International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
"A National Conference on Recent Trends in Civil Engineering-II"
Volume 5, Special Issue 03, March-2019.

A STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF FRESH AGGREGATE BY RECYCLED AGGREGATE

Gowhar Aziz[1] , Rahul Chaudhary[2], Priyanka Mandal[3]

[1]*Assistant Professor Department of civil engineering, VIT Jaipur,*
[2]*M.Tech. Student Department of civil engineering, MNIT Jaipur,*
[3]*M.Tech. Student Department of civil engineering, KITE Jaipur,*

***Abstract*— Aggregate is one of the main ingredients in producing concrete. It covers 75% of the total for any concrete mix. The strength of the concrete produced is dependent on the properties of aggregates used. Hence need for an alternative coarse aggregate arises. The aim for this project was to determine the strength and durability characteristics of high strength structural concrete by using recycled coarse aggregates, which will give a better understanding on the properties of concrete with recycled aggregates. The scope of this project was to investigate the possibility of using low cost recycled coarse aggregates as an alternative material to coarse aggregate in high strength structural concrete. The experimental investigation were carried out using detailed strength and durability related tests such as compressive strength test of cubes, flexural strength test of beams. The tests were conducted by replacing the coarse aggregates in high strength concrete mixes by 0, 5, 20, 40, 60, 80 and 100% of recycled coarse aggregates.**
In this paper we have use Recycled Aggregates (RA) use as an aggregate in the production of new concrete was investigated. The performance of compressive strength produced by Recycled Aggregate Concrete (RAC) and results are compared with the Natural Coarse Aggregate Concrete (NAC). The RA is collected from local demolished structure. The studies were conducted with an M30 mix with the selected w/c ratio: 0.43 and the development of compressive strength of the RAC and NAC at the age of 7 & 28 days were studied.

Keywords*— Recycled Aggregates (RA), Natural Coarse Aggregates (NA), Recycled Aggregate Concrete (RAC), Natural Coarse Aggregate Concrete (NAC).

I. INTRODUCTION

A technology in the world is brought for modelling of world by constructing various type of building, dam, road, bridge, barrage etc. using steel, concrete, bricks etc but the majority of construction all over the world is mostly based on concrete structures and concrete can be moulded in any shape and size as per demand and wishes but steel and brick can't be done so. Concrete is economical as compared to steel structure and it has also low cost of maintenance, easy mechanism for work. Concrete is a composite materials which is prepared with mix of cement, fine aggregate, coarse aggregate and water. It can be widely use for any type of structure as per choice and demand and percentage constituents of concrete can be changed as per load and strength requirement by infrastructure.

In any country, construction accounts for about 60 percent of the plan outlay. Out of this, cement & cement product would account for more than 50 percent. Today in India the annual consumption of cement is in the order of 22 million tonnes. It is estimated that the cost of mortar and concrete made from 22 millions tons of cement would work out to about 4000 crore rupees

II. MATERIALS

3.2 Aggregates

Aggregates for concrete consists of gravel and sand which represents the grain skeleton for the concrete. All cavities which are within this skeleton need to be filled with binder paste as much as possible. Concrete aggregates occupy approximately 80% of total concrete weight and 70 – 75% of total concrete volume. Optimum use of the aggregates quality and size improves the concrete quality, mainly coarse aggregate maintain better improvement for performance.

Aggregates can occur naturally, industrially which are produced like lightweight aggregates as well as recycled aggregates. Aggregates are cleaned and graded in industrial facilities by mechanical processes such as crushing, screening, mixing together and washing For high-quality concrete. Concrete aggregates should have a strong bond with cement paste, should not interfere with the cement hardening and it should not have any negative appearance on concrete durability after setting time.There are mainly two type of aggregate which are used for this study are given as follows

Coarse Aggregate
Natural aggregate
The Coarse aggregate is obtained from locallly available i.e from Gunawata, Jaipur and only visual inspection is done for the shape,texture,cleavage and angularity of coarse aggregate.Shape and angularity of aggregate has shown the quality and standard which means that how the the quality of coarse aggregate and how can be used the same.

