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Evaluation of Mechanical Properties of Concrete Made with Metakaolin Scrap, Melting Iron Slag and Copper Smelting Slag

M. DarvishNezhad Aliabad[1,*] , Y. Zandi[2] , Z. DarvishNezhad Aliabad[3]

[1] Department of Civil Engineering Bandar Abbas Branch, Islamic Azad University, Bandar Abbas, Iran
[2] Department of Civil Engineering Tabriz Branch, Islamic Azad University, Tabriz, Iran
[3] Department of Architect Branch, Pars University of Architecture and Art, Tehran, Iran

ABSTRACT: Concrete is the most important consumable in constructional construction, which is increasing. Cement is used as a constituent of concrete to produce it, and on the other hand it produces 8% of the world's carbon dioxide produced. In this study, the mechanical properties and durability of concrete made with copper smelting slag, iron melt slag and metalaoleene as a substitute for cement have been investigated. A total of 384 samples were made up of 16 mixing designs with varying degrees of replacement of copper smelting slag, iron smelting, and metalaole waste. Mixing scheme According to the American ACI 211.1 regulations and the conditions for the SSD materials, dry aggregates then cement materials after that, and finally the supernatant, were gradually added to the mixture. On the designs in a fresh state, a slump test, and in a hardened condition at the age of 7, 14, 28, and 90 days, the compressive strength was tested according to standard BS 1881 and at 28 days of pressure test in accordance with DIN 1048-5. In all designs containing pozzolan, we see a decrease in water absorption compared to a pozzolan design. In, the constant percent displacement of water under pressure is related to the designs containing metalaole and the most related to the plans containing copper smelting slag.

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1- INTRODUCTION

Pozzolans are silica, or silica-alumina, which alone have no adhesion value or have low adhesion value, but form very finely in moisture during chemical reaction with calcium hydroxide at normal temperatures to form cementitious compounds. This reaction is called the pozzolanic reaction. [1]

Iron smelting slag: A by-product of smelting iron ore to separate metal from other non-metallic components that can be considered a combination of metal oxides.

Copper Melting Slag: A by-product obtained during the treatment of raw copper and copper smelting,

Meta-kaolin: It is a very active pozzolan and promotes the mechanical properties of concrete in the short and long term. The use of metaquaoline improves the microstructure of the concrete.

2- METHODOLOGY

Original Carbani investigated the effects of slag on concrete by using different percentages of slag instead of cement in concrete. Zineali [3] has done research on the effect of replacing meta-kaolin waste instead of cement on lightweight self-compacting concrete. In a study, Ghodousi et al. [4] investigated self-compacting concretes containing different percentages of methaquinone and slag and their composition. Fadai et al. [5] conducted studies on the replacement of different percentages of copper smelting slag and its effects on compressive strength. Have done. In 2011 Carniero and Mello [6] conducted studies on the excessive addition of metaquaoline waste to concrete and reported its effects on compressive strength. Wild's research [7] also presented results of increased resistance to low-level replacement in 1996. And then in 2006 Poon et al [8] conducted similar experiments on water uptake and infiltration. In a 2015 study, Shamsi Siahi et al. [9] investigated the different percentages of cement slag replacement and its impact on permeability. Segchi et al. [10] investigated the effect of smelting slag on the influence of pressurized water on concrete in 2013. Sharifi et al. [11] in their research on self-compacting concrete resistance containing different percentages of copper smelting slag to.

Replacing Cement, Mir Hosseini et al. [12] examined the compressive strength growth of concrete at 7 to 90 days by replacing different percentages of melted copper slag instead of cement.

Consumed cement In this project, Hormozgan cement type 2 cement, Bandar Abbas drinking water, sand were extracted from local mine (Minab sand) and P10-3R superlubricant, meta-ethylene waste consumed by Iranian Kaviani factory. The chemical properties can be seen in Table 1:

*Corresponding author's email:mahdidarvishnezhad@iauba.ac.ir

Table 1. Chemical Analysis of Kavian Plant's Metakaolin

Materials	LOI	MgO	CaO	Fe_2O_3	Al_2O_3	SiO_2
Meta-kaolin waste	2	0.2	0.2	1/6	42	52

