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Recycled Aggregate Concrete

Eldhose M Manjummekudiyil[1], Shibi Varghese[2], Jaleen George[3]
Assistant Professor[1], Associate Professor[2], Professor[3],
Department of Civil Engineering, M A College of Engineering, Kothamangalam,Kerala, India

Abstract:- Concrete is a very important construction material. The main composition of concrete is cement (commonly Portland Cement), coarse aggregates (such as blasted rubble), fine aggregates (such as sand) and water. Cement is the binder that binds the aggregates together. Coarse aggregates are mainly obtained from quarries, using advent blasting methods, wherever competent bedrock deposits of aggregate quality exists. Fine aggregate used is dry sand, which is available naturally or manufactured. The purpose of this paper is to study concrete behaviour by replacing the aggregates in concrete with recycled wastes. This study is intended to make construction more economical wherever recycled concrete can be used. It is also considered in regard of environment by reducing the disposal of the construction wastes by using them efficiently.
The various recycled wastes which used for this purpose are-
1. Tiles- disposed broken tiles
2. Bricks- broken brick bat
3. Laterite powder
4. Concrete wastes
5. Plastering wastes

I. INTRODUCTION

Concrete is one of the most important elements in Civil Engineering. The use of concrete as a construction material is been almost inevitable in today's construction industry. It is estimated that the present consumption of concrete in the world is of the order of 10 billion tones every year. The ability of concrete to withstand the action of water without serious deterioration makes it an ideal material for building structures.
Concrete is a composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate. Aggregate is granular material, such as crushed stone, gravel, sand, crushed blast-furnace slag or construction and demolition waste. This study is based on replacing the natural aggregates in concrete with building wastes such as roofing tiles, broken brick bats, plastering wastes and laterite powder. The recycled concrete cubes of standard size are casted in design mix ratio in M25 grade and they are tested for their characteristic compressive strength. Due to the increased use of concrete, it can cause the extinction of natural aggregates. So it is necessary to find alternatives for the coarse and fine aggregates used, which should be easily available and economical as well. Also the disposal of the building wastes is a problem faced, which can be solved if the study succeeds.To obtain concrete with sufficient strength economically is another objective of this study.

II. MATERIALS AND METHODS

The scope of the study is limited to investigate the strength of the concrete prepared using building wastes as aggregates, and to know its suitability in construction. The cost of concrete is also analysed and compared with that of conventional concrete.

Standard consistency	30%
Initial Setting Time	190 minutes
Final Setting Time	325 minutes
Specific Gravity	3.15
28 day mortar cube strength	63.67 N/mm^2 (average)
Brand Name	DALMIA SUPEROOF OPC, 53 GRADE

TABLE I .PROPERTIES OF CEMENT USED IN CONVENTIONALCONCRETE

TABLEII .PROPERTIES OF COARSE AGGREGATE USED IN CONVENTIONAL CONCRETE

Specific Gravity	2.63
Water Absorption	Nil
Free Moisture	Nil

TABLEIII .SIEVE ANALYSIS RESULTS OF COARSE AGGREGATEUSED IN CONVENTIONALCONCRETE

IS Sieve	Percentage of Passing
25mm	100
20mm	99.6
12.5mm	56
10mm	16.4
4.75mm	0

TABLEIV .PROPERTIES OF FINE AGGREGATE USED IN CONVENTIONAL CONCRETE

Specific Gravity	2.72
Water Absorption	Nil
Free Moisture	2.8%
Sieve Analysis	ZONE II

TABLE V.SIEVE ANALYSIS RESULTS OF FINE AGGREGATEUSED IN CONVENTIONALCONCRETE

IS Sieve	Percentage of Passing	IS Limits for zone II
4.75mm	93.0	90 to 100
2.36mm	76.4	75 to 100
1.18mm	55.4	55 to 90
600microns	40.4	35 to 59
300microns	28.4	8 to 30
150microns	9.1	0 to 10
Pan	0	-

The fine aggregate is of grading zone II.

COMPRESSIVE STRENGTH TEST ON M25 CONVENTIONAL CONCRETE
Mix ratio(Design Mix)
Cement: Fine Aggregate : Coarse Aggregate : Water = 1 : 1.69 : 3.23 : 0.45

TABLE VI.7 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	73.1	32.49	29.91
2	66	29.33	
3	62.8	27.91	

TABLE VII.28 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 28 day Compressive Strength (N/mm^2)
1	82	36.44	35.54
2	80.2	35.64	
3	77.7	34.53	

The average compressive strength of concrete cubes after 28 days = 35.54 N/mm^2

TABLE VIII.PROPERTIES OF CEMENT USED IN RECYCLED CONCRETE

Standard consistency	30%
Initial Setting Time	190 minutes
Final Setting Time	325 minutes
Specific Gravity	3.15
28 day mortar cube strength	63.67 N/mm^2 (average)
Brand Name	DALMIA SUPEROOF OPC, 53 GRADE

