Partial Replacement of Copper Slag as Fine Aggregate

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Abstract

This project present the usage of copper slag for the partial replacement for fine aggregate the experimental procedure is conducted for the replacing percentage of 10%,15%,20%.for this above replacement percentage m25 grade concrete is used. the main objective of this project is to know the strength and durability of partial replaced concrete.to evaluate the strength and durability the various test were conducted.these resulted that the concrete strength is increased with addition of copper slag with concrete.

Keywords — *copper slag, concrete, durability, replacement, compressive strength.*

I. INTRODUCTION

The utilization of industrial waste or secondary materials has encouraged the production of cement and concrete in construction field. New by-products and waste materials are being generated by various industries. Dumping or disposal of waste materials causes environmental and health problems. Therefore, recycling of waste materials is a great potential in concrete industry. For many years, by-products such as fly ash, silica fume and slag were considered as waste materials. Concrete prepared with such materials showed improvement in workability and durability compared to normal concrete and has been used in the construction of power, chemical plants and under-water structures.

Copper slag is an industrial by-product material produced from the process of manufacturing copper. For every ton of copper production, about 2.2 tonnes of copper slag is generated. It has been estimated that approximately 24.6 million tons of slag are generated from the world copper industry. Although copper slag is widely used in the sand blasting industry and in the manufacturing of abrasive tools, the remainder is disposed of without any further reuse or reclamation.

The use of copper slag in the concrete industry as a replacement for cement can have the benefit of reducing the costs of disposal and help in protecting the environment. Despite the fact that several studies have been reported on the effect of copper slag replacement on the properties of Concrete, further investigations are necessary in order to obtain a comprehensive understanding that would provide an engineering base to allow the use of copper slag in concrete. The results indicated that the water demand reduced by almost 22% at 100% copper slag replacement compared to the control mixture. The strength and durability of HSC were generally improved with the increase ofcopper slag content in the concrete mixture[1].

II. MATERIALS AND METHODOLOGY

The various journals were collected and studied on the partial replacement of the fine aggregate by different materials. According to these journals the process of the experiment and the method of the experimentation and the different tests conducted in those journals were studied and learned. On the basis of the studies of the journals collected for the experiment the experimental methodology for the project was choose.

FLOW CHART

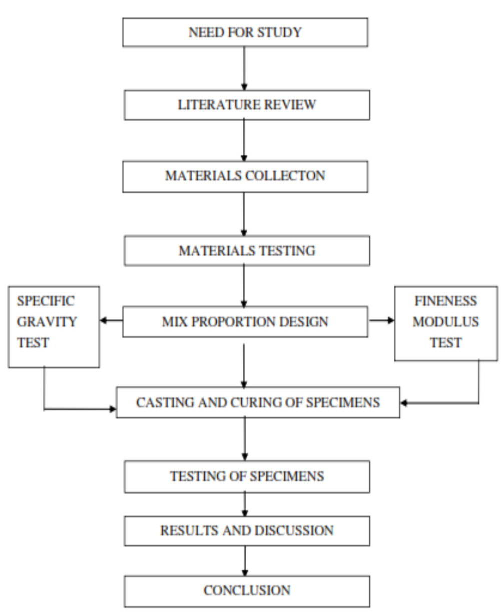

Fig.3.1Flow chart for experimental methodology

A. *Materials Used And Its Properties*

Used Materials

- Cement : Ordinary Portland cement Grade 53
- Fine Aggregate : Natural sand (river sand)
- Coarse Aggregate: Crushed aggregate maximum size of 20mm
- Water : Tap water.
- Copper slag

Table.1.Cement Properties

Test Particulars	Results Obtained	Requirements As Per Is 12269-1970
Fineness of cement (%)	4.3	3-7
Specific gravity	3.1	3.1-3.15
Normal consistency (%)	32	30-35
Initial setting time (min)	32min	30
Final setting time (hrs)	8 hours	10 hours
Compressive strength (MPa)	53	53

Table2.Fine Aggregate Properties

Test Particulars	Result Obtained	Requirments As Per Is 12269-1970
Specific gravity	2.54	2.60 – 2.90
Fineness modulus	2.89	-
Water absorption (%)	0.7%	MAX 1%

Table.3.Coarse Aggregate Properties

Test Particulars	Result Obtained	Requirments As Per Is 12269-1970
Specific gravity	2.707	2-3
Crushing value	31.5	40-45
Impact value	12.5	15-20
Water absorption (%)	2.5%	1%-3%

B. *Tests On Hardened Concrete*

Compressive strength on cubic specimens (150X150X150mm), were determined for 7, 14 and 28 days.Split tensile strength on cylinders (150mmX300mm) was found for 7,14 and 28 days. Modulus of elasticity is obtained from split tensile strength values.Flexural strength on beam specimens (500X100X100mm), were determined for 7and 28 days.

