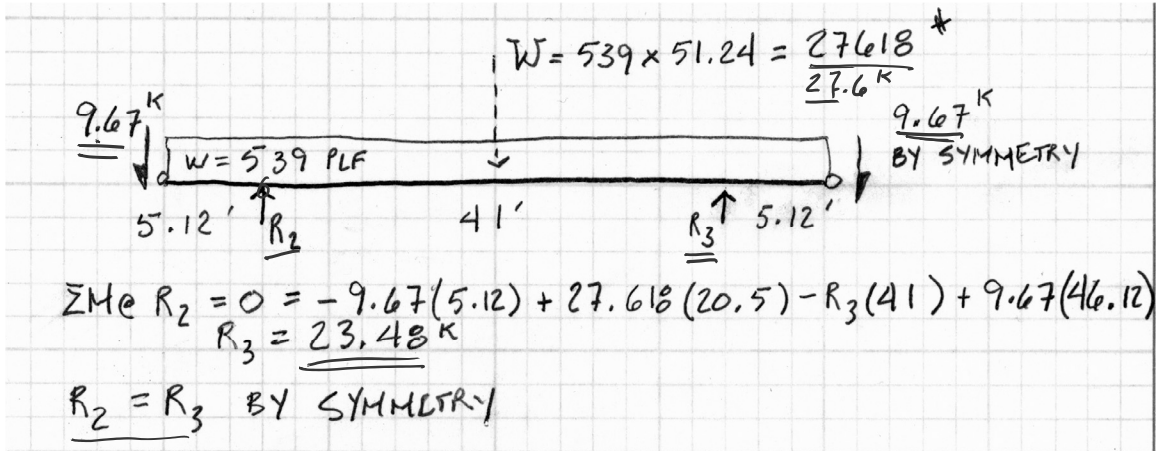
FBD 1

Reactions



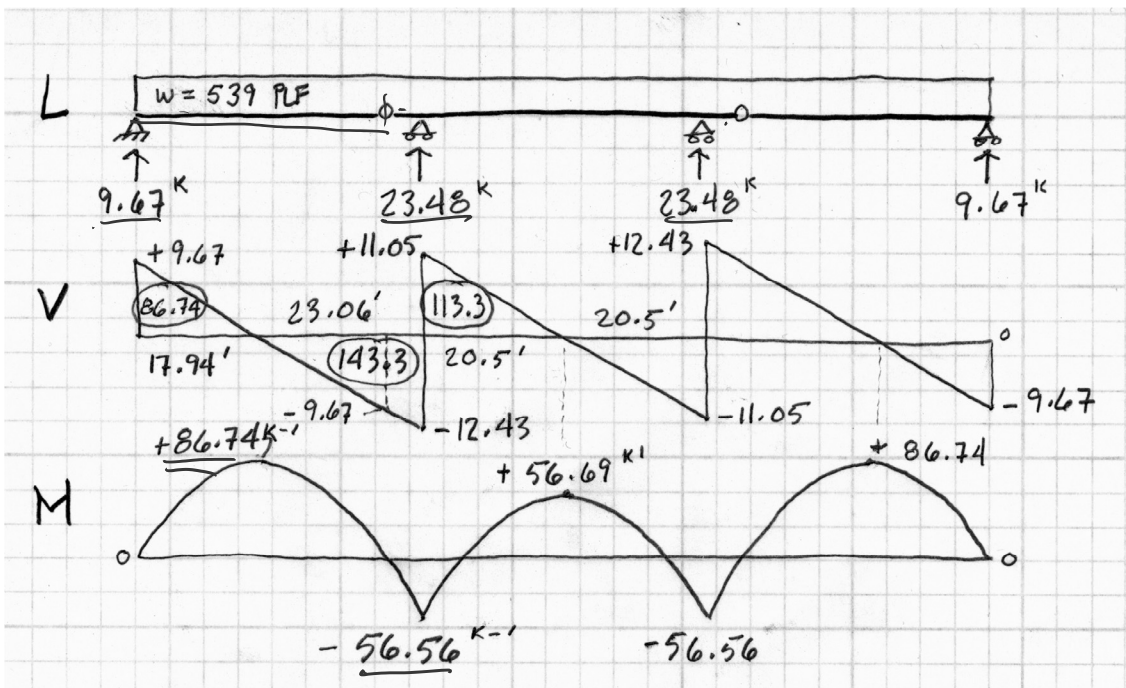
# Example Problem cont.

