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Parametric Analysis of Flexural Member with Fully Replacement of Coarse Aggregate by Plastic Aggregate Below the Neutral Axis of Beam

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***Abstract* - In case of simply supported reinforced concrete beam, the portion above neutral axis is in compression and the portion below neutral axis is in tension. Tension and compression on the neutral axis is zero. Concrete takes compressive stress and steel takes tensile stress, so concrete below neutral axis is not necessary. Plastic waste is increases day by day and this waste we cannot burnt and dispose so reuse of plastic us very essential. In this project we fully replace coarse aggregate by recycled plastic aggregate below the neutral axis of beam and we take flexural test on RC beam. Due to rapid growth of industries and due to urbanization in the country it leads lot of infrastructure. So that it leads to many problems like lack of construction material, increased productivity of wastes and other products. This project deal with the reuse of recycled plastic waste as partial replacement of natural coarse aggregate in M20 grade concrete and usually M20 grade concrete is used for most constructional works.**

***Index Terms* - neutral axis, concrete, compressive stress, tensile stress.**

I.INTRODUCTION

The plastic is growing segment in environment and biggest problem of 21st century. Maximum plastic wastes are increases in industries and in the household and in each country waste consumption is different. In India use of plastic is high than several regions. In order to overcome this problem, we should have to use it in proper or effective way. The project is about use of recycled plastic waste in beam.

Reinforced cement concrete is one of the main components in construction of various structures like industries. Now a day's use of concrete is increased too much. The concrete includes cement, sand, aggregate and water, there is acute shortage of raw materials for its preparation. Lot of research were carried out for the investigation of alternate materials for cement, sand and aggregate that can be used in concrete. For cement locally available material like copper slag, rice husk, fly ash, etc. are used. For natural and artificial sand are used. Now a day's natural aggregate on the way of extinction. In this project we use recycled plastic aggregate by fully replacing natural coarse aggregate below the neutral axis of beam. Concrete is the initial structural component, but aggregate is very important component in structure. Now a day the problem faced by the construction industry is acute shortage of raw materials. In case of simply rested reinforced concrete beam, the portion below neutral axis is in tension and above neutral axis is in compression. As a concrete is weak in taking tension stress, so that steel reinforcements are provided in this zone. The concrete below the neutral axis act as a stress transfer medium between the compression and tension zone. Fully replace of the coarse aggregate below the neutral axis is an idea that can create savings in materials, reduction in weight and achieve the approximate same strength which is given by conventional beam. In this project, Parametric analysis of flexural member with fully replacement of coarse aggregate by plastic aggregate below the neutral axis of beam.

II.SCOPE OF WORK

1. The test can be carried out for different grades of concrete
2. We can take the flexural strength test by replacing natural coarse aggregate by various materials like hollow pipes, brick, expanded polystyrene sheets etc. Expanded polystyrene sheets, terracotta, and hollow blocks etc.

III. OBJECTIVES

1. To reduce self-weight of beam.
2. To study a breaking stress of beam by replacing coarse aggregate by recycled plastic aggregate below the neutral axis.
3. To analyze the ultimate load carrying capacity of the beams after replacing the natural coarse aggregate below neutral axis.

IV. METHODOLOGY

1. Collection of material
2. Testing of material
3. Design calculation
4. Casing of specimen
5. Testing
6. Analysis
7. Result
8. Conclusion

V. TESTING OF MATERIAL

1. Cement:

Grade = 53

Type = Ordinary Portland Cement

Material	Test	Result
Cement	Specific Gravity	3.10
	Initial setting time	160 min.
	Final setting time	510 min.
	Consistency test	7mm from bottom

2. Fine aggregate:

The size of aggregate which is than 4.75 mm is known as fine aggregate or sand.

Type = Natural fine aggregate

Material	Test	Result
Sand	Specific Gravity	2.29
	Water absorption	2.3%
	Fineness modulus	3.539

3.Natural Course Aggregate. :-

Size = 12 to 20 mm

Material	Test	Result
Coarse Aggregate	Specific Gravity	2.76
	Fineness modulus	7.54
	Density	1680 kg/m^3
	Impact Value	19.88%
	Water absorption	1.20%

4.Plastic Coarse Aggregate

For casting the beam, we use M20 grade concrete. The proportion of M20 grade concrete is 1: 1 ½: 3

Material	Test	Result
Plastic aggregate	Water absorption	0%
	Fineness modulus	7.25
	Specific Gravity	0.95
	Impact Value	0.81%

5.Steel:

Singly reinforced beam.

