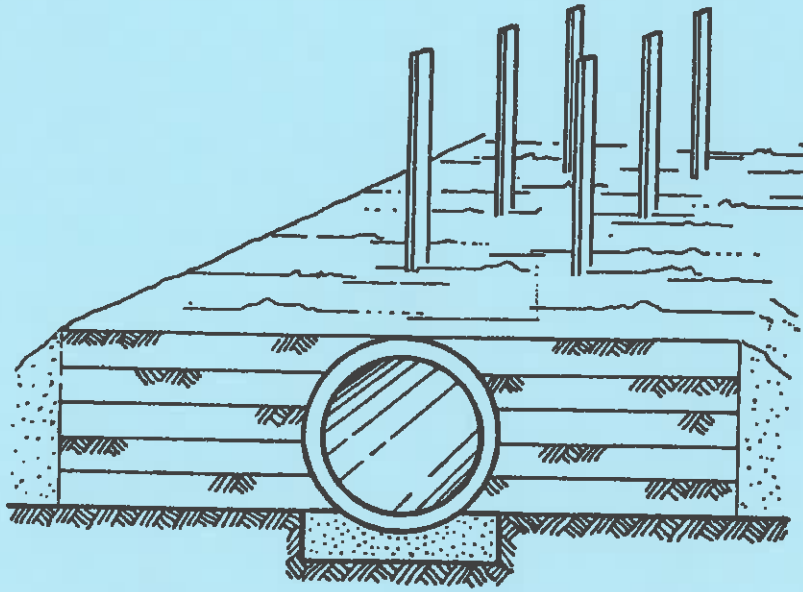
Florida Department of Transportation

PIPE PLACEMENT INSPECTION



PIPE PLACEMENT INSPECTION

a training course developed

for the

FLORIDA DEPARTMENT OF TRANSPORTATION

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FOREWORD

Pipe Placement Inspection is a training course that covers the activities required to insure proper field inspections. The major areas covered in this course include:

- delivery and storage of pipe;
- pipe alignment and grade;
- installing pipe culvert;
- underdrain;
- documentation; and
- installing inlets and manholes.

DIRECTIONS TO COURSE USERS

TRAINING TECHNIQUE

This course has been designed for self-instructional training, so that construction inspection personnel will have an understanding of the fundamentals of minor drainage structures construction.

- You can work alone;
- You can make as many mistakes as are necessary for learning -- and correct your own mistakes; and
- You can finish the training at your own speed.

You will keep this book as your reference, so work neatly.

The Department Construction Training Policy requires that you take two courses within the first year of your employment: Construction Mathematics and Contract Plan Reading. For Pipe Placement Inspection, you will need both. In addition, you should have completed Earthwork Inspection or know the subject matter thoroughly.

HOW TO USE THIS BOOK

This is not an ordinary book. You cannot read it from page to page as you do other books. This book gives you some information and then asks a series of questions about that information. The questions are asked in such a way that you will have to think carefully and draw some conclusions for yourself. If you have difficulty answering the questions, review the sections that give you trouble before going on.

The answers to the questions are at the end of each chapter.

EXAMINATION

An Examination has been developed for Pipe Placement Inspection.

The Examination contains questions and problems only -- and no answers. To help you prepare for the Examination, a Review Quiz is included at the end of this course. If you have no difficulty with the Review Quiz, the Examination should present no problems.

CHAPTER ONE

Basic Information

CONTENTS

1

BASIC INFORMATION

INSPECTOR RESPONSIBILITY

The Inspector's primary duty is to see that the work is being done as it is spelled out in:

- Contract Documents:
- Plans
- Standards Specifications;
- Technical Special Provisions;
- Special Provisions
- Supplemental Special Provisions

These controls ensure that the construction will meet the conditions intended in the design. By following correct procedures that produce sound and lasting construction, you perform a valuable service to the public. It is an important job. If plans, special provisions and the Standard Specifications are not followed, undesirable maintenance problems will most likely occur.

This then, is your responsibility.

You should not attempt to "run the show." A good Inspector stays within the limits of the specifications and does not dictate to the Contractor. Knowing how to make a good suggestion at the right time is necessary for a good relationship between the Contractor and the Inspector. A Contractor's cooperation can often be gained by an explanation of the reason for the specification. Therefore, it is your responsibility to be familiar with sections and provisions of the Specifications that concern your job.

Another important point about your job is this -- Pipe Placement Inspection is an on-going operation. It's not a "one-shot" deal. Inspection starts long before the first pipe is laid and continues throughout the construction.

The following are just some of the things an Inspector of Pipe Placement gets involved in:

- The Preconstruction Conference involves such topic as:

  -- Project Original Condition;
  -- Sublet Work;
  -- Utility Adjustments;
  -- Schedule of Operations;
  -- Erosion Control; DBE Requirements;
  -- Traffic Control; and
  -- Type of pipe to be used

- On-going inspections include:

  -- Checking Line and Grade Stakes;
  -- Ensuring that Proper Equipment and handling is used;
  -- Ensuring that Placement of Pipe is as Specified
  -- Inspecting Excavation and Bedding;
  -- Inspecting Backfill and
  -- Inspecting joint tightness per tolerances.

- Other inspections include:

  -- Inspecting Pipe for Damage Before and After it is Unloaded;
  -- Checking Quantities for Missing Items;
  -- Storing Procedures;
  -- Placement of Pipe According to Plans; and
  -- Proper Handling of Pipe;
  -- Proper Density Test
  -- Check Video/Deflection

These are just some of the inspections involved. The remaining chapters in this course will cover these tasks in detail. NOW TAKE THE QUIZ ON THE FOLLOWING PAGE.

QUIZ

Remember, as the Inspector, you do not dictate how the work is performed but you are concerned that the finished product meets the requirements of the plans and specifications.

Your primary responsibility is to ensure that construction work is done according to the _____, the _____, the _____, the _____, the _____, the _____, and the _____

NOW, BEGIN THE GENERAL REVIEW OF PIPE ON THE NEXT PAGE.

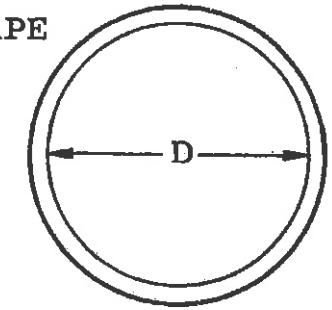
GENERAL REVIEW OF PIPE

Pipe must conform to plan specifications. To ensure this, Inspectors should know about pipe. This chapter will be a review of basics -- things you learned in the Plan Reading Course.

The main types of pipe used in Florida are concrete pipe (CP), metal pipe (either aluminum or steel), polyethylene pipe and PVC pipe.

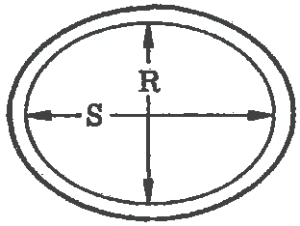
The pipe used in the field should be of the same cross sectional area and shape called for by the contract plans. Pipe culverts may have several different shapes. End views of the most common pipe are shown below:

ROUND SHAPE



Round Pipe

D = Diameter



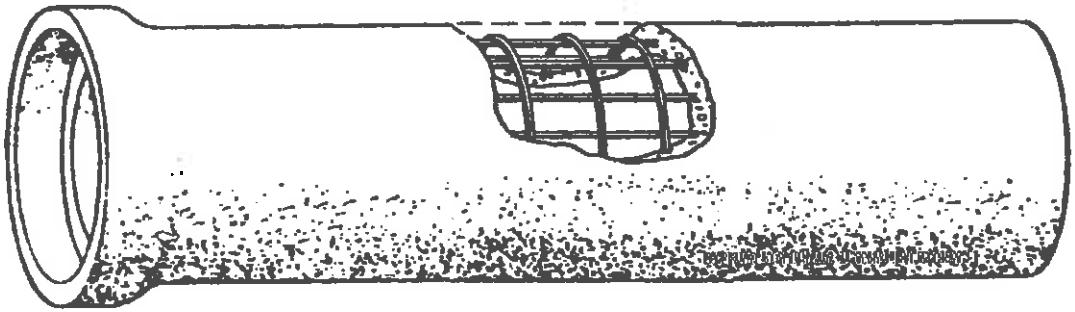
Elliptical Pipe

S = Span

R = Rise

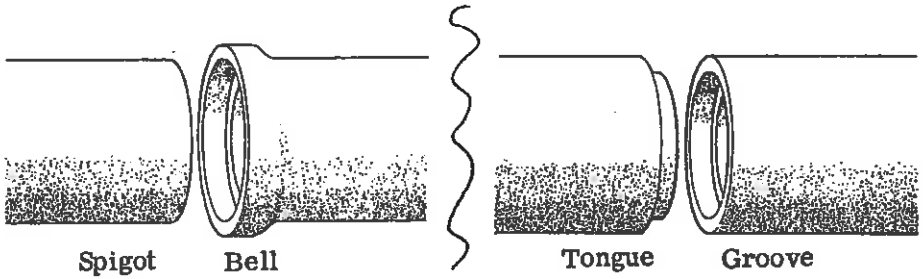
CONCRETE PIPE

Concrete may be fabricated with steel reinforcing in the pipe walls. Non-reinforced and fiber reinforced pipe are also available.



Concrete Pipe (CP)

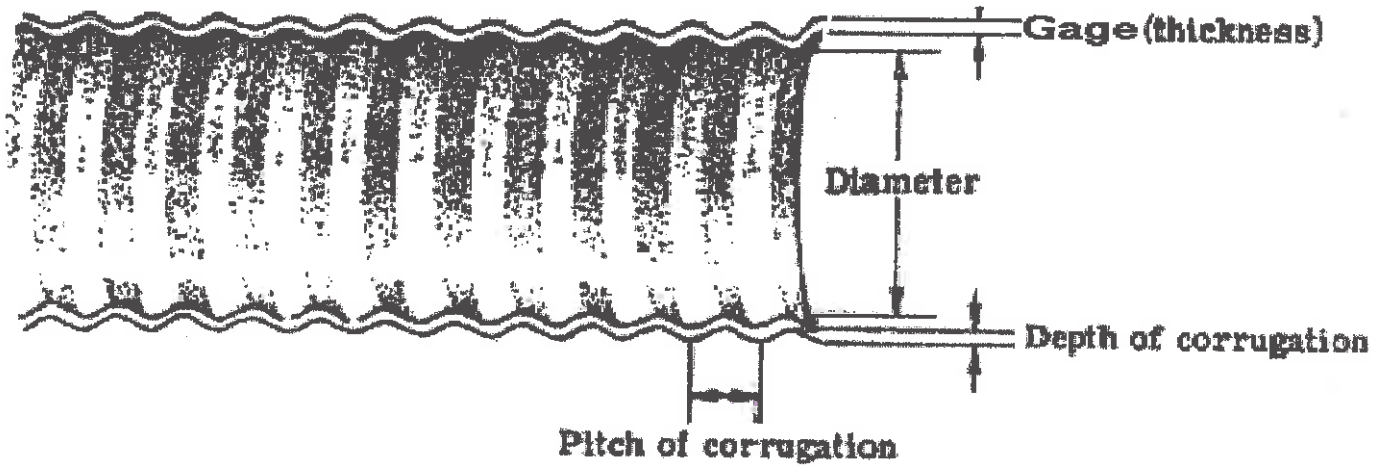
Two common configurations of CP are the bell and spigot -- and the tongue and groove. We will discuss both later:



Concrete pipe is available in several classes -- according to the strength of the concrete. There are six classes of concrete pipe -- Class S, I, II, III, IV and V -- with Class V the strongest.

CORRUGATED METAL PIPE (CMP)

Metal pipe has corrugations that increase its strength. To inspect this pipe, you need to know the four dimensions shown below:



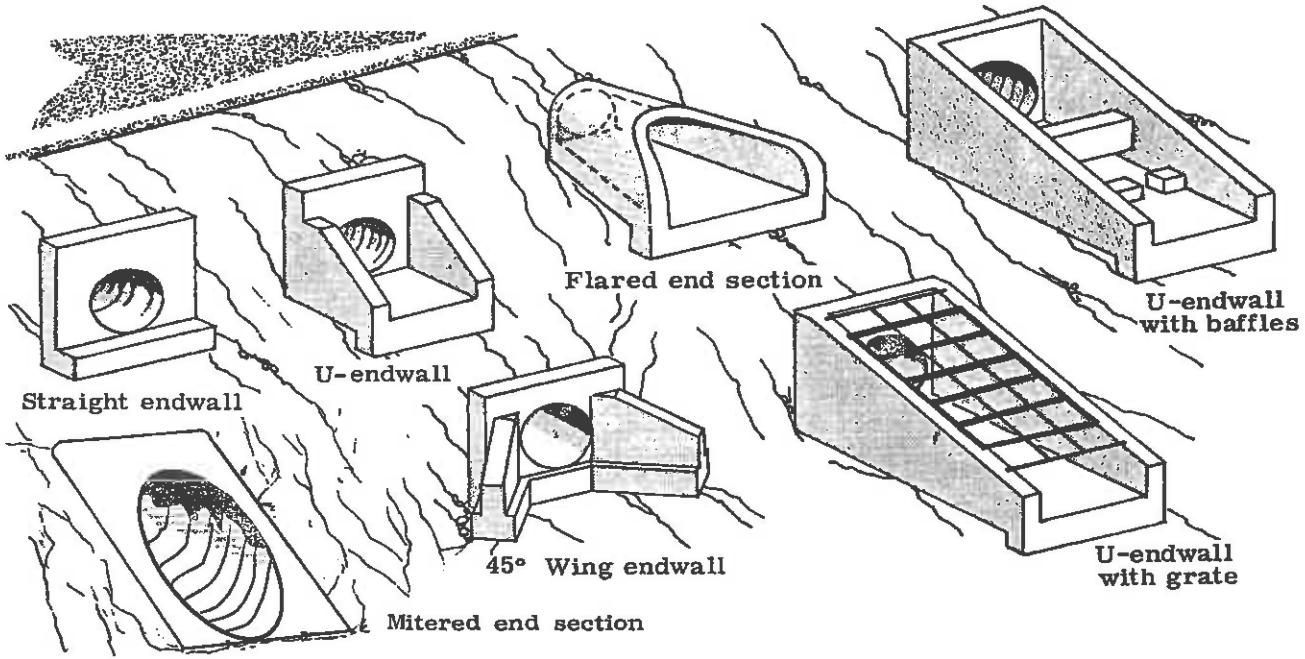
(Remember, larger gage numbers indicate thinner material -- while smaller gage numbers indicate thicker material). Metal pipe thickness is expressed in inches (gage). Refer to Standard Index 205 and note that thickness of pipe are listed in both inches and (gage).

PLASTIC PIPE

There are currently two types of plastic pipe allowed for use on FDOT projects. Corrugated polyethylene and poly vinyl chloride (PVC). Corrugated polyethylene pipe used for sidedrain, crossdrain and stormdrain must have a corrugated exterior and a smooth interior. PVC pipe must have a smooth interior but may be supplied with either a corrugated exterior or smooth exterior. Refer to the specification to assure that the type and manufacturing process certified to by the manufacturer is what's supplied. Unlike concrete and metal pipe, each plastic pipe manufacturer only produces one strength of pipe.

END TREATMENT

Endwalls or other end treatment give culverts pleasing appearances and help prevent the erosions of surrounding embankments. Special end treatments also increase the efficiency of water flow. Study the figures below :



Standard drawings provide details of endwalls. When drainage structure sheets are included in the plans, index drawing should be shown.

QUIZ

CMP Thickness is given in terms of _____.

(Is 8 gage metal thicker than 10 gage metal? _____.)

