ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Analysis of rubber aggregates used concrete beams

Priyanka Asutkar[1*], S. B.Shinde[1], P. R. Punase[2]
[1]MGM's Jawaharlal Nehru Engineering Collage, Aurangabad, MH, India
[2]SSBT Collage of Engineering and Technology, Jalgaon, MH, India.
***Corresponding author:E-Mail:priyaasutkar1992@gmail.com**

ABSTRACT

Concrete is one the most extensively used construction material all over the world. Many scientists and researchers are in quest for developing alternate construction material that are environment friendly and contribute towards sustainable development. Huge amount of rubber tyres waste is generating day by day which creates the disposal problem and has many environmental issues. As this scrap rubber waste is an elastic material having less specific gravity, energy absorbent material can be used as a replacement material for obtaining light weight concrete. In present study the coarse aggregates in concrete are replaced with rubber aggregates by varying the replacement proportion from 0% to 20% with increment of 5%. The elastic properties are determined from concrete cubes. 3 cubes for each percentage of replacement are casted and tested after 28th days of curing. Method of initial functions is used for the analysis of beams. The Method of initial functions (MIF) is an analytical method of elasticity theory from which stresses and displacement can be determined. This attempt of replacing the coarse aggregates with rubber aggregates will save the natural aggregates, reduces weight of structure and also helps achieve sustainability.

KEY WORDS: Rubber scrap, Method of initial functions, beams.

1. INTRODUCTION

The scarcity and availability of sand and aggregate at reasonable rates are now giving anxiety to the construction industry. Over years, deforestation and extraction of natural aggregates from river beds, lakes and other water bodies have resulted in huge environmental problems. Erosion of the existing topography usually results in flooding and landslides. Moreover, the filtration of rain water achieved by deposits of natural sand is being lost, thereby causing contamination of water reserves used for human consumption. Hence, to prevent pollution authorities are imposing more and more stringent restrictions on the extraction of natural aggregates and its crushing. The best way to overcome this problem is to find alternate aggregates for construction in place of conventional natural aggregates. In this research rubber aggregates from discarded tyre rubber in sizes 20-10 mm, is partially replaced with natural aggregates in cement concrete.

Method of initial functions (MIF): MIF was first proposed by Malieev in 1951 and further developed by Vlasov in 1955. Beams that are built of more than one material are called composite beams. It is difficult to analyze the laminated beams by the bending theory used for ordinary beams. In MIF, equations governing the flexure of composite laminated beams are derived without making any assumption regarding the physical behavior of beams. The method of initial functions (MIF) has been used for deriving the equations. It is an analytical method of elasticity theory allows us to obtain the exact solutions for certain types of problems without use of hypotheses about the character of the stress-strain state of the structural element. In recent years the MIF has been used intensively for the analysis of various problems. For example, three-dimensional elasticity equations for circular cylindrical shells are solved by assuming Taylor series expansions for finding stresses and displacements.

2. MATERIAL AND METHODS

The rubber aggregates are obtained by shredding the scrap tire rubber in 20mm size. Heavy vehicles tire scraps were used for preparing the rubber aggregates. The percentage of replacement is done by volume. Cubes size is taken as 150 x1 50 x 150 mm. The properties of material used are discussed below.

Table.1.Physical properties of materials used

Material	Specific gravity	Bulk Density (kg/m^3)
Rubber aggregates	1.10	650
Fine aggregates	2.6	1650
Coarse aggregates	2.8	1720

Table.2.Mix proportion (kg/m^3)

Designation	Cement (kg)	Water (litres)	Fine aggregates (kg)	Coarse aggregates (kg)	Rubber aggregates (kg)
NC - 0%	364.81	225.17	610.43	1239.64	-
RC -5%	437.77	224.2	590.03	1177.65	23.30
RC -10%	437.77	224.2	590.03	1115.67	46.73
RC- 15%	437.77	224.2	590.03	1053.69	70.101
RC-20%	437.77	224.2	590.03	991.71	93.46

Figure.1.Rubber Aggregates (20mm)

Figure.2.Concrete Cubes

Compressive test on concrete cubes: The coarse aggregates in the concrete was replaced successively by different percentage of rubber aggregates with varying proportion from 0%, 5%, 10%, 15%, 20%.The concrete cubes of size $150mm^3$ were casted and tested after 28 days of curing.

Figure.3.Testing of concrete cubes

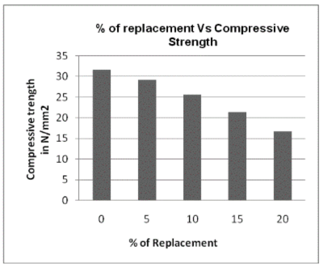

Figure.4.Variation of compressive strength for different percentage of replacement

Table.3.Compressive strength of cubes for various percentage of replacement

% of replacement	Coarse aggregates replaced concrete (N/mm^2)
0%	31.7
5%	29.23
10%	25.61
15%	21.34
20%	16.61

