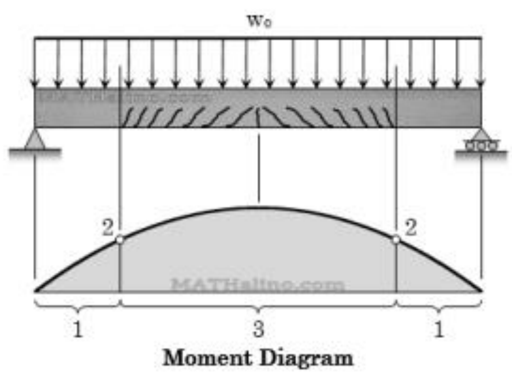
FLEXURAL ANALYSIS OF BEAM BY WORKING STRESS METHOD

Behaviour of Reinforced Concrete Beam under Loading:

Working Stress Analysis for Concrete Beams Consider a relatively long simply supported beam shown below. Assume the load (Wo) to be increasing progressively until the beam fails.

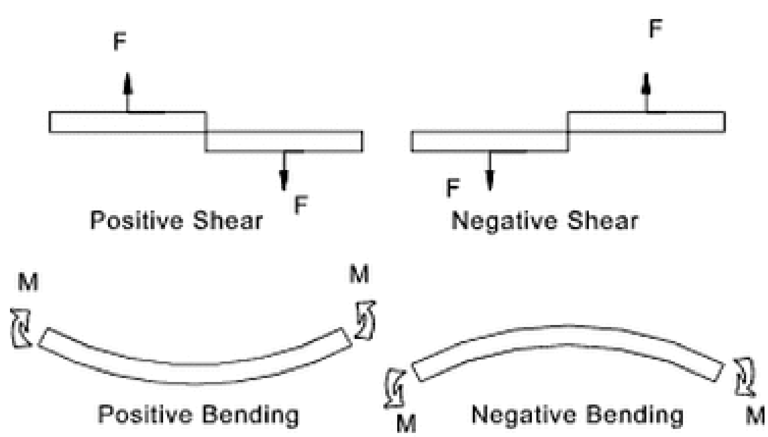
The beam will go into the following three stages:

1- **Uncrack Concrete Stage.**
2- **Crack Concrete Stage (Elastic).**
3- **Ultimate Stress Stage – Beam Failure.**



At section 1: Uncrack stage:

1- Actual moment, (M) < Cracking moment (Mcr).
2- No cracking occur.
3- The gross section resists bending.
4- The tensile stress of concrete is below rupture.



fc < 0.5 fc' .... Concrete is Elastic

fs < fy .... Steel is Elastic

fct < fr .... Un-cracked

$$n = \frac{Es}{Ec} = \frac{200000}{4700\sqrt{fc'}}$$

Where:

fc: Actual compressive Strength for Concrete.

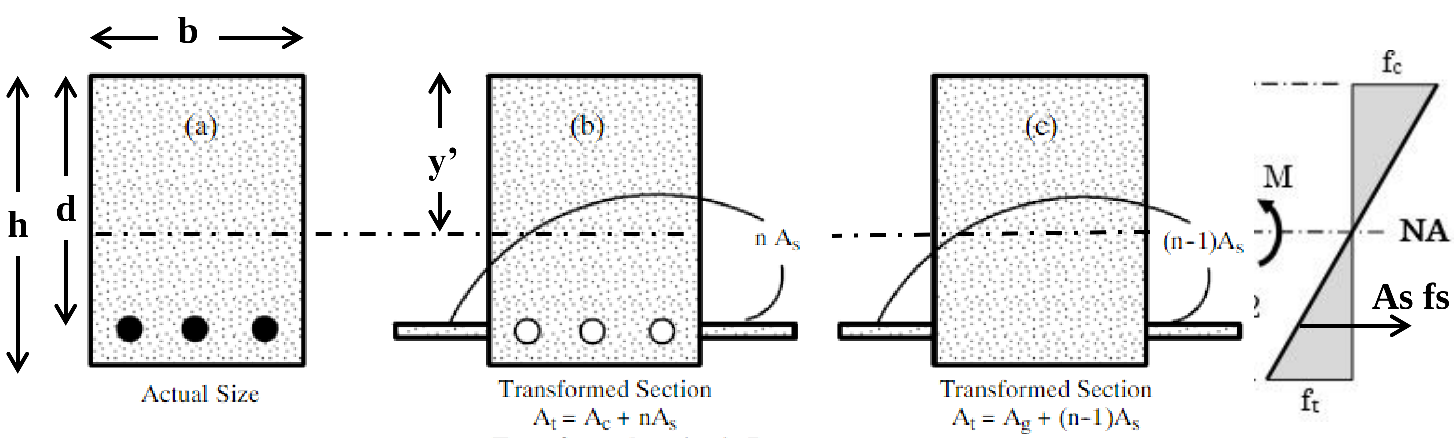
fc': Maximum compressive Strength for Concrete.

fs: Actual tensile strength for steel.

fy: Yield strength for steel.

fr: Modulus of rupture.

n: Modulus ratio.



Transformed section in Beams

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At Section 2 : Crack concrete stage:

1- Actual moment, (M) > Cracking moment (Mcr).
2- Elastic stress stage.
3- Cracks developed at the tension fiber of the beam and spreads quickly to the neutral axis.
4- The tensile stress of concrete is higher than the rupture strength.
5- Ultimate stress stage can occur at failure.