The strongest concrete pipe is Class _____ pipe.

An elliptical pipe is listed as being 24" X 18". Which measurement is the span?
_____.

What are the two common configurations of concrete pipe? Bell and _____ ; Tongue and _____.

BE SURE YOU KNOW THE BASICS. THEN GO ON TO CONTRACT DOCUMENTS.

CONTRACT DOCUMENTS

STANDARD SPECIFICATIONS

The Standard Specifications for Road and Bridge Construction set forth the directions, provisions and requirements that apply to all contractors on all projects. These include legal requirements for bidding and performing the work, construction details, material specifications, methods of measurement and basis of payment for work performed.

TECHNICAL SPECIAL PROVISIONS

These are technical specifications which must be prepared, signed and sealed by a Professional Engineer registered in the State of Florida. This engineer is someone other than the State Specifications Engineer or the State Specifications Office Staff.

SPECIAL PROVISIONS

When unusual problems or conditions arise during the design or development of a project and special instructions are necessary, these will be covered by Special Provisions which are included only in the contracts of projects to which they apply.

SUPPLEMENTAL SPECIAL PROVISIONS

When last minute changes are required after the special provisions have been completed, Supplemental Special Provisions are issued to everyone having a set of special provisions.

RANKING AUTHORITY OF CONTRACT DOCUMENTS

The order of ranking authority of all contract documents -- necessary to resolve discrepancies (from highest to lowest) -- is special provisions, technical special provisions, plans, standards, development specifications, supplemental specifications, and standard specifications.

PIPE CULVERT SHEETS

Detail information is located on several sheets within the plans. Information shown and respective sheets are as follows:

Plan and Profile Sheets : These sheets contain plan views of the proposed culverts.

Summary of Drainage Structures Sheets : These sheets show total quantities, Locations, Type of Structure, and Description.

Optional Pipe Tabulation Sheets : These sheets identify any pipe material that may be used for a given structure or specific pipe size. **NOTE**: The Contractor is to identify that material he wishes to use at the preconstruction conference. This sheet is also helpful in the event of a change order. Having the acceptable material tabulated allows the inspector to know what material can be allowed for a substitution.

Sidedrain Tabulation Sheet : Gives a summary of sidedrain pipe sizes. **NOTE**: If a specific type is called out in the plans that is the only type material allowed. However, if no particular material is designated, any pipe material contained in the specifications may be used.

Drainage Structure Sheets: These sheets identify structure type, size of pipe, Standard Index reference and direction. Pipe information is sometimes shown on cross-section sheets.

Most information you need (types of pipe allowed, quantity of pipe, size of pipe, and location) in order inspect pipe is contained within these sheets.

QUIZ

Use the data on the previous page to answer the following question:

What view of the proposed pipe is located on the Plan and Profile Sheet? _____

When is the Contractor required to identify the type of Optional Pipe material he is going to use on the job?

_____

How do you know what type of material can be used at each location? _____

O.K. How did you do? This chapter should be easy, but if you need to, study it again now. Be sure you know this basic information before you begin Chapter Two.

ANSWERS TO QUESTIONS

Page 1-5

- Special Provisions
  Technical Special Provisions
  Plans
  Standards
  Developmental Specifications
  Supplemental Specifications
  Standard Specifications

Page 1-10

- gage numbers
- (Yes)
- V
- 24 in.
- spigot
  groove

Page 1-13

- Plan
- At the Preconstruction Conference
- Check the Optional Pipe Tabulation Sheets

CHAPTER TWO
Delivery And Storage Of Pipe

CONTENTS

2

DELIVERY AND STORAGE OF PIPE

ACCEPTING PIPE

Pipe delivered to a project site must be identified and checked for damage before it is accepted. The types of identification and kinds of possible damage vary with the types of pipe.

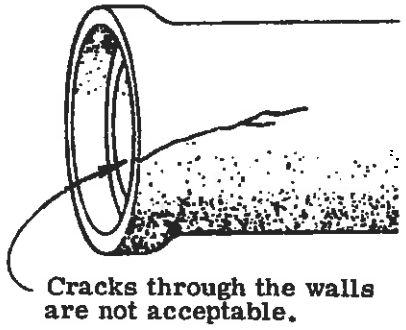
CONCRETE PIPE

Concrete pipe and end sections are tested and approved at the manufacturers plant and are identified by the official Department pretested stamp. If possible, the pipe should be checked for this stamp before unloading. But, just because it is stamped does not mean that it is acceptable on the job. It means it was acceptable at the time it was stamped. It is up to the Inspector and the Contractor to make sure defective pipe are not installed on a FDOT project. Also pipe can be damaged during shipment, so it is the Inspectors job to look over the pipe and enter damaged or missing items on the delivery ticket. Here are a few points to look for when inspecting concrete pipe.

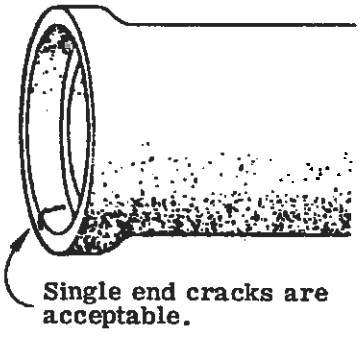
Before accepting pipe at the job site, Verify the identification marking and specified size.

- Fractures or cracks passing through the walls of concrete pipe are causes for the rejection of pipe. A single end crack that is not larger than the depth of the joint is acceptable.

Be sure to check both the inside and outside of the walls for cracks. Some cracks are hairlines -- hard to detect without careful examination:



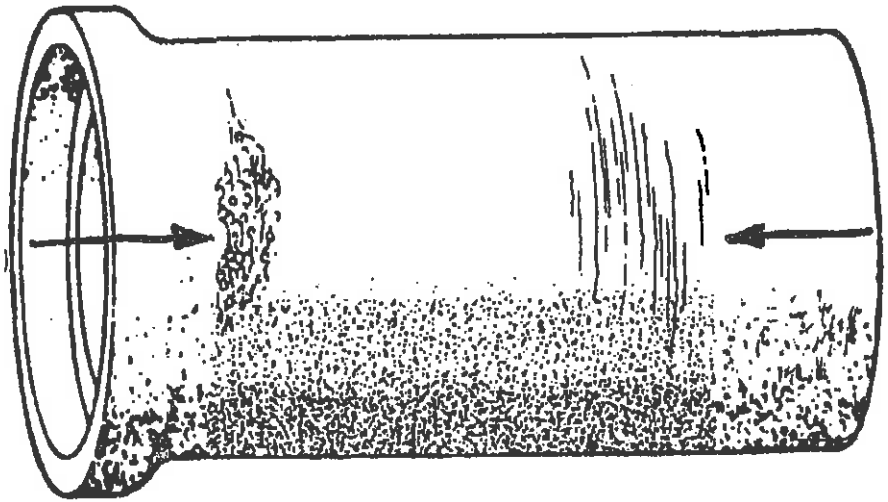
Cracks through the walls are not acceptable.



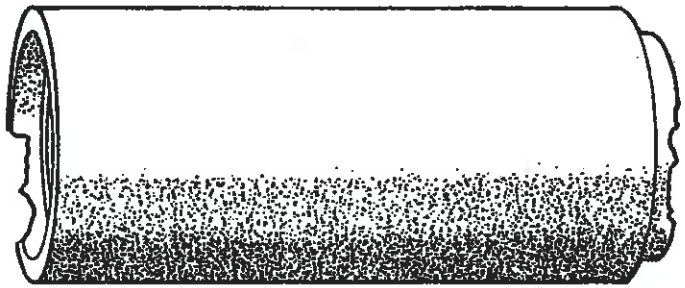
Single end cracks are acceptable.

- Defects that indicate improper proportioning, mixing or molding of the concrete are not acceptable. These defects will be seen as honeycombed areas or surfaces with open textures like those shown below:

Honeycombing
(exposed aggregate)

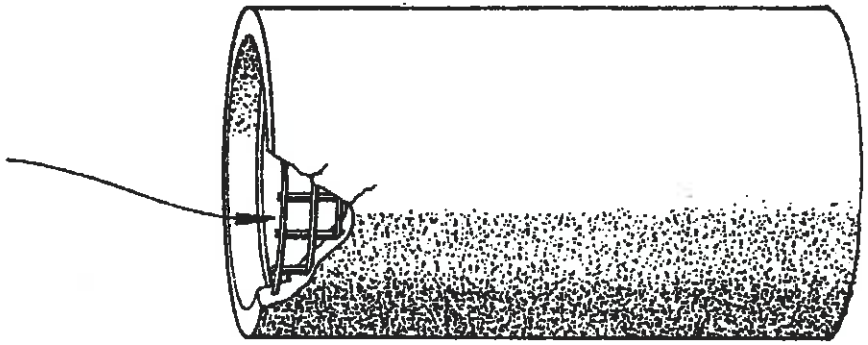


Open texture
(caused by improper mix
or manufacturing process)



Damage caused by improper handling may be repaired or rejected.

The broken concrete and exposed reinforcing steel make it impossible to join this pipe to another.



- Exposed reinforcing
  anywhere on the pipe is cause for rejection or the pipe can be cut for joining to a manhole, junction box, inlet, etc.

In some cases minor chips or breaks in concrete pipe can be patched with mortar. Chapter 7 provides guidance on acceptable and/or repairable defects. Check with the Project Engineer to be sure repair is allowed.

QUIZ

Name four defects in CP that could cause rejection:

_____

_____

_____

_____

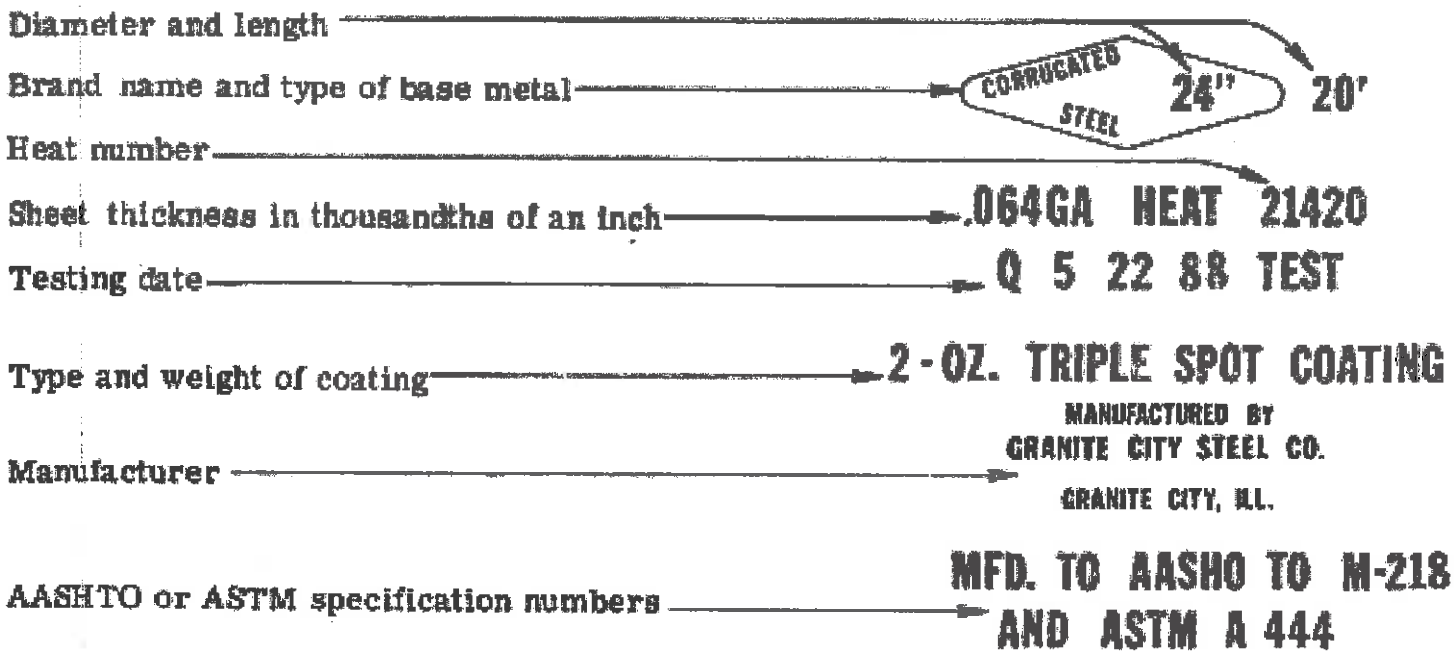
The Project Engineer may approve the repair of _____ in CP.

CP is identified by the official _____.

As an Inspector, could you accept CP with single cracks in their ends?_____.

CORRUGATED METAL PIPE

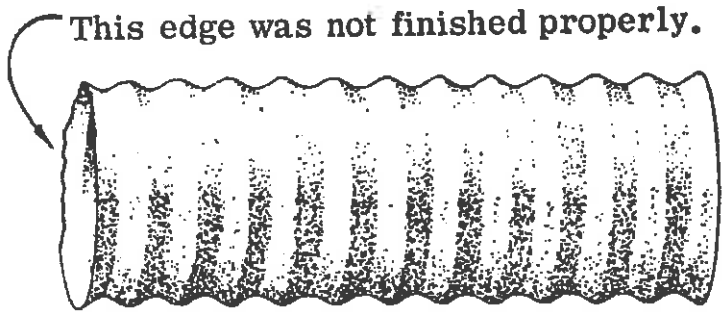
At the time CMP is delivered, the Technician must obtain the pipe certification papers. A Technician must be sure that the heat numbers on the pipes match the heat numbers on the certification papers. CMP is inspected at the manufacturing plant and a seal placed on the pipe. Upon delivery remove the seal and record the seal number on the Daily Report along with the pipe location. Study the examples below, which show typical markings on a pipe:

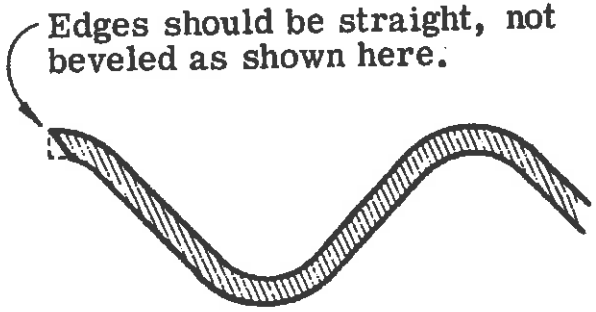


Brand names must be legible. If they are not, the pipe must be rejected.

A Technician should also inspect each CMP delivered to a project for damage and workmanship. The following defects indicate damage or poor workmanship and the presence of any of them in CMP is cause for rejection.

- pushed Corrugated metal pipe should not be damaged during transportation to the project. Pipe that is out of shape or bent along centerline is not acceptable. For example, elliptical pipe must arrive in elliptical shape -- not round or crushed.





- Pipe that is bent or dented -- usually caused by mishandling -- is not acceptable

- Pipe with bruised, broken or scaling zinc coat is not acceptable.

Some CMP has a bituminous coating. This type of pipe must be covered with an even coating before it can be accepted.

NOW TAKE QUIZ ON THE FOLLOWING PAGE.

QUIZ

In order for CMP to be accepted for use in the field:

Edges must be _____.

Coatings must be _____.

Dented CMP must be _____.

