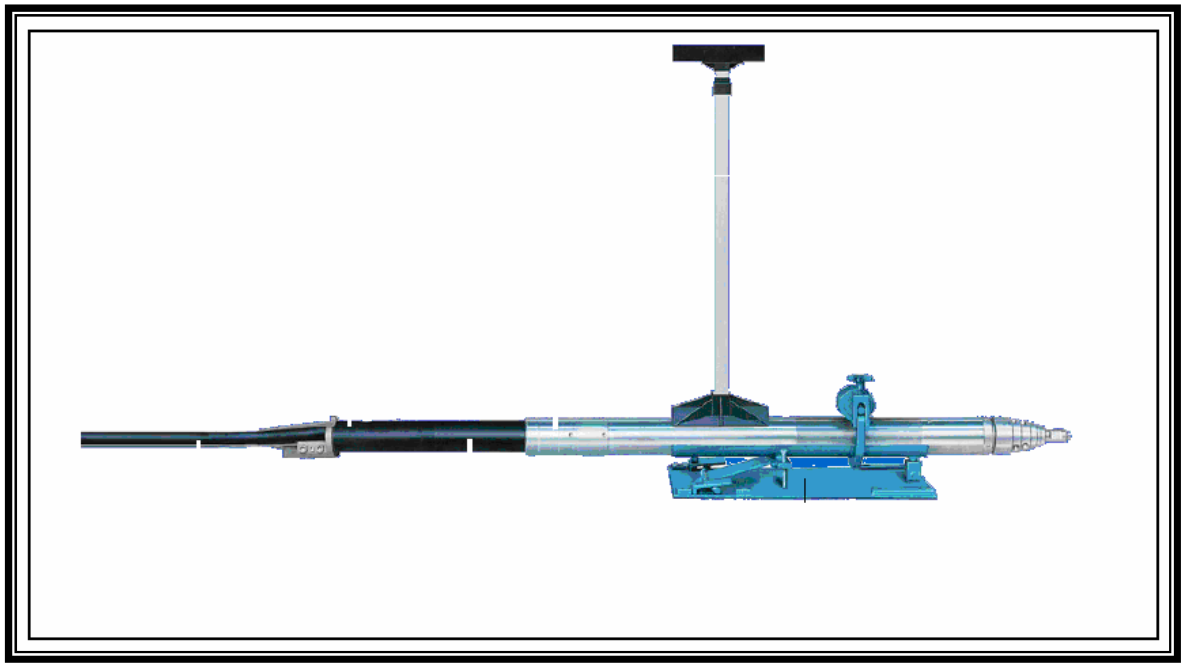
IMPACT MOOLING



Brought by :-

WqE

No.20, Jalan Jaya 1, Taman Jaya,
81300 SKUDAI, Johor Bahru,
Johor.

Tel/Fax : +607-5567291
Email : sales@wqe.com.my

Introductions

Impact moling is a trenchless installation method for placement of small diameter pipes, ducts and cables, in which percussion or hammering action of pneumatic piercing tool is used to create the bore by compacting and displacing the soil rather than moving it. The method typically is non-steer able although steer able system reached the market in recent years.

When properly designed, impact moling is the simplest and the least expensive trenchless[1] technology installation method. It is the most widely used trenchless installation method: Utility companies throughout the world widely use this technique for installation of service connection to gas, water and sewer mains, usually under sidewalks, driveways and other shirt crossing under 150 feet. General advantages of impact moling are low operational and reinstatement costs, relative simplicity in operating, minimal or no excavation beyond the necessary connection pits or termination points for the installed product, and minimal public disruption. Support equipment is limited to a small air compressor, and perhaps a small backhoe or trencher to open and reinstate the connection/termination pits.

Feasibility of the method is restricted by its generic limitations (limited boring diameter and length) and by local ground conditions that can greatly affect performance. Adverse ground conditions may include cobbles, dense dry clays and other non-compactible soils. Such soils may drastically reduce penetration, rates, contribute toward surface upheaval and/or deviation from the desired straight-line path. The ability to trace the path while boring – a long available option – is useful in detecting path deviation so the bore may be aborted for another attempt before trouble is caused. Steer able moles address the path deviation shortcoming of non-steer able moles and are poised to expand the usability of the method by virtue of being able bore to curved path.

Impact moles are also known as earth piercing tools, soil displacement hammers, percussive moles or pneumatic moles. Although hydraulic-powered

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[1] Non-directional slender rod boring system often attached to trenching equipment may be less expensive for short installation under driveways, sidewalks and the like.

impact mole designs have been attempted over the years, current commercially available products are pneumatic-powered.

Method Description

This section explains the principle of impact moling and the installation procedure.

PRINCIPLE

Impact moles consist of an enclosed steel tube containing an air-powered piston (also referred as the stiker) that strikes the nose of the tool driving it forward. A bore is formed by displacing and compacting the soil laterally. The friction between the ground and the mole body prevents the mole from rebounding backwards. Repeated impacts of the piston advance the whole unit through the ground. There is no rigid connection between the mole and the insertion pit, and the progress of the mole relies upon the frictional resistance of the ground for its overall forward movement.

The hammering action an either be a simple striking of the piston onto the forward end of the unit or a two-stage action of a specially designed moving head. Figure 1 shows the two-stage action. This first compresses the pre-tensioned steel spring[2], which forces the chisel head assembly forward independently of the main casing. The first impact creates a pilot boe. Then, the same continues force thrust the main casing ahead. The second impact expands the borehole to its final diameter.

