Topics

Continuous beam

(a) Elastic method of Redistribution.

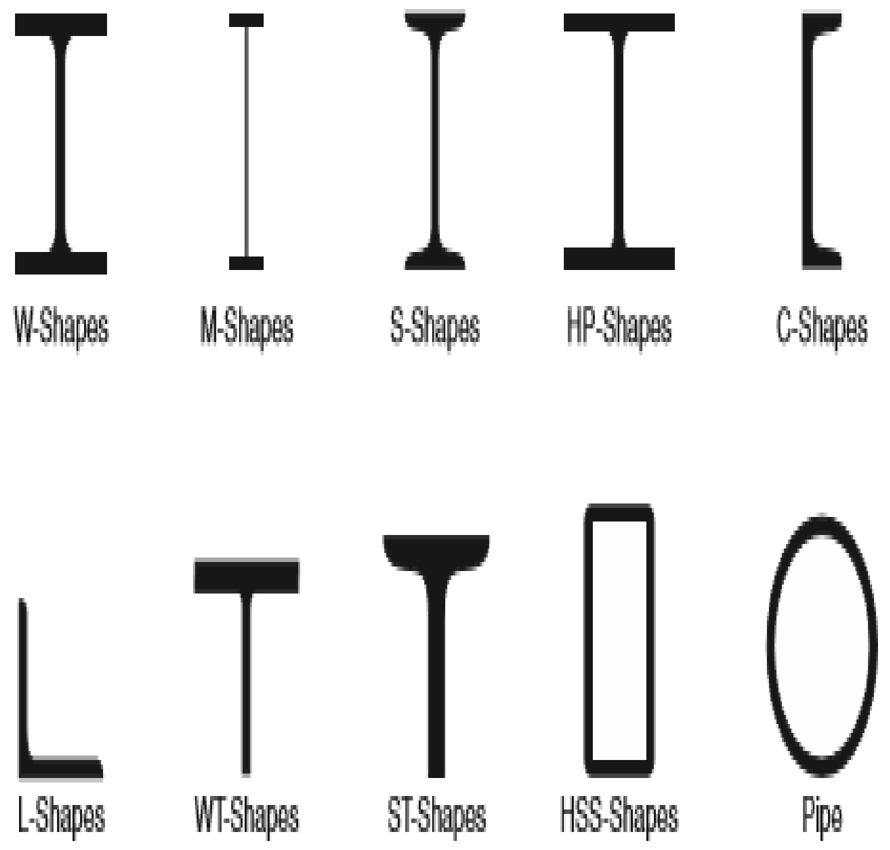
Or (0.90 RUle)

For Compact steel beam section

Shape	Steel Type		
	ASTM Designation	F_y, ksi	F_u, ksi
Wide flanged beams	A992	50–65	65
Miscellaneous beams	A36	36	58–80
Standard beams	A36	36	58–80
Bearing piles	A572 Gr. 50	50	65
Standard channels	A36	36	58–80
Miscellaneous channels	A36	36	58–80
Angles	A36	36	58–80
Ts cut from W-shapes	A992	50–65	65
Ts cut from M-shapes	A36	36	58–80
Ts cut from S-shapes	A36	36	58–80
Hollow structural sections, rectangular	A500 Gr. B	46	58
Hollow structural sections, square	A500 Gr. B	46	58
Hollow structural sections, round	A500 Gr. B	42	58
Pipe	A53 Gr. B	35	60

Note: F_y = specified minimum yield stress; F_u = specified minimum tensile strength

