

Minutes of the 7th meeting of RILEM TC-246 TDC

Ghent, April 23-24, 2015

Time & Venue	<p>09:00 – 17:00, Thursday, Apr. 23, 2015</p> <p>Faculty of Engineering&Architecture, meeting room Simon Stevin, Ghent Uni., Josef Plateaustaat 22, 9000 Ghent</p> <p>09:00 – 14:30, Friday, Apr. 24, 2015</p> <p>Magnel Laboratory for Concrete Research, Room Riessauw, Ghent Uni. Technologiepark-Zeijnaarde 904-9052 Ghent</p>
Main Subjects	<ol style="list-style-type: none"> 1) Opening of the meeting and welcome address by Prof. Yao Yan; 2) Self-introduction of new participants; 3) Introduction of Ghent University from Prof. Nele de Belie; 4) Acceptance of the minutes of the 6th Meeting of TC-246 TDC (Munich Meeting); 5) Brief introduction on progress of on-going work of RILEM TC 246-TDC after the meeting in Munich; 6) Reports and discussion on the test results of first and/or second series test; 7) Compilation and discussion of test results of the first series; 8) Modification of the test program; 9) Discussion on the preparation of final summary report of the TC; 10) Discussion on the program of the 8th TC meeting and international seminar, which will be held in conjunction with ICCI in Beijing between Oct. 13 and Oct. 15, 2015; 11) Follow-up TCs; 12) Next steps and any other business; 13) Closure of the meeting.
Participants	<p>10 persons all together attended the meeting:</p> <p>Mrs. Yunus Md Balqis, Prof. Nele De Belie, Dr. Hugo Eguez Alava, Dr. Rui Miguel Ferreira, Dr. Sylvia Kessler, Dr. Li Juan, Prof. Max J. Setzer, Prof. Wang Ling, Dr. Wang Zhendi, Prof. F. H. Wittmann, Prof. Yao Yan</p>
Moderator	Dr. Li Juan

1. Opening of the meeting

Prof. Yao Yan, the Chairlady of TC 246-TDC, introduced the agenda at the beginning of this meeting. She extended her warm welcome to all the participants and her special thanks to Prof. Nele De Belie from Ghent Univ. for the preparation of the meeting.

All participants accepted the agenda of the meeting.

All participants accepted the minutes of the 6th meeting of TC 246-TDC (Munich Meeting).

2. Brief overview on the progress of RILEM TC-246 TDC after the meeting in Munich

Dr. Li Juan, gave a brief introduction on the progress of ongoing work of TC 246-TDC after the meeting in Munich.

The first test series were carried out in five labs, and the following main conclusions were achieved.

1) The chloride content decrease with the increase of depth, gradually reaching to the initial chloride content. The measured chloride profile can be modelled by Fick's second law, and the diffusion coefficient can be determined by curve fitting.

2) The diffusion coefficient of concrete under compression decreases first and then increases with stress ratio. When a 30% of ultimate compressive load is applied, the chloride ingress by diffusion seems to be progressively hindered. But when the stress ratio reaches to 60%, the chloride diffusion speeds. Low stress ratio of compressive stress reduces the chloride diffusion in concrete, but when the stress ratio exceeds the critical value, the chloride diffusion speeds.

3) The diffusion coefficient of concrete under tension increases with stress ratio. When a 50% of maximum tensile load is applied, the chloride content of the layer with the same depth is higher than that without load. And when the stress ratio reaches to 80%, the chloride content significantly increase. The application of tensile load speeds up chloride diffusion in concrete.

4) Whether external load is applied or not, no matter what kind of load it is, the chloride diffusion depth increase with the exposure time and the diffusion coefficient decreases with the exposure time.

For the second test series, several modifications of the test program had made at the Munich meeting. 6 labs would like to participate in the second test series.

3. Reports and discussion of the test results of the second test series of 5 labs

The test procedure and test result in each lab was reported in this meeting.

