A Boring and Skirting Machine

by

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Introduction

Design and construction of foundations in weak sub-soil stratum is a difficult engineering problem, especially when the bearing capacity is low, water table is high and foundations are called for sustaining high loads. To meet with these problems, different methods of ground improvements are deployed, e.g. sand drains (Moran et. al., 1958, Casagrande and Poulos, 1969, Nonveiller, 1967, Chalmers and Harris, 1981), sand wicks geo-drains etc. (Broms, 1979) with a combination of pre-load in soft saturated cohesive sub-soils. In the case of non-cohesive soils, compaction by vibrofloatation (Engelhardt and Kirsch, 1977) or heavy falling weights (Mehard, 1972, West and Solocombe, 1973) detonation of explosives (Long and George, 1967), electro-osmosis (Bjerrum and Overland, 1957 Rao and Bhandari, 1976) etc, are used. These methods are time consuming and call for imported machines thus requiring huge foreign exchange besides trained and skilled personnel at the site. Alternative to the above, cast-in-situ bored or driven piles, floating or partially compensated foundations have been used from time to time. Skirted granular pile foundations (Rao and Bhandari, 1979), their design and construction have recently been developed at the Central Building Research Institute, Roorkee. The granular pile foundations provide an economical and speedy foundation method which may cater for multitude of civil engineering structures subjected to high loads.

The granular piles are constructed by compacting 20-70 mm stone aggregate and 15 per cent locally available sand mixtures in layers of 30-50 cm, in a bore hole made by manually operated spiral auger and using hammers 125-500 Kg with the help of an electrically driven winch. Generally the piles are installed in triangular pattern. These piles are known to sustain high loads in comparison to virgin sub-soil stratum. When the pile groups are collectively skirted by cast-in-situ R.C.C. skirt; the load carrying capacity is further increased and settlement is significantly reduced. Bofore the construction of R.C.C. skirt, a trench is constructed by specially fabricated

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cutting tools, scrapers and devices for collecting loose cut-earth from the skirt trench. The preparation of the skirt trench is carried out manually. The width of the skirt may vary from 20 to 40 cm and depth 3 to 4 m only. Similarly for the granular piles, bore holes of 30 to 60 cm in diameter and depth upto 5 m or more may be needed depending upon the design loads and the depth of the compressible stratum.

Essential Requirements

The bore holes and trenches are required to be made with minimum disturbance of original soil conditions. In view of shallow depth involved in skirted foundation and also difficult site conditions, the device employed for making these foundations should primarily be light, compact and portable. Efforts made to employ manual methods for installing bore holes and cutting trenches using specially designed tools proved awfully slow and uneconomical for skirts having depth more than one metre. Sophisticated equipments are available for making trenches and holes, but these have large capacity and prove cumbersome resulting in uneconomical skirted foundations which are comparatively of much smaller dimènsions. A special purpose machine named as Boring and Skirting Machine has therefore been developed at CBRI which fulfills the essential requirements of lightness, compactness and portability besides being cheaper in cost and operation.

The present paper describes the salient features of the machine developed at this Institute for the construction of R.C.C. skirting trench/ bore holes for the granular piles—which are needed for the skirted granular pile foundation.

Boring and Skirting Machine

The boring and skirting machine (Fig. 1) comprises of a wheeled trolley (1)* and a tilting type boom (2) which is hinged with two vertical supports (3) raised from the trolley (1). The boom can be tilted between vertical to horizontal positions and vice-versa with the help of a mechanical pulling device (4). During working, when the boom (2) is vertical, its bottom end (5) is bolted rigidly with the trolley (1). The machine is moved forward and backward on four wheels (6) and (7). The front two wheels (6) have individual steering arrangement to facilitate turning of the machine during movement. The rear wheels (7) are coupled rigidly on a common shaft (8) supported on two bearing housings (9) attached to the bottom of trolley (1) frame. The movement of trolley (1) can be achieved by rotating the rear wheel shaft (8) with the help of a hand cranking system (10) coupled with the said rear wheel shaft (8) through chain and sprocket arrangement (11). Lateral stability of the boom (2) and the machine against overturning side ways during operation is increased with the help of four telescopic type levelling screw pads (12) provided at all the four corners of the trolley (1). These levelling screw pads (12) when extended out fully increase the lateral stability of the machine.

