Al-Azhar University Civil Engineering Research Magazine (CERM)
Vol. (41) No. (4) October, 2019

The effect of aggregate temperature on the properties of concrete with different cement content

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الملخص:
يتناول البحث نقاطا تعتبر من اهم الموضوعات في تطبيقات الهندسه الإنشائيه وهي تنفيذ المنشآت الخرسانيه في الأجواء ودرجات الحراره المتغيره اثناء فصول العام المختلفه حيث يدرس البحث تأثير درجات حرارة الركام المختلفه علي خواص مادة الخرسانه الناتجه سواء في حالتها الطازجه مثل مخروط الهبوط او في حالتها المتصلده مثل مقاومة الضغط ومقاومة الشد للخرسانه ولقد خلص البحث الي مجموعه من النقاط الهامه التي يلزم ان تكون امام اعين المهندسيين والمتخصصين في اعمال الإشراف علي الأعمال الإنشائيه ولاسيما اعمال صب الخرسانه المسلحه وبنود ضبط الجوده الخاصه بها للحصول علي خلطه خرسانيه تحقق مقاومة الضغط المطلوبه طبقا لتوصيات المهندس الإنشائي المصمم للمشروع .

Abstract:

Generally, the temperature has a significant effect in the concrete strength in both long and short term which is considered as the most important property of the concrete. The change of temperature is also affect the rate of hydration, the time of suspicion ……etc . The research discuss the effect of aggregate temperature on the properties of concrete and the effect of cement content on the results of the concrete strength during the change of temperature. The variables of the experimental program are the value of temperature of the aggregates and the cement content in the mix design. All the tests are implemented in the laboratories of the materials in pyramids higher institute for engineering and technology. A theoretical study followed by laboratory tests , results and conclusion are implemented in this research .

Changes of temperatures .

The change of temperatures mean :
- The temperature of weather .
- Temperature of aggregates .
- Temperature of cement .
- Temperature of water mixture .
- Relative humidity .
- Solar radiation .

Hot weather causes some problems during concrete cast such as difficult workability , losses in water mixture of the mix and shrinkage crakes . The evaporation rate is a result of the cumulative effect of the temperature due to relative humidity , wind speed and solar radiation . These factors leading to increase the rate of hydration . The temperature and fineness of cement play also an important role in the hydration process.

In these papers , it will be concentrated on the effect of aggregate temperature as a variable accompanied by cement content .

Effect of high temperature on the components of concrete :

1- Effect of high temperature on aggregates :

The temperature of aggregates is one of the factor which control the temperature of the mix . The higher values of temperature change the properties of aggregates themselves

but normally this phenomenon is not occur in the concrete mix .The reasonable change in temperature in aggregate affect the degrees of temperature of the concrete mix . In these papers , the effect of different degrees of temperature of aggregates on the properties of concrete mix will be studied .

2 – Effect of high temperature of cement :

The hot weather effects the cement by reducing its compressive strength . It is also noticed that when the cement was stored at hot climate two or three months , this has a direct effect on the performance of cement and consequentially the concrete mix properties .

3 – Effect of high temperature water mixture :

The hot water mixture has an important and significant effect on concrete mix . It change the basic properties of concrete on both short and long terms .

Effect of hot weather on fresh concrete properties :

Potential problems of freshly mixed concrete hot weather could be concluded to : -

- Water demand increase .
- Increase the slump loss rate .
- Increase the cracks of plastic shrinkage .
- Increase air content in the mix which affect the density and compressive strength Of the concrete .
- Affect the workability of the fresh concrete .

Experimental program :

An experimental tests program is planned to achieve the research target using the following factories:

1 - Water temperature is 20 ^{0}C , fine and coarse aggregate ratio is (1 : 2) , water content (W/C) equal 0.5 and cement type is ordinary Portland cement are constant.

2 – Cement content is variable where mixes of 350 kg cement / m ^{3} and 450 kg cement / m ^{3} were used .

