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Foundation conditions at 'Leighlands', Perth.

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The concrete brick dwelling at 'Leighlands' [EP176947] is 19 years old. Cracking developed soon after it was erected, and during the exceptionally wet winter of 1974 became very severe. The house has now been condemned as unsafe, and the owners have requested information about soil conditions before a new house is constructed.

GEOLOGY

Both the existing and the proposed house site are situated on flat ground 30 m apart. At the ground surface there is an uneven cover, approximately 0.5 m thick, of a fine, poorly sorted, gravel of Quaternary age.

Clay of Tertiary age underlies this gravel. West of 'Leighlands' the land slopes down to the South Esk River; the owner reports landslips on these slopes.

Four trial pits were dug by back-hoe to investigate the subsoil.

Hole 1. Near the south-west corner of the house.

Depth (m)	
0-0.75	Dry, orange clay soil and gravel.
0.75-1.5	Stiff dry plastic clay, grey and orange in colour.
1.5 -2.2	Firm, dry clay; patchy grey, red and orange in colour. The grey patches tend to be plastic, the red patches have a harder, more brittle character.

Hole 2. Near the north-east corner of the house.

Depth (m)	
0-0.75	Gravelly sand and soil.
0.75-1.5	Stiff dry plastic clay; orange and grey in colour.
1.5 -2.2	Fairly soft clay, very plastic with shiny polished surfaces; pale grey and red in colour.

Hole 3. South-west of drive circle.

Depth (m)	
0-0.85	Humic soil overlying gravel.
0.85-1.4	Stiff dry plastic clay with some tree root material; greenish grey with some red colour.
1.4 -2.2	Stiff dry plastic clay; patchy - grey, orange and red.

Hole 4. South-west of drive circle.

Depth (m)	
0-0.75	Soil and gravel.
0.75-1.5	Stiff dry plastic clay; grey and orange colour.
1.5 -2.0	Stiff dry plastic clay; patchy - grey, orange and red.

TEST RESULTS

Samples were taken from a depth of 0.9 m in Holes 2 and 3 and were submitted for X-ray diffraction (XRD) mineral analysis, and for Atterberg Limit tests.

	Hole 2	*Hole 3*
Liquid Limit	94	90
Plasticity Index	76	69
Linear shrinkage	20%	18%

Orientated XRD analysis showed the samples to be composed of kaolin quartz and possibly illite. The sample from Hole 3 showed a broad and distinct peak for montmorillonite and that from Hole 2 showed a subdued peak for this mineral.

From orientated XRD analysis it is not possible to estimate the percentages of a particular mineral in a sample, but the sample from Hole 3 does appear to have an appreciable amount of montmorillonite, and it also appears to be present in the sample from Hole 2. The plasticity and shrinkage limits for these clays are high by world standards, but are not abnormally high for Tertiary clay of this area; however it is very unusual to find montmorillonite in this clay. Montmorillonite is known to be a troublesome mineral for engineers, due to its high water absorption capacity.

FOUNDATION CONDITIONS

The surface gravel is known locally to be a problem when wet, and should be removed from the house site.

In each test hole except Hole 2, the clay was firm and dry to a depth of at least 2 m. In Hole 2 soft, damp clay was found at 1.5 m which indicates that water is present in fissures and could rise to affect near-surface clay during wet periods. Near-surface groundwater can cause problems through rising damp, swelling of the clay, or soft areas beneath the foundation. It is suggested that 'soft spots' are watched for, and allowed for, during construction.

The most likely problems are those connected with the expansive nature of the clay which seasonally swells and shrinks, and puts foundations under considerable strain. The usual way to prevent structural damage in these conditions is to place the foundation below the zone of seasonal volume change by employing some form of small diameter drilled pier. Walls are then supported on grade beams, above the heave level of the soil.

Another approach to this problem is to use a rigid raft foundation which must be properly designed and adequately reinforced.

RECOMMENDATION

In view of the plastic nature of the clay at this site, and the presence of montmorillonite, it is recommended that an engineer with experience in foundation design be employed to compare the cost of the two suggested foundation types, and to design a suitable foundation.

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