

Basic tunnelling still a viable method

Al Tenbusch of small-bore tunnelling equipment manufacturer and supplier Tenbusch of Lewisville, Texas, describes the two main methods of hand mining and essential considerations

When the term hand mining is used, we know that we are talking about some type of tunnelling. For those who have never been in a tunnel, digging a tunnel by hand conjures up images from World War II movies where the prisoners of war are escaping.

In modern construction practice 'hand mining' is a viable and cost-effective method of constructing a tunnel, but there are some limitations.

Hand mining will not be viable where the tunnel is too small for manned entry or too large so the face of the tunnel becomes unstable. Instability of the tunnel face is a function of the soil cohesion properties and groundwater effects. Hand mining is normally limited to reasonable ground conditions. Some groundwater can usually be tolerated, especially if the tunnel is constructed up-grade.

In order to discuss the methodology of hand mining, it is helpful to focus on the structure of the tunnel and the utility for which it will be used.

Depending on the ground, excavation in 'hand mining' can literally use hand tools

(even trowels have been used to finish the profile) or hand-held powered spaders for example. In larger sections a device such as a backhoe excavator could be used.

Some tunnels are constructed using the utility pipeline as the structure itself whereas others are constructed by inserting the utility pipeline into a larger diameter liner. The following materials can be used for a tunnel liner and/or pipe:

- Liner plate,
- Beam and lagging,
- Corrugated metal pipe,
- Steel casing,
- Concrete pipe,
- Wood box tunnel.

There are specific job-site-related parameters including ground conditions that will dictate which structure is appropriate. However, hand mining is normally suitable for all the support materials listed above.

Hand mining is safer and more efficient if accomplished by using a tunnel 'shield'.

Figure 1, below, shows a typical articulating tunnelling shield used for hand mining.

Such a shield serves many purposes:

- It provides protection for the men as

they work;

- Can be configured to allow for steering of the tunnel – both vertically and horizontally;
- Provides a strong and rigid mounting point for excavation tools;
- And provides structure to locate material handling equipment such as conveyors.

In addition, 'sand shelves' may be introduced at the face as part of the tunnelling shield to increase the stability of the tunnel face and further protect the men. Figure 2, below, shows a hand mining tunnelling shield with sand shelves.

It is important to realise that hand mining will progress by one of two methods:

- Jacking the pipe (pipe jacking) – Insertion of the advancing string of new pipe (as is the case with steel casing or concrete pipe) section by section from the insertion pit;
- Liner plate/beam and lagging – advancing the shield forward by pushing off the assembled tunnel liner product (as is common with liner plate and beam and lagging tunnel structures) – shown in Figure 3, page 60.

Below left: Figure 1, a typical articulating hand-mining shield of 48in (1.22m) diameter; **Below right:** Figure 2, hand mining tunnelling shield equipped with sand shelves, 99in (2.51m) diameter



Right: Figure 3, cutaway view of a typical hand mining liner-plate application

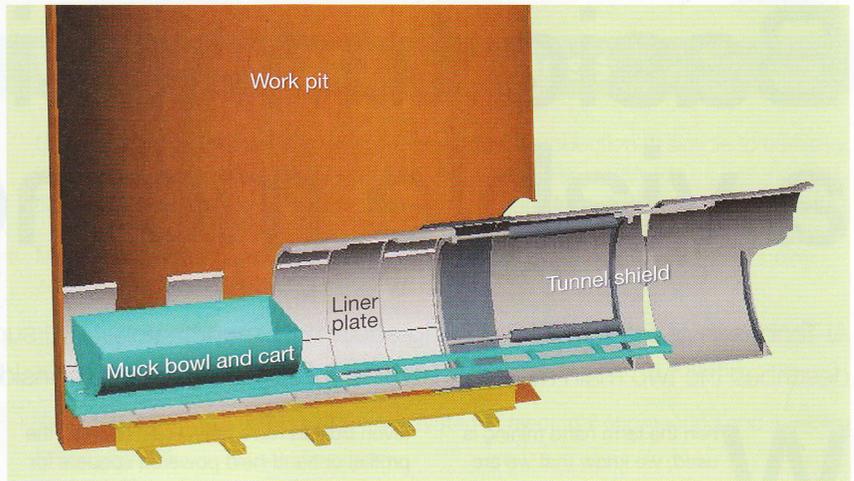
The following is a comparison of the two hand mining methods.

Jacking the pipe/pipe jacking:

- New pipe is jacked length by length as the men excavate the face from within the protective shield.
- The shield has steering capability to maintain grade and alignment.
- The jacking equipment is substantial and requires a sizable work pit/drive pit.
- The jacking equipment must have a stable backstop to push against.
- Jacking the pipe string typically requires the use of a lubricant to minimise the skin friction encountered as the pipeline is pushed into place.
- When the tunnel is complete the annular space surrounding the pipeline must be filled with grout.
- Several materials are available for pipelines including: clayware, polymer concrete, reinforced concrete, steel, and ductile iron.

Liner plate/beam and lagging (as shown in figure 3):

- The new liner plate is installed one ring



- at a time as the tunnel is advanced.
- The crew excavates the face from within the protective shield.
- The shield is advanced by hydraulic cylinders within the shield that push against the most recently assembled liner plate ring.
- The shield has steering capability to maintain grade and alignment.
- Installation does not require the use of a jacking unit.
- The work area must be large enough to

launch the shield and allow for the entrance and exit of both the men and the materials.

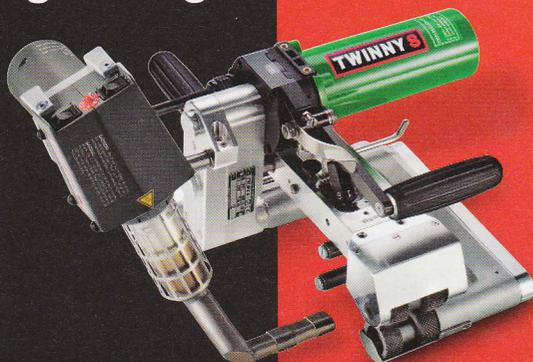
- Liner plate installation does not require the use of a lubricant.
- The installed liner plate is typically grouted in place at the end of each shift or work day.

When performed properly, hand mining is a viable, safe, and cost effective means of tunnel construction. ■

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