Banha University
Faculty of Engineering - Shoubra
Civil Engineering Department

Computation of Nonlinear (STR602)

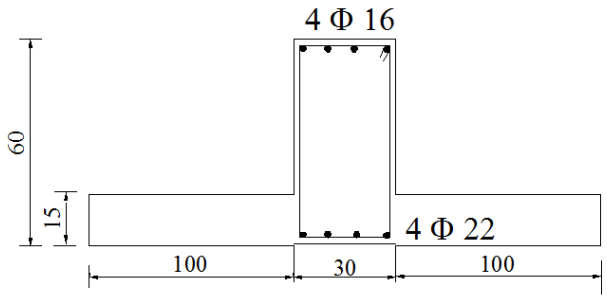
For Master of Engineering Sciences

Assoc. Prof. Taha Ibrahim

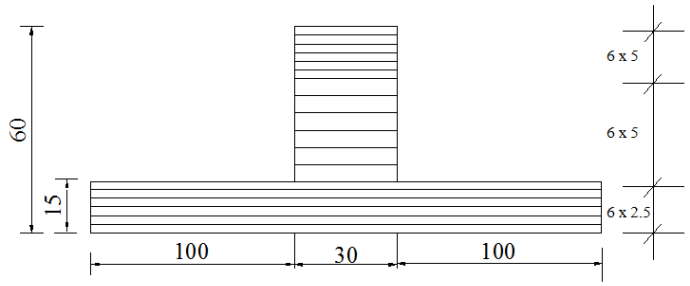
Lecture 3

For the given section shown in Figure 1, the axial strain at mid height of the section ϵ_0 **= -0.0009** and the slope **φ = - 0.0001** (d`= d`` = 2.5 cm). Using the given stress-strain curves for steel and concrete in tension and compression, it is required to:

(a) Calculate and draw the strain distribution;
(b) Calculate and draw the stress distribution;
(c) Calculate axial, coupling and flexural stiffness's (A,B and D) using the secant modulus of elasticity;
(d) Calculate section capacity (M and N);

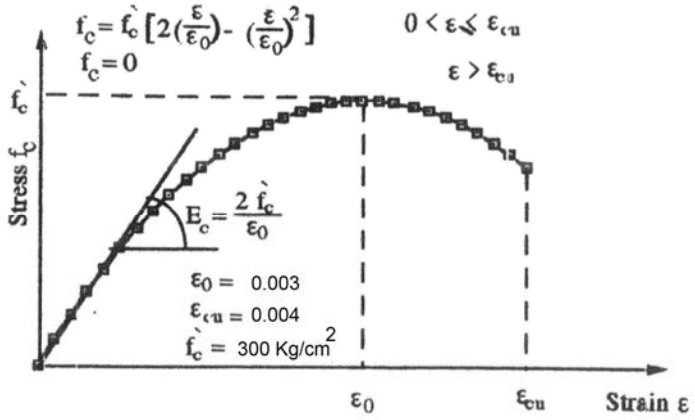


Beam Section
(d` = d`` = 2.5 cm)

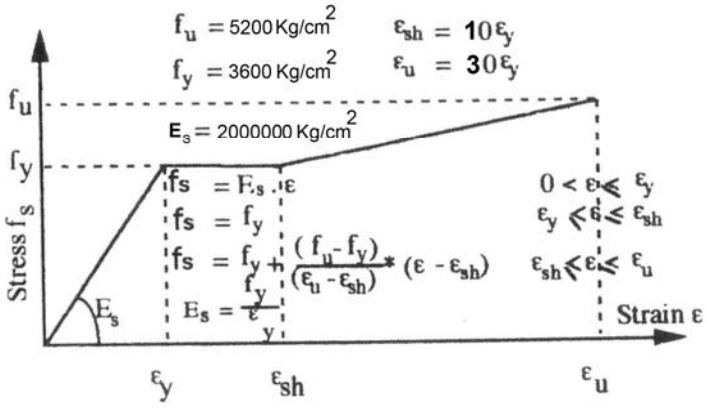


Layered System

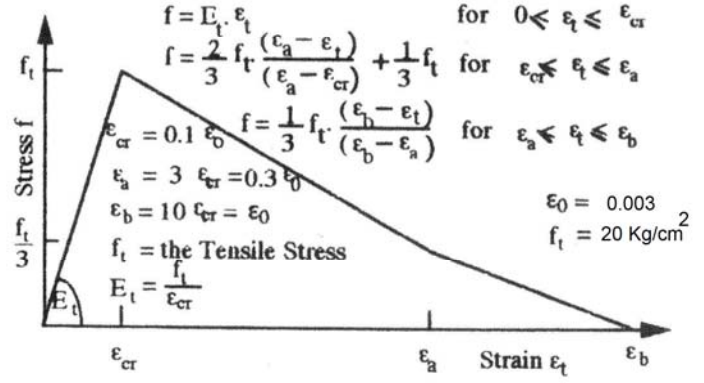
BENHA UNIVERSITY
SHOUBRA FACULTY OF ENGINEERING
CIVIL ENGINEERING DEPARTEMENT
Master of Science (M.Sc)
Code: STR602



