

OUTLINE :

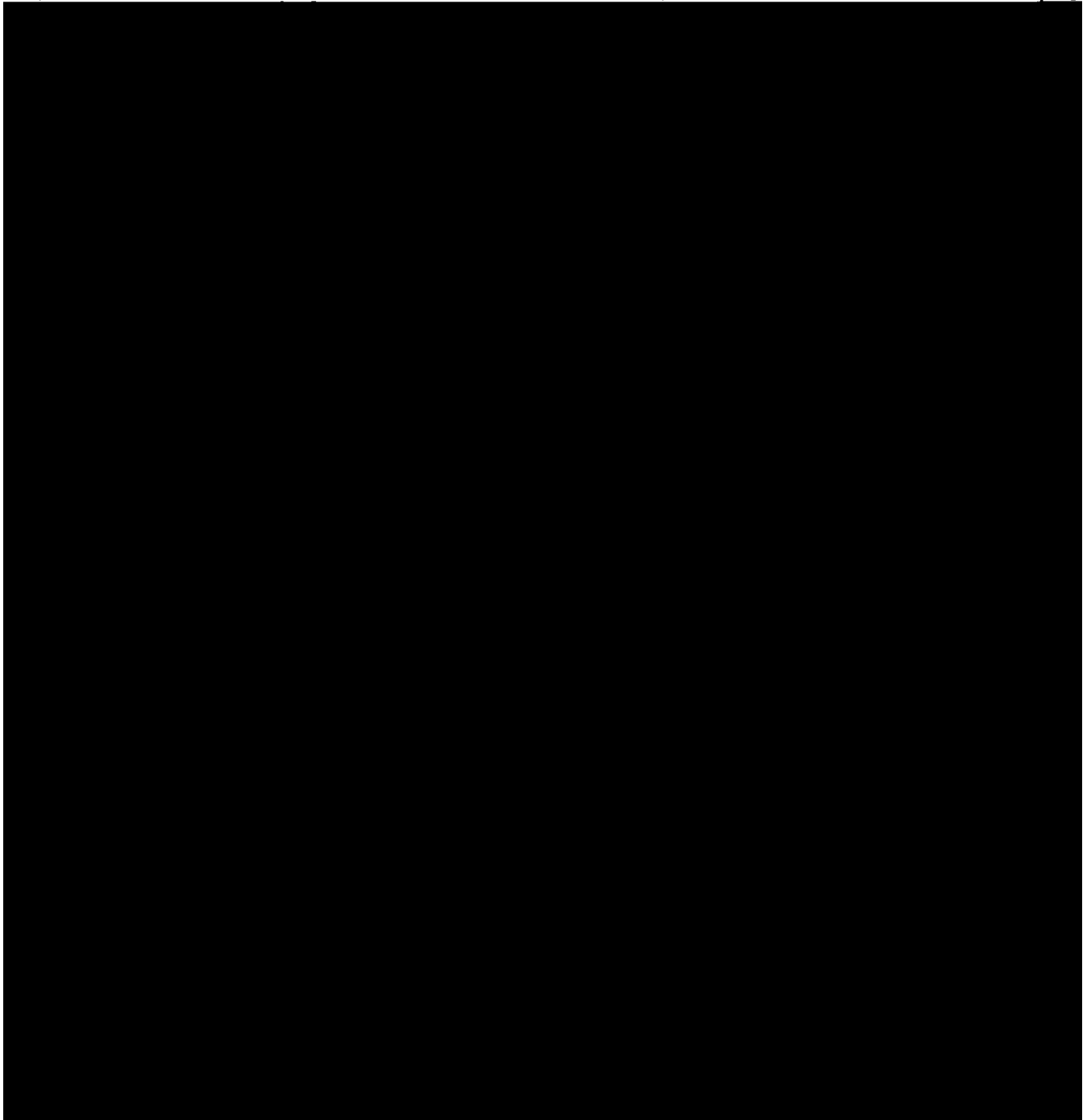
T. AXIAL LOADS - STRESS AND STRAIN

W / ... LINEAR STRESS - STRAIN LAW OF HOOKE'S LA
 EFFORT ... OF MEMBER WITH CIRCULAR CROSS
 BEDDING MOMENT ... SHEAR AND
 BEAM ... FLEXURE
 BEAM ... SHEARING
 STATICALLY INDETERMINATE BEAM BY SUPERPOSITION
 EQUATION
 REDUCED -
 OF MATERIAL IS ... PRINCIPAL PROBLEM IN
 STRAIN OF ... RELATION OF ...
 MEMBER ...
 ANALYSIS ...
 MEMBER AS ... EQUILIBRIUM
 BY ...
 THIS ...
 HAZARD ... AN INTERNAL ... SYSTEM BEVEL

EQUILIBRIUM OF THE PARTS TO EITHER SIDE OF THE SECTION. THE FIGURE BELOW ILLUSTRATES THIS PRINCIPAL WITH THE FORCE SYSTEM SHOWN IN TERMS OF COMPONENTS AT THE CENTROID OF THE SECTION. IF THE

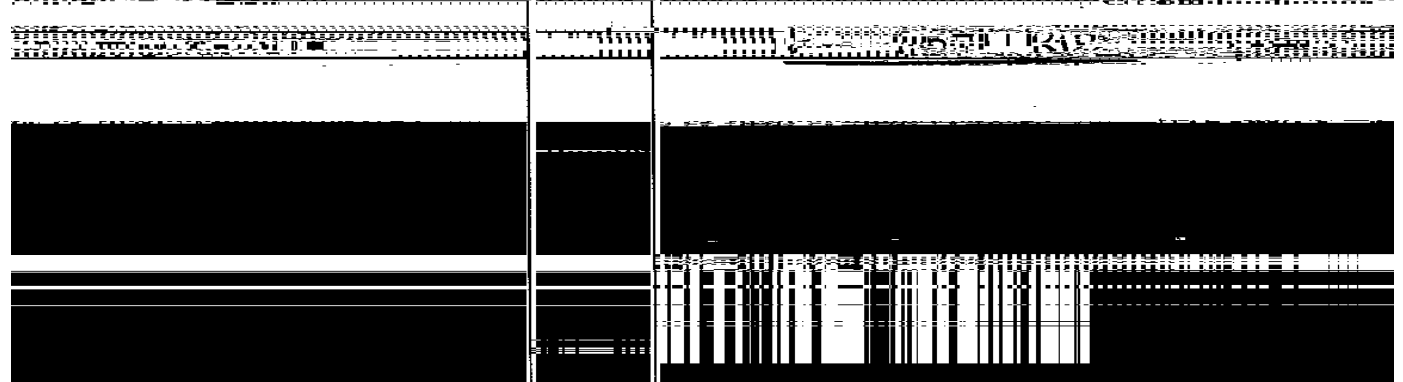
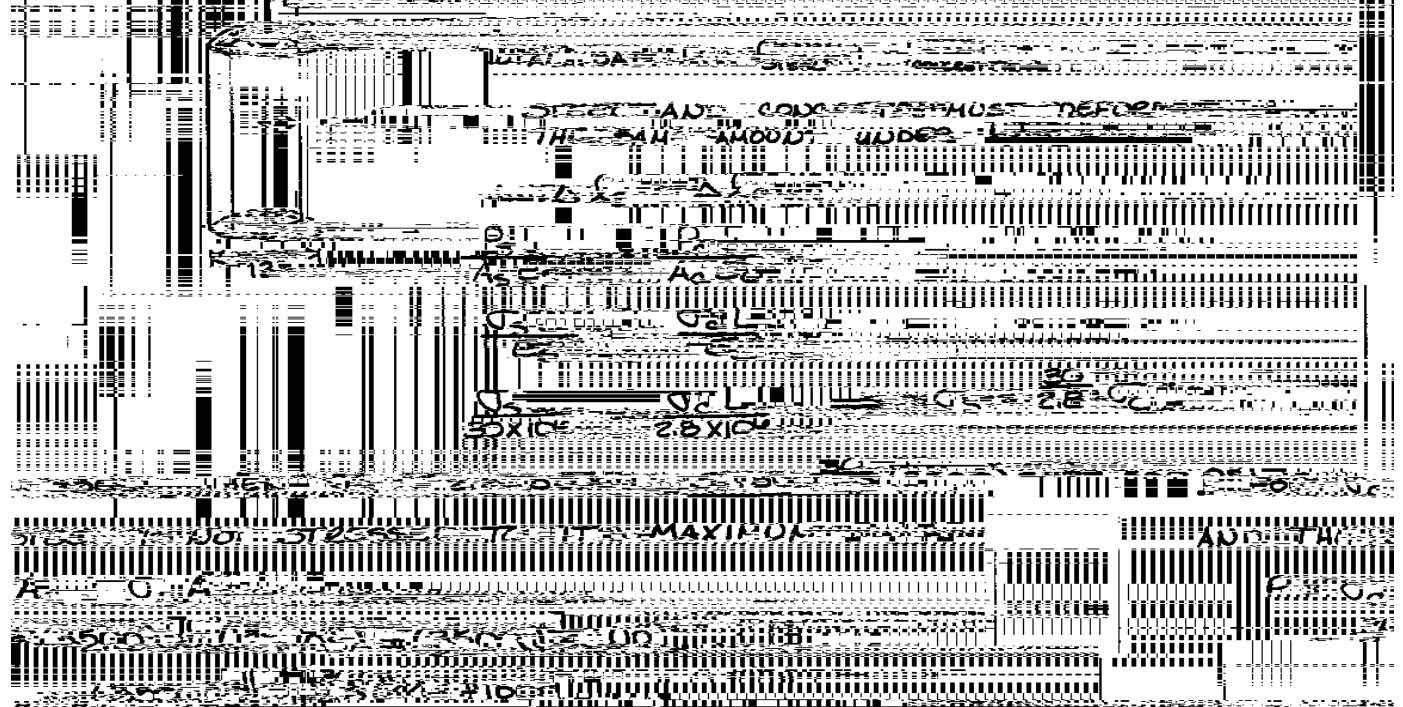