Ast =Top bars of 2 nos. 8 mm diameter Bottom bars 2 nos. 10 mm diameter. Main bars Stirrups = 6mm. diameter @ 100 mm. c/c

Concrete Cover = 20mm

Casting of specimens

The total number of specimens required for testing

Specimen	Dimension	Total No.
Beam	700mm x150mm x 150mm	4
Cube (made up of 100% P. A.)	150mm x150mm x 150mm	3

VI. DESIGN

Position of neutral axis

$Xu/0.0035 = d-Xu/0.87fy/2x105+0.002$

$Xu/d- Xu = 0.0035/0.87x415/2x105+0.002$

$Xu/125-Xu = 0.0035/0.038$

$Xu/125-Xu = 0.921$

$Xu = 115.125 – 0.921 Xu$

$Xu+0.921 Xu = 115.125$

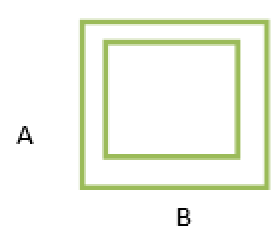
$1.921 Xu = 115.125$

$Xu = 59.929mm$

$Xu = 60mm$

IV. Numbers of stirrups require

L= 0.7 m B= 0.15 m A= 0.15 m



b = B-2 x cover a= A- 2 x cover

= 150- 2 x 25 =150- 2 x 25

= 100mm = 100mm

L = 2(A+ B) + 24Ø

= 2(100+100) + 24 x 6

= 0.554 m =544mm

Number of stirrups = T.L. – 2 x cover/Spacing +1
= 650 – 2 x 25 / 90 + 1
= 7.66 ≈ 8 nos.

VII. CONCRETE MIX DESIGN

Cement (Kg/m3)	394.32
Fine aggregate (kg/m3)	657.612
Coarse aggregate (Kg/m3)	1156.771
Water (li/m3)	186
Water cement ratio	0.5
Mix ratio	1:1.668:2.934

VIII. CONSTRUCTION AND WORKING

Materials required for one beam.
1. Above the neutral axis
Cement = 3.78 kg
Sand = 6.30 kg
Aggregate = 11.09 kg
2. Below the neutral Axis
Cement = 5.78 kg
Sand = 9.48 kg
Plastic Aggregate = 16.67kg

IX. TESTING ON PLASTIC CUBE

Strength should be come:

Days	Strength should be come in %	Strength should be come in N/mm^2	Result in N/mm^2
7	65%	13	13.734
14	90%	18	17.658
28	100%	20	20

