COMMUNITY GARBAGE ASH MADE CONCRETE FOR MINOR STRUCTURAL REPAIR WORK

VALSAN PADINCHARE PURAYIL[1], ARVINTH.R.A[2]

[1]PG Scholar, Department of Civil Engineering, Adithya Institute of Technology, Coimbatore, India

[2]Assistant professor, Department of Civil Engineering, Adithya Institute of Technology, Coimbatore, India

Abstract: This paper deals with an experimental study to determine the suitability of partial replacement of fine aggregate with Community Garbage Ash in concrete. The aim is to examine the Physical properties of the normal M25 concrete in repair work as partial replacement of fine aggregate in concrete. This experimental investigation will study and experiment the strength, compaction and durability of partially replacement of fine aggregate with Garbage ash type of concrete. To make the available waste materials to partial replace of normal fine aggregates in concrete for concrete work will be helpful for the MSWM management and economical for the users, so the researchers can provided a reliable design data based the study of such kind of materials.

I. INTRODUCTION

World present produces at around approximately 2378 Million Tons of Garbage / Municipal solid waste ash. When India at present 256 Million Tons of ash were used in as road base material and used as replacement in concrete and other application. The Garbage ash / Municipal solid waste ash it cannot be safe for store open ground and like that areas and the other hand construction activity can be increases day by day the various construction techniques, methods as well as materials can be improved. The amount of Garbage ash / Municipal solid waste ash day by day increase over the recent years due to large quantity of municipal solid waste can be increase. Most of the times the Garbage ash / Municipal solid waste ash it can be placed as a open areas or dumped into the landfill sites. Several researches have studied the possibility of recycling ashes in the cement and concrete manufacturing, as aggregates and or mineral additions. The objective of this study is to examine the Physical properties of the normal M25 concrete work as partial replacement of fine aggregate in concrete. An experimental investigation was planned to study the strength, compaction and durability of partially replacement of fine aggregate with Garbage ash type of concrete.

II. MATERIAL PROPERTY

Specific gravity of cement

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement. Specific gravity of cement = 3.15

Consistency of cement paste

The standard consistency of the cement paste is defined as the consistency which will permit the Vicat plunger to penetrate to a point 5 – 7mm from the bottom of the Vicat mould. Since different grades of cement differ in fineness, pastes with same water content may differ in consistency when first mixed. % of water for standard consistency = 30.5%

Initial setting time

Place the test block under the rod bearing the needle. Lower the needle gently in order to make contact with the surface of the cement paste and release quickly, allowing penetrating the test block. Repeat the procedure till the needle fails to pierce the test block to a point 5.0 ± 0.5mm measured from the bottom of the mould, is the initial setting time.

Final setting time

Replace the above needle by the one with an annular attachment. The cement should be considered as finally set when, applying the needle gently to the surface of the test block. The needle makes an impression there in, while the attachment fails to do so. The period elapsing between the time, water is added to the cement and the time, the needle makes an impression on the surface of the test block, while the attachment fails to do so, is the final setting time.

Initial setting time = 19min

Final setting time = 260min (4hr 30min)

III. PROPERTIES OF CEMENT

TABLE: I CHEMICAL CONSTITUENTS OF CEMENT

S. No.	CONSTITUENTS	SYMBOL	PERCENTAGE
1	Tricalcium aluminate $(CaO)_3 \cdot Al_2O_3$	C3A	0 – 13%
2	Tricalcium silicate $(CaO)_3 \cdot SiO_2$	C3S	45 – 75%
3	Dicalcium silicate $(CaO)_2 \cdot SiO_2$	C2S	7 – 32%
4	Tetracalciumaluminoferrite $(CaO)_4 \cdot Al_2O_3 \cdot Fe_2O_3$	C4AF	0 – 18%

Table: II Physical Properties of Cement

S.No	PROPERTIES	VALUES
1	Specific Gravity	3.15
2	Bulk Density	1440 Kg/m^3
3	Surface area	225 m^2/Kg
4	Initial setting time	30 min
5	Final setting time	600 min

Fine aggregate specific gravity

Specific gravity of an aggregate is considered to be a measure of strength or quality of the stone. Specific gravity test helps in the identification of stone. Specific gravity test is conducted using pycnometer. Specific gravity of fine aggregate = 2.63

Table: III Sieve Analysis of Fine Aggregate (Sand)

Sieve size (mm)	Mass retained	Cumulative mass retained (g)	Cumulative % finer	IS Range for Zone II
4.75	0	0	100	90-100
2.36	43	43	95.7	75-100
1.18	245	288	71.2	55-9
0.60	363	651	34.9	35-59
0.30	234	885	11.5	8-30
0.15	105	990	1	0-10
Fineness modulus: 2.54				

