International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

An Experimental Analytical Studies on Flexural Behaviour of Rcc Two Way Slabs

Thangalla Triveni & A. Ramakrishnaiah

[1]M.Tech (Structural Engineering), Department of Civil Engineering, Bharath Educational Society Group of Institutions, Golden Valley Integrated Campus, Madanapalle, AP, 517325, India.

[2]Associate Professor of Civil Engineering, Bharath Educational Society Group of Institutions, Golden Valley Integrated Campus, Madanapalle, AP, 517325, India.

ABSTRACT

Concrete is the most commonly used material because of its ease in getting required shapes in various types of constructions. The present day concrete demands high performance with economy. A huge quantity of concrete is consumed by construction industry all over the world. The demand of aggregate and cement used in concrete is increasing worldwide every year due to rapid industrialization and urban development. On the other hand, vast amounts of construction and demolition (C&D) wastes are generated due to demolition of existing structures and increased construction activities which create landfill problems worldwide. The excessive utilization of aggregate for concrete production leads to excessive exploitation of natural aggregate and environmental degradation from quarrying activities.

This has resulted in renewed interest in use of Recycled Aggregates (RA) as a viable source of concrete ingredients. The modulus of elasticity of concrete is a very important parameter reflecting the ability of concrete to deform elastically. Deflections and crack widths are the parameters which give us warning that the structure is about to fail so that there will be sufficient time to react. The aim of study is to verify the influence of steel reinforcement on the modulus of elasticity of reinforced concrete members and also to compare the parameters such as deflection, strains and crack width between the slabs that are laid by using complete natural coarse aggregate and 50% of recycled coarse aggregate.

Study carries casting and testing of two way slab specimens by using natural coarse aggregate and 50% replacement with recycled aggregate. The concrete grade considered for study is M25. In the experimental study the concrete mix has been designed as per the guidelines given in IS: 10262-2009 published by Bureau of Indian Standards. In slab specimens, the steel reinforcement varies from 0.3%, 0.4%, 0.5% in both the cases (natural and recycled) by using 6mm and 8mm diameter rebars. The size of two way slab is 600mm × 800mm × 90mm. The value of modulus of elasticity (E) is evaluated from the load vs. deflection curve of slab specimens.

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

INTRODUCTION

Concrete is the most commonly used material in various types of constructions. Concrete is widely used for the construction of buildings, foundations, pavements, bridges, and motorways, runways, parking structures, dams, reservoirs, pipes, fences and poles. The present day concrete demands high performance with economy. Concrete is a material with which any shape can be cast. It is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. It is difficult to find out other material of construction which is as versatile as concrete.

A huge quantity of concrete is consumed by construction industry all over the world. Concrete is an artificial material in which the aggregates both are fine and coarse are bonded together by the cement when mixed with water. Concrete solidifies and harden after mixing and placements due to chemical process known as hydration. The water reacts with the cement, which bounds the other components together eventually creating a stone like material. The concrete has become so popular and indispensable because of its inherent properties. Concrete has unlimited and innovative applications in the construction field.

Construction technologies being develop and refined the builders featured in their responses to environmental and social issues surrounding the extraction of raw materials from nature and their use in construction for built environment. Although these materials and method have traditionally been considered "primitive" and therefore inferior to more highly processes materials in terms of safety, durability, performance, occupants health, and comfort with respect to environmental issue, consumption of environmental products and energy within the construction industry has created a significant demand for raw materials and for production thereby contributing to the many environmental problems associated with diverse ecosystem.

RECYCLED AGGREGATE

Recycled aggregate (RA) is aggregate resulting from the processing of material previously used in construction. According to the European Standards for concrete there is a full possibility for the use of RA in concrete. The acceptable ways for the use must be determined according to the national specifications.

Objectives of the study

The objectives of the present research work:

1. To determine the serviceability and strength aspect of the reinforced cement concrete two way slabs by varying the percentage of steel i.e., 0.3%, 0.4% and 0.5% and also the diameter of the reinforcement i.e., 6 mm and 8 mm and also the percentage of steel i.e., 0.3%, 0.4% and 0.5%.
2. To determine the serviceability and strength aspects of reinforced cement concrete two way slabs by replacement of coarse aggregate with 50% recycled coarse aggregate.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

3. Comparison of results obtained with natural coarse aggregate and recycled coarse aggregate in two way reinforced cement concrete slabs.

2. LITERATURE REVIEW

Aron Zaslavsky (1967) presented a yield line analysis for simply supported rectangular concrete slabs (isotropically reinforced) with central rectangular openings, under uniformly distributed load. The three possible yield line patterns (mechanisms) are analyzed and design diagrams were derived for rapid determination of the correct mechanism and the required ultimate moment. Numerical examples are also provided.

Adrian E Long (1975) presented formulae for isotropically reinforced square slabs supported on square columns. Application to relevant test results reported in the literature indicated that the formulae represent a significant improvement over previous methods which are largely empirically based.

3. MATERIALS AND METHODS

Cement

Cement is the most important ingredient in concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure in concrete.

Aggregate

Aggregate are the important constituents of the concrete. They give body to the concrete, reduce shrinkage and effect economy. The mere fact that the aggregate occupy 70-80% of the volume of the concrete involves in this study.

Fine Aggregate

The material which passes through 4.75 mm sieve is termed as fine aggregate. It is a granular form of silica. The locally available river sand conforming to zone-II of IS 383-1970 has been used as fine aggregate.

Coarse Aggregate

The coarse aggregate is the strongest and the least porous component of concrete. It is also a chemically stable material. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture.

Recycled Coarse Aggregate

The recycled coarse aggregate is used in this investigation is obtained by crushing the tested laboratory concrete cubes.

Manual breaking of tested concrete cubes to obtain recycled coarse

Aggregate

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

Sieving of Recycled Coarse Aggregate

Recycled Coarse Aggregate Sample

WATER:

Water used in the construction should be free from acids, oils, alkalies, vegetables or other organic Impurities. Water has two functions in a concrete mix. Firstly, it reacts with the cement to form cement paste in which the inert aggregates are held in suspension until the cement paste has hardened.

