Study effect of Vibration of surface liquid , Temperature & Concentration on the surface tension of water

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Abstract

Self compacting concrete (SCC) can be classified as high performance concrete. As the name suggests, it does not require to be vibrated to achieve full compaction. This offers many benefits and advantages over conventional concrete.
This study aims to evaluate the fresh and hardened properties of SCC produced by using locally available materials. This study includes also the influence of different percentages of polypropylene fibers (PPF); added by about (0, 0.5 and 1) % by the total volume, on the same properties. To achieve these aims six different mixes of SCC (with and without fibers) are mixed, tested and evaluated.

Also, this study aims to identify the mechanical properties of SCC specimens (with and without fibers) at high temperature, including compressive and flexural strengths. The effect of different heating rates (25, 100, 400 and 700)^{0}C on the mechanical properties of SCC is studied. The difference of the mechanical properties between normal and high strength SCC is identified. The test results show that all the mixes have good consistency and workability from the filling ability and passing ability point of view. Also, the addition of PPF gives a homogeneous and cohesive mix with slight decrease in workability. However, the addition of PPF causes a slight reduction in compressive strength which increased as the percentage of PPF increased, while this addition causes a noticed increment in flexural strength.
Also, it is found that compressive and flexural strengths decreased as the heating temperature increased.

Keywords: Self compacting concrete, high temperature, strength, fiber.

الخلاصة :

تعرف الخرسانة ذاتية الرص بانها خرسانة عالية الاداء, وكما هو واضح من الاسم انها لا تحتاج الى رص ميكانيكى مما يجعلها مميزة ومفضلة عن الخرسانة التقليدية. يهدف هذا البحث الى تقييم الخصائص الطرية والصلبة للخرسانة ذاتية الرص المنتجة باستخدام مواد محلية متوفرة, ايضا يهدف الى توضيح تاثير نسب مختلفة من الياف البولي بروبلين التي اضيفت بمقدار (0-0,5-1,0)% من الحجم الكلي للخرسانة على نفس الخصائص الطرية والصلبة. لتحقيق ذلك, 6 خلطات مختلفة من الخرسانة ذاتية الرص (مع او بدون الياف) تم تصميمها وخلطها وفحصها بالاضافة الى مناقشة النتائج.

كذلك يهدف البحث الى دراسة الخصائص الميكانيكية (مقاومة الانضغاط و مقاومة الانحناء) لنماذج الخرسانة ذاتية الرص (مع او بدون الياف)تحت تاثير الحرق فى درجات حرارة مختلفة. حيث تم دراسة تاثير التدرج الحرارى (100,400,700)^{0}س اضافة الى النماذج التى تم فحصها بدرجة حرارة الغرفة 25^{0}س ,اضافة الى دراسة الاختلاف فى الخصائص الميكانيكية بين الخلطات المختلفة للخرسانة ذاتية الرص ذات المقاومة الاعتيادية والمقاومة العالية. ايضا وجد ان قابلية التشغيل جيدة كما ان اضافة الياف البولى بروبلين اكسبت خلطات الخرسانة ذاتية الرص قوام متجانس ومتماسك مع انخفاض قليل فى قابلية التشغيل. على اية حال، ان اضافة الياف البولى بروبلين سببت انخفاض قليل فى مقاومة الانضغاط وزيادة ملحوظة فى مقاومة الانحناء. كما وجد ان مقاومة الانضغاط والانحناء انخفضت بشكل واضح عند زيادة درجة حرارة الحرق.

1. Introduction:

Surface Tension, condition existing at the free surface of a liquid, resembling the properties of an elastic skin under tension [1]. The tension is the result of intermolecular forces exerting an unbalanced inward pull on the individual surface molecules; this is reflected in the considerable curvature at those edges where the liquid is in contact with the wall of a vessel .More specifically, the tension is the force per unit length of any straight line on the liquid surface that the surface layers on the opposite sides of the line exert upon each other .The tendency of any liquid surface is to become as small as possible as a result of this tension, as in the case of mercury, which forms an almost round ball when a small quantity is placed on a horizontal surface [1,2].The near-perfect spherical shape of a soap bubble, which is the result of the distribution of tension on the thin film of soap, is another example of this force; surface tension alone can support a needle placed horizontally on a water surface . Surface tension is important at zero gravity, as in space flight :Liquids cannot be stored in open containers because they run up the vessel walls.

