457.201 재료역학 및 실험
Mechanics of Materials and Lab.

Professor
Juhyuk Moon PhD
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TT 10:00-12:00
Lecture & Lab

Teaching Assistant
Nankyoung Lee
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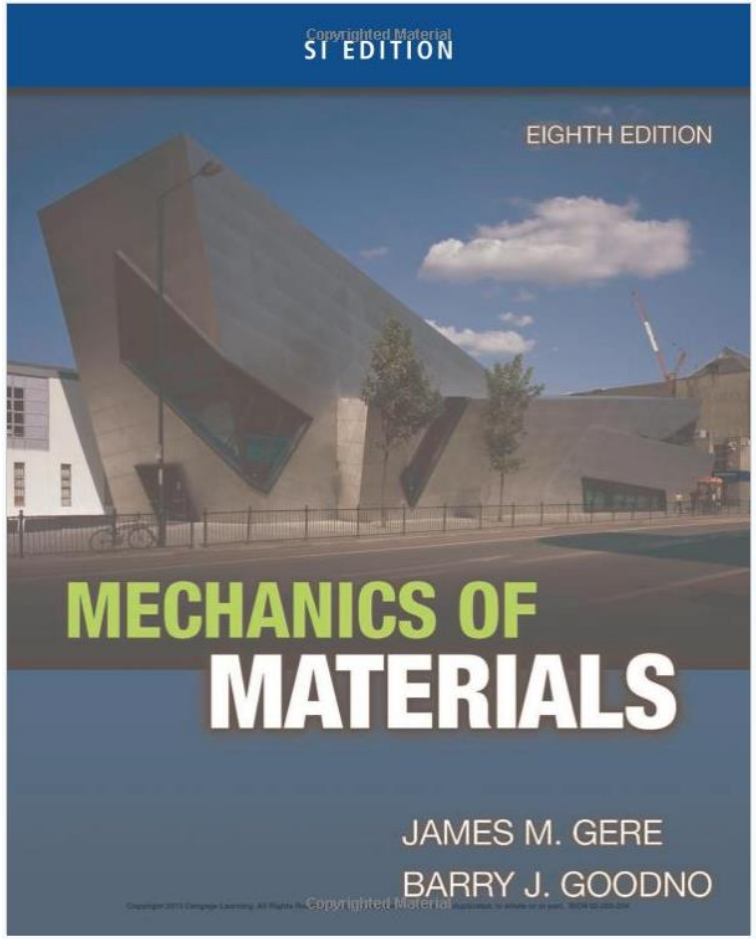


