

A note on

## Some guidelines to preferred practice in hillside construction

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These guidelines on hillside construction have been developed from experience in the coastal districts of New South Wales, Australia. In these districts, a contributory cause of damage to residential structures has been the insufficient consideration of geological factors in design and construction.

The guidelines are not intended to be exhaustive. Detailed recommendations can usually only be made after a detailed investigation to determine site geological conditions. To achieve maximum benefit, this investigation should be carried out prior to the disturbance of the ground, design of the structure, footings or site works. The investigation would normally include the identification of site strata, geological mapping, testing and analysis.

### Effects on adjoining land

Landslips, their causes and their consequences do not respect arbitrary property boundaries. Alterations to landform, loading, or subsurface drainage patterns on one block may result in movement on another. Therefore, any works proposed on a given block of land should be viewed not only in respect of their possible effects on that block, but also in relation to the possible effects on the surrounding blocks.

### Siting and planning

Houses should not be sited on, or in the path of, obviously unstable land. In addition, the steep slopes found in the coastal districts of New South Wales generally do not suit houses of the type normally constructed on flat land.

Where soil creep is expected, provision should be made to prevent creeping soil exerting an excessive pressure on structures – e.g. a clear space could be provided between a house, and any cut slope or “flexible” retaining wall.

### Earthworks

Care must be taken to minimise the disturbance of the ground by way of cutting and filling. Retaining walls should always be provided to excavations in materials other than solid rock, unless it can be shown that the excavation will not initiate land instability. Where cuts greater than one metre are contemplated, a careful geotechnical investigation should normally be undertaken prior to excavation, however there may be some situations (e.g. a slope with a wet toe) where even one metre is excessive.

Where possible, filling should be avoided and spoil removed from the site. However, if filling is unavoidable, the fill should be properly “keyed” into the slope and compacted in layers in accordance with standard engineering practice. Care should also be taken to ensure that natural water courses and underground water efflux points are not blocked. Fills greater than one metre deep should be avoided unless the stability of the slope under the filling is well established, and there may be some situations where even one metre is excessive.

Any filling within close proximity ( $\approx$  three metres) of the toe of a cliff line should be of free draining fill material.

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### Retaining walls

The magnitude and distribution of earth pressure upon retaining structures in a geologically active environment (typical of hillside situations), is often considerably different to the earth pressures computed by conventional “active pressure” analysis, e.g. where soil creep is expected or pre-existing slip-planes occur then considerably increased earth pressures result, and the distribution of the pressure is not linearly related to the height of the wall.

Retaining walls designed to be relatively “inflexible” and have a long life, should only be designed after the most thorough site investigation. Alternatively, a “flexible” wall (i.e. a wall capable of accepting overload with observable, but non-catastrophic deformation) can often be used with resulting economies. House footings should be sited beyond the zone of influence of such flexible walls.

Retaining walls should generally have adequate weep-holes, and be backfilled with a free-draining material.

### Drainage

It is preferable that all roof and surface runoff should be piped direct to the street or Council system. Where this is impossible all storm-water should be channelled to natural drainage systems, or dispersed evenly in a manner that will not contribute to land instability. Similarly, all household effluent should be disposed of through a sewerage or “pump-out” system, unless it is absorbed in an area where it will not contribute to the instability of the land.

Where the landform is altered (e.g. by excavation for house sites or driveways) suitable gradients and drainage should be provided to prevent ponding of water.

### House footings

Generally, footings should be taken below the level of significant soil moisture variation, and if practical taken to bedrock. Provision should be made in continuous or strip footings for differential movement, unless the footings are on established bedrock or other stable stratum. Footings taken through creeping soil to bedrock should be designed to resist the considerable lateral pressures that may be imposed by soil creep.

The excavations for footings which are designed to be founded on rock should be carefully inspected prior to footing construction to confirm that the footing is founded upon bedrock, rather than on floaters or detached blocks of rock. This inspection is of particular concern in talus material or close to a cliff top or ledge, and should be carried out prior to the placement of concrete (or similar material).

### Flexible house structures

Where the site investigation reveals that small movements may be expected in the house foundation materials, then it is suggested that a “flexible” house structure be adopted to allow for these movements.

House structures of timber or metal framing, and sheeted with timber, metal walling or asbestos cement, have a capacity to accept differential movements without showing signs of distress, whereas masonry structures tend to crack after only small movements. Liberally jointed brickwork which is not continuous over door heads, windows etc., can sometimes be also considered an acceptable material for use in “Flexible House Structures”, but its use should be restricted.

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