Reuse of Solid Waste from Building Demolition for the Replacement of Natural Aggregates

R. Kamala, B. Krishna Rao

Abstract—In this industrial world, recycling construction material plays an important role to preserve natural resources. These studies seek to greener environment since it seeks to develop recycle waste material for construction. The use of recycle aggregates and solid wastes from construction and demolition waste is showing a prospective application in construction and as alternative to primary and natural aggregate. It conserves natural resources and reduces the space required for land fill disposal. In the laboratory the crushed tile aggregate has been tried as partial replacement substitute to convectional coarse aggregate in concrete making of cubes, cylinders, beams. These were cast and tested for compressive strength, split tensile and flexural strength after a curing period of 7, 28, 56 days. The results indicate effectiveness of crushed ceramic waste as partial replacement of conventional coarse aggregate up to 40 percent, without affecting the design strength.

Keywords: ceramic waste, demolition waste, super plasticizer, solid waste, conventional coarse aggregates.

I. INTRODUCTION

Building materials account for about half of all materials used and about half the solid waste generated worldwide. They have an environmental impact at every step of the building process extraction of raw materials is processing, manufacturing, transportation, construction and disposal at the end of a building's useful life.

Rapid industrial development causes serious problems all over the world such as depletion of natural aggregates and creates enormous amount of waste material from construction and demolition activities. One of the ways to reduce this problem is to utilize the wastes. The building rubbles collected from damaged structures contains waste concrete, tiles, brick, steel, wood etc., among these the ceramic tiles are used in this project. Due to disposal of ceramic wastes from building demolition in a land fill, the ceramics comes in contact with ground water, sand and causes toxic effects. The application of crushed tile aggregate concrete produced by aggregate replacing method which is effective in reducing both cost and environment impact. The standard point of energy saving and conservation of natural resources, the use of alternative constituents in construction materials is now a global concern. The tiles are crushed to suitable size and used as coarse aggregate. Based on the trial mixes compressive strength of partial replacement of tiles with coarse aggregate is found to be higher than the compressive strength of conventional concrete.

Manuscript Received on October, 2012.

R.Kamala, P.G Student, Department of Civil Engineering, JNT University/Kakinada, Andhra Pradesh, India.

B.Krishna Rao, Asst. Professor, Department of Civil Engineering, JNT University/KakinadaA.P, India.

II. MATERIALS

A. Cement:

The cement used in all mixtures was commercially available Portland cement of 43 grade manufactured by Anjani Portland cement company confirming to IS 8112:1989 was used in this study. The specific gravity of cement was 3.13. The initial and final setting time were found as 89 minutes and 216 minutes respectively.

B. Fine aggregate:

Locally available river sand passed through 4.75mm IS sieve is used as fine aggregate. The specific gravity of sand is 2.64 and fineness modulus of 3.64. The loose and compacted bulk density values obtained are 1556 Kg/m^3 and 1644 Kg/m^3 and water absorption is 1.10%.

C. Coarse aggregate:

a) The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 20mm having a specific gravity 2.88 and fineness modulus of 6.78.The loose and compacted bulk density values obtained are 1481Kg/m^3 and 1570 Kg/m^{3}respectively, water absorption of 1.10%.

D. Ceramics waste:

The ceramic wastes are obtained from a local building that has been demolished. The waste ceramics are crushed into pieces with crushing machine in laboratory. The aggregates passing through IS sieve 20mm and retained on 12.5mm are taken. The specific gravity of tile aggregates is 2.27 and fineness modulus of 5.64. The loose and compacted bulk densities are 1248Kg/m^3 and 1337Kg/m^3 respectively.

E. Super Plasticizer:

Conplast SP 337 is used as super plasticizer and is used in all concrete mixes.

Table 1: Properties of Super Plasticizer

Property	Colour	Specific gravity	Dosage in 1/m^3	Setting time
Values	Brown	1.18	2.28	1-3 hrs

III. EXPERIMENTAL PROGRAM

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate and crushed ceramic aggregate. The variation of strength of hardened concrete using solid wastes as partial replacement of conventional aggregate is studied by casting cubes, cylinders and beams until 60%. The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse aggregate and solid wastes tiles are mixed in dry

state and then the desired water quantity is added and the whole concrete is mixed for 5 minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured into the moulds in 3 layers by poking with tamping rod for cubes of 150X150X150 mm size and cylinders of 150mm diameterX300mm and beams of 100X100X500mm size were tested for compression, split tensile and flexural strengths. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7, 28, 56 days the specimens are removed and these are tested for compression, split and flexural strengths and the results are compared with conventional concrete.