2. Theoretical part:

Molecules normally attract each other and tend to stick together .To understand the reasons for this we would need to study basic molecular physics and the various bonding forces that make this happen.In a solid these forces are strong and hold the molecules together in a rigid structure .In a liquid these forces are weaker and not strong enough to make the structure rigid but strong enough to hold it together; in gas these forces are very weak and unable to hold the mass together at all so the molecules are almost free to wander .When molecules of a substance stick to each other that called cohesion .When the molecules of a liquid stick to a solid surface called adhesion .When adhesion is strong than cohesion, the liquid will stick to the surface and is said wet the surface .For example oil will wet the surface of a steel plate .When cohesion strong than adhesion the liquid will not stick to the surface . For example mercury will not stick to glass [2,3] .Show Fig.(1)

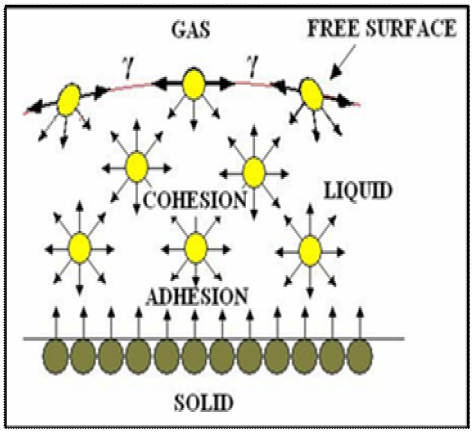

Fig.(1) The forces between the molecules of liquid

The surface tension arises because of the intermolecular forces of attraction that molecules in a liquid exert on another this force between like molecules called cohesive forces[3] .A liquid, however is often in contact with a solid surface such as glass then additional forces of attraction come in to play they occur between molecules of the liquid and molecules of the solid surface and being between unlike molecules are called adhesive forces . the tube with very small diameter, which is called a capillary when a capillary open at both ends, is inserted in to liquid the result of the competition between cohesive and adhesive forces can be observed .For instance Fig. (2) shows a glass capillary inserted into water[4].

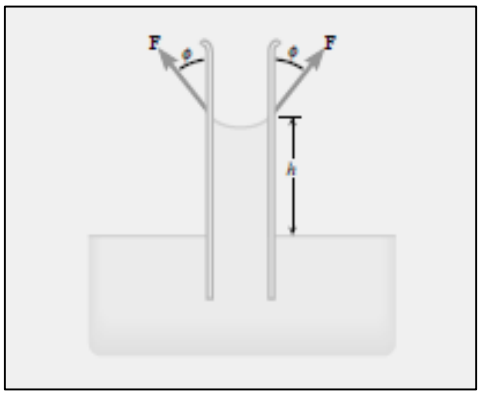

Fig. (2) a glass capillary inserted into water.

Surface tension is an effect within the surface layer of a liquid that causes that layer to behave as an elastic sheet .In the bulk of the liquid each molecule is pulled equally in all directions by neighboring liquid molecules, resulting in a net force of zero .At the surface of the liquid, the molecules are pulled inwards by other molecules deeper inside the liquid but they are not attracted as intensely by the molecules in the neighboring medium .Therefore all of the molecules at the surface are subject to an inward force of molecular attraction which can be balanced only by the resistance of the liquid to compression[5].

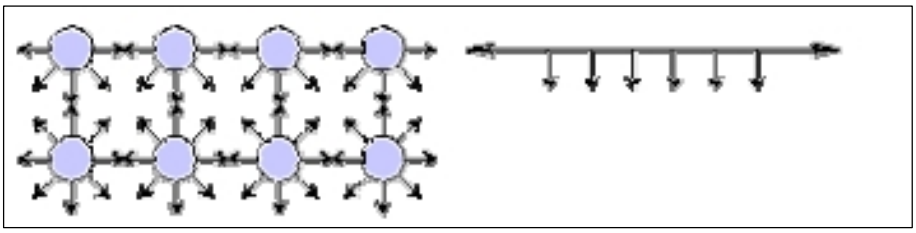

Fig (3) Molecules on the surface of a liquid experience an imbalance of forces

From the Fig.(4) illustrate the molecular basis for surface tension by considering the attractive forces that molecules in a liquid exert on one another . Fig(4-a)shows molecules with the bubbles so that it is surrounded on all sides by other molecules .The surrounding molecules attract the central molecule equally in all direction, leading to a zero net force .In contrast Fig.

