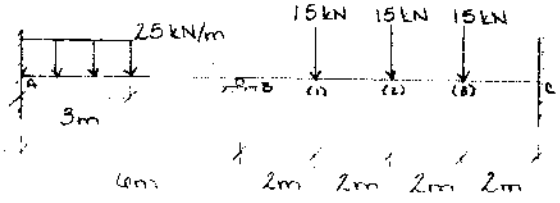
10/10

48.5 ÷ 3 / 90

(Problem 12-1) Determine the moments at the supports. EI is constant. Assume B is a roller and A and C are fixed.



FIXED END MOMENTS

$FEM_{AB} = \frac{Wa^2}{12L^2}(6L^2 - 8aL + 3a^2) = \frac{25(3)^2}{12(6)^2}(6(6)^2 - 8(3)(6) + 3(3)^2) = 51.5625$ kN·m ↻

$FEM_{BA} = -\frac{Wa^3}{12L^2}(4L - 3a) = -\frac{25(3)^3}{12(6)^2}(4(6) - 3(3)) = -23.4375$ kN·m ↺

$FEM_{BC1} = \frac{Pab^2}{L^2} = \frac{15(2)(6)^2}{8^2} = 16.875$ kN·m ↻
$FEM_{BC2} = \frac{PL}{8} = \frac{15(8)}{8} = 15$ kN·m ↻
$FEM_{BC3} = \frac{Pab^2}{L^2} = \frac{15(6)(2)^2}{8^2} = 5.625$ kN·m ↻
$\Rightarrow FEM_{BC} = 37.5$ kN·m ↻

$FEM_{CB1} = -\frac{Pa^2b}{L^2} = -\frac{15(2)^2(6)}{8^2} = -5.625$ kN·m ↺
$FEM_{CB2} = -\frac{PL}{8} = -\frac{15(8)}{8} = -15$ kN·m ↺
$FEM_{CB3} = -\frac{Pa^2b}{L^2} = -\frac{15(6)^2(2)}{8^2} = -16.875$ kN·m ↺
$\Rightarrow FEM_{CB} = -37.5$ kN·m ↺

DISTRIBUTION FACTORS

$DF_{BA} = I/6 \,/\, I/6 + I/8 = 0.571$ $\quad DF_{BC} = I/8 \,/\, I/6 + I/8 = 0.429$

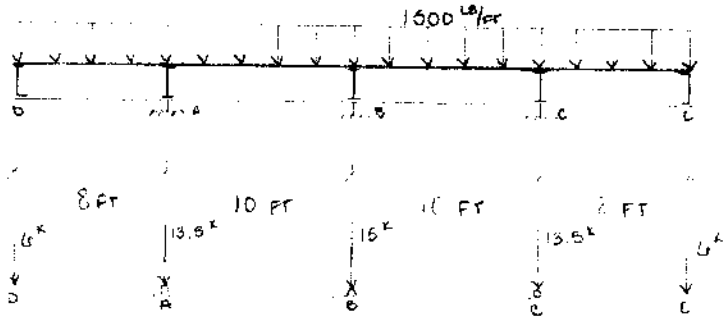
TABLE

MEMBER	AB	BA	BC	CB
DIST. FACTORS		0.571	0.429	
FEMs	+51.5625	-23.4375	37.5	-37.5
BALANCE B		8.0297	6.0328	
CARRYOVER	-4.0149			3.0164
FINAL	+47.5476	-31.4672	+31.4672	-40.5164

$M_A = M_{AB} = 47.5476$ kN·m, (+) ↻ ← M_A
$M_C = M_{CB} = -40.5164$ kN·m, (-) ↺ ← M_B

10/10

(Problem 12-6) Determine the moments at A, B, and C and then draw the moment diagram for the girder DE. EI is constant. Assume the support at B is a pin and A and C are rollers. The distributed load rests on simply supported floor boards that transmit the load to the floor beams.



