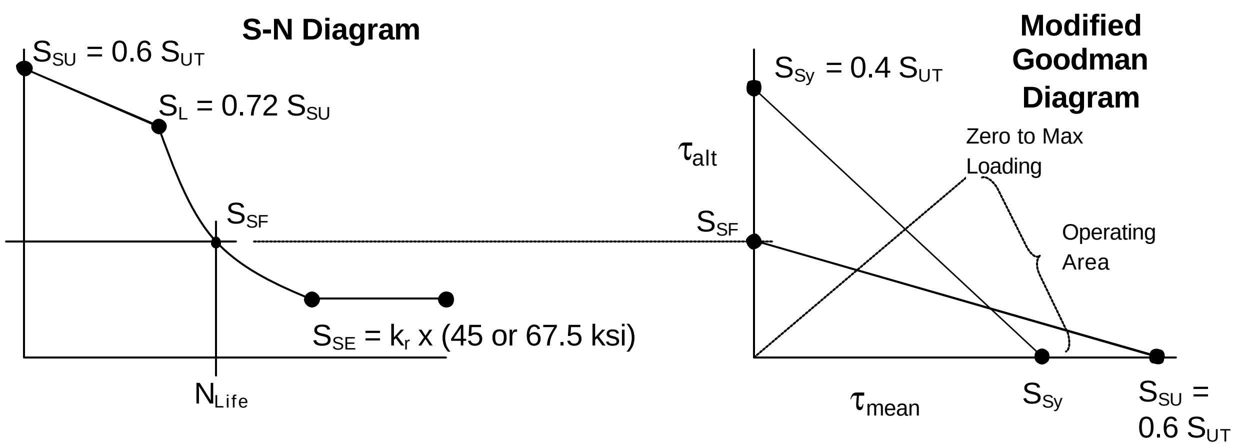
Fatigue / Cyclic Loading of Helical Springs

- Helical springs are NEVER used as both compression and extension springs (Hamrock, top of P. 796).
- Therefore, loading is never fully reversing, so we will be using the modified Goodman diagram instead of an S-N plot.
- BUT, if a finite life is specified, use the S-N diagram to compute the allowable shear stress for N cycles of life, to use in the Goodman diagram (S_{se}):
  - Use $S_L = 0.72\ S_{SU}$ because this is Torsional loading [Eq. 7.8]
  - S_{SU} is the shear ultimate strength:
    $S_{SU} = 0.60\ S_{UT}$ [Eq. 17.30]
  - Use $S'_{SE} = 45$ KSI for unpeened springs, and [Eq. 17.29]
    $S'_{SE} = 67.5$ KSI for peened springs (Hamrock, top of P. 797).
    for materials in Table 17.2 with wire diameter d < 3/8" (10mm).
  - Note that these S'_{SE} are corrected for ALL modification factors EXCEPT reliability, k_r.



- Apply the Wahl curvature correction factor to BOTH τ_{mean} and τ_{alt}.
- Procedure:
  A. Get the steady (mean) and alternating loads, P_m and P_a.
  B. Compute the mean and alternating shears, using K_{Wahl}:

$$\tau_{m,a} = \frac{8DK_W P_{m,a}}{\pi d^3}$$

  C. FOS against yielding:

$$n_s = \frac{S_{Sy}}{\tau_a + \tau_m} = \frac{0.4 S_{UT}}{\tau_{\max}}$$

  D. FOS against fatigue (Infinite life):

$$n_s = \frac{S_{SE}}{\tau_a}$$

  E. FOS against fatigue (Finite life):

$$n_s = \frac{S_{SF}}{\tau_a}$$