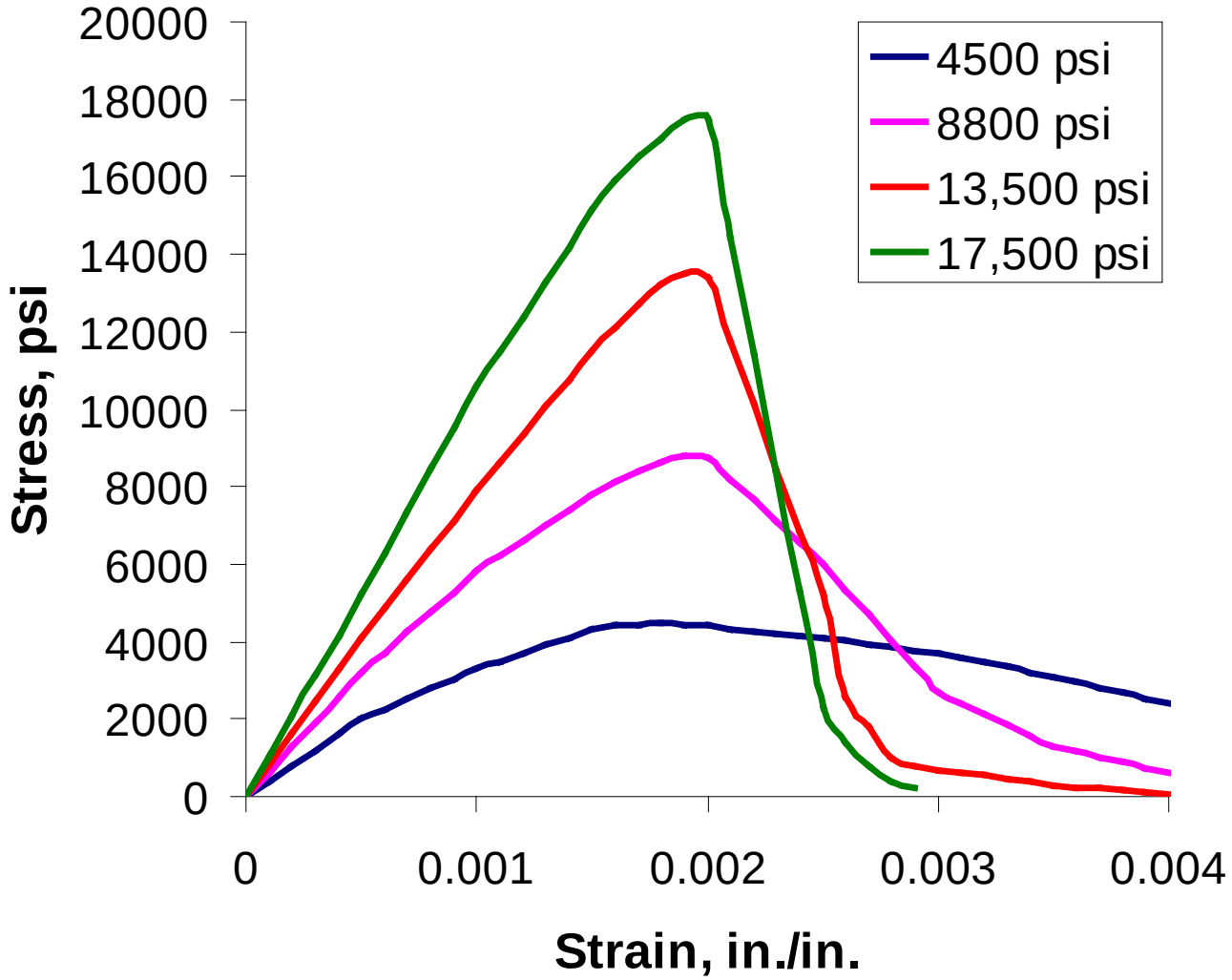
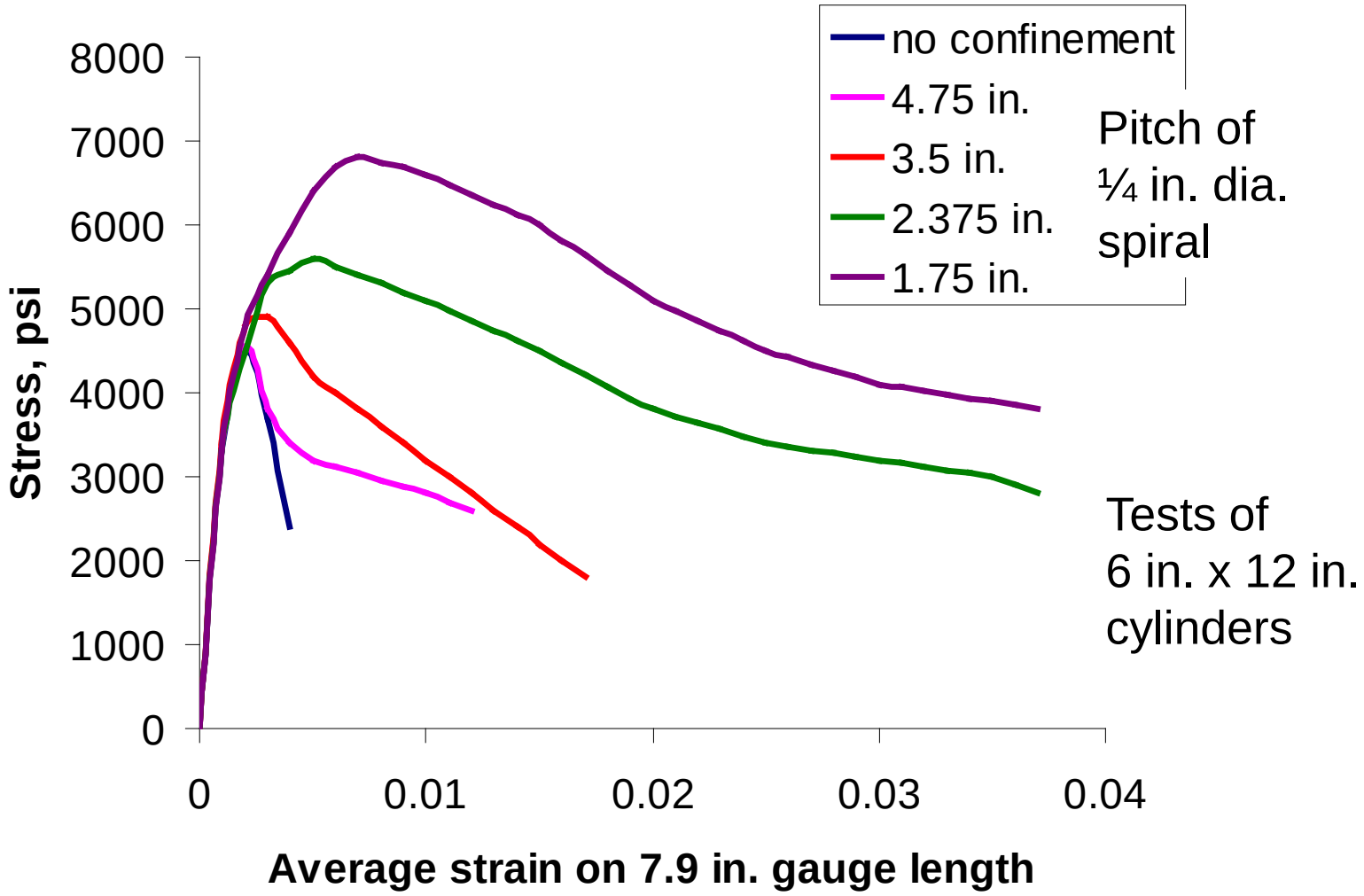
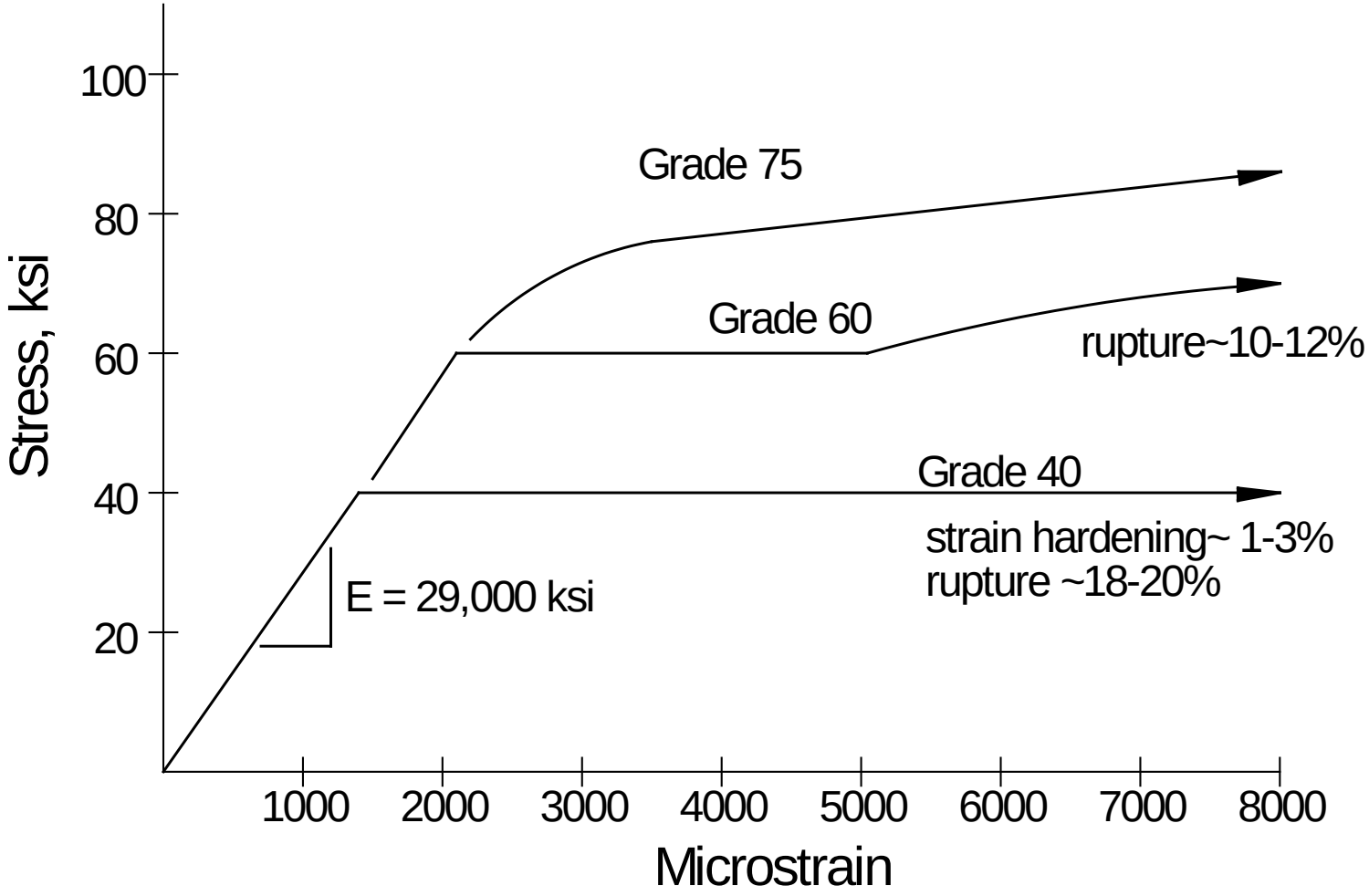
Unconfined Concrete Stress-Strain Behavior



