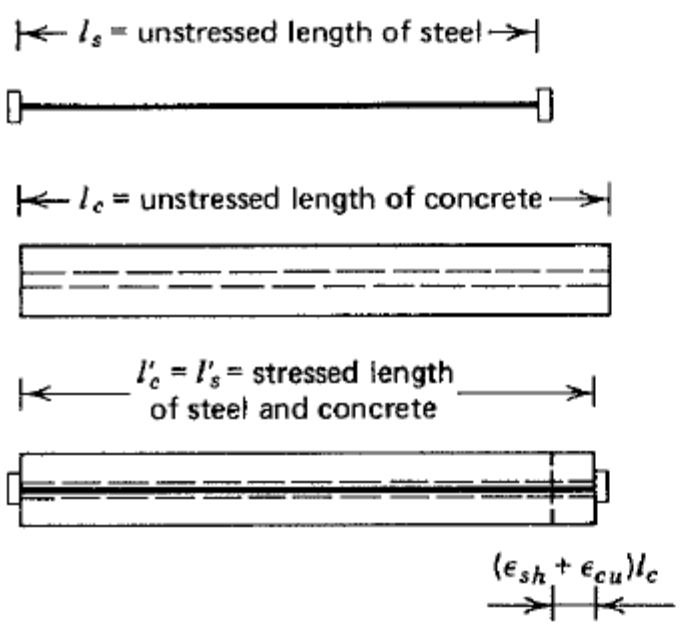
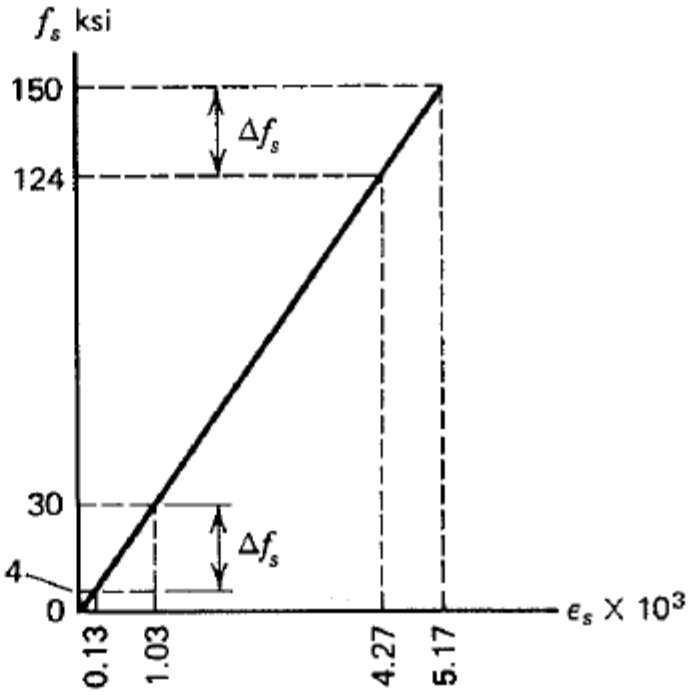
PRE-STRESSING-Introduction

- The structures and component members to be considered are composed of concrete, pre-stressed with steel tendons.
- The use of high strength steel for pre-stressing is necessary for basic physical reasons.
- The mechanical properties of this steel, are quite different from those of the steel used for ordinary reinforced concrete.
- In addition to the higher strength, the designer must account for differences in ductility, lack of a well-defined yield point, and other characteristics of great engineering significance.
- The concrete used in pre-stressed members is characteristically of higher compressive strength than that used for reinforced concrete.

PRE-STRESSING-High strength Steel

- Steel is stressed and after transfer, exact stress transfer was observed.
- In ordinary steel (30 ksi to 4 ksi), 87% loss was observed, however for high strength steel (150 to 124), 17% loss was observed.





PRE-STRESSING-Types of steel used

- There are three common forms in which steel is used for pre-stressed concrete tendons: cold-drawn round wires, stranded cable, and alloy steel bars.
- Grade designations for strand and bars, correspond to the minimum tensile strength in ksi units.
- For the widely used seven-wire strand, two grades are available: Grade
- 250 (f_{pu} = 250 ksi) and Grade 270.
- The higher strength Grade 270 strand is now more widely used than the lower strength strand.
- For alloy steel bars, two grades are used: the regular Grade 145 is most common, but special Grade 160 bars can be ordered.
- The minimum tensile strength for cold-drawn wires varies from 235 to 250 ksi, depending on diameter and type.