The following codes are used for coarse aggregate
IS-383-1970-specificatin for aggregate from natural source
IS-2386 (Part-I)-1963-For particle size and shape
IS-2386 (Part-III)-1963-For Specific Gravity,Density & water absorption

Recycled aggregate
The recycled aggregate are collected from the source broken cubes , beams and demolished structures. The concrete debris were collected locally from different sources and broken into the pieces of approximately 20mm size with the help of hammer .The foreign matters were sorted out from the pieces. Further, those pieces were mechanically sieved through sieve of 4.75 mm to remove the finer particles. The recycled coarse aggregates were washed to remove dirt, dust etc. and collected for use in concrete mix.

Fine Aggregate
There are four grading zone for fine aggregate as per IS-383:1970 and these are Grading Zone I, Grading Zone II, Grading Zone III & Grading Zone IV.
These grading zone classified as per pecentage passing material from various sieves and thereare mainly four zones and they all have different passing percentage limit for different sieves but there is only one seive(600 micron) which is almost common to all Zone specification so the zone can be predicted from there.
Precentage of passing for 600 micron sieve of all zones are given below :
For Grading Zone I 15% to 34%
For Grading Zone II 35% to 59%
For Grading Zone III 60% to 79%
For Grading Zone IV 80% to 100%
The fine aggregate is taken from Banas,Tonk,Rajashtan and designated IS- Sieve for the material passing through Zone-II is found.

Cement
World is occupied by construction and infrastructure by the means of cement or steel structure but mostly cement is used due to its economical and low maintenance cost and for high and earlier strength, PPC is perfect to take into use for work and also minimize the quantity of cement when the design is performed for mix proportion with super-plasticizer and no doubt, PPC is eco-friendly, economical but does not receive high strength quickly.

Water
The pH value of water should be in between 6.0 and 8.0 according to IS 456-2000.The sea Water generally contains salinity of about 3.5% in which about 80% is sodium chloride. Many researchers have been conducted to study the corrosion problem of steel Embedded in concrete where sea water is used as mixing water in concrete nevertheless the Indian standard is adamant and do not permit using sea water for mixing or curing in reinforced Concrete constructions, but allows for using of sea water only for PCC work that too under unavoidable circumstances. Generally the water that is fit for mixing of water in concrete is also fit for curing. However where appearance is important, water containing impurities which cause stains should not to be used. The most important elements that cause stains in the concrete are iron, and organic matters. It is also found that even sea water also causes stains in concrete. Hence water containing iron, organic matters and also sea water should not be used for curing of concrete when appearance is also set as criteria for the acceptance of concrete.

Chemical Admixture
There are various type of chemical admixture which are used in construction and they are retarding admixture, accelerating admixture, water reducing admixture, air-entraining admixture, Superplasticizing admixture and retarding superplasticizing admixture but water reducing superplasticizer (workability aid) has been used here.

Chemical Admixture
It has high workability to flow for concrete mixes so that large or difficult pours can be carried out with little or without compaction. It can also be used to achieve large water reductions in concrete mixes of normal workability there by producing higher early and final strengths. It is also non flammable product which will prevent from any fire accident at working place and there is no environmental hazardous. The dosages need to be kept within a limit from 0.5% -5 % of cementitious material for good performance and high dosage may harm on strength of concrete. Also it is need to keep away from direct sunlight & frost temperature. Rotate the barrels once in 3 months to keep materials in proper consistency for durability. Shake well before use.
Brand of Admixure: lignoproof
Product Form : Black Brown liquid

III. EXPERIMENTAL PROGRAMME

In order to determine the gradation of the recycled aggregate and natural aggregate sieve analysis test were performed as per IS code. In present investigation the workability was determined by slump test as per IS 1199, compressive strength test by compressive testing machine of capacity 2000 KN as per IS 516 – 1959 and flexural strength test by universal testing machine of capacity 600 KN as per IS 516 – 1959.