IV. MIX DESIGN

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate and crushed ceramic aggregate. The variation of strength of hardened concrete using solid wastes as partial replacement of conventional aggregate is studied by casting 3 cubes, 3 cylinders and 3 beams for each and every replacement. The concrete was prepared in the laboratory using mixer. The cement fine aggregate and coarse aggregate and solid wastes tiles are mixed in dry state and then the desired water quantity is added and the whole concrete is mixed for 5 minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured into the moulds in 3 layers by poking with tamping rod for cubes of 150X150X150 mm size and cylinders of 150mm diameterX300mm and beams of 100X100X500mm size were tested for compression, split tensile and flexural strengths. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7, 28, 56 days the specimens are removed and these are tested for compression, split and flexural strengths and the results are compared with conventional concrete.

Table 2: Mix Proportions

Mix ID	Cement Kg	F.A Kg	C.A Kg		Water 1/m^3	SP 1/m^3
			CA	Tiles		
M1	456.19	551.36	1278.15	-	191.6	-
M2	456.19	551.36	1150.33	127.81	191.6	2.28
M3	456.19	551.36	1022.52	255.63	191.6	2.28
M4	456.19	551.36	849.70	383.44	191.6	2.28
M5	456.19	551.36	766.89	511.26	191.6	2.28
M6	456.19	551.36	639.07	639.07	191.6	2.28
M7	456.19	551.36	511.26	766.89	191.6	2.28

V. RESULTS AND DISCUSSIONS

Compressive strength and split and flexural strengths were conducted at the end of 7, 28, 56 days. The compressive strength of the ceramic concrete has been varied from 32.88-46.88 Mpa and the split tensile strength is varied from 2.47-3.72Mpa and flexural strength is varied from 5.33-7.82Mpa for 28 days. After the comparison of properties the ceramic waste can be used in the place of conventional aggregate. But it is observed that the strength decreases from 50% replacement of coarse aggregate. Hence until 40% we can use ceramic tiles collected from building demolition as replacement of coarse aggregate.

Table 3: Test results

Mix Id	Compressive Strength (N/mm^2)		
	7d	28d	56d
NCC(M_1)	32.00	42.22	46.20
M2	32.88	42.56	47.86
M3	39.55	43.51	48.00
M4	40.00	45.34	50.78
M5	42.22	46.88	52.26
M6	32.66	40.00	44.57
M7	30.00	39.22	40.64

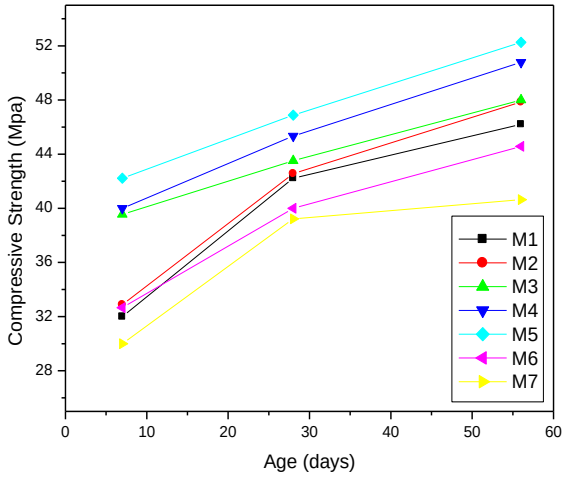

Fig 1: Compressive strength (Mpa)

Table 4: Test results

Mix Id	Split tensile Strength (N/mm^2)		
	7d	28d	56d
NCC(M_1)	2.33	3.15	3.58
M2	2.47	3.49	3.83
M3	2.61	3.55	3.88
M4	3.04	3.64	4.02
M5	2.82	3.72	4.23
M6	2.00	2.84	3.88
M7	2.05	2.45	3.64

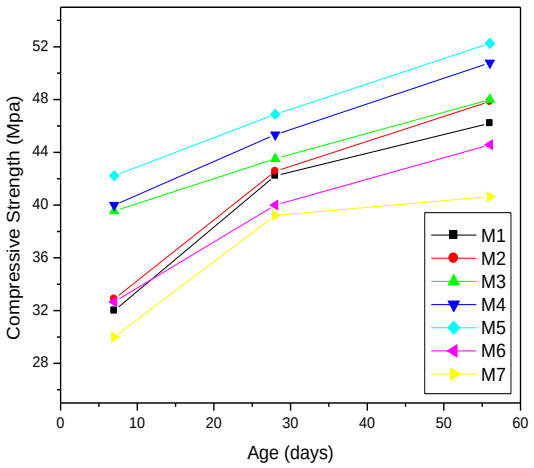

Fig 2: Split tensile strength (Mpa)

Table 5: Test results

Mix Id	Flexural Strength (N/mm^2)		
	7d	28d	56d
NCC(M_1)	5.20	6.8	7.40
M2	5.33	7.14	7.88
M3	6.96	7.42	7.96
M4	7.24	7.68	8.02
M5	7.68	7.82	8.44
M6	5.14	6.32	7.18
M7	4.98	6.54	7.38

