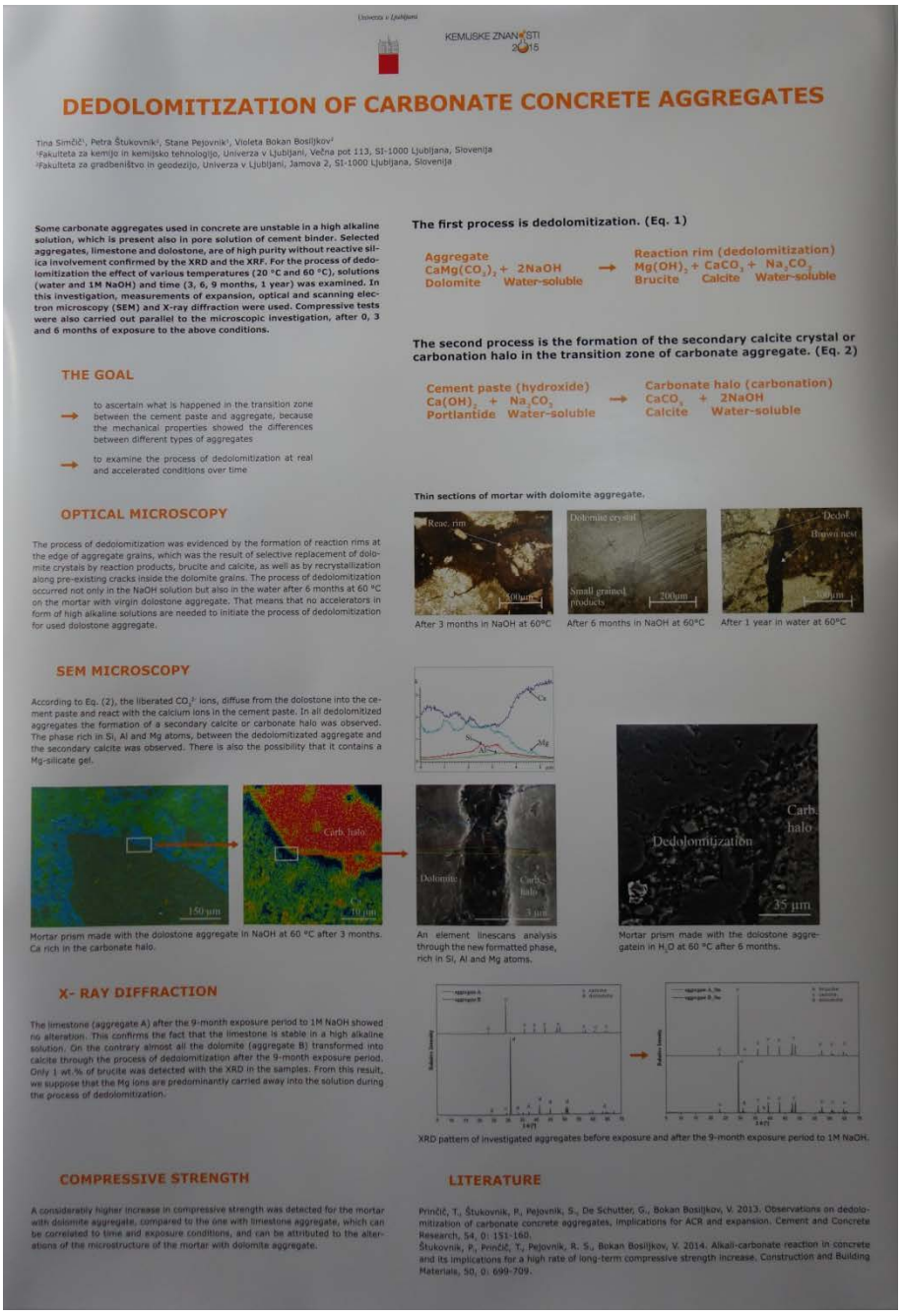
Udeležba dveh doktorskih študentov UL FGG na spoznavni konferenci doktorskih in podoktorskih študentov in raziskovalcev UL FKKT – Kemijske znanosti 2015

Asistenti UL FKKT so ob podpori vodstva fakultete, študentskega sveta ter študentske organizacije UL FKKT pripravili spoznavno srečanje ''Kemijske znanosti 2015'' (http://www.fkkt.uni-lj.si/sl/novice/novica/?tx_ttnews%5Byear%5D=2015&tx_ttnews%5Bmonth%5D=01&tx_ttnews%5Btt_news%5D=425&cHash=aaade47133315208d7bec67d089716f9). Mladi raziskovalci so na 57 posterjih predstavili dosežke svojega raziskovalnega dela. Trije najlepši posterji, po izboru učiteljev UL FKKT in mentorjev z drugih institucij, so prejeli priznanja.