Table.4.Method of Testing

Method of Testing				
Name Of Test	**Size of Mould**	**Number Of Days**		
Compression Test	150x150x150 mm	7	14	28
Split Tensile Strength	Ht-300 & Dia-150 mm	7	14	28
Flexural strength	500x100x100mm	7	-	28

III. RESULT AND DISCUSSION

A. *Compressive Strength*

For the determination of cube compressive strength of concrete. Specimens, of size 150X150X150mm size were cast and cured for 7, 14 and 28 days in tap water. After the specimens are dried in open air, subjected to cube compression testing under digital compressive testing machine.

The cube compressive strength (f) was computed from the fundamental principle as

$$F = P/A$$

Where f =load at failure /cross sectional area (N/mm^2)

P = load at failure (N)

A = Area of the specimen (mm^2)

Fig.1.Compression Testing Machine

Table.5. Test Results Cubes For Compressive Strength

Sl.no	Curing Days	Average Compressive Strength in n/mm^2			
		Control Concrete	Copper Slag Concrete		
			10%	15%	20%
1	7	20.44	17.333	24.222	25.333
2	14	22.667	22.222	26.222	27.111
3	28	24.889	26.667	27.111	28.44

The average compressive strength for cube at different percentages (0%, 10%, 15% and 20%) at age 7, 14 and 28 days are given in table, it Can be noted that, concrete strength compare with control concrete. The fig shows the ductile failure of cube specimens. The graphical representation shows the compressive strength of copper slag.

Test Result Of Cubes For Compression

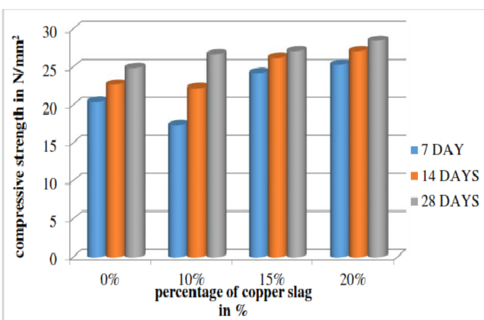

Fig.2.Comparison of Compressive Strength of Cubes

B. Split Tensile Strength

For the determination of splitting tensile strength of concrete, cylinder specimens of diameter to length ratio 1:2 was selected , with diameter as 150 mm and the length as 300 mm specimens were dried in open air after 7,14 and 28 days of curing and subjected to splitting tensile test under compressive testing machine.

The splitting tensile strength (f) was obtained using the formula,

$$F = 2P/3.14dl \ (N/mm^2)$$

Where

P= load at failure (N)

d = diameter of specimen (mm)

l= length of specimen (mm)

Fig.3.Compression Testing Machine

Table.6.Test Results Cylinders for Split Tensile Strength

Sl.no	Curing days	Average split tensile strength in n/mm^2			
		Control concrete	Copper slag concrete		
			10%	15%	20%
1	7	1.982	1.697	2.122	2.264
2	14	2.335	1.839	2.688	2.829
3	28	2.546	2.263	2.970	3.395

The average Split Tensile strength for cube at different percentages (0%, 10%, 15% and 20%) at age 7,14 and 28 days are given in table, it Can be noted that, concrete strength compare with control concrete. The fig shows the ductile failure of cube specimens. The graphical representation shows the Split Tensile strength of copper slag

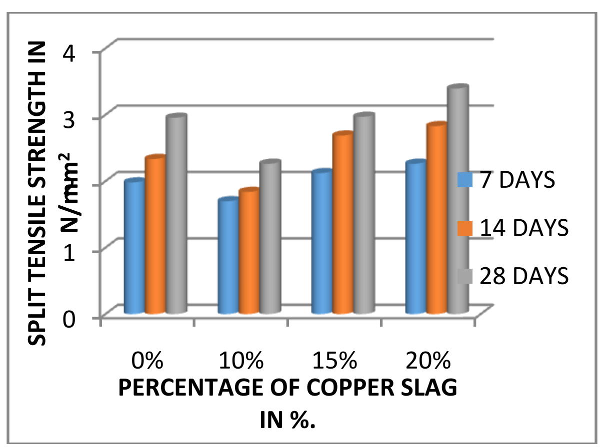

Fig.4.Comparison of Split Tensile Strength of Cylinders

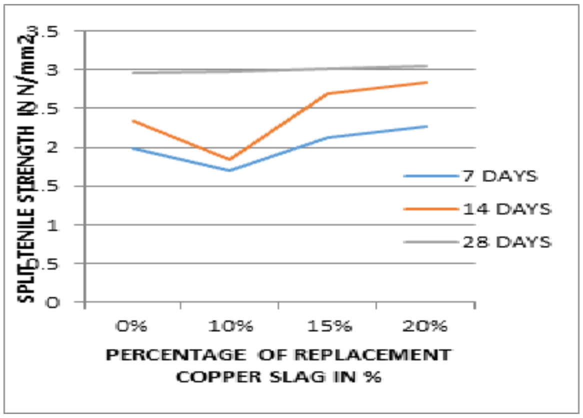

Fig.5. Flexural Strength

For the determination of flexural strength of concrete, beam specimens of dimension 500mmx100mmx100mm specimens were dried in open air after 7,14 and 28 days of curing and subjected to flexural test under flexural testing machine.

