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+91 99405 72462



+9163819 07438



ijmrsetm@gmail.com



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Experimental Study on Utilization of Copper Slag as a Partial Replacement of Fine Aggregate in Concrete

C.VIGNESH, MR.M.SELVA BHARATHI, M.E.,

Department of Civil Engineering, Jayam College of Engineering and Technology, Nallanur, India

Assistant Professor, Department of Civil Engineering, Jayam College of Engineering and Technology, Nallanur, India

ABSTRACT: Sustainability and resource efficiency are becoming increasingly important issues in today's construction industry. This study reports the potential use of granulated Copper slag from Sterlite Industries as a replacement for sand in concrete mixes. The effect of replacing fine aggregate by copper slag on the compressive strength and split tensile strength are studied in this work.

The share alternative of sand by granulated copper slag will be 0%, 10%, 20%, 30%, 40% and 50%. Nowadays one of the primary trouble in building industries is inadequate and unavailability of development materials. In this experimental study, an effort has been made to use copper slag in concrete and research has been carried out to center of attention on the behavior of flexural and compression participants underneath a range of proportions of copper slag.

The goal of the challenge is to examine the compressive and break up tensile energy of the ordinary concrete with that of concrete made with the aid of partial substitute of satisfactory combination with Copper slag.

I. INTRODUCTION.

1.1 GENERAL

Concrete is a composite fabric composed broadly speaking of water, aggregate, and cement. Sand is an essential cloth for the guidance of concrete. Nowadays, the demand of natural sand is very excessive in the creating international locations like India, due to the massive utilization of concrete to fulfill the speedy infrastructure growth. In India, there is a serious chance to surroundings and society due to massive utilization of natural sand deposits. Rapid extraction of sand from river mattress reasons many troubles like loss of vegetation, reducing of water desk and additionally it motives disturbance to aquatic life. The price of the sand has accelerated due to its demand. Because of this condition, researches started cheaply accessible fabric as an choice for natural sand. Utilization of industrial waste or secondary fabric has extended in building discipline for the concrete manufacturing due to the fact it contributes to lowering the consumption of natural resources.

So researchers developed waste administration techniques to observe for alternative of satisfactory aggregates for particular need. To produce each and every ton of copper, about 2.2 to three heaps of copper slag is generated as a spinoff material. Currently about 2600 heaps of copper slag is produced and a whole accumulation of round 1.5 million tons. As the copper settles down in the smelter, it has a greater density, impurities continue to be in pinnacle layer and then transported to a water basin with a low temperature for solidification. The cease product is a solid, challenging fabric that goes to the crusher for similarly processing. Copper slag is a spinoff got all through the mattes melting and refining of copper. Copper slag used in this work was once added from Sterlite Industries Ltd (SIL), Tuticorin, Tamil Nadu, India. The use of copper slag in cement and concrete affords possible environmental as nicely as financial advantages for all associated industries, mainly in areas the place a massive quantity of copper slag is produced.



COPPER SLAG



II. LITERATURE REVIEW

2.1 LITERATURE STUDIES BASED ON CONCRETE WITH COPPER SLAG

J. T. Shahu, S. Patel and A. Senathipathi The fundamental goal of the current find out about is to quantify the affect of vital elements such as fly ash content, dolime content material and curing duration on the shear electricity and stiffness traits of copper slag–fly ash–dolime (CFD) combine for its nice utilization in the base path of bendy pavements. Unconfined compression checks are carried out on specimens with one of a kind fly ash (10–40%) and dolime (0–20%) contents cured up to 28 days. A combine of 20% fly ash and 80% copper slag stabilized with 15% dolime used to be observed to be the most suitable for use in the base route of bendy pavements.

Next, sturdiness assessments and unconsolidated undrained triaxial checks are carried out on the foremost mix. The energy accomplished after 28 days of curing duration for the choicest combine used to be observed to be least inclined to the impact of alternate moist and dry cycles. Empirical relationships are developed to estimate vital diagram parameters such as deviator stress at failure, elastic modulus, and concord of the stabilized mix, which can be used to decide dolime and fly ash contents to attain a goal electricity inside a given curing period. Finite-element analyses of a five-layer bendy pavement device are carried out; and the equal thickness, provider lifestyles ratio, and cost-effectiveness of CFD combine in relation to the traditional water-bound macadam (WBM) layer are evaluated

James S. Gidley, A. M. William and Sack M A established survey of waste utilization in building is made from an environmental engineer's factor of view. Generic environmental affects are reviewed with a view to the choice influences of waste disposal. Applicable Federal policies are temporarily reviewed. The environmental affects of 5 important building makes use of are discussed.

ceramics and insulation, concretes, aggregates, development metals, and embankments, avenue base and landfills. Techniques of mitigating these affects are additionally discussed. The most essential environmental influences show up to be dusting and leaching; each of these are considerably mitigated by means of solidifying the waste. On the whole, environmental issues strongly prefer extra significant waste utilization in construction, even though precise wastes can also be too unstable to use.

