

# CHAPTER FIVE

## CONCLUSIONS

This research studies the effect of retempering of concrete containing maximum dosage of Type G, using Type G and Type F based on different bases at different mixing times, different cement contents and different cement sources on concrete properties. Also retempering using a mix of Type G and Type C is studied. The following conclusions are present:

1. The use of a mix of Type G and Type F as an initial admixture, enhances initial slump compared with that of the use of Type G of the same dosage.
2. The use of an admixture based on naphthalene, decreases slump loss compared with that based on melamine.
3. When ordinary Portland cement concrete containing a maximum recommended dosage of Type G (1.5%), and  $400\text{kg/m}^3$  cement content is compared with the same concrete without retempering, the following conclusions are held:
  - a) Retempering using 0.75% of Type G, after 30 minutes of mixing, delays setting time (initial setting time is 25 hours).
    - It ensures a negligible one day cube compressive strength. It decreases 3 days compressive strength by 14.84%. It yields almost the same 7, 28 and 90 days compressive strength. It enhances the 90 days splitting tensile strength by 4.3%. It decreases 90 days modulus of elasticity by 8.7%.
    - It increases percentage of water absorption at 90 days by 3.0%,
    - So if one uses an over dosage of 50% of the maximum dosage of Type G and saves concrete from shrinkage, mechanical properties are acceptable after 3 days.

b) Retempering using 1.5% of Type G, after 60 minutes of mixing ensures initial setting time of 26.75 hours. It has a zero one day compressive strength.

- It decreases 3, 7, 28 and 90 days compressive strength by 40, 5.4, 9.1, and 8.10%, respectively.
- It decreases 90 days splitting tensile strength by 16.2%.
- It also decreases 90 days modulus of elasticity by 6.2 %.
- It slightly affects absorption.

So if one uses an over dosage of 100% of the maximum dosage of Type G and saves concrete from shrinkage, mechanical properties can be acceptable after 7 days with reduction of tensile strength after structural calculations.

It's not recommended to retemper concrete having the maximum dosage of Type G using Type G

c) Retempering using 0.75% of Type F based on naphthalene decreases one and 3 days compressive strength by 25.2, and 13.2% respectively.

- It slightly affects compressive strength at later ages.
- It decreases 90 days splitting tensile strength by 7.1%.
- It does not affect 90 days modulus of elasticity.
- It slightly increases absorption by 4.7%.
- It increases initial setting time from 6.3 to 11.66 hours

d) Retempering using 1.5 % of Type F based on naphthalene after 60 minutes yields negligible one day compressive strength.

- It decreases 3 days strength by 10%.
- It slightly affects compressive strength at 7, 28, and 90 days.
- It decreases 90 days splitting tensile strength by 10%.
- It slightly decreases 90 days modulus of elasticity by 4.5%.
- It decreases absorption by 10%.
- It increases initial setting time from 6.3 to 26 hours

- e) Retempering using 0.75% of Type F based on melamine, after 30 minutes, increases one, 3, 7, 28, and 90 days compressive strength by 435 %, 31.48 %, 19.6 %, 5.2 % and 4.46 % respectively.
- It enhances 90 days tensile strength and modulus of elasticity by 7.9 and 12.5% respectively.
  - It increases absorption by 4.7 %.
  - It increases initial setting time from 6.3 to 8 hours.
- f) Retempering using 1.5% of Type F based on melamine after 60 minutes, increases one, 3, 7, 28 and 90 days compressive strength by 376.5 %, 42 %, 19 %, 5.6 % and 11.9 % respectively.
- It enhances 90 days splitting tensile strength and modulus of elasticity by 18.4 % and 8.5% respectively.
  - It increases absorption by 10 % however this absorption is less than that of control mix without superplasticizers.
  - It increases initial setting time from 6.3 to 16.08 hours.
- g) Retempering using 1.5% of Type C, after 60 minutes, improves compressive strength especially at early ages.
- A slight decrease (2%) is observed at 90 days compressive strength.
  - It slightly improves workability.
  - It decreases 90 days splitting tensile strength by 18.2%.
  - It slightly enhances modulus of elasticity.
  - It increases absorption by 22.5%. So it is not preferred to redo using Type C if the maximum dosage of Type G is used.
- h) Retempering using a mix of Type G and Type C improves 3 days compressive strength but it decreases 28 and 90 days compressive strength.
- It considerably decreases splitting tensile strength and decreases modulus of elasticity.

