Studying the Strength of Self Compacting *Concrete* According to the Ratio of Plasticizers and Slump Flow Using Experimental Method

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Abstract: The use of self compacting *concrete in* concrete structures increasingly has become prevalent in recent years. In this regard, the use of admixtures in this type of concrete and determining the proportion of them will be important. In this study we aimed to, by taking the ratio of powdery materials and plasticizers and the main materials formed concrete mixing, during tests conducted in 4 groups, in laboratory of Islamic Azad University of Tabriz, we observed adding the powdery materials, 10% to 15%, increased the 28-day strength of concrete. Also results showed that adding plasticizers increase *t*he slump by 40% and reduce water consumption by 20% per cubic meter.
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1. Introduction

Self compacting *concrete,* due to its own weight, without the need for vibration, allows air bubbles out in Narrow and compact areas of reinforcement. It also prevents separation of concrete bleed water and aggregates and evenly penetrates the total area at the same time. In this case, the obtained concrete will be in integrated and appropriate mode. Another advantage of self compacting *concrete* is very good pumping ability due to the slump at the long distances. Moreover the use of this concrete will dramatically reduce concreting time and noise pollution and on the other hand reduces vibration costs. Despite all the advantages, self compacting *concrete has* disadvantages such as separation of aggregates and concrete bleeding. One of the solutions to this problem is the use of admixtures and increasing the viscosity of concrete using these materials.

2. Background research

Self compacting *concrete* was proposed in 1986 by Okamura in Japan (okamura ,H,et al,1999). It was constructed in 1988 in the workshop and made acceptable results in terms of physical and mechanical properties of concrete. An article about the concrete was published in 1989 by Ozava et al. The first workshop that was dedicated to examine the concrete and the materials used in self compacting *concrete* in August 1998 was held in Kochi University in Japan and several articles presented at the world in relation to the development of self compacting *concrete* (K. Ozawa, University of technology). Also self compacting *concrete* is used in many projects and the most important application of that is in the developing world in the longest cable bridge (1998 m), Akashi Kiaky Bridge. Self compacting *concrete* blocks have been used in the bridge and during the project, 20% of the total project time savings were achieved. The project duration was reduced from 2.5 years to 2 years and is now in use in several countries.

3. Self compacting concrete properties

Self compacting *concrete* have different slump and admixtures characteristics than conventional concrete.

- Normally, the self compacting *concrete* should have a slump of more than 600 mm and should not be detached.
- Maintaining the flow of concrete at least 90 minutes
- Ability to resist the horizontal gradient of 3%
- Pump capacity at least 10 meters pipe length
- 28-day compressive strength of 250 to 600 kilograms per square centimeter
- Initial compressive strength of concrete used in building is about 50 to 200 kilograms per square centimeter in the first 15 to 20 hours at 20 ° C.
- Due to its heavy weight, self compacting *concrete* can penetrate to the desired location.
- It has many applications in the structures that have a high density of reinforcement. See Fig. 1. (Structures designed for earthquake).

After being placed into molds quickly locates at the bottom of the mold and concreting can be completed between 1.5 to 2.5 hours (depending on the type of use and its amount, concreting ends in 45 minutes).

In retrofit projects dramatically decrease in time, number of workers, vibration, and electricity, etc occurs.

The most important property of self compacting *concrete:* If properly designed and executed, following the earthquake of magnitude 7 and above, shows certain reactions.

Fig. 1. Concreting in high density reinforcement

4. Tips for materials and mixing self compacting concrete

The most important materials used in this type of concrete are cement, sand and plasticizers.

The cement should be between 350 to 400 kilograms per cubic meter. There is a risk of condensation if you select more than 500 kilograms per cubic meter and selection of less than 350 kilograms per cubic meter would allowed if Pozzolanic materials or fly ash are used. Also gravel in appropriate amounts is used in the mix design to prevent detachment of aggregate. The sand is to increase the flow of concrete to the appropriate amount. Additional materials are including *fine* aggregates and plasticizers. *Fine* aggregates are powdery materials of stone and cement and plasticizers like silica fume and fly ash, in order to reduce the heat of hydration of concrete mix that improves the long-term performance of concrete. Use of plasticizers can reduce water content up to 20% (walraven, j structural aspects).