ASTM A
Fy & Fu

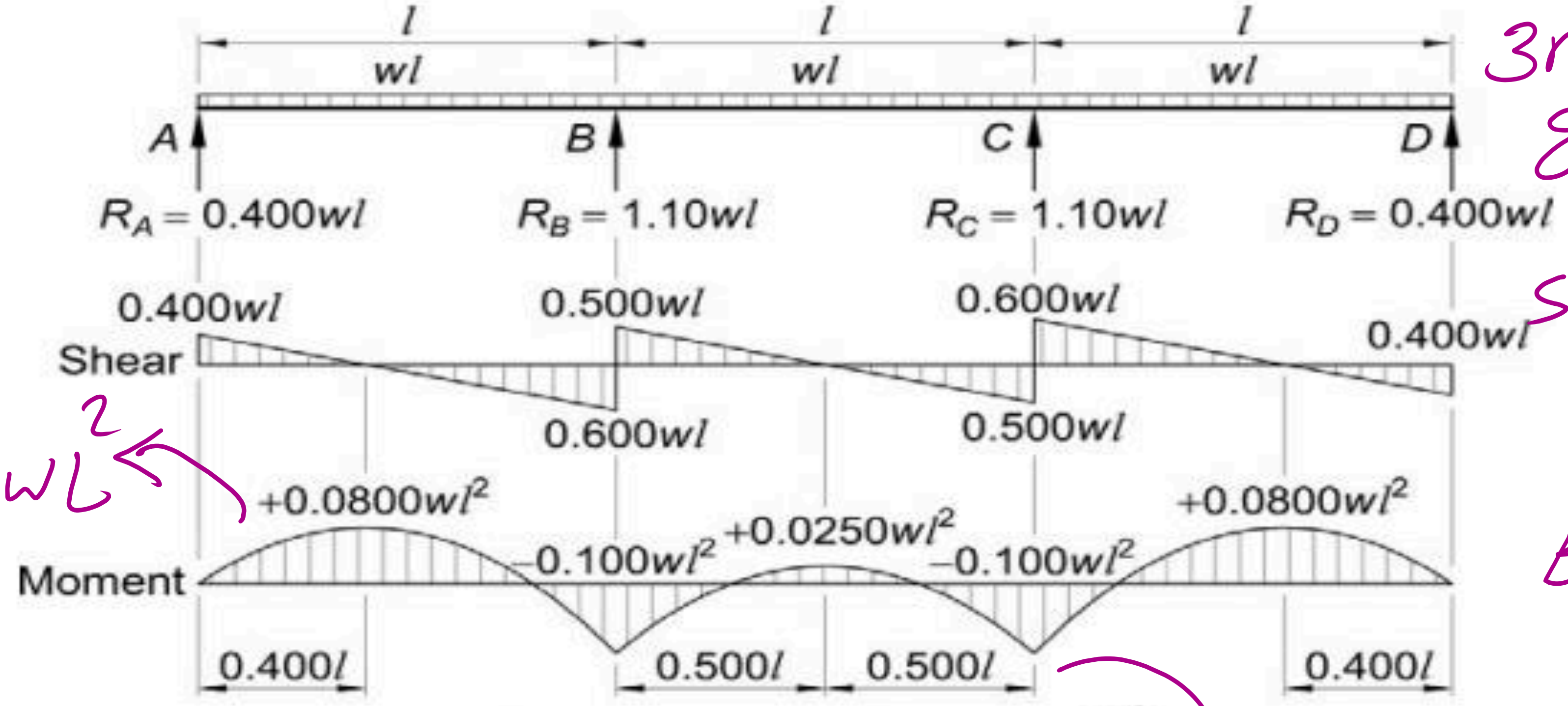


Continuous beam

39. CONTINUOUS BEAM — THREE EQUAL SPANS — ALL SPANS LOADED

Under wUL

with 3ree Equal spans



$M_{+ve} = 0.08WL^2$

BM

Δ_{max} (0.446l from A or D) $= 0.0069\dfrac{wl^4}{EI}$

$M_{-ve} = 0.10\ WL^2$

CM #15   Page 3-207

Table 3-22c

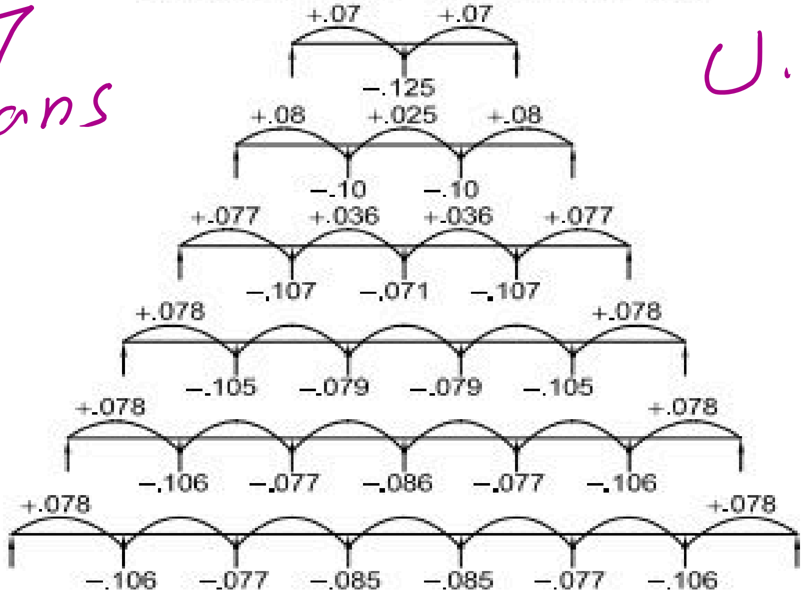
Continuous Beams

Moments and Shear Coefficients—Equal Spans, Equally Loaded

Uniform Load

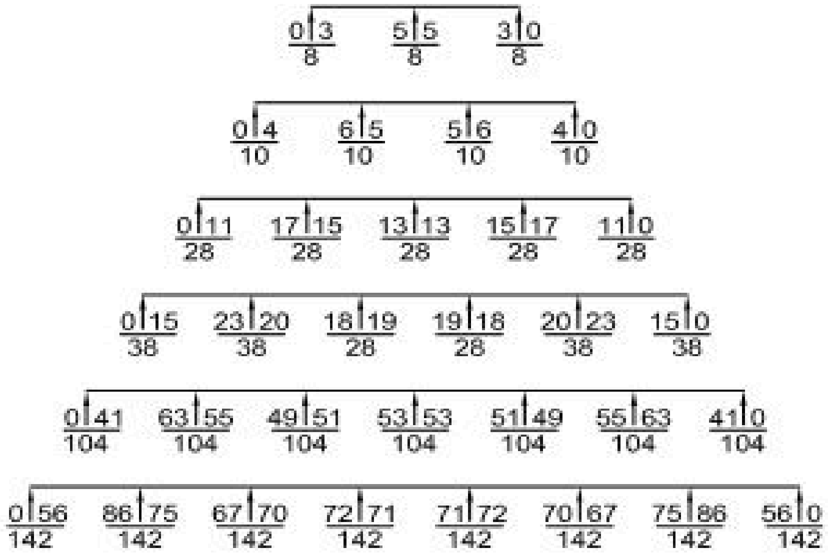
2-7 spans

Moment in terms of wl^2



U.L

Shear in terms of wl



CHAPTER B

DESIGN REQUIREMENTS

This chapter addresses general requirements for the design of steel structures applicable to all chapters of this Specification.

The chapter is organized as follows:

B1. General Provisions
B2. Loads and Load Combinations
B3. Design Basis ← Clause B3
B4. Member Properties
B5. Fabrication and Erection
B6. Quality Control and Quality Assurance
B7. Evaluation of Existing Structures

3. Required Strength

The required strength of structural members and connections shall be determined by structural analysis for the applicable load combinations as stipulated in Section B2.

Design by elastic or inelastic analysis is permitted. Requirements for analysis are stipulated in Chapter C and Appendix 1.

Provision B3.3

$\frac{9}{10}$ M-ve

The required flexural strength of indeterminate beams composed of compact sections, as defined in Section B4.1, carrying gravity loads only, and satisfying the unbraced length requirements of Section F13.5, is permitted to be taken as nine-tenths of the negative moments at the points of support, produced by the gravity loading and determined by an elastic analysis satisfying the requirements of Chapter C, provided that the maximum positive moment is increased by one-tenth of the average negative moment determined by an elastic analysis. This moment redistribution