Why Buildings Decay

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Common Causes of Decay

“Causes of decay are complex and there may be two or three operating simultaneously”

• Structural Issues
• Climatic Causes
• Botanical and Biological
• Insects and Animals
• Atmospheric Pollution
• Poor Construction, inappropriate repair and neglect
Diagram showing the structural loading on a typical domestic two storey building. The loading on a church building would be very similar.
Common Structural Elements

“Gravity is both the force that keeps buildings standing and the major cause of their destruction”

• Foundations
• Beams (eg. a stone lintel over a door/window)
• Arches (pointed and semi-circular)
• Vaults (an arched “ceiling” – usually stone)
• Walls
• Piers and columns
Damage caused to a vaulted roof by ground movement
Figure 6.9 Investigation of foundations, York Minster, England
(Courtesy: Shepherd Building Group Ltd)

The photograph shows that the voids were continuous and in fact ran from below the high altar nearly to the west end. Under the central tower the masonry had bent with the settlement, but luckily none of the voids had collapsed.
View of St Davids Cathedral nave looking west. Notice how the columns lean outwards. This is due to the weight of the roof and has been taking place over many centuries. Inadequate foundations and an earthquake have also played a part! Medieval masons built buttresses against the external walls of churches & cathedrals to counteract the sideways thrust caused by the weight of the roof.
View of St Davids Cathedral nave clerestory looking west
Parish Church of St Martin, Cwmyoy, Monmouthshire. Notice the pronounced lean of the tower and the buttress at its base to counteract it. The church is built on a hillside which over time has moved.

The next slide shows the nave of St Martin looking east. It illustrates how much the church has been affected by ground movement.
Climatic Causes – Sun

- **Sunlight**
  - UV light is particularly damaging to organic materials such as wood, textiles, pigments, etc
    - Causing colours to fade and surfaces to become brittle

- **Thermal Expansion**
  - Building materials expand when heated and contract when cooled
    - As a consequence, stresses can build up between the individual materials and the building as a whole
  - The seasonal temperature and the amount of sun, wind and rain falling directly onto different parts of a building all contribute to the overall thermal movement
Damage to untreated wood caused by the sun
Climatic Causes - Moisture

“Faulty disposal of rainwater is the most frequent cause of deterioration in ancient masonry”

• Rainwater washing against the surface of a structure will gradually wear it away
  – Mortar and porous masonry are particularly vulnerable

• Rainwater penetration into the individual materials of the structure causes more damage through:
  – Salt crystallisation
  – Continual wetting and drying
  – The action of frost and ice
Climatic Causes - Wind

- Wales is exposed to higher winds and rain fall than most other parts of the UK

- Wind can exert a strong directional force
  - The exposed side of a building can therefore be subject to a “pushing” action, while the protected (lee) side can experience a “suction”
  - Towers, spires and bell towers can move in high winds
    - Norwich Cathedral’s 325ft (99m) spire has been found to move to and fro around 3” (75mm) in a high wind!

- Wind exacerbates the general external erosion of most building materials
  - Roof coverings (eg. tiles, slates, lead and copper sheet) can be lifted in a high wind
  - hard grit particles can be driven into soft stone and brick pockets, boring holes into them by the action of the wind rotating the particles or scouring their surfaces
Damaged stonework probably caused by a combination of factors such as dust particle erosion, soft or poor quality stone, heat and frost
Botanical

- Ivy and other “creeping” plants can damage masonry if unchecked
  - Ivy drives a bullet-headed root into crumbling masonry causing disintegration of the material
    - If forcibly removed it can pull off a weak surface of brickwork or plaster
    - It should be killed first then removed when it has died back (usually after several weeks)
  - Care should be taken when inspecting an ivy covered wall
    - The ivy might possibly be the only thing holding it up!
- Climbing plants can be grown on frames or wires attached to walls
- The presence of plants growing in a wall is usually an indication of decayed mortar and excess moisture
- Large plants or shrubs growing at the base of walls can trap moisture and their roots can damage underground drains
- Trees near buildings can undermine their foundations and cause ground heave
- In clay soils trees can withdraw ground moisture causing the surrounding soil to shrink, thus causing movement of the foundations and subsequent cracking of walls
Ivy and masonry bee damage to historic brickwork
Daisies growing in an area of damaged mortar on a historic wall
Biological

• Bacteria, lichens, mosses and fungi can damage buildings
  – Bacteria and lichens produce acids which react chemically with the building materials
• Algae, moss and lichens produce humus in which larger and more damaging plants can grow
  – A build up of these can cause retention of moisture in the building materials
• Fungi, mildew, moulds and yeasts do not need sunlight for growth
  – Wood is particularly at risk from dry and wet rot fungus
  – Dry rot fungus attacks dry wood (it has its own moisture source)
  – Wet rot fungus needs a moisture content of 25% before it attacks wood
• Be careful when using fungicides and weed killers – they can damage the building materials!
An accumulation of moss on a roof will cause damage due to its weight, water retention and the lifting of tiles as it grows.
Insects

