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Experimental Study on Harden Concrete to Increase behaviour of Concrete to Increase its Strength by Copper Slag

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Abstract: *In this paper, a new MPPT technique is proposed which suggests a modified perturb and observe algorithm to reach fast to the MPP compared to the conventional perturb and observe technique. This work explains the PV equivalent circuit, current-voltage, power-voltage characteristics of photovoltaic systems and the operation of the some commonly used MPPT techniques.*

Keywords: MPPT techniques

I. INTRODUCTION

Coarse granular material (the fine and coarse aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. Concrete is widely used for making architectural structures, foundations, brick or block walls, pavements, bridges or overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure.

The amount of concrete used worldwide, ton for ton, is twice that of copper, wood, plastics, and aluminum combined. Concrete's use in the modern world is exceeded only by that of naturally occurring water. Concrete is also the basis of a large commercial industry. Globally, theready-mix concrete industry, the largest segment of the concrete market, is projected to exceed $100 billion in revenue by 2015. In the United States alone, concrete production is a $30-billion-per-year industry, considering only the value of the ready-mixed concrete sold each year

Need of copper slag in construction industry

The aggregates typically account about 75% of the concrete volume and play a substantial role in different concrete properties such as workability, strength, dimensional stability and durability. Conventional concrete consists of sand as fine aggregate and gravel, limestone or granite in various sizes and shapes as coarse aggregate. There is a growing interest in using waste materials as alternative aggregate materials and significant research is made on the use of many different materials as aggregate substitutes such as coal ash, blast furnace slag, and copper slag aggregate. This type of use of a waste material can solve problems of lack of aggregate in various construction sites and reduce environmental problems related to aggregate mining and waste disposal. The use of waste aggregates can also reduce the cost of the concrete production.

Copper Slag

Copper slag is a byproduct obtained the metal smelting and refining of copper. Copper slag used in this work was brought from Sterlite Industries Ltd (SIL), Tuticorin, and Tamilnadu, India. SIL is produced per day and a total accumulation of around 1.5 million tons. It is a byproduct obtained during the metal smelting and refining of copper. To produce every ton of copper approximately 2.2-3.0 tons copper slag is generated as a byproduct material. Utilizationof copper slag in application such as Portland cement substitution and as aggregates has threefoldadvantages of eliminating air pollution problems. The countermined copper slag has to be properly treated or washed to meet

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certain recycling criteria before it can be further used for other application. The products of one ton copper generates approximately 2-3 tons of copper slag

Copper slag is the toxic for environment because it contains large amount of heavy metals in their oxide. Separated impurities are collected and removed and various substance are added to purified metal which melt it and enrich it, and in those processes slag is generated again as a byproducts. This type of generated slag depends on the method of cooling of the melted mass on the type of processes metal. The production of granulated copper slag sized grains are created. Due to its composition, this material has excellent hydraulic properties and in the presence of an appropriate will behave in a manner similar to Portland cement. Expanded for any slag is more porous and has a smaller volume than air cooled slag. The current quantity of copper slag is estimated at approximated 2.2 million tons. A large quantity of this material on landfill and its potential as a substitute for traditional material has investigated to carry out research into the possibilities of various applications of slag construction primarily as aggregate in concretemixtures.

Fig.1.1 Copper Slag

Problem statement

Construction industry is a global industry. Nashik is one of the fastest growing cities in India. Therefore demand for natural sand increases. As this sand is used in large amount in the construction of building, road, etc. of concrete. The demand of natural sand is high as the naturalsand sources are limited, availability of natural sand is difficult and also cost is increasing. So copper slag is better alternative to partially or fully replacement of natural sand. Copper Slag is used for enhance the durability and produce high performance concrete.

Objective

The principal aim of this project is to explore the possible use of copper slag in future building construction and road pavement. Therefore To meet the overall aim of project, the following tests are carried out.