is not permitted for moments in members with F_y exceeding 65 ksi (450 MPa), for moments produced by loading on cantilevers, for design using partially restrained (PR) moment connections, or for design by inelastic analysis using the provisions of Appendix 1. This moment redistribution is permitted for design according to Section B3.1 (LRFD) and for design according to Section B3.2 (ASD). The required axial

Unstiffened Elements

TABLE B4.1b
Width-to-Thickness Ratios: Compression Elements Members Subject to Flexure

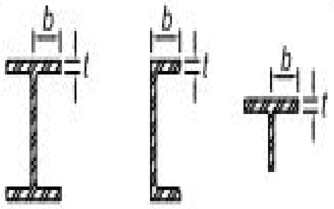
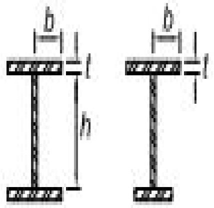
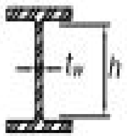
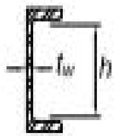
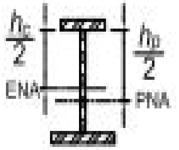
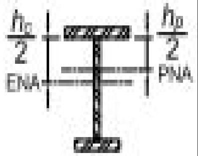
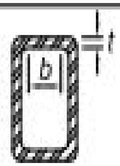
	Case	Description of Element	Width-to-Thickness Ratio	Limiting Width-to-Thickness Ratio		Examples
				λ_p (compact/noncompact)	λ_r (noncompact/slender)	
Elements	10	Flanges of rolled I-shaped sections, channels, and tees	b/t	$0.38\sqrt{\frac{E}{F_y}}$	$1.0\sqrt{\frac{E}{F_y}}$	
	11	Flanges of doubly and singly symmetric I-shaped built-up sections	b/t	$0.38\sqrt{\frac{E}{F_y}}$	$0.95\sqrt{\frac{k_cE}{F_L}}$ [a] [b]	

TABLE B4.1b (continued)
Width-to-Thickness Ratios: Compression Elements Members Subject to Flexure

	Case	Description of Element	Width-to-Thickness Ratio	Limiting Width-to-Thickness Ratio		Examples
				λ_p (compact/noncompact)	λ_r (noncompact/slender)	
	15	Webs of doubly symmetric I-shaped sections and channels	h/t_w	$3.76\sqrt{\frac{E}{F_y}}$	$5.70\sqrt{\frac{E}{F_y}}$	 
	16	Webs of singly symmetric I-shaped sections	h_c/t_w	$\dfrac{\frac{h_c}{h_p}\sqrt{\frac{E}{F_y}}}{\left(0.54\frac{M_p}{M_y}-0.09\right)^2} \le \lambda_r$ [c]	$5.70\sqrt{\frac{E}{F_y}}$	 
nts	17	Flanges of rectangular HSS	b/t	$1.12\sqrt{\frac{E}{F_y}}$	$1.40\sqrt{\frac{E}{F_y}}$	