• Organic materials (such as wood) are most vulnerable to insect attack
• Incidence of beetle attack in the UK is:
  – Woodworm of common furniture beetle (80%)
  – Deathwatch beetle (5-8%)
  – Wood boring weevils (4-5%)
  – Power post beetle (2%)
  – House longhorn beetle (0.5%)
• Woodworm attack only the sapwood in oak but will also attack the heartwood in other soft & hardwoods
  – A large proportion of attacks are in roof spaces
  – If active the holes clean, sharp edged and cream coloured
  – If inactive the holes will be dirty and greyish in colour
  – Look for bore holes and sawdust as evidence of infestation
• Masonry bees
  – burrow in soft stone, weak bricks and crumbling mortar joints
Woodworm Boreholes

Woodworm Dust
Damage to a historic wall caused by masonry bees, an inappropriate pointing style and hard cement mortar. Some of the stone blocks have been replaced and now stand proud of the face of the wall.
Animals - Bats

• All species protected by law
  – It is an offence to kill them or disrupt their nesting sites
• If planning repair work, you will need to determine if bats are present and make a plan to minimise disruption to them
  – Consult your Local Authority, Local Wildlife Trust or the Bat Trust for advice
  – They may recommend a bat survey and report by a trained professional
  – Make sure you factor this into your schedule of work
• Try to minimise any places of entry into the building
  – If they are already present and could pose a real health hazard, you will need to seek professional advice to remove them
  – Take care when cleaning bat droppings and urine
Damage to brass caused by bat urine
Animals - Birds

• Nesting birds are protected by law
  – It is an offence to kill or disturb wild birds when nests are in use and to destroy their eggs
  – Good practice to avoid work that might disturb them from early March to Late August

• Congregating birds (such as feral pigeons) can cause problems when surfaces become covered with droppings and nest litter
  – Ensure you wear protective gloves and shoes when cleaning these areas
    • Bird droppings can be highly corrosive to building materials and a health hazard to people
Heavily soiled stonework due to bird droppings. Note the corner damage to one of the blocks. Corners are weak points and the corrosive nature of the bird droppings may have contributed to the damage.
Animals – Rats and Mice

• Can gain access to buildings through the smallest holes
  – Young mice can squeeze through a 6mm (1/4”) hole and young rats through a (1/3”) hole
• They are excellent climbers so don’t think small holes at the top of a wall are inaccessible to them
• Rats can burrow to a depth of 750 mm (30”) and dig long distances horizontally if the soil is loose (eg. around buried pipes and cables)
• They can (and do!) burrow into clay and chalk walls and thatched roofs
• Make sure that grills and vents are secure, also holes/cracks around windows, doors and pipes are sealed
• Wear protective gloves (and possibly masks) when cleaning up droppings and urine
Atmospheric Pollution

• Naturally weathering will cause stone to deteriorate over many thousands of years and bricks over several hundred years.
• This process is accelerated by pollutants released into the atmosphere:
  – Oxides from the burning of coal and oil
  – Nitrogen from vehicle exhausts
• These combine with moisture in the atmosphere to produce a corrosive mixture:
  – Typically sulphuric and nitric acids
• Direct contact with wet stone of pollutant particles can also cause severe decay (acid deposition):
  – Often more corrosive than acid rain
  – Can attack sheltered areas not reached by acid rain

http://www.qub.ac.uk/geomaterials/weathering/usd.html
Atmospheric Pollutants Can Attack:

- Stone
- Bricks, roofing tiles and terracotta
  - Frost resistant products usually OK
- Mortars, renders, cement and concrete
- Glass
- Ferrous metals
- Non-ferrous metals
Poor Construction

- Cowboy builders are not a new phenomenon!
  - Georgian builders often used inferior quality building materials

- Everything is not always as it seems
  - Some “stone” Georgian and Victorian buildings only have an outer face (or skin) of stone which is tied back to the structure with iron cramps
    - These cramps are susceptible to rust

- Many medieval buildings have no foundations or very shallow ones
  - The foundations of York Minster were underpinned because of settlements
Inappropriate Repairs

• Using modern cement mortar to repoint old walls
• Chemically injected damp proof courses
• Application of water repellent coverings to exterior walls (and renders)
• Use of modern emulsion paints on internal walls
When a historic solid wall is covered with modern impermeable materials, the wall cannot control its own moisture content and consequently suffers from accelerated decay.
Spalling of stone in a historic wall due to the inappropriate use of hard cement mortar
The gaps in the mortar at the base of this wall are caused by “splashback” from rain falling on the hard cobbles at its base. Notice also the open holes (just above the level of the red brick) where a damp proof course (dpc) has been chemically injected. The area above the holes still appears to be damp suggesting that the dpc is not working.
Neglect

• Blocked rainwater goods, broken grills and plants growing in gutters and walls
  – Encourages moisture to penetrate the fabric
• Slipped and missing roofing tiles
• Rusting metal windows
• Exposed woodwork
• Algae and fungal growths
• Excessive moisture inside the building
• Etc, etc, etc!!!
Any Questions?

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