ISSN 2348-6201

EFFECT OF PLASTIC SYNTHETIC AGGREGATE IN THE PRODUCTION OF LIGHTWEIGHT CONCRETE

[1]Elvis M. Mbadike, [2]Ezeokpube G.C.
Elvis M. Mbadike:
[1,2]Lecturer, Department of Civil Engineering, Michael Okpara University of Agriculture, Umudike, Nigeria
E-mail: elvis_mbadike@yahoo.co.uk

ABSTRACT

In this research work, the effect of plastic synthetic aggregate in the production of lightweight concrete was studied. The plastic synthetic aggregate was used to replace 0-40% of coarse aggregates. A mix proportion of 1:1.8:3.7 with water cement ratio of 0.47 were used. Concrete cubes of 150mmx150mmx150mm of coarse aggregate/plastic synthetic aggregate were cast and cured at 3,7,28,60 and 90 days respectively. At the end of each hydration period, the three concrete cubes for each hydration period were crushed and their average compressive strength recorded. A total of ninety (90) concrete cubes were cast. The result of the compressive strength tests for 5-40% replacement of coarse aggregates with plastic synthetic aggregate ranges from 8.07-36.71N/mm^2 as against 24.58-41.21N/mm^2 for the control test. The workability for 5-40% replacement of coarse aggregates with plastic synthetic aggregate ranges from 12-61mm as against 8mm for the control test (0% replacement).

KEYWORDS: Plastic synthetic aggregate; coarse aggregates; compressive strength; workability.

Council for Innovative Research

Peer Review Research Publishing System

Journal: Journal of Advances in Biotechnology

Vol 2, No. 1
editor@cirworld.com
www.cirworld.com, member.cirworld.com

ISSN 2348-6201

INTRODUCTION

Lightweight concrete can be produced by partially replacing the normal weight coarse aggregate particles with plastic synthetic aggregate. The particle and bulk densities for the plastic synthetic aggregate used are 58 and 18kg/m^3 respectively. The plastic synthetic aggregate is commercially available with suitable chemical coating, which is necessary to achieve a uniform dispersion in the fresh concrete mixture and to avoid segregation during mixing and handling of concrete. The plastic synthetic aggregate has negligible water absorption due to its closed cellular structure. Cook (1997) reported that the standard workability tests are not suitable for the plastic synthetic aggregate concrete since they are sensitive to the unit weight of concrete. Sri Ravindrarajah (1999) made similar observation when working with some materials together with plastic synthetic aggregate. The use of plastic synthetic aggregate in concrete manufacture may provide a satisfactory solution to the problems posed by concrete production (Basher et al, 2005). Finally, the use of plastic synthetic aggregate should not impair concrete durability. Tradition assessment methods must therefore be adapted to evaluate this material (Chatterji, 1992).

This study contributes to the development of a methodology for assessing concrete manufactured from plastic synthetic aggregate. The methodology is based on the study of concrete containing this material.

The durability and the environmental impact of concrete are closely connected to its transport properties which control the kinetics of the penetration of water and aggressive agents into concrete (Pimiento et al, 1999). The movement of chemical species within the material and the leaching of certain chemicals are also closely linked to concrete diffusivity (Remond et al, 2002).

Finally, the strength characteristics of concrete containing increasing levels of plastic synthetic aggregate were studied to identify the influence of the plastic synthetic aggregate on concrete produced with it (Mehta P.K., 1997s).

METHODOLOGY

Concrete mixtures with six levels plastic synthetic aggregate ranging from 5-40% and concrete mixtures with no plastic synthetic aggregate were investigated to determine their effect on the strength of concrete. The mixtures were labeled M0, M5, M10, M20, M30 and M40 with the different synthetic aggregate replacement percentages of coarse aggregates represented by the final digits in the label. The mixtures were proportioned for a target cube strength of 43N/mm^2 and had a cementitious material content of 340kg/m^3, a fine aggregate content of 627kg/m^3, a coarse aggregate content of 1273kg/m^3 and a water cementitious ratio of 0.47

Crushed plastic synthetic aggregate angular in shape with a non toxic chemical coating and having a mean diameter of 2.5mm were used in the concrete mixtures. The fine aggregate used was clean river sand, free from deleterious substances with a specific gravity of 2.62 and bulk density of 1533kg/m^3. The coarse aggregate was obtained from a local supplier with a maximum size of 20mm, specific gravity of 2.65 and bulk density of 1467kg/m^3. Both aggregates conforms to BS 877 (1967) and BS 3797 (1964,76) respectively for coarse and fine aggregates. The cement used was Ordinary Portland Cement (Dangote) which conforms to BS12.