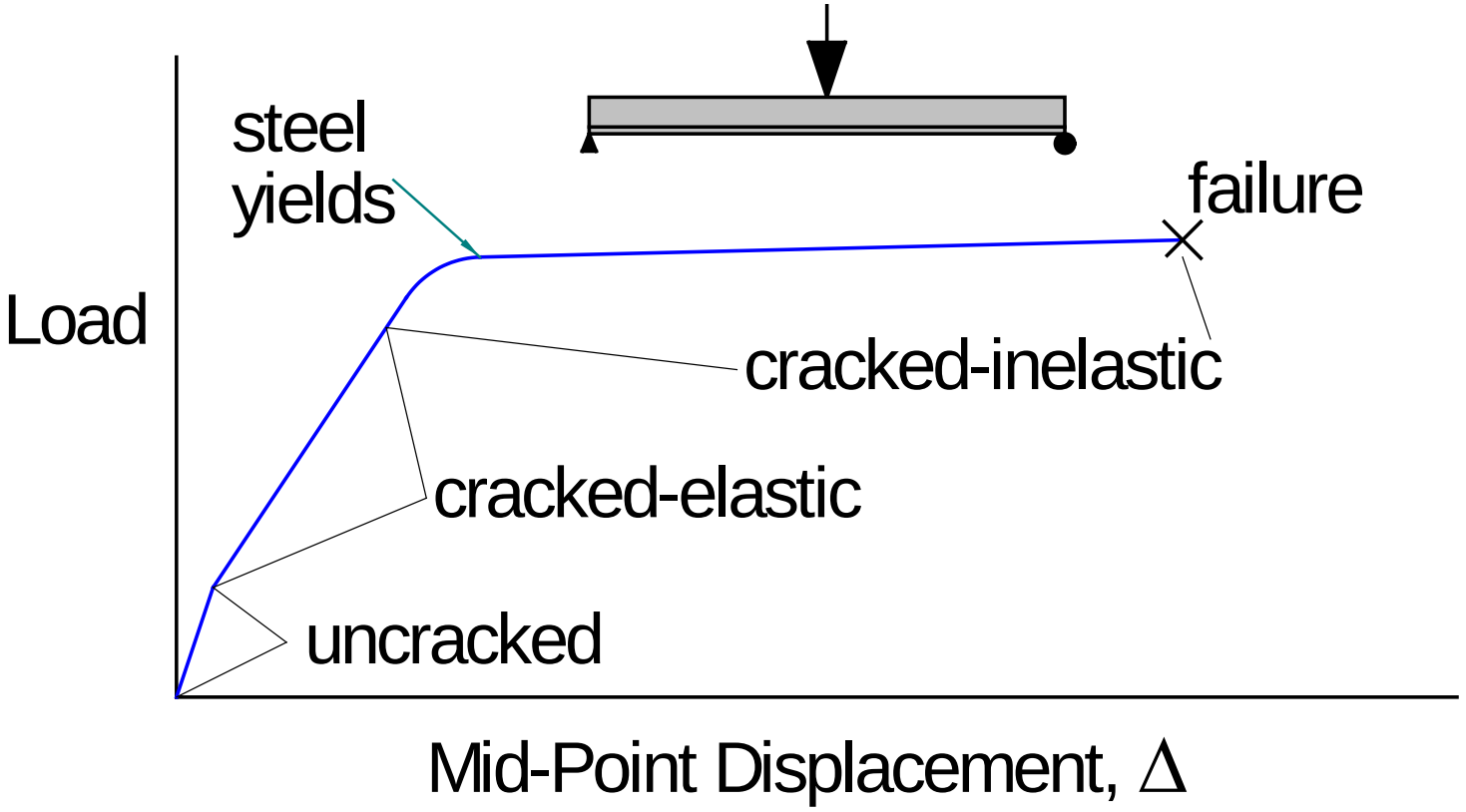
Confined Concrete Stress-Strain Behavior