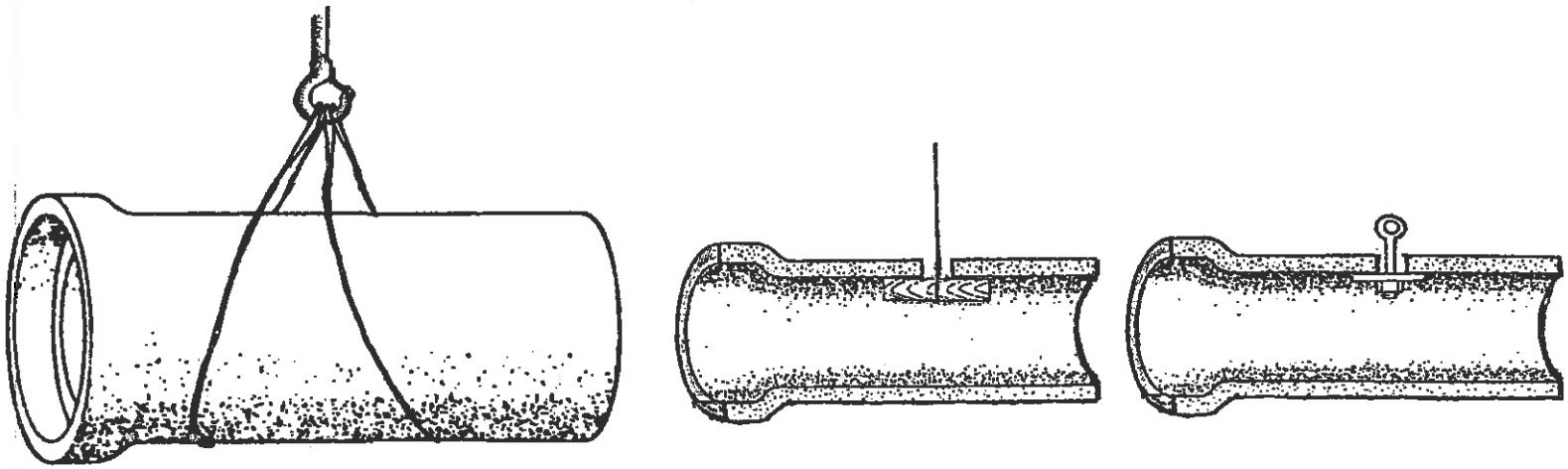
As an Inspector, you should compare the markings on a CMP with the pipe's _____.

PLASTIC PIPE

Certification papers for the pipe and gasket materials must be obtained at the time of delivery. Pipe must be identified and inspected for damage. Inspect pipe corrugations for cuts or splits, gaskets, and ends for damage from transportation or unloading

HANDLING PIPE

When pipe is delivered to a project, be sure it is unloaded properly. Unloading is the Contractor's responsibility, but seeing that the pipe is not damaged is a joint responsibility – both the Contractor's and the Inspector's. Shown below are three common methods of handling pipe larger than 54 inches using conventional lifting equipment like that which is used in trench excavation:



The pipe should always be lifted in a horizontal position and in a manner to not damage it.

When pipe has a lifting hole, weight must be evenly distributed along the inside barrel of the pipe. This can be done by passing a single looped sling through the hole and around 4 x 4 or 6 x 6 piece of timber. This timber should be at least 25% of the length of the pipe section being lifted.

Here are several more points about handling pipe:

- Bituminous-coated pipe must be handled with wide slings -- not chains or cables that will scratch the coating.
- Corrugated metal pipe should never be pushed or rolled -- this will dent or bend the pipe. Also, pipe should never be dropped or dragged.
- If a concrete pipe has been damaged but can be repaired, it should be marked and set aside for repair.
- Damaged pipe that cannot be repaired or restored must be rejected.

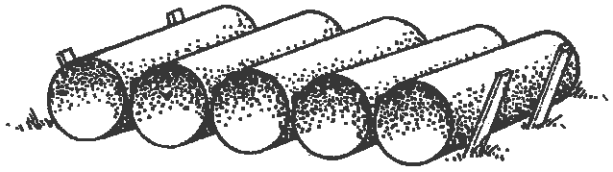
Observe the following when receiving and handling plastic pipe.

a. Small diameter pipe may be handled with manpower alone.
b. For pipe that cannot be moved by hand, use a forklift with forks spread or a nylon sling and backhoe.
c. Do not drop pipe directly onto ground.
d. Do not use loading boom or forklift directly on or inside of pipe.
e. Do not allow pipe ends to strike each other.
f. Place pipe in a smooth flat area free of debris and rocks.

STORING PIPE

Pipe should be unloaded and stored within the right-of-way as close as possible to the installation site -- but not in the way of construction work. Sometimes it has to be stored in the clear zone. If it is, a barrier system should be used, as per Standard Index 600, to protect the traveling public. Pipe should be piled neatly and orderly on clean high ground, wherever possible. If necessary, wood slats should be used to separate the individual pipes. Bituminous coated pipe must be separated in order to

protect the coating. If space permits, it is recommended that the pipe not be placed on top of each other. This weight can cause damage to the bell and spigot ends.



Rehandling pipe can also cause damage. Every effort should be made to plan in advance the sequence of installation to avoid the need for moving the pipe again. In the work area, if the trench is open, pipe should be placed on the trench side away from the excavated materials, and always protected from traffic and other construction operations. A lot of problems can be avoided if the Contractor and Inspector do some advanced planning for the handling and storing of pipe. Care should be taken in the storage of rubber gaskets and lubricants also.

Take the following steps when storing plastic pipe:

a. Non-pallatized pipe may be stockpiled on a flat, clear area.
b. Support lengths evenly; prevent excessive bending.
c. Block stockpile at 1/3 and 2/3 of length of pipe.
d. Stack pipe no higher than 6 feet.
e. Alternate and offset bell for each row of pipe.
f. Do not drag pipe on ground.
g. Avoid striking pipe ends in a manner that could cause damage.

STORING RUBBER GASKETS AND LUBRICANTS

Pipe can be in the best condition possible but if it cannot be joined properly, there will still be serious problems. The key to effective joints is good rubber gaskets and joint lubricants. These will normally arrive with the pipe shipment.

RUBBER GASKETS

When gaskets arrive, they should be checked to ensure that they are the right size and have been pre-tested and certified. Pipe lubricant must be on the Qualified Products List for acceptance. The gaskets should be stored in a cool, dry place out of the direct rays of the sun. Heat and sunlight can cause gaskets to split and crack. Damaged gaskets and those with defective splices must be rejected and placed in a separate pile so they will not be used.

One method of avoiding problems with gaskets is to keep only one day's supply at the actual worksite. The rest can be stored in a dry, cool area away from the worksite.

LUBRICANTS FOR RUBBER GASKETS

Only lubricants on the Department's approved "Qualified Products List" can be used on joints. There are two types of joint lubricants -- water soluble and non-water soluble. Unless the Contractor specifies a particular lubricant, the manufacturer will usually send the water soluble. When a pipe is being laid in a wet trench, the non-water soluble must be used.

Lubricants are to be stored in a cool area out of direct sunlight. Containers should be resealed when not in use.

SUMMARY

Remember these key points about the handling and storing of pipe:

- In unloading, always protect the pipe--especially the ends.
- See that slightly damaged pipe is repaired before being placed.
- Reject all badly damaged pipe -- it can only cause major problems later.
- Good storing practices protect the pipe, gaskets, and lubricant.
- Watch for good joining practices using the right materials.

NOW TAKE THE QUIZ ON THE FOLLOWING PAGE.

QUIZ

Should pipe be stored outside the right-of-way limits if the location is closer than the closest possible location inside the right-of-way? _____.

Larger pipe may have _____ for lifting them.

When handling metal pipe, workers should not push, _____, _____, or _____ it.

One of the keys to effective joining is the use of good _____ and _____.

Pipe should be lifted in a _____ position.

If chains are used to lift pipe, what else must the Contractor use? _____.

Why must bituminous-coated pipe not be lifted by chains? _____.

ANSWERS TO QUESTIONS

Page 2-5

- Cracks through walls
  Honeycomb
  Open-Textured areas
  Exposed reinforcing
- minor chips or damage
- DOT pretested stamps
- Yes

Page 2-9

- even
  evenly spaced, tight
  finished (straight)
  intact (undamaged)
- rejected
- certification papers

Page 2-14

- No
- Handling holes
- roll, drop, drag
- lubricants, gaskets
- horizontal
- Padding
- Will scratch coating

CHAPTER THREE

Pipe Alignment and Grade

CONTENTS

3

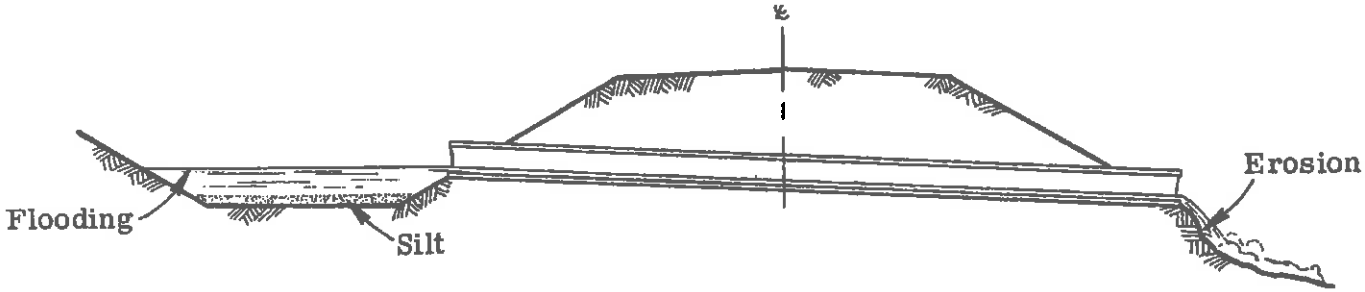
PIPE ALIGNMENT AND GRADE

The planned line (horizontal alignment) and grade (vertical alignment) will be shown on the plans. On the other hand, field conditions may warrant a change in the alignment of a pipe. You should inspect the proposed location to verify the actual drainage situation. Let's look at a couple of situations that would indicate changes in the planned locations.

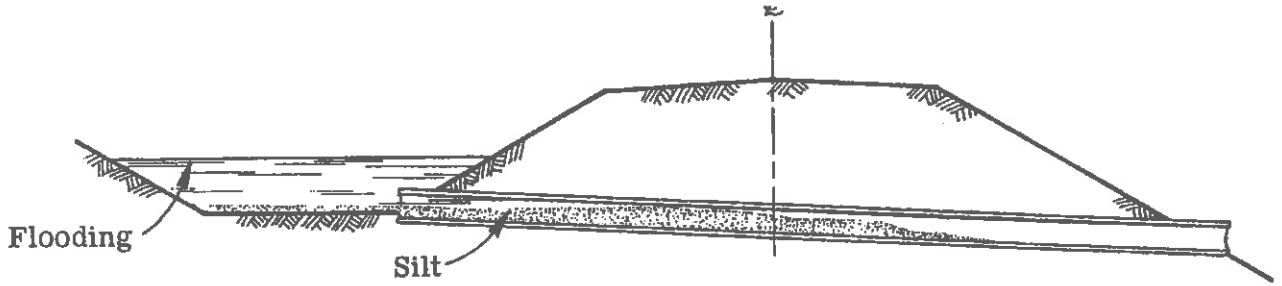
EVALUATING FIELD CONDITIONS

Problems arise when the planned flow line is not at the same level as the natural flow line. This can cause flooding, erosion and siltation. Nevertheless there are situations, where the designer has intended that the FL not match the natural flow line due to permitting and/or stormwater management requirements.

Here the planned elevation of the pipe was maybe too high -- possibly causing flooding and erosion.

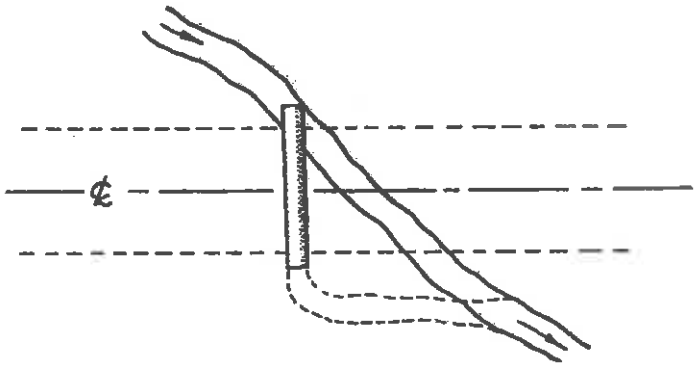


Here the pipe was planned too low -- allowing silt to settle in the pipe.

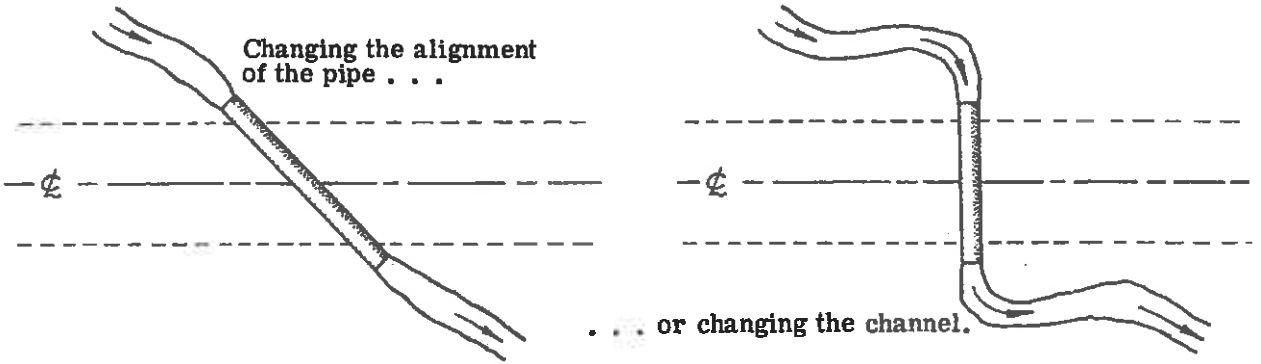


Any questions about the flow line of a pipe, should be discussed with your Project Engineer.

Here the planned alignment does not provide for a direct entrance and exit.



A change in the planned alignment could be accomplished by:



Whenever you question a planned location, discuss it with your Project Engineer. He will decide what action should be taken.

QUIZ

Name two field situations which would indicate that changes could be discussed with the Project Engineer.

1. _____

2. _____

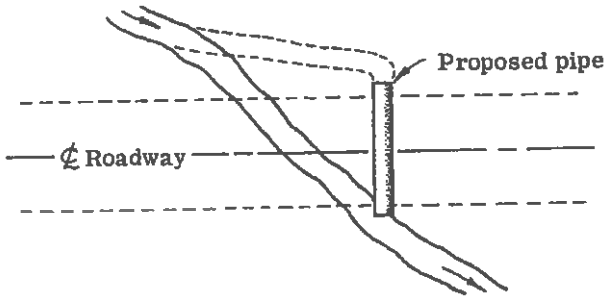
Who should decide what actions are taken when pipe locations do not fit field conditions?

_____.

Pipe installed at an elevation higher than the actual drainage bed will cause _____ at the inlet and _____ at the outlet.

Name two ways to correct the situation below: _____

_____



PIPE STAKING

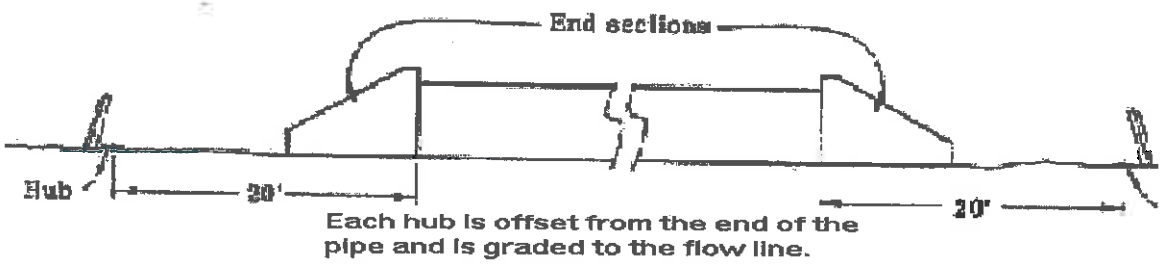
Many methods and systems are used to stake pipe, so before we begin this section we must make one point: check with the survey crew chief, pipe foreman or Project Engineer to be sure that you understand where stakes will be placed, what will be placed on the stakes, and how you will be able to use them during construction.

