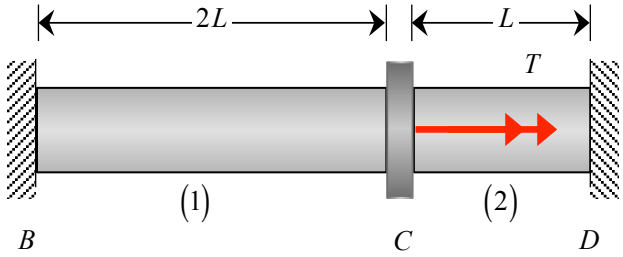
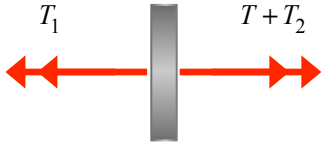
Summary: indeterminate shafts



Consider an axial torque T acting on a shaft with a circular cross section. To solve for torque in each element, use the four-step plan:



1. *EQUILIBRIUM*: $(1)\ \sum M = T_2 + T - T_1 = 0$

2. *TORQUE/ROTATION*: $(2)\ \Delta\phi_1 = \dfrac{T_1(2L)}{GI_P}$

   $(3)\ \Delta\phi_2 = \dfrac{T_2 L}{GI_P}$

3. *COMPATIBILITY:* $(4)\ \phi_C = \phi_B + \Delta\phi_1 = \Delta\phi_1$

   $(5)\ \phi_D = \phi_C + \Delta\phi_2 = \Delta\phi_1 + \Delta\phi_2 = 0$

4. *SOLVE:* $(2),(3),(5) \Rightarrow 2\dfrac{T_1 L}{GI_P} + \dfrac{T_2 L}{GI_P} = 0 \Rightarrow T_2 = -2T_1 \quad (6)$

   $(1),(6) \Rightarrow -2T_1 + T - T_1 = 0 \Rightarrow T_1 = \dfrac{1}{3}T \Rightarrow T_2 = -\dfrac{2}{3}T$