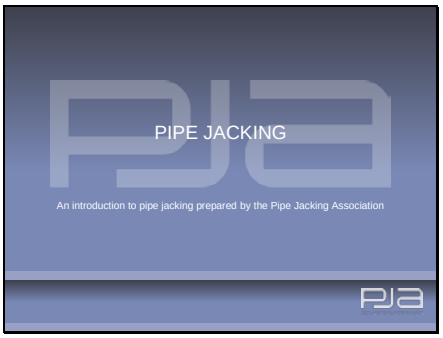
Pipe Jacking Association: Introduction Presentation

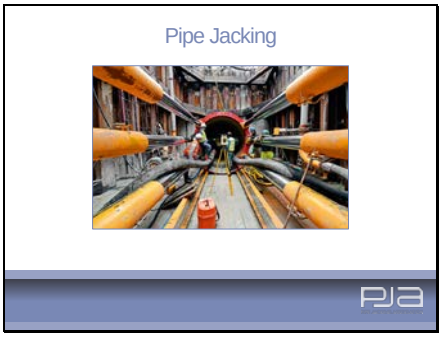
Lecture notes

Slide 1



This introduction to pipe jacking has been prepared by the Pipe Jacking Association as an aid to engineers and others seeking an introduction to the science and art of pipejacking.

Slide 2



Pipe jacking is a tunnelling technique for the installation of pipes using powerful hydraulic jacks to drive purpose designed pipes through the ground at the same time as excavation is taking place at the face.

Slide 3

A range of machines are available, to suit varying ground conditions, to install pipes typically in the range 150 to 2,400 mm or greater if required. Lengths of up to a kilometre or more can be jacked depending on ground conditions and pipe diameter. Drives can be either in a straight line, to a radius or a series of radii. Concrete, Grp, clay and steel pipes can be jacked.

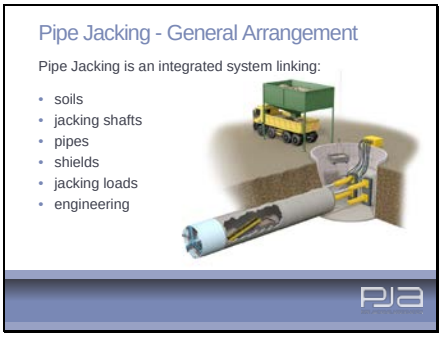
Pipe Jacking Association: Introduction Presentation

Lecture notes

Slide 4

In smaller non-man entry diameters, generally one metre and below, the system is often referred to as microtunnelling although this term is also used to describe automated tunnelling operations in larger diameters.

Slide 5



The integrity of a pipe jacking operation is dependent upon the inter-relationship of a number of factors: soil investigation and interpretation; jacking shaft design; pipe design; pipejack shield selection; hydraulic considerations; and laser engineering and control.

Slide 6

The latest tunnelling technology has been incorporated into pipe jacking excavation systems and a range of machines are available for pipejacking in most ground conditions from soft water bearing strata to hard rock.

Pipe Jacking Association: Introduction Presentation

Lecture notes

Slide 7

A backacter – an open face shield in which a mechanical backacter is mounted for excavation purposes.

Slide 8

An open face cutter boom – an open face shield in which a cutter boom is mounted for excavation purposes.

Slide 9

A tunnel boring machine – a shield having a rotating head. Various cutting heads are available to suit a broad range of ground conditions.

Pipe Jacking Association: Introduction Presentation

Lecture notes

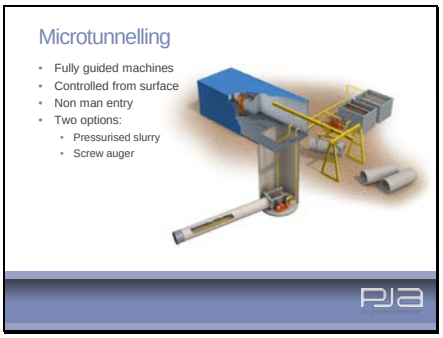
Slide 10

An earth pressure balance machine or EPBM – a full-face tunnel boring machine in which the excavated material is transported from the face by a balanced screw auger or screw conveyor. The face is supported by excavated material held under pressure behind the cutter head in front of the forward bulkhead. Pressure is controlled by the rate of passage of excavated material through the balanced screw auger or valves on the screw conveyor.