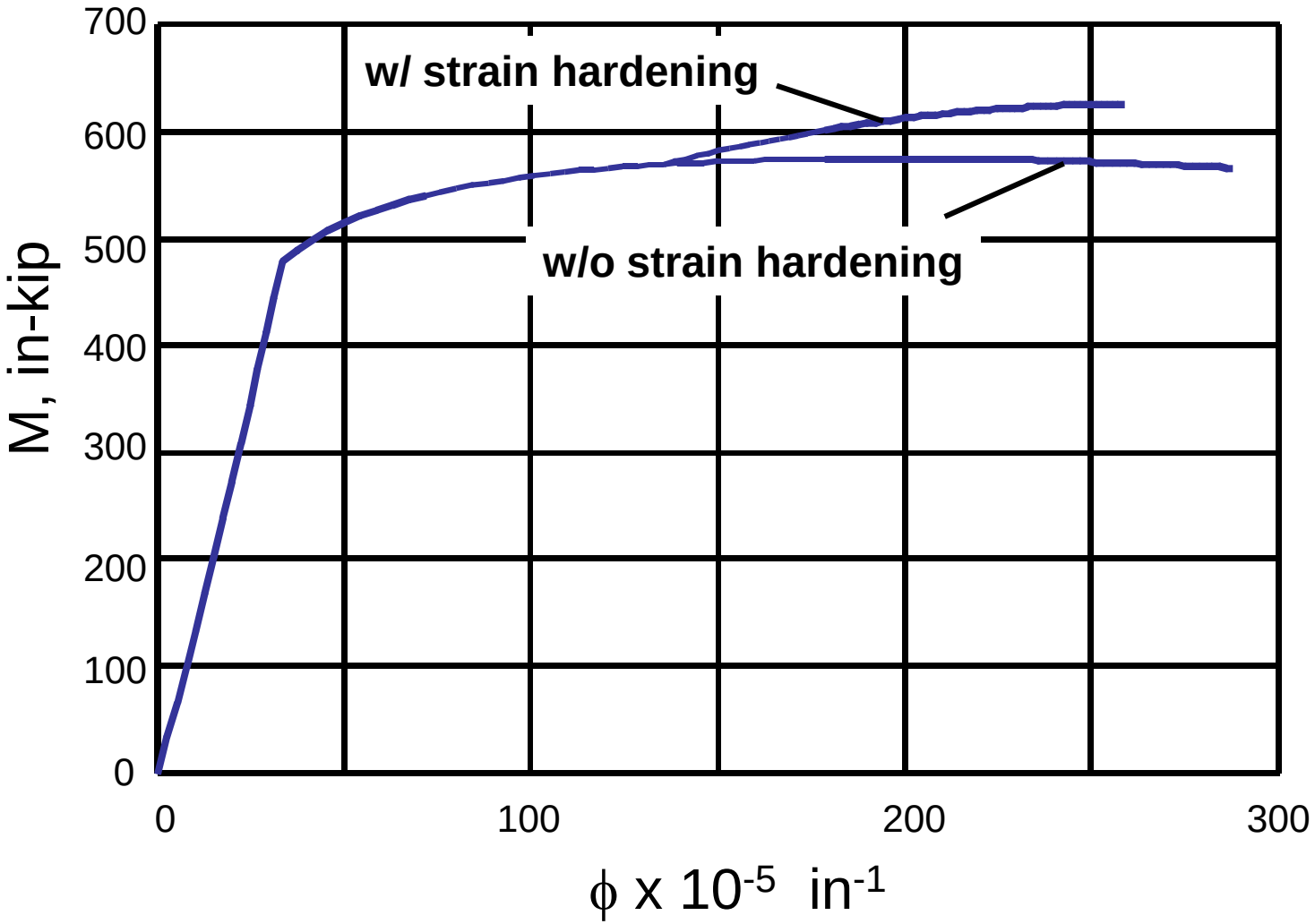
Reinforcing Steel Stress-Strain Behavior