IV. RESULTS AND DISCUSSION

a) Gradation of particles

As per IS-383:1970,Banas Sand of zone - II was recommended for concrete mix.The Sieves recommended for Gradation of Banas Sand are 10mm, 4.75mm, 2.36mm, 1.18mm, 600 micron, 300 micron and 150 micron.

b) **Table 1** Sieve Analysis of Fine Aggregate(IS 383/2386)

Location: Jaipur
Source : Banas
Size of Aggregate: Natural Sand

Sieve size	**Retained (gm)**			**% Retained weight**	**Cumulative % Retained**	**Cumulative % Passing**	**Limit as per IS 383**
	Sample 1	**Sample 2**	**Average**				
10 mm	0	0	0	0	0	100	100
4.75 mm	12	12	12	1.2	1.2	98.8	90-100
2.36 mm	21	19	20	2	3.2	96.8	75-100
1.18 mm	51	58	54.5	5.45	8.65	91.35	55-90
600 micron	569	456	512.5	51.25	59.9	40.1	35-59
300 micron	283	377	330	33	92.9	7.1	8.0-30
150 micron	56	70	63	6.3	99.2	0.8	0-10
PAN	8	8	8	0.8	**265.05**		
Total	1000	1000	1000	100			

Fineness Modulus = 265.05/100 = **2.65**

Grading Zone = II

Test accepted / rejected under clause-Accepted as per 4.3 (Table 4) of IS: 383- 1970.

Coarse Aggregate Grading (10mm)

As per IS-383:1970,The Sieves recommended for Gradation of Gunawata coarse aggregate are 12.5mm, 10mm,4.75mm and 2.36mm.

Table 2 Sieve Analysis of 10 mm Aggregate(IS 383/2386)

Location: Jaipur
Source : Gunawata
Size of Aggregate: 10mm

Sieve size	Retained (gm)			% Retained weight	Cumulative % Retained	Cumulative % Passing	Limit as per I-S 383
	Sample 1	Sample 2	Average				
12.5 mm	0	0	0	0	0	100	100
10 mm	36	47	41.5	2.08	2.08	97.93	85-100
4.75 mm	1342	1348	1345	67.25	69.33	30.68	0-20
2.36 mm	487	470	478.5	23.93	93.25	6.75	0-5
PAN	135	135	135	6.75	**164.66**	0.00	
Total	2000	2000	2000	100.00			

Fineness Modulus = 164.66/100 = **1.65**

Coarse Aggregate Grading (20mm)

As per IS-383:1970,The Sieves recommended for Gradation of Gunawata coarse aggregate are 40mm, 20mm, 10mm, and 4.75mm.

Table 3 Sieve Analysis of 20 mm Aggregate(IS 383/2386)

Location: Jaipur
Source : Gunawata
Size of Aggregate: 20mm

Sieve size	Retained (gm)			% Retained weight	Cumulative % Retained	Cumulative % Passing	Limit as per IS 383
	Sample 1	Sample 2	Average				
40 mm	0	0	0	0	0	100	100

20 mm	2372	2330	2351	58.775	58.78	41.225	85-100
10 mm	1468	1489	1478.5	36.9625	95.74	4.2625	0-20
4.75 mm	150	171	160.5	4.0125	99.75	0.25	0-5
PAN	10	10	10	0.25	**254.27**	0	
Total	4000	4000	4000	100			

Fineness Modulus = 254.27/100 = **2.5**

Combined Coarse and fine aggregate grading

As per IS 383:1970 The Aggregate in each test consisted of 36.20% caorse aggregate (20mm) and 23.80% coarse aggregate(10mm) and 40% fine aggregate and gading of aggregate lies between the limit.