PRE-STRESSING-Round wires

Table 2.1 Properties of uncoated stress-relieved wire (ASTM A 421)

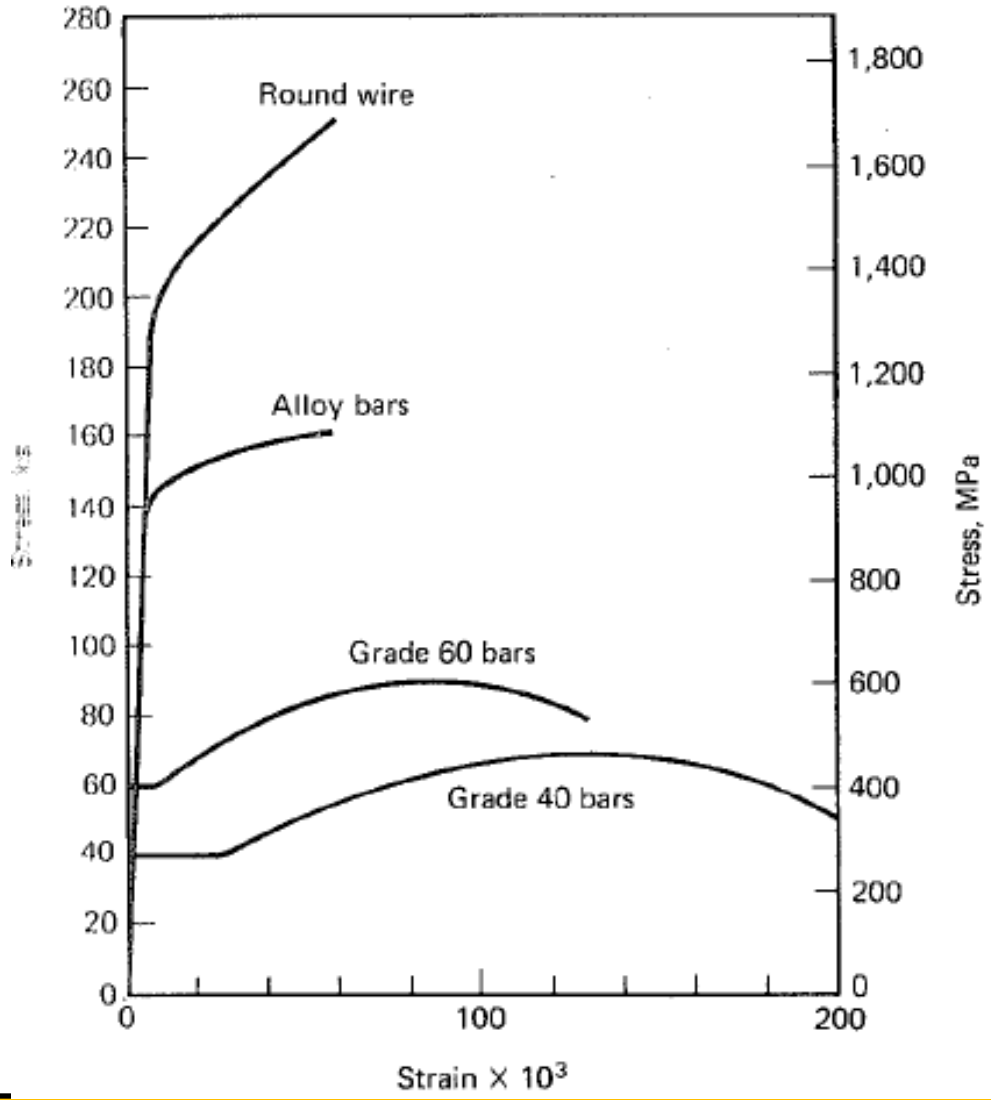
Nominal diameter in. (mm)	Minimum tensile strength psi (MPa)		Minimum stress at 1% extension psi (MPa)	
	Type BA	Type WA	Type BA	Type WA
0.192 (4.88)	[a]	250,000 (1725)	[a]	200,000 (1380)
0.196 (4.98)	240,000 (1655)	250,000 (1725)	192,000 (1325)	200,000 (1380)
0.250 (6.35)	240,000 (1655)	240,000 (1655)	192,000 (1325)	192,000 (1325)
0.276 (7.01)	[a]	235,000 (1622)	[a]	188,000 (1295)