V.M.A (Thickener) vs. powders is used to increase adhesion. Blowing agents can also be used in the design of concrete mixing. Maximum aggregate size depends on the practical applications of design and is usually limited to 20 mm. (Particles smaller than 0.125 mm) are considered as powder amount (Admixture Sheet – ATS 13).

5. Conducted Experiments

5.1. Testing devices

Slump cone had 300 mm height, 200 mm basal diameter and 100 mm upper diameter. Plate, pedestal (smooth, hard, non-absorbent and perfectly smooth and flat with dimensions of 90 × 90 cm that a circle with a diameter of 50 cm was inscribed), scaled meter.

5.2. Mixing design

Cement + powder 500 kg (280 +270)
Sand, gravel (1618 kg)
Micro Silica 3%
Water (changeable according to performance) 167.3 liters
Plasticizer 7.5 to 5 kg

5.3. How to make the concrete?

Cement used is type 2 Portland cement
Micro silica used was from domestic companies' production
Aggregates used were coarse and broken type with a maximum size of 20 mm.
Fine aggregates used were normal type.
Super *Plasticizers were* carboxylated and were from domestic companies.

First, sand and gravel with one-third of the water were added into *the* mixer. Thereafter cement, pozzolanic materials and micro silica with other one-third of the water were added. Then the remaining water and plasticizer were added to the mix. Mixing carried out for 3 minutes in the mixer and then the process stopped for 3 minutes. Then the mixture was mixed for 2 minutes and so the concrete would be achieved.

5.4. Slump flow

According to ACI regulation defines; concrete flow is the ability of fresh concrete or mortar mix to flow. Word performance refers to: easy to placing, compacting capacity, easy concrete surface finishing, and resistance to detachment. Unfortunately, little experiments have been conducted on performance of concrete. However, in this research we have tried to test concrete performance with some simple physical properties. It should be noted that the tests do not measure the slump performance but describes concrete flow. ASTM regulation has stated performance as follows (ASTM C 143):

Determiner properties required for the transport of fresh concrete mixed with minimal loss of uniformity.

ACI 116R-90 regulation has stated performance as follows:

Property of freshly mixed concrete or mortar which determines the ease and homogeneity, concrete can be mixed it, poured in place, be compact and finish the concrete surface. ACI regulation defines; calls concrete flow as relative mobility or ability of freshly mixed concrete or mortar to flow. This property of concrete is obtained by slump experiment. Given all the constraints mentioned, Slump test is very useful for workshop control and module to module as well as hourly changes of materials in concrete.

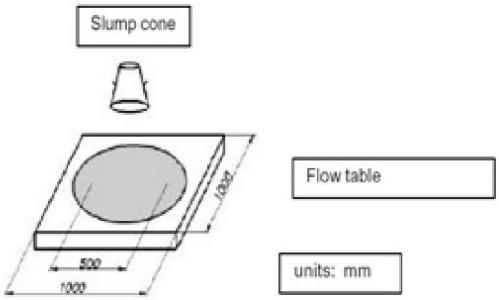

Fig. 2. Slump cone

5.5. Methods

In order to test, a cone as in Figure 2 was considered. Cone axis in the center of plate is aligned and gets wet. 6 liters of concrete is poured into it and the concrete surface will be smooth. Filling the cone should be taken without any internal or external compression. After filling, cone is pulled up with a constant speed. When motion stopped, two perpendicular diameters are measured and the average is obtained. Figure 3 shows the slump flow circle.

Fig. 3. Slump flow of self compacting concrete

6. Conclusions

In this laboratorial study, we tried to according to previous studies and adding obtained data, propose the points and proportions in designing and production of self compacting concrete including the concrete mixtures and a simple workshop experiment. Regardless of the time factor in the slump test, because of the experimental design and the effect of fine and coarse aggregates in concrete flow and proportion of powdery materials and their effect on water absorption, the amount of plasticizers are according to the proportions.

