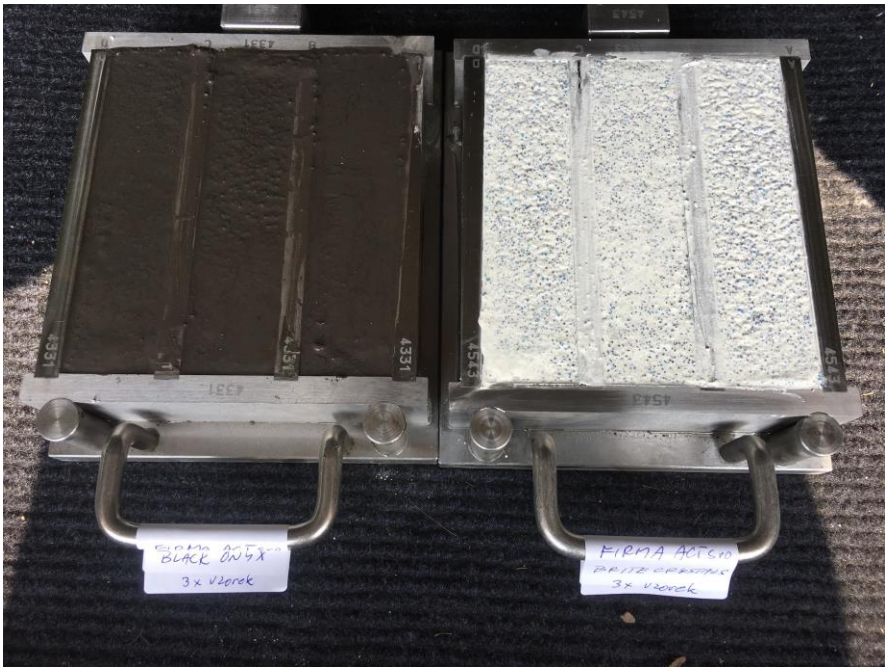

Report no. 2018/104:

Measurement of development of autogenous shrinkage of cement specimens after 28 days and determination of their basic mechanical properties.

MESOCOS
Measurement Solutions & Control Systems

ACT
ADVANCED CONCRETE TECHNOLOGIES

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1 Methodology

Based on the samples provided by the investor – Advanced Concrete Technologies s.r.o., the autogenous shrinkage of the cement blocks - samples of pool plaster used for swimming pool finishes.

Two sets of samples were provided, each set containing three specimens of standard dimensions 40 x 40 x 160 [mm] according to certified stainless steel molds. After measuring the development of autogenous shrinkage for 28 days (read once daily at the same time), the blocks were destructively tested on the MTS Alliance machine with a loading capacity of 60 kN. The first test was a three-point bending, to evaluate bending strength and broken beams, pressure tests were then carried out on 40 x 40 [mm] slots.

The results of the tests described above are the subject of this report.

Measuring instruments used: 0 10 / 0.01 mm gauge with a pushing force of 80 N, destructive testing machine MTS Alliance, 60 kN.

2 Shrinkage Results

- Plaster shrinkage progression - sample set A - Diamond Brite Onyx

		DIAMOND BRITE ONYX [mm]				DIAMOND BRITE ONYX [%]				
date	day	I.	II.	III.	mean	I.	II.	III.	mean	std/2
18. 4.	0	159,27	159,23	159,22	159,24	0,000	0,000	0,000	0,000	0,000
19. 4.	1	159,24	159,17	159,17	159,19	0,021	0,036	0,031	0,029	0,007
20. 4.	2	159,20	159,14	159,14	159,16	0,042	0,057	0,052	0,050	0,007
21. 4.	3	159,18	159,12	159,12	159,14	0,054	0,069	0,065	0,063	0,007
22. 4.	4	159,16	159,09	159,09	159,11	0,071	0,086	0,081	0,080	0,005
23. 4.	5	159,14	159,07	159,07	159,09	0,084	0,099	0,094	0,092	0,007
24. 4.	6	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,005
25. 4.	7	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,006
26. 4.	8	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,008
27. 4.	9	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,008
28. 4.	10	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,007
29. 4.	11	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,005
30. 4.	12	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,006
1. 5.	13	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,005
2. 5.	14	159,13	159,07	159,06	159,09	0,088	0,103	0,098	0,096	0,004
3. 5.	15	159,13	159,06	159,06	159,08	0,090	0,105	0,100	0,099	0,004
4. 5.	16	159,12	159,06	159,06	159,08	0,093	0,108	0,103	0,101	0,006
5. 5.	17	159,12	159,05	159,05	159,07	0,095	0,110	0,105	0,103	0,005
6. 5.	18	159,11	159,05	159,05	159,07	0,097	0,113	0,108	0,106	0,007
7. 5.	19	159,11	159,05	159,04	159,07	0,100	0,115	0,110	0,108	0,004
8. 5.	20	159,11	159,04	159,04	159,06	0,102	0,117	0,112	0,111	0,005
9. 5.	21	159,10	159,04	159,04	159,06	0,105	0,120	0,115	0,113	0,008
10. 5.	22	159,10	159,04	159,04	159,06	0,105	0,120	0,115	0,114	0,005
11. 5.	23	159,10	159,04	159,04	159,06	0,106	0,121	0,116	0,114	0,006
12. 5.	24	159,10	159,04	159,03	159,06	0,106	0,121	0,117	0,115	0,005
13. 5.	25	159,10	159,04	159,03	159,06	0,107	0,122	0,117	0,115	0,008
14. 5.	26	159,10	159,03	159,03	159,05	0,108	0,123	0,118	0,116	0,008
15. 5.	27	159,10	159,03	159,03	159,05	0,108	0,123	0,118	0,117	0,005
16. 5.	28	159,10	159,03	159,03	159,05	0,109	0,124	0,119	0,117	0,007

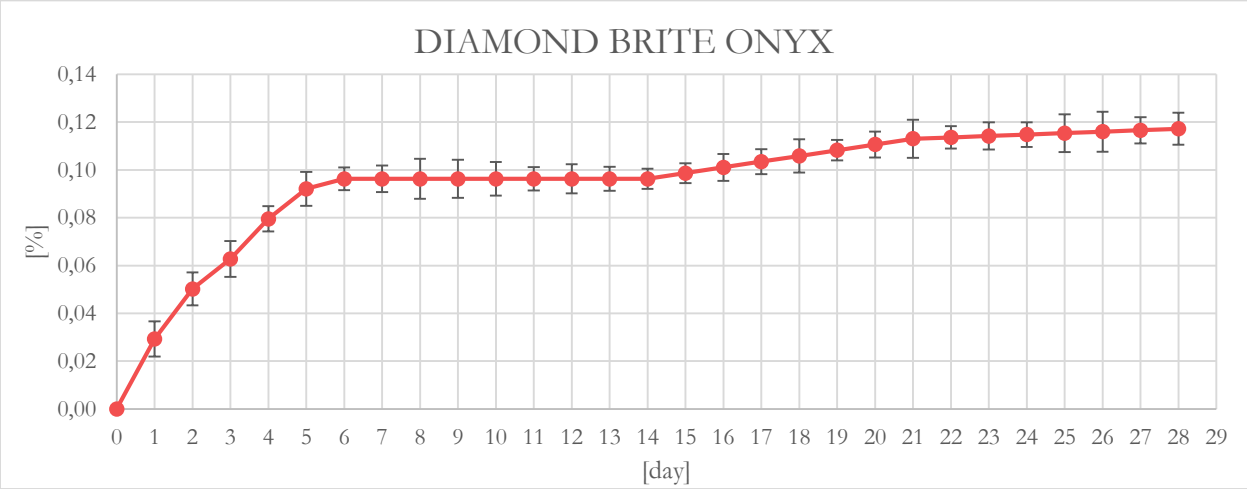
Mean = mean value
*Std = standard deviation, std = sqrt(mean(abs(x - x.mean())**2))*

- Plaster shrinkage progression - sample set B – Brite Crystal Light Blue

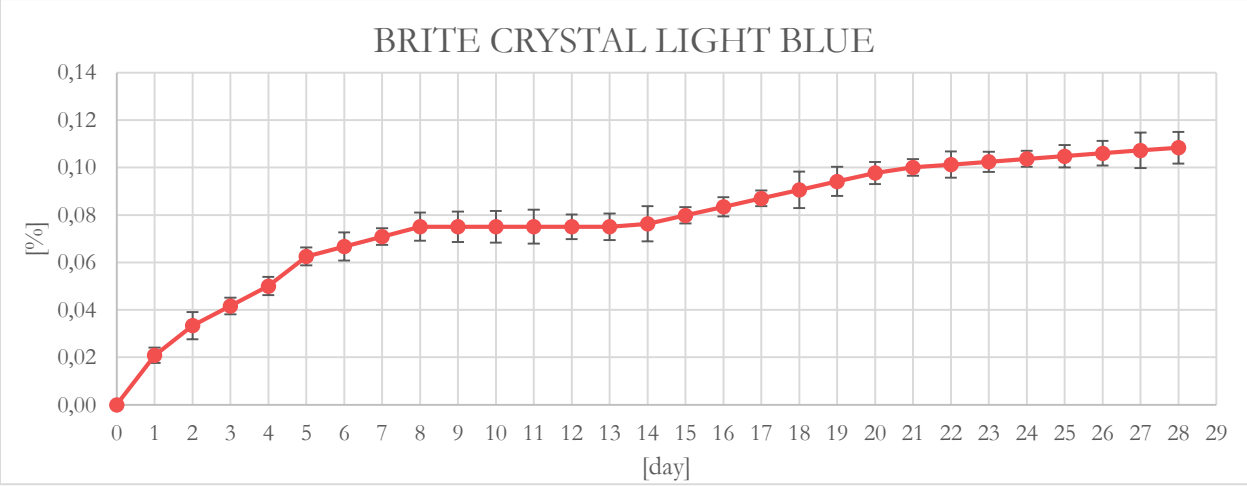
		BRITE CRYSTAL LIGHT BLUE [mm]				BRITE CRYSTAL LIGHT BLUE [%]				
date	day	I.	II.	III.	mean	I.	II.	III.	mean	std/2
18. 4.	0	159,91	159,95	159,96	159,94	0,000	0,000	0,000	0,000	0,000
19. 4.	1	159,89	159,91	159,93	159,91	0,014	0,027	0,021	0,021	0,003
20. 4.	2	159,87	159,89	159,91	159,89	0,027	0,039	0,034	0,033	0,006
21. 4.	3	159,85	159,87	159,89	159,87	0,035	0,048	0,042	0,042	0,003
22. 4.	4	159,84	159,86	159,88	159,86	0,043	0,056	0,051	0,050	0,004
23. 4.	5	159,82	159,84	159,86	159,84	0,056	0,069	0,063	0,063	0,004
24. 4.	6	159,81	159,83	159,85	159,83	0,060	0,073	0,067	0,067	0,006
25. 4.	7	159,81	159,83	159,85	159,83	0,064	0,077	0,071	0,071	0,003
26. 4.	8	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,006
27. 4.	9	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,006
28. 4.	10	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,007
29. 4.	11	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,007
30. 4.	12	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,005
1. 5.	13	159,80	159,82	159,84	159,82	0,068	0,081	0,076	0,075	0,006
2. 5.	14	159,80	159,82	159,84	159,82	0,070	0,082	0,077	0,076	0,007
3. 5.	15	159,79	159,81	159,83	159,81	0,073	0,086	0,080	0,080	0,003
4. 5.	16	159,79	159,81	159,83	159,81	0,077	0,089	0,084	0,083	0,004
5. 5.	17	159,78	159,80	159,82	159,80	0,080	0,093	0,088	0,087	0,003
6. 5.	18	159,78	159,80	159,81	159,80	0,084	0,097	0,091	0,091	0,008
7. 5.	19	159,77	159,79	159,81	159,79	0,088	0,100	0,095	0,094	0,006
8. 5.	20	159,76	159,78	159,80	159,78	0,091	0,104	0,098	0,098	0,005
9. 5.	21	159,76	159,78	159,80	159,78	0,093	0,106	0,101	0,100	0,004
10. 5.	22	159,76	159,78	159,80	159,78	0,095	0,107	0,102	0,101	0,006
11. 5.	23	159,76	159,78	159,80	159,78	0,096	0,108	0,103	0,102	0,004
12. 5.	24	159,75	159,77	159,79	159,77	0,097	0,110	0,104	0,104	0,003
13. 5.	25	159,75	159,77	159,79	159,77	0,098	0,111	0,105	0,105	0,005
14. 5.	26	159,75	159,77	159,79	159,77	0,099	0,112	0,107	0,106	0,005
15. 5.	27	159,75	159,77	159,79	159,77	0,101	0,113	0,108	0,107	0,007
16. 5.	28	159,75	159,77	159,79	159,77	0,102	0,114	0,109	0,108	0,007

Mean = mean value
*Std = standard deviation, std = sqrt(mean(abs(x - x.mean())**2))*

- Shrink Progression Chart - Sample Set A - Diamond Brite Onyx



- Shrink Progression Chart - Sample Set B - Brite Crystal Light Blue



3 Mechanical Test Results

- Tensile bending strength - three-point bending
  sample set A Diamond Brite Onyx

  I. 1,87 MPa (269.78 psi)
  II. 2,42 MPa (350.99 psi)
  III. 2,34 MPa (339.39 psi)

- Tensile bending strength - three-point bending
  sample set B Brite Crystal Light Blue

  I. 6,38 MPa (925.34 psi)
  II. 5,89 MPa (854.27 psi)
  III. 5,75 MPa (833.97 psi)

- Pressure Strength – sample set A Diamond Brite Onyx

  I.a 9,71 MPa (1408.32 psi)
  I.b 8,94 MPa (1296.68 psi)

  II.a 13,10 MPa (1899.99 psi)
  II.b 12,82 MPa (1859.38 psi)

  III.a 10,00 MPa (1450.38 psi)
  III.b 9,80 MPa (1421.37 psi)

- Pressure Strength – sample set B Brite Crystal Light Blue

  I.a 26,50 MPa (3843.50 psi)
  I.b 27,42 MPa (3976.93 psi)

  II.a 24,10 MPa (3495.41 psi)
  II.b 24,98 MPa (3623.04 psi)

  III.a 21,42 MPa (3106.71 psi)
  III.b 22,30 MPa (3234.34 psi)

4 Conclusion

It was found by experimental measurement, that the absolute autogenous shrinkage of the samples delivered, was almost identical in both sets of samples over the long term. The difference between both samples was in the initial rate of chemical shrinkage development. The sample Diamond Brite Onyx shrinkage development is faster than Brite Crystal Light Blue sample. This phenomenon of slower rate of shrinkage in Brite Crystal Light Blue plaster can be positively reflected in the small development of micro-cracks in the early stages of application and, above all, the hydration of the plaster, where the tensile strength is far from reaching its maximum.

By mechanical measurements, it was found that Diamond Brite Onyx plaster shows significantly less tensile strength than the Brite Crystal Light Blue. This corresponds to the measurement of the compressive strength, where, in the case of Brite Crystal Light Blue, a significantly higher compressive strength was achieved. The greater resistance of Brite Crystal Light Blue to mechanical stresses is certainly beneficial and can result in a longer lifetime of the Brite Crystal Light Blue plaster.

In Prague: 1.6.2018

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