What is collapsible ground?

Certain types of ground may contain layers that are prone to undergo a sudden and permanent reduction in volume (collapse) due to the metastability of an internal microfabric within the deposit.

Overview

- Some kinds of natural deposit can collapse, i.e., they undergo a rapid reduction in volume. This can occur when they are loaded and subsequently saturated with water.
- Collapsible deposits can lead to damage to buildings and infrastructure such as building foundations and underground utilities (e.g., water, gas, electricity).
- Loessic silts are thought to be the only rock type in the UK prone to collapse and these are largely confined to south-east Essex and northern Kent.
- The BGS produces 1:50 000 maps of the potential for collapsible ground in England, Scotland and Wales.

Why does it occur?

Collapse occurs when collapsible deposits are loaded and subsequently saturated with water. This is followed by a rapid reduction in volume of the ground, which can lead to differential settlement.

As a result of their mode of formation and mineral composition, collapsible deposits are remarkably open at a microscopic scale. Clay-sized particles both coat individual silt grains and form bridges between quartz particles thus producing a relatively high amount of voids within the deposit. The open structure is held together by bonding of the clay minerals, the strength of which is generally thought to increase with time. However, this open structure is only metastable, as the bonding mechanism may hold together under the weight of a considerable thickness of overlying deposits, but under conditions of additional loading and wetting will often collapse.

If a building is constructed on collapsible deposits (such as loess) that are already saturated, normal settlement or staged collapse of the ground will tend to occur during foundation construction, so that by the time the building is complete the ground will have lost its potential to collapse. Problems arise when buildings are constructed on relatively strong, partially saturated deposits that become weakened on subsequent saturation. Saturation might occur through changes in the local water table, following leakage from service pipes, or from installation of a soakaway.

While some thick metastable brickearths will collapse ‘under their own weight’ when saturated with water, in the UK, thicknesses of loessic deposits are such that they should not provide sufficient weight for self-collapse.

Even where they may be prone to collapse, surface loessic deposits of less than 1 m thickness are unlikely to cause significant difficulties to engineering construction. Such deposits are likely to be largely removed during site preparation or

Building damage caused by collapse of brickearth deposits in Torbay, UK. Image © NERC.
are unlikely to affect shallow foundations, which are generally excavated to depths of at least 1–2 m below ground level.

Watch an animation of collapsible ground (click here).

**What problems can it cause?**

The amount by which the ground can collapse is determined by the thickness of the collapsible deposit and by its material characteristics, such as porosity (the overall volume of voids within the deposit). Collapse might involve a relatively small reduction in volume, perhaps of only one per cent of the thickness of the deposit (say 10 millimetres in a 1 metre thickness of collapsible ground). However, rapid subsidence (collapse) of only a few millimetres can cause damage to buildings or utility services, particularly if it leads to the uneven removal of support from beneath a structure.

**What is the cost to the UK economy?**

No estimates of the cost to the UK economy are available. However, the distribution of collapsible ground in the UK is much more limited than for most other kinds of geological hazard, and very specific conditions are required to trigger the hazard. This means that the overall cost to the economy is likely to be modest.

**UK Example**

Subsidence at a house in Torbay, East Devon, has been attributed to the collapse of metastable loessic materials in the shallow subsurface. The house was demolished.

**Where does it occur?**

It is thought that the only rock type occurring in the UK that is prone to collapse is loessic silt. Loess is a silty, wind-blown deposit. It forms in arid areas, typically during periods of cold climate. Loess in the UK is usually described as brickearth.

*Loessic silt, or brickearth, deposits overlying Thanet Beds at Cliffsend, Pegwell Bay, near Ramsgate in Kent. Image © NERC.*

*Potentially collapsible deposits in the UK are confined to south-east Essex and northern Kent. Image © NERC.*
Areas of the UK that are significantly susceptible to this hazard are largely confined to south-east Essex and northern Kent.

However, it is possible that in other areas of the UK, pockets of loess remain that have not been recognised or that, for some reason, are not shown on geological maps, but which are sufficiently thick to present geotechnical problems. This appears to be the case in east Devon.

**Scientific detail**

**How is the hazard measured?**

The general distribution of loessic deposits is determined by geological survey.

The presence of such deposits at a particular site would be determined by conventional ground investigations involving trial pits or shallow boreholes, or both.

The presence of a collapsible metastable deposit at a particular site requires detailed laboratory tests on undisturbed samples. These tests are normally carried out with an odometer.

**How often is the hazard measured?**

Regional geological surveys are generally carried out at intervals of many decades. There are no current plans for a resurvey of the areas that are most susceptible to this hazard, as the local geological maps are considered fit for purpose.

Site investigation and laboratory testing are carried out according to specific needs, for example prior to construction on a previously undeveloped site on a possibly collapsible deposit.

**How is the hazard characterised?**

The severity of the hazard is characterised by the BGS according to the likelihood that collapsible ground is present at a particular site. This is inferred from (a) the recorded distribution of loessic silts and (b) the proven occurrence of a collapsible deposit, based on laboratory tests.

**Triggering mechanisms**

The hazard is triggered by first loading the ground, for example by the construction of a building, and then saturating it with water, for example by rising groundwater, leaking service pipes or surface flooding.

**Scenarios for future events**

The worst case scenario would be of an extensive building programme or construction project that included foundations within or above deposits that are prone to collapse, but where the presence of such deposits was not recognised by appropriate ground investigation or materials testing. If this was followed by extensive flooding or elevation of groundwater levels in that area, ground collapse could be triggered.

**BGS data**

- BGS GeoReports [www.shop.bgs.ac.uk/Georeports](http://www.shop.bgs.ac.uk/Georeports)
- BGS GeoSure: National Ground Stability Data [www.bgs.ac.uk/products/geosure/collapsible.html](http://www.bgs.ac.uk/products/geosure/collapsible.html)

Further information

Contact the BGS Shallow Geohazards team by:

Email: enquiries@bgs.ac.uk
Telephone: 0115 936 3143

BGS GeoSure website:
[www.bgs.ac.uk/products/geosure/home.html](http://www.bgs.ac.uk/products/geosure/home.html)