STAKES

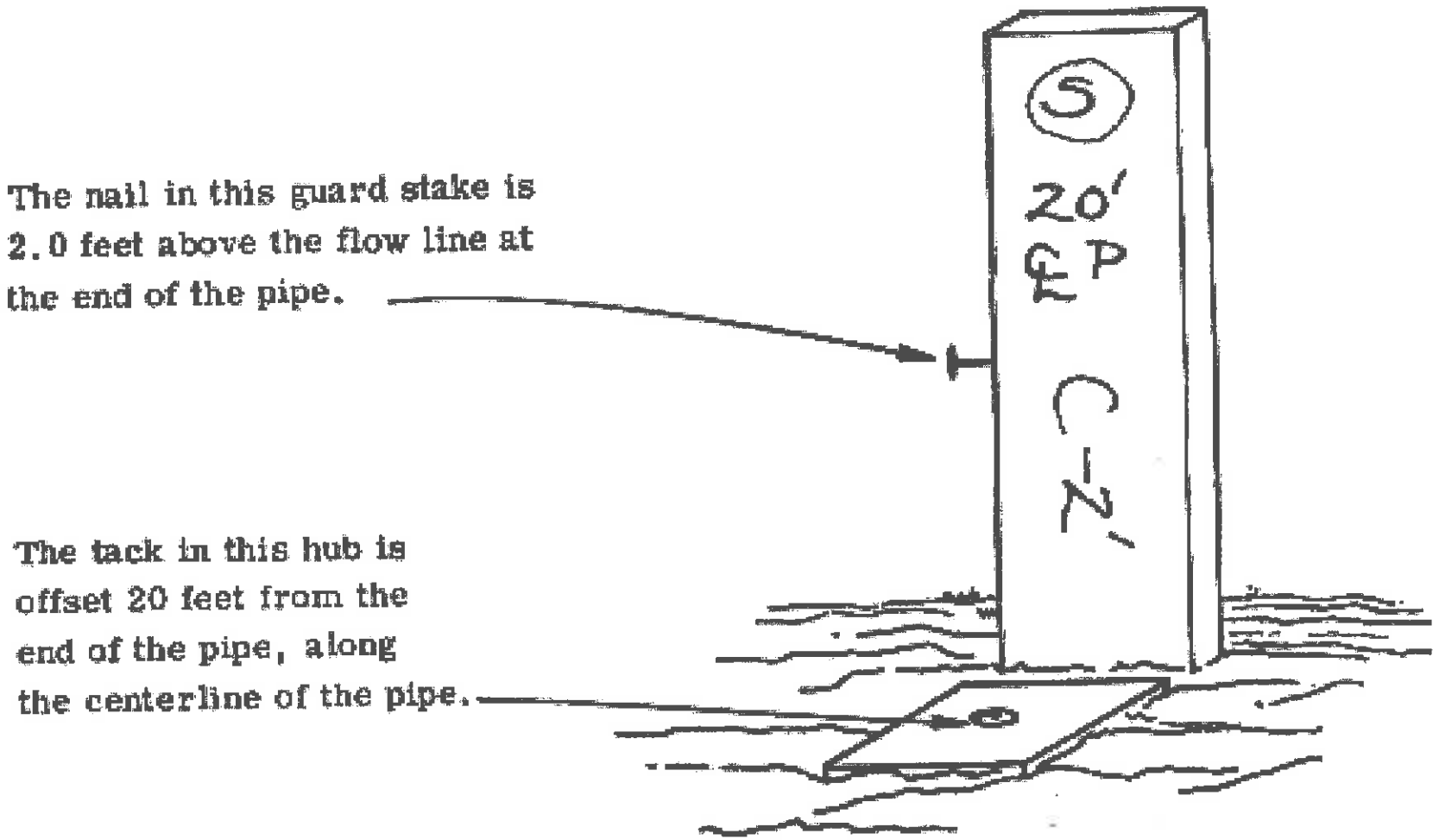
All pipe stakes should contain basic information about the horizontal alignment (line) and vertical alignment (grade) of a pipe culvert. The stakes should contain:

- an offset distance to the centerline of the pipe; and
- a cut or fill distance to the pipe flowline.

One example of pipe staking is shown below:



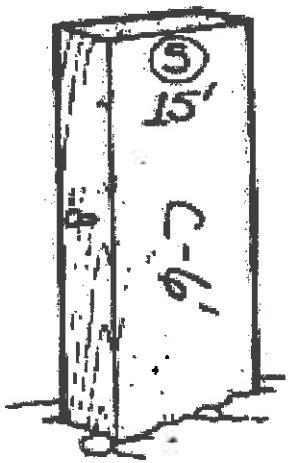
Both ends of the pipe culvert are staked in the same manner.



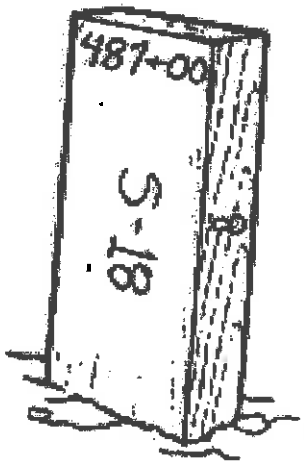
In many cases, the stakes will contain more information than is shown here. For instance, the Contractor may place the station number or structure number on the back of the guard stakes.

QUIZ

(FRONT)



(BACK)



Where does this pipe cross the roadway? _____.

What is the structure number? _____.

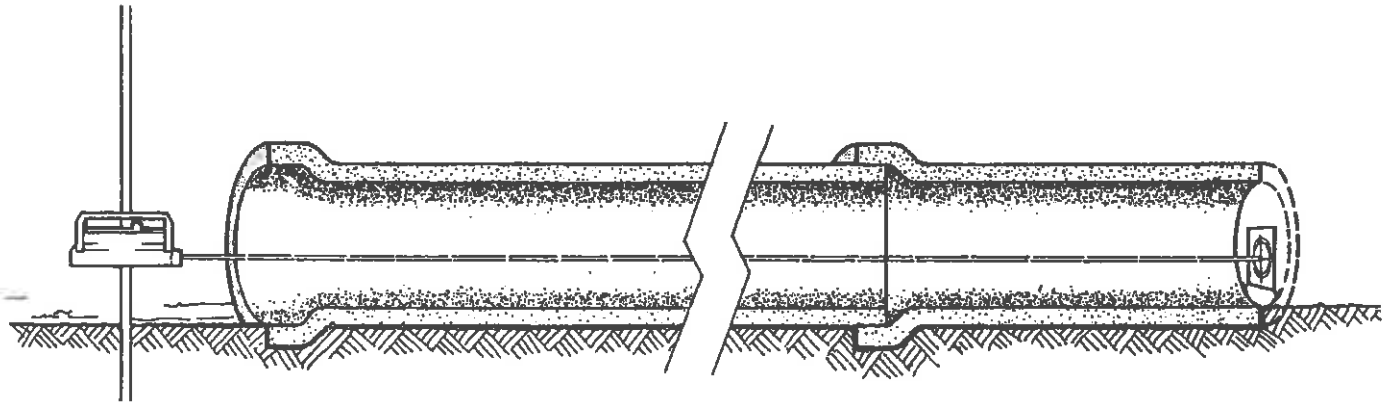
If the elevation of the nail is 102.8, what is the elevation of the flow line of the pipe? _____.

What is the offset distance from the pipe to the stake? _____.

LASER SYSTEMS

You will find more and more Contractors using laser systems to control pipe alignment and grade. Laser systems operate like this.

1. A control box is set up at one end of the pipe culvert. The box is offset directly above the flow line of the pipe.
2. The control box emits a laser beam of light. This is adjusted so that it travels at the required slope.
3. A target board is set up on the flow line of the other end of the pipe. When the beam of light hits the center of the target, the pipe is at the proper grade.



- You should check the set up of the laser. Be sure that the control box is set up on the pipe centerline. You can check this by using the stakes that are set initially (the same as we have just discussed).

- Be sure that the control box is set at the proper slope. Occasionally check the dial on the control box that indicates the slope.

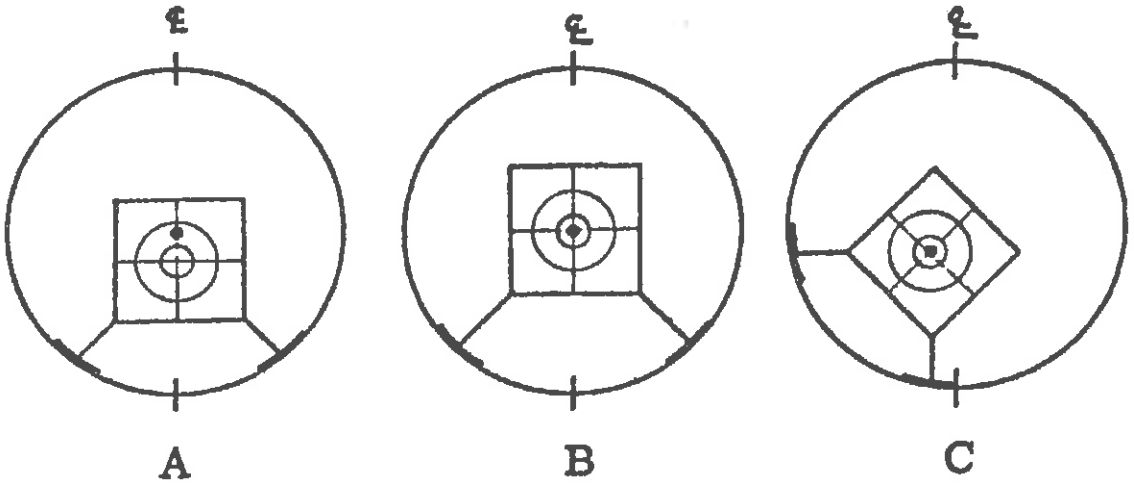
- Watch the workers when they set the target in the pipe. Be sure that it is directly over the flow line, not over to one side.

QUIZ

The control box in a laser system emits a _____, which travels at the same _____ as the pipe flow line.

How can you find out whether the laser beam is set at the proper slope?

Which of the diagrams below shows that the pipe is in the proper place? _____ (The laser beams are indicated by the dots.)



ANSWERS TO QUESTIONS

Page 3-5

- 1. When the planned pipe bottom is higher or lower than the actual drainage bottom
  2. When the planned alignment does not permit direct entrance or exit
- Project Engineer
- flooding, erosion
- Change pipe alignment
  Change channel alignment

Page 3-8

- Sta. 487 + 00
- S-18
- 96.8
- 15 ft.

Page 3-11

- laser beam of light, slope
- Check the dial on the control box
- B

CHAPTER FOUR

Installing Pipe Culvert

CONTENTS

4

INSTALLING PIPE CULVERT

This section deals with the preparation of pipe foundations and bedding, the laying and joining of pipe and the backfilling of the trench. If any portion of the pipe projects above the existing surface, then prior to placing the pipe an embankment must be built to a level above the pipe. The trench for the pipe can then be excavated in the embankment.

PIPE FOUNDATIONS

The foundation and bedding for a pipe culvert should be constructed to provide uniform support throughout the length of the pipe. The foundation should be firm and the bedding should be loosened beneath the middle third of the pipe.

After the pipe trench has been excavated to the level shown on the pipe stakes, it is necessary to inspect the exposed soil. If the material seems unusually wet or yielding, consult with the Project Engineer to determine the amount of undercut necessary.

TRENCH SAFETY

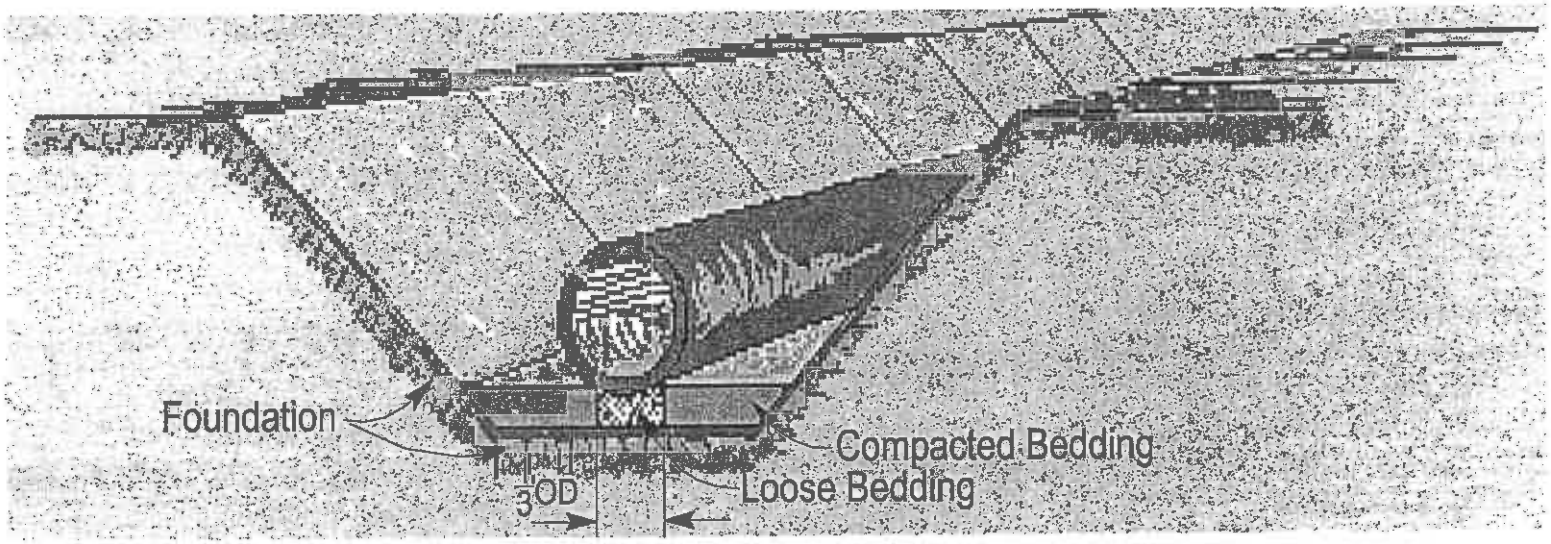
Whenever trenches are excavated, you should be sure that they are safe. The sides must be angled out to the natural ground line and heavy equipment should not operate near the edges. Also, excavated material must be stockpiled at safe distances away from trench edges.

If the trench is deep -- more than 5ft -- shoring, sheeting or other bracing may be required to hold the sides. The Occupational Safety and Health Administration -- OSHA -- publishes a manual on safety requirements. Consult this manual for specific requirements.

PIPE FOUNDATION AND BEDDING

The foundation and bedding for a pipe culvert should be constructed to provide uniform support throughout the length of the pipe.

After the pipe trench has been excavated to the level required to place the pipe, it is necessary to inspect the exposed soil. If the material is rock or extremely hard, or if the material seems unusually wet or yielding, consult with the Project Engineer to determine the amount of undercut necessary. Soft material below the pipe can cause the pipe to settle, often unevenly. Hard material can increase the stress in the pipe wall.
The bedding zone normally extends 4" below the pipe. If rock or hard material must be removed, the bedding zone will extend to 12" below the pipe. The material in the bedding zone should meet the specifications for backfill around the pipe.



