VOLUME-7, ISSUE-5, MAY-2018 • PRINT ISSN No 2277 - 8160

Original Research Paper

Engineering

UTILIZATION OF COPPER SLAG IN CONCRETE AS A REPLACCEMENT OF FINE AGGREGATE: A REVIEW

Ankit Patadia M.E.(Structural Engineering), Marwadi Education Foundation, Rajkot,

Bhavik K. Daxini Assistant Professor, Civil Engineering Department Marwadi Education Foundation, Rajkot,

ABSTRACT Manageability and asset effectiveness are getting to be expanding vital issues inside the present concrete industry. This examination reports the potential utilization of granulated copper slag as a substitution for sand in concrete blends. Numerous nations are seeing a fast development in the development business, which includes the utilization of characteristic assets for the improvement of framework. This development represents a danger to common assets that are accessible. Copper slag is considered as waste material and can be utilized as substitution of fine totals. The likelihood of substituting normal fine total with modern results, for example, squander foundry sand and base fiery debris offers specialized, monetary and ecological favorable circumstances which are of extraordinary significance in the present setting of supportability in the development area. This paper manages the review for copper slag as substitution of fine aggregates in concrete.

KEYWORDS : Copper Slag, Waste, Concrete, Fine Aggregate

Introduction

In India, there is extraordinary request of totals primarily from structural building industry, for street and solid developments. Be that as it may, these days it is an extremely troublesome issue for accessibility of fine totals. So the analysts created squander administration systems to apply for substitution of fine totals for particular needs. Common assets are exhausting worldwide while in the meantime the produced squanders from the business are expanding generously. The practical improvement for development includes the utilization of nonconventional and creative materials, and reusing of waste materials so as to remunerate the absence of normal assets and to discover elective ways rationing the earth. The quick increment in the regular totals utilization consistently because of the expansion in the development business overall implies that the totals holds are being exhausted quickly, especially in forsake nations. It has gone as far as anyone is concerned that, without legitimate elective totals being used soon, the solid ventures internationally devour 8-10 billion tons of normal totals, after a few years that will be renewed.

Copper slag is one of the materials that are considered as a waste material which could have a promising future in the development business as fractional or full substitute of either concrete or totals. It is a result acquired amid the matte purifying and refining of copper. To create each ton of copper, around 2.2– 3.0 tons copper slag is created as a side-effect material. In India copper slag is delivered by numerous enterprises one of them is Sterlite Industries Ltd (SIL), Tuticorin Tamil Nadu. It is delivering Copper slag amid the fabricate of copper metal. Right now, around 2600 tons of Copper slag are created every day and an aggregate gathering of around 1.5 million tons. In the event that we can utilize the copper slag set up of normal sand, at that point we can progressively get a material to supplant the sand, which is eco-accommodating and savvy. Consequently there is a developing need to locate the elective answer for the slag administration.

2. Physical and Chemical Properties of Copper Slag

Copper slag is black glassy and granular, possesses Similar grain size range like sand. Indian slag has a specific gravity of 3.4 to 4.1. The mass density of the copper slag is 1.9 to 2.15 kg/m3, which is Most similar mass density Conventional fine aggregate.

Table : 1 Physical Properties Copper Slag

Physical Attributes	Copperslag
Particleshape	Irregular
Appearance	Blackandglassy
Type	Aircooled
Specificgravity	3.91
Percentageof voids%	35
Bulkdensityg/cc	2.08
Finenessmodulus	3.47
Angleof internalfriction	51°20'
Ultimateshearstresskg/cm2	0.4106
Waterabsorption%	0.16
Moisturecontent%	0.1
Finenessm2 /kg(aftergrinding)	125

Table : 2 Chemical Properties of Copper Slag

Chemical Component	%ofchemical component
SiO2	70.19
Fe2O3	12.99
Al2O3	0.79
CaO	1.88
MgO	0.23

