

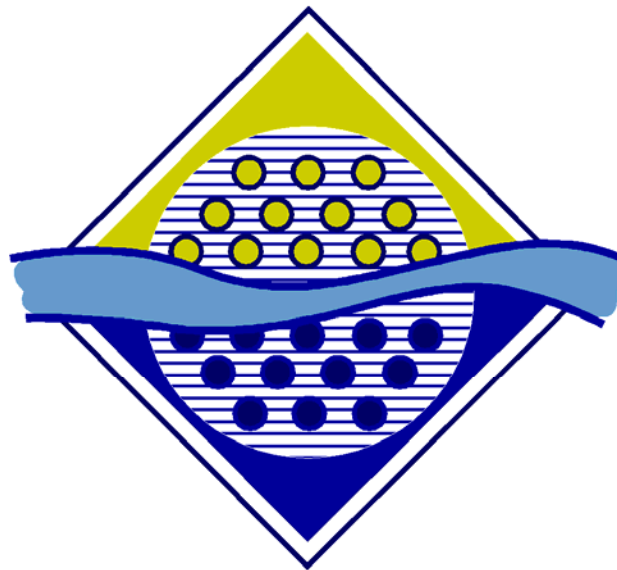


Department of
Environment and Conservation



Acid Sulfate Soils Guideline Series

IS MY HOUSE BUILT ON ACID SULFATE SOILS?



ACID SULFATE SOILS

information and awareness

What are acid sulfate soils, and why are they a problem?

Acid sulfate soils are naturally occurring waterlogged soils that contain pyrite or other iron sulfide minerals. These soils are found in low-lying coastal areas, especially next to estuaries. Pyrite also occurs in material dredged from some estuaries. Acid sulfate soils are also often found adjacent to some wetlands elsewhere on the Swan Coastal Plain, and near salt lakes or seasonally waterlogged land in inland areas of the State.

These soils are harmless if they are not disturbed. However, if they are exposed to air by drainage, excavation or excessive pumping of groundwater, the pyrite will react with oxygen from the air to form sulfuric acid and sulfate minerals, and the soil may swell. If houses or other urban infrastructure are built directly on acid sulfate soils that are being exposed to oxygen, there is a risk that structural damage to houses will take place.

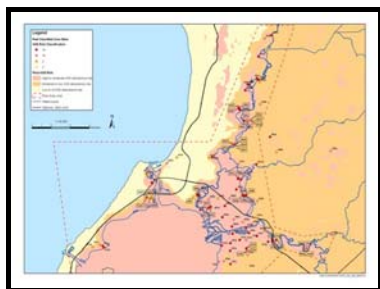
The structural damage may be caused by chemical reactions of sulfuric acid and sulfate minerals with the concrete, which reduce its strength. The upward and outward forces generated by swelling soils beneath houses may also cause concrete floors to 'heave' upwards by several centimetres, may crack walls, and may distort door and window frames. This often makes it difficult to open and shut doors and windows in houses that are being damaged by pyrite oxidation. Generally, structural damage to houses by pyrite is caused by a combination of chemical and physical factors. These structural problems can be expensive to repair, and require specialised engineering techniques to be used so that problems do not recur.

As many houses were built before the issue of acid sulfate soils was recognised in Western Australia, special building techniques and materials that can prevent structural damage taking place from pyrite oxidation were not used. Therefore, it is important that homeowners are able to recognise the signs of structural damage so that technical help can be obtained quickly if there is evidence that house damage may be occurring.

This brochure provides an inventory of visual indicators of acid sulfate soil effects that homeowners can look for inside the house, on exterior walls and paved areas, and in the garden to help determine whether structural damage might be occurring. The presence of only one or two of the following indicators is generally of no concern. However, the more of the following visual indicators you find, the more significant is the risk that your house is being damaged by pyrite oxidation. There are also many other possible causes of structural damage, but a detailed investigation is required to identify these. It is recommended that you contact either your Local Government Authority or a structural engineer for advice if you either find extensive cracking in floors or walls, or see more than two of the other visual indicators outlined below.

How do I find out if acid sulfate soils are likely to occur in my neighbourhood?

