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Research Article

EXPERIMENTAL INVESTIGATION ON COMPRESSIVE STRENGTH OF CONCRETE WITH VERBASCUM THAPSUS (MAHUR) HERBAL ADDITIVE

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ABSTRACT
Due to the high usage of concrete in construction, civil engineers try to decrease the defects of concrete and increase the benefits of it by using some methods. One of these methods is adding additive materials in order to achieve mentioned target. Undoubtedly in the usage of these materials engineers should pay attention to economic issues, decreasing costs of project and their availability. Most of these additive materials used in concrete, are chemicals and albeit they improve some properties of concrete they have some negative effects on other features of it.
In this investigation an herbal additive material is used in concrete, this herbal material is the powder of the leaves of a plant named Mahur or Khargushak (Verbascum Thapsus) that grows in the mountains naturally. The experimental results of specimens in this investigation indicate that adding this herbal material during concrete mixing increases compressive strength up to 12%.

***Keywords**: Verbascum Thapsus (Mahur), Compressive Strength of Concreter, Water per Cement Ratio*

INTRODUCTION
In construction, concrete consumption due to the immense benefits in various application and different forms ,is increasing; In fact ,the most widely used building material is concrete .Per capita production of structural concrete in the world is around one tone per person in the year. It means in the world about 6 million tons of concrete is produced and consumed each year and this production and consumption increases about 1 to 1.5 percent each year. The most important ingredient of concrete is cement. According to Consumption statistics of concrete and cement, a considerable amount of dust and air emissions and Greenhouse Gases, resulting from the production of cement and concrete consumption are produced which can be a serious threat to the human's environment. Per production of each tone of cement Klinger, about 1.3 tones CO2 gas and about 160 Kg dust is sent to the air (Ramezanianpour and Esmailpour, 1991; Neville, 1981).
The entire world now is aware of their obligation and duty to consider environmental protection and sustainable development. Man believes that all human are affected by adverse environmental impacts arising from the development. Undesirable and harmful effects of producing Greenhouse gases in increasing global temperature, melting polar ice, changing climate and the destruction of Ozon layer are not exclusive to any particular country, but they are universal subjects. Therefore, necessary actions for minimizing the harmful effects of cement and concrete production and consumption, is a public duty and responsibility (Ramezanianpour, 1998; ACI Committee 209.R-80, 1984).
On the other hand, construction increasing and as its result increasing in production and consumption of concrete for the sustainable development of any country is essential. So the engineering societies and science manufacturing centers, should take serious actions with proper planning to increase advantages of concrete and reduce its adverse effects. To improve the quality of the concrete industry and its alignment with the environment and sustainable development, effective steps should be taken. In this regard, increasing mixed and Pozzolanic cements and replacing part of cement with materials in order to reduce Klinger consumption, can be good solution to achieve the aforementioned goals (Ramezanianpour, 2014).
Using Verbascum plant powder as an additive material in concrete mixing reduces cement consumption and increase compressive and improves some concrete mechanical properties of the concrete.

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In this paper, the concrete specimens containing Verbascum plant powder with different amount as a percentage of the cement weight is provided and compressive strength is tested and the obtained results are discussed.

Laboratory Samples

Sample Specifications

As it was introduced in the project objectives part, in order to determine the effects of different amounts of Verbascum plant powder in compressive strength of concrete and determine its optimum amount, seven different amount of Verbascum powder as a percentage of cement weight has been used in a concrete with fixed mixture. On the other hand, it's likely that with increasing amount of Verbascum powder, amount of concrete water reduces (The number of concrete slump is reduced). This will increase the strength of concrete because of this the water –cement ratio is considered as one of the research's variables.

Thus the compressive strength of samples are tested and checked for a type of concrete (C25) with three different water-cement ratios (0.5 ,0.55,0.6) and for each water-cement ratio, 7 different percentage of Verbascum powder (3,2,1.5,1,0.75,0.5,0.25 percent) as an additive are used.

