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Capacity of Rectangular Post-Tensioned Section;

Concrete compressive strength;	$f'_c=4000\text{psi}$
Depth of equivalent stress block;	$\beta_1=0.85$
Nonstressed Steel Strength;	$f_{yn}=60\text{ksi};$
Span Length;	$L=55\text{ft};$
Thickness/Depth of cross section;	$h=30\text{in};$
Tributary width;	$b=24\text{in};$
Depth to non-stressed tension reinforcement;	$dt=26\text{in};$
Depth to non-stressed compression reinforcement;	$dc=0\text{in};$
Depth to stressed reinforcement;	$dp=27\text{in};$
Ultimate stress of prestressed strand;	$f_{pu}=270\text{ksi};$
Yield stress of prestressed strand (use 0.9 for low relax);	$f_{py}=248\text{ksi}$
Jacking Stress;	$f_{pj}=189\text{ksi}$
Effective stress in prestressed strand (after losses);	$f_{se}=160\text{ksi};$
Assumed stress loss;	$fl=f_{pj}-f_{se}; \quad fl=29.0000\text{ksi};$
Modulus of Elasticity of strand;	$E_p=28500\text{ksi};$
Modulus of Elasticity of nonstressed steel;	$E_m=29000\text{ksi};$
Area of nonprestressed tension reinforcement;	$A_s=4.0\text{in}^2;$
Area of nonprestressed compression reinforcement;	$A_{s'}=0\text{in}^2;$
Area of prestressed strands;	$A_{ps}=2.188\text{in}^2;$
Effective Force;	$F_{se}=f_{se}*A_{ps}; \quad F_{se}=350.0800\text{kips};$
Resistance factor for flexure;;	$\phi_b=0.9;$
Resistance Factor for shear;	$\phi_v=0.75;$

Presstressed reinforcement ratio;	$P_p=A_{ps}/(dp*b);$	$P_p=0.0034;$
Nonstressed tension reinforcement ratio;	$P=A_s/(dt*b);$	$P=0.0064$
Nonstressed compression reinforcement ratio;	$P'=A_{s'}/(dt*b);$	$P=0.0064;$
Span to Depth Ratio;	$SD=L/h;$	$SD=22.0000;$

Flexural Strength;

If f_{se} is greater than $0.5*f_{pu}$ than approximate methods may be used;

Check if approximate methods are applicable; $Ch1=\text{if}(f_{se}>0.5*f_{pu}, \text{"Yes"}, \text{"No"}); \quad Ch1=\text{"Yes"}$

Flexural Strength Approximate Method;

Members with Bonded Strands;

Factor for prestressing type; $\gamma_p=0.28;$
 "0.55 For deformed ($f_{py}/f_{pu} \geq 0.8$)"
 "0.4 For stress-relieved wire and strands, and plain bars ($f_{py}/f_{pu} \geq 0.85$)"
 "0.28 For low-relaxation wire and strands (f_{py}/f_{pu})"

Use;;

Tension reinforcement index;	$\omega=P*f_{yn}/f'_c;$	$\omega=0.0962;$
Compression reinforcement index;	$\omega'=P'*f_{yn}/f'_c;;$	$\omega'=0.0962;$
Stress in prestress strand variable;	$Vr1=P_p*f_{pu}/f'_c+dt/dp*(\omega-\omega');$	$Vr1=0.2279;$
Stress in prestress strand (bonded);	$f_{psb}=f_{pu}*(1-(\gamma_p/\beta_1)*(Vr1));$	$f_{psb}=249.7288\text{ksi};$

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If compression reinforcement is taken into account then $Vr1$ shall be greater than 0.17 and d' not less than $0.15 \cdot dp$; Check

$ChVr1 = \text{if}(\text{and}(Vr1 > 0.17, dc > 0.15 \cdot dp), "OK", "NG");$ $ChVr1 = \text{"OK"}$

Members with Unbonded Strands;

For span to depth ratio less than or equal to 35;

$f_{psu1} = \min(f_{se} + 10 \text{ksi} + f'c / (100 \cdot P_p), f_{py}, f_{se} + 60 \text{ksi});$ $f_{psu1} = 181.8464 \text{ksi}$

For span to depth ratio greater than 35;

$f_{psu2} = \min(f_{se} + 10 \text{ksi} + f'c / (300 \cdot P_p), f_{py}, f_{se} + 60 \text{ksi});$ $f_{psu2} = 173.9488 \text{ksi}$

Stress in prestress strand (Unbonded);

$f_{psu} = \text{if}(SD > 35, f_{psu2}, f_{psu1});$ $f_{psu} = 181.8464 \text{ksi}$

Use bonded (1) or unbonded (2) Strand;

Strand=1;

Stress in prestress strand;

