International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-1, October, 2019

# Scrutiny of a RCC Beam by Ansys with Non-Identical Collapsed Mechanisms under Assorted Loading Conditions

**K. Madhan Gopal, G. Sreenivasulu, Sunkesula Sudhakar**

***Abstract:*** ***Scrutiny of reinforced concrete beam by Ansys with non-identical collapsed mechanisms under assorted conditions. As per is code: IS: 456-2000. to evaluation for finite element examination a beam element various kinds of authors are done their research by using software's like Ansys, abacus, civil FEM, mat-lab from this one they are studied based on various types of work flows regarding fracture proliferation patterns, in this journal i would like to do numerical examination by FEA software as well as experimental work repercussion analogy from data source. Potential of work is based on the design conditions of design of singly reinforced beam doubly reinforced concrete beam.***

***Keywords: Scrutiny, Ansys, FEA Proliferation patterns, design of singly reinforced beam, doubly reinforced concrete beam.***

## I. INTRODUCTION

In converse modeling behavior amount in bending, happens Reinforced Concrete usual are rectangular section with tensile steel reinforcement ratios to represent the tensile, balanced, and compressive collapsed mechanism. The beams to behavior outcomes criteria of reinforced concrete beams can be determined by the examination evaluation about ANSYS of FEM examination Beams are plays vital role in structural elements of buildings to taking loads from slabs and to transfer these loads to columns. These beam components we analyses by finite element examination is of elemental stress, strain and crack proliferations of various patterns aspects to meet their original functions where does it failure takes place. The design Criteria as per specific requirements minimum satisfactory ranges of standard design methodology to meet its functions without fails. The beam is composite materials of element this can develops collapsed mechanisms when it reaches their engineering properties of the design criteria which is not exposed beyond the scope of work smoothening. The beams is subjected to the concentrated and uniformly distributed load at middle span and collapsed behavior to possess in RCC we are numerically solved collapse

Revised Manuscript Received on October 30, 2019.
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According to manual calculation examination is more suitable to represent the RC beam behavior of collapsed condition.

