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Suitability of Fly Ash Aggregates for Complete Replacement as Coarse Aggregate

C Puneetha[1] and C Siva Kumar Prasad[2]

[1]Post graduate, Department of Civil Engineering, Siddhartha Institute of Science & Technology, Puttur, Andhra Pradesh, India.
E-mail: saipuneethareddy@gmail.com
[2]Head &Assistant Professor, Department of Civil Engineering, Siddhartha Institute of Science & Technology, Puttur, Andhra Pradesh, India.
E-mail: sivakumarprasad.c@gmail.com

ABSTRACT

Concrete is not only cheapest construction material when compared with steel and wood, but as widely used in our country. The ingredient used in manufacturing of concrete such as strong granite ballast; sand is become scares due to their quantum of consumption. Fly ash is byproduct obtained during manufacturing of power in thermal power plants. The safe disposal of fly ash is a challenge for the engineers. Aggregates made from fly ash comes under the category of light weight aggregates which used in the manufacturing of light weight concrete is becoming popular now a days. Good deal of literature available on partial replacement of fly ash aggregate in concrete. The current study got a distinction in the sense; it checks the possibility of complete replacement of fly ash aggregate in concrete. M20, M30 and M40 concrete was study for complete replacement of fly ash aggregate. It was found that M20 gave satisfactory result for different water cement ratios. However, M30 and M40 grade concrete failed at almost all water cement ratios. In present investigation, fresh and hardened properties and durability properties of medium strength concrete like M20, M30 and M40 grades with different water cement ratios of 0.30,0.35,0.40,0.45,0.50 and 0.55 as 100% replacement of coarse aggregate with fly ash pellets. And it is observed from the present results were as M20 results are satisfactory related to targeted mean strength, rest of M30 and M40 results are not extracted to target mean strength. And also durability properties of M25 grade concrete with water cement ratios of 0.35,0.40,0.45,0.50 and 0.55 by adding sulphuric acid curing test in 96 days.

KEYWORDS: Cold bonding technique, fly ash pellets, light weight concrete, compressive strength.

INTRODUCTION

Researchers have reported that the global fly ash market reached a total value of 40 billion USD in the past 5 years. A recent future trend analysis by Nester anticipated that the global growth of market increases by 30% by the end of 2023, thereby boosting construction projects. Construction industry accounts for about 40% of total global waste generated. Fly ash is a coal combustion residual(CCRs) and stands as one of the largest waste material generated in US, along with other materials like bottom ash is flue gas desulfuroicatons(FGD).
The increasing waste of flue ash and the growing challenges associated with the disposal have become a problem to the coal industry. Studies have found the fly ash can be used as an additive material in the construction industry. Researchers till date on this material usage in concrete produce light weight aggregate without compromising on the mechanical properties of the elements. While many materials can be used as light weight aggregates (LWA). The use of fly ash provides the necessary solution focusing the disposal of waste in coal industry.
This research mainly focusing on suitability of fly ash aggregates and the properties of concrete mixtures as a fully replacement of cement and natural sand. The scope of this study, the main goal is to improve compressive strength of concrete at different grades of varying different water cement ratios. Fly ash is the cheapest material of all concrete constitutes and is much less expensive than natural aggregate. The usage of fly ash waste is to reduce the environmental pollution like water pollution, air pollution and disposal problems on agricultural lands. To overcome all above effects we are using fly ash waste as a coarse aggregate replacement in different grades of concrete and also we can reduce the cost of the project.

EXPERIMENTAL STUDY

2.1 MATERIALS USED:

Ordinary Portland cement 53 Grade is used in concrete according to BIS specification IS: 12269-2013. Coarse aggregates are 10mm and 12 mm. Specific gravity of fly ash coarse aggregate pellets is 1.409. Natural sand with maximum size of 4.75 mm is used. Specific gravity of the sand is 2.409.Class F Fly ash has used with specific gravity of 2.2. Tap water is used.