Table 4 Combined Aggregate Gradation (As Per IS 383 -1970)

Sieve Size (mm)	**% Passing**						**Combined Gradation**	**Specification Limits**
	20 mm Size		**10 mm Size**		**Sand**			
	100%	**36.20%**	**100%**	**23.80%**	**100%**	**40%**	**100%**	
40	100.00	36.20	100.00	23.80	100.00	40.00	100.00	100.00
20	91.10	32.98	100.00	23.80	100.00	40.00	96.78	95-100
4.75	4.20	1.52	6.00	1.43	92.20	36.88	39.83	30-50
0.6	0.00	0.00	0.00	0.00	40.00	16.00	16.00	10-35
0.15	0.00	0.00	0.00	0.00	1.90	0.76	0.76	0-6

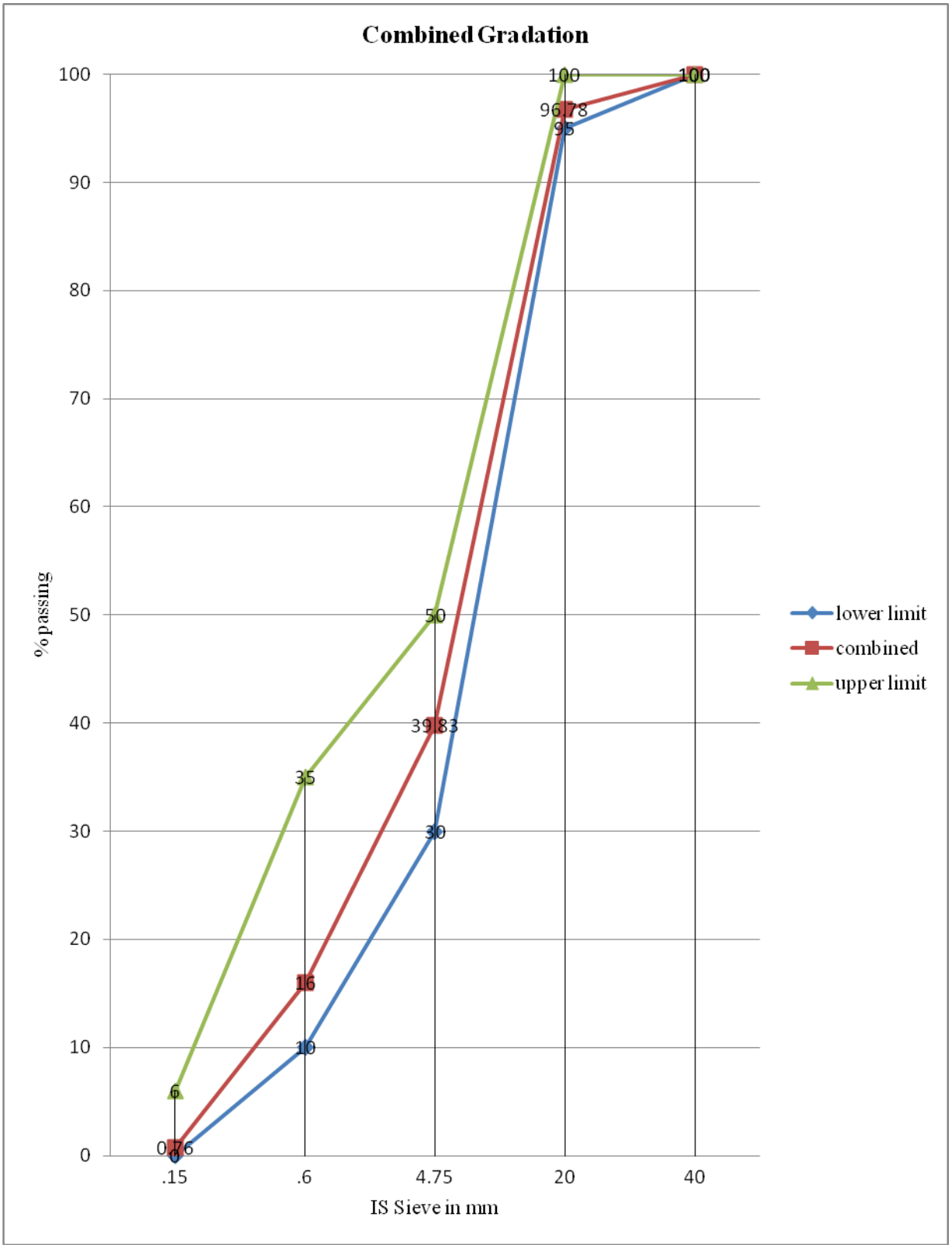


