
Building undermind coast erosion

HAZARDS 2

Several types of hazards result from the nature and behavior of ground near the surface of the Earth, principally where weaker materials cover hard rocks or active erosion is taking place due to the action of water, wind or ice.

Weak geological materials, such as unconsolidated sand, silts and soft clays, naturally weather back to lower angles until the slope becomes stable. Subsequent steepening, whether through natural erosion, or excavations, such as cuttings and quarries, may cause slope failure. Similarly accumulations of loose natural debris and man-made structures such as tips, dams and embankments can become unstable.

There are two main types of movements in unstable slopes: materials containing appreciable amounts of water flowing down the slope (flows); and less saturated materials moving across underlying strata as a result of high water pressure immediately beneath the moving mass (slide). Water has a strong influence in both. Therefore major events tend to follow periods of heavy rainfall, melting of snow or ice, or significant leakage from broken water pipes. The scale of movements can vary from small quantities of soil to many cubic kilometres of rock. These may take place slowly or suddenly but usually there are warning signs such as the appearance of cracks in the ground and unusual discharges of water from slopes. Major slides frequently occur because of reactivation of earlier landslides.

Landslides are dealt with by re-profiling slopes or draining water. Where the problem is too large to solve or cannot be dealt with quickly, monitoring and warning systems may have to be relied upon. In most cases, failure occurs in appreciable slopes but some geological materials, notably weak clays, may move at very slight gradients. Movement of some materials, especially sensitive "quick clays", can be triggered when lateral support is removed by erosion or digging with no ground slope at all. Climate change affects the potential for landslides if increased rainfall and higher groundwater pressures occur.

Strong erosion of weak rocks by the scouring action of sea or river water, and water emerging from the face can lead to rapid retreat of cliffs with consequent loss of land and property. Sediment produced by erosion is carried away and deposited elsewhere thus protecting the receiving area from erosion. Erosion can be delayed or halted by works such as embankments and groynes. However this cuts off the supply of sediment to other areas that may, in turn, suffer erosion. Therefore erosion-deposition systems need to be considered as a whole before any remedial works are undertaken.

Strong rocks form steep cliffs. If these are weakened by fractures, rock falls occur. Small potential rockfalls can be dealt with by removing loose material, pinning blocks to the slope, supporting these or concreting them in place, or cutting the slope to a lower angle. But large falls are difficult to avoid. Stand off distances can be left at the foot of the slope with trenches to trap falling debris. These steps are practical only where the problem is localized and near property, roads or other structures that need to be safeguarded. In mountainous and polar areas avalanches of snow and ice, sometimes incorporating rocks, may occur. These can be controlled to some extent by deflection barriers and snow sheds. Such events are becoming more frequent as climate warming begins to melt snow, and ice that binds rock debris together.

Vertical subsidence of the ground surface occurs above natural underground cavities, such as caves, or man-made cavities such mines, tunnels, shafts and wells. It can also result from compaction of loose sediments when these are place under heavy loads such foundations, or from readjustment of the ground surface when fluids such as groundwater, oil or natural gas are pumped out. This can be particularly serious in low-lying coastal areas because depression of the ground surface may lead to more frequent flooding. In polar or mountainous regions, melting of the upper layers of seasonally frozen ground can also cause subsidence.


Path damaged by rocktail


Road disrupted by landslide


Subsidence over old mine

Some geological materials, such as certain clays, swell when conditions are wet and shrink when dry. These can damage buildings and roads due to heaving or withdrawal of support from foundations. Most weak geological sediments undergo significant compaction when placed under load by constructions. However some are particularly susceptible to compaction, such as loose sands and peat. Some waterlogged sands flow when placed under loads leading to localized collapse of constructions.

Shallow groundwater may also react chemically with construction materials. For example, saline water from the sea or from evaporation in arid areas may corrode metal formwork. Water rich in sulphates from dissolution of minerals such as gypsum (calcium sulphate) may lead to adverse reactions in concrete.

Ground hazards caused major financial losses and, in some cases, significant loss of life. It is important to understand to nature, extent, severity, and frequency of occurrence of hazards in each area so that these can be taken into account in planning and development.

These leaflets have been prepared by Dr B R Marker OBE (UK) in collaboration with Professor Dr J J Pereira (Malaysia) and Professor I A Nyambe (Zambia)

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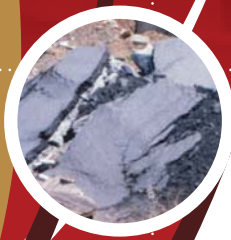

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