FIXED END MOMENTS

$FEM_{DA} = 0$
$FEM_{AD} = 6(8) = 48$ K-FT ↻
$FEM_{AB} = 0$
$FEM_{BA} = 0$
$FEM_{BC} = 0$
$FEM_{CB} = 0$
$FEM_{CE} = 6(8) = 48$ K-FT ↺
$FEM_{EC} = 0$

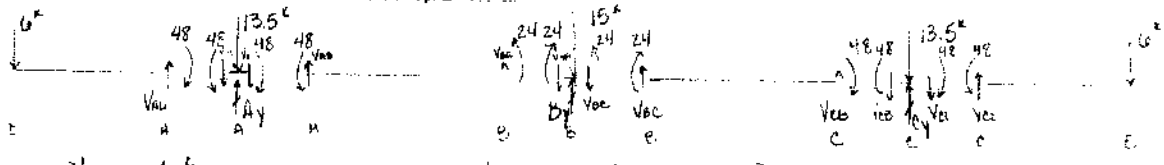
DISTRIBUTION FACTORS

$DF_{AD} = 0$ $DF_{AB} = 1$
$DF_{BA} = 0.5$ $DF_{BC} = 0.5$
$DF_{CB} = 1$ $DF_{CE} = 0$

TABLE

MEMBER	DA	AD	AB	BA	BC	CB	CE	EC
DIST FACTORS		0	1	0.5	0.5	1	0	
FEM'S	0	-48	0	0	0	0	+48	0
BALANCE			+48			-48		
CARRYOVER				+24	-24			
FINAL	0	-48	+48	+24	-24	-48	+48	0

$M_{AD} = -48$ k-ft, (-) ↻ ← M_{AD}
$M_{AB} = 48$ k-ft, (+) ↺ ← M_{AB}
$M_{BA} = 24$ k-ft, (+) ↺ ← M_{BA}
$M_{BC} = -24$ k-ft, (-) ↻ ← M_{BC}
$M_{CB} = -48$ k-ft, (-) ↻ ← M_{CB}
$M_{CE} = 48$ k-ft, (+) ↺ ← M_{CE}



$V_{AD} = 6^K$
$V_{CE} = 6^K$

$\Sigma M_B = 0$ $48 + V_{AB}(10) - 24 = 0$
$V_{AB} = -7.2^K$

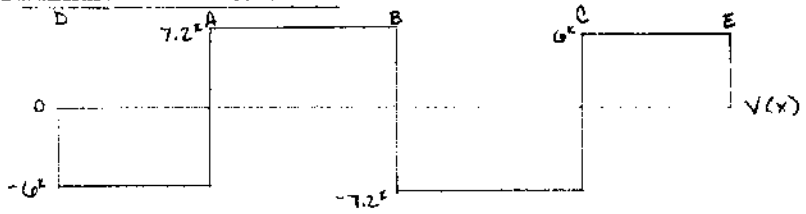
$\Sigma M_A = 0$ $48 - 24 + V_{BA}(10)$
$V_{BA} = -7.2^K$

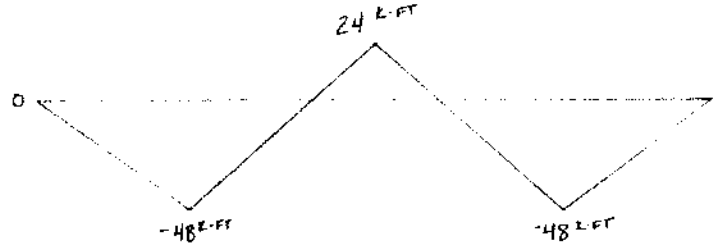
$\Sigma M_C = 0$ $24 + 48 + V_{BC}(10)$
$V_{BC} = -7.2^K$