5. Unbraced Length for Moment Redistribution

The moment redistribution provisions of Section B3.3 refer to this section for setting the maximum unbraced length, L_m, when moments are to be redistributed. These provisions have been a part of the AISC *Specification* since the 1949 edition (AISC, 1949). Portions of members that would be required to rotate inelastically while the moments are redistributed need more closely spaced bracing than similar parts of a continuous beam. However, the magnitude of L_m is often larger than L_p. This is because the L_m expression accounts for moment gradient directly, while designs based upon an elastic analysis rely on C_b factors from Section F1.1 to account for the

F13-5 Continuation

benefits of moment gradient. Equations F13-8 and F13-9 define the maximum permitted unbraced length in the vicinity of redistributed moment for doubly symmetric and singly symmetric I-shaped members with a compression flange equal to or larger than the tension flange bent about their major axis, and for solid rectangular bars and symmetric box beams bent about their major axis, respectively. These equations are identical to those in Appendix 1 of the 2005 AISC *Specification* (AISC, 2005) and the 1999 LRFD *Specification* (AISC, 2000b), and are based on research reported in Yura et al. (1978). They are different from the corresponding equations in Chapter N of the 1989 AISC *Specification* (AISC, 1989).

Case of Lb For Plastic analysis

5. Unbraced Length for Moment Redistribution

For moment redistribution in indeterminate beams according to Section B3.3, the laterally unbraced length, L_b, of the compression flange adjacent to the redistributed end moment locations shall not exceed L_m determined as follows.

(a) For doubly symmetric and singly symmetric I-shaped beams with the compression flange equal to or larger than the tension flange loaded in the plane of the web

$$L_m = \left[0.12 + 0.076\left(\frac{M_1}{M_2}\right)\right]\left(\frac{E}{F_y}\right)r_y \qquad \text{(F13-8)}$$

Lm = maximum Unbraced Length

where

F_y = specified minimum yield stress of the compression flange, ksi (MPa)
M_1 = smaller moment at end of unbraced length, kip-in. (N-mm)
M_2 = larger moment at end of unbraced length, kip-in. (N-mm)
r_y = radius of gyration about y-axis, in. (mm)
(M_1/M_2) is positive when moments cause reverse curvature and negative for single curvature

There is no limit on L_b for members with round or square cross sections or for any beam bent about its minor axis.

