Lesson #7

Trenching Techniques

What is in this Lesson?

1. The primary goal of proper trench construction.
2. The three types of excavations.
3. The external loads exerted on buried pip lines.
4. The offset distance of hub stakes.
5. Four methods of obtaining proper trench alignment.
6. Typical minimum and maximum depth of cover for water line installations.
7. The shape of a properly dug trench.
8. The proper width of a trench.
9. The impact on pipe loading caused by widening the trench at or below the springline.
10. The distance that spoils must be placed in back of a trench.
11. Two safety concerns associated with the placement of backfill material and the removal of spoils.
12. One special concern associated with trenching for appurtenances and structures.
13. Two ways to de-water a trench.
14. Advanced notice requirements before blasting.
15. The proper use of protective sleeves and skids in tunnel excavations.

Key Words

- A.C.
- C.I.P.
- Distributed Load
- Flexible Pipe
- Modulus of Elasticity
- Rigid Pipe
- Springline
- Surcharge
- Concentrated Loads
- D.I.P.
- Excavation
- Invert
- PVC
- Semi-rigid Pipe
- Superimposed Load
- Trench

Trenching Techniques

Introduction

Goal of Proper Trenching

The goal of trenching is to construct a trench in a manner that it properly supports and protects the pipe. This must be done while making the process of laying pipe as easy as possible and while protecting the safety of the crew and the public. This goal should be met with minimal side effects: minimum damage to public and private property, minimum disruption of service, and as little inconvenience to the public as possible. It is the intent of this lesson to provide the tools necessary (providing that proper operation of trenching equipment is known) to properly and safely construct a trench for the purpose of installing a pipeline.

Items Covered in This Lesson

This lesson includes some background on three topics:

1. The various types of excavations and pipe loadings.
2. The process of opening a trench, properly placing the spoils, properly placing the piping materials, removing the spoils, and placing bedding and backfill material at the site.
3. A few special considerations such as dewatering, blasting and tunneling. This material follows the standard specifications.

What is Not Covered

The use of shoring, proper bedding and backfill techniques will be covered elsewhere.

Background on Excavations

Excavation Defined

OSHA defines an excavation[1] as any man-made cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reason of the excavation. What this essentially means is someone dug a hole in the ground in order to do some work.

Types of Excavations

On the other hand, the construction industry describes three excavation conditions. They are trench, embankment, and tunneling.

Trench

A trench[2] includes those conditions in which a conduit is installed in a relatively narrow ditch that has been cut in undisturbed soil and the ditch is backfilled to the original level (OSHA defines "trench" as a narrow excavation made below the surface of the

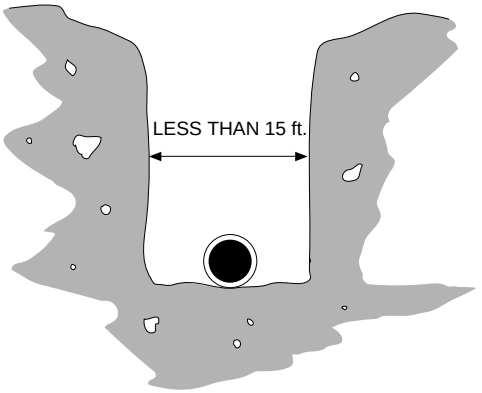
[1] **Excavation** - Any man-made cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reason of the excavation.

[2] **Trench** - A narrow excavation made below the surface of the ground. In general the depth is greater than the width, but the width of a trench is not greater than 15 feet.

ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet).

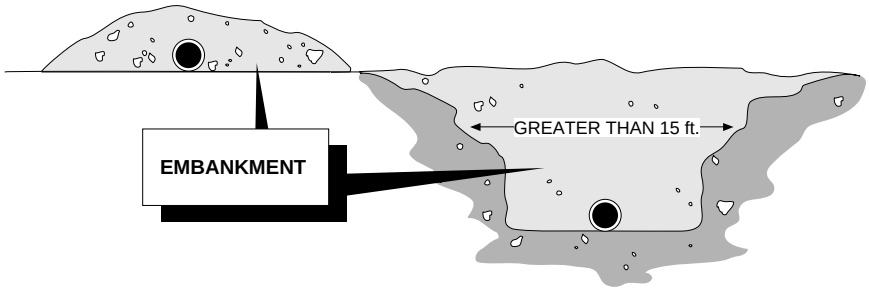
Embankment

Embankment includes those conditions in which the



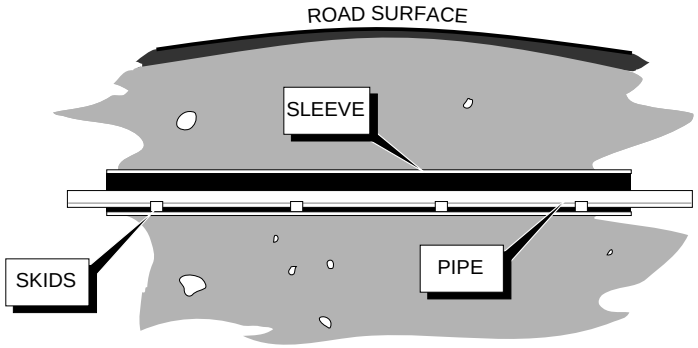
TRENCH

trench is so wide that the backfill does not affect the pipe loading, or where the trench is covered with fill to above the original ground level.



Tunneling

Tunneling is any condition where the conduit is placed underground without disturbing the ground above it. We will mention some considerations about tunneling, but the majority of this material will deal with the trench.



TUNNELING

External Loads on Pipe

In order to have an appreciation for the dynamic forces at work that cause pipelines to be damaged, it is necessary to endure some academics on external pipe loading. This is some of that “nice-to-know” material that does not directly affect the job, but indirectly affects trenching procedures - and therefore can affect the job.

Vertical Loading on a Pipe

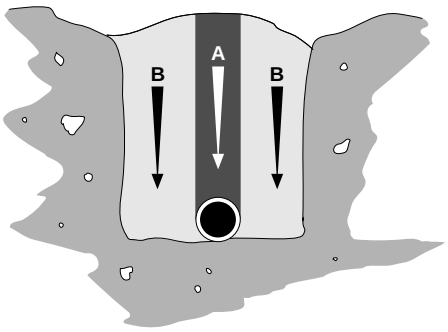
The loading on a pipe that causes concern is vertical loading (loading from the top of the pipe). This vertical loading can be broken into two major forces: 1) those forces that result from gravity on the backfill, and 2) those forces that are the result of some external load on the top of the ground called a superimposed load[3].

Load from Gravity

View Backfill as 3 columns

The load resulting from gravity can best be understood by first viewing the backfill as three columns of earth (see diagram). The first is the weight of a column directly above the pipe (column A). The second vertical force is the shearing forces between columns A and B and between both B columns and the walls of the trench. Think of shearing force in terms of the friction between the columns.