The Department of Environment and Conservation (DEC) has compiled broad-scale risk maps for several coastal regions of WA where a high or moderate probability of ASS occurrence has been identified. The ASS risk maps are accessible via Landgate's Shared Land Information Platform (SLIP) which delivers land-based spatial information. Details on how to access risk maps and ASS data is available on DEC's website at www.dec.wa.gov.au/ass



The ASS maps show two risk categories –

- **Class 1** – (red/pink) high to moderate risk of ASS occurring within 3m of natural soil surface.
- **Class 2** – (orange) moderate to low risk of ASS occurring within 3m of natural soil surface but high to moderate risk of ASS deeper than 3m of natural soil surface.

Areas outside these two risk categories have not been assessed due to the absence of suitable geological and geochemical information, however, ASS materials may occur in these areas.

In regions where acid sulfate risk soils maps do not yet exist, areas with the following features should be considered to have a high risk of being underlain by acid sulfate soils:

- Low-lying coastal areas (less than five metres above sea level), particularly near mangroves or salt marshes.
- Land next to wetlands or seasonally waterlogged areas that are less than five metres higher than these features.
- Land where dredge spoil or waste materials from mine sites have been used as construction fill for development sites.

Visually assessing whether acid sulfate soils are oxidising beneath your property

External paved surfaces

The best place to start looking for signs of structural damage is outside of the house in carports, garages or on concrete patios. The most obvious signs of damage caused by swelling of soil beneath house foundations are star-shaped cracks in concrete paving and floor surfaces (Figure 1). The floor may also bulge upwards in the vicinity of these cracks – check by using a large spirit level. There is often a fine white 'chalky' deposit around the edges of the cracks that can be seen to consist of a mass of needle-like crystals when viewed with a magnifying glass. These crystals are very delicate and disintegrate as soon as they are touched.

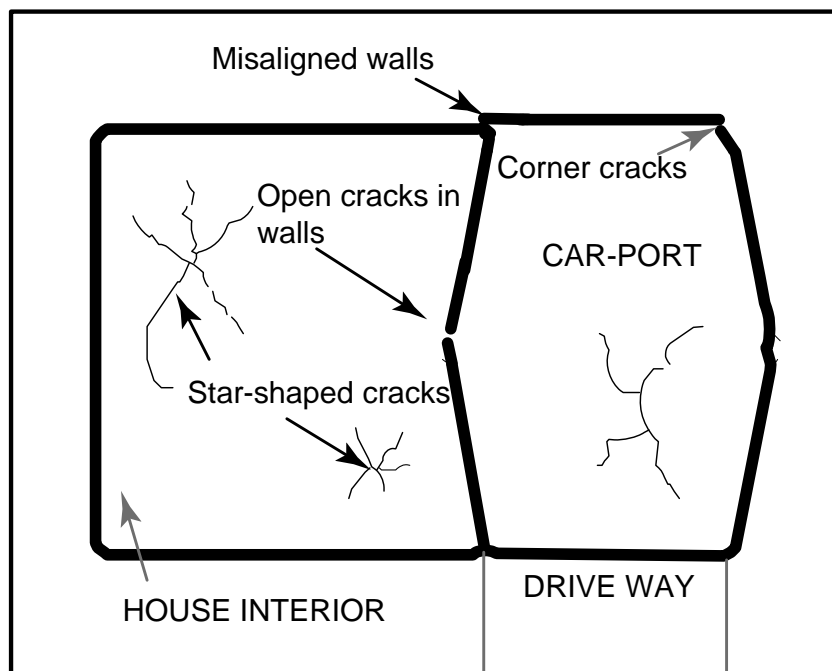


Figure 1. Typical pattern of cracking of floors and walls caused by the oxidation of pyrite beneath house foundations (adapted from ACQC, 1999).

If the concrete around cracks crumbles when prodded with a screwdriver, it is likely that it has been affected by chemical reactions with sulfuric acid and sulfate salts in the underlying soil, a process known as 'sulfation'. Areas affected by sulfation can be identified by lightly tapping the concrete floor with a hammer. These areas sound 'dull' or 'hollow' in comparison with solid concrete.

External walls

The large lateral forces that can be generated by swelling soils can exert very large stresses on walls that can lead to cracking and displacement of brickwork. Cracking in walls is often first seen in the corners of carports or garages, and it often appears as if one wall is 'peeling away' from another, with the cracks progressively increasing in size over a period of months or years.

