Brief Technical Description

FREW

Suggested description for use in memos/letters, etc

FREW is a program used to analyse the behaviour of flexible retaining walls. It predicts the displacement, shear forces, and bending moments of the wall and the earth pressures each side of the wall resulting from a series of actions. These actions include excavation, filling, dewatering, changing soil or wall properties and applying or removing struts, anchors or surcharges. The program models the soil as an elastic continuum and allows for soil failure by restricting the earth pressures to lie within the active or passive limits and also includes the effect of arching.

Brief description for inclusion in reports

The following pages contain a summary of the analysis method used by FREW. It is intended that they can be copied and included with calculations or reports as the need arises.

FREW is a program to analyse the soil structure interaction problem of a flexible retaining wall, for example a sheet pile or diaphragm wall.

The wall is represented as a line of nodal points and three stiffness matrices relating nodal forces to displacements are developed. One represents the wall in bending and the others represent the soil on each side of the wall. The soil behaviour is modelled using one of three methods: -

1. **"SAFE" flexibility method** - the soil is represented as an elastic solid with the soil stiffness matrices being developed from pre-stored stiffness matrices calculated using the "SAFE" finite element program. This method is ideally limited to a soil with linearly increasing stiffness with depth, but empirical modifications are used for other cases.
2. **Mindlin method** - the soil is represented as an elastic solid with the soil stiffness based on the integrated form of the Mindlin Equations. This method can model a wall of limited length in plan but is ideally limited to a soil with constant stiffness with depth but again empirical modifications are used for other cases.
3. **Subgrade reaction method** - the soil is represented as a series of non interactive springs. This method is considered to be unrealistic in most circumstances.

The program analyses the behaviour for each stage of the construction sequence. At each stage it calculates the force imbalance at each node imposed by that stage and calculates displacement and soil stresses using the stiffness matrices. If the soil stresses are outside the active or passive limiting pressures correction forces are applied and the problem solved iteratively until the stresses are acceptable. Allowance can be made for arching within the soil body when calculating the active and passive limiting pressures.

The following input parameters are included in the analysis:

- problem geometry including dig depths, distances to remote boundaries
- wall profile bending stiffness and creep
- soil stratification, strength, density and stiffness
- struts (or anchors) including prestress, stiffness, inclination and a lever arm (to represent rotational fixity).
- surcharges including depth and extent
- groundwater levels and pore pressures each side of wall.

The program gives results for earth pressures, shear forces and bending moments in the wall, strut forces and displacements. These are presented in tabular form and can be plotted diagrammatically. In addition the number of iterations, the displacement error between successive interactions and the maximum earth pressure error are output.

Full details of the assumptions and analysis methods are included in the following paper.

Pappin J W, Simpson B, Felton P J, and Raison C (1986).
"Numerical analysis of flexible retaining walls". Symposium on computer applications in geotechnical engineering. The Midland Geotechnical Society, April.