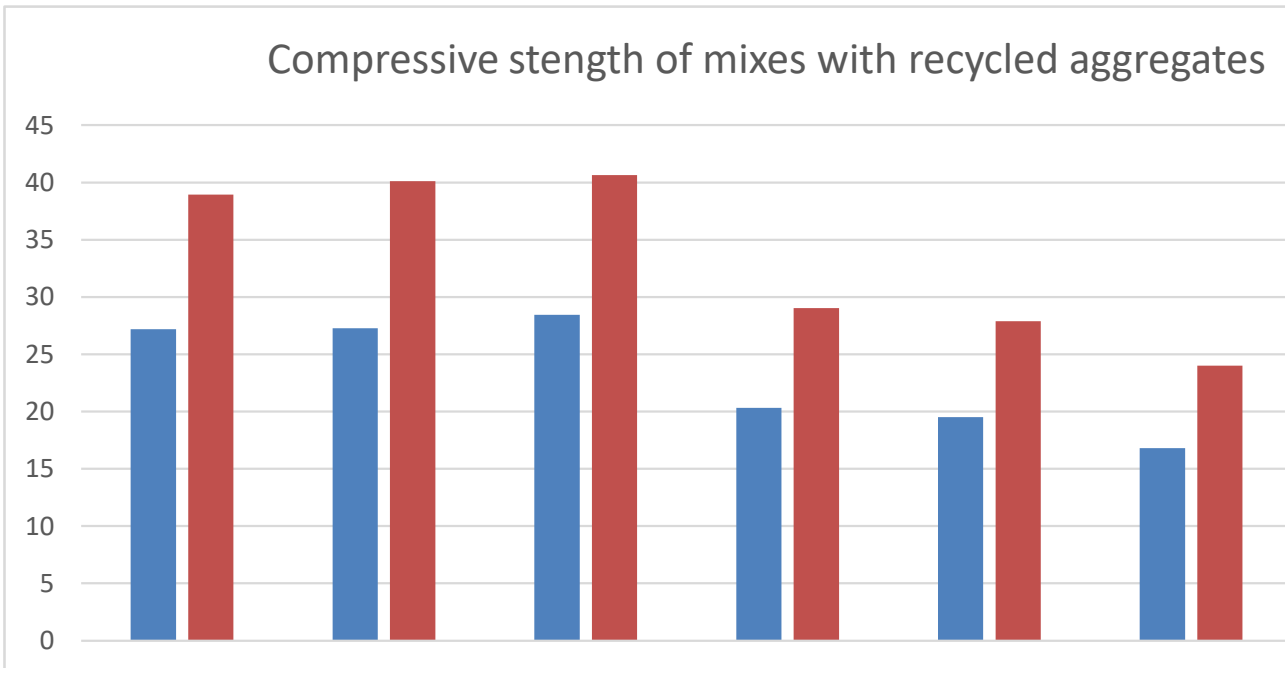
Fig. Combined Aggregate Gradation

Due to the uniformity in the gradation of the particles of the recycled aggregates, it is concluded that the recycled aggregates can be utilized for the replacement of the natural aggregates

Compressive Strength

This test is performed as per IS 516 – 1959 in order to determine the compressive strength of the cubes casted by replacing the natural sand with crushed stone sand by a variable percentage. This test is performed by compressive testing machine of capacity 2000KN.