Table 4. Elastic Properties

Material	% of Replacement of Coarse Aggregates	Load (KN)	E (N/mm^2)	G (N/mm^2)	μ
Coarse aggregates replaced with rubber aggregates concrete	0	100	28729.13	1197.47	0.20
	5	98.80	24658.06	10274.19	0.20
	10	97.50	21589.82	8995.75	0.20
	15	93.20	16827.65	7011.52	0.20
	20	85.20	14284.55	5951.89	0.20

Analysis of composite beam by MIF: The following values of beam dimensions are chosen for the particular problem. H=250mm, l=2000mm. The boundary condition of simply supported edges is given by X=Y=v=0, at x=0 and x=l. A Point load is assumed, on top surface of the beam. The expression for point load in sine series is given by Taking Po=100 N/m and x=l/2. The design loads Po are calculated by using IS 456-2000. The elastic properties are determined by using expression from ACI-318. μ is constant for all cases, and G is determined by using the expression E=2G(1+ μ).

3. RESULTS AND DISCUSSION

The analytical results of stresses and displacement by using method of initial functions are shown in the following table.

Table.5.Beam loaded with point load 100KN

Depth of Beam	V (mm)	X (N/mm^2)	Bending Stress (N/mm^2)
400	0.51	0	7.67
350	0.51	0.53	5.74
300	0.51	0.78	3.93
250	0.512	0.93	2.182
200	0.512	0.968	0.49
150	0.511	0.92	-1.19
100	0.511	0.79	-2.87
50	0.51	0.54	-4.58
0	0.51	0	-6.26

Table.6.Beam loaded with point load 98.80 KN

Depth of Beam	V (mm)	X (N/mm^2)	Bending stress (N/mm^2)
400	0.579	0	7.33
350	0.58	0.38	5.47
300	0.58	0.67	3.71
250	0.58	0.85	2.01
200	0.579	0.93	0.37
150	0.578	0.88	-1.2
100	0.577	0.73	-2.8
50	0.571	0.43	-4.53
0	0.574	0	-6.24

Table.7.Beam loaded with point load 97.50 KN

Depth of Beam	V (mm)	X (N/mm^2)	Bending stress (N/mm^2)
400	0.648	6.84	7.27
350	0.648	5.13	5.45
300	0.648	3.5	3.7
250	0.648	1.94	2
200	0.647	0.15	0.35
150	0.646	-1.06	-1.1
100	0.645	-2.56	-2.74
50	0.643	-4.08	-4.6
0	0.641	0	-6.03

Table.8.Beam loaded with point load 93.20 KN

Depth of Beam	V (mm)	X (N/mm^2)	Bending stress (N/mm^2)
400	0.805	0	7.068
350	0.805	0.35	5.29
300	0.805	0.62	3.62
250	0.804	0.78	1.98
200	0.804	0.85	0.24
150	0.803	0.81	-1.1
100	0.801	0.66	-2.64
50	0.799	0.39	-4.21
0	0.796	0	-5.84

The following figure shows the profile of stresses and displacement across the depth of beam.

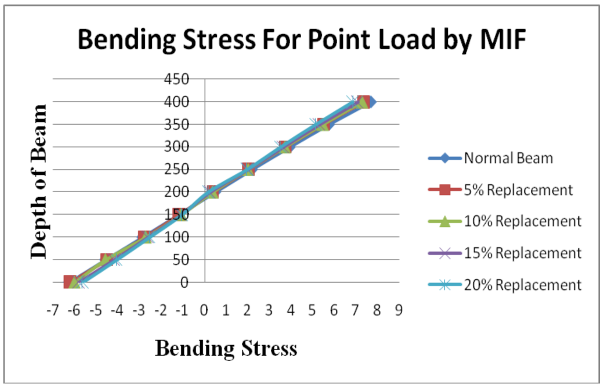

Figure.5.Variation of bending stress for different percentage of replacement. The bending Stress decreases as the percentage replacement of coarse aggregates by rubber aggregates in concrete increases. Reduction of bending stress is less upto 15% but suddenly decreases by 12% for 20% replacement of coarse aggregates

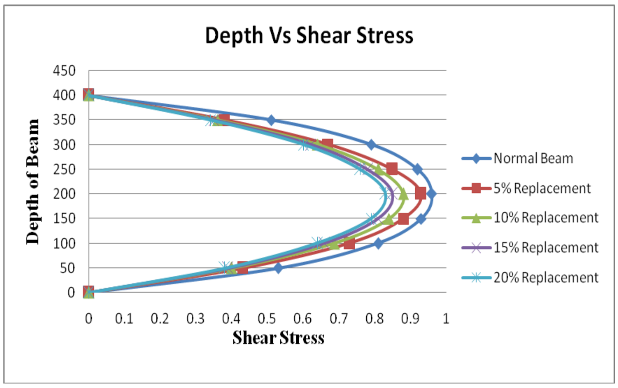

Figure.6.Variation of shear stress for different percentage of replacement across the depth. The shear Stress is zero at top end of the beams and maximum at centre. As percentage replacement of coarse aggregates by rubber aggregates in concrete increases the shear stress decreases

