Incorporation of Cow dung Ash to Mortar and Concrete

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ABSTRACT:
This paper presents result on study of cow dung ash (CDA) as supplementary cementing material in mortar and concrete. The experiments are designed to study the effects of adding CDA in various percentages by weight (5 % to 30 %), of cement and cured for periods of 7, 14, 28, days before testing for the compressive strengths. And also involves determination of setting time, consistency limits, and workability of CDA in various percentages by mixing with Portland cement. And also for progressing the sustainable development, includes more utilization of waste materials to make sustainable concrete and sustainable mortar for constructing the green buildings in future.
Keywords: Cow dung ash, Sustainability, Physical Properties, Compressive Strength, Consistency, workability

1.0 INTRODUCTION:

It is well known that sustainable development, one of the most important issues in the world at present days, involves to build our communities in such a way that we can all live comfortably without consuming all of our resources, we make an impact on the environment through how we survive our lives. In fact, it is well accepted by everyone that concrete executes outstanding responsibilities for the construction of modern infrastructures, industrialization (M.R.Karim, 2011). Besides, it is relevant to mention that the concrete industry today is the largest consumer of natural resources water, sand, gravel, and crushed rock. For these reasons, sustainable concrete and sustainable mortar is one of the prime topics in concrete industry all over the world and its main objective is to reduce the amount of polluting and carbon dioxide (CO_2) gases emitted during the manufacture of concrete more efficient use of waste materials, (Mehta, 2004). Development of a low-energy, long-lasting, flexible buildings and structures, exploiting the thermal mass of concrete in a structure to reduce energy demand. Approximately, one ton of CO_2, a greenhouse gas, is delivered into the atmosphere for each ton of cement production. Worldwide, the cement industry is responsible for about 1.4 billion tons in 1995, which caused the emission of as much CO_2 gas as 300 million automobiles statistically for almost 7% of the total world production of CO_2 (Malhotra, 2000). Hence environmental pollution and global warming is increasing continuously and, natural resources and energies are being reducing day by day. Since global warming has known as the most crucial environmental issue at present time and sustainability is becoming an important issue of economic and political debates (Meyer, 2005). And for the next developments in the concrete industry will not be the new types of concrete produced with expensive materials and special methods but low cost and highly durable concrete mixtures containing largest possible amounts of industrial and agricultural waste/byproducts that are suitable for supplementary use of Portland cement, virgin aggregate, and drinking water Supplementary cementitious materials can be used for improved concrete performance in its fresh and hardened state. For use in concrete, supplementary cementitious materials, sometimes referred to as mineral admixtures, need to meet requirements of established standards. They may be used individually or in combination in concrete. They may be added to the concrete mixture as blended cement or as a separately batched ingredient at the ready mixed concrete plant. They are primarily used for improved workability, durability and strength. These materials allow the concrete producer to design and modify the concrete mixture to suit the desired application. Concrete mixtures with high Portland cement contents are susceptible to cracking and increased heat generation. These effects can be controlled to a certain degree by using supplementary cementitious materials. Supplementary cementitious materials such as fly ash, slag and silica fume enable the concrete industry to use hundreds of millions of tons of byproduct materials that would otherwise be land filled as waste (Mehta, 2004). Furthermore, their use reduces the consumption of Portland cement per unit volume of concrete. Portland cement has high energy consumption and emissions associated with its manufacture, which is conserved or reduced when the amount used in concrete is reduced (Mehta, 1999; Malhotra, 2000)

2. 0 PURPOSE OF THE RESEARCH WORK

The application of supplementary material (CDA) to cement in various percentages is to be done by replacing 10%, 20% and 30% individually for achieving,

(i) To produce and evaluate the products for partial replacement of cement using the byproducts.
(ii) To minimize the overall environmental effects of concrete production using these materials as partial replacement.
(iii) To promote the preservation of the environment and natural resources through a process optimization of waste.
(iv) To develop a cost competitive structural light weight concrete by incorporating supplementary materials.

3.0 REGARDING SUPPLEMENTARY MATERIAL (COW DUNG):

The cow dung ash is obtained from cow excreta which is dried to sunlight and subjected to burning as a result ash is obtained in black color. In many parts of the developing world, caked and dried cow dung is used as fuel. Dung may also be collected and used to produce biogas to generate electricity and heat. Cow dung is also an optional ingredient in the manufacture of adobe mud brick housing depending on the availability of materials at hand. In many parts of the developing world, caked and dried cow dung is used as fuel. Dung may also be collected and used to produce biogas to generate electricity and heat. In cold places, cow dung is used to line the walls of rustic houses as a cheap thermal insulator.

3.1 Chemical properties of cow dung: Cow dung is a nitrogen rich material, potassium, phosphorous and calcium. (Smith and Wheeler, 1979). Cow dung has a relatively high carbon to the nitrogen ratio. Chemical composition of the cow dung revealed that while there was no difference in the organic matter (OM), nitrogen (N) and manganese (Mn). Contents of calcium (Ca), phosphorus (P), zinc (Zn) and copper (Cu) were higher by 10.8, 8.0, 84.1 and 21.7 percent in the dung. (Garg and Mudgal, 2007).

3.2 Physical properties of cow dung:

a) It is bulky
b) It has large ash content
c) It has low volatile content after burning
d) Carbon content is low
e) Burning ratio is low

4.0 RESULTS AND DISCUSSIONS:

4.1 Compressive Strength: The compressive strength of cubes is calculated as per IS: 456-2000. By adding various percentages of CDA to cement the strength of concrete is decreases by increasing the ash percentage. The compressive strength is calculated by taking average of three cubes for each 10%, 20%, 30%percentage.In below table.1 shows for 10% of adding cow dung ash, the average compressive strength is 23.1 N/mm^2,17.44,N/mm^2, and 15.25N/mm^2 for 28,14,7 days respectively. Similarly by adding 20% of cow dung ash to cement the average strength 11.3N/mm^2, 9.15N/mm^2, and 6.53N/mm^2.Finally by adding 30% of cow dung ash to cement the average strength are 5.81 N/mm^2, 5.44 N/mm^2, and 4.06 N/mm^2.

Table.1 Compressive Strength of Concrete with Different Mix Ratios of CDA

S.No	Supplementy Material	Percentage of CDA	Age (DAYS)	Compressive Strength (N/mm^2)			
				Cube.1	Cube.2	Cube.3	Average
1.	CDA	10%	7	15.69	15.69	14.38	15.25
			14	17.44	17.44	17.44	17.44
			28	23.54	22.67	23.10	23.10
2.	CDA	20%	7	6.54	6.104	6.97	6.53
			14	9.15	8.72	9.59	9.15
			28	11.77	10.90	11.33	11.3
3.	CDA	30%	7	3.92	3.92	4.36	4.06
			14	5.66	5.23	5.45	5.44
			28	6.54	5.23	5.66	5.81

4.2Consistency limits:

The basic aim is to find out the water content required to produce a cement paste of standard consistency as specified by the IS: 4031 (Part 4) – 1988. The principle is that standard consistency of cement paste when mixed with different percentages of cow dung ash is that consistency at which the Vicat plunger penetrates to a point 5-7mm from the bottom of Vicat mould. Vicat apparatus conforming to IS: 5513 – 1976, balance. Whose permissible variation at a load of 1000g should be +1.0g, Gauging trowel conforming to IS: 10086 – 198. By adding cow dung ash to cement, requires more water content by increasing the ash content. In table.2 shows that for 10%, 20%, and 30% of ash percentages the percentage of water is 0.42, 0.65, and 0.80 respectively.

Table.2 Consistency Limits for Different Mix Ratios of CDA

CDA %	Consistency limit
10%	0.42
20%	0.65
30%	0.80

4.3 Setting time:

\Calculating the initial and final setting time as per IS: 4031 (Part 5) – 1988. To do so we need Vicat apparatus conforming to IS: 5513 – 1976, Balance, whose permissible variation at a load of 1000g should be +1.0g, Gauging trowel conforming to IS: 10086 – 1982.In this, initial and final setting time is calculated for each 10%, 20%, and 30% cow dung ash percentages by adding to cement paste. In table.3 shows initial setting time and final setting time for adding 10% CDA is 49 minutes and 390 minutes. Similarly for adding CDA of 20% an initial and final setting time is 80 and 443 minutes.

For 30% adding CDA initial and final setting time is 127 and 490 minutes respectively. This shows by increasing the percentages of ash initial and final setting time is increasing, up to maximum of 490 minutes for 30%.

Table.3 Setting Time for Different CDA mix ratios

CDA %	Initial Setting time (Minutes)	Final Setting time (Minutes)
10%	49	390
20%	80	443
30%	127	490

4.4 Workability:

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 – 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod. In this test, the workability of concrete is determined for each different mixed proportions of cow dung ash to cement. In table.4 shows that for 10% of cow dung ash mixing gives workability of 50 mm and for 20% and 30% are 80mm and 100 mm respectively. Due to high percentage of water requirement the workability value increases by increasing the cow dung ash percentages.

Table.4 Workability of CDA in Various Percentages

CDA %	Workability (mm)
10%	50
20%	80
30%	100

CONCLUSION:

Performance of cow dung ash with concrete although seriously limited by its low compressive strength, cow dung ash concrete can be made to perform well in certain floor and wall applications. When CDA is mixed with concrete it requires more quantity of water while increasing the ash content. It performs well in when a limited percentage (up to 10%) can be used for floor applications or as a building component not subject to high structural stresses. It has serious limitations that must be understood before it is put to use. Within these limitations, the advantages of cow dung ash concrete offers lightness of weight, and low thermal conductivity make it a useful construction material. However, the strength of cow dung ash concrete when made in the most commonly used proportion is only 10 to 15 percent of that of normal concrete. It is not usable where high structural strength is required or where it would be subjected to heavy traffic and severe abrasive action. Its ash content also prohibits installation of lean mixes in environments of excessive moisture. However, strength is drastically reduced as the percentage of cow dung ash is increased. In general, cow dung ash concrete is not recommended for use where water accumulates or where water is constantly present. The specific gravity of cow dung ash is 2.The compressive and the flexural strengths of CDA concrete for the ages investigated such that the lowest values obtained at 30% additive level of ash. The initial and final setting time is increases by increasing the cow dung ash. This paper mainly highlights the significance and necessity of consumption of these waste materials for the manufacturing of sustainable concrete for construction of green buildings in future.

REFRENCES:

[1] Paramasivam, P. and Loke, Y.O., Study of Sawdust Concrete. Proc. Int. Conf. on Materials of Construction for Developing Countries, Bangkok, Thailand, pp. 169-179. (1978).
[2] Narang, K.C., Kini, M.R. and Canapathy, R., Development of masonry cements from industrial wastes.National Seminar on Building Materials., their Science and Technology, INSA, New Delhi, IIA(12), pp. l-18. (1982)
[3] Elinwa, AU and Ejeh, S.P. (2003).”Effects of the incorporation of sawdust waste incineration fly ash in cement pastes and mortars. Journal of Asian Architecture and Building Engineering, 1-7.
[4] Elinwa, A.U. and Mahmood, Y. A. (2002). “Ash from timber waste as cement replacement material. Cement and Concrete Composites, 24, 219 – 222.
[5] Ambroise, J., Murat, M. and Pera J. (1985), Hydration Reaction and Hardening of Calcined Clays and Related Minerals: V. Extension of the Research and General Conclusions. Cement Concrete Res. 15, pp. 261–268
[6] Dunster, A.M., Parsonage, J.R. and Thomas, M.J.K. (1999). Pozzolanic Reaction of Metakaolinite and its effects on Portland cement Hydration. J. Mater. Sci: 1345–1350.
[7] Caldarone, M.A. and Gruber, K.A. High reactivity metakaolin (HRM) for high performance concrete. Proceedings of Fifth CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete (V. M. Malhotra ed.). 1995, ACI Proceedings SP 153, 2, 815-827.
[8] Poon, C.; Lam, L.; Kou, S.C.; Wong, Y.; and Wong, R., “Rate of Pozzolanic Reaction of Metakaolin in High-Performance Cement Pastes”, Cement and Concrete Research, Vol. 31, 2001, pp.1301-1306.
[9] R. Siddique, J. Klaus, Influence of metakaolin on the properties of mortar and concrete: a review, Appl. Clay Sci. 43 (2009) 392–400.
[10] J.A. Kostuch, V. Walters, T.R. Jones, High performance concretes incorporating metakaolin: a review, in: R.K. Dhir, M.R. Jones (Eds.), Concrete 2000: Economic and Durable Construction Through Excellence, E&FN SPON, London, 1996, pp. 1799–1811.
[11] Dubey, A. and Banthia, N. “Influence of High Reactivity Metakaolin and Silica Fume on the Flexural Toughness of High Performance Steel Fiber-Reinforced Concrete" ACI Materials Journal Vol. 95 No. 3 May-June 1998.
[12] Smith, L.N. and W.E. Wheeler, 1979. Nutritional and Economic Value of Animal excreta. J. Anim. Sci., 48
[13] M.R. Karim, M.F.M. Zain, M. Jamil, F.C. Lai, M.N. Islam, 2011, Necessity and Opportunity of Sustainable Concrete from Malaysia's Waste Materials, Australian Journal of Basic and Applied Sciences, 5(5): 998-1006, 2011 ISSN 1991-8178.
[14] Mehta, 2004, “High-Performance, High-Volume Fly Ash Concrete for Sustainable Development”, International Workshop on Sustainable Development and Concrete Technology, May 20-21, Beijing, China.
[15] Mehta and Malhotra, V.M., 2002, High-Performance, High-Volume Fly Ash Concrete. Supplementary Cementing Materials for Sustainable Development, Inc., Ottawa, Canada, 101 pp.
[16] Meyer, 2005, Concrete as a green building material, Invited Lecture, Proceedings of the Third Int. Conference on Construction Materials, ConMat'05, Vancouver, Aug. 22-25.
[17] Paramasivam, P. and Loke, Y.O., Study of Sawdust Concrete. Proc. Int. Conf. on Materials of Construction for Developing Countries, Bangkok, Thailand, pp. 169-179. (1978).
[18] Narang, K.C., Kini, M.R. and Canapathy, R., Development of masonry cements from industrial wastes. National Seminar on Building Materials., their Science and Technology, INSA, New Delhi, IIA(12), pp. l-18. (1982)
[19] Elinwa, AU and Ejeh, S.P. (2003).”Effects of the incorporation of sawdust waste incineration fly ash in cement pastes and mortars. Journal of Asian Architecture and Building Engineering, 1-7.

[20] Elinwa, A.U. and Mahmood, Y. A. (2002). "Ash from timber waste as cement replacement material. Cement and Concrete Composites, 24, 219 – 222.

[21] Garg Anil Kumar and Mudgal Visha., "Organic and mineral composition of Gomeya (cow dung) from Desi and crossbred cow", International Journal of Cow Science, Volume : 3, Issue : 1&2, 2007