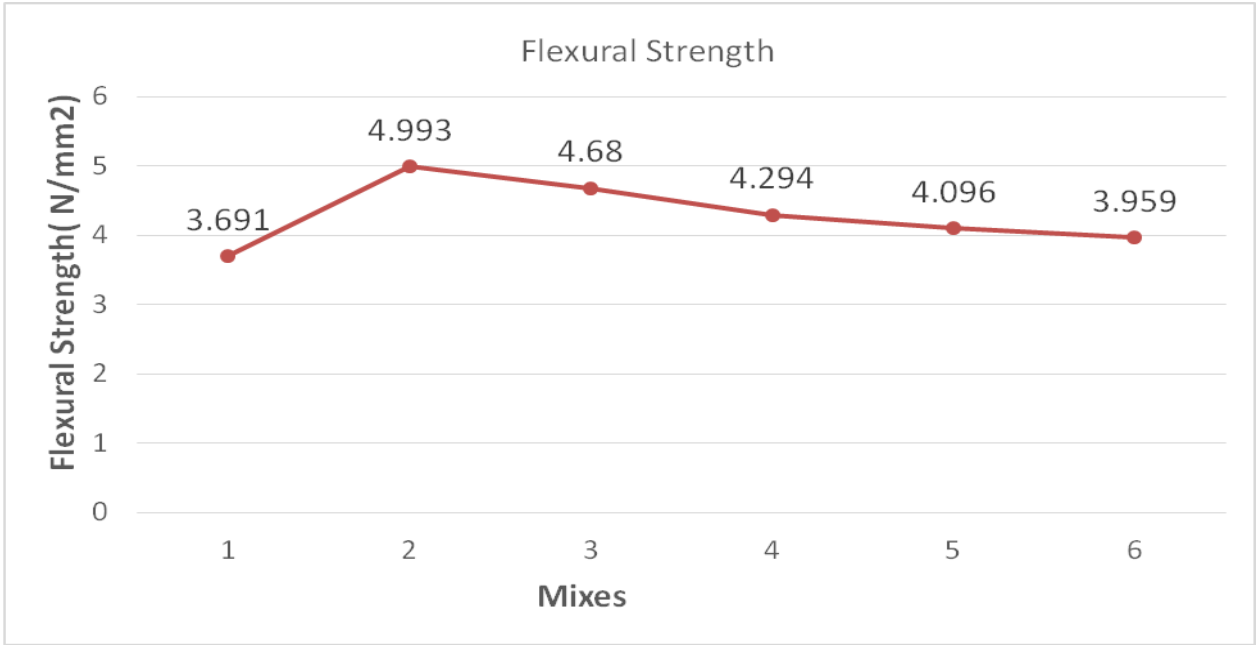
The variation of compressive strength is shown in the graph.



The compression test result indicates the increasing trend of compressive strength in the early age of concrete specimens with 20% recycled aggregate. However, it shows that the strength of recycled aggregate specimens were gradually increased up to 20% replacement of recycled aggregate and then it decreases at 100% replacement of recycled aggregate after 28 days. The target strength of M30 grade is 38.25 Mpa that are achieved for these specimens tested in the study. The results also show that the concrete specimens with 20% replacement of recycled aggregate get the highest strength when compared to the concrete specimens with different percentage of recycled aggregate. From the above result it is possible to use 20% recycled aggregate for higher strength of concretes.