PRE-STRESSING- Stranded Cable

Table 2.2 Properties of uncoated seven-wire stress-relieved strand (ASTM A 416)

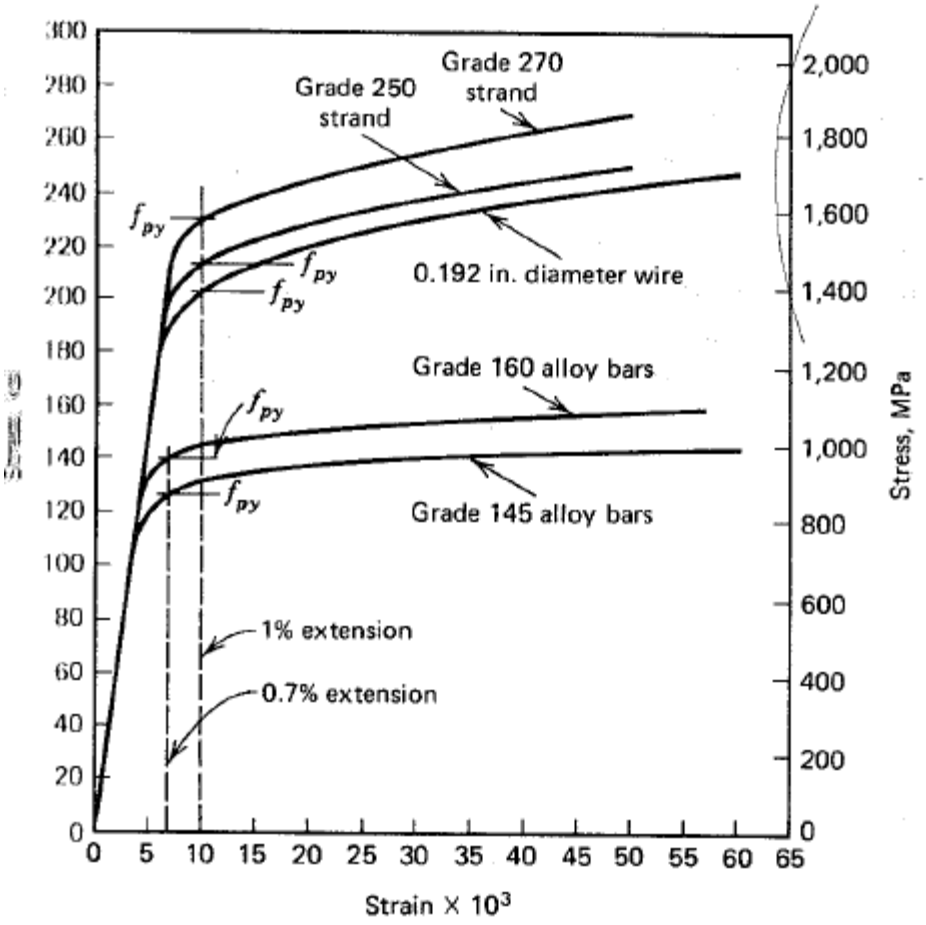
Nominal diameter in. (mm)	Breaking strength lb (kN)	Nominal area of strand in.^{2} (mm^2)	Minimum load at 1% extension lb (kN)
		Grade 250	
0.250 (6.35)	9,000 (40.0)	0.036 (23.22)	7,650 (34.0)
0.313 (7.94)	14,500 (64.5)	0.058 (37.42)	12,300 (54.7)
0.375 (9.53)	20,000 (89.0)	0.080 (51.61)	17,000 (75.6)
0.438 (11.11)	27,000 (120.1)	0.108 (69.68)	23,000 (102.3)
0.500 (12.70)	36,000 (160.1)	0.144 (92.90)	30,600 (136.2)
0.600 (15.24)	54,000 (240.2)	0.216 (139.35)	45,900 (204.2)
		Grade 270	
0.375 (9.53)	23,000 (102.3)	0.085 (54.84)	19,550 (87.0)
0.438 (11.11)	31,000 (137.9)	0.115 (74.19)	26,350 (117.2)
0.500 (12.70)	41,300 (183.7)	0.153 (98.71)	35,100 (156.1)
0.600 (15.24)	58,600 (260.7)	0.217 (140.00)	49,800 (221.5)

PRE-STRESSING- Stress strain prop.



PRE-STRESSING- Stress strain prop.

- For strands, yield stress is taken at 1% strain.
- For alloy bars, the yield stress is taken at 0.7% strain.



