**Minutes of the 5th meeting of RILEM TC-CCC WG4**

February 24, 2022, Online

|  |  |
| --- | --- |
| **Time** | Thursday 24 February 2022, 16:00-18:00 (Beijing Time)  [9:00-11:00 (UTC+2)] |
| **Venue** | Microsoft Teams Online Meeting Room |
| **Main Subjects** | 1. Reports and discussion on the results of the 2nd round test 2. Discussion of the draft of the final report of WG4 3. Discussion of the draft of the recommendation of WG4 |
| **Participants** | Altogether 20 participants attended the meeting:  Bin LI, Cheng ZHANG, Chuansheng XIONG, Elodie PIOLET, Juan LI, Ling WANG, Muhammed BASHEER, Nele DE BELIE, Philip VAN DEN HEEDE, Quoc Tri PHUNG, Siham KAMALI-BERNARD, Tushar BANSAL, Visalakshi TALAKOKULA, Wenyu HAN, Xinyu SHI, Yan YAO, YING XIAO, Yu HUANG, Zhendi WANG, Zhiyuan LIU |
| **Moderator** | Juan LI |

At the beginning of the meeting, Prof. Yan YAO, the chairlady of RILEM TC 281 WG4, welcome all the participants and made an opening speech. She expressed her gratitude to all members who contributed to the WG4 work and hoped that all members would work together to facilitate a solid final report and recommendation. Then Prof. Juan LI introduced the meeting agenda and briefly reviewed the minutes of the last WG4 meeting. Mr. Xinyu SHI from CBMA and Mrs. Elodie PIOLET from INSA-RENNES presented the results of 2nd round comparative test in seven labs (CBMA, UGent, Bennett U., Mahindra U., QUT, and Yantai U. and INSA-RENNES), respectively. Following that, Prof. Nele DE BILIE addressed the regulations of publishing TC works in Materials & Structure. At last, the final report and recommendation files drafted by CBMA were discussed. In this meeting, the following conclusions were drawn based on all members’ comments:

**1. The progress of the 2nd round comparative tests**

For the compressive load + carbonation test, the test at 2% CO2 was conducted by six labs (CBMA, UGent, Bennett U., Mahindra U., QUT, and Yantai U.) and the test at 20% CO2 was conducted by 3 labs (CBMA, QUT, and Yantai U.). The test strength and carbonation depth differed slightly between labs, while the load effect was consistent at each CO2 concentrations. The recorded mix proportions, test rigs, carbonation chambers, and measurement used in each lab were basically consistent while the raw materials are slightly different. In the discussion, Dr. Philip suggested comparisons on the sieve curve of aggregate and the composition of FA & BFS. He also pointed out the bleeding problems due to the 0.6 water-binder ratio may be one reason for high carbonation depth in UGent. Dr. Phung stressed an important factor to the carbonation depth’s difference is the fineness of SCM. Prof. Nele recommended supplement comparisons on the coarse aggregate properties (e.g., type: broken aggregate or round aggregate). Prof. Siham recommended a vacuum saturation test to determine the absorption coefficient & total porosity for further comparisons. She also suggested a comparison between measurement of the carbonation depth by providing carbonation photos in each lab, because human error could be significant based on her experience with another project. All labs shall conduct the necessary experiments depending on their practical conditions, and subsequently, share the critical information with the secretary for further analysis.

For the tensile load + carbonation test, the test was only conducted by CBMA, because Mahindra U. faced challenges in COVID pandemic and tension equipment. The result showed that the carbonation depth increases as the tensile load increases. The CO2 concentration and concrete type didn’t greatly affect such load effect. In the perspective of quantitative analysis, the load effect on carbonation depth of OPC concrete is identical at 2% and 20% CO2, while that of SCMs concrete at 2% CO2 is greater than that at 20% CO2.

