Optimization Of Expanded Polystyrene Beads (Flyash Geometrical)

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Abstract*— Fly ash production in India is in itself posing an environmental problem. Therefore it is necessary to consume.fly ash in a way that would be helpful in construction Of important civil structures. Like in Construction of embankments and backfilling behind retaining walls presents problems of settlement and stability. Use of appropriately strong but lightweight material in such constructions can solve many problems. Light weight factory manufactured expanded polystyrene (EPS) geo-foam blocks of standard sizes are being used in several countries (Norway, Netherlands, US, Japan, France, Germany, UK etc) since about 1990. Further development tin this res pect was a composite lightweight geo-material made from soil + EPS beads + 10 to 15 % cement. It's use in many geo-constructions started from about 2000. However, this lightweight geo-material technology has not yet found its plin geotechnical construction practice in our country. Various technologies and studies have indicated possible aspects of improvement in the improvement of the geo material of EPS- Fly ash. The following project work as we present before you is an investigations that are carried out in this respect and the outcome is presented. The proposed Geo-material has three main constituents namely fly ash (FA), EPS beads (B) and ordinary Portland cement (C).The fly ash is available in huge quantity in our country from several thermal power plants. This fly ash forms the main constituent of our proposed geo-material. The lightness of the material is accomplished by adding EPS beads in fly ash. A small quantity of cement is proposed to be used for development of strength parameters since fly ash in itself has no strength property. An intensive laboratory experimentation was planned involving testing of 105 samples of composite material of different proportions of three constituents and under four curing periods of 7, 14,21 and 28 days The increase of strength achieved by the use of proposed cement and EPS content was satisfactory. The proposed geo material could be used in frame structures. The Quality of EPS beads could also be used to resist the heat that usually pose a problem in the summers. The practical applicability of the experimental study could suggest newer ways of consuming the Fly ash and help in reducing the menance caused by it.

I. INTRODUCTION

1.1 General

Fly ash is the fine-grained dusty material that is recovered and collected from furnace flue gasses by electrostatic ash precipitators. Fly ash is a by product from coal based thermal power plants. It has been generally considered a waste material in the past and disposal of which has posed numerous ecological and environmental problems. However, recent researches have shown that fly ash has potential to act as invaluable ingredient in cement and concrete if used within the framework of prescribed specifications and quality systems. The fly ash is now considered as are source material rather than a waste in civil engineering and material science. In addition fly ashcan be gainfully used for various other applications .In developing countries like India power generation is most important requirement for economic and social development. At the time of independence in 1947, the installed capacity was 1,361MW, which has increased to 1, 87, 732 MW on 31 March, 2012. Out of it, 1, 10, 232 MW is thermal (Coal/Lignite) based and is responsible to cogenerate nearly 200 million tons of fly ash per year .In 12th Five Year Plan, the Planning Commission has set up target to enhance power capacity by89,000MW, out of which 53,400 MW will

come from Coal/Lignite based thermal power plants. By the end of 2017, the fly ash generation is expected to reach 300 million tons per year and likely to continue to grow with same pace at least for next two to three decades. The disposal of such large quantity of fly ash is indeed a challenge before all stakeholders. In this paper an effort has been made to outline the present status of generation, utilization and future strategy to increase effective use of this wonderful material.

1.2 Quality and Type of fly ash Available in India

There are two types of fly ash available, siliceous and calcareous depending upon the fuel used, coal or lignite respectively. The specifications of both are given in Indian standard IS: 3812 (Part I)2013 and they generally conforms to class 'F' and class 'C' fly ash respectively as per ASTM C618-(2012). In our Area of Nagpur region there is mostly presence of class F fly ash and hence the same has been used in our current project. The thermal plants for testing of fly ash were selected from North, South Central and East India covering large geographical area. It is seen that chemical properties like oxide composition, LOI ,insoluble residue, chloride content and reactive silica are in close proximity. The carbon content has shown variability. In modern thermal power plant new units like in Chandrapur, Simhadri and Singrauli, the carbon content is about 0.2% while in older plant units Badarpur and Tuticor in, it is about 0.9%.This may be due to change in technology of burning coal in boilers. However, the total carbon content in various fly ash samples is below 1%. The variation in Trace/ heavy metals is also not too large though sources of coal for these power plants are quite different. In all the chemical parameters, the quality of fly ash conforms to Indian Standard IS: 3812 (Part 1) -2013 with reasonable margin.

The physical properties like specific gravity, lime reactivity and soundness are also within very close range and within acceptable limits of IS: 3812 (part 1) — 2013. The fineness of fly ash varies depending upon the field of ESP from which it is drawn or a composite sample representing all the fields of ESP. IS 3812 (Part 1) — 2013 specifies minimum fineness of fly ash 3200 cm /g if it is directly mixed with OPC or used in. In our project we have used the fly ash from the koradi plant and tested it in Anacon Lab and performed test on cubes in the lab of Ramdeobaba college geotechnical lab. Fly ash constituted the major portion of our work. The cubes were prepared by using weight proportions. Fly ash being constant with change in the proportions of cement and EPS beads. The Main aim of the experiment was to find the compressive strength of fly ash cubes attained due to combination of OPC43 and EPS beads.