FBD 2  
Reactions



# Example Problem cont.

Force Diagrams





# Example Problem cont.

REQ'D

STEEL BEAM DESIGN

$M_u = 86.74 \text{ K-FT}$      $V_u = 12.43 \text{ K}$

$M_u = \phi M_n$

$M_n = \frac{M_u}{\phi} = \frac{86.74}{0.9} = 96.38 \text{ K-FT}$

$M_n = F_y Z_x$

$Z_x = \frac{M_n}{F_y} = \frac{96.38(12)}{50 \text{ ksi}} = 23.13 \text{ in}^3$

LOOK UP SECTION IN  $Z_x$  TABLE

CHOOSE W12x19 ✓

$Z_x = 24.7 > 23.13$  ✓

$\phi M_n = 92.6 > 86.74$  ✓

CHECK SHEAR

$\rightarrow \frac{h}{t_w} = 46.2 < 59$  ✓

$A_w = t_w d = 0.235(12.5) = 2.87 \text{ in}^2$

$\rightarrow \phi V_n = (1.0) 0.6 F_y A_w = 0.6(50)(2.87)$

$\phi V_n = 86.01 \text{ K} > 12.43 = V_u$  ✓

STRENGTH

Table 3-2 (continued)  
W-Shapes  
Selection by  $Z_x$

$F_y = 50 \text{ ksi}$

$Z_x$

$\phi M_n$

Shape	$Z_x$ in <sup>3</sup>	$M_p/\Omega_b$		$\phi_b M_n$		$M_r/\Omega_b$		$\phi_b M_x$		$BF/\Omega_b$		$\phi_b BF$		$L_p$ ft	$L_r$ ft	$I_x$ in <sup>4</sup>	$V_n/\Omega_v$		$\phi_v V_n$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD							
W14x26	40.2	100	151	61.7	92.7	5.33	8.11	3.81	11.0	245	70.9	106								
W8x40	39.8	99.3	149	62.0	93.2	1.64	2.46	7.21	29.9	146	59.4	89.1								
W10x33	38.8	96.8	146	61.1	91.9	2.39	3.62	6.85	21.8	171	56.4	84.7								
W12x26	37.2	92.8	140	58.3	87.7	3.61	5.46	5.33	14.9	204	56.1	84.2								
W10x30	36.6	91.3	137	56.6	85.1	3.08	4.61	4.84	16.1	170	63.0	94.5								
W8x35	34.7	86.6	130	54.5	81.9	1.62	2.43	7.17	27.0	127	50.3	75.5								
W14x22	33.2	82.8	125	50.6	76.1	4.78	7.27	3.67	10.4	199	63.0	94.5								
W10x26	31.3	78.1	117	48.7	73.2	2.91	4.34	4.80	14.9	144	53.6	80.3								
W8x31	30.4	75.8	114	48.0	72.2	1.58	2.37	7.18	24.8	110	45.6	68.4								
W12x22	29.3	73.1	110	44.4	66.7	4.68	7.06	3.00	9.13	156	64.0	95.9								
W8x28	27.2	67.9	102	42.4	63.8	1.67	2.50	5.72	21.0	98.0	45.9	68.9								
W10x22	26.0	64.9	97.5	40.5	60.9	2.68	4.02	4.70	13.8	118	49.0	73.4								
W12x19	24.7	61.6	92.6	37.2	55.9	4.27	6.43	2.90	8.61	130	57.3	86.0								
W8x24	23.1	57.6	86.5	36.5	54.9	1.60	2.40	5.69	18.9	82.7	38.9	58.3								
W10x19	21.6	53.9	81.0	32.8	49.4	3.18	4.76	3.09	9.73	96.3	51.0	76.5								
W8x21	20.4	50.9	76.5	31.8	47.8	1.85	2.77	4.45	14.8	75.3	41.4	62.1								
W12x16	20.1	50.1	75.4	29.9	44.9	3.80	5.73	2.73	8.05	103	52.8	79.2								
W10x17	18.7	46.7	70.1	28.3	42.5	2.98	4.47	2.98	9.16	81.9	48.5	72.7								
W12x14	17.4	43.4	65.3	26.0	39.1	3.43	5.17	2.66	7.73	88.6	42.8	64.3								
W8x18	17.0	42.4	63.8	26.5	39.9	1.74	2.61	4.34	13.5	61.9	37.4	56.2								
W10x15	16.0	39.9	60.0	24.1	36.2	2.75	4.14	2.86	8.61	68.9	46.0	68.9								
W8x15	13.6	33.9	51.0	20.6	31.0	1.90	2.85	3.09	10.1	48.0	39.7	59.6								
W10x12	12.6	31.2	46.9	19.0	28.6	2.36	3.53	2.87	8.05	53.8	37.5	56.3								
W8x13	11.4	28.4	42.8	17.3	26.0	1.76	2.67	2.98	9.27	39.6	36.8	55.1								
W8x10	8.87	21.9	34.9	13.6	20.5	1.54	2.30	3.14	8.52	30.8	26.8	40.2								

ASD    LRFD

<sup>1</sup> Shape exceeds compact limit for flexure with  $F_y = 50 \text{ ksi}$ ; tabulated values have been adjusted accordingly.

<sup>2</sup> Shape does not meet the  $h/t_w$  limit for shear in AISC Specification Section G2.1(a) with  $F_y = 50 \text{ ksi}$ ; therefore,  $\phi_v = 0.90$  and  $\Omega_v = 1.67$ .