STEEL

Steel reinforcement bar is also known as rebar, reinforcing bar, reinforcing steel and reinforcement steel. It is a versatile constructional material which is widely used in the construction industry for making of the reinforced concrete. Reinforcement concrete (RC) is a composite material made up of concrete and some form of reinforcement – most commonly steel rods, bars, wires or mesh of steel rods and steel wires.

MIX DESIGN OF M25 GRADE OF CONCRETE

Cement	Fine aggregate	Coarse aggregate	Water
1	1.91	3.4	0.48

4. RESULTS AND ANALYSIS

Compressive strength

Type of Concrete Mix(M25)	Compressive Strength (MPa)		
	3 Days	7 Days	28 Days
Control mix	15.8	23.4	33.8
RCA-25%	13.6	19.3	29.6
RCA-50%	14.5	22.3	32.3
RCA-75%	13.2	18.9	28.5

TWO WAY SLAB TEST RESULTS

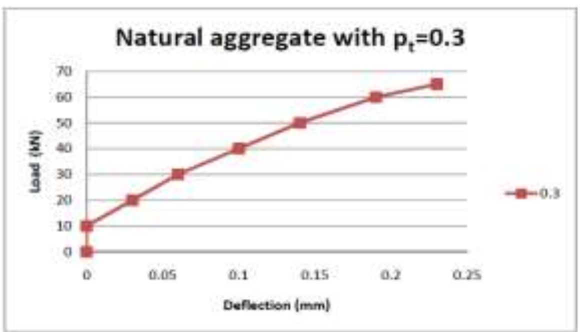
Ultimate Load

Specimen	Experimental ultimate load (kN)	Theoretical ultimate load (kN)
S0.3%(6Ø)+RA (50%)	61.23	50.28
S0.3%(6 Ø)	64.05	50.28
S0.4% (6Ø)+RA (50%)	69.61	60.56
S0.4% (6 Ø)	72.36	60.56
S0.5% (6Ø)+RA (50%)	73.27	76.02
S0.5% (6 Ø)	76.53	76.02
S0.3%(8Ø)+RA (50%)	66.53	50.88
S0.3% (8 Ø)	68.94	50.88
S0.4% (8Ø)+RA (50%)	75.36	63.32
S0.4% (8Ø)	78.62	63.32
S0.5% (8Ø)+RA (50%)	81.2	80.1
S0.5% (8Ø)	84.3	80.1

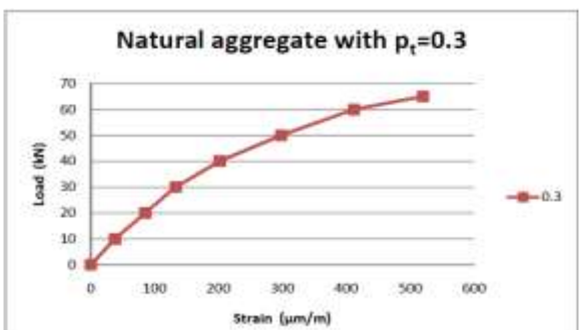
Flexural characteristics of specimens with S0.3% (6Ø)

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

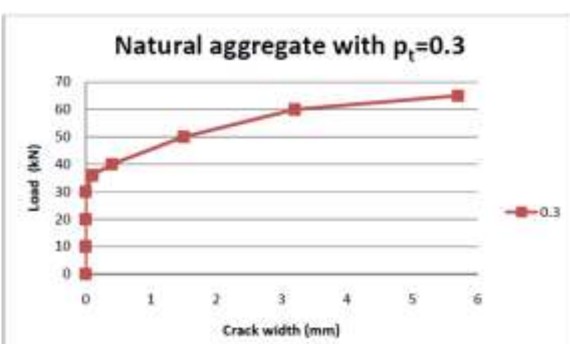
Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	38	0
20	0.03	85	0
30	0.06	133	0
36	**0.09**	**171**	**0.1**
40	0.12	202	0.4
50	0.32	298	1.5
60	0.64	412	3.2
65	1.36	520	5.6



Relation between load v/s deflections



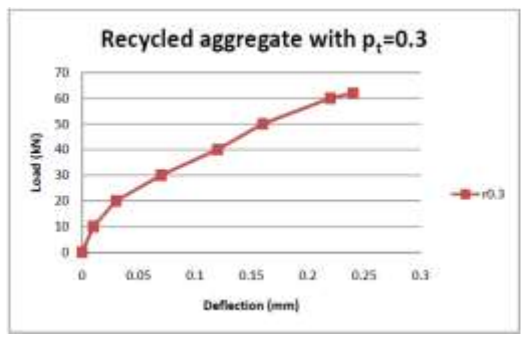
Relation between load v/s strains



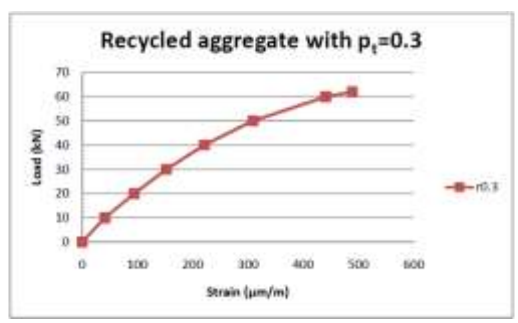
Relation between load v/s crack width

Flexural characteristics of specimens with S0.3% (6Ø) + 50% (RCA)

Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	41	0
20	0.03	94	0
30	0.09	152	0
33	**0.09**	**163**	**0.1**
40	0.18	221	0.8
50	0.48	309	2.0
60	0.96	441	3.8
62	1.44	489	4.3