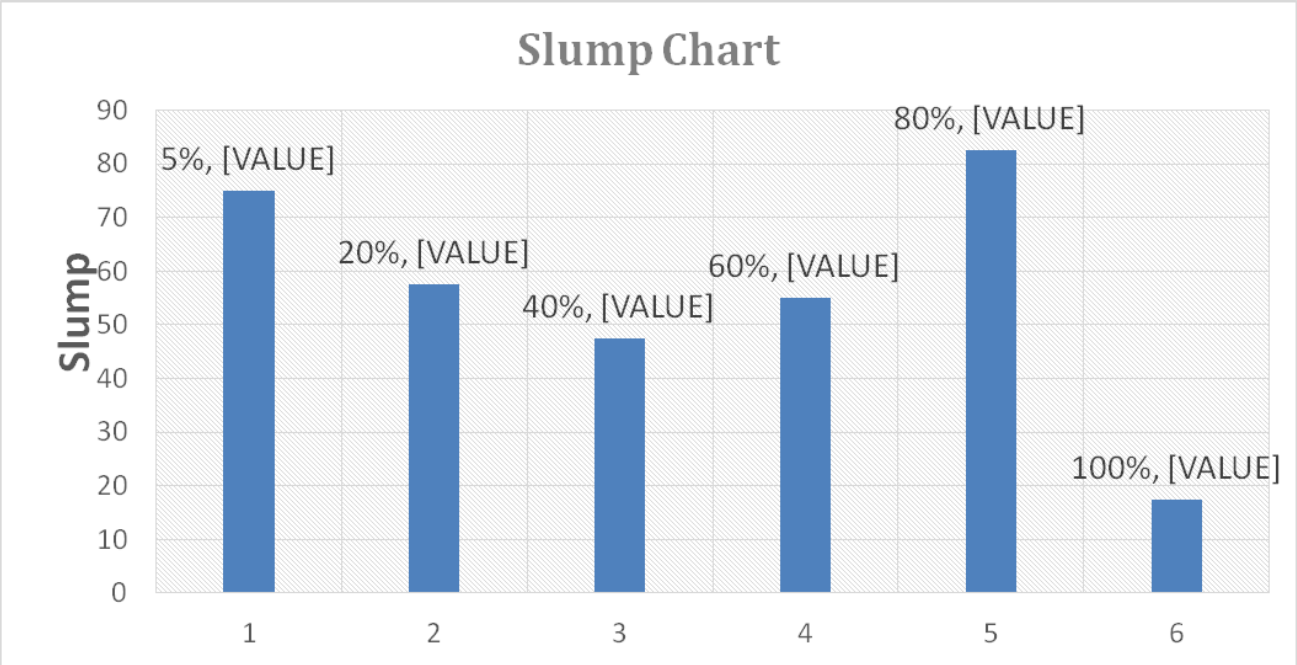
Flexural Strength

The mix chosen for the preparation of the cube samples was M30, designed as per IS 10262 -2009.135 cube moulds of size 15cm X 15cm X15cm were made for the analysis. The variation in the compressive strength of the concrete is shown in graph as