According to the results, the values of strength, plasticizers and the slump are shown (Table 1). Figure 4 shows strength changes with the amount of plasticizer. Figure 5 shows the curve of plasticizer with slump and figure 6 shows the curve of the strength and the slump flow. According to the results obtained, the strength decreases with increasing amount of plasticizer (Fig. 4), Slump flow increases with increasing amounts of plasticizer (Fig. 5), and strength decreases with increasing slump flow (Fig.6). Using the values obtained and using random and non-random multivariate regression, according to Figure 6, the equation of strength, plasticizer and slump obtained according to the following equation:

R= -3.05279 PL+0.02158 SL+36.27

In the above equation, R is the concrete strength (Mpa), SL is slump flow (Cm) and PL refers to plasticizer (Liter).

Table 1. Strength, plasticizer and slump

strength	plasticizer	slump
31.9	5.8	600
31.3	5.9	600
31	6	615
30	6.2	620
30	6.7	635
29.5	6.9	650
28.4	7.2	651
27.2	7.5	652

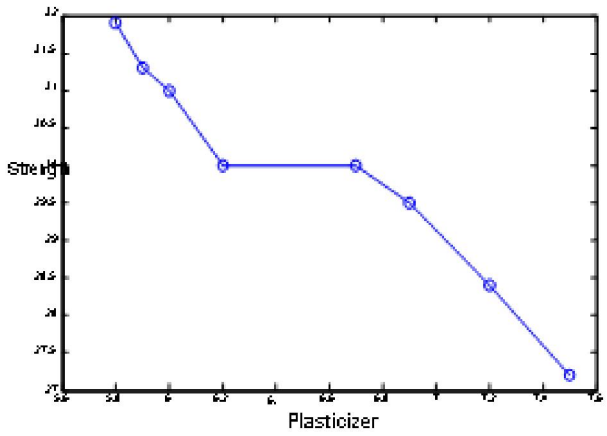

Fig.4. Strength changes by plasticizer

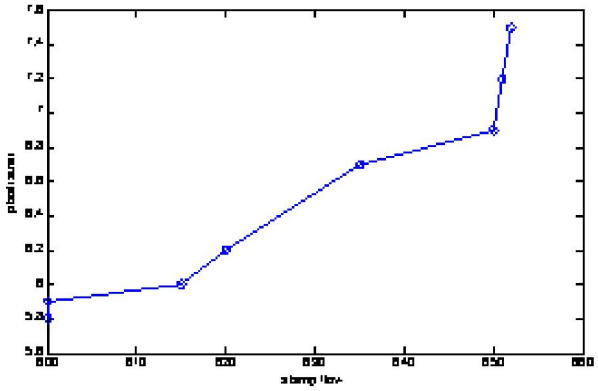

Fig. 5. Slump flow changes by plasticizer

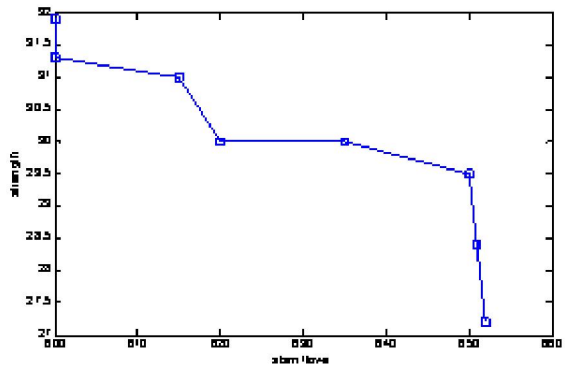

Fig. 6. Strength changes by slump flow

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.967004
R Square	0.935096
Adjusted R	0.909134
Standard E	0.46822
Observati	8

ANOVA

	df	SS	MS	F	gnificance F
Regressio	2	15.7926	7.8963	36.01836	0.001073
Residual	5	1.096149	0.21923		
Total	7	16.88875			

	Coefficients	tandard Err	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Upper 95.0%
Intercept	36.27787	12.10519	2.996886	0.030207	5.160492	67.39525	5.160492	67.39525128
X Variable	-3.05279	1.007565	-3.02987	0.029086	-5.64282	-0.46276	-5.64282	-0.462764805
X Variable	0.021587	0.029133	0.740993	0.492009	-0.0533	0.096476	-0.0533	0.096475823

3/15/2013

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