서 울 대 학 교

Architecture

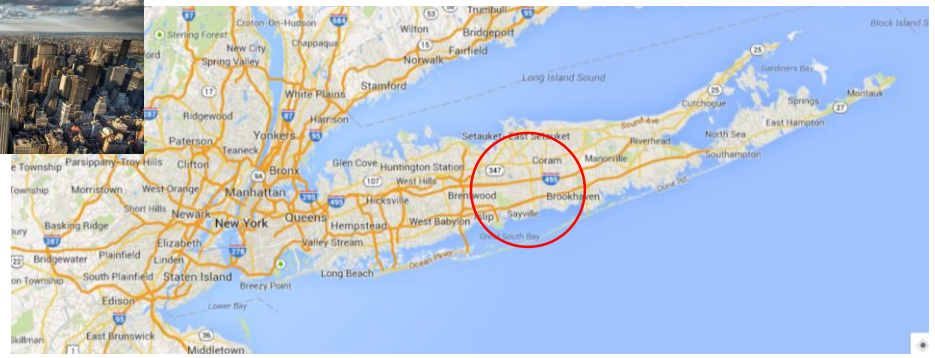
Architectural Engineering

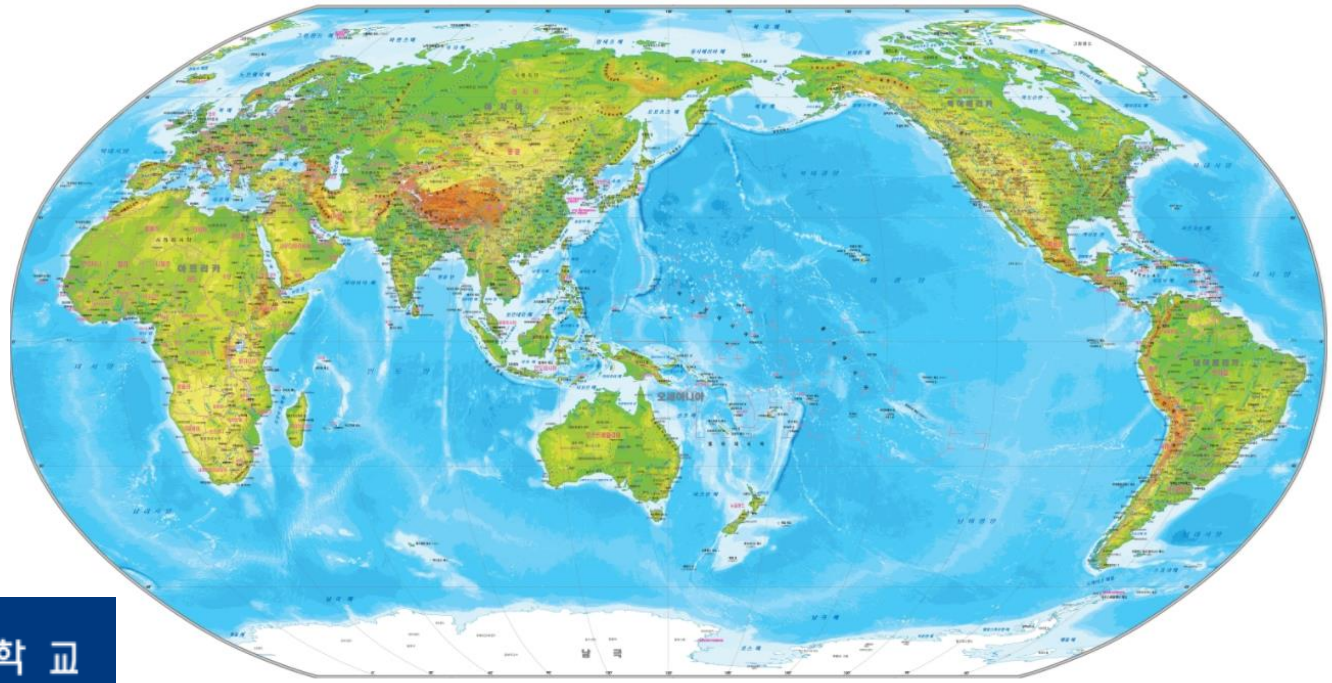
Structural Engineering

Berkeley
UNIVERSITY OF CALIFORNIA

Civil & Environmental Engineering

Material Science Engineering





Stony Brook University

BROOKHAVEN NATIONAL LABORATORY

Mechanical Engineering

Civil Engineering

서 울 대 학 교

Civil & Environmental Engineering

NUS National University of Singapore

Civil & Environmental Engineering

457.201 재료역학 및 실험
Mechanics of Materials and Lab.

- Course objective:
- Equips students with fundamental knowledge in structural mechanics & structural materials for engineering.
- Pre-requisite to structural analysis/design modules essential for professional engineering practice.