2.2 MIX PROPORTIONS

Mix design was prepared by viewing the cement, sand, artificial fly ash aggregate pellets and water, by using the Indian standard method IS:456-2000 and IS:10262-2009 was prepared by grades of concrete they are M20, M30 and M40 with water cement ratios of 0.3, 0.35, 0.40, 0.45, 0.50, 0.55

Mix proportions for M20 Concrete

S.No	w/c	Cement (kg/m^3)	Fine aggregate(kg/m^3)	Fly ash aggregate(kg/m^3)	Water (lts/m^3)
1	0.40	403	617	642	235
2	0.45	358	647	645	241
3	0.50	322	675	644	240
4	0.55	293	701	642	239

Mix proportions for M30 Concrete

S.No	w/c	Cement (kg/m^3)	Fine aggregate(kg/m^3)	Fly ash aggregate(kg/m^3)	Water (lts/m^3)
1	0.30	450	605	629	215
2	0.35	434	592	643	232
3	0.40	399	618	643	239
4	0.45	358	647	645	241
5	0.50	320	676	645	240

Mix proportions for M40 Concrete

S.No	w/c	Cement (kg/m^3)	Fine aggregate(kg/m^3)	Fly ash aggregate(kg/m^3)	Water (lts/m^3)
1	0.30	450	571	648	215
2	0.35	433	592	643	231
3	0.40	403	617	642	241
4	0.45	360	647	644	242

2.3 TEST PROCEDURE

2.3.1 Mixing of concrete

Firstly, fly ash aggregates, fine aggregate, cement and water are to be taking according to mix design quantities. Choose a smooth, clean and water tight platform, measured quantity of sand and cement is spread evenly. Mix properly up to a uniform color and then pour a fly ash aggregates. After pour the measured quantity of water, by using a spade mix it properly without segregation. Concrete was prepared under moderate exposure condition.

2.3.2 Preparation of cubes

After mixing of concrete, cubical moulds of size 150mm x 150mm x 150mm are coated with castor oil and then prepared concrete was poured in to cubical moulds in three layers. By using a tamping rod each layer must be tampered in 25 blows to entrap the air.

2.3.3 Curing

Cubes were stored in moisture for 24 hours**,** the moulds were removed and marked .Then, test specimens are cured in water up to a 28 days in room temperature of about $27^0 \pm c$.

3. RESULTS AND DISCUSSION

3.1 Fresh concrete

For fresh concrete workability test by using a slump cone test. The shape and texture of fly ash aggregates affects the fresh property of the concrete. Fly ash aggregate has a rounded in shape and promotes the good workability than natural coarse aggregate. For different grades of concrete slump test values was experimentally as listed below:

Slump cone test values in mm

M20 grade concrete	w/c	0.40	0.45	0.50	0.55
	Values in mm	140	60	50	85

M30 grade concrete	w/c	0.30	0.35	0.40	0.45	0.50
	Values in mm	40	100	110	120	100

M40 grade concrete	w/c	0.30	0.35	0.40	0.45
	Values in mm	25	60	90	120

Figure 3.1: Slump cone test

3.2. Hardened concrete

For hardened concrete compressive strength test was experimentally conducted for different grades of concrete. The test was performed according to Indian standards as IS:516-1959 were conducted on 12 cubes for M20 grade concrete,15 cubes for M30 grade concrete and 12 cubes for M40 grade concrete mixtures were cast and after 24 hours, the specimens are de-molding stored in a curing tank. After 28 days using a compression testing machine of 400 tons capacity

