Author's reply to Hill, Stamatopoulos and Kotzias

The contribution is a valuable one in that it is a further illustration of the fact that residual soils of this group may possess good engineering properties despite high water contents and Atterberg limits. The range of water contents and Atterberg limits quoted by Hill *et al.* is certainly very similar to that normally found in Indonesian latosols and the ϕ values of around 30° are also normal. No specific data on shear strength or compressibility were included in my Paper but ϕ values were found to range from about 30° to 40° with the lower values surprisingly occurring in the latosols and the higher values in the andosols.

However the information given by Hill *et al.* on the environment in which the soil occurs and the reported colour variations raises some interesting questions in relation to its mode of formation and in particular as to whether the soil actually belongs to the latosol group. The present on-shore environment, with its shallow water table would not be conducive to the formation of a latosol, and the off-shore deposit, if a residual soil, could clearly not have been formed in its present environment. It seems likely therefore that the land surface here has at some time been considerably higher in relation to the sea level than it is at present. This is not improbable in view of the very active geological history of the area generally.

It should perhaps have been emphasized in my original Paper that geological factors can easily give rise to situations in which the present environment of the soil is not that in which it was formed and the pattern of occurrence of the soils described in my Paper no longer applies.

It is thus not possible to say with any certainty whether or not the soils described by Hill *et al.* are latosols and in any case this is only of secondary importance. The engineer is interested in the engineering properties and in methods of assessing these. A general observation with respect to residual clays in Indonesia is that those whose Atterberg limits plot below the A-line on the plasticity chart are generally formed in well drained environments and possess good engineering properties, while those whose Atterberg limits plot above the A-line are formed in poorly drained areas and tend to possess poor engineering properties.

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Fabric changes in consolidated kaolin

- McCONNACHIE, I. (1974). *Géotechnique* **24**, No. 2, 207–222.
 Discussion by Foster (1974). *Géotechnique* **25**, No. 1, 153–154.

Author's reply to Foster

I should like to provide the following detailed information in amplification of the points which Foster has raised.

With regard to the occurrence of single particles, my findings were that when domains had been outlined on the studied micrographs the structural elements which remained, i.e. single particles, were comparatively few in number and were therefore considered to be unimportant. Any links which they did form would be weak.

A standard procedure was adopted for the preparation of the slurries for consolidation. Each slurry was mixed for thirty minutes in a mechanical mixer of the type suggested in BS 1377:1967 for the preparation of samples for particle size distribution analysis. The slurry was subsequently evacuated for thirty minutes to remove air introduced during mixing. No chemicals were added at any stage and the mean pH of the resultant slurry was 4.3. Such a value of pH would result in positive edge charges (Schofield and Samson, 1953) although most inter-particle contacts were face-face within domains.

Ultra-thin sections from an impregnated sample of the original dry clay powder were examined in the electron microscope and the structure found to be similar to that of the slurry. The vast majority of fabric elements were domains which remained from the original clay or were formed during its subsequent purification.

Referring to the Paper, the arrows on Figs 2–5 indicate the vertical direction (p. 216) which in these cases was also the cutting direction; the sections were 700 Å thick (p. 221).

The work I have reported was a continuation of earlier work (Smart, 1967) which acknowledged a study made by Tovey (1965) who had shown that the disruption of kaolin samples during impregnation with Vestopal W was not a serious problem. Thus my investigation of this aspect was limited to a brief study of sample strain in the horizontal direction during impregnation. All samples expanded after submergence in distilled water prior to the water–acetone–resin substitution process. The values of expansion were approximately 0.5, 0.5 and 2%. Two samples contracted during impregnation giving final strain values approximately equal to zero; in the third specimen the initial expansion of 2% was not recovered. Strains of such magnitude were not thought sufficiently great to have significantly affected the quantitative analysis.

A subsidiary investigation was undertaken to examine the distortion of ultra-thin sections during microtomy. Vertical ultra-thin sections were cut in the vertical direction from impregnated samples of the slurry and of specimens consolidated to 0.1, 10 and 1000 kgf/cm² (10, 1000 and 100 000 kN/m²). The end faces of the impregnated blocks and the last ultra-thin section cut from each were examined and photographed using an optical microscope. Measurements of block and section, usually on photographs at a magnification of 330 times, were made in the cutting direction and at right angles to it. The results are presented here in Table 1. The most significant compression is at zero pressure, well below the main effect noted at approximately 10 kN/m². Distortion of this magnitude would significantly affect the measured values of packing density and domain orientation and may account for the high degree of preferred orientation found in two of the zero pressure samples (Fig. 9). The trend of compression appears to be opposite to the general trend of domain orientation.

Inter-domain contacts were classified and counted on micrographs from vertical ultra-thin sections cut in the vertical direction and usually at a magnification of 40 000 times, corresponding to a resolution of approximately 50 Å. Contacts were defined only if there appeared to be actual physical contact (effectively a separation of less than 50 Å) in the plain of the micrograph

Table 1

Pressure, kN/m ²	Compression in direction of cut, %	Compression at right angles to direction of cut, %
0	20	7
10	5	0
1 000	2	No measurements
100 000	–2	–1

between domains in the three configurations. Inter-domain approaches were excluded. I agree that the establishment and classification of contacts are subjective and regard these uncertainties as partially responsible for the scatter on the graphs in Fig. 11 of the Paper. Nevertheless, I believe that the exercise was a necessary element of the concept under investigation.

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The design of permanent cutting slopes in stiff fissured clays

CHANDLER, R. J. and SKEMPTON, A. W. (1973). *Géotechnique* 24, No. 4, 457–466.

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The conclusions from this Paper appear at first sight very neat and simple. I question whether, from the point of view of a practical engineer concerned with the prediction of stability of a cutting, the conclusions may not be too simple. I have these particular observations.

The assumptions about the average pore-pressure factor r_u appear unsatisfactory. Is it possible to indicate for each instance cited how reasonable the value of 0.3 may be? Cutting slopes are usually formed fairly symmetrically in clay so that it is often instructive to consider why a failure has occurred in a particular part of one side and not elsewhere. Surface topography and groundwater movement within the fissured weathered clay seem to be the principal factors causing variation in r_u . Chandler (1974) has described the brecciated Lias clay as having a considerable variation in permeability with depth and this might be expected to give rise to appreciable variation in r_u of seasonal or briefer duration on account of groundwater movements. If a mechanism of gradual equilibration of long-term pore-pressures occurs, failure may be expected when the combined short-term effects, taking account of progressive failure and water pressure in joints, cause the factor of safety to drop below 1.0. With the increase of time, the ultimate cause of failure may be a less extreme event than would have been necessary at a previous time. Can the Authors relate the failures to specific occasions of short-term reduction in safety factor, on account, for instance, of intense or prolonged rainfall?

With the increasing awareness that the Mohr failure envelope for weak and fragmented rock, for powders, for spoil heaps and many other materials is curved convex upwards, there appears to be need of an explanation as to why such a phenomenon does not occur with some at least of the clays described. A 'brecciated fabric of lithorelicts set in a matrix of softer and disturbed clay' appears almost certain to display such a feature. At low loading, failure surfaces will develop to avoid shearing the lithorelicts whilst at higher loading these will increasingly tend to become overstressed. The data appear inadequate to compare against such a hypothesis since the lowest value of mean effective stress is an order of magnitude higher than the value