평창올림픽 봅슬레이 경기장

부산 엘시티 추락사고

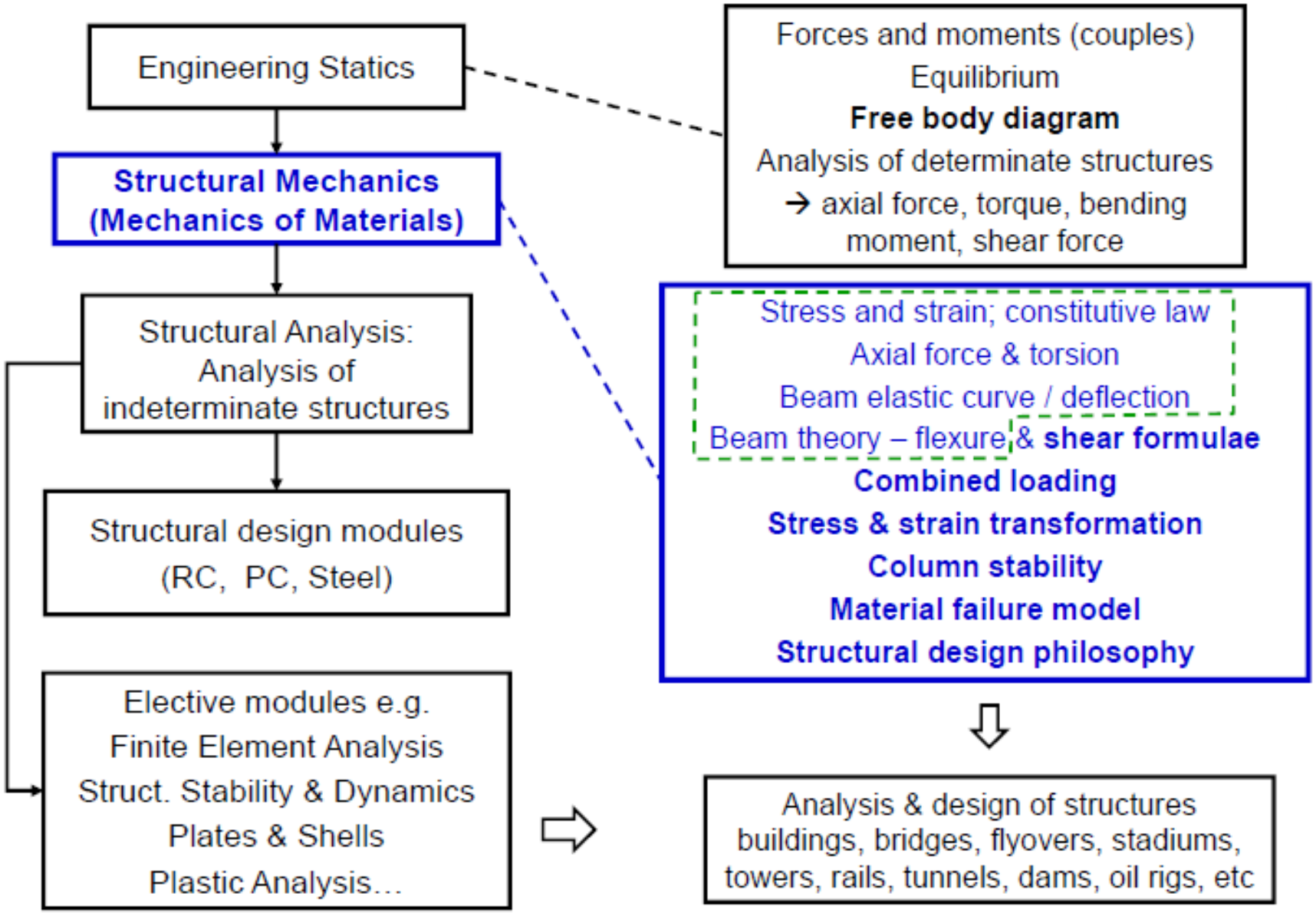

Fig. 4: Track section ready for shotcreting


Fig. 5: Shotcreting the sliding track wall


Fig. 6: A curved track section

(Photos of shotcrete from Samsung C&T)

Role of Structural Mechanics



Syllabus change

- Evaluation
  - Attendance: 10%
  - HW: 30%
    - Lab report (1~3) – n.d.
    - Problem solving (5-10 questions in each chapter)
  - Midterm: 20% (10th May)
  - Final: 40% (14th June)
  - Kahoot extra point??

Syllabus change

- F grade
  - No show in Exams
  - More than 25% absence
  - No submission of more than 20% of homework
  - No submission of lab reports

- Lab #1 – Tension test (confirmed but when?)
- Lab #2 – Shear and bending moment of beam (?)
- Lab #3 – Deflection of beam (?)

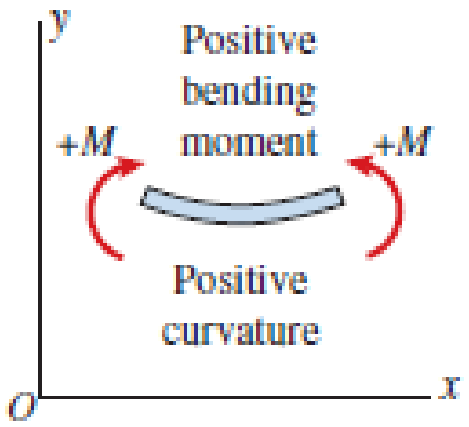
Kahoot.it – Paper folding result

Paper folding

Final Scores

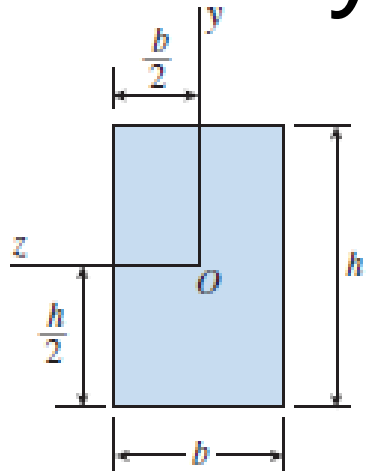
Rank	Players	Total Score (points)	Correct Answers	Incorrect Answers
1	Silber	3786	4	1
2	v수현짱짱맨v	3722	4	1
3	Yujin	3709	4	1
4	??	3648	4	1
5	kdh	3620	4	1
6	에이다가즈아	3415	4	1
7	Die Kavallerie	3012	3	2
8	yop	2986	3	2
9	masheesuh	2983	3	1
10	아앙거난띠	2947	3	1
11	끙	2922	3	2
12	만년소환	2897	3	2
13	닉닉	2894	3	2
14	Jeon	2870	3	2

So how can we "quantify" flexibility?