If the trench is undercut to remove undesirable foundation material, the undercut must be filled and compacted to the level of the bedding zone of the pipe. Next, the bedding material must be placed. The bedding material should meet the specifications for backfill around the pipe. The bedding material must be compacted except below the middle third of the outside diameter of the pipe. This will be accomplished after the pipe has been laid during backfill compaction. Loosely placed, uncompacted bedding directly below the invert of the pipe significantly reduces stresses in the pipe wall. The pipe can nestle into the bedding and form a continuous, uniform contact. When unstable conditions are encountered and when specifically authorized by the Engineer in writing, select material on granular material may be used for backfilling.

If the trench was not undercut, the soil below the middle third of the pipe must be loosened.

Once the bed is prepared, the pipe can be placed. The Contractor must excavate for pipe bells before laying the pipe.

The pipe is placed and material is compacted under the haunches of the pipe. A small mechanical tamper or a hand tamp is generally used. Be sure that the pipe is not moved or damaged during compaction. If the pipe is flexible be sure the pipe does not deflect excessively.

DEWATERING PROCEDURES

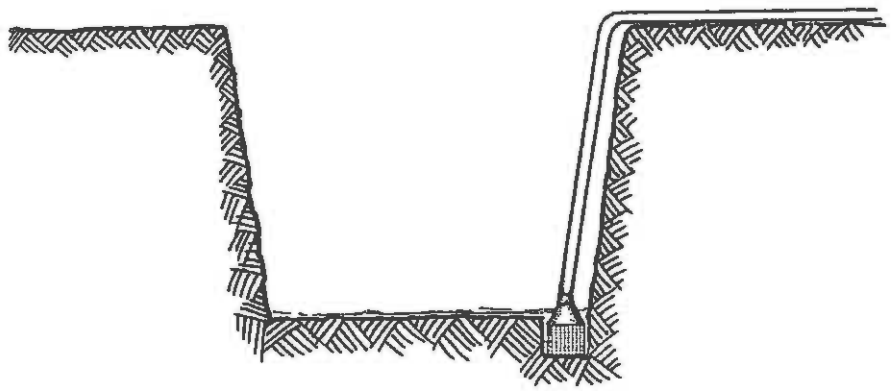
There will be times when a firm foundation for the pipe cannot be achieved. Then dewatering may be necessary. Here are the alternatives you have:

- The sump pump method
- The well point method; and
- Select materials and underwater placement.

These methods of dewatering are discussed on this page and the next two pages.

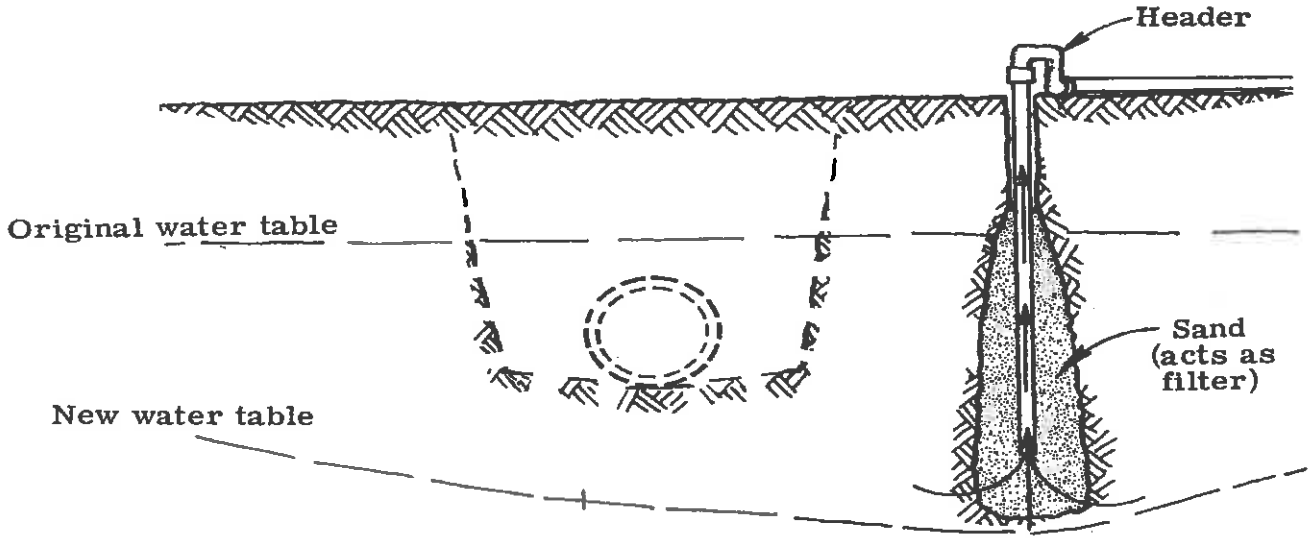
SUMP METHOD

This is the most common method of dewatering. A lower cut is made on one side or at one end of the trench and the water flows to a sump located there. The water is then pumped through a pipe and away from the trench area. The Inspector must be sure that the flow of water to the sump does not erode the pipe bedding or undermine the pipe previously laid.



WELLPOINT METHOD

In some cases, sump pumping will not be effective and it will be necessary to use wellpoints. This is shown below. In this process, the well points are jetted into the ground and a sand filter is placed at the tips. The wellpoint risers are connected to a main pipe that is connected to the wellpoint pump. When the pump is running, the well points draw the water into the pipe and, over a period of time, the water table is lowered.



SELECT MATERIAL AND UNDERWATER PLACEMENT

If neither of the other two methods work, the job becomes more difficult. This will involve at least two steps:

- undercutting the bed; and
- placing select material

This is a special operation and must be approved by the Engineer in writing and noted in the job diary. You will need to discuss with him a method to check alignment since it is an underwater operation. You should also be alert to the fact that only non-soluble lubricant is used.

In all the methods of dewatering, you must ensure that the disposal of the water is not violating any other regulations such as polluting a live stream, or running on to private property. You must also review Special Provisions and Permits for monitoring discharge water

Take the following quiz and then go on the INSPECTING CULVERT INSTALLATIONS.

QUIZ

What is the most commonly used method of dewatering? _____.

What is placed at the tips of wellpoints after they are jetted into the ground? _____

If undercutting and backfill is required to get a firm foundation, consult the _____.

In all the methods of dewatering, you must be sure that the disposal of the water is not violating any other regulations such as polluting a live stream or _____.

INSPECTING CULVERT INSTALLATIONS

Horizontal alignment and grade are important and should be checked at the following times:

- When the Contractor sets the laser -- check it. Horizontal and vertical alignment can be checked by using a string line and a marked rod. Check the laser against the initially set stakes.
- When the Contractor finishes preparing the pipe foundation and bedding -- check the pipe's bed.
- As the sections of pipe are being laid -- check the flow line of each section.

Check the widths, depths and lengths of pipe beds before the pipe is installed. There should be no sharp breaks in the bed -- it should be loosened below the middle third of the pipe. Check the bedding alignment by eye. All beds should be straight.

Testing of flexible pipe for deflection may be performed using one of several methods. Testing equipment may be in the form of calibrated video equipment, Mandrel, measuring sticks or tapes or by deflectometer. Testing should be performed upon completion of all paving operations

Finally, check the contract plans or standard drawings if you have any questions. They provide the information you probably need. If not, consult your Project Engineer.

Whenever the Contractor does not comply with the plans and specifications, advise him of the nonadherence. If he still fails to comply, inform the Project Engineer.

QUIZ

When preparing bedding it should constructed to provide (three criteria). _____, _____, _____.

What course of action should a contractor take if the method of preparation of the bedding in the plans is different than in the specifications. _____ _____ .

As the Contractor installs a pipe culvert, the Technician should check three things to ensure proper alignment and grade. Name them.

_____, _____, _____

If the Inspector has questions about a culvert's installation he should check the: _____ or _____.

Before a pipe is installed, the bed should be:

_____ A. loosened
_____ B. undulating.
_____ C. rough.
_____ D. smooth.
_____ E. straight.

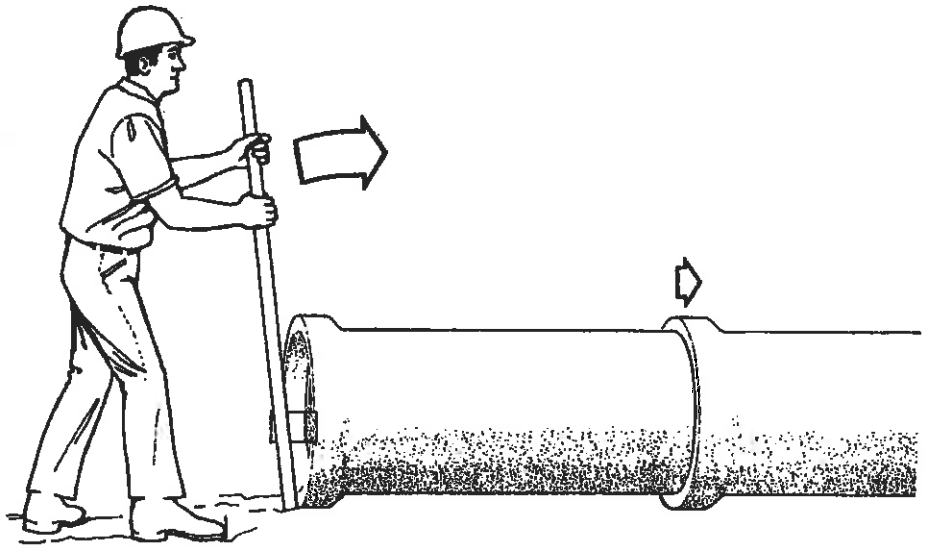
CONCRETE PIPE (CP)

Concrete pipe must be handled carefully. Check the pipe before it is in place for cracks and chips. If it is damaged it will have to be rejected or repaired.

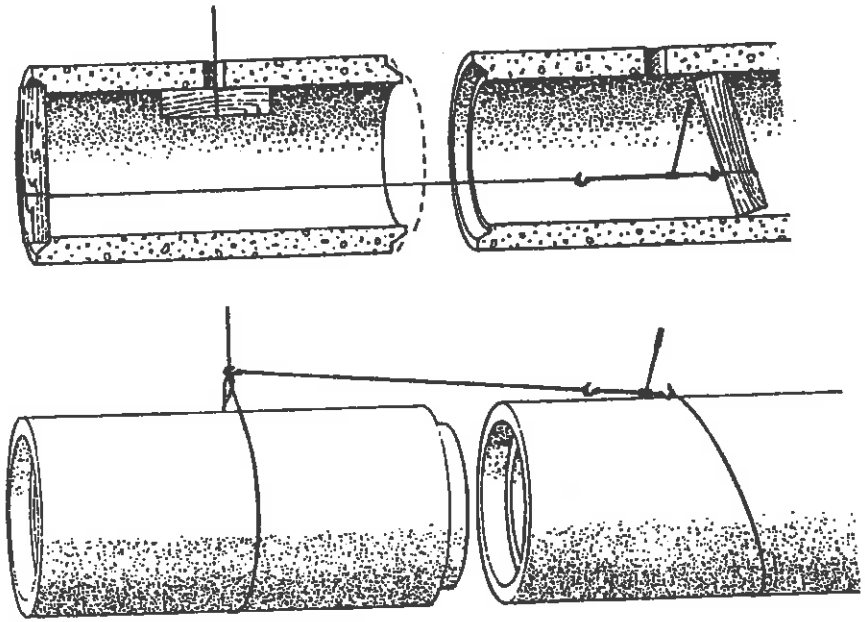
Pipe should be laid from the outlet end to the inlet end (uphill).

Pipe up to approximately 24 in. in diameter can be pushed into place by a bar and wood block, as shown at the right. Trench excavation equipment may be used.

Whenever any pipe is being pushed into place by heavy equipment, wood blocks should be used as cushions.



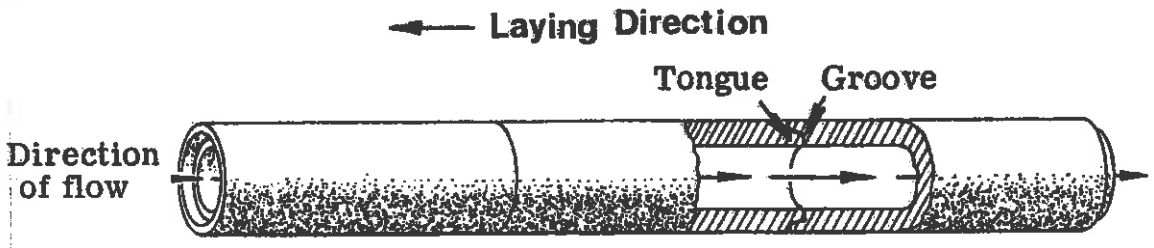
Larger pipe can be joined with the use of come-alongs, power pullers or trenching equipment.



Whatever methods are used, be sure that the pipe is not damaged. Any sections that are dropped or dragged should be inspected immediately for defects.

Pipe with lifting holes must be placed with holes at the top. Be sure that these holes are filled in accordance with the specifications.

Tongue and groove pipe sections should be placed so that the groove is on the upstream end.

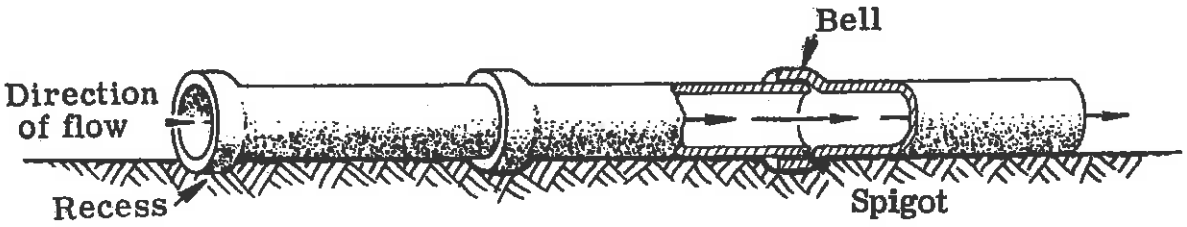


UPSTREAM

TONGUE AND GROOVE PIPE

DOWNSTREAM

For the same reason, bell and spigot pipe should be placed so that the bell is on the upstream end.



BELL AND SPIGOT PIPE

Also, when laying bell and spigot pipe, be sure that recesses are made in the bedding for the bells. This is necessary for proper bedding. On the other hand, if the recesses are too large, the joints will not have the necessary bedding support.

QUIZ

Whenever CP is pushed into place by heavy equipment, _____ should be used as cushions.

Pipe must be laid with the handling holes at the _____.

Which is placed on the upstream end:

the bell or spigot? _____.
the tongue or the groove? _____.

Bedding should be recessed for _____.

The method of joining concrete pipe requires your careful attention. Whether bell and spigot pipe or tongue and groove pipe, the ends must be fully entered and the inner surfaces should be reasonably flush and even.

Joints for rigid pipe are made with round rubber, profile gaskets or other types of joining recommended by the manufacturer and approved by the Project Engineer.

Three types of concrete pipe joints are normally used by the Department:

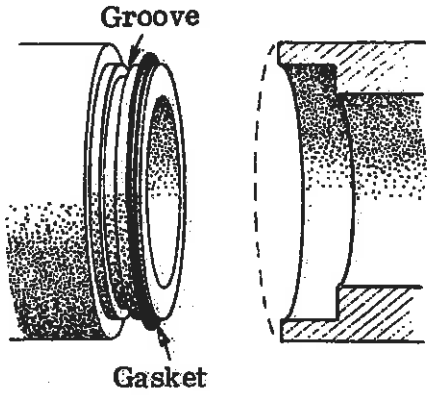
1. Rubber O-Ring or Profile Gasket;
2. Preformed mastic adhesive; and
3. Concrete collar.

