A

$$\begin{bmatrix} 60 & 40 & 0 & 0 \\ 30 & 140 & 40 & 0 \\ 0 & 40 & 140 & 30 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} M_A \\ M_b \\ M_C \\ M_d \end{bmatrix} =$$

Get matrix inverse

U load elastic reaction			
-6750	0	0	0
-6750	-16000	0	0
0	-16000	-6750	0
0	0	0	0

$$\begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix}$$

DL

$w_1 = 1$

$w_2 = 1$

$w_3 = 1$

$w_4 = 0$

A-1

$$\begin{bmatrix} M_A \\ M_B \\ M_C \\ M_D \end{bmatrix} = \begin{bmatrix} 60 & 40 & 0 & 0 \\ 30 & 140 & 40 & 0 \\ 0 & 40 & 140 & 30 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1} \left(\begin{bmatrix} 1 \\ 1 \\ 1 \\ 0 \end{bmatrix} \right.$$

+

P load elastic reaction			
-337.5	0	0	0
-337.5	0	0	0
0	0	0	0
0	0	0	0

$$\begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

$P_1 = 15$

$P_2 = 0$

$P_3 = 0$

$P_4 = 0$

W. vector

$$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 0 \end{bmatrix}$$

$$+ \begin{bmatrix} 60 & 40 & 0 & 0 \\ 3 & 140 & 40 & 0 \\ 1 & 140 & 140 & 30 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\times \begin{bmatrix} 15 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

