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"Examine The Impact On Beam Behaviour When Coarse Aggregate Is Substituted With Plastic Aggregate Beneath The Beam's Neutral Axis"

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ABSTRACT

In a simply supported reinforced concrete beam, tension occurs below the neutral axis while compression occurs above it. On the neutral axis, there is neither tension nor compression. Concrete can only withstand compressive stress, while steel can withstand tensile stress, so adding concrete below the neutral axis is not advisable. The quantity of plastic waste is increasing dramatically, and since it is not biodegradable, finding new uses for old plastic is critical. For this project, we will use recycled plastic aggregate to totally replace coarse aggregate below the beam's neutral axis and perform flexural testing on the RC beam. The country's rapid industrialization and urbanization necessitate the construction of extensive infrastructure. This causes a cascade of problems, including an excess of waste products and an increase in the production of construction materials, among others. Most construction projects utilize M20-grade concrete, which this program intends to enhance by substituting recovered plastic waste for part of the natural coarse aggregate.

Keywords: Recycled Plastic wastes, Plastic concrete, Neutral axis, tensile stress, Compressive strength**.**

INTRODUCTION

The primary environmental problem of the twenty-first century is the expansion of plastic, which is rapidly spreading across the biosphere. Industries and households mostly produce plastic garbage, with the amount varying by country. Plastic consumption in India exceeds that of several other areas. To overcome this hindrance, we must use it properly and efficiently. This project's primary focus is on using beams made from recovered plastic trash. Reinforced cement concrete is an essential component in the construction of a variety of structures. Sand, aggregate, water, and cement, all of which are important raw resources for concrete manufacturing, are in limited supply. Researchers have conducted numerous studies to explore substitutes for cement, sand, and aggregate in concrete. We make cement from widely accessible components like copper slag, rice husks, and fly ash. The overall state of nature is drastically declining. In this project, recycled plastic is used to completely replace natural coarse aggregate below the beam's neutral axis. While aggregate is an essential component of all structures, concrete is the major material. The building sector is now experiencing a serious lack of raw materials. Tensile stress affects the horizontally supported part of a reinforced concrete beam, while compressive stress affects the vertically supported section. Due to the restricted capacity of concrete to withstand tension stress, steel reinforcements were used in this position. The concrete transmits stress between the compression and tension areas below the neutral axis. Do a parametric analysis on a flexural component where plastic aggregate is used instead of coarse aggregate below the beam's neutral axis. This will lower the weight and make the strength similar to that of a normal beam.

1. 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

2. 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.

4 METHODOLOGY:

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

5 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 knownas 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 = 20mmCasting 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

6 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 XuXu+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
= 700– 2 x 25 / 90 + 1
= 8.66 ≈ 9 nos.

7 CONCRETE MIX DESIGN:

Cement (kg/m^3)	394.32
Fine aggregate (kg/m^3)	657.612
Coarse aggregate (kg/m^3)	1156.771
Water (li/m3)	186
Water cement ratio (kg/m^3)	0.5
Mix Ratio	1:1.668:2.934

8 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

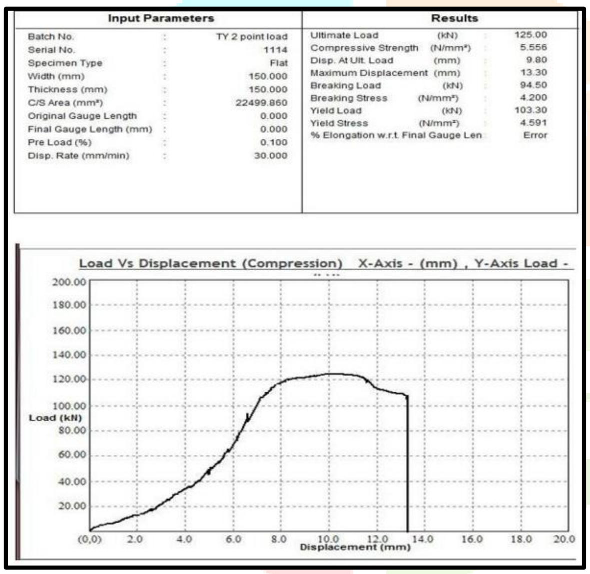
9 TESTING ON PLASTIC CUBE:

Strength should be come:-

Days	Strength should be come in %	Strength should be come in N/mm2	Result in N/mm2
7	65%	13	13.724
14	90%	18	17.658
28	100%	20	20

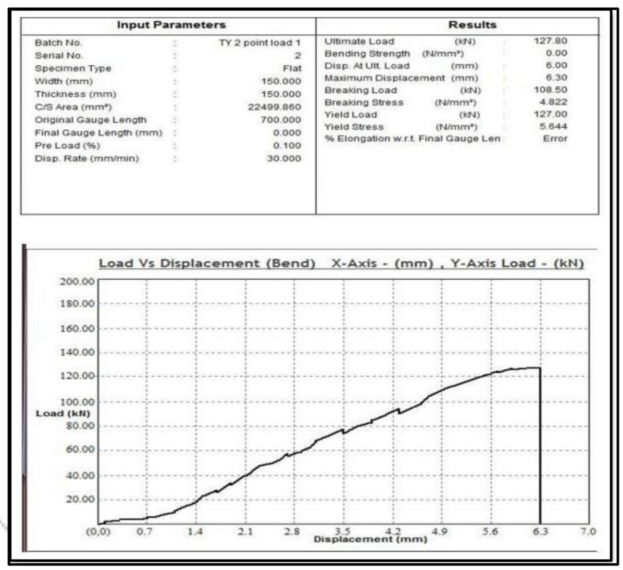
10 TESTING ON CONVENTIAL BEAM:

RESULT OF CONVENTIONAL BEAM



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			

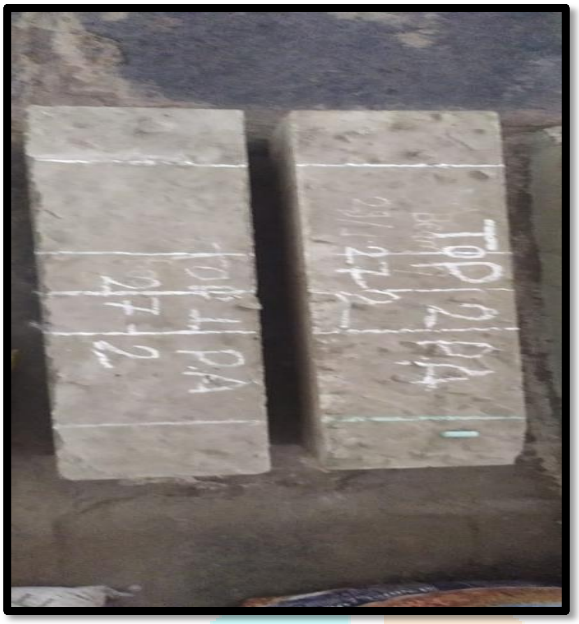
Beam – 1



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			

Beam – 2

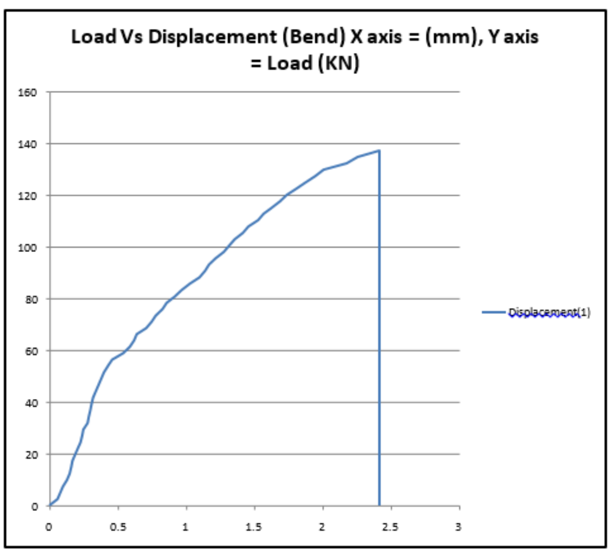
11. TEST ON PLASTIC BEAM (PLASTIC BELOW N.A.)