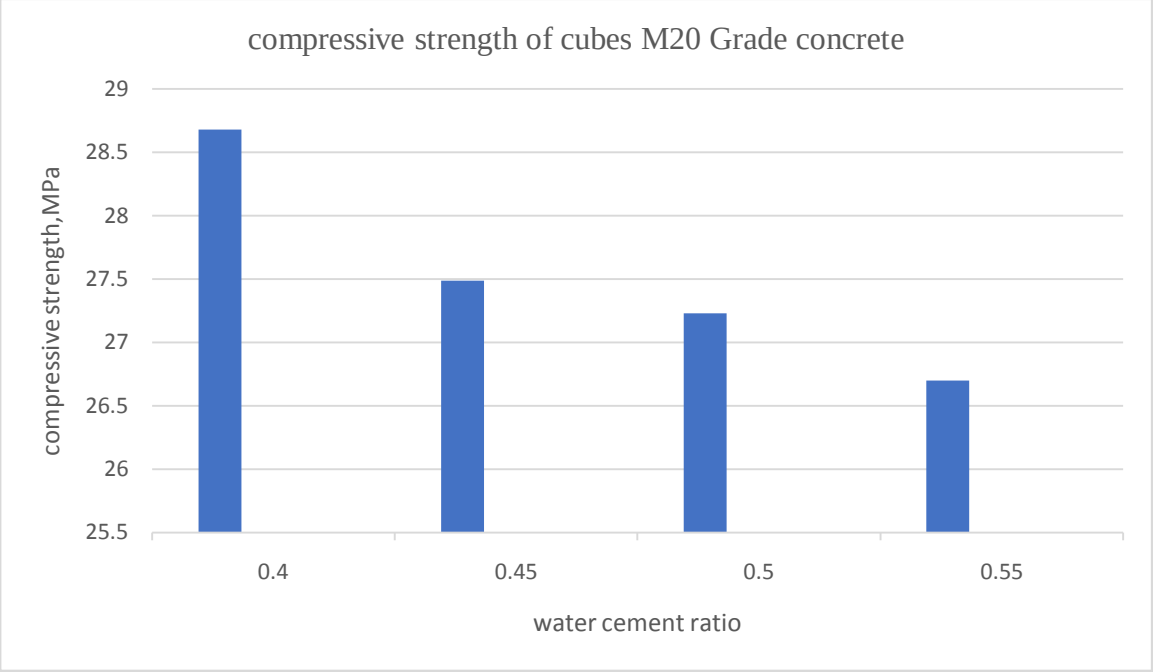
Figure 3.2: Experimental set up to find the compressive strength of concrete

4 RESULTS AND DISCUSSION

The following tables and figures shows the compressive strength of the cubes for M20, M30 and M40 grades of concrete with different water cement ratios after 28 days:

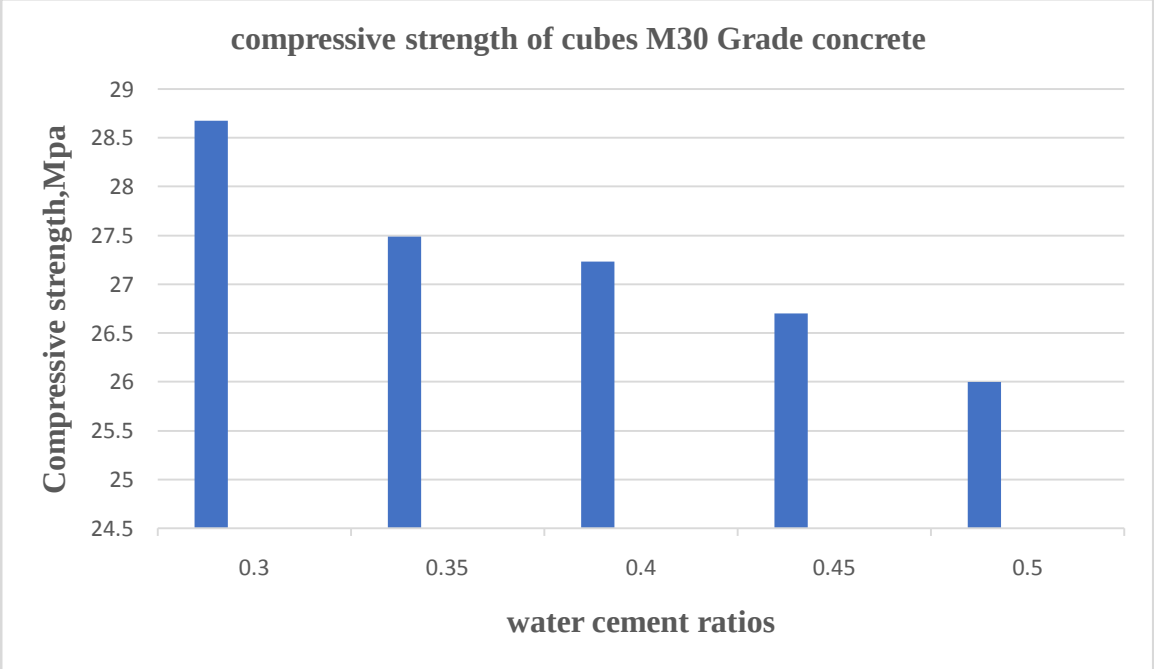
Compressive strength of cube sM20 Grade concrete