Large cracks may eventually also appear in the middle of external walls. Often the brickwork on one side of these cracks bulges out more than on the other side of the crack – the amount of displacement can be tested with a large spirit level. Occasionally whole sections of wall are displaced outwards, and although they run parallel to the main body of the wall, they may be misaligned by a few millimetres (Figure 1).

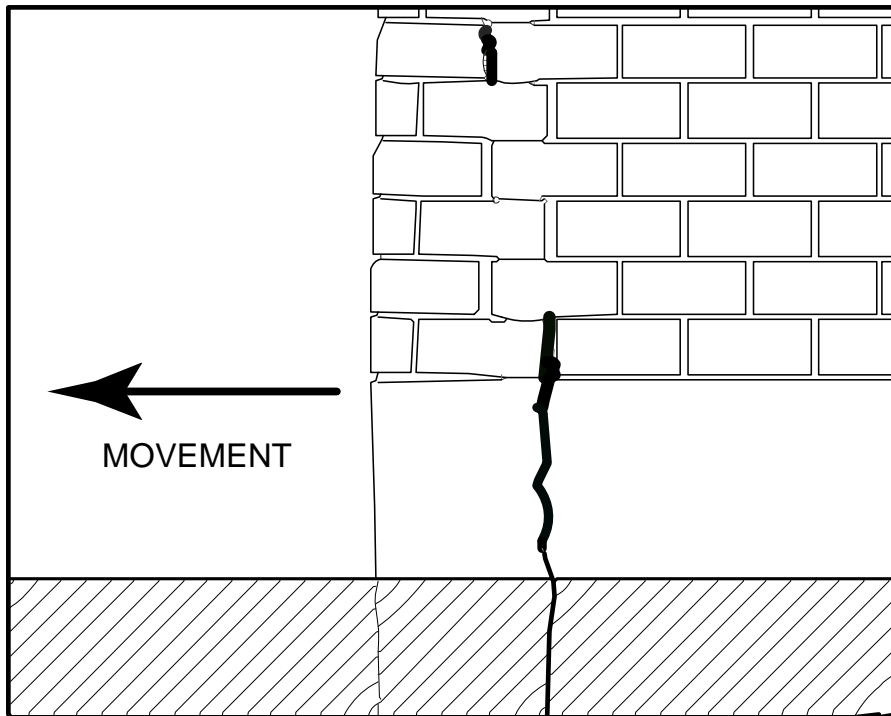


Figure 2. Cracking and increased lateral displacement of basal courses of bricks or stonework (adapted from ACQC, 1999).

The lateral forces exerted on walls by swelling pyritic soils may also displace lower courses of bricks more than bricks higher in the wall, causing cracking near corners, and slumping of some sections of brickwork (Figure 2).

The mortar between bricks near ground level may often flake and progressively fall out, and the surface of adjacent bricks may also become badly corroded in cases where houses have been built on acidifying soils.

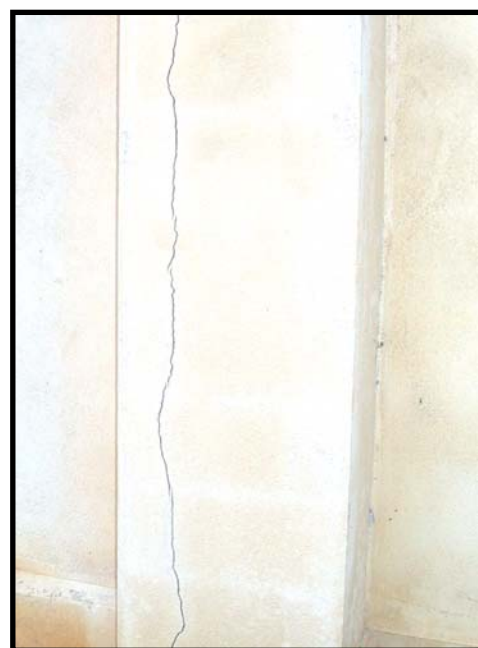


Figure 3. Cracks in external walls

Garden

The first visual indications of oxidising acid sulfate soils in gardens are often the appearance of bare patches in lawns or garden beds. These patches differ from patches caused by water repellent soils or lawn beetle attack in that they are often covered with an oily looking black slime in winter. These bare patches (Figure 3) are acid scalds, and in summer the surface soil may be very acidic, and contain soluble aluminium at levels that are toxic to most plants. The slime that forms in winter consists of iron monosulfide minerals that form from the chemical reaction of iron and sulfate with organic matter in the lawn. The slime layer usually disappears in dry weather, sometimes leaving a thin rusty layer or 'fluffy' white sulfate salt crystals on the soil surface.