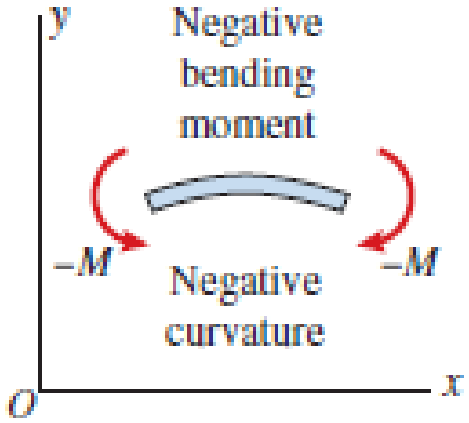


$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

$$I = \int_A y^2 \, dA$$



$$I = \frac{bh^3}{12}$$



Chapter 1. Tension, Compression, and Shear

- Materials
  - Concrete, Steel, Polymer etc.
- Stress-strain
- Hooke's law
- Poisson's ratio
- Shear

Materials

- Steel

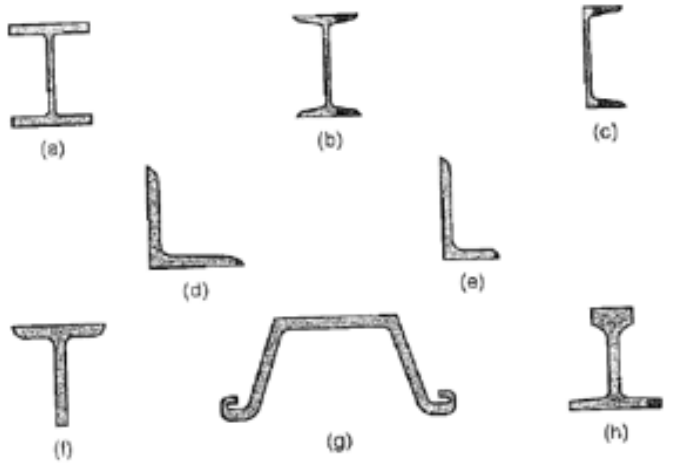


FIGURE 3.5 Shapes commonly used in structural applications: (a) wide-flange (W, HP, and M shapes), (b) I-beam (S shape), (c) channel (C and MC shapes), (d) equal-legs angle (L shape), (e) unequal-legs angle (L shape), (f) tee, (g) sheet piling, and (h) rail.

(Mamlouk & Zaniewski 1999)