Let's discuss each of these in some detail.

The "O" ring gasket is just that. It is a complete circle and is used mainly on circular concrete pipes. This gasket fits into a groove on the pipe tongue or spigot. When the pipe is in place, it holds the gasket securely and the joint is complete.

Here your job is to see that a good joint is made. If there is a gap on the inside of the pipe between sections read the specifications for gap allowance. If the joint is not acceptable, the pipe must be relaid.

Now, let's look at the steps involved in joining this type of pipe.



1. Be sure the spigot surfaces are clean and all foreign matter is removed from the groove. The best thing to use is a bristle brush or wire brush.

2. Thoroughly lubricate the gasket and spigot groove. Be sure the lubricant is on the Department's approved list.

3. Stretch the gasket around the spigot and into the groove.

4. Use a smooth object, like a screwdriver, under the gasket and run it completely around the pipe. This equalizes the tension on the gasket.

5. Clean all bell joint surfaces.

6. Lubricate the flared bell surfaces.

7. Lower the pipe into the trench and line it up so that the gasket touches all parts of the bell surfaces.

8. Finally, "make the joint" with a bar or mechanical device. The pipe should be supported until the joint has been pushed home.

If a problem develops, use the checklist on the next page to identify the problem.

PROBLEM	POSSIBLE CAUSE	SOLUTION
JOINT WILL NOT GO "HOME"	1. DIRT IN BELL	1. CLEAN AND LUBRICATE BELL
	2. UNEVEN GASKET TENSION	2. SEAT GASKET USING SCREWDRIVER
	3. POOR ALIGNMENT OF PIPE BEING LAID	3. REALIGN PIPE BEING LAID BEFORE BARRING. DO NOT "DIVE" PIPE WHEN MAKING JOINTS.
	4. IMPROPER GASKET	4. CHECK GASKET FOR PROPER SIZE AND DIAMETER
	5. INCOMPATIBLE JOINT	5. MAKE SURE PIPE IS FROM THE SAME MANUFACTURER OR HAS COMPATIBLE JOINT
	6. IMPROPER LUBRICATION	6. RELUBRICATE GASKET, GROOVE AND BELL
JOINT IS LOOSE	1. IMPROPER GASKET	1. CHECK GASKET FOR PROPER SIZE AND DIAMETER
	2. INCOMPATIBLE JOINT	2. MAKE SURE PIPE IS FROM THE SAME MANUFACTURER OR HAS COMPATIBLE JOINT
JOINT WILL NOT STAY "HOME"	1. GASKET IS NOT ROTATING	1. CHECK SPIGOT GROOVE FOR ROUGH SPOTS OR DIRT. CLEAN AND LUBRICATE SPIGOT GROOVE.
	2. UNEVEN GASKET TENSION	2. SEAT GASKET USING SCREWDRIVER

QUIZ

Lubricants used on gaskets must be on the Department's _____.

If a joint won't go "home," what are three possible problems?

1. _____.
2. _____.
3. _____.

Another form of joint is the preformed mastic adhesive. Compared to concrete collars, cold plastic adhesive is easier and faster to apply. Here are the steps:

1. First, the pipe joint surface is thoroughly cleaned.
2. Primer is applied and allowed to dry as recommended by the manufacturer.
3. Next, one side of the protective paper is removed.
4. The joint must be dry immediately prior to placing mastic adhesion strip
5. Now, mastic adhesive strips -- paper side up – are laid on the cleaned and primed joint surface. Department specifications require that mastic adhesive be applied to both the bell and spigot. This ensures both interior and exterior "squeeze out."
6. Be sure the mastic covers the entire joint surface.
7. The strips are placed end to end around the joint and the pipe is lowered into position.
8. The protective paper is removed and the pipe is forced into connection using a bar or mechanical device.

When this connection is made, mastic adhesive material will "squeeze out" from the joint. Inside the pipe this should be trimmed off. When this "squeeze out" is uniform all around the pipe, a good seal has been made. If there are major holes where there is no "squeeze out", it may be necessary to disjoint the connection and add more mastic adhesive.

One last point -- in very hot weather be sure the mastic adhesive is kept in the shade. It can also be dipped in water before use to make it more workable. When the temperature is below 60 F, the mastic adhesive should be stored in an area above 70 F or artificially warmed to 70 F.

QUIZ

Before mastic adhesive is used, _____ must be applied.

Mastic adhesive is applied to both the _____ and _____.

_____ must be uniform around the circumference of the pipe inside and outside.

What makes mastic adhesive more workable in hot weather? _____.

The third type of joint – one not as commonly used as the other two -- is the concrete collar. This type of joint is used on dissimilar pipe joints. It is a cast-in-place band around the pipe joint.

In placing a concrete collar, the big thing to watch for is that the concrete beneath the flow line is solid and not honeycombed.

Questions you might have concerning this joint are generally answered in the standard index. If not, then contact your Project Engineer.

CORRUGATED METAL PIPE (CMP)

CMP requires care in handling, laying, and backfilling

There are two types of corrugation -- annular and helical. Annular uses rivets or bolts for seams and joints. A newer and better type of corrugation is helical steel pipe which is manufactured from one roll of sheeting. This gives it a continuous watertight seam which is folded and locked.

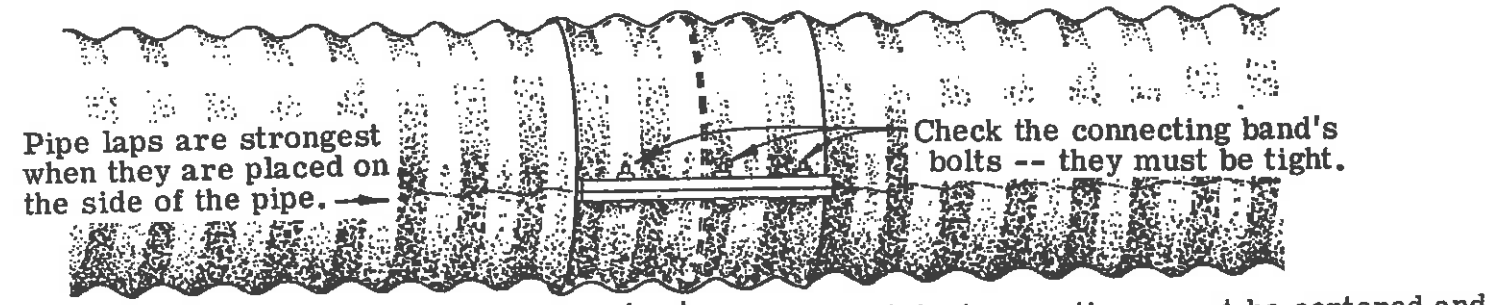
Approved coupling bands are required.

The standard gasket joint uses a flat gasket placed under the coupling band. A special O-ring gasket is allowed for use on helical pipe which has two circular corrugations at the pipe ends. The O-rings are placed within the last corrugation on each pipe. This is commonly called a "hugger band."

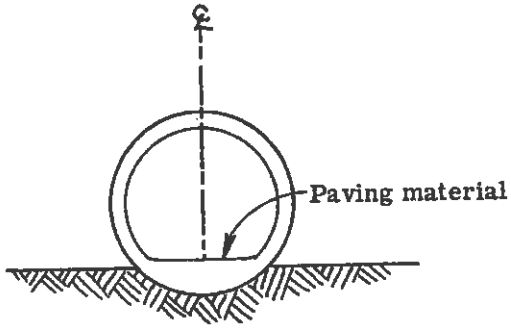
As with concrete pipe it is very important to check steel pipe for damage when it arrives at the work site. Each pipe will be tagged and should be checked against the plans and specifications. If necessary, minor repairs and chipped coating can be corrected but serious damage to pipe calls for rejection by the Technician.

On the next page is an illustration of one installation and some points to watch for.

Corrugated metal pipe is not as difficult to place as CP -- it fits end to end. The sections are connected with corrugated connection bands that are bolted in place.



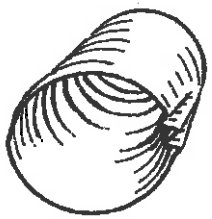
If bituminous coated CMP with paved inverts is used, then be sure the center of the paved invert is on the centerline of the pipe.



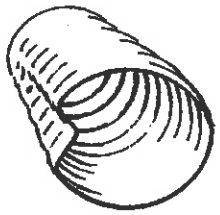
After the pipe has been placed, you should make a final inspection. This is the kind of damage you should look for:

Deflection

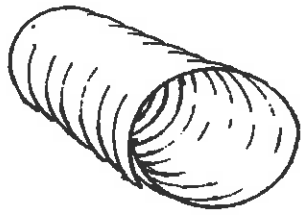
Yield buckling



Elastic buckling



Seam failure



These kinds of pipe damage can result from improper backfilling.

PLASTIC PIPE (PVC AND POLYETHYLENE)

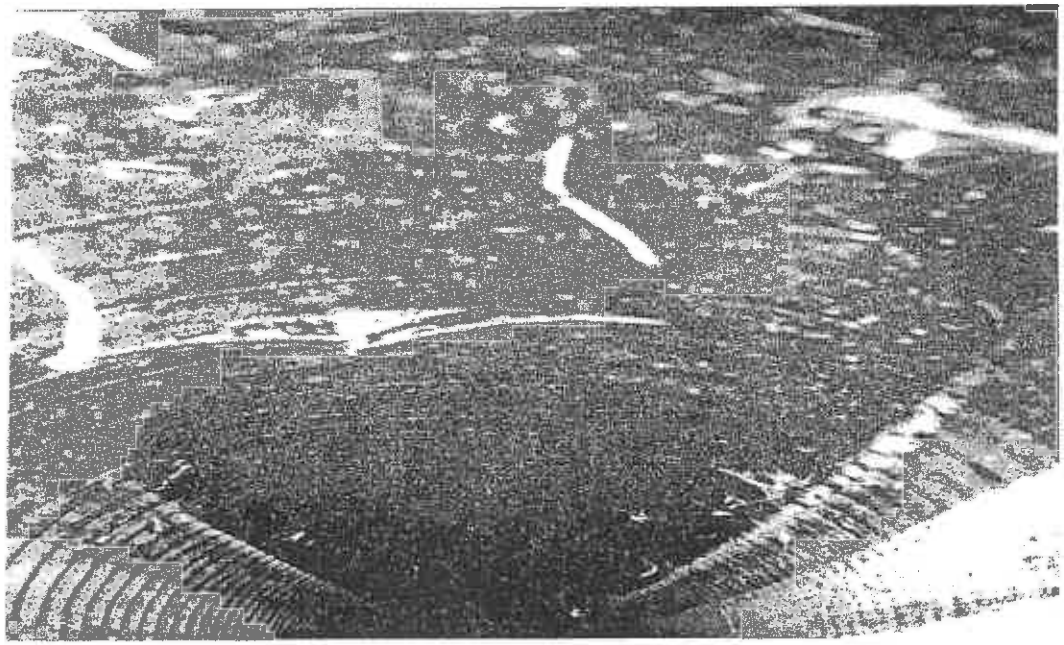
Plastic pipe requires care in handling, laying, and backfilling. Polyethylene pipe is manufactured with two types of corrugation -- annular and helical. Helically corrugated polyethylene pipe is not allowed on Department projects. Assure that annular corrugated pipe is what is being certified to for use.

Only bell and spigot joints are allowed, with the exception of polyethylene split couplings which can be used for repair purposes. Assure that all joints have clean gaskets and are wrapped with filter fabric upon installation.

As with concrete pipe and metal pipe it is very important to check plastic pipe for damage when it arrives at the work site. Each pipe will be stamped and should be checked against the plans and specifications. Permanent markings indicating source and type of pipe should be evident on the pipe. Plastic pipe should be checked for cracking, splitting, gouges, tears and cuts. The interior of the pipe should also be checked for distortion and visible rippling.

Assure that plastic pipe is installed in accordance with the specifications. When plastic pipe is placed, deflection of the pipe material will occur. Pipe deflected in excess of the limits called for in the Specifications is cause for rejection of the pipe.

After the pipe has been placed, you should make a final inspection. This is the kind of damage you should look for:



These kinds of pipe damage can result from improper backfilling.

QUIZ

When installing CMP –

Pipe seams should be placed on the _____ of the pipe.

Connecting band bolts must be _____.

Corrugations must _____.

When the standard gasket joint is used, the gasket is placed in the _____.

BACKFILLING PIPE

Good procedures in backfilling are essential to an effective drainage system. The following three-stage procedure is used under normal conditions:

- In the first stage, the backfill is compacted beneath the haunches of the pipe using mechanical or hand tamps.

- The second stage consists of placing the backfill material (be sure that all backfill material is suitable) in 8 inch loose layers and compacting with mechanical tamps or vibrators. The 8 inch loose layer should compact to about 6 inches. Backfilling and compacting should be alternated on each side of the pipe to bring it up together to prevent lateral displacement of the pipe. The backfill around concrete pipe must be compacted to at least 100% of the maximum Standard Proctor. The backfill around metal and plastic pipe must be compacted to at least 95% of a Standard Proctor. The second stage operation is continued until the backfill is at least one foot above the top of the pipe.

- The third stage consists of backfilling the remainder of the pipe trench and may be accomplished in the same manner as for the second stage or by using equipment such as dozers, front-end loaders, etc., to spread and compact the backfill. The material allowed in the trench must be material shown on Roadway and Traffic Standard Index No. 505. If the pipe is beneath the roadway, compact the backfill in 12" lifts to a density of 100% of a Standard Proctor. In locations away from the roadway, compact the backfill material to a firmness about equal to the soil next to the trench.

When the pipe has been placed in a trench that has been dewatered either by pumping or well-points, the dewatering must be continued until the backfill has been placed above the ground waterline. Puddling or placing backfill under water will not be allowed except when the pipe has been laid under water. However, the Contractor may add water to the material during backfilling operations to increase the moisture content and assist in obtaining maximum density.

So far we haven't mentioned thick lift compaction. This procedure is a little different. If the Contractor has compaction equipment capable of thicker lifts than those we have discussed, lifts in granular materials can go up to 900 mm (3 feet). Density tests must still be run every 12 inches and the Contractor must furnish equipment and the men to dig the pits for the tests. Use of thick lift compaction is never allowed in the soil envelope.

Another point to remember -- heavy equipment should never be allowed to pass over the culvert until backfill materials have been placed and compacted. This will be either to the finished earthwork grade or a minimum of 1.2 m (4 feet) above the top of the pipe.

Backfilling is important and the Inspector's responsibility here is a big one -- to be sure that the pipe is not moved or damaged during compaction. You will need to look for uniform operations just like with all backfill operations. The backfilling should be done by adding uniform lifts on each side of the pipe.

QUIZ

Wet soil should be undercut and backfilled with _____ before pipe is placed.

Backfill material is normally placed around the pipe in lifts no greater than _____ loose.

Before backfilling, the pipe should be checked for _____ and _____.

FINAL PIPE INSPECTION

After all paving operations on the project are completed, make a final inspection of the pipe. The pipe may have to be dewatered to obtain access. The contractor will videotape pipe according to the specifications, and give the videotape to the inspector. The contractor will tell the Engineer when the taping will be done, and an inspector should be present.

Pipe larger than 48" in diameter can be entered for inspection. The Engineer can also waive the video taping requirement for smaller diameter pipe if the pipe is short enough to be inspected from the ends of the pipe. Typical side drain pipe will be short enough to waive the requirement.