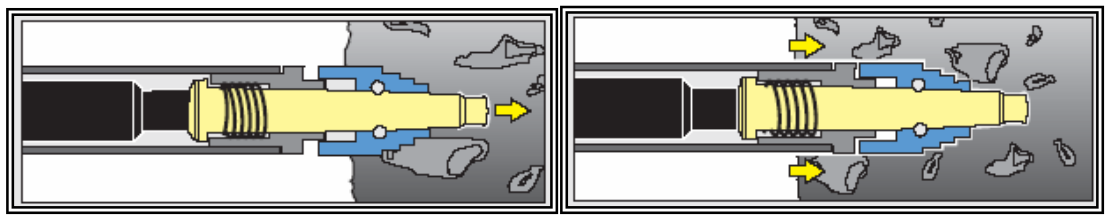

Figure 1 : Two-stage moving head action

[2] The latest advancement in the active head design eliminates the need for the spring. See Appendix.

INSTALLATION PROCEDURE

Non-steerable moles typically involve the excavation of two pits: an insertion pit and a receiving pit. After the careful alignment of the mole in the insertion pit, the tool is expected to advance through the ground in a straight line. A single person can operate the mole.

Steerable moles may be launched from the surface or from a pit. The operation requires a two-man crew. A walkover tracking system is used, as in directional drilling industries, where one operator walks the bore route with walkover locator device and monitors the progress of the tool in the ground. The other operator is a tool operator who implements the required course corrections using the guidance controls.

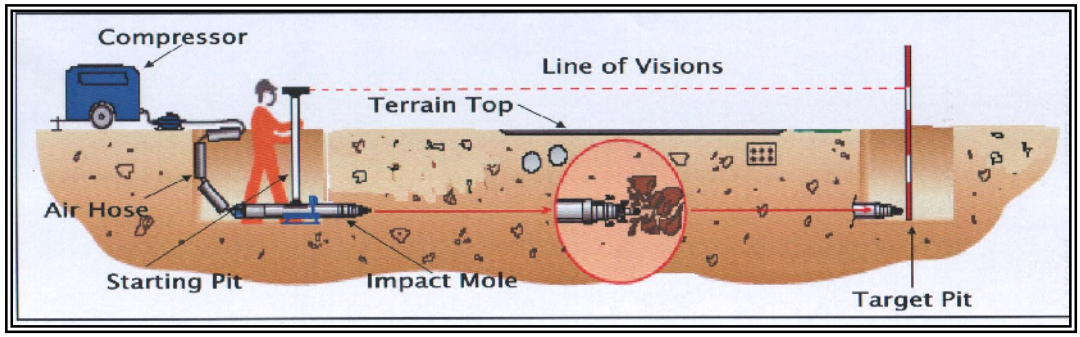

Figure 2: The schematic of impact moling

A product pipe, cable or cable duct can either be directly towed into the bore during procedure or subsequently inserted into place after the borehole is completed (providing suitable soil conditions for unsupported borehole). Usually the mole first creates the unsupported bore, and upon removing the unit from the receiving pit, the product pipe is attached to the air hose and pulled into the bore (the most popular mode operation), or the pipe is sometimes pushed into its place.

Impact moling can also be used for dead-end bores, in which case the tool is reserved after bore is completed and removed from the ground through the insertion pit.

Range of Applications

Impact moling can be used for installation pipes up to 10 inches in diameter, but typically is used for pipes in the diameter range between ½ and 4 inches. Installed pipes are usually made of PVC, HDPE or steel. Depending on tool size and soil conditions, the maximum boring distance for non-steerable moling is between 10-100 ft, or even longer, but the typical installation length is usually up to 35ft in one run. Steerable system allows moling to be carried out in longer runs, up to 200 ft in good soil conditions. However, penetration rates of moles in comparison to other techniques such as directional drilling should be taken into account when longer bores are being considered.

The method has a wide range of applications. Besides gas and water service lines, these tools are used for cabling, cable ducts, garden irrigation, water treatment systems, outside water supplies, landscape lighting, drain replacements, lead piping replacement, etc. Impact moles can also be used for other applications, for example in pipeline rehabilitation for pulling a liner into the pipe or in non-utility applications for the installation of environmental wells.

Because the method uses a compaction principle to create the bore, this technique is appropriate for compressible soils. Ground conditions suitable for impact moling include clays, silt, peat and generally soft cohesive material. Sands and gravel are considered less appropriate, especially if they are densely packed, while solid rock is entirely unsuitable for this technique.

Market for Impact Moling

Impact moles are the most widely used trenchless construction equipment. Tens of thousands are in service with utilities and contractors worldwide (Flaxman 1999).

Both the gas and the water industry have a large demand for new service lines installation. More than 1.2 million polyethylene gas services are installed annually in the United States, of which about 800,000 are new installations and 4000,000 are replacements (Fisk et al 1995). The average service length is 70 ft, about 95% of them are under 4 inches in diameter, and 72 are under 2 incehs in diameter. In addition, about 17,000 miles of polyethylene gas mains are

installed each year, of which 95% are up to 4 inches in diameter and 72% up to 2 inches in diameter. Open-cut methods are used for installation of about 95% of new gas services and for more than 66% of new gas mains. The water industry has a similar demand for small pipe installation.

In favorable soil conditions, impact moling might be the best-suited trenchless method to address these segments of gas and water industry, because even the smallest mini-directional drills are larger and more costly than impact moles. However, additional factors such as potential for surface upheaval and overall job productivity should be taken into consideration when selecting impact moling over other installation methods. One must also remember to factor in costs associated with the air compressor required to operate a mole. Still, compared to other trenchless methods on smaller jobs, and especially to open cut and resurfacing, impact moling can obtain substantial cost and time savings. On some projects time saving can be measured in ours and even in days.