3 – Aggregates temperature is variable where (20 ^{0} c , 30 ^{0} c , 40 ^{0} c , 50 ^{0} c and 60 ^{0} c are used .

4 – All the specimens were tested in the materials and concrete laboratories of Pyramids higher institute for engineering and technology .

5 – All the concrete mixes were tested at fresh and hardened state in which slump testes in fresh state and 15 x 15 x 15 cubes in hardened state are performed .

6 – The cubes were used for compression strength of the resulted concrete (after 28 days of casting) .

7 – Concrete beams of dimensions 15 x 15 x 60 cm are used for flexural after 28 days of casting.

8 – For splitting (indirect tensile strength test) , cylinder specimens of 15 cm diameter and 30 cm height are used also after 28 days of casting .

Mixes design :

The traditional mixes (0.8 m ^{3} coarse aggregate , 0.4 m ^{3} fine aggregate , 350 kg and 450 kg ordinary Portland cement and W/C = 0.5) were used in preparing the tested specimens.

Results :

This item describes the results of the experimental program including the effect of changing the temperature of aggregates on the properties and behavior of concrete in both of its fresh and hardened state . Also the effect of cement content on the results are studied .

Fresh concrete results :

Results of slump tests :

Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Slump values (cm)
20	350	5.8
30	350	5.1
40	350	3.7
50	350	2.2
60	350	2.1

Table (1) : Results of aggregate temperature (^{0} C)and slump values (cm) for cement content 350 kg / m ^{3}

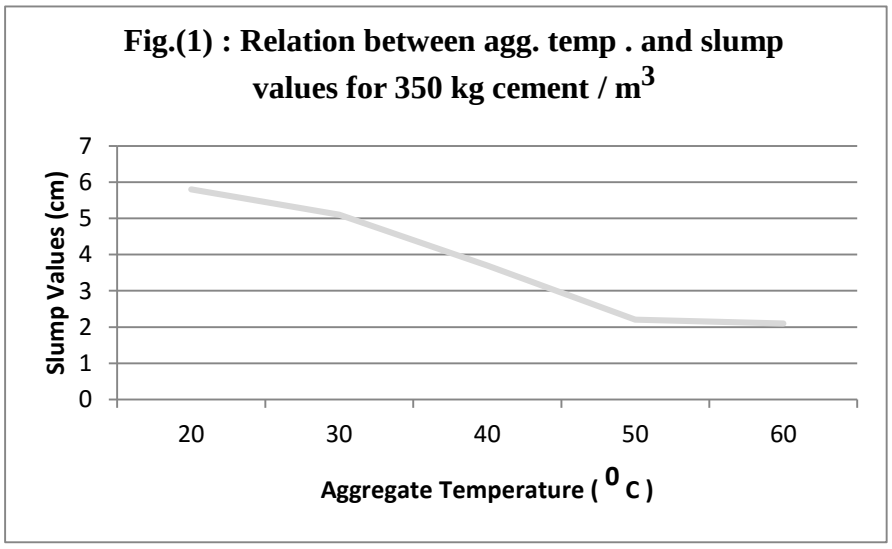


Fig.(1) : Relation between agg. temp . and slump values for 350 kg cement / m^3

Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Slump values (cm)
20	450	4.3
30	450	2.8
40	450	2.3
50	450	1.9
60	450	1.4

Table (2) : Results of aggregate temperature (^{0} C)and slump values (cm) for cement content 450 kg / m ^{3}

