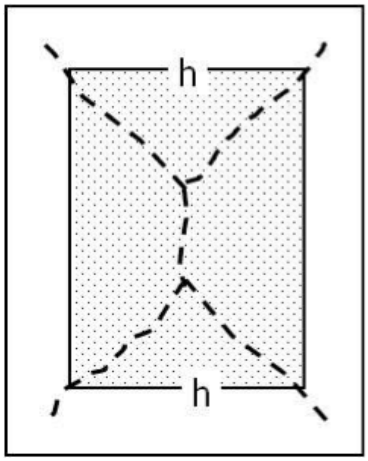
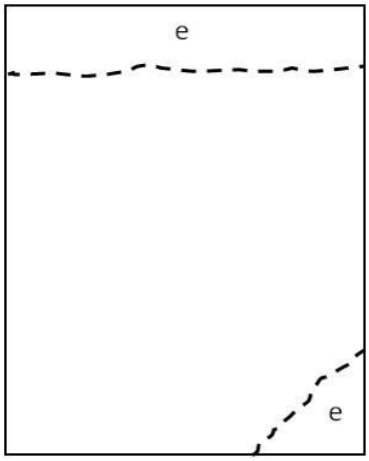
Failure mechanisms of residential raft slabs on moisture reactive soil

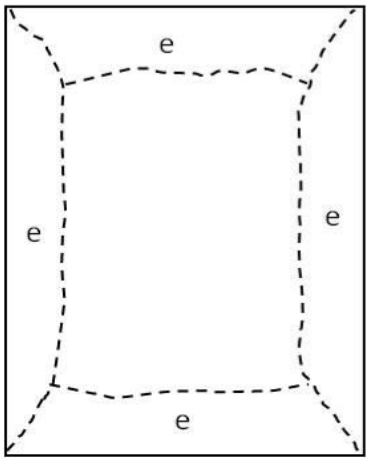
The following diagrams depict the yield line patterns for plausible failure mechanisms of the equivalent rectangular slab model adopted in the ultimate strength analysis and design of residential slabs on reactive soil.



Global hogging & sagging failures



Local corner & edge failures



Multiple yield line failure

Global hogging & sagging failures

The shaded portion in the diagram represents the soil-slab contact area in hogging mode failures and the non-contact area in sagging mode failures. The width h of the shaded portion is a complex function of surface movement, involving a cubic equation solution algorithm.

The yield line patterns for global hogging and sagging failure mechanisms develop as follows: The first yield line more than likely starts along the centreline parallel to the long side of the equivalent rectangle, where the bending moment is greatest. As surface movement increases, the central yield line lengthens and then splits into two yield lines heading at about 45^0 angles to the corners. When the yield lines are fully developed, distortion of the slab is like the motion of a three-dimensional mechanism consisting of four plane segments hinged together along the yield lines and rotating relative to each other about the yield lines.

Local corner and edge failures

The problem with potential local corner and edge failure mechanisms is that there is no way of relating them to surface movement. Designers wishing to explore corner and edge failures could consider taking distance e in the diagram as the edge distance defined in AS-2870.

Local slab panel failure

The yield line pattern for local slab panel failure is identical to global hogging failure; with the addition of sagging moment yield lines around the edges. The critical panel is where the upward soil pressure is greatest, at the centre of the slab in subsiding surface movement, and at the edges in heaving surface movement.

Multiple yield line failure

The segment bounded by the central yield lines is roughly the slab support area. However, this failure mechanism has too many yield lines. Whilst yield lines parallel to the edges of the slab may appear at the onset of cracking, they will ultimately either merge into a single yield line, as in the global mechanism, or develop as local corner or edge failure.

Governing failure mechanism

Like, *"The strength of a chain is that of its weakest link" ... "Slabs on moisture reactive soil fail when & how they most easily can".*

According to the upper/lower bound theorem in structural mechanics, the governing failure mechanism for slabs on reactive soil is the one exhibiting the lowest ultimate surface movement capacity. Conversely, the governing failure mechanism is the one requiring the highest ultimate strength to sustain the most severe combination of loading and surface movement.

It is impossible to predict a-priori which failure mechanism governs. Global hogging failure usually governs on building sites under normal moisture conditions at time of construction. Global sagging failure may govern on a building site that is abnormally dry at time of construction. Isolated corner and edge failures may govern on building sites exhibiting non-uniform soil characteristics, such as for example inadequately compacted soil on a cut-fill site, or the presence of gilgais. Isolated slab panel failure may govern when stiffening ribs are too widely spaced or when the slab thickness is too small.