Fine aggregate-sand

Specific Gravity of Sample (W_2 - W_1) = 2.51

Voids Ratio = 0.43

Bulk Density = 1.67

Porosity = 30.09

Aggregate properties specific gravity

Specific gravity is the ratio of the mass of a solid or liquid to the mass of an equal volume of distilled water at 4ºC (39ºF). In the specific gravity determinations for aggregates, the average water temperature is 21ºC (70ºF). Water at 21ºC (70ºF) weighs 998 kg/m3 (62.3 lb/ft3). However, for ease of calculation, the mass (weight) of water used for metric concrete mix designs is 1000 kg/m3. The specific gravity of aggregates that are predominantly limestone will vary from 2.58 to 2.65. The specific gravity of aggregates that have a high percentage of trap rock, granite, or quartzite will vary from 2.65 to 2.75.

Gradation and fineness modulus

The range in size and quantity of an aggregate is referred to as the gradation. To produce a uniform quality concrete, limitations are placed on the proportions of aggregate of the different sizes. The gauge is referred to as "Fineness Modulus". The selected sieves are called the Fineness Modulus (F.M.) sieve series and consist of the following coarse aggregate sizes: 75 mm, 37.5 mm, 19 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 300 µm, and 150 µm (3 in., 1-1/2 in., 3/4 in., 3/8 in., No.4, 8, 16, 30, 50, and 100). The numerical value for F.M. is obtained by adding the percentage passing each of the sieves in the fineness modulus series, dividing this result by 100, and subtracting from 10. There are 10 sieves used for this analysis. Generally, the F.M. is only calculated for the fine aggregate and the 75 mm, 37.5 mm, and 19 mm (3 in., 1-1/2 in., and 3/4 in.) sieves are not used for the gradation. Therefore, when calculating the F.M. for the fine aggregate the percent passing the remaining sieves is added up, divided by 100, and subtracted from 7. A greater F.M. represents coarser sand. See 5-694.148 for a F.M. calculation.

The void content of aggregate is that part of the bulk volume of the drymaterial that is occupied by air or void space. In the void content test, 0.02832 m3 (1 ft3) of the dry aggregate is weighed and the absolute volume of solid material is determined.

Specific gravity

Specific gravity of an aggregate is considered to be a measure of strength or quality of the stone. Specific gravity test helps in the identification of stone. Specific gravity is conducted using pycnometer. Specific gravity of coarse agg = 2.7

Test on community garbage ash

Specific gravity of the Waste Ash is considered to be a measure of strength or quality of the Ash. Specific gravity test helps in the identification of Ash. Specific gravity test is conducted using pycnometer. Specific gravity of course aggregate = 0.905

Replacement for fine aggregate:

Table IV Replacement of fine aggregate

% REPLACEMENT	CEMENT (Kg)	MSW ASH	FINE AGGREGATE (Kg)	COARSE AGGREGATE (Kg)
10	450	77.19	771.90	990.84
20	450	154.38	617.52	880.675
30	450	231.57	540.33	770.588
40	450	308.76	463.14	660.504

Amount of water required = 197 litres.

Specimens for casting

The specimens for casting determines various sizes and volume to determine the strength in compression ,flexural,tensile strength of concrete. During casting its very hard to handle because of odour . When handling with MSWI Ash, proper precation to be taken .

Cubes

The cubes for casting size are 150mmx150mmx150mm.

Cylinders

The cylinders for casting size are dia 150mm and height 300 mm.

Beams(prism)

The prism for casting size are 150mmx150mmx700mm.

Table V Lists for replacement specimen

PERCENTAGE REPLACEMENT OF MSWI ASH	NO OF SPECIMENS FOR TESTS
10%	3 CUBES 3 BEAMS 3CYLINDERS
20%	
30%	
40%	

IV.TEST ON CONCRETE WORKABILITY OF CONCRETE

The behavior of green or fresh concrete from mixing up to compaction depends mainly on the property called "workability of concrete". Workability of concrete is a term which consists of the following four partial properties of concrete namely, Mixability, Transportability, Mouldability and Compatibility.