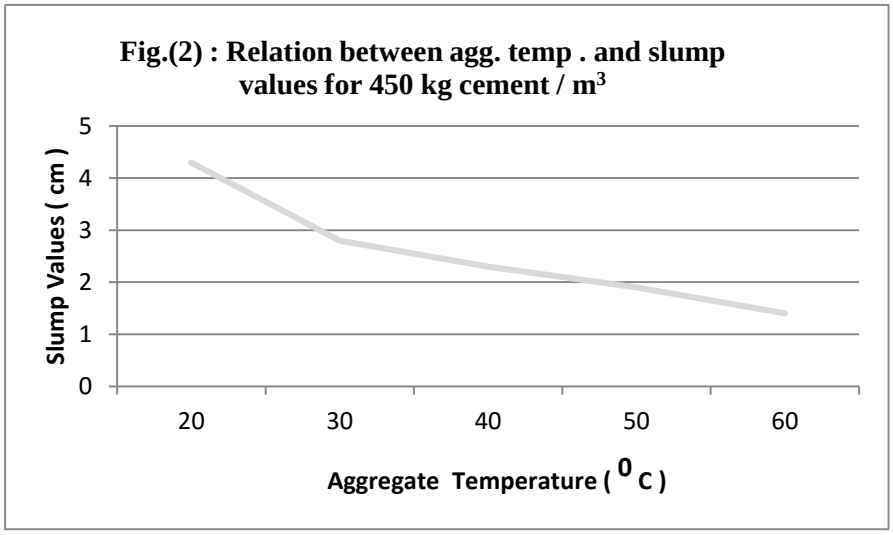


Fig.(2) : Relation between agg. temp . and slump values for 450 kg cement / m^3

Hardened concrete results :

A – Compressive strength (after 28 days) :

Aggregate temperature (^{0} C)	Cement content (kg / m^3)	Compressive strength (28 days) (Kg / cm^2)
20	**350**	**257.8**
30	**350**	**201.6**
40	**350**	**193.7**
50	**350**	**152.2**
60	**350**	**117.3**

Table (3) : Results of aggregate temperature (^{0} C) and compressive strength (kg / cm^2) for cement content 350 kg / m^3

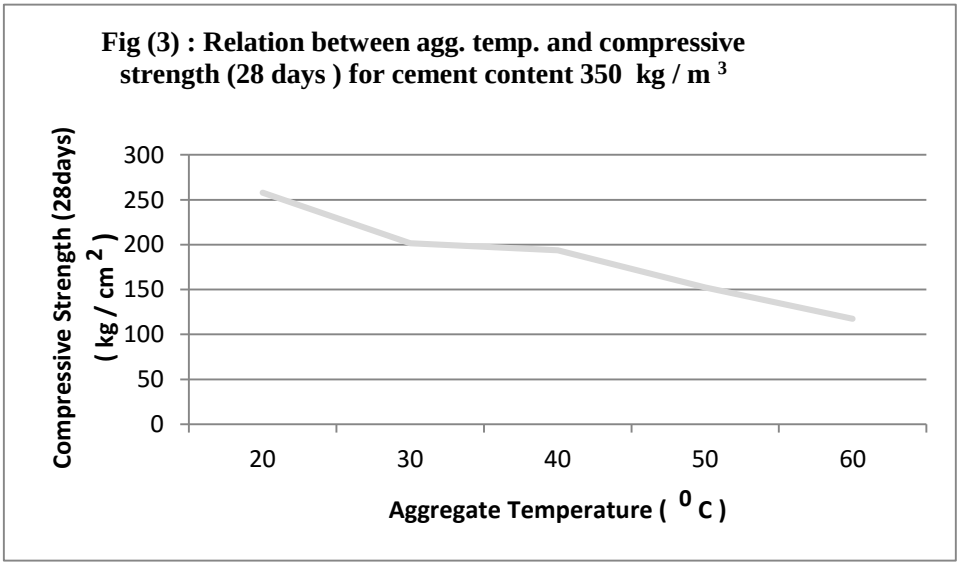
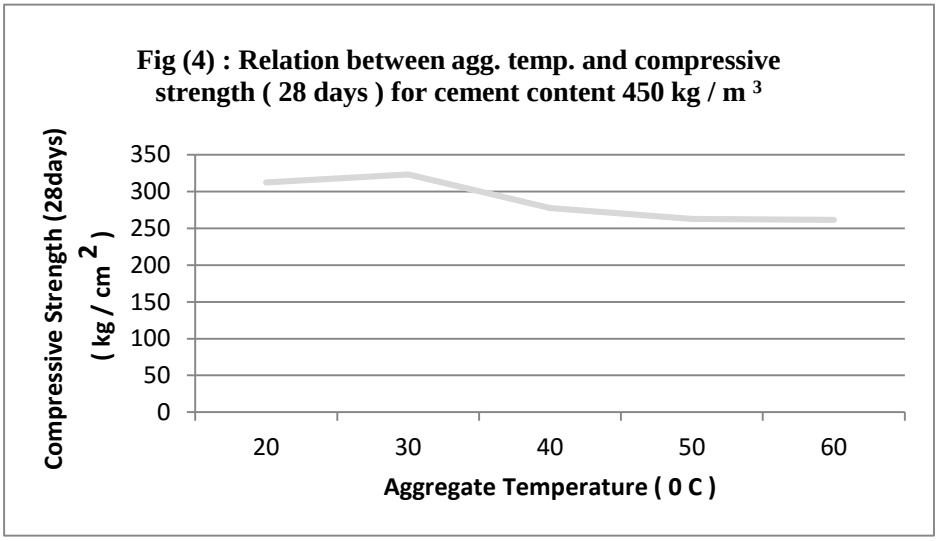