Mrs. Balqis Yunus introduced the results of the second test series at Delft Univ. of Technology (TU Delft). After 6 weeks penetration, both drilling and grinding were employed to take samples. They found that the diffusion coefficient of concrete exposed to 0, 30% and 60% of its ultimate

compressive stress is $4,3576 \times 10^{-12} \text{ m}^2/\text{s}$, $3,7632 \times 10^{-12} \text{ m}^2/\text{s}$, $6,7974 \times 10^{-12} \text{ m}^2/\text{s}$. It is noted that the pH of chloride solution containing 2g/l calcium hydroxide reduced from 12~12.5 to 8.0~8.5 was observed. It is expected due the circulation activity.

Dr. Eguez Hugo made a presentation of the test results at Ghent University. All the specimens were subjected to chloride penetration and compressive load simultaneously. After 39 weeks exposure, the sample was ground directly using a small drilling bit instead of a drilled core for obtaining chloride profile. The reduction of chloride ingress by diffusion was observed when a permanent 30% of ultimate compressive load was applied. A decrease was noticed in both the modeled surface chloride concentration and in the diffusion coefficient. When a permanent 60% of the failure load was applied to the concrete an increase in the chloride ingress was rapidly noticed, and the modeled surface chloride content was increased about 3 times.

Dr. WangZhendi introduced the second test results at CBMA. Chloride penetration combined with compression and tension was studied in their laboratory. Grinding method and Titration method to take powder and to obtain chloride profile were used, respectively. It is found that the diffusion coefficient of concrete under compression decreases first and then increases with stress ratio. Low stress ratio of compressive stress reduces the chloride diffusion in concrete, but when the stress ratio exceeds the critical value, the chloride diffusion speeds.

Moreover, the diffusion coefficient of concrete under tension increases with stress ratio. When a 50% of maximum tensile load was applied, the chloride content of the layer with the same depth was higher than that without load. And when the stress ratio reaches to 80%, the chloride content significantly increase. The application of tensile load speeds up chloride diffusion in concrete.

Entrust by Pro. Li Weihong, Prof. Wang Ling introduced the test results from Dalian University. 3 stress ratio, namely 0,30%, and 60% compressive stress of the ultimate failure stress were applied on prism specimens. An electric percussion drill was used to take powder from the hardened concrete. The imprecise of depth control by electric percussion drill was noticed. The decrease of chloride diffusion coefficients with time was also observed.

And Dr. Sylvia Keßler made an introduction of the progress of the second test series carried out in TUM. They investigated prism concrete subjected to 3 different level of compressive load and chloride penetration. A drilling method was employed to take powder from the hardened concrete. It is noted that total chloride ingress increase and chloride diffusion coefficient decrease with exposure time for all load level specimens. An inner damage of concrete under different load level was also investigated to find the real the damage degree by modal analysis, acoustic

emission and ultrasonic measurement. They found that concrete structure didn't show pronounced deterioration measured with non-destructive testing methods under load levels of 30% and 60%. Structural changes of the microstructure are detectable starting with a load level of 80%. The results show the designed load levels perhaps too low for the development of micro crack.

The participants discussed the results, and some modifications were made on the basis of the second test series.

4. Compilation and discussion of test results of the first series

Dr. Hugo Eguez Alava is volunteered to compile the existing test results from 5 labs. Secretariat will collect the data with a given format and forward to Hugo for compilation. The data submission of each lab shall be right after the 36 weeks data available.

CBMA: end of May;

Dalian Univ.: end of May;

TU Delft: early June;

Ghent Univ.: early June (18 weeks data available);

TUM: end of July

It is expected that Hugo will provide a draft of summary report of first test series by August so that the summary report of the TC can be prepared based on it.

5. Modifications of the test program

The participants discussed the test program of the second test series in detail. Experiences and opinions were presented. After discussion, the following decisions were made.

- 1) Chemical titration is recommended. Whether LIBS can be widely applied is to be confirmed;
- 2) The chloride solution shall be isolated from the atmosphere because there is a risk that the pH value is decreased due to carbonation. pH value must be checked regularly;
- 3) Use epoxy mortar instead of epoxy to fill the groove for similar elastic modulus when specimens will be used for measurement of chloride content at different ages;
- 4) Comparative evaluation of the chloride diffusion coefficient should be run on the basis of three given chloride profiles;
- 5) Drilling of sample for chemical analysis cannot control the depth precisely. Milling is recommended for sampling;
- 6) If time is enough, pilot tests can be done to investigate the high stress ratio and low stress ratio in some labs;
- 7) Those labs with ultrasonic tests facilities will run the tests to compare the change in

travelling time of unloaded and loaded concrete;

- 8) If above two pilot tests are feasible, the comparative tests will be run in follow-up TCs.