$\Sigma M_B = 0$ $24 + 48 - V_{CB}(10)$
$V_{CB} = 7.2^K$

$A_y = 26.7^K$ ↑
$B_y = 0.6^K$ ↑
$C_y = 26.7^K$ ↑

SHEAR AND MOMENT DIAGRAMS





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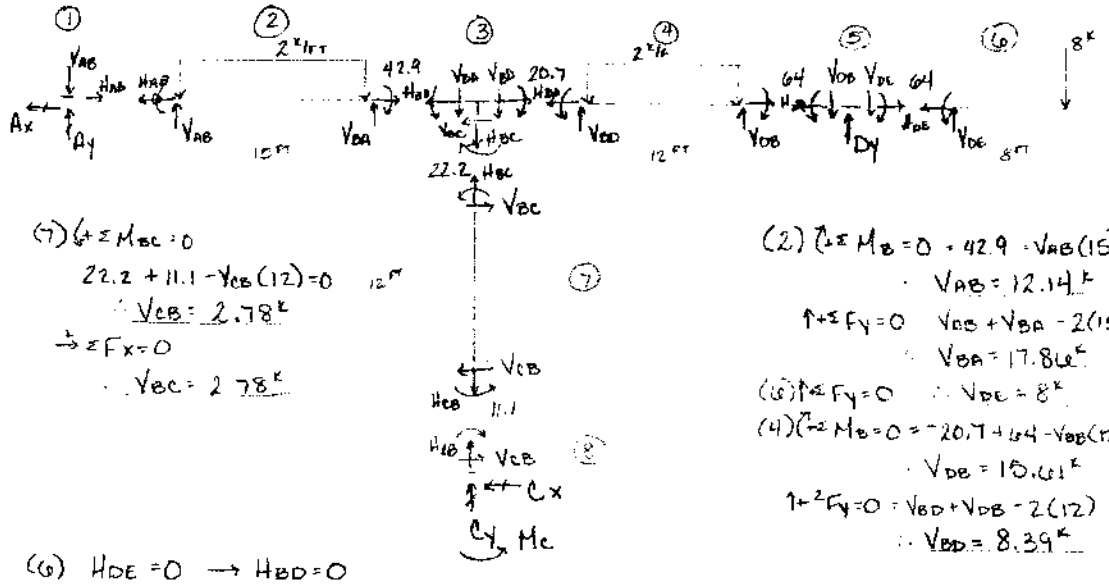


(7) $\circlearrowleft \Sigma M_{BC} = 0$

$22.2 + 11.1 - V_{CB}(12) = 0$

$\therefore V_{CB} = 2.78^K$

$\rightarrow \Sigma F_x = 0$

$\therefore V_{BC} = 2.78^K$

(2) $\circlearrowleft \Sigma M_B = 0 + 42.9 - V_{AB}(15) - 2(15)(7.5)$

$\therefore V_{AB} = 12.14^K$

$\uparrow + \Sigma F_y = 0 \quad V_{BD} + V_{BA} - 2(15) = 0$

$\therefore V_{BA} = 17.86^K$

(6) $\uparrow \Sigma F_y = 0 \quad \therefore V_{DE} = 8^K$

(4) $\circlearrowleft \Sigma M_E = 0 = -20.7 + 64 - V_{DB}(12) + 2(12)(6)$

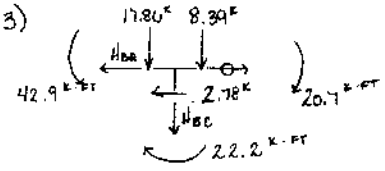
$\therefore V_{DB} = 15.61^K$

$\uparrow + \Sigma F_y = 0 : V_{BD} + V_{DB} - 2(12)$

$\therefore V_{BD} = 8.39^K$

(6) $H_{DE} = 0 \rightarrow H_{BD} = 0$

(3)