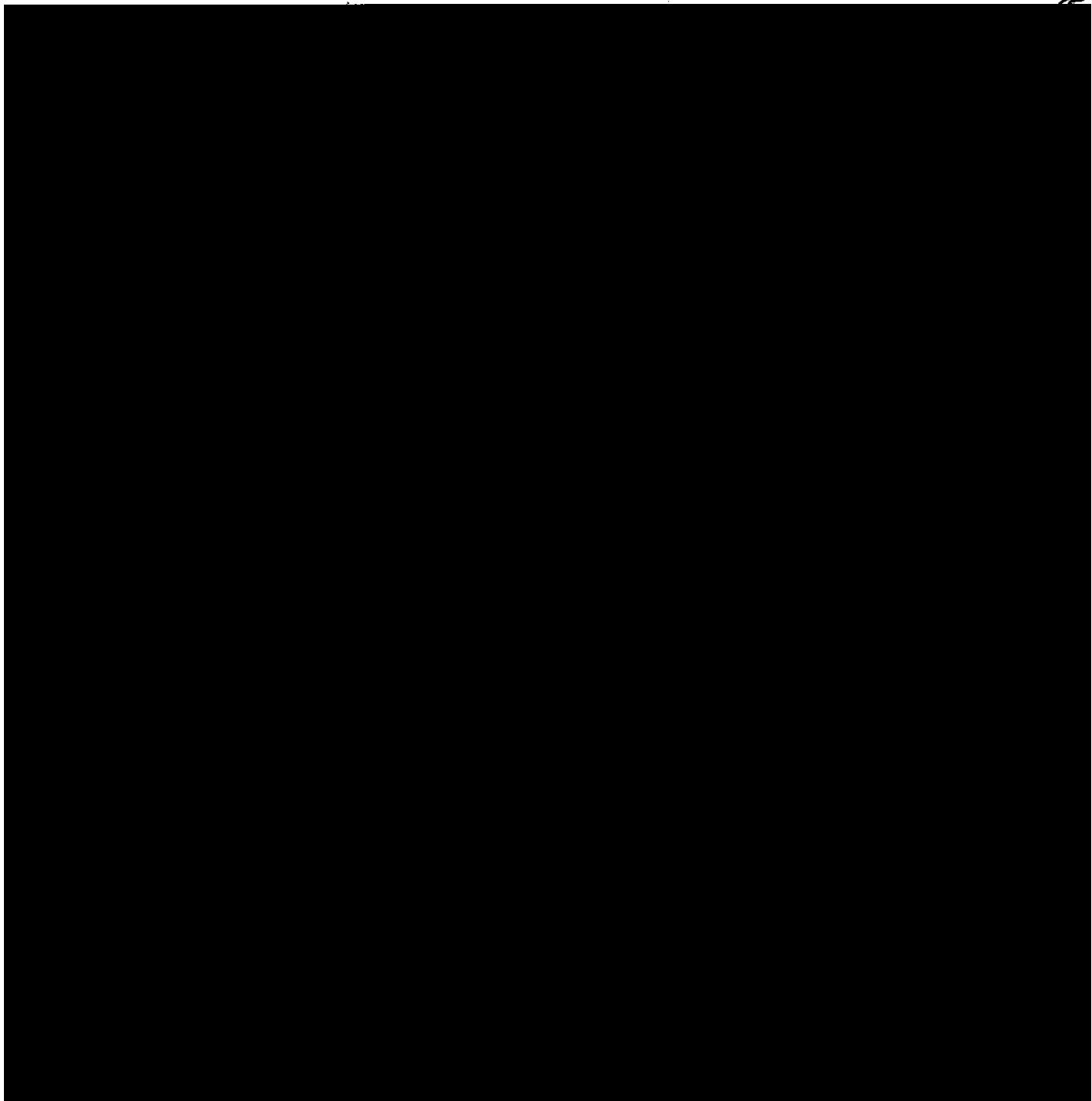
FROM EDGE COMPOUSE, NOT NOW BE STUDIE

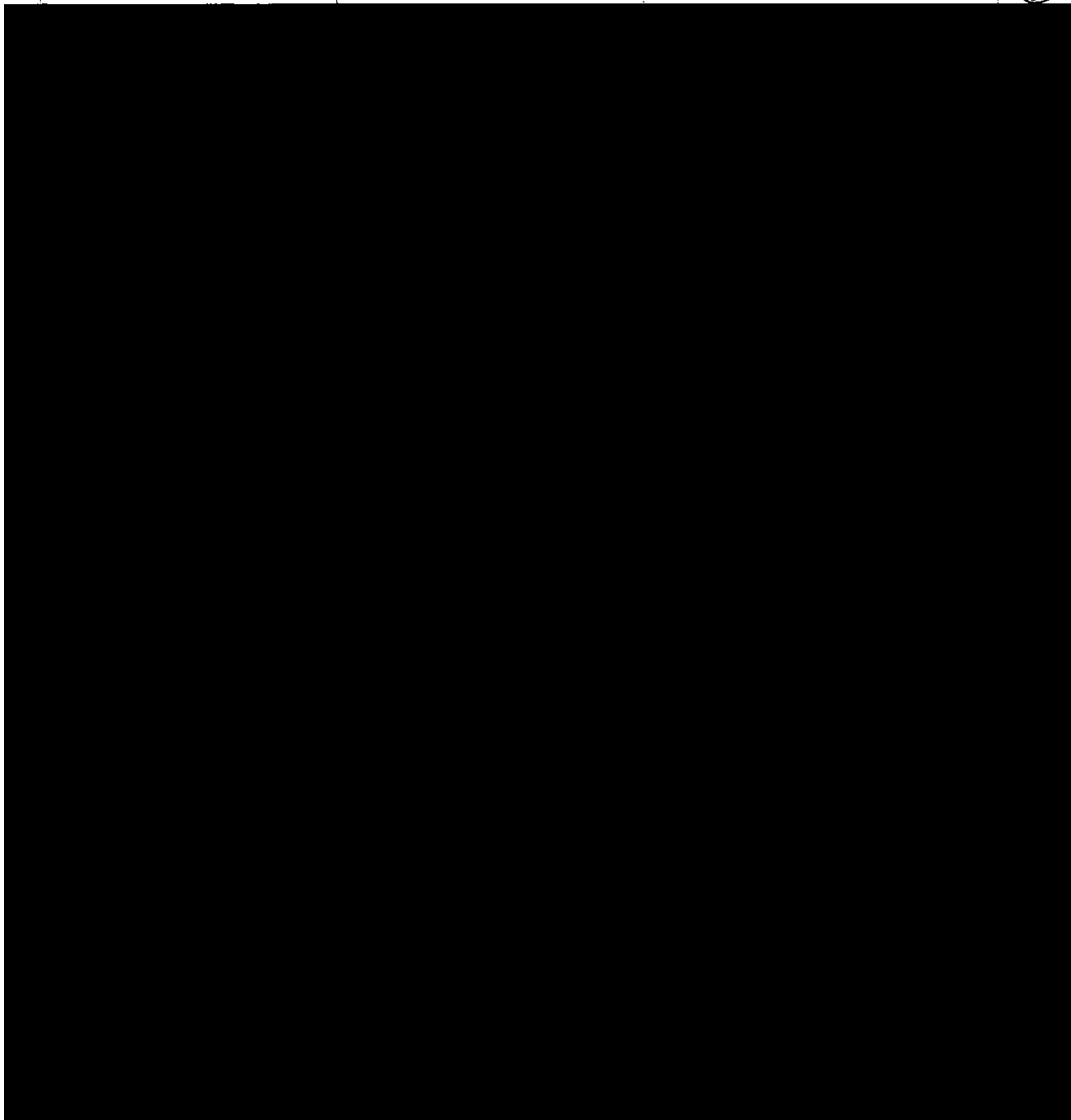


AXIAL FORCE EXAMPLE

A STEEL CYLINDER 12 IN. OUTSIDE DIAMETER AND A WALL THICKNESS OF 1.5 IN. IS SUBJECTED TO AN AXIAL LOAD OF 100,000 LBS. THE ALLOWABLE STRESS IN STEEL IS 20,000 PSI AND THE ALLOWABLE STRESS IN CONCRETE IS 1,000 PSI. THE YOUNG'S MODULUS OF STEEL IS 29,000,000 PSI AND THE YOUNG'S MODULUS OF CONCRETE IS 4,000,000 PSI.