6. Discussion on the preparation of final summary report of the TC

As decided in Munich meeting, the final summary report of the TC-TDC will be prepared according to the following timetable:

- 1) Outline, April 2015,
- 2) Draft, September 2015,
- 3) Final report, June 2016.

The final summary report will be focused on the test results, and the test methods will be detailed in recommendation. The summary report will be published in *Materials and Structures*, the length should be not more than 15 pages (including 15 figures and tables).

7. Discussion on the program of the 8th TC meeting and international seminar held in conjunction with 2015 ICC

The 8th meeting of RILEM TC-246TDC will be held on 16 October, 2015, 8:30-12:00 am in Beijing, China. The main content of the TC meeting was decided after discussion. By then, a draft recommendation should be available. The first thing on the agenda is to discuss each items of the proposed recommendation, especially the chapter 8: Evaluation of test results. The next is to report and discuss the test results of the second test series of each lab. It is also the major issue to discuss the final summary report of TC 246 –TDC.

The international seminar will be held on Tuesday, 13 October, 2015, 1:30-3:30 pm in Beijing, China. With regard to the program of the international seminar , the main items were as follows:

- 1) Introduction /Prof. F. H. Wittmann; (10 min.)
- 2) Test methods /Prof. Eric Schlangen; (15 min.)
- 3) Test results
Prof. Nele De Belie ; (10 min.) Compression
Prof. Wang Ling; (10 min.) Tension
- 4) Modeling and prediction /Prof. Christoph Gehlen; (15 min.)
10 min. Discussion
- 5) 3 more potential speakers
Abdelhafid KHELIDJ, Nantes Univ., France (15 min.)
Erika Holt, VTT, Finland (15 min.)
LI Kefei, Tsinghua Univ., China (15 min.)

10 min. Discussion

8. Follow-up TCs

Follow-up TCs can focus on the following subjects:

Investigation into the influence of the quality of concrete (high strength and low strength, composite binders) on the stress sensitivity of chloride penetration;

Influences of processes such as carbonation and freeze-thaw cycles on the chloride penetration;

Influences of damaging parameters on service life;

Influences of hindered frost shrinkage on chloride penetration and service life.

9. Next step and any other business

As one of the expected outcome, one international seminar “Prediction of Service Life of Reinforced Concrete Structures, Relevant Material Properties, and Most Severe Load Combinations” was planned in conjunction with the 70th RILEM WEEK in Denmark, on August 21-24, 2016. Prof. Nele De Belie will inform the secretariat when the specific time is fixed. To sum up, the following dates and places for the 3 meetings have been fixed (See Table I).

Table I. next meetings

NO.	Meeting	Date	Venue
1	8th meeting	In conjunction with <u>ICCC 2015</u> (Oct. 13-16, 2015 Beijing) (1) International Seminar on “Durability of concrete under combined mechanical and environmental actions” Tuesday, 13 October, 2015, 1:30-3:30 pm (2) TC Meeting Friday, 16 October, 2015, 8:30-12:00 am	Beijing
2	9th meeting	In conjunction with the 5th International Conference on the Durability of Concrete Structures (June. 16-17, 2016 Shenzhen, China) TC Meeting 14-15 June, 2016 Shenzhen.	Shenzhen
3	10th meeting	In conjunction with the 70th RILEM Week (August 21-24, 2016) Int’l seminar/TC Meeting 21-24 August, 2016	Lyngby, Denmark

10. Closing remarks

The meeting was closed at 12:30 on Apr. 24, 2015. In the wrap-up presentation, Prof. Yao Yan, summarized the main points briefly and expressed her sincere thanks to all the experts

present for their input and support for the TC to make this meeting meaningful and successful. She offered her special thanks to Professor De Belie for hosting and providing all the excellent arrangement for this meeting. She also expressed her special thanks to all the participants for their hard work and support for the RILEM TC 246-TDC. The next TC meeting is scheduled in Beijing this October. She looked forward to meeting all the TC members there.