P vector

$M_A = -55.815$ kips.ft $+ (-73.231) = -129.05$ Ft.kips

$M_b = -113.365$ kip.ft $+ (-22.282) = -135.66$ Ft.kips

$M_C = -130.11$ kip.ft $+ (6.368) = -123.74$ Ft.kips

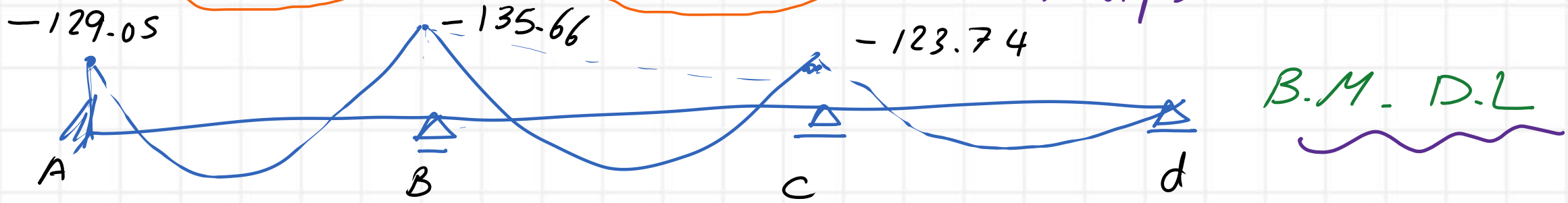
$M_d =$ 0 $+ 0 = 0$

(DL) U.D.L

DL P.Load

$w_D = 1$ k/ft

$P_d = 15$ k/ft



FT.kips

B.M. D.L

Bending moment For Uniform Dead Loads

$M_A = -167.45$ kips.ft $+(-97.64) \simeq -265.0$ Ft.kips

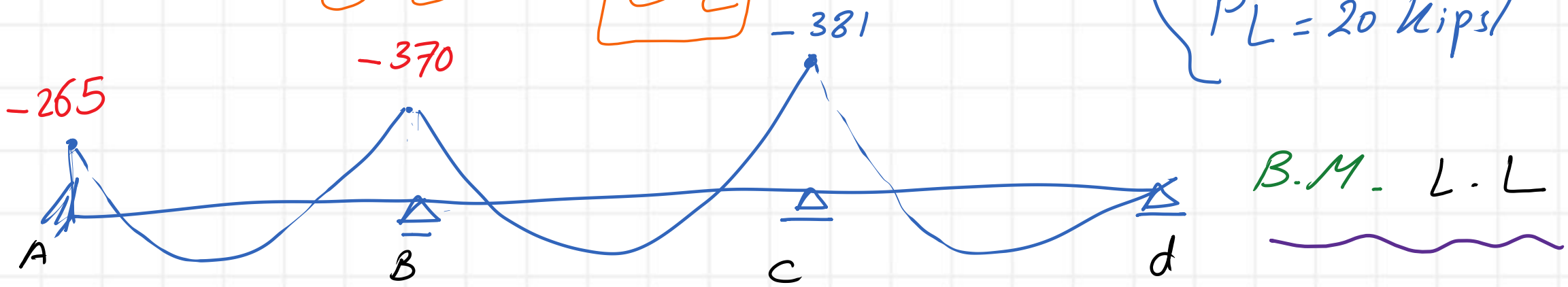
$M_b = -340.094$ kip.ft $+(-29.72) \simeq -370.0$ Ft.kips