PRESSURE VESSEL & HOOKE'S LAW PROBLEM

7
CYLINDRICAL

51. EXAM SPRING 1978

PRESSURE VESSEL IS 24" O.D. WITH $\frac{1}{4}$ " WALL

A STEEL

THICKNESS IS 1/4" AND IS MADE OF A STEEL WITH A TENSILE STRENGTH OF 100,000 PSI

THE VESSEL IS SUBJECTED TO AN INTERNAL PRESSURE OF 1000 PSI

DETERMINE THE HORIZONTAL AND VERTICAL STRESS DISTRIBUTION THROUGH THE THICKNESS OF THE WALL



0.015 X 10⁶ PSI 0.31 X 10⁶ PSI

BIAXIAL HOOKE'S LAW

CONVOLUTIONAL STRESS



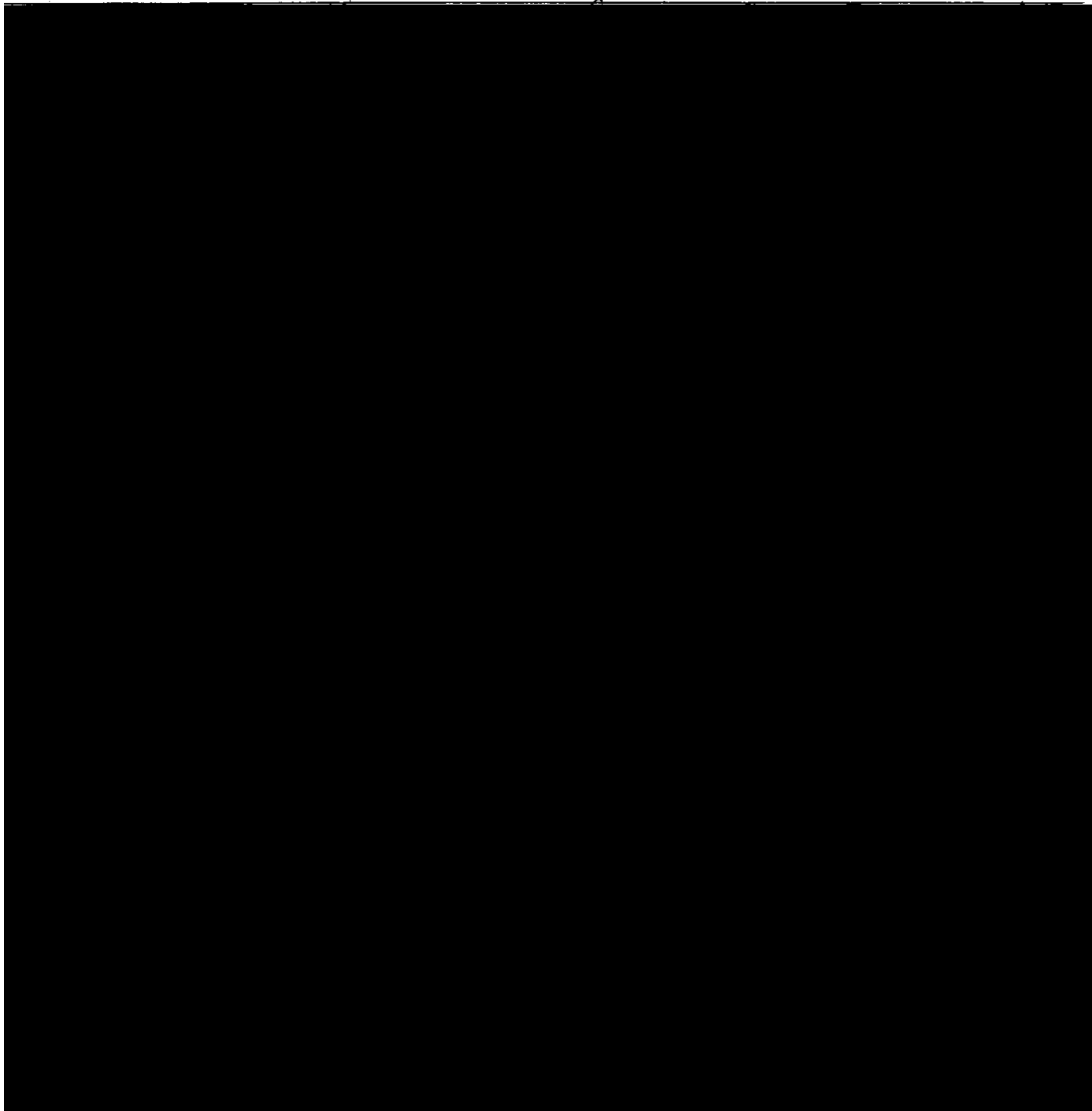
INTERNAL PRESSURE

INTERNAL PRESSURE

INTERNAL PRESSURE
RADIUS
RIBS

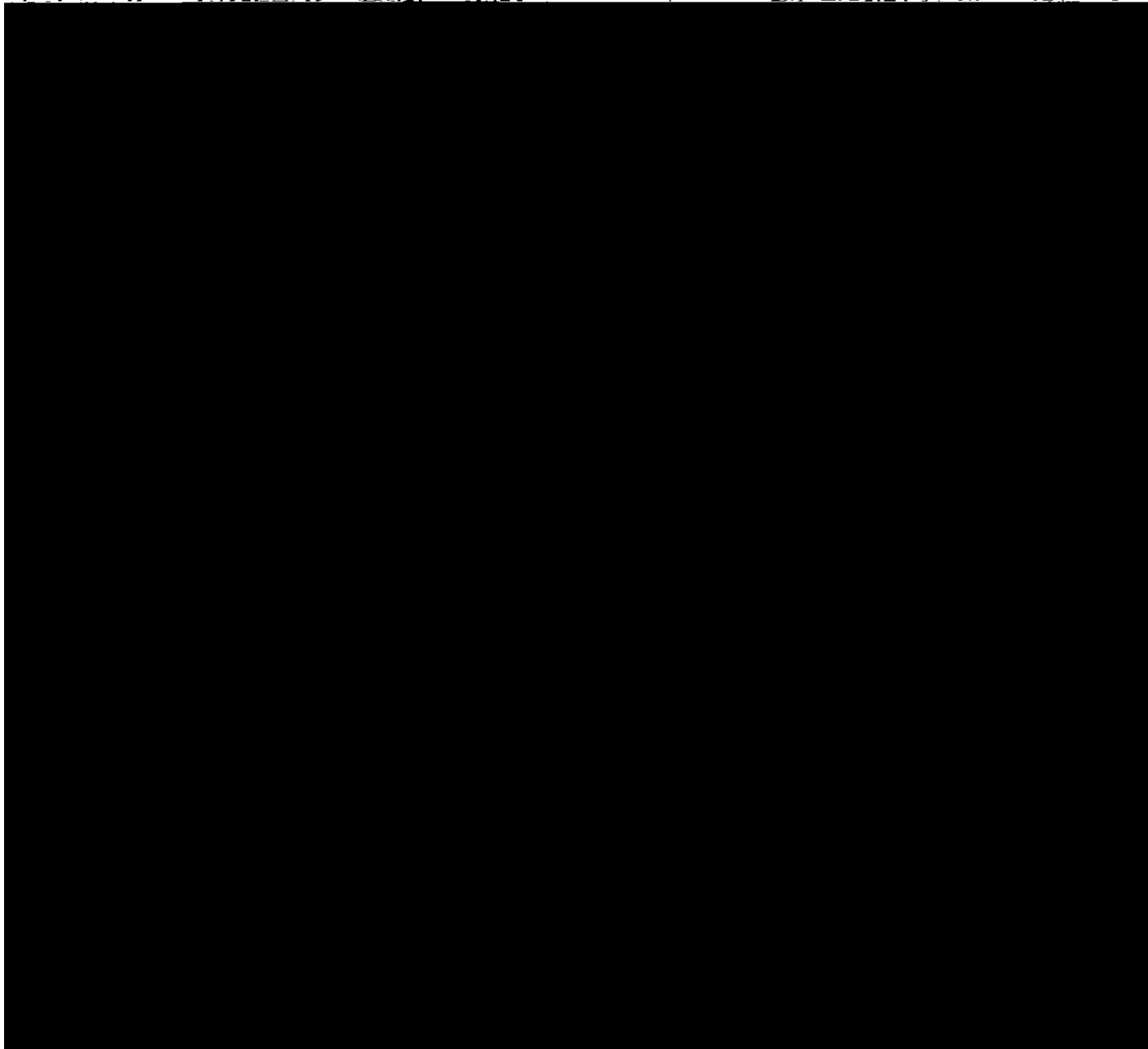
INTERNAL PRESSURE
AVERAGE
WALL THICKNESS