(4-b) shows a molecule in the surface, since there how a molecule in the surface, since there are no molecules of the liquid above the surface, this is molecule experiences a net attractive force pointing toward the liquid interior .This net attractive force causes the liquid surface to contract toward the interior until repulsive collision forces from the other molecules halt the contraction at the point when the surface area is minimum surface area for a given volume nearly spherical drops of water are a familiar sight[5,6].

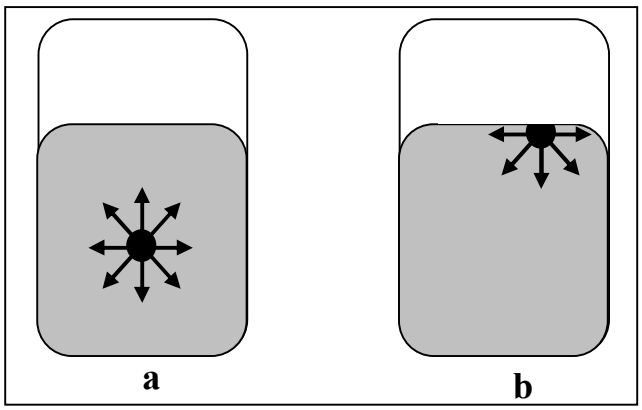

Fig. (4) a .Represent molecular within the bluk liquid is surrounding an all sides by on the molecular, which attract it equally in all directions, leading to a zero net force .b .Represent molecule in the surface experiences a net attractive force pointing toward the liquid interior because there are no molecules of the liquid above the surface.

The net effect of this situation is the presence of free energy at the surface .The excess energy is called surface free energy and can be quantified as a measurement of energy per unit area .It is also possible to describe this situation as having a line tension or surface tension, which is quantified as a force per unit length measurement .The common units for surface tension are dynes/cm.[7] Surface tension represents the ratio between the affective forces in the length unit at the angle equal 90^{o} , the unit of it is N/m. There are many methods used to measure the value of surface tension. The first one depended on determine the height of liquid in the tube, can give by equation[7] :

$$(\sigma)=\left(\frac{r^{3}}{h+1}\right)\rho g r^{2} \quad \text{.....(1)}$$

r is the radius of tube ,h the high of liquid, ρ the density of liquid and g the earth acceleration 9.8m/sec^2

Table (1) show many value of surface tension for different types of liquid with different temperature [1]

Table (1) represents the value of surface tension for different types of liquid with different temperature

Surface tension N/m	.Temp C°	Material
72.86±0.05	*20*	*Water-air*
72.00	*21.5*	*Water*
71.99±0.05	*25*	*Water*
28.88	*20*	*Benzene-air*
27.56	*30*	*Benzene-air*

3. Experimental Part

Fig.(5) represent the setup of system, incident the laser at very small angle equaled 4° at distilled water , by using function generator change the frequency from (110 to 380)Hz, at room temperature, after that change the temperature from 280 to 380 K with fix frequency at 125Hz, and there are many calculation must do it to get the value of surface tension the first step is determine the wave number by using the following equation[1]:

$$q = \frac{2\pi}{\lambda}\sin\frac{r}{2}\left[\sin\left(\theta-\frac{r}{2}\right)+\sin\left(\theta+\frac{r}{2}\right)\right] \quad \text{.....(2)}$$

Where λ the wavelength of laser (632.8) nm, θ and r diffraction angle. When the frequency increased many of waves appeared in water by these waves the water become as a grating so the fringes would appear on the screen at distance L and the distance between each fringe would increase when the frequency increased too. The surface tension can be determined by using the following equation [1,2]:

$$\sigma = \frac{4\pi^2 f^2 \rho}{\frac{2\pi}{\lambda}\sin\frac{r}{2}\left[\sin\left(\theta-\frac{r}{2}\right)+\sin\left(\theta+\frac{r}{2}\right)\right]^3} \quad \text{...(3)}$$

ρ is the density of water, f is the frequency and π constant equal 3.14.
and from equation (2) the surface tension become[1]:

$$\sigma = \frac{w^2\rho}{q^3} \quad \text{.....(4)}$$

w^2 is the angler frequency can get from following equation;

$$w = 2\pi f \quad \text{..... (5)}$$

After determined the surface tension repeat the steps but with different temperatures by using heater and thermometer with fix frequency at 110Hz as Fig (5), change the temperature at each 10 degree begin from 273K to 330K.Later add NaCl salt in different weight from 1g to 2.5g with 40ml of water and fix all parameters as table (2).