## II. BLOCK DIAGRAM

### A. flow chart

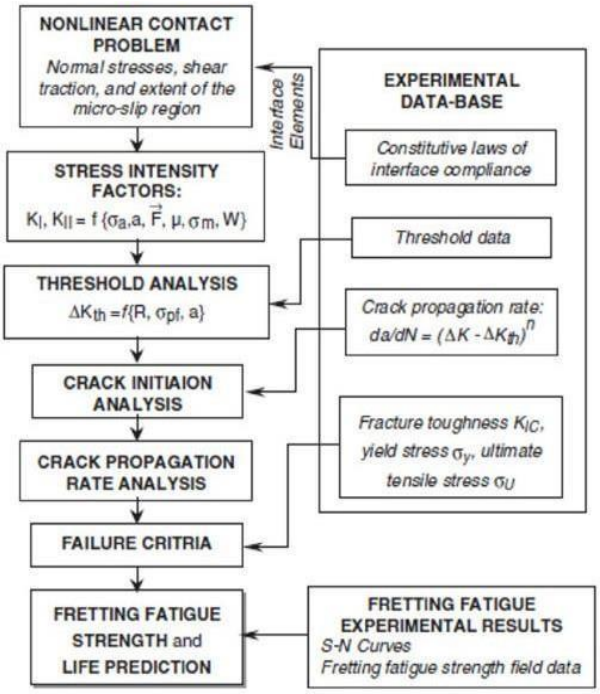



**Fig 1 examination flow chart of problem solving levels**

### B. Linear Elastic Fracture Modulus Curves

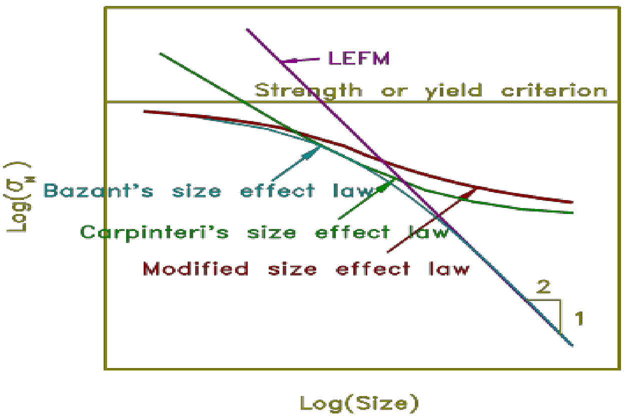



**Fig 2 Linear Elastic Fracture Modulus Curves**

### C. Flow Chart of ANSYS Schematic Levels

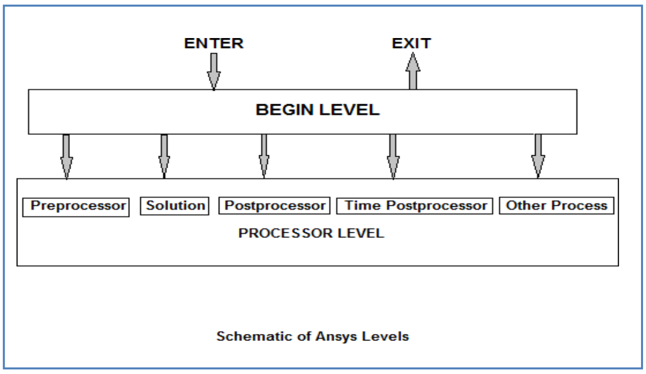



Fig 3 Flow Chart of ANSYS

### D. Flow-chart of fracture mechanics

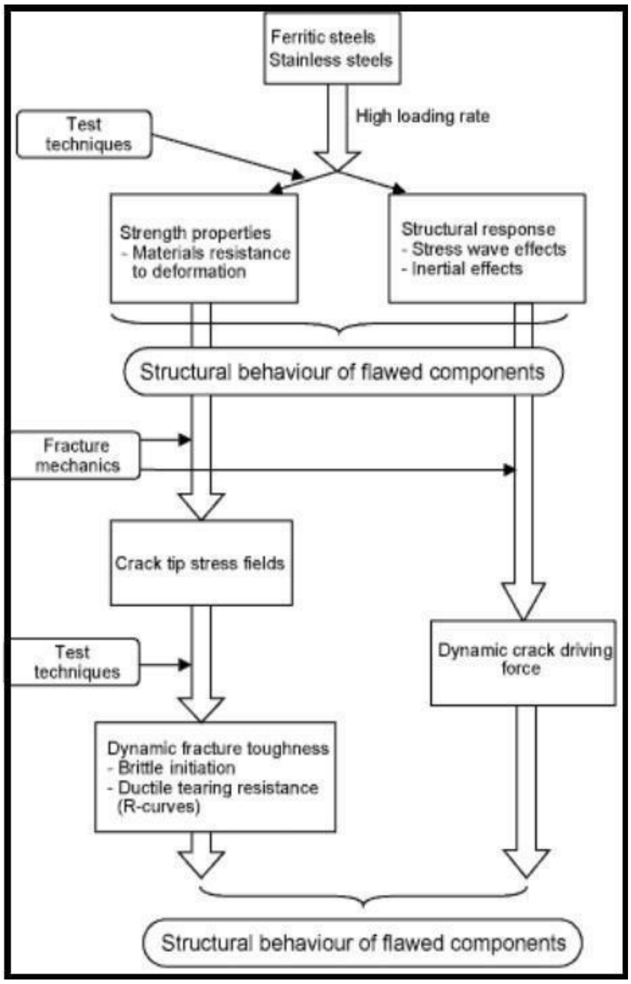



Fig 4 structural behavior of network flow diagram

## III. FRACTURE MECHANICS OF EXAMINATION MODES

### i. Factor of safety formulation graphical representation

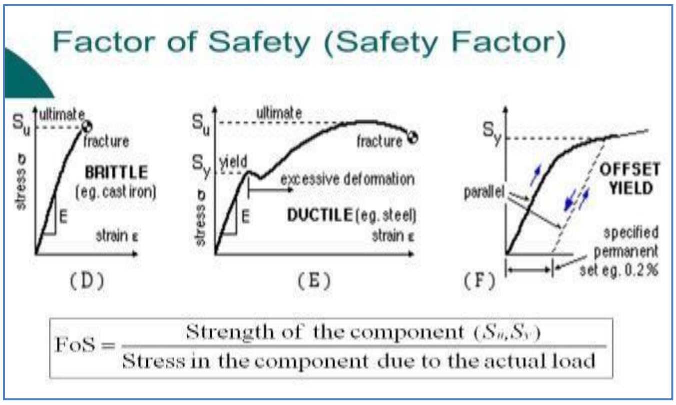



Fig 5 Factor of safety formulation graphical representation

### ii. Stress-strain graphical representation along with limitations formulae graph

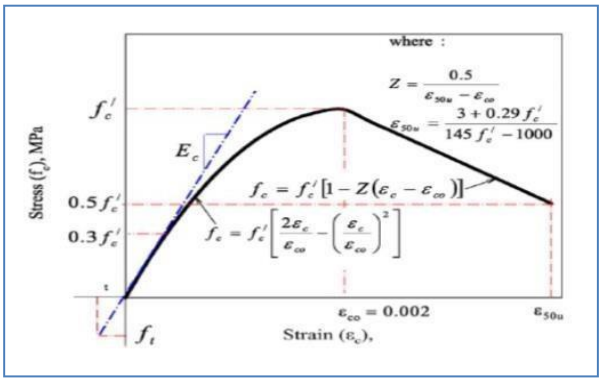



Fig 6 Stress-strain graphical representation along with limitations formulae graph

### iii. Stable and unstable crack growth

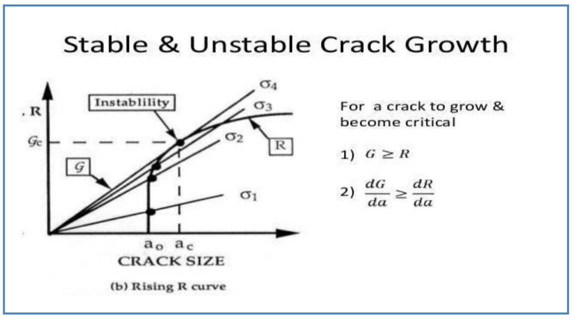



Fig 7 Stable and Unstable crack growth

### iv. R-Rising curve for brittle materials

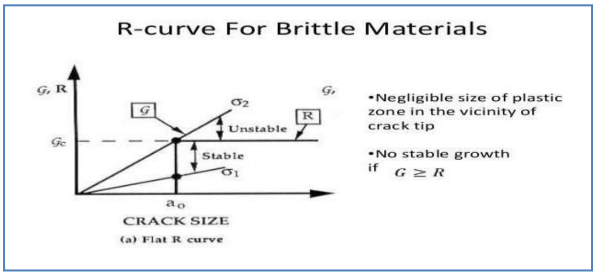



Fig 8 R-Rising curve for brittle materials

**v. Mode 1 or opening crack**

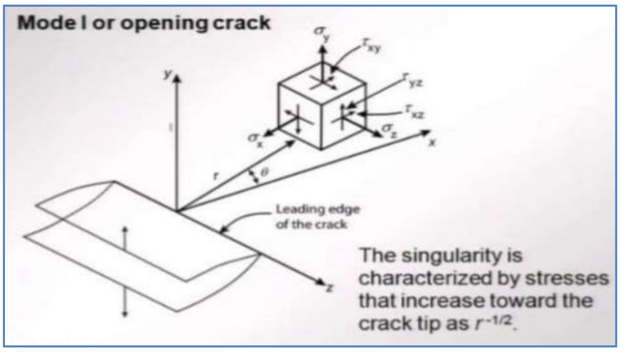



**Fig 9 Mode 1 or opening crack**

## IV. TARGETS TO ACHIEVE FROM THIS PAPER

1. Reinforced concrete beam design calculations
2. Modeling of Beam in ANSYS software
3. Strain Examination of beam model in ANSYS
4. Checking conditions of a beam under various loading conditions of collapsed mechanism principles.
5. Deformation proliferation patterns of beam and limitations of examination.
6. Design of simply supported beam in MATLAB.