Slump test

Four mixes are to be prepared with water-cement ratio (by mass) of 0.50, 0.60, 0.70 and 0.80, respectively, and for each mix take 10 kg of coarse aggregates, 5kg of sand and 2.5kg of cement with each mix proceed

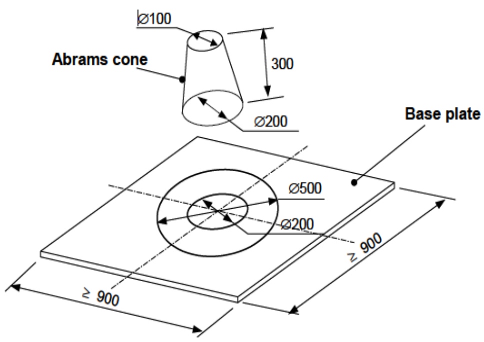

Fig.1 Slump cone

The slump was measured using slump cone apparatus and the slump was found from 115 to 125 for control mix and 110 to 120mm for quarry dust and saw dust concrete. The slump values indicate that the workability of quarry dust and saw dust concrete is more or less equal to controlled concrete.

Compressive strength of concrete

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Fig.2 Concrete Compression testing

Flexural strength of concrete

It is the ability of a beam or slab to resist failure in bending. It was measured by loading the un-reinforced concrete beams. The flexural strength is expressed as "modulus of rupture". Flexural modulus of rupture is about 12 to 20 % of compressive strength. A beam specimen was casted for determining the flexural strength of concrete. Rollers are placed at centre to centre distance; the test specimen was casted and cured for 7days, 28days and tested for maximum load.

Fig.3 Flexural Strength

Split tensile strength for concrete

- Splitting tensile strength of fine aggregates replaced bottom ash concrete specimens were inferior than control concrete specimens at all the ages.
- Cylindrical mould of diameter 150 mm and height 300 mm were used.
- The oil was applied along the inner surface of the mould for easy removal of cylinder from the mould.
- Concrete was poured throughout its length and compacted well by tamping road as well as vibrating table.

V.RESULTS AND DISCUSSION

Compaction factor

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. The compaction factor did not show much variation compared to the conventional concrete.

Table.VI Compaction factor results for MSW Ash replacement

S.No	Percentage of MSW ASH	COMPACTION FACTOR
1	0	.912
2	10	.875
3	20	.870
4	30	.816
5	40	.816

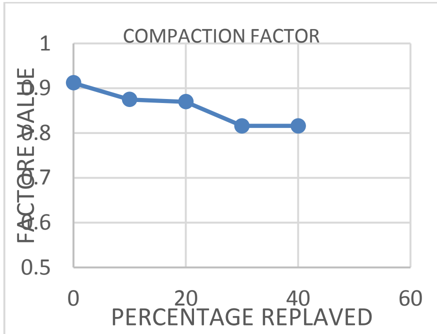

Fig:4 Compaction factor results for MSW Ash replacement

Hardened properties of concrete:

The hardened properties of concrete for various replacement percentages of MSW ash are determined. The mechanical properties of concrete are determined by conducting the following tests at 7 and 28 days.

Compressive strength test:

Compressive strength tests are carried out on cubes of size 150 mm x 150 mm x150 mm. The specimens are tested after keeping it for curing at the age of 7 and 28 days. The results obtained are compared with the results of a control mix specimens. The results are tabulated below.

Table.VII Compressive strength test results for MSW Ash replacement

S. No.	% REPLACEMENT	COMPRESSIVE STRENGTH			
		7 DAYS		28 DAYS	
		LOAD (kN)	COMPRESSIVE STRENGTH(N/mm^2)	LOAD (kN)	COMPRESSIVE STRENGTH(N/mm^2)
1	0	400	17.77	640	28.44
2	10	360	16	630	28
3	20	410	18.22	670	29.77
4	30	300	13.33	490	21.77
5	40	250	11.11	450	20