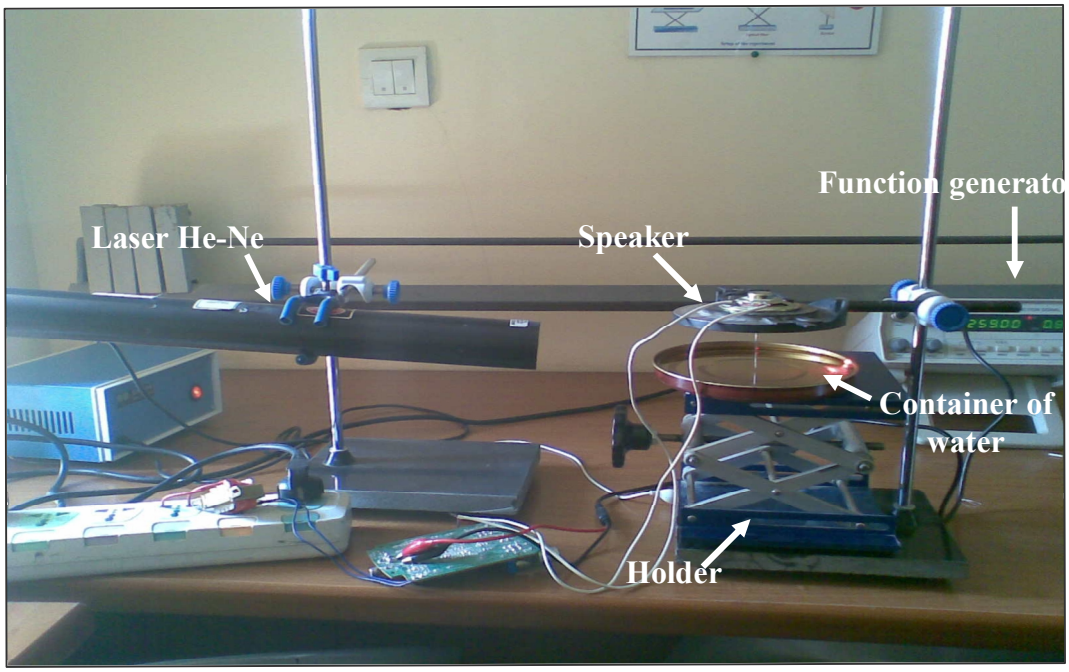

Fig. (5) Schematic of the apparatus

Table (2) Represent the parameters that used to measure the surface tension of water after addition NaCl salt

Sample	Water ml	Frequency Hz	Temperature K	Salt NaCl g
Sample 1	40	110	273	1
Sample 2	40	110	273	1.5
Sample 3	40	110	273	2
Sample 4	40	110	273	2.5

4.Results and discussion:

From Fig (6) the distance between fringes increase when the vibration increased too and this came from the increasing in the value of frequency by function generator, therefore the vibration will broke the bonds between molecules and the molecular move in the different direction.

The Fig(7)shows the relation between wave number and frequency so that the increasing in the wave number or frequency will reduce the surface tension because the adhesive force between the liquid and container would be decrease, therefore the increasing in the vibration of liquid will reduce the value of surface tension, show Fig(8).

From Fig (9) the increasing in temperature would reduce the value of surface tension because the heat give the molecular motion energy and this help to made motion of them random so the bonds between molecules will be weak and the cohesive will be weak and the adhesive between container and water decreased too, therefore the value of surface tension will reduce too.

From Fig (10) the addition of (NaCl) led to increase in the value of surface tension, the adhesion force increased compared with cohesion force because the salt made as a doping molecule made cut the band between molecules of water, therefore the adhesion force become larger then cohesion force.

5.Conclusions:

From our results we found the surface tension affected by two parameters the first one is frequency (the vibration of water surface).

The second parameter is temperature when the temperature is high the value of surface tension decreased because of the heat made the motion of molecules was random so the connection between molecules reduce until become interrupt.

When add the salt NaCl the adhesion force increased and the cohesion force decreased therefore the surface tension increased.

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