**CODE BOOKS REFERED**

1. IS:456-2000 code of practice for plain cement concrete reinforced cement concrete.

2. IS10262-2009concrete mix proportioning -guidelines.

3. IS10262-1982 recommended guidelines for concrete mix design.

4. IS383-1970 Specifications for coarse aggregate (C.A) and fine aggregate (F.A) from natural sources.

5. ACI-318(1995) building code requirements for reinforced concrete. 10262-1982 recommended guide line for concrete mix design.

## V. LITERATURE'S INSPECTION

**AntonioF.Barbosa** (1998) the possibilities of performing nonlinear finite element examination of reinforced concrete structures using Ansys concrete model. It can be observed in the load-deflection patterns of beams on comparing the behavior of the RC beam with that of the pre-stressed concrete of a beam element. Advantage of pre-stressing was verified as the pre-stressed concrete beam was seen..

**P.Fannig** (2001) Reinforced concrete beams and 9.0m post-tensioned concrete beams, constructed in ANSYS V5.5 using the dedicated concrete element have accurately captured the departure of non linear ultimate strength of RCC beams are failure patterns was found In comparison to the theoretically predicted data, the numerical method of examination using ANSYS was seen to satisfactorily predict the behavioral responses of the beams up to failure.

**Dahmani**(2010) However, a discrepancy was observed in the initial value of effective restrain in the tendons predicted by the numerical examination, the reason for which is unclear. The variation of compressive stress in concrete beyond the stage of initial cracking could not be estimated using the theories of structural examination owing to the absence of formulations that took into account the decreasing effectiveness of the section in the cracked stage.

**Mahmood Hossein** (2011) et'll his work isaround 10 percent. However, a discrepancy was observed in the initial value of effective restrain in the tendons predicted by the increasing loads were evaluated and compared to theoretical data obtained using the theories of structural examination. In comparison to the theoretically predicted data, the numerical method of examination using ANSYS was seen to satisfactorily predict the behavioral responses of the beams up to failure

**Nimiya Rose Joshuva**(2014) the response of reinforced and pretension concrete beams to vertical loading was investigated using the finite element software package ANSYS 12.0.The load-deflection response, variations of stresses in concrete and strains in the steel reinforcements and pre-stressing tendon were evaluated and compared to theoretical data obtained using the theories of structural examination.

**Manivannan** (2014) is analyzed ANSYS to access however, a discrepancy was observed in the initial value of effective restrain in the tendons predicted by the numerical examination, the reason for which is unclear. The variation of compressive stress in concrete beyond the stage of initial cracking could not be estimated using the theories of structural examination owing to the absence of formulations that took into account the decreasing effectiveness of the section.

**Neha.S Badiger** (2014) the finite element software package ANSYS 12.0.The load-deflection response, variations of stresses in concrete and strains in the steel reinforcements and pre-stressing tendon were evaluated.

**T.Subramani** (2016) behavior of slab represented by the load-deflection curves in ANSYS show close in the initial value of effective restrain in the tendons predicted by the numerical examination, the reason for which is unclear. The variation of compressive stress in concrete beyond the stage of initial cracking could not be estimated using the theories of structural examination owing to the absence of formulations that took into account the decreasing effectiveness of the section in the cracked stage.

**S.S.Kadam** (2017) Ferro cement partial replacement of research and studied variational application of the non-linearity of the beam element progress in ANSYS 15.0 software is used.

**DarmansyahTjitradi** (2017) modeling singly RCC beams with various conditions represented in collapse with tensile reinforcement ratio variation can be modeled using 3D modified numerical modeling with span of member are enlarger than the deformations to overcome to with stand of the satisfied results.

**G.Prasanth** (2018) et'll critical load which in turn depends on the notch depth of specimen and is found to be reducing on increasing the extracted notch factor of critical stress influences (KIC) is the material property, for any structure subjected to a crack with particular notch to depth ratio,factor of the critical stress intensity(KIC) at various levels.

## VI. PROPOSED METHODOLOGY EXPERIMENTAL PROGRAMME

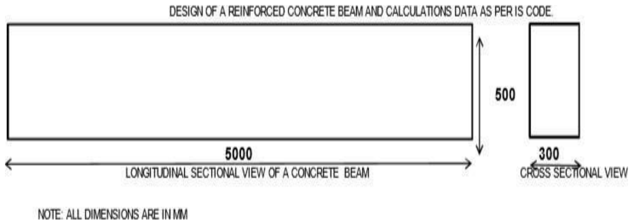



**Fig 10 Beam element diagram**

### 1) Design Calculations and Discussions

*A. Design of Singly Reinforced Beams*

DESIGN OF RECTANGULAR BEAM DATA

L =5000mm (span or length of the beam) B=300mm (width or breadth of the beam) D=500mm (depth of the beam)

Effe.depth of the beam=462.5mm Concrete mix M20 (fck) =20N/mm$^2$ Reinforcement (fy) =415N/mm$^2$

Factored Moment (Mu)=50KN-M

Mu/bd $^2$=50x10^6/(300x462.5x462.5=7.790

Design as singly reinforced beam Pt=0.226

Area of tensile steel=Pt bd/100

(0.226x462.5x300)/100

Required Ast=314mm$^2$

Provide 2 nos of 12mm 226mm$^2$(At bottom) Provide 2 nos of 12mm 226mm$^2$(At bottom)

Hence safe =452mm$^2$

**Calculation for shear:** Shear force V =43KN VU=V/bd

VU =43x10^3/300x500

=0290N/mm$^2$

ζ c max=2.8N/mm$^2$ (Refer Table:20 IS456-2000) ζ c=0.59 (Refer Table:20 IS456-2000) Asv/Sv=b(v-ζ c )/0.87fy)

Choose 8 mm dia rod 2-legged links Asv/Sv=101 mm$^2$

Sv=101x.87x415/(300x(0.29-0.59)

==-405.2mm

Sv max=0.75d

=375

Hence provided stirrups 2L 8 mm at 200mm c/c

Hence safe

**Check For Deflection**

Basic span ratio = **20** (As per cl. 23.2.1 of IS 456-2000) Fs = 167

FOR TENSION

Percentage of steel =0.326

Correction (F1) = **1.05** (As per fig.4 of IS 456-2000)

Allowable L/d ratio (basicxF1) = 21 mm

Actual span/depth ratio = (5/0.4625)

= 10.81 mm

10.81 < 21.00

Finally, the actual ratio is less than the allowable ratio. It is enough to control deflection Hence Safe.

