Global Journal of Science Frontier Research: E Interdiciplinary
Volume 15 Issue 1 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Using Urban Sewage Filtration Sludge for Producing Construction Material

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In order to conduct this study, mouldswith dimensions of 15 x 15 x 15 cm were prepared. In each series of production of light concrete samples, dry sludge was taken from Ghods filtration plant and lime was added to the sludge 24 hours before making concrete samples, in order to increase its pH to 12 and destroy microorganisms. Sludge was used at the weight percentages of 0. 10, 20, 30, 40 and 50 of the cement , and the produced concretes were tested for pressure resistance after being processed with the moisture caused from perspiration of the blocks at the ages of 7, 28 and 90 days and determination of the specific gravity.

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GJSFR-E Classification : *FOR Code : 870199, 870399*

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Evaluating average pressure resistance of the samples shows that up to 30%, sewage sludge works as a fine granular material or filler and the pressure resistance of the samples increases with the increase in sludge percentage compared to control group. Nevertheless, we observe a decrease in pressure resistance of the samples with the increase in dry urban sewage sludge percentage at 30, 40 and 50 percents of sludge compared to control group, which is due to higher water absorption of the dry sludge and its increased impurity (particularly, organic impurities)resulting in inappropriate hydration operation.

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I. Introduction

Considering the great volume of waste production in recent years, using different types of waste for producing construction material ha gained a specific importance. With regard to increased level of health of people, establishing filtration plants for urban sewage has become a requirement of today's human society.

Sludge is an inevitable product of sewage filtration plants, and high water content of sludge and its contamination to pathogens, presence of unstable material in it, and production of bad odor, has rendered sludge filtration and disposal as a principal dilemma in sludge management.(1)

With respect to application of urban and industrial sewage filtration sludge, different investigations have taken place worldwide. The results acquired from these investigations show that using these wastes in production of building material is possible. (2)

On the other hand, construction enjoys an increasing trend in the world. Meanwhile, concrete, being the most important and the most used building material, should be taken into consideration. Regarding the industrialization trend of construction and promotion in light concrete production technology, which results in lighter buildings, replacement of material used in construction of light concrete with urban sewage filtration sludge can provide a great help to environment protection.

In this study, using dry sludge of urban sewage filtration plants for producing light concrete was investigated.

II. Material and Methods

a) Sewage sludge preparation and concrete production

Sewage sludge needed for production of concrete samples, was taken as dry sludge from Ghods town filtration plant and used for making concrete. In each series of production, about 10 grams of lime was added to the sludge 24 hours before making concrete samples, in order to increase its pH up to 12-13 and consequently, destroy microorganisms present in it.

The cement used, was of the black type 2 kind and since no specific resistance of concrete was expected and the results were only for comparison, the resistance of 450 kg per cubic meter of concrete was selected. Proportion of water to cement was also considered a 0.60. A liquid special foam light cement at a 1/20 proportion of water volume was also added to the mixture.

Concrete cubes of 150 mm dimension were used for studying the effect of urban sewage sludge on specifications of light concrete.

b) Foam producing liquid for light concrete

One of the most important parameter in producing light concrete is using a suitable and good quality foam producing liquid. Foam producing liquid is mixed with air, after being diluted with a specific proportion of water, and produces a very resistant foam. Produced foam bubbles should enjoy a suitable resistance and keep their stability against physical and

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chemical forces caused from mixing with concrete and being poured into mould, and also stay resistant until the preliminary hardening of the concrete.(3)`

In general, foams are divided into two classes of protein foams and chemical foams.(4)

In this study, the basic foam used was a protein foam from Azarkavin company with the name of AK-350.`

The plan of mixing light concrete samples produced from urban sewage sludge:

The plan of mixing light concrete samples is as follows:

Table 1 : The concrete mix design

Plan of mixing	(Kg) cement	water (Lit)	foam (Lit)	sewage sludge (Kg)
control sample A	450	270	13	0
Sample B With 10% sewage sludge of the cement weight	450	270	13	45
Sample C With20% sewage sludge of the cement weight	450	270	13	90
Sample DWith30% sewage sludge of the cement weight	450	270	13	135
Sample EWith 40% sewage sludge of the cement weight	450	270	13	180
Sample F With 50% sewage sludge of the cement weight	450	270	13	225

III. Result

After performing different examinations over the samples of light concrete produced from urban sewage sludge, following result were acquired. The measured parameters have been provided in tables and diagrams. In this study, standards of the Iranian Standards and Industrial Research Institute and American Cement Institute (ACI) were used in production and testing the concrete samples.

Measurement of specific gravity and pressure resistance:

For measuring specific gravity, produced concrete samples were taken out of the nylon cover package of processing and they were weighed with a scale after 1 to 2 hours.

And for measuring pressure resistance of the samples, after measuring specific gravity, they were placed on the pressure testing device. The time of appearance of the first crack on the sample is determined as the maximum resistance.

The average specific gravity and pressure resistance of the samples have been provided in tables 2 to 4.

