Simon Colwill

# Time, Patination and Decay: The Agents of Landscape Transformation



COLWILL, Simon (2017): Time, Patination and Decay: The Agents of Landscape Transformation. In: Creation/Reaction. ECLAS Conference 2017, University of Greenwich, London UK. Conference proceedings, pp. 293–312. ISBN: 978-0-9935909-6-2

## Time, Patination and Decay: The Agents of Landscape Transformation.

> `One hopes one builds forever, but one has either to anticipate or accept change and its effects ...´ S. Child [1: p303]

In landscape architecture the optimal condition is often not reached at the time of practical completion, projects mature through time and patination throughout the project lifecycle. The processes of patination and subsequent deterioration leave traces on the surfaces of the built environment which highlight deficiencies in design and detailing, construction and maintenance. Patination is a process of addition to a surface acquired through age and exposure. This process is followed by decay, a process of subtraction from a surface which is detrimental to the fabric. The transformation between these two processes can be quickly exceeded due to unfavourable design, detailing, construction, weathering, usage and/or maintenance.

Current research at the Technische Universität Berlin is based on the hypothesis that it is possible to optimise design, detailing, construction and maintenance techniques by monitoring and evaluating projects at regular intervals after completion. A low-threshold and non-destructive monitoring method to `read´ and decipher these traces of time is being developed in order to pinpoint the agents of landscape transformation and identify frequently occurring points of weakness in built landscapes. The methods being developed align with the principles of construction pathology by identifying a relationship between the `visual signs and symptoms´ (effects) observed and `pathological conditions´ (causes). This enables causes to be determined and recommendations for the most appropriate course of action to be made [2].

Inherent weaknesses are an inevitable and unavoidable factor of all structures resulting from the form of the structure, material properties

# Time, Patination and Decay: The Agents of Landscape Transformation.

**Simon Colwill**
Technische Universität

**Keywords:**
time, patina, decay, multi-temporal analysis, vulnerability, built landscape

and wear and tear; for example, mechanical damage to exposed table corners or the natural discolouration of wood (greying). Inherent weakness can be optimised, but not completely eliminated, through improved design, quality of materials and maintenance.

Weaknesses can, however, also be caused by misjudgements in the planning and execution of the design, low quality materials, poor workmanship and maintenance, which are often the result of budgetary restraints. These weaknesses can be minimised or avoided through increasing awareness of previous failures through feedback loops to the profession – thus avoiding the repetition of failures.

> `… every new piece of construction is to some extent a hypothesis and its performance in practice is the experiment. But where are the designer/experimenters?´ B. Bordass [3: p29].

Most construction projects include experimental or innovative aspects such as a special form, new materials or surface treatments [3: p29]. Furthermore, so-called `standard details´ are actually work in progress, and need to be updated on a regular basis to suit specific site requirements. This acquired knowledge from experimentation, innovation and development needs to be feed back to the profession for research and development purposes. Feedback is however not routine and therefore weakness and failure persist. [3: p23].

The field research focuses on projects within the city of Berlin; which ensures the comparability of social and microclimatic characteristics. It is based on multi-temporal photographic surveys which form the basis for the subsequent analysis and evaluation. The core period of research covers the first 5 years of post-completion project development, further surveys of older projects allow for a period of up to 25 years to be analysed. Data collection reports and project data sheets provide important background information on site specific data and other observations. The photographic recordings are assigned metadata (e.g. location, completion date, facility, material) and stored in a database. The analysis and evaluation of the data is carried out both quantitatively and qualitatively. By comparing selected images from the initial state with the associated subsequent recordings, the process-dependent changes become visible. Frequently occurring areas of deterioration highlight points of weakness and vulnerability. Comparisons of the rate of change between different objects and projects allow premature ageing to be determined, and the common causes identified. Expert interviews will be employed at a later stage to develop prevention, minimisation and protection strategies in order to counteract the problems identified.

The agents of landscape transformation seldom act independently of one another but are interrelated and complex. The following list of main causes has been established through an initial analysis of 400 case studies. These cause criteria are subdivided into those relating to the **Context, Component Quality**, and **Operating Conditions**. Due to the complex nature of these processes some of the criteria inevitably overlap with one another [Fig. 1] [4: pp166-177] [5: p398].

The following detailed discussion of the causes and commonly found effects of these agents is not exhaustive and will be added to or adapted during the ongoing analysis of further case studies.

## Context

*1. Site and contextual factors*

These factors include the specific geographical location, microclimate (urban, coastal, upland and forest microclimates), degree of exposure, aspect (slope), and the influences from surrounding elements such as buildings and vegetation. Factors such as the **degree of exposure**, **topography** and **aspect** strongly influence the intensity of microclimatic agents.
**Organic matter** such as leaves, fruit, flowers,

seeds or sap from neighbouring vegetation is transported to the lowest points of our built works through runoff and erosion. This accumulation of organic matter slowly decays leading to increased moisture retention and initiates soil formation which in turn provides the perfect physical and hydric conditions for spontaneous plant growth [6: p13] [7: pp 63 et seq., 80]. Vegetation can also influence the built environment through **direct contact** causing abrasion and increased shading, in turn creating an increased level of humidity and an increased rate of degradation. Progressive **root growth** may penetrate into built elements causing direct damage, or beneath structures, which can cause heave, displacement, breakage or foundation failure [8: pp 10 et seq.].

Soils that are prone to volume change are particularly problematic in the built environment. Periods of drought may cause **soil shrinkage** which can lead to structural subsidence. Prolonged periods of rain can lead to **soil expansion** (heave), which may also cause structural damage.

Other contextual factors include the surrounding traffic, which can influence the site through **airborne pollution**, and **mechanical damage**.

The effects of contextual factors:

- Airborne sediments are mainly deposited in the lower-velocity lee of vertical elements such as walls, edgings, kerbs, bollards, at the base of street furniture as well as in the corners and joints of built elements [Fig. 2a].
- Drainage channels and gullies, being at the lowest point of the built landscape, are particularly prone to this form of decay [Fig. 2b].
- Many cases of surface damage to paving caused by occurrences of root heave have been identified [Fig. 2c].
- Intensive shading by vegetation, nearby buildings or other built elements is a common cause of increased surface moisture, surface soiling, and spontaneous vegetation growth [Fig. 2d].
- Structural subsidence has also been

observed, caused by soil shrinkage, settlement, excessive loading or deficient foundations.