*B .Design of Doubly Reinforced Beams*

DESIGN OF RECTANGULAR BEAM DATA

L =5000mm (span or length of the beam) B=300mm (width or breadth of the beam) D=650mm (depth of the beam)

Effe.depth of the beam=612.5mm Concrete mix M20 (fck) =25N/mm$^2$ Reinforcement (fy) =415N/mm$^2$

Factored Moment (Mu)=1705KN-M

Mu/bd $^2$= 1705x10^6/(300x612.5x612.5)

=15.200

Design as doubly reinforced beam Pt=2.460

Pc =1.330

Area of tensile steel=Pt*bd/100

(2.46x462.5x300)/100

Required Ast=314mm$^2$

Provide 5 nos of 12mm 2454 mm$^2$ (At bottom) Provide 5 nos of 12mm 2454 mm$^2$ (At bottom)

Hence safe =4909mm$^2$

Area of compression steel = pc bd/100

= (1.33x300x612.5)/100

Required Asc = 2444 mm$^2$

Provided **2** nos of **16** mm 402 mm$^2$ (At top)

Un Safe(Redesign by changing the dimensions with in limits of IS456-2000)

**Calculation for shear:** Shear force V =43KN VU=V/bd

VU =43x10^3/300x500

=0290N/mm$^2$

ζ c max=2.8N/mm$^2$ (Refer Table:20 IS456-2000) ζ c=0.59 (Refer Table:20 IS456-2000) Asv/Sv=b(v-ζ c )/0.87fy)

Choose 8 mm dia rod 2-legged links Asv/Sv=101 mm$^2$

Sv=101x.87x415/(300x(0.29-0.59)

==-405.2mm

Sv max=0.75d

=375

Hence provided stirrups 2L 8 mm at 200mm c/c Hence safe

**Check For Deflection**

Basic span ratio = **20** (As per cl. 23.2.1 of IS 456-2000)

Fs=222

FOR TENSION

Percentage of steel= 2.671

Correction (F1) = **0.95** (As per fig.4 of IS 456-2000)

Fig 14 shear force diagram

0.896mm

Allowable L/d ratio (basicxF1) = 19 mm Actual span/depth ratio = (5/0.025)

= 8.16 mm

8.16 < 19.00

Finally, the actual ratio is less than the allowable ratio. It is enough to control deflection

**Hence Safe**

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-1, October, 2019

43.0682 KN/M

FOR COMPRESSION

Percentage of steel = 0.219

Correction (F1) = **1.15** (As per fig.5 of IS 456-2000)

Allowable L/d ratio (basicxF1) = 23mm

Actual span/depth ratio = (5/0.6125)

= 8.16 mm

8.16 < 23.00

Finally, the actual ratio is less than the allowable ratio. It is enough to control deflection

**Hence Safe**

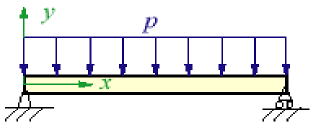
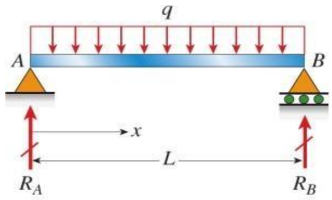
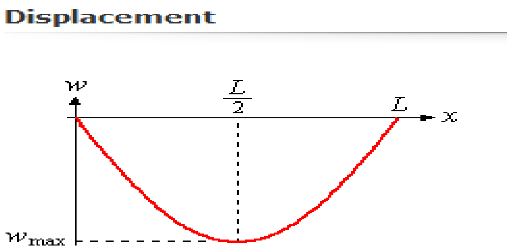



**Fig 11 Beam loading case diagram**




(a)

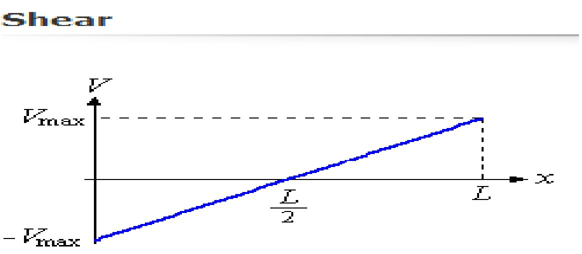
**Fig 12 Reactions or force diagram**




$$w(x) = -\frac{p\,x\,(L^3 - 2x^2 L + x^3)}{24\,EI}$$

**Fig 13 Deflection diagram**

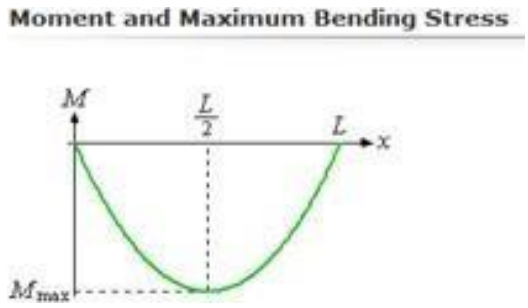
$$w_{max} = w\left(\frac{L}{2}\right) = -\frac{5\,p\,L^4}{384\,EI} = 0.896\text{mm}$$




$$V(x) = -\frac{1}{2}\,p\,(L - 2x)$$

**Fig 14 shear force diagram**

$$V_{max} = V(0 \& L) = -\frac{pL}{2} = 43.0682 \text{ KN/M}$$




$M(x) = -\frac{1}{2}\,p\,(L-x)\,x$ **and maximum bending stress**

$$M_{max} = M\left(\frac{L}{2}\right) = -\frac{pL^2}{8} = -405.2 \text{ KN-M}$$

$$\sigma_{max} = \left|M_{max}\right|\frac{c}{I} = \left|\frac{pL^2}{8Z}\right| = 7.790 \text{KN/M}^2$$

