Method of chemical soil solidification.

Chemically solidified soil for underpinning existing building structure is formed as a continuous wall portion 22 of solidified soil together with a series of spaced buttress portions 20 of solidified soil extending outwardly from the wall portion under the building structure. The untreated soil present between adjacent buttress portions "sticks" thereto and acts with the buttress portions and continuous wall portion as a single monolithic unit.
Method of Chemical Soil Solidification

This invention relates to chemical soil solidification pursuant to civil engineering works wherein it is desired to provide a rigid underpinning to an existing building structure.

The general technique of chemical soil solidification is well known and comprises drilling a series of spaced bore holes in the ground which is to be solidified, inserting an injector pipe into each bore hole and sequentially, from the bottom of the pipe upwards, injecting grout out of the side walls of the pipes into the ground. The grout may comprise a silicate solution which will permeate the soil surrounding the injector pipe and harden into a solidified mass of soil. Obviously differing chemical grouts can be chosen for differing conditions of use and the grain size distribution of the soil will largely determine which grout is to be used and how far the grout will permeate the soil away from the injector pipe.

It is already known to use chemical soil solidification techniques in the underpinning of existing buildings whereby a monolithic retaining wall of chemically solidified soil is created below the foundations of the building. For example, some considerations of the technique are discussed by Kirsch and Samol in the December 1978 issue of Tiefbau in an article entitled "Injektionsverfahren zur Baugrundverbesserung". In this article consideration is also given to the size of the retaining wall and the safety factors to be taken into account and it is suggested, with reference to Figure 22, that the volume of the solidified soil comprising the retaining wall can be reduced by employing ground anchors.
Obviously it is economically advantageous to reduce the volume of grout required for any specific underpinning operation as the chemicals used are expensive but it is not always feasible to use auxiliary ground anchor methods to accomplish such a corresponding reduction in volume of the solidified soil.

It is an object of the present invention to provide an improved method of forming a chemically solidified soil underpinning.

In accordance with the invention there is provided a method of forming an underpinning by injecting soil with a chemical grout to solidify the soil permeated by the grout characterised in that the grout is injected into the soil to form a continuous wall portion of solidified soil and is also injected into the soil transversely of the wall portion at spaced intervals therealong to form a series of spaced apart buttress portions of solidified soil; the spacing and configuration of the buttress portions being pre-determined in such manner that the wall portion and buttress portions together with unsolidified soil therebetween function as a monolithic unit to resist the static forces imposed thereon.

The buttress portions, together with the untreated soil therebetween, thus act in counterweighting the static thrust imparted to the underpinning; the effect of the untreated soil being to "stick" between the buttress portions.

Other features of the invention will become apparent from the following description given herein solely by way of example with reference to the accompanying drawings wherein:

Figure 1 is a cross-section through soil under an existing building structure showing the arrangement of injector pipes to form underpinning in accordance with the invention
Figure 2 is a top plan view of the solidified soil after grout injection and Figure 3 is a perspective view of the solidified soil shown in Figure 2.

In Figure 1 of the drawings there is shown diagrammatically the foundations of an existing building structure having a strip foundation raft 10. To the left of the structure is indicated an excavated space 12, the provision of which necessitates underpinning of the existing structure otherwise the soil 14 under the foundations may tend to collapse outwardly into the excavated space 12. To accomplish this underpinning by means of chemical soil solidification in accordance with the invention, two alternating sets of inclined bore holes 16A, 16B, 16C, 16D, 16E, 16F are drilled (as shown in chain dot outline) under the building structure for the formation of buttress portions 20 of the underpinning whilst single sets of pairs of bore holes 18A, 18B are drilled for the formation of wall portions 22 of the underpinning between the buttress portions 20. The spacing of these sets of bore holes, and their angle of inclination, is determined by the composition and consistency of the soil to be solidified. In the example illustrated, a set of six bore holes 16A to 16F are drilled for each buttress portion 20 and a set of two bore holes 18A, 18B are drilled for the wall portions 22.

Grout injector pipes are then inserted into each bore hole and chemical grout is pumped through the pipes to emerge into each bore hole sequentially from the bottom of the pipe upwards to permeate the soil surrounding the pipes to the outlined configuration shown in Figure 1 which comprises an end buttress portion 20 and part of the continuous underpinning consisting of wall portion 22 and further buttress portions 20. The injector pipes are subsequently withdrawn from the bore holes. The actual grout injection technique is known and does not form any part of this invention.
This operation is repeated at spaced intervals along the length of the raft foundation, see Figure 2, to form the continuous wall portion 22 of solidified soil (as shown bounded by the dotted line in Figure 1) and a series of spaced buttress portions 20 as shown by the full line outline in Figure 1. The completed treated solidified soil then has an overall configuration as shown in Figures 2 and 3. It will be appreciated that untreated soil 24 is present between adjacent buttress portions 20 and it is found, in accordance with the invention, that the untreated soil "sticks" and as such acts with the buttress portions and continuous wall as a single monolithic unit to resist the static forces imposed thereon.

In a typical example the depth of the underpinning may be from 4 to 8 metres with the ratio of the thickness of the treated buttress portions 20 of the underpinning to the untreated thickness of soil 24 therebetween being approximately 2:1. The sets of inclined bore holes shown in Figures 1 and 2 are spaced at approximately 1 - 1.5 metres apart along the length of the strip foundation 10 which is to be underpinned.

Of course the configuration of the underpinning will not be of the precise form shown in the drawings due to the inherent nature of the operation, but the general overall configuration will be similar to that shown.

In prior underpinning practice, a continuous solidified wall and buttress section of chemically solidified soil has been provided of a configuration similar to that shown in the accompanying drawings but wherein the space between the individual buttress portions of the present invention has also comprised treated solidified soil. However it is found in forming underpinning in accordance with the invention, that a typical saving of some 20% by volume of grout material may be accomplished without detracting from the load bearing capability of the underpinning.
CLAIMS

1. A method of forming an underpinning by injecting the soil with a chemical grout to solidify the soil permeated by the grout characterised in that the grout is injected into the soil to form a continuous wall portion (22) of solidified soil and is also injected into the soil transversely of the wall portion at spaced intervals therealong to form a series of spaced apart buttress portions (20) of solidified soil; the spacing and configuration of the buttress portions being pre-determined in such manner that the wall portion and buttress portions together with unsolidified soil (24) therebetween function as a monolithic unit to resist static forces imposed thereon.

2. A method of forming an underpinning substantially as hereinbefore described with reference to the accompanying drawings.

3. Underpinning whenever produced by the method according to either one of Claims 1 or 2.