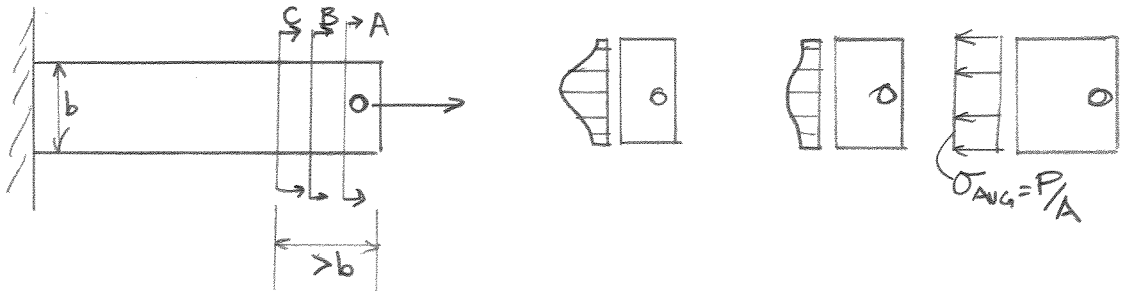
CLASS #10 - STRESS CONCENTRATIONS (END of CH 4)

OBJECTIVES: ① DESCRIBE COMPLEX STRESS CONCENTRATIONS
② DEFINE STRESS CONCENTRATION FACTOR (K)
③ INELASTIC BEHAVIOR

Venant's

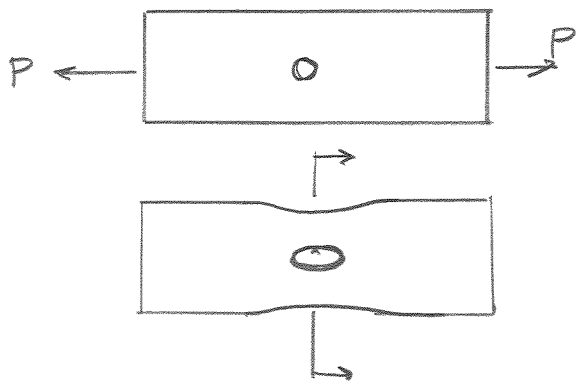
① REVIEW ST. VENANT'S PRINCIPLE

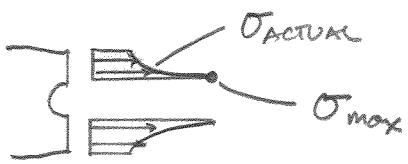
- STRESS CONCENTRATIONS in VICINITY of LOADING ARE COMPLEX
- DO NOT "AVERAGE" OUT UNTIL ONE DIMENSION AWAY