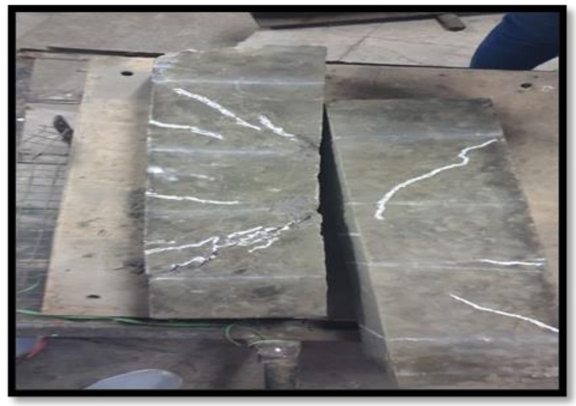
X. MANUFACTURING PROCESS OF BEAM

Marking of neutral axis

XI. TESTING ON CONVENTIONAL BEAM

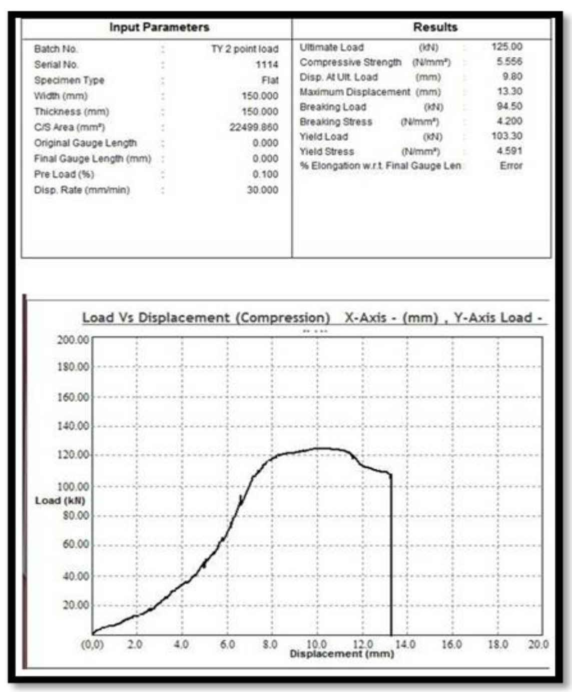
Two-point loading

Two-point loading on conventional beam



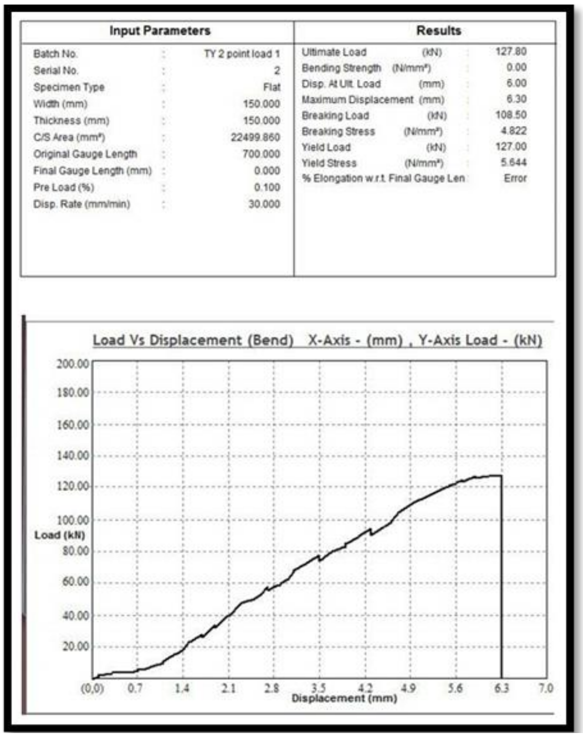
After Testing

RESULTS OF CONVENTIONAL BEAM
Beam -1



Input Parameters		Results		
Batch No.	TY 2 point load	Ultimate Load	(kN)	125.00
Serial No.	1114	Compressive Strength	(N/mm²)	5.556
Specimen Type	Flat	Disp. At Ult. Load	(mm)	9.80
Width (mm)	150.000	Maximum Displacement	(mm)	13.30
Thickness (mm)	150.000	Breaking Load	(kN)	94.50
C/S Area (mm²)	22499.860	Breaking Stress	(N/mm²)	4.200
Original Gauge Length	0.000	Yield Load	(kN)	103.30
Final Gauge Length (mm)	0.000	Yield Stress	(N/mm²)	4.591
Pre Load (%)	0.100	% Elongation w.r.t. Final Gauge Len		Error
Disp. Rate (mm/min)	30.000			

