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Experimental Study of Effects of Nano Particles and Bio Fillers on Strength of Vedic Plaster

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***Abstract*—To minimize the negative impact on environment due to manmade construction materials it is now became the requirement of construction sector to develop energy efficient materials with enhanced durability by incorporating natural waste. From ancient periods, the people in rural villages have been using cow dung plaster for thermal comfort and ease of application. Due to low durability and less life span the cow dung plaster has not been utilized as the main construction material. Vedic plaster is commercially available plaster with cow dung in it among with various natural materials. The properties of vedic plaster such as less density, less heat exchange and requirement of no curing makes vedic plaster alternative to gypsum plaster. This paper shows effects of waste shell powder and graphene on vedic plaster. The test results showed average reduction in compressive strength of about 37% with addition of shell powder up to 10%. The prepared plaster composite can be used for various construction applications where non-load bearing, economical lightweight material is required. Even with changes in properties of vedic plaster the waste shell powder can be used to make components and can still be applied to walls of low cost houses because it satisfies minimum values stated in referred standards.**

***Keywords*— Vedic plaster, Graphene, Nano-particles, bio-filler, seashell, etc.**

I. Introduction

The human population is increasing day by day and so is the need of more houses. This puts lots of pressure on construction sector to construct houses at rapid rate while reducing cost of construction but also maintaining the quality of constructed houses. This increase in population also cause to increase in waste generation of various types. Recently lots of efforts are being made to incorporate waste materials into construction materials to reduce waste accumulation and also to reduce cost of construction with making it more environment friendly. There is lots of literature available on making core construction material i.e. Cement more environment friendly to reduce carbon footprint and mainly to reduce energy consumption during manufacturing. Plaster is layer of material which is applied on outside and inside of buildings and houses. That means it directly affects the heat transmission through walls. To reduce energy consumption of any house or structure insulation of structure is must. If there is no heat transmission from outside to inside and vice versa then that structure can be said energy efficient because most of the energy is required for heating or cooling. This means that the materials that we apply on the inside and outside of structure or house or building directly affects its energy consumption and requirement of heating and cooling.in current constructional practices gypsum plaster is used inside while cement plaster is used outside and there are no suitable alternatives to these materials. The main disadvantage of gypsum is that it can retain water where there is presence of dampness and brittleness but is widely used because of its smooth finishes and pleasing aesthetics. Vedic plaster is newly developed plaster which includes cow dung among other natural materials. Although there is lots of research already done on improvising gypsum and cement plaster there is very few literatures available on vedic plaster which is least explored material. The main reason of adding graphene into plaster is because of recent discoveries, graphene is proving to be the best construction material in terms of improving strength, physical properties of materials in which it is added. The more waste that can be incorporated in vedic plaster without affecting its minimum strength more economical it becomes from manufacturers point of view as seashell waste is abundantly available. This paper mainly focuses on effects of seashell powder and graphene on compressive strength of vedic plaster.

II. Experimental Plan

A. Materials

Vedic plaster is used as base material i.e. main material. Vedic plaster contains cow dung and gypsum among other natural materials according to manufacturers, also curing is not required or necessary as per manufacturers. It was first sieved to remove any lumps and to check freedom from coarse particles. The sample of 100gm was sieved through 1.18 mm standard IS sieve. The freedom from coarse particles was found out to be 4.89%. Even though cow dung is present in vedic plaster, no odour or smell of dung was perceived which was unexpected. Shell waste was obtained having average size of 3-4 cm as shown in Fig. 1. Any organic matter present in it was removed to avoid decomposition and adverse chemical reactions. Then the shell

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waste was finely powdered by small industrial grade crusher. Powder passing from 1.18 mm standard IS sieve was used further for mixing.

Fig. 1 shell waste

Fig. 2 shows Graphene-L that was used. It has pure low surface area. Graphene-L is derived by chemical exfoliation methods. The powder form of graphene was used to enable uniform dispersion of graphene in vedic plaster during dry mixing. The technical parameters of graphene used are tabulated in TABLE-I.

Fig. 2 Graphene-L

TABLE I
TECHNICAL PARAMETERS OF GRAPHENE-L

Graphene -L	**Description**
Purity	~99%
Thickness(z)	~5-10 nm
Number of Layers	5-10
Average Lateral Dimension (X&Y)	~10 µm
Surface Area	60-200*m^2/g
Bulk Density	0.45 g/cm^3
Chemical Formula	C
CAS No	7782-42-5
Physical Form	Fluffy, Very Light Powder
Odour	Odourless
Colour	Black Powder

B. Preparation of samples

The samples were prepared as per stated in IS: 2542 (Part II/Sec 1 to 8) – 1981. To get target strength, percentage of water for normal consistency first 6 trial samples were prepared out of which 3 were placed for curing up to 7 days while remaining three were kept in normal environment without curing to examine the effect of curing and no curing on strength of vedic plaster. The composition table prepared by reviewing literature regarding inclusion of waste shell powder and graphene. The optimum limit was obtained and variable proportions were prepared as tabulated in TABLE-II. To add Indian gum in vedic plaster in sample-6 it was kept inside water for soaking overnight and while mixing materials it was mixed with water for uniform distribution all over to get full effect.