## VII. ALGORITHM FOR SIMPLY SUPPORTED BEAM IN MATLAB

```
clc; clear all; close all;
disp('CHECKED / VERIFIED ')
disp('............................................................. ')
disp('date:15/10/2019')
disp('MATLAB CODE by SUNKESULA SUDHAKAR M.Tech. (Structural Engineering')
w=input('enter the width of the support in mm='); b=input('enter the breadth of the beam='); fck=input('grade of concrete=');
fy=input('grade of STEEL='); format short
l=input('enter the length of the beam in mts='); % in meters
depth=(l*1000)/15;
disp(depth);
diam=input('enter thE DIA OF MAIN BAR of the beam=');
cc=input('enter thE CLEAR COVER=');
dias=input('enter thE DIA OF STIRRUPS BAR =');
D=diam*0.5+cc+dias+depth;
fix(D); leff=l+(w/1000); leff1=l+(depth/1000);
Leff=min(leff,leff1); disp(Leff); wb=25*1*D*(b/10^6);
imload=12;%Kn/m W=wb+imload; Wu=1.5*W;
Mu=Wu*Leff^2/8; Vu=Wu*Leff*0.5;
drequired=sqrt((Mu*10^6)/(0.138*fck*b));
if(drequired<depth)
   fprintf('provided depth is adequate'); else
    fprintf('provided depth is not adequate'); end
%% TESILE REINFORCEMENT
a1=((0.87*fy*fy)/(fck*b)); b1=-(0.87*fy*depth);
c1=Mu*10^6;
v=[a1 b1 c1]; Ast=roots(v);
disp('first root'),disp((Ast(1)));
disp('second root'),disp((Ast(2))); Astr=min(Ast);
noofbars=Astr*4/(pi*diam*diam); noofbarprovided=ceil(no of bars); disp(no of bars provided);
%% DESIGN OF SHEAR REINFORCEMENT
% NOMINAL SHEAR STRESS
tu=(Vu*1000/(b*depth)); disp(tu); pt=Astr*100/(b*depth);
disp(pt);
```

```
%% table 19 os IS 456-2000
x=input('x values in 2x2 matrix form='); y=input('y values in 2x2 matrix form='); pt;
tc=interp1(x,y,pt);
tcmax=2.8;% for M 20 grade of concrete disp(tc);
if ((tu>tc)&& (tu<tcmax))
    disp('shear reinforcement has to be designed'); else
    disp('no need to design the shear reinforcement'); end
Vuc=tc*b*depth/(1000);% shear resistance disp(Vuc);
Vus=Vu-Vuc;% shear to be resisted by shear reinforcement(VERTICAL STIRRUPS
Asv=(2/4)*(pi*dias^2); sv=0.87*fy*Asv*depth/(Vus*1000);
vm=0.87*fy*Asv/(0.4*b);% minimum spacing of stirrupsdisp(Svm);
max_Sv=0.75*depth; disp(max_Sv); if(max_Sv<300)
    disp(max_Sv); else
300;
end N0striups=(Leff*1000/Svm); disp(round(N0striups));
disp('******<<< END >>>*******')
```