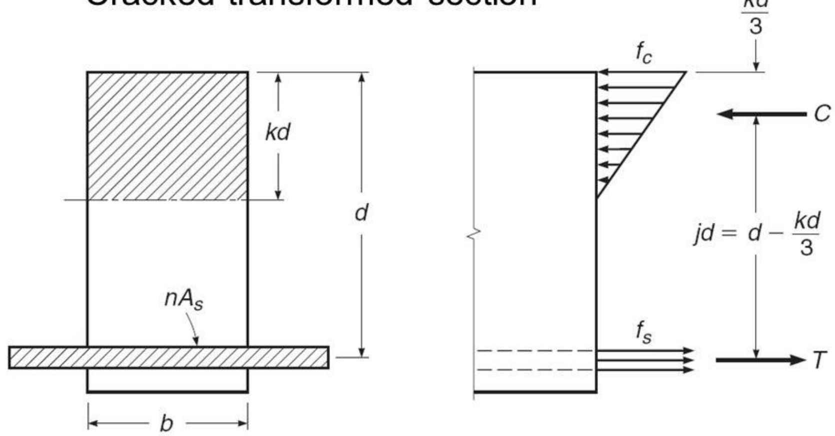
fc < 0.5 fc' .... Concrete is Elastic

fs < fy .... Steel is Elastic

fct > fr .... Cracked

$$n = \frac{Es}{Ec} = \frac{200000}{4700\sqrt{fc'}}$$

Cracked transformed section



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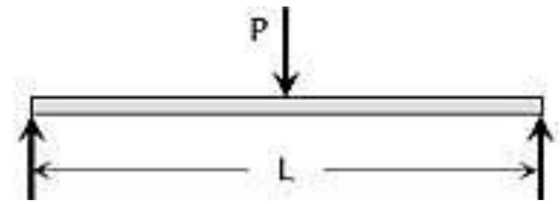
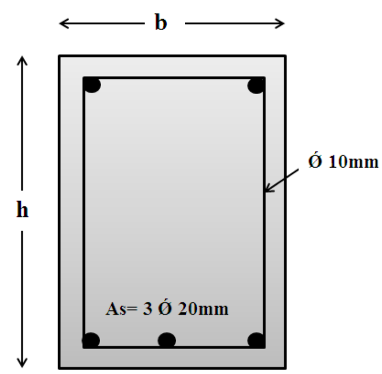
Ex: Find Maximum load (P) can be applied at the center of the beam shown for information:

b= 250 mm , h= 500 mm , Es= 200000 n/mm2,

Ec= 22000 N/mm2, fy= 300 MPa, fc'= 20 MPa

L= 5 m





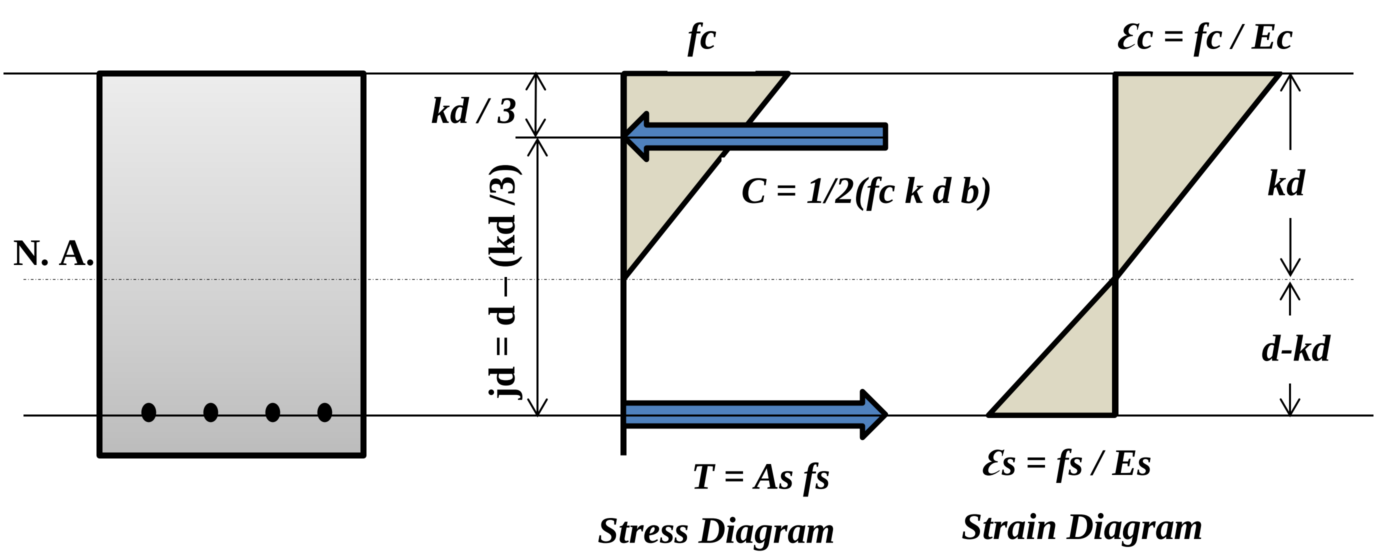
Design of R.C. Rectangular Beam by W.D. Method:

Notes:

1- **Analysis:** Given a cross section, concrete strength, reinforcement size and location, and yield strength, compute the resistance or strength. In analysis there should be one unique answer.

2- **Design**: Given a factored design moment, normally designated as select a suitable cross section, including dimensions, concrete strength, reinforcement, and so on. In design there are many possible solutions.

3- **Balance Section**: is economical section because it is used both of steel and concrete properties in high level.



From Strain Diagram:

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From Stress Diagram:

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Ex: Design the cantilever shown in fig. by using the following data:

fc' = 20 N/mm2 , *fy* = 275 N/mm2 , Es = 200000 N/mm2 ,

ɣc = 24 KN/m3.