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TABLE III
COMPOSITION TABLE

specimens	Shell powder content (%)	Graphene content (%)
Sample-1	-	-
Sample-2	5	-
Sample-3	10	-
Sample-4	15	-
Sample-5	15	1

In addition to above samples one extra set of specimens “sample-6” were prepared by mixing gahtti gum or Indian gum in water to observe effects on physical properties of vedic plaster.

C. Testing of samples

After 7 days of no curing the samples were tested for compressive strength. The speed of moving head of testing machine was kept less than 1mm per minute.

Fig. 3 preparation and mixing of materials

Fig. 4 casted specimens

Fig. 5 cube testing

III. RESULTS AND DISCUSSION

The lowest strength obtained with replacement of vedic plaster with 15% of waste shell powder which suggests further addition of shell powder will not only decrease the strength of existing plaster but unfit for any practical usage. The addition of Indian gum showed some promising results. Graphene was added only in sample 4 having 15% waste shell powder replacement because it resulted into weakest sample.the addition of graphene increased stregth of sample 5 significantly. The results of compressive strength test for various specimens are tabulated below. Addition of Indian gum resulted in more flow able mix than other samples but strength was decreased significantly than samples having only vedic plaster.

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TABLE IIIII
COMPRESSIVE STRENGTH TEST RESULTS

Sample no	Weight (gm)	Load (KN)	Strength (N/mm2)	Average Strength
1	485	15.40	3.05	3.16
	510	16.15	3.20	
	515	16.40	3.25	
2	483	7.72	1.55	1.88
	485	11.46	2.30	
	501	9.00	1.80	
3	478	10.95	2.17	1.9
	459	8.47	1.70	
	463	9.22	1.85	
4	455	2.50	0.49	0.46
	464	2.20	0.43	
	460	2.34	0.47	
5	452	6.15	1.22	1.50
	457	8.0	1.58	
	460	8.5	1.68	
6	471	7.07	1.42	1.62
	465	9.37	1.88	
	480	7.77	1.56	

The comparison of compressive strength of various samples is represented graphically in Fig. 6 for better understanding.

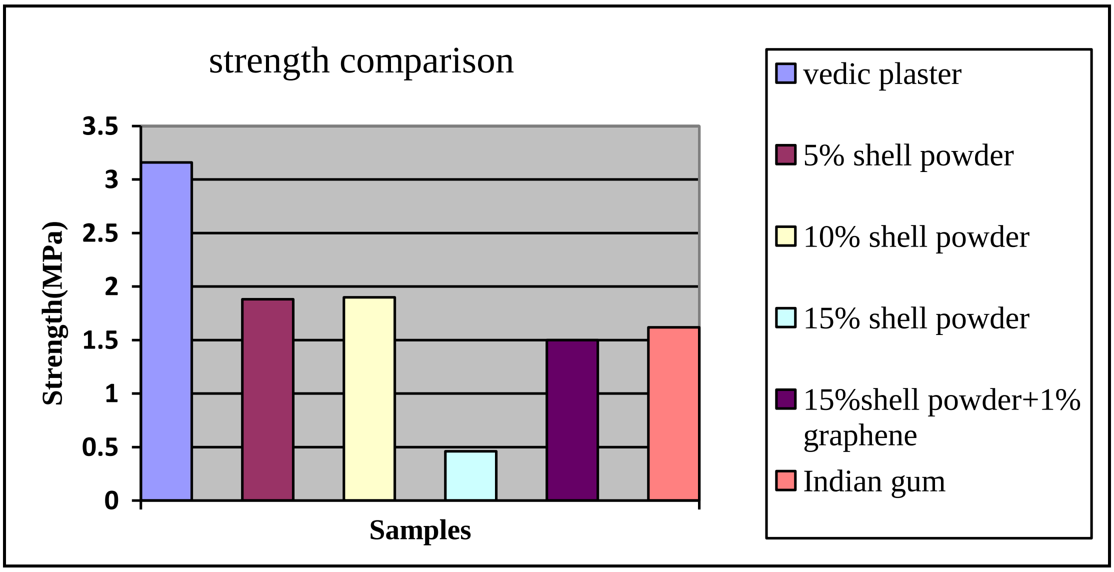

Fig. 6 comparison of compressive strength of various samples

From above results it is clear that addition of waste shell powder above 10-15% results in weaker specimens i.e. low compressive strength. Also minor shrinkage cracks are observed in sample 4 after applying to brick wall directly. No shrinkage cracks were observed in any other prepared samples. Due to addition of graphene in plaster the color of plaster changes to greyish black which might be unsuitable for aesthetic application like false ceiling. Usage of Indian gum resulted in to most flow able paste which can be used as spray able plaster.

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IV. CONCLUSION

1. The addition of waste shell powder in vedic plaster resulted into more flow able and increased set density as proportion of shell powder increase. The addition of waste shell powder up to 10% of weight of vedic plaster decreases compressive strength an average of 37%. The values obtained in the tests excepting sample-4 are sufficient to fulfil the minimum values stated in is 2547 (part-ii)-1976.

2. Addition of Indian gum water resulted into most flow able mix along with compressive strength of 1.6 MPa. This combination of material can be utilized as spray able plaster in some cases.

3. The test results also show that inclusion of graphene in weakest specimen can improve its strength significantly. Further study is required to assess methods of including graphene into plaster as increased percentage of graphene results in uneven dispersion of graphene particles.

4. The results show that such plaster/composite can accordingly be suitable for various applications such as walls of low cost housing or even in rural houses.it can be used in manufacturing components which will be non-load bearing and economical.

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