A sample per each water-cement ratio without Verbascum powder, as a control sample is prepared, which in the whole experiment, 144 cubic specimens with dimension of 15 Cm to test the compressive strength are provided. To enhance the accuracy of specimens in all samples, two specimens are prepared to check the compressive and average strength of two samples is considered as the sample strength.

Concrete Aggregates of Specimens: The aggregates used in the concrete of specimens are from Tabriz gravel and sand quarries are used and aggregate gradations are according to table 1.

Additive Powder of Verbascum Plant: Verbascum plant after being dried has been crushed and powdered and with aforementioned percent as a percentage of the cement is used in the concrete specimens.

Verbascum plant is a plant that grows on the mountain slopes as a weed and is abundant at Azerbaijan area of Iran (Figure 1). In the past, crushed Verbascum plant was mixed with clay and it was used for making oven and cruse, still in some villages this method is used. From the older people points of view in villages, using this plant in the clay, increases clays strength and reduces its cracks. This effect and subject causes encouragement and motivate for this research.

Flowers of Verbascum plant that have abundant mucilage, are dried in the shade and after being powdered, poured in hot water and are used for treatment of colds and chest softener .Ointments also made from the Verbascum plant powder and put on a wound for wound healing, Verbascum leaves are dried and its powder is used in fishing as bait. Verbascum plant grows mostly in Asia and Europe and it grows alit in the most temperate regions, foothills and rangelands of Iran especially in Azerbaijan. Samples of dried flowers of this plant can be found in some groceries (Shaghaghi, 2010).

Figure 1: Verbascum plant

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Verbascum has hot tempers and its flowers have lots of mucilage. This plant has sulfide compounds, calcium compounds, vitamin B and other minerals like protein and fiber. Oil of flowers of this plant in many parts of Europe is used as a home remedy for various ailments such as tuberculosis, ear infections and inflammation of the eyelids. Verbascum has properties such as expectorant, light diuretic, calming, wound repair, anti- inflammatory and is used to treat coughs and bronchitis, also Verbascum is an effective solution for hair and eyebrows growth.
Verbascum was analyzed in the laboratory and its ingredients are in the table 2. According to this table, the main ingredient of this plant is nitrogen, potassium, magnesium and iron.

Table 1: Gradation of consumption aggregate

Number of sieve	Size of the aperture of sieve	Weight remained on sieve	percentage of residue on the sieve	Cumulative percentage of residue on the sieve	Cumulative percentage of rejected from sieve
1	25	0	0	0	100
0.75	19	70	2.8	2.8	97.2
0.5	125	230	9.2	12	88
0.375	95	220	8.8	20.8	79.2
4	4.75	450	18	38.8	61.2
10	2	360	14.4	53.2	46.8
16	1.18	230	9.2	62.4	37.6
30	0.6	290	11.6	74	26
50	0.3	240	9.6	83.6	16.4
100	0.15	130	5.2	88.8	11.2
200	0.075	280	11.2	100	0.0

Table 2: Ingredients of Plant

Total nitrogen	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Iron (Fe)	Bor (B)
Percentage				mg per Kg				
1.4	0.09	0.45	0.14	22.5	64	38.5	1740	33.5

Laboratory
This research plan has been done at the concrete technology laboratory of the Tabriz Azad University. The equipment used are related to laboratory of the university such as ELE digital concrete breaker jack device with capacity of 200 tones and molds and other devices used in the sampling and curing of the samples.
Concrete Mixture of Specimens
Concrete mixture of specimens for three water-cement ratio, are summarized in the table 3 (Concrete admixture handbook, 1984; ACI committee 212.1R-81, 1984). In this table "G" is the amounts of gravel, "S" is the amounts of sand," C" is the amounts of cement and "W" is the amount of water per each m3 of concrete and Dc is the specific weight of fresh concrete.

