

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

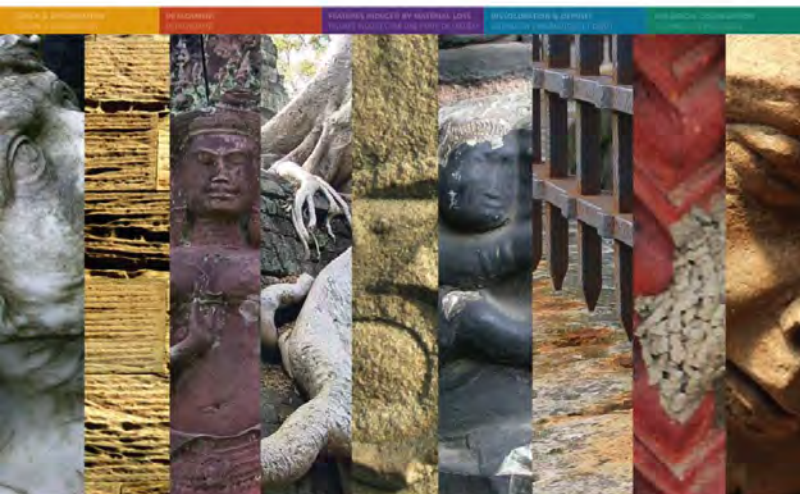
Damage Atlases

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

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

ICOMOS-ISCS :

Illustrated glossary on stone deterioration patterns
Glossaire illustré sur les formes d'altération de la pierre



English-French version
Version Anglais-Français

MDCS / Monument Diagnosis and Conservation System
The online damage-expert for
monumental buildings

Home Damage Atlas FAQ Contact Wizards Wiki EN | NL Login

Search directly the
extensive damage atlas

What is MDCS?
MDCS – the Monument Diagnosis and Conservation System – is an interactive support tool for the inventory and evaluation of damage to monumental buildings. During visual inspections MDCS helps to identify the types of materials and the types of damage. Based on the damage types found, hypotheses on possible causes are suggested. On the basis of the final diagnosis, conservation can be planned.

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What is MDCS?
MDCS helps to clearly define and record damage types. This provides clear communication between parties in the construction industry: architects, contractors, inspectors, insurance agencies. It is a first step towards determining causes and responsible procedures.

Monitoring your own monument
MDCS helps in (visual) monitoring the state of the monument by the owner / administrator.

TNO Innovation for life
TU Delft
Ministerie van Onderwijs, Cultuur en Wetenschap

Table 1 - Overall context of salt decay **Both MDCS & ICOMOS considered**

	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. <i>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.</i>
Damage patterns possibly relevant to salt decay	<ul style="list-style-type: none"> ● Disintegration <ul style="list-style-type: none"> ○ Layering (brick, stone) <ul style="list-style-type: none"> ■ delamination ■ exfoliation ■ spalling ■ scaling ○ Loss of cohesion <ul style="list-style-type: none"> ■ crumbling (brick) ■ sanding (stone, mortar) ■ powdering (brick) ■ chalking (stone) ■ bursting (mortar) ■ voids (bedding mortar) ■ alveolization (brick) ■ erosion (stone) <ul style="list-style-type: none"> - alveolization - selective weathering ○ Detachment (material systems) <ul style="list-style-type: none"> ■ loss of adhesion (mortar) ■ blistering (paint/coating) 	<ul style="list-style-type: none"> ● Crack and deformation <ul style="list-style-type: none"> ○ Crack (relevant subtypes: <i>fracture, hair crack, splitting</i>) ○ Deformation ● Detachment <ul style="list-style-type: none"> ○ Blistering ○ Bursting ○ Delamination (relevant subtype: <i>exfoliation</i>) ○ Disintegration (relevant subtypes: <i>crumbling, granular disintegration</i>, the later divided into <i>powdering, chalking, sanding, sugaring</i>) ○ Fragmentation ○ Peeling (relevant subtypes: <i>flacking, contour scaling / spalling</i>) ● Material loss <ul style="list-style-type: none"> ○ Alveolization ○ Erosion (relevant subtype: <i>differential</i>)

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)



	Damage type	References
Surface change		
1	Chromatic alteration (incl. fading, moist spots, staining, discoloration)	<p>Icomos (stone) https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf</p> <p>MDCS (brick, mortar, stone, plaster) https://mdcs.monumentenkenis.nl/damageatlas/2/category</p> <p>https://mdcs.monumentenkenis.nl/damageatlas/248/category</p> <p>https://mdcs.monumentenkenis.nl/damageatlas/100/category</p> <p>https://mdcs.monumentenkenis.nl/damageatlas/58/category</p>
2	Efflorescence (incl. salt crust –adherent layer, fluffy –easily brushed off)	<p>Icomos (stone) https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf</p> <p>MDCS (brick, mortar, stone, plaster) https://mdcs.monumentenkenis.nl/damageatlas/10/category</p> <p>.....</p>
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

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



DELAMINATION . DÉLITAGE



Delaminati
gravestone p
from frost ac

Délitage d'
en grès pou
l'action du g

Scotland, Bre
Cathedral Gr
meter wide sl
Ref IW 31 / 1.



ICOMOS Stone Atlas

EXFOLIATION . EXFOLIATION



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').

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 nears the Our Lady church, Trier, Germany

MDCS Damage Atlas

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 1x)	3-4	100%

Thank You