INTERNAL PRESSURE



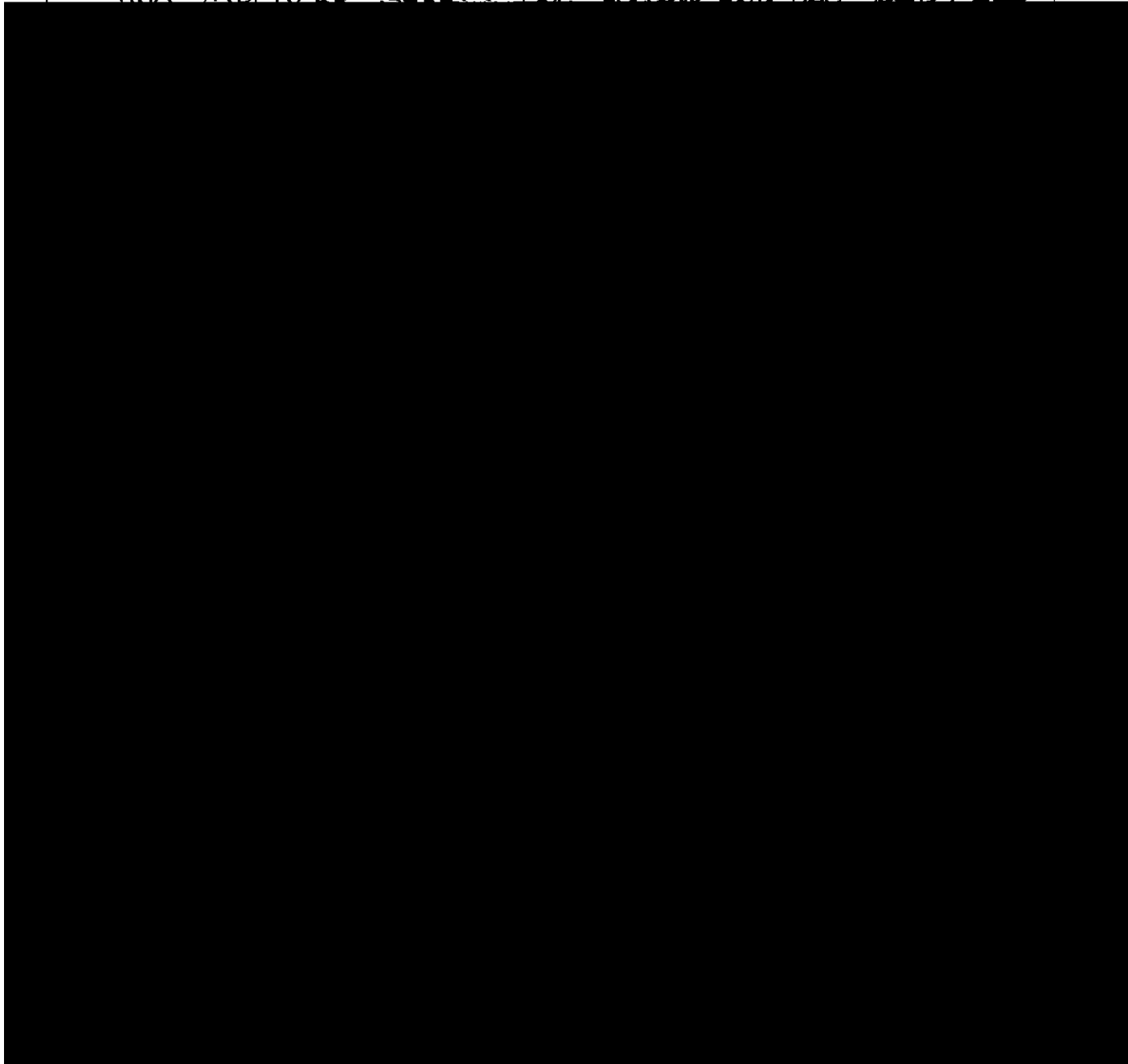
TORSION EXAMPLE

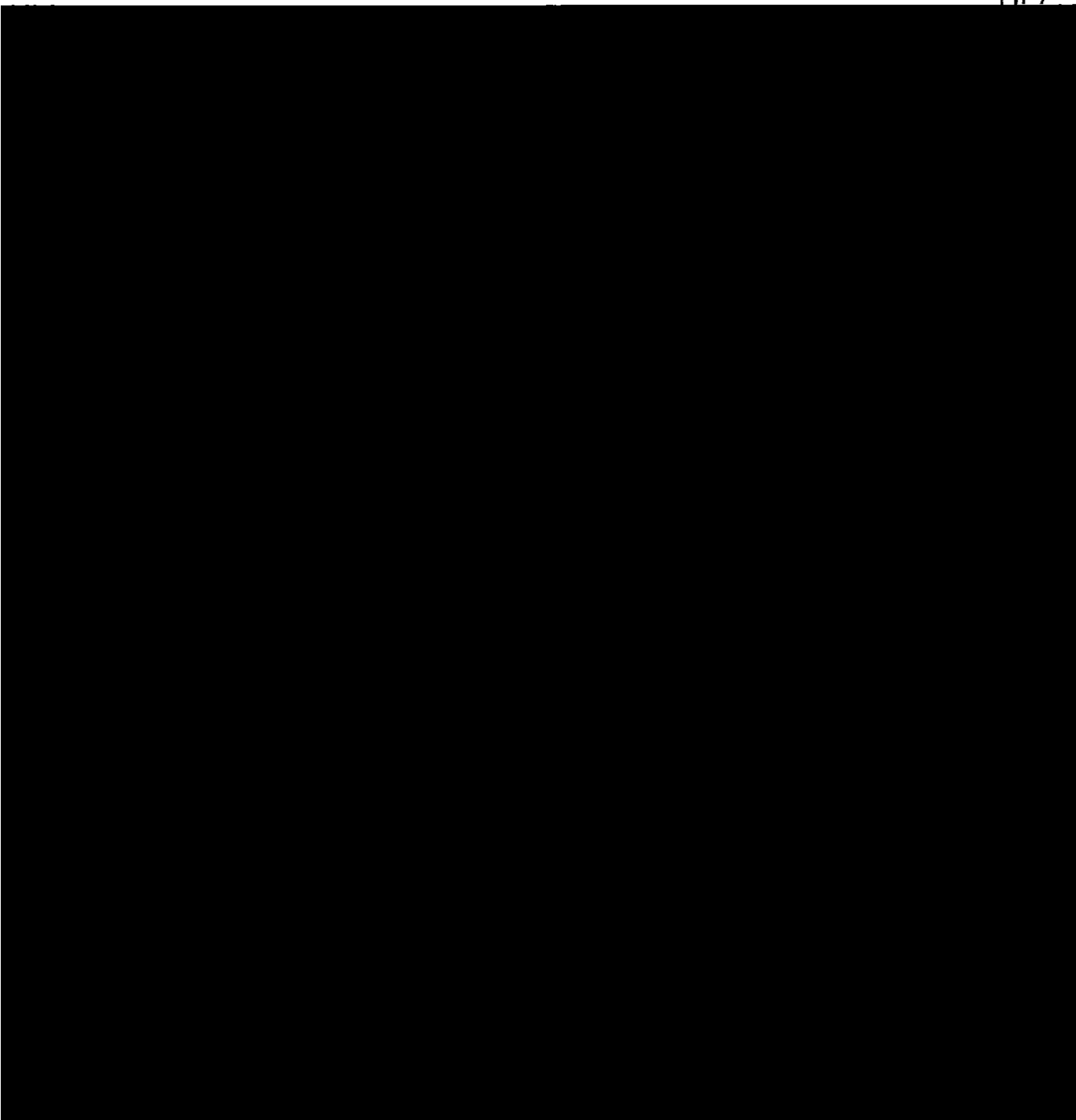
THE HOLLOW STEEL SHAFT ($G = 12 \times 10^6$ PSI) MUST TRANSMIT