Reinforced Concrete Behavior



Typical Moment Curvature Diagram



f'_c = 4 ksi

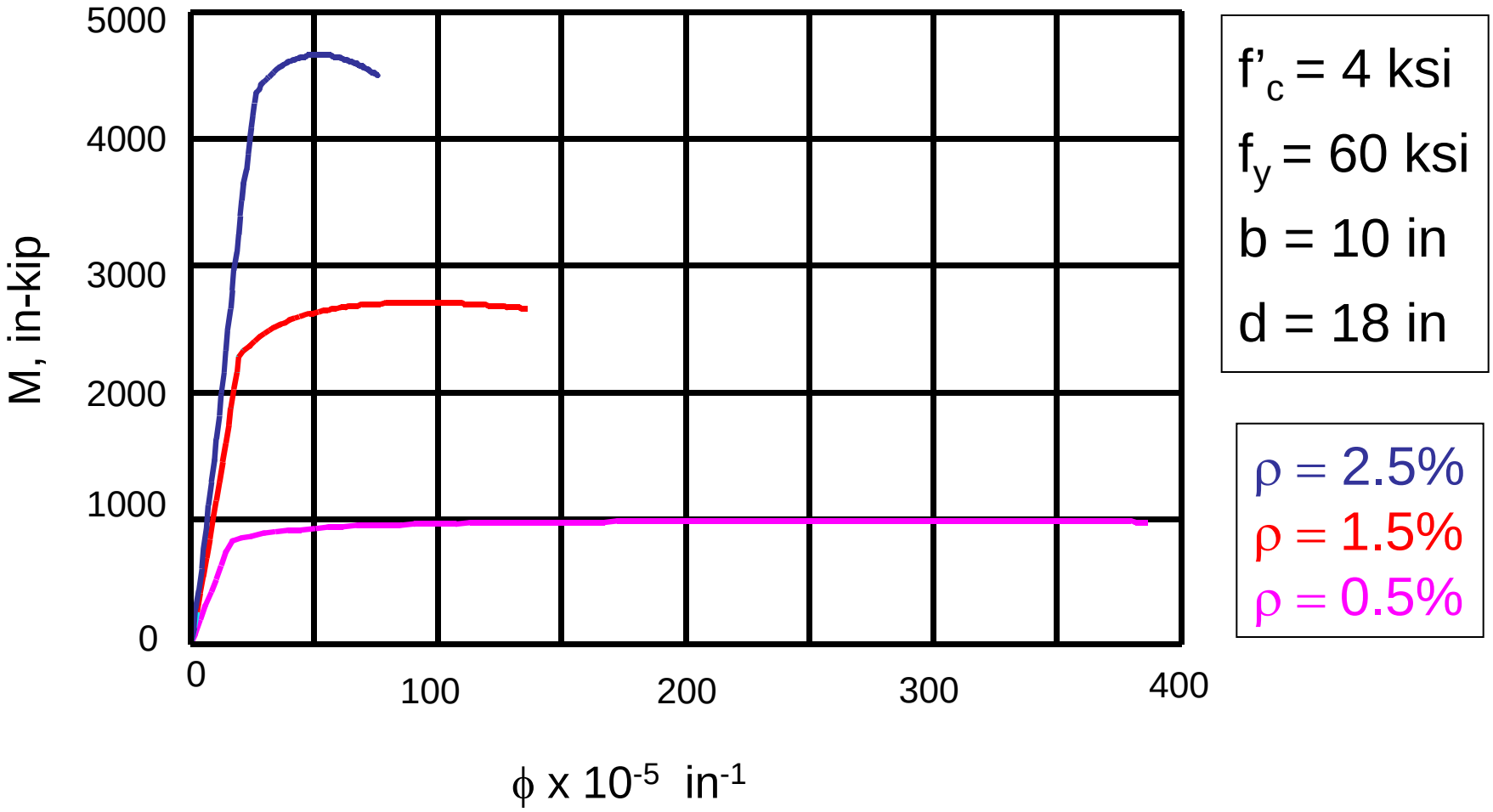
f_y = 60 ksi

b = 8 in

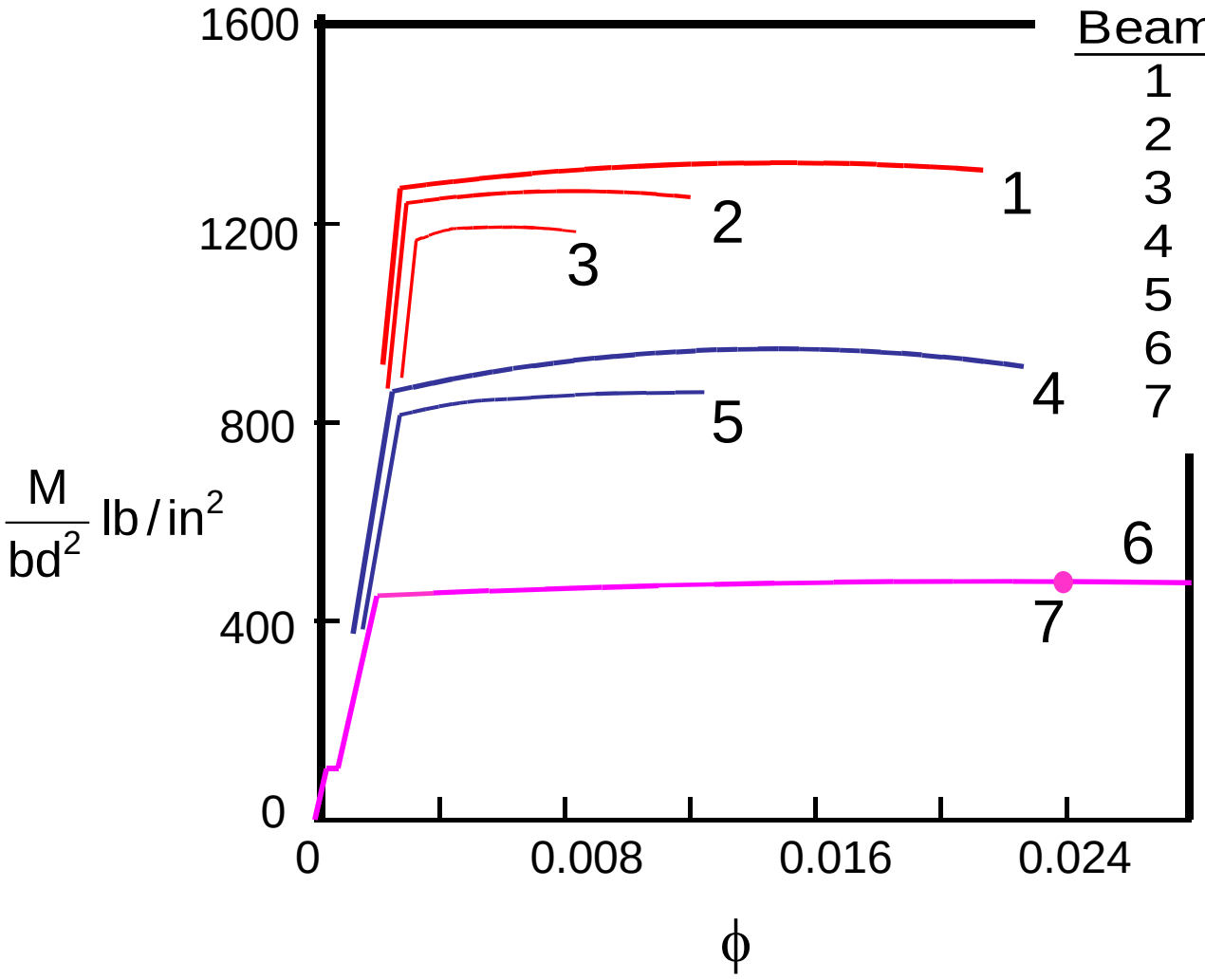
d = 10 in

ρ = 0.0125

Influence of Reinforcement Ratio