Joo-Hwa Tay, Sze-Yunn Hong and Kuan-YeowShowIndustrial sludge is generated at a fee of one hundred metric tons/day, from a copper slag recycling plant. The industrial sludge is presently being landfilled. However, restrained availability of landfill web sites has raised the want of an choice disposal. A renewed hobby in changing the industrial sludge into development substances has been triggered to gain a attainable disposal choice in saving the depleting herbal sources of uncooked substances as nicely as the environment. This find out about describes the use of sintered sludge pellets as a entire substitute for ordinary granite aggregates in concrete.

The pelletized sludge was once fired to a temperature of 1,135°C at which the sintering method occurs, producing a challenging fused basalt-like mass. In evaluation with everyday granite aggregates, the sintered sludge pellets show a greater mixture strength, a greater porosity, and a decrease mixture density that manifests attributes higher than that required of building aggregates. The concrete solid with the pelletized aggregates finished a compressive power of 38.5 N/mm² after 28 days and used to be same to the manipulate specimen. Leaching checks performed on the sludge pellets and concrete confirmed that all leachate infection ranges decided the use of the column leaching take a look at are inside perfect levels after a hundred thirty days of stabilization. The experimental effects indicated that a whole alternative of traditional aggregates with sintered sludge pellets for structural concrete is each technically and environmentally feasible.

B. Jaivignesh, R. S. GandhimathiIn the contemporary world, most of the herbal assets are depleting swiftly due to their excavation at a excessive rate. In that manner, the assets for the development substances are unexpectedly depleting and



accordingly their value is also increasing.

Hence, the lookup is to be accomplished for discovering out the choice substances for cement, sand, and coarse aggregate. In this paper, copper slag as substitute of nice combination is tried out to discover the most fulfilling share of replacement. The predominant goal of this paper is to locate out choice cloth for concrete to meet the needs of best combination for the upcoming years, to furnish enough power at minimal cost, to make the eco-friendly structures. This paper describes the most advantageous stage of substitute for electricity and sturdiness of concrete through changing extraordinary share of copper slag by way of weight of great mixture for a combine M30 grade concrete for locate out the ideal ratio of copper slag.

R R Chavan & D B Kulkarni This paper reviews on an experimental application to check out the impact of the usage of copper slag as a substitute of satisfactory combination on the electricity properties. Copper slag is the waste cloth of matte smelting and refining of copper such that every ton of copper generates about 2.5 lots of copper slag. Copper slag is one of the substances that is viewed as a waste which may want to have a promising future in development Industry as partial or full replacement of aggregates.

For this lookup work, M25 grade concrete used to be used and assessments had been performed for a number proportions of copper slag alternative with sand of zero to one hundred percent in concrete. The received outcomes had been in contrast with these of control concrete made with everyday Portland cement and sand.

Jayapal Naganur¹, Chethan B. A Utilization of industrial waste or secondary substances has motivated in development enterprise for the manufacturing of concrete due to the fact it make a contribution to decreasing the consumption of herbal resources. Copper slag is one of the substances that is regarded as a industrial waste which can be used in building Industry. This paper offers the outcomes of an experimental investigation on the residences of concrete the usage of copper slag as partial alternative of first-class aggregate.

For this lookup work, M20 grade concrete used to be used and exams wereincreased considerably as copper slag share make bigger in contrast with the manage mixture. A substitution of up to forty to 50% copper slag as a fantastic combination yielded similar power to that of the manage mixture. However addition of copper slag extra than 50% resulted in energy discount in contrast to traditional concrete.

D. Brindha and S. Nagan Sustainability and useful resource effectivity are turning into growing vital troubles inside today's development industry. This learn about reviews the manageable use of granulated copper slag from Sterlite Industries as a alternative for sand in concrete mixes. The impact of changing quality mixture by means of copper slag on the compressive electricity and cut up tensile electricity are tried in this work.