$E_p \approx 29{,}000$ ksi = 200 kN/mm^2 for wires
$E_p \approx 27{,}000$ ksi = 186 kN/mm^2 for strand
$E_p \approx 27{,}000$ ksi = 186 kN/mm^2 for bars

FIGURE 2.4 Typical stress – strain curves for prestressing steels.

PRE-STRESSING- Stress strain prop.

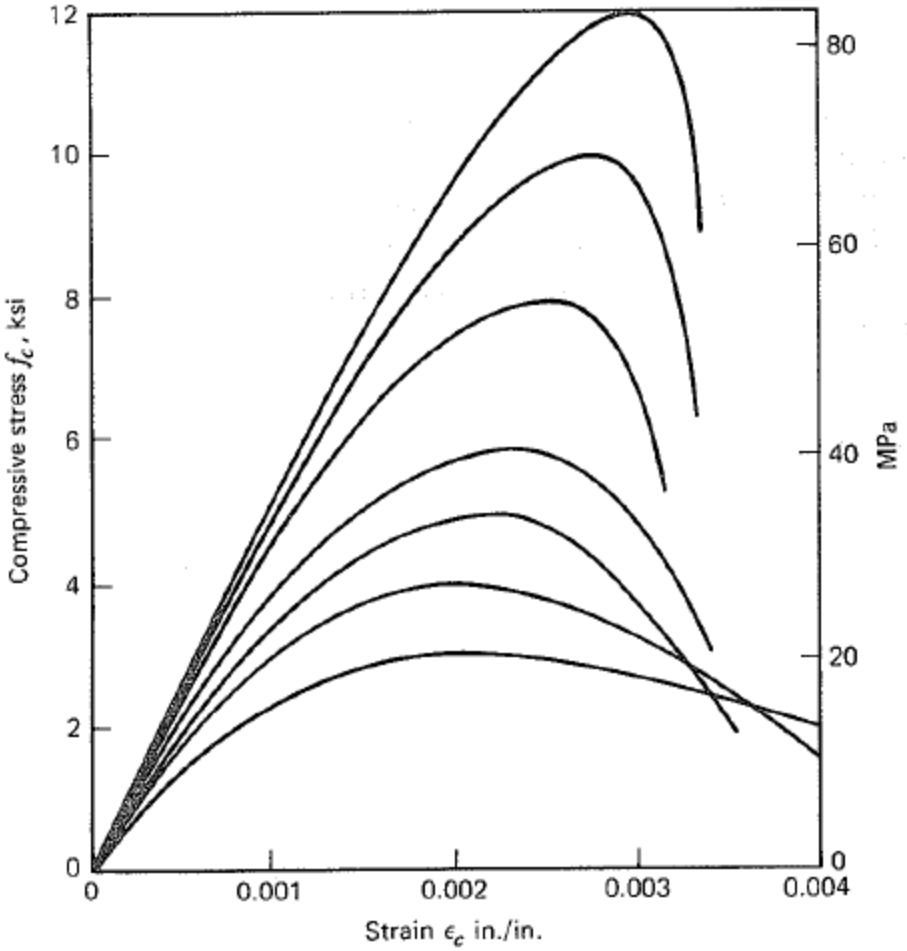
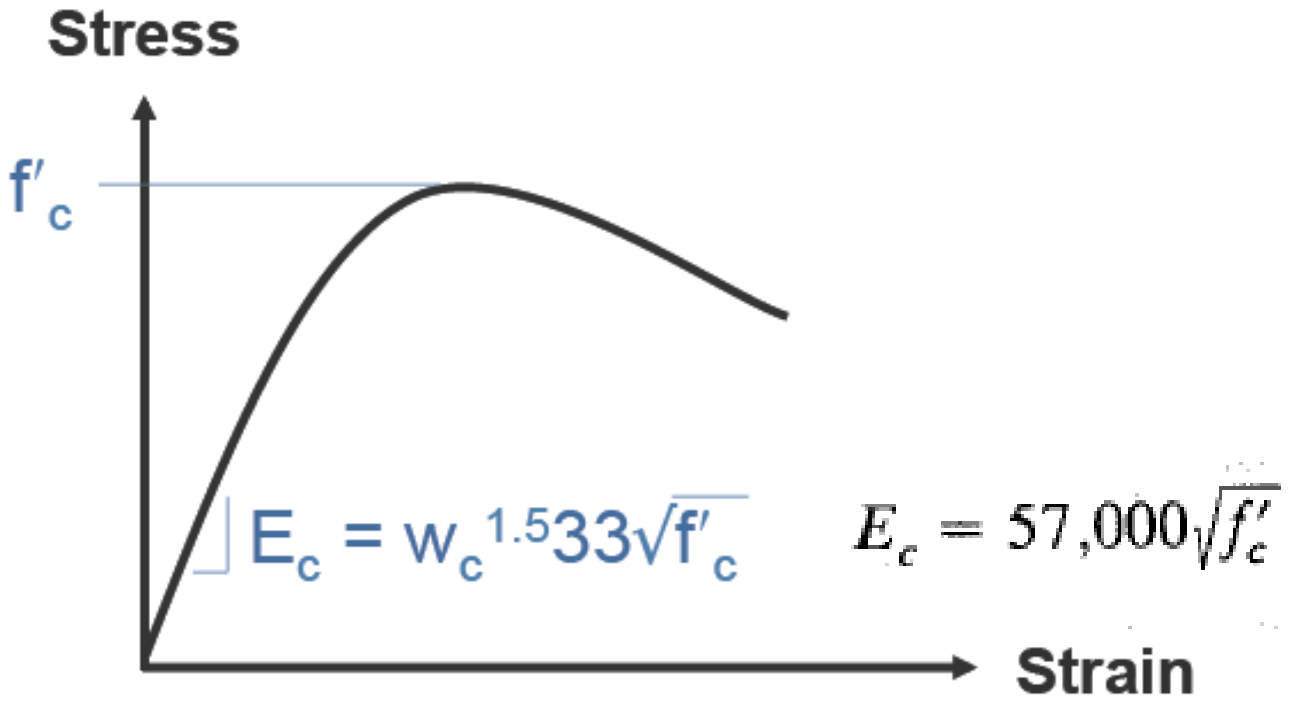