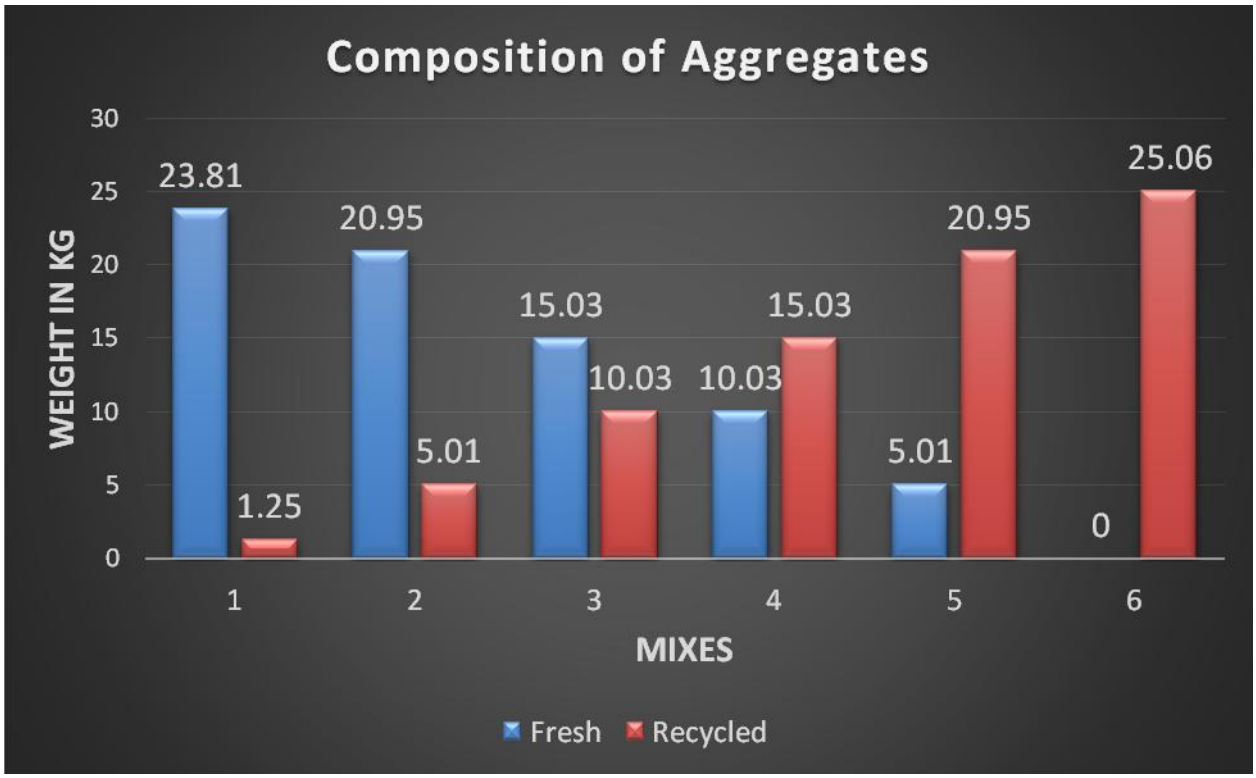


Slump test

The variation of the slump values for different mixes is represented in the graph.



The variation of the recycled aggregates with the fresh aggregates is shown as



V. CONCLUSIONS

- The experimental results show that the early compressive strength of concrete made of natural coarse aggregate and recycled coarse aggregate is approximately same.
- The slump test indicates a decreasing trend of workability when the percentage of recycled aggregate are increased. According to the result, the highest slump obtained was 110mm and the lowest slump was 15mm for M30 grade concrete. The workability was good and can be satisfactorily handled for 0% recycled aggregate to 100% recycled aggregate. The slump obtained is less with more percentage of recycled aggregate concrete mixes.

- The compression test result indicates the increasing trend of compressive strength in the early age of concrete specimens with 20% recycled aggregate. However, it shows that the strength of recycled aggregate specimens were gradually increased up to 20% replacement of recycled aggregate and then it decreases at 100% replacement of recycled aggregate after 28 days. The target strength of M30 grade is 38.25 Mpa that are achieved for these specimens tested in the study. The results also show that the concrete specimens with 20% replacement of recycled aggregate get the highest strength when compared to the concrete specimens with different percentage of recycled aggregate. From the above result it is possible to use 20% recycled aggregate for higher strength of concretes.
- Hence the recycled aggregate can be used in concrete with 20% replacement of natural coarse aggregate.

VI. REFERENCES

1. G. Fathifazl and A. Abbas (2009) "New Mixture proportioning Method for concrete made with coarse recycled aggregate concrete."
2. Leelawat T. and Dhir (2000) "Use Of Recycled Concrete Aggregate In High Strength Concrete, Material And Structure"
3. V. Ramasamy and Dr. Viswas (2009) "Durability Properties of Rice Husk and ash Concrete"
4. S.k. Kaushik (2009) "Non Destructive Testing and its role In rehabilitation"
5. Prof. Chatana M Vyas (2013) "Use of Recycled Course Aggregate And Concrete"
6. Prof. Darshana R Bhatt (2013)"Use of Recycled Course Aggregate And Concrete"
7. Hajideva (2002) "Influence of Industrially Produced Recycled Aggregates On Flow Properties Of Concrete"
8. M. Maclean (2009) "Energy and Green House Gas Emission Trade-off of Recycled Concrete Aggregate
9. Concrete Technology Theory and Practice, M.S SHETTY, S. Chand - New Delhi.
10. "Concrete Mix Design" (Oct. – Nov. 2002), Ambuja Technical Literature, Vol. No. 79.
11. IS: 10262-1982, Indian Standard, Recommended guidelines for concrete mix design, Bureau of India Standard, New Delhi, India.
12. IS: 10262-2009, Indian standard Concrete mix proportioning - guidelines (First revision) Bureau of India Standard, New Delhi, India.
13. IS: 456-2000 Code of practice for plain and reinforced concrete (fourth edition), 2000.
14. IS: 4926-2003, Standard on Ready mixed concrete – Code of Practice, BIS, New Delhi.
15. IS: 383-1970, Indian Standard specification for coarse and fine aggregates from natural sources for concrete (Second Revision).
16. IS: 2386-1963 (Part -3) Indian Standard, Methods of Test for Aggregates for Concrete (Part -3) Specific Gravity, Density, Voids, Absorption & Bulking.