Leaching research exhibit that granulated copper slag does no longer pave way for leaching of dangerous factors like copper and iron existing in slag. The share alternative of sand by using granulated copper slag have been 0%,5%,10%,15%,20%,30%,40% and 50%. The compressive electricity used to be located to extend by way of about 3540% and cut up tensile energy by way of 3035%. The experimental investigation confirmed that proportion substitute of sand by way of copper slag shall be up to 40%

Ansu John and Elson John This paper highlights the feasibility learn about on the utilization of induction furnace slag as an choice for traditional quality aggregate. In this find out about the compressive power traits of mortar and concrete made with partial substitute of exceptional mixture the usage of induction furnace slag was once considered. For the experimental investigation, mixes had been organized with great mixture alternative the use of 20 percent, 30 percent, forty percent, 50 percentage and 60 percentage induction furnace slag. Compressive energy check on mortar and concrete had been carried out and the check effects indicated that first-rate combination alternative the use of 30 percentage induction furnace confirmed a higher overall performance compared to manage mix.

Meenakshi Sudarvizhi. S, Ilangoan. R The improvement of building substances have posed troubles and task that initiated international lookup applications and persevered traditional and non-conventional functions main to closing economy. Researchers developed waste administration techniques to practice for benefits for precise needs. The use of Copper Slag (CS) and Ferrous Slag (FS) in concrete offers environmental as nicely as financial advantages for all associated industries, in particular in areas the place a huge quantity of CS and FS is produced. Owing to the shortage of quality combination for the training of mortar and concrete, partial substitute of CS and FS with sand have been attempted. CS and FS are by-products acquired throughout matte smelting and refining of CS and FS. This work reviews an experimental process to look into the impact of the use of CS and FS as partial alternative of sand.

The energy traits of traditional concrete and slag concrete such as compressive strength, tensile power have been found.



Six sequence of concrete combos had been organized with distinctive proportions of CS and FS ranging from 0% to 100%. The take a look at consequences of concrete have been received with the aid of including CS and FS to sand in more than a few percentages ranging from 0%, 20%, 40%, 60%, 80% and 100%. All specimens had been cured for 7, 28, 60 & ninety days earlier than compression electricity take a look at and splitting tensile test. The effects point out that workability will increase with amplify in CS and FS percentage. The best compressive electricity bought was once 46MPa (for one hundred percent replacement) and the corresponding electricity for manage combine was once 30MPa. The built-in strategy of working on secure disposal and utilization can lead to advantageous. Effects on the ecology and environmental also. It has been located that upto 80% replacement, CS and FS can be efficiently used as alternative for exceptional aggregate. Further lookup work is wished to discover the impact of CS+FS as excellent aggregates on the sturdiness residences of concrete.

ThongamPrantic Singh, Dr. Rajashekhar. M. R and Suhas R This paper reviews on an experimental investigations carried out to consider the consequences of concrete combine houses organized with partial substitute of satisfactory aggregates by means of copper slag at ranges of 10%, 20%, 30%, 40%, 50% and 60%. In this study, M30 grade concrete was once viewed to learn about the energy parameters, compressive and flexural electricity improvement for concrete curing durations of 3, 7 and 28 days. It was once determined that all mixes yielded similar or greater compressive and flexural power than the manage concrete for all curing periods. Compressive and flexural electricity will increase with appreciate to the proportion substitute of copper slag by means of the weight of best mixture up to 40% replacement. The compressive power of dice and flexural power of beam at 28 days curing length used to be accelerated by way of 31.6% to 54.87% and 10.87% to 26.62% respectively with substitute of copper slag.

The first-class of concrete mixes used to be located desirable from ultrasonic pulse velocity. Flexural fatigue evaluation used to be carried out to predict fatigue existence of concrete specimens the place 40% of satisfactory combination used to be changed by way of copper slag and most energy is obtained; at three stress ratios (0.65, 0.70 and 0.75 of fatigue failure loads). From the records got S-N curves are developed the usage of linear regression mannequin thinking about log regular distribution as is being at present adopted. The variety of repetitions to failure used to be in contrast with the IRC: fifty eight mannequin and located that up to 0.75 stress ratio it suggests greater quantity of repetitions to failure than the counseled IRC-58 fatigue lifestyles and at higher stress ratio it fail earlier.

V. Sushma, Dr. T. Suresh Babu, K. V. Manikanta This paper offers a microgrid consisting of unique disbursed technology (DG) gadgets that are related to the distribution grid. An energy-management algorithm is applied to coordinate the operations of the special DG devices in the microgrid for grid-connected and islanded operations. The proposed microgrid consists of a photovoltaic (PV) array which features as the essential era unit of the microgrid and a proton change membrane gasoline phone to complement the variability in the energy generated by means of the PV array. A lithium-ion storage battery is integrated into the microgrid to mitigate height needs in the course of grid-connected operation and to compensate for any scarcity in the generated energy for the duration of islanded operation.

