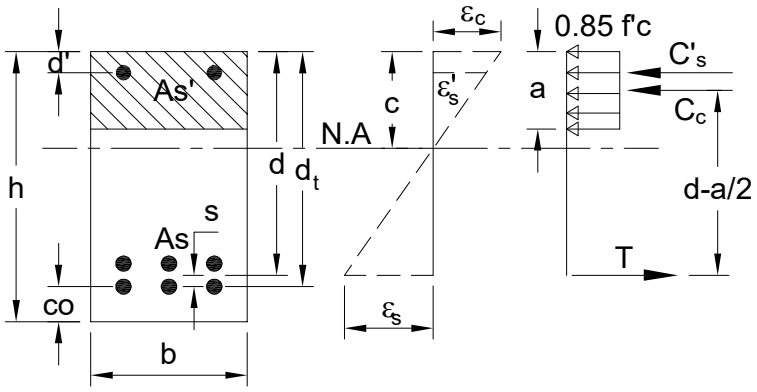
Design of Rectangular Section with Compression Reinforcement as per ACI 318-11 Chapters 9 & 10



System

Width of Concrete Section, b=		12.0 in
Depth of Concrete Section, h=		32.5 in
Concrete Cover, co=		2.5 in
Effective Depth of Concrete Section to Extreme Layer , d_t= h - co = 32.5 - 2.5	=	30.0 in
Distance between C.G of Tension Reinforcement and Extreme Layer, s=		1.2 in
Effective Depth of Concrete Section to C.G of Tension Reinforcement, d=d_t - s	=	28.8 in
Depth of Compression Reinforcement, d'=		2.5 in

Load

Bending Moment due to Dead Load, M_D=		430.0 kip*ft
Bending Moment due to Live Load, M_L=		175.0 kip*ft
Ultimate Bending Moment, M_U= $(1.2*M_D)+(1.6*M_L)$	=	796.0 kip*ft

Material Properties

Concrete Strength, f'_c=		4000 psi
Yield Strength of Reinforcement, f_y=		60000 psi
Modulus of Elasticity of Reinforcement, E_s=		29000000 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),		
β_1= IF(f'_c≤4000;0.85;IF(f'_c≥8000;0.65;1.05-0.00005*f'_c))	=	0.85

Check If Compression Reinforcement is Required

ω_t=	$0.31875*\beta_1$	=	0.271
R_{nt}=	$\omega_t*(1-0.59*\omega_t)*f'_c$	=	910.7 pci
R_n=	$\frac{M_U*12000}{\Phi*b*d_t^2}$	=	982.7 psi
Compression Reinforcement is:	IF(R_n>R_{nt};"Required";"Not Required")	=	Required

Determine Required Moment Resisted by Compression Reinforcement

ω_t=	$0.31875*\beta_1$	= 0.271
ρ_t =	$0.31875 * f'_c * \beta_1 / f_y$	=0.01806
ρ=	ρ_t*d_t/d	=0.01881
ω=	$\rho*f_y/f'_c$	=0.28215
Moment Resisted by Tension RFT, M_{nt}=	$\omega*(1-0.59*\omega)*\frac{f'_c*b*d^2}{12000}$	= 780.3 kip*ft
Moment Resisted by Compression RFT, $M'_n = M_U/\Phi - M_{nt}$		= 104.1 kip*ft

Required Area of Compression Reinforcement

d'/c_{limit}=	$1-\frac{f_y}{E_s*0.003}$	= 0.31
c_{limit}=	$\left(1-\frac{(f_y)}{E_s*0.003}\right)*d_t$	= 9.3 in
c_{cal}=	$0.375*d_t$	= 11.3 in
d'/c_{cal}=	$d'/(c_{cal})$	= 0.22
f'_{si}=	$MIN(0.003*E_s*(1-d'/c_{cal}); f_y)$	= 60000 psi
f'_s=	$IF(d'/c_{cal} \le d'/c_{limit}; f_y; f'_{si})$	= 60000 psi
Required Reinforcement Area for Compression, A'_s=	$\frac{M'_n*12000}{f'_s*(d-d')}$	= 0.79 in^2
Provided Reinforcement, Bar=	SEL("ACI/Bar"; Bar;)	= No.6
Provided Reinforcement, A_{sb}=	TAB("ACI/Bar"; Asb; Bar=Bar)	= 0.44 in^2
Number of Bars, n=		2
Vertical Reinforcement, A'_{s_Prov}=	$A_{sb} * n$	= 0.88 in^2
Check Validity=	$IF(A'_{s\_Prov} \ge A'_s; "Valid"; "Invalid")$	= Valid
Required Reinforcement Area for Tension, A_s=	$A'_s + (\rho*b*d)$	= 7.29 in^2

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

A_{s_min1}=	$\frac{3*\sqrt{f'_c}*b*d}{f_y}$	= 1.09 in^2
A_{s_min2}=	$\frac{200*b*d}{f_y}$	= 1.15 in^2
A_{s_min}=	$MAX(A_{s\_min1}; A_{s\_min2})$	= 1.15 in^2
Required Area of Reinforcement, A_{sc_Req}=	$MAX(A_s; A_{s\_min})$	= 7.29 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=			6
Vertical Reinforcement, A_{sc_Prov}=	A_{sb} * n	=	7.62 in^2
Check Validity=	IF($A_{sc\_Prov} \geq A_{sc\_Req}$; "Valid"; "Invalid")	=	Valid

Design Summary

Required Reinforcement Area for Compression, A'_s=	A'_{s_Prov}	=	0.88 in^2
Required Area of Reinforcement, A_{sc}=	A_{sc_Prov}	=	7.62 in^2