- Slump cone test
- Compaction factor test.
- Vee consistometer
- Flow table test

Scope of project work

Nashik is a fastest growing city in the India, so construction of building is growing rapidly. For construction of building sand is an important material. The availability of natural sand is limited and cost is also high, so it is uneconomical. Therefore it is better to find alternative material for natural sand. Copper slag is a better alternative for sand aggregate. The cost of copper slag is less than natural sand so it is economical to use in construction of concrete structure. By

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using copper slag in concrete construction the durability of concrete is increases and produces a high performance concrete

II. LITERATURE REVIEW

Mohammed Nadeem, Dr. A.D. Pofale (2012)

Studied on "Replacement Of Natural Fine Aggregate With copper Slag - A Waste Industrial By-Product In Cement Mortar Applications As An Alternative Construction Materials." In this investigation, cement mortar mixes 1:3, 1:4, 1:5 & 1:6 by volume were selected for 0, 25, 50, 75 & 100% replacements of natural sand with granular slag for w/c ratios of 0.60, 0.65, 0.70 & 0.72 respectively. The study gave comparative results for mortar flow behaviors, compressive & split tensile strengths, brick mortar crushing & pulls strengths and their co-relations. The study comprises of The experimental results obtained show that partial substitution of ordinary sand by slag gives better results in both the applications i.e. masonry & plastering. The sand replacement from 50 to 75% improved mortar flow properties by 7%, the

compressive strength improved by 11 to 15 % for the replacement level from 25 to 75%. At the same time brick mortar crushing & pull strengths improved by 10 to 13% at 50 to 75% replacement levels. The co-relation between mortar compressive/split tensile strengths and brick crushing/pull strengths shows linear dependencies on each other's. The study concluded that granular could be utilized as alternative construction material for natural sand in masonry & plastering applications either partially or fully

Mohammed Nadeem, Arun D. Pofale (2012)

This is project of "Experimental investigation of using copper slag as an alternative to fine aggregates (coarse and fine) in concrete." These project present results of experimental investigations carried out to evaluate effects of replacing aggregate (coarse and fine) with that of slag on various concrete properties. The basic objective of this study was to identify alternative source of good quality aggregates which is depleting very fast due to the fast pace of construction activities in India. Use of slag - a waste industrial byproduct of iron and copper production provides great opportunity to utilize it as an alternative to normally available aggregates (coarse and fine). In this study, concrete of M20, M30 and M40 grades were considered for a W/C ratio of 0.55, 0.45 and 0.40 respectively for the replacements of 0, 30, 50, 70 and 100% of aggregates (Coarse and Fine) by slag. Whole study was done in two phases, i.e. replacement of normal crushed coarse aggregate with crystallized slag and replacement of natural fine aggregate with granular slag. The investigation revealed improvement in compressive strength, split tensile and flexure strength over control mixes by 4 to 8 %. The replacement of 100 % slag aggregate (coarse) increased concrete density by about 5 to 7 % compared to control mix. Based on the overall observations, it could be recommended that slag could be effectively utilized as coarse and fine aggregates in all the concrete applications.

R. padmapriya, V.K. Bupesh Raja (2014)

In this research they studied on "Replacement of fine Aggregate by copper Slag in Concrete." The aim of experiment is to use of more and more environmental friendly materials in any Industry in general and construction industry in particular, is of paramount importance. Crushed sand as a replaced material to natural sand has become beneficial and is common in the world. This helps in reducing the likely damage to the ecological balance due excessive sand lifting from river beds, affecting the ground water level. Preventing the depletion of natural resources and enhancing the usage of waste materials has become a challenge to the scientist and engineers. The world copper industry produces about 780 Mt of crude copper and an average of about 400 Kg of solid by products is generated in the copper industry per tonne of crude copper. The present investigation deals with usage of copper slag as a partial replacement coarse aggregate and M-Sand to fine aggregate respectively. Initially the optimum percentage copper slag to be replaced is found out by conducting 28 days compressive strength on cubes of size 150 mm x150mmx150mm with 20%, 40%, 60%, 80% replacement of coarse aggregate by copper slag. With these optimum percentage of copper slag the hexagonal shaped paver block specimens of side 125mm and height 80mm were casted and tested for its compressive strength, split tensile strength, flexural Strength and water absorption tests. It is found that replacement of river sand by 25% M sand

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and coarse aggregate by 40% copper slag gives the maximum strength and is most suitable for areas not exposed to marine conditions.