1.3 Use of fly ash in ready mix concrete and cements

The replacement levels of class F fly ash is 15-20% by Mass of the cementious material and for class C fly ash it is 15-40% fly ash by weight of cementious material.

1.4 Problems dues to Fly ash generation and its disposal

Disposal and management of fly ash is a major problem in coal-fired thermal power plants. Fly as The missions from a variety of coal combustion units show a wide range of composition. All elements below atomic number 92 are present in coal ash. A 500 MW thermal power plant releases 500 t ,Fly ash approximately every day. Particulate matter (PM) considered as a source of air pollution constitutes fly ash. The fine particles of fly ash reach the pulmonary region of the lungs and remain there for long periods of time; they behave like cumulative poisons. The submicron particles enter deeper into the lungs and are deposited on the alveolar walls where the metals could be transferred to the blood plasma across the cell membrane. The residual particles being silica (40—73%) cause silicosis. All the heavy metals generally found in fly ash are toxic in nature. Fly ash can be disposed-off in a dry or wet state. Studies show that wet disposal of this waste does not protect the environment from migration of metal into the soil. Heavy metals cannot be degraded biologically into harmless products like other organic waste. Studies also show that coal ash satisfies the criteria for Land fill disposal, according to the Environmental Agency of Japan. According to the hazardous waste management and handling rule of 1989, fly ash is considered as non-hazardous. With the present practice of fly-ash disposal in ash ponds (generally in the form of slurry), the total and required for ash disposal would be about 82,200 ha by the year 2020 at an estimated 0.6 ha per MW. Fly ash can be treated as a by-product rather than waste.

II. MATERIALS & SPECIFICATION OF MATERIALS

2.1 Cement:- Cement is used in varied proportions in the project. It has been used in proportion of 2% to 10% with respect to Fly ash which is kept at Constant of 4kg by weight per sample . For filling a cube of 15cm x 15 cm x15cm. The cement we have used is Ordinary Portland cement of grad e 43. 43 Grade Cement is the popular grade of Cement with low heat of hydration and long life of Concrete Structures. This grade of cement Develops a n early strength at 3 rd and 7 th day with exceptionally high 28 th day strength.

Table 3.1.1 :-BIS specification (or Opc 43 Grade of Cement as used in our proiect

Description	Unit(%)(max)
Insoluble Residue(IR)	3%
Magnesium oxide(Mgo)	6%
Sulphuric Anhydride(S03)	2.5% when C3A <5&3%when C3A>5
Loss of Ignition(Loi)	5%
Lime saturation Factor	0.66-1.02
Alumina iron ratio	0.66%(min)
Chloride	0.10%
Surface area	225(m2/kg)< min & gt;
Initial set	30 min
Final set	600 min

2.2 EPS BEADS: - EPS beads are colorless and consists polystyrene and dissolved pentane. EPS is non-biodegradable, chemically inert in both soil and water. EPS is hydrophobic in nature. It has closed cell structure which prevents absorption of water in it. It is highly compressible material available in different types for specific purpose. There are few compounds that dissolve EPS, for example, gasoline and diesel fuel.

2.3 EPS beads- EPS beads can be used as lightweight fill material in construction of embankments, abutments and backfilling of retaining walls. Various studies have been done on utilization of EPS beads as a fill material by blending them with soil and cement as a binder material.

Standard Specification for Expanded Polystyrene (EPS) - This specification covers the type, physical properties and dimensions of Expanded Polystyrene. The use of the Expanded Polystyrene by this specification is regulated by building codes. The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information purposes only. The following standards contain provisions which through reference in this text, constitute provisions of this American National Standard.

Table2.4 Physical properties of the EPS Beads.

Specific gravity	Bulk density	Particle Diameter
0.011	6860 g/cc	Spherical (8-9mm)

2.5 Fly ash — Fly-ash used in our project was made available to us from the koradi power plant which was tested by Anacon Lab. The results of the test confirmed our notion that the class of fly-ash was class F.

3.1 Mixing ratios

Mix ratio in our project can be defined as the ratio of Cement(C) to EPS Beads(B). The weight of the fly ash is taken constant for each sample and an additive ratio of concerned proportion is taken. If a constant Weight of Fly ash is taken as W, than for a mix of C/B, the weight of cement will be

Wc = (C/100) x W; and the weight of the beads will be (B/100) X W.