Figure 4. Acid scalds in turf

If you dig into an acid scald in summer, soil just beneath the surface may have brown rusty looking mottles, and often contains bright yellow streaks and mottles. The yellow material is an iron sulfate mineral called jarosite. This mineral only forms when soil is very acidic (a pH of less than 3.5). Always wear gardening gloves when digging in very acidic soil and avoid skin contact with this material as it may cause skin irritation in sensitive individuals.

The disintegration and disappearance of iron monosulfide black slime layers in summer releases acid that can cause intense corrosion of metal posts and sheds in gardens. The corrosion typically only occurs in a distinct layer at ground level (Figure 4).



Figure 5. Corroded metal fence

House interior

Structural damage caused by the oxidation of pyritic soil is often difficult to detect inside the house because the effects are often obscured by floor coverings and plaster coatings on walls.

Often the first sign that there may be a problem is when interior doors become difficult to close and scrape the floor surface when being opened and shut. On floor surfaces covered with ceramic tiles or wood parquetry, tiles may become loose in particular areas for no apparent reason. If these features are seen in a room, check how flat the floor is by using a length of cord and a spirit level to make a horizontal reference line across the room. Note any areas where the floor surface appears to bulge upwards and the magnitude of the bulges. If floors are covered by rugs or loosely fitting carpets, it may be possible to pull the covering back to look at the underlying concrete floor. The presence of star-shaped radial cracks and/or white chalky deposits in areas with bulges may indicate damage is being caused by the oxidation of pyrite in soil beneath the concrete slab of the house.

Fine 'hairline' cracks that are often seen on plasterwork inside houses are generally of no concern, and often result from minor shrinkage of plaster or settling of new brickwork. However, cracks more than one millimetre wide may be of concern, particularly if there is evidence that plaster is flaking from the edges of the cracks and is falling to the floor and if the wall surface across the crack is not level.

References and additional information sources

Association des Consommateurs pour la Qualité dans la Construction (ACQC),
Pyrite and your House <http://www.consommateur.qc.ca/acqc/PyriHouse.pdf>

Department of Environment and Conservation -- information on acid sulfate soils in Western Australia and management guideline documents are available at web site www.dec.wa.gov.au/ass

National Working Party on Coastal Acid Sulfate Soils -- *An Introduction to Acid Sulfate Soils* available at http://www.mincos.gov.au/_data/assets/pdf_file/0003/316065/natass.pdf

Queensland Department of Natural Resources Management -- general information and fact sheets on acid sulfate soils are available at <http://www.nrm.qld.gov.au/land/ass/>.

Your evaluation

External paved surfaces

Star-shaped cracks on concrete paving in car-ports, garages and patios

White chalky deposits around cracks

Edges of cracks crumble easily when prodded with a screwdriver

Areas of concrete that have a 'dull' or 'hollow' sound when tapped with a hammer

External walls

Vertical cracking in corners inside garages or car-ports

Cracks on external walls with visible displacement of brickwork

Cracks near corners of external walls with displacement and slumping of brickwork near ground level

Mortar between bricks near ground level is falling out

Brick surfaces near ground level are corroding

Garden

Bare patches in the lawn that are covered with black slime in winter

The black slime disappears in summer leaving a thin rusty layer or some white salts

Soil beneath the bare patches has rusty brown or yellow mottles in summer

Metal posts, sheds or other metal fittings are corroded in a distinct layer at ground level

House interior

Internal doors that are difficult to open and shut and scrape the floor

Areas with loose floor tiles

Radial star-shaped cracks visible in concrete below floor coverings

Cracks more than 1 mm wide in walls with flaking plaster and visible displacement of the wall