$H_{BA} = -2.78^K$

$H_{BC} = -26.25^K$

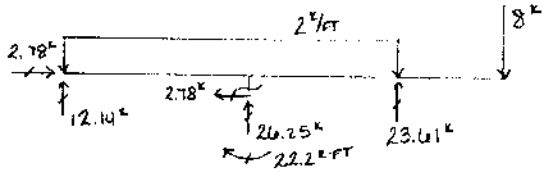
$\therefore H_{CB} = -26.25$

REACTIONS

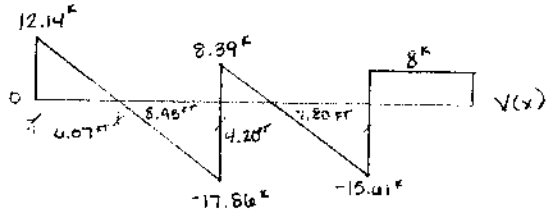
$M_C = 11.1^{K\text{-FT}}$ ↻ $\quad A_y = 12.14^K$ ↑

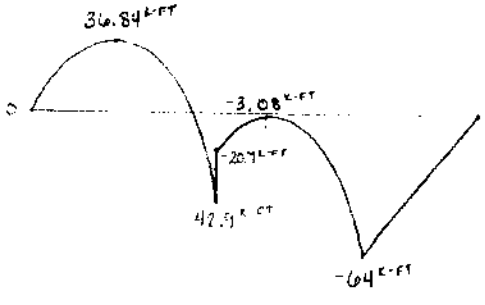
$C_y = 26.25^K$ ↑ $\quad A_x = 2.78^K$ →

$C_x = 2.78^K$ ← $\quad D_y = 23.61^K$ ↑



SHEAR AND MOMENT DIAGRAMS





(Problem 12-16) Determine the moments at the ends of each member of the frame. The members are fixed connected at the supports and joints. EI is the same for each member.

PART 1: WITHOUT SIDESWAY

$FEM_{CD} = FEM_{CB} = 0$

$FEM_{AB} = \frac{+PL}{8} = \frac{12(12)}{8} = +22.5^{K\text{-}FT}$ ↻

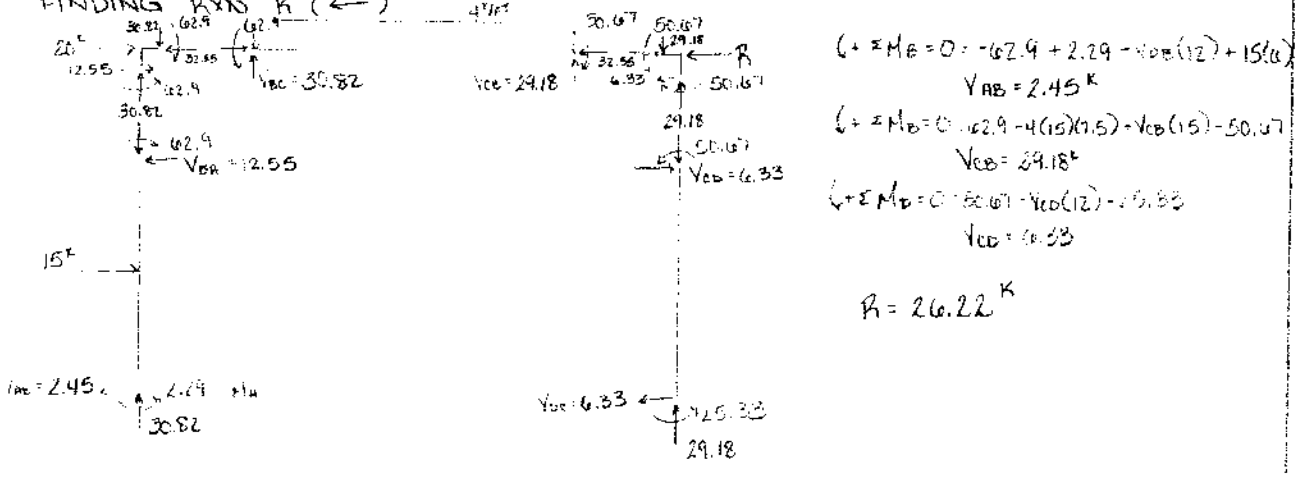
$FEM_{BA} = \frac{-PL}{8} = \frac{-18(12)}{8} = -22.5^{K\text{-}FT}$ ↺