Slide 11

A slurry machine - another full-face tunnel boring machine in which the excavated material is transported from the face suspended in a slurry. Various cutting heads are available to suit a broad range of ground conditions and may incorporate internal crushers to deal with cobbles and small boulders. The pressure of the slurry is used to balance the groundwater and face pressure.

Slide 12

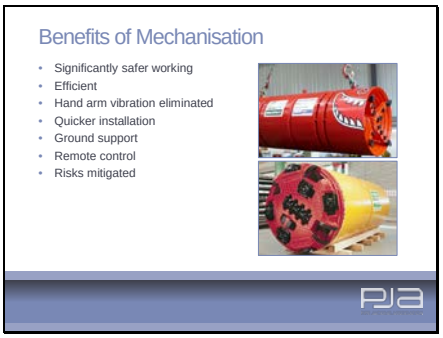


These fully guided machines are remotely controlled from the surface. There are generally two types, both having face support capability, pressurised slurry and auger machines.

Pipe Jacking Association: Introduction Presentation

Lecture notes

Slide 13

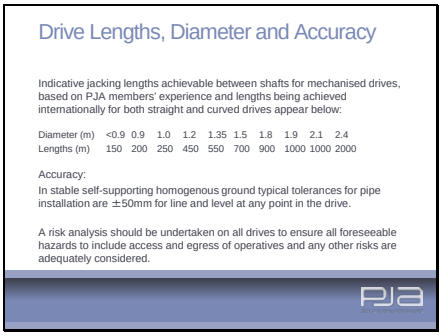


To summarise, the range of mechanised excavation systems available offer a combination of rapid excavation and safety mechanisms to control potentially unstable ground conditions. In addition remote controlled pipe jacking in contaminated ground avoids risks to operatives.

Slide 14

Guidance systems linked to an operator console enable continual line and level checks. Far greater control of accuracy and tolerance compliance is ensured even in the most difficult ground. The requirement for man-entry into the pipejack is minimised with surveying operations managed from the surface.

Slide 15



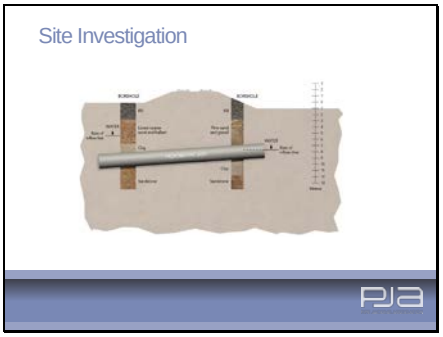
Tunnelling technology enables mechanised drives up to a kilometre or greater to be undertaken depending on pipe diameters. When operatives are working within the tunnel a risk analysis must be undertaken to ensure all hazards are assessed to include access and egress. In stable, self-supporting homogenous ground, typical tolerances for pipe installation are ±50 mm of line and level.

Lecture notes

Slide 16

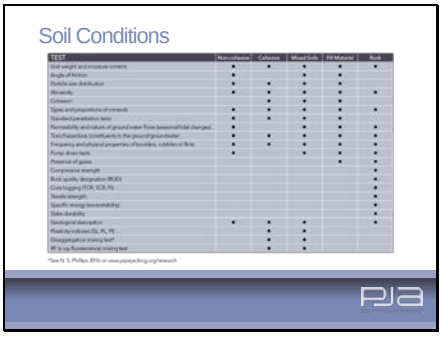
A range of materials are used as pipe jacking linings to include concrete, grp, clay and steel. Concrete jacking pipes which usually incorporate reinforcement, and have flexible joints, and clay pipes, should be manufactured in accordance with relevant standards.