The manage graph for the DG inverters employs a new mannequin predictive manipulate algorithm which allows quicker computational time for giant electricity structures via optimizing the steady-state and the transient manage issues separately. The format thinking is diverse via a number check eventualities to display the operational functionality of the proposed microgrid, and the bought consequences are discussed.

Srinivas C. H, S. M Muralan Copper slag is one of the substances which is regarded as waste substances in the manufacturing of copper, which can be used as partial alternative of nice aggregates in concrete. This paper provides the effects of an experimental learn about on a number of sturdiness exams on concrete containing copper slag as partial alternative of sand. In this report, M30 grade of concrete was once designed and exams had been carried out with special share of copper slag as satisfactory combination in concrete. The effects indicate that workability will increase with will increase in the copper slag percentages. The Compressive Strength is elevated up to 8.63 percent as in contrast to regular concrete. The Rapid chloride penetration take a look at is carried out to recognize the chloride ion penetrability. Also, accelerated corrosion method by way of galvano-static weight loss technique is carried out to understand the corrosion price of concrete.

Binaya Patnaik, Seshadri Sekhar, T. Srinivasa Raon An test used to be performed to inspect the electricity and sturdiness homes of concrete having copper slag as a partial alternative of sand (fine aggregate) and outcomes have been introduced in this paper. Two distinct kinds of Concrete Grade (M20 & M30) have been used with exceptional proportions of copper slag alternative (0 to 50%) in the concrete. Strength & Durability residences such as Compressive Strength, Split Tensile Strength, Flexural Strength, Acid Resistivity and Sulphate Resistivity have been evaluated for each mixes of concrete. Test consequences indicates that the electricity homes of concrete has accelerated



having copper slag as a partial substitute of Sand (up to 40%) in concrete alternatively in phrases of sturdiness the concrete located to be low resistant to acid assault and greater resistance in opposition to Sulphate attack.

Pranshu Saxena, Ashish SimaltIn the current situation carbon emission and sand mining are essential subject due to its hazardous impact to surroundings and making serious imbalance to the ecosystem. Various research have been carried out to limit extreme impact on environment, the usage of byproducts like copper slag as partial alternative of pleasant aggregate. Different researchers have additionally published severa makes use of of copper slag as a changing agent in deciding the energy of concrete. A complete overview of research has been introduced in this paper for scope of alternative of high-quality mixture from copper slag in concrete.

Dr. A. Leemarose, P. SuganyaConcrete occupies special role amongst the modern-day building materials. Concrete is a fabric used in constructing construction, consisting of a hard, chemically inert particulate substance, acknowledged as combination (usually made for extraordinary sorts of sand and gravel), that is bond via cement and water. Now a days utilization of industrial soil waste or secondary substances has prompted in development area for the production of cement and concrete due to the fact it make a contribution to decreasing the consumption of herbal resources. Copper slag is received as waste product from the sterlite industries.

Experiments are carried out to discover the opportunity of the use of copper slag as a alternative of sand in concrete mixtures. The use of copper slag in cement and concrete presents workable environmental as nicely as financial advantages for all associated industries, mainly in areas the place a giant quantity of copper slag is produced. The essential focal point of this learn about is to locate out the energy and sturdiness homes of concrete in which high-quality mixture is partly changed with 10%, 20%, 30%, 40%.

Hyung-Kew Lee, Jaehoon Chung, Sun-Il Chang and Euisik Yoon In this paper, we record real-time dimension outcomes of a number contact forces exerted on anew flexible capacitive three-axis tactile sensor array based totally on polydimethylsiloxane (PDMS). A unit sensor consists of two thick PDMS layers with embedded copper electrodes, a spacer layer, an insulation layer and a bump layer. There are 4 capacitors in a unit sensor to decompose a contact pressure into its ordinary and shear components. They are separated via a wall-type spacer to enhance the mechanical response time. Four capacitors are organized in a rectangular form.

The total sensor is an eight × eight array of unit sensors and every unit sensor responds to forces in all three axes. Measurement effects exhibit that the full-scale vary of detectable pressure is round 0–20 mN (250 kPa) for all three axes. The estimated sensitivities of a unit sensor with the cutting-edge setup are 1.3, 1.2 and 1.2%/mN for the x-, y- and z-axes, respectively. A easy mechanical mannequin has been set up to calculate every axial pressure thing from the measured capacitance value. Normal and shear pressure distribution photos are captured from the fabricated sensor the use of a real-time dimension system. The mechanical response time of a unit sensor has been estimated to be much less than one hundred sixty micro seconds. The flexibility of the sensor has additionally been confirmed by means of working the sensor on a curved floor of four mm radius of curvature.