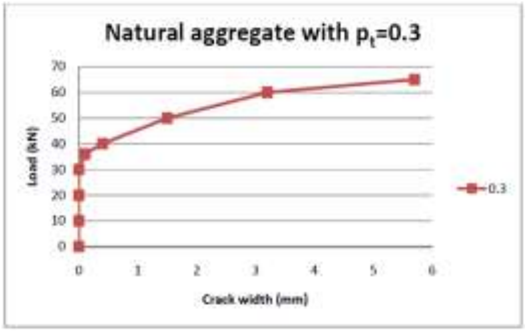


Relation between load v/s deflections



Relation between load v/s strains

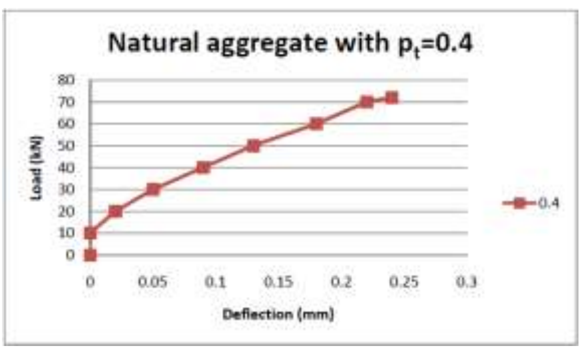
International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019



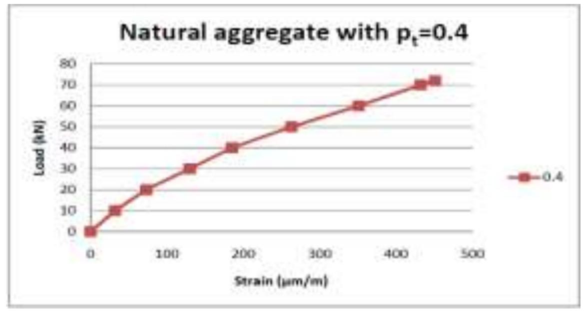
Relation between load v/s crack width

Flexural characteristics of specimens with S0.4% (6Ø)

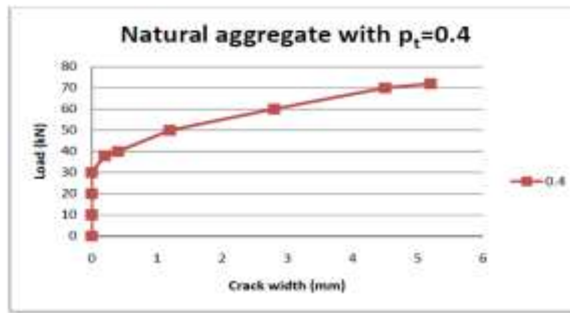
Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	32	0
20	0.02	73	0
30	0.06	130	0
38	**0.09**	**163**	**0.2**
40	0.09	185	0.4
50	0.24	263	1.2
60	0.48	351	2.8
70	0.96	432	4.5
72	1.22	451	5.2



Relation between load v/s deflections



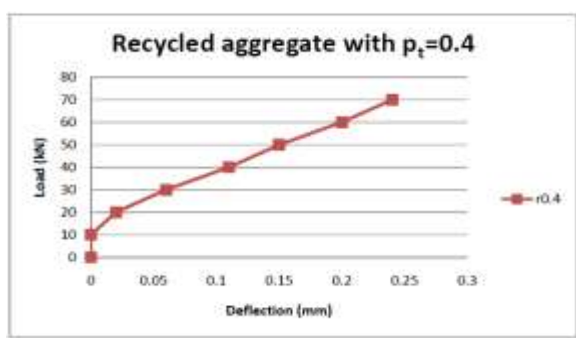
Relation between load v/s strains



Relation between load v/s crack width

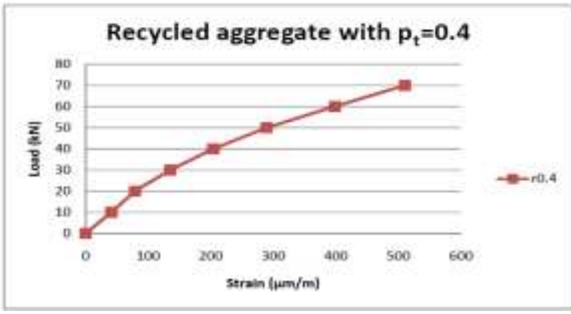
Flexural characteristics of specimens with S0.4% (6Ø) + 50% (RCA)

Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	41	0
20	0.03	79	0
30	0.06	135	0
35	**0.09**	**156**	**0.2**
40	0.12	204	0.4
50	0.36	289	1.5
60	0.7	398	3.2
70	1.14	510	5.1

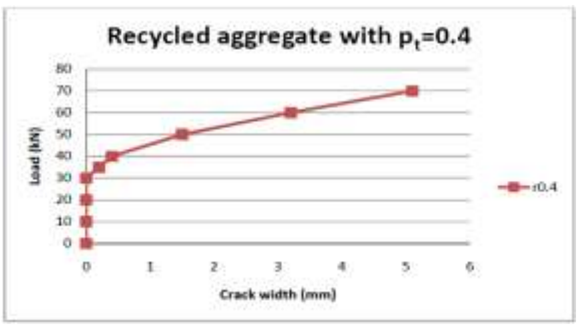


e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

Relation between load v/s deflections



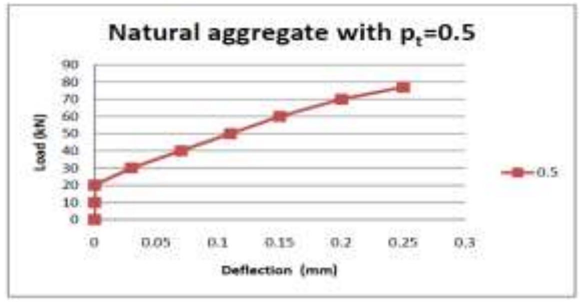
Relation between load v/s strains



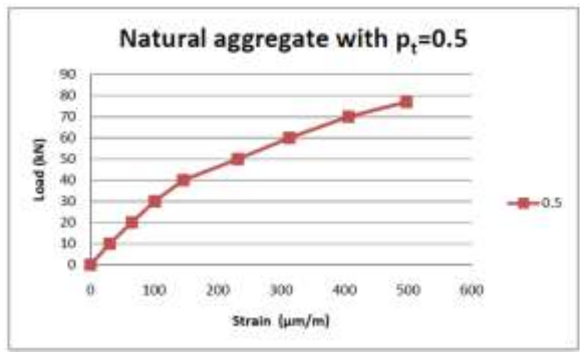
Relation between load v/s crack width

Flexural characteristics of specimens with S0.5% (6Ø)