Slide 17



Site investigation is the most important pre-requisite for any tunnelling project. This should be carried out by a suitably qualified geotechnical specialist or geotechnical adviser with considerable experience of tunnelling schemes, under the general direction of the tunnel designer.

Slide 18

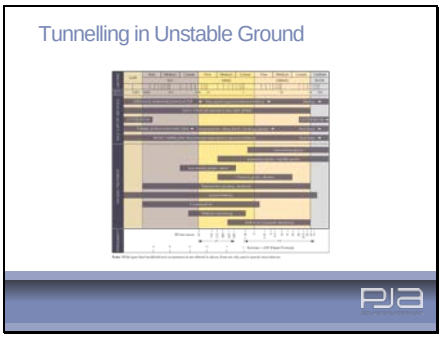


The choice of excavation method will depend on ground conditions. Unstable ground at the face of the tunnel must be controlled to prevent ground loss, and to enable mining to take place safely. This can be achieved using a suitable tunnelling machine or by stabilising the face using appropriate geotechnical processes.

Pipe Jacking Association: Introduction Presentation

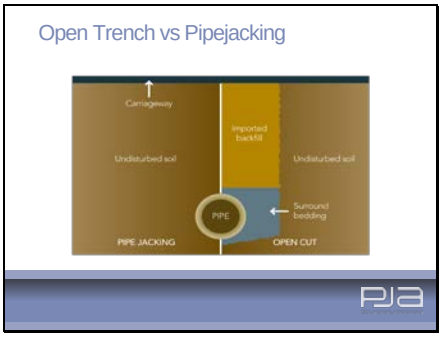
Lecture notes

Slide 19



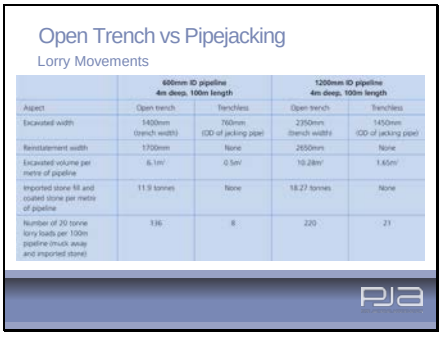
Tunnelling method selection depends on ground stability. Unstable ground can be managed either by suitable machine selection to control face pressures or by stabilising the ground using geotechnical processes. When tunnelling in unstable ground specialist geotechnical advice should be sought.

Slide 20



Comparing open-cut with pipejacking it shows that disruption is largely eliminated. The requirement for excavation is dramatically reduced as there is no requirement for imported fill.

Slide 21

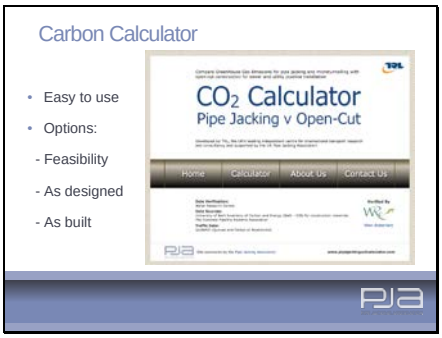


On an average contract, vehicle movements are reduced by 90%, excavated material is only around 8-10% of open cut volumes, and no additional quarried materials are required, so protecting the environment.

Pipe Jacking Association: Introduction Presentation

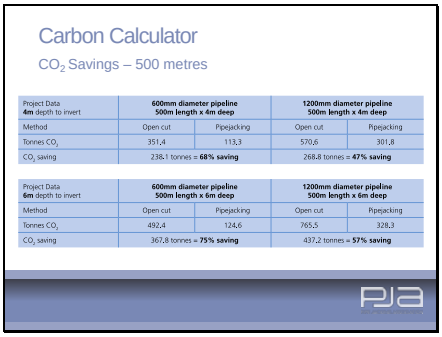
Lecture notes

Slide 22



The Transport Research Laboratory has developed a web-based tool for the PJA to compare greenhouse gas emissions for pipe jacking and microtunnelling with open-cut for sewers and utility pipeline installation. The data sources and methodology has been peer reviewed by the Water Research Centre.