Water cement ratios	Compressive strength in MPa	Average compressive strength in MPa
0.4	28	28.68
	28.71	
	29.33	
0.45	26.2	27.49
	27.82	
	28.44	
0.5	27.02	27.23
	27.11	
	27.55	
0.55	26.2	26.70
	26.5	
	27.4	



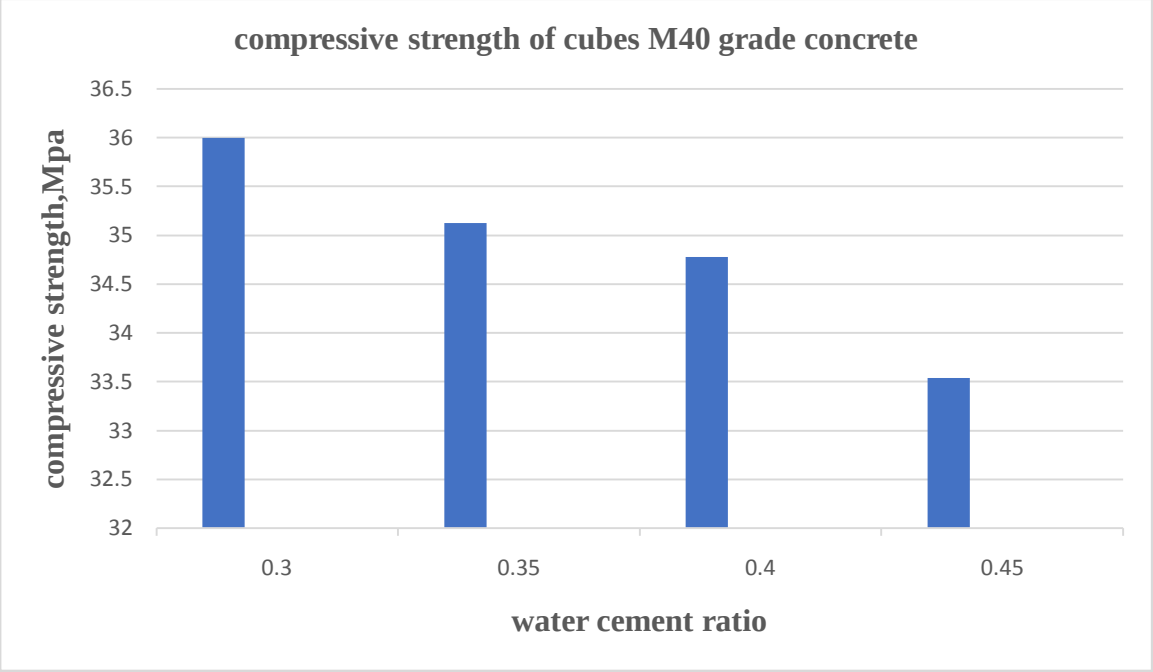
Compressive strength of cubesM30 Grade concrete

Water cement ratios	Compressive strength in MPa	Average compressive strength in MPa
0.3	35.11	28.68
	34.66	
	34.31	
0.35	34.9	27.49
	33.86	
	33.33	
0.4	32.88	27.23
	33.77	
	33.44	
0.45	33.4	26.7
	33.3	
	32.88	
0.5	31.11	31.88
	32	
	32.53	



