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Sustainable Controlled Low Strength Material without sand and chemical admixture by using Industrial Byproduct

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Abstract **- In India thermal power plant is a major power providing corporation, produce huge amount of west like pond ash which is hazardous to environment. It is necessary to dispose pond ash in environmental friendly manner like controlled low strength material(CLSM) is best solution. Conventional CLSM is the mixture of cement sand and some industrial west and chemical admixture to maintain properties of CLSM. study concern about sustainable CLSM which is the mixture of pond ash, blast furnace slag cement without Sand and chemical admixture. utilization of sustainable CLSM save our natural resource like sand. this paper presents detailed characterization of NTPC pond ash like physical, chemical, mineralogical, morphological and Engineering properties. In the present study different mix ratio 0.1, 0.3, 0.5, 1 and 2 consider for experimental feasibility study. CLSM made with different Percentages of water and cement. total 540 cylinder of size 75x 150 mm were cast as per ACI229R. Result obtain compressive strength varying from 2.2 Mpa to 12.5 Mpa. Density measure at time of casting is in the range of 990 to 1255 Kg/mm3. Flowbility varying from 170-310mm. Out of total 45 mixes, four efficient were selected which is the most feasible CLSM which can effectively use for structural fill application according to ACI229R. this successful utilization of pond ash and BFS in production of CLSM without sand and admixture is important to sustainable development of new CLSM. Based on the present investigation pond ash and BFS can be used as an alternate fine aggregate.**

Index Terms - Controlled low strength material (CLSM), Flowability, Pond ash, blast furnace slag, filling material.

1.INTRODUCTION

Controlled low-strength material (CLSM) one of the self-levelling and self compacting cementitious material for backfill used in place of compacted conventional fill [1]. CLSM also called as flowable fill self compacted backfill, slurry, soil cement, and flowable mortar etc.[2,3]. The application of CLSM has a broad range like structural fill conduit bedding, pavement base, trench backfilling, conduit bedding and void filling[4]. generally cost of CLSM is more than conventional granular backfill or compacted soil, but CLSM has many advantages include less equipment requirement (flowable) and less on-site labour and, speedy construction, the ability for use in the tight or confined access area. Generally, CLSM has sufficient strength and act as a substantial structural fill, backfill material. harden time depends on water content used in CLSM mixture, usually, CLSM mixture contains more water required more time of harden (in some cases 8–24 h). Ramme et al. [5] recommended scratching can be minimizing the use of more volumes of the fine grade material in CLSM. gypsum dry wall and pond ash are fine material use in proposed CLSM. Gypsum contains high contents of CaSo4 which is used as a binder[6]. gypsum dry wall board use in many innovative and architectural construction activity. dry wall resulting due to new or demolish existing old building are dumped nearby roadside and then landfilling [7]. it is reported that these dry wall release harmful h2S gas into the atmosphere. the problem of disposal of these dry wall become serious for the upcoming future. therefore these study overall focused on the use of gypsum dry wall in CLSM. waste generated from the thermal power plant is fly ash, pond ash and bottom ash. The bottom ash mixed with fly ash and these slurry disposed of in pond dykes near thermal power plant .this huge pond ash create posing threat to the area near the power plant. wet disposal method is the best method and mostly used industries.pond dykes required more land to store huge pond. In India where the ratio of land to population is small .this disposal of pond ash is not easy and suitable need some other disposal method. this is the need of present study.

Many studies carried out on CLSM in many countries like Canada United state of the kingdom, Australia Japan Koria and very few research was done in Asian countries such as India. Industrial waste and local waste mostly use in the construction of CLSM signify from most studies. studies show that local waste and the industrial byproduct is used in CLSM effective way to solve the disposal problem of waste. powdered gypsum, quarry dust, rise husk, pond ash, fly ash,

blast furnace slag, bagasse ash mostly utilise in CLSM in India. for example, Siddique studied spent foundry sand and industrial by product in CLSM[8-9], Chittoori utilise native high plasticity clay in construction of CLSM[10], Raghavendra used bagasse ash and also gypsum wall board and the blast furnace slag for CLSM.[11-14]. Uchibagle andRam Rathan Lal introduce gypsum dry wall in CLSM[15]. Horiguchi use incinerated sewage sludge ash used in the construction of CLSM [16].