## VIII. RESULTS ANALYSIS

### 1) Load V/S Deflection Graphs

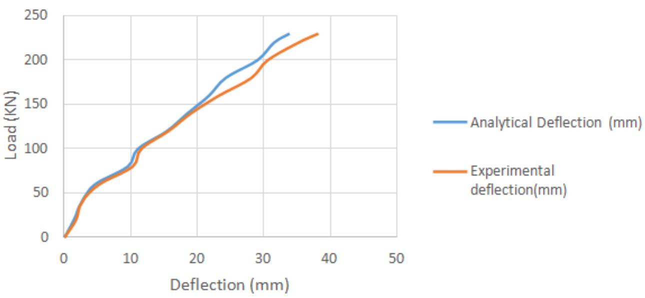



**Fig 1 Load Vs Deflection for Doubly Reinforced Beam and MATLAB**

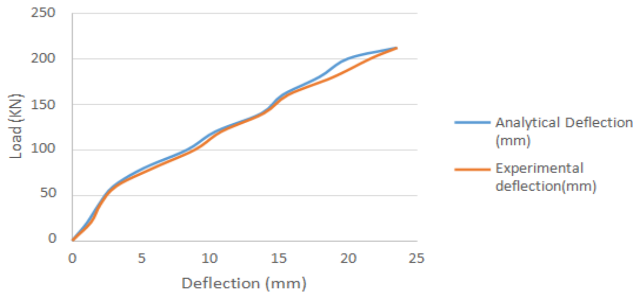



**Fig 2 Load Vs Deflection for Singly Reinforced Beam and MATLAB**

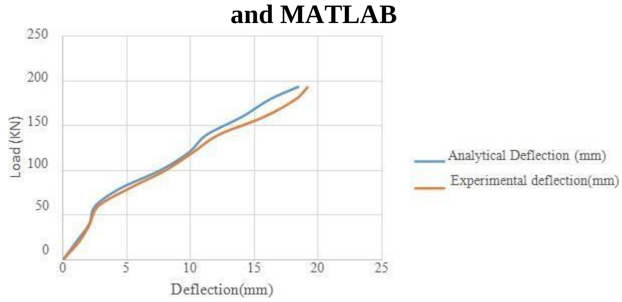



**Fig 3 Load Vs Deflection for Singly Reinforced Beam and design data comparison**

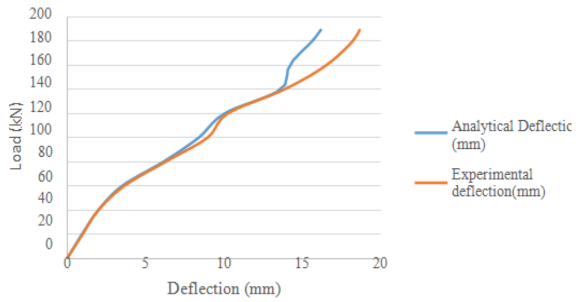



**Fig 4 Load Vs Deflection for Singly Reinforced Beam and Doubly Reinforced Beam design calculation data**

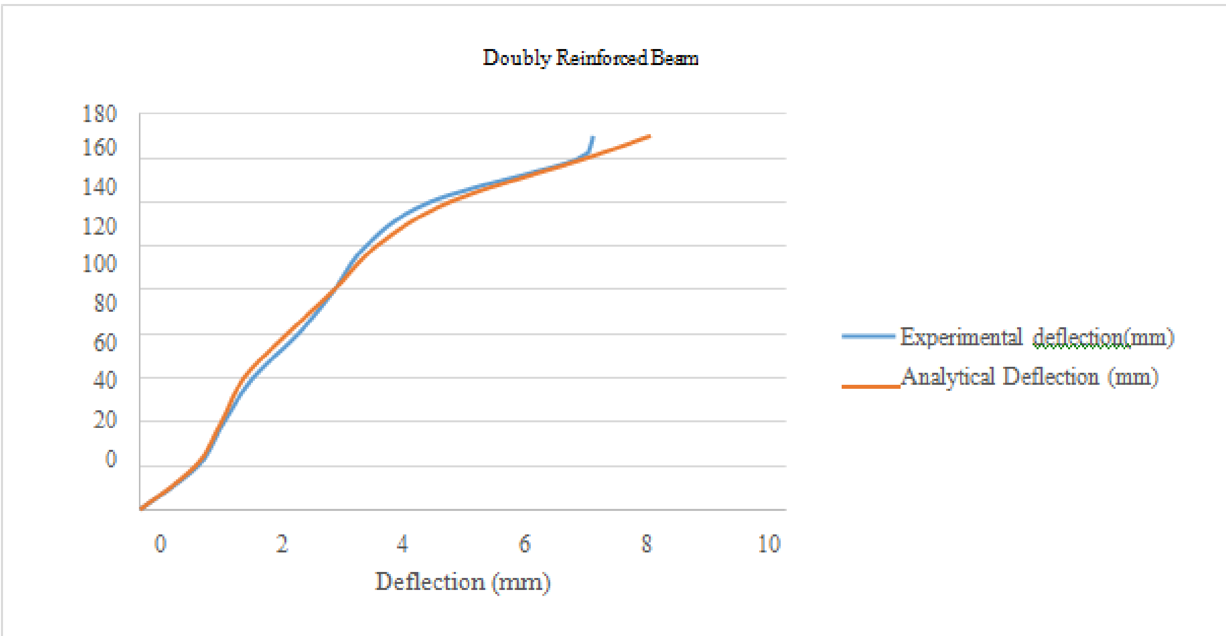



**Fig 5 Load Vs Deflection for Doubly Reinforced Beam**

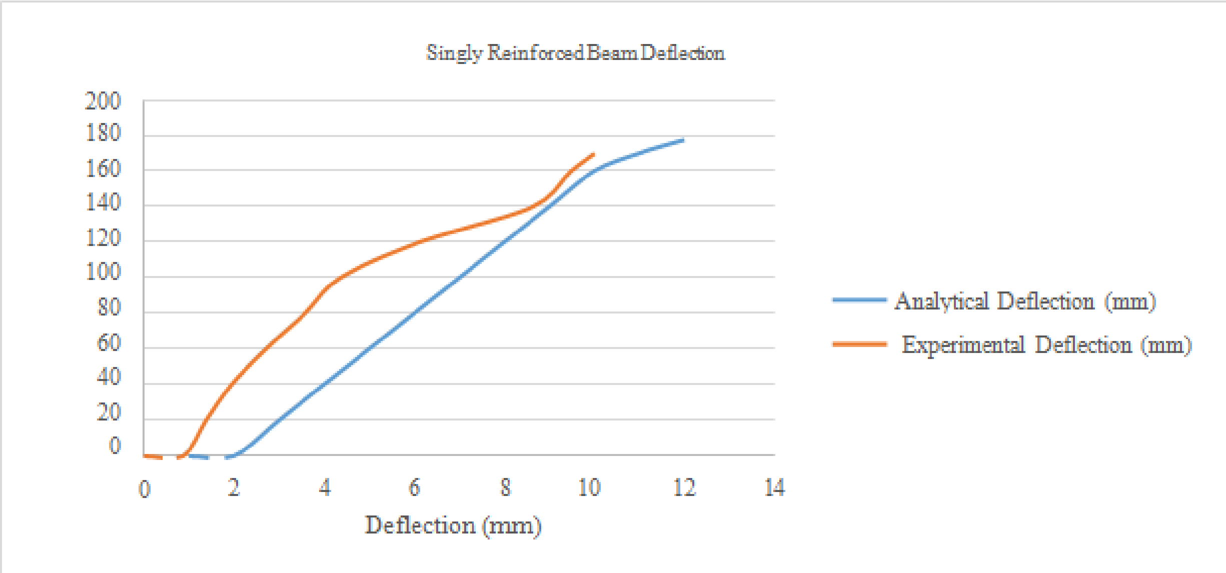



**Fig 6 Load Vs Deflection for Singly Reinforced Beam**

### 2) Ansys Final Resultant Diagrams

*a) Normal Elastic Strain*