Tests to determine density, workability and compressive strength were carried out in this study. For the compressive strength test, plastic synthetic aggregate was used to replace 0 to 40% of coarse aggregates by weight. For the compressive strength test 150mm cube specimen were used. A total of 90 specimens were cast and cured in water at room temperature in the laboratory for 3,7,28,60 and 90 days. At the end of each hydration period, three specimens for each were tested for compressive strength and the average recorded.

For the workability, a standard slump cone measuring 300mm x 200mm x 100mm was used. The compaction was also in three layers as carried out in compressive strength, i.e 1/3, 2/3 and 3/3 using tamping rod. (Neville, A.M, 1981).

RESULTS AND DISCUSSION

Table 1-6 shows the result of the compressive strength of concrete with 0-40% replacement of coarse aggregate with plastic synthetic aggregate. The result shows that strength development increases with increase in hydration period. The result of the compressive strength for 5-40% replacement of coarse aggregate with synthetic aggregate ranges from 8.07-36.71N/mm^2 as against 24.58-41.21N/mm^2 for the control test. The result shows that there is a decrease in the strength of concrete produced as the percentage replacement level of coarse aggregates with synthetic aggregate increases.

Table 7 shows the result of workability of concrete produced when plastic synthetic aggregate are used in a certain replacement level of coarse aggregates. The result of workability for 5-40% replacement of coarse aggregates with synthetic aggregate ranges from 12-61mm as against 8mm for the control test. The result shows that the higher the workability of concrete produced, the lower the strength of concrete.

Table 1: Result of compressive strength obtained with 0% replacement of coarse aggregates with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	551	24.49	
150x150x150	3	528	23.47	24.58
150x150x150	3	580	25.78	
150x150x150	7	500	22.22	
150x150x150	7	705	31.33	29.55
150x150x150	7	790	35.11	
150x150x150	28	750	33.33	
150x150x150	28	777	34.53	35.89
150x150x150	28	896	39.82	
150x150x150	60	750	33.33	
150x150x150	60	800	35.58	37.30
150x150x150	60	968	43.02	
150x150x150	90	1001	44.49	
150x150x150	90	833	37.02	41.21
150x150x150	90	948	42.13	

Table 2: Result of compressive strength obtained with 5% replacement of coarse aggregates with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	510	22.67	
150x150x150	3	600	26.67	23.05
150x150x150	3	446	19.82	
150x150x150	7	628	27.91	
150x150x150	7	567	25.20	25.84
150x150x150	7	549	24.40	
150x150x150	28	689	30.62	
150x150x150	28	727	32.31	30.52
150x150x150	28	644	28.62	
150x150x150	60	790	35.11	
150x150x150	60	712	31.64	31.78
150x150x150	60	643	28.62	
150x150x150	90	766	34.04	
150x150x150	90	900	40.00	36.71
150x150x150	90	812	36.09	

ISSN 2348-6201

Table 3: Result of compressive strength obtained with 10% replacement of coarse aggregates with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	433	19.24	
150x150x150	3	502	22.31	20.37
150x150x150	3	440	19.56	
150x150x150	7	490	21.78	
150x150x150	7	470	20.89	22.22
150x150x150	7	540	24.00	
150x150x150	28	615	27.33	
150x150x150	28	655	29.11	27.02
150x150x150	28	554	24.62	
150x150x150	60	625	27.78	
150x150x150	60	704	31.29	29.26
150x150x150	60	646	28.71	
150x150x150	90	613	27.24	
150x150x150	90	687	30.53	30.07
150x150x150	90	730	32.44	