$M_C = -390.33$ kip.ft $+(+8.49) = -381.84$ Ft.kips

$M_d = 0$ $+0 = 0$

U.L C.L

$(W_L = 3$ K/ft, $P_L = 20$ kips$)$



B.M. L.L

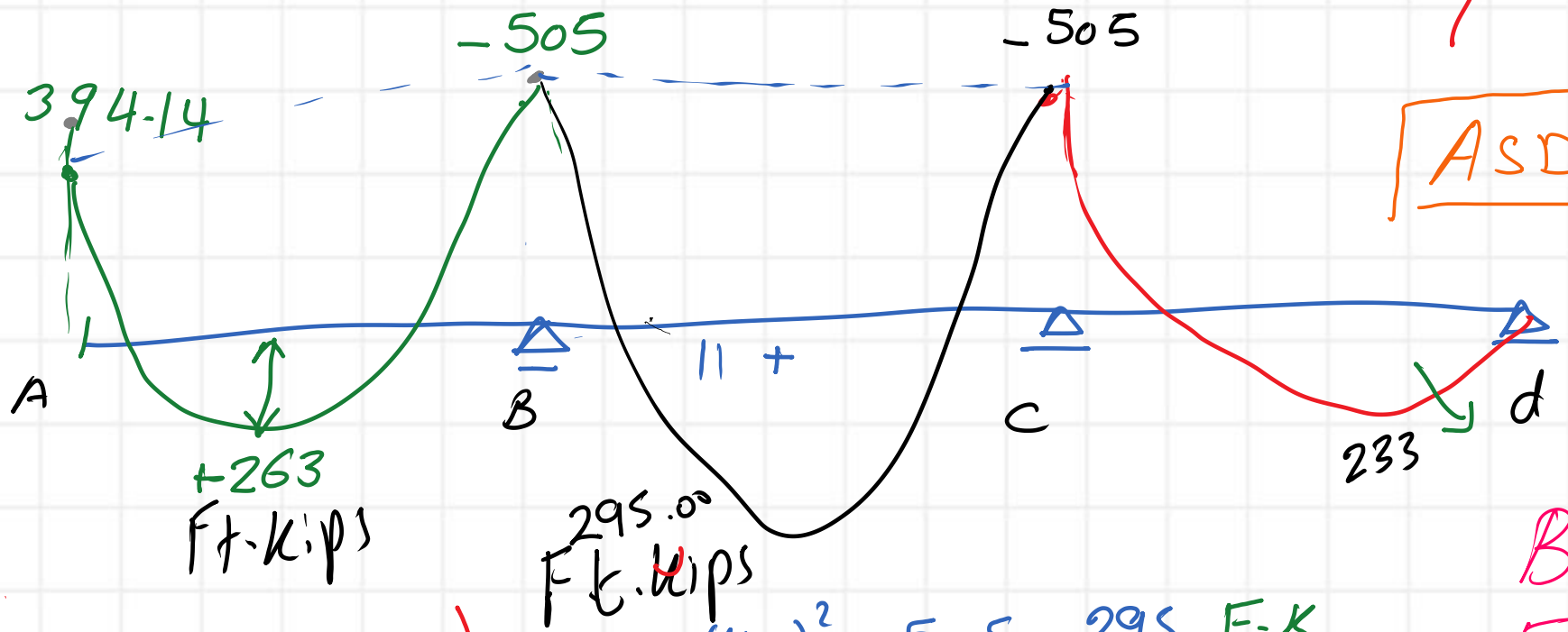
Bending moment For Live Loads

	M_{DL}	M_{LL}	M_{Final}	
M_A	-129.05	$+-265.0$	$=-394.14$	ft.kips
M_b	-133.65	$+-370.0$	$=-505.0$	Ft kips
M_C	-123.742	$+-381.84$	-505	Ft.kips
M_d	$-$	0	$=0$	Ft kips

$$M_{+ve}\,Ab = \frac{wL_1^2}{8} + \frac{P_t L_1}{4} - \frac{1}{2}(394+505)$$

$$= \frac{4(30)^2}{8} + \frac{35(30)}{4} - (450)$$

$$= 263 \text{ F.kips}$$



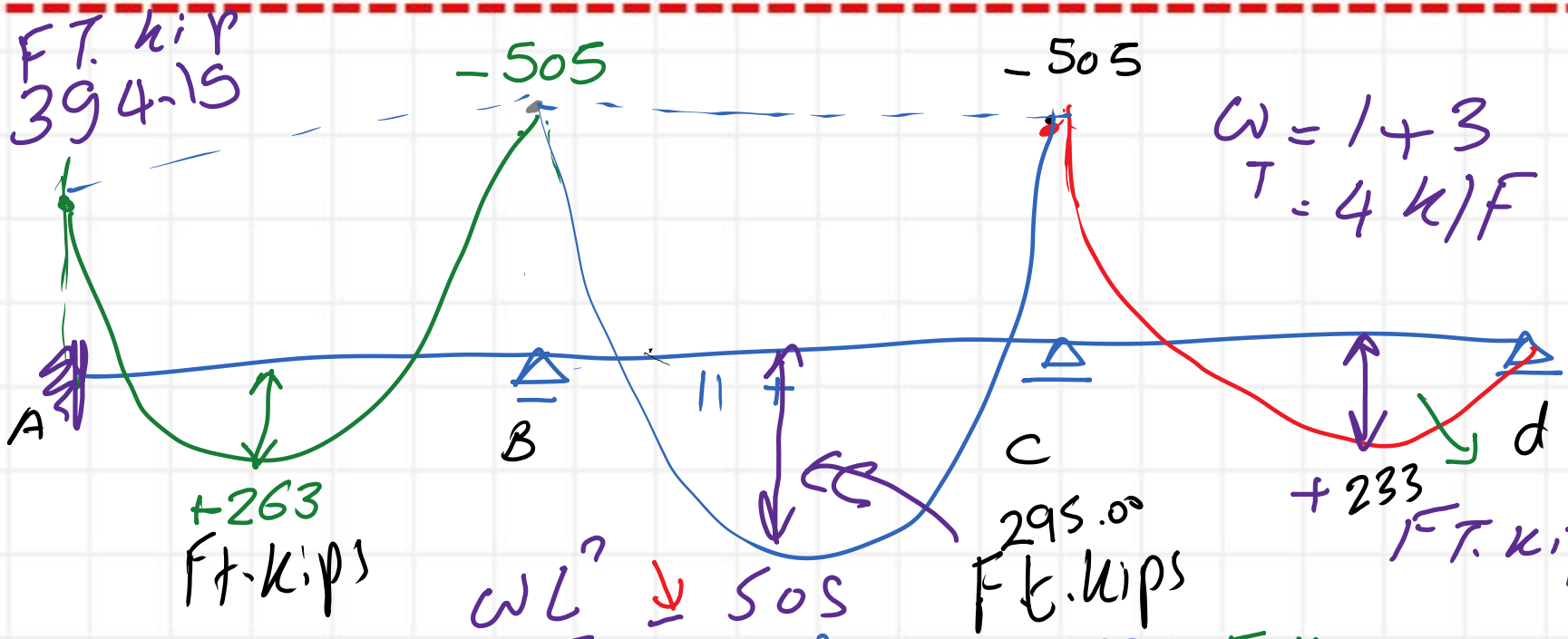
$$\frac{4(40)^2}{8} - 505 = 295 \text{ F-K}$$

