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DISCUSSION

Foundation failure in a ferruginous clayey sand

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Could ponding (and/or slaking) alone have caused a more than threefold reduction in the ultimate bearing capacity of the aggregated clayey sand? The answer, I think, must be no!

24. If it were not, there would have been an alarming rate of foundation failures in the Mushin and Aguda areas of Lagos, which have similar soil to the one described by the Author and are often flooded for several weeks at a time between April and July, when the rains are heaviest.

25. The Author readily concedes that expectation of rampart slope failures in road cuttings, which would have been a logical consequence of low soaked shear strength, is not borne out in practice (§ 12). His first reason for this unexpected behaviour is clearly untenable as it is common during the rainy season for rains to fall for several days with little or no opportunity for evaporation. His second reason, while more plausible, cannot tell the complete story. To the self-draining property of the soil one should add the naturally low groundwater level. It is the combination of these two factors which prevents the build-up of the pore water pressure sufficient to cause soaked shear strength properties.

26. Figure 1 and the high permeability of the soil indicate that soaked conditions similar to those obtained for his laboratory samples would have been most difficult to obtain at the site. Moreover, the slaking test (using air-dried samples) cannot be a serious attempt at simulating the behaviour of the soil *in situ* (§ 7).

27. I agree that inundation of the foundation trench by rain water would cause some reduction in bearing capacity but one doubts if it can be as high as suggested (§ 13). I have observed this sort of foundation failure in the Victoria Island and Badagry Expressway areas of Lagos. These areas have loose fine sands and the natural groundwater level is often as high as 0.6 m below the natural ground level. Thus, inundation by a heavy rainfall could easily cause soaked shear strength conditions. For this reason, safe bearing capacity is usually limited to 25–30 kN/m².

28. It appears that the evidence points to a different kind of failure from that suggested by the Author.

29. A look at Fig. 1 again is instructive. The strip foundation would have been narrow (i.e., less than 3 ft) and was definitely said to be at shallow depth. The foundation itself was as close as 0.2 m to the edge of the slope in places. The foundation effectively 'dams' the rain floodwater which under normal circumstances would drain downhill into the stream. The soil is 'highly permeable', which is suggestive of loose packing. Thus, the conditions for a 'piping' failure are excellent. Only a moderate head is required, which was provided by the obstructed rainwater flood!

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30. Perhaps the Author might like to consider this possibility supported by a few calculations. It would also be interesting to know if the portion of the strip foundation *parallel* to the direction of flood water flow exhibited the failure. If it did not, that would certainly lend more credence to my assertion that ponding, on its own, cannot cause over threefold reduction in the ultimate bearing capacity of the soil.

Dr Jackson

The comment of Mr Omo Iyoha that the failure observed was due to simple piping is interesting.

32. The soil in this area is cohesive both from its clay content and by iron oxide cementation which will preclude piping failures to a major extent. This cohesion is known to exist because laboratory specimens had to be cut to shape, although its value is not reflected in a measurable c' . The soil certainly has a measurable c_u when dry. There was no evidence of erosion channels.

33. The location of the site on a hill slope is noteworthy. Prolonged leaching by surface and subsurface floodwater had reduced the soil (which naturally supports steep slopes of up to 25 m high at 60° or more) to a 'metastable' condition. Similar and more alarming failures have been observed by the Author at the Army Barracks sited on a similar slope in the Coastal Plains Sands on the outskirts of Calabar. At Mushin and Aguda, such slopes and the consequent leaching of soils are absent. At Victoria Island and Badagry Road the soils are alluvium, cohesionless to a great extent and with a totally different geological history.

34. There was failure of the footing parallel to the direction of flow, though of limited extent because in this area the red zone thins out uphill.