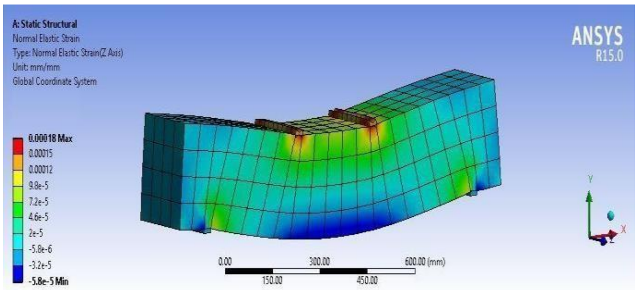



**Fig 1 Normal Elastic Strain Diagram**

*b) Shear Elastic Strain*

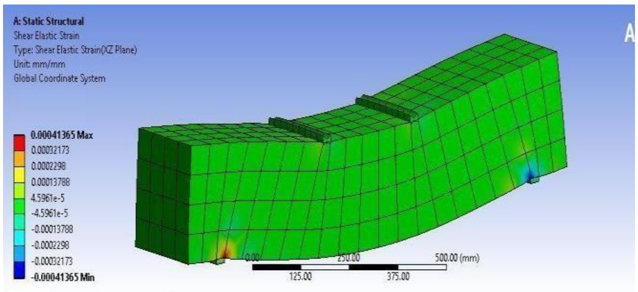



**Fig 2 SHEAR Elastic Strain Diagram**

### 3) Directional Deformation

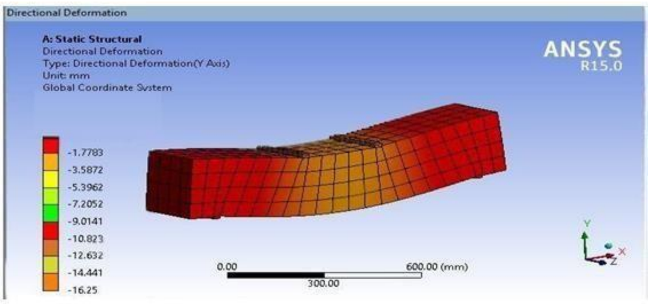



**Fig 3 Directional Deformation**

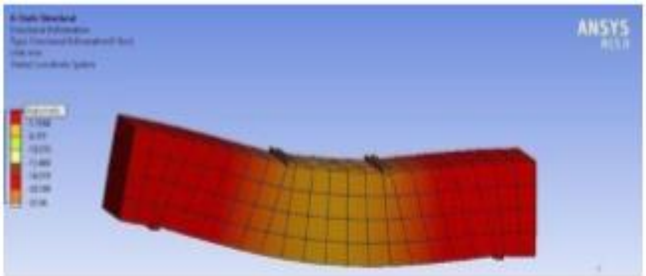



**Fig 4 Directional Deformation**

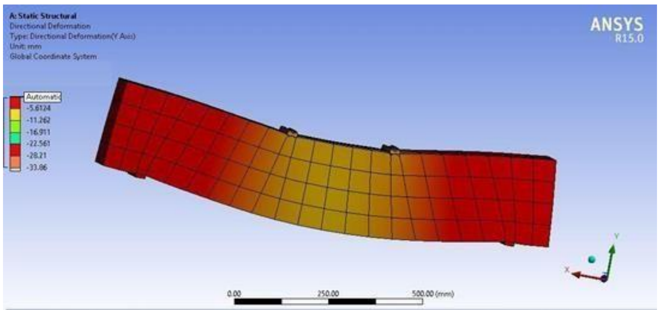



**Fig 5 Directional Deformation**

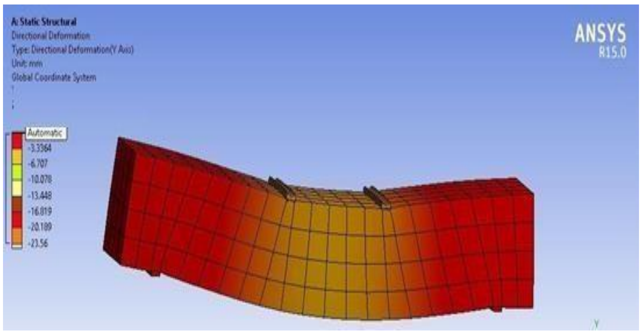



**Fig 6 Directional Deformation**

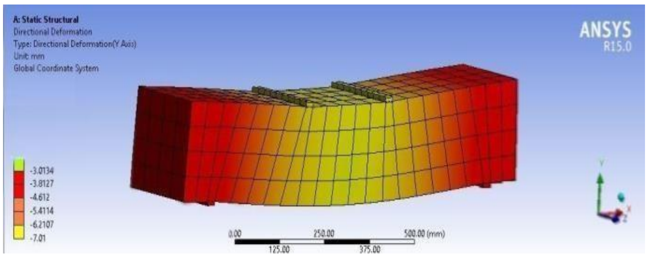



**Fig 7 Directional Deformation**

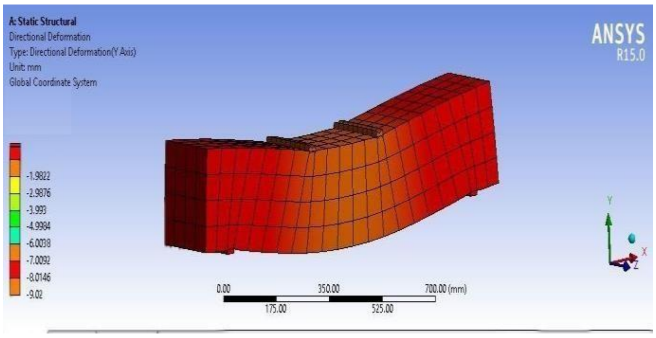



**Fig 8 Directional Deformation**

### 4) Ansys Normal Stress Diagram

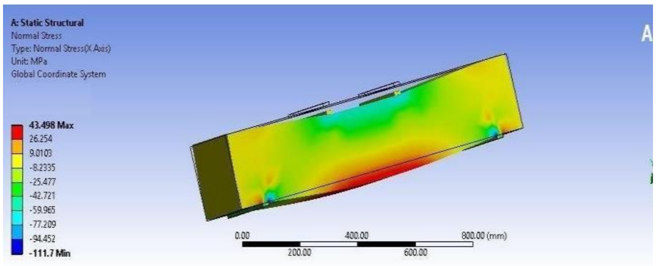
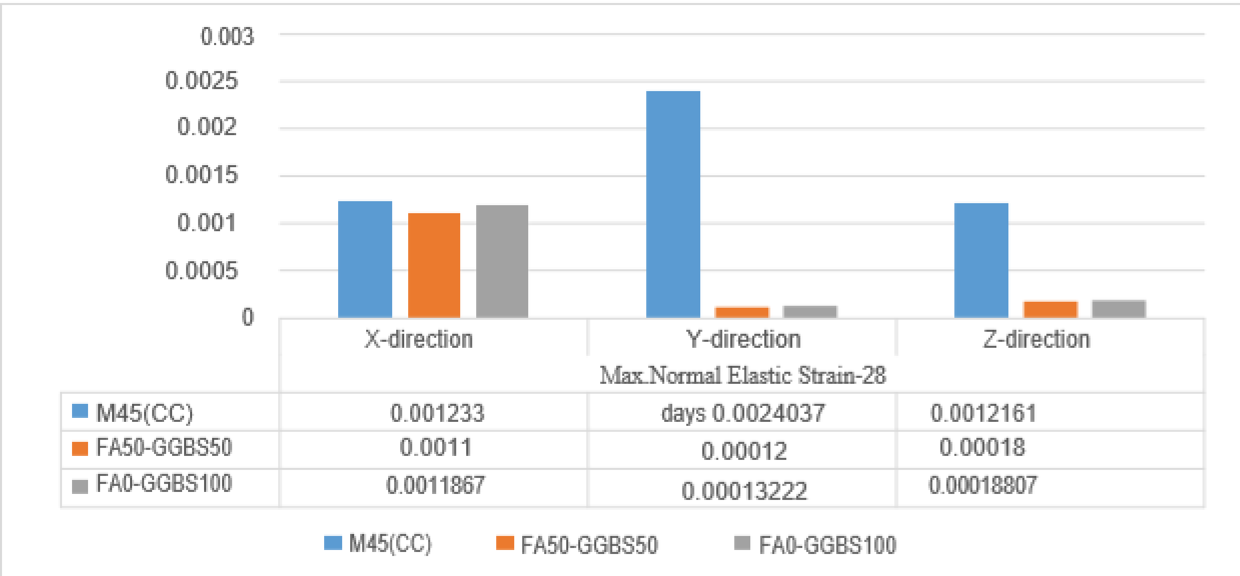