3. USE OF COPPER SLAG IN VARIOUS FIELDS

Use Production of copper slag in cement clinker production

Production of copper slag in cement clinker production FeSiO3, it has It has a low melting point, calculated temperature for cement clinker. Therefore, Use of copper slag to replace iron powder as iron adjusting material facilitates cement production and shortens or does away with the need of miners has been leveled (Huang 2001). Result of the performance test showed Cement made with copper slag worked better than using iron powder

Use of copper slag in blended cement

The role Effect of Copper Slag as Pozzolanic Material of Ordinary Portland Cement and Hydration Reaction and Properties of Mortar and Concrete has been covered in various (Al-Jabri et al 2006, Tata et al 2007, Malhotra 1993, Tixier et al 1997, Ariro and mobasher 1999). Incorporation of copper slag into cement mortar, induce an increment in the leached elements reported by Sanchez de Rojas et al (2004). Another study Showed that the amount of leached element of copper slag was significantly lower than the regulation level determined by US Environmental Protection Agency (USAPA) (Alter 2005). Arino and mobasher (1999) hinted that upwards to 15% copper slag can be utilized as a cement substitute with a constant w / c ratio of 0.4. This Gives higher compressive strength ordinary cement.

4. Literature Review

Jacket al.(2002)statedthatCarbonationmaycompensate, some

concretepropertiessuchas compressive strength, splitting strength, electrical resistivity andchloride ionpenetration. However, corrosiontest resultsshowedthat carbonationincreases the corrosionrateof reinforcingsteel.

Al-Jabrietal.(2009)examinedthattherewasaslightincreaseintheHP Cdensityofnearly5%withtheincreaseof copperslagcontent, whereastheworkability increasedrapidlywith increase incopper slag percentage. The addition of upto50% of copper slag as asand replacement yielded comparable strength with that of the control mix. However, furtheradditionsofcopperslaghadcauseda reductioninthestrengthduetoanincreaseofthefree watercontentin themix.Mixeswith80%and100%copperslagreplacementgavethelo west compressivestrengthvalueof approximately80MPa, whichwasalmost16%lowerthanthe strengthof thecontrolmix. Theresultsalsodemonstratedthatthesurfacewaterabsorption decreasedascopperslagquantitywasincreasedupto40%replaceme nt;beyondthatlevelofreplacement,theabsorptionratehadincreased rapidly Khanzadietal.(2009)examinedthatanincreaseofabout10–15%compressivestrengthand an increase of 10–18%splitting tensile strength had occurred when alimestonecoarse aggregate whereplacedbycopperslagcoarseaggregateinhighstrengthconcr ete.

Brindhaetal.(2010)per formedthereplacementofsandbycopperslag by0%,5%,10%,15%,20%,30%,40%and50%.Theresultshowedthatth ecompressivestrengthincreased by35-40%and thesplitten silestrength by30 -35%.Theexperimentalinvestigationshowed thatpercentagereplacementofsandbycopperslagshallbeupto40% Pazhani et al. (2010) founded that the slump value for 100% replacement of fine aggregate with copper slag increased from60mm to 85mm. It showed that the water consumed by the copper slag during mixing was very less as compared with river sand. The water absorption for 100% replacement of fine aggregate with copper slag was decreased by 33.59%.Another finding was that for 100% replacement of fine aggregate with copper slag the pH value wasdecreased by 3.04%

Brindhaetal.(2011)foundedthatthe strengthofconcrete wouldincrease withrespectto the percentage ofslagadded byweightoffineaggregateupto40%ofadditionsand15%of cement Sudarvizhietal.(2011)suggested thatcopperslagandferrousslagcan beusedass and replacement till80%.Shealsostatedthat 100%replacement ofsandbycopperslag and ferrousslag wouldnotbea dvisable.

Najimietal.(2011)foundedthattheeffectivenessofcopperslagreplac ementinimproving theconcreteresistanceagainstsul phateattack by5%,10%and15%ofsandledto57.4%, 63.4%and64.7% lowerex pansionthanthatofconcretewithoutcopperslag.

Arivalaganetal.(2013)reviewedthattheflexuralstrengthof thebeami ncreasedby21%to 51% whilereplacementof copperslag. Anotherconclusionwasthatbyusingcopperslagasa partialre placementforsand, strengthincreasedup to 40%replacementlevel. Higherlevel replacementledto segregation and blee dingdueto lesswaterabsorptioncapacityofcopper slag.