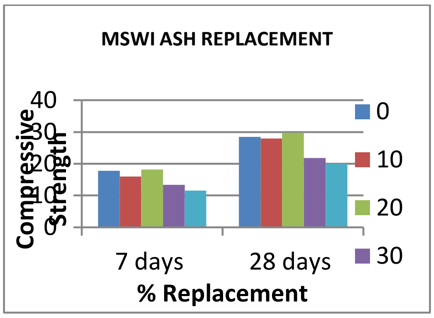

Fig 5 Bar chart showing compressive test results

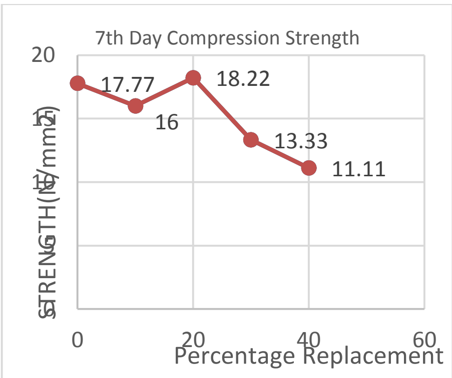

Fig 6 Graph showing 7th compressive test results

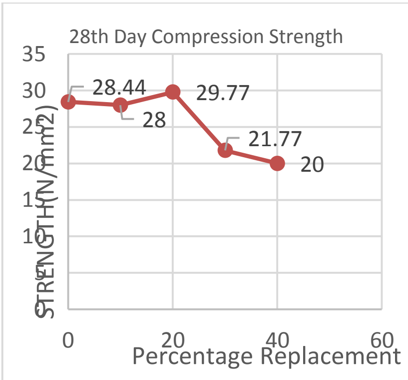

Fig 7 Graph showing 28th compressive test results

Split tensile strength test:

For the determination of split tensile strength test of concrete cylinder specimens of diameter 150 mm and height 300 mm were casted. The cylinders were casted for 0%,10%, 20%, 30%, and 40%. The tests were conducted on cylinders at an age of 7 and 28 days. The results are tabulated below.

Table VIII Split tensile test results for MSW Ash replacement

S. No.	% REPLACEMENT	SPLIT TENSILE STRENGTH			
		7 DAYS		28 DAYS	
		LOAD (kN)	SPLIT TENSILE STRENGTH (N/mm^2)	LOAD (kN)	SPLIT TENSILE STRENGTH (N/mm^2)
1	0	240	3.39	270	3.86
2	10	200	2.82	230	3.25
3	20	230	3.25	260	3.67
4	30	170	2.4	190	2.68
5	40	150	2.12	170	2.4

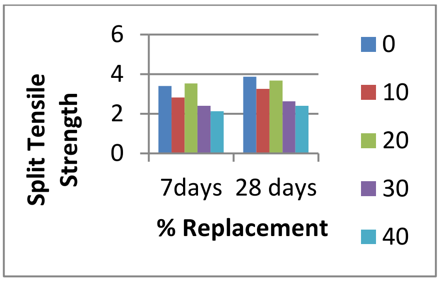

Fig.8 Bar chart showing: split tensile test result

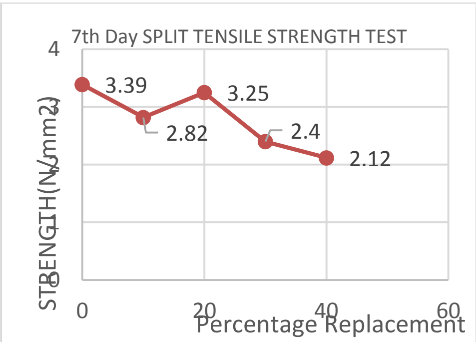

Fig.9 Graph showing 7th Tensile strength test results

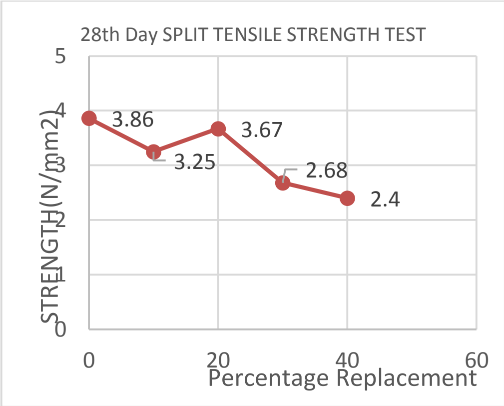

Fig.10 Graph showing 28th Tensile strength test results

Flexural strength test results

Flexural strength test is carried out on prism specimens of dimensions 150 mm x 150 mm x 700mm. The test is carried out by applying two point loading on the prism at the age of 7 and 28 days. The tests are carried out at various percentages of fly ash replacement at 30%, 40% and 50% and bottom ash for fine aggregate at 10%, 20% and 30%. The results are tabulated below.

Table.IX Flexural strength test results for MSW Ash replacement

S. No.	% REPLACEMENT	FLEXURAL STRENGTH			
		7 DAYS		28 DAYS	
		LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	0	9.1	2.91	12.6	3.6
2	10	9.0	2.79	12.4	3.45
3	20	8.9	2.75	12.0	3.5
4	30	8.7	2.4	10.5	3.1
5	40	6.7	2.2	9.3	2.89