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RESULTS AND DISCUSSION

Cubic specimens prepared in accordance with previous paragraphs, after curing in the laboratory conditions at the ages 7, 14, 28 days, have been tested under pressure experiment. The average results of two specimens are considered as result of test sample.

Results of compressive strength of specimens for 8 different amounts of Verbascum powder (0% as control sample and 0.25 and 0.5, 0.75, 1, 1.5, 2, 3 percent of cement weight), and for three different water-cement ratio (0.5, 0.55, 0.6), are mentioned in the table 4.

Table 3: Concrete mixture in C25 concrete

Water-Cement ratio	G (kg/m^3)	S (kg/m^3)	C (kg/m^3)	W (kg/m^3)	Dc (kg/m^3)
0.5	1115	715	350	175	2355
0.55	1115	690	350	193	2355
0.6	1115	680	350	210	2355

Table 4: Results of the compressive strength tests of specimens

Verbascum powder percentage	Age of Sample (Day)	Water – cement Ratio	compressive strength (MPa)	Verbascum powder percentage	Age of Sample (Day)	Water-cement Ratio	Compressive Strength (MPa)
		0.5	16.8			0.5	17.8
	7	0.55	15.1		7	0.55	16.25
		0.6	15.2			0.6	13.6
		0.5	26			0.5	25.1
0%	14	0.55	22.65	1%	14	0.55	22.95
		0.6	21.9			0.6	18
		0.5	28.95			0.5	30.5
	28	0.55	27.45		28	0.55	27.9
		0.6	25.9			0.6	23.2
		0.5	19.35			0.5	18.95
	7	0.55	17.25		7	0.55	17.2
		0.6	20.6			0.6	12.35
		0.5	30.1			0.5	24.35
0.25%	14	0.55	21.7	1.5%	14	0.55	22.85
		0.6	27.55			0.6	17.2
		0.5	31.2			0.5	26.3
	28	0.55	27.25		28	0.55	27.53
		0.6	32.25			0.6	24.5
		0.5	19.75			0.5	20.4
	7	0.55	17		7	0.55	19.75
0.5%		0.6	15.35	2%		0.6	13.25
	14	0.5	22.9		14	0.5	28.85
		0.55	20.7			0.55	24.2

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		0.6	17.55			0.6	17.8
		0.5	31.55			0.5	33.3
	28	0.55	25.85		28	0.55	29.25
		0.6	23.75			0.6	23.1
		0.5	16.5			0.5	6.4
	7	0.55	14.9		7	0.55	3.95
		0.6	15			0.6	3.8
		0.5	21.35			0.5	15.4
0.75%	14	0.55	19.35	3%	14	0.55	6.9
		0.6	18.7			0.6	6.75
		0.5	27.45			0.5	22.8
	28	0.55	25.65		28	0.55	10.6
		0.6	25.45			0.6	10.1

Effects of Verbascum Powder on Compressive Strength of Concrete

Results of cubic samples in compressive experiments at the ages 7, 14, 28 days, with different amount of Verbascum powder and different water-cement ratio, according to table 4, are shown as diagrams of figure 2. These diagrams illustrate that adding Verbascum powder to concrete, increase concrete compressive strength .The increase in concrete compressive strength depends on amounts of Verbascum powder. In some cases, from the point of the amount of powder added and the water-cement ratio, reduction of compressive strength has been seen but in the most cases there is increase in strength.