Inspect the pipe for poor line and grade, excessive joint gaps, joint misalignment, leaks, damage, and debris. (Include pictures of line and grade problems, damage, leaks, and debris?) Plastic and metal pipe must also be checked for deflection. The inspector can carry a measuring device into larger diameter pipe. A good device would be a stick cut to the allowed deflected diameter. The stick can be rotated around while walking through the pipe to check for deflection in all directions. However, concentrate on vertical deflection because it will be the most common type. (Drawings illustrating horizontal and vertical deflection.) At locations where the deflection is close to the allowed limit, hold one end of the stick against the side of the pipe, and rock the other end back and forth and side to side to be sure the stick will pass through the pipe at its full length.

Deflection in smaller diameter flexible pipe is more difficult to measure because the inspector cannot enter the pipe. Testing equipment such as a mandrel, calibrated video equipment, or a deflectometer may be used to measure deflection. (However, using the equipment can be costly. If the Department requires the Contractor to use one of these devices, and it shows that the pipe is not over deflected, then the Department must pay for the measurements.) The Engineer must use good judgment to ensure that flexible pipe is not over deflected and avoid the cost of deflection testing equipment if it is not needed.

Recognizing a pipe that is deflected 5% can be difficult. If a pipe is deflected a uniform amount of about 5% along its' entire length, then over deflection can be hard to determine by simple observation. However, if there is a localized deflection, or indentation, which is near round sections of pipe, the localized deflection can be spotted easily. In fact, localized deflections of less than 5% can appear to be deflected much more than 5%.

The inspector should observe a flexible pipe from both ends to decide if it might be deflected more than 5%. Start by measuring the deflection at the ends of the pipe.

Next, use a powerful light, at least 1,000,000 candles, to look down the pipe. If the end measurements are not close to the 5% deflection limit, and if localized deflections are not observed when looking down the pipe, then the pipe is not over deflected. If the end measurements are close to 5% or if there are obvious localized deflections, then the Department's deflection measuring device can be inserted further into the pipe with extensions to measure points in question. If the inspector's observations indicate that the pipe is over deflected, then the Engineer must inform the Contractor. If the Contractor needs further proof that the pipe is over deflected, then testing equipment can be used to test the deflection.

JACKING INSTALLATION

Jacking or tunnel installation is used where an open excavation is not possible because of surface obstructions like a railroad. This is an unusual situation and it will normally be spelled out in the plans or special provisions.

Two types of loading conditions need to be considered when jacking concrete pipe. The first is the axial load due to the jacking pressures applied during the placement and the second is the earth loading due to the overburden.

Axial load is the pressure around the pipe. It must be kept uniform to avoid undue pressure on any one section of the pipe. A cushioning material such as plywood or hardwood is good for this.

Earth load is the "down" weight on the pipe. This can be reduced by making the excavation ahead of the lead pipe as close as possible to the shape and dimension of the pipe.

QUIZ

_____ and _____ for pipe installation is used when an open trench is not permitted.

If you need to, review the procedures for installing pipe. When you're ready, go on to UNDERDRAINS.

ANSWERS TO QUESTIONS

Page 4-7

- The sump pump method
- Sand Filters
- Project Engineer
- Running onto private property

Page 4-9

- Uniform support, firm foundation, loosened beneath the middle third of the pipe
- Contact Project Engineer
- Bell, spigot, pipe bedding, flow line elevation
- Plans, Standard Indexes
- A,D,E

Page 4-13

- Wood blocks
- Top
- Bell, groove
- Bells

Page 4-17

- Approved list
- Dirt, Uneven Tension, Poor Alignment

Page 4-19

- Primer
- Bell, spigot
- Squeeze out
- Dipping in water

Page 4-24

- Side
- Tight
- Match
- Coupling bend

Page 4-27

- Granular materials
- 8 inches
- alignment, grade

Page 4-30

- Jack, bore

CHAPTER FIVE

Underdrains

CONTENTS

5

UNDERDRAINS

Before looking at underdrains, the importance of subdrainage must be stressed because it is often overlooked until it is too late. Pavement can be placed in good condition but, if the subgrade is not stable due to subsurface water, the pavement will not hold up. If you look at a road and see "alligator" cracking, you can be quite sure there is excessive moisture in the base or subgrade.

Underdrains are installed for three reasons:

- To control seepage in cuts and on hillside locations;
- To lower the ground water table as in low areas; and
- To drain the subgrade of water either from the surface or below the surface.

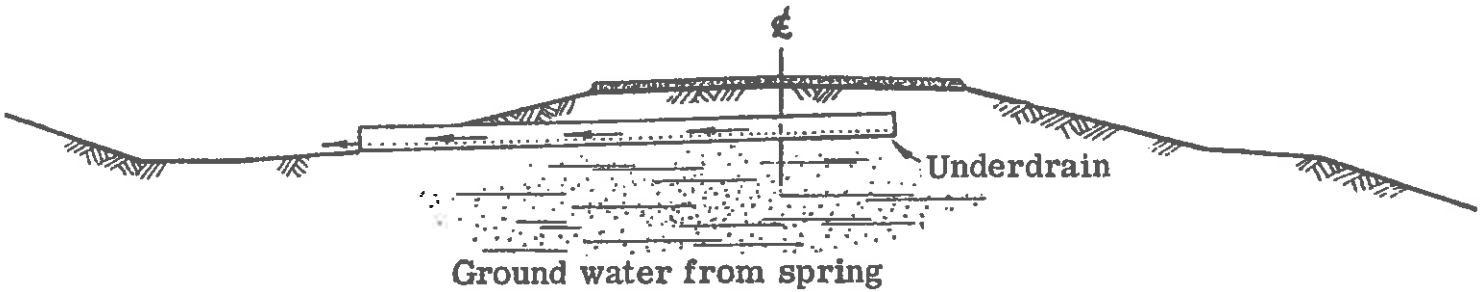
As an Inspector, you should know where, when and how underdrains are installed. If the situation arises, you will be able to spot the need for underdrains and take the problem to your Project Engineer for him to take action.

WHERE TO INSTALL UNDERDRAINS

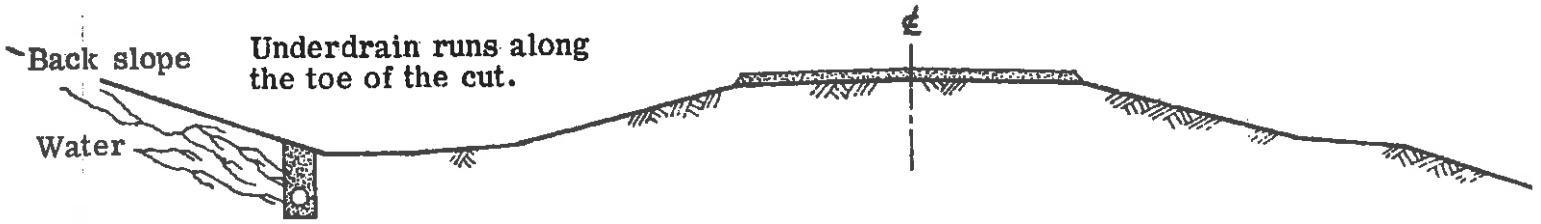
Underdrains are shown on the plans, but conditions may arise that require their installation in unanticipated problem areas. You must be able to verify the need for planned underdrains as well as recognize the need for additional underdrains.

In general, underdrains will be installed at locations experiencing the following conditions:

- Where undercut of impervious material (clay) occurs in a municipal section. Underdrains will prevent trapping water between the impervious layer and the bottom of the subgrade.
- Where the natural ground water table is at or above the bottom of the subgrade. Underdrains will draw the water down.
- Where a seepage occurs in a cut section. Underdrains will prevent the back slopes from sloughing or sliding.



- Where ground water springs exist below the subgrade. Underdrains will intercept and drain off the water.



- Where hydrostatic pressure builds up behind retaining walls. Underdrains will relieve the pressure and prevent displacement.

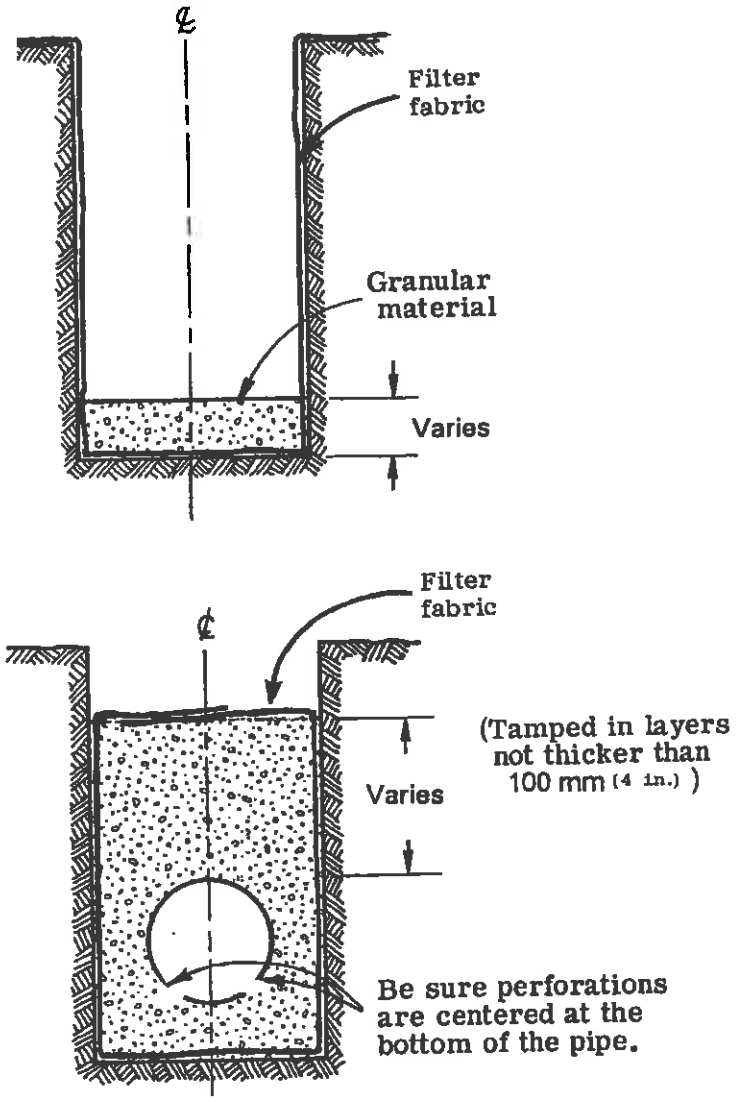
There are four underdrain standards in the Roadway Design Standards.

The installation of a typical underdrain is shown here:

A trench is excavated below the pipe's grade line, lined with filter fabric and filled with granular material. Like other pipe, an underdrain's alignment and grade are controlled by the alignment and grade of the trench. You should check the Contractor's laser alignment and trenching material operation frequently. It will save you time later.

When the bed is ready, the underdrain pipe is placed. Be sure the perforations are on the bottom and that joints are correctly made and covered. The pipe is then covered. Then the filter fabric is wrapped over the granular material.

The remainder of the trench is then backfilled.



WHEN TO INSTALL UNDERDRAINS

You must know also when underdrains will most likely be needed. The best times to check for subsurface water are:

- After clearing and grubbing;
- During excavation operations, particularly in steep cuts;
- During extended wet periods
- After heavy rains.

HOW TO INSTALL UNDERDRAINS

Underdrain pipe is installed in trenches and backfilled with granular materials. Your inspection duties are the same as for other types of pipe -- plus a few special points.

- Underdrain pipe must be laid with the perforations down;
- The dead ends of underdrains must be plugged and the outlets -- except in catch basins and manholes -- must be screened.

QUIZ

List four times when the Inspector should look for subsurface conditions that call for underdrain:

_____.
_____.
_____.
_____.

Underdrain pipe must be installed with the perforations at the _____ of the pipe.

Outlets of underdrains are <u>not</u> screened when they exit into _____ or _____.

When you are ready, begin Chapter Six.

ANSWERS TO QUESTIONS

Page 5-7

- After clearing and grubbing.
  After heavy rains.
  During excavation.
  During extended wet periods.
- bottom
- catch basins, manholes

CHAPTER SIX

Documenting Pipe Placement

CONTENTS

6
DOCUMENTING PIPE PLACEMENT

DAILY REPORT OF CONSTRUCTION

Pipe culvert installations are documented in the Daily Report of Construction by recording the following information for each installation:

- The location of the pipe by stations;
- Length and dimensions of pipe;
- Rejected pipe identification, with reason for rejection; and
- Horizontal and vertical alignment changes, if necessary after proper approval.
- Pipe Deflection

In your report, you should add any comments on the workmanship or unusual events during the installation. Be sure to sign your name at the end of the report.

Pipe culvert is paid for by the meter (foot). The final pay quantity is the plan quantity subject to the provisions of the Standard Specifications completed in place and accepted.

An example of a completed report is shown on the next page.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DAILY REPORT OF CONSTRUCTION

700-010-13
CONSTRUCTION
01/01

Date:	Contract ID:	Financial Project ID:	Inspector:
6/2/2000	11108	19719125201	R. Good

High Temp: 68°F (20°c)	AM Conditions:	PM Conditions:
Low Temp: 42°F (6°c)	PARTLY CLOUDY	COOL

Remarks

General:

Excavated trench and laid 180 l.n. Ft. (55 meters) 36" (900mm) RCP RT. from sta 135+60 (135+66) to sta. 137+40 (136+15).
Set Precast inlet RT. sta. 135+60 (135+60) and precast M.H. RT. sta. 137+40 (136+15)
% deflection measured by mandrel, loss observed to be 6% of the pipe diameter.
BackFilled 36" (900mm) RCP RT. from sta. 135+60 (135+60) to 137+40 (136+15)

Contractors survey crew staked pipe RT. from 139+00 (136+60) to sta. 142+35 (137+60).

Accidents (Circle One): No Yes See Accident Report Dated: _____	Day of Week	Contract Day	Total Days
	FRIDAY	53	108

Visitors

Contractor(s) and Personnel

#	Name	Type	#	Hrs	Type	#	Hrs	Type	#	Hrs
1.	Prime	Supt	1	8	Foreman	1	8	Skilled	2	8
		Semi Skilled	2	8	Common	4	8	Trainee		
2.	Sub/Utility	Supt			Foreman			Skilled		
	I.L. PIPE, INC.	Semi Skilled			Common			Trainee		
3.	Sub/Utility	Supt			Foreman			Skilled		
		Semi Skilled			Common			Trainee		
4.	Sub/Utility	Supt			Foreman			Skilled		
		Semi Skilled			Common			Trainee		

Contractor(s) Equipment (Active or Idle)

Contr/Sub #	Equipment ID	Description	(A) Active or (I) Idle	# Hours Used	Total Hours Used
2	IP407	BACKHOE	A	8	8
2	IP358	FRONTEND LOADER	A	8	8
2	IP 118	MECHANICAL TAMPS	A	8	16
2	IP 642	TRUCK, DUMP	I	—	8
2	IP 624	TRUCK, FLATBED	A	8	8
2	IP 815	ROLLER, VIBRATORY	A	8	8
2	IP 907	SPREADER, BOX	A	8	8

Date:	Contract ID:
6/2/2000	11108

700-010-13
CONSTRUCTION
01/01

Estimated Work Performed

Contr/Sub #	Line Item #	Pay Item Code	Location	Time (AM/PM) Beginning	Time (AM/PM) Ending	Installed Qty	Installed Units
2		425-1-11	Sta. (135+60) 135+60 RT.	8:00AM	10:00AM	1	ea.
2		425-2-11	Sta (136+15) 137+40 RT.	11:00AM	1:00PM	1	ea.
2		430-1-126	135+60 (135+60) to	2:00PM	5:00PM	(55) 180	(M) L.F.
			137+40 (136+15)				

EFFECTS OF WEATHER ON MAJOR WORK ITEMS (CHECK CONTROLLING ITEMS):

Major and/or Controlling Work Items	No Effect All Day	Effected Less Than 50% of Work Day	Effected More Than 50% of Work Day	No Work All Day
_____	O	O	O	O
_____	O	O	O	O
_____	O	O	O	O
_____	O	O	O	O
_____	O	O	O	O
_____	O	O	O	O

TECHNICIANS SIGNATURE AND RATING:	HOURS AT JOB SITE	TOTAL HOUR
Jimmy Dilit EAS Level I	FROM 8:00 AM TO 5:00 PM	8 hrs.