$FEM_{BC} = \frac{+wL^2}{12} = \frac{4(15)^2}{12} = +75^{K\text{-}FT}$ ↻

$FEM_{CB} = \frac{-wL^2}{12} = \frac{-4(15)^2}{12} = -75^{K\text{-}FT}$ ↺

MEMBER	AB	BA	BC	CB	CD	DC
DIST. FACT.		0.556	0.444	0.444	0.556	
FEMs	+22.5	-22.5	+75	-75	0	0
BALANCE		-29.19	-23.31	+23.3	+41.7	
CARRYOVER	-14.595		-16.65	-11.655		+20.85
BALANCE		-9.2574	-7.3926	+5.1748	+6.4802	
CARRYOVER	-4.6287		+2.5874	+3.6963		+3.2401
BALANCE		-1.4386	-1.1488	+1.6412	+2.0561	
CARRYOVER	-0.7193		+0.8206	-0.5744		+1.0276
BALANCE		-0.4563	-0.3643	+0.2550	+0.3144	
CARRYOVER	-0.0355		+0.0405	-0.0283		+0.0507
BALANCE		-0.0225	-0.0180	+0.0126	+0.0157	
FINAL	+2.2933	-62.9357	62.9357	-50.6717	+50.6717	+25.3281

FINDING RXN R (←)



PART 2 : WITH SIDESWAY

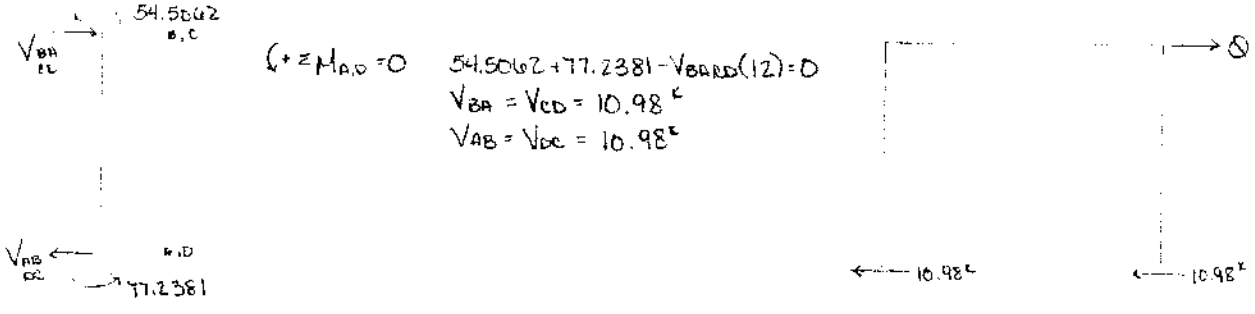
$FEM_{BC} = FEM_{CB} = 0$

$FEM_{AB} = FEM_{BA} = FEM_{CD} = FEM_{DC} = \frac{+6EI\Delta}{L^2}$

ASSUME $\frac{6EI\Delta}{L^2} = 100^{1-K}$

MEMBER	AB	BA	BC	CB	CD	DC
DIST. FACT		0.556	0.444	0.444	0.556	
FEMs	+100	+100	0	0	+100	+100
BALANCE		-55.6	-44.4	-44.4	-55.6	
CARRYOVER	-27.8		-22.2	-22.2		-27.8
BALANCE		+12.3432	+9.8568	+9.8568	+12.3432	
CARRYOVER	+6.1716		+4.9284	+4.9284		+6.1716
BALANCE		-2.7402	-2.1882	-2.1882	-2.7402	
CARRYOVER	-1.3701		-1.0941	-1.0941		-1.3701
BALANCE		+0.6083	+0.4858	+0.4858	+0.6083	
CARRYOVER	+0.3042		+0.2429	+0.2429		+0.3042
BALANCE		-0.1351	-0.1078	-0.1078	-0.1351	
CARRYOVER	-0.0676		-0.0539	-0.0539		-0.0676
BALANCE		+0.0300	+0.0239	+0.0239	+0.0300	
FINAL	+77.2381	+54.5062	-54.5062	-54.5062	+54.5062	+77.2381