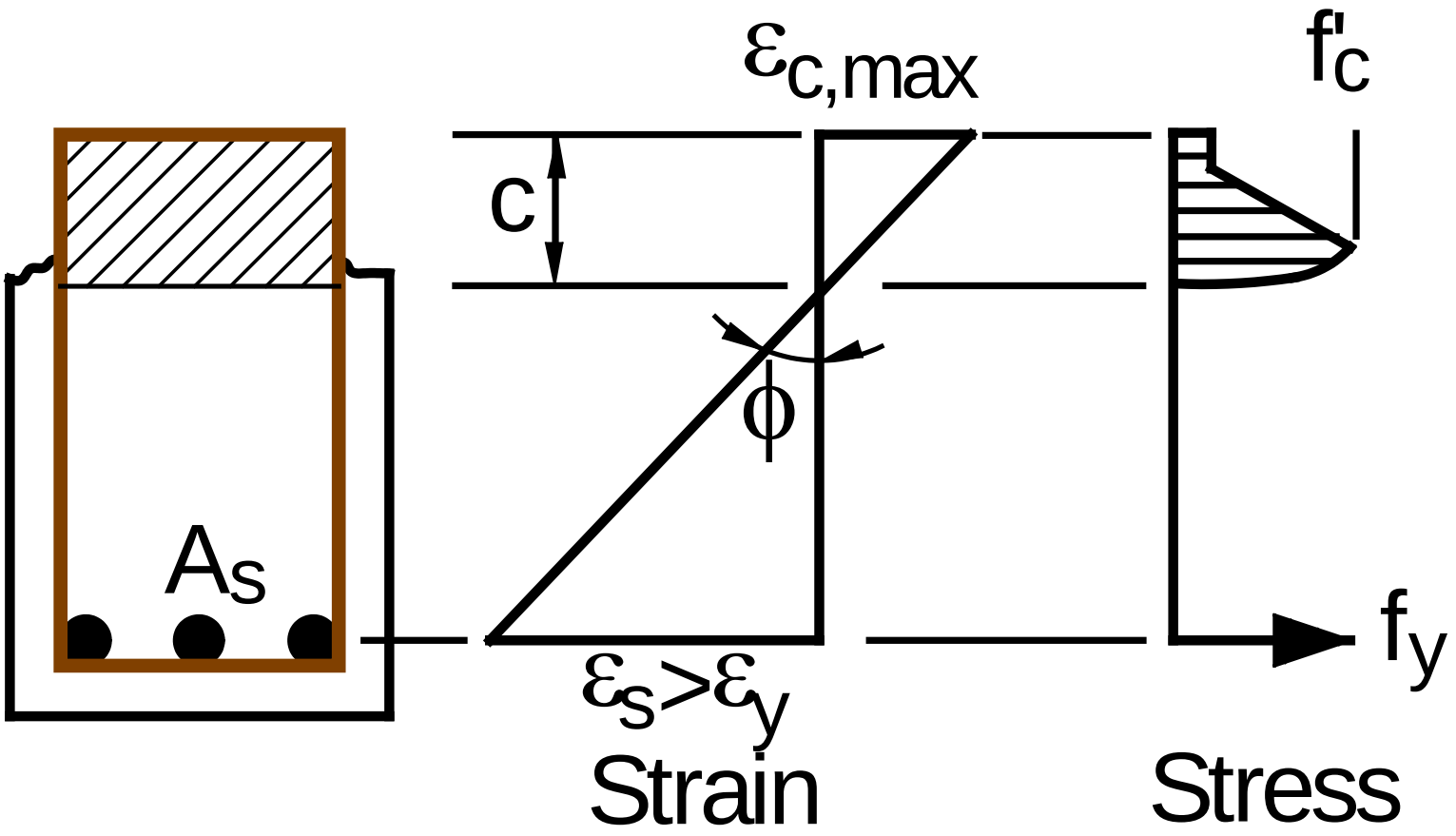


Influence of Compression Reinforcement

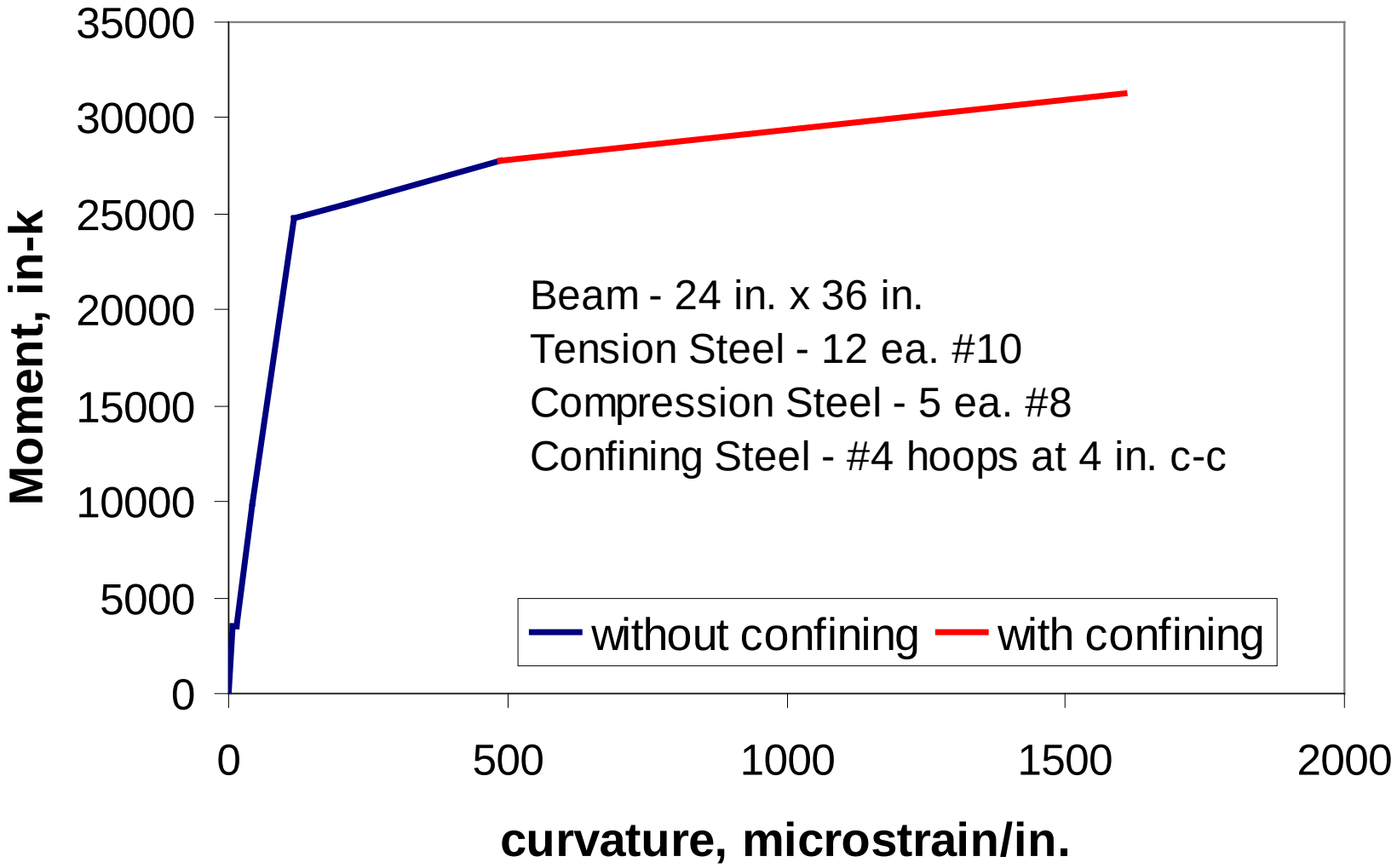


Beam	ρ	ρ'
1	0.0375	0.0250
2	0.0375	0.0125
3	0.0375	0
4	0.0250	0.0125
5	0.0250	0
6	0.0125	0.0125
7	0.0125	0