Table 2. Chemical analysis of Isfahan iron smelting slag

Fe	AL_2O_3	MgO	MnO	FeO	SiO_2	Cao	Materials
5	2	7	6	25	15	45	Weight percent

Table 3. Chemical Analysis of Middle East Copper Melt Slag

Fe2o3	Sio2	cao	Al2o3	Cuo	Mgo	Materials
47	33	6	9	1.7	2	Weight percent

The smelting slag used by Isfahan smelting plant with chemical compounds is given in Table 2 below:

The copper smelting slag prepared by Middle East Safe Company with specifications is shown in Table 3:

Mixing scheme: The mixing scheme is prescribed by ACI 211.1 and SSD Aggregate Conditions because the grains used are dry, and the effect of grain water absorption on the amount of water is also considered. Properties of mixing designs made for all 910 grains (1010 kg / m3) and 1080 grains (kg / m3) and water content to cement 0.4 and lubricant content 0.6% are shown in Table 4.

The following table shows the amount of pozzolans consumed by weight percentage of cement. In the schematic designation, the letter C represents the copper smelting slag, the letter S denotes the smelting slag, the letter M denotes the metacaulene waste and the right number of each letter represents the percentage of replacement of the corresponding pozzolan.

Compressive Strength Testing: According to BS 1881 [13], official compressor laboratories have performed a cubic sample of 150 million translators.

Standard testing: Water pressure control, at a given time, limited water depth in concrete as DIN 1048-5 realization point [14]. Then at EN 12390-8, using the paper summary, you can present this experiment with three more goals of sampling concrete three days from the control surface (5 times).

3- RESULTS AND DISCUSSION

As can be seen in Fig. 1 below, the addition of pozzolan to concrete results in a slump in all cases. In general, the addition of pozzolans due to their higher water uptake compared to cement will in most cases reduce water loss and decrease the flow of concrete.

From the above Fig., we can see that the effect of smelting slag on slip drop is more than metaquaoline and copper slag. In composite designs, iron slag also plays a dominant role in slip drop. To cement and reduce the efficiency of fresh concrete.

In the mixing designs of this study the ratio of water to cement is the same. Therefore, the effect of this factor was the same in all the concrete and the variable factor in this study was the different percentage of pozzolan in the concrete. In Fig. 2 a comparison of the compressive strength is presented below. As can be seen in Fig. 2, all designs show increased compressive strength with increasing age. In comparison between the different percentages of pozzolan that were replaced by cement alone, the highest 7, 14, and 28-day compressive strength were associated with the plan containing 10% of the metaquinoline waste, and the highest 90-day compressive strength was associated with the plan containing 10% of the methaquinone and the plan containing 10% 15% is the smelting slag. Also the lowest compressive strength of all ages is related to the design containing 20% copper smelting slag.

Table 4. Specifications of designs made

Metakaolin Scrap		Melting Iron Slag		Copper Smelting Slag		Cement	name	number
(kg/m3)	%	(kg/m3)	%	(kg/m3)	%	(kg/m3)		
0	0	0	0	0	0	450	R_0	1
0	0	0	0	45	10	405	C_{10}	2
0	0	0	0	67.5	15	382.5	C_{15}	3
0	0	0	0	90	20	360	C_{20}	4
45	10	0	0	0	0	405	M_{10}	5
67.5	15	0	0	0	0	382.5	M_{15}	6
90	20	0	0	0	0	360	M_{20}	7
0	0	45	10	0	0	405	S_{10}	8
0	0	67.5	15	0	0	382.5	S_{15}	9
0	0	90	20	0	0	360	S_{20}	10
45	10	0	0	45	10	360	$C_{10}M_{10}$	11
0	0	45	10	45	10	360	$C_{10}S_{10}$	12
45	10	45	10	0	0	360	$S_{10}M_{10}$	13
22.5	5	22.5	5	45	10	360	$C_{10}S_5M_5$	14
22.5	5	45	10	22.5	5	360	$C_5S_{10}M_5$	15
45	10	22.5	5	22.5	5	360	$C_5S_5M_{10}$	16