Continuous beam with Two Equal Spans

Under U.L
Compact section

M-ve 0.125 wL²

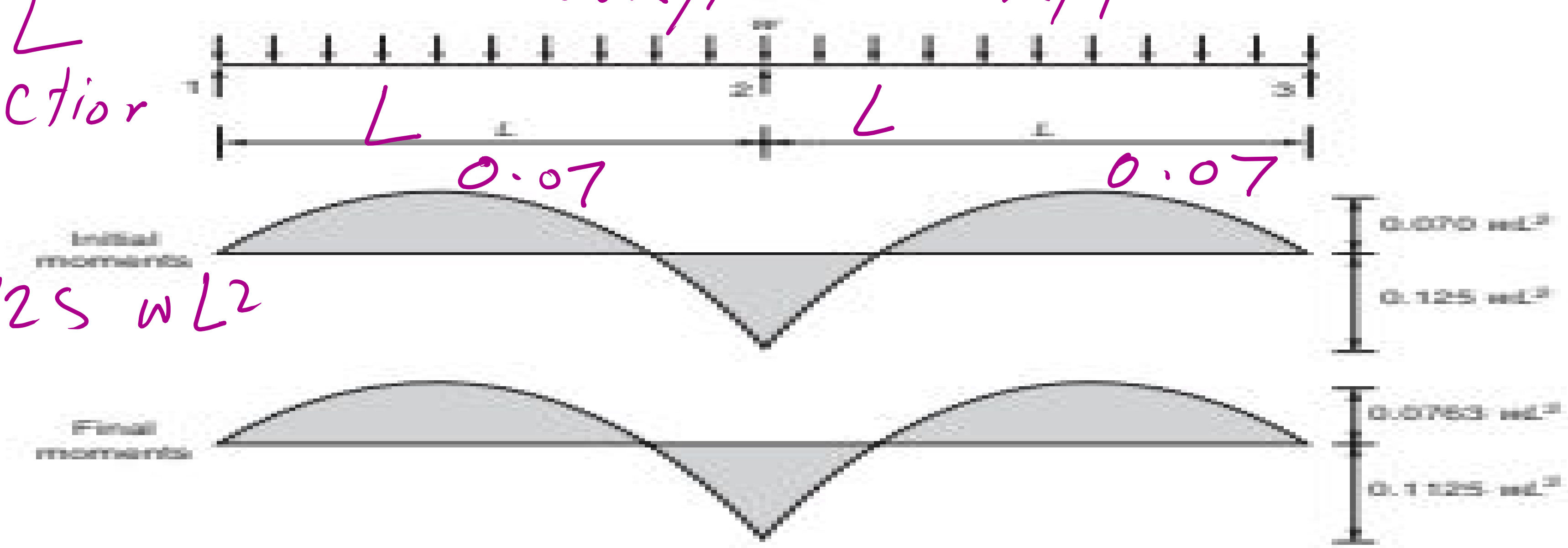


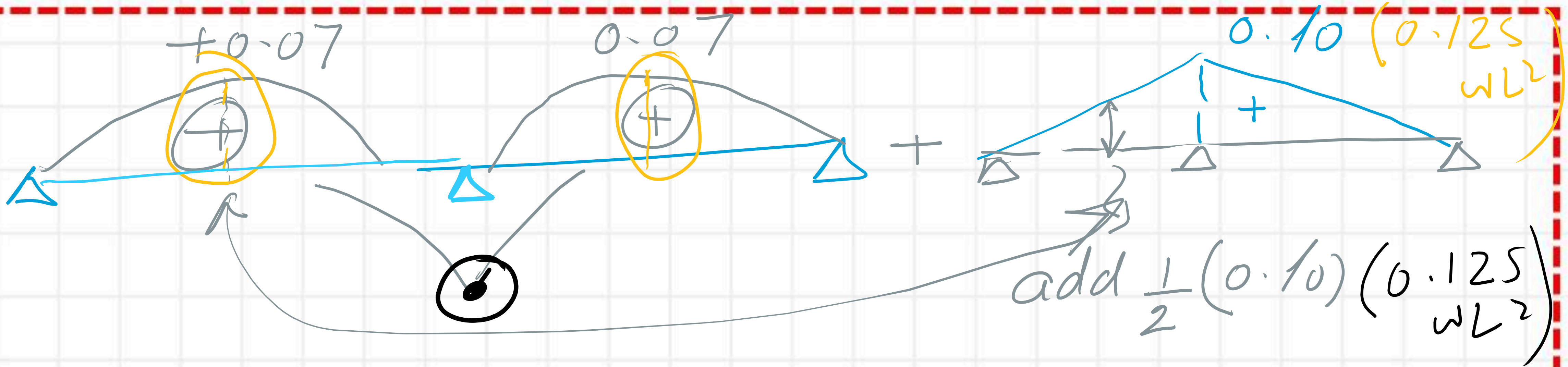
Figure 4.15 Redistribution of moments.