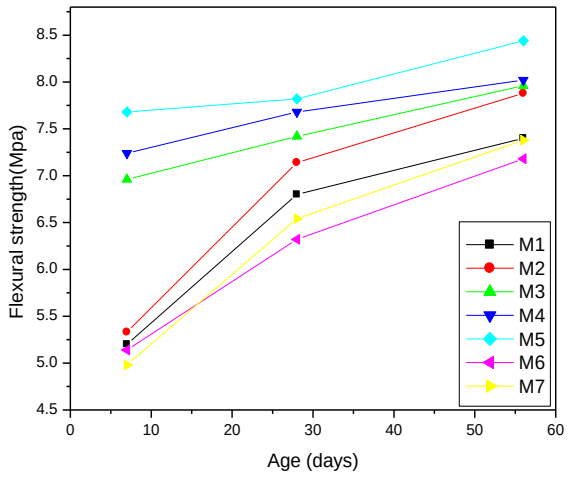

Fig 3: Flexural strength (Mpa)

VI. CONCLUSIONS

Waste tiles are the main problem of tile industries and from demolition buildings. The aim of this investigation was the utilization of tiles collected from demolition buildings in concrete as coarse aggregate. The use of tiles in concrete has positive effects on the environment and obtaining lower costs. From the above investigations carried out the ceramic scrap from building demolition waste can be used as coarse aggregate. The coarse aggregate can be replaced until 40% of ceramic waste. The following are the conclusions obtained after performing the above experiments

1. From the above study concluded that increasing the tile percentage from 50 decreases the strength of concrete.
2. By observing above results we can conclude that by increasing the percentage up to 40 replacement of coarse aggregate the strength increases.
3. The workability of crushed tile aggregate concrete is equilibrium of fluidity, deformability, filling ability and resistance to segregation. This equilibrium has to be maintained for a sufficient time period to allow for transportation, placing and finishing.
4. The results obtain shows that there is decrement in the Flexural strength of beams for 56 days. It seems to be economical.
5. The maximum 28 days split tensile strength was obtained with 40% replacement of crushed tile aggregates and the strength is more at 28 days of curing compared to the NCC mix.

REFERENCES

1. How-Li Chen*, Tsong Yen, Kuan-Hung Chen. Use of building rubbles as recycled aggregates. Cement and concrete research 33(2003)125-132.
2. I. B. Topcu** and Canbaz. Utilization of crushed tile as aggregate in concrete. Iranian Journal of science & technology, Transaction B, Engineering, Vol. 31, No. B5, pp561-565
3. Yong, P.C. and Teo, D.C.L. Utilization of recycled aggregate as coarse aggregate in concrete. UNIMAS E-Journal of civil engineering, Vol. 1: issue 1/August 2009
4. Investigations on stone dust and ceramic scrap as aggregate replacement in concrete. International journal of civil and structural Engineering volume1, No 3, 2010.
5. Corinaldesi, V., Giuggiolini, M & Moriconi, G. (2002). Use of building rubbles from building demolition in mortars. Waste Management, Vol, 22, pp. 893-899.
6. Mansur, M. A., Wee, T.H. & Cheran, L. S. (1999). Crushed bricks as coarse aggregate for concrete.ACI Materials Journal Vol. 96, No.4, pp. 478-484.
7. Khaloo, A. r. (1995). Crushed tile coarse aggregates concrete. Cement, Concrete,/ and Aggregates (ASTM journal), Vol. 17, No. 2, pp. 119-125.
8. Sagoe- Crentail, K. K., Brown, T. & Taylor, A. H. (2001). Performance of concrete made with commercially produced coarse recycled concrete aggregate. CCR, Vol. 031,pp 707-712.
9. Frondiston, Y.S. (1977). 'Waste Concrete as aggregate for New Concrete.' ACI journal (August); 373-376.
10. C.S.Poon*, S.C.kou and L.Lam.Use of recycled aggregates in moulded concrete bricks and blocks
11. Khalaf, F. M. et al.(2004).'Recycling of demolished masonry rubble as coarse aggregate in concrete. Review'. ASCE J Mater civil Eng (2004,331)-340
12. Rao, A., Jha, K.n. and Misra S.(2005).'Use of aggregates from recycled construction and demolition waste in concrete'. Journal of resources conservation and recycling, 50(2007); 71-81.
13. Gonzalez, F.B. and Martinez, A.F. (2006).Concrete with aggregates from demolition waste and silica fume. Materials and mechanical properties.' of Journal of Building and Environment.
14. Malhotra, V.M. (1978).'Use of recycled concrete with aggregates.' Proceedings of the symposium on Energy and resource conservation in the Concrete Industry CANMET rep.No. 76-8, CAMNET, Ottawa Canada(1978):;4-16.