A power head (13) with speed reducing system is employed to revolve a long vertical cutter shaft (14) which at its bottom end carries a helical auger (15) or any other cutter for making bore holes (16) in the ground. The assembly of power head (13) and the cutter (15) can be lifted up and lowered down during the boring operation with the help of a motorised

* Number in bracket refer to components shown in Fig. 1.

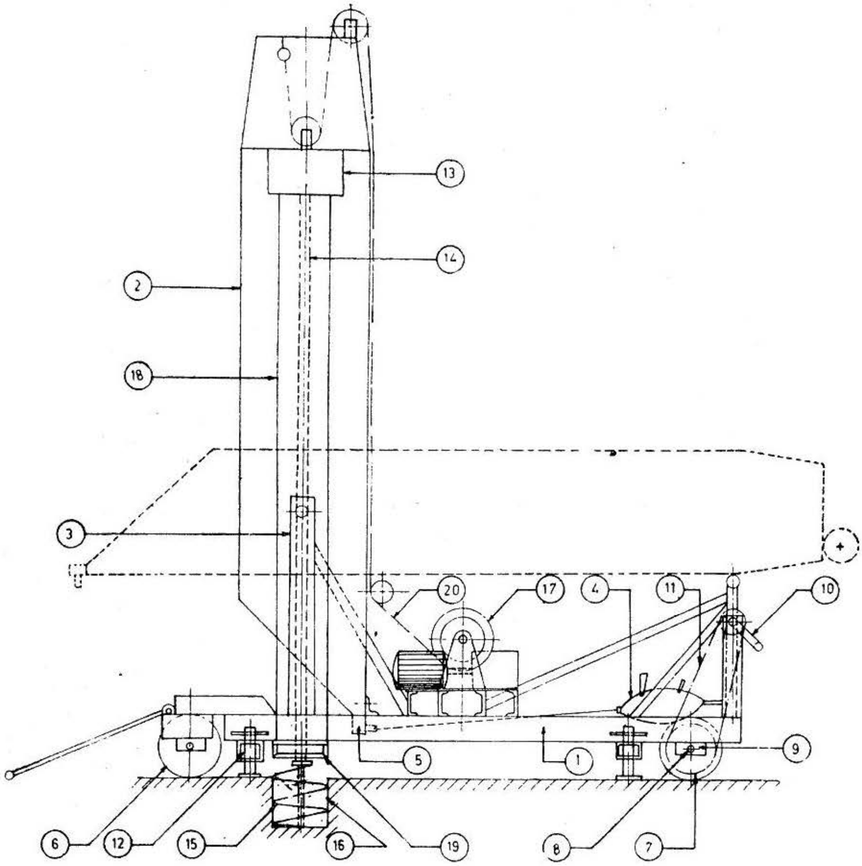

FIGURE 1 Line Diagram of Boring and Skirting Machine

winch (17) which is mounted on the trolley (1). A casing pipe (18) enclosing the cutter shaft (14) throughout its full length is used during trenching operations since its top end is connected with the bottom face of the power head (13) while its lower end is left to hang down freely. A squaring head (19) comprising of sharp edged cutting blades is attached to the bottom of the casing pipe (18) whenever trenching operations are required to be done. The features of the machine described in above is subject matter of the patent filed by the CBRI for this machine.

Operation with Machine

The machine is transported with its boom (2) horizontal (Fig. 2) and brought to the place where a bore hole (16) is required to be constructed. The boom (2) is brought to the vertical position and is held there rigidly by bolting its bottom end (5) with the trolley (1). The machine is levelled horizontal by extending out and operating the four levelling screw pads (12) while simultaneously ensuring that the helical auger or cutter (15) is located centrally with respect to the bore hole (16) required to be drilled. The assembly of power head (13), cutter shaft (14), helical auger or cutter

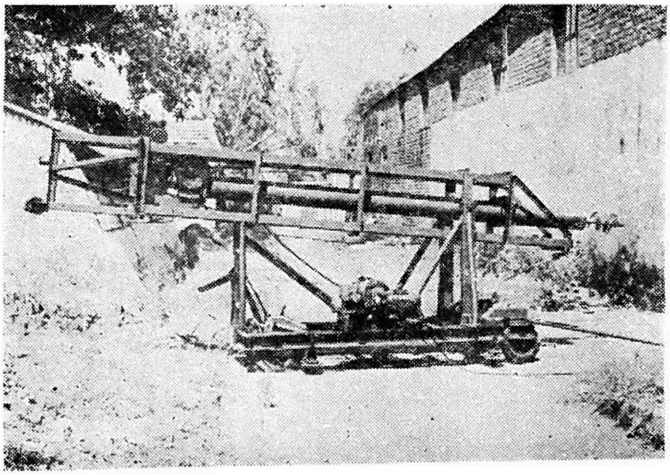

FIGURE 2 Boring Skirting Machine in Transportation with Boom in Horizontal Position