Itwasalsoobservedthatthesandreplaced copper slagbeamssho wedanincreasein energyabsorptioncapacity Binayaetal. (2014)reviewedthatthebehaviourof copperslagis similartothatofriversand usedas fineaggregatein concrete.He alsonotedthatthecompressivestrengthofconcrete increaseswiththeadditionofcopperslagupto40%,afterthatit startsdecreasingonfurther additionofit.

Raja Abhishek et al. (2015) reviewed that Addition of Copper Slag in Concrete increases the density, thereby the self-weight of Concrete. The results showed that the workability of Concrete increased substantially with increase of Copper Slag content in the concrete mixture due to the low water absorption, coarser (in nature than sand) and glassy surface of Copper slag, thereby the Strength properties also improved

M.A.G. Dos et al (2017) reviewed that Tensile strength of concretes reduced with the increase of blasted copper slag content. Higher reductions were also seen for concretes with over 40% replacement, highlight the 33.5% decrease. The results of the static elastic modulus tests showed that the addition of blasted copper slag to the concretes did not cause significant variations in the deformation capacity, making them only slightly less brittle. The greatest reduction in stiffness occurred for the blend with 100% substitution.

5. Conclusion

From evaluating the above research papers identified with copper slag significant conclusions can be made:

The substitution of stream sand by copper slag is conceivable in solid blend. For M 20 and M 25 review concrete, the ideal sand substitution extent is by and large 35-40%. In addition, for the most part the sand can be supplanted till 50-60% by copper slag in concrete.

By and large the exploratory examination is completed for M 20 and M 25 review concrete. Assist examination ought to be done with respect to M55 and above, which could be helpful for multi-story structures, development of scaffolds, turnpikes, interstates, airplane terminal runways and so on where quality prerequisite.

6. Acknowledgement

TheAuthorsthankfullyac knowledge to Dr.Sarang Pandey (Principal & Dean, MEFGI) ,Dr.Siddharth Shah(Head of The Deartment, MEFGI),Dr.TarakVora,Dr. AnkurBhogayatafortheirmotivationsa ndinfr a structural support to carry out this research