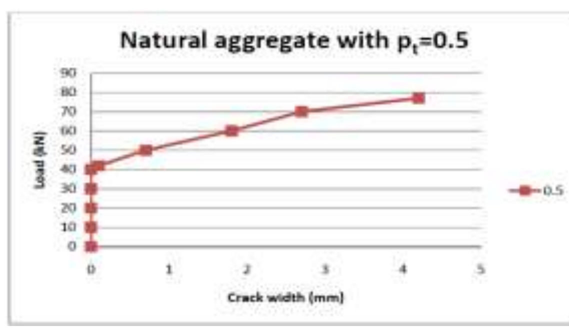
Load (KN)	Deflections (mm)	Strains μm/m	Crack width (mm)
0	0	0	0
10	0	30	0
20	0	65	0
30	0.03	101	0
40	0.08	146	0
42	**0.09**	**151**	**0.1**
50	0.18	232	0.7
60	0.42	313	1.8
70	0.90	406	2.7
77	1.56	497	4.2



Relation between load v/s deflections



Relation between load v/s strains

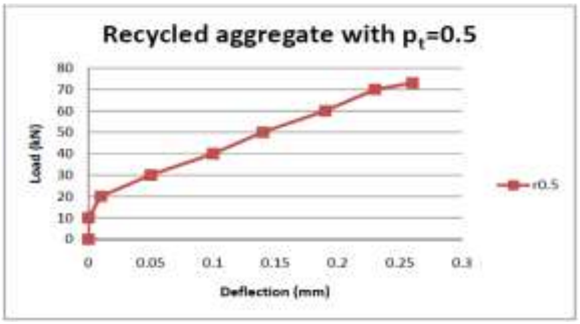


Relation between load v/s crack width

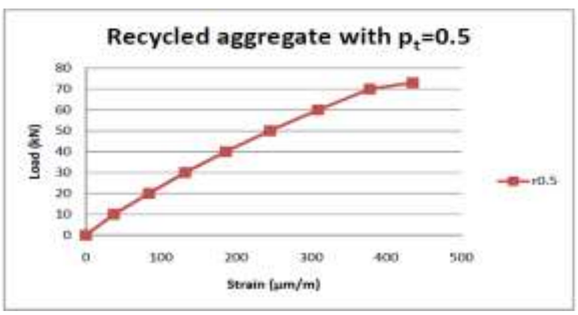
Flexural characteristics of specimens with S0.5% (6Ø) + 50% (RCA)

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

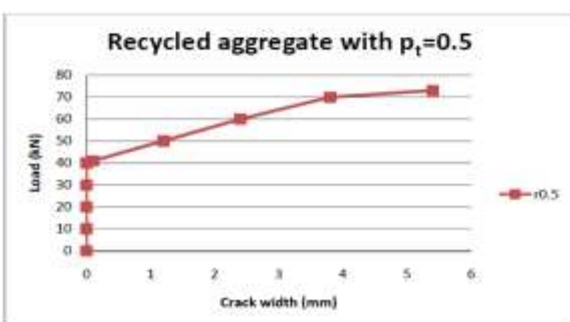
Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	37	0
20	0.03	84	0
30	0.06	132	0
40	0.09	186	0
41	**0.10**	**189**	**0.1**
50	0.24	245	1.2
60	0.54	309	2.4
70	0.96	378	3.8
73	1.28	435	5.4



Relation between load v/s deflections



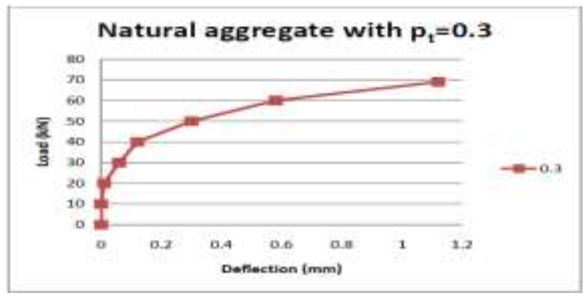
Relation between load v/s strains



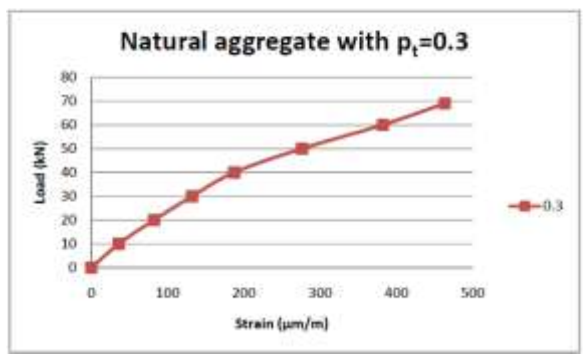
Relation between load v/s crack width

Flexural characteristics of specimens with S0.3% (8Ø)

Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	36	0
20	0.03	82	0
30	0.06	132	0
37	**0.09**	**155**	**0.3**
40	0.12	187	0.6
50	0.30	276	1.5
60	0.58	382	3.1
69	1.18	463	5.3

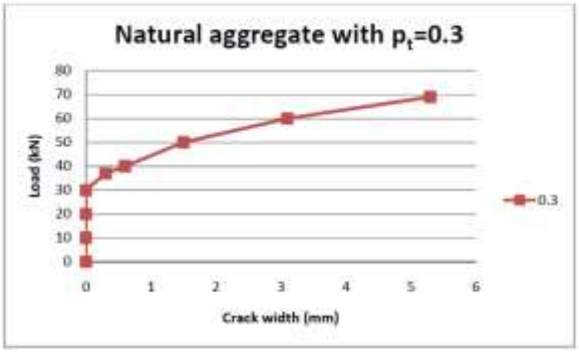


Relation between load v/s deflections



Relation between load v/s strains

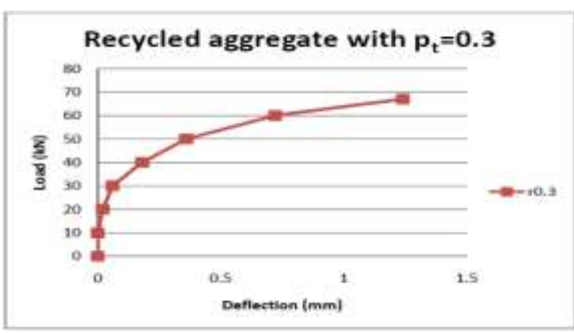
International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019