Fig (3) : Relation between agg. temp. and compressive strength (28 days) for cement content 350 kg / m^3

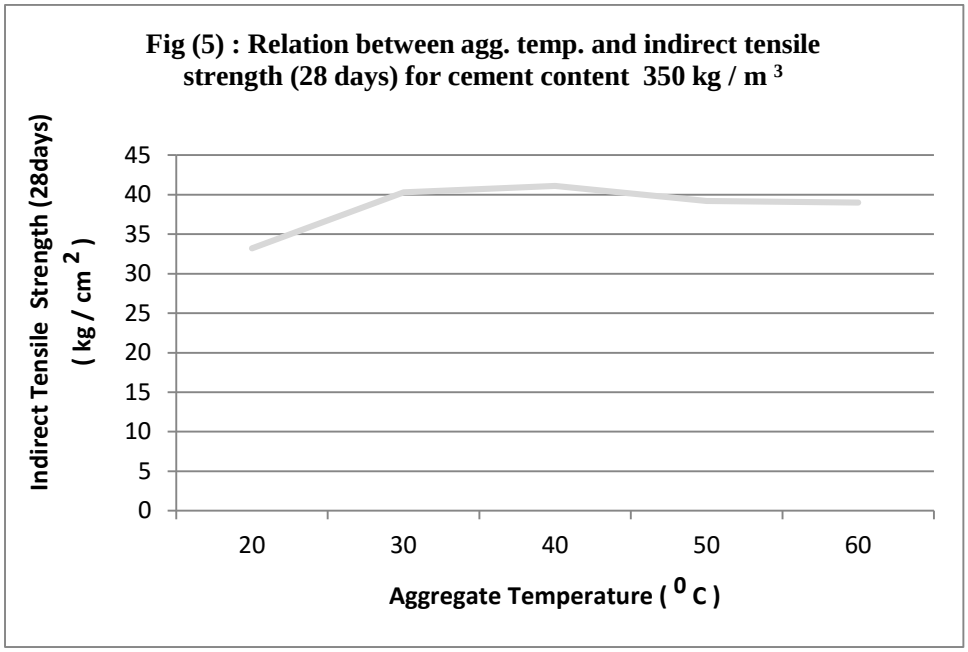
Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Compressive strength (28 days) (Kg / cm ^{2})
20	450	312.3
30	450	323.2
40	450	277.5
50	450	263
60	450	261.4

Table (4) : Results of aggregate temperature (^{o} C)and compressive strength (kg / cm ^{2}) for cement content 450 kg / m ^{3}



