DEFICIENT GEOTECHNICAL PROJECT SUPPORT FOR MIDDLE EASTERN RESIDENTIAL DEVELOPMENT PROJECTS

During recent years HKA has become increasingly involved with several extensive low rise residential developments throughout the Middle East, where the ground conditions encountered have given rise to dispute

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Of late, it has become progressively apparent that there is a general perception of the granular desert soils which prevail throughout the Arabian Peninsula frequently being expected to provide characteristically good bearing capacity and low settlement potential. As such, the dominant soil types are somewhat routinely regarded as offering a reliable foundation medium. A consequence of this school of thought is that geotechnical exploratory work for low rise general development projects may well be minimalist, rudimentary, or not infrequently both.

Whilst a substantially homogeneous continuum of relatively compact and well graded granular soils would typically be expected to provide reasonable foundation conditions adequate for modest loading conditions, such a wide-ranging presumption cannot be relied upon within arid environments. Arid soils are frequently characterised by factors that are derived from their having been subject to prevailing moisture deficit conditioning and which directly influence their engineering performance. Of particular significance are:

- Unsaturated Soils: Surface desiccation with underlying soils having a low moisture content where the groundwater level remains at a low level;
- Aeolian Origins: Many arid soils have been transported and deposited by wind, from which poor (substantially uniform) grading characteristics are typical and very loose or loose in situ conditions prevail;
- Permeability: Susceptibility to groundwater movement is enhanced by poor grading and looseness of state;
- Soil Chemistry: Soils with a high content of salts, mainly sulphates and chlorides which are largely soluble, coupled with saline groundwater conditions;
- Cementation: The capillary rise of saline groundwater followed by surface evaporation gives rise to increased surface concentration of soluble salts. This process can lead to the cementing of soils by the precipitation of salts and development of duricrust; and
- Accelerated Weathering: The rate and depth of bedrock weathering is increased in both arid and tropical environments. In particular, high plasticity clays derived from highly active (moisture susceptible) clay mineral products are frequently derived from the rapid deep weathering of volcanic rocks.

Whilst an ultimate bearing capacity failure in granular soils is an unlikely prospect, it is important that designers are aware of the considerable near surface variability of arid ground conditions that can prevail, and of the several adverse consequences of soil disturbance, ground loading or change of groundwater conditions. The undernoted table summarises various circumstances that have been identified by HKA whilst conducting investigation into several instances of building serviceability threshold exceedance through the Middle East:

CONTRIBUTORY FACTORS	CONSEQUENCE
Loose state of compaction	Excessive Settlement & creep
Loose soil state coupled with groundwater inundation	Collapse Settlement
Fine grading and loose soil state	Aeolian Erosion
Elevated salt concentrations	Corrosion & Concrete Deterioration
Cemented soils and mobile groundwater	Duricrust Disintegration
Concentrated loading	Puncture of Duricrust
High activity plastic soils subject to change of moisture content	Heave or Shrink/Swell
Surface water, irrigation, inadequate drainage provisions	Collapse Settlement

The above noted listing is illustrative, but not exhaustive.

Middle Eastern housing development projects can be extensive, each incorporating several hundred closely spaced residential units, invariably involving two and three-story construction. Building construction is typically of reinforced concrete framed structures, with assorted sizes of pad foundations, together with blockwork infill panels and partition walls.

Such structures are normally very tolerant of moderate tilt and sway deformations that are likely to be associated with excessive differential settlements between the individual foundation units. Without there being an imminent likelihood of ultimate collapse, the acceptable serviceability threshold can be grossly exceeded, whilst the stiff blockwork infill panelling becomes susceptible to extensive crack propagation.

A single common factor has emerged from the several dispute circumstances where HKA have been assigned to provide expert assistance to investigate – insufficient ground investigation.

Numerous inadequacies in project ground exploration have regularly been identified, these having prevailed in several permutations and to various levels of deficiency:

- Desk study lacking or inadequate
- Inappropriate or ill-informed scoping of exploratory work
- Insufficient frequency of exploratory locations
- Under reliance on in situ testing methods
- Absence of geotechnical field supervision
- Baseline laboratory testing
- Lack of credible interpretation
- Invariable absence of interpretive reporting
- Instances of basic recommendations having been blatantly disregarded

Without an adequate package of ground exploration planning, procurement, implementation, interpretation and design application being applied at project inception, the ground remains a hazard. In such circumstances, the consequent cumulative costs of disruption, investigation, remediation and possible litigation may be readily expected to far exceed what should have been correctly expended on competent front end geotechnical services.

ABOUT THE AUTHOR

Dudley M English has over 35 years of extensive experience in geotechnical engineering, allied with many principal sectors of civil engineering. This has involved desk study, investigation, design, construction and related independent advisory services. He has accumulated experience on a wide range of projects throughout UK, Middle East, India and South-East Asia.

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