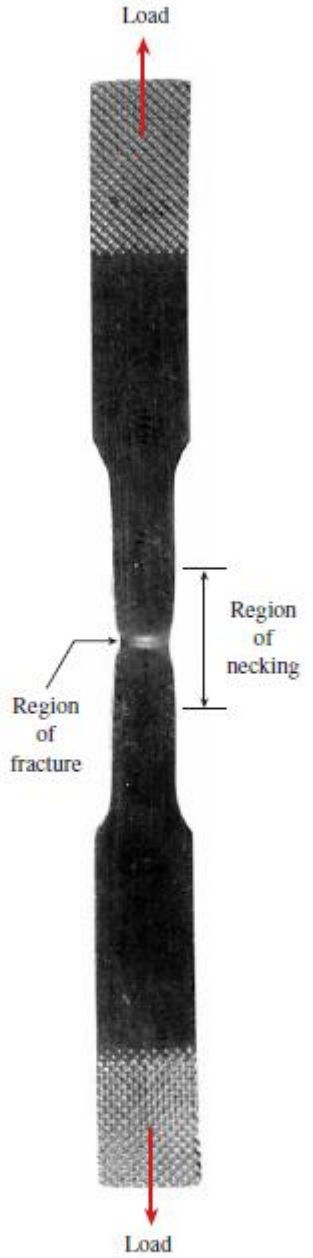
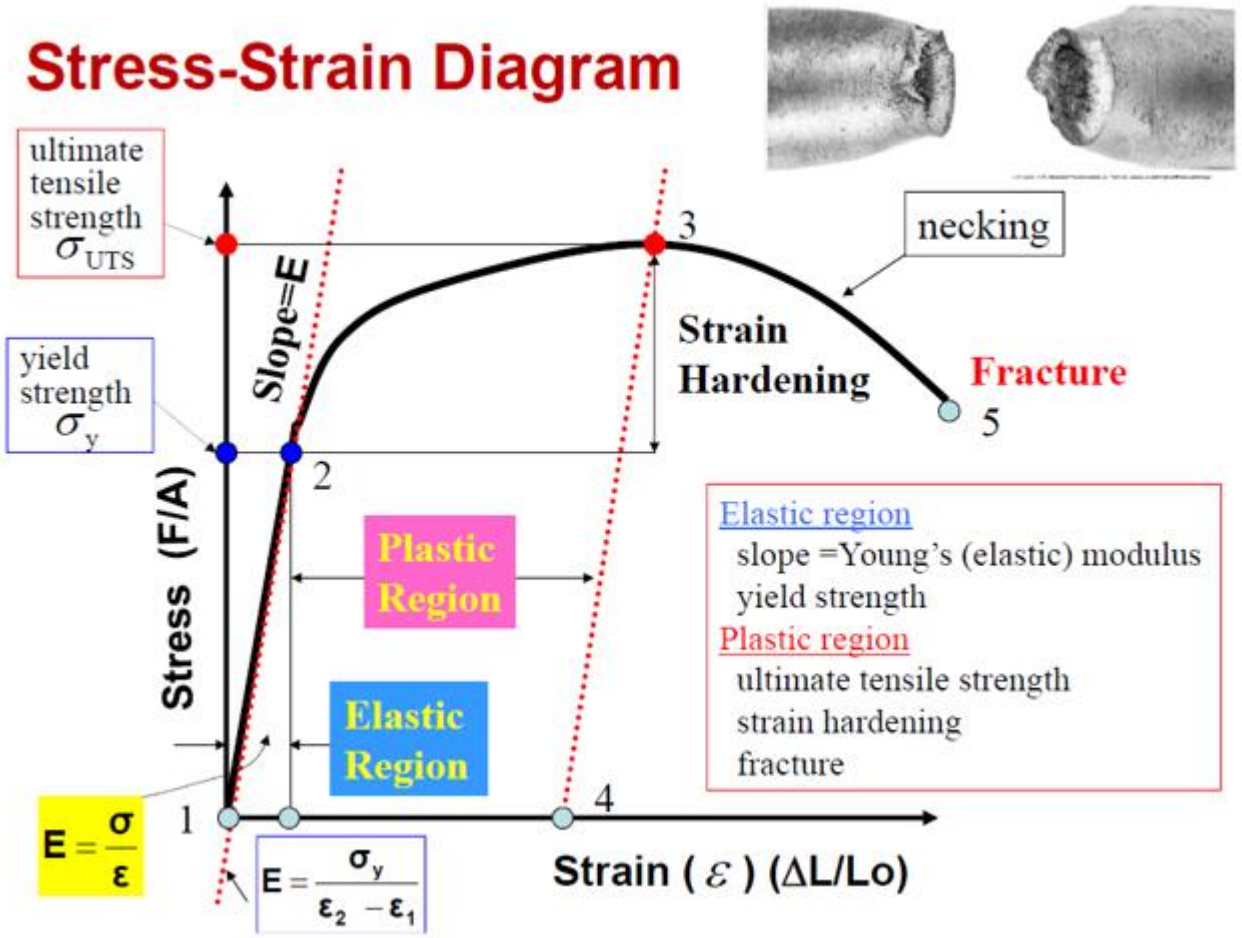
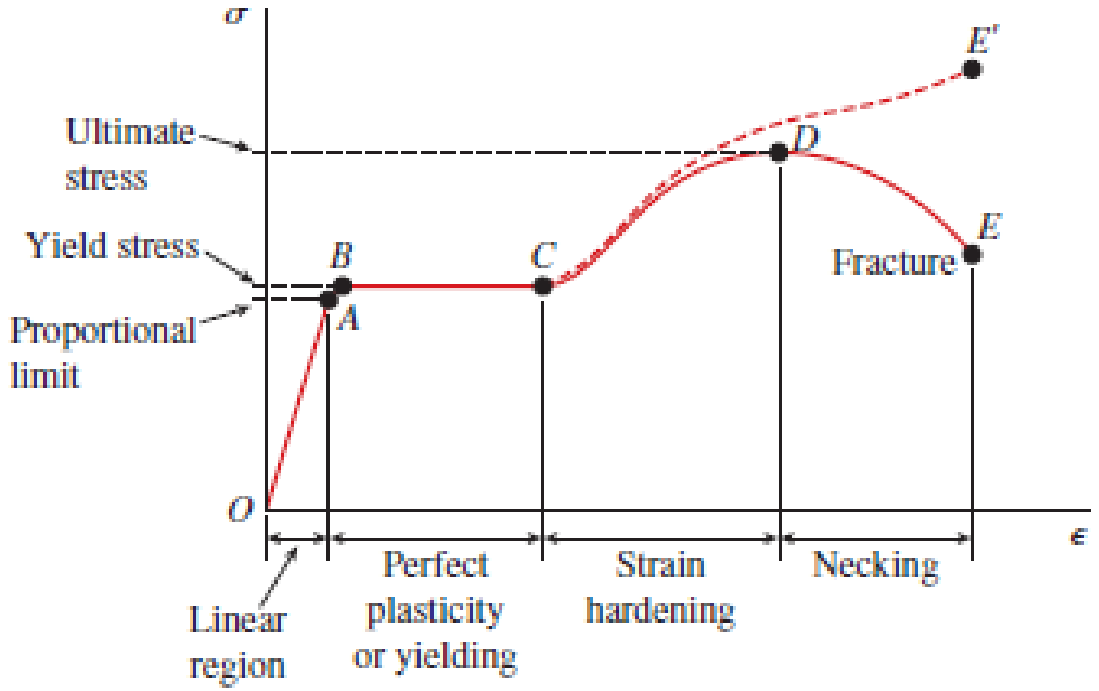