The objective of this paper is to develop sustainable CLSM by using Industrial by product which can solve the problem of disposal of such industrial by product like local pond ash and blast furnace slag. In conventional CLSM Natural resources like sand is used which create the scarcity of sand in proposed CLSM no natural resources is used which is environment-friendly CLSM.

Properties of CLSM

Flowability: CLSM can flow easily on the time of placing at the site is the main requirement. CLSM can flow without segregation while pumping. Flowability is find out according to ASTM Standard

Unconfined compressive strength: Compressive strength is referred as unconfined compressive strength and it is depend on the different material use in the construction of CLSM.

Unit weight (Density): Density is found after mixing material for specified time then weight after filling in the mould with standard volume as per ACI 229 R.

Excavatability: In case where future excavation expected excavatability property of CLSM is important parameter for manual excavation compressive strength which is less than of 0.3 Mpa. by mechanical equipment CLSM required a compressive strength of range 0.3-0.7 Mpa.

MATERIAL

pond ash used for the construction of CLSM collected from the NTPC thermal power plant Mouda Nagpur Maharashtra India. the physical properties of pond ash are specific gravity 2.0. From standard proctor test result of maximum, dry unit weight is 1.3 gm/cc and optimum moisture content 16%. the coefficient of uniformity 5.7and coefficient of curvature1.17 which indicate that pond ash has good quality for use in filling the application. morphological characteristics of pond ash also calculated. fig 1 shows the SEM image of pond ash which indicate pond ash content rounded and spherical particle.

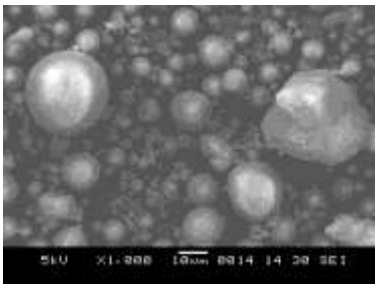

Fig1.
SEM image of pond ash

blast furnace slag collected from Sunflag industries Bhandara Maharastra India. %. consolidation test done on bfs shows the coefficient of consolidation 0.747 and compression index found to be 0.027. fig 2 shows the grain size distribution curve of BFS the cement ware used in the present work is ordinary Portland cement of grade 53. the normal tap water is used in the CLSM mix at normal room temperature.

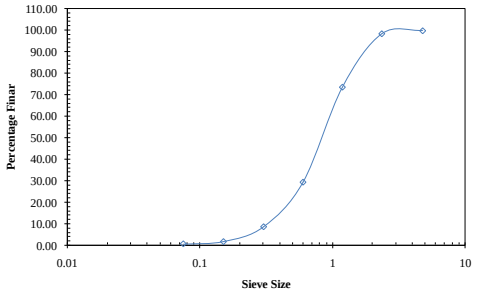

fig 2
grain size distribution of blast furnace slag

RESULT AND DISCUSSION

The ACI Committee 229 was frame up in 1985establish a report which includes applications, handling, performance, proportioning and placement of CLSM mixture for different application. as there is no other than this code available for CLSM since 1999, it is used for the present paper. Generally, for establishing the mix design of CLSM trial and error or past experience were used. In present paper, Mix ratio is defined the ratio of weight of cement wall to the weight of blast furnace slag The mix proportion of various CLSM mixture is shown in table 1.