Table 2 : 7-day compressive strength of concrete made from sewage sludge

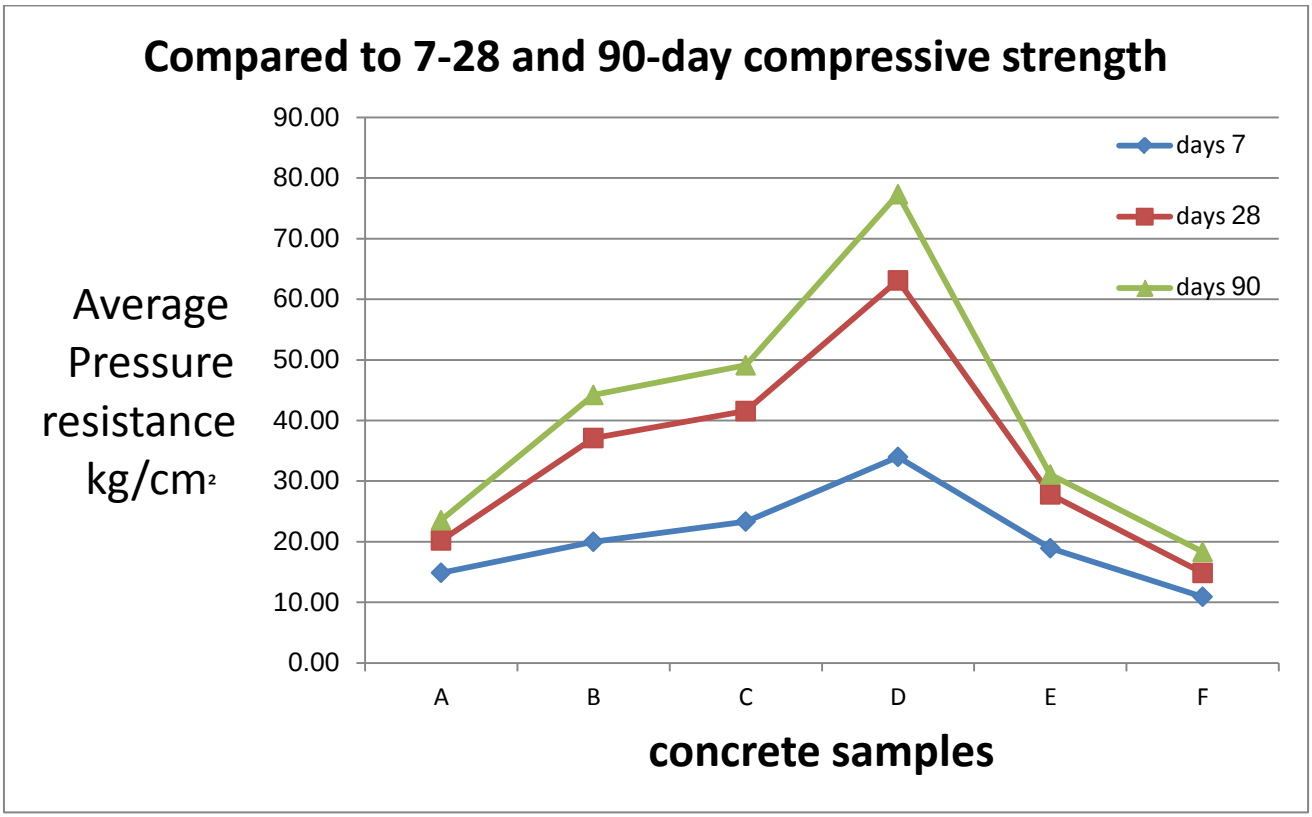
concrete samples	Weight (gr)	Average Weight (gr)	Force (kg)	Dimensions (cm)	Pressure resistance (Kg/cm²)	Average Pressure resistance (Kg/cm²)
control sample A	2195	2200	3300	15x15x14.9	14.67	14.89
control sample A	2205		3400	15x15x14.9	15.11	
Sample B With %10 sewage sludge of the cement weight	2332	2338.5	4500	15x15x14.9	20	20
Sample B With %10 sewage sludge of the cement weight	2345		4500	15x15x14.9	20	
Sample C With 20% sewage sludge of the cement weight	2468	2480.5	5200	15x15x14.8	23.11	23.33
Sample C With 20% sewage sludge of the cement weight	2493		5300	15x15x14.9	23.56	
Sample D With 30% sewage sludge of the cement weight	2632	2643.5	7600	15x15x14.7	33.78	34
Sample DWith30%sewage sludge of the cement weight	2655		7700	15x15x14.8	34.22	
Sample E With 40%sewage sludgeof the cement weight	2760	2778.5	4000	14.7x14.6x14.2	18.64	18.94
Sample E With 40% sewage sludge of the cement weight	2797		4100	14.7x14.5x14.3	19.24	
Sample F With %50 sewage sludge of the cement weight	2843	2855	2100	14x14.1x13.7	10.64	10.93
Sample F With %50 sewage sludge of the cement weight	2867		2200	14x14x13.6	11.22	