**Component Quality**

*1. Design and detailing factors*
These include change due to the quality of the **design** and **detailing** and insufficient or defective **durability features**.

> `Designers repeat details and reuse certain materials ... In this way, `learning by mistakes,´ rules of thumb, and various shorthand methods and detail practices are established over a number of years, to be repeated, elaborated on, or, as is sometimes the case, misappropriated and lost over time.´ N. Kirkwood [4: p183]

In the design phase conceptional ideas are transformed into tangible design solutions. The specific **geometry** and **form** of each element needs to allow not only for the appropriate usage, but also for weathering (e.g. rainwater runoff) and ease of maintenance through time. The **site programming** (functional concept) can lead to conflicts of usage, and in turn to detrimental change.
The **detailing** phase acts as an intermediary between the design process and project realisation by relating material to form and function. The main stimuli for change are due to the **suitability** of the selected **material** and **surface finish** for the specific use. Through ensuring **ease of maintenance and repair**, it is possible for elements to reach their optimal service life.
Good detailing relies on a thorough understanding of design concepts, construction techniques and material properties over time. Many detailing factors influence time based change:

- Design and technical design in general: e.g. form, material selection, fixings, jointing and compliance with construction standards
- Structural design: e.g. dimensioning, stability

- Drainage: surface and sub-surface drainage, rainwater runoff in general
- Maintainability: ease of maintenance and repair
- Durability features: all methods of constructive protection including drip edges, copings, and surface treatments.

A few examples of design and detailing problems from the field research are listed below:

- The form of construction elements often determines the patterns of change and decay. For example, objects with very acute angles, such as edgings and short walls, often become chipped or broken through mechanical damage [Fig. 3a]. Also, non-chamfered or unrounded edges of paving elements are frequently chipped, especially at the turning points of vehicular traffic [Fig. 3b].
- Structural design issues such as the bending of low steel railings or the wooden laths of benches bending between the supports [Fig. 3c] have been identified.
- Minimal drainage gradients are often found leading to a reduced rate of runoff and an increased rate of sedimentation and decay in the joints and on the paving.
- Many elements suffer from the accumulation of waste or the development of spontaneous growth within or beneath the construction, which is often only removable with extensive maintenance [Fig. 3d].
- Constructive protection measures such as wall copings are often not implemented leading to extensive staining.
- Irrigation systems have been found to cause severe staining when directed towards walls and paths.
- \`Desire paths´ (paths created by erosion) are often found due to a lack of paths in the desired route. Also, right angled path junctions often lead to damage by users and/or maintenance traffic rounding off the corners.

*2. Material specific factors*

\`The effects of age and wear are powerful diversifying agents´ D. Pye [9: p65].

Various material specific factors influence change and deterioration through time. These factors relate to the quality and durability of the material and its surface protection. Durability characterises the ability of a material to perform its required function over its expected service life under scheduled maintenance. Each individual material reacts differently to the influences of weathering, use and maintenance over time. Practitioners need to understand the strengths, weaknesses and other unique characteristics of each material and forecast how the material will endure through time. Selecting the right material and surface finish for the job also relies on knowledge of the desired object form, function, site of installation, the intensity and frequency of use, and the foreseen level of maintenance and repair. Another consideration is that the site of installation may be located in an aggressive environment influenced by intensive use or misuse, intensive freeze-thaw cycles, or where grit or de-icing salt is spread in winter. Surface finishing can enhance material properties for specific applications.

Material change through time can be classified into those which influence the aesthetics, and those which lead to a reduction in functionality, stability, and/or durability. Time often improves the look of materials by blending imperfections on surfaces, highlighting surface structure through deposits of dirt, growth of lichen or by fading colours. These continual processes of change can be regulated through regular maintenance and repair in order to achieve an optimal service life.

Many material related weaknesses have been observed through the field research, some of the main factors are detailed below:

- The greying and cracking of wood and the discolouration of synthetic surfaces occurs rapidly in exposed locations due to ultraviolet radiation.
- Water absorption of materials is a major factor, especially for horizontal surfaces that

are subject to intensive cycles of wetting and drying, freezing and thawing and increased staining from airborne sediments [Fig. 4a].

- Insufficient or defective coatings and finishes such as paints or powder coatings leads to moisture penetration below the surface coatings which cannot easily escape and therefore leads to an increased rate of decay.
- Fixings such as screws, bolts, rivets and nails are the source of many problems. Screws and nails in wood and wood-plastic-composites often lift over time due to the flexing of the timber through use [Fig. 4b]. Corrosion and/or contact corrosion of fixings due to inappropriate specification is commonly found, this leads to staining and structural damage.
- Jointing is a common source of weakness mainly due to the loss of jointing material and spontaneous vegetation growth.
- Many cases of `picture framing´ (darkened perimeters of paving materials formed by efflorescence being transported from the bedding material between the joints) have also been identified on concrete and natural stone paving.
- The erosion of embankments through cycles of use, weathering and landslides was often identified [Fig. 4c].
- Elements that are subject to mechanical surface damage through use such as bike stands or bollards are particularly susceptible to corrosion.
- Production process faults, for example due to the soiling of concrete formwork, or insufficient compaction, were often found. These often become more visible through time due to the effects of weathering. [Fig. 4d].

*3. Implementation factors*

These agents include the quality of **implementation**, **workmanship**, **site supervision, construction technique**, and conformance with **construction standards**.

`The increased time and cost pressure

during construction often leads to deficiencies in the construction work. Thus, in the implementation process, recognised rules of technology are often violated or construction plans are deviated from.´ C. Bahr, K. Lennerts [10: p27]

David Pye views workmanship as an extension of the design process; he states that `…design can only become manifest through workmanship´ [11: p9]. The quality of workmanship is dependent on the qualifications and experience of the construction staff, managers and site supervisors. Mechanical damage and/or surface soiling can occur throughout the construction process from material transportation, to assembly and the use of machines on site.

Frequently found points of weakness due to implementation factors include:

- Efflorescence and spots of rust staining (from exposed reinforcement) on the surfaces of concrete elements were frequently identified [Fig. 5a].
- Asphalt surfaces with a rolled on crushed stone finish are often not evenly coated, with time and wear the surfaces become increasingly irregular. [Fig. 5b]
- The Settlement of paving elements surrounding facilities such as manholes, where compaction during construction is more difficult [Fig. 5c].
- Cracking or breakage of large in-situ concrete surfaces, especially those with specific forms [Fig. 5d].
- Many cases of repairs (mainly to concrete and stone elements) from the construction period were found, which often become more evident due to weathering through time.

## Operating Conditions

*1. Environmental processes*

These agents include weathering, climate, chemical and biological agents which affect materials in differing ways depending on the surface properties. These processes occur in a cyclic manner; from daily cycles (e.g. temperature, precipitation) to seasonal cycles (summer, autumn, winter, spring) throughout the entire lifecycle of the project. The intensity of these agents through time highly influences the rate of deterioration.

**Climatic agents** include factors such as water, ice, frost, snow, sun, wind, humidity and temperature. In sunny locations colours generally fade; synthetic materials become brittle, wood twists and cracks. Thermal expansion and contraction from **temperature** change and **relative humidity** places stress on many materials leading to cracking or the fracture of surface coatings.

**Rainwater** is a major cause of erosion and transporter of airborne sediments (e.g. particulate matter). The surface flow of water on built elements is highly influenced by the object form, material, surface properties and the proximity to the ground. Ground proximity is a major problem due to the splashback of rainfall which, depending on the surface properties, reaches a height of 20-30cm.

**Wind** can cause direct stress to the structure and also transports pollution and sediments.

**Chemical agents** are mainly airborne pollutants (e.g. industrial, marine pollutants) or aggressive soil conditions that attack the surfaces of built elements. The deposition of dust, dirt, pollen, and other **atmospheric contaminants** on the surfaces of built elements leads to **surface soiling**. This deposition is increased on rough and/or structured surfaces, surfaces prone to frequent wetting, as well as in joints, gaps and surface imperfections.

**Biological agents** include vegetation growth and animals such as dogs, foxes, birds (especially pigeons) insects and rodents [12: p127] [13: p283].

**Spontaneous vegetation growth**, generally due to a lack of maintenance over long periods of time, leads to an increased the rate of decay through increased shading, moisture retention and root actions.

A few examples of environmental impacts identified via field research are listed below:

- The climatic effects on horizontal surfaces were found to be particularly pronounced especially on unbound surfaces. This leads to an increased rate of soiling and natural succession [Fig. 6a].

- Surfaces below objects, such as under waste containers, which are particularly undisturbed through use and/or maintenance, are susceptible to increased rate of succession.
- Surface soiling at the top and base of built elements, was frequently found [Fig. 6b].
- Cases of spontaneous vegetation growth are widespread throughout the city, especially in the recesses, corners, edges and joints of built elements [Fig. 6c].
- Many cases of damage from dogs digging next to benches, and rodents burrowing under surfaces or into embankments have been identified [Fig. 6d].

*2. User actions / usage*

> `Science .... has not enabled us to predict the behaviour of people; which very many designers need to be able to do. ... We design failures chiefly because we cannot make reliable predictions about responses.´ D. Pye [9: p27].

Humans cause physical stress to the built environment through use, misuse or underuse, which is difficult (if not impossible) to foresee in advance. Therefore, in an optimal situation, the level of maintenance and repair needs to be adjusted to the resulting situation. In structural terms, usage is a form of loading which can be static or dynamic, and exerts force upon the structure. The intensity and frequency of these interactions dictate the impact of these forces over time.

**Overuse** describes a space or element with an excessive frequency and/or intensity of use causing detrimental deterioration.

**Misuse** refers to the impact of wilful destruction (criminal vandalism) and use appropriation (uses of an object for a purpose or in a manner other than intended). In this research project, these forms of misuse are evaluated purely on their

impact on the specific structure.
**Underuse** describes a space or element which is used less than expected. This reduced rate of trampling often leads to an increased rate of spontaneous vegetation growth [14 p96] and therefore to an increased need for maintenance.

Many problems developing from usage over time have been identified from the field research, including:

- In many projects, intense use is focused on certain areas or objects whereas others remain disused.
- Overuse often leads to severe surface erosion especially to unbound surfaces (e.g. grass areas, compacted gravel) [Fig. 7a].
- Many different forms of accelerated deterioration through wilful destruction were identified [Fig. 7b].
- Chewing gum trodden flat by human traffic is especially frequent near building entrances and public seating [Fig. 7c].
- Many forms of use appropriation, such as using bike stands as benches or play equipment, have been observed, leading to unintentional soiling and damage.
- Underuse often becomes visible through an increased rate of succession [Fig. 7d].

*3. Maintenance and repair*

> \`Feedback into the growth or decay of a landscape allows the landscape architect to have a positive, creative role in its development, rather than a negative, mitigating view of change, which is encompassed in the notion of \`maintenance.´ J. Raxworthy [15: p193]

Maintenance and repair operations involve performing repeated cycles of routine actions which aim to keep the project in working order, prevent problems from arising and restore dysfunctional elements. The quality of the maintenance operations is dependent on the qualifications and experience of the maintenance staff and site supervisors. The **frequency**, **quality**

and **intensity** of these operations highly influence the rate of deterioration through time.
**Insufficient** or **incorrect maintenance** often leads to accelerated deterioration, reduced usability, a downward spiral of decay. **Incorrect maintenance,** for example by using abrasive brushes, or aggressive chemical solutions, can cause surface discolouration or abrasion, thus leading to corrosion, erosion and/or permanent surface damage.
It is therefore essential to know the available level of maintenance, type of equipment, and skills of the maintenance staff in the planning phase so that the planning can be adjusted accordingly.

The problems resulting from maintenance and repair in Berlin are extensive; some of the main findings are listed below:
Insufficient maintenance is a significant factor in most of the field studies leading to spontaneous vegetation growth in corners, joints and drainage elements [Fig. 8a].
Particularly difficult to reach surfaces are often not maintained, for example surfaces behind railings or areas between the wood laths of a bench.
A few cases of surface erosion/abrasion from mechanical and/or chemical maintenance have been identified [Fig. 8b].
Insufficient repair is a major problem which can also lead to risk of injury. For example warped boards or protruding screws on wooden decks [Fig. 8c].
Graffiti removal often leaves visible residues, especially on coloured surfaces [Fig. 8d].

*4. Force majeure*
This factor covers the level of impact of unforeseeable natural disasters such as flooding, earth movement (e.g. landslide, earth quakes), extreme storm damage and human factors such as war, terrorist activities and riots. The visible signs of such events are specific to the individual event itself; generally however cause extensive damage over wide areas.

Very few of the Berlin case studies can be linked to this factor; however fallen trees and damage resulting from traffic accidents have been documented.

## Conclusion

> `The `research´ of detail has previously been considered of little significance in practice. ... the results of the studies were rarely made available to others´ N. Kirkwood [4: p183]

The methodology being developed within this research project enables a formalised monitoring of built works and a tool for continuous improvement. This enables an iterative learning process from previous innovations and problems in order to optimise the performance of future projects in the design, detailing and construction phases of the project. The results can also be used during the post- occupancy phase to compare the developing condition with a catalogue of case studies in order to take appropriate measures to counteract negative change.

The initial case study evaluations display a great diversity of weaknesses throughout public space in Berlin and generate a wide range of detailed knowledge on project development. Raising awareness on weakness and problems is however problematic within the profession; no one wants to take the blame, be faced with ruined reputations or legal liability issues. Without learning from past problems, and passing this knowledge on to others through publications and teaching, they will continue to be repeated. This is shown by the repeated occurrence of many weaknesses and failures observed throughout our field research. Learning from problems is a form of `lifelong learning´ from built works and should become a standard part of `research and development´ within the profession.

The landscape architecture profession needs to develop a culture of criticism, reflection and learning from the detrimental processes of change through time. Several publications and platforms are available for buildings such as the `Journal of Performance of Constructed Facilities´

and the web platforms `Failures Wiki´ [A] and the `Building Failures Forum´ [B] [16 p.328]. A confidential journal or web platform for the dissemination of specific knowledge related to innovation, weakness and decay in landscape architecture projects is long overdue.

**Notes**

[1] CHILD, Susan (1997): Interview with Susan Child in: KIRKWOOD, Niall (1999): The Art of Landscape Detail. Fundamentals, Practices, and Case Studies: Wiley

[2] WATT, David (1999): Building pathology. Principles and practice. Malden, Mass: Blackwell Science (Building pathology series).

[3] BORDASS, B. (2004): Learning from what we build. In: S. Macmillan ed. 2004. Designing better buildings: quality and value in the built environment. London: Spon. pp21-32.

[4] KIRKWOOD, Niall (1999): The Art of Landscape Detail. Fundamentals, Practices, and Case Studies: Wiley.

[5] COLWILL, S. (2016): Time, Design and Construction: Learning from Change to Built Landscapes Over Time. In Bridging the Gap. ECLAS Conference 2016, Rapperswil, Switzerland. Conference Proceedings.

[6] BOT, Alexandra; BENITES, Jose (2005): Importance of soil organic matter. Rome: FAO (FAO soils bulletin 80).

[7] LOIDL-REISCH, Cordula (1987): Der Hang zur Verwilderung. Wien, Picus Verlag.

[8] DARLINGTON, Arnold (1981): Ecology of Walls. London. Heinemann Educational Books

[9] PYE, David (1995): The nature and art of workmanship. Revised ed., repr. London: Herbert Press.

[10] BAHR, Carolin; LENNERTS, Kunibert. (2010): Lebens- und Nutzungsdauer von Bauteilen. Final

report from the research program `Zukunft Bau`, on behalf of the Bundesinstituts für Bau-,Stadt- und Raumforschung and the Bundesamtes für Bauwesen und Raumordnung, Berlin
Translated by Simon Colwill

[11] PYE, David (2007, ©1978): The nature and aesthetics of design. Revised ed., repr. London: Herbert Press.

[12] LOIDL-REISCH, Cordula (1996): Der Hang zur Verwilderung: Freiraum und Patina. p. 124-133. In: Architektenkammer Hessen, Toyka, Rolf (Ed.): Patina. Hamburg, Berlin, Dresden; Junius.

[13] REINSCH, Dietmar (1991): Natursteinkunde. Eine Einführung für Bauingenieure, Architekten, Denkmalpfleger und Steinmetze. Stuttgart, Enke Verlag.

[14] LUNDHOLM, Jeremy (2014): Vegetation of Urban Hard Surfaces. In Jari Niemelä (Ed.): Urban ecology. Patterns, processes, and applications. Reprinted with corrections. Oxford: Oxford University Press (Oxford Biology), pp. 93–102.

[15] RAXWORTHY, Julian. R. (2013): Novelty in the Entropic Landscape: Landscape architecture, gardening and change. Doctoral Dissertation, University of Queensland.

[16] PARFITT, M. Kevin (2012): Why Buildings Fail. Are We Learning From Our Mistakes? In Buildings 2 (4), pp.326–331. DOI: 10.3390/buildings2030326.

*Websites*

[A] Failures Wiki; Available online: http://failures.wikispaces.com

[B] Building Failures Forum; Available online: http://buildingfailures.com

| | Cause criteria |
|---|---|
| Context | **Site and contextual factors**<br>Change/decay due to degree of exposure, aspect, access and circulation etc. |
| Component Quality | **Design and detailing factors**<br>Change/decay due to due to quality of design, detailing and durability features |
| | **Material specific factors**<br>Change/decay due to material suitability and/or quality. |
| | **Implementation factors / workmanship**<br>Change/decay due to quality of implementation,  workmanship (conformance with construction standards and guidelines) |
| Operating conditions | **Environmental processes / weathering**<br>Change/decay due to environmental processes |
| | **User actions / usage**<br>Change/decay due to intensity of use and/or misuse (physical stress caused by humans, animals, plants, vehicles etc.) |
| | **Maintenance and repair**<br>Quality and frequency  of maintenance and repair |
| | **Force majeure**<br>Level of impact of incidents such as flooding, fire, riots etc. |

*Fig. 1: The AGENTS of landscape transformation. [4: pp166-177] [5: p398].*

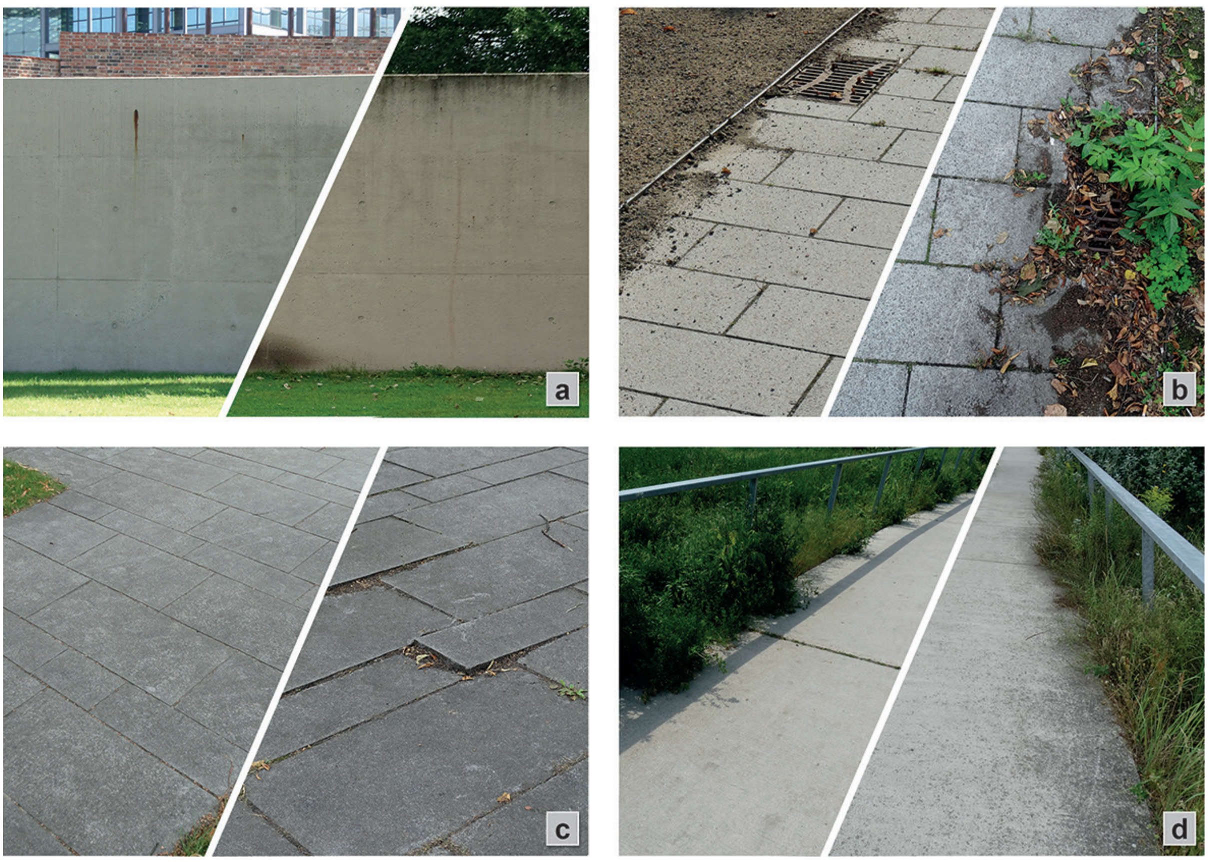


*Fig. 2: a) Deposits of airborne sediments: year 1/ year 10. b) Airborne sediments causing blockage: year 1/ year 8. c) Root actions causing heave: year 1/ year 4. d) Intensive shade leading to succession: year1/ year 6. [Photos: S. Colwill]*

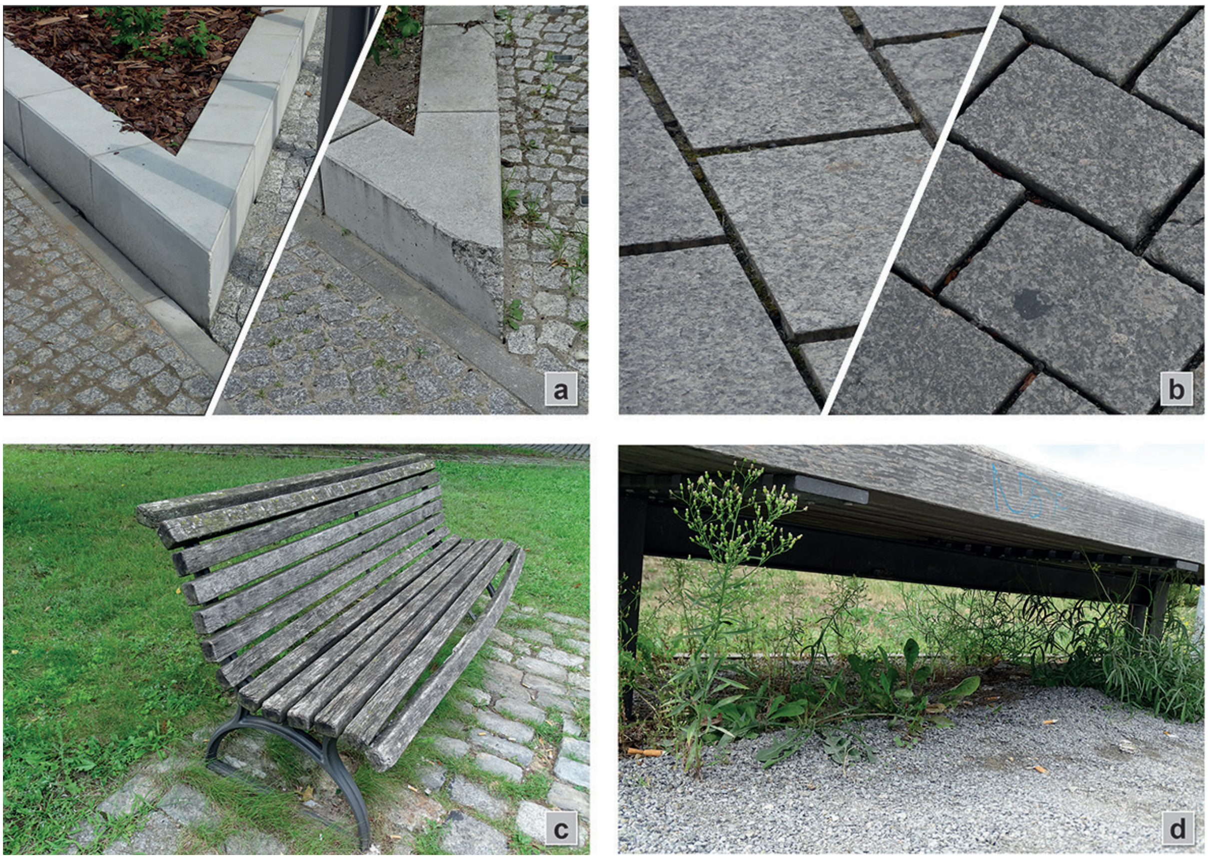


*Fig. 3: a) Breakage of acute angle: year1/ year 7. b) Chipped non-chamfered paving: year1/ year 11. c) Structural design weakness: year 12. d) Spontaneous growth below bench: year 7 [Photos: S. Colwill]*

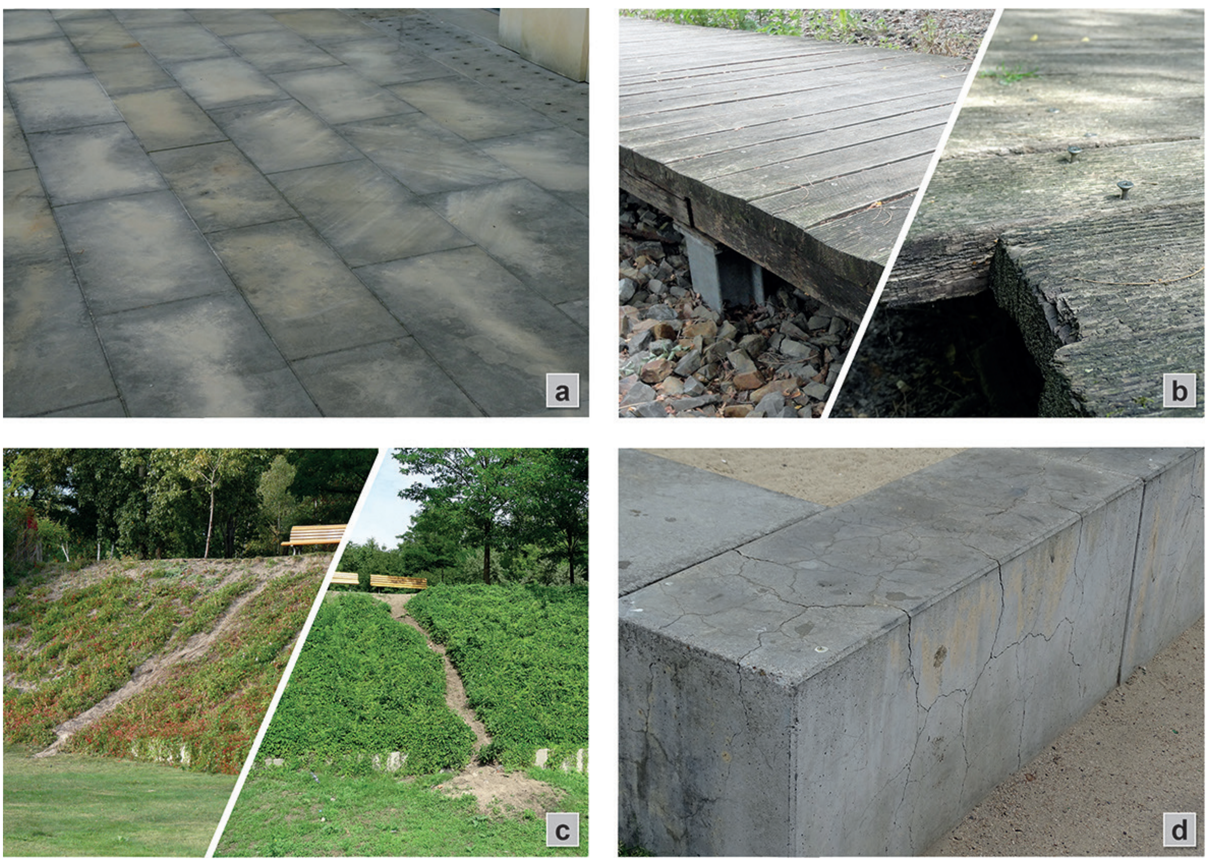


*Fig. 4: a) Water absorption increasing staining: year 8. b) Lifting of screws: year 4/ year 7. c) Embankments erosion: year 01/ year 07. d) Weathering highlighting production faults: year 7 [Photos: S. Colwill]*

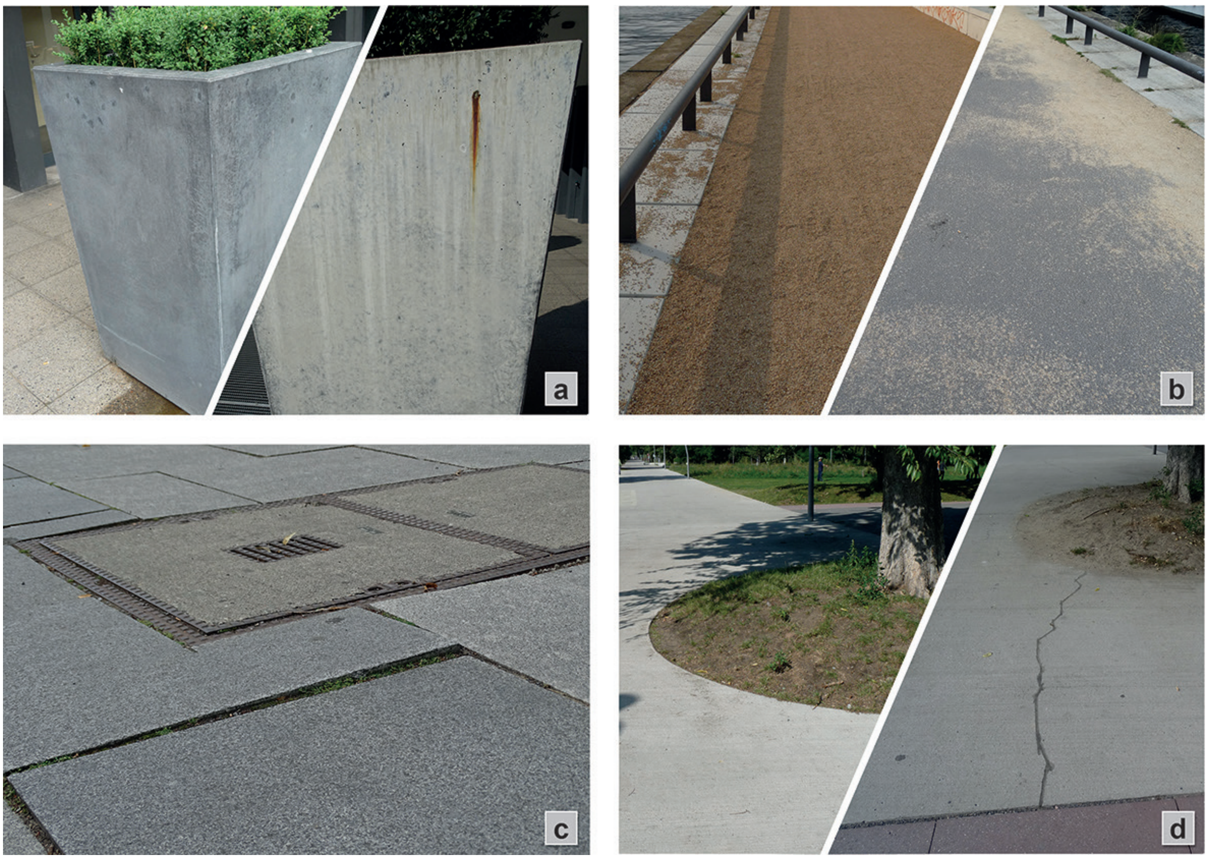


*Fig. 5: a) Efflorescence and spots of rust staining: year 1/ year 8. b) Surface becoming increasingly irregular: year 1 / year 7. c) Settlement of paving surrounding facilities: year 7. d) Cracking of in-situ concrete surfaces: year 2/ year 5 [Photos: S. Colwill]*

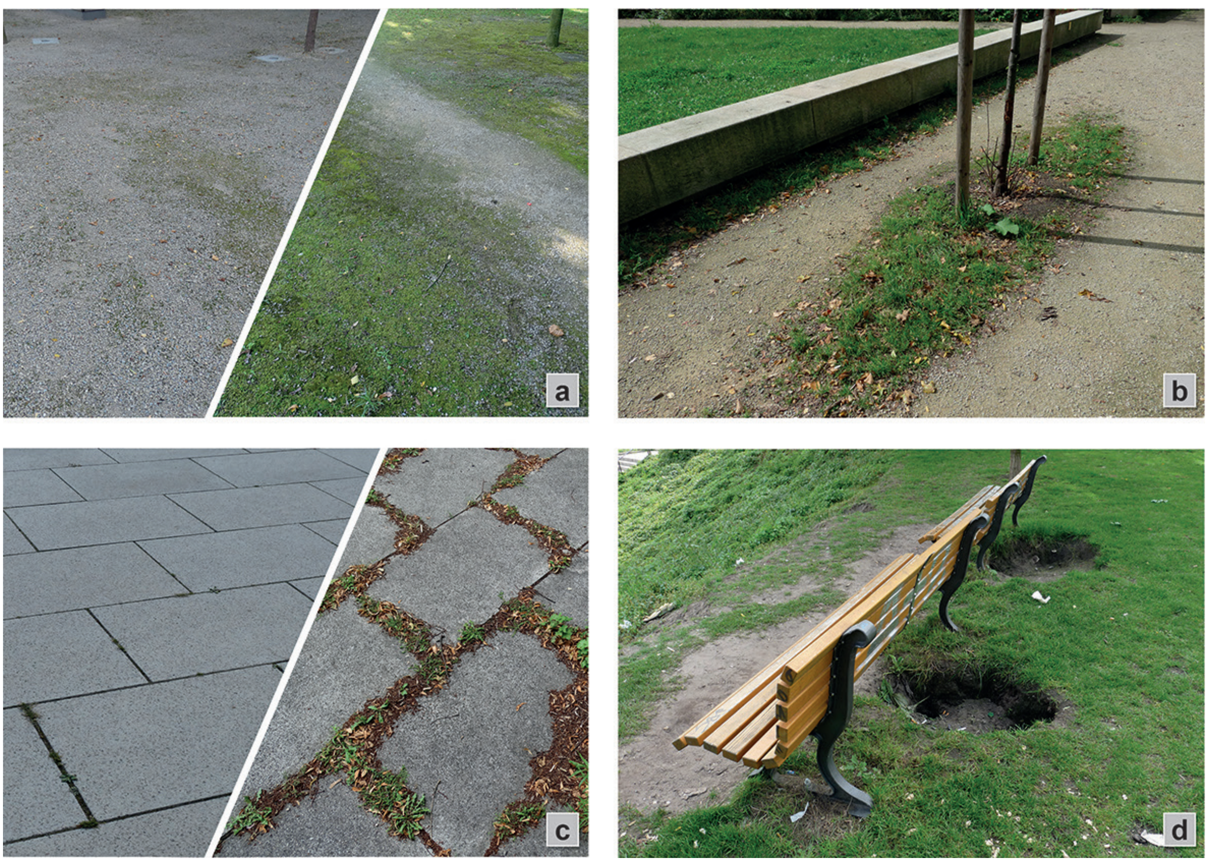


*Fig. 6: a) Increased soiling on horizontal unbound surfaces: year 2/ year 7. b) Increased succession in undisturbed areas: year 3. c) Spontaneous vegetation growth: year 01/ year 07. d) Dogs burrowing beside benches: year 2 [Photos: S. Colwill]*

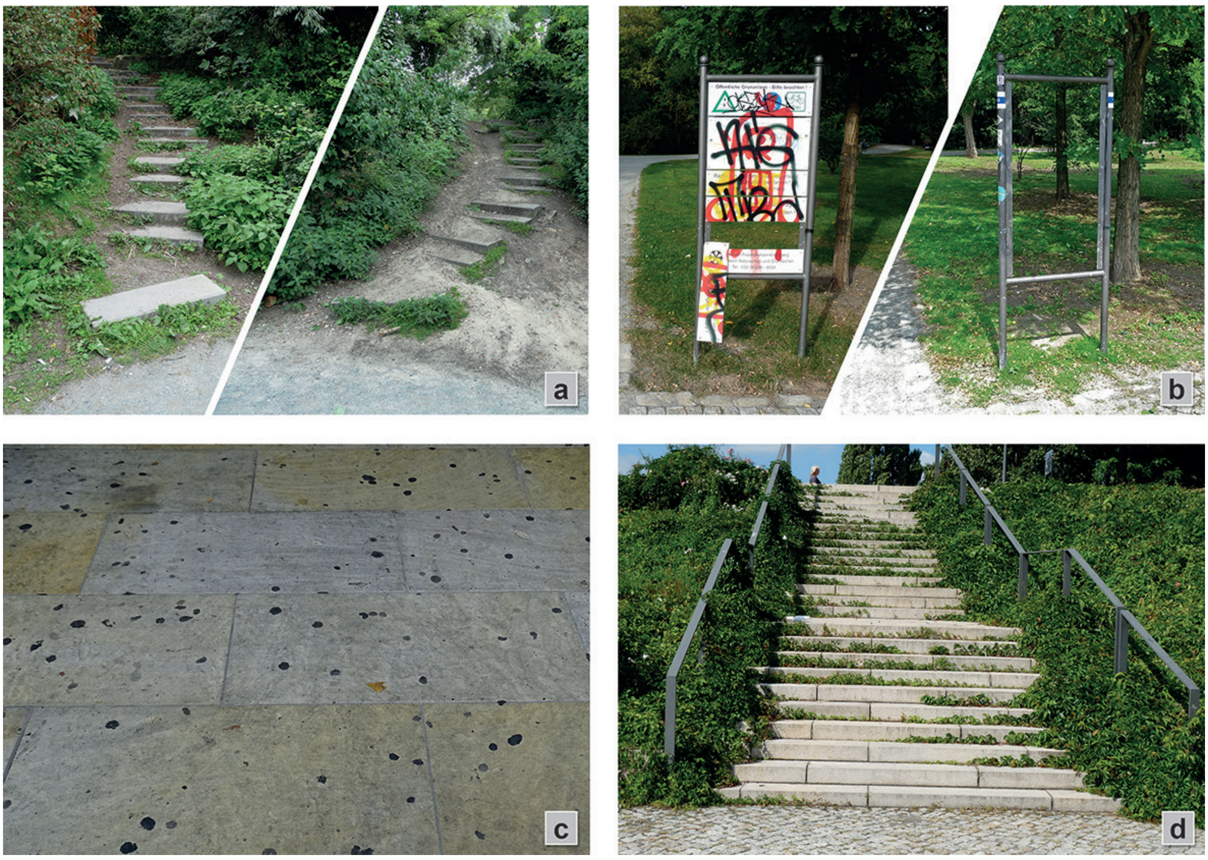


*Fig. 7: a) Overuse causing surface erosion: year 2/ year 7. b) Wilful destruction: year 01/ year 07. c) Chewing gum trodden into surface: year 15. d) Increased succession due to underuse: year 5 [Photos: S. Colwill]*

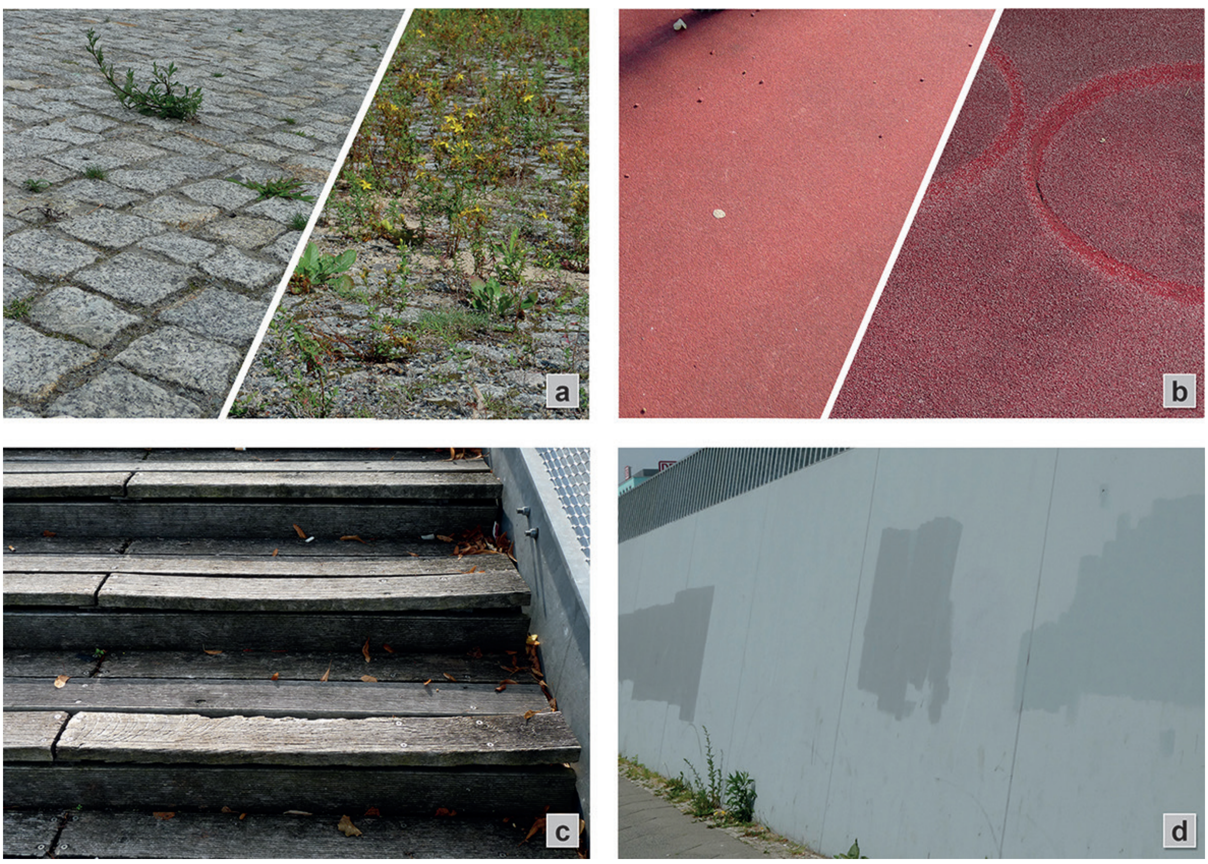


*Fig. 8: a) Insufficient maintenance: year 1/ year 6. b) Surface damage from maintenance: year 01/ year 06. c) Insufficient repair leading to risk of falling: year 10. d) Visible residues from graffiti removal: year 1 [Photos: S. Colwill]*