S.P Palanisamy, G. Maheswaran, M.G.L. Annaamalai (2014-15)

In this research they studied the "copper Slag to Improve the High Strength of Concrete." A Copper slag is an industrial by-product of copper industry. It possesses the problem of disposal as waste and is of environmental concern. The results were compared with conventional concrete property can be maintained with advanced mineral admixtures such as copper slag powder as partial replacement of cement 0 to 40%. Experiments were conducted to determine the compressive strength; split tensile strength of concrete with various percentages of copper slag aggregate. Compressive strength of copper slag concrete with different dosage of slag was studied as a partial replacement of cement. From the experimental investigations, it has been observed that, the optimum percentage of copper slag for high strength concrete.

III. METHODOLOGY

Material Investigation and Mix Proportion

3.1 Cement

The Ultratech 53 grade cement was used in this study. Ordinary Portland cement is manufactured by intimately mixing together calcareous and argillaceous materials, burning at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of compiling the chemical and physical requirement given in IS: 12269-1987.

The first step in the cement manufacturing process is obtaining raw material. Generally raw materials consist of combinations of lime stone, shell or chalk, clay, sand or iron-ore. It is brought from mined near the plant. Once the raw material to arrive at the cement plant, the materials are proportioned to create a cement with a specific chemical composition. Powder is made by 85% lime stone, 13% clay and 2% latrite are crushed in raw mills. The powder is sent in blending cello and mixed with the help of air pressure. Then it is stored in storage cell.

3.1.1 Consistency Test Vicat Apparatus

(Standard Consistency) Purpose:

It is used to determine the standard consistency, initial and final setting of cement (As per IS 4031 – Methods of physical tests for hydraulic cement).

Brand Of Cement – Ultratech

Grade Of Cement – 53 Grade OPC Observation Table:

Table no 3.1 Standard Consistency test

1	Wt of sample in gm	300 gms	300 gms	300 gms
2	Water added in ml	85	86	86
3	Reading in mm	8	6	6
4	Water % for consistency	28.33	28.67	28.67
5	Selected consistency		28.67	

Calculation:

% of water (P) = W/C x 100Where,

W = quantity of water added C

= quantity of cement used

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Requirement
As per (IS 4031, part 5 1988, 2000) the standard consistency is obtained when theplunger penetrate to a point 33 to 35 mm from top of vicat mould.

Result
The percentage by weight of water required to make a paste of cement of normalconsistency is P = 28.67
Setting Time VICAT APPARATUS
(Initial setting time of cement)

Observation table

Table no 3.2 Initial and Final setting time of cement

1	Starting time in hrs	10.10 am
2	Initial setting time in hrs	12.45 am
3	Final setting time in hrs	2.20 pm
4	Initial setting time in min	155 min
5	Final setting time in min	250 min

Result
Initial setting time of given cement sample is 155min and final setting time is 250 min.
Requirement
As per IS the initial setting time shall not be less than 30 min and final setting time shallnot be greater than 10 hrs
Fineness
Purpose:
To find out the quantity of course material present in cement.
Reference:
I.S.269-1989: specification for ordinary Portland cement and low heat cement
Apparatus:
90micron IS sieve, weighing balance with weight, tray, wire, brush etc.
Observation table

Table no 3.3 Fineness test

1	Sample taken in W1 gm	100	100	100
2	Passing through is 90 micronSieve	98.14	97.99	98.04
3	Retained on is 90 micron sieveW2 gm	1.86	2.01	1.96
4	Fineness (%) (W2/W1 X100)	1.86	2.01	1.96
5	Average			1.94%

Result
Percentage of residue of cement by dry sieving (i.e. fineness) is 1.94%.

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Requirement
As per IS 269 – 1989, the fineness of cement by dry sieving should not exceed 10% by weight as in case of ordinary Portland cement and should not exceed 5% for rapid hardening cement

Fine aggregate
The fine aggregate used in this investigation was clean river sand and the following testswere carried out on sand as per IS: 2386- 1968 (III).
The sieves are used for the determination of particle size distribution of fine aggregate bysieving. (As per IS 2386 part 1 – Methods of test for aggregates for concrete).

Sizes of sieves :
Sieves of the sizes 10mm, 4.75 mm, 2.36 mm, 1.8mm, 600 mic., 300 mic., and 150 mic.

