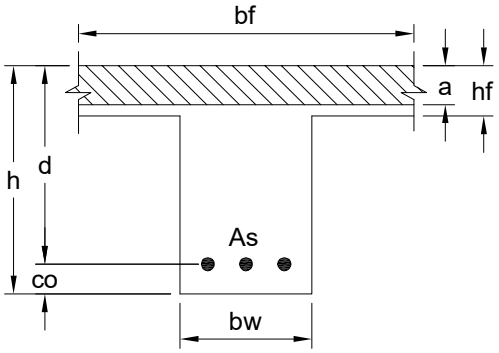
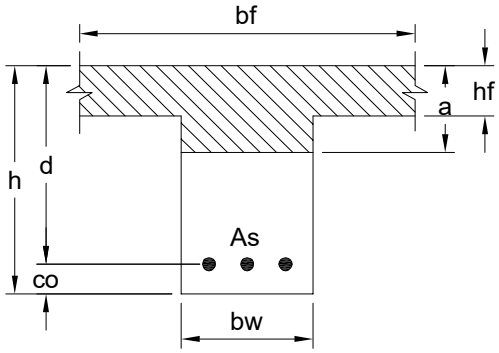
Design of Flanged Section with Tension Reinforcement only as per ACI 318-11 Chapters 9 & 10



Design as Rectangular Section



Design as Flanged Section

System

Width of Concrete Flange, b_f=			30.0 in
Width of Concrete Web, b_w=			10.0 in
Depth of Concrete Section, h=			20.0 in
Thickness of Top Flange, h_f=			2.5 in
Concrete Cover, co=			1.0 in
Effective Depth of Concrete Section, d=	h - co = 20.0 - 1.0	=	19.0 in

Load

Bending Moment due to Dead Load, M_D=			72.0 kip*ft
Bending Moment due to Live Load, M_L=			196.0 kip*ft
Ultimate Bending Moment, M_U=	$(1.2*M_D)+(1.6*M_L)$	=	400.0 kip*ft

Material Properties

Concrete Strength, f'_c=			4000 psi
Yield Strength of Reinforcement, f_y=			60000 psi
Tension Strength Reduction Factor (According to Cl.9.3.2 of ACI318), Φ=			0.90
Factor for Rectangular Compressive Stress Block (According to Cl.10.2.7.3 of ACI318),			
β_1=	IF(f'_c≤4000;0.85;IF(f'_c≥8000;0.65;1.05-0.00005*f'_c))	=	0.85

Design as Flanged Section

Compressive Strength of Flange, C_f=	$0.85*f'_c*h_f*\frac{b_f-b_w}{1000}$	=	170.0 kips
Area of Reinforcement for Flange in Compression, A_{sf}=	$\frac{C_f}{f_y}*1000$	=	2.83 in^2
Nominal Moment for Flange, M_{nf}=	$\frac{A_{sf}*f_y}{12000}*\left(d-\frac{h_f}{2}\right)$	=	251.2 kip*ft
Nominal Moment for Web, M_{nw}=	$M_U/\Phi-M_{nf}$	=	193.24 kip*ft

R_{nw}= $\dfrac{M_{nw} * 12000}{\Phi * b_w * d^2}$ = 713.7 psi

ρ_w= $0.85 * f'_c / f_y * \left(1 - \sqrt{1 - \dfrac{2 * R_{nw}}{0.85 * f'_c}}\right)$ = 0.0135

Area of Reinforcement for Web in Compression, A_{sw}= $\rho_w * b_w * d$ = 2.56 in^2

Required Area of Reinforcement, A_{s_T}= $A_{sf} + A_{sw}$ = 5.39 in^2

Depth of Rectangular Stress Block for Web, a_w= $\dfrac{A_{sw} * f_y}{0.85 * f'_c * b_w}$ = 4.52 in

Design as Rectangular Section

R_n= $\dfrac{M_U * 12000}{\Phi * b_f * d^2}$ = 492.46 psi

ρ= $0.85 * \dfrac{f'_c}{f_y} * \left(1 - \sqrt{1 - \dfrac{2 * R_n}{0.85 * f'_c}}\right)$ = 0.0089

Area of Reinforcement, A_{s_R}= $\rho * b_f * d$ = 5.07 in^2

Depth of Rectangular Stress Block, a= $\dfrac{A_{s\_R} * f_y}{0.85 * f'_c * b_f}$ = 2.98 in

Section Type and Reinforcement

Section Design as: IF(a>h_f; "Flanged Sec."; "Rectangular Sec.") = Flanged Sec.

Area of Reinforcement, A_s= IF(a>h_f; A_{s_T}; A_{s_R}) = 5.39 in^2

Minimum Area of Reinforcement (According to Cl.10.5 of ACI318),

A_{s_min1}= $\dfrac{3 * \sqrt{f'_c} * b_f * d}{fy}$ = 1.80 in^2

A_{s_min2}= $\dfrac{200 * b_f * d}{fy}$ = 1.90 in^2

A_{s_min}= MAX(A_{s_min1} ; A_{s_min2}) = 1.90 in^2

Required Area of Reinforcement, A_{sc_Req}= MAX(A_s; A_{s_min}) = 5.39 in^2

Provided Reinforcement, Bar= SEL("ACI/Bar"; Bar;) = No.10

Provided Reinforcement, A_{sb}= TAB("ACI/Bar"; Asb; Bar=Bar) = 1.27 in^2

Number of Bars, n= 5

Vertical Reinforcement, A_{sc_Prov}= $A_{sb} * n$ = 6.35 in^2

Check Validity= IF($A_{sc\_Prov} \geq A_{sc\_Req}$; "Valid"; "Invalid") = Valid

Check Tension Controlled

Distance from Extreme Compression Fiber to Neutral Axis,

c=	IF(a>h_f; a_w/β_1;a/β_1)	=	5.32 in
c/d =	c / d = 5.32 / 19.0	=	0.280
IF(c/d>0.375; "Add Com. RFT"; "Tension Controlled")		=	Tension Controlled

Design Summary

Required Area of Reinforcement, A_{sc}=	A_{sc_Prov}	=	6.35 in^2