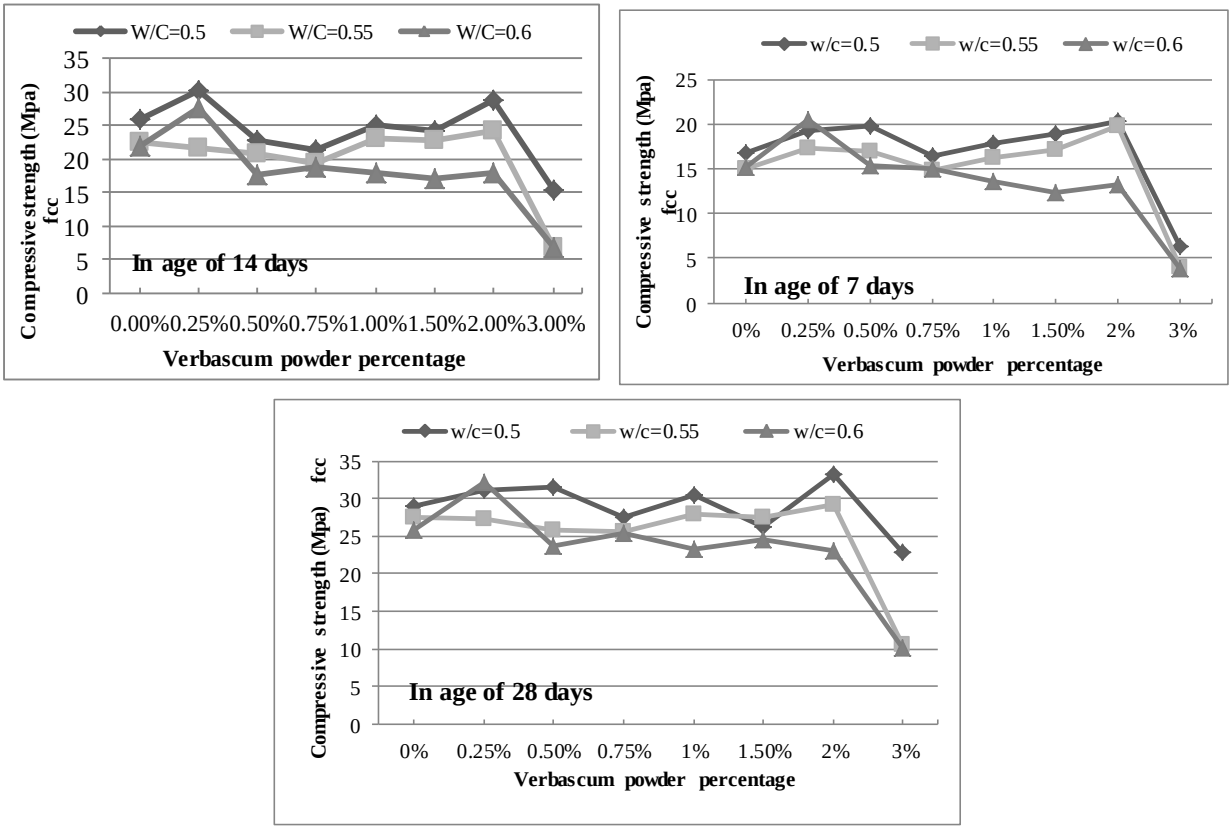

Figure 2: Compressive strength of concrete with different amounts of Verbascum powder

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Diagrams of figure 3, illustrate changes in compressive strength of cubic samples for water-cement ratios 0.5, 0.55, 0.6 with different amount of Verbascum powder.