Table 1.
Mix proportion

Mix Ratio (PA/BFS)	(Cement/BFS) %	Water Content %
10% (0.1)	10% ,20% ,30%	45%, 50%, 55%
30% (0.3)	10% ,20% ,30%	45%, 50%, 55%
50 %(0.5)	10% ,20% ,30%	45%, 50%, 55%
1	10% ,20% ,30%	45%, 50%, 55%
2	10% ,20% ,30%	45%, 50%, 55%

A. Compressive strength

The compressive strength of CLSM is a very important property and it is correlated to mix component of material as mainly CLSM is used as structural fill/ backfill. In the present study, a cylinder of size 75mmx150mm was used for testing compressive strength as per ASTM D4832 and ACI229R. the material is flowable so the cylindrical mould was covered by plastic and no vibration and rodding required for each mix total, 12 cylinder were casted for compressive strength test. the curing was done for 7, 14 ,28 and 56 days. The water content was maintained 45%, 50% and 55% for all CLSM mixtures. The moisture pond ash kept in the oven for 30 min. The mixture Cement by pond ash 0.1, 0.2 and 0.3. Volume of pond ash to volume of blast furnace slag is consider 0.1,0.3,0.5,1 and 2. Testing of CLSM mix sample shown in fig 3.

fig. 3
Testing for compressive strength

Fig.4 indicate the relation sheep between curing days and compressive strength for various CLSM mix M2C1S1(Volume of pond ash to volume of blast furnace slag is 0.3and volume of cement to volume of blast furnace slag is 0.1), M2C2S1 (Volume of pond ash to volume of blast furnace slag is 0.3and volume of cement to volume of blast furnace slag is 0.2)and M2C3S(Volume of pond ash to volume of blast furnace slag is 0.3and volume of cement to volume of blast furnace slag is 0.3) for 45% water content. The specimen was tested for 7days, 14 days, 28 days and 56 days. the result indicates that the pond ash and blast furnace slag used in CLSM mix affects the compressive strength. from the graph It can be noticed that the strength the CLSM mix increases as the curing period increases. the compressive strength increases as Vc/Vbfs ratio increases for all curing period. for M2C3S1 mix fulful the requirement for structural fill application as per ACI 229R and other mix can be utilize as a other filling material which required the compressive strength less than 8 MPa. The same graph was observed for all mixes, and the maximum compressive strength of 10.87 MPa was observed for mix M2C3S1 for 28 days curing. fig 5 indicate the graph for water content 55%. this graph also shows same trend as compressive strength increases as curing period increases. M2C3S3 and M3C3S3 are feasible for higher strength requirement filling application as per ACI229R. fig 6 represent graph between compressive strength and CLSM mix for Vpa/Vbfs ratio is 0.1 and Vw/Vbfs= 0.45, it clearly indicate as ratio increases the compressive strength increases for all curing period.