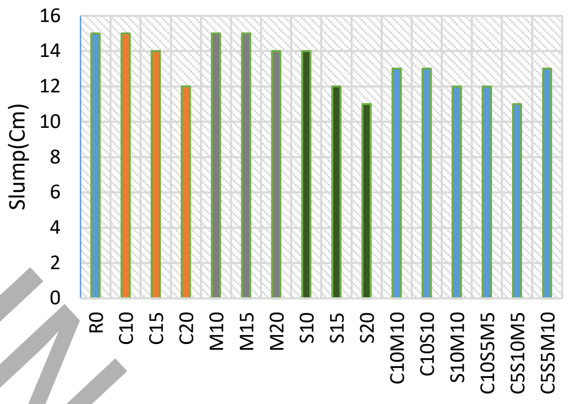

Fig. 1. Diagram of the results of the slump test

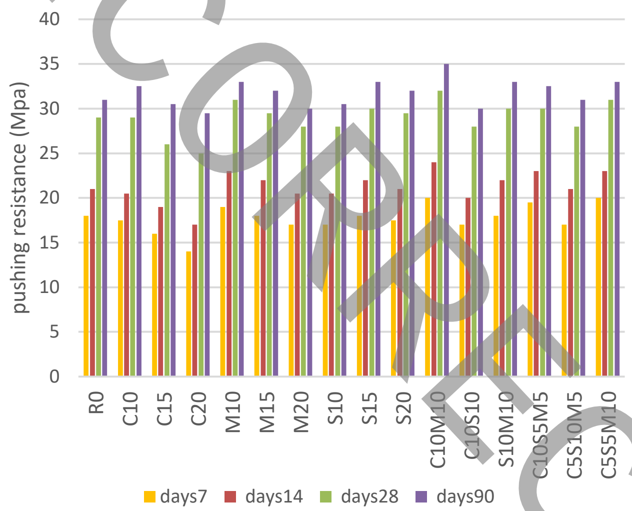

Fig. 2. Compressive strength diagram

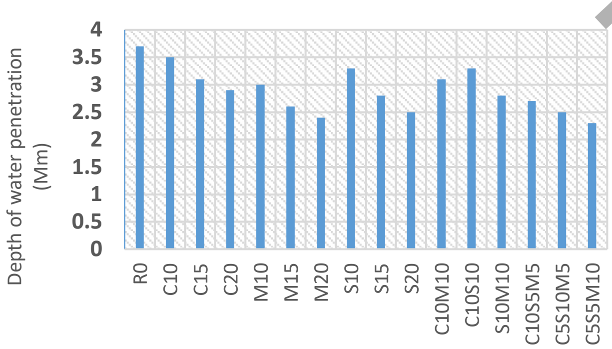

Fig. 3. Water infiltration depth chartConclusion

By replacing metaquaoline from zero to 10%, there is an increase in compressive strength - the trend of increasing resistance for designs containing metaquaoline waste is similar to that of the control design. However, the increase in replacement percentage by more than 10% due to the meta-kaolin-like cementitious property and its lower adhesion to the cement itself was associated with a decrease in compressive strength to 17% lower than the control sample after 17% replacement.

As shown in Fig. 3 below, as the percentage of pozzolanic replacement increases, we see a decrease in water penetration into the concrete samples. According to the proposed regulation of concrete reliability in the Persian Gulf coast [15] The maximum permissible permeability for concrete is 50 mm which in most cases satisfies the depth of penetration of water to the values of this standard. The lowest penetration is related to the C5S5M10 three-component hybrid design.

4- CONCLUSION

- The addition of pozzolan due to the absorption of more pozzolanic water results in a decrease in concrete slump. The least water infiltration was related to the designs containing meta-ethylene waste and the most to the designs containing copper smelting slag.
- In designs containing meta-kaolin waste has the best compressive strength and shows the lowest compressive strength in designs containing copper smelting slag.
- Copper and iron smelting slag has no effect on resistance at an early age but at 90 days of age results in increased concrete strength.
- The reason for the decrease in resistance with increasing percentage of pozzolan replacement can be attributed to their thinning effect. By increasing the replacement of pozzolan with cement and reducing the amount of cement, the hydration reactions of cement and consequently the production of portlandite will decrease.
- In all cases with pozzolan replacement, concrete permeability and water absorption decrease, with most of the concrete containing pozzolan being less than 30 mm in penetration.

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