Beam 2

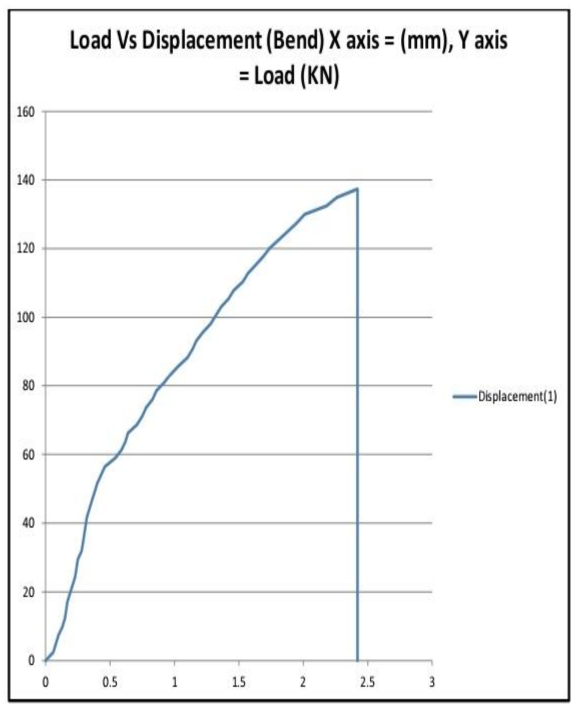


Input Parameters			Results		
Batch No.	:	TY 2 point load 1	Ultimate Load (kN)	:	127.80
Serial No.	:	2	Bending Strength (N/mm²)	:	0.00
Specimen Type	:	Flat	Disp. At Ult. Load (mm)	:	6.00
Width (mm)	:	150.000	Maximum Displacement (mm)	:	6.30
Thickness (mm)	:	150.000	Breaking Load (kN)	:	108.50
C/S Area (mm²)	:	22499.860	Breaking Stress (N/mm²)	:	4.822
Original Gauge Length	:	700.000	Yield Load (kN)	:	127.00
Final Gauge Length (mm)	:	0.000	Yield Stress (N/mm²)	:	5.644
Pre Load (%)	:	0.100	% Elongation w.r.t. Final Gauge Len	:	Error
Disp. Rate (mm/min)	:	30.000			

After testing

Beam 1

Input Parameters			Results		
Batch No.	:	TY 2 point load	Ultimate Load (KN)	:	137.340
Serial No.	:	4	Disp. At Ult. Load	:	2.40
Specimen Type	:	Flat	Maximum Displacement(mm)	:	2.42
Width (mm)	:	150.000	Breaking Load (KN)	:	107.910
Thickness (mm)	:	150.000	Breaking Stress (N/mm²)	:	4.798
C/S Area (mm²)	:	22499.860			
Original Gauge Length	:	0.000			
Final Gauge Length (mm	:	0.000			
Pre Load (%)	:	0.100			
Disp. Rate (mm/min)	:	30.000			



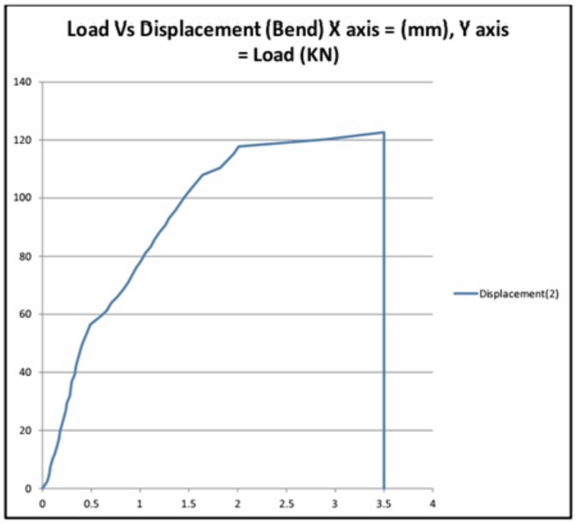
Beam 2

XI. TEST ON PLASTIC BEAM (PLASTIC BELOW N.A.)

Beam Specimen

Deflection dial gauge for displacement measurement

Input Parameters			Results		
Batch No.	:	TY 2 point load	Ultimate Load (KN)	:	122.625
Serial No.	:	3	Disp. At Ult. Load	:	2.9
Specimen Type	:	Flat	Maximum Displacement(mm)	:	3.5
Width (mm)	:	150.000	Breaking Load (KN)	:	95.647
Thickness (mm)	:	150.000	Breaking Stress (N/mm^2)	:	4.251
C/S Area (mm^2)	:	22499.860			
Original Gauge Length	:	0.000			
Final Gauge Length (mm	:	0.000			
Pre Load (%)	:	0.100			
Disp. Rate (mm/min)	:	30.000			



XII. RESULTS

Objective -1

Reduce self-weight of beam

Specimen	Weight in 'Kg'		Average Weight in 'Kg'
Conventional beam	1.	43.065	42.425
	2.	41.785	
Beam made up of plastic aggregate (below N.A.)	3.	36.010	34.878
	4.	33.745	