Two Affects of Shearing Forces



The shearing forces affect loading in one of two different ways, depending upon the backfill conditions. First, if the settling of the earth column above the pipe (column A) is at the same rate as the B columns, then the friction between the backfill and the trench walls will decrease the overall load on the pipe. This is the typical condition that prevails when the trench backfill is properly compacted.

Different Settling Rates

The second condition exists where the settling rate of the columns are different. This would normally happen in an uncompacted trench. In this case, the columns next to the trench walls(B) settle faster than column A. This would result in an increased load on the pipe as columns B pull down on column A, which is directly above the pipe.

[3]**Superimposed load** - External loads placed on a pipe not resulting from the backfill. Examples of superimposed loads are the weight from traffic or buildings.

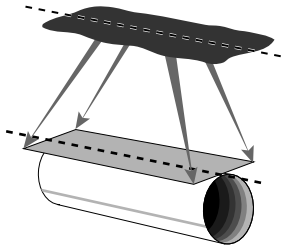
Superimposed Loads

Two Categories

Superimposed loading is divided into two major categories: concentrated loads[4] and distributed loads[5].

Concentrated Loads

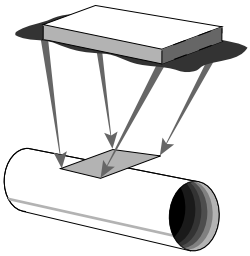
Concentrated loads are loads positioned directly over a pipe. A common concentrated load would be the load caused by a truck passing over pipe. The impact that the load has on the pipe depends upon the weight from the wheels, the height of the fill over that pipe, the shape of the original trench, and the type of road surface. A gravel street will give a greater load on pipe than will a paved street. This is because the load can be distributed more evenly with a paved street.



Concentrated Load

Distributed Loads

Distributed loads are loads placed over a large area above the pipe. This is the type of load resulting from crossing under a railroad. The load is dependent upon the original trench shape, bedding condition, and nature of the structure above the pipe.



Distributed Load

Comparisons

Concentrated loads are loads that start out concentrated, as with a truck tire. This type of load is distributed along the length of the pipe. Loads that start our as distributed are concentrated on a small area of the pipe. thus distributed loads are of greater concern than concentrated loads.

[4]**Concentrated Loads** - Vertical external loads placed on a pipe. Typically represented by a truck driving over the pipe at right angles to the pipe.

[5]**Distributed Load** - The vertical load placed on a pipe by some structure above the pipe, such as a building, paved street, or railroad track.

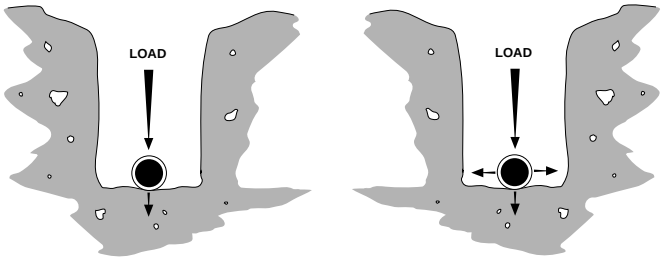
Compensation for Load Effects

Reaction Based on Pipe Type

Compensation for the effects of these loads is different for different types of pipe. Piping materials are divided into three categories based on how they respond to external loads: rigid pipe[6], flexible pipe[7], and semi-rigid pipe[8].

Rigid Pipe

Rigid pipe, such as A.C.[9], C.I.P.[10] and D.I.P.[11] transfers the load to the bottom of the pipe and is therefore affected most by the condition of the trench bottom. An uneven bottom can cause the pipe to be deflected downward by the vertical loads and result in pipe failure.



Flexible Pipe

Flexible pipes, such as PVC[12] and steel, transfer the load to both the bottom and walls of the pipe. It is important for the integrity of the pipe that the bedding material alongside the pipe be compacted. This compaction allows the bedding to push back on the walls of the pipe when they are deflected outward, and thus maintain the roundness or integrity of the pipe. (This property of the soil is called the Modulus of Elasticity[13] of the soil.)

Semi-Rigid Pipe

Semi-rigid pipe, such as pretinsioned concrete cylinder pipe, transfers the load from the top of the pipe down and out in an egg shaped pattern. The majority of the load is distributed along the bottom and the haunches of the pipe. The modules of elasticity of the soil is critical to the support of semi-rigid pipe.

Trench Requirements

In conclusion, rigid pipe needs a solid bottom under the pipe, and flexible pipe needs a solid bottom under and solid bedding alongside the pipe.

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[6] **Rigid Pipe** - Pipe that cannot have its vertical or horizontal dimension distorted more than 0.1 percent without structural damage. Examples are Asbestos Cement, Gray Cast Iron, and Ductile Cast Iron.

[7] **Flexible Pipe** - Pipe that can have a vertical or horizontal dimension defection of more than 3 percent without structural damage. Examples are PVC and thin walled steel pipe.

[8] **Semi-rigid Pipe** - Pipe that can withstand a change of more than 0.1 percent, but not more than 3% in its vertical or horizontal dimensions without structural damage. Examples are Pretensioned concrete, Prestressed Concrete, and cement mortar-lined steel pipe.

[9] **A.C.** - Asbestos Cement Pipe

[10] **C.I.P.** - Cast Iron Pipe, also called Gray Cast Iron Pipe. It is made by injecting molten cast iron into a spinning mold

[11] **D.I.P.** - Ductile Iron Pipe. Made the same as cast iron pipe, except that magnesium is mixed with the cast iron, developing a material of exceptional strength.

[12] **PVC** - Poly Vinyl Chloride. A plastic pipe made by forcing heated plastic through a die.

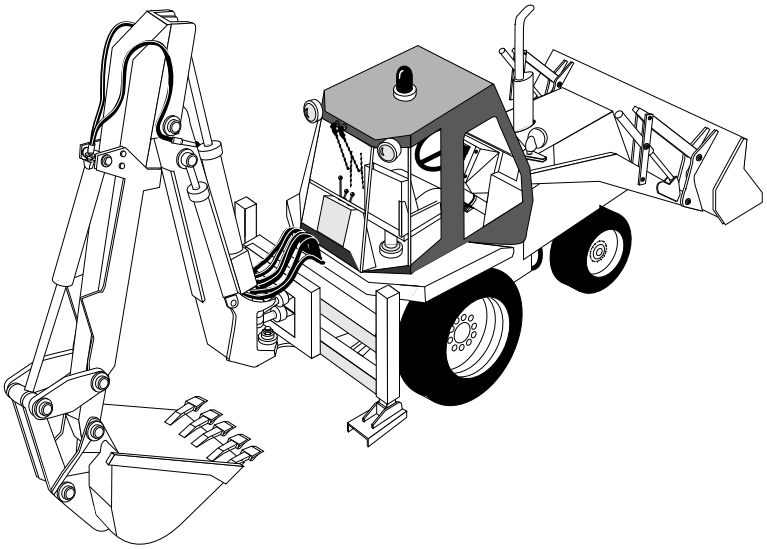
[13] **Modulus of Elasticity** - The resilience of the bedding material. When a pipe is deflected, this is the ability of the soil to push back on the pipe and counteract the deflection.

