Petrografic evaluation after 5 years of exposure to seawater

Microanalyses of 5 years old concretes from marine exposure compared to the 28 days (non-exposed concrete), the 6 months and the 2 years analyses of the same concretes.

Micrographs shown are mostly from the Western side of panels and taken in fluorescent light mode (green), polarized og x-polarized light.

Measured numbers are given as average numbers for each of the two surface sections, west side of panel (W) and east side of panel (E).

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July 31, 2015
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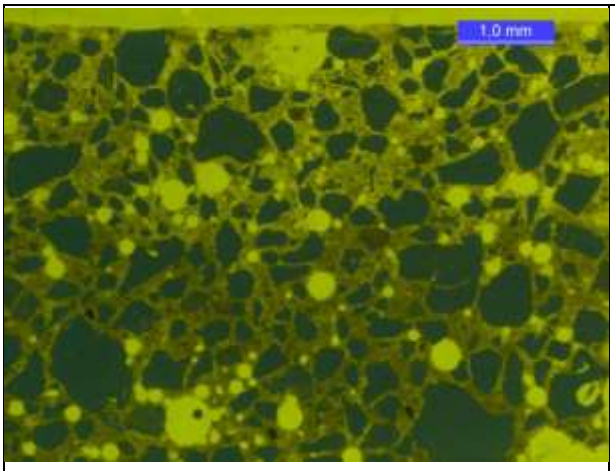
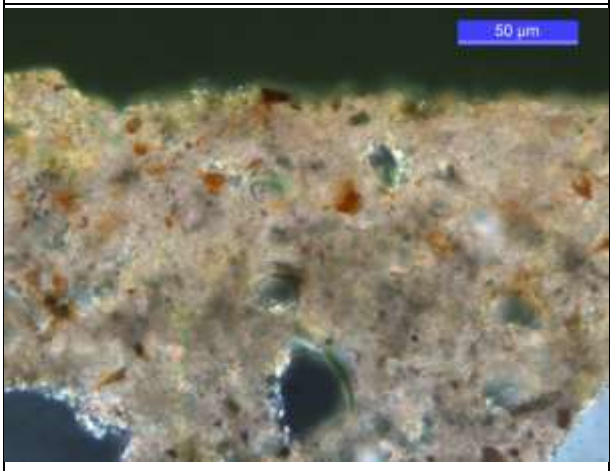
Concrete No. A

Age 6 mth's





Micro-observations (6 months images)
Surface: Intact with a thin calcite crust.

Carbonation: Outer 0.3 mm (W), 0.4 mm (E). Calcite crystals are observed in voids in carbonated zone. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Not distinct.
2. Popcorn carbonation: Not distinct.
3. Opaline paste behind popcorn: from 0.3-2.5 mm (W), from 0.3-1.8 mm (E).

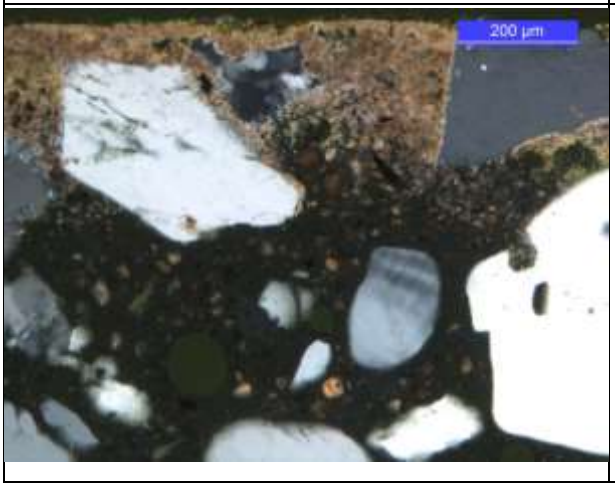
Ettringite: Observed in air voids to max. 3.5 mm; tiny crystals.

Porosity: Increased in outer 2 mm (W), 1.5 mm (E).

CH: Relatively large crystals in interior paste and in adhesion defects.

Cracks: Few fine surface cracks in East section.

Air: Appears well distributed.



Observation (28 days, non-exposed concrete):
Surface: Covered by a thin calcite layer.
Carbonation: Not observed.
Porosity: Uniform paste porosity throughout core.
W/c estimated: About 0.45.
Cracks: None in surface; generally none in paste except few adhesion cracks.
Air: Relatively poor structure, air content appears lower than 4.5%, few of the smallest voids, some air void clusters present.

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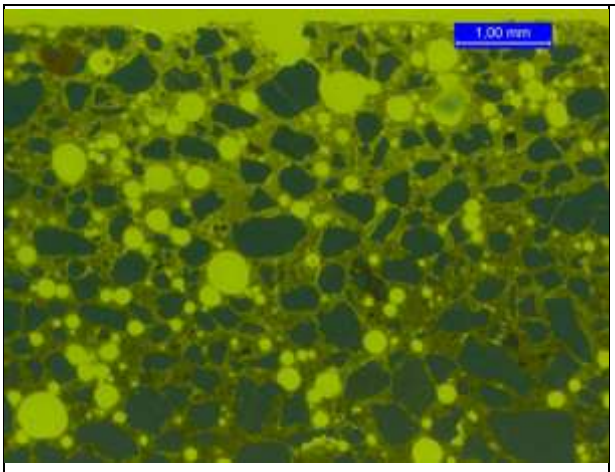
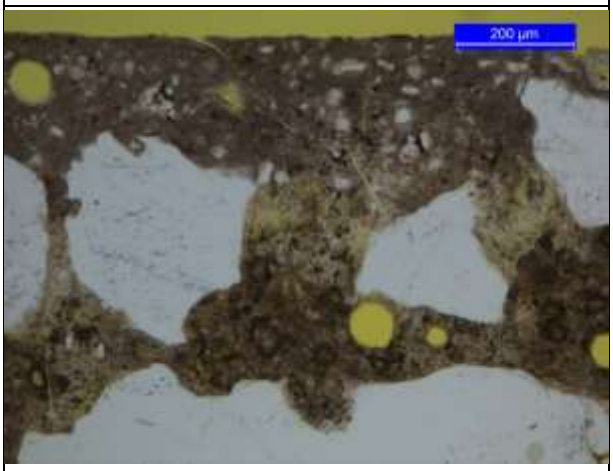
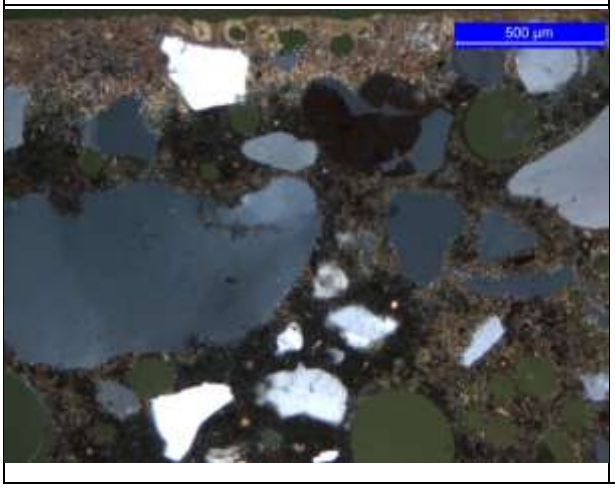
Concrete No. A

Age 2 years







Micro-observations (2 years images)
Surface: Intact, covered with calcite crust (W-section). Generally scaled at the E-section.

Carbonation: Carbonated paste is observed in the outer 0.3 mm (W), 0.1 mm (E) (scaled off). Calcite crystals are observed in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Present. Distinct, from 0.3-0.8 mm (W), not observed (E).
2. Popcorn carbonation: from 0.8 to 1.8 mm (W), 0 mm (E).
3. Opaline paste behind popcorn: from 1.8-3 mm (W), from 0.1-4 mm (E).

Ettringite: Needles in air voids throughout but most intense in leached zone, to 2 mm (W), to 2 mm (E).

Porosity: Increased porosity in the outer 2.5 mm (W), 3.5 mm (E).

CH: Relative large crystals in paste, adhesion defects and in air voids.

Cracks: Small brittle paste cracks in the leached surface. One fine crack to max. 3 mm's depth (W-section) and one fine crack to 12 mm (E).

Air: Relatively poor air void structure.

Gypsum: Not observed.

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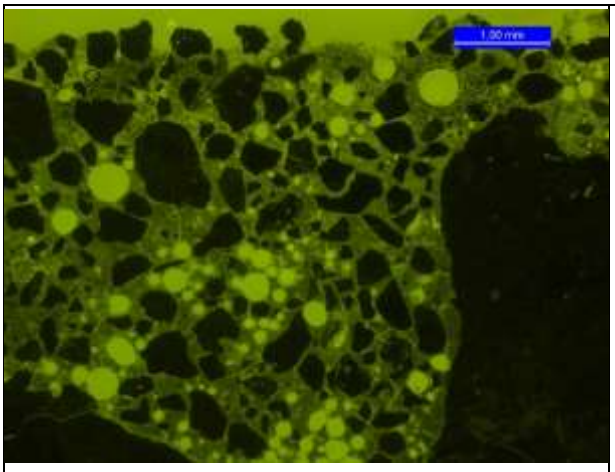
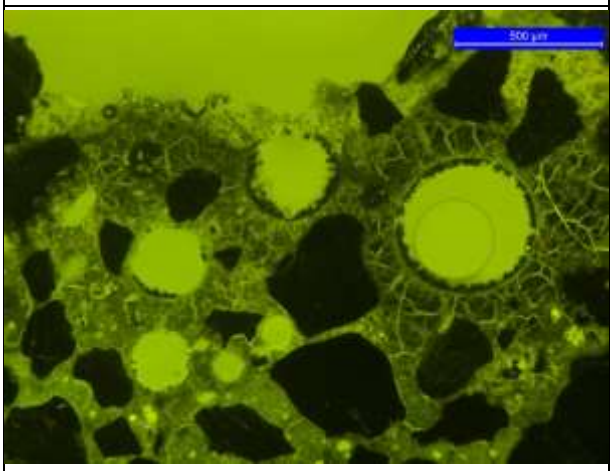
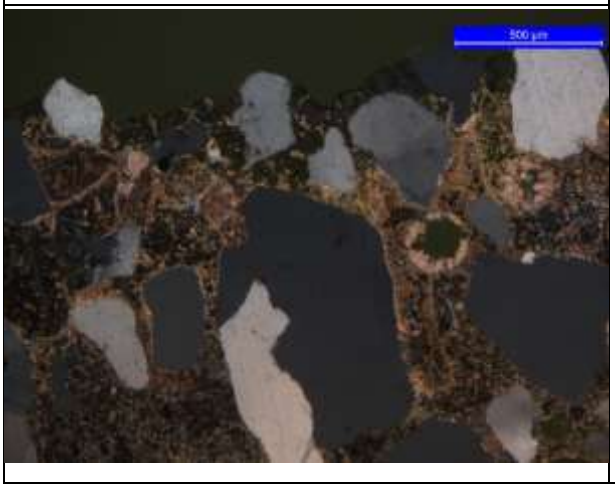
Concrete No. A

Age 5 years







Micro-observations (5 years images)
Surface: Partly scaled with exposed sand grains.

Carbonation: Not present, scaled off.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Present, distinct, to 0.4 mm (W), not observed (E).
2. Popcorn carbonation: from 0.4-1.2 mm (W), to 1.2 mm (E).
3. Opaline paste behind popcorn: from 1.2-7.5 mm (W & E).

Ettringite: Needles in air voids throughout but most intense in leached zone, to 6 mm (W), 8 mm (E), where it appears with an orange birefringence.

Porosity: Increased porosity in outer 7.5 mm.

Cracks: Small brittle paste cracks in outer leached zone. One fine crack to max. 3 mm's depth (W).

Air: Relatively poor air void structure.

Gypsum: Not observed.

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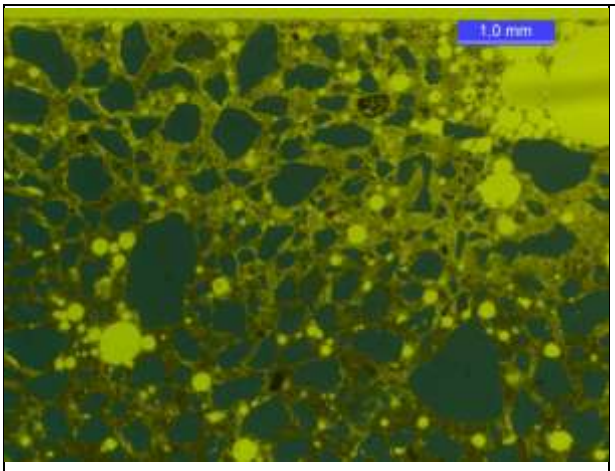
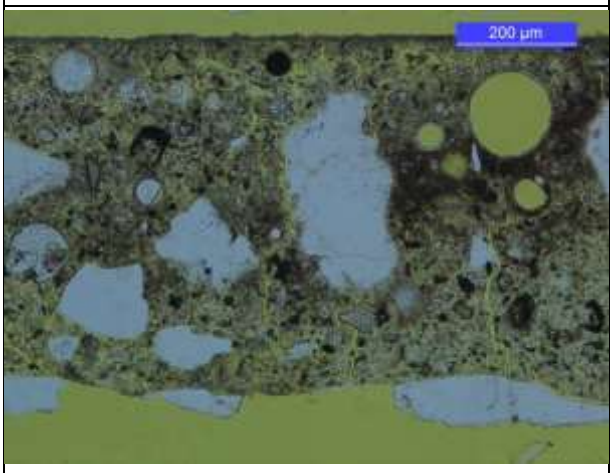
Concrete No. B **Age 6 mth's**





Micro-observations (6 months images)
Surface: Intact (W), scaled (E), and partly covered by a thin calcite crust.

Carbonation: 0.1 mm (W), 0 mm (E).

Based on the structural appearance the outermost surface region can be divided into 3 zones:

1. Leached zone behind carbonation: from 0.1-0.5 mm (W), 0 mm (E).
2. Popcorn carbonation: Not distinct.
3. Opaline paste behind popcorn carbonation: from 0.5 -2.5 mm (W), to 2.2 (E).

Ettringite: Needles are observed in air voids near the surface.

Porosity: Increased in the outer 2 mm (W), 1.8 mm (E).

CH: Relatively large crystals in interior paste and in adhesion defects.

Cracks: Brittle micro-cracks in the surface regions.

Air: Some agglomerated air voids.

Observation (28 days, non-exposed concrete):
Surface: No calcite layer on surface.
Carbonation: Not observed.
Porosity: Generally uniform paste porosity through core with a weak increase towards the surface.
W/c estimated: About 0.45.
Cracks: None in surface, very few in the paste as well as few adhesion cracks with CH.
Air: Relatively poor structure, air content probably on target but air voids are highly clustered especially along aggregate.

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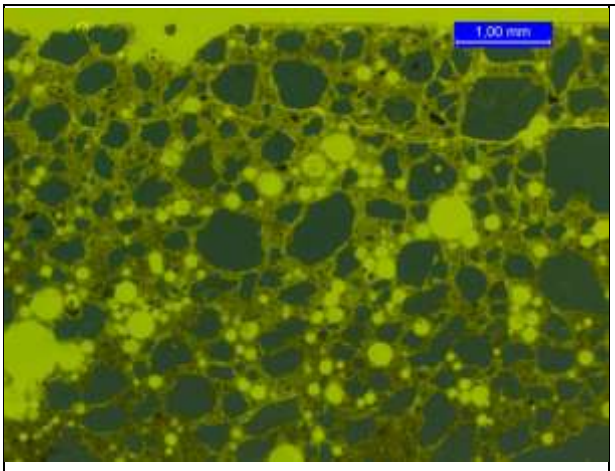
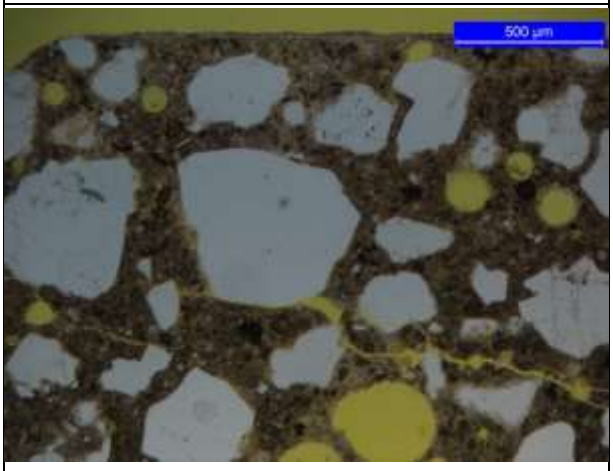
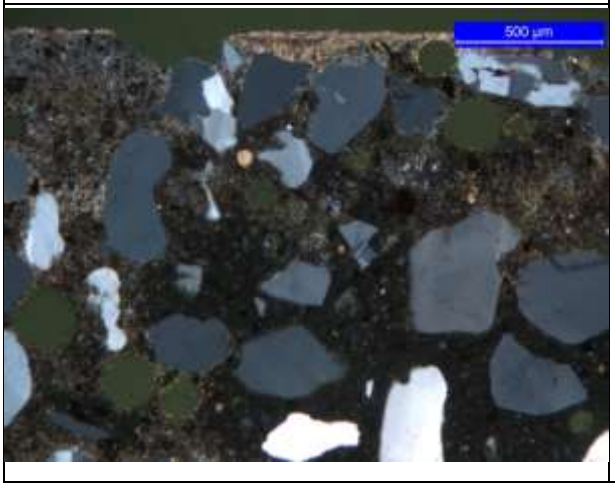
Concrete No. B **Age 2 years**







Micro-observations (2 years images)
Surface: Intact to slightly scaled with exposed sand. Calcite is occasionally observed as a thin crust on the surface.

Carbonation: Outer 0.8 mm (W), rather uneven zone. Outer 0.1 mm (E). Calcite crystals are present in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Not distinct.
2. Popcorn carbonation: from 0.8-1.5 mm (W), from 0.1-1.2 mm (E).
3. Opaline paste behind popcorn: from 1.5-3.5 mm (W), from 1.2-3.5 mm (E).

Ettringite: Needles in air voids throughout concrete but most intense outer 2 mm (W & E).

Porosity: Increased porosity in outer 3.5 mm (W); 2 mm (E).

CH: Relatively large crystals in interior paste and in adhesion defects.

Cracks: Small brittle paste cracks in outer leached zone. One fine crack to max. 4 mm's depth (W) and one to 10 mm (E). Surface parallel cracks are observed in the outer 1.8 mm (W) and 0.6 mm (E).

Air: Uneven air void structure, clustering.

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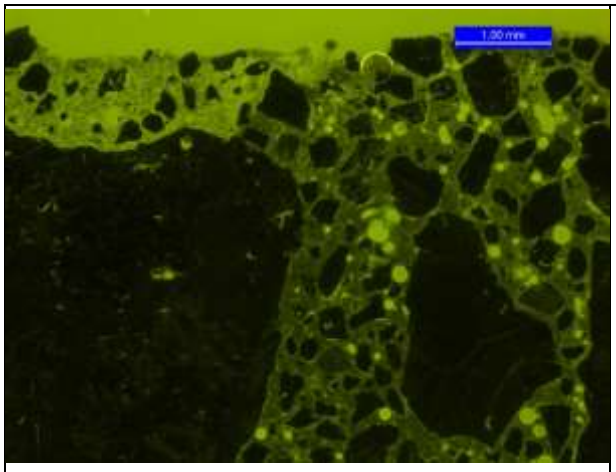
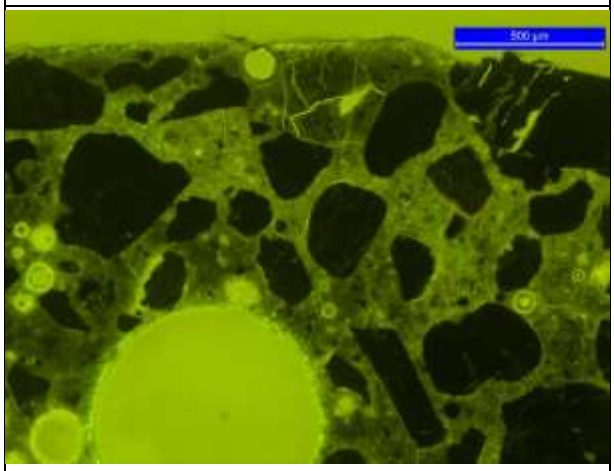
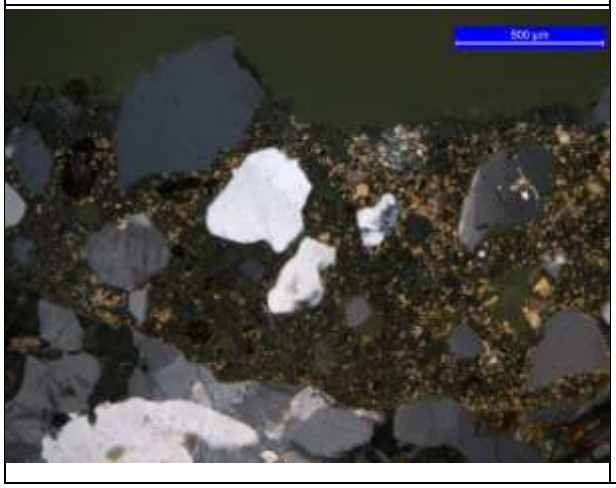
Concrete No. B **Age 5 years**







Micro-observations (5 years images)
Surface: Intact (E) to partly scaled with exposed sand (W). A thin calcite crust is occasionally observed on the surfaces.

Carbonation: Not observed. Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: outer 0.2 mm (W), 1.2 mm (E).
2. Popcorn carbonation: from 0.2-1.2 mm (W), from 1.2-2 mm (E).
3. Opaline paste behind popcorn: from 1.2-5 mm.

Ettringite: Needles in air voids throughout but most intense outer 12 mm, where it appears with an orange birefringence.

Porosity: Increased porosity in outer 5 mm.

Cracks: Small brittle paste cracks in outer leached zone. One fine crack to max. 4 mm's depth (W).

Air: Relatively poor air void structure.

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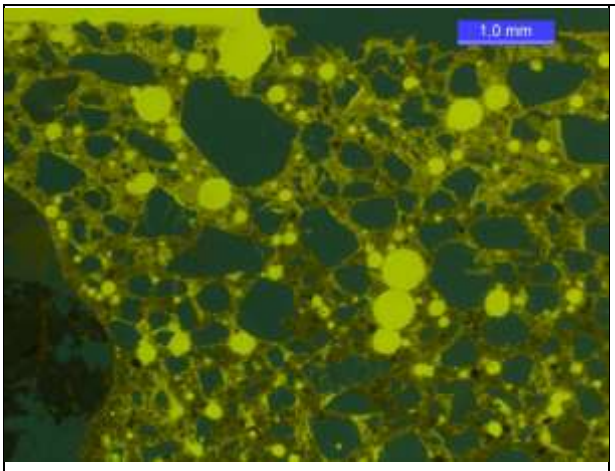
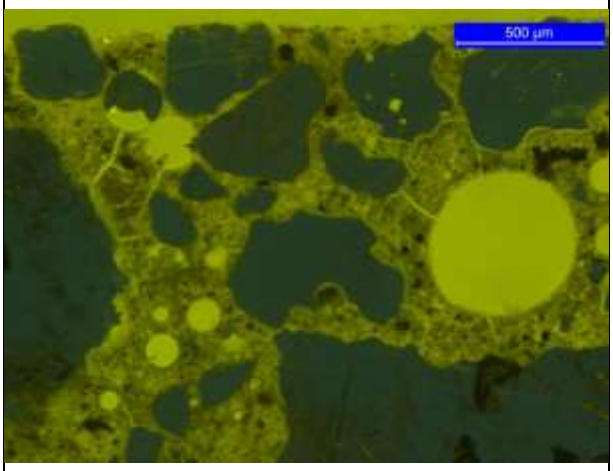
Concrete No. C **Age 6 mth's**





Micro-observations (6 months images)
Surface: Partly scaled with exposed sand grains (W), intact (E). Biological growth at surface.

Carbonation: Carbonated surface to 0.1 mm. Calcite crystals in voids. Rusty spots present in carbonated paste.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Leached zone behind carbonation: from 0.1-0.4 mm (W), from 0.1-0.3 mm (E).
2. Popcorn carbonation: From 0.4-0.6 mm (W), from 0.3 to 0.8 mm (E).
3. Opaline paste behind popcorn: 0.6-3 mm (W), from 0.8-2.4 mm (E).

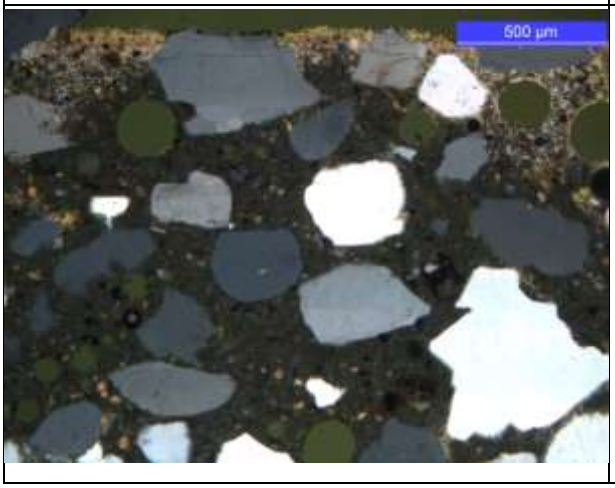
Ettringite: Needles in air voids in the outer 0.8 mm (W & E)

Porosity: Increased in outer 2 mm (W), not distinct (E).

CH: Relatively large CH crystals in interior paste and in adhesion defects.

Cracks: Some brittle micro-cracks in the outer leached zone. Two surface cracks in East section extending to 3 and 5 mm's depth.

Air: Some agglomerated air voids.



Observation (28 days, non-exposed concrete):
Surface: No calcite layer on surface.
Carbonation: Weak sign observed.
Porosity: Generally uniform throughout core with a weak increase towards the surface.
W/c estimated: About 0.45.
Cracks: None in surface, very few in paste as well as few adhesion cracks.
Air: Relatively poor structure, air content probably on target but air voids are highly clustered especially along aggregate.

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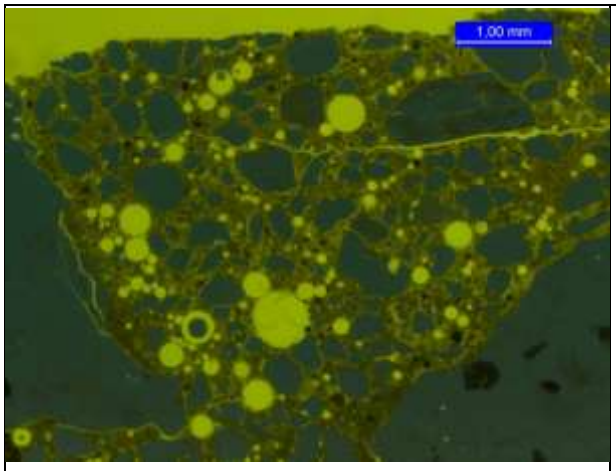
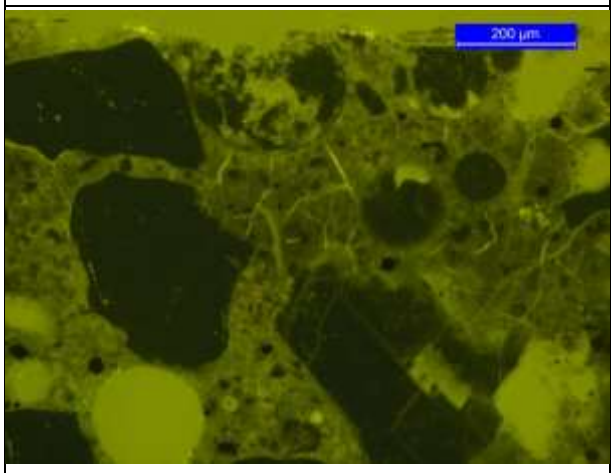
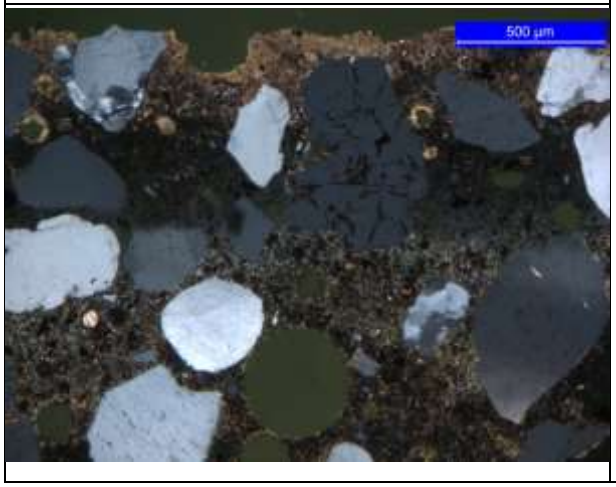
Concrete No. C **Age 2 years**







Micro-observations (2 years images)
Surface: Partly scaled with exposed sand.

Carbonation: Outer 0.2 mm. Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.2-0.6 mm thick (W), from 0.2-0.8 mm (E).
2. Popcorn carbonation: from 0.6-1.5 mm (W), from 0.8-1.7 mm.
3. Opaline paste behind popcorn: from 1.5-3.5 mm (W), from 0.8 mm-2.5 mm.

Ettringite: Needles in air voids throughout but most intense outer 2 mm (W), 4 mm (E).

Porosity: Increased porosity in outer 1.2 mm (W), 1.4 mm (E).

Cracks: Small brittle micro-cracks in outer leached zone. One fine crack to max. 10 mm's depth; few surface parallel cracks at depth of 1.2-3.2 mm (W).

Air: Uneven distributed, agglomerated.

Gypsum: Not observed.

Concrete No. C **Age 5 years**

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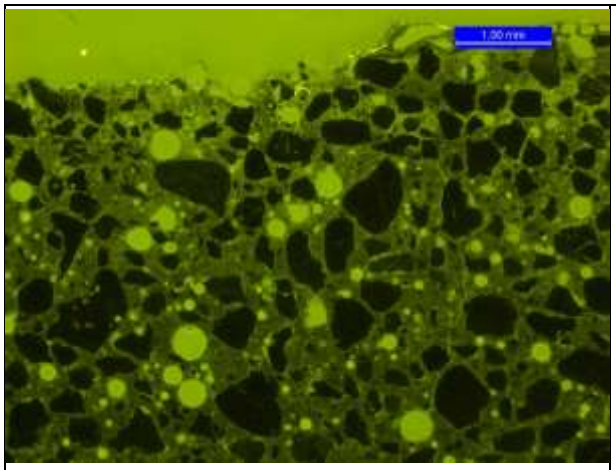

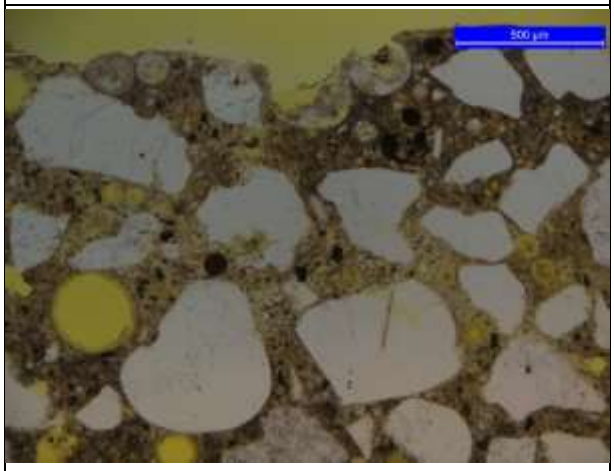

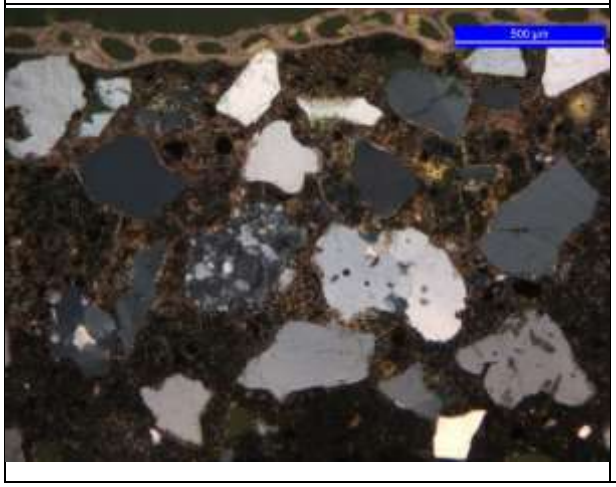

Micro-observations (5 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.4 mm. Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.4-0.8 (W), 0.4-1.2 mm (E).
2. Popcorn carbonation: from 0-8-1 mm (W), from 1.2-1.5 mm (E).
3. Opaline paste behind popcorn: from 1-6 mm (W), 1.5-4 mm (E).

Ettringite: Needles in air voids throughout but most intense outer 20 mm (W), 18 mm (E), where it appears with an orange birefringence.

Porosity: Increased porosity in outer 1.2 mm (W), 1.4 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. One fine crack to max. 10 mm's depth (W). Few surface parallel cracks at depth of 1.2-3.2 mm.

Air: Relatively poor air void structure.

Gypsum: Observed in one air void in popcorn zone in E section.

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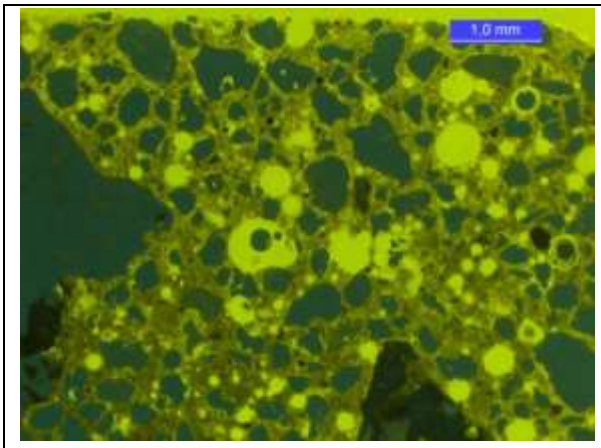
Concrete No. D **Age 6 mth's**



Micro-observations (6 months images)
Surface: Scaled (W) to partly scaled (E) with exposed sand grains. A calcite crust occurs occasionally on surface. Biological growth observed.

Carbonation: Outer 0.2 mm is carbonated. Calcite crystals occurs in voids (W & E). Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:
1. Leached zone behind carbonation: from 0.2-0.4 mm (W & E).
2. Popcorn carbonation: from 0.4-0.6 mm (W & E).
3. Opaline paste behind popcorn: From 0.6 to 2 mm (W), from 0.6-0.8 mm (E).

Ettringite: Needles in air voids to 0.6 mm (W), 1 mm (E).

Porosity: Increased in outer 1 mm (W), 0.8 mm (E).

Cracks: Some brittle paste cracks in the outer leached zone. Generally no cracks in interior paste.

Air: Ok air void structure.

Gypsum: Observed in an air void near the surface (W).

Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer on surface.
Carbonation: Weak sign observed at surface.
Porosity: Very uniform paste porosity throughout core
W/c estimated: About 0.45.
Cracks: No cracks in surface except for 1 surface parallel crack 1.5 mm under surface. Very few cracks in paste, some adhesion cracks observed.
Air: Relatively low air content, seems to be lower than target, few of the very small voids.

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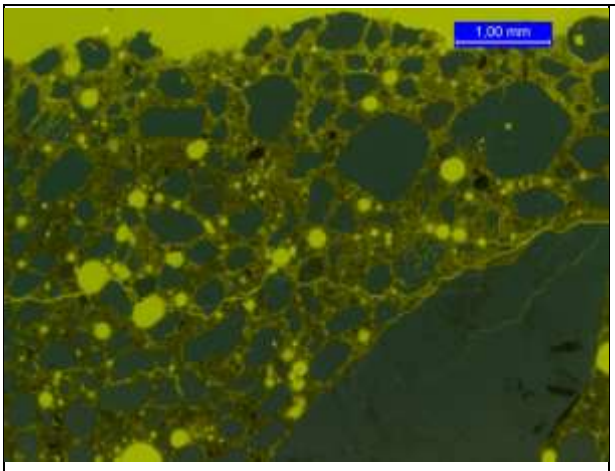
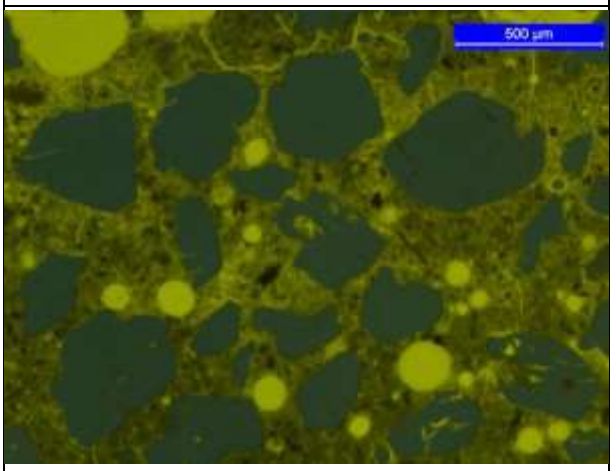
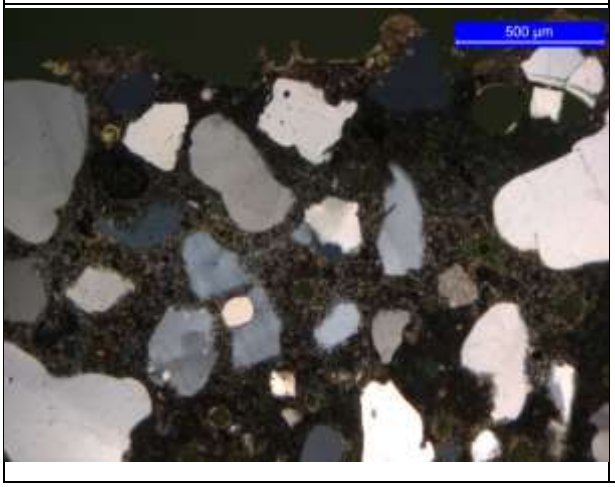
Concrete No. D **Age 2 years**







Micro-observations (2 years images)
Surface: Scaled with exposed sand.

Carbonation: Carbonated in the outer 0.1 mm (W), 0.2 mm (E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. 0.1-0.4 mm (W), 0.2-0.4 mm (E).
2. Popcorn carbonation: from 0.4-1.2 mm (W & E)
3. Opaline paste behind popcorn: from 1.2-2.5 mm (W & E).

Ettringite: Needles in air voids throughout but most intense outer 4 mm (W), 4.5 mm (E). In section E the crystals appears with an orange birefringence.

Porosity: Increased porosity in outer 1.2 mm (W), 1.5 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. Some fine cracks perpendicular and parallel to the surface in the outer 6-8 mm (W). One fine surface crack to 4 mm (E). Some adhesion cracks.

Air: Ok air void structure.

Gypsum: Possible observed in an air void in the surface region (E).

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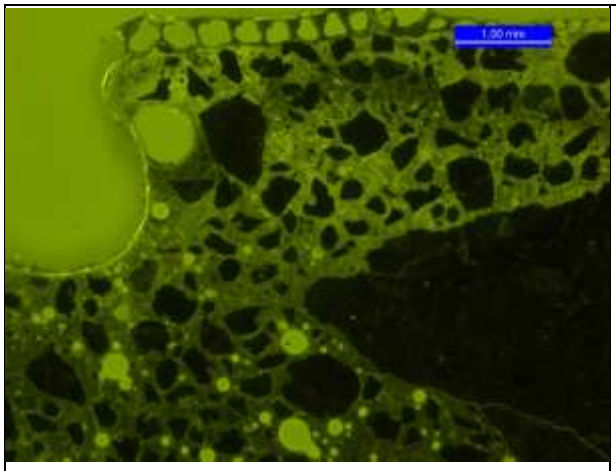
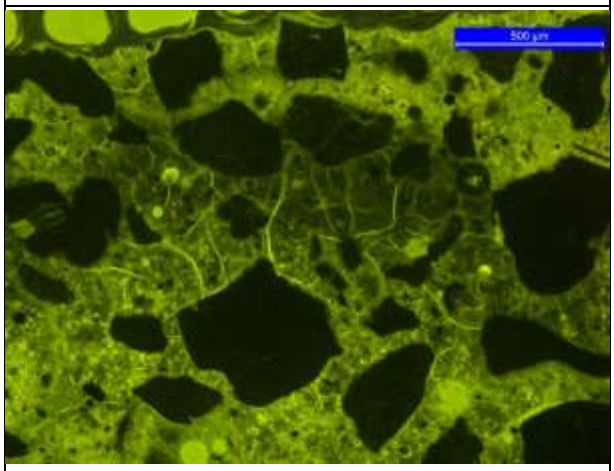
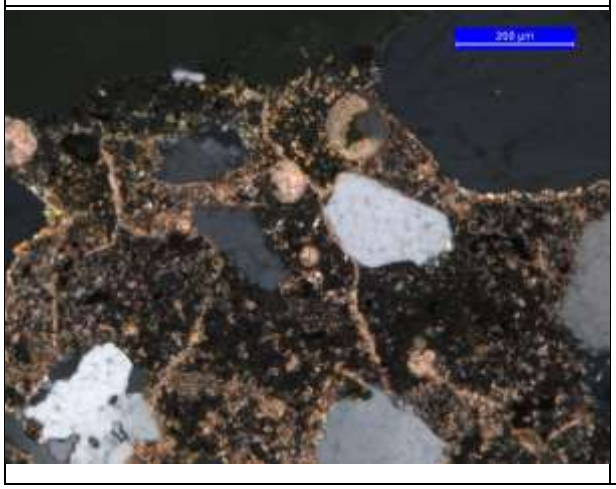
Concrete No. D **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.4 mm (E), not observed in (W). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0-0.6 mm (W), from 0.4-0.8 mm (E).
2. Popcorn carbonation: from 0.6-2 mm (W), 0.8 mm-2 mm (E).
3. Opaline paste behind popcorn: from 2-4 mm 8 (W), from 2-10 mm (E), where it appears with an orange birefringence.

Ettringite: Needles in air voids throughout but most intense outer 4-4.5 mm.

Porosity: Increased porosity in outer 1.2 mm (W), 1.5 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. Some fine cracks in the outer 6-8 mm. Some adhesion cracks.

Air: Ok air void structure.

Gypsum: Not identified.

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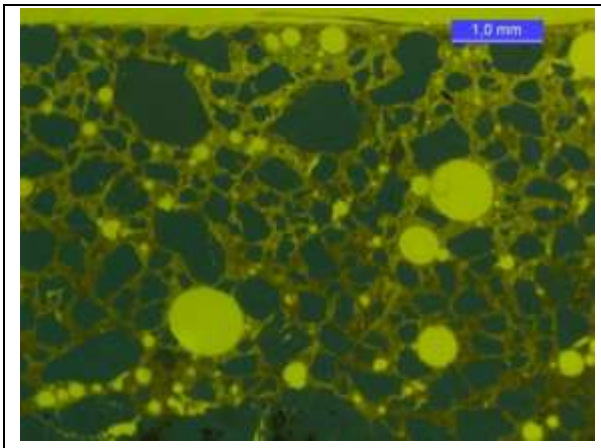
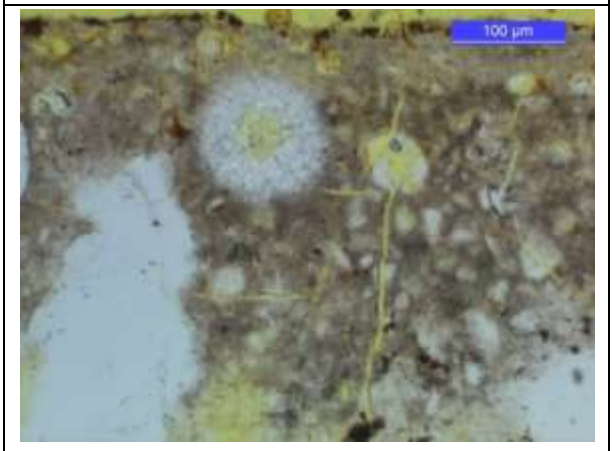
Concrete No. E **Age 6 mth's**





Micro-observations (6 months images):
Surface: Intact surface partly covered by a calcite crust. Biological growth at surface.

Carbonation: To 0.2 mm (W & E). Calcite crystals in voids. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

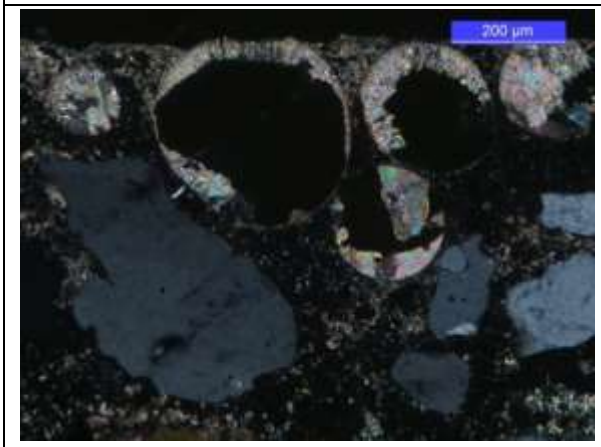
1. Leached zone behind carbonation: from 0.2-0.4 mm.
2. Popcorn carbonation: From0.4-0.6 mm (W), from 0.4-0.5 mm (E).
3. Opaline paste behind popcorn: from 0.6-2.4 mm, from 0.5-2 mm.

Ettringite: Needles in air voids to 0.8 mm (W), 0.4 mm (E).

Cracks: Many small brittle micro-cracks in the outer leached zone. Generally no cracks in interior paste.

Porosity: Increased in outer 2 mm (W & E).

Air: Uneven distributed.



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer on surface.
Carbonation: No sign of carbonation.
Porosity: Uniform paste porosity throughout core, weak increase towards surface.
W/c estimated: About 0.45.
Cracks: Some plastic cracks in surface. Very few cracks in paste.
Air Relatively poor air void structure, air content probably on target but air voids are somewhat clustered especially along aggregate.

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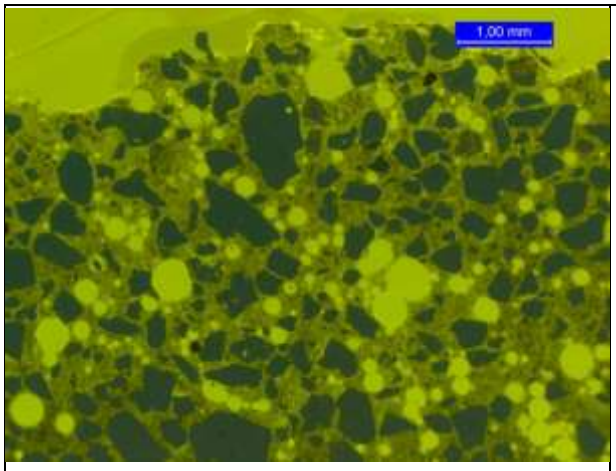
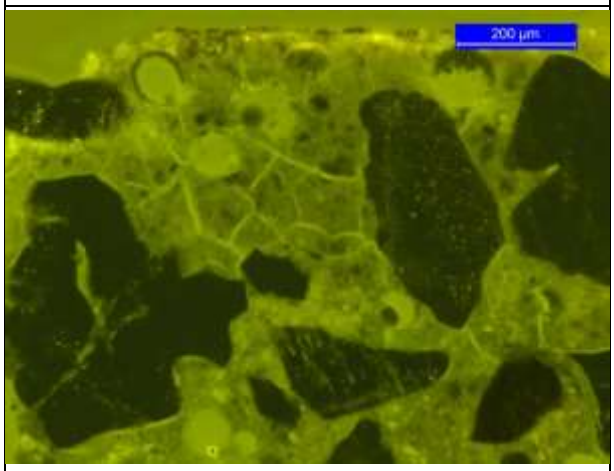
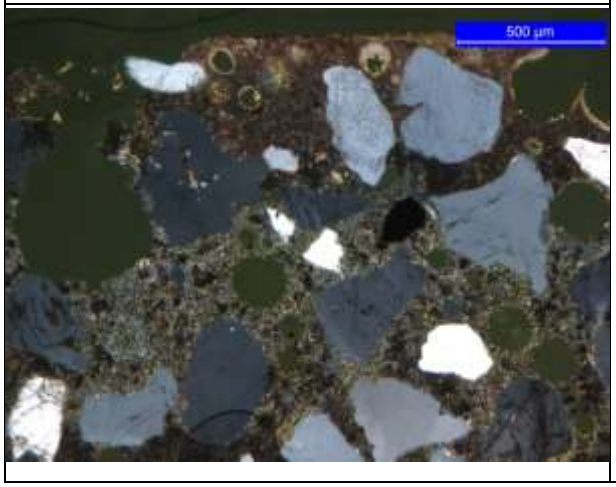
Concrete No. E **Age 2 years**







Micro-observations (2 years images):
Surface: Partly scaled with exposed sand grains.

Carbonation: Carbonated in the outer 0.4 (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0.4-0.5 mm (W), from 0.4-0.8 mm (E).
2. Popcorn carbonation: from 0.5-1.5 mm (W), from 0.8-1.2 mm (E).
3. Opaline paste behind popcorn: from 1.5-3.5 mm (W), from 1.2-4 mm (E).

Ettringite: Needles in air voids throughout but most intense outer 2.5 mm (W & E). Distinct orange birefringence of "ettringite" near popcorn zone.

Porosity: Increased porosity in outer 1.2 mm (W), 1.8 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. One fine surface crack to 4 mm's depth (W).

Air: Poor air void structure, uneven distributed.

Gypsum: In few voids in section W.

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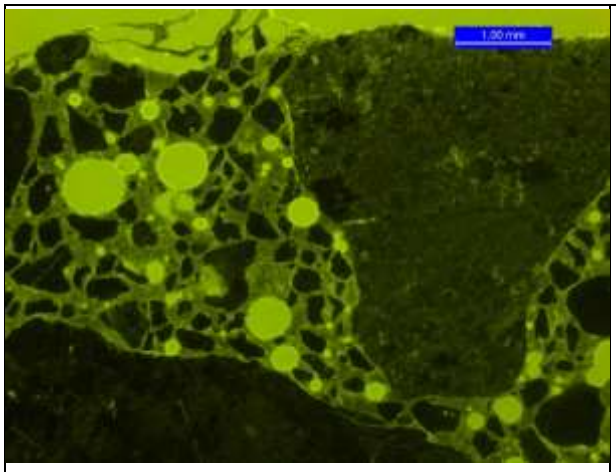
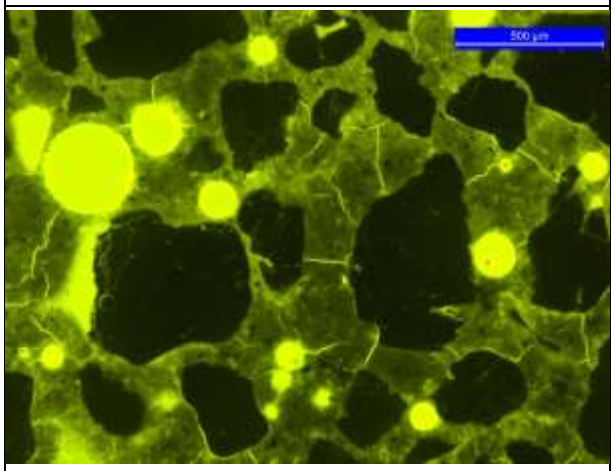
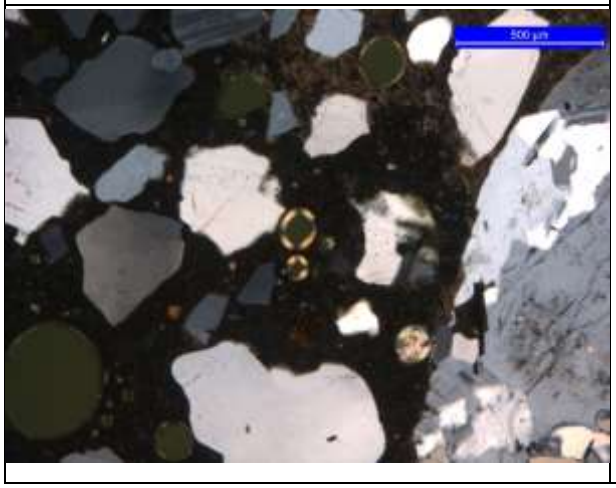
Concrete No. E **Age 5 years**







Micro-observations (5 years images):
Surface: Scaled (W) to partly scaled (E) with exposed aggregate. Occasionally covered by a calcite crust.

Carbonation: Not observed. Calcite crystals in voids near surface.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.2 mm (W), from 0-0.4 mm (E).
2. Popcorn carbonation: from 0.2-1.5 mm (W), from 0.04-1 mm (E).
3. Opaline paste behind popcorn: from 1.5-6 mm (W), from 1-6 mm (E).

Ettringite: Needles in air voids throughout but most intense outer 12 mm (W) and 10 mm (E). Distinct orange birefringence of "ettringite" near popcorn zone.

Porosity: Increased porosity in outer 1.5 mm (W), 0.8 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. Fine crack to 4 mm's depth.

Air: Poor air void structure.

Gypsum: Observed in few air void in section E

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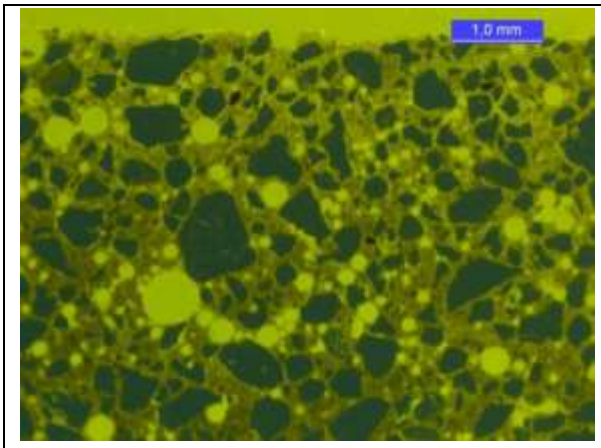
Concrete No. F **Age 6 mth's**



Micro-observations (6 months images)
Surface: Scaled (E) to partly scaled (W) with exposed sand grains. Biological growth at surface.

Carbonation: to 0.2 mm (W & E). Calcite crystals in voids. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:
1. Leached zone behind carbonation: from 0.2-0.4 (W), from 0.2-0.3 (E).
2. Popcorn carbonation: from 0.4-0.7 mm (W), from 0.3-0.6 mm (E).
3. Opaline paste behind popcorn: from 0.7-2.4 mm (W), from 0.6-1.2 mm (E).

Ettringite: Needles in air voids in especially the leached paste where it appears more massive, to 1 mm (W), to 0.6 mm (E).

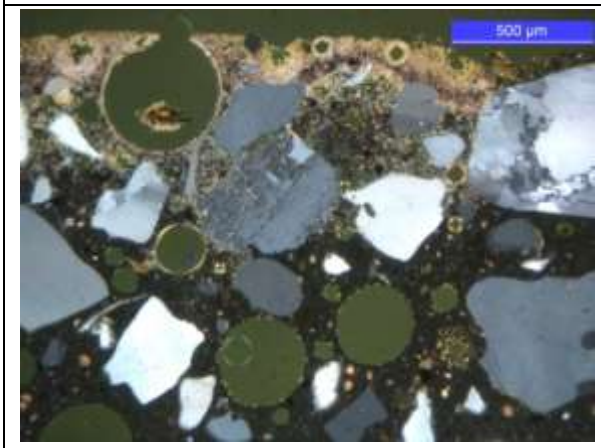
Porosity: Increased in outer 1.5 mm (W), not observed in E section.

CH: Very large crystals observed in interior paste below leached zone.

Cracks: Many small brittle micro-cracks in the outer leached zone.

Air: Some agglomerated air.

Gypsum: Observed in few air voids near surface (W).



Observation (28 days. non-exposed concrete):
Surface: Thin calcite layer on surface.
Carbonation: No sign of carbonation.
Porosity: Uniform paste porosity throughout core, weak increase towards surface. Paste appears rather opaline.
W/c estimated: About 0.45.
Cracks: No cracks in surface; very few cracks in paste, few adhesion cracks.
Air: Relatively poor air void structure, air content probably on target but air voids are somewhat clustered especially along aggregate.

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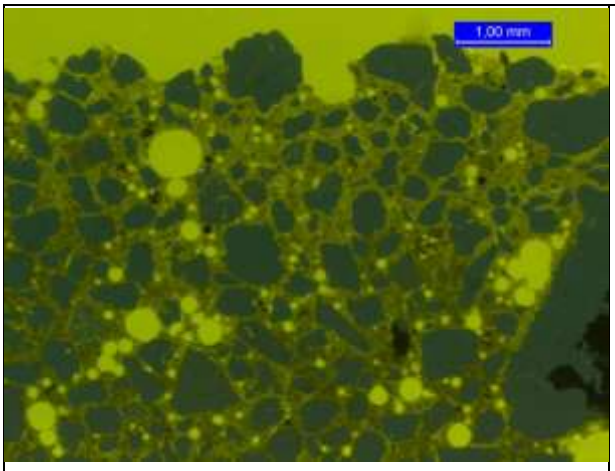
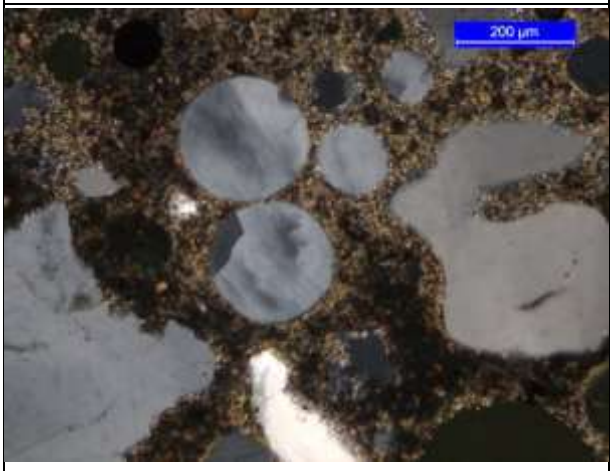
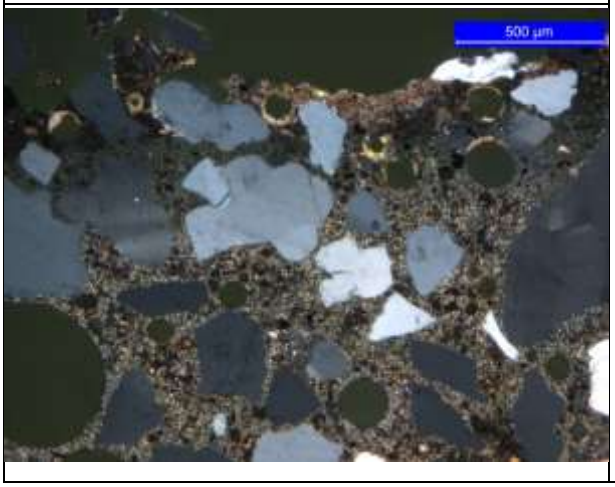
Concrete No. F **Age 2 years**







Micro-observations (2 years images)
Surface: Scaled (W) to partly scaled (E) with exposed sand grains.

Carbonation: Paste in the outer 0.2 mm is carbonated. Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.2-1 mm (W), from 0.2-0.4 mm (E).
2. Popcorn carbonation: from 1-2 mm (W), from 0.4-0.8 mm (E).
3. Opaline paste behind popcorn: from 2-4 mm (W), from 0.8-3.5 mm (E).

Ettringite: Needles in air voids throughout but most intense outer 18 mm (W), 13 mm (E). Distinct orange birefringence of "ettringite" near popcorn zone.

Porosity: Increased porosity in outer 2 mm (W), 1 mm (E).

Cracks: Small brittle micro-cracks in outer leached zone.

Air: Some agglomerated air.

Gypsum: Observed in several air voids in the popcorn carbonated zone (W & E).

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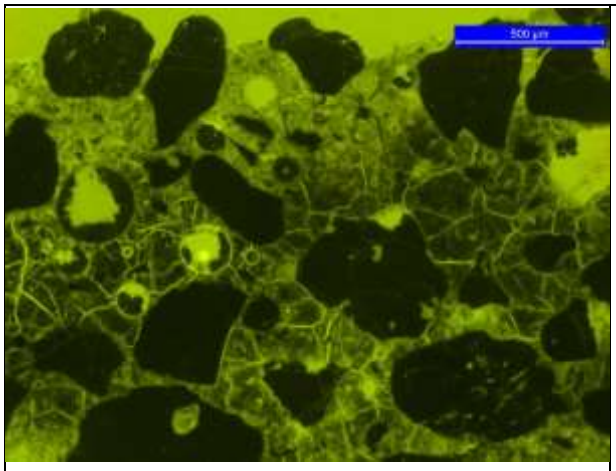
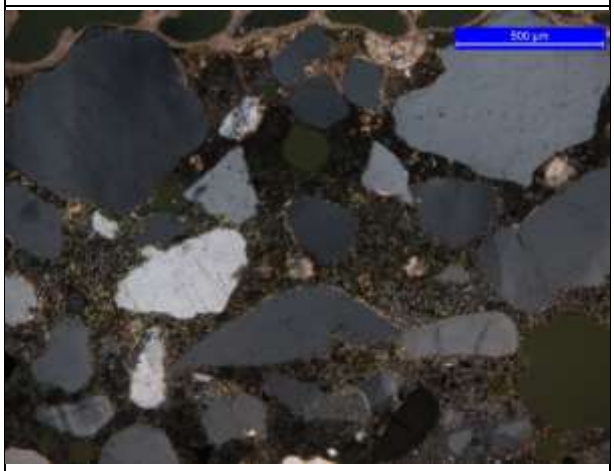
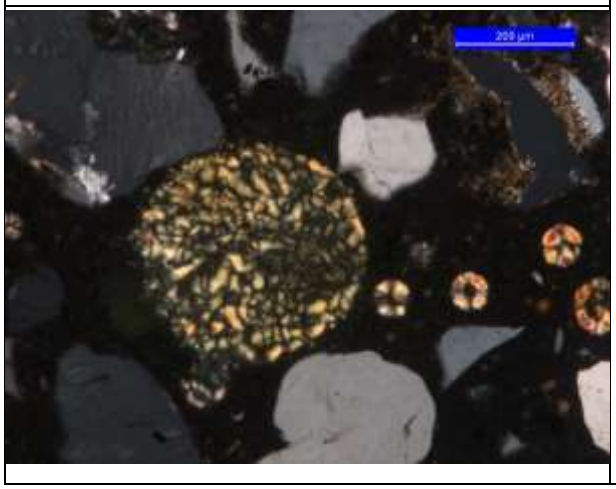
Concrete No. F **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed aggregate.

Carbonation: Outer 0.2 mm (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.2-0.6 mm (W & E).
2. Popcorn carbonation: from 0.6-1.2 mm (W & E).
3. Opaline paste behind popcorn: from 1.2-6 mm (W & E).

Ettringite: Needles in air voids throughout but most intense outer 22 mm (W), 24 mm (E). Distinct orange birefringence of "ettringite" in popcorn zone.

Porosity: Increased porosity in outer 0.6 mm (W), 1.2 mm (E).

Cracks: Small brittle paste cracks in outer leached zone.

Air: Some agglomerated air.

Gypsum: Observed in several air voids in popcorn carbonated zone.

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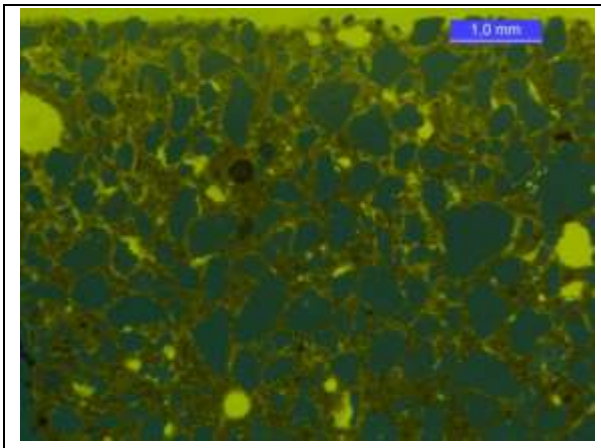
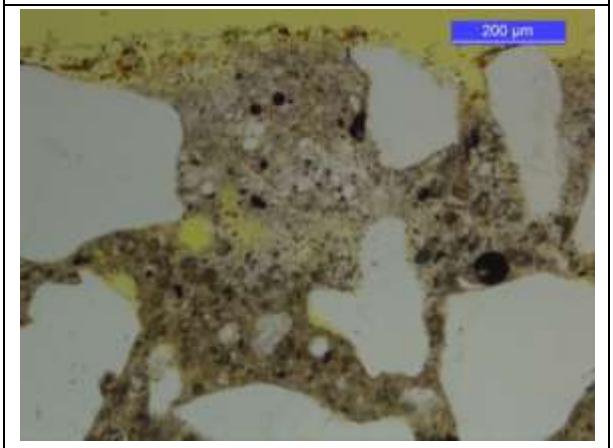
Concrete No. G **Age 6 mth's**





Micro-observations (6 months images)
Surface: Scaled (E) to partly scaled with exposed sand grains. Biological growth at surface.

Carbonation: to 0.3 mm (W), 0.2 mm (E). Calcite crystals in voids. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Leached zone: From 0.3-0.4 mm (W), not distinct in (E).
2. Popcorn carbonation: from 0.4-0.5 mm (W), not distinct in (E).
3. Opaline paste behind popcorn: from 0.5-1.2 mm (W), to 1.2 mm (E).

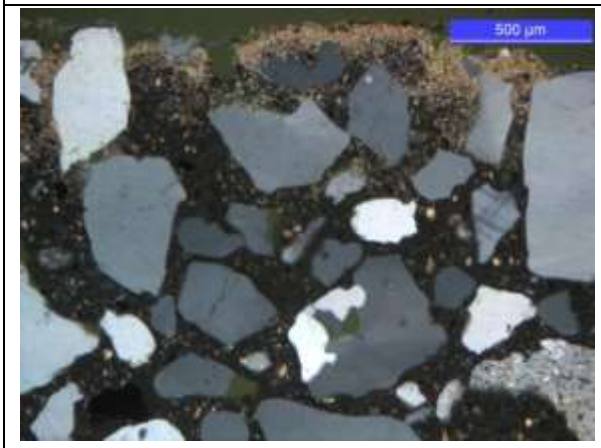
Ettringite: Observed in the few air voids, but not distinct.

Porosity: Increased porosity in outer 0.8 mm (W & E).

Cracks: Some smaller brittle micro-cracks in the outer leached zones.

Air: Low content, not entrained.

Gypsum: Not observed.



Observation (28 days, non-exposed concrete):
Surface: Calcite layer on surface not observed.
Carbonation: to 0.3 mm, along crack in the surface to 1.5 mm.
Porosity: Generally uniform paste porosity throughout core, however with a distinct increased porosity towards the surface. Paste rich areas present.
W/c estimated: About 0.45.
Cracks: Few in surface, some in paste and some adhesion cracks with CH, shrinkage cracks in paste rich areas
Air: Few voids, as target

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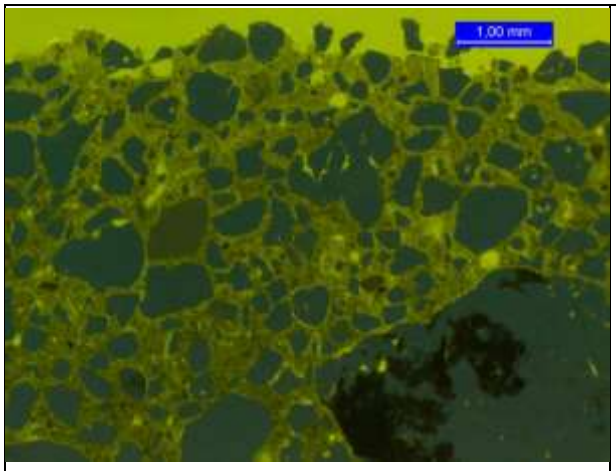
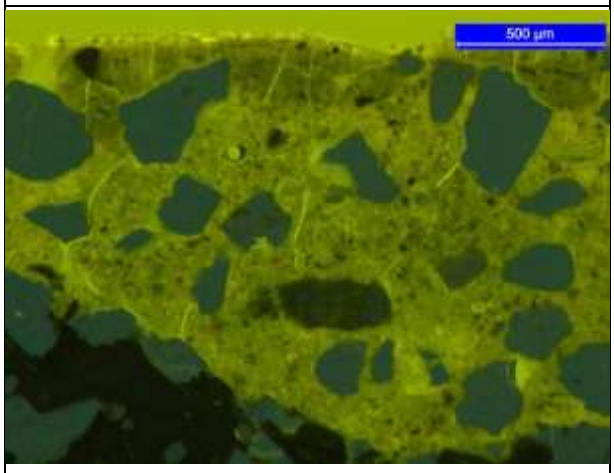
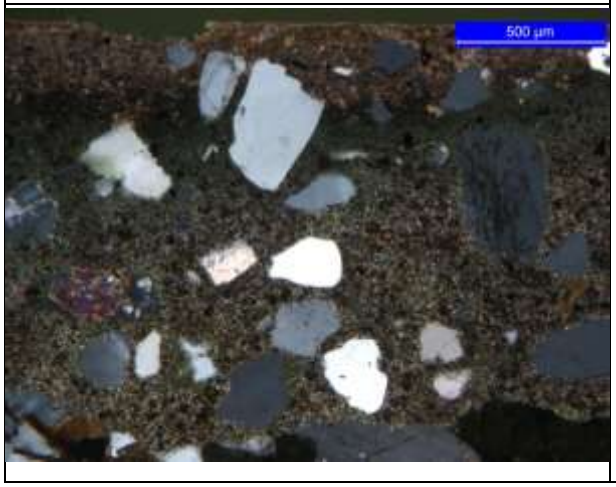
Concrete No. G **Age 2 years**







Micro-observations (2 years images)
Surface: Partly scaled (W) to scaled (E) with exposed sand grains.

Carbonation: to 0.2 mm (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0-2-0.4 mm thick (W), from 0.2-0.6 mm (E).
2. Popcorn carbonation: from 0.4-1.5 mm (W), from 0.6-1-5 mm (E).
3. Opaline paste behind popcorn: Not distinct.

Ettringite: Not much but intense in air voids in the popcorn carbonated zone. Distinct orange birefringence of "ettringite".

Porosity: Increased porosity in outer 1.5 mm (W), 2 mm (E).

Cracks: Small brittle micro-cracks in outer leached zone.

Air: Few air voids, not entrained.

Gypsum: Observed in air voids in the popcorn carbonated zone in both sections.

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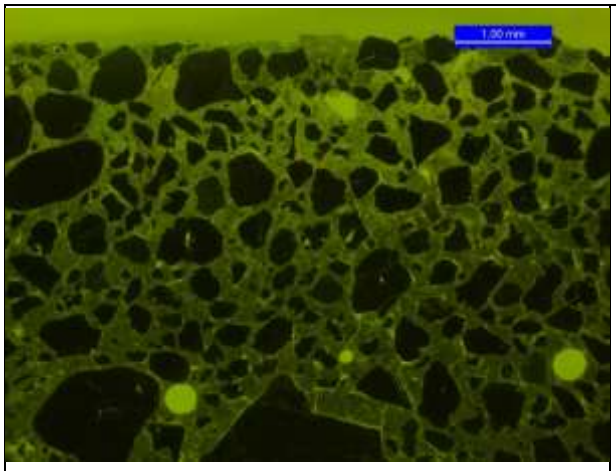
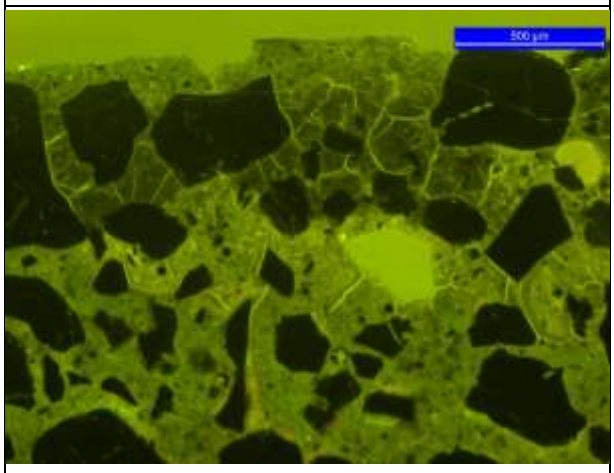
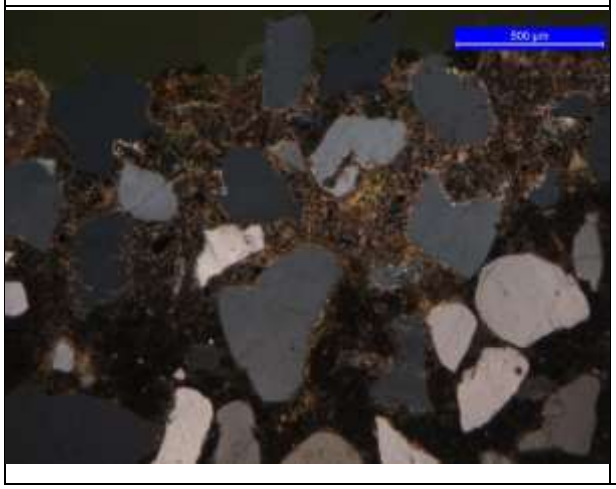
Concrete No. G **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Not observed. Calcite crystals in voids in near surface.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0-0.2 mm (W), 0-0.6 mm (E).
2. Popcorn carbonation: from 0.2-1.2 mm (W), from 0.6-1.2 mm (E).
3. Opaline paste behind popcorn: from 1.2-4 mm (W), from 1.2-6 mm (E).

Ettringite: Not much but intense in air voids in the popcorn carbonated zone, to 6 mm (W), 10 mm (E). Distinct orange birefringence of "ettringite".

Porosity: Increased porosity in outer 1.2 mm (W), 2 mm (E).

Cracks: Small brittle paste cracks in outer leached zone.

Air: Few air voids, not air entrained.

Gypsum: Observed in air voids in popcorn carbonated zone in East section.

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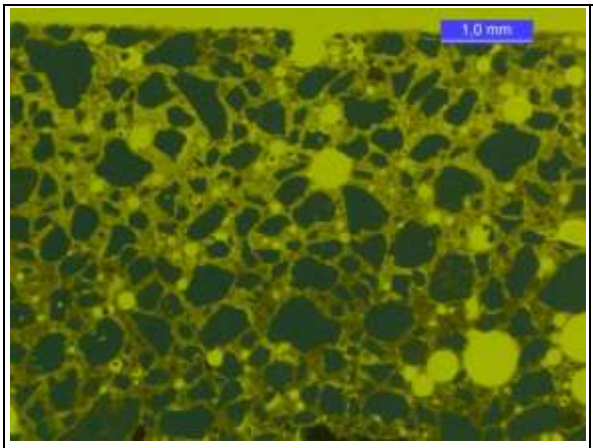
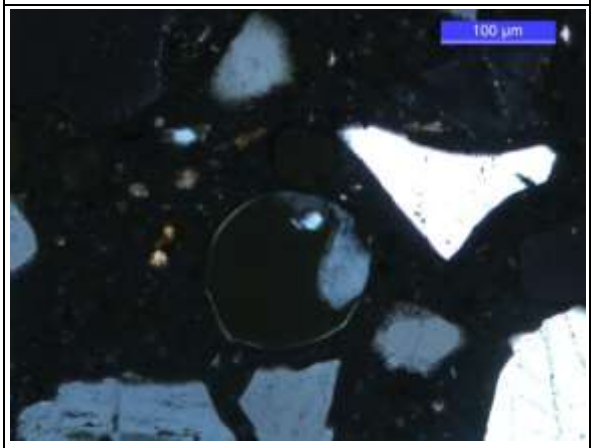
Concrete No. H **Age 6 mth's**





Micro-observations (6 months images)
Surface: Partly scaled with exposed sand grains (W) to intact (E). Biological growth at surface.

Carbonation: Outer 0.3 mm (W), 0.1 mm (E). Calcite crystals in voids. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Leached zone behind carbonation: not distinct (W), from 0.1-0.4 mm (E).
2. Popcorn carbonation: not distinct (W), from 0.4-6 mm (E).
3. Opaline paste behind popcorn: from 0.3-1.2 mm (W), from 0.6-2.5 mm (E).

Ettringite: Needles in air voids, distinct to 1.2 mm (W), 2 mm (E).

Porosity: Increased porosity to depth of 1.8 mm (W),, 2 mm (E).

Cracks: Few smaller brittle micro-cracks in the outer leached zone.

Gypsum: Observed in some air voids near surfaces.

Observation (28 days, non-exposed concrete):
Surface: Calcite layer on surface not observed.
Carbonation: Not observed.
Porosity: Generally uniform paste porosity throughout core, weakly increased towards surface. Opaline paste at surface.
W/c estimated: About 0.45.
Cracks: Few adhesion cracks near surface. Few paste cracks.
Air: Relatively poor air void structure, air content probably on target but air voids are somewhat clustered especially along aggregate and at surfaces.

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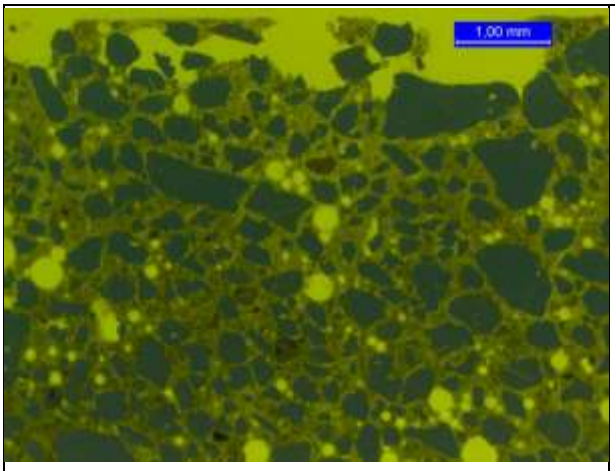
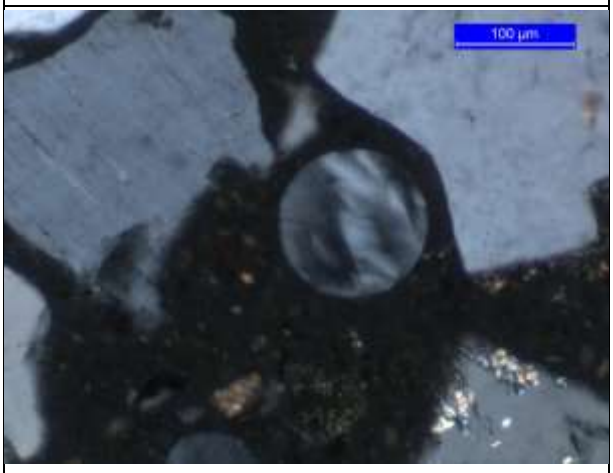
Concrete No. H **Age 2 years**





Micro-observations (2 years images):
Surface: Partly scaled (W) to scaled (E) with exposed aggregate.

Carbonation: Outer 0.2 mm (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. 0.2-0.6 mm (W & E).
2. Popcorn carbonation: from 0.6-1.5 mm (W), from 0.6-1 mm (E).
3. Opaline paste behind popcorn: Not distinct (W), from 1-4 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 8 mm (W), 6 mm (E).

Porosity: Increased porosity in outer 3 mm (W), 2 mm (E).

Cracks: Small brittle micro-cracks in outer leached zone.

Air: Relatively poor structure.

Gypsum: Observed in air voids in the popcorn carbonated zone in both sections.

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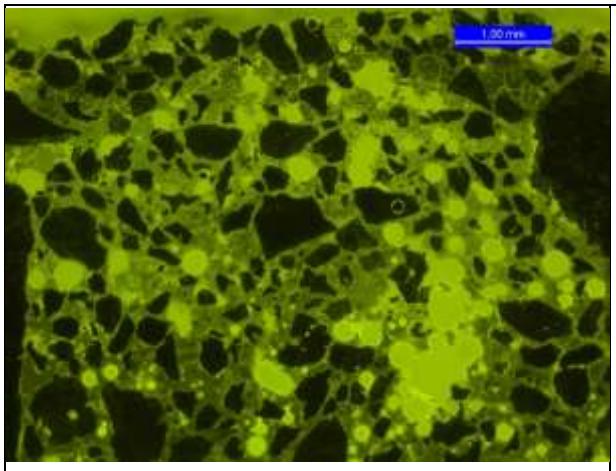
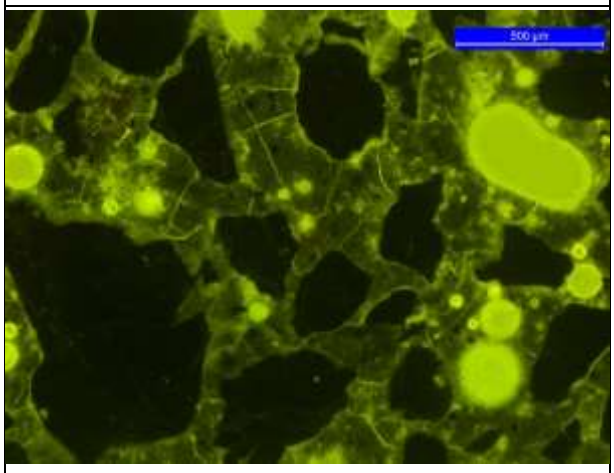
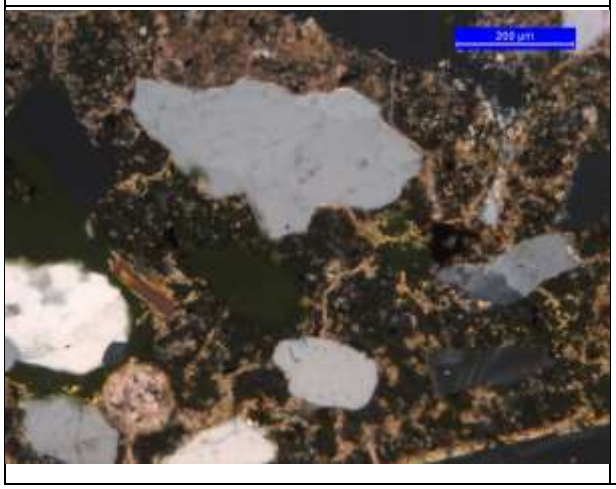
Concrete No. H **Age 5 years**







Micro-observations (5 years images):
Surface: Scaled (W) to partly scaled (E) with exposed aggregate.

Carbonation: Outer 0.4 mm (E), not seen in (W). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, 0-0.6 mm (W), from 0.4-0.6 mm (E).
2. Popcorn carbonation: 0.6-2.6 mm (W), from 0.6-1.2 mm (E).
3. Opaline paste behind popcorn: from 2.6-6 mm (W), from 1.2-7.5 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 10 mm (W), 7 mm (E). The "ettringite" has an orange birefringence.

Porosity: Increased porosity in outer 3 mm.

Cracks: Small brittle paste cracks in outer leached zone.

Air: Relatively poor structure, with some agglomeration.

Gypsum: Not observed.

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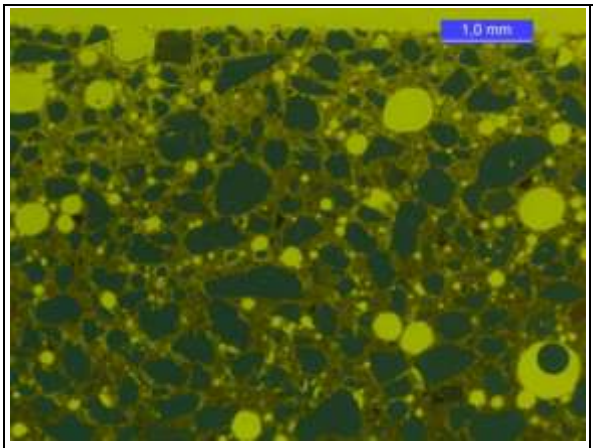
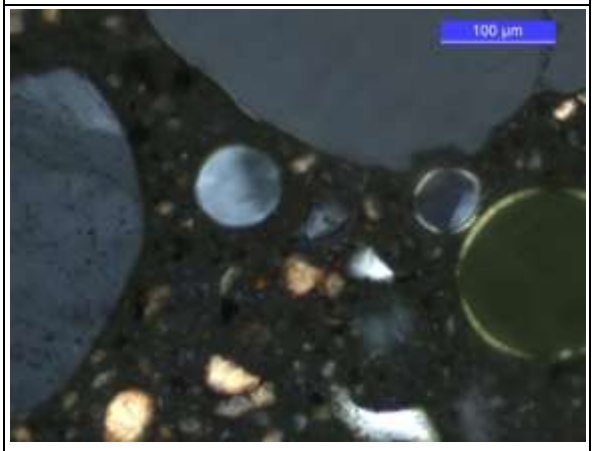
Concrete No. I **Age 6 mth's**





Micro-observations (6 months images)
Surface: Partly scaled with exposed sand grain. Occasionally covered by a calcite crust.

Carbonation: Outer 0.1 mm (W), 0.2 mm (E). Calcite crystals present in air voids. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0.1-0.3 mm (W), from 0.2-0.4 mm (E).
2. Popcorn carbonation: from 0.3-0.4 mm (W), from 0.4-0.5 mm (E).
3. Opaline paste behind popcorn: from 0.4-1.8 mm (W), from 0.5-1.8 mm (E).

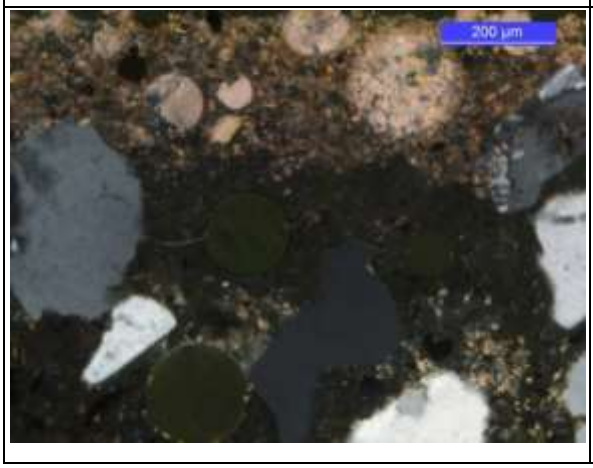
Ettringite: In air voids to 1.5 mm (W), to 1.2 mm (E). Occasionally "ettringite" has an orange birefringence in (E) section.

Porosity: Increased in the outer 1.5 mm (W), 1.2 mm (E).

CH: Relatively large crystals in interior paste and in adhesion defects.

Cracks: Small brittle cracks

Gypsum: Observed in voids positioned in popcorn zone (E).



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer on surface.
Carbonation: Not observed.
Porosity: Generally uniform paste porosity throughout core, weakly increased towards surface. Paste rich area around air clusters.
W/c estimated: About 0.45.
Cracks: Few plastic at surface, few adhesion cracks with CH.
Air: Relatively poor air void structure, air content probably on target but air voids are somewhat clustered especially along aggregate.

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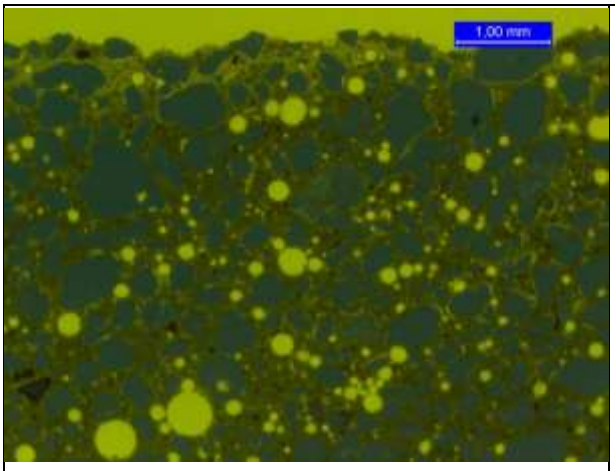
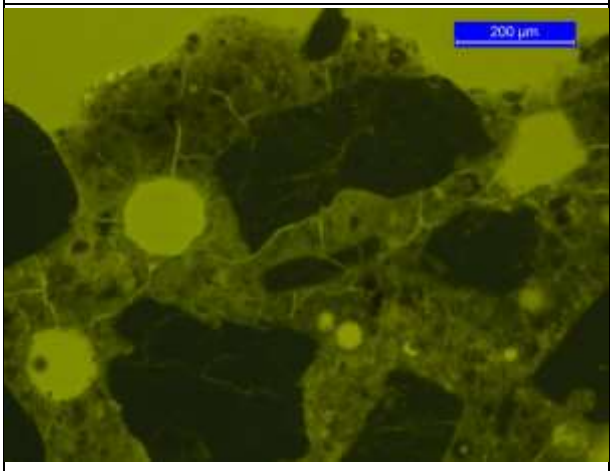
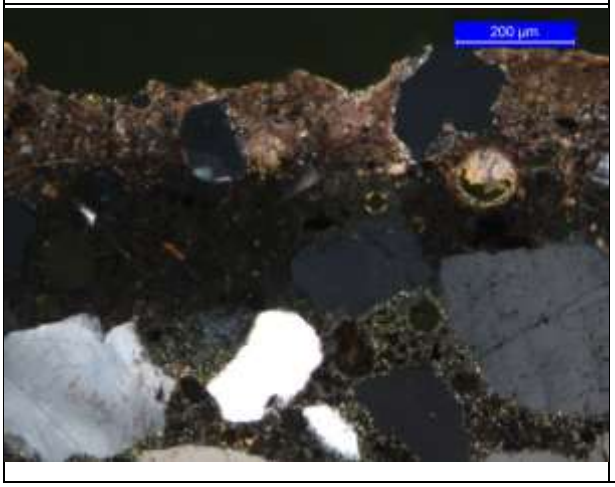
Concrete No. I **Age 2 years**







Micro-observations (2 years images)
Surface: Scaled (W) to partly scaled (E) with exposed sand.

Carbonation: Outer 0.1 mm (W), 0.2 mm (E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0.1-0.4 mm (W), from 0.2-0.6 mm (E).
2. Popcorn carbonation: from 0.4-0.6 mm (W), from 0.6-1.2 mm (E).
3. Opaline paste behind popcorn: from 0.6-1.2 mm (W), from 1.2-2.5 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 3 mm (W), 4 mm (E). An orange birefringence of "ettringite" is occasionally observed.

Porosity: Increased porosity in outer 0.6 mm (W), 1.3 mm (E).

Cracks: Small brittle micro-cracks occurs in the outer leached zone.

Air: Relatively poor structure.

Gypsum: Observed in air voids in the popcorn carbonated zone of both sections.

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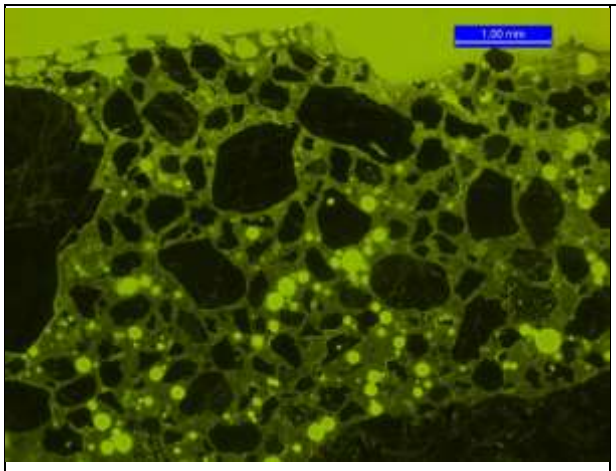
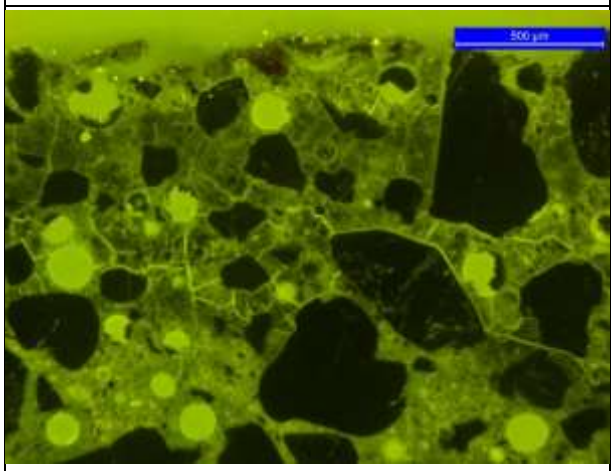
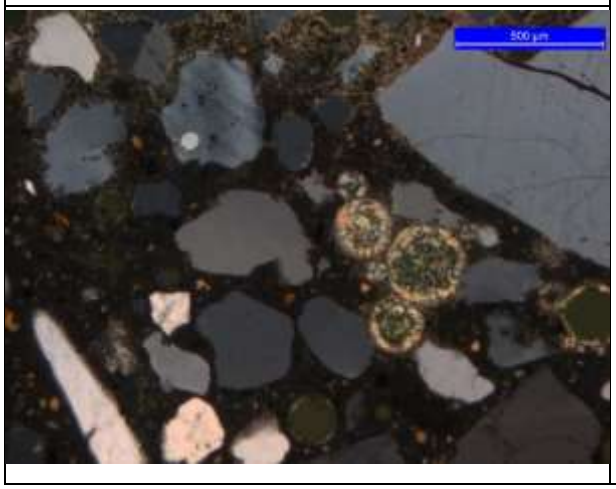
Concrete No. I **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed aggregate, partly covered by a calcite crust.

Carbonation: Outer 0.4 mm (W), not distinct in (E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.4-0.6 mm (W), to 0.2 mm (E).
2. Popcorn carbonation: from 0.6-1.8 mm (W), from 0.2-1.4 mm (E).
3. Opaline paste behind popcorn: from 1.8-4.0 mm (W), from 1.4-6 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 16 mm (W), 12 mm (E). Most of the "ettringite" here has an orange birefringence.

Porosity: Increased porosity in outer 2 mm (W), 1.2 mm (E).

Cracks: Small brittle paste cracks appear in outer leached zone.

Micro-cracks are present in the Opaline paste behind popcorn carbonation.

Air: Relatively poor structure.

Gypsum: Observed in few air voids in both sections.

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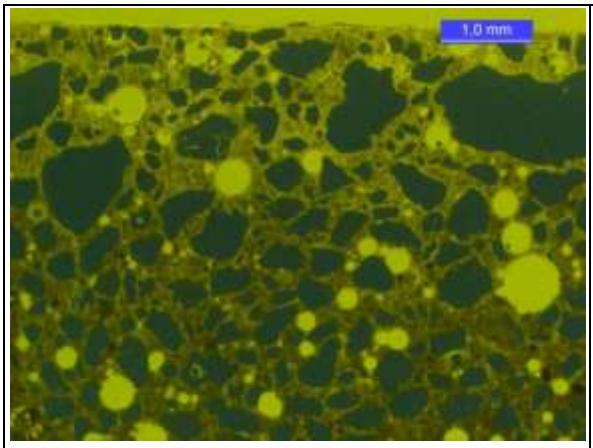
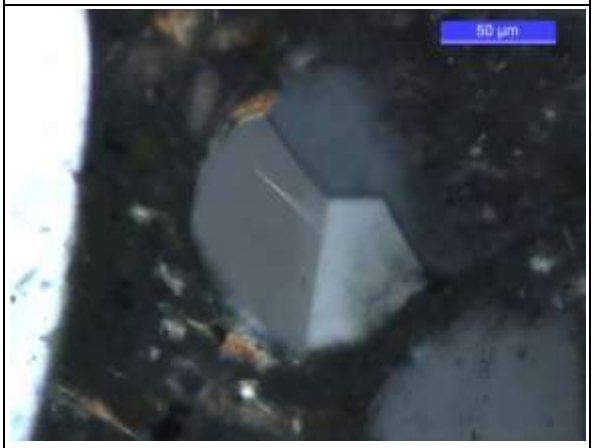
Concrete No. J **Age 6 mth's**





Micro-observations (6 months images)
Surface: Intact (W) to partly scaled (E) with exposed sand grains. Large calcite crystals in voids of carbonated zone.

Carbonation: Outer0.2 mm (W & E). Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

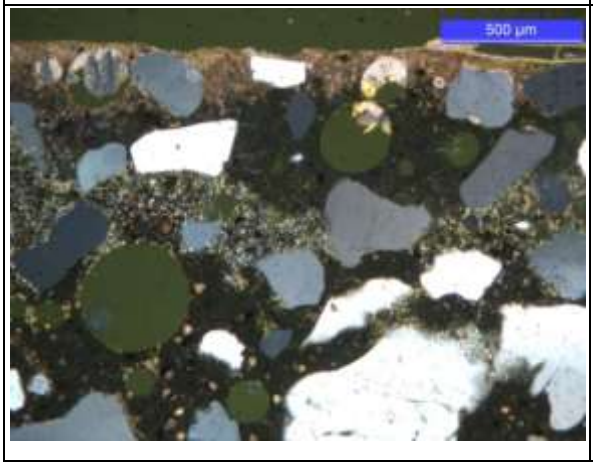
1. Leached zone behind carbonation: from 0.2-0.5 mm (W), from 0.2-0.3 mm (E).
2. Popcorn carbonation: from 0.5-1 mm (W), from 0.3-0.6 mm (E).
3. Opaline paste behind popcorn: from 1-2.5 mm (W), from 0.6—1.5 mm (E).

Ettringite: Observed in air voids to 2 mm (W & E). Occasionally orange birefringence of "ettringite" observed in both sections.

Porosity: Increased to 2.0 mm (W), and 1.2 mm (E).

Cracks: Small brittle micro-cracks in the outer leached zone.

Gypsum: Observed in voids of popcorn zone (W).



Observation (28 days, non-exposed concrete):
Surface: Calcite layer on surface not observed.
Carbonation: Not observed.
Porosity: Generally uniform paste porosity throughout core, weakly increased towards surface.
CH: In adhesion cracks and small air voids.
W/c estimated: About 0.45
Cracks: Some at surface, some adhesion cracks throughout, few paste cracks.
Air: Well distributed air void structure, air content on target.

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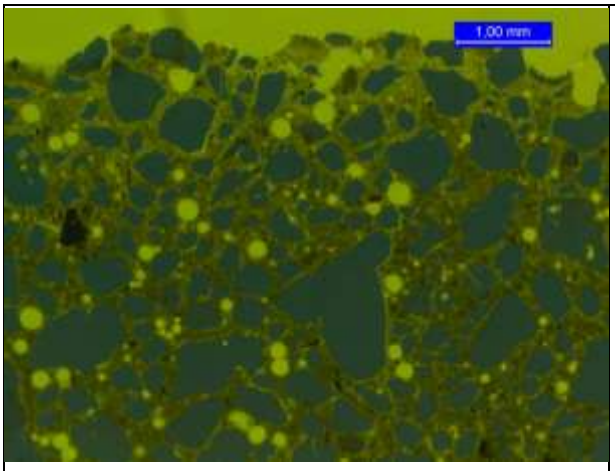
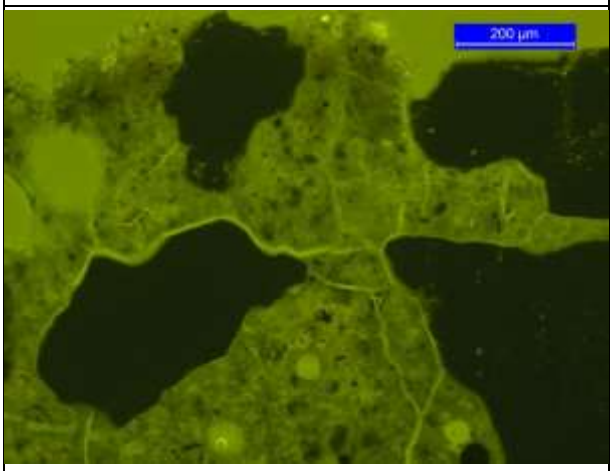
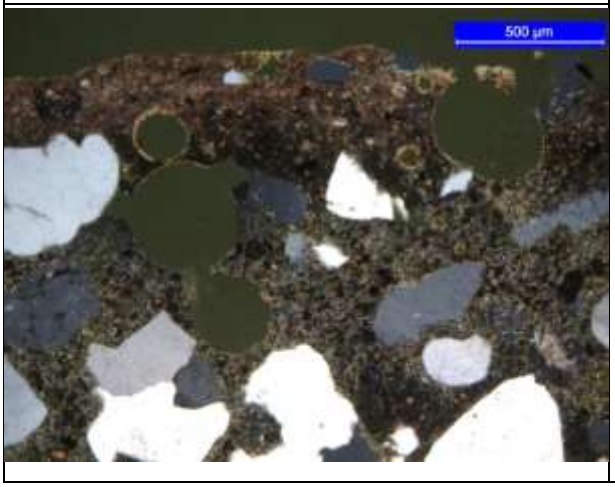
Concrete No. J **Age 2 years**







Micro-observations (2 years images)
Surface: Partly scaled with exposed sand grains.

Carbonation: Outer 0.2 mm (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0.2-0.4 mm (W), from 0.2-0.6 mm (E).
2. Popcorn carbonation: from 0.4-1.5 mm (W), from 0.6-1 mm (E).
3. Opaline paste behind popcorn: Not distinct (W), from 1-3.5 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 6 mm (W), 4 mm (E). Occasionally "ettringite" shows orange birefringence (E).

Porosity: Increased porosity in outer 1 mm (W), 1.2 mm (E).

Cracks: Small brittle micro-cracks in outer leached zone.

Air: Well distributed.

Gypsum: Observed in air voids in the popcorn carbonated zone in both sections.

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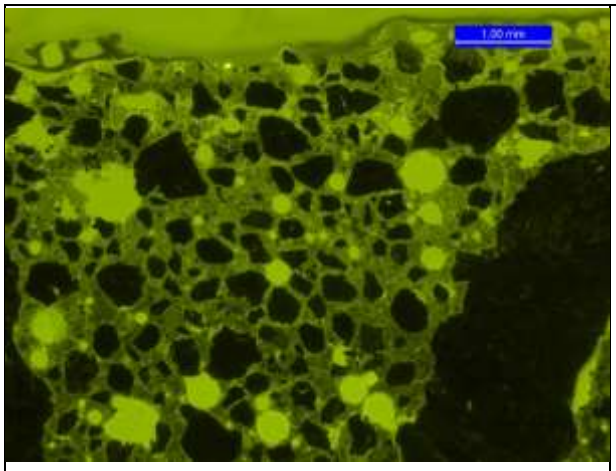
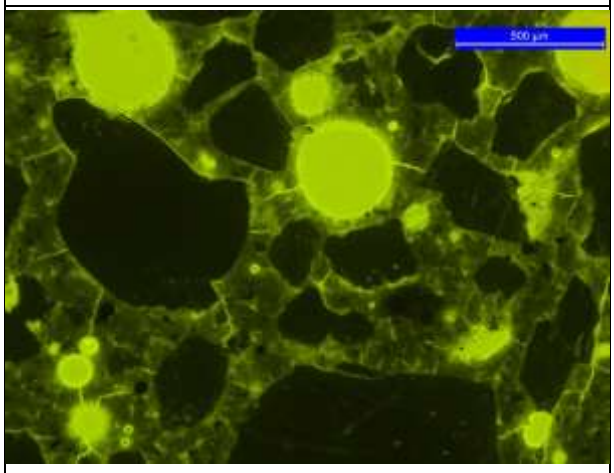
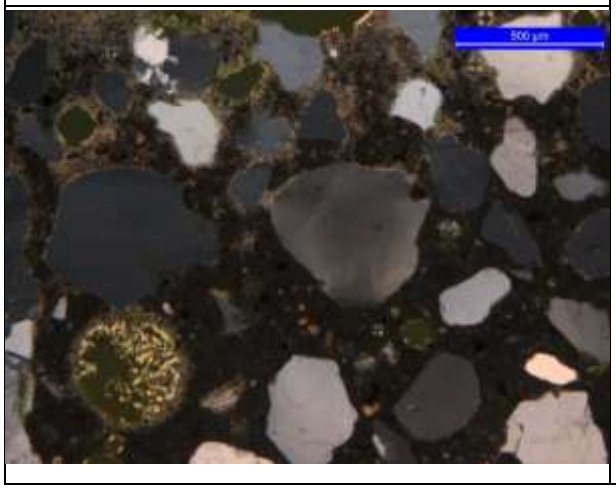
Concrete No. J **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Not distinct. Calcite crystals in voids in the surface region.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0-0.2 mm (W & E).
2. Popcorn carbonation: from 0.2-2 mm (W), from 0.2-2.4 mm (E).
3. Opaline paste behind popcorn: from 2-6 mm (W), from 2.4-6 mm (E).

Ettringite: Observed in voids throughout but most distinct in the outer 7 mm (W), 15 mm (E). Distinct orange birefringence of "ettringite".

Porosity: Increased porosity in outer 2.5 mm (W & E).

Cracks: Small brittle paste cracks in outer leached zone.

Air: Well distributed.

Gypsum: Observed in few air voids in popcorn carbonated zone (E).

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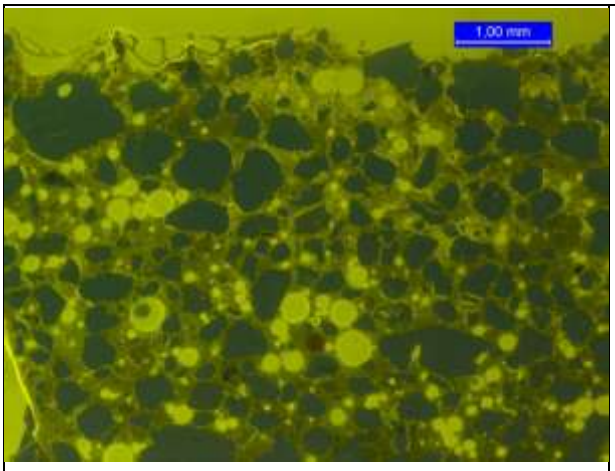
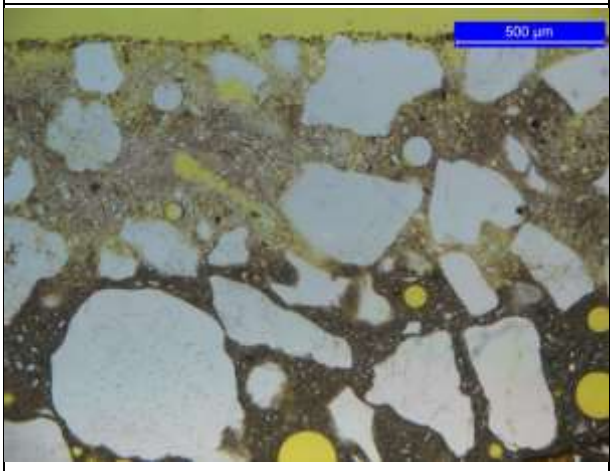
Concrete No. K **Age 6 mth's**





Micro-observations (6 months images):
Surface: Scaled with some exposed sand grains. Occasionally calcite crust on surface.

Carbonation: Not distinct. Calcite crystals in voids of carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

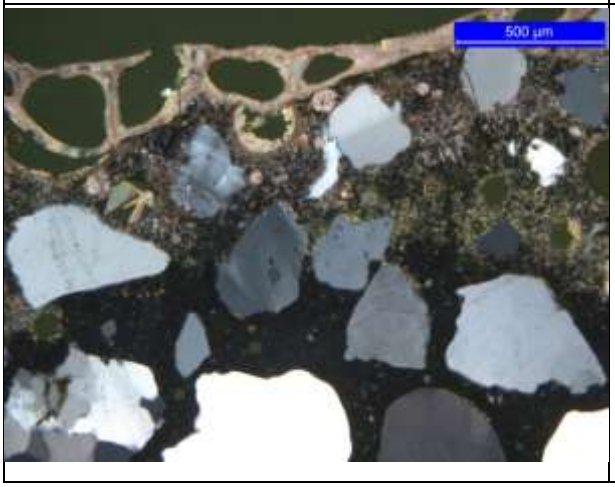
1. Black zone behind carbonation: from 0-0.3 mm (W), from 0-0.2 mm (E).
2. Popcorn carbonation: from 0.3-0.8 mm (W), from 0.2-0.6 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Porosity: The outer 0.6 mm (W), 0.8 mm (E) is porous.

Ettringite: Abundant precipitations of needle shaped ettringite in air voids below carbonation front to max. 3 mm (W), 2 mm (E).

Cracks: Some brittle micro-cracks in outer leached zone. Three surface cracks in West section (crack width <0.01 mm) to depths 0.5. 1 and 2 mm. One surface crack in East section to 3 mm.

Air: Uneven distributed.



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer at surface. Feathery phases in voids exposed at surface.
Carbonation: Not observed.
Porosity: Generally inhomogeneous paste porosity throughout core (patchy). Distinctly increased porosity towards surface.
W/c estimated: About 0.45
Cracks: None at surface, some paste cracks in the interior.
Air: Uneven distributed, air content probably on target but air voids are somewhat clustered especially along aggregate.

Greenish paste at interior, light grey at surface.

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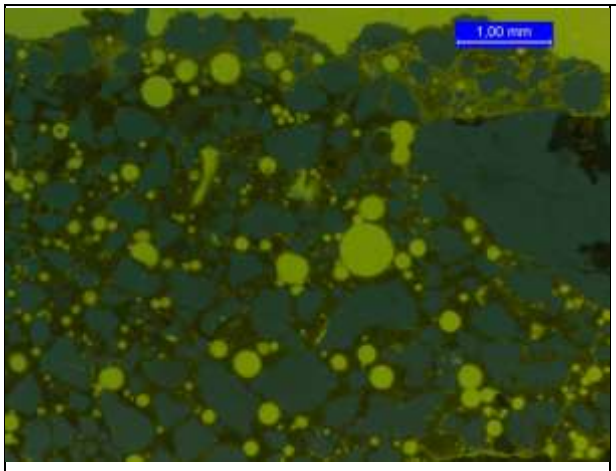
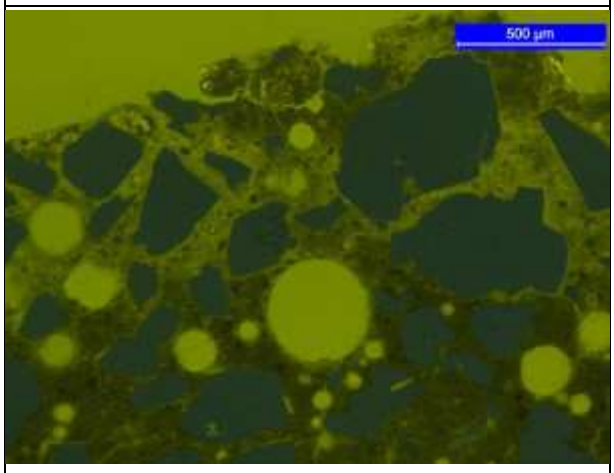
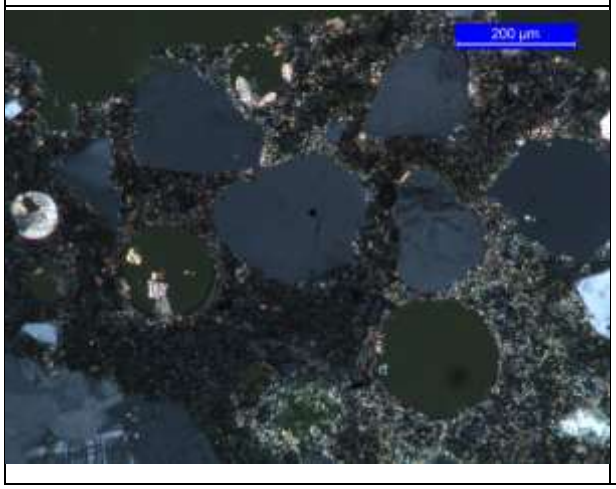
Concrete No. K **Age 2 years**







Micro-observations (2 years images):
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.1 mm (W & E). Calcite crystals in voids in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct, from 0.1-0.4 mm (W), from 0.1-0.6 mm (E).
2. Popcorn carbonation: from 0.4-0.8 mm (W), from 0.6-1.2 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in voids throughout but most distinct in the outer 10 mm (W & E). Orange birefringence of "ettringite" is observed.

Porosity: Distinct increased porosity in outer 0.8 mm (W), 1 mm (E).

Cracks: Small brittle micro-cracks in the outer leached zone.

Air: Uneven distributed.

Gypsum: Observed in few air voids in both sections.

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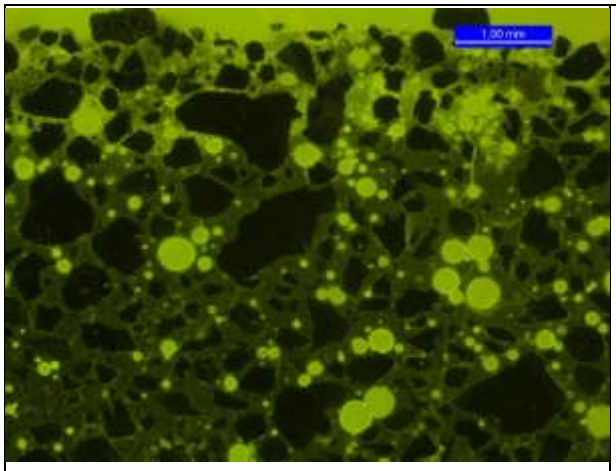
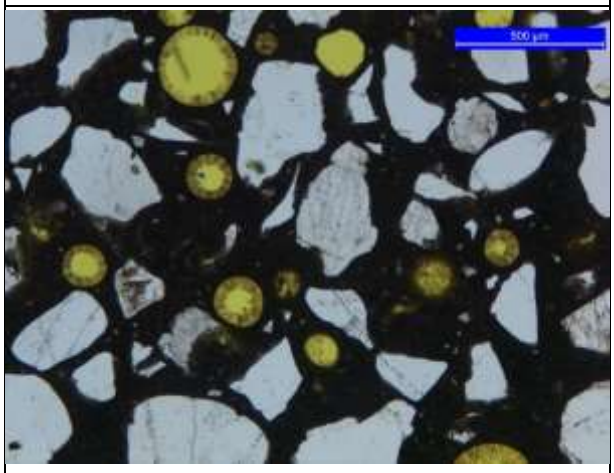
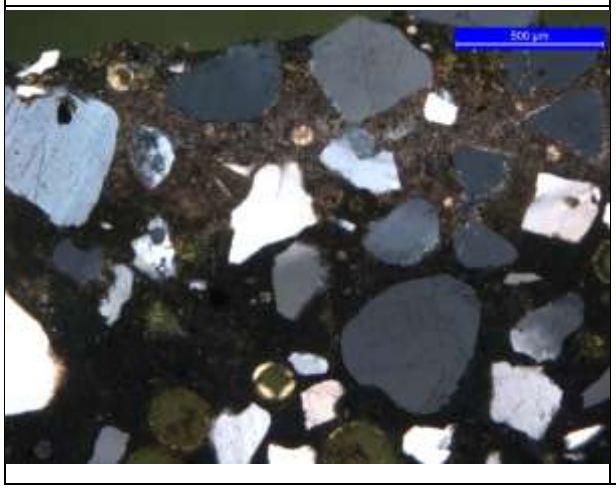
Concrete No. K **Age 5 years**







Micro-observations (5 years images):
Surface: Scaled with exposed sand grains.

Carbonation: Not observed. Calcite crystals in voids in the surface region.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: Distinct. From 0-0.2 mm (W & E).
2. Popcorn carbonation: from 0.2-1.2 mm (W & E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in voids throughout but most distinct in the outer 14 mm (W), 12 mm (E). Occasionally orange birefringence of "ettringite" observed.

Porosity: Increased porosity in outer 1.5 mm (W & E).

Cracks: Small brittle paste cracks in outer leached zone.

Air: Uneven distributed.

Gypsum: Observed in few air voids in both sections.

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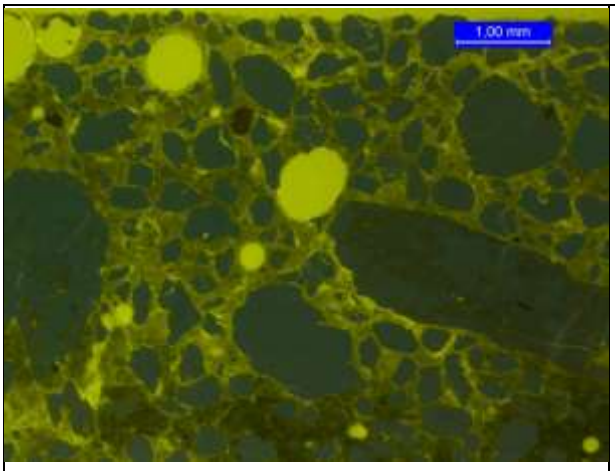
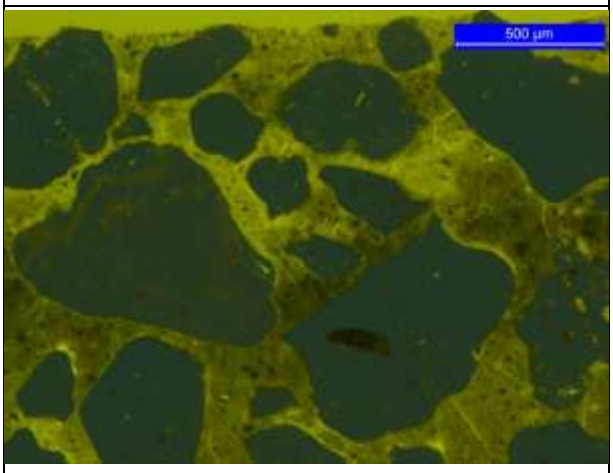
Concrete No. L **Age 6 mth's**





Micro-observations (6 months images):
Surface: Partly scaled with exposed sand grains.

Carbonation: Not observed. Calcite crystals in air voids of near surface.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.1 mm (W & E).
2. Popcorn carbonation: from 0.1-0.5 mm (W & E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

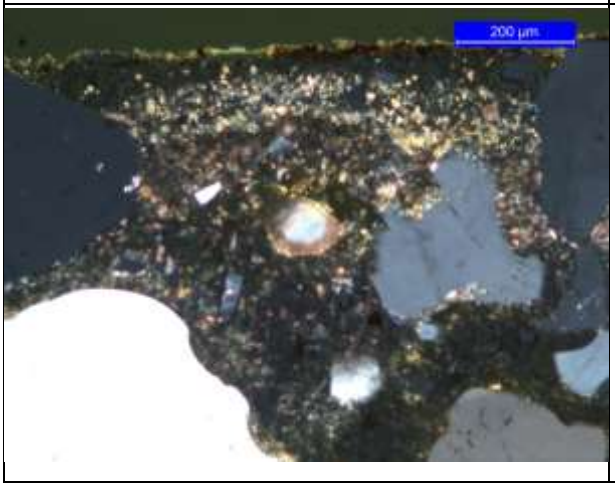
Porosity: The outer 0.8 mm (W), 0.7 mm (E) is highly porous.

Ettringite: Minor observed behind the popcorn carbonated zone.

CH: Some precipitation in air voids.

Cracks: Few brittle cracks observed in the outer leached zone. Many adhesion cracks in outer 5 mm of the West section and in the outer 3.5 mm of the East section.

Air: Low; not entrained.



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer present at surface.
Carbonation: Not observed.
Porosity: Generally inhomogeneous paste porosity throughout core. Porosity increases towards surface.
W/c estimated: About 0.40
Cracks: Some adhesion cracks, especially near surface.
Sign of bleeding pockets.
Air: Low; not entrained

Greenish paste at interior. light grey at surface

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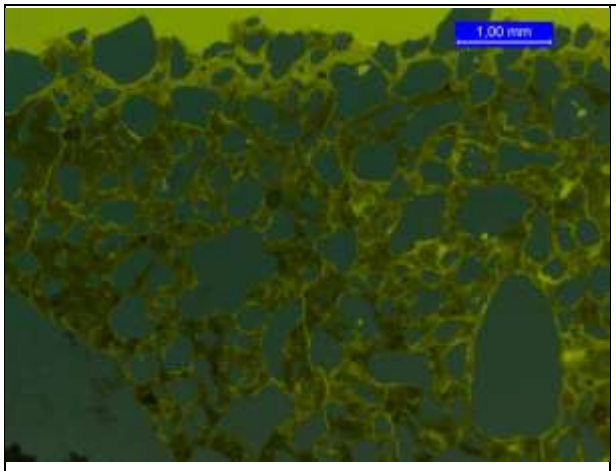
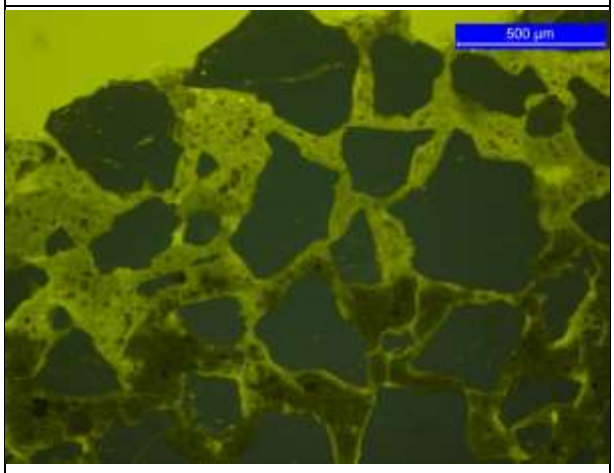
Concrete No. L **Age 2 years**





Micro-observations (2 years images):
Surface: Scaled with exposed sand grains.

Carbonation: Not observed.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.4 mm (W&E).
2. Popcorn carbonation: from 0.4-1 mm (W), from 0.4-0.8 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in air voids mostly in outer 2 mm.

Porosity: Distinct increased porosity in outer 1 mm.

Cracks: Small brittle paste cracks in outer leached zone. Some paste cracks and adhesion cracks present near the surface.

Air: Low, not entrained.

Gypsum: Not observed.

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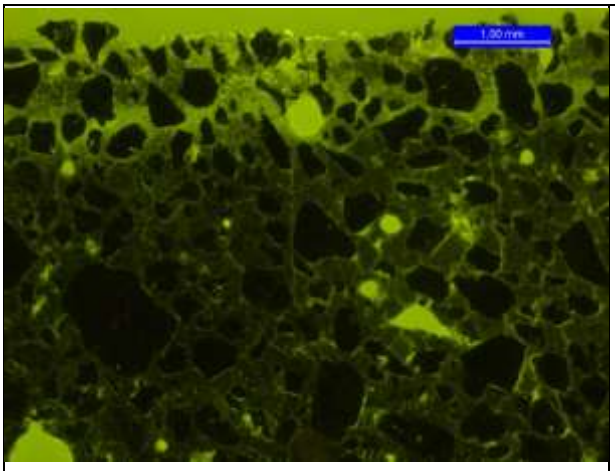
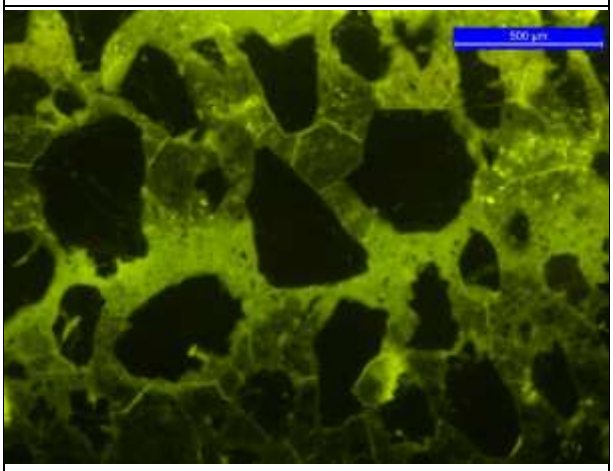
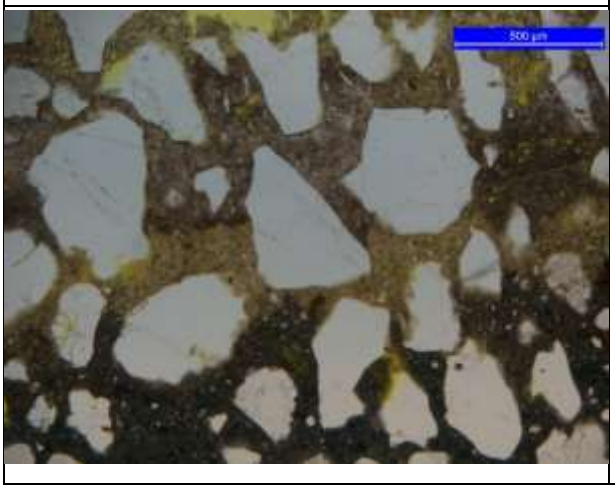
Concrete No. L **Age 5 years**







Micro-observations (5 years images):
Surface: Scaled with exposed sand grains.

Carbonation: Not observed.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.2 mm (W&E).
2. Popcorn carbonation: from 0.2-1.2 mm (W), from 0.2-0.8 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in voids mostly in outer 4 mm.

Porosity: Increased porosity in outer 1.2 mm.

Cracks: Small brittle paste cracks in outer leached zone. Some cracking, adhesion in the surface region.

Air: Low, not entrained.

Gypsum: Not observed.

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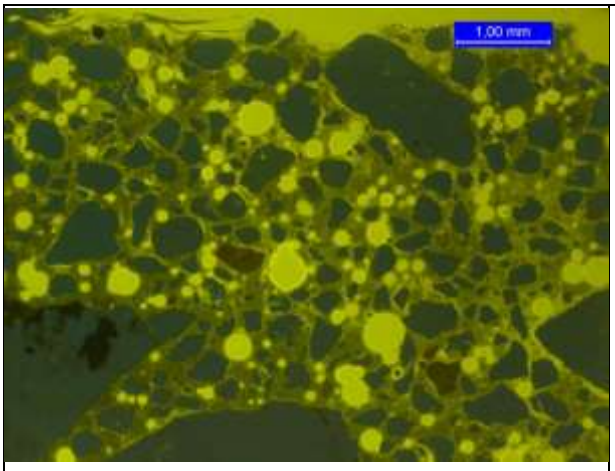
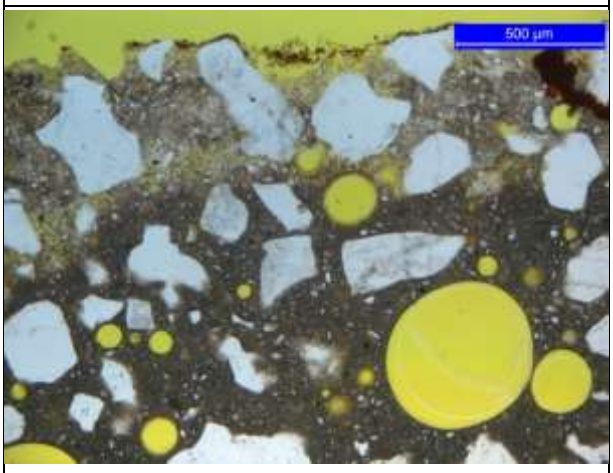
Concrete No. M **Age 6 mth's**





Micro-observations (6 months images)
Surface: Scaled with exposed sand grains. Occasionally covered by a calcite crust. Biological growth at surface.

Carbonation: Not observed. Calcite crystals in voids of near surface.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.1 mm (W), from 0-0.4 mm (E).
2. Popcorn carbonation: from 0.1-0.6 mm (W), 0.4m-0.6 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

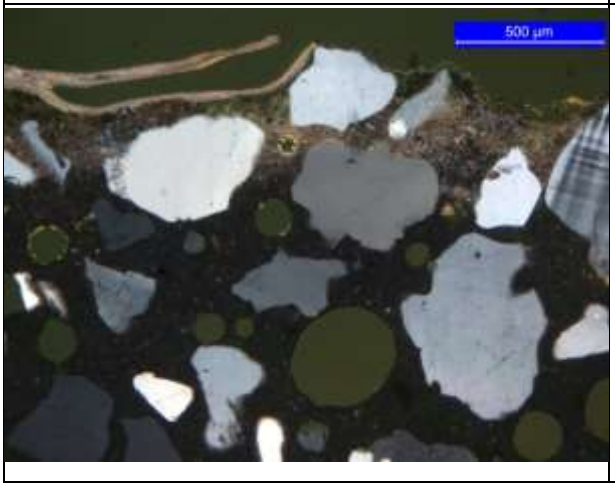
Porosity: The outer 0,4 mm (W), 0.6 mm (E) is highly porous.

Ettringite: Abundant needle shaped ettringite in air voids below popcorn front to4 mm (W), 2 mm (E).

Cracks: Some small brittle micro-cracks in the outer leached zone. Two surface cracks in West section (crack width <0.01 mm) to depths 3 and 7 mm. Two surface cracks in East section to 3 mm.

Air: Well distributed.

Gypsum: Not observed.



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer at surface.
Carbonation: Not observed.
Porosity: Generally inhomogeneous paste porosity.
Porosity distinctly increases towards surface.
W/c estimated: About 0.40
Cracks: None at surface or inside concrete.
Air: Well distributed air void system.

Distinct greenish paste at interior, light grey at surface (outer 24 mm).

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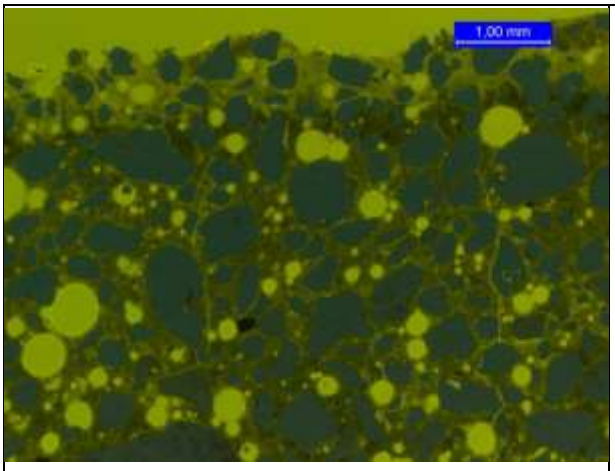
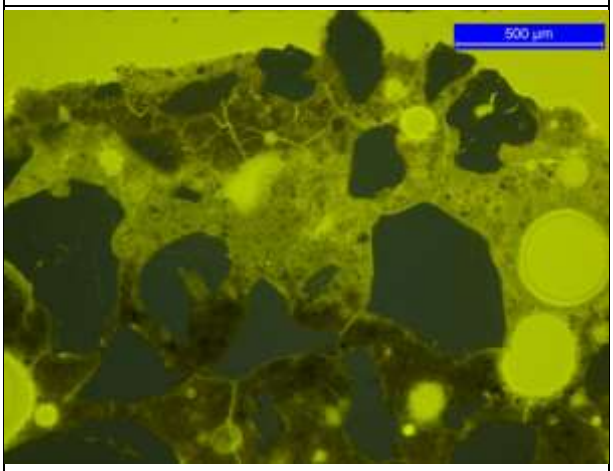
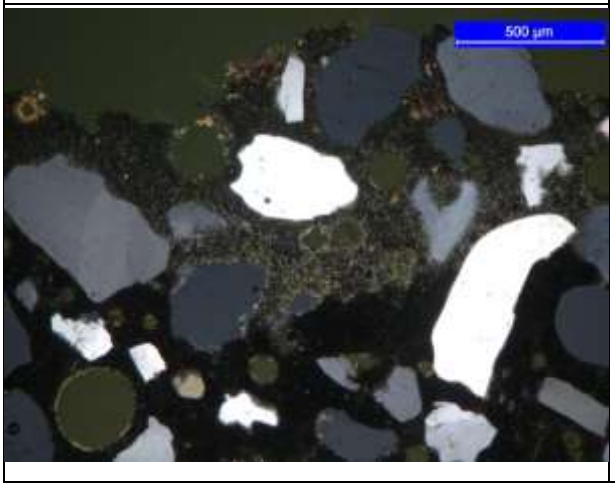
Concrete No. M **Age 2 years**







Micro-observations (2 years images):
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.2 mm (W), 0.1 mm (E).

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0.2-0.6 mm (W), from 0.1-0.6 mm (E).
2. Popcorn carbonation: from 0.6-1 mm (W), from 0.6-1.2 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in air voids mostly in the outer 7 mm (W), 4 mm (E). Occasionally "ettringite" appears with an orange birefringence (W).

Porosity: Increased porosity in outer 1 mm.

Cracks: Small brittle micro-cracks in outer leached zone. Some paste cracks and adhesion cracks in the surface region.

Air: Well distributed.

Gypsum: Not observed.

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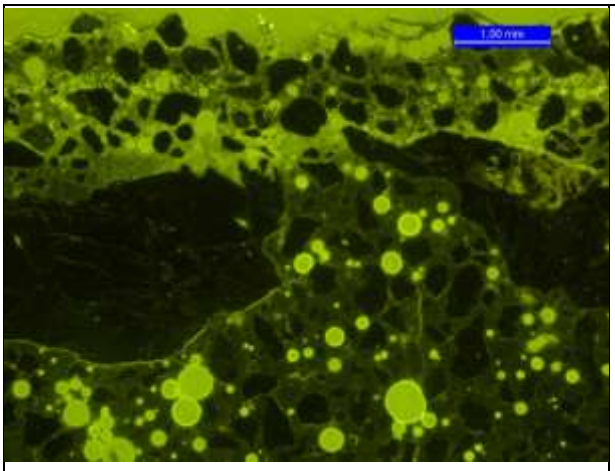
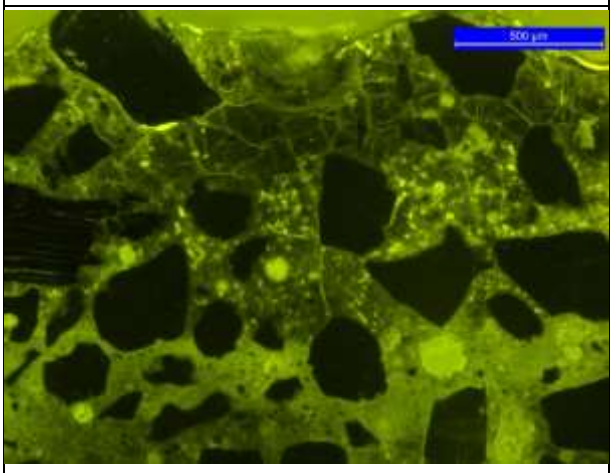
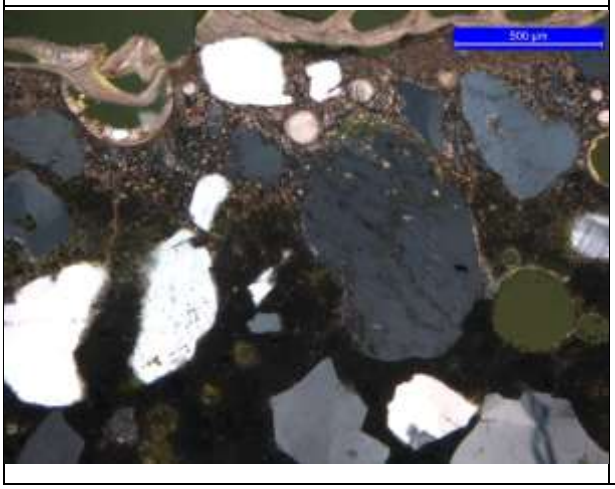
Concrete No. M **Age 5 years**







Micro-observations (5 years images):
Surface: Scaled with exposed sand grains. Occasionally covered by a calcite crust.

Carbonation: Not present.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0-0.2 mm (W&E).
2. Popcorn carbonation: from 0.2-1 mm (W), from 0.2-0.8 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in voids mostly in the outer 12 mm. Occasionally "ettringite" has an orange birefringence.

Porosity: Increased porosity in outer 1.5 mm (W), 1.2 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. Some cracking, adhesion in the surface region.

Air: Well distributed.

Gypsum: Not observed.

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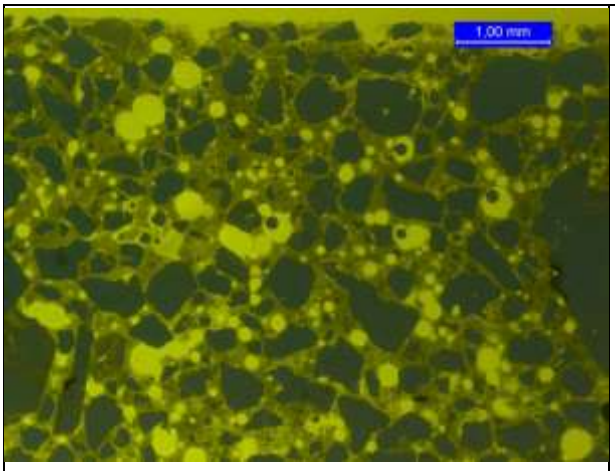
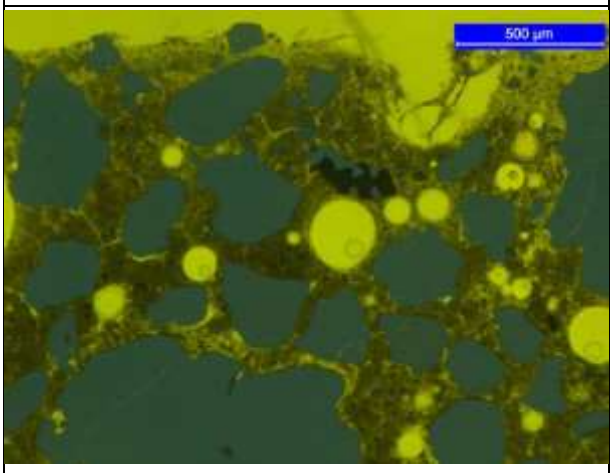
Concrete No. N **Age 6 mth's**





Micro-observations (6 months images)
Surface: Scaled with exposed sand grains.

Carbonation: Not observed. Calcite crystals present in voids near surface. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

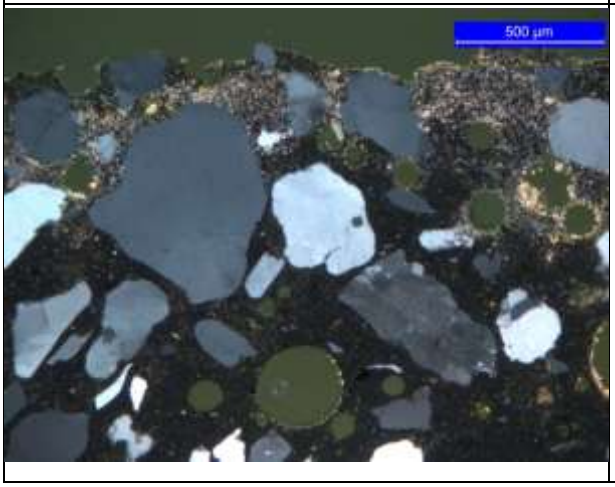
1. Leached zone behind carbonation: from 0-0.2 mm (W), from0-0.1 mm.
2. Popcorn carbonation: from 0.2-0.5 mm (W), from 0.1-0.6 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Porosity: The outer 0.4 mm is highly porous.

Ettringite: Some needle shaped ettringite in air voids below popcorn carbonation 2 mm.

Cracks: Brittle micro-cracks in the outer leached zone.

Air: Well distributed.



Observation (28 days, non-exposed concrete):
Surface: Thin calcite layer at surface.
Carbonation: Not observed.
Porosity: Generally inhomogeneous paste porosity.
Porosity distinctly increases towards surface.
W/c estimated: About 0.40
Cracks: None at surface, some adhesion cracks observed in the interior.
Air: Well distributed air void system.

Distinct greenish paste at interior, light grey at surface (outer 30 mm)

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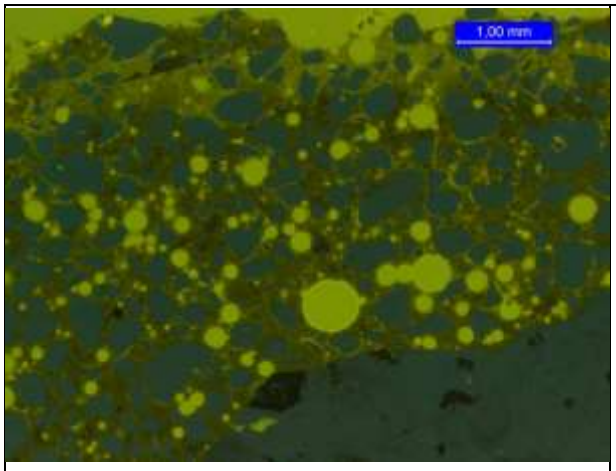
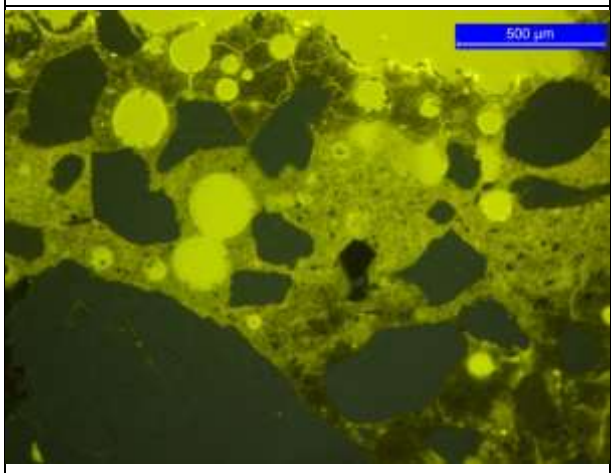
Concrete No. N **Age 2 years**





Micro-observations (2 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.1 mm. Calcite crystals present in air voids.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: from 0.1-0.6 mm (W&E).
2. Popcorn carbonation: from 0.6-1 mm (W&E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in air voids mostly in the outer 10 mm (W), 12 mm (E). Orange High birefringence of "ettringite" is occasionally seen in W section.

Porosity: Increased porosity in outer 1 mm (W) and 1.2 mm (E).

Cracks: Small brittle micro-cracks in the outer leached zone. Some paste and adhesion cracks in the surface region.

Air: Well distributed.

Gypsum: Observed in few air voids in W section.

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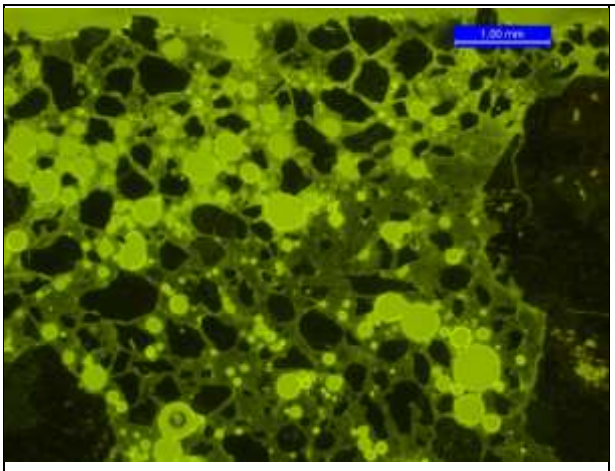
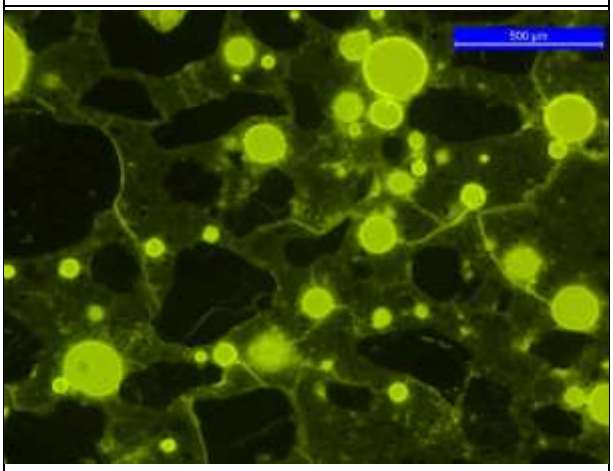
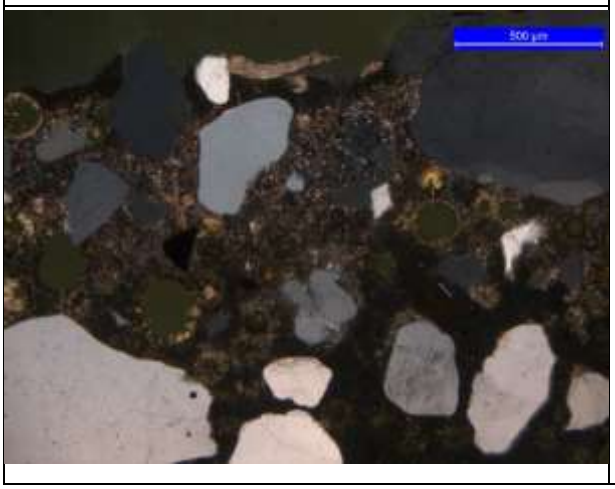
Concrete No. N **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed sand grains. Occasionally a calcite crust is observed.

Carbonation: Not observed.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: 0-0.2 mm (W&E).
2. Popcorn carbonation: from 0.2-1.2 mm (W), from 0.2-0.8 mm (E).
3. Opaline paste behind popcorn: Not possible to see due to very dark paste.

Ettringite: Observed in voids mostly in the outer 10 mm (W), 12 mm (E). Occasionally orange birefringence of "ettringite" in section E.

Porosity: Increased porosity in outer 2.5 mm (W), 1.2 mm (E).

Cracks: Small brittle paste cracks in outer leached zone. Some cracking, adhesion in the surface region.

Air: Well distributed.

Gypsum: Observed in few air voids in E section.

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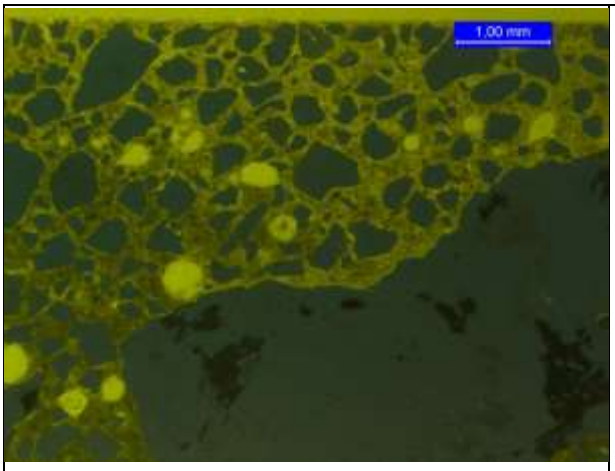
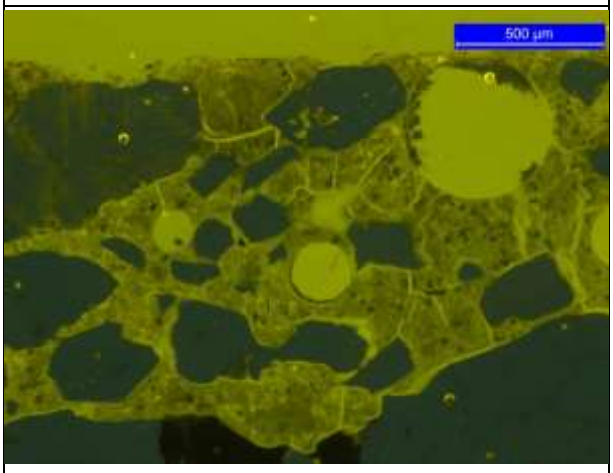
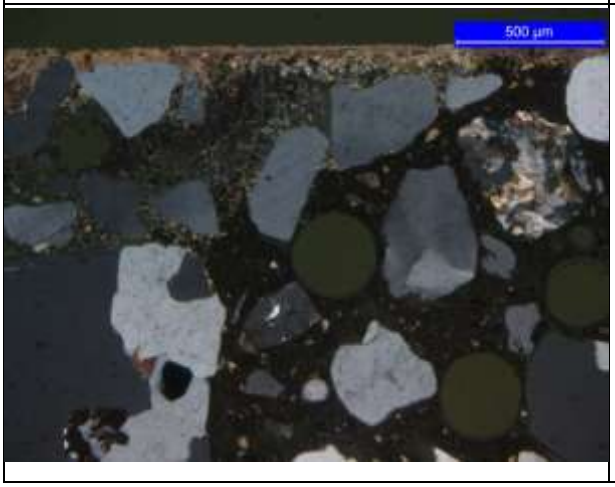
Concrete No. O **Age 6 mth's**







Micro-observations (6 months images)
Surface: Intact (W) to partly scaled (E). Occasionally a calcite crust is observed.

Carbonation: Carbonated paste to 0.2 mm. Calcite crystals in voids of carbonated zone. Rusty spots present in carbonated zone.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Leached zone behind carbonation: from 0.2-0.4 mm (W), from 0.2-0.5 mm (E).
2. Popcorn carbonation: from 0.4-0.8 mm (W), from 0.5-0.6 mm (E).
3. Opaline paste behind popcorn: from 0.8-2 mm (W), from 0.6-2 mm (E).

Ettringite: Some needle shaped ettringite in air voids below popcorn carbonation to 4 mm.

Cracks: High number of brittle micro-cracks in the outer leached zone.

Air: Air voids are lined with a membrane.

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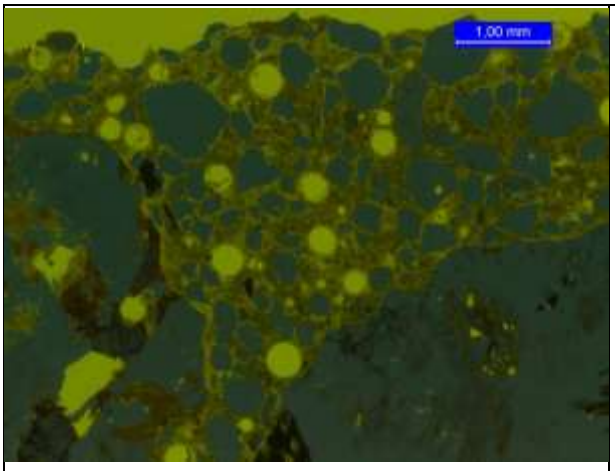
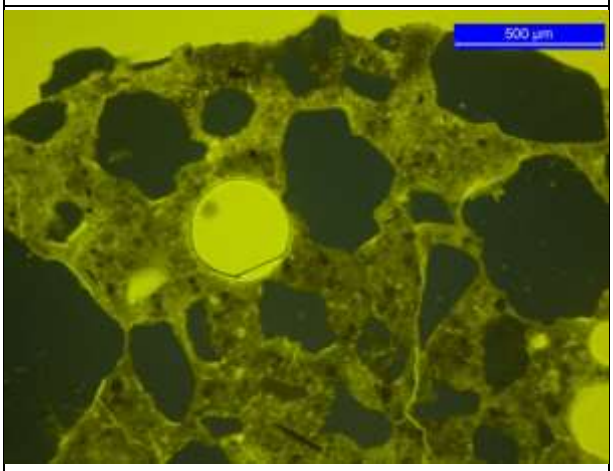
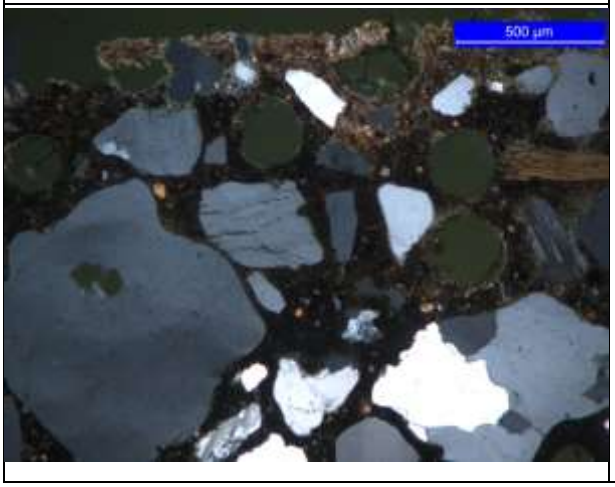
Concrete No. O **Age 2 years**







Micro-observations (2 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.4 mm.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:

1. Black zone behind carbonation: not observed.
2. Popcorn carbonation: from0.4-0.8 mm (W), from 0.4-0.6 mm (E).
3. Opaline paste behind popcorn: from 0.8-2 mm (W), from 0.6-1.5 mm.

Ettringite: Ettringite: Some needle shaped ettringite in air voids below popcorn carbonation to 4 mm.

Porosity: Not distinct.

Cracks: Only few in paste.

Air: Air voids are lined with a membrane.

Gypsum: Not observed.

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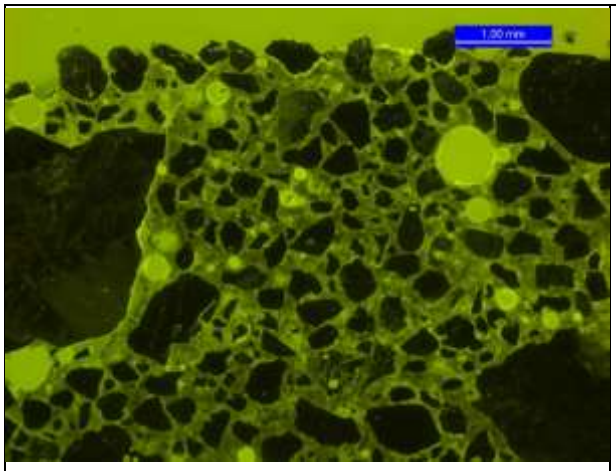
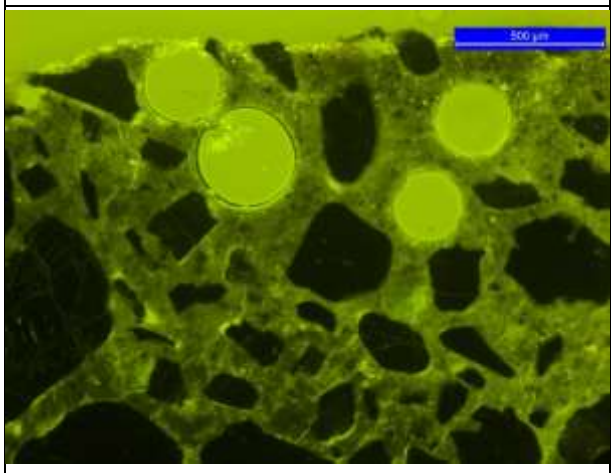
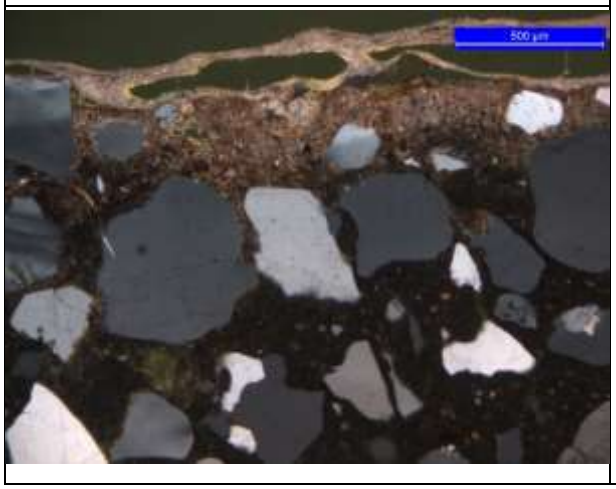
Concrete No. O **Age 5 years**







Micro-observations (5 years images)
Surface: Scaled with exposed sand grains.

Carbonation: Outer 0.4 mm.

Based on the structural appearance, the outermost surface region can be divided into 3 zones:
1. Black zone behind carbonation: Not distinct.
2. Popcorn carbonation: Not distinct.
3. Opaline paste behind popcorn: from 0.4-3 mm (W), 0.4-4 mm (E).

Ettringite: Ettringite: Some needle shaped ettringite in air voids below popcorn carbonation to 4 mm.

Porosity: Not distinct.

Cracks: Few adhesion in the surface near region.

Air: Air voids are lined with a membrane.

Gypsum: Observed in few air voids in section E.