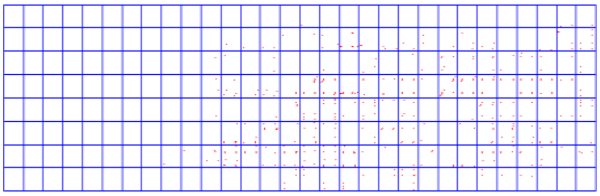

**Fig 9 for Directional Deformation Of Normal Stress Diagram**

### 6) From The Experimental Results Bar Graphs

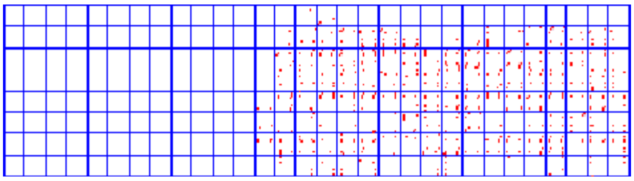



**Bar Graph 1 from the Experimental Results**

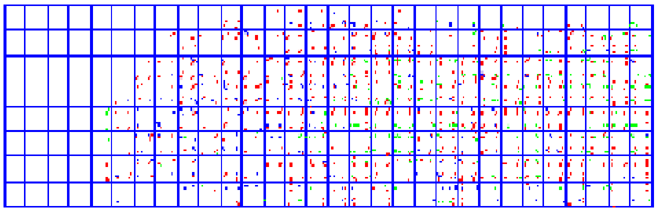
### 5) Crack Patterns Diagrams



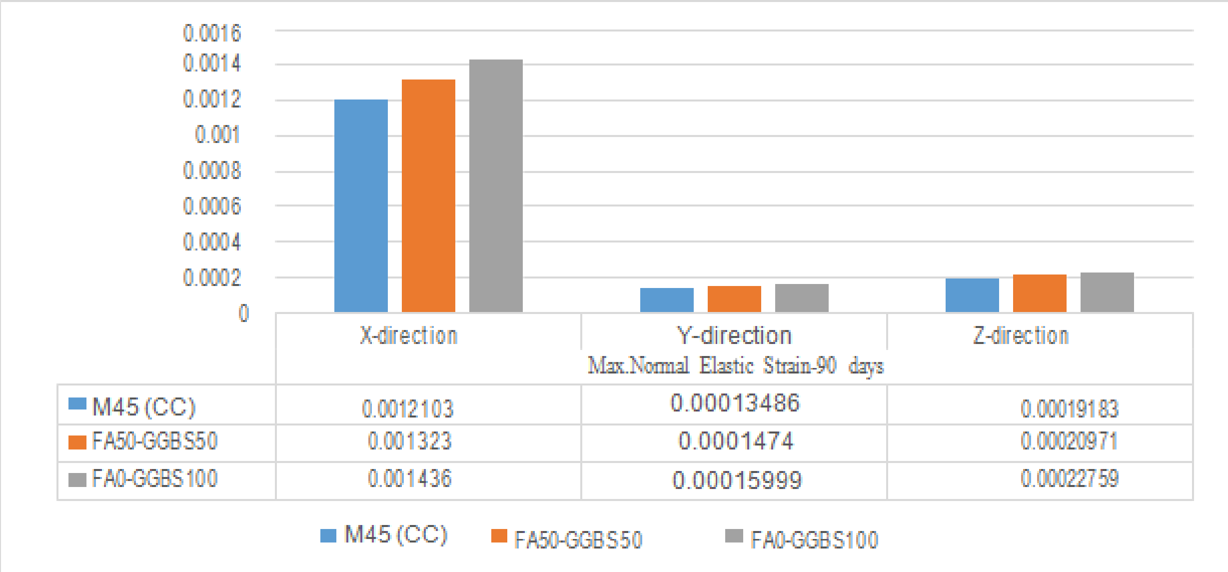
a) *crack patterns of beam when Type 1 reinforcement is placed*



b) *crack patterns of beam when Type 2 reinforcement is placed*



c) *crack patterns of beam when Type 3 reinforcement is placed*




**Bar Graph 2 from the Experimental Results**

## IX. CONCLUSION

From these results of the above content will be solved by the Ansys and other software are used and got results as reached to satisfy levels as the literature's inspection of loop holes are fulfilled further studies uniformly distributed (UDL) and collapsed behavior observed from load of the first crack up to fully collapse. The results show that the RCC beams are to be analyzed using software of ANSYS of The behavior of reinforced FEM that beams with tensile collapsed condition has a lower flexural capacity and collapsed conditions according to the values obtained s is more suitable to represent the rc beam behavior of collapsed condition are also done in future extent by the various changes like reinforcement materials, properties, different modes of load application, selected sectional changes by

The patterns of the beams, release of some portion of the material to design of singly RC concrete beams can we numerically solved by the examination of calculation and Singly RCC beam, Doubly RCC beam.

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