Na dogodku sta sodelovala tudi doktorska študenta UL FGG, asist. Petra Štukovnik in Matej Čehovin.

Tina Simčič in Petra Štukovnik pri svojem posterju.

Asist. Petra Štukovnik je, skupaj z doktorsko študentko UL FKKT Tino Simčič, predstavljala poster »Dedolomitization of Carbonate Concrete Aggregates«, ki je povzetek objav dveh izvirnih znanstvenih člankov v revijah »Cement and Concrete Research« in »Construction and Building Materials«.



Univerza v Ljubljani

KEMIJSKE ZNANOSTI 2015

DEDOLOMITIZATION OF CARBONATE CONCRETE AGGREGATES

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Some carbonate aggregates used in concrete are unstable in a high alkaline solution, which is present also in pore solution of cement binder. Selected aggregates, limestone and dolostone, are of high purity without reactive silica involvement confirmed by the XRD and the XRF. For the process of dedolomitization the effect of various temperatures (20 °C and 60 °C), solutions (water and 1M NaOH) and time (3, 6, 9 months, 1 year) was examined. In this investigation, measurements of expansion, optical and scanning electron microscopy (SEM) and X-ray diffraction were used. Compressive tests were also carried out parallel to the microscopic investigation, after 0, 3 and 6 months of exposure to the above conditions.

THE GOAL

- to ascertain what is happened in the transition zone between the cement paste and aggregate, because the mechanical properties showed the differences between different types of aggregates
- to examine the process of dedolomitization at real and accelerated conditions over time

OPTICAL MICROSCOPY

The process of dedolomitization was evidenced by the formation of reaction rims at the edge of aggregate grains, which was the result of selective replacement of dolomite crystals by reaction products, brucite and calcite, as well as by recrystallization along pre-existing cracks inside the dolomite grains. The process of dedolomitization occurred not only in the NaOH solution but also in the water after 6 months at 60 °C on the mortar with virgin dolostone aggregate. That means that no accelerators in form of high alkaline solutions are needed to initiate the process of dedolomitization for used dolostone aggregate.

SEM MICROSCOPY

According to Eq. (2), the liberated CO_3^{2-} ions, diffuse from the dolostone into the cement paste and react with the calcium ions in the cement paste. In all dedolomitized aggregates the formation of a secondary calcite or carbonate halo was observed. The phase rich in Si, Al and Mg atoms, between the dedolomitizated aggregate and the secondary calcite was observed. There is also the possibility that it contains a Mg-silicate gel.

X- RAY DIFFRACTION

The limestone (aggregate A) after the 9-month exposure period to 1M NaOH showed no alteration. This confirms the fact that the limestone is stable in a high alkaline solution. On the contrary almost all the dolomite (aggregate B) transformed into calcite through the process of dedolomitization after the 9-month exposure period. Only 1 wt.% of brucite was detected with the XRD in the samples. From this result, we suppose that the Mg ions are predominantly carried away into the solution during the process of dedolomitization.

COMPRESSIVE STRENGTH

A considerably higher increase in compressive strength was detected for the mortar with dolomite aggregate, compared to the one with limestone aggregate, which can be correlated to time and exposure conditions, and can be attributed to the alterations of the microstructure of the mortar with dolomite aggregate.

The first process is dedolomitization. (Eq. 1)

Aggregate: $CaMg(CO_3)_2$ + $2NaOH$ (Dolomite, Water-soluble) → Reaction rim (dedolomitization): $Mg(OH)_2$ + $CaCO_3$ + Na_2CO_3 (Brucite, Calcite, Water-soluble)

The second process is the formation of the secondary calcite crystal or carbonation halo in the transition zone of carbonate aggregate. (Eq. 2)

Cement paste (hydroxide): $Ca(OH)_2$ + Na_2CO_3 (Portlantide, Water-soluble) → Carbonate halo (carbonation): $CaCO_3$ + $2NaOH$ (Calcite, Water-soluble)

Thin sections of mortar with dolomite aggregate.