- Generally it considerably increases absorption, so it is not preferred to use this concept.
- i) Retempering using 0.75 % of Type G and 0.20% of Type G based on polycarboxylic decreases one days compressive strength by 95%.
- It decreases 3, 28, and 90 days compressive strength by 27 %, 5.6 %, and 8.7 %.
  - It decreases 90 days tensile strength by 31.5 %.
  - It increases absorption by 13%.
- 4 – When ordinary Portland cement concrete with low cement content ( $250 \text{ kg/m}^3$ ) containing a maximum recommended dosage of Type G is compared with the same concrete without retempering, the following conclusions are presented:
- Retempering using 1.5 % of Type G almost eliminates one day compressive strength.
  - It enhances 3, 7, 28 and 90 days compressive strength.
  - It enhances 90 days splitting tensile strength and modulus of elasticity.
  - It slightly decreases absorption.
- 5 – When ordinary Portland cement concrete with cement content of 300 and 350  $\text{kg/m}^3$  containing a maximum recommended dosage of Type G is compared with the same concrete without retempering, the following conclusions are held:
- Retempering using 1.5% of Type G eliminates one day compressive strength.
  - It generally enhances 3, 7, 28 and 90 days compressive strength.
  - It decreases 90 days splitting tensile strength in the range of 19 to 20 %.
  - It slightly decreases 90 days modulus of elasticity in the range of 5.5 and 8.0 %.
  - It decreases absorption by 12 and 9.4 % respectively.
- 6 – The negative effect of using an over dosage of Type G with CEM I 32.5 N is higher than that with CEM I 42.5 N.

7 – On comparing CEM I 32.5 N concrete with cement content of 400 kg/m<sup>3</sup> containing a maximum recommended dosage of Type G (1.5%), with the same concrete without retempering, the following conclusions are present:

- Retempering using 1.5 % Type G admixture eliminates one day compressive strength.
- It reduces 3, 7, 28 and 90 days compressive strength by 52.2 %, 25 %, 8.1 % and 7.8 % respectively.
- It reduces 90 days splitting strength and modulus of elasticity by 12.0 % and 12.1 % respectively.
- It increases absorption by 1.1 %.

8 – On comparing concrete containing 400 Kg/m<sup>3</sup> sulfate resisting cement (C<sub>3</sub>A of 1.463, SO<sub>3</sub> = 2.2 , Source1) and containing maximum recommended dosage of Type G (1.5%), with the same concrete without retempering, the following conclusions are held:

(a)- Retempering using 0.75 % of Type G decreases one, 3, 7, 28 and 90 days compressive strength by 33.8 %, 18.4 %, 5.5 %, 10 %, and 15.3 % respectively.

- It increases initial setting time from 6.66 to 11.0 hours.
- It decreases splitting tensile strength and modulus of elasticity by 4.6 and 16.8 % respectively.
- It increases absorption by 4.10 %.

(b)- Retempering using 1.5 % of Type G yields the following conclusions:

- It increases initial setting time from 6.66 to 60 hours.
- It yields a negligible one day compressive strength:
- It decreases 3, 7, 28 and 90 days compressive strength by 99 %, 64.70 %, 31 %, and 31 % respectively.
- It decreases 90 days splitting tensile strength and 90 days modulus of elasticity by 2.0 % and 23.2 % respectively.
- It slightly decreases absorption.

9– On comparing concrete containing 400 Kg/m<sup>3</sup> sulfate resisting cement ( $C_3A = 1.22$  and  $SO_3 = 2.17$ , Source2) and a maximum dosage of Type G (1.5%), with the same concrete without retempering, the following conclusion are held

(a) Retempering using 0.75 % of Type G, yields the following conclusions:

- It increases initial setting time from 18 to 35.08 hours.
- It yields negligible one day compressive strength
- It decreases 3, 7, 28 and 90 days compressive strength by 61.6 %, 8.4 %, 8.0 % and 10 % respectively.
- It decreases 90 days splitting tensile strength and 90 days modulus of elasticity by 23.2, and 11.4 respectively.
- It increases absorption by 19.3 %.