② STRESS CONCENTRATIONS

- ACTUAL STRESS DISTRIBUTION VERY COMPLEX
- THEORY of ELASTICITY





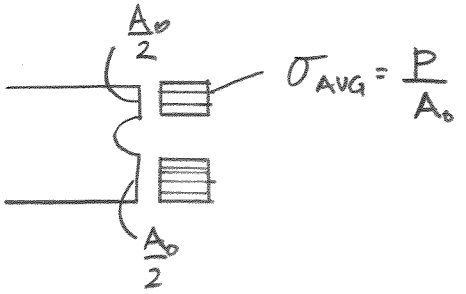
$$P = \int_A \sigma \, dA$$

- USUALLY DO NOT NEED TO KNOW THE DISTRIBUTION. RATHER DESIGN for σ_{max}

③ STRESS - CONCENTRATION FACTOR K

- COMMON SHAPES, TABULATE $K = \frac{\sigma_{max}}{\sigma_{AVG}}$

ALLOWS US TO ANALYZE FOR σ_{AVG}
BUT TO DESIGN FOR σ_{max}

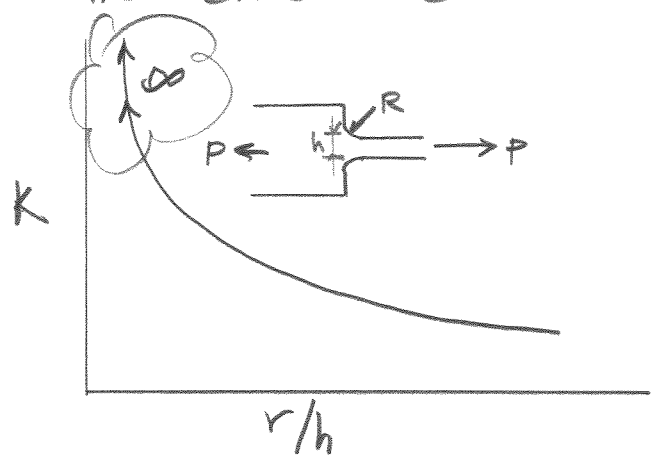


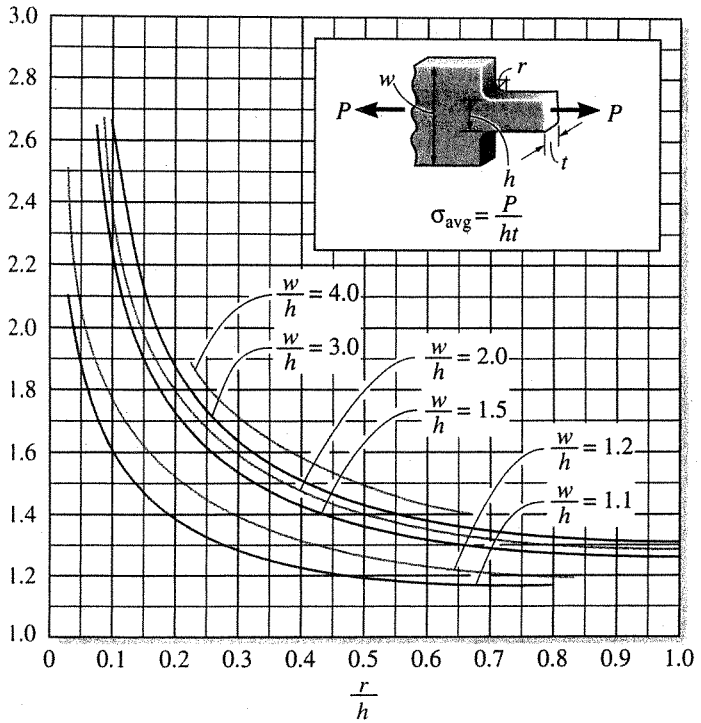
$$\sigma_{max} = K \sigma_{AVG}.$$

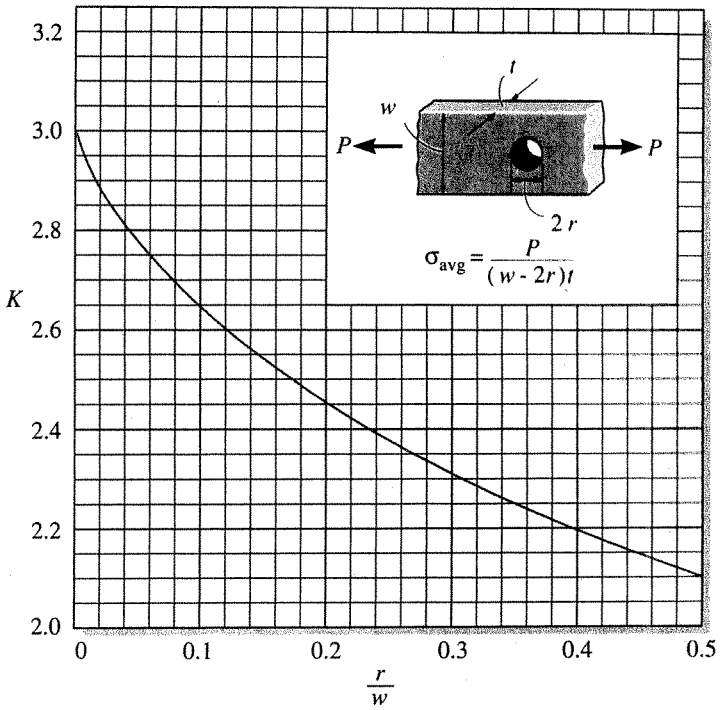
- K REPORTED IN HANDBOOKS (EXPERIMENTALLY DERIVED)
(SEE TABLE / CHART)

