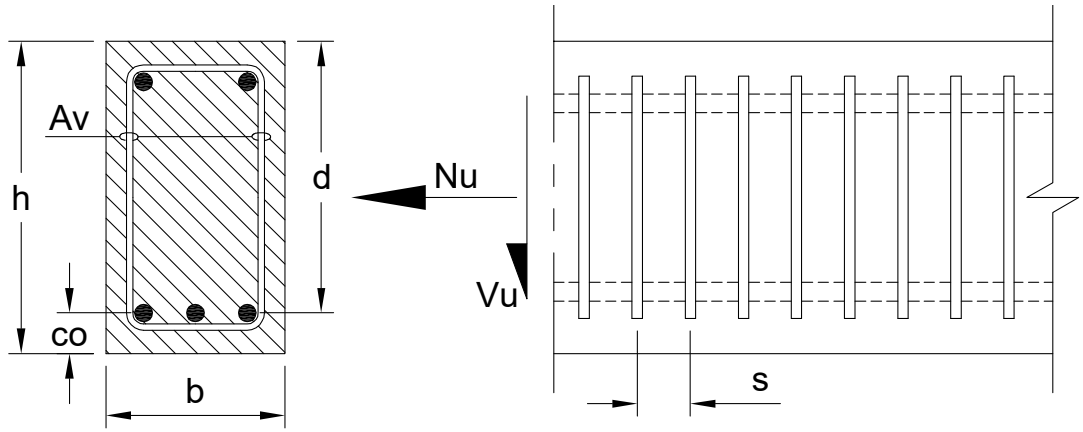
Design of Shear Reinforcement for Section Subject to Shear & Axial Tension

As per ACI318-11 Chapter 11



System

Width of Concrete Section, b=			10.5 in
Depth of Concrete Section, h=			18.0 in
Concrete Cover, co=			2.0 in
Effective Depth of Concrete Section, d=	h - co	=	16.0 in

Load

Shear Force due to Dead Load, V_D=			12.8 kips
Shear Force due to Live Load, V_L=			9.0 kips
Ultimate Shear Force, V_u=	$(1.2*V_D)+(1.6*V_L)$	=	29.8 kips
Axial Tension Force due to Dead Load, N_D=			-2.0 kips
Axial Tension Force due to Live Load, N_L=			-15.2 kips
Ultimate Axial Tension Force, N_u=	$(1.2*N_D)+(1.6*N_L)$	=	-26.7 kips

Material Properties

Concrete Strength, f'_c=	3600 psi
Yield Strength of Reinforcement, f_y=	40000 psi
Shear Strength Reduction Factor (According to Cl.9.3.2 of ACI318), Φ=	0.75
Modification Factor for Lightweight Concrete, λ=	0.85

Determine Concrete Shear Strength

Nominal Shear Strength provided by Concrete (According to Eq. 11-8 of ACI318),

$V_c = 2*\left(1+\frac{N_u*1000}{500*h*b}\right)*\lambda*\frac{\sqrt{f'_c}*b*d}{1000}$ = 12.3 kips

Shear Reinforcement is : IF(V_u>Φ∗V_c;"Required";"Not Required") = Required

Determine Area of Shear Reinforcement

Nominal Shear Strength provided by Reinforcement (According to Eq. 11-2 of ACI318),

$V_s = \dfrac{V_u - \Phi * V_c}{\Phi}$ = 27.4 kips

Maximum Allowable Shear Strength provided by Reinforcement (According to Cl.11.4.7.9 of ACI318),

$V_{s\_max} = 8 * \lambda * \dfrac{\sqrt{f'_c} * b * d}{1000}$ = 68.5 kips

$IF(V_s > V_{s\_max};$ "Increase Beam Dimension"; "OK") = OK

Spacing of Provided Stirrups, s= 5.0 in

Required Area of Reinforcement, $A_v = \dfrac{V_s * s * 1000}{f_y * d}$ = 0.21 in^2

Minimum Area of Reinforcement (According to Cl.11.4.6.3 of ACI318),

$A_{v\_min1} = \dfrac{0.75 * \sqrt{f'_c} * b * s}{f_y}$ = 0.06 in^2

$A_{v\_min2} = \dfrac{50 * b * s}{f_y}$ = 0.07 in^2

$A_{v\_min} = MAX(A_{v\_min1}; A_{v\_min2})$ = 0.07 in^2

Required Area of Reinforcement, $A_{vc\_Req} = MAX(A_v; A_{v\_min})$ = 0.21 in^2

Provided Reinforcement, Bar= SEL("ACI/Bar"; Bar;) = No.3

Provided Reinforcement, A_{sb}= TAB("ACI/Bar"; Asb; Bar=Bar) = 0.11 in^2

Number of Stirrups, n= 1

Provided Area of Reinforcement, $A_{vc\_Prov} = A_{sb} * n * 2$ = 0.22 in^2

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

Determine Maximum Permissible Spacing of Stirrups

Allowable Shear Strength provided by Reinforcement for Spacing Limit (According to Cl.11.4.5.3 of ACI318),

$V_{s\_limit} = 4 * \lambda * \dfrac{\sqrt{f'_c} * b * d}{1000}$ = 34.3 kips

Factor for Maximum Spacing of Stirrups, Fac= $IF(V_s \leq V_{s\_limit};1;0.5)$ = 1.0

Maximum Spacing of Stirrups (According to Cl.11.4.5.1 of ACI318),

$s_{max} = MIN(d / 2;24) * Fac$ = 8.00 in

Check Validity= $IF(s \leq s_{max};$"Valid"; "Invalid") = Valid

Design Summary

Provided Area of Shear Reinforcement, $A_{vc\_Prov} = A_{vc\_Prov}$ = 0.22 in^2

Spacing of Stirrups, s= s = 5.00 in