$M_{-ve} = 0.125\,wL^2$

$M_{+ve} = 0.07\,wL^2$

$+ \;=\; (-)$

$0.125\,wL^2 \qquad 0.10\,(0.125\,wL^2) \qquad \frac{9}{80}\,wL^2$



$$M_{+ve} = 0.07\,wL^2 + \frac{0.10}{2}\left(0.125\,wL^2\right)$$

$$= wL^2\left(0.07 + 0.05(0.125)\right) = \frac{61}{800}\,wL^2$$

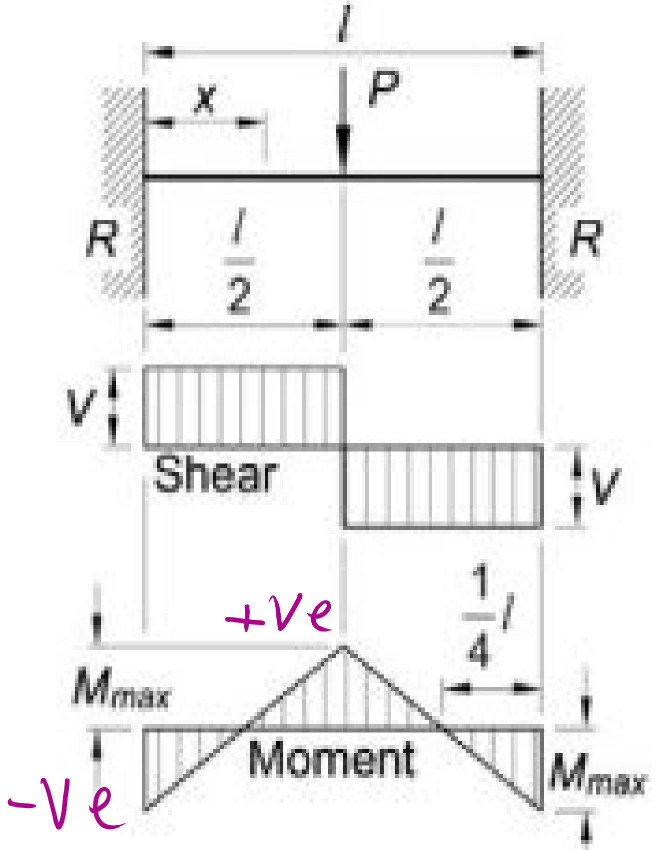
$$M_{+ve} = 0.07625\,wL^2$$

$$M_{-ve} = \frac{9}{80}\,wL^2 = 0.1125\,wL^2$$

Case of Fixed ends beam

16. BEAM FIXED AT BOTH ENDS — CONCENTRATED LOAD AT CENTER

with Concentrated at mid span



Total Equiv. Uniform Load .... $= P$

$R = V$ .... $= \frac{P}{2}$

M_{max} (at center and ends) .... $= \frac{Pl}{8}$

M_x (when $x < \frac{l}{2}$) .... $= \frac{P}{8}(4x - l)$

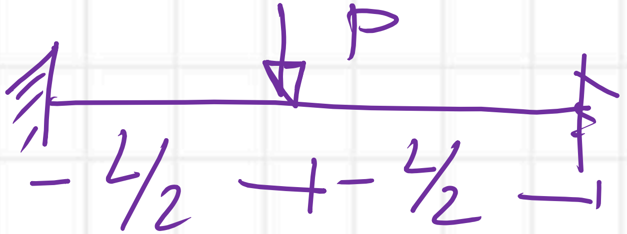
Δ_{max} (at center) .... $= \frac{Pl^3}{192\,EI}$

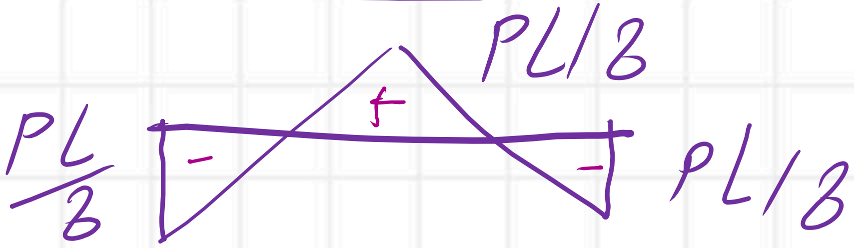
Δ_x (when $x < \frac{l}{2}$) .... $= \frac{Px^2}{48\,EI}(3l - 4x)$

Moment Diagram

Moment is drawn in Compression side

Moment value after redistribution





$$M_{-ve\ Final} = \frac{PL}{8}(1-0.10) = 0.9\,\frac{PL}{8} = \frac{9}{80}PL = 0.1125\,PL$$

$$M_{-ve} = 0.1125\,PL$$

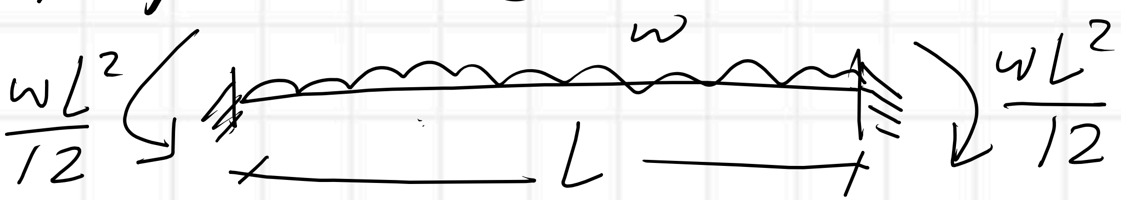
$$M_{+ve\ Final} = \frac{PL}{8}(1+0.10) = \frac{1.1}{8}PL \Rightarrow$$