ASD

B.M. Total

Check Zero Shear

Bending moment For service Loads



$W = 1 + 3$

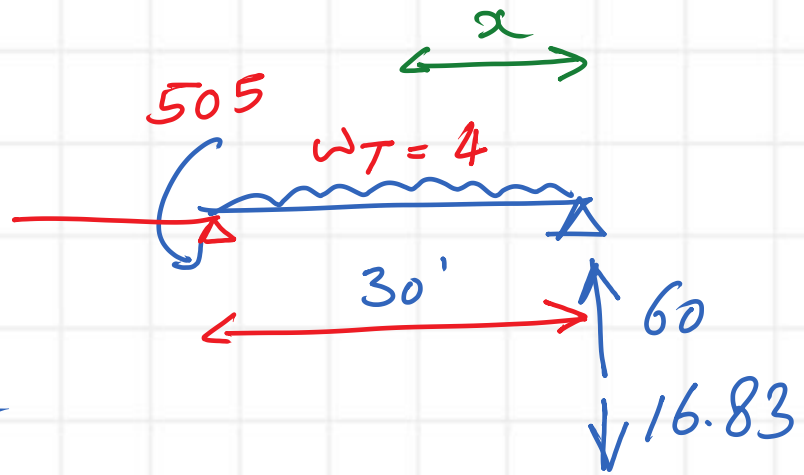
$T = 4$ k/F

ASD Design

Check Zero Shear

$\frac{wL^2}{8} \downarrow 505$

$\frac{4(40)^2}{8} - 505 = 295$ F.K



$Q = 0$ at $x \Rightarrow$

$4x = 60 - 16.83 \rightarrow x = 10.793'$

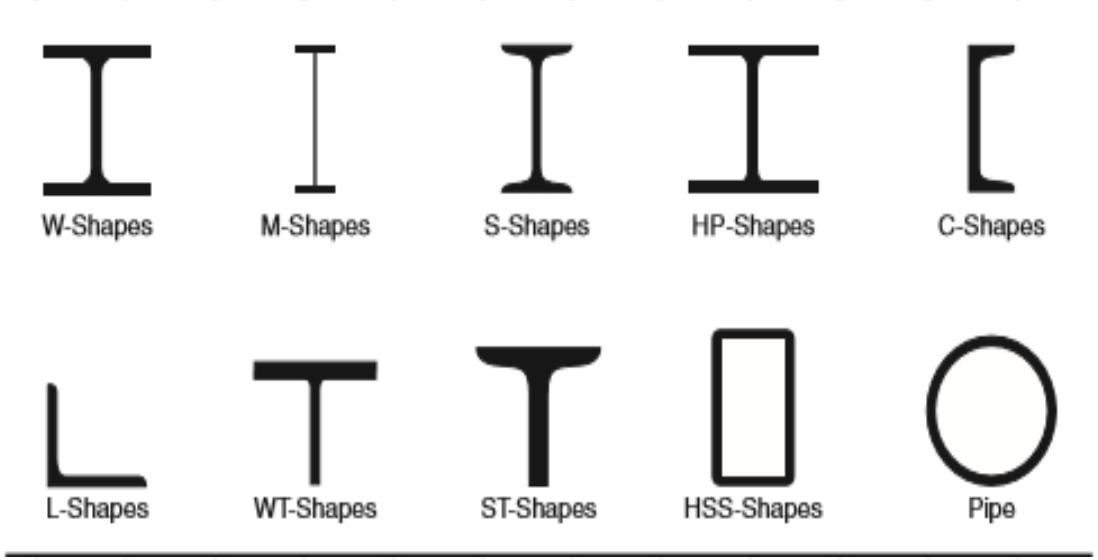
$M_{+ve\ max} = (60 - 16.83)(10.793) - 4\frac{(10.793)^2}{2}$