7. References

1. Amin Nazer, Jordi Pay, María Victoria Borrachero, Jos E Monz, "Use Of Ancient Copper Slags In Portland Cement And Alkali Activated Cement Matrices", Also, 22-Oct-15
2. BinayaPatnaik, SeshadriSekhar And Srinivasa Rao, "An Experimental Investigation Optimum amount of copper slag as fine aggregate in mixed copper slag Concrete", Current international journal of engineering technology accepted on October 25, 2014, available online on 26th October 2014
3. BinayaPatnaik, SeshadriSekhar. T, Srinivasa Rao, "Relationship Relationship between compressive strength of fine aggregate in mixed slag and optimum slag usage Concrete", I-Manager's Journal On Civil Engineering March - May 2014
4. Binod Kumar, "Properties Development of pavement quality concrete and dry lean concrete with miniaturized copper slag Aggregate", Taylor & Francis International journal of pavement engineering, 2013 Received 12 January 2011; Final Version Received 7 September 2012
5. C. K. Madheswaran , P. S. Ambily , J. K. Dattatreya , N. P. Rajamane, "Studies On the use of copper slag as a substitute material for river sand in buildings Constructions", Springer
6. ChinmayBuddhadev, JayeshkumarPitroda, Prof. Chetna M. Vyas, "Innovative Study of Copper Slag and Casting Sand in Design Mixed Concrete", Multidisciplinary Issues Journal of International Studies in January 2015
7. Er. Anwar Ahmed,Er. Mohammad KashifKhan,Dr. Syed AqeelAhmad,AtharHussain, "Studying Properties of copper slag and concrete Glass Wool Fibre", International Journal Of Emerging Technologies In Engineering Research
8. Harn-Wei Kua, "Attributional Life cycle inventory evaluation of recycled copper slag as building materials Singapore", Transactions Of The Institute Of Measurement And Control Sage
9. Hassan Ziari, Ali Moniri, Reza Imaninasab&MostafaNakhaei, "Effect Of copper slag Performance Of Warm Mix Asphalt", Taylor & Francis International Journal of Pavement Engineering
10. Hiromichi Takebe, Sayuri Tomita, Akira SaitohMasayasu, Kawahara, Yuri Sueoka, Masayuki Sakakibara, "Effect Of Crystallization On Microstructure And Elution Properties In Copper Slag", Springer Crossmark 15-May-17
11. ImanAfshoon And Yasser Sharifi, "its effect on the fresh properties of ground copper slag and self-setting concrete as auxiliary cement material", Taylor & Francis The Eyes Journal Part A: Citizen & Structural Engineering, 2014
12. Jieun Lee, Sunjung Kim, Doyun Shin, "Electrolytic Recovery Of Fe From Cu Smelter Slag In Nitric Acid Solution", Springer
13. Chung Masahiro, Kim Byung-soo, Joo Hyun Park, "Effect Cao addition on iron recovery from solid smelting slag Carbon", The Minerals, Metal & Materials Association and ASM International 2013 Metallurgy and Materials Transaction
14. Junwei Song, "Effect Of copper slag Properties And Structure Of Cement And Concrete", Applied Mechanics And Materials
15. Jun-Yi Wua, Fang-Chih Chang, H. Paul Wangc, Ming-JerTsaib, Chun-Han Kob And Chih-Cheng Chena, "Selective Leaching Process For The Recovery Of Copper And Zinc Oxide From Copper-Containing Dust", Taylor & Francis Environmental Technology
16. K.Mahendran, N.Arunachelam, "Study On Utilization of copper slag as fine aggregate in geopolymer Concrete", Researchgate Jul-15
17. Krishna Murari, Rafat Siddique, K. K. Jain, "Use Waste copper slag, sustainable Material", Springer 03 May,2014
18. Leila Miganei, EberhardGock, Marcela Achimovičová, Lutz Koch, Horst Zobel,