After 3 months in NaOH at 60°C | After 6 months in NaOH at 60°C | After 1 year in water at 60°C

Mortar prism made with the dolostone aggregate in NaOH at 60 °C after 3 months. Ca rich in the carbonate halo.

An element linescans analysis through the new formatted phase, rich in Si, Al and Mg atoms.

Mortar prism made with the dolostone aggregate in H_2O at 60 °C after 6 months.

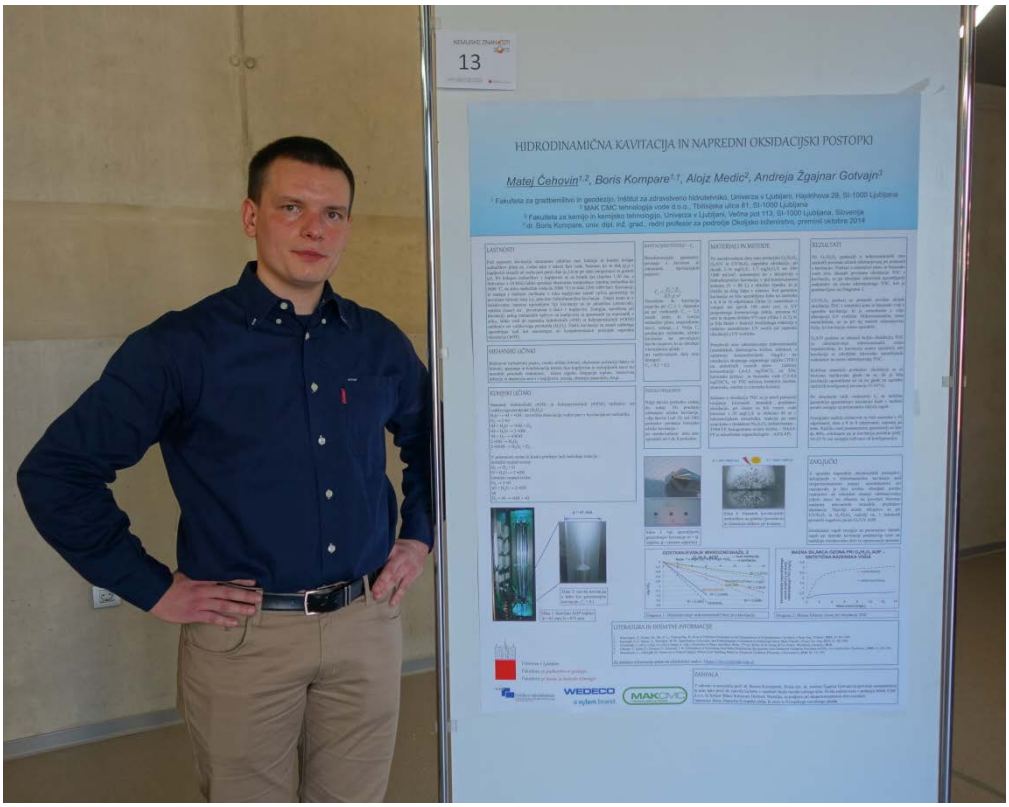
XRD pattern of investigated aggregates before exposure and after the 9-month exposure period to 1M NaOH.

LITERATURE

Prinčič, T., Štukovnik, P., Pejovnik, S., De Schutter, G., Bokan Bosiljkov, V. 2013. Observations on dedolomitization of carbonate concrete aggregates, implications for ACR and expansion. Cement and Concrete Research, 54, 0: 151-160.
Štukovnik, P., Prinčič, T., Pejovnik, R. S., Bokan Bosiljkov, V. 2014. Alkali-carbonate reaction in concrete and its implications for a high rate of long-term compressive strength increase. Construction and Building Materials, 50, 0: 699-709.

Tina in Petra s prof. dr. Stanetom Pejovnikom, Tininim mentorjem pri doktoratu, in prodekanjo UL FKKT za področji doktorskega študija in raziskovalne dejavnosti, prof. dr. Brigito Lenarčič.

Matej Čehovin je na prireditvi predstavil poster z naslovom »Hidrodinamična kavitacija in napredni oksidacijski postopki«.



Matej Čehovin ob svojem posterju.