TORSION EXAMPLE

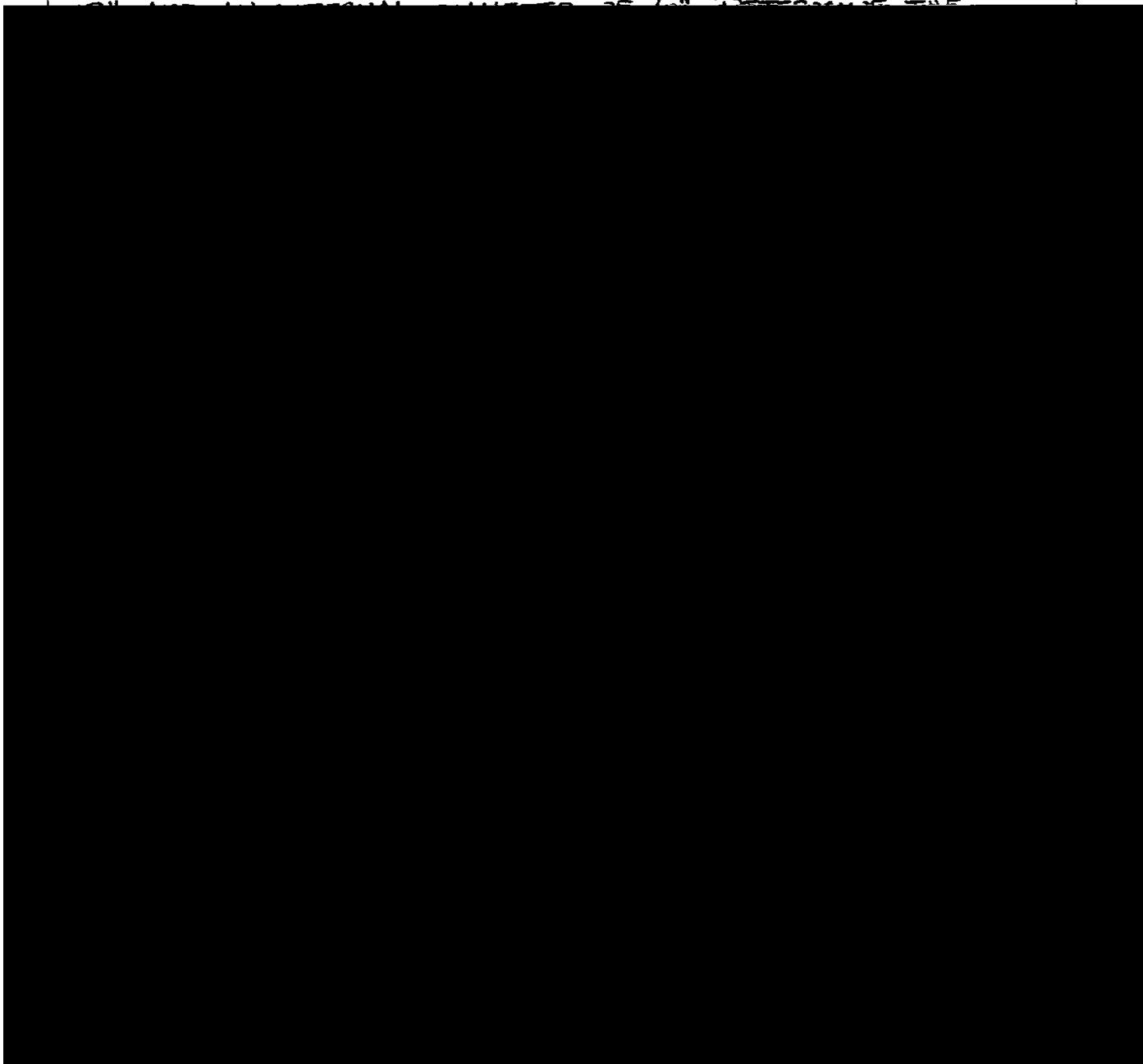
TWO CIRCULAR SHAFTS, ONE HOLLOW AND ONE SOLID, ARE



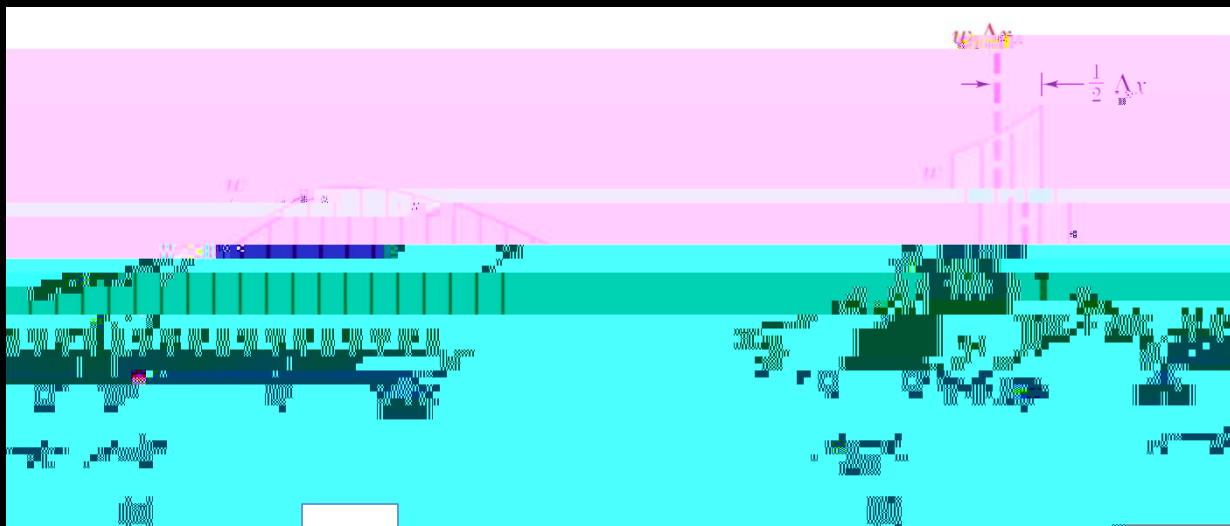


TORSION PROBLEM FROM EIT EXAM - SPRING, 1972

A HOLLOW STEEL SHAFT HAS AN EXTERNAL DIAMETER OF
3.0 INCHES AND AN INTERNAL DIAMETER OF 2.5 INCHES. DETERMINE THE

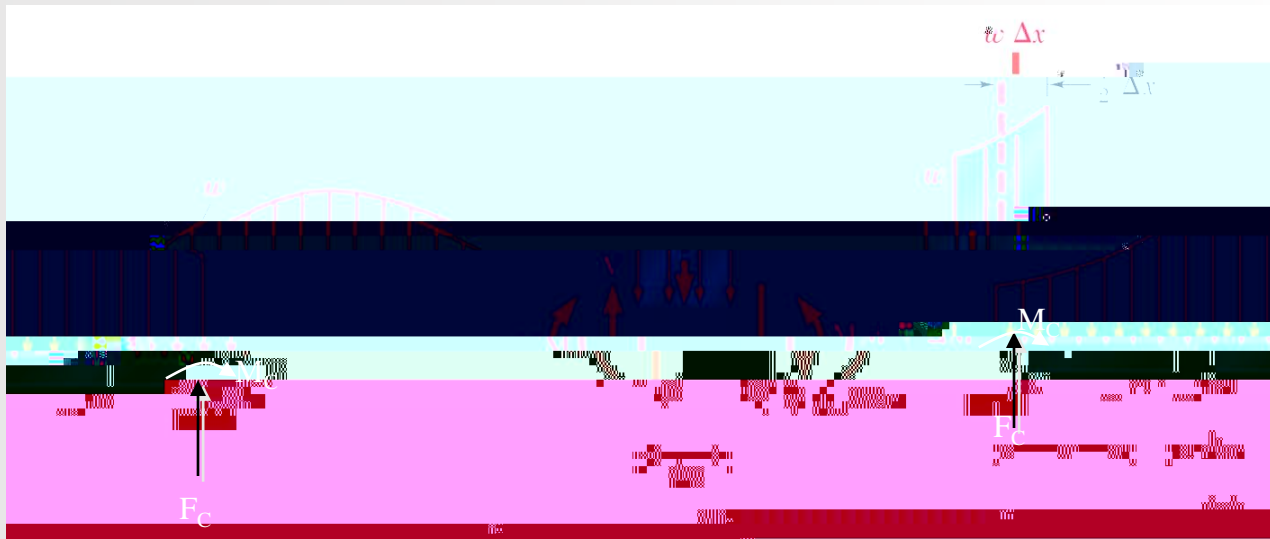


IV. SHEAR AND BENDING MOMENT IN BEAMS



-
-
-
-

[Empty rectangular box for notes or calculations]



IF THERE ARE CONCENTRATED FORCES/MOMENTS ACTING AT A POINT,

$$\begin{aligned}
 + &= + () \\
 + &= + (\curvearrowright)
 \end{aligned}$$

SHEAR & MOMENT IN BEAMS

A 16 FT. BEAM HAS SIMPLE SUPPORTS AT THE ENDS AND CARRIES A LOAD AS INDICATED IN THE FIGURE.