FIGURE 2.6 Typical compressive stress–strain curves for normal density concrete with w_c = 145 pcf. Adapted from Ref. 2.9.

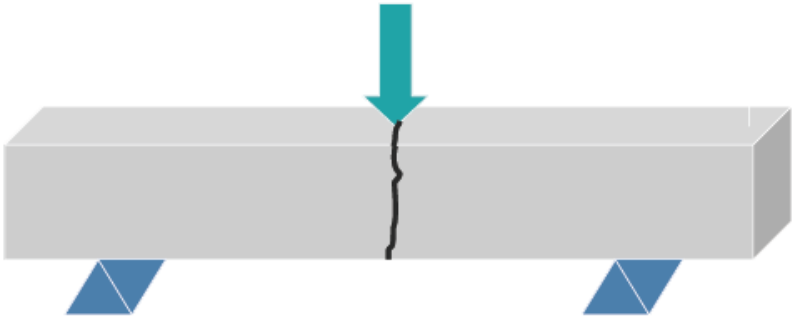
PRE-STRESSING- Stress strain prop.

- Compressive strength Curve



PRE-STRESSING- Tensile st. Of conc.

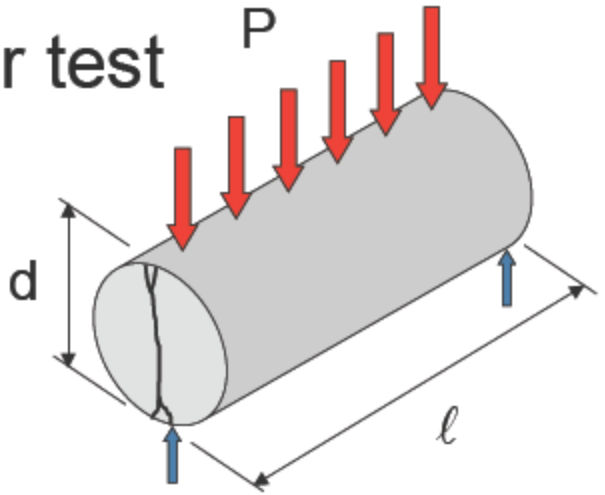
- Tensile strength
  - Varies between 8% and 15% of the compressive strength
    - Modulus of rupture (flexural test)



$$f_r = \frac{PL}{bh^2}$$ usually between $8\sqrt{f'_c}$ and $12\sqrt{f'_c}$,

PRE-STRESSING- Tensile st. Of conc.

- Split cylinder test



$$f_{ct} = \frac{2P}{\pi \ell d}$$