Compressive strength of cubesM40 Grade concrete

Water cement ratios	Compressive strength in MPa	Average compressive strength in MPa
0.30	36	36
	36.08	
	34.66	
0.35	35.55	35.13
	35.2	
	34.66	
0.40	35.11	34.78
	34.66	
	34.58	
0.45	33.77	33.54
	33.24	
	33.6	



4. CONCLUSIONS

From the experimental studies conducted following conclusions:

- M20 grade concrete as the water cement ratio is 0.40, 0.45 found to be good workability results, still increase to water cement ratio of 0.50, and 0.55 even though w/c ratio is more, there was good workability, but there was a same time light chance for the segregation and bleeding, workability values also reducing.
- M30 grade concrete as the water cement ratios of 0.30, 0.35 found to be satisfactory workability results but w/c ratios of 0.40, 0.45 and 0.50 results showed good improvement.
- M40 grade concrete as the water cement ratios of 0.30, 0.35 0.40 and 0.45 similar trend is followed like M30 grade, but it may not be able to complete hydration process.
- The average compressive strength for w/c 0.4, 0.45, 0.50 and 0.55 is found to be 28.68, 27.49, 27.23 and 26.70 respectively. For the w/c ratio, the average compressive strength is more than that of the targeted mean strength.
- The average compressive strength for w/c 0.3, 0.35, 0.40, 0.45 and 0.50 is found to be 35, 34.03, 33.36, 33.203 and 31.88 respectively. For the w/c ratio, the average compressive strength is less than that of the targeted mean strength.
- The average compressive strength for w/c 0.30, 0.35, 0.40 and 0.45 is found to be 36, 35.13, 34.78 and 33.54 respectively. For the w/c ratio the average compressive strength is less than that of the targeted mean strength.

REFERENCES

1. Dr.HeshamA.Numan,MohammedHazimYaseen and Ahmed Hussein Obed ,"The Influence of Inclusion Volcanic Pumice On The Concrete Properties ,International Journal of Civil Engineering and Technology(IJCIET) 9 (13), 2018,pp.1890-1904.
2. Winsley, J. and Muthukannan, M., (2018): "A preliminary study on the physical properties of an alternative coarse aggregate made with red soil and fly ash". The Open Construction & Building Technology Journal, vol.12, December2018,pp.347-353, http://revue.ummto.dz/index.php/JMES/article/view/1872
3. Bright BrabinWinsley, J., and M.Muthukannan (2018): "Expanded Fly Ash Clay Aggregate a Sustainable Alternative Coarse Aggregate for Concrete," Journal of Materials and Engineering Structures, 2018, Vol. 5, Issue 4, pp. 347–353, http://revue.ummto.dz/index.php/JMES/article/view/1872.
4. Haryanto, Y., Widyaningrum, A., Sudibyo, G.H. and Maryoto, A., 2017. "Mechanical properties of lightweight aggregate concrete

reinforced with soda can waste fibre". In MATEC Web of Conferences (Vol. 138, p. 01021).EDP Sciences,http: //DOI:10.1051/matecconf/201713801021.