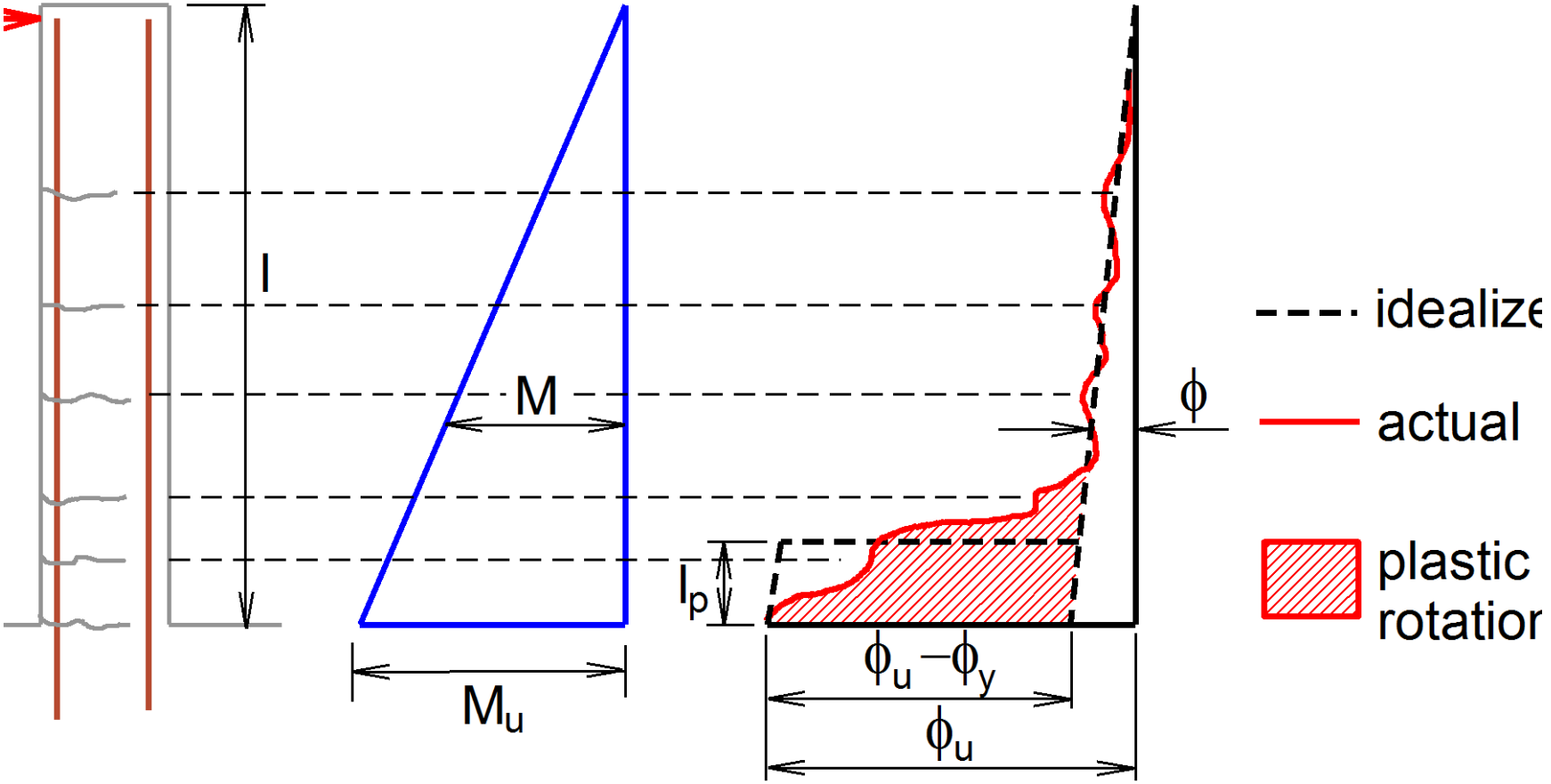
Moment-Curvature with Confined Concrete



Moment-Curvature with Confined Concrete



Plastic Hinging



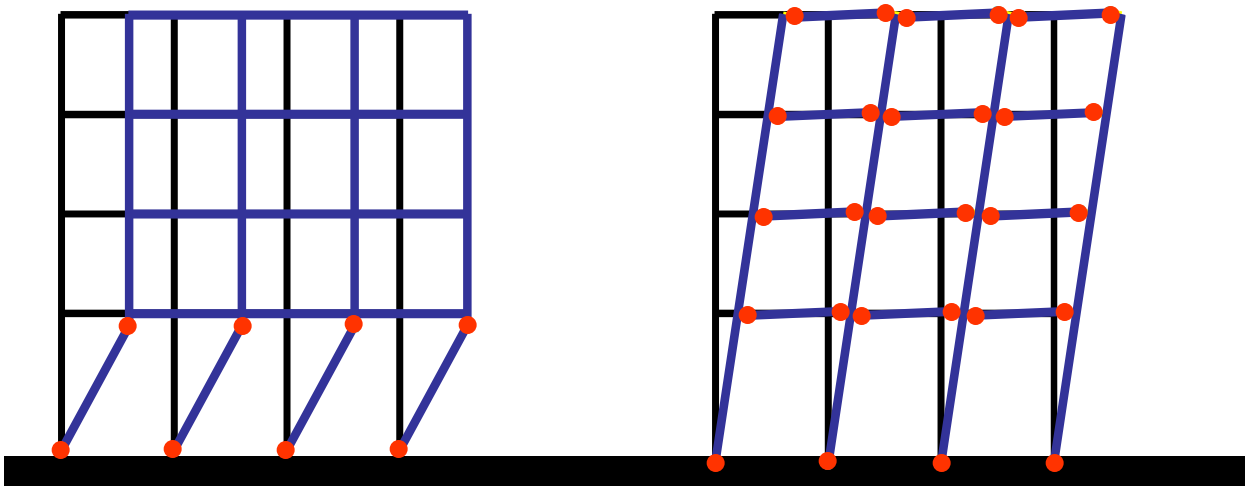
Strategies to Improve Ductility

- Use low flexural reinforcement ratio
- Add compression reinforcement
- Add confining reinforcement

Other Functions of Confining Steel

- **Acts as shear reinforcement**
- **Prevents buckling of longitudinal reinforcement**
- **Prevents bond splitting failures**