(15) and the casing pipe (18) is allowed to come down till the auger or cutter (15) rests on the ground and the wire rope (20) of the motorised winch (17) is further allowed to get loosened so that the weight of the said assembly of power head (13) etc. is maintained on the auger (15). The helical auger (15) rotated under these conditions tends to dig into the clay and cuts the earth. When the auger (15) is full of cut spoilage, it is lifted up with the power winch (17) and the spoilage removed from the auger (15). The auger (15) is again lowered down into the bore hole (16) for further cutting. In a number of such repetitive operations, bore hole (16) of desired depth is achieved.

For trenching, a number of bore holes (16) are first made side by side touching each other. The squaring head (19) is later attached to the bottom of the casing pipe (18). A trench is obtained by punching down all the left-out portions of earth between the two bore holes (16) (Fig. 3).

The cut clay is removed by auger (15) (Fig. 4) or at times rammed down itself for which the depth of bored holes (16) should be little more than the required depth of the trench.

Working Trials

The machine was put to use for boring and trenching operations (Figs. 3 and 4). Both the boring and trenching times were found to be affected by the type of soil, and the dimensions of the bore or trench. It was observed that for boring holes of 18 cm diameter in silty-sand, the average drilling time was 10 minutes for 2.25 m deep holes and 18 minutes for 3 m deep holes. For a hole of 25 cm diameter, the machine took about 12 minutes for a depth of 2 m and 22 minutes for a depth of 3 m. In making trenches of outer size 1.5×1.5 m and width 25 cm and depth 1.33 m around a foundation soil plug of size 1×1 m, the average total time for trenching was observed to be 2 hours and 15 minutes whereas for making a trench of 18 cm width and 2.75 m depth, the trenching time was 1 hour and 35 minutes per metre of straight length of the trench. Two

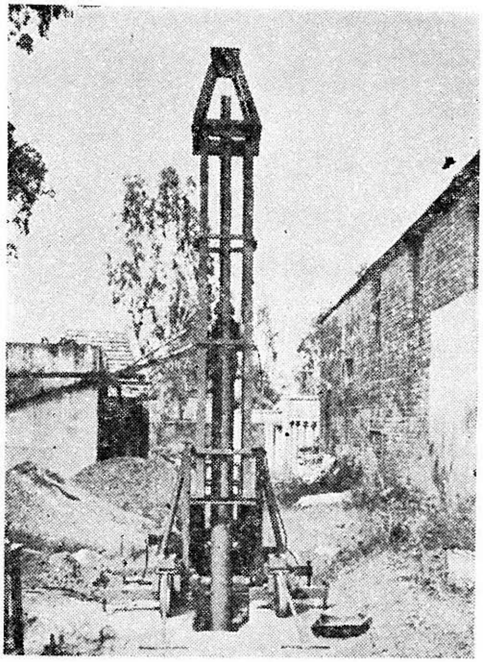

FIGURE 3 Illustration of Trenching Operation

FIGURE 4 Removal of Cut Clay From the Trench with the Help of Helical Auger

persons were engaged to carry out the boring and skirting operations on the machine.

Salient Features

(*i*) Capacity : (*a*) Bore diameter : 15 to 60 cm

(*b*) Bore depth : 3 m dry and upto 8 m with bentonite

(*c*) Trench width : 15 to 60 cm

(*d*) Trench depth : 3 m dry and upto 8 m with bentonite

(*ii*) Self weight : 650 Kg.

(*iii*) Major Dimensions : (*a*) Trolley—2 × 1 m

(*b*) Boom—4.870 m long

(*iv*) Portability : Capable of being split into a number of sub-assemblies

(*v*) Power : 6 H.P.

Conclusion

The boring and skirting machine developed in the institute is compact and light. The machine has been successfully tried. The operation and maintenance are simple. Besides being suitable for making skirted foundations, the machine is also capable of making bore holes for granular, bored pile and under-reamed pile foundations. The machine can also be used for making inclined bores for batter pile foundations. The know-how of the machine is available from CBRI as Technical Aid to the industry. The paper forms the part of normal research programme of the Central Building Research Institute and is published with the permission of the Director.

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