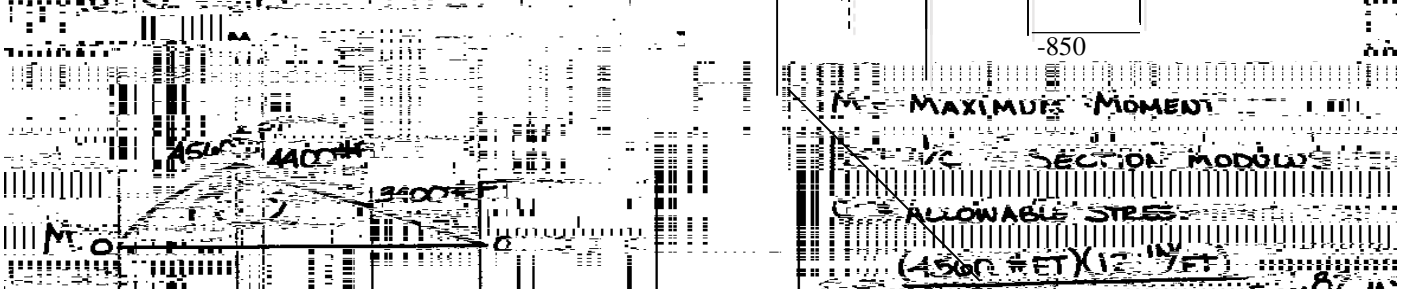
(0.1) PROBLEM: NEARLY TO ANY APPROXIMATE, CALCULATE THE LOAD SHEAR AND BENDING MOMENT DIAGRAMS. WRITE IN MAGNITUDES OF THE ESSENTIAL VALUES. ADVANCE THE DIMENSION FROM THE LEFT END OF THE BEAM. WHEN THESE VALUES ARE

EVALUATED IN SECTION MODULI BENDING C

AND DIAGRAM 600 Lb

200 #/FT

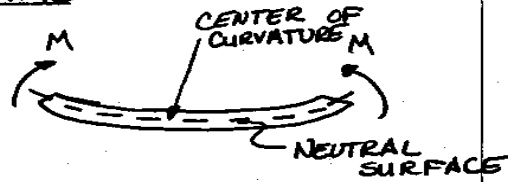
$M_p = 20(5)(9) + 600(5) = 1350$
 $M_p = (20(4) + 600)(4) - 20(16) = 1350$



M.O

V. FLEXURAL STRESSES IN BEAMS

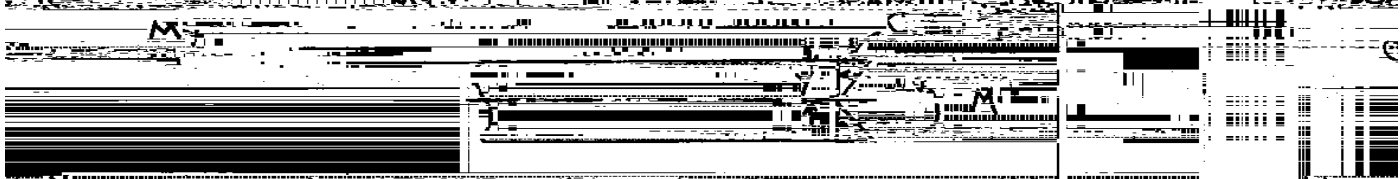
BENDING MOMENTS, M , ON A BEAM SEGMENT CAUSE DEFORMATIONS AS SHOWN AND THE RADIUS OF CURVATURE, ρ , AND M ARE RELATED BY:



$M = EI \frac{1}{\rho}$ WHERE E IS MODULUS OF ELASTICITY



STRESS VAR. LINEARLY OVER THE DEPTH OF THE BEAM



FORMULA IS VALID IN THE PLANE OF BENDING FOR THE STRESS BY LOADING MUST BE PERPENDICULAR

V. SHEARING STRESSES IN BEAMS

MAXIMUM SHEAR STRESS IS GIVEN BY

$$\tau_{max} = \frac{VQ}{Ib}$$

WHERE V IS THE SHEAR FORCE

Q IS THE FIRST MOMENT OF THE AREA ABOVE OR BELOW THE POINT

I IS THE MOMENT OF INERTIA OF THE BEAM

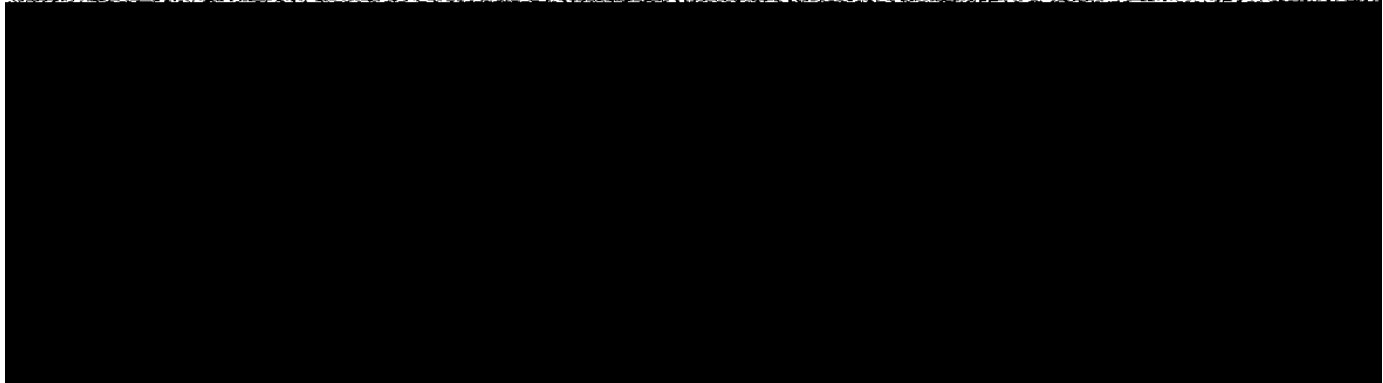
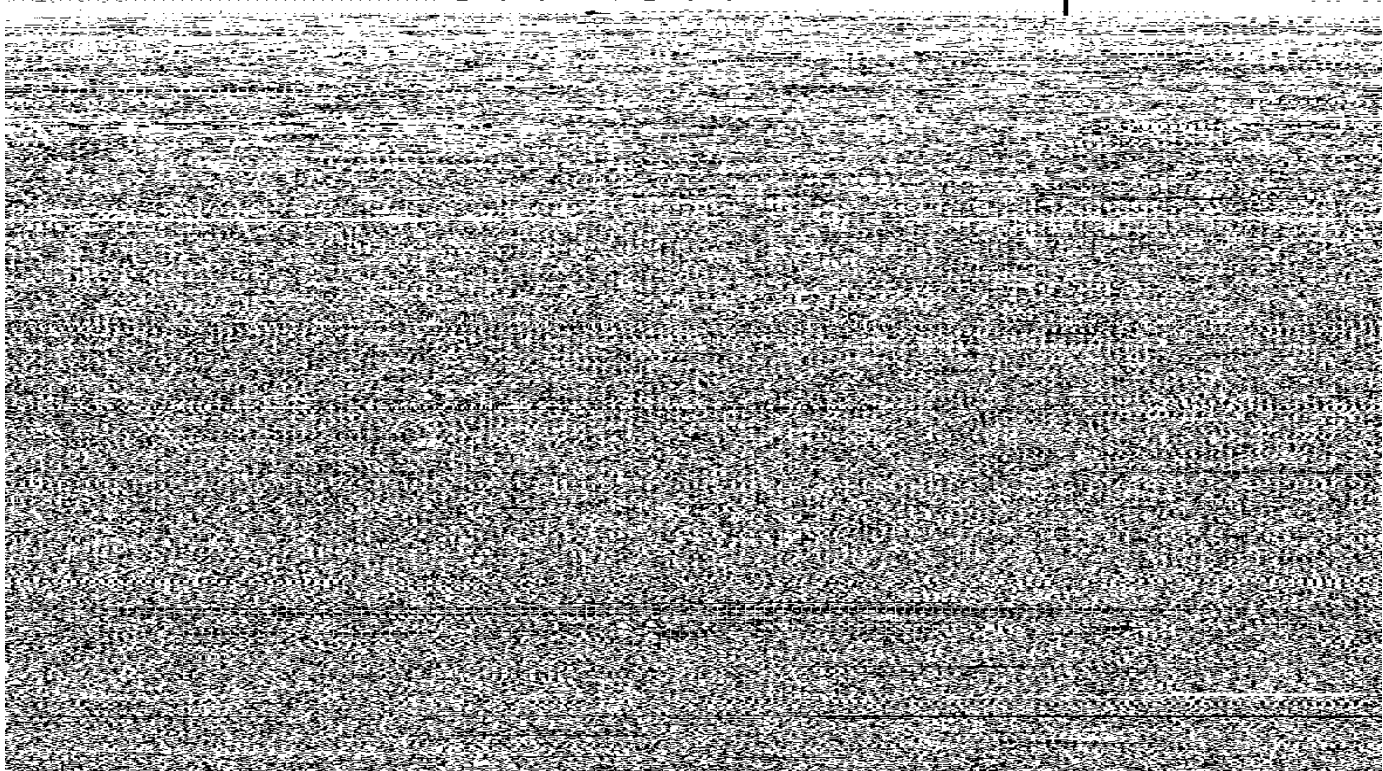
b IS THE WIDTH OF THE BEAM AT THE POINT