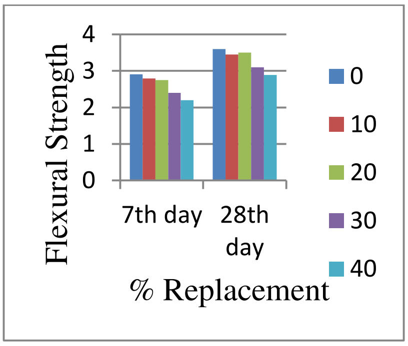

Fig.11 Bar chart showing flexural strength test result

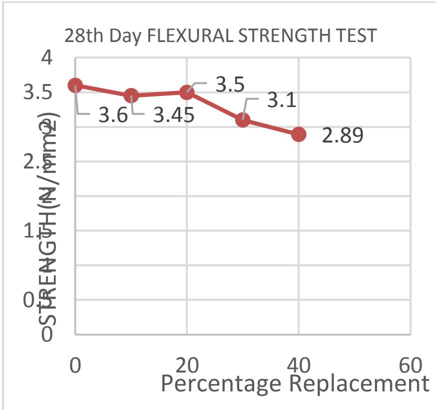

Fig.13 Graph showing 28[th] flexural strength test results

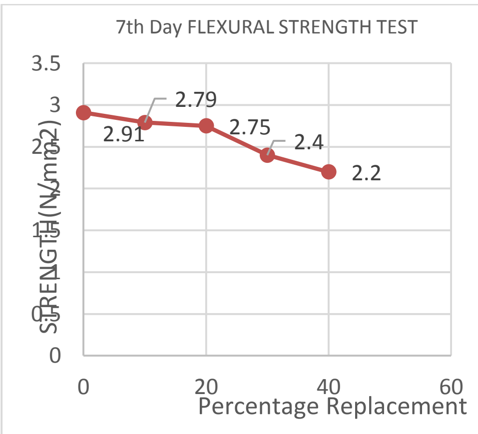

Fig.12 Graph showing 7[th] flexural strength test results

VI. CONCLUSION

Based on the study on strength of partial replacement of fine aggregate with MSW Ash in concrete followings is concluded.

- Optimum percentage for replacement of MSW ash founded based on review of literature we can be replaced up to 20%.
- In order to reduce the usage of fine aggregate partial replacement of MSW ash percentage is increased to get good strength based on the replacement.
- Partial replacement of fine aggregate on MSWI ash with varying percentages

like 10%, 20%, 30% and 40% on M-25 concrete mix design is done.

- Test on concrete for determining a various properties are recommended and explained.

VII. APPLICATIONS

1. This type of concrete can be used in all type of building
2. It can be used in concrete kerb.
3. Paving blocks can be manufactured using this type of concrete.
4. This also finds application in the manufacture of building blocks.
5. It is expected to give good results when it is used in the construction of compression members.

REFERENCES

1. Abdulhameed et al. (2012) ‘Properties of concrete using tanjung bin power plant coal bottom ash and fly ash’, International Journal of Sustainable Construction Engineering & Technology Volume 3, Issue 2, pp.159-161.
2. Abhinav Shyam1, Abdullah Anwar, Syed Aqeel Ahmad (2016) ‘Effect of Copper Slag as Partial Replacement of Fine Aggregate in Concrete’, A Literature Review IJIRSET, Vol. 5, Issue 12, pp 127-129.
3. Deepak S, Dr V.Ramesh (2015) ‘Properties of Municipal Solid Waste Incinerator Ash in Concrete’, International Journal Of Engineering And Computer Science, Volume 4 Issue 6, pp. 12322-12326.
4. Kadam M.P et al. (2013) ‘Effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio’, International Journal of Advanced Technology in Civil Engineering, Volume-2, Issue-1, pp.158-160.
5. Malkit Singh et al. (2016) “Strength properties and micro-structural properties of concrete containing coal bottom ash as partial replacement of fine aggregate”, Construction and Building Materials 50; pp.246–256.
6. Mathiraja C, (2013) ‘A Study on Concrete Using Bottom Ash, Manufacturing Sand and Hybrid Steel and Coir Fibres’, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 10, Issue 1, pp. 55-57.
7. Remya raju1, mathews m. Paul & k. A. Aboobacker (2014) ‘Strength performance of concrete using bottom ash as fine aggregate’,impact: International Journal of Research in Engineering & Technology, Vol. 2, Issue 9, pp.111-122.
8. Tang P et al. (2012) ‘The application of MSWI bottom ash fines in high performance concrete’, 1st International Conference on the Chemistry of Construction Materials.
9. Yogesh Aggarwal, Rafat Siddique, (2014) ‘Microstructure and properties of concrete u sing bottom ash and waste foundry sand as partial replacement of fine aggregates’, Construction and Building Materials, Volume 12, Issue 6, pp. 210–223.