FIG. 1-11 Necking of a mild-steel bar in tension

Steel

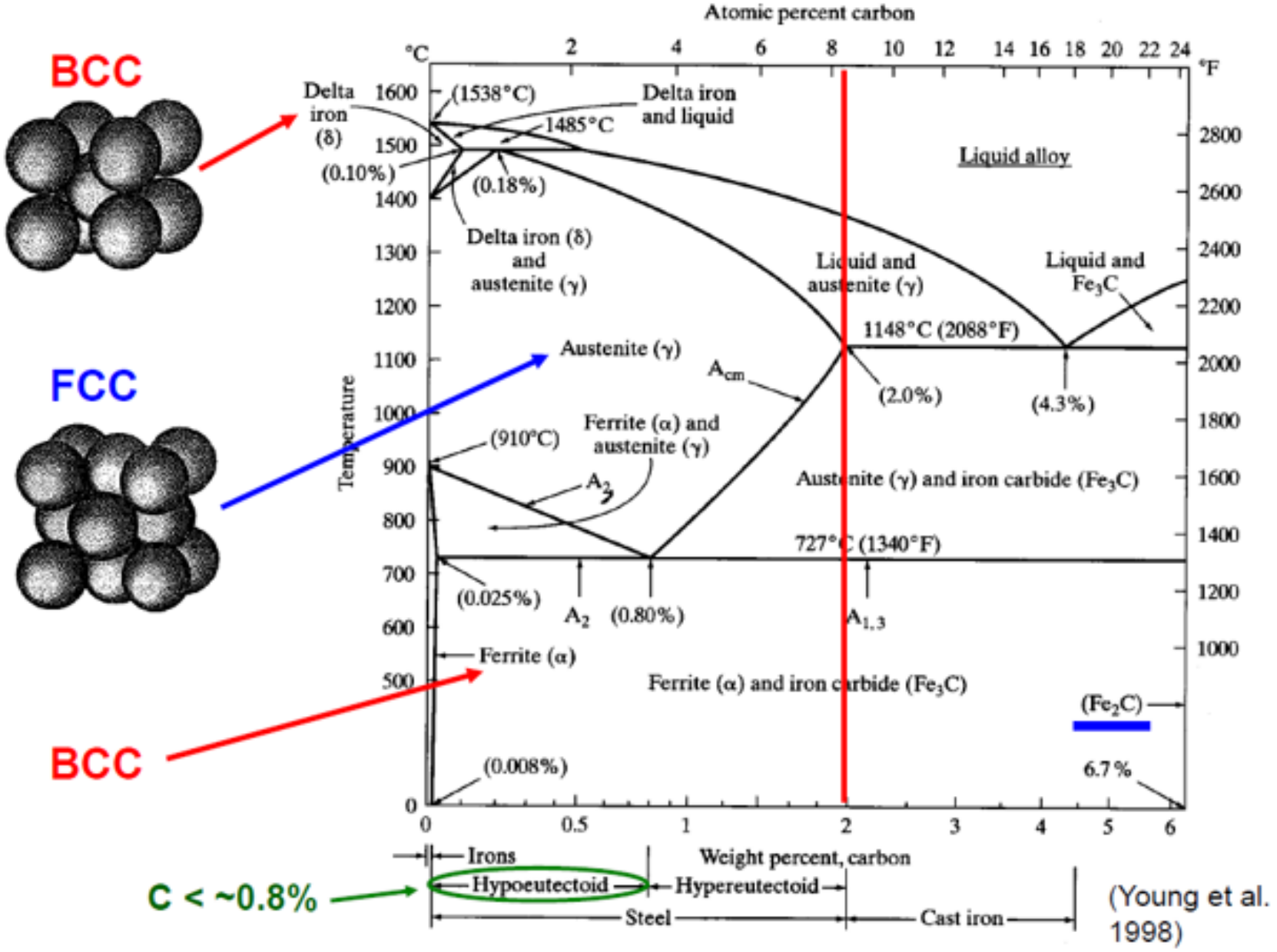




Steel

- In Compression?