(b) Retempering using 1.50 % of Type G, yields the following conclusions:

- It increases initial setting time from 18 to 54.8 hours.
- It yields zero one day compressive strength.
- It decreases 3, 7, 28 and 90 days compressive strength by 88.6 %, 31.7 %, 20 % and 17.5 % respectively.
- It decreases splitting tensile strength and modulus of elasticity by 19.5 and 22.2 %.
- It slightly increases absorption.
- It is not preferred to retemper sulfate resisting cement concrete using Type G.

10– When concrete containing 400 kg/m<sup>3</sup> sulfate resisting cement having a maximum dosage of Type G (1.5%), compared with retempering using 1.5% Type G, and retempering using 1.5 % of Type F based on naphthalene, yields the following conclusions:

- It decreases initial setting time from 60 to 12.66 hour.
- It increases one day compressive strength from 0.0 to 1.1 N/mm<sup>2</sup>.
- It increases 3, 7, 28 and 90 days compressive strength by 11 times, 258 %, 53 %, and 50 % respectively.
- It enhances tensile strength and modulus of elasticity by 60.8 and 30.8 % respectively.
- It decreases absorption by 2.6 %.

11– For concrete containing 400 kg/m<sup>3</sup> sulfate resisting cement having a maximum dosage of Type G (1.5%), compared with retempering using 1.5% G, retempering using 1.5 % of Type F based on melamine, yields the following conclusions:

- It decreases initial setting time from 6 to 12.83 hour.
- It increases one days compressive strength from 0.0 to 6.6 N/mm<sup>2</sup>.
- It increases 3, 7, 28 and 90 days compressive strength by 154 times, 2.23 times, 72.7 %, and 75% respectively.
- It enhances tensile strength and modulus of elasticity by 60.8 and 50.8 respectively.
- It decreases absorption by 2.4 %.

12– Concrete containing  $400 \text{ kg/m}^3$  sulfate resisting cement has a 1.5 % dosage of Type F based on melamine, compared with concrete having 1.5% Type G and retempered using 1.5% of Type G, Retempering using 1.5 % Type F based on melamine, yields the following conclusions:

- It increases one day compressive strength from 0.0 to  $12.28 \text{ N/mm}^2$ .
- It enhances 3, 7, 28, 90 days compressive strength by 151 times, 2.2 times, 65.9 % and 65 % respectively.
- It enhances tensile strength by 79.6 and 61.4 % respectively and modulus of elasticity.
- It decreases initial setting time from 60 to 10.66 hour.
- It decreases absorption by 19 %.

13– It's recommended to use Type F based on naphthalene as a retempering admixture for concrete containing the maximum dosage of Type G, in spite of the low early strength. The used dosage of Type F mustn't exceed 50% of Type G dosage.

14– It's recommended to use Type F based on melamine as a retempering admixture for concrete containing the maximum dosage of Type G if high early strength is required.

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## ملخص البحث

يهدف هذا البحث إلى دراسة تأثير إعادة تشغيل الخرسانة باستخدام جرعة من الإضافات (عالية التلدين المؤجلة للشك) تتعدى الحد الأقصى المسموح به.

وتشمل هذه الدراسة خمسة ابواب تلخيصها على النحو التالي:

### الباب الأول:

- مقدمة عن الخرسانة
- تاريخ استخدام الإضافات في الخرسانة

### الباب الثاني:

- نظرة عامة
- تصنيف الإضافات
- تأثير إعادة التشغيلية على خواص الخرسانة
- صناعة الخرسانة الجاهزة بمحطات الخلط

### الباب الثالث:

- خصائص المواد المستخدمة في الدراسة من اسمنت و ركام ناعم و ركام خشن و اضافات كيميائية
  - البرنامج العملي للدراسة
  - اختبارات الخرسانة الطازجة و المتصلدة
  - متغيرات الدراسة:
١. زمن اعادة تشغيلية الخرسانة و ذلك بعد زمن خلط صفر و ٣٠ دقيقة و ٦٠ دقيقة مقاسه من لحظه اضافة الماء للخرسانة
  ٢. نوع الاضافات الكيميائية المستخدمة في الخلطات الخرسانية بدون اضافات ، اضافات نوع G ، و مزيج من نوع G و F
  ٣. نوع الاضافات الكيميائية المستخدمة في اعادة تشغيل الخرسانة حيث تم استخدام اضافات نوع G، و نوع F، و الجيل الثالث من نوع F، و نوع C سريعة الشك
  ٤. نوع الاسمنت حيث استخدم الاسمنت البورتلاندي العادي من مصادر مختلفة ورتب مختلفة و الاسمنت المقاوم للكبريتات من مصدريين
  ٥. المحتوى الاسمطي بالخلطات حيث تم استخدام ( ٢٥٠ كجم، ٣٠٠ كجم، ٣٥٠ كجم، ٤٠٠ كجم، ٤٦٠ كجم اسمنت + ٤٠ كجم غبار سيليكات ) /م<sup>٣</sup>