Trenching

Opening the Trench

Equipment Used

Trenching is accomplished with the use of some type of mechanical machine, usually a backhoe, operated by a reliable backhoe operator. This operator is responsible to the crew leader on the job. The crew leader is responsible for directing the backhoe as well as the rest of the job.



Responsibility of Operator

The backhoe operator must be aware of and work smoothly with the crew. The backhoe will be used to remove material from the trench and place the pipe in the trench. The safety and ease of work of the crew must always be prime considerations of the backhoe operator. The trench should be straight and smooth. Care must be taken to protect and assure that the edge of the pavement is not damaged by the backhoe. Damage to the edge will result in having to recut the pavement.

What to Watch For

While digging the trench, the operator and the crew should be on the lookout for obstacles which would hamper progress or represent a safety hazard. Typical areas of concern are overhead wires, traffic, pedestrians (especially sidewalk superintendents), underground utilities, and members of the crew. Special attention should be paid to the whereabouts of the person with the shovel looking for underground utilities. In general, the backhoe bucket should be idle while hand excavation is being done in the trench.

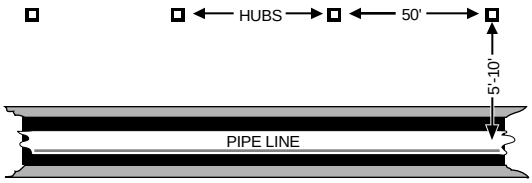
Trench Alignment

Introduction

Digging a trench in the proper location and at the proper depth is accomplished by using one or more techniques. Some of the most common techniques are described below. Regardless of which technique is used, there are several important reasons for keeping the trench, and thus the pipe, in its proper location. They include:

- Limiting headloss - a straight line has less headloss than a crooked line.
- Lower material cost - it takes less piping material when the alignment is straight.
- Less dig-in - it is much easier to locate a line when it is located at the proper depth and alignment.

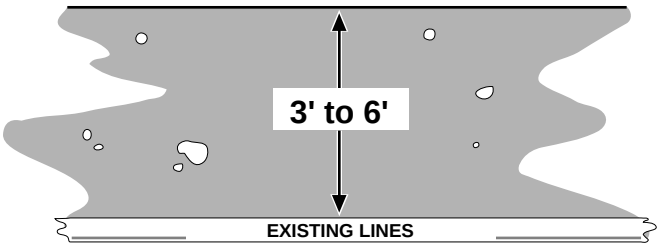
Criteria



The trench must meet the profile and alignment designated by the hubs and stakes placed at the job site. These hubs and stakes will typically be offset from the trench alignment by 5 or 10 feet from the center of the trench. The stakes and hubs are normally placed 25 or 50 feet apart. The crew leader should make sure that the backhoe operator can see the stakes and is aware of the alignment precision required. The profile should be checked at each hub by the crew leader with the use of a hand level, electronic level, or other leveling device such as a batter board.

Line Extensions

When existing lines are extended short distances, profile data is often not given. In these cases, the line should be laid at a depth required by local conditions. In areas where freezing does not occur, it is typical to require only a three (3) foot cover. A cover of five (5) to six (6) feet is typical in most areas. In some locations in northern Canada and Alaska, it is not uncommon to require a twelve (12) foot cover.



Alignment Methods

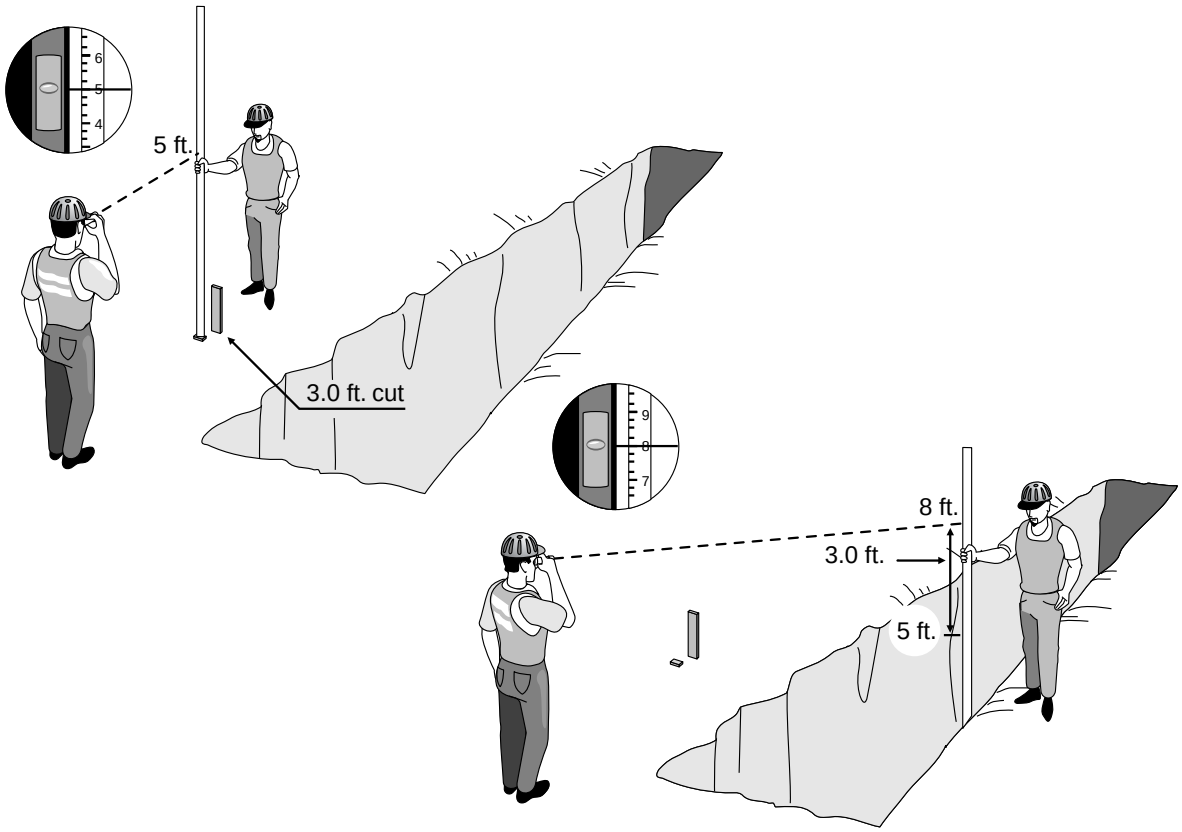
There are four methods used to maintain the alignment of the pipe:

- Hand level
- Batter boards
- Electronic level
- Transit and level rod

In the discussion it is assumed workers have been trained in the use of electronic levels and transits.