The flexural strength (f) was obtained using the formula,

$$F = PL/bd^2 \ (N/mm^2)$$

Fig.6.Flexural Testing Machine

Table.7.Test Results Beam For Flexural Strength

Sl.no	Curing days	Average flexural strength in n/mm^2			
		Control concrete	Copper slag concrete		
			10%	15%	20%
1	7	5.25	6.00	6.50	5.00
2	28	8.25	8.50	10.25	8

The average flexural strength for beam at different percentages (0%, 10%, 15% and 20%) at age 7,28 days are given in table, it Can be noted that, concrete strength compare with control concrete. The graphical representation shows the flexural strength of copper slag.

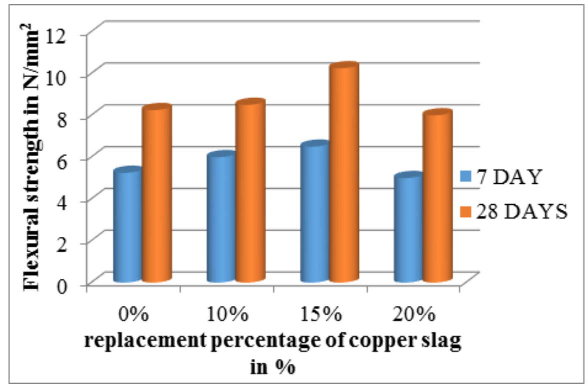

Fig.7. Comparison of Flexural Strength of Beam

IV. CONCLUSION

The concrete was prepared for the M_{25} grade concrete with partial replacement of fine aggregate by copper slag with various percentages of 0%, 10%, 15% and 20%. The specimens were casted for 7days, 14 days and 28 days then tested. The results are presented above.

V. REFERENCES

[1] Al-Jabri, K. and Makoto Hisada. “Copper slag as sand replacement for high performance concrete”, Cement & Concrete Composites, Vol. 31, pp. 483- 488, 2009.
[2] Akihiko, Y. and Takashi, Y. “Study of utilisation of copper slag as fine aggregate for concrete”, Ashikaya Kogyo Daigaku Kenkyu Shuroku, Vol. 23, pp. 79-85, 1996.
[3] Al-Jabri, K., Taha, R. and Al-Ghassani, M. “Use of copper slag and cement by-pass dust as cementitious materials” Cement, Concrete Aggregates, Vol. 24, No.1, pp. 7-12, 2005.
[4] Al-Jabri, K.S., Abdullah, H., Al-Saidy and Ramzi Taha. “Effect of copper slag as a fine aggregate on the properties of cement mortars nd concrete”, Construction and Building Materials, Vol. 25, pp. 933-938, 2011.
[5] Al-Jabri, K.S., Taha, R.A., Al-Hashmi, A. and Al-Harthy, A.S. “Effect of copper slag and cement by-pass dust addition on mechanical properties of concrete”, Construction and building materials, Vol. 20, pp. 322-331, 2006.
[6] Alpa, I. and Deveci, H. “Utilization of flotation wastes of copper slag as raw material in cement production”, Journal of hazard materials, Vol. 159, No. 2, pp. 390-395, 2008.
[7] Al-Jabri, K.S., Makoto Hisada, Abdulla, H.A. and Al-oraini, S.K. “Performance of high strength concrete made with copper slag as a fine aggregate”, Construction and building materials, Vol.23, pp. 2132-2140, 2009.
[8] Arino, A.M. and Mobasher, B. “Effect of copper slag on the strength, and toughness of cementitious mixtures”, ACI Materials Journal, Vol. 96, No. 1, pp. 68-75, 1999.
[9] ASTM C-1202-09--Standard test method for electrical indication of concrete’s ability to resist chloride ion penetration: Annual Book of ASTM standards (Philadelphia). 1992
[10] ASTM C642-97, Standard test method for density, absorption, and voids in hardened concrete. West Conshohocken (PA): ASTM Internationa, 1997.

[11] ASTM C-876-09, Standard test method for corrosion potentials of uncoated reinforcing steel in concrete. Annual Book of ASTM standards (Philadelphia).
[12] ASTM D5233-1995d, Standard Test Method for Single Batch Extraction Method for Wastes: ASTM International, 1992.
[13] Awad Al-Karni, and Abdulhafiz Alshenawy, "Modeling of Stress- Strain Curves of Drained Triaxial Test on Sand", American Journal of Applied Sciences, Vol. 3, No. 11, pp. 2108-2113, 2006.
[14] Ayano Toshiki, Kuramoto Osamu, and Sakata Kenji, "Concrete with copper slag fine aggregate", Society of Materials Science, Vol. 49,pp. 1097-1102, 2000.