#### الفصل الرابع:

يختص بعرض و مناقشة و تحليل نتائج الاختبارات التي تم اجرائها علي الخرسانة الطازجة و المتصلدة حيث تم عرضها في جداول و اشكال.

#### الفصل الخامس:

يختص بالاستنتاجات التي تم التوصل اليها من هذه الدراسة وتشمل هذه الاستنتاجات:

- استخدام خليط من الاضافه نوع G ونوع F يحسن من الهبوط الاولي مقارنة باستخدام النوع G فقط
- استخدام اضافات من النوع F اساسها نفتالين تقلل من فقد هبوط الخرسانة مقارنة باستخدام النوع F التي اساسها ميلامين

• الخرسانة ذات اسمنت مقاوم للكبريتات (نسبة  $C_3A=1.22$ ، و نسبة  $SO_3=2.17$ ) و تحتوي علي اقصي جرعة 1.5% من الاضافة G فان اعادة التشغيل بجرعه 1.5 % من الاضافة G يؤدي الي الاستنتاجات التاليه (مقارنة بنفس الخرسانة بدون اعادة التشغيل):

- تزيد زمن التصلب الاولي من ٦,٦٦ ساعة الي ٦٠ ساعة
- ادي ذلك لعدم وجود مقاومة ضغط بعد يوم و تقلل مقاومة الضغط بعد ٣، ٧، ٢٨، و ٩٠ يوم ب ٩٩%، ٦٤%، ٧%، ٣١%، ٣١% علي الترتيب
- ادي ذلك لنقص مقاومة شد الانفصال و معايير المرونه ب ٢% و ٢٣، ٢% علي الترتيب كما ادي ذلك لنقص الامتصاص قليلا.
- اذا استخدم اقصي جرعة من الاضافة G مع الاسمنت المقاوم للكبريتات فلا يمكن استخدام الاضافة G في اعادة التشغيل و استخدام الاضافه F التي اساسها ميلامين بجرعه ١,٥% مقارنة باستخدام ١,٥% G كاعادة تشغيل يؤدي الي:
- تحسن مقاومة الضغط بعد يوم من صفر الي ٦,٦ نيوتن/مم<sup>٢</sup> و تزيد مقاومة الضغط بعد عمر ٣، ٧، ٢٨، و ٩٠ يوم ١٥٤ مرة، ٢,٢٣ مرة، و ٧٢,٧%، و ٧٥% علي الترتيب و تزيد مقاومة شد الانفصال و معايير المرونه ب ٦٠,٨%، و ٥٠,٨% علي الترتيب



جامعة الاسكندرية  
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## تأثير اعاده التشغيلية باستخدام جرعه زائدة من الاضافات عالية التلدين على خواص الخرسانة

رساله علميه مقدمه الي

قسم الهندسة الانشائية  
كلية الهندسة – جامعة الاسكندرية  
استيفاء لمتطلبات الحصول علي درجة

الماجستير في العلوم

في

الهندسة الانشائية

لجنة الحكم و المناقشة

موافقة

.....

أ.د/ رجب مجاهد عبد النبي  
أستاذ دكتور خواص و اختبارات المواد  
قسم الهندسة الانشائية كلية الهندسة  
جامعة بنها

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أ.د/ حافظ السيد اليمني  
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قسم الهندسة الانشائية كلية الهندسة  
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أ.د/ عبد الوهاب محمد عوض  
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مقدم من

م / عبد الرحمن احمد محمد محمد دياب

بكالوريوس الهندسة المدنية – كلية الهندسه – جامعة الاسكندرية

تسجيل: ٢٠١٠

تقديم: ٢٠١٤