ENGINEER IN CHARGE (NAME, RANK AND INITIALS):
H. ED HONCHO EAS Level II H.H. — 6/2/2000 Date

Entered Into Site Manager:	Date:	By:

DISTRIBUTION: Original - Project Engineer
Copy - Contractor (As requested)

QUIZ

Pipe is identified by recording three data. Name them.

_____.
_____.
_____.

Where are pipe culvert installations documented? _____.

Which of the following should you comment on in your reports?

____ A. Weather conditions
____ B. Unusual events during installation
____ C. Equipment used
____ D. Workmanship

How is pipe culvert paid for? _____.

How is the final pay quantity determined? _____.

ANSWERS TO QUESTIONS

Page 6-4

- Dimensions
  Length
  Location
- Daily Report of Construction
- All of them
- by the meter (foot)
- plan quantity, subject to limits in Standard Specifications

CHAPTER SEVEN

Installing Inlets and Manholes

CONTENTS

7
INSTALLING INLETS AND MANHOLES

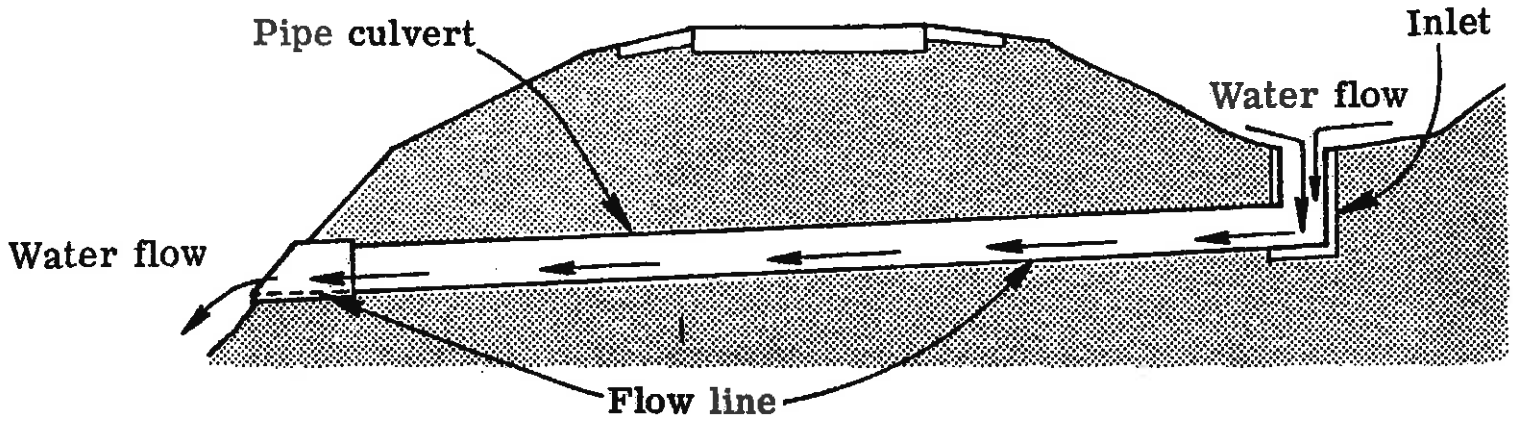
INTRODUCTION

The purpose of an inlet is to provide a means for storm water to enter a pipe system. A manhole provides access to a pipe system so that the system can be inspected and cleaned out. It also serves as a junction where two or more pipes intersect or where a line of pipe changes direction.

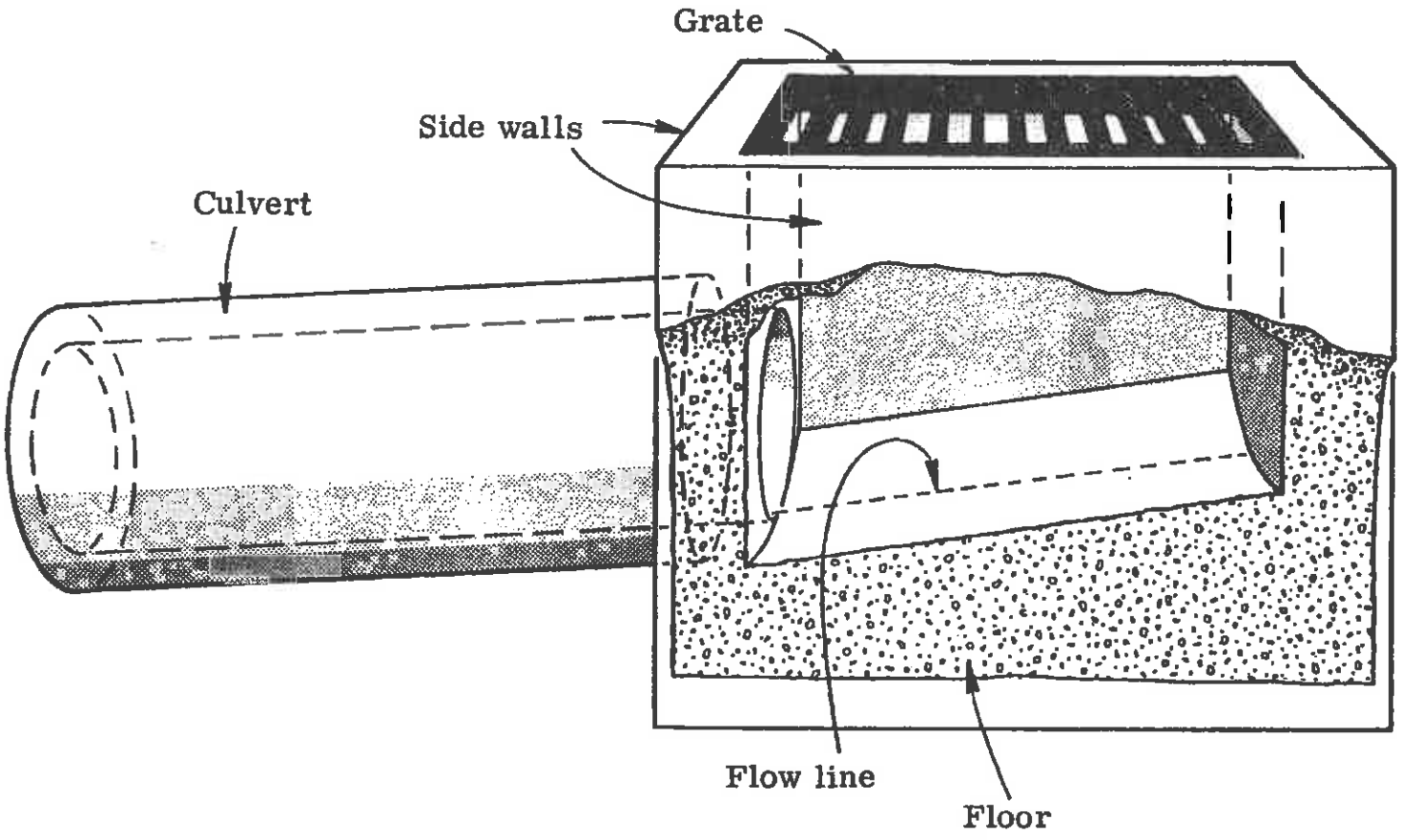
It is critical that density be achieved around inlets and manholes. Density requirements for inlets and manholes are the same as for culverts and sometimes the contractor does not employ the same compactive effort around these structures as on the pipe line. Close scrutiny of this area is extremely important to assure the required density is obtained.

Inlets and manholes can be constructed of various combinations of brick, concrete masonry units, cast-in-place concrete, and precast construction.

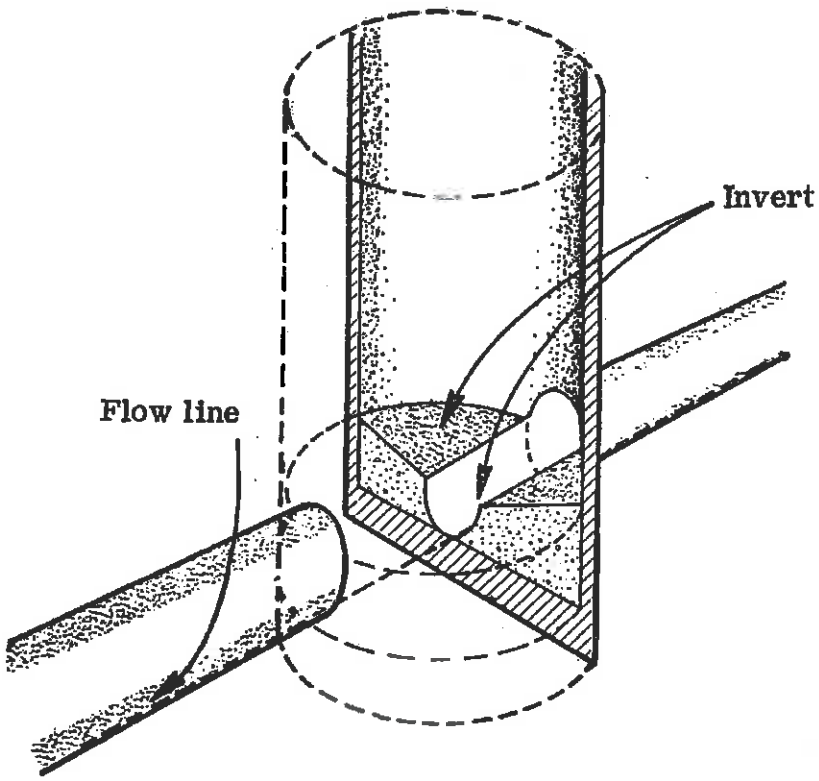
The illustration below is a cross section of a roadway showing the use of an inlet into a culvert.



The drawing below shows a cross section of an inlet. The slanted floor of the inlet provides a smooth flow line into the culvert.



The drawing on the right shows a cross section of a manhole. In this case, it is a part of a sewage system. The invert is constructed along the flow line of the pipe which provides for maximum efficiency through the manhole. Inverts are constructed according to the standard index.



QUIZ

Storm water enters a pipe system through an _____.

If the system must be opened for cleaning and inspection, a _____ is constructed.

Name four types of inlet construction:

1. _____.
2. _____.
3. _____.
4. _____.

BRICK MASONRY

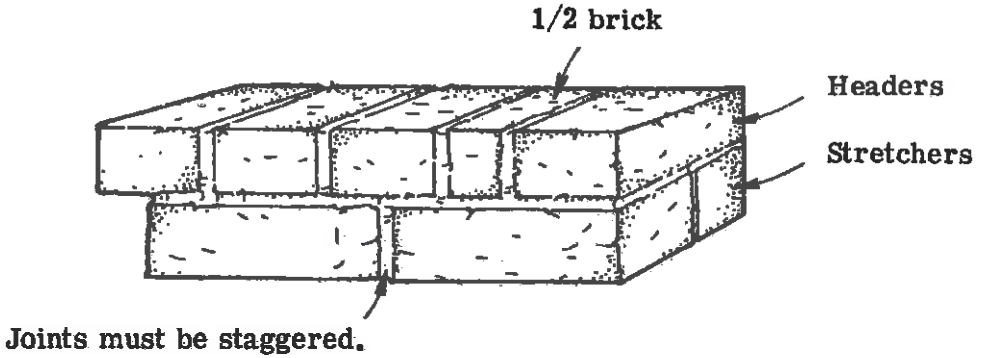
The Standard Specifications limit brick masonry construction to circular structures that are built in place.

Brick masonry must be strong and constructed to the line and grade as stated in the plans. Your job as an Inspector is to be sure that the Contractor does the brick masonry work according to the plans. The work begins, the brick and mortar sand must be tested and approved for use. You must be familiar enough with brick masonry to distinguish between good and poor quality work. Good quality brick masonry must meet several requirements:

- The bricks to be used must be thoroughly cleaned and saturated with water before being laid. The wetting down is necessary so that the water required for hydration will not be absorbed by the brick.

- The bed on which the bricks are set also must be cleaned and well-moistened with water before mortar is placed on top of it.

- The bricks should be arranged so that the wall resists horizontal forces pushing inward on the masonry. By constructing on a radius, an arch effect is created and the wall is strengthened. A header and stretcher pattern should be used -- unless otherwise indicated on the plans – to gain strength.



- The joints should be between 1/4 inch and inch thick and thoroughly filled with mortar.

- No spalls or bats (cut bricks) should be used except when shaping around irregular openings or when needed to finish a course (one layer). In the latter case, a full brick is used to finish each course to the corner and the bat is placed in the interior of the course.

- To insure water-tightness, the structure must be plastered both on the inside and the outside.

- If any bricks or joints are broken or moved after laying, the bricks should be removed and cleaned. Also, the mortar must be thoroughly cleaned from the bed and joints, and the bricks must be relaid in fresh mortar.

- The masonry should be protected and kept wet for 48 hours after completion of the work.

- It is important to measure the inside diameter, height, and elevation to ensure that the structure agrees with the plans.

QUIZ

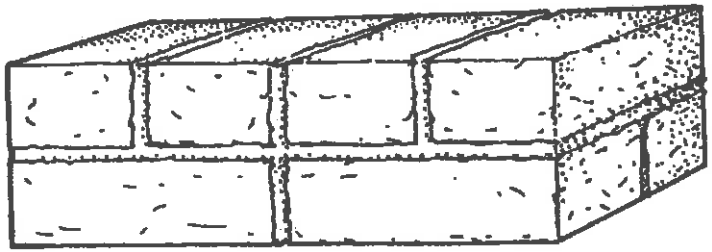
Before brick is laid, it should be cleaned and _____.

To give brick masonry walls strength, they are constructed on a _____ and the joints between courses are _____.

The joints between bricks should be between _____ and _____ thick.

If a bat is used to finish a course, where should it be placed? _____.

Are both the inside and outside of a structure plastered? _____.



What is wrong in the brick arrangement shown above?_____.

What should be done if a brick is moved after being placed? _____.

CAST-IN-PLACE CONSTRUCTION

For cast-in-place construction, concrete should be placed only after the forms are properly set and braced. You should also make sure reinforcing steel is securely supported and tied. Another important check is to inspect the grade at the top of the forms to be sure it complies with the plans. Finally, when the forms are removed, all areas of honeycomb should be repaired to protect against possible leaks.

PRECAST CONSTRUCTION

Check precast structures for structural defects, cracks or damage. If a problem is found, notify contractor immediately to prevent structure from being installed. Depending on type of problem found. Contractor and Technician or the Contractor, Technician and Manufacturer should inspect structure together to determine if it is repairable. Repairs should be made using proper repair techniques and materials. If not repairable, structure should be rejected and removed from jobsite as quickly as possible to prevent its use.

There is a guide to use for inspecting and rejecting precast structure:

Non-Repairable Defects:

- Large areas of honey-combing
- Large areas of precast structure broken off through mishandling that destroy the structural integrity of the