Design for a Concrete Future on Clays

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Synopsis: A "green" philosophical learning point is to harness and enhance natural responses to structures as part of the design and construct approach. An original engineering design system is explored that looks to the environment to identify key responses involved in placing concrete slab foundations on reactive clay soils. By identifying and accelerating features of natural stability and mimicking the presence of a larger building footprint using a moisture stabilizing membrane, the available natural stability is harnessed at considerably lower monetary (20–40%) cost and potential Australian greenhouse gas saving (ca. 3% total construction budget) compared with present stiffened raft foundation methods; and rebating up to 66% of the present cost premium of "green buildings".

Keywords: Reactive clay soils, green design, concrete slab, foundation stabilisation, clay stabilisation.

1. Introduction

The short history of green building construction in Australia has encountered a number of obstacles to mainstream adoption. One of which is cost that is estimated by Johnson (1) to be a $300 per metre squared or 15% premium to incorporate the "green" materials and architectural features such as increased ceiling height and larger windows. As "green" building materials become more widely adopted and production costs reduce the approach should become affordable – but how long is this process going to take? Ideally design approaches that increase efficacy and reduce construction cost at equal or improved quality will have a key role in the adoption of green building approach or "getting the show on the road" without regulatory intervention; and the more quickly this is done the more rapidly Australia will achieve a heritage of sustainable buildings.

Architectural design is well appreciated but what is an engineering design of a structure, or for that matter, a "green" design? Fundamentally the engineering design makes a building fit for the purpose of interacting with its environment. Philosphically, concrete structures are often designed to resist imposed forces; the stiffened raft on clay soils outlined in AS 2870 (2) is one example. How can engineering designs of concrete structures become "green" when forces they must withstand are seemingly fixed and immutable?

2. The Challenge of Clay Soils

Clays, unlike sand, expand when wet incorporating moisture into their molecular structure between interstitial layers. The expansiveness of the clay depends on its geochemistry and how many water molecules it can stably "pack into" its structure (3). The moisture content of the soil is thus intimately related to the degree of expansion.

Constructing a building however on a clay site forever changes the moisture content of the clay beneath the concrete slab.

The polyethylene membrane that acts as a vapour retarder beneath the concrete slab guards against rising damp and moisture delaminating floor coverings (4) but has another effect. Ultimately, the vapour retarder assists moisture to accumulate beneath the polyethylene leading to a permanently saturated expanded pad of clay in the centre of the slab.

Not so the edges. During the first few years of the concrete structure as a whole the unevenness in water content within the clay is a complicated dynamic that can reasonably be described as writhing, settling to a more permanent swell and shrinkage pattern at the edges where moisture can escape and re-accumulate seasonally (5).