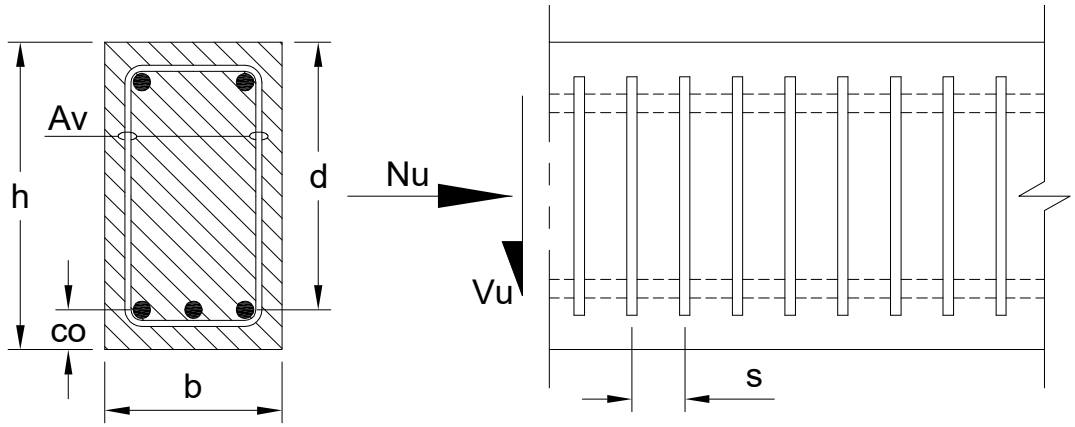
Design of Shear Reinforcement for Section Subject to Shear & Axial Compression

As per ACI318-11 Chapter 11



System

Width of Concrete Section, b=			12.0 in
Depth of Concrete Section, h=			16.0 in
Concrete Cover, co=			2.25 in
Effective Depth of Concrete Section, d=	h - co	=	13.75 in

Load

Shear Force due to Dead Load, V_D=			10.0 kips
Shear Force due to Live Load, V_L=			5.0 kips
Ultimate Shear Force, V_u=	$(1.2*V_D)+(1.6*V_L)$	=	20.0 kips
Axial Compression Force due to Dead Load, N_D=			4.2 kips
Axial Compression Force due to Live Load, N_L=			3.1 kips
Ultimate Axial Compression Force, N_u=	$(1.2*N_D)+(1.6*N_L)$	=	10.0 kips

Material Properties

Concrete Strength, f'_c=	4000 psi
Yield Strength of Reinforcement, f_y=	60000 psi
Shear Strength Reduction Factor (According to Cl.9.3.2 of ACI318), Φ=	0.75
Modification Factor for Lightweight Concrete, λ=	1.00

Determine Concrete Shear Strength

Nominal Shear Strength provided by Concrete (According to Eq. 11-4 of ACI318),

V_c=	$2*\left(1+\frac{N_u*1000}{2000*h*b}\right)*\lambda*\frac{\sqrt{f'_c}*b*d}{1000}$	=	21.4 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=	$\frac{V_u - \Phi * V_c}{\Phi}$	=	5.3 kips

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

V_{s_max}=	$8 * \lambda * \frac{\sqrt{f'_c} * b * d}{1000}$	=	83.5 kips
IF(V_s>V_{s_max}; "Increase Beam Dimension"; "OK")		=	OK
Spacing of Provided Stirrups, s=			6.75 in
Required Area of Reinforcement, A_v=	$\frac{V_s * s * 1000}{f_y * d}$	=	0.04 in^2

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

A_{v_min1}=	$\frac{0.75 * \sqrt{f'_c} * b * s}{f_y}$	=	0.06 in^2
A_{v_min2}=	$\frac{50 * b * s}{f_y}$	=	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})	=	0.07 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}=	$4 * \lambda * \sqrt{f'_c} * b * d / 1000$	=	41.7 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	=	6.88 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	=	6.75 in