$= 465.93 - 232.93 = 233$ Ft. kips

span cd

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

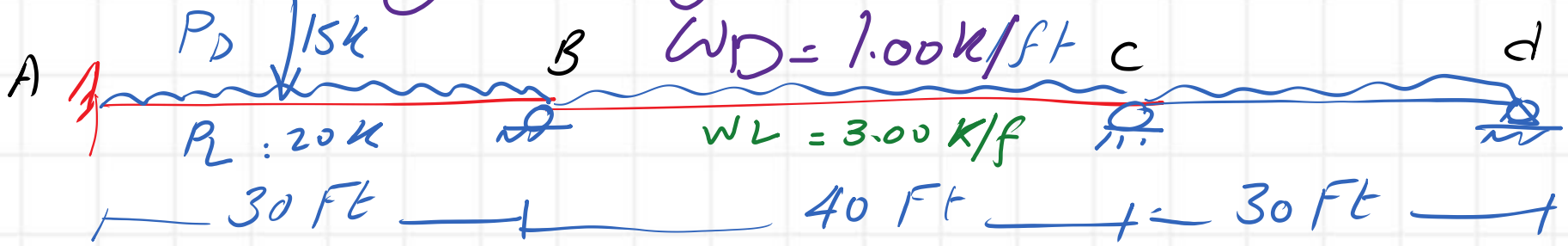
Note: F_y = specified minimum yield stress; F_u = specified minimum tensile strength