Table 3 : 28-day compressive strength of concrete made from sewage sludge

concrete samples	Weight (gr)	Average Weight (gr)	Force (kg)	Dimensions (cm)	Pressure resistance (Kg/cm²)	Average Pressure resistance (Kg/cm²)
control sample A	2212	2202.5	4600	15x15x15	20.44	20.22
control sample A	2193		4500	15x15x14.9	20	
Sample B With %10 sewage sludge of the cement weight	2346	2349.5	8300	15x15x15	36.89	37.11
Sample B With %10 sewage sludge of the cement weight	2353		8400	15x15x14.8	37.33	
Sample C With 20% sewage sludge of the cement weight	2474	2488.5	9300	15x15x14.8	41.33	41.56
Sample C With 20% sewage sludge of the cement weight	2503		9400	15x15x14.8	41.78	
Sample D With 30% sewage sludge of the cement weight	2647	2643.5	14300	15x15x14.9	63.56	63.11
Sample D With 30% sewage sludge of the cement weight	2640		14100	15x15x14.7	62.67	
Sample E With 40% sewage sludge of the cement weight	2772	2779	5900	14.7x14.6x14	27.49	27.82
Sample E With 40%sewage sludge of the cement weight	2786		6000	14.7x14.5x14.1	28.15	
Sample F With %50 sewage sludge of the cement weight	2822	2829.5	2900	13.6x14.1x13.5	15.12	14.86
Sample F With %50 sewage sludge of the cement weight	2837		2700	13.4x13.8x13.4	14.6	

Table 4 : 90-day compressive strength of concrete made from sewage sludge

concrete samples	Weight(gr)	Average Weight (gr)	Force(kg)	Dimensions(cm)	Pressure resistance (kg/cm²)	Average Pressure resistance (Kg/cm²)
control sample A	2218	2210.5	5200	15x15x14.9	23.11	23.56
control sample A	2203		5400	15x15x15	24	
Sample B With %10 sewage sludge of the cement weight	2352	2357	9900	15x15x14.9	44	44.22
Sample B With %10 sewage sludge of the cement weight	2362		10000	15x15x14.8	44.44	
Sample C With20%sewage sludge of the cement weight	2478	2494	11100	15x15x14.8	49.33	49.11
Sample C With 20% sewage sludge of the cement weight	2510		11000	15x15x14.7	48.89	
Sample DWith30%sewage sludge of the cement weight	2650	2656	17300	15x15x14.7	76.89	77.33
Sample D With 30% sewage sludge of the cement weight	2662		17500	15x15x14.7	77.78	
Sample E With 40% sewage sludge of the cement weight	2780	2787	6600	14.7x14.6x14.1	30.75	31.09
Sample E With 40% sewage sludge of the cement weight	2794		6700	14.7x14.5x14	31.43	
Sample F With %50 sewage sludge of the cement weight	2847	2850	3300	13.5x14.2x13.4	17.21	18.35
Sample F With %50 sewage sludge of the cement weight	2853		3500	13.3x13.5x13.6	19.49	



IV. Discussion and Conclusion

With evaluation of the result provided from measurement of pressure resistance of the samples produced from dry urban sewage sludge, it was observed that up to around 40% of the dry sludge to cement weight, the pressure resistance of the samples increases with the increase in sludge percentage compared to control group, with the peak increase at 30%. This was evident at all measurements of pressure resistance at the ages of 7, 28 and 90 days of the light concrete samples. With the increase of dry urban sewage sludge to 50% of the cement weight, a decrease in pressure resistance of the samples is observed compared to control group.

Evaluation of the increasing trend of the pressure resistance of the samples made from urban sewage sludge up to 30% of the cement weight, shows that sewage sludge works as a fine granular material or filler and the pressure resistance of the samples increases with the increase in sludge percentage compared to control group, although, with the increase in sludge percentage from 30 to 40 and 50, we observe a decrease in pressure resistance of the samples, which is due to higher water absorption of the dry sludge and its increased impurity (particularly, organic impurities) and prevents appropriate hydration operation.

Comparison of the pressure resistance of the samples at the ages of 7, 28 and 90 days of the light concrete samples show that resistance of the samples at the age 90 days is higher than that of the 28 and resistance of the samples at the ages of 28 and 90 days are higher than that of the 7 days, and therefore, increasing the duration of processing time is one of the effective factors in increasing the pressure resistance.

Hereby, it is suggested that in case of mass and industrial production of light concrete using sewage sludge, in order to achieve a faster retrieval of the moulds and economic privilege, processing of the concrete be done with steam.

Considering difficult access to clay in northern and southern parts of Iran, and high expenses of transporting clay or its products like bricks and blocks, one can consider production of light concrete block and panel, which is completely economic.

Light concrete made of urban sewage sludge can also be used as building material for making floors and slope of roofs instead of light pellets and cement. In case of replacement of such concrete with specific gravity of around 800 kg per cubic meter, usual dead weight of floors of different stories of a building can be reduced from 1300 to 800 kg per cubic meter.

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