Concrete Stress-Strain Curve in Compression



Trilinear Stress-Strain Cirve for Steel Reinforcement in Tension and Compression



Trilinear Model for Concrete in Tension

comp. concrete given		
Fc' =	300	Kg/cm2
Fyst	2400	Kg/cm2
$\epsilon_{0=}$	0.003	
$\epsilon_{cu=}$	0.004	

Tension concrete given		
Fcu =	300	Kg/cm2
Ft =	20	Kg/cm3
$\epsilon_{0=}$	0.003	
$\epsilon_{cr=}$	0.0003	
Et	66666.667	Kg/cm2

Steel given		
St 37	360/520	
Fy	3600	Kg/cm2
Fu	5200	Kg/cm2
Es	2000000	Kg/cm2
ϵ_y=	0.0018	
ϵ_u=	0.054	
ϵ_{sh}=	0.018	

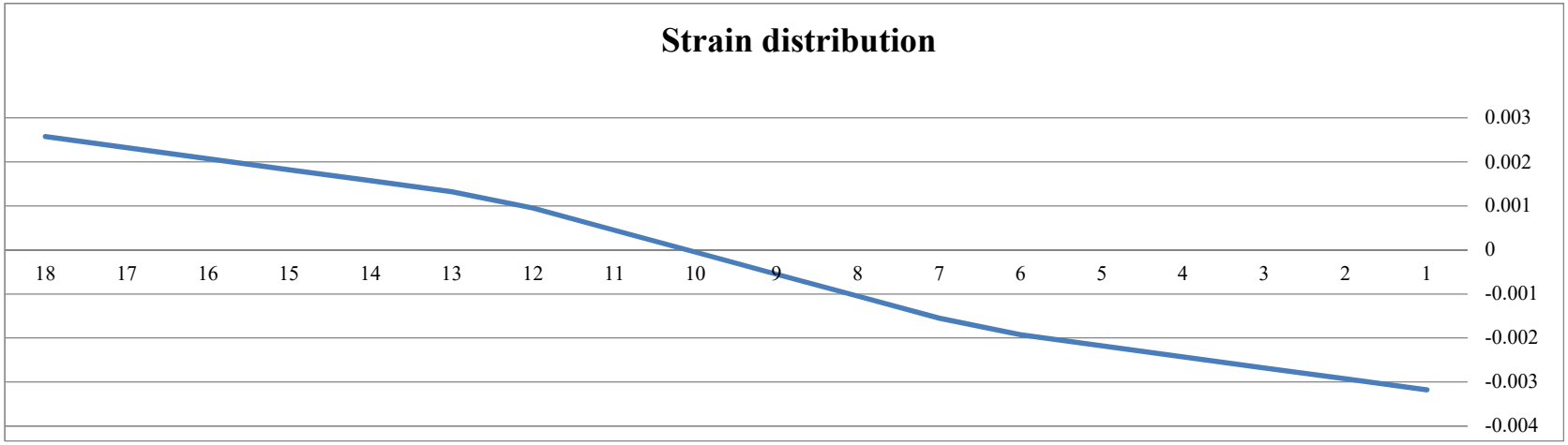
ϵ_{cr}=	0.0003
ϵ_a=	0.0009
ϵ_b=	0.003
Et	66666.66667

axial strain at mid height ϵ_0=	-0.0003
slope =	-0.0001

b=	230	cm	t=	60	cm	As=	6.084	cm2
						As'=	3.218	cm2

layer no .	layer type	T_l (CM)	b_l (CM)	z_l (CM)	ϵ_l	status	F_l (Kg/CM2)	E secant (Kg/CM2)
1	concrete	2.5	230	-28.75	-0.003175	c-comp	-298.9791667	94166.66667
2	steel	2.5	6.083	-26.25	-0.002925	steel	-3600	1230769.231
3	concrete	2.5	230	-23.75	-0.002675	c-comp	-296.4791667	110833.3333
4	concrete	2.5	230	-21.25	-0.002425	c-comp	-288.9791667	119166.6667
5	concrete	2.5	230	-18.75	-0.002175	c-comp	-277.3125	127500
6	concrete	2.5	230	-16.25	-0.001925	c-comp	-261.4791667	135833.3333
7	concrete	5	30	-12.5	-0.001550	c-comp	-229.9166667	148333.3333
8	concrete	5	30	-7.5	-0.001050	c-comp	-173.25	165000
9	concrete	5	30	-2.5	-0.000550	c-comp	-99.91666667	181666.6667
10	concrete	5	30	2.5	-0.000050	c-comp	-9.916666667	198333.3333
11	concrete	5	30	7.5	0.000450	c-ten	16.66666667	37037.03704
12	concrete	5	30	12.5	0.000950	c-ten	6.507936508	6850.459482
13	concrete	2.5	30	16.25	0.001325	c-ten	5.317460317	4013.177598
14	concrete	2.5	30	18.75	0.001575	c-ten	4.523809524	2872.260015
15	concrete	2.5	30	21.25	0.001825	c-ten	3.73015873	2043.922592
16	concrete	2.5	30	23.75	0.002075	c-ten	2.936507937	1415.184548
17	steel	2.5	3.217	26.25	0.002325	steel	3600	1548387.097
18	concrete	2.5	30	28.75	0.002575	c-ten	1.349206349	523.9636308
	Σt=	60						

a) Strain distribution



b) Stress distribution