Slide 23



This example demonstrates the significant carbon savings that can be achieved over 500 metres.

Slide 24

A major application for pipejacking is for new foul and surface water drainage, culverts and watercourses. It is also used for crossings under roads, railways, rivers and canals for the installation of gas and water mains, oil pipelines, electricity and telecommunications cable ducts, and subways

Pipe Jacking Association: Introduction Presentation

Lecture notes

Slide 25

Pipe jacking provides the best engineered, safest and most cost effective form of tunnel lining available and is applicable in a wide range of ground conditions.

Slide 26

Pipe jacking and microtunelling are inherently safe tunnelling systems. Man hours worked are substantially reduced as are the risks of utility strikes. Surface disruption is minimised and the finished structure is maintenance free.

Slide 27

Compared to open-cut trenching, pipe jacking and microtunnelling systems reduce the social and environmental disturbance for the installation of services in urban areas

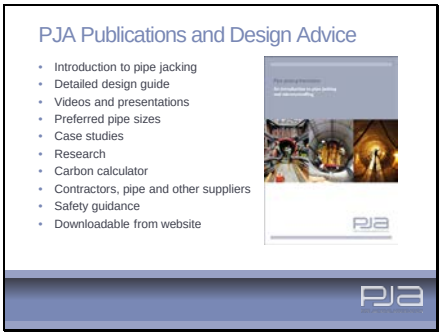
Pipe Jacking Association: Introduction Presentation

Lecture notes

Slide 28

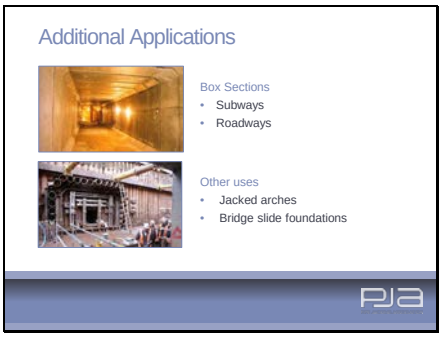
Research has been carried out at leading universities to include the design and performance of jacking pipes, the interaction between the soil and pipes using a variety of lubricants, and the effect of various conditioners on the efficiency of the overall jacking process, including excavation. Full details of research activities are available on the PJA website.

Slide 29



The PJA produce a range of publications to include a general overview, a detailed design guide, case studies, guidance for designers, videos and presentations. These are downloadable from the PJA website.

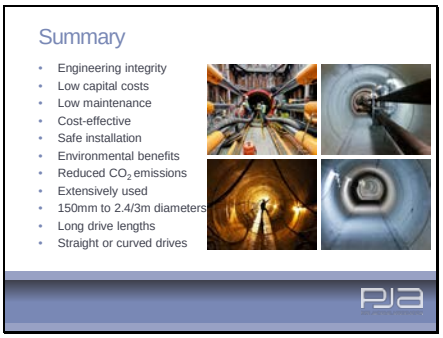
Slide 30



In addition to conventional conduits pipe jacking has a variety of specialist applications. These include box sections for subways and roadways, bridge foundations for bridge slides and also jacked arches.

Lecture notes

Slide 31



To summarise: pipe jacking is a proven system used extensively for sewerage infrastructure and other utility installations. Pipe diameters typically range from 150mm to 2.4 metres and can be greater when required. Drive lengths of up to 1,000 metres are readily achievable and considerably longer lengths have been successfully jacked. Drives can be either in a straight line, to a radius, or a series of radii. Pipe jacking delivers improved engineering performance and integrity over alternative tunnelling systems.

Slide 32