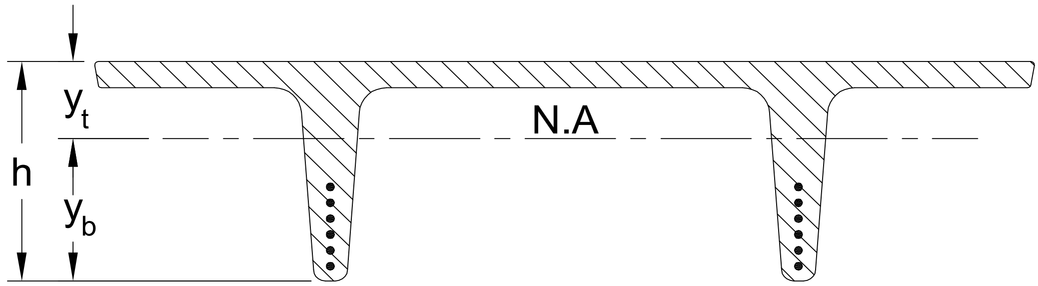
Estimating Prestress Losses as per ACI 318-11 Chapter 18



System

Area of Concrete Section, A_c=			449 in^2
Depth of Concrete Section, h=			24 in
Concrete Cover, co=			2 in
Effective Depth of Concrete Section, d=	h - co	=	22 in
Moment of Inertia for Concrete Section, I_c=			22469 in^4
Distance from Bottom Fiber to Neutral Axis, y_b=			17.77 in
Distance from Top Fiber to Neutral Axis, y_t=	$h - y_b$	=	6.23 in
Number of Strands, n=			8.0
Area of One Strand, A_s=			0.153 in^2
Eccentricity of Strands, e=			9.77 in
Volume per Surface Area, V.S=			1.35 in
Average Relative Humidity, RH=			75.00 %

Load

Factored Moment due to Dead Load, M_D=	1617 kip*in
Factored Moment due to Superimposed Dead Load, M_{SD}=	691 kip*in
Factored Moment due to Live Load, M_L=	1382.00 kip*in

Material Properties

Concrete Strength, f'_{ci}=			3500 psi
Concrete Strength, f'_c=			5000 psi
Tensile Strength of Prestressed Steel, f_{pu}=			270000 psi
Yield Strength of Prestressed Steel, f_{py}=	$0.9 * f_{pu}$	=	243000 psi
Jacking Stress, J_s=	$0.74 * f_{pu}$	=	199800 psi
Modification Factor for Lightweight Concrete, λ=			1.00
Modulus of Rupture (According to Eq. 9-10 of ACI318), f_r=	$7.5 * \lambda * \sqrt{f'_c}$	=	530 psi
Concrete Density, w_c=			150 psi

Modulus of Elasticity of Concrete (According to Cl. 8.5.1 of ACI318), Modulus of Elasticity for Initial Concrete, E_{ci}= $w_c^{1.5} * 33 * \sqrt{f'_{ci}}$ = 3586616 psi

Modulus of Elasticity for Concrete, E_c= $w_c^{1.5} * 33 * \sqrt{f'_c}$ = 4286826 psi

Modulus of Elasticity of Prestressed Steel, E_s= 28500000 psi

Calculation of Losses

1- Elastic Shortening of Concrete (ES)

Initial Force of Prestress, P_{pi}= J_s * (n * A_s)/1000 = 244.6 kips

Prestress Type= SEL("ACI/Kes" ;Type;) = Pretensioned

K_{es}= TAB("ACI/Kes" ;Kes ;Type=Type) = 1.00

K_{cir}= TAB("ACI/Kcir" ;Kcir ;Type=Type) = 0.90

f_{cir}= $K_{cir} * \left(\frac{P_{pi}}{A_c} + \frac{P_{pi}}{I_c} * e^2 \right) - \frac{M_D * e}{I_c}$ = 0.722 ksi

Elastic Shortening of Concrete, ES= $K_{es} * E_s * f_{cir} / E_{ci}$ = 5.74 ksi

2- Creep of Concrete (CR)

Prestress Type= SEL("ACI/Kcr" ;Type;) = Pretensioned

Factor of, Kcr= TAB("ACI/Kcr" ;Kcr ;Type=Type) = 2.00

Creep Losses, CR= $K_{cr} * \frac{E_s}{E_c} * \left(f_{cir} - M_{SD} * \frac{e}{I_c} \right)$ = 5.61 ksi

3- Shrinkage of Concrete (SH)

Prestress Type= SEL("ACI/Ksh" ;Type;) = Pretensioned

Factor of, K_{sh}= TAB("ACI/Ksh" ;Ksh ;Type=Type) = 1.00

Shrinkage Losses, SH= $8.2 * 10^{-6} * K_{sh} * \frac{E_s}{1000} * (1 - 0.06 * V.S) * (100 - RH)$ = 5.37 ksi

4- Relaxation of Tendon (RE)

Prestress Type= SEL("ACI/KreJ" ;Type;) = relaxation strand-Grade Low 270

Factor of, K_{re}= TAB("ACI/KreJ" ;Kre ;Type=Type) = 5000 psi

Factor of, J= TAB("ACI/KreJ" ;J ;Type=Type) = 0.04

Ratio of f_{pi}/f_{pu}, r= SEL("ACI/r" ;r;) = 0.74

Factor of, C= TAB("ACI/r" ;C ;r=r) = 0.95

Relaxation of Tendon, RE= $\left(\frac{K_{re}}{1000} - J * (SH + CR + ES) \right) * C$ = 4.11 ksi

5- Total Allowance of Losses and Effective Prestress Force after all Losses

Total Allowance of Losses, L_s= $ES + CR + SH + RE$ = 21 ksi

Effective Prestress Stress, f_{se}= $J_s / 1000 - L_s$ = 179 ksi

Effective Prestress Force after All Losses, P_e= fse $* (n * A_s)$ = 219 kips

Calculation Summary

Total Allowance of Losses, L_s= L_s = 21 ksi

Effective Prestress Force after All Losses, P_e= P_e = 219 kips