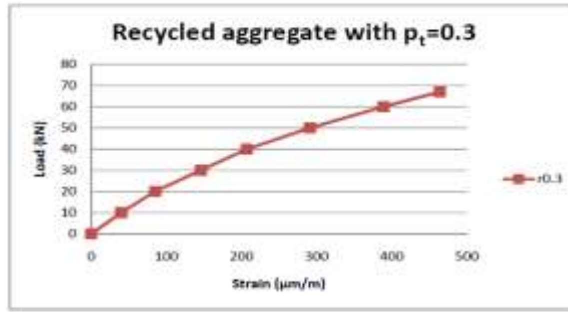
Relation between load v/s crack width

Flexural characteristics of specimens with S0.3% (8Ø) + 50% (RCA)

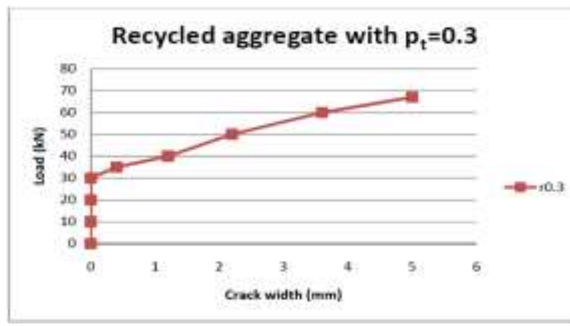
Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	40	0
20	0.02	85	0
30	0.06	146	0
35	**0.09**	**163**	**0.4**
40	0.18	207	1.2
50	0.36	291	2.2
60	0.66	389	3.6
67	1.12	464	5.0



Relation between load v/s deflections



Relation between load v/s strains

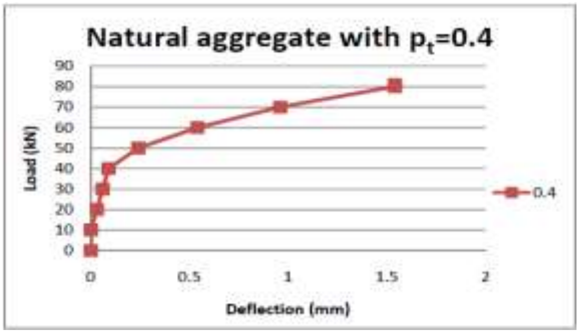


Relation between load v/s crack width

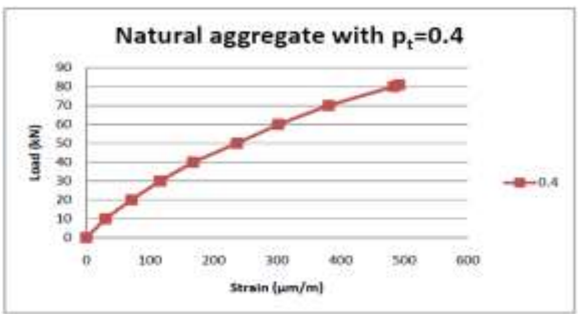
Flexural characteristics of specimens with S0.4% (8Ø)

Load (KN)	Deflections (mm)	Strains µm/m	Crack width (mm)
0	0	0	0
10	0	30	0
20	0.01	71	0
30	0.03	116	0
40	0.06	168	0
45	**0.10**	**182**	**0.2**
50	0.24	237	0.8
60	0.54	302	1.9
70	0.96	381	3.2
80	1.54	483	4.8
81	1.54	492	5.0

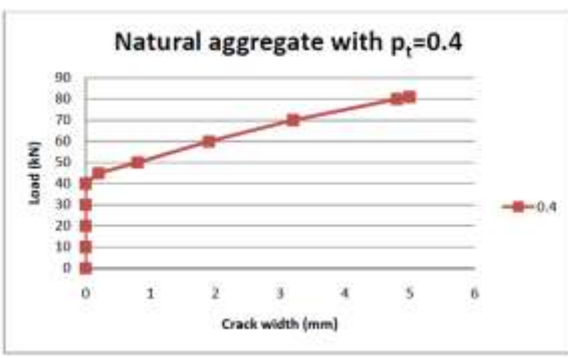
International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019



Relation between load v/s deflections



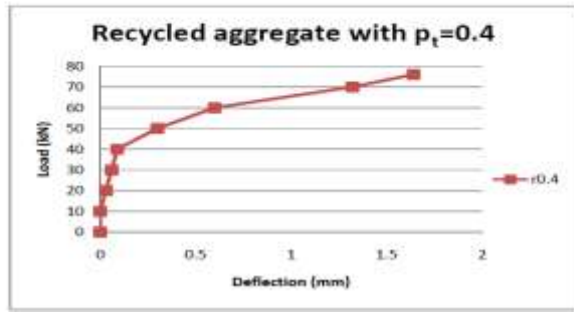
Relation between load v/s strains



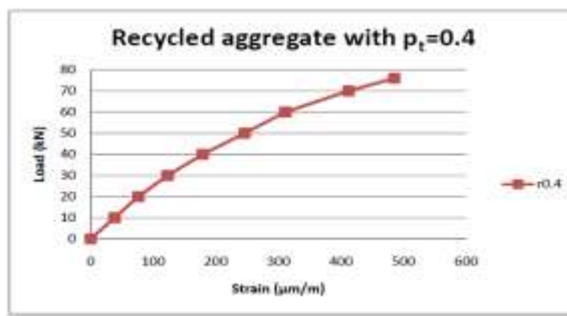
Relation between load v/s crack width

Flexural characteristics of specimens with S0.4% (8Ø) + 50% (RCA)