④ SHARP CORNERS

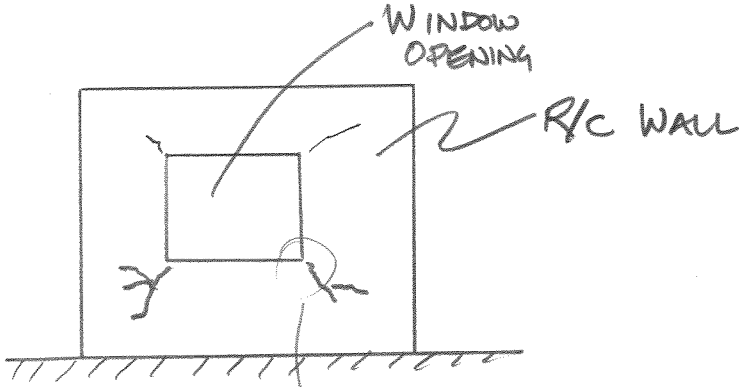
SHARP CORNERS "CONCENTRATE" A LOT OF STRESS
- THIS IS AVOIDED WHERE POSSIBLE IN CIVIL ENG.




3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
r/h
w/h = 4.0
w/h = 3.0
w/h = 2.0
w/h = 1.5
w/h = 1.2
w/h = 1.1
P
P
w
r
h
t
σavg = P/ht


3.2
3.0
2.8
2.6
2.4
2.2
2.0
K
0
0.1
0.2
0.3
0.4
0.5
r/w
P
P
w
t
2r
σavg = P/(w - 2r)t

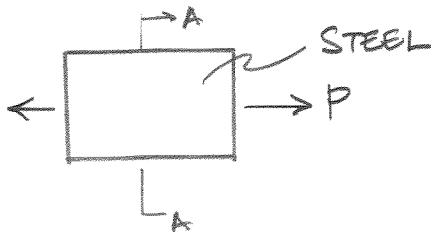
FOR EXAMPLE:



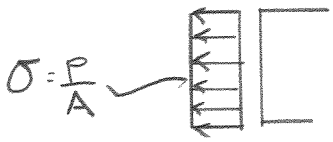
TYPICAL TO FIND CRACKING AT WINDOW CORNERS

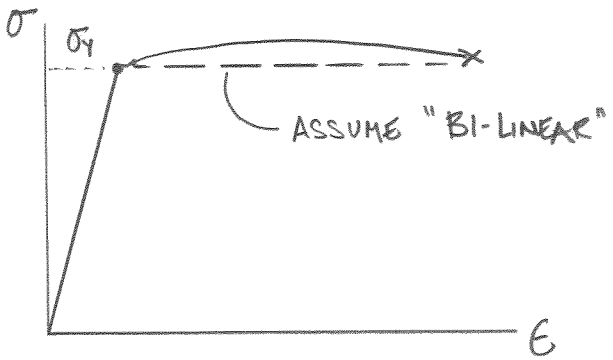
⑤ INELASTIC AXIAL DEFORMATION

CONSIDER STEEL ELEMENT



at CROSS SECTION A-A





THEN AS P↑,
σ↑ UNTIL
$P = A\sigma_y$

THEN σ REMAINS σ_y & AXIAL MEMBER QUICKLY ELONGATES, ε↑

NOW, LET US DRILL A HOLE: