Education & Skills
Funding Agency

Concrete cladding - monitoring building condition

A guide for schools

February 2018

Of interest to school leaders, governors, staff, local authorities, academy trusts and charitable trusts.

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1. Introduction

Concrete cladding – monitoring condition

Maintaining an understanding of building condition and building performance is a key responsibility for many parts of the education estate.

Concrete cladding is used in many schools. The Education and Skills Funding Agency (ESFA) is making this guide available to schools and responsible bodies having become aware of instances of defects in concrete cladding, in schools in the worst condition, being replaced through the Priority School Building Programme (PSBP). Cladding may suffer from defects not necessarily linked to the age of the materials in use. Many causes of concrete defects are known and are relatively easy to address if identified in good time. If concrete cladding is allowed to deteriorate, it can create risks even when not carrying structural loads.

This guidance recommends periodic inspections. It provides information to help schools and responsible bodies in undertaking such activities. Concrete cladding will nearly always be visible externally and this document includes images to help with identifying this construction material.

About this guidance note

This document takes you through detailed guidance on how to:

- identify if concrete cladding is used in your school
- implement inspections
- examine building cladding in detail
- assemble information to support effective risk assessments

More detailed information on the wider subject of health and safety in schools can be found in the document; 'Health and safety: advice on legal duties and powers' (For local authorities, school leaders, school staff and governing bodies - February 2014). [1]

This guidance note does not replace existing legislation. It signposts and supports relevant documents relating to building maintenance responsibilities. Clarity on interpretation of statutory instruments can be obtained from the applicable source legislation and associated guidance.

The ESFA acknowledges the services provided by AECOM, in producing this document.

[1] (Available online at time of publication @ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335111/DfE_Health_and_Safety_Advice_06_02_14.pdf)

2. Identifying the need for inspections and some methods to prevent deterioration

2.1 General

All schools need to have arrangements in place to manage the condition of their premises. A need for unplanned or unexpected maintenance work can be disruptive, preventing full utilisation of a building.

This guidance details proactive methods to enable early identification of potential problems with concrete cladding, to allow timely assessment and repairs. Inspections can happen in parallel with the ongoing operation of a school. Both scheduled and reactive inspections should:

- check that school buildings are safe and weather tight
- identify how urgent it is to deal with any defects
- support investment to correct defects and / or prevent re-occurrence of the same

The development of an effective inspection management and reporting process will assist governance decisions.

2.2 Identifying the presence of concrete cladding and its design

Architectural precast facade panels are used as the external cladding for many public buildings, an example of which is below. We recommend that each school maintain a record of its buildings that have concrete cladding.

A concrete cladding panel typically consists of the following elements:

- concrete – the key requirements of which are minimum thickness, compaction, and finish
- brackets – including support corbels and restraints, the key requirements of which are secure fixing and corrosion resistance. There are normally four brackets per panel; two brackets take the weight of the panel and two are for restraint. Materials used for the brackets may include concrete, mild steel and stainless steel
- a vapour barrier - this is generally at the back of any insulation materials used. It is either a metal foil or a membrane material
- Interfaces - including acoustic barriers and fixings, a key requirement of which is being permanently secured
- seals - the key requirements of which are attachment and completeness

There may also be steel reinforcement hidden within the concrete ('rebar').

2.3 Identifying the presence of cladding defects

Defects are often evidenced by a change including, but not limited to, any of the following:

- significant cracks (over 0.2 metres in length)
- delamination
- deformation
- stains emanating from corroded steel, including steel attachments
- movement of a whole cladding unit / non-parallel gaps between units
- significant changes in colour, even in a small area

Visual inspections or surveys to provide early diagnosis for repairs is essential. This is to enable repairs before any deterioration sets in. A safe and timely action can be cost-effective, as well as avoiding possible disruption to the use of the building due to concerns with safety.

2.4 Identifying potential repairs

Through the careful evaluation of the extent and cause of any defects, procedures can be implemented to accomplish one or more of the following objectives:

- restore and increase strength
- restore and increase stiffness
- improve functional performance
- provide water tightness
- improve appearance of the concrete surface
- improve durability
- prevent development of corrosive environment at reinforcement

Depending on the nature of defects, including accident damage, one or more repair methods may be selected. For example, tensile strength may be restored across a crack by injecting it with epoxy or other high-strength bonding agent. It may be necessary, however, to provide additional strength by adding reinforcement or using post-tensioning.

(Potentially, epoxy injection alone can be used to restore the original stiffness of the panel if further cracking is not anticipated).

Cracks causing leaks in water-retaining structures should be repaired unless the leakage is considered minor or there is an indication that autogenous healing is already sealing the crack. Actions to arrest leaks may be complicated by the difficulty of making repairs while a building is in service.

Cosmetic considerations may need refinishing of repairs to cracks. Crack locations may still be visible after some types of repair and therefore some form of coating over the entire surface may be required.

To minimize future deterioration due to the corrosion of reinforcement, cracks exposed to a moist or corrosive environment (eg salty costal winds), should be sealed.

2.5 Prevention of deterioration

Deterioration of materials cannot be completely prevented, but some simple measures can help to extend the life of concrete cladding panels.

Any actions to prevent or reduce the amount of water soaking into the concrete can be helpful eg:

- maintenance of gutters and down-pipes to prevent escape of waters to other than the intended drainage point
- drainage / clearance, including site maintenance, which prevents water ponding up against any panels (including snow)
- sealing up of open cracks in the concrete surface
- use of exterior grade waterproof paint on areas of panels that may be subject to water splash from passing vehicles, noting that such splash is likely to include some amount of road salt which can significantly increase the risk of deterioration

Take care if cleaning the surface of concrete cladding. This is because the acid or alkali content of many cleaning materials will be aggressive to the concrete. There are specialist products and contractors for cleaning of concrete if required.

3. Implementing inspections

3.1 Standard inspections

A general inspection of building facades should be undertaken at a minimum of six-month intervals. The standard inspection is visual, including the use of binoculars to enable closer inspection of areas of the building that are difficult to access. Avoid working at height wherever possible.

At intervals not exceeding twelve months, we recommend inspections include the use of a camera with a zoom lens to record specific features, and to track any changes in condition over time. An appointed individual who has read and understood this guidance should carry out inspections.
The following areas should be carefully and regularly checked:

- the periphery of windows and doors adjacent to or within the precast panels
- ground-level interface with the facade, in particular any dampness
- drainage areas including gutter and downpipes
- the corners of the building - this is an area where internal reinforcement does not always get sufficient concrete cover
- services (eg water pipes) and ducting that penetrate the facade
- any damp areas on the facade, or visible white marks
- cracks: this is essential and is covered in detail within this guidance
- cladding units out of alignment / moved
- seals between units

Further details of standard inspections are included in Appendix 1, which includes:

- recommended actions
- images to guide the identification of risks arising from defects

Section 4 of this document, 'Inspecting buildings in order to gather more detailed information', provides further instructions to facilitate inspections. This includes guidance on how to locate and record the presence of defects, and to identify their cause.

3.2 Specialist inspection / surveys

The standard inspections may find or suspect defects that require further specific and more detailed inspection. A specialist or surveyor with appropriate experience and competence may be required for this. Detailed examinations may also require use of access equipment, including ladders. Engaging specialists may be essential to identify all of the causes of any defect.

4. Inspecting buildings in order to gather more detailed information

Scheduled building examinations should be implemented which identify both defects and their cause. Non-specialists who have read and understood this guidance document can carry out routine surveys. When any inspections identify defects, the school or responsible body should as a priority, decide if further inspection by appropriate specialists is required. If so, the timescale to complete further examination of the building should also be specified.

Routine surveys should include actions to identify and record the following:

- delamination of the material
- general condition of the concrete area: cleanliness, unevenness, etc
- presence of cracks and crack width and length
- condition of joints and / or sealant
- presence of water, either settling on the surface or running over it
- prevailing temperature and weather conditions on day of inspection

Recognising and noting any type of cracks in concrete is the main objective. Every crack has a cause and you should attempt to identify the cause(s) in each case, eg is the unit (or crack) moving? is the crack wet or dry?
It is important to make sure that cracks are checked promptly and are then fixed, to avoid further deterioration.

It should be possible to establish how far advanced any decay is. If still within the 'corrosion initiation phase' (see Section 5 of this document), it is likely that no significant corrosion problems will yet have occurred. Your maintenance programme can then be a proactive one.

If your assessment suggests that the structure lies within the 'corrosion propagation phase', then a more reactive maintenance program will be necessary. Planned interventions may be as simple as providing a new coating every 5 years or may involve a combination of different repair techniques, eg patch repair, coatings and cathodic protection.

Relevant examination techniques include the following:

4.1 Surveying of cleanliness and general appearance

The surface should be checked visually for the presence of; discoloured concrete, flaws in the material, efflorescence (lime bloom), powdering, organic growth (lichens, algae), contamination, stains that cannot be removed, and decay.

4.2 Surveying of surface unevenness and fixed position of panels

Visual inspection of pre-cast surface unevenness will reveal the presence of cavities pores and pits. The survey should also look for any panels, which appear to have come loose, whether completely or in part. Checks should be made at ground level for evidence of decay, specifically looking for any fragments that have fallen to the ground.

4.3 Surveying cracks

Cracks are the most common problem with precast concrete. Possible reasons are:

- plastic shrinkage (or “drying”)
- thermal stress - freezing / thawing
- panel movement
- imposition of loads
- corrosion of the internal steel reinforcement bars (‘rebar’)
- impact damage

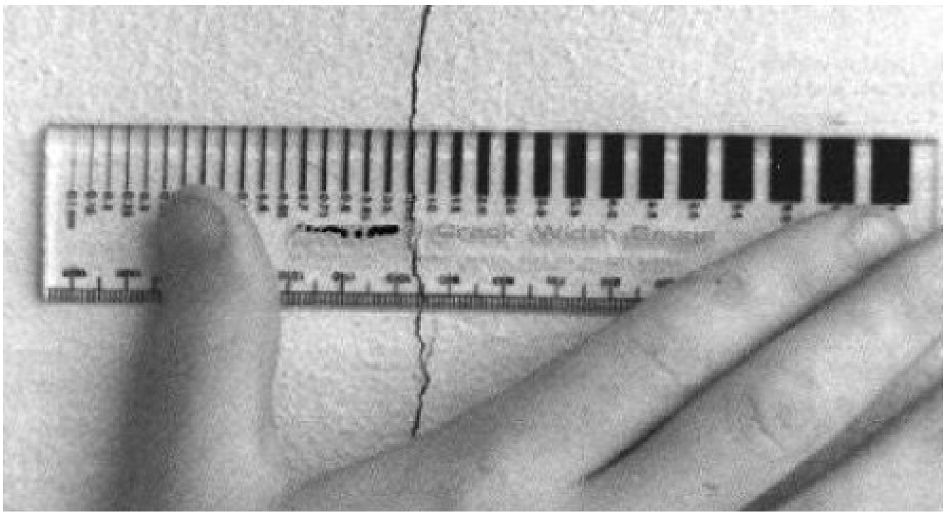
The work of inspectors to determine the source of cracking should also assist in identifying if cracking is likely to have stabilized. Some cracks, like those caused by concrete shrinkage, are shallow cracks caused by forces that allow conditions to stabilize quickly and do not lead to structural problems. Others, like those caused by freezing / thawing or corrosion of rebar, will permanently affect the durability and stability of the concrete. Any long-term instability can cause serious structural or safety problems over time.

Cracks that appear before the concrete has hardened are termed plastic cracks. Plastic cracks are typically due to poor mix design, placement practices or curing methods. Settlement, construction movement and excessively high rates of evaporation can also cause cracks.

A crack that appears after concrete has hardened can have a variety of causes, and often multiple causes. Table A classifies cracks according to the length of time it takes for them to appear. Table B describes various types and causes of cracks, with images showing typical examples. (See tables overleaf).

4.4.1 Crack width

For your routine surveys, simple gauges (illustrated) may measure crack width.



Dimensions can vary with temperature, so activities to measure crack width should also record temperature, weather conditions as well as date and time. Make a suitable mark on the concrete surface to show where a crack is measured, to enable repeat measurement at the same location.
It may also be important to record the length of the cracks. In some cases, the exact length is difficult to measure because the cracks narrow down gradually. Cracks over 0.2 metres length need to be measured and recorded. In areas where no access is possible, a professional surveyor can estimate crack width or length.

Table A - Types of cracks in concrete

Type of Cracking	Form of Crack	Primary Cause	Time of appearance
Plastic settlement	Between the outer face of the cladding and rebar (a steel reinforcing bar within the concrete itself) and aligned with this	Subsidence around a rebar / excessive water in the mix	Ten minutes to three hours
Plastic shrinkage	Diagonal or random	Excessive early evaporation	Thirty minutes to six hours
Thermal expansion and contraction	Transverse (example: across the panel)	Excessive heat generation or temperature gradients related to concrete curing	One day to two or three weeks
Drying shrinkage	Transverse or pattern	Excessive water in the mix / poor joint placement / joints over spaced	Weeks to months
Freezing and thawing	Typically wide defects in the external surfaces but not deep	Inadequate air entrainment; non-durable coarse aggregate	After one or more winters
Corrosion of reinforcement	Above reinforcement	Inadequate concrete cover; ingress of moisture or chloride	More than two years
Alkali reaction	‘Map’ style pattern cracks / cracks parallel to joints or edges	Reactive aggregate plus moisture	Typically, over five years, but may be much sooner with highly reactive aggregate
Sulfate (eg detergent) attack	Irregular pattern cracks	External or internal sulfate (eg detergents promoting the formation of ettringite. Ettringite is a hydrous calcium aluminium sulfate mineral. It can be yellow or colourless.)	One to five years

Table B - Cracking defects

Type of Cracking	Typical image
Freezing and thawing Crack tends to be wide at the surface but not deep.	
Carbonation Cracks tend to appear in straight lines over the reinforcement that is slowly corroding. The cracks develop over a length or area of reinforcement. After more deterioration, the concrete will spall off exposing the reinforcement. Any exposed reinforcement is corroded into a smooth profile. Tapping with a hammer may give an early detection of change. Specialist testing can determine the cause precisely.	 

Type of Cracking	Typical image
Chloride induced corrosion Areas of reinforcement are affected. Any areas of exposed reinforcement tend to be ragged or pitted. Early detection can be made by hammer tap testing to check for delaminated concrete. Specialist testing can determine the cause precisely.	 
Alkali-aggregate reaction A ‘map’ pattern of cracks may occur, often with white gel at the surface (inset).	

Type of Cracking	Typical image
Sulfate (eg caused by detergent) Irregular pattern cracks.	

4.4.2 Presence of water

Surveys should look for areas or parts of the concrete that are damp or wet. Identify where possible, the source(s) of moisture. Any leaking gutter, pipe or other water run-off could be important, so the survey should look for water stains, which should be noted. Defects in a vapour barrier are also likely to result in water penetration, damp patches, mould or rust stains.

4.4.3 Possible impact damage

Damage due to external impact may be identified by looking for various indicators, including:

- the impact is likely to be at, or close to ground level
- the damage is likely to be restricted to the immediate area of the impact
- the panel may to be deflected in some way
- any reinforcement exposed will not be heavily corroded within a few weeks of the impact occurring
- paint (or debris) residue from the impacting item

Impact damage will appear suddenly, in contrast to most other defects (which develop slowly).

4.4 Surveying of delamination

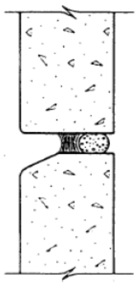
Tapping on the concrete surface with a light hammer will help to detect delamination around the concrete structure or identify any loose aggregate in the surface of the substance. A hammer of about 1lb (450 grams) weight is ideal for this purpose. The surface of the concrete is tapped lightly. There will be a very noticeable change in tone if the concrete is delaminated. Where access is not possible, a visual inspection can seek to locate delamination, looking for surface irregularities in areas next to cracks.

4.5 Survey of the sealant

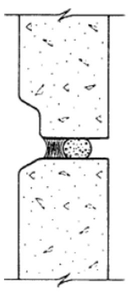
Precast concrete facades use this type of joint with a single line of defence, for its weatherproofing capacity, which is normally in the form of a sealant applied close to the exterior surface. The outer seal is designed to be replaced over the life of the building, generally every 20 to 25 years.

<u>Typical profiles</u>

Recessed butt joint - typical

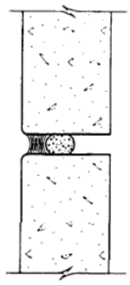


Horizontal joint

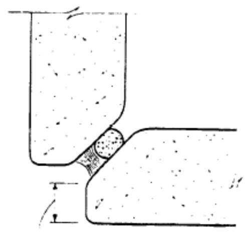


Alternative profile

Flush butt joint (least desirable)

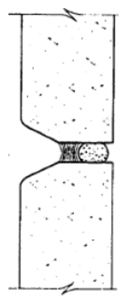


Recessed corner joint

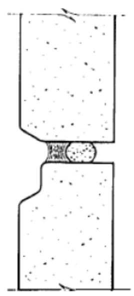


(13 mm x maximum aggregate size used, or 19mm minimum)

Recessed butt joint - typical

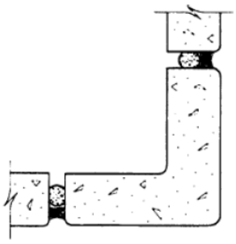


Vertical joint

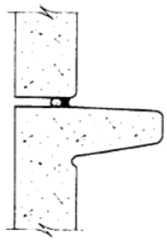


Alternative profile

Corner joint detail



Joints in panel with narrow ribs



Sealants are to be checked for the following:

- visual inspection of the continuity of seal
- visual inspection for signs of deterioration, such as cracks or colour changes due to ultra violet (UV) light

5 Risk assessment - changes to cladding materials over time

5.1 Concrete

In the past, concrete was seen as a material that does not deteriorate. This is a misconception and there are multiple examples of deterioration. Defects may occur early in a building's lifespan and may be linked to environments close to salt water (costal locations).

Maintenance measures for reducing the risk of concrete deterioration include the following:

- cleaning
- crack repairs
- applying coatings and sealers
- replacing sealers and movement joints
- preventing water ingress or persistent dampness, for example from broken or inefficient drainage

5.2 Deterioration - concrete

Deterioration of precast concrete will be visible in one of the following forms:

- cracks - these may develop into spalls
- corrosion of internal steel reinforcement - an early sign of corrosion occurring may be visible rust stains on the surface. This is one of the most likely causes of cracks and spalling
- spalling - where some parts of the concrete detach, fall off and leave a residual void

5.3 Steel (Reinforcement) [2]

Corrosion of embedded steel is the most common cause of concrete problems. Corroding steel expands and can crack the surrounding concrete and cause sections of concrete to break loose in flakes.

Steel rebar is typically protected by a thin film that develops as part of a chemical reaction with the cement in concrete.

The coating, termed passivity lowers the rate of corrosion to a point at which it becomes insignificant. Several conditions can damage this passive coating, increasing the corrosion rate of reinforcement steel.

[2] This does not apply to stainless steels

To achieve passivity, the concrete should maintain a level of alkalinity between 9.5 and 13.
If the alkalinity is too low, the rate at which embedded steel deteriorates will increase. Low alkalinity forms either by acidic gases, such as carbon dioxide (CO2) absorbed into the concrete, or by leaching of water. Being a porous material, the concrete surrounding the steel may absorb CO2 and water. Both CO2 and water can also be absorbed through cracks caused by excessive structural loading, shrinkage, or plastic settlement.

Inadequate coverage of the steel reinforcement is especially common in the risers of concrete stairs, or near to control joints installed perpendicular to the embedded rebar. In the latter circumstance, localized cracking can be found at locations where the rebar and control joints overlap.

5.4 Deterioration - steel (corrosion stages)[3]

When concrete becomes contaminated or gives reduced protection, corrosion of steel reinforcement may occur where used within the cladding unit.

Once initiated, the corrosion process is difficult to stop.

The products produced from the corrosion process are larger than the original steel and the subsequent expansion causes cracks in the concrete, which may allow for further deterioration in an ongoing cycle.

The corrosion process for reinforced steel is defined by two phases:

- the Initiation Phase
- the Propagation Phase

By definition:
- the Initiation Phase is the time taken to become exposed or subject to contamination and hence conducive to corrosion
- the Propagation Phase is the period in which the accelerated corrosion of the steel leads to rust, cracking and spalling

Once the structure is inspected, it should be possible to establish in which phase the structure currently resides.

If within the corrosion propagation phase, a more reactive maintenance regime will be required. Early detection of structural defects through prompt diagnosis allows defects to be treated promptly.

[3] This does not apply to stainless steels

5.5 Risk assessment guidance

The important question to answer is:

- Is the defect likely to result in pieces of concrete falling and possibly the entire panel?

The illustrations in Appendix 1 give a guide for assessment of the safety risks but cannot cover every possible defect or occurrence.

Any falling concrete constitutes a hazard, but some consideration needs to be given to the height from which it may be falling.

It is difficult to be certain of the sizes or weights of pieces of concrete and heights of falls, which risk causing injury to persons.

If in doubt, it is better to take a safe approach and make temporary arrangements to prevent access to the area underneath the defect until an inspection by a specialist is completed.

The recommendations of a specialist should be followed to establish a safe environment.

5.6 Health and safety guidance

Any school or responsible body planning to operate, procure or accommodate any building inspection, maintenance or construction activity, is advised to consult a competent health and safety advisor.

Guidance on health and safety aspects is available from the HSE website http://www.hse.gov.uk.

This document is also available from our website gov.uk/esfa.

Appendix 1 - Cladding defect examples

* All recommended actions to include:
1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No	Description	Cause and structural risk	Photo	Recommended action and safety risk*
1.	Crack in the precast at the interface with the window	Cause: Water ingress at the joint Risk: Crack increase in length and depth due to further water and possible freeze/thaw		Application of a sealant may reduce rate of deterioration. Safety: no immediate cause for concern. Long term risk of cracking developing to an isolated part of concrete and to fall off.
2.	Cracking at the corners and interfaces	Cause: Water ingress at joint with adjacent panel. Lack of (or deterioration of) adequate fixing. Risk: Crack increase in length and depth due to further water and possible freeze / thaw.		

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
3.	Possible settlement cracks	Cause: Defect in the means of support of the panel, or possibly in the fabrication stage. Risk: The integrity of the panel is not secure. Cracks may increase in severity.		Consider increasing the frequency of surveys for this defect. Application of a sealant may reduce rate of deterioration but will not solve the main problem which is the overall stability of the panel. Safety: moderate cause for concern.
4.	Cracks-possible water leak	Cause: Water may be leaking into the panel. In the example, water may come directly from the item fixed to the surface, or possibly the method of fixing allows water to ingress. Risk: Crack increase in length and depth due to further water and possible freeze / thaw.		Application of a sealant may reduce rate of deterioration. Safety: no immediate cause for concern. Long term risk of cracking developing to an isolated part of concrete and to fall off.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
5.	Spalling concrete on the corner of the building Exposed reinforcement	Cause: Long term cracking has deteriorated and reinforcement has corroded due to moisture, causing spall. Low cover to the reinforcement may have contributed. Adjacent panels also spalled due to close attachment of panels. Risk: The spalled areas now have low cover to reinforcement and may contribute to deteriorate. The low cover may be widespread.		Consider increasing the frequency of surveys for this defect. Arrange for a close inspection to check for any delaminated or loose concrete. Safety: moderate cause for concern, Any loose or delaminated concrete has a high risk of falling. The risk here is that loose materials may fall away again at some point. An action may be to remove any concrete at risk, seal any cracks and apply coating to the reinforcement, and then keep monitoring. Application of a suitable coating to the reinforcement may reduce rate of deterioration but will not solve any problem with the concrete.
6.	Spalling concrete	Cause: Long term cracking has deteriorated and reinforcement has corroded due to moisture, causing spall. Low cover to the reinforcement may have contributed. Adjacent panels also spalled due to close attachment of panels. Risk: The spalled areas now have low cover to reinforcement and may continue to deteriorate. The low cover may be widespread.		

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
7.	Spalling concrete	Cause: Water may come directly from the item fixed to the surface, or possibly the initial method of fixing the damaged panel. Risk: The spalled areas now have low cover to reinforcement and may continue to deteriorate.		Arrange for a close inspection to check for any delaminated or loose concrete. Safety: no immediate cause for concern unless there are pieces of loose concrete. The example illustrated appears to have already spalled any loose concrete, but is likely to continue to deteriorate over a period of months.
8.	Spalling concrete (same problem on different levels)	Cause: Possible causes could be a water leak, persistent weather direction, or defective installation. Risk: The spalled areas now have low cover to reinforcement and may continue to deteriorate.		Look for any clues why the defect is repeating. Arrange for a close inspection to check for any delaminated or loose concrete. Safety: moderate cause for concern if there are pieces of loose concrete. The example illustrated appears to have already spalled any loose concrete in which case there may be low risk, but it is likely to continue to deteriorate over a period of months.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

<table>
<tr><th>No.</th><th>Description</th><th>Cause and structural risk</th><th>Photo</th><th>Recommended action and safety risk*</th></tr>
<tr><td>9.</td><td>Spalling at corners</td><td>Cause:

The corners are more liable to defects due to possible low cover to the reinforcement resulting in cracks and possible carbonation.

Risk:

The spalled areas now give poor cover to reinforcement and may continue to deteriorate.</td><td></td><td>Arrange for a close inspection to check for any delaminated or loose concrete. Application of a suitable coating to exposed reinforcement will reduce risk of further deterioration but only partly.

Safety: moderate cause for concern if there are pieces of loose concrete. The example illustrated appears to have already spalled any loose concrete in which case it may be a low risk, but is likely to continue to deteriorate over a period of months.</td></tr>
<tr><td>10.</td><td>As above.</td><td></td><td></td><td>As above.
Safety: these examples have not been observed so closely, and it is more difficult to see if there may be any loose concrete.</td></tr>
</table>

* All recommended actions to include:

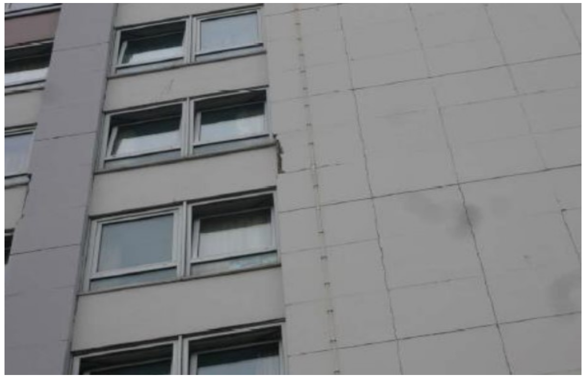
1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
11.	Spalling concrete - large areas (Note long, fine cracks)	Cause: See above spalling examples. Also, the fixing to the surface may have damaged the surface and / or be allowing water ingress. Risk: The panel may be weakend due to the large loss of concrete. The same cause may be continuing.		Arrange for a close inspection to check for any delaminated or loose concrete. Safety: moderate to high cause for concern if there are cracks in the panel and / or pieces of loose concrete.
12.	Joints in the precast are cracking and sealant is failing	Cause: The sealant may have deteriorated or not been fully installed. Risk: Water ingress may cause further damage to the concrete.		Application of a sealant may reduce rate of deterioration. Safety: no immediate cause for concern. Long term risk of further deterioration to the panels.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
13.	Window and roof interface details of the precast facade	Cause: Any interfaces may be vulnerable to deterioration. In this case accumulation of water on the roof, (or possibly snow or rain bouncing back up) may have resulted in water ingress. The item fixed to the surface may also be a cause. Risk: The same cause may be continuing.		Safety: no immediate cause for concern as any falling concrete is not a hazard in this location. Long term risk of further deterioration to the panels. In this case, any failure in the panel may damage the item fixed to the surface.
14.	Sealant failing in the joints	Cause: Areas of failing sealant are likely to be due to a problem with the material (which will have a limited design life). Risk: Water ingress is likely to cause deterioration to the concrete panels.		Safety: no immediate cause for concern. Long term risk of further deterioration to the panels.

Appendix 1 - Cladding defect examples

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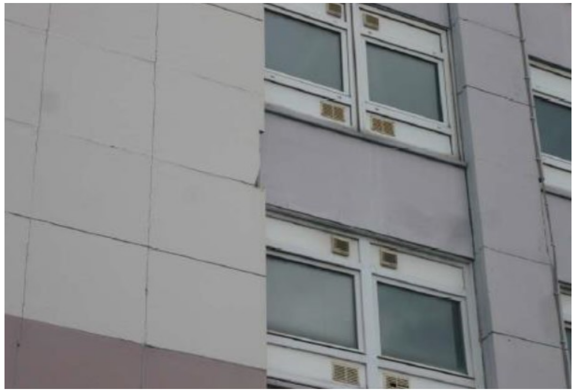
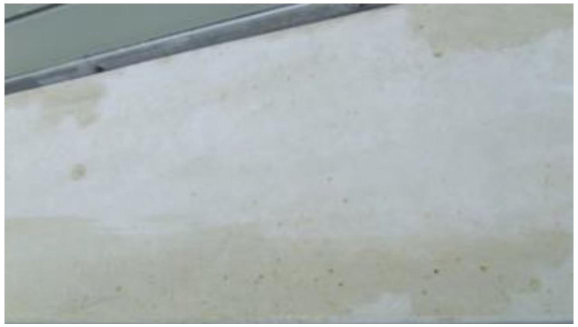
No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
15.	Other items in the fascia. This example: ducts for air intake	Cause: The air intakes (or similar insertions in the surface) will corrode if not provided with adequate protection. Corrosion of steel is expansive and may cause cracks in the surrounding concrete. Rust staining may be unsightly.		Application of a suitable coating would reduce risk. Safety: no immediate cause for concern.
16.	Damp area on the façade.	Cause: Water may ingress from inside or from above. Risk: The dampness will initiate corrosion to the reinforcement.		The reason for the dampness should be established and eliminated if possible. Safety: no immediate cause for concern.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

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2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
17.	Unclear defects (Some defects may occur that are not easy to define)	Cause: For defects in concrete the most likely cause is ingress of water. Risk: The extent and severity of the defect needs to be assessed to understand the risk to the structure.		The reason for the dampness should be established and eliminated if possible. Safety: the example shown seems to be of no immediate concern.
18.	Reinforcement visible	Cause: Lack of concrete cover to the reinforcement, possibly combined with water ingress. Risk: The deterioration will continue, leading to further areas of concrete spalling off.	 	Arrange for a close inspection to check for any delamination or loose concrete, and to judge the extent of concrete loss. Safety: this could be a moderate risk if there is no loose concrete and if the loss of concrete section is less than approximately 30mm. If either of these two conditions is exceeded, the risk should be considered as high.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

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2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
19.	Reinforcement visible (or rust staining)	Cause: Lack of concrete cover to the reinforcement, possibly combined with water ingress. Risk: The deterioration will continue, leading to areas of concrete spalling off.		Application of a suitable coating would reduce risk, but not completely. Safety: no immediate cause for concern unless support brackets are deteriorated. Long term risk in that deterioration will continue. Note that defects to the internal face, where visible, should be considered the same as to the external face.
20.	Local defects	Cause: Possibly, incorrect fixing screws used on the window fixing. Risk: The deterioration will continue, and will likely to lead to cracks.		Local repair may reduce risk of further deterioration. Safety: no immediate cause for concern.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
21.	Water ingress points	Lifting eyes used for construction have not been filled. Risk: Water stands in the opening and soaks into the concrete.		Arrange for the holes to be filled with suitable material. Check for signs of deterioration in the adjacent panels. Include inspections in future surveys, as deterioration may take time to appear. Safety: no immediate cause for concern.
22.	Significant cracks	Cause: Patterns of cracks or long and / or wide cracks indicate a significant problem. Risk: The integrity of the panel may be seriously reduced.		The panel should be considered as unstable, with pieces of concrete likely to fall. Arrange for a close inspection to check the condition. There may be a number of different causes (see examples in Table B). Safety: high risk of falling concrete.

Appendix 1 - Cladding defect examples

* All recommended actions to include:

1. Record location, severity and extent of defect (as accurately as reasonably possible), including photo
2. Monitor by checking any development in further surveys

No.	Description	Cause and structural risk	Photo	Recommended action and safety risk*
23.	Long and wide cracks	Cause : - As above. The pattern of crack shown is likely to be due to loading or other stress. Risk: The integrity of the panel may be seriously reduced.		The panel should be considered as unstable, with pieces of concrete likely to fall. Arrange for a close inspection to check the condition. Safety: high risk of falling concrete.
24.	Damp areas	Cause: Significant water ingress. Risk: The integrity of the panel may be seriously reduced.		The panel should be considered as unstable, with pieces of concrete likely to fall, at least until a close inspection is carried out to understand the extent of the defect. Safety: high risk of falling concrete.

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