Hand Level

Newer Technology	While the hand level process is newer technology, it does require more skills and has a greater potential for error than the batter board technique.
Equipment	A hand level, level rod, and two people are required.
Position	One person must be positioned to see one hub and the trench with only a small amount of movement of the body. The second person must stand next to one of the hubs facing the first person.
Cut Stake	The depth of the cut is noted from the cut stake.
Level Rod	The level rod is placed on one of the hubs. The person with the hand level lines up on the level rod and reads the elevation.
Moving the Level Rod	The person with the level rod now moves to the center of the trench and positions the level rod in a vertical position.
Sighting-in	The person with the hand level swings their upper body so that the level rod can be seen in the hand-level. (The key is to hold the hand level level when the body is rotated.)



Take the Reading

Determine the new reading from the level rod. When the difference between the first and second readings is equal to the cut on the cut stake, the trench is at the proper depth.

Alignment

Alignment is determined by placing the level rod in a horizontal position between the hub and the center of the trench. When the height on the level rod is equal to the offset, the trench is in alignment.

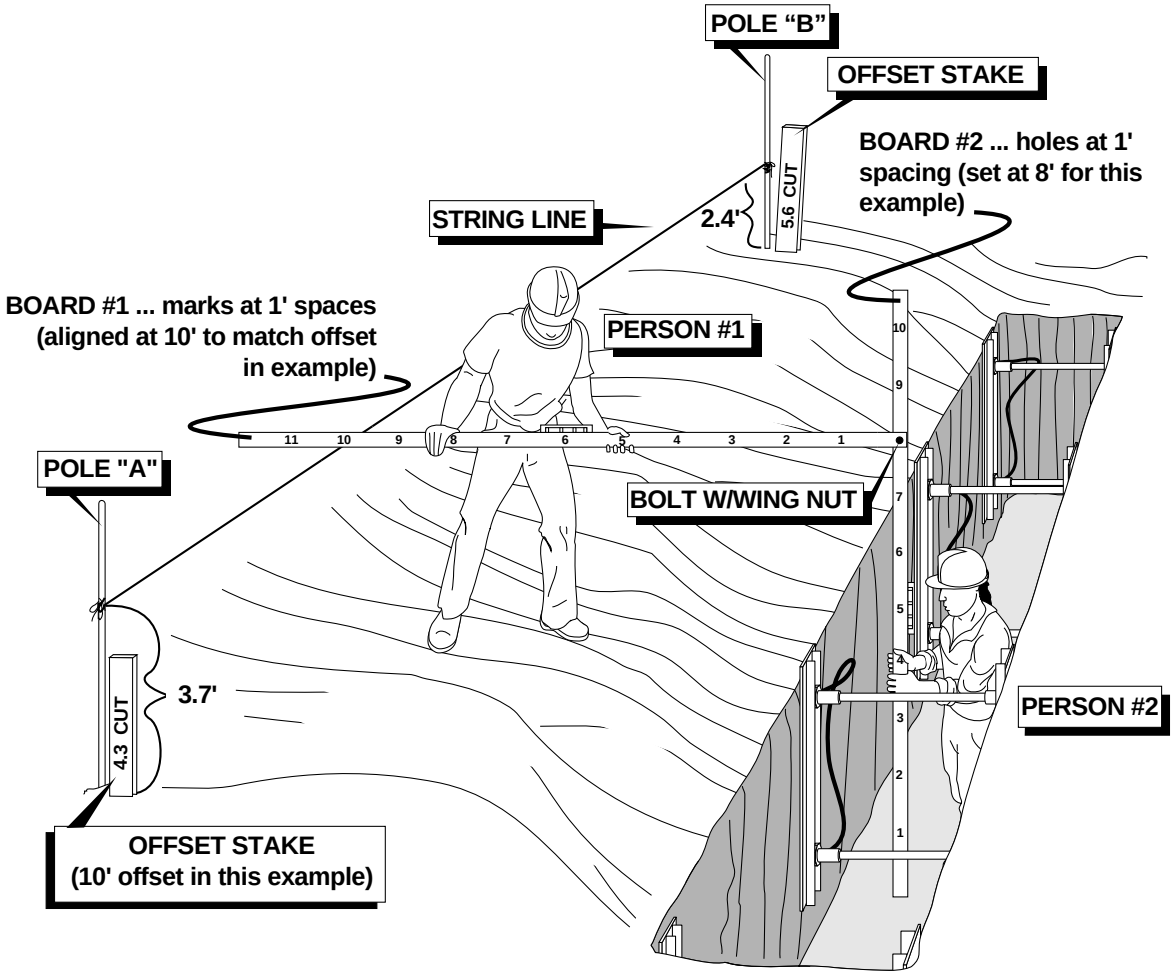
Batter Boards

Old Technology Revived

Batter boards are considered by many to be old technology. However, once engineers confirmed that straight pipe lines had lower head loss than crooked pipe lines, the construction crews identified batter boards as a method that allowed them to make a straight trench that matched the grade designated by the engineer.

Equipment

The batter board technique requires two people, two boards fastened with a bolt (as shown in the drawing), and two hand levels.



The Steps - Length of Vertical Board	The first step is to determine the length desired for board #2. The length should allow the horizontal board to be at a reasonable height above the ground. Typically this is 2 to 4 feet above the ground.
Set the Poles	Second, drive long rebar pins next to the hubs (vertical poles A & B in the example).
Height of String	A string must be run between the two pieces of rebar. In order to determine the height of the string, first look at the cut stake. In the example, the cut stake shows a cut of 4.3 feet. Subtract the depth of the cut (4.3') from the length of the vertical board (Board #1, which is 8'). 8' - 4.3' = 3.7 feet.
Height for Pole A	Using a ruler, measure up from the hub 3.7 feet and place a mark on the pole.
Height for Pole B	Repeat this process at the second pole. 8' - 5.6' = 2.4 feet.
String with No Sag	String a line between the two poles, making sure it does not sag.
Following the Back-hoe	As the back-hoe proceeds along the trench the batter boards are used to make sure the trench bottom is on grade and in alignment. This is accomplished by placing the vertical board in the center of the trench and holding it plumb.
Horizontal Board - Depth	Person #1 holds the horizontal board (Board #1) so that it is level. When Board #1 just touches the string, the trench is at the correct depth.
Horizontal Board - Alignment	Alignment is correct when the offset distance lines up with the string. In the example, the offset is 10 feet. So, when the vertical board is centered in the trench and the 10 foot mark on the horizontal board lines up with the string, the trench is in alignment.

Electronic Level

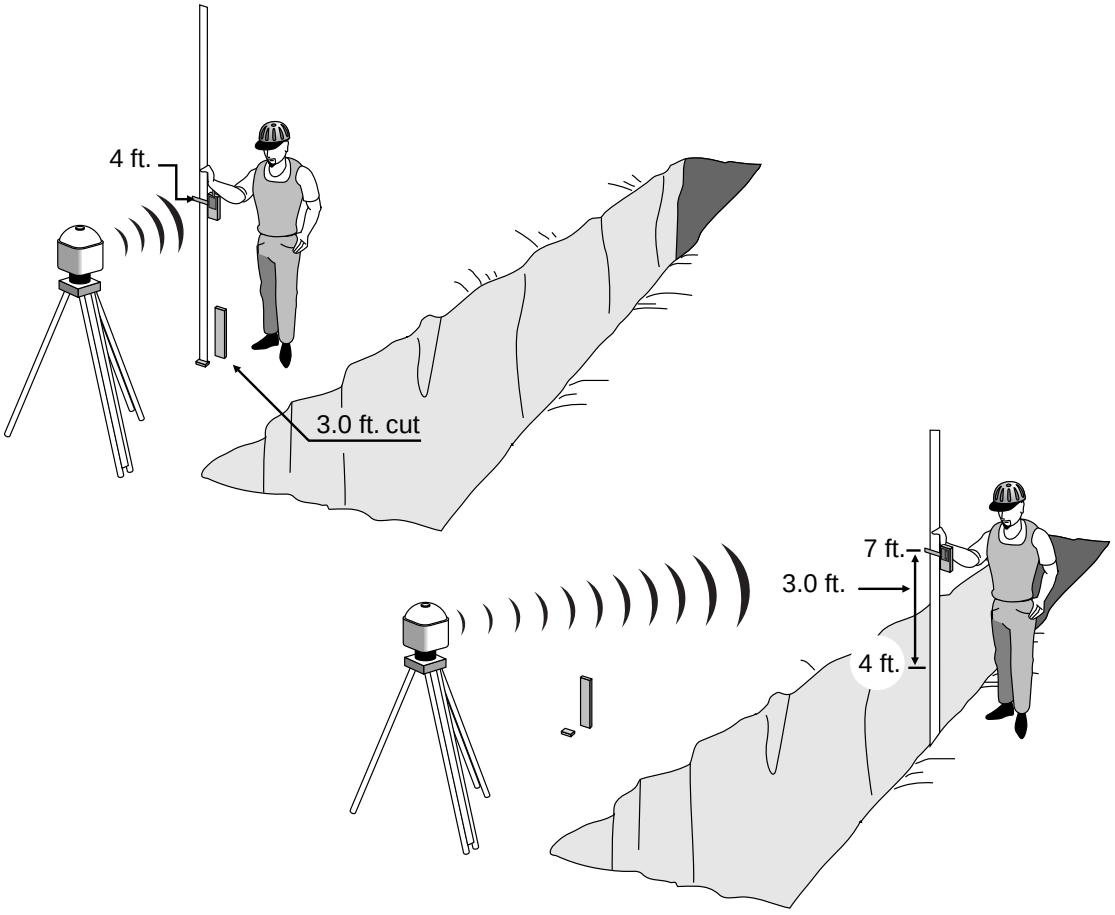
Skill Required	The use of an electronic level is accurate and dose not require a high level of skill
Equipment	This technique requires an electronic level, electronic target, level rod, and one person.
Electronic Transmitter	A transmitter mounted on a tripod sends out an narrow band signal. When the target is placed in line with signal a steady tone is produced. When the target is above or below the signal the tone pulses.
Level Rod	The target is placed on a level rod and the rod set on on one of the hubs. The target is moved up or down the level rod until a steady tone is produced. The height of the level rod is noted.
Target Moved	The depth shown on the cut stake is added to the height of the level rod and the target moved up the rod to this position.

Moving the Level Rod

The target and level rod now moves to the center of the trench and positions the level rod in a vertical position. If the tone is steady the depth has been reached. If the tone pulses the level rod is moved up. If time between pulses increases the trench needs to be deepened. If the pulses decrees as the rod is moved up the trench needs to be filled.

Alignment

Alignment is determined by placing the level rod in a horizontal position between the hub and the center of the trench. When the height on the level rod is equal to the offset, the trench is in alignment.



Transit and Level Rod

Skill Required

The use of a transit and level rod, while more accurate than the hand level, requires more skill and thus has a greater potential for error than the batter board or laser level techniques.

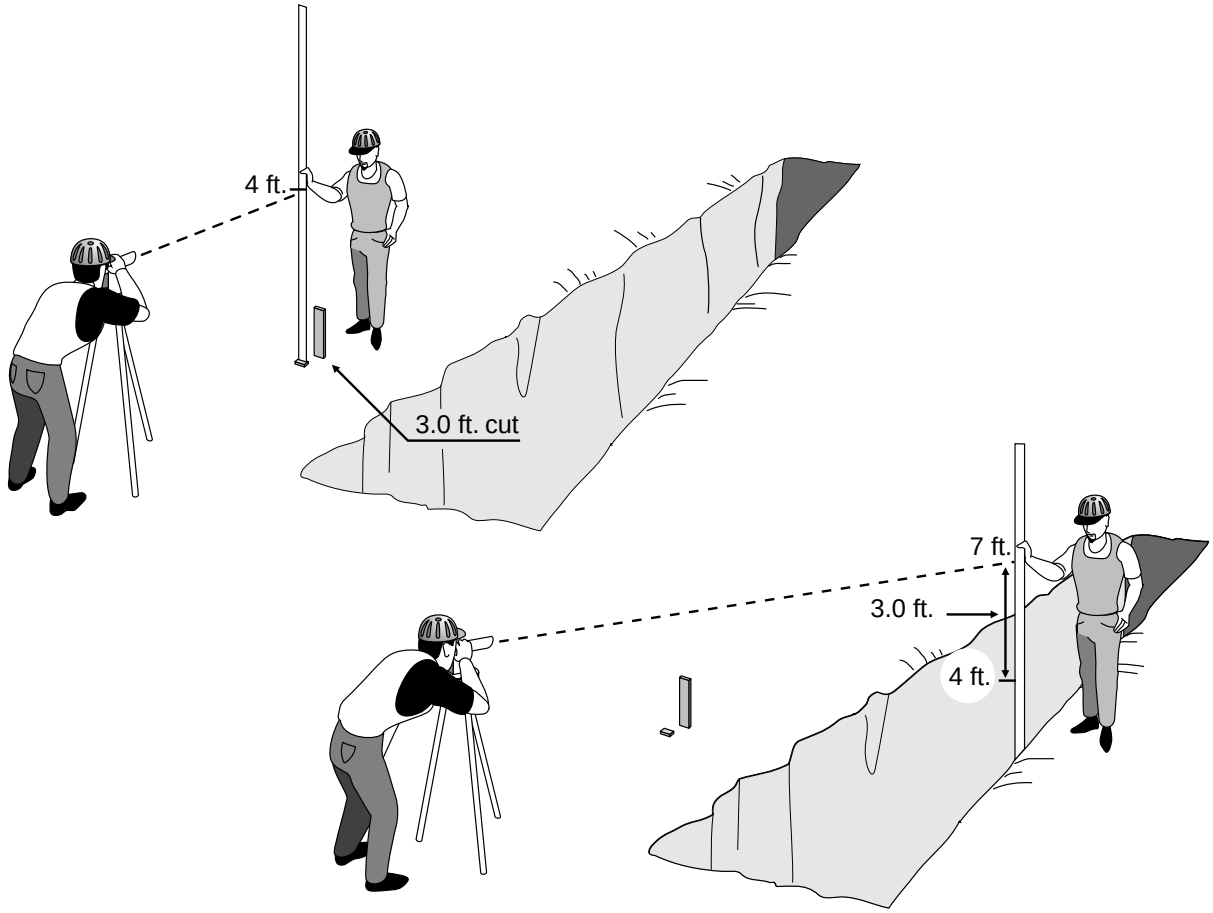
Equipment

This technique requires a transit, level rod, and two people.

Position

One person must be in position to see one hub and the trench. The second person with the transit must stand next to one of the hubs, facing the first person.

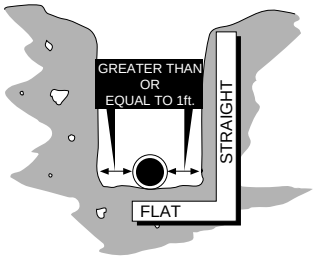
Cut Stake	The depth of the cut is noted from the cut stake.
Level Rod	The level rod is placed on one of the hubs. The person with the transit lines up on the level rod and reads the elevation.
Calculate Elevation	Either the person at the transit or the one at the level rod must add the cut from the cut sheet to the elevation read at the hub.
Moving the Level Rod	The person with the level rod now moves to the center of the trench and positions the level rod in a vertical position.
Check Elevation	The person at the transit rotates the transit until the level rod can be seen. Then compares the reading to the calculated reading. Based on the comparison the trench is either dug deeper or filled. In order to provide proper support for the pipe it is better to stop digging before the trench is over dug and has to be refilled.
Alignment	Alignment is determined by placing the level rod in a horizontal position between the hub and the center of the trench. When the height on the level rod is equal to the offset, the trench is in alignment.



Trench Shape

Sides and Bottom

Trenches are usually constructed with flat bottoms and straight sides. As mentioned in the section on loadings, the width of the trench affects the loading on the pipe. To minimize this loading, the trench is dug not more than two feet wider than the diameter of the pipe. To allow for construction, the trench should always be at least one foot wider than the pipe diameter. Extra width may be required to allow for special structures or for shoring.

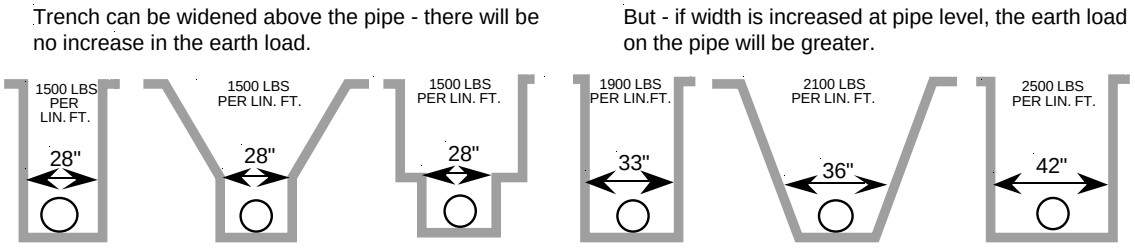


When to Slope the Walls

There are times when it is necessary to shape the trench some way other than the classic straight parallel sides. One situation would be when the material is unstable and shoring is not available. In this case, the trench can be sloped as described in the section on shoring.

How Far Down to Slope

When sloping the walls, be sure that the sloping does not start before the top of the pipe. To understand the impact of sloping below the top of the pipe and the impact of wide trenches, refer to the drawing below. Notice the great increase in pipe loading based on trench size and shape.



Compensating for Large Pipe

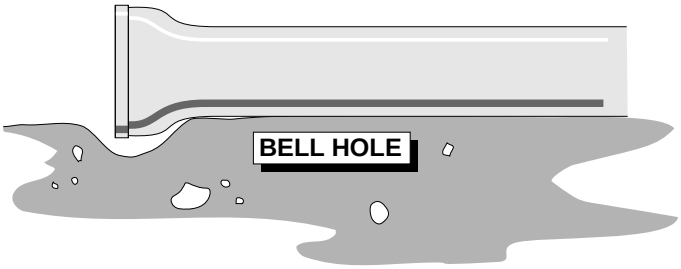
A second need for a wide trench results from laying large diameter pipe. In this case it is difficult to reach around the pipe to tighten bolts on fittings and mechanical joints. To accommodate this situation, a two-step trench is often dug (called benching) as shown on page 212. The first step starts at the center (springline[14]) of the pipe. This minimizes the impact of the widened trench.

The Need for Bell Holes

The trench bottom should be smooth and solid. Bell holes need to be hand dug to allow the pipe to be fully supported by the bottom of the trench. When the trench bottom contains soft material or rocks larger

[14]**Springline** - The center line of a pipe.

than 6 inches, they must be removed and the bottom of the trench filled with 6 inches of selected and tamped material. Remember, the trench bottom must not give when the pipe is under load.



Shaping for Appurtenances and Structures

Shaping for Thrust Blocks

Thrust blocks and support blocks associated with valves, hydrants, and fittings must be against solid, undisturbed ground. Special care and coordination are required between the person with the shovel and the backhoe operator to see that the trench is properly shaped for these items and, at the same time, is not over dug.

Walls Square and Perpendicular

Bank walls used to support thrust blocks should be square and perpendicular with the floor of the trench. Over digging and filling in of the space behind a thrust block destroys the integrity of the thrust block. Valves and some fittings are placed on concrete blocks. These blocks should be dug in by hand to reduce the possibility of over digging.

Installing and Removing Forms

When it is necessary to excavate for the building of an underground facility such as a concrete pressure regulating valve vault, it is important that adequate space be provided for both installation and removal of the forms.

Placement of Spoils

Two Methods of Removal

All unsatisfactory or unneeded material (spoils) removed from the trench must be removed from the job site. Two methods are used to accomplish this task. The spoils may be placed directly in a dump truck by the backhoe, or they may be placed on the ground and removed by a front-end loader.

Place Back of the Toe of the Slope

When the spoils are placed next to the trench, they must be placed so that the toe of the slope of the spoils is at least 2 feet from the edge of the trench. This reduces the load the spoils place on the side walls of the trench, the possibility of trench cave-in, and the amount of loose material that rolls back into the trench.

Don't Hamper Job

These spoils and the equipment associated with their removal should not hamper traffic or hinder the task of the crew in installation of the pipe and appurtenances.

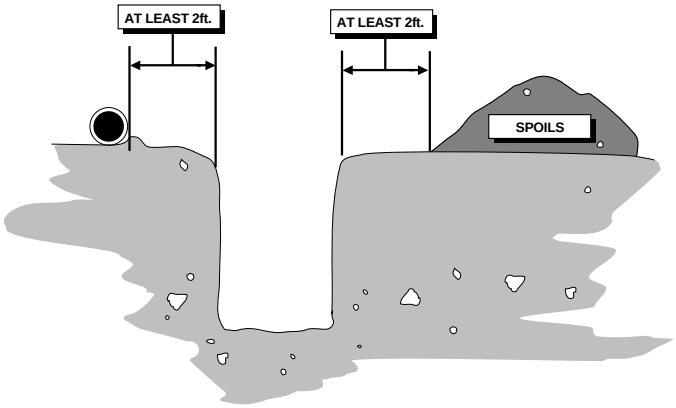
When to Get out of the Trench

When equipment is used to pick up the spoils, it should not be operated while anyone is in the trench. Vibration and superimposed load from the equipment may cause the trench to cave-in.

Pipe Materials at the Job Site

Place Opposite of Spoils

Pipe and other construction materials may be strung out along the job site. They should be on the opposite side of the ditch from the spoils and close enough to be reached by the backhoe but no closer than 2 feet from the edge of the trench. They should not interfere with traffic or with the crew.



Using a Trailer for the Pipe

When it is not possible to place the materials next to the job site, they may be delivered and used from a trailer. The trailer should be placed opposite of the spoils or behind the backhoe. The trailer may be replenished by returning to the storage yard, or material may be stockpiled close to the job site, and the trailer replenished from the stockpile. Be sure that the trailer does not interfere with traffic, traffic controls or the removal of spoils.

Removal of Spoils

Can Cause Trench Failure

The use of heavy equipment next to an open trench can create enough vibration to cause the trench walls to fail. For this reason, care should be taken in removal of the material to reduce the amount of vibration. This can be done by not removing the material until after that section of the trench has been refilled. Under no circumstances should spoils removal be undertaken while a crew member is in the trench. Yes, even if there is shoring in the trench.

Bedding and Backfill Materials

Two Feet From Trench

Like the spoils, bedding and backfill materials stored next to the trench line should be no closer than two feet from the edge of the open trench. Another alternative is to have the material stockpiled at convenient locations along the pipeline, and then have it hauled to the trench by a front-end loader.

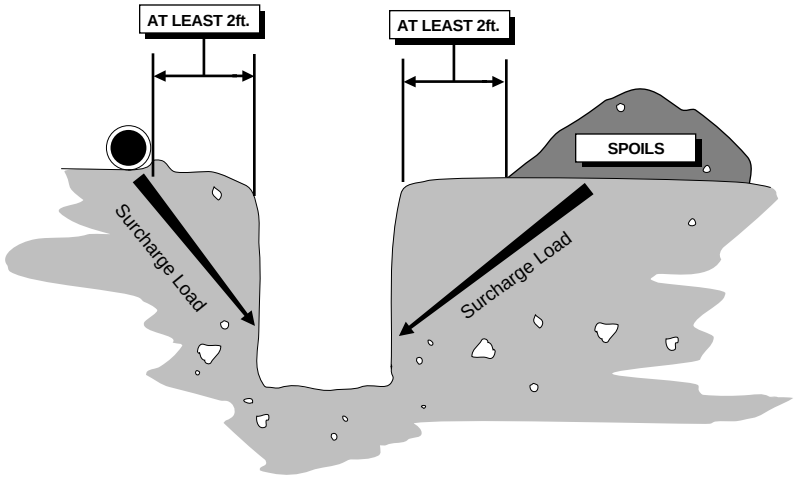
Using a Cement Mixer

In addition to using a backhoe or front-end loader to re-fill the trench, graded bedding or backfill material may be delivered and placed directly into the trench using a cement mixer. This allows the crew to place precise quantities of material in defined layers.

Considerations for Surcharge

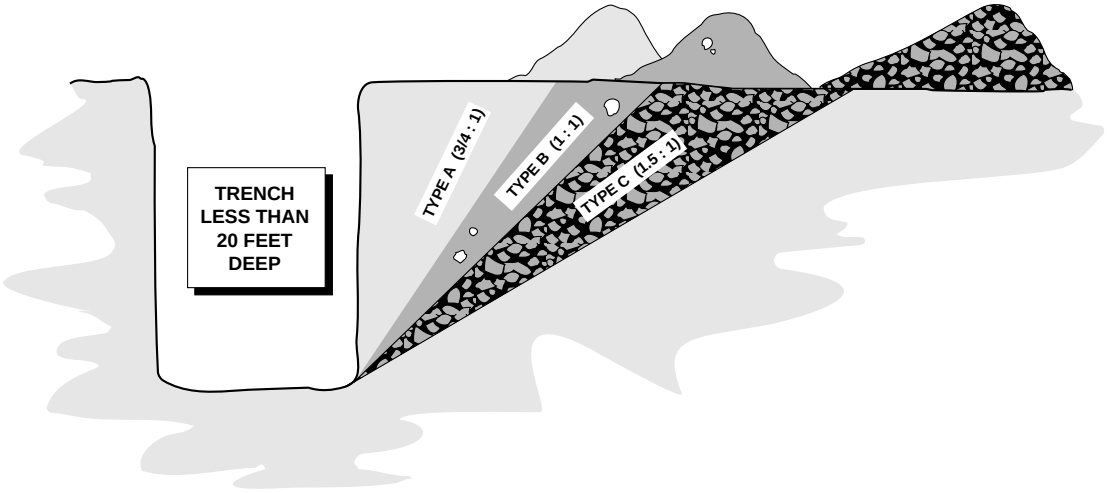
Cause of Surcharge

Spoils, bedding, and backfill material, pipe, equipment, and vibration can all contribute to additional loading on the walls of a trench. This loading is called a surcharge[15]. To reduce the surcharge, no materials should be placed within two feet of the trench.



Reducing Surcharge

To determine the best placement of the spoil bank, first identify the soil type and depth of the trench. Then run an imaginary line from the bottom of the trench to the top of the ground. The center of the spoil bank should be beyond this line. This lowers the amount of load on the trench walls.



[15]**Surcharge** - The weight contributed to the walls of a trench by the load adjacent to the trench. Typically this load is composed of the spoil bank and construction equipment.

Special Considerations

Dewatering

Keep Trench Bottom Dry

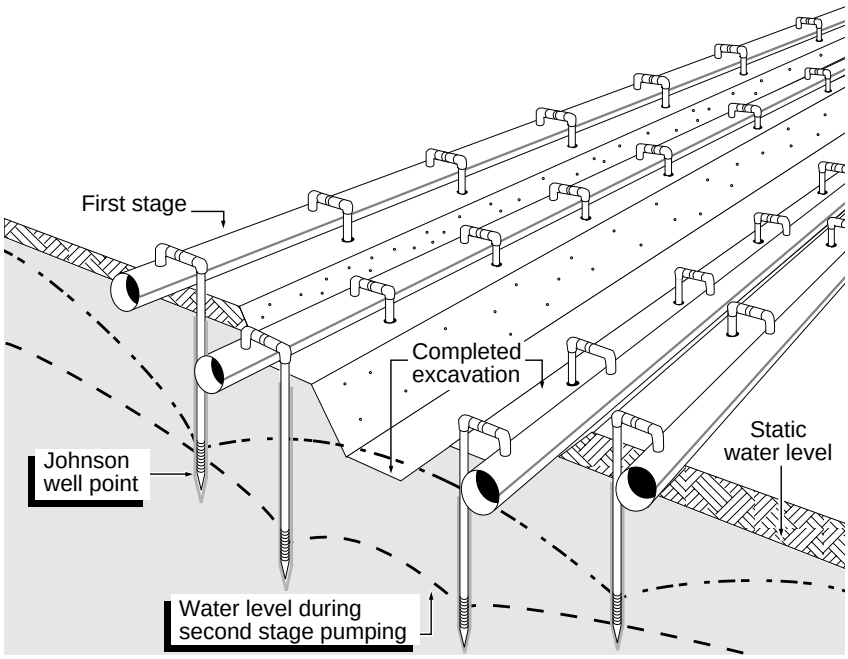
As previously mentioned, the bottom of the trench must support the pipe weight and any loads placed on the pipe. Therefore, it is necessary that the trench bottom remain dry at all times. More information on methods of preventing water entry and dewatering is found in lesson seven (7) of the "Cave-in Protection and Competent Person" text.

Three Methods of Dewatering

When the trench bottom is below the water table, the trench must be dewatered. There are at least three common methods that are used to meet this requirement:

1. Well points

Well points are driven next to the trench and connected to a pump that is used to remove excess water from the surrounding ground. A well point is a specially designed screen with a hard pointed end and supportive case. The screen may be made of stainless steel or bronze. The point is screwed onto a piece of pipe (usually 1 1/2 or 2 inch) and driven into the ground using a hydraulic or mechanical device.

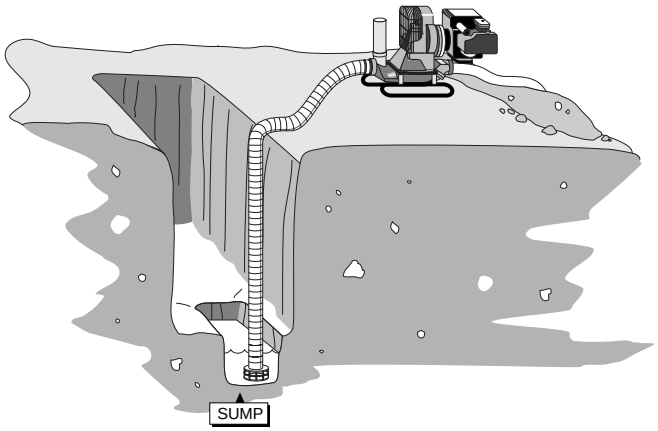


2. Sumps

Sumps may be dug at several locations along the edge of the ditch. Diaphragm trash pumps are usually used to remove the water from these sumps.

3. Crushed Rock and Sump

A portion of the trench bottom may be removed and replaced with crushed rock or pea gravel. Gravel is also used to fill in a sump or to form a channel to move the water to a sump. In either case, the water is removed from the trench.



Disposal of Water

Water from the trench must be disposed of in such a manner so as not to cause contamination of downstream water sources or represent a nuisance to pedestrians, traffic, or the construction crew. Care should be taken to prevent the plugging of storm drains and culverts.

Blasting

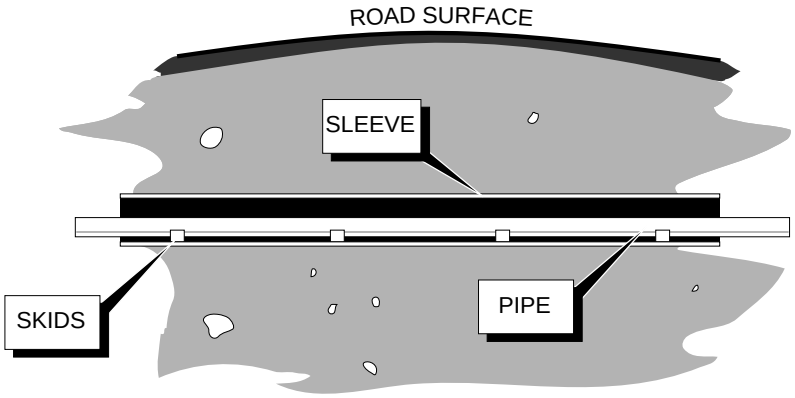
72 Hour Notice

It is necessary at times to blast in order to dig the trench. When blasting, it is necessary that all public within 500 feet of the blasting area be notified 72 hours prior to the impending blast. It should go without saying that the blasting must always be done in accordance with state and local regulations and be performed by a qualified person.

Tunneling

Protective Sleeve

When it is necessary to cross under railroads and some state and federal highways that cannot be cut open, it is necessary to tunnel under. The common technique used in tunneling requires the placement of a protective sleeve in the tunnel prior to the installation of a pipeline.

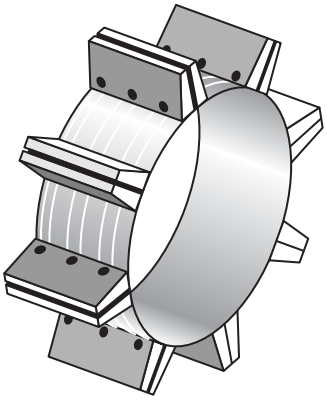


TUNNELING

Skids Every 10 Feet

For ease of installation and removal and for support of the pipe within the sleeve, approved skid supports are installed at ten foot intervals.

Pipe support



Conclusion

The use of proper techniques in trenching is important to the long term integrity of the pipe line. The process must be done in a manner which protects the safety of the crew and traffic, while meeting the requirement of making the job easy to perform. In meeting these construction goals, it's important not to lose sight of the fact that the reason for constructing a proper trench is to properly install a pipe that will last for years without being damaged by external loads. This means that the trench bottom must be properly constructed, the trench must be properly aligned and on grade, and shaped to minimize loads on the pipe.

Trenching Techniques Worksheet

1. The primary goal of proper trenching is to properly _____ and protect the _____.

2. An excavation that is deeper than its width is called a _____. An excavation where the ditch is filled above the top of the ditch is called an _____. Boring under a roadway is referred to as _____.

3. Hubs and stakes placed at the construction site for alignment and grade are placed at a _____ degree angle to the center line, _____ or_____ feet apart, and ___ or ___ feet offset from the trench.

4. When extending a line less than 12 inches in diameter and no grade is given, the line should have a cover between _____ and _____ feet.

5. Draw a profile diagram of a properly dug trench, indicate considerations for the shape of the sides and bottom.

_____

_____

6. Draw a diagram showing where a trench taper should stop in relationship to the pipe.

7. Normally, a trench should not be more narrow than the pipe width plus _____ and no wider than the pipe width plus _____.

8. Spoils should be placed _____ feet back from the edge of the trench.

9. During the removal of spoils and the placement of backfill next to the trench, vibration may cause _____.

10. The removal of spoils causes safety considerations for _____ and _____.

11. During trenching for the placement of appurtenances, what special considerations should be given?

12. A trench may be dewatered by:

    a.

    b.

    c.

13. In a tunnel excavation, skids should be placed every _____ feet along the pipe.

14. When it is necessary to blast, the public located with in _____ feet of the blast area should be notified _____ hours prior to blasting.