Consider,

42.425 = 100 %

34.878 = X

X x 42.425 = 34.878 x 100

X = (34.878 x 100) / 42.425

X = 82.21 %

Reduced in weight = 100 – 82.21

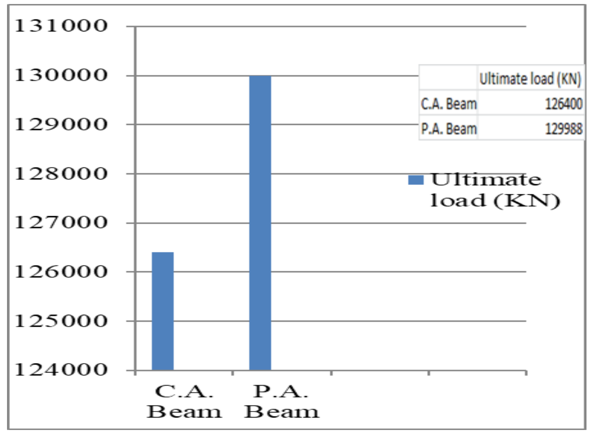
= 17.79 % ≈ 18 %

Therefore, reduced in weight is 18%

OBJECTIVE- 2

Ultimate load carrying capacity and Breaking load of conventional and plastic beam

Type of beam		Ultimate load In 'N'	Average Ultimate Load 'N'
Conventional Beam	Beam-1	125000	126400
	Beam-2	127800	
Plastic Beam (below neutral axis)	Beam-1	122625	129983
	Beam-2	137340	

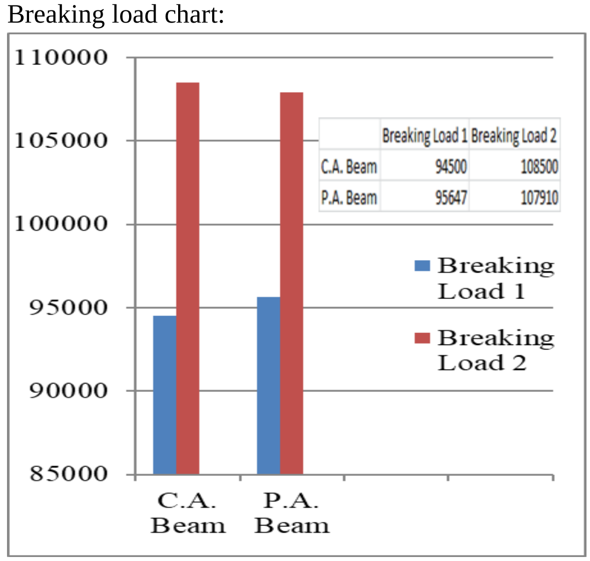


OBJECTIVE - 3

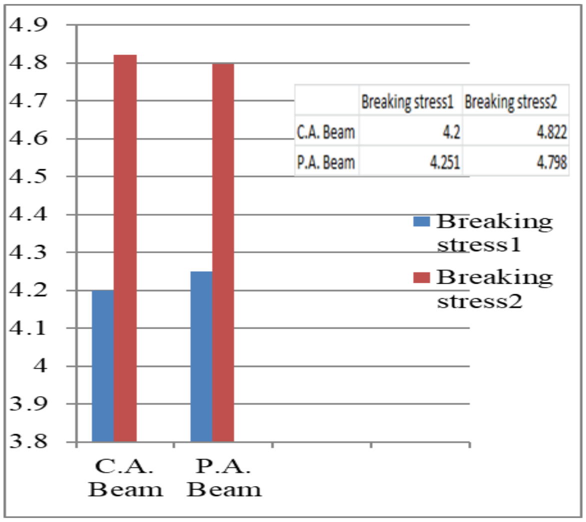
Breaking load and Breaking stress of conventional and plastic beam

Type of beam		Breaking load in N	Average Breaking Load in N	Breaking stress in N/mm^2	Average Stress in N/ mm^2
Conventional Beam	Beam-1	94500	101500	4.200	4.511
	Beam-2	108500		4.822	
Plastic Beam (below N.A.)	Beam-1	95647	101779	4.251	4.524
	Beam-2	107910		4.798	

Breaking load chart:



Breaking Stress Chart:



C.A. – Coarse aggregate
P.A. – Plastic aggregate

XIII. CONCLUSION

1. As compare to conventional beam the plastic beam (below neutral axis) has 18% less weight
2. The conventional beam and plastic beam (below neutral axis) have partially more flexural and breaking strength so that we can use it as a construction material in a structure
3. This project is eco-friendly because we use plastic waste as a construction material by recycling it in plastic aggregate, it helps to reduce plastic waste and pollution.

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