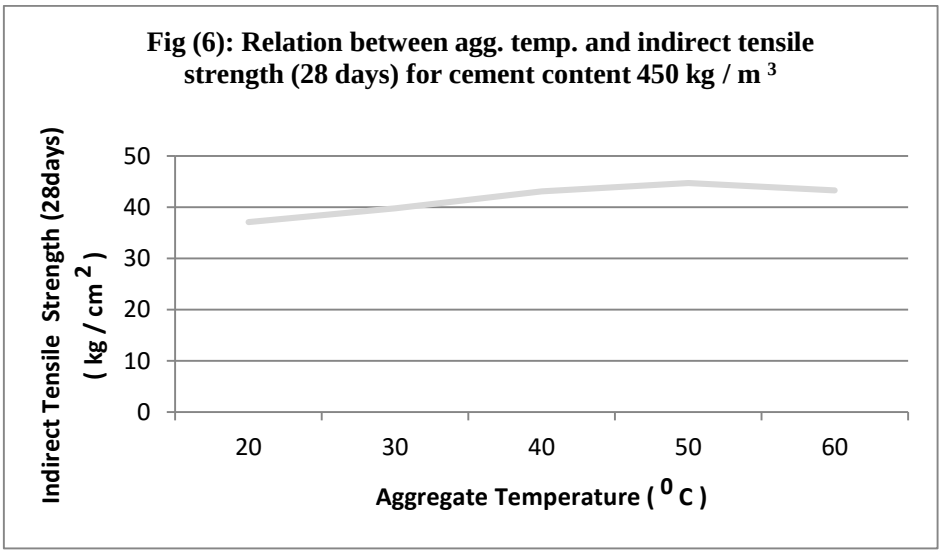
Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Indirect tensile strength (28 days) (Kg / cm ^{2})
20	350	33.2
30	350	40.3
40	350	41.1
50	350	39.2
60	350	39

Table (5) : Results of aggregate temperature (^{0} C)and indirect tensile strength (kg / cm ^{2}) for cement content 350 kg / m ^{3}



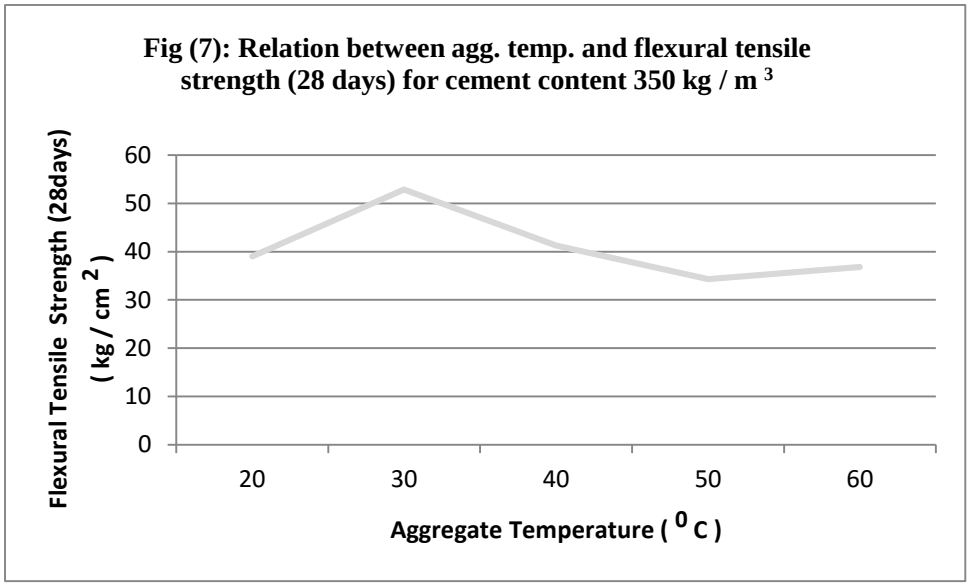
Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Indirect tensile strength (28 days) (Kg / cm ^{2})
20	450	37.1
30	450	39.8
40	450	43.1
50	450	44.7
60	450	43.3

Table (6) : Results of aggregate temperature (^{0} C) and indirect tensile strength (kg / cm ^{2}) for cement content 450 kg / m ^{3}



Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Flexural tensile strength (28 days) (Kg / cm ^{2})
20	350	39
30	350	52.9
40	350	41.3
50	350	34.3
60	350	36.8

Table (7) : Results of aggregate temperature (^{o} C) and flexural tensile strength (kg / cm ^{2}) for cement content 350 kg / m ^{3}



Aggregate temperature (^{0} C)	Cement content (kg / m ^{3})	Flexural tensile strength (28 days) (Kg / cm ^{2})
20	450	36.2
30	450	37.1
40	450	35.8
50	450	33.2
60	450	32.4

Table (8) : Results of aggregate temperature (^{o} C) and flexural tensile strength (kg / cm ^{2}) for cement content 450 kg / m ^{3}

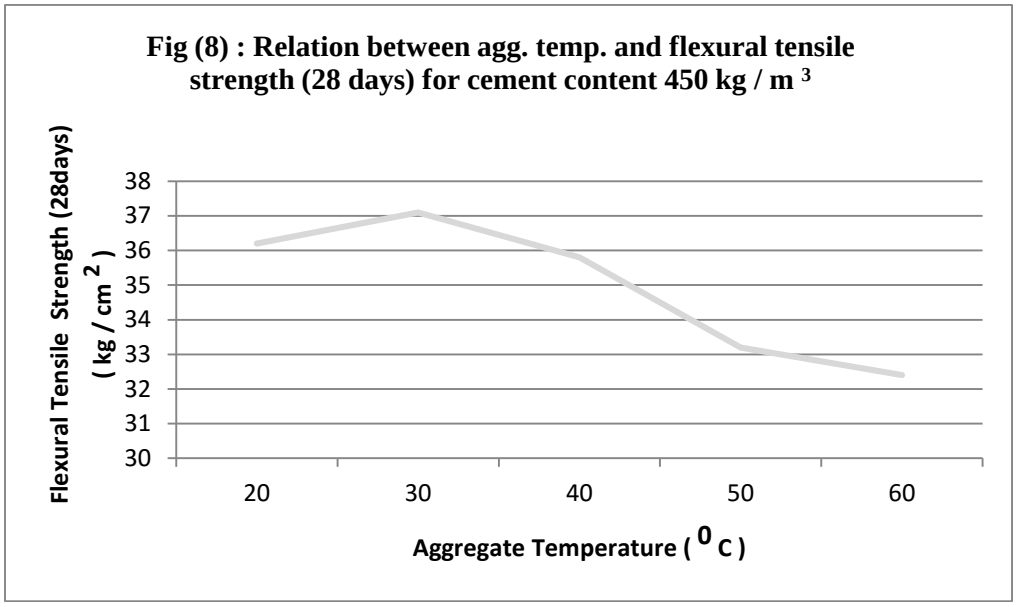


Fig (8) : Relation between agg. temp. and flexural tensile strength (28 days) for cement content 450 kg / m ^{3}

Conclusions :

As a result of these papers , the following investigations and conclusions can be summarized as follows : -

1 – As the aggregates temperature increases , the slump values are decreasing by a ratio 5 % - 68 % .

2 – For mixes with cement content 450 kg / m ^{3}, it is found that increasing the aggregates temperature decreased also the values of slump and increasing the cement content in the mixes cause an additional decrease in the slump values by 15 % - 60 %.

3 – For mixes with cement content 350 kg / m ^{3} , as the temperature of aggregates increases the values of compressive strength decreases by about 22 %

4 – Increasing the cement content in the mixes , this increase the compressive strength of concrete for all the different degrees of temperatures .

5 – For indirect tensile strength , as the degrees of temperature of aggregates increased the indirect tensile strength results show a little difference of increasing and decreasing and from another view it is noticed that increasing the cement content in the mixes increase the values of readings by about 10 % .

6 - In case of flexural tensile strength , as increasing the temperature of aggregates , these increases the results of flexural tensile strength up to 40 ^{0} C then a decrease is occur for 50 ^{0} C and 60 ^{0} C and increasing the cement content in the mixes did not show any significant change.

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