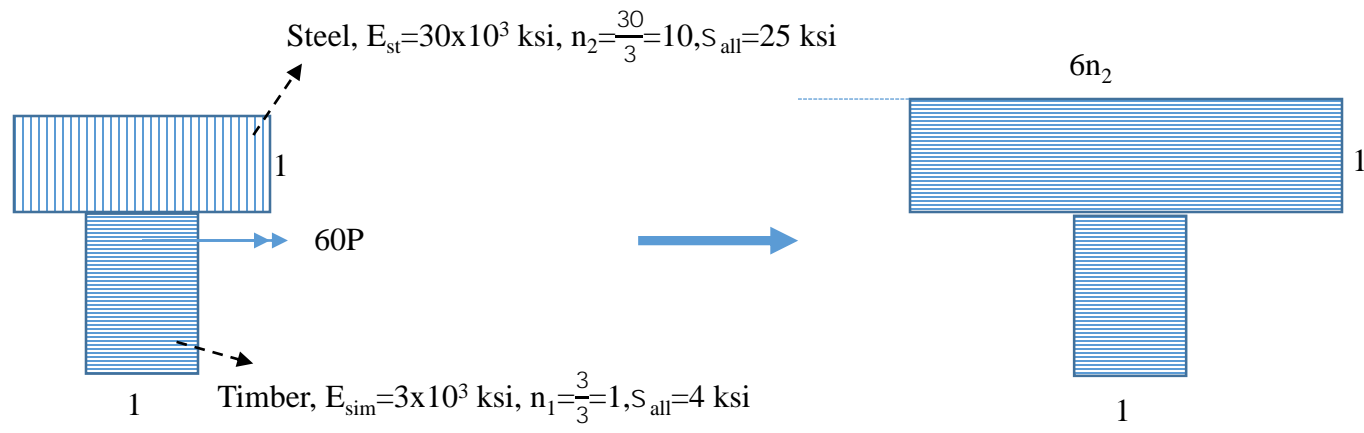
NEUTRAL AXIS

FLEXURE EXAMPLE

GIVEN THE BEAM SHOWN BELOW. THE ALLOWABLE TENSILE UNIT STRESS IS 3000 PSI ; THE ALLOWABLE COMPRESSIVE UNIT STRESS IS 10,000 PSI . NEGLECTING THE WEIGHT OF THE BEAM, WHAT IS THE MAXIMUM

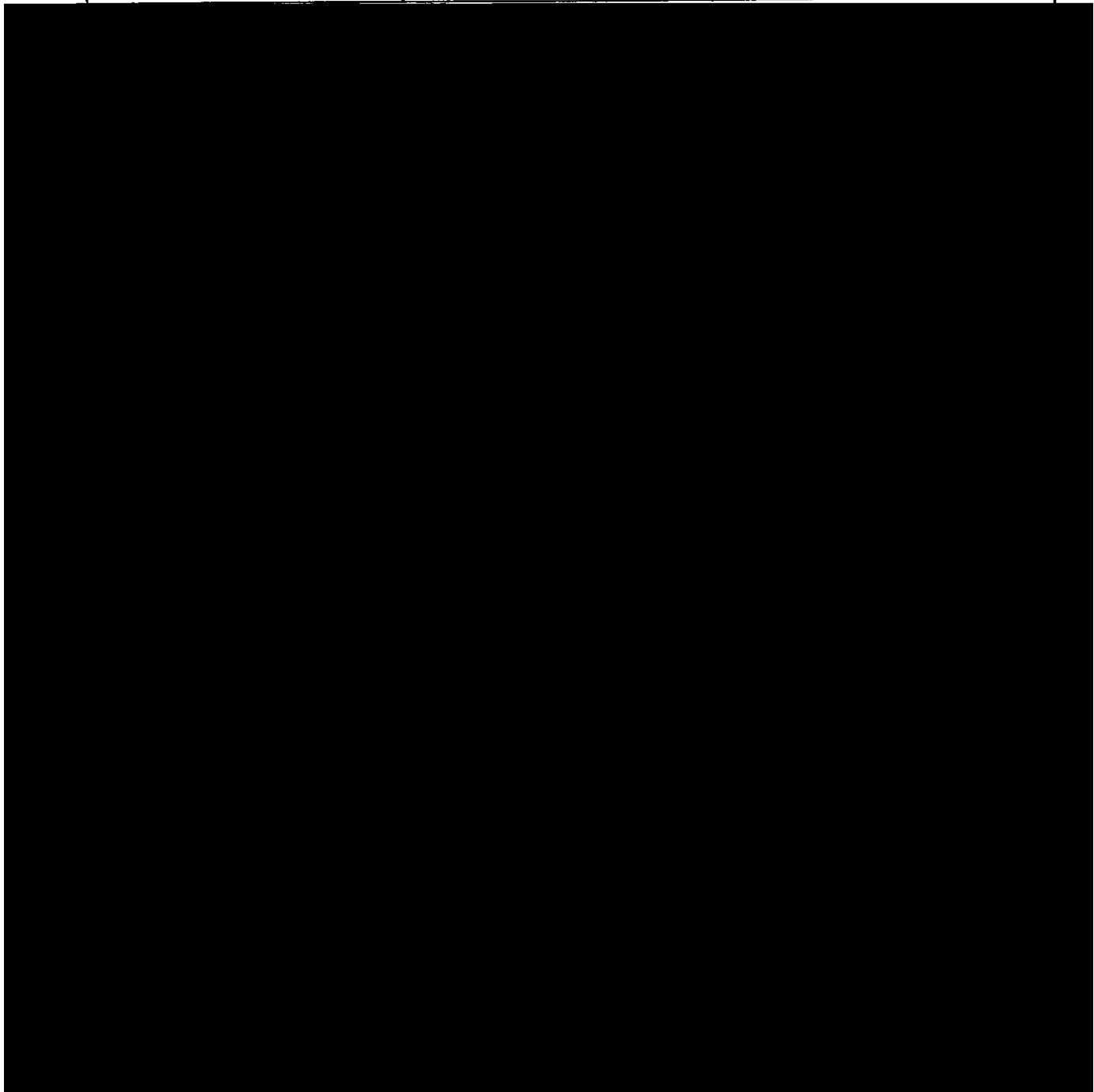
~~LOAD THAT CAN BE APPLIED AT THE FREE END OF THE BEAM.~~