FINDING Q ($\longrightarrow$)



$Q = 21.96$

MEMBER END MOMENTS ($M = M_o + (\frac{R}{Q})M_Q$)

$M_{AB} = 2.2933 + (\frac{21.96}{21.96})(77.2381)$ ∴ $M_{AB} = 95.51^{K\text{-}FT}, (+)$ ↻

$M_{BA} = -62.9357 + (\frac{21.96}{21.96})(54.5062)$ ∴ $M_{BA} = 2.14^{K\text{-}FT}, (+)$ ↻

$M_{BC} = -62.9357 + (\frac{21.96}{21.96})(-54.5062)$ ∴ $M_{BC} = -2.14^{K\text{-}FT}, (-)$ ↺

$M_{CB} = -50.6717 + (\frac{21.96}{21.96})(-54.5062)$ ∴ $M_{CB} = -115.75^{K\text{-}FT}, (-)$ ↺

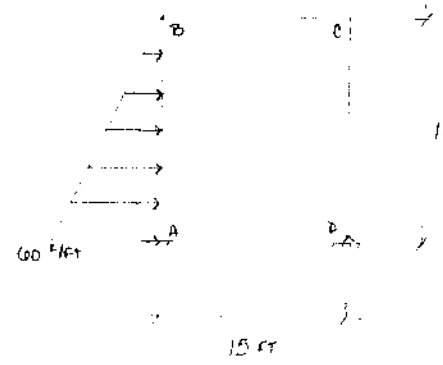
$M_{CD} = 50.6717 + (\frac{21.96}{21.96})(54.5062)$ ∴ $M_{CD} = 115.75^{K\text{-}FT}, (+)$ ↻

$M_{DC} = 25.3281 + (\frac{21.96}{21.96})(77.2381)$ ∴ $M_{DC} = 117.55^{K\text{-}FT}, (+)$ ↻

← END MOMENTS

(Problem 12-19) The side of the frame is subjected to the hydrostatic loading shown. Determine the moments at each joint and support. EI is constant.

8.5/10



DISTRIBUTION FACTORS

$DF_{BA} = \frac{I/18}{I/15 + I/18} = 0.4545$

$DF_{BC} = \frac{I/15}{I/15 + I/18} = 0.5455$

$DF_{CB} = \frac{I/15}{I/15 + 3/4(I/18)} = 0.6154$

$DF_{CD} = \frac{I/18(3/4)}{I/15 + 3/4(I/18)} = 0.3846$

PART I: WITHOUT SIDESWAY

$FEM_{AB} = \frac{+wL^2}{20} = \frac{60(18)^2}{20} = +972^{K\cdot FT}$)

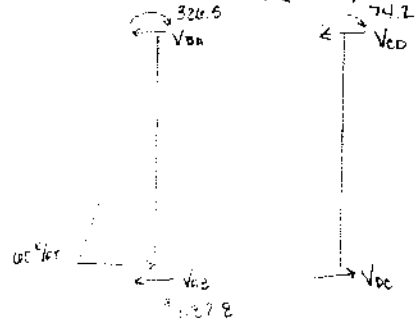
$FEM_{BA} = \frac{-wL^2}{30} = \frac{-60(18)^2}{30} = -648^{K\cdot FT}$)