Table 4: Result of compressive strength obtained with 20% replacement of coarse aggregate with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	425	18.89	
150x150x150	3	458	20.36	18.89
150x150x150	3	392	17.42	
150x150x150	7	509	22.62	
150x150x150	7	446	19.82	19.92
150x150x150	7	390	17.33	
150x150x150	28	450	20.00	
150x150x150	28	516	22.93	21.17
150x150x150	28	463	20.58	
150x150x150	60	578	25.69	
150x150x150	60	560	24.89	25.05
150x150x150	60	553	24.58	
150x150x150	90	640	28.44	
150x150x150	90	551	24.49	26.65
150x150x150	90	608	27.02	

Table 5: Result of compressive strength obtained with 30% replacement of coarse aggregate with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	235	10.44	
150x150x150	3	280	12.44	12.80
150x150x150	3	349	15.51	
150x150x150	7	303	13.47	
150x150x150	7	366	16.27	14.18
150x150x150	7	288	12.80	
150x150x150	28	419	18.62	
150x150x150	28	475	21.11	19.67
150x150x150	28	434	19.29	
150x150x150	60	486	21.60	
150x150x150	60	402	17.87	20.48
150x150x150	60	494	21.96	
150x150x150	90	483	21.47	
150x150x150	90	568	25.24	21.21
150x150x150	90	381	16.93	

Table 6: Result of compressive strength obtained with 40% replacement of coarse aggregate with plastic synthetic aggregate.

Cube size (mm)	Age of cube (days)	Test load (kN)	Compressive Strength (N/mm^2)	Average Comp. Strength (N/mm^2)
150x150x150	3	200	8.89	
150x150x150	3	160	7.11	8.07
150x150x150	3	185	8.22	
150x150x150	7	210	9.33	
150x150x150	7	186	8.27	9.47
150x150x150	7	243	10.80	
150x150x150	28	192	8.53	
150x150x150	28	219	9.73	10.00
150x150x150	28	264	11.73	
150x150x150	60	203	9.02	
150x150x150	60	237	10.53	10.78
150x150x150	60	288	12.80	
150x150x150	90	308	13.68	
150x150x150	90	214	9.51	11.95
150x150x150	90	285	12.67	

Table 7: Result of workability of concrete produced with 0-40% replacement level of coarse aggregates with plastic synthetic aggregate.

% Level of Polystyrene granules	Workability (mm)
0	8
5	12
10	19
20	36
30	48
40	61

CONCLUSION

The conclusion of the study can be summarized as follows:

- **a.** The use of plastic synthetic aggregate in the production of concrete will reduce the strength of concrete produced.
- b. The strength development in the concrete produced increases with the increase in hydration period
- c. Since plastic synthetic aggregate reduces the strength of concrete produced, it can be used as a retarder
- d. The strength of concrete decreases with the increase in workability.

REFERENCES

Cook, D.J (1997): Coarse aggregate polystyrene granules mixes for use in masonry unit, building and environment, pp150-182.

Sri Ravindrarajah, R. (1999): Bearing strength of concrete containing polystyrene aggregate, 8th International Conference on durability of buildingmaterials and components, Vancouver, Canada, vol 1,pp 505-514

Basher, McCabe C.C. and Long A.E. (2005): "The influence of admixture on the properties of fresh and hardened concrete". Journal of Scientific Industrial Research vol 8, pp199-214.

Chatterji A.K. (1992): "Adsorption of lime and pozzolanic activity". Journal of Scientific Industrial Research, vol 19B, pp493-494.

Pimienta, P. Remond S., Rodrigues N., Bournazel J.P.(1999): Assessing the properties of mortar containing municipal solid waste incineration fly ash. International congress creating with concrete, University of Dundee, pp 319-326

Remond S., Pimienta P and Bentz D.P. (2002): Effect of incorporation of municipal solid waste fly ash in concrete. Journal of Cement and Concrete Research, vol 10, pp 12-14.

Mehta P.K (1997): Properties of blended cement in concrete production, ACI journal proceedings, vol 75,pp 310-313

British Standards Institution, BS 877 (1967): "Foamed or expanded blast furnace slag lightweight aggregate for concrete". London, pp8.

British Standards Institution, BS 3797 (1964): "Lightweight aggregates for concrete" London pp8

British Standards Institution, BS 3797 (1976): "Lightweight aggregate for concrete" London, pp10.

British Standards Institution, BS 12 (1978): "Specification for Ordinary and Rapid Portland Cement".London pp38.

Neville A.M. (1981): Properties of concrete, 3rd edition,pitman, New York.