Physical properties of copper slag
Copper slag is black glassy and granular in nature and has a similar particle size range like sand. The specific gravity of Indian slag lies between 3.4 and 4.1. The bulk density of copper slag varies between 1.9 to 2.15 kg/m^3 which is almost similar to the bulk density of conventional fine aggregate. Table 4.5 shows physical properties of copper slag. The free moisture content present in slag was found to be less than 0.5%. Gradation test was conducted on copper slag and sand showed that both copper slag and sand had comparable particle size distribution as shown in Table 4.4 However, it seems that sand has higher fines content than copper slag.
Tests to determine specific gravity and water absorption for copper slag and sand were carried out in accordance with ASTM C128. The results presented in Table 4.2 shows that copper slag has a specific gravity of 3.91 which is higher than that of sand (2.57) and OPC (3.12) which may result in production of HPC with higher density when used as sand substitution. Table 4.4shows sieve analysis report for various proportions of sand by copper slag. Table shows that the measured water absorption for copper slag was 0.16% compared with 1.25% for sand. This suggests that copper slag would demand less water than that required by sand in the concrete mix. Therefore, it is expected that the free water content in concrete matrix will increase as the copperslag content increases which consequently will lead to increase in the workabilityof the concrete.
The presence of silica in slag is about 26% which is desirable since itis one of the constituents of the natural fine aggregate used to normal.

Specific Gravity
IS: 2386 PART III
Specific gravity test for coarse aggregatePurpose **:**
The pycnometer is used to determine the specific gravity of aggregate as per IS 2386 partIII – Methods of test for aggregates for concrete

OBSERVATION TABLE

Table No 3.16 Flakiness index

Sieve size(mm)		Wt. of Agg. 200 pieces	Wt. of Agg. Pass	Wt. of Agg. retaine	Total % age Flacky	Wt. of Agg. retaine	Wt. of Agg. Pass through	Total %age elongate
Passing	Retained							

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		(A) (gm)	throug H thk gauge (B) (gm)	d on thk gauge (C) (gm)	Agg. (D)=100 *(B/A) (%)	d on length gauge (E) (gm)	length gauge (F) (gm)	d Agg. (G)= 100*(E/ E+F) (%)
25.0	20.0	0	0	0	0.00	0	0	0.00
20.0	16.0	1919.5	65.5	1854	3.41	112	1742	6.04
16.0	12.5	997.5	67.5	930	6.77	176	754	18.92
12.5	10.0	484	43.5	440.5	8.99	107.5	333	24.40
10.0	6.3	195	27	168	13.85	48	120	28.57
Total	**wt.**	3596	203.5	3392.5	5.66	443.5	2949	13.07

Max. Size: 20mmResult
Flakiness index (F.I) = Sum of D =5.66% Elongation index (E.I.) = Sum of G = 13.07% Combined flakiness & Elongation index = 18.73%**Physical properties of coarse aggregate**

Table No.3.17 Physical properties of coarse aggregate

Property	Value
color	Dark gray
Specific gravity	2.79
Water absorption	0.26%
Flakiness index	5.66%
Elongation index	13.07%

IV. EXPERIMENTAL SETUP AND PROCEDURES

Experimental work

Workability: Workability is a measure of the ease with which a fresh mix of concrete or mortar can be handled and placed. For various mixes the concrete were prepared. In the fresh concrete, the slump cone test and compaction factor test were carried out

Slump cone test: The slump test result is a measure of the behaviour of a compacted inverted cone of concrete under the action of gravity as per IS 1199. It measures the consistency or the wetness of concrete.

Compacting factor test: Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS 1199 [13]. The apparatus used is Compacting factor apparatus.

V. RESULTS

Table 5.1 Test results for slump cone compacting factor

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Replacement of fine Aggregate.	Slump(mm)	Compacting Factor	Degree of Working
0	26	0.82	Low
8	27.5	0.86	Low
16	30	0.88	Low
24	32.5	0.50	Low
32	34.5	0.92	Low
40	36	0.96	Low
48	38.5	0.99	Low

Table 5.2 Test result for Vee consitometer

Copper Slag (%)	Vee Bee Time (sec.)
0	13.6
8	12.4
16	12.1
24	10
32	9.4
40	9.1
48	8.6

VI. CONCLUSION

From the Result and Discussion the following conclusions were made;

Replacement of fine aggregate using copper slag in concrete increases the density ofconcrete thereby increases the self-weight of concrete.

The workability of concrete increases by increase in copper slag content with fineaggregate replacement at same water cement ratio.

The construction industry is the only area for safe use of waste materials, which reducethe environmental problems, space problems and cost of construction

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