Original X-section

Transformed X-section

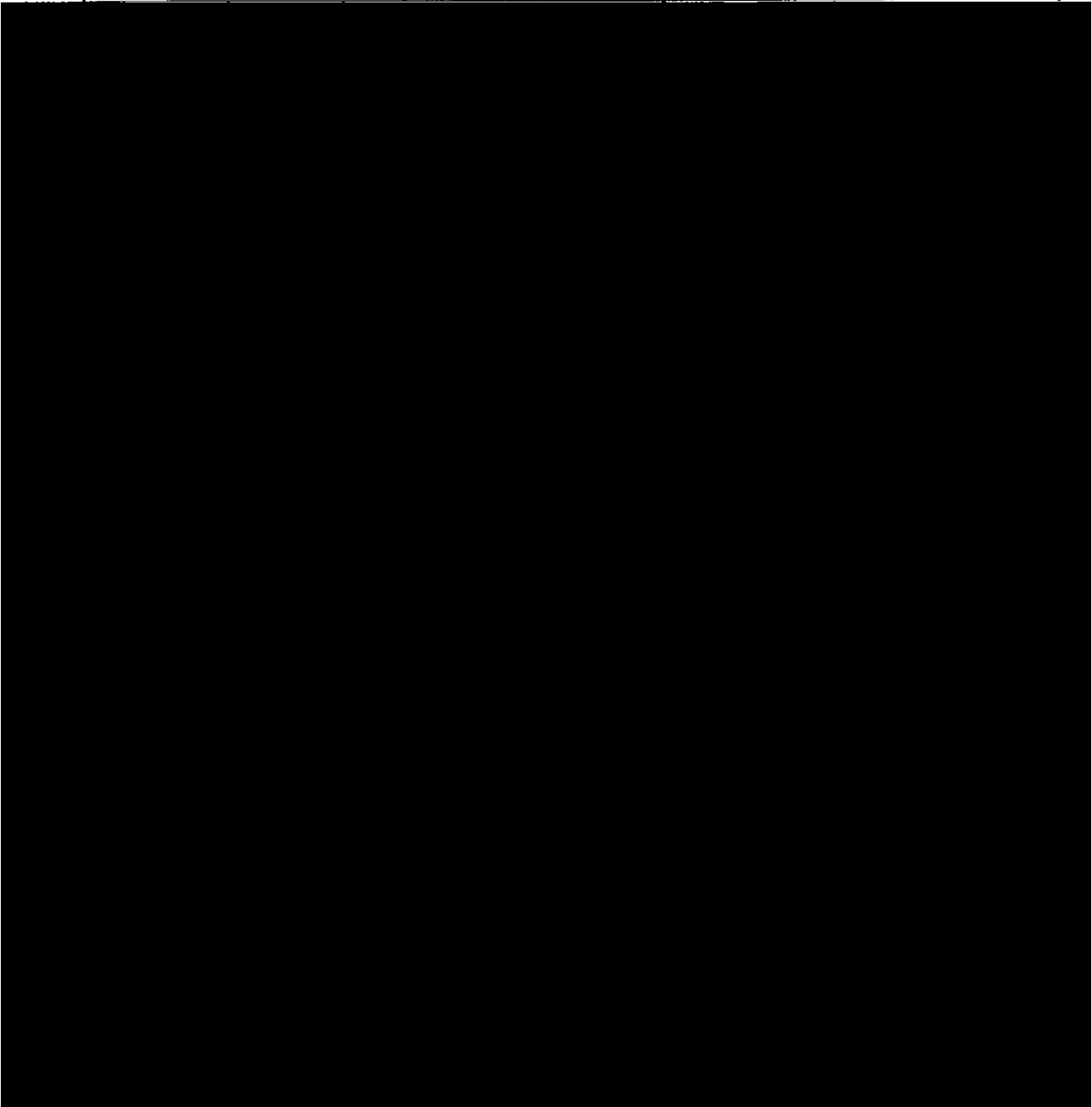




22-142 100 SHEETS
22-144 200 SHEETS

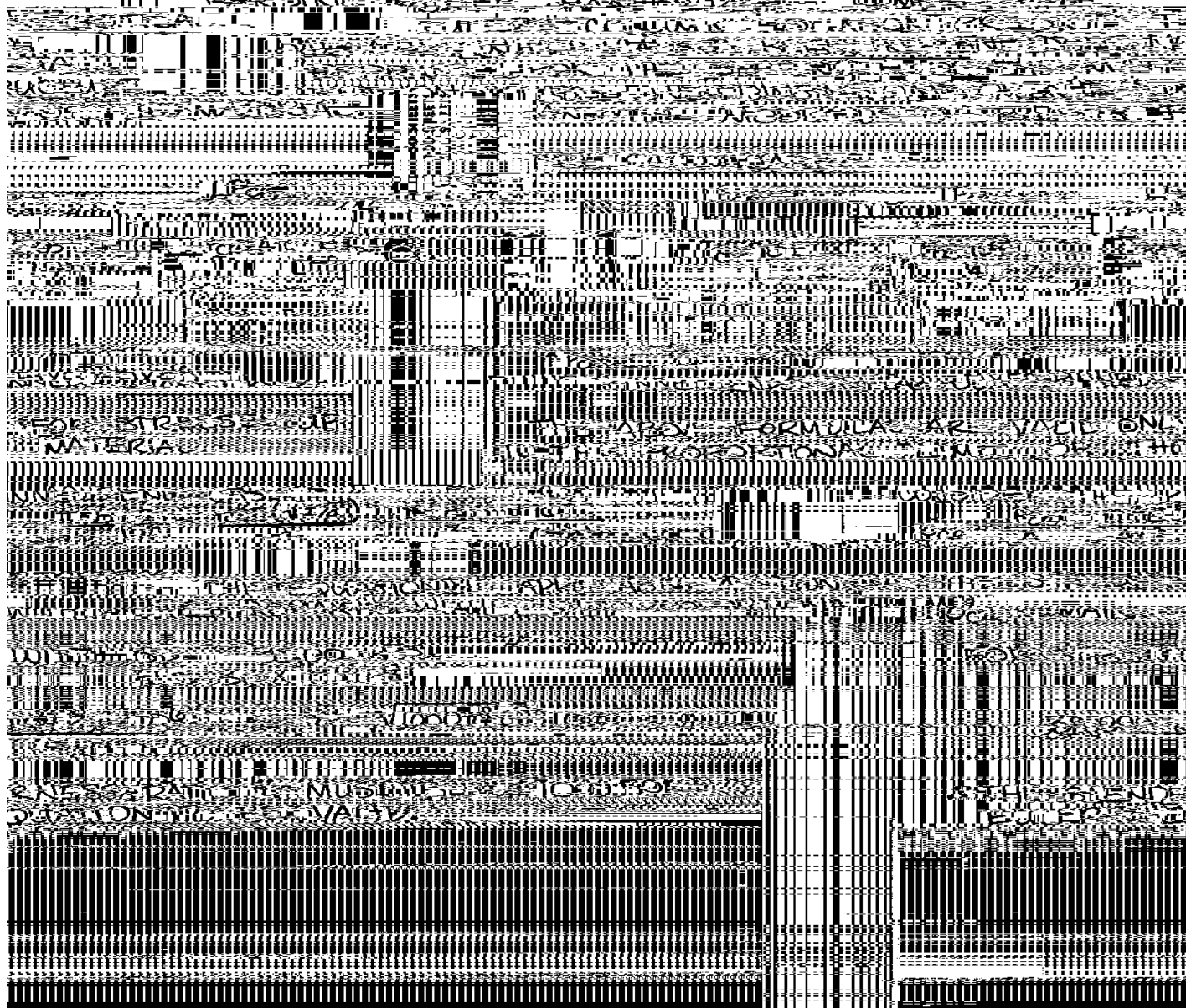
SUMMARY OF REVISIONS





IX. EULER COLUMN EQUATION

WHEN THE LENGTH OF A COMPRESSION MEMBER IS LARGE IN COMPARISON WITH ITS TRANSVERSE DIMENSIONS, FAILURE TENDS TO OCCUR BY BUCKLING OR LATERAL



EULER COLUMN EQUATION

A 2-INCH DIAMETER STEEL ROD, 48 INCH LONG IS

FIXED AT ONE END AND FREE AT THE OTHER END. A 100 LB LOAD IS APPLIED AT THE FREE END.

DETERMINE THE CRITICAL LOAD FOR BUCKLING. THE WEIGHT OF THE BAR IS TO BE NEGLECTED.

THE MODULUS OF ELASTICITY IS $E = 29 \times 10^6$ PSI.

THE YIELD STRESS IS $S_y = 42,000$ PSI.

THE TENSILE STRENGTH IS $S_u = 58,000$ PSI.

THE COEFFICIENT OF THERMAL EXPANSION IS $\alpha = 6.5 \times 10^{-6}$ IN/IN/°F.

THE THERMAL STRAIN IS $\epsilon_T = \alpha \Delta T$.

THE TOTAL STRAIN IS $\epsilon = \epsilon_T + \epsilon_m$.

THE MAXIMUM THERMAL STRAIN IS $\epsilon_{Tmax} = \alpha \Delta T_{max}$.

THE MAXIMUM THERMAL STRAIN IS $\epsilon_{Tmax} = 6.5 \times 10^{-6} \times 120 = 7.8 \times 10^{-4}$.

THE MAXIMUM THERMAL STRAIN IS $\epsilon_{Tmax} = 0.00078$.

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STRESS TRANSFORMATION

$$\sigma_{x\phi} = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \left(\frac{\sigma_x - \sigma_y}{2}\right) \cos(2\phi) + \tau_{xy} \sin(2\phi), \quad \tau_{x\phi} = -\left(\frac{\sigma_x - \sigma_y}{2}\right) \sin(2\phi)$$