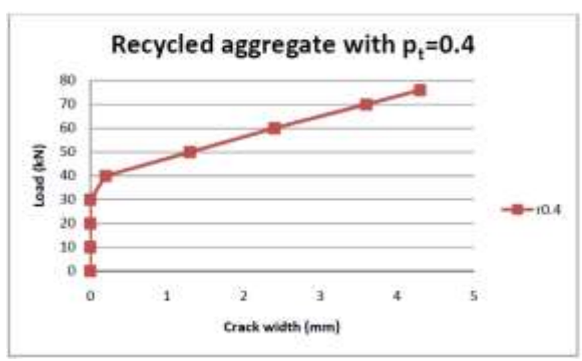
Load (KN)	Deflections (mm)	Strains μm/m	Crack width (mm)
0	0	0	0
10	0	38	0
20	0.03	76	0
30	0.06	123	0
40	**0.09**	**162**	**0.2**
50	0.30	246	1.3
60	0.60	311	2.4
70	1.08	412	3.6
76	1.54	485	4.3



Relation between load v/s deflections



Relation between load v/s strains

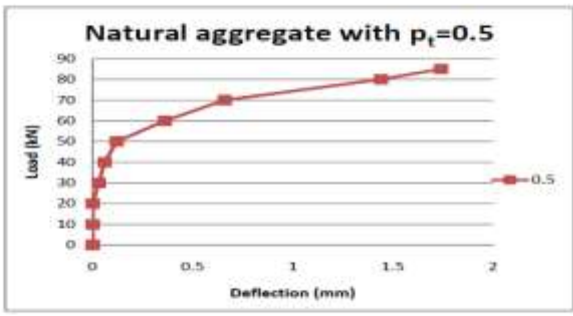


Relation between load v/s crack width

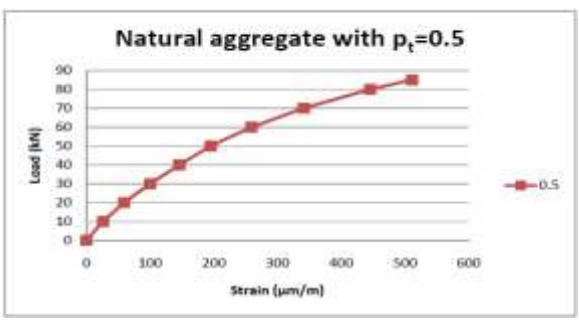
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

Flexural characteristics of specimens with S0.5% (8Ø)

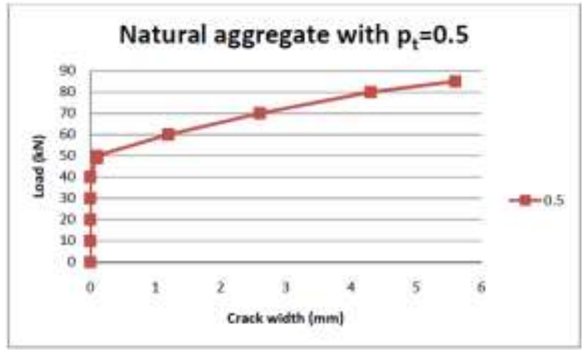
Load (KN)	Deflections (mm)	Strains μm/m	Crack width (mm)
0	0	0	0
10	0	26	0
20	0	59	0
30	0.03	100	0
40	0.06	146	0
49	**0.10**	**187**	**0.1**
50	0.12	195	0.1
60	0.36	259	1.2
70	0.78	341	2.6
80	1.34	445	4.3
85	1.74	511	5.6



Relation between load v/s deflections



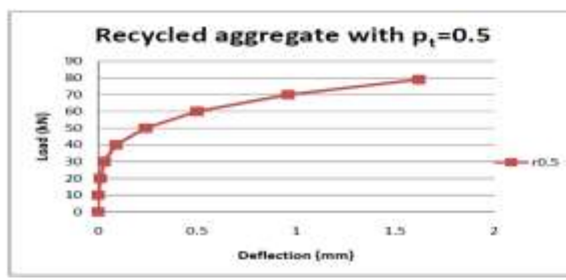
Relation between load v/s strains



Relation between load v/s crack width

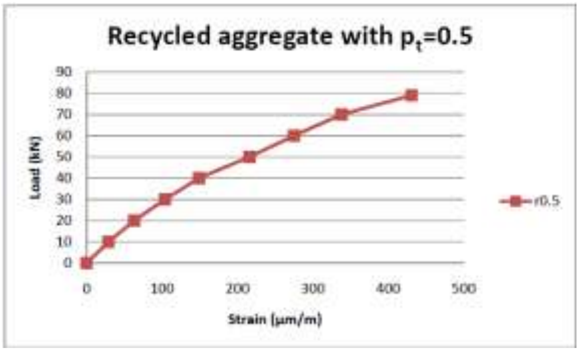
Flexural characteristics of specimens with S0.5% (8Ø) + 50% (RCA)

Load (KN)	Deflections (mm)	Strains μm/m	Crack width (mm)
0	0	0	0
10	0	29	0
20	0.01	63	0
30	0.03	104	0
40	0.06	149	0
44	**0.09**	**165**	**0.3**
50	0.24	216	0.9
60	0.50	275	1.7
70	0.96	338	3.3
79	1.52	431	4.8