$FEM_{BC} = FEM_{CB} = FEM_{CD} = FEM_{DC} = 0$

MEMBER	AB	BA	BC	CB	CD	DC
DIST. FACT.		0.4545	0.5455	0.6154	0.3846	
FEMs	+972	-648	0	0	0	0
BALANCE		294.516	353.484			
CARRYOVER	147.258			176.742		
BALANCE				-108.767	-67.975	
CARRYOVER			-54.384			0
BALANCE		+24.718	+29.666			
CARRYOVER	+12.389			+14.833		
BALANCE				-9.128	-5.705	
CARRYOVER			-4.564			0
BALANCE		+2.074	+2.490			
CARRYOVER	+1.037			+1.245		
BALANCE				-0.766	-0.479	
CARRYOVER			-0.383			0
BALANCE		+0.174	+0.209			
CARRYOVER	+0.087			+0.105		
BALANCE				-0.065	-0.040	
CARRYOVER			-0.033			0
BALANCE		+0.015	+0.018			
FINAL	+1132.771	+326.503	-326.503	-74.199	+74.199	0

-1/2 Sign

FINDING R AND R (←)

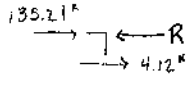


$(+\circlearrowleft \Sigma M_A = 0 = -326.5 + V_{BA}(15) - \frac{1}{2}(60)(18)(\frac{1}{3}18) + 1132.8$

$V_{BA} = \cancel{135.21^K}\ 404.79$

$(+\circlearrowleft \Sigma M_D = 0 = -74.2 + V_{CD}(15) = 0$

$V_{CD} = 4.12^K$ -1



$R = \cancel{139.33^K}\ 400.67$

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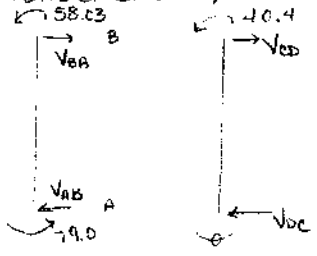
PART 2: WITH SIDESWAY

[illegible]	[illegible]	-1.146	-1.404	-5.991	+2.495
CARRYOVER	+0.587		-1.996	+0.705	0
BALANCE		-0.907	-1.089	-0.434	-0.271
CARRYOVER	-0.454		-0.217	-0.545	0
BALANCE		+0.099	+0.118	+0.330	+0.210
CARRYOVER	+0.050		+0.165	+0.059	0
BALANCE		-0.076	-0.092	-0.036	-0.023
CARRYOVER	-0.038		-0.018	-0.046	0
BALANCE		+0.008	+0.010	+0.028	+0.018
FINAL	79.009	+58.026	-58.026	-40.461	+40.439	0

FINDING Δ (→)



$\zeta + \Sigma M_A = 0 = 58.03 + 79.0 - V_{BA}(18) = 0$

$V_{BA} = 7.61^K$

$\zeta + \Sigma M_D = 0 = 40.4 - V_{CD}(18) = 0$

$V_{CD} = 2.24^K$

$\therefore \Delta = 9.85^K$

MEMBER END MOMENTS $(M = M_c + (\frac{E}{S})M_\Delta)$

$M_{AB} = 1132.771 + (\frac{139.33}{9.85})(79.009)$

$M_{BA} = -326.503 + \;''\; (58.026)$

$M_{BC} = +326.503 + \;''\; (-58.026)$

$M_{CB} = 74.199 + \;''\; (-40.461)$

$M_{CD} = -74.199 + \;''\; (+40.439)$

$\therefore M_{AB} = 2250^{K\text{-}FT}, (+) \circlearrowleft$

$\therefore M_{BA} = 494^{K\text{-}FT}, (+) \circlearrowleft$

$\therefore M_{BC} = -494^{K\text{-}FT}, (-) \circlearrowright$ ← END M.

$\therefore M_{CB} = -498^{K\text{-}FT}, (-) \circlearrowright$

$\therefore M_{CD} = 498^{K\text{-}FT}, (+) \circlearrowleft$

$\therefore M_{DC} = 0^{K\text{-}FT}$

Incorrect due to w/o Sidesway values!