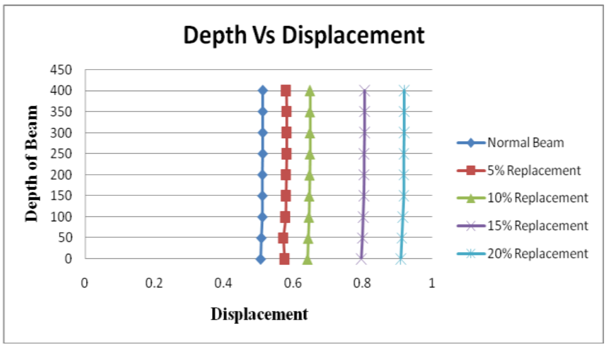

Figure.7.Variation of displacement across depth of beam for different percentage of replacement. The variation of displacement (v) is almost linear across the depth. It increases with increase in percentage replacement of coarse aggregates by rubber aggregates in concrete. Less variation is observed 5% and 10% but displacement is more for 15 % and 20% replacement

4. CONCLUSION

- The following conclusions are made based on the above experimental work and analysis by MIF.
- Experimentally it is seen that the compressive strength of the concrete decreases when coarse aggregates are replaced by rubber aggregates. The rubber aggregates can be effectively replaced up to 15%.
- The results of shear stress and bending stresses are analysed by using MIF satisfies the physical behaviour of beam.
- The analytical results shows that the bending Stress decreases as the percentage replacement of coarse aggregates by rubber aggregates in concrete increases.
- The results indicate that displacements are more for rubber aggregates replacement.
- This study suggest that use of scrap material will help to recycle the material and can be effectively used in concrete. This will save the natural aggregates and also helps to achieves sustainability.

REFRENCES

Damodhara Reddy B, Aruna Jyothy S, Ramesh Babu P, Experimental Investigation on Concrete by Partially Replacement of Ware Aggregate with Junk Rubber, The International Journal Of Engineering And Science (IJES), 2(12), 2013, 61-65.

Eldhose C, Soosan TG, Studies on Scrap Tyre Added Concrete for Rigid Pavements, International Journal of Engineering Research, 3(12), 2014, 777-779.

El-Gammal A, Abdel-Gawad AK, El-Sherbini Y, Shalaby A, Compressive Strength of Concrete Utilizing Waste Tire Rubber, Journal of Emerging Trends in Engineering and Applied Sciences, 1 (1), 96-99.

Eshmaiel Ganjia, Morteza Khorami, Ali Akbar Maghsoudi, Scrap-tyre-rubber replacement for aggregate and filler in concrete, Construction and Building Materials 23 (2009) 1828–1836.

Galileev SM, Matrosov AV, Method of initial function in the computation of sandwich plate", International Applied Mechanics, 31(6), 1995, 496-476.

Gintauta Skripkiunas, Audriud Grinys, Benjaminas Cernius, Deformation properties of concrete with Rubber waste additives, Material Science, 13(3), 2007, 219-223.

Iyengar KTS, Pandya SK, Application of the method of initial functions for the analysis of composite laminated plates, Ingenieur-Arehiv, 56, 1986, 407-416.

Kotresh KM, Mesfin Getahum Belachew, Study On Waste Tyre Rubber As Concrete Aggregates, International Journal of Scientific Engineering and technology, 3(4), 2014,433-436.

Panda KC, Parthi PS, Jena T, Scrap-Tyre-Rubber Replacement for Aggregate in Cement Concrete: Experimental Study, International Journal of Earth Science and Engineering, 05, 06(01), 2012, 1692-1701.

Patel Rakesh, Dubey SK, Pathak KK, Method of Initial Functions for Composite Laminated Beams", International Conference on Benchmarks in Engineering Science and Technology ICBEST, 2012, 4-7.

Patel Rakesh, Dubey SK, Pathak KK, Analysis of Composite Beams using Method of Initial Functions, International Journal of Advanced Structures and Geotechnical Engineering, 1(2), 2012, 83-86.

Patel Rakesh, Dubey SK, Pathak KK, Analysis of in filled beam using method of initial functions and comparison with FEM", Engineering Science and Technology, an International Journal 17, 2014, 158-164.

Piti Sukontasukkul, Use of crumb rubber to improve thermal and sound properties of pre-cast concrete panel, Construction and Building Materials, 23, 2009, 1084–1092.

Sebastian VK, Iyengar Raja KT and Chandrashekhara K, Method of initial functions in the analysis of thick circular plates, Nuclear Engineering and Design, 36(3), 1976, 341-354.

Sergey M Galileev, Pavel Y Tabakov, Mathematical Foundations of the Method of Initial Functions for the Application to Anisotropic Plates, 2nd International Conference on Mechanical, Nanotechnology and Cryogenics Engineering, 2013, 59-63.

Wakchaure MR, Prashant A Chavan, Waste Tyre Crumb Rubber Particle as A Partial Replacement to Fine Aggregate in Concrete, International Journal of Engineering Research & Technology (IJERT), 3(6), 2014, 1206-1209.

Xiaoyan Huang, Ravi Ranad, Wen Ni, Victor C, On the use of recycled tire rubber to develop low E-modulus ECC for durable concrete repairs, Construction and Building Materials, 46, 2013,134–141.