Therefore the total weight of the sample will be Wt=W + Wc + WB ; The cement content in our project was taken from 2% to 10% and EPS beads range was taken from 0.5% to 2%. From the previous studies as reported have taken different ranges and reported various values of strength after careful evaluation of all the result we had decided to use this particular range for our study since this mix combination were never used, therefore had a potential to vast application if mechanically tested for the use. We also tried for water content of 45% in various mix proportion and found that the workability was not

sufficient. Therefore we used water content of 50% of flyash. The sample was prepared by weigh mixing, all the items were measured and added. Mixing was done by concrete mixing machine as hand mixing could give erroneous result. Water content for the mixing was kept at 50% of weight of the Fly ash. The cubes were properly oiled grease and nuts were tighte of the filled cubes was done by using tamping rod in initial stage of the fill and later using table vibrator machine. Curing was done using gunny bags. Pond curing is not suggested as it would have led to the complete washout of the sample.

3.1 mixing of sample

3.2 casting of cube

4.1 Curing

Is the process of maintaining satisfactory moisture content and temperature in freshly cast specimen for a definite period of time immediately following placement. The process serves two major purpose:

- It prevents or replenishes the loss of moisture from the geofoam specimen.
- It maintain a favorable temperature for hydration to occur for a definite period

We cure geo foam specimen to maximize its strength i.e. increase structural integrity and reduce cracks.
Water curing can be done using following techniques:
a) Ponding
b) Immersion
c) Fogging
d) Wet covering

4.2 Ponding

It used to cure flat surface where water could be easily ponded. The best practice is to cure the shortly after the chemical reaction has started allowing the concrete to be hardened. Curing conditions will be maintained during the first 24 hours or at least until the setting time of cement has passed.

5.1 Compression testing machine

A compression test is any test in which a material experiences opposing forces that push inward upon the specimen from opposite sides or is otherwise compressed , “squashed”, crushed, or flattened. The test sample is generally placed in between two plates that distribute the applied load across the entire surface area of two opposite faces of the test sample and then the plates are pushed together by a universal test machine causing the sample to flatten. A compressed sample is usually shortened in the direction of the applied forces and expands in the direction perpendicular to the force. A compression test is essentially the opposite of the more common tension test.

5.1 Compression testing machine

Salient feature of compression testing machine are :
• High stability welded assembly
• 500 kN tensile and 1000 Kn compression capacity
• 100 mm piston stroke with safety limit switch
• Upper compression platen with ball seating assembly and lower platen included
• Set of two tensile grips and jaw faces included
• Platen hardness of min 55 HRC
• Distance pieces include

5.2 Tamping rod
The tamping rod is a round, straight steel rod used with concrete cylinder molds, slump cone sand unit weight tests. It measures 5/8″ diameter by 24″ length. Both ends are rounded to a hemispherical tip. Tamping rods are dimensionally accurate rods used to tamp fresh concrete into concrete cylinder molds and grout sample boxes to eliminate voids and excess air

5.3 Trowel
A hand trowel is a gardening tool which is designed for digging small holes, transplanting seedlings, planting bulbs, and performing similar tasks. Many gardeners find hand trowels immensely useful, and they are quite common in gardening sheds as a result.

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5.5 Cube mould
These Concrete Cube Mould are use for making Concrete /cement Cubes which are use for preparation of concrete cube specimens of high strength materials for compression testing. The standard size of concrete cube mould is 150 mm. the moulds for the specimens must be made of cast iron or cast steel.

5.6 Weighing machine
A weighing balance is an instrument that is used to determine the weight or mass of an object. It is available in a wide range of sizes with multiple weighing capacities and is an essential tool in laboratories, commercial kitchens and pharmacies.

5.7 Vibrating Table
The Vibrating table is entirely constructed of thick steel. The table top is made of thick mild steel plate and has stops along its edges to prevent moulds from walking off the table during operation

VI. RESULT

6.1 Test carried on the sample mix for compressive strength provided us a definite pattern for our study. The effect of Beads on Compressive strength and also the effect of curing period were studied under the project.

Table 6.2. compressive strength

sr. no.	C/B mix Ratio	Weight of flyash	Weight of Cement	Weight of beads	Total value calculated	Compressive strength %
1	10/1.5	4000	400	60	4460	33% 7 days
2	10/1.5	4000	400	60	4460	51% 14 days
3	10/1.5	4000	400	60	4460	82% 21 days
4	10/1.5	4000	400	60	4460	93% 28 days

The above combination is able to generate an ultimate strength of greater than 1000 KPA and hence can be recommended for use in the practical application on field.

6.3 Gain of strength with increase in the number of days.
The gain of strength was observed during entire period of our project work. We observed that the gain of strength during the initial period of 14 days varied from a range of 20 to 40% but the gain of strength varied from the range of 30% - 90 % from 14th day to 21 st Day and than a nominal increase in strength was measured from 21st day till 28th day. The following data is represented in the form of column charts as under.

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