5. Venkatesh, B. and Krishna, B.V., 2015. "A Study on the Mechanical Properties of Light Weight Concrete by Replacing Course Aggregate with (Pumice) and Cement with (Fly Ash),"international journal of engineering research & technology (IJERT) Volume 04,Issue 08 (august 2015).http://doi.org/10.17577/IJERTV4/IS080385.
6. Nadesan, M.S. and Dinakar, P., (2017): "Mix design and properties of fly ash waste lightweight aggregates in structural lightweight concrete,"Case studies in construction materials journal, Elsevier, vol.7, December 2017, pp.336-347, https://doi.org/10.1016/j.cscm.2017.09.005.
7. T.DivyaBhavana,Rapole Kishore kumar,S.nikhil and P.sairamchander,"study of light weight concrete",International Journal of Civil Engineering and Technology,8(4),2017,pp,1223-1230.https://doi.org/
8. Reddy, M.V.S., Nataraja, M., Sindhu, K., Harani, V. and Madhuralalasa, K., 2016. "Performance of light weight concrete using fly ash pellets as coarse aggregate replacement". International Journal of Engineering Research Technology, ISSN 0974-3154 Volume 9, Number 2(2016), pp.95-104 52, http://doi.org/10.1088/1757-899X/970/1/012013
9. Kanagavel, R. and Arunachalam, K., 2015. Experimental investigation on mechanical properties of hybrid fiber reinforced quaternary cement concrete. Journal of Engineered Fibers and Fabrics, 10(4), p.155892501501000407. https://doi.org/10.1177/155892501501000407
10. IS 516-1959: Method of Tests for Strength of Concrete, BUREAU OF INDIAN STANDARDS, New Delhi, India, http://www.iitk.ac.in/ce/test/IS-codes/is.516.1959.pdf
11. IS 2386 (Part I)-1963: Methods of Test for Aggregates for Concrete, Particle Size, and Shape. BUREAU OF INDIAN STANDARDS, New Delhi, India, http://www.iitk.ac.in/ce/test/IS-codes/is.2386.1.1963.pdf
12. IS 2386 (Part III)-1963: Methods of test for aggregates for concrete, Specific gravity, density, voids, absorption and bulking, BUREAU OF INDIAN STANDARDS, New Delhi, India,http://www.iitk.ac.in/ce/test/IS-codes/is.2386.3.1963.pdf
13. IS 4031 (Part 3)-1988: Methods of physical tests for hydraulic cement, Determination of soundness, BUREAU OF INDIAN STANDARDS, New Delhi, India, https://law.resource.org/pub/in/bis/S03/is.4031.3.1988.pdf
14. IS 4031 (Part 4)-1988: Methods of physical tests for hydraulic cement, Determination of consistency of standard cement paste, BUREAU OF INDIAN STANDARDS, New Delhi, India, http://www.iitk.ac.in/ce/test/IS-codes/is.4031.4.1988.pdf
15. IS 4031 (Part 5)-1988: Methods of physical tests for hydraulic cement, Determination of initial and final setting times, BUREAU OF INDIAN STANDARDS, New Delhi, India, http://www.iitk.ac.in/ce/test/IS-codes/is.4031.5.1988.pdf
16. IS 4031 (Part 6)-1988: Methods of physical tests for hydraulic cement, Determination of compressive strength of hydraulic cement (other than masonry cement), BUREAU OF INDIAN STANDARDS, New Delhi, India,http://www.iitk.ac.in/ce/test/IS-codes/is.4031.6.1988.pdf
17. IS 4031 (Part 11)-1988: Methods of physical tests for hydraulic cement, Determination of density, BUREAU OF INDIAN STANDARDS, New Delhi, India.
18. https://law.resource.org/pub/in/bis/S03/is.4031.11.1988.pdf
19. Kailash C. Bhoi and Rashmi R. Pattnaik (2018): "Investigation into low-density fly ash aggregate in micro-concrete for lightweight concrete repair," Journal of Building Pathology and Rehabilitation, Springer, December 2018, Vol. 3, Issue 1, Article number: 10, pp. 1-9, https://doi.org/10.1007/s41024-018-0039-z
20. Patel, S.K., R.K. Majhi, H.P. Satpathy, and A.N. Nayak (2019): "Durability and microstructural properties of lightweight concrete manufactured with fly ash cenosphere and sintered fly ash aggregate," Construction and Building Materials Journal, Elsevier, November 2019, Vol. 226, pp. 579-590, https://doi.org/10.1016/j.conbuildmat.2019.07.304
21. Krishna raju, "Design of Concrete Mixes" , Year 2005
22. A.M.Nevile, "Properties of Concrete", ELBS with Longman 1987
23. M.S.Shetty, "Concrete Technology", Year 2008