JörgKähler, "New Residue-Free Processing From copper slag Smelter", Journal Of Cleaner Production Received Date: 27 February 2017 Revised Date: 23 June 2017 Accepted Date: 23 June 2017
19. Liu Weiping, "Use Copper Slag To Prepare Copper Matrix Composites", Advanced Materials Research
20. M. A. Tantawy , Salwa A. Ahmed, Elham M. Abdalla, Mostafa I. Qassim, "Immobilization Of Copper Ions Laden Kaolin Waste: Influence Of Thermal Treatment On Its Immobilization In Cement Paste", Springer 19-Dec-14
21. M. Ramesh, K.S.Karthic, T. KarthikeyanAnd A. Kumaravel, "Construction Materials From Industrial Wastes-A Review Of Current Practices", International Journal of Environmental Studies Development. Industrial construction materials Wastes-A Review of current practice
22. M. V. Patil,Y. D. Patil,G. R. Veshmawala, "Performance Copper slag as a substitute for sand Concrete", International Journal of Applied Engineering Research
23. M.A.G. Dos Anjos, A.T.C. Sales*, N. Andrade, "Blasted Copper slag as fine aggregate in Portland cement Concrete", Journal Of Environmental Management 8-Feb-17 Accepted 12 March 2017
24. Maosheng Chen, Zirong Han, Leizhi Wang, "Recovery Of Valuable Metals From Copper Slag By Hydrometallurgy", Advanced Materials Research Trans Tech Publications, Switzerland
25. MohitSain, MohitKansal, Mukesh Kumar, "An Experimental Study On The Concrete Properties M20 Due To Addition Of Copper Slag", International Journal For Technological Research In Engineering 2/1/2017
26. PaladiRajendra Kumar, "Laboratory Study on black cotton soil with copper slag Fly-Ash", Reasearchgate International journal of innovative research in science, engineering, technology
27. PratimaMeshram, LalitBhagat, Uday Prakash, BanshiDhar Pandey &Abhilash, "Organic Acid leaching of base metal from copper granular slag and its evaluation Mechanism", Canadian Metallurgical Quarterly Canada Metallurgical Society 02 Mar 2017.
28. PredragDjordjevic, NatasaMitevska, Ivan Mihajlovic, DjordjeNikolic&ZivanZivkovic, "Effect Basis of slag based on distribution coefficient between copper mat and specific slag Metals", Taylor & Francis Mineral Processing And Extractive Metallurgy Review: An International Journal Accepted Author Version Posted Online: 18 Jan 2013.Published Online: 20 Sep 2013.
29. Rahul S, RaslMuhammedRafeeq, Dr. T SenthilVadivel,Dr. S Kanchana, "Experimental Study on the properties and effects of copper slag Compacting Concrete", International Journal Of Science Technology & Engineering
30. Raja Abishek, Krishna Murari, Atul Singh AndSachinGangwa, "Copper Slag, alternatives for river sand and concrete Manufacturing", Civil Engineering and Environment Journal Technology. January-March, 2015
31. Sandhyarani Biswas,1 Amar Patnaik,2 And Ritesh Kaundal2, "Effect Of Redmud Copper slag particles on the physical and mechanical properties of bamboo fiber reinforced epoxy Composites", Hindawi Publishing Corporation Received 26 April 2012; Revised 20 October 2012; Accepted 3 November 2012
32. SanghamitraKunduAman Aggarwal SiddharthMazumdar K. Bhargava Dutt, "Stabilization Characteristics of copper mine buckle by utilization as substitute for cement in concrete: preliminary Investigations", Springer Environ Earth SciCrossmark Received: 24 April 2015 / Accepted: 1 September 2015
33. Sanjay Kumar Bharat, Soon Hoe Chew, "Geotechnical Behavior of recycled copper slag cement system Treated Singapore Marine Clay", Springer Crossmark, Receipt: April 8, 2015 / Acceptance: April 4, 2016
34. Song Jun-Wei, "Study On Effect of copper slag Admixtures To Properties & Structure Of Concrete", Information Technology Journal
35. StoykoGyurov, NikolayMarinkov, YoannaKostova, Diana Rabadjieva, Daniela Kovacheva, Christina Tzvetkova, GaliaGentscheva, Ivan Penkov, "Cool slag technology plan Processing", International Journal Of Mineral Processing Received Date: 18 April 2016 Revised Date: 4 November 2016 Accepted Date: 10 November 2016
36. Tiejun Chun, Chao NingHongming Long, Jiaxin Li And Jialong Yang, "Mineralogical Characterization Copper slag from ton-ring non-ferrous metal group China", Crossmark
37. V. Karthik, Dr. G. Baskar, "Study Study on durability of self-compacting concrete using copper slag ", International Journal of Civil Engineering (Ijciet)
38. Vikas .S. Koli,V. G. Sayagavi,P. J. Salunke, "A Examination of performance evaluation of concrete by partially replacing fine aggregate with copper slag and cement Silica", International Journal Of Science Technology & Engineering
39. Vimarsh S.P, BasavanaGowda S.N, Dr. Ramesh B.R, "Study About strength characteristics Fiber-reinforced concrete by partial substitution of sand by copper slag ", International Civil Engineering Research Institute Xiaolong Song, Yang Jianxin, Bin Lu, Bo Li "Investigation of life cycle management of industrial waste in the case of copper Slag", Waste Management & Research Sage
40. Xiaolong Song, Yang Jianxin, Jingwei Wang, Wenjie Wu, "Assessing The Life Cycle Environmental And Economic Performance of copper slag Recycling",
41. Zhe Wang, Guohe Huang, Chunjiang An, Lirong Chen &Jinliang Liu, "Removal Adsorption process of copper, zinc and cadmium in water quenching furnace Slag", Taylor & Francis Desalination And Water Treatment
42. Zhou Xian-Lin,* Zhu De-Qing, Pan Jian And Wu Teng-Jiao, "Utilization Waste copper slag To Produce Directly Reduced Iron For Weathering Resistant Steel", Isij International, Received On January 5, 2015; Accepted On March 26, 2015