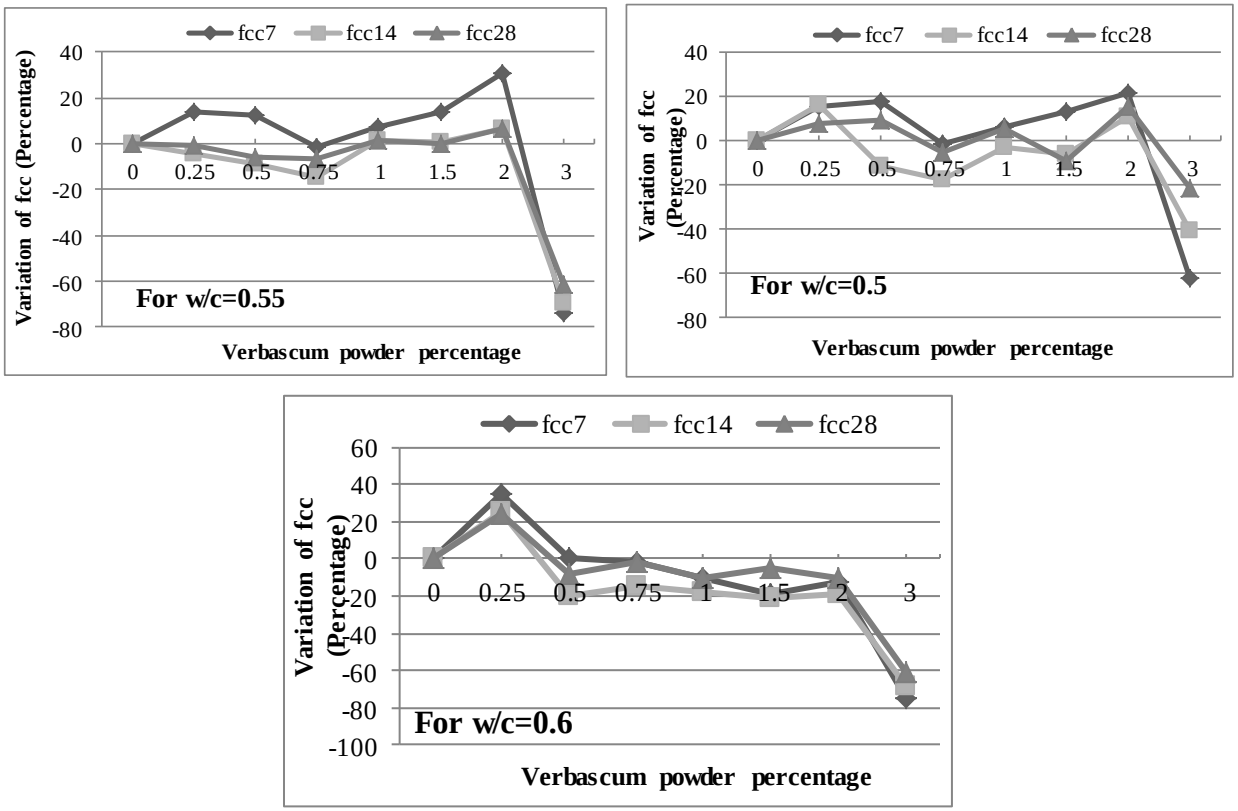

Figure 3: Changes of compressive strength of concrete containing Verbascum powder.

From table 4 and diagrams of figures 2 and 3, the following results are obtained: It should be noted that in this table and diagrams, f_{cc7}, f_{cc14} and f_{cc28} are compressive strength of cubic samples at the ages of 7, 14, 28 days.

A- Adding Verbascum powder to concrete in the most cases, increases concrete compressive strength, in some cases reduction of strength has been seen.

B- The maximum increasing of compressive strength of concrete was when the amount of Verbascum powder used in concrete was 2 percent of cement weight. For the amounts of 3 percent or more of Verbascum powder compressive strength of concrete reduced considerably.

C- Increase in concrete compressive strength containing Verbascum powder at the lower age is more, this result demonstrate that adding Verbascum powder to concrete, accelerate concrete and reaching to its goal strength. To prove this issue, supplementary experiments are needed.

D-In the most samples, by increasing water- cement ratio, compressive strength of concrete is reduced and this strength reduction is variable with increasing Verbascum powder percentage in samples.

E- There is more increase in compressive strength of concrete containing Verbascum powder compared to concrete without powder, in lower water –cement ratio.

Conclusion

According to the results of tests, which are provided in tables and diagrams, following results are obtained:

1-Adding Verbascum powder to concrete, in the most cases, increases concrete compressive strength around 12 percent.

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2- The greatest increase in the concrete compressive strength is observed when the amount of Verbascum powder used in concrete was 2 percent of cement weight.
3-The amount of compressive strength of concrete containing Verbascum powder in lower water –cement ratio, is more.

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