Terminology of damage

RILEM – TC-ASC Salt crystallisation test

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Goal RILEM ASC

Develop realistic accelerated salt crystallization test

-stone, brick, mortar, plaster and combinations

-salt load, specimen size

-damage description + qualification

RILEM ASC Salt Damage Atlas?

Review existing atlases

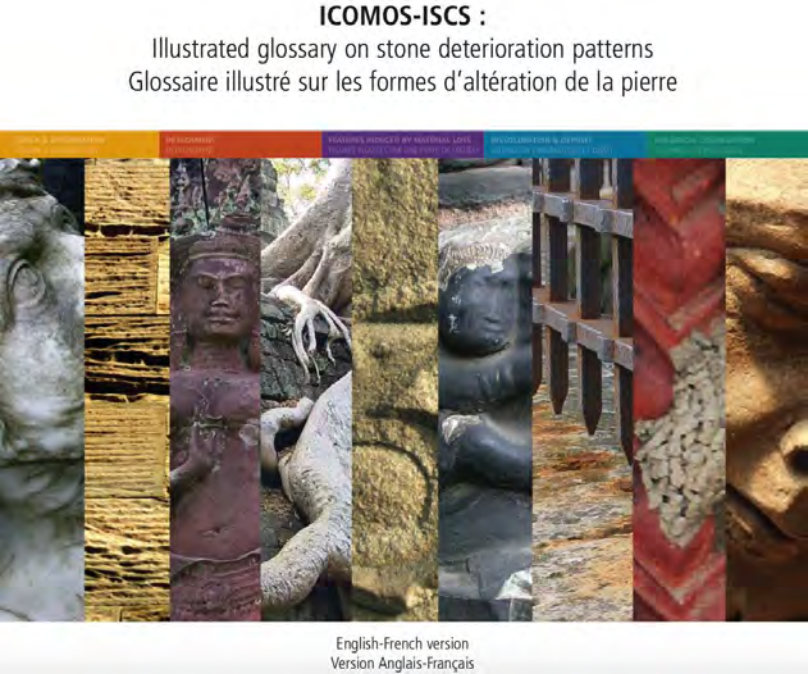
ICOMOS – Stone

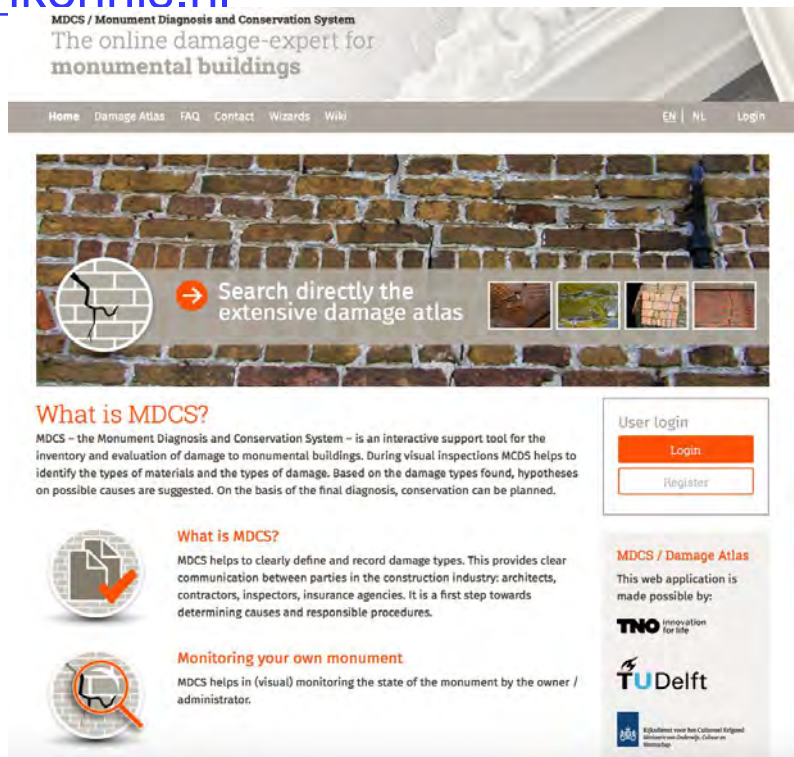
MDCS – Stone, Brick, Mortar, Plaster

Damage Atlases

Icomos – glossary stone deterioration → iscs.icomos.org/glossary.html

MDCS – different materials and structures → (interactive) → https://mdcs.monumentenkennis.nl





Both MDCS & ICOMOS considered

Table 1 - Overall c ntext of salt decay

	MDCS	ICOMOS
Materials addressed	Porous building materials (brick, stone, bedding/pointing/repair mortars and plaster/render mortars). Also, although not explicitly, systems composed by two porous materials or by porous materials and a paint/coating.	Natural stone. Note: definitions are often detailed and too specific to be directly applicable to the wide range of porous building materials that can be object of the RILEM salt crystallization test.
Damage patterns possibly relevant to salt decay	• Disintegration ○ Layering (brick, stone) ■ **delamination** ■ **exfoliation** ■ **spalling** ■ **scaling** ○ Loss of cohesion ■ **crumbling** (brick) ■ **sanding** (stone, mortar) ■ **powdering** (brick) ■ **chalking** (stone) ■ **bursting** (mortar) ■ **voids** (bedding mortar) ■ **alveolization** (brick) ■ **erosion** (stone) - **alveolization** - **selective weathering** ○ Detachment (material systems) ■ **loss of adhesion** (mortar) ■ **blistering** (paint/coating)	• Crack and deformation ○ **Crack** (relevant subtypes: ***fracture***, ***hair crack***, ***splitting***) ○ **Deformation** • Detachment ○ **Blistering** ○ **Bursting** ○ **Delamination** (relevant subtype: ***exfoliation***) ○ **Disintegration** (relevant subtypes: ***crumbling***, ***granular disintegration***, the later divided into ***powdering***, ***chalking***, ***sanding***, ***sugaring***) ○ **Fragmentation** ○ **Peeling** (relevant subtypes: ***flacking***, ***contour scaling*** / ***spalling***) • Material loss ○ **Alveolization** ○ **Erosion** (relevant subtype: ***differential***

Result

- Rather comparable damage types in two atlases, sometimes alternative name
- 30 different types of damage applicable (salt crystallization)
- Different types of efflorescence ?

Proposal

- No new (RILEM ASC) salt damage atlas
- But: provide easy access to existing atlases / photos
- Reduce no. types with ca 50%
- Limited no. types of efflorescence (photos)

Long crystals	Powdery	Cauliflower	Crust
			

	Damage type	References
Surface change		
1	Chromatic alteration (incl. fading, moist spots, staining, discoloration)	**Icomos (stone)** https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf **MDCS (brick, mortar, stone, plaster)** https://mdcs.monumentenkennis.nl/damageatlas/2/category https://mdcs.monumentenkennis.nl/damageatlas/248/category https://mdcs.monumentenkennis.nl/damageatlas/100/category https://mdcs.monumentenkennis.nl/damageatlas/58/category
2	Efflorescence (incl. salt crust –adherent layer, fluffy –easily brushed off)	**Icomos (stone)** https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf **MDCS (brick, mortar, stone, plaster)** https://mdcs.monumentenkennis.nl/damageatlas/10/category .....
3	Subflorescence / Cryptoflorescence	
Layering		
4	Exfoliation / Delamination	
5	Spalling	
6	Scaling / Flaking	
Loss of cohesion		
7	Crumbling	
8	Granular disintegration (incl. sanding, sugaring, powdering, chalking, selective weathering, alveolisation)	
9	Bursting	
10	Brick-blistering	
Detachment		
11	Loss of adhesion	
12	Peeling (of paint)	
13	Blistering (of paint)	
14	Push out	
Cracking		
15	Crack (width *x* mm)	
16	Crazing / craquelé	
Deformation		
17	Bulging	

Damage types
From 30 → 17

	Damage type	References
Surface change		
	1 Chromatic alteration (incl. fading, moist spots, staining, discoloration)	**Icomos (stone)** https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf **MDCS (brick, mortar, stone, plaster)** https://mdcs.monumentenkennis.nl/damageatlas/2/category https://mdcs.monumentenkennis.nl/damageatlas/248/category https://mdcs.monumentenkennis.nl/damageatlas/100/category https://mdcs.monumentenkennis.nl/damageatlas/58/category
	2 Efflorescence (4 types; see photos)	
	3 Subflorescence / Cryptoflorescence	
Layering		
	4 Exfoliation / Delamination	**Icomos (stone)** https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf **MDCS (brick, mortar, stone, plaster)** … … https://mdcs.monumentenkennis.nl/damageatlas/114/category#overview …
	5 Spalling	

Delaminati
gravestone p
from frost ac

Délitage d'
en grès pouv
l'action du g

Scotland, Bre
Cathedral Gra
meter wide sl
Ref IW 31 / I.

ICOMOS Stone Atlas

Natural stone » Disintegration » Layering » Delamination

Layering (more than one layer) of material with an originally laminated structure. Layering is parallel to the original bedding plane (form Latin: 'lamina, laminae').

MDCS Damage Atlas

Possible causes

Delamination can occur in materials with an originally laminated structure and it can be the result of a salt crystallization process and/or frost action.

Salt crystallization can take place in the presence of both soluble salts and moisture.

Frost action can occur under the following combination of conditions: (i) frost sensitive material; (ii) high moisture content in the material; (iii) sudden drop of temperature below freezing point.

Delamination, red sandstone, building neasr the Our Lady church, Trier, Germany

Current state of affairs: try-out damage description & qualification

Table-examples_*summary (of 6)*

Photo	Damage type	Salt efflorescence type	Severity (1-4* = low to high)	Extension (surface area) (1-4 x, 0-100%)
	Efflorescence 4x Blistering 3x Bulging 1x	Efflorescence 4x (crust 3x; powdery 2x)	1-4	65-100%
	Efflorescence 6x Bursting 1x Scaling 1x Spalling 1x	Efflorescence 6x (cauliflower 3x; crust 2x)	3-4	40-100%
	Efflorescence 2x Bulging 4x	Efflorescence 2x (crust 1x; powdery	3-4	100%

Thank You