$$M_{+ve} = 0.1375\,PL$$

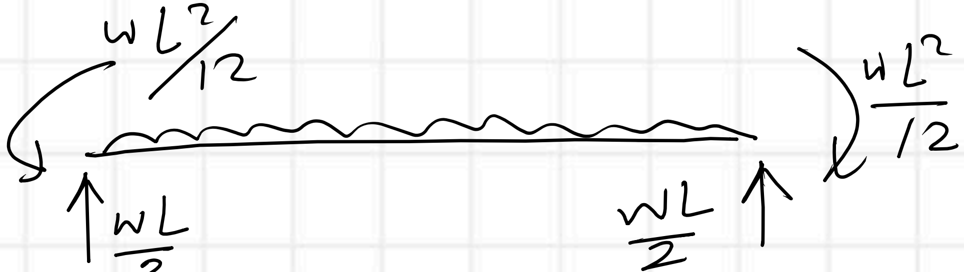
statically indeterminate beam

Case of Fixed end beam

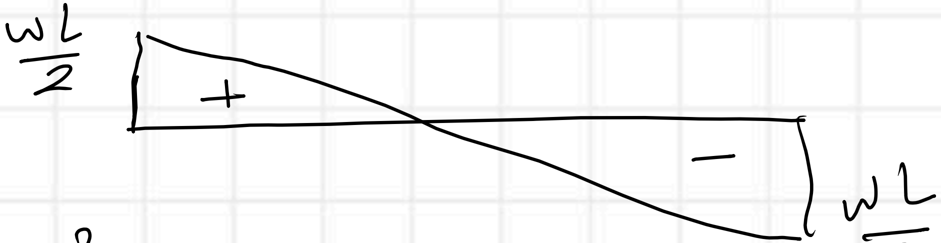
Before → 0.90 method



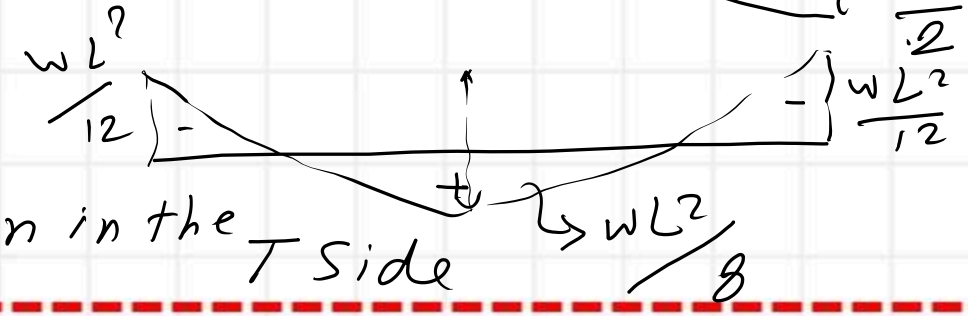
F.B.D



S.F.D



B.M.D

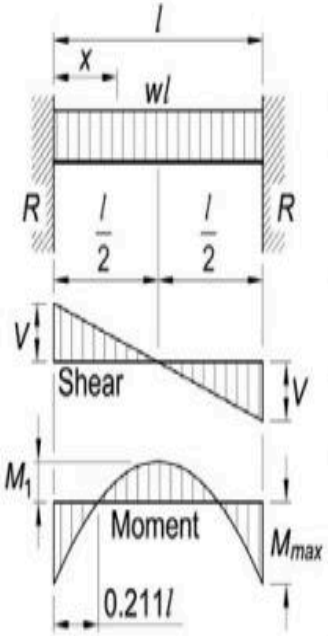


Drawn in the T side

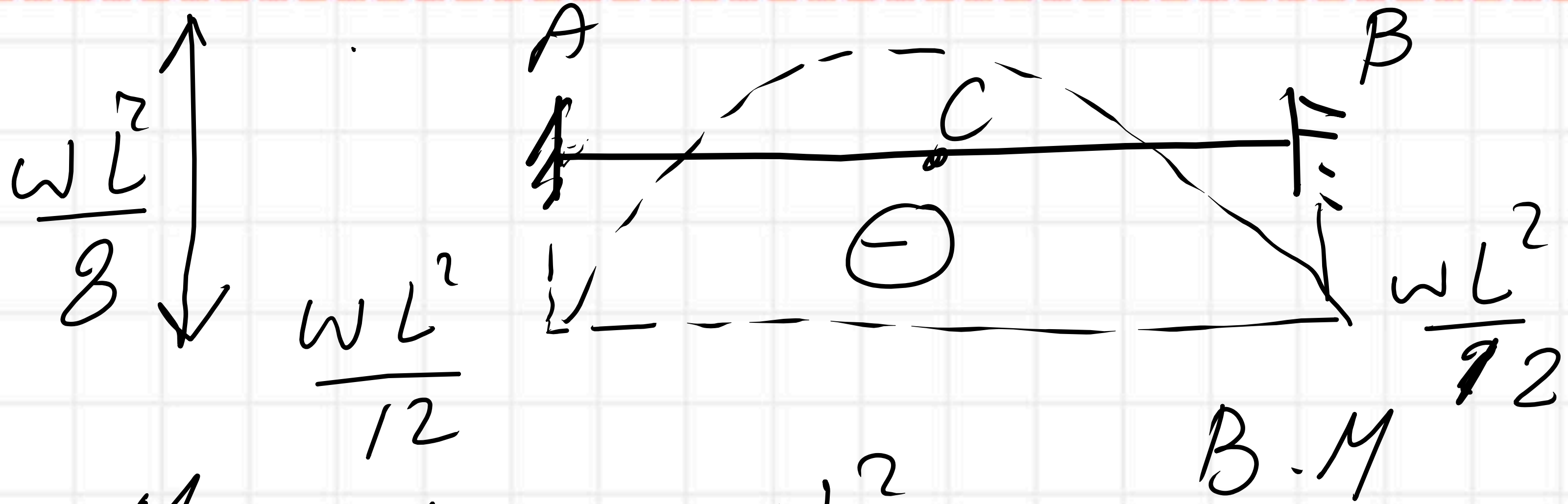
U.L Table 3-23 (continued) Uniform Load

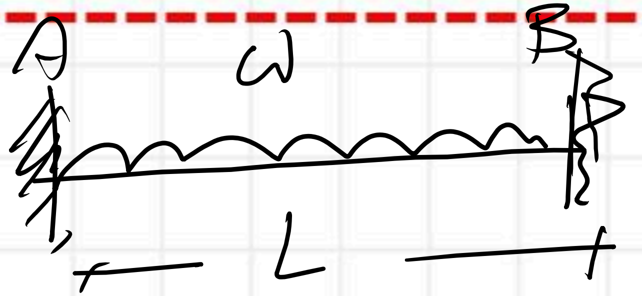
Shears, Moments and Deflections

15. BEAM FIXED AT BOTH ENDS — UNIFORMLY DISTRIBUTED LOADS



Total Equiv. Uniform Load	$= \frac{2wl}{3}$
$R = V$	$= \frac{wl}{2}$
V_x	$= w\left(\frac{l}{2} - x\right)$
M_{max} (at ends)	$= \frac{wl^2}{12}$
M_1 (at center)	$= \frac{wl^2}{24}$
M_x	$= \frac{w}{12}(6lx - l^2 - 6x^2)$
Δ_{max} (at center)	$= \frac{wl^4}{384EI}$
Δ_x	$= \frac{wx^2}{24EI}(l-x)^2$

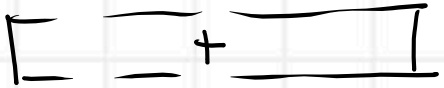




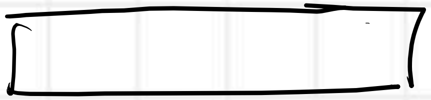
$$M_A = M_B = -\frac{wL^2}{12}$$