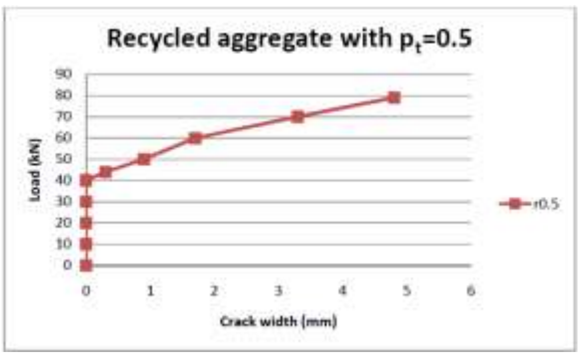


Relation between load v/s deflections

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

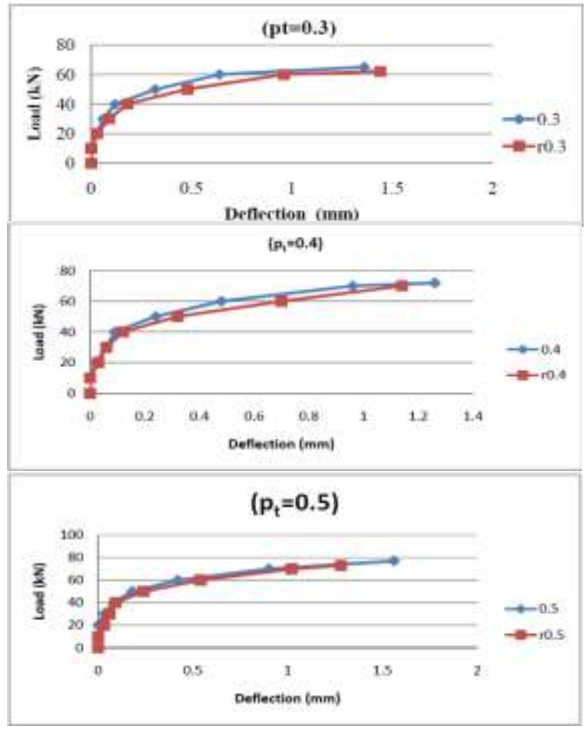


Relation between load v/s strains

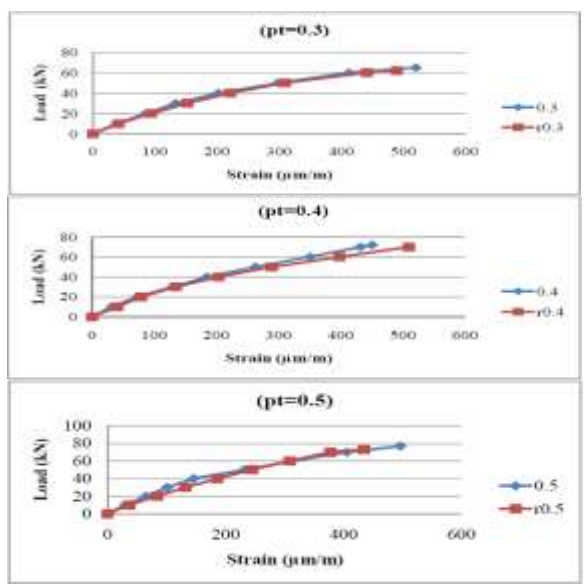


Relation between load v/s crack width

Comparison of deflections between natural and recycled aggregate with 6 mm dia reinforcement @ 0.3, 0.4 and 0.5 percentages of steel:

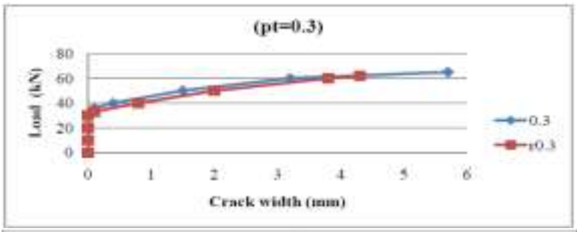


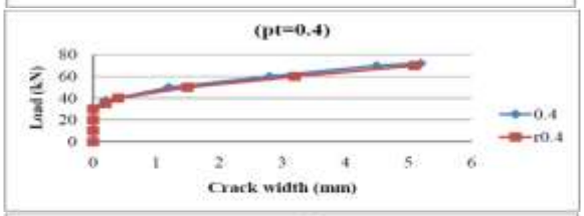
Comparison of strains between natural and recycled aggregate with 6 mm dia Strains @ 0.3, 0.4 and 0.5 percentages of steel:

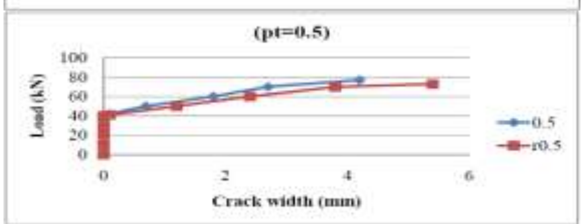


e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

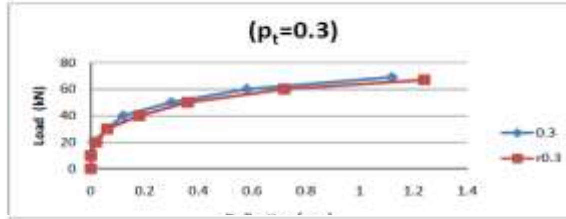
Comparison of crackwidths between natural and recycled aggregate with 6 mm dia Strains @ 0.3, 0.4 and 0.5 percentages of steel:

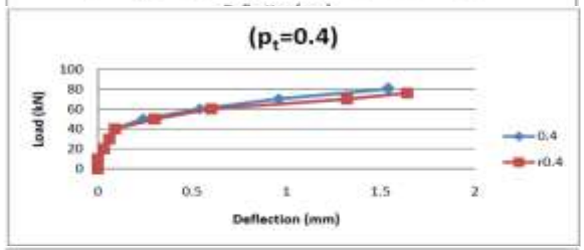


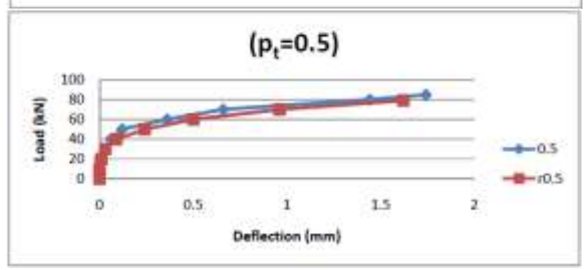




Comparison of deflections between natural and recycled aggregate with 8 mm dia Strains @ 0.3, 0.4 and 0.5 percentages of steel:

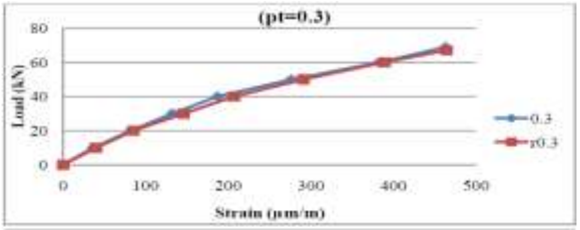


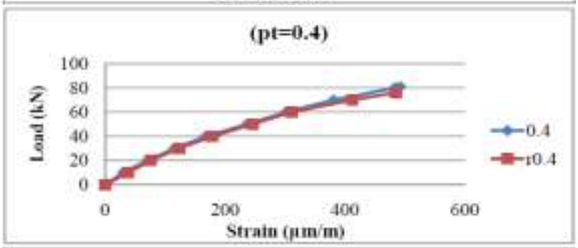


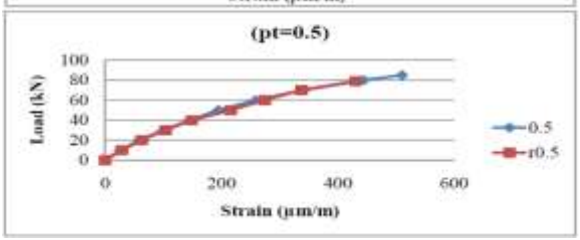


Comparison of strains between natural and recycled aggregate with 8 mm dia Strains @ 0.3, 0.4 and 0.5 percentages of steel:

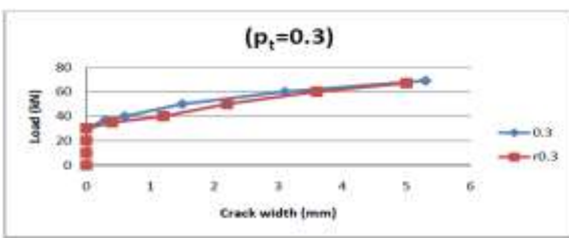
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

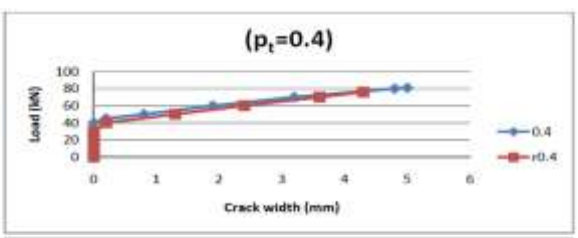


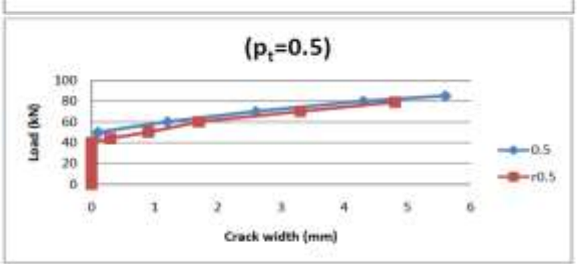




Comparison of crack width between natural and recycled aggregate with 8 mm dia Strains @ 0.3, 0.4 and 0.5 percentages of steel:

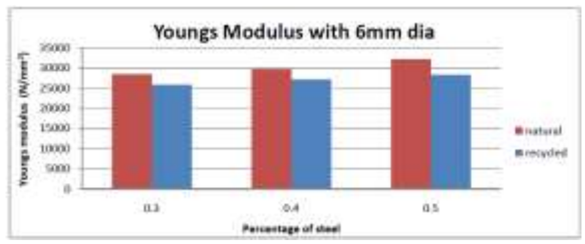






Results of modulus of elasticity

Specimen	Modulus of elasticity (N/mm2)
S0.3% (6Ø)+RA (50%)	25884.12
S0.3% (6 Ø)	28498.23
S0.4% (6Ø)+RA (50%)	27205.94
S0.4% (6 Ø)	29738.15
S0.5% (6Ø)+RA (50%)	28321.24
S0.5% (6 Ø)	32223.25
S0.3%(8Ø)+RA (50%)	27719.45
S0.3% (8 Ø)	29278.32
S0.4% (8Ø)+RA (50%)	31033.28
S0.4% (8Ø)	31374.59
S0.5% (8Ø)+RA (50%)	33738.25
S0.5% (8Ø)	33772.29



Relation between modulus of elasticity v/s percentage of steel

Relation between modulus of elasticity v/s percentage of steel

5. CONCLUSIONS

1. By using 50% recycled aggregate the flexural strength of the slabs are almost same as that to the natural aggregate slab strength.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 03
March 2019

2. Upto the first crack point, the deflections are linear beyond that the deflections are increases non-linearly and rapidly.
3. As the percentage of steel increases the crack width decreases. The decrease in percentage of crack width is 60% between 0.3% and 0.5% percentage of steel.
4. Modulus of elasticity of the slab increases with increase in percentage of steel. The increase in percentage of modulus of elasticity is 14% between 0.3% and 0.5% percentage of steel.
5. The modulus of elasticity obtains by deflections and strain of slabs gives almost equal values.

REFERENCES

[1]. Vyas C.M, Bhatt D.R (2013) "Use of Recycled Coarse Aggregate in Concrete". IJSR – international journal of scientific research Vol-2/issue -1, Jan 2013.

[2]. Concrete Technology by Shetty.M.S, first edition, S.Chand publications, 1982.

[3]. IS 456-2000. Plain and Reinforced concrete code for practice. Bureau of Indian Standards, New Delhi (India).

[4]. IS 383-1970. Specification for coarse and fine aggregate from natural sources for concrete. Bureau of Indian Standards, New Delhi (India).

[5]. IS 10262:2009. Concrete Mix proportioning- Guidelines. Bureau of Indian Standards, New Delhi (India).

[6]. IS 2386 (Part1&3):1963 "Methods of test for aggregates for concrete."

[7]. IS 516:1959 "Method of test for strength of concrete."

[8]. IS 8112:1989. Specifications of 43 grade OPC cement. Bureau of Indian Standards, New Delhi (India).