III. OBJECTIVE AND METHODOLOGY

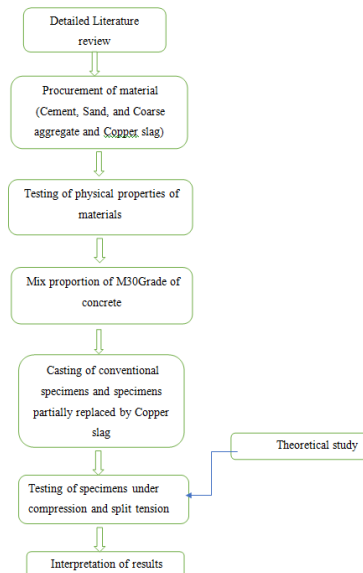
3.1 OBJECTIVE OF STUDY

The goal of the challenge is to learn about the conduct of specimens which are in part changed by means of copper slag beneath compression and cut up tension.

3.2 METHODOLOGY

The goal is executed by way of adopting the following methodology.

1. Review of Literatures.
- two Testing of materials.
- three Mix design.
- four Casting of traditional and in part changed specimens.
5. Testing of specimens.
6. Theoretical study.
7. Interpretation of results.



IV. EXPERIMENTAL INVESTIGATIONS

4.1. OBJECTIVE OF TESTING

The Experimental programme consists of series of materials, Investigation of cloth properties, Arrival of combine percentage for the chosen grade of concrete, Specimens casting and checking out of specimens for mechanical homes such as Compressive electricity and Split Tensile strength.

4.2. PROPERTIES OF MATERIALS USED

4.2.1. CEMENT

OPC forty three grade cement is used for all concrete mixes. The cement used used to be clean and barring any lumps. Testing of cement was once performed as per IS: 8112-1989. The a number exams have been performed on the cement and the consequences received are mentioned in Table 4.1

| S.no | Characteristics | Values obtained | Standard values |
|------|---------------------------|-----------------|----------------------|
| 1 | Standard Consistency Test | 31% | 26% - 32% |
| 2 | Specific Gravity | 3.15 | |
| 3 | Fineness test | 5.15% | <10% |
| 4 | Initial Setting Time | 34 min | Not less than 30min |
| 5 | Final Setting Time | 254 min | Not more than 600min |
| 6 | Soundness | 3 mm | Less than 10mm |

4.2.2 COARSE AGGREGATE

Locally accessible coarse aggregates having the most measurement of 20mm had been used in the existing work. Testing of coarse aggregates used to be executed as per IS: 383-1970. They had been then washed to do away with dirt and filth and used to be dried to floor dry condition. The more than a few take a look at consequences carried out on coarse aggregates are given in Table 4.2



V. RESULTS AND DISCUSSION

Compressive Strength test



CUBE AFTER TESTING



SPLIT TENSILE TEST



CYLINDER AFTER TESTING



SPLIT TENSILE TEST



BEAM AFTER TESTING



VI. CONCLUSION

- The conduct of CS appears to be comparable to river sand for its use as first-class combination in concrete mixes. However minor adjustment/modifications have to be made in view of the higher unique gravity and hard floor texture and the extent of CS proposed to be used.
- The CS as it is, has greater fineness modulus indicating coarser common particle size. Therefore, it can also be preferable to avoid the use of CS as the solely high-quality combination in concrete mixes; it might also be vital to add traditional sand additionally in order to enhance the particle measurement distribution of the concrete mix to get the cohesiveness and pleasant workability.
- It is determined that the compressive energy and flexural energy of concrete can be elevated via partial alternative of copper slag for exceptional aggregate.
- From the above experimental effects it is proved that, copper slag can be used as partial



alternative for the herbal sand, and the compressive and flexure strengths are accelerated as the proportion of copper slag is accelerated up to most efficient level. The highest quality share of substitute of herbal sand by using copper slag is 40%.

- The absolute best compressive power acquired was once 48.44MPa (40% replacement) and the corresponding electricity for manipulate concrete used to be 34MPa.
- Further lookup work is wanted to discover the impact of copper slag as satisfactory aggregates on the greater grade of concrete and sturdiness residences of concrete.

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