Structural Behavior
Frames

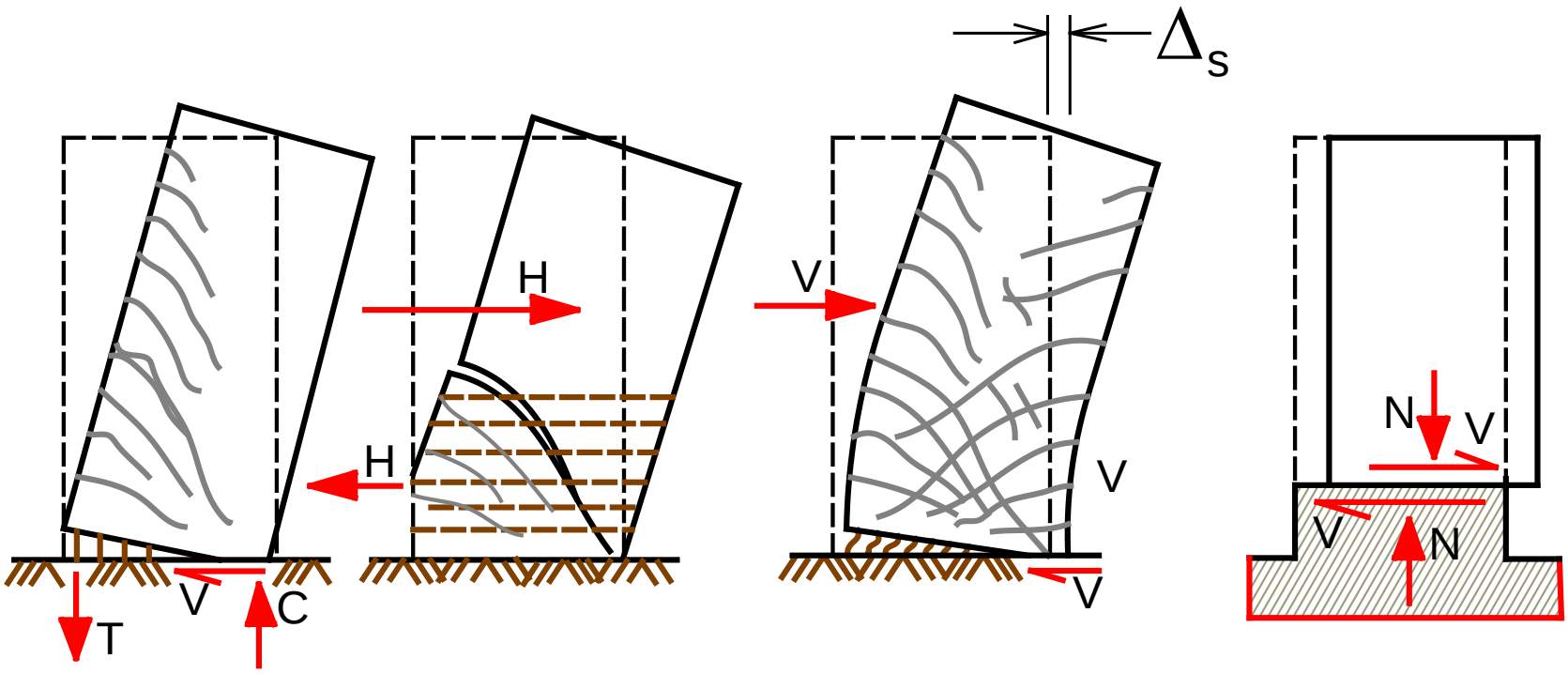


Story Mechanism

Sway Mechanism

Story Mechanism

Structural Behavior - Walls



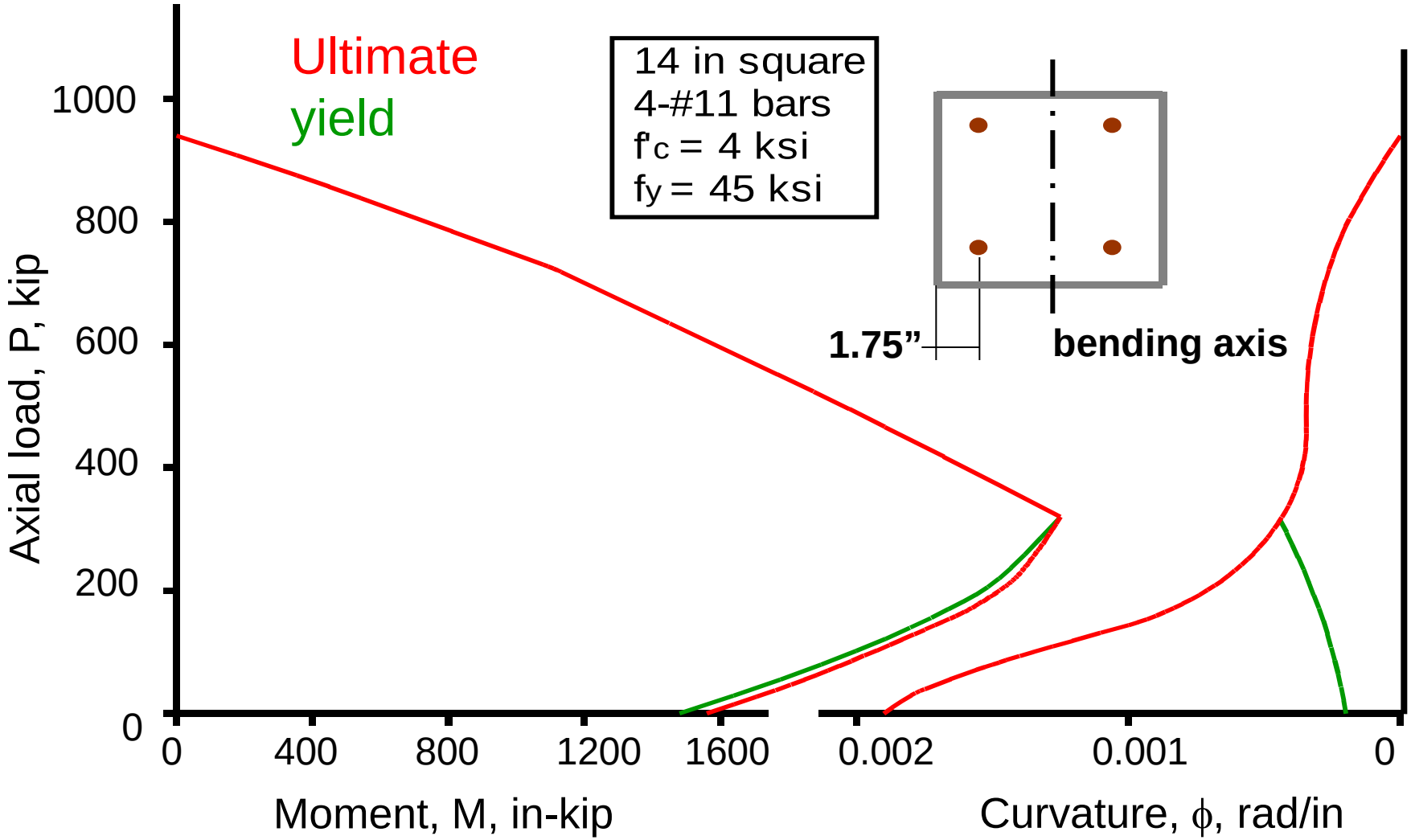
Flexural failure

Horizontal tension

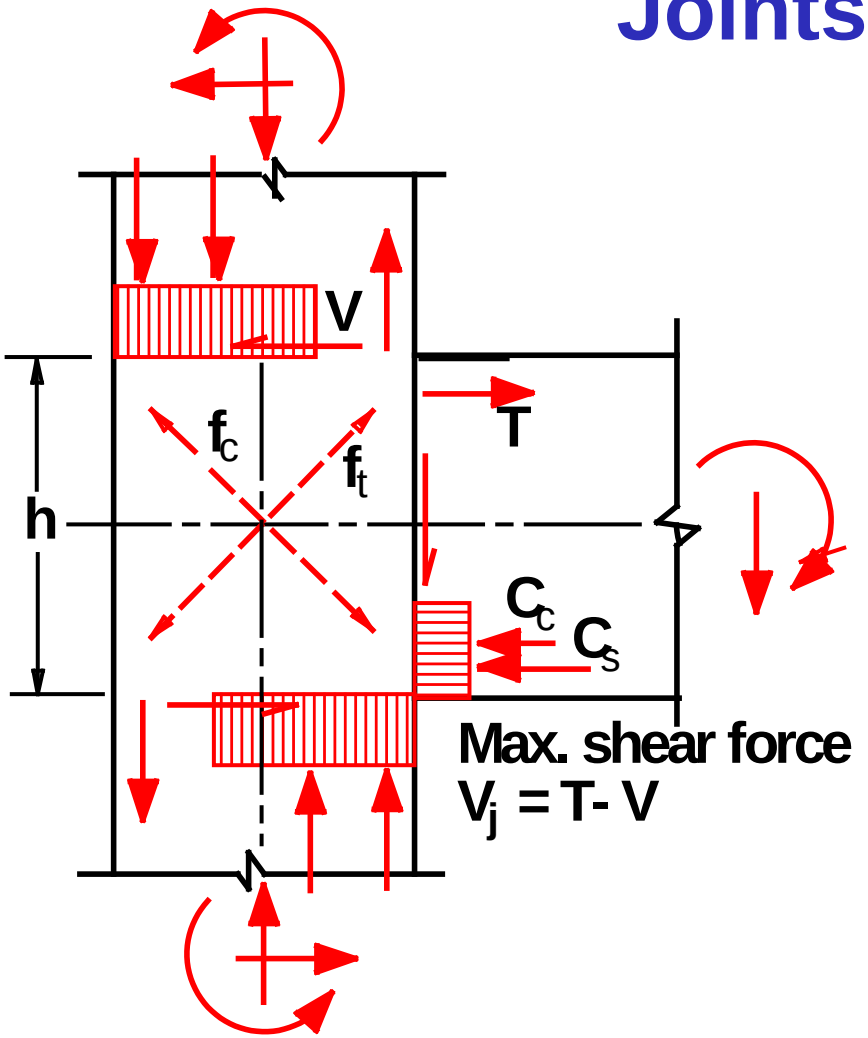
Sliding on flexural cracks

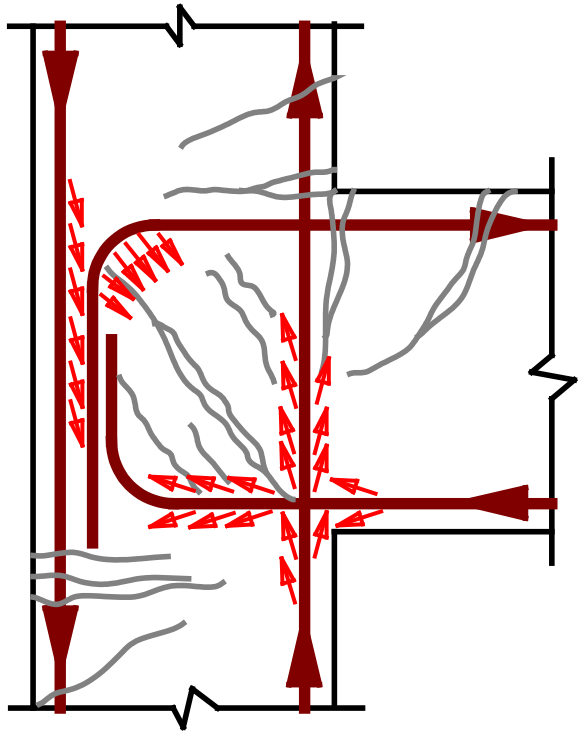
Sliding on construction joint

Structural Behavior - Columns

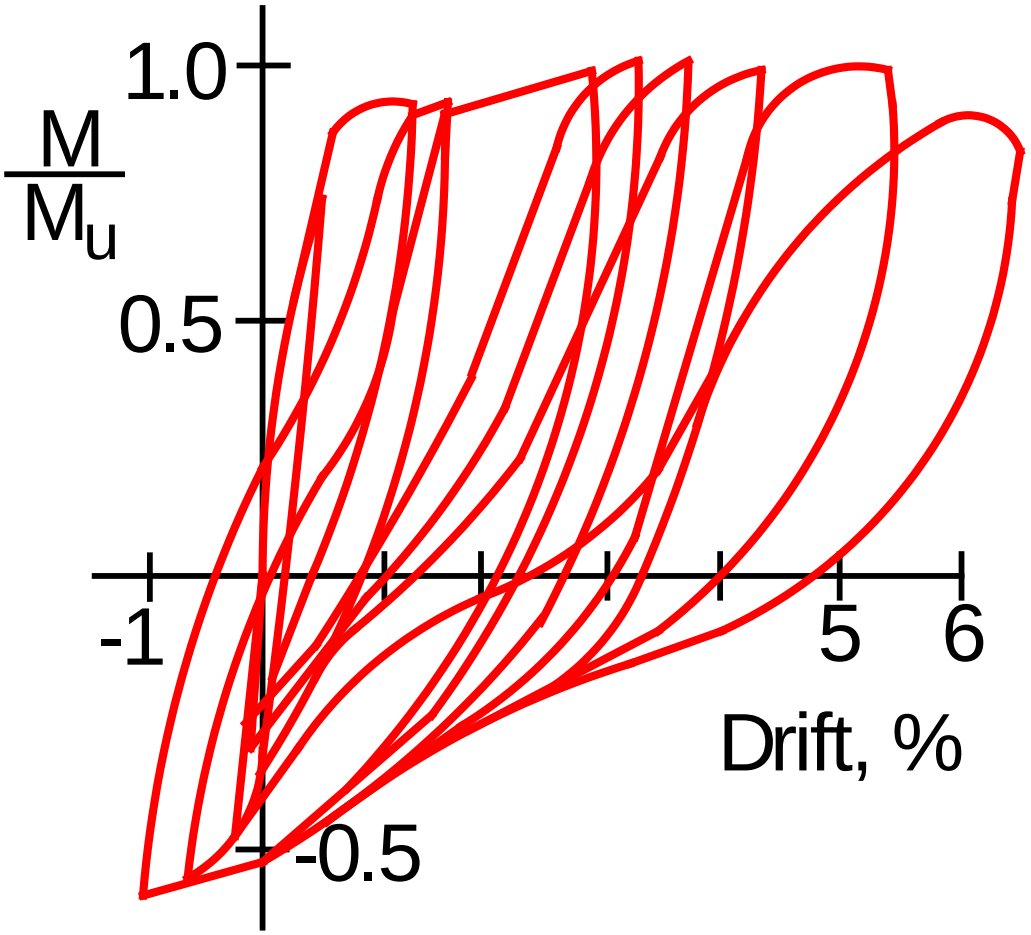


Structural Behavior
Joints

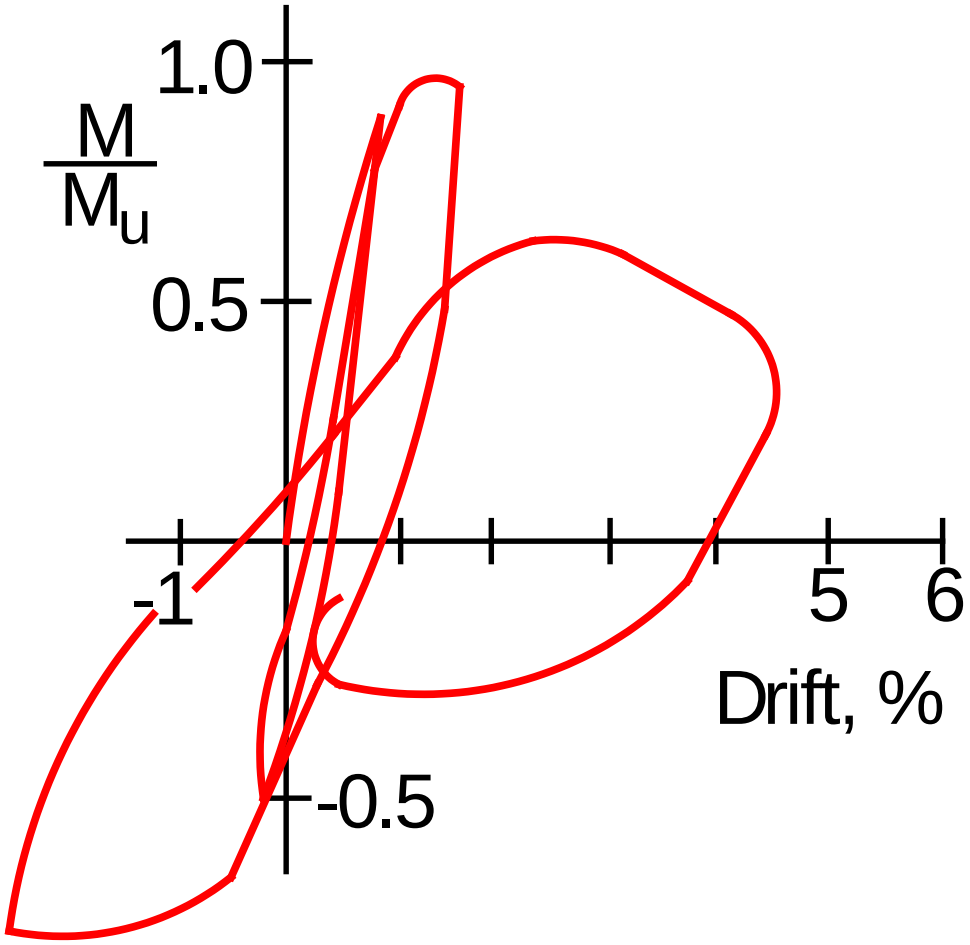




Hysteretic Behavior of Joint with Hoops



Hysteretic Behavior of Joint without Hoops



Joint Failure – No Shear Reinforcing

Summary of Concrete Behavior

- **Compressive Ductility**
  - Strong in compression but brittle
  - Confinement improves ductility by
    - Maintaining concrete core integrity
    - Preventing longitudinal bar buckling
- **Flexural Ductility**
  - Longitudinal steel provides monotonic ductility at low reinforcement ratios
  - Transverse steel needed to maintain ductility through reverse cycles and at very high strains (hinge development)

Summary of Concrete Behavior

- **Damping**
  - Well cracked: moderately high damping
  - Uncracked (e.g. prestressed): low damping
- **Potential Problems**
  - Shear failures are brittle and abrupt and must be avoided
  - Degrading strength/stiffness with repeat cycles
    - Limit degradation through adequate hinge development