For the flexural load + carbonation test, the mortar ~~board~~ specimens with water-binder ratio of 0.6 (Cement I) & 0.5 (Cement III) were cured with a procedure of 1+6+19 days (Cement I) & 1+6+21 days (Cement III) and then loaded with flexural load level of 14.7% (Cement I) & 25.6 % (Cement III), which was different from the WG4 prescribed (for compressive and tensile load). It was found that the carbonation depth increases under tensile load and decreases under compressive load, and such an effect was more evident in natural carbonation. In discussion, Mr. Zhiyuan LIU indicated the different carbonation depth on the top surface and the bottom surface was also noted even at a 0.5 water-binder ratio.

For the miscellaneous investigations, the influence of the following factors on the carbonation depth has been investigated: (1) direction of the specimen’s placement; (2) curing time; (3) the time interval after specimen splitting and before measuring; (4) measured surfaces. In addition, the carbonation depth within the curing period and the load monitoring were tested. These investigations further standardized the procedure of comparative test and will be covered in detail in the final report.

**2. The final report of TC 281-CCC WG4**

The 1st version of the final report will contain tests results of all seven labs and will be drafted by CBMA in the next two months. If the manuscript is restricted by the limitation of TC publications on total lines or figures, the flexural load + carbonation test of the mortar specimen will be reorganized as supplement files. Based on all members’ comments, the title of the final report is “Results of comparative testing for determining carbonation depth of loaded concrete: technical report of RILEM TC 281-CCC”. The frame is revised as:

Abstract

1 Introduction

2 Materials and testing methods

2.1 Preparation of specimens

2.2 Loading rigs and load compensation

2.3 Measurement of carbonation depth

3 Results and discussion

3.1 Test strength

3.2 Test carbonation depth

3.2.1 Under compressive load

3.2.2 Under tensile load

3.2.3 Under flexural load

3.3 Influence of different aspects on carbonation depth

3.3.1 Factor related to facilities

Placement direction

Load Compensate

3.3.2 Factor related to curing procedure

Curing period

Carbonation in curing period

3.3.3 Factor related to the carbonation depth measurement

Measured surfaces

Time interval

4 Conclusions

Acknowledgement

Reference

**3. The recommendation of TC 281-CCC**

The carbonation under three types of loads was conducted by seven labs during the 2nd round comparative test. Among these tests, the compressive load and the tensile load experiments are both applied on concrete specimens and have a consistent curing procedure & specimen length. On the other hand, the flexural load experiment was applied on mortar specimens utilizing the curing procedure & specimen dimensions that are different from the previous two experiments. Therefore, the combined action of two types of loads and carbonation will be standardized in one recommendation named “Recommendation of RILEM TC 281-CCC: Test methods to determine carbonation of concrete under compression and tension load”. Another recommendation will be prepared for the experiments of “flexural load + carbonation”. The title was suggested as “Recommendation of RILEM TC 281-CCC: Test method to determine carbonation of mortar under flexural load”. A consistent frame is still recommended for the two recommendations. The revised frame according to all members’ comments is listed as follows:

Abstract

1 Introduction

2. Scope and applications

3. Equipment, specimens, and test procedure

3.1 General

3.2 Test equipment

Loading device

Carbonation chamber

3.3 Specimens

3.4 Test procedure

Casting

Curing

Compressive strength and tensile strength

Seal

Loading

Accelerated carbonation

Measurement of carbonation depth

4. Calculation of the test result

5. Test report

Acknowledgement

Reference

It should be noted that uncertainty determination should be introduced in the fourth section.

**4. Next steps**

The listed timetable and the modified deadline were agreed upon by all participants. At least one WG4 meeting will be arranged which is recommended before the next TC meeting in June. If needed, two meetings are also feasible.

**Table Following tasks and timetable**

|  |  |  |  |
| --- | --- | --- | --- |
| **Labs** | **Task** | **Period** | **Deadline** |
| ALL | Supplement critical information | 2 months | 1st May |
| CBMA | 1st draft of the final report & recommendation |
| ALL | WG4 comments | 2 weeks | 15th May |
| CBMA | Revised final report & recommendation | 2 weeks | 1st June |
| ALL | TC CCC comments | 2 weeks | 15th June |
| CBMA | Submission | 2~3 weeks | Before 15th July |
| ALL | Next WG4 meeting if needed | \ | Before June |