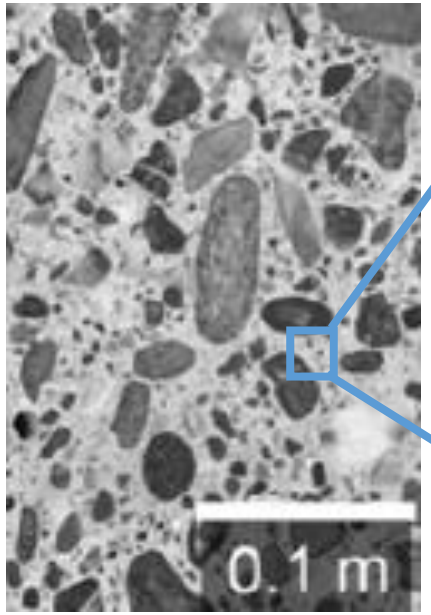
Steel

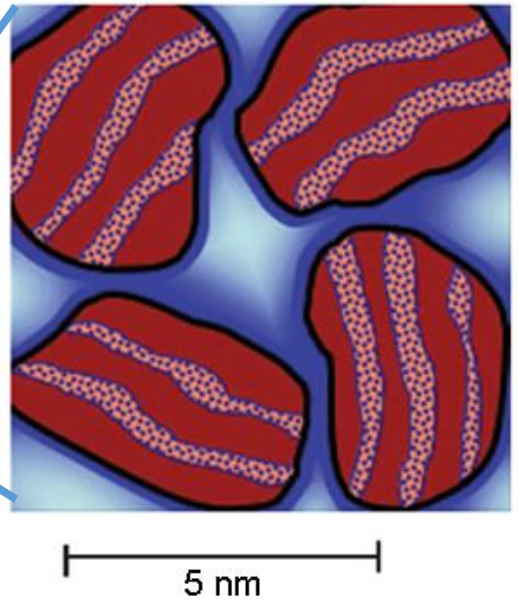


Concrete

- Stress-strain diagram

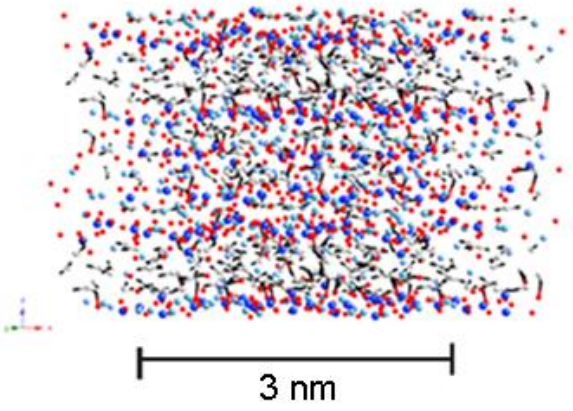
Concrete





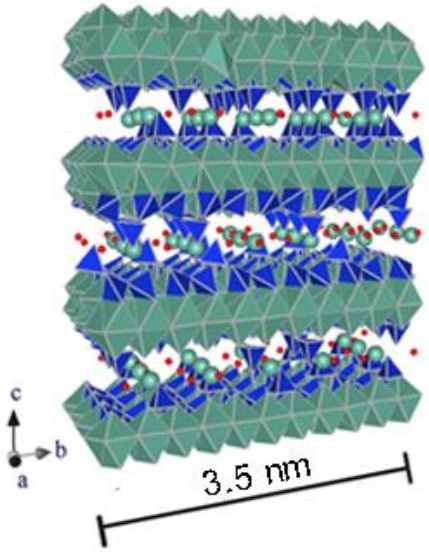
C-S-H nano-particle
(Image from Allen et al. Nature Material, 2008)

Northwestern



Molecular model of C-S-H
(Image from Pellenq et al. PNAS, 2009)

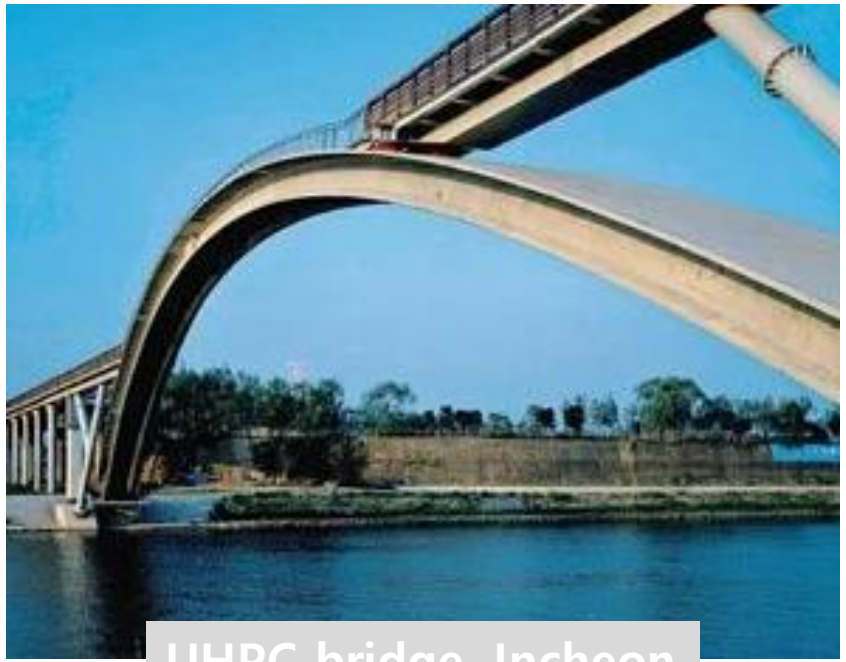
MIT



Refined C-S-H by PDF
(Image from Skinner et al., PRL, 2010)