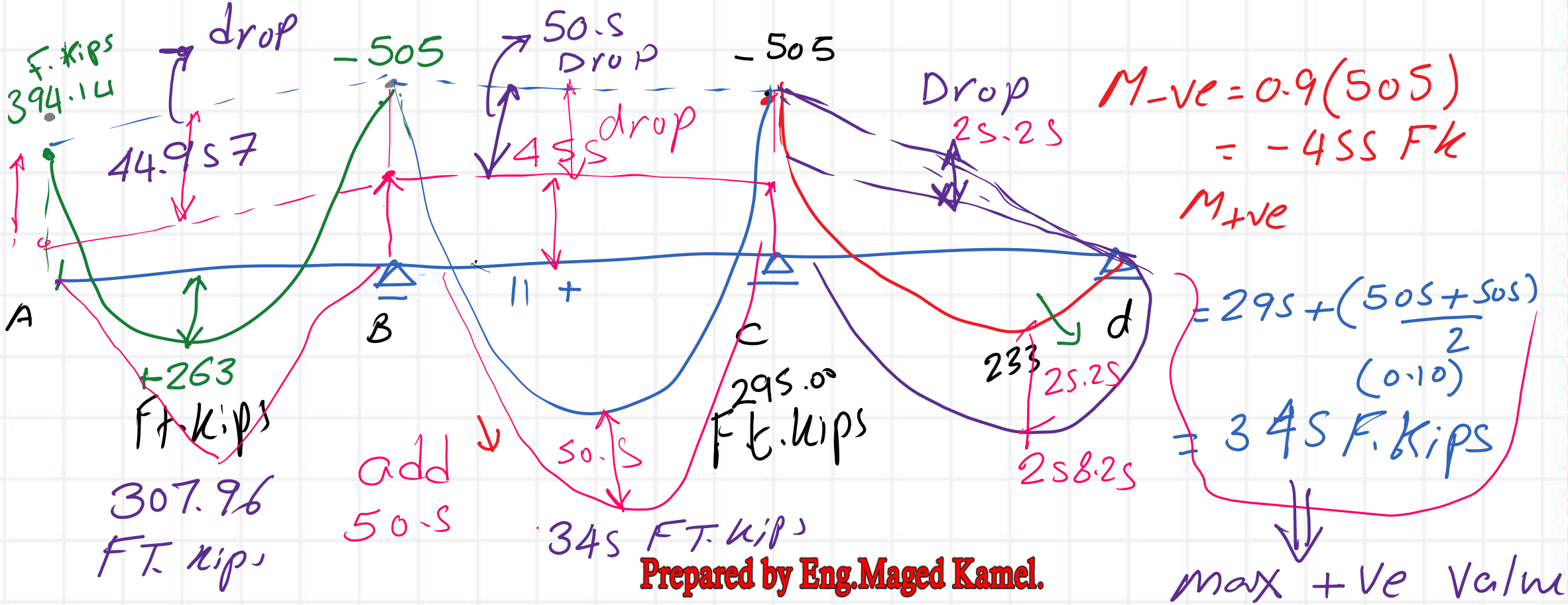


Analysis by Using 0.90 rule

Add 10% to +ve moment

deduct 10% From -ve moment





M-ve = 0.9(505)
= -455 Ft

M+ve

= 295 + (505+505)/2 (0.10)

= 345 F.kips

max +ve Value

Max -ve Value

$M_{D+L} = -455$ -ve FT.kips

Maximum +ve Value

M_{DL} +ve (345) ft.kips

$\frac{M_n}{\Omega} \geq M_{Total}$ $\Omega = 1.67$

$M_n = f_y Z_x = 455\,(1.67) = 760$ Ft kips

$= 760(12) = 9118.2$ inch kips

$F_y = 50$ ksi

$Z_x = \frac{9118.20}{50} = 182.36$ inch^3

Table 3.2 $\Rightarrow$ For design

ASD Design

Maximum M

$\max(455, 345) = 455$ (-ve, +ve) FT. kips

Z_x required = 182.36 inch³

⇒ ASD

Z_x

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

F_y = 50 ksi

Design ⇒ MD = 455 FT. kip

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF/Ω_b	$\phi_b BF$	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
		kip-ft	kip-ft	kip-ft	kip-ft	kips	kips				kips	kips
	in.³	ASD	LRFD	ASD	LRFD	ASD	LRFD	ft	ft	in.⁴	ASD	LRFD
W24×84	**224**	**559**	840	**342**	515	**16.2**	24.2	**6.89**	**20.3**	**2370**	**227**	340
W21×93	221	551	829	335	504	14.6	22.0	6.50	21.3	2070	251	376
W12×136	214	534	803	325	488	4.02	6.06	11.2	63.2	1240	212	318
W14×120	212	529	795	332	499	5.09	7.65	13.2	51.9	1380	171	257
W18×97	211	526	791	328	494	9.41	14.1	9.36	30.4	1750	199	299
W24×76	**200**	**499**	**750**	**307**	462	**15.1**	22.6	**6.78**	**19.5**	**2100**	**210**	**315**
W16×100	198	494	743	306	459	7.86	11.9	8.87	32.8	1490	199	298
W21×83	196	489	735	299	449	13.8	20.8	6.46	20.2	1830	220	331
W14×109	192	479	720	302	454	5.01	7.54	13.2	48.5	1240	150	225
W18×86	186	464	698	290	436	9.01	13.6	9.29	28.6	1530	177	265
W12×120	186	464	698	285	428	3.94	5.95	11.1	56.5	1070	186	279

Z_x = 182.36 inch³ required

Z_x selected = 200 inch³

W 24 x 76

M_P/Ω = 499 Ftk > 455 Ftk