TABLE IX.PROPERTIES OF BROKEN BRICK BATSCOARSE AGGREGATEUSED IN RECYCLED CONCRETE

Specific Gravity	2.1
Water Absorption	16.5%
Free Moisture	Nil

TABLE X. SIEVE ANALYSIS RESULTS OF BROKEN BRICK BATSCOARSE AGGREGATE

IS Sieve	Percentage of Passing
25mm	100
20mm	88.2
12.5mm	22.8
10mm	5.8
4.75mm	0

TABLE XI.PROPERTIES OF ROOFING TILES COARSE AGGREGATEUSED IN RECYCLED CONCRETE

Specific Gravity	2.2
Water Absorption	16.3%
Free Moisture	Nil

TABLE XII.SIEVE ANALYSIS RESULTS OF ROOFING TILES COARSE AGGREGATE

IS Sieve	Percentage of Passing
25mm	100
20mm	99.6
12.5mm	56
10mm	16.4
4.75mm	0

TABLEXIII.PROPERTIES OF PLASTERING WASTEFINE AGGREGATEUSED IN RECYCLED CONCRETE

Specific Gravity	2.45
Free Moisture	2.2%
Sieve Analysis	ZONE II

TABLE XIV.SIEVE ANALYSIS RESULTS OF PLASTERING WASTES (FINE AGGREGATE)

IS Sieve	Percentage of Passing	IS Limits for zone II

4.75mm	100	90 to 100
2.36mm	89.4	75 to 100
1.18mm	70.9	55 to 90
600microns	41.4	35 to 59
300microns	15.7	8 to 30
150microns	8.2	0 to 10
Pan	0	-

TABLEXV.PROPERTIES OF LATERITE BRICK POWDERFINE AGGREGATEUSED IN RECYCLED CONCRETE

Specific Gravity	2.27
Free Moisture	2.8%
Sieve Analysis	ZONE II

TABLE XVI.SIEVE ANALYSIS RESULTS OF LATERITE BRICK POWDERFINE AGGREGATE

IS Sieve	Percentage of Passing	IS Limits for zone II
4.75mm	100	90 to 100
2.36mm	80	75 to 100
1.18mm	59.8	55 to 90
600microns	39.2	35 to 59
300microns	25.2	8 to 30
150microns	12.7	0 to 10
Pan	0	-

TYPE OF ADMIXTURE USED

Dr. FIXIT PIDICRETE CF 151M3(S)- It is a super plasticising admixture design with specially formulated polymers to produce homogeneous concrete, free from bleeding and segregation. It also imparts the cohesiveness to concrete mix for easy pouring with better surface finish.Concrete is mixed with 50-70% of the mixing water (based on mix design by weight). About 0.5% of the cement quantity by weight is added to the remaining 30% mixing water and poured to the batch mixer. This admixture should not be added in dry mixes under any circumstances.

COMPRESSIVE STRENGTH TEST ON M25 RECYCLED CONCRETE WITH ROOFING TILES AS COARSE AND PLASTERING WASTES AS FINE AGGREGATES

Mix Ratio:

Cement : Fine Aggregate : Coarse Aggregate : Water = 1 : 1.51 : 2.15 : 0.89

TABLE XVII.7 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	41.2	18.31	
2	40.8	18.13	18.07
3	40	17.78	

TABLE XVIII.28 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 28 day Compressive Strength (N/mm^2)
1	65.1	2.93	
2	63.5	28.22	28.35
3	62.8	27.91	

COMPRESSIVE STRENGTH TEST ON M25 RECYCLED CONCRETE WITH ROOFING TILES AS COARSE AND LATERITE POWDER AS FINE AGGREGATES

Mix Ratio:

Cement : Fine Aggregate : Coarse Aggregate : Water = 1 : 1.51 : 2.15 : 0.92

TABLE XIX.7 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	38.5	17.11	
2	37.8	16.8	16.62
3	35.9	15.96	

TABLE XX.28 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	59.2	26.3	
2	58.4	25.96	25.72
3	56	24.89	

COMPRESSIVE STRENGTH TEST ON M25 RECYCLED CONCRETE WITH BROKEN BRICK BATS ROOFING TILES AS COARSE AND PLASTERING WASTES AS FINE AGGREGATES

Mix Ratio:

Cement: Fine Aggregate: Coarse Aggregate: Water = 1:1.48:2.58: 0.89

TABLE XXI.7 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	40.1	17.82	
2	38.3	17.02	17.08
3	36.9	16.4	

TABLE XXII.28 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	63	28	
2	61.2	27.2	26.97
3	57.9	25.7	

COMPRESSIVE STRENGTH TEST ON M25 RECYCLED CONCRETE WITH BROKEN BRICK BATS AS COARSE AND LATERITE POWDER AS FINE AGGREGATES

Mix Ratio:

Cement : Fine Aggregate : Coarse Aggregate : Water = 1 : 1.37 : 2.25 : 0.94

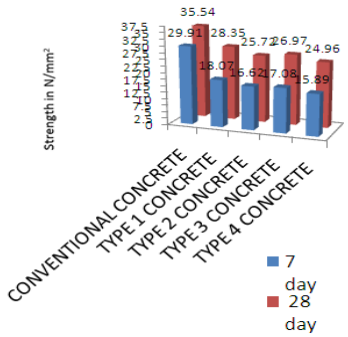
TABLE XXIII.7 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	36.5	16.22	
2	36	16	15.89
3	34.8	15.47	

TABLE XX1V.28 DAY STRENGTH

Specimen No	Load in Tones	Compressive Strength (N/mm^2)	Average 7 day Compressive Strength (N/mm^2)
1	58.3	25.91	24.96
2	56	24.89	
3	54.2	24.09	

STRENGTH COMPARISON BETWEEN CONVENTIONAL AND RECYCLED CONCRETE



COST ANALYSIS OF CONCRETES

From the above chart it can be inferred that concrete prepared using roofing tiles as coarse aggregate and plastering wastes as fine aggregate (Type 1) is having the highest strength among recycled aggregate concretes. The 28 day compressive strength of Type 1concrete is 80% the strength of conventional concrete. Hence Type
1 concretecan be recommended for use.

TABLE XXV.COST OF $1m^3$CONVENTIONAL M25 CONCRETE

Material	Quantity	Amount
Cement	370 kg	Rs. 2812
Fine Aggregate	625.19 kg	Rs. 263
Coarse Aggregate	1193.8 kg	Rs. 454
	Total	Rs. 3529

USING ROOFING TILES AS COARSE AGGREGATE AND PLASTERING WASTES AS FINE AGGREGATE

TABLE XXVI.COST OF $1m^3$ RECYCLED CONCRETE

Type 1 - Roofing tiles(coarse) ; plastering wastes(fine)

Type 2 - Roofing tiles(coarse) ; laterite powder(fine)

Type 3 - Broken brick bats(coarse) ; plastering wastes(fine)

Type 4 - Broken brick bats(coarse) ; laterite powder(fine)

Cement (370kg)	Rs. 2812
Labour charge for crushing aggregates	Rs. 50
Pidicrete Admixture	Rs. 345
Total	Rs. 3205

TABLE XXVII.COST OF 1m^3 RECYCLED CONCRETE USING ROOFING TILES AS COARSE AGGREGATE AND LATERITE POWDERAS FINE AGGREGATE

Cement (370kg)	Rs. 2812
Labour charge for crushing aggregates	Rs. 46
Pidicrete Admixture	Rs. 345
Total	Rs. 3203

TABLE XXVIII.COST OF 1m^3 RECYCLED CONCRETE USING BROKEN BRICK BATS AS COARSE AGGREGATE AND PLASTERING WASTES AS FINE AGGREGATE

Cement (370kg)	Rs. 2812
Labour charge for crushing aggregates	Rs. 49
Pidicrete Admixture	Rs. 345
Total	Rs. 3206

TABLE XXIX.COST OF 1m^3 RECYCLED CONCRETE USING BROKEN BRICK BATS AS COARSE AGGREGATE AND LATERITE POWDER AS FINE AGGREGATE

Cement (370kg)	Rs. 2812
Labour charge for crushing aggregates	Rs. 40
Pidicrete Admixture	Rs. 345
Total	Rs. 3197

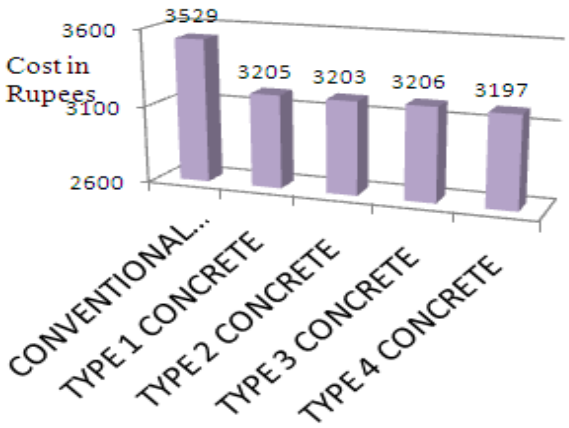


Fig 2:- Cost Comparison between conventional and recycled concrete

From the above chart it can be inferred that concrete prepared using recycled aggregates are more economical than conventional concrete. Hence recycled aggregate concrete can be used for economical construction.

IV. CONCLUSION

An effort has beenmade through this study to evaluate the strength of concrete by replacing the natural aggregates by building wastes, viz. roofing tiles, broken brick bats, plastering wastes and laterite powder. It has been found that required characteristic compressive strength is obtained for the recycled concrete. Recycled aggregate concretehas been found cheaper as compared to conventional concrete. Hence recycled aggregate

proves to be good alternative for natural aggregates and they have to be used, wherever possible. By implementing this techniquein future, it will help in preventing the extinction of natural aggregates and also the problem of dumping of building wastes can be checked. It also makes construction more economical.

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