UC Berkeley

Ultra-High Performance Concrete



UHPC bridge, Incheon

$$I = \int_A y^2 \, dA$$

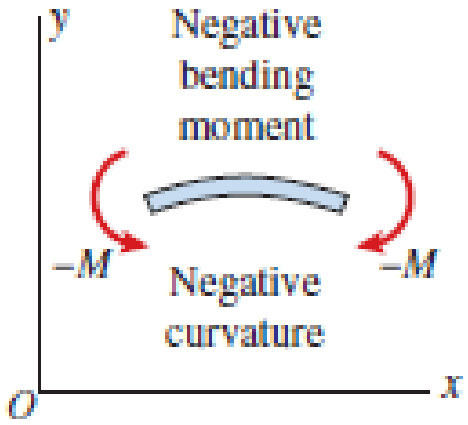
$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

UHPC structure, Calgary Canada

Determine the direction of support

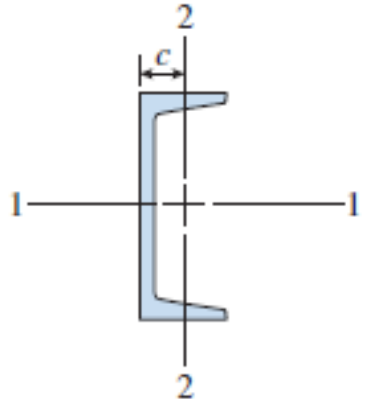
$$I = \int_A y^2 \, dA$$

$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

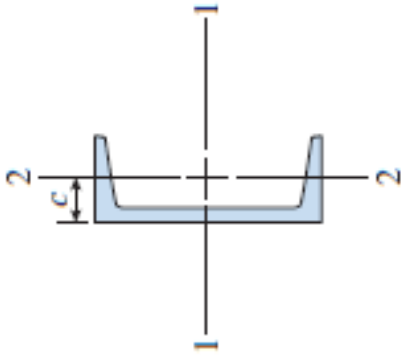


Determine the direction of column section

Case A



Case B

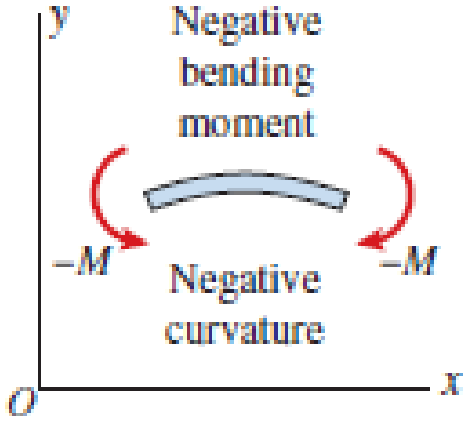


$$I = \int_A y^2 \, dA$$

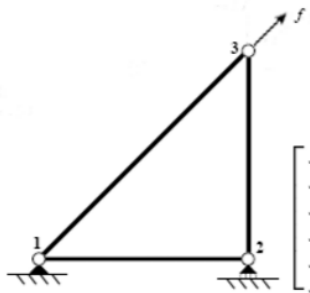
$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

TABLE E-3(a) PROPERTIES OF CHANNEL SECTIONS (C SHAPES) – USCS UNITS (ABRIDGED LIST)

Designation	Weight per foot	Area	Depth	Web thickness	Flange		Axis 1-1			Axis 2-2			
					Width	Average thickness	I	S	r	I	S	r	c
	lb	in.^{2}	in.	in.	in.	in.	in.^{4}	in.^{3}	in.	in.^{4}	in.^{3}	in.	in.
C 15 × 50	50.0	14.7	15.0	0.716	3.72	0.650	404	53.8	5.24	11.0	3.77	0.865	0.799
C 15 × 40	40.0	11.8	15.0	0.520	3.52	0.650	348	46.5	5.45	9.17	3.34	0.883	0.778
C 15 × 33.9	33.9	10.0	15.0	0.400	3.40	0.650	315	42.0	5.62	8.07	3.09	0.901	0.788



What is the difference?



$$\mathbf{f} = \mathbf{K}\mathbf{u}$$

Or

$$\begin{bmatrix} f_{x1} \\ f_{y1} \\ f_{x2} \\ f_{y2} \\ f_{x3} \\ f_{y3} \end{bmatrix} = \begin{bmatrix} k_{11} & k_{12} & k_{13} & k_{14} & k_{15} & k_{16} \\ k_{21} & k_{22} & k_{23} & k_{24} & k_{25} & k_{26} \\ k_{31} & k_{32} & k_{33} & k_{34} & k_{35} & k_{36} \\ k_{41} & k_{42} & k_{43} & k_{44} & k_{45} & k_{46} \\ k_{51} & k_{52} & k_{53} & k_{54} & k_{55} & k_{56} \\ k_{61} & k_{62} & k_{63} & k_{64} & k_{65} & k_{66} \end{bmatrix} \begin{bmatrix} u_{x1} \\ u_{y1} \\ u_{x2} \\ u_{y2} \\ u_{x3} \\ u_{y3} \end{bmatrix}$$

Helix bridge, Singapore

Golden gate bridge, CA USA