Beam specimen

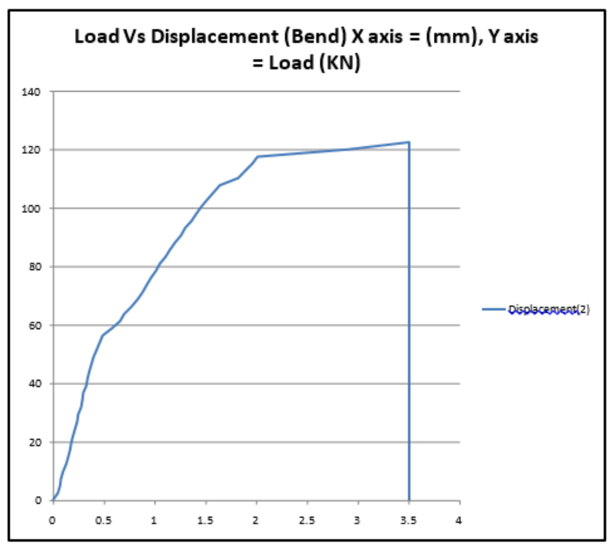
After testing

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 – 1

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/mm²)	: 4.251
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

12. 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 neutral axis)	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

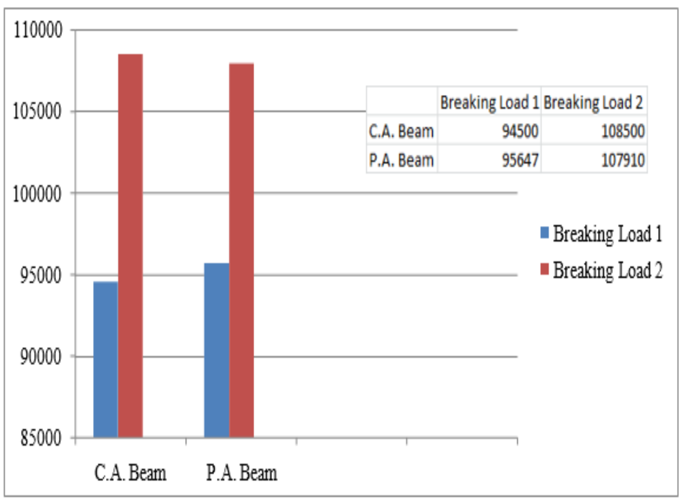
Type of beam		Ultimate load In N	Average Ultimate Load N
Conventional Beam	Beam-1	125000	126400
	Beam-2	127800	
Plastic Beam (below neutral axis)	Beam-1	122625	129983
	Beam-2	137340	

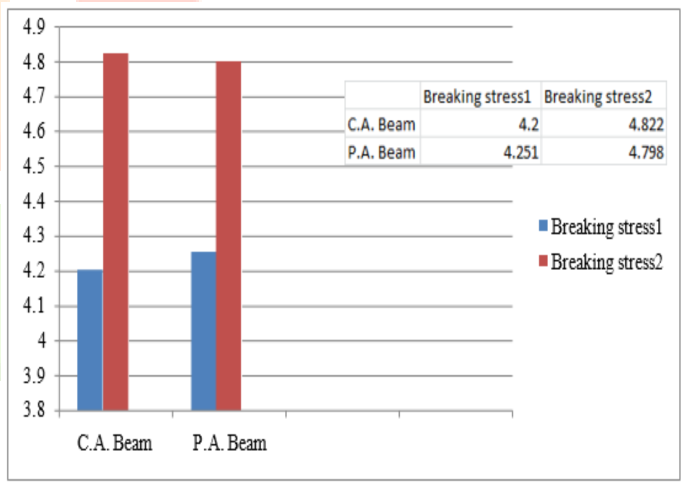
Objective - 3

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/mm²**	**Average Stress in N/mm²**
Conventional Beam	Beam-1	94500	101500	4.200	4.511
	Beam-2	108500		4.822	
Plastic Beam (below neutral axis)	Beam-1	95647	101779	4.251	4.524
	Beam-2	107910		4.798	

Breaking load chart
Breaking stress chart





C.A. – Course Aggregate

P.A. – Plastic Aggregate

13. 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) has 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 help to reduce plastic waste and pollution.

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