$$M_{C_{+ve}} = \frac{wL^2}{8} - \frac{wL^2}{12} = \frac{(3-2)wL^2}{24} = \frac{wL^2}{24}$$

$\frac{wL^2}{12}$ +



$0.10\left(\frac{wL^2}{12}\right)$ $\Rightarrow$



$0.90\left(\frac{wL^2}{12}\right) = \frac{3}{40} wL^2$

or $\left(wL^2 \frac{1}{13.33}\right)$

Statically indeterminate beam   CM # 15   page 3-213

AFTer 0.90 Redistribution

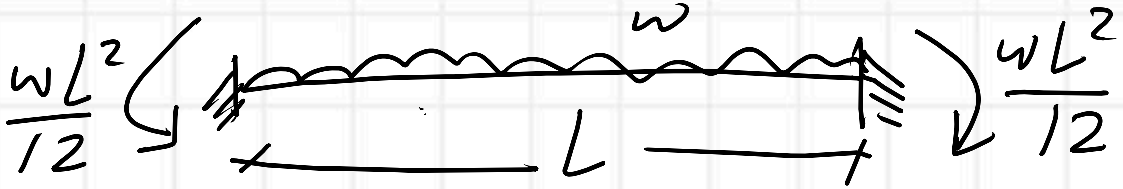
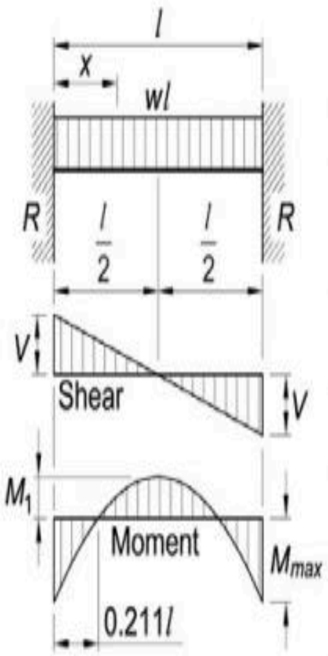


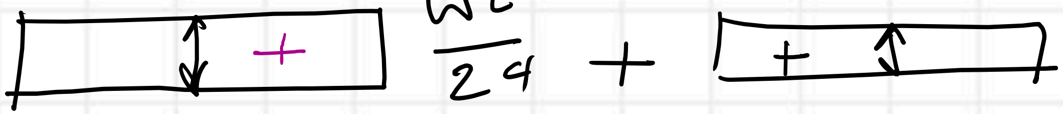
Table 3-23 (continued)

Shears, Moments and Deflections

15. BEAM FIXED AT BOTH ENDS — UNIFORMLY DISTRIBUTED LOADS



Total Equiv. Uniform Load	$= \frac{2wl}{3}$
$R = V$	$= \frac{wl}{2}$
V_x	$= w\left(\frac{l}{2} - x\right)$
M_{max} (at ends)	$= \frac{wl^2}{12}$
M_1 (at center)	$= \frac{wl^2}{24}$
M_x	$= \frac{w}{12}\left(6lx - l^2 - 6x^2\right)$
Δ_{max} (at center)	$= \frac{wl^4}{384EI}$
Δ_x	$= \frac{wx^2}{24EI}(l-x)^2$



M_{+ve} final

$$= \frac{wL^2}{24} + \frac{0.10\,wL^2}{12} = \frac{1.2\,wL^2}{24}$$

$\frac{wL^2}{20} \rightarrow$ instead of $\frac{wL^2}{24}$