$f_{ps} = \text{if}(\text{Strand} == 1, f_{psb}, f_{psu});$ $f_{ps} = 249.7288 \text{ksi}$

Depth of Compression block;

$a = (A_{ps} \cdot f_{ps} + A_s \cdot f_{yn}) / (0.85 \cdot f'c \cdot b);$ $a = 0.8031$

Moment about centroid of compression block;

$M_n = A_{ps} \cdot f_{ps} \cdot (dp - 0.5 \cdot a) + A_s \cdot f_{yn} \cdot (dt - 0.5 \cdot a);$ $M_n = 1433628.9259$

Moment capacity;

$M_c = M_n \cdot \phi;$ $M_c = 1290.2660 \text{kip_ft}$

Strain Compatability to Find Moment Capacity;

"Assume Maximum concrete strain = 0.003"

For ASTM A 416 Grade 270 ksi low-relaxation, seven wire stress-strain relationships are as follows:

" $\epsilon_p \leq 0.0086$ then $f_{ps} = 28500 \text{ksi} \cdot \epsilon_{ps}$ "

" $\epsilon_p > 0.0086$ then $f_{ps} = 270 - 0.04 / (\epsilon_{ps} - 0.007)$ "

Effective strain in prestressing steel;

$e_{pe} = f_{se} / E_p;$

$e_{pe} = 0.0056;$

Location of neutral axis;

$c = 11.95 \text{in};$

Strain of nonstressed tension reinforcement;

$\epsilon_{nt} = 0.003 \cdot ((dt - c) / c);$

$\epsilon_{nt} = 0.0035;$

Strain of prestressed strand;

$\epsilon_{ps} = e_{pe} + 0.003 \cdot ((dp - c) / c);$

$\epsilon_{ps} = 0.0094;$

Stress of nonstressed tension reinforcement;

$f_t = \min(f_{yn}, E_m \cdot \epsilon_{nt});$

$f_t = 60.0000 \text{ksi};$

Stress of prestressed strand;

$f_p = \text{if}(e_{pe} \leq 0.0086, 28500 \text{ksi} \cdot \epsilon_{ps}, 270 - 0.04 / (\epsilon_{ps} - 0.007));$ $f_p = 267.6799 \text{ksi};$

Compressive stress block;

$a = \beta_1 \cdot c;$

$a = 10.1575 \text{in};$

Compressive force;

$C = 0.85 \cdot f'c \cdot a \cdot b;$

$C = 828.8520 \text{kip};$

Tension in nonstressed tension steel;

$T_t = f_t \cdot A_s;$

$T_t = 240.0000 \text{kip};$

Tension in prestressed steel;

$T_p = f_p \cdot A_{ps};$

$T_p = 585.6837 \text{kip};$

Check if " $C = T_t + T_p$ ";

$T_{tot} = T_t + T_p;$

$T_{tot} = 825.6837 \text{kip};$

$Chk3 = \text{if}(C < T_{tot}, "Inc. C", "Dec. C");$

$Chk3 = \text{"Dec. C"};$

Iterate values of c, Try New c equal to;

$Avg = (T_{tot} + C) / 2;$

$Avg = 827267.8285;$ $\%inc = (T_{tot} - Avg) / Avg;$

$\%inc = -0.0019;$

$Newc = \%inc \cdot c + c;$ $Newc = 11.9271 \text{in};$

Moment about centroid of compression block;

$M_n = T_t \cdot (dt - a/2) + T_p \cdot (dp - a/2);$

$M_n = 1488.3348 \text{kip_ft};$

Moment capacity; $M_c = \phi \cdot M_n;$

$M_c = 1339.5013 \text{kip_ft};$

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Shear;

Concrete Shear Nominal Capacity;	$V_n = 2 * (f'_c)^{0.5} * b * d_p / 1 \text{ in} * 1 \text{ lb}^{-1/2} * 1 \text{ lb};$	$V_n = 81.9662 \text{ kip};$
Shear Capacity;	$V_{cc} = \phi_v * V_n;$	$V_{cc} = 61.4747 \text{ kips}$
Steel Capacity;		
Area of shear reinforcement;	$A_v = 0.8 \text{ in}^2;$	
Yield strength of shear reinforcement;	$f_{yv} = 60 \text{ ksi};$	
Spacing;	$S = 12 \text{ in};$	
Nominal shear strength;	$V_{ns} = A_v * f_{yv} * d_p / S;$	$V_{ns} = 108.0000 \text{ kip};$
Shear reinforcement capacity;	$V_{cs} = V_{ns} * \phi_v;$	$V_{cs} = 81000.0000$
Section shear strength;	$V_c = V_{cc} + V_{cs};$	$V_c = 142.4747 \text{ kip};$