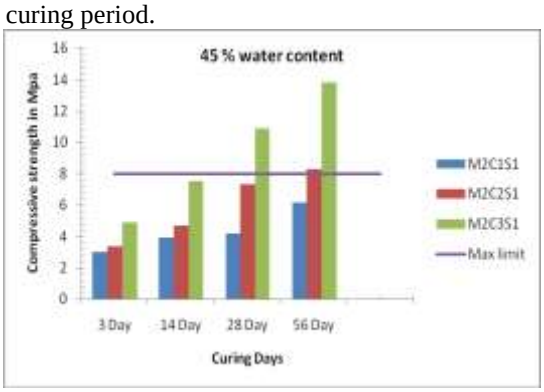

fig 4
compressive strengrth for Vw/Vbfs=0.45

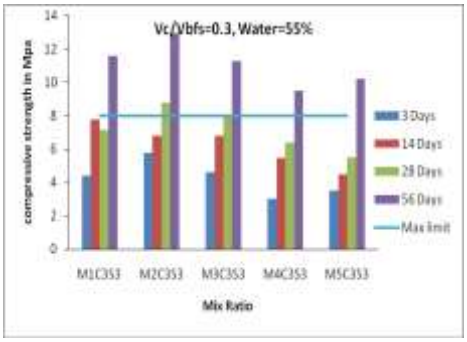

fig 5
compressive strengrth for Vw/Vbfs=0.55

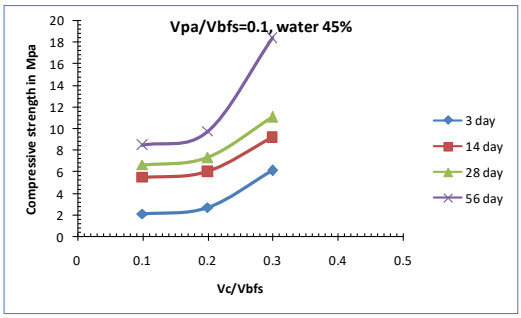

fig 6
compressive strengrth

B. *Flowability*

The test of flowability was conducted by using open-ended cylinder 75 mm x 150 mm according to ASTM D610. Measurement of flowability shown in the Fig. 4. and from Fig 5 it is cleared that when water content increases flowability increases and it was observed that flowability reduces by increasing cement content. flowability obtain in the range of 170 to 190 mm. result indicate that for all CLSM mix the flowability in the range of normal flowable as per ACI 229R. flowability measurment are shown in fig 7.

Fig 8 indicate the flowability increases as the Vw/Vbfs ratio increases.

fig 7
Flowability mesurment

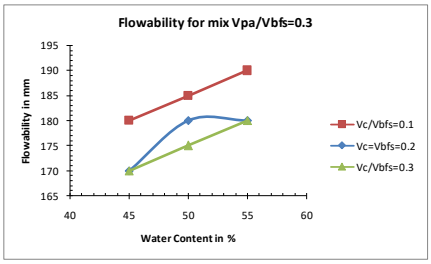

fig 8
Flowability

C Density

Dry density was measured after attending7,14 and 28 days curing at the time of testing. density were calculated by taking an average of densities of three cylinders. first weight of the cylinder was calculated accurately as well volume of cylinder were determine and Densities for mixtures calculated in kg/m3. Density measure at time of casting obtain is in the range of 990 to 1255 Kg/mm$^{3.}$ from fig 9 it is clear that that the density of CLSM mix Decreases as increasing water content.

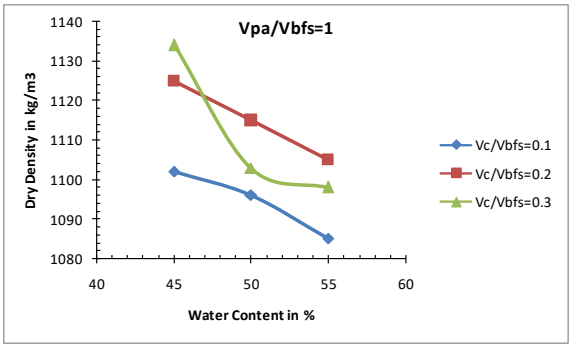

fig 9
density for CLSM mix

CONCLUSION

1. Compressive strength increases as curing period increases, and also when Vc/Vbfs ratio increases strength increases.
2. Pond ash and Blast furnace slag without sand and chemical admixture have the potential possibility to be used in controlled low strength material production by incorporating west and by elimination of and sand in CLSM production it will contribute to sustainable development by saving natural resources like sand and reducing landfilling demand.
3. The maximum compressive strength of 12.5 MPa was noticed for 28 day curing for and 2.2 MPa minimum compressive strength obtain.
4. mix having 0.2 and 0.3 ratio of volume of cement to blast furnace slag cab be used as a structural fill application and other Mix can be use as other filling application like pavement base, void filling, conduit bedding and backfill behind retaining wall according to ACI229R.
5. All CLSM mix in the range of Normal and high flowabilty 170- 310 mm according to ASTM D6103.
6. Density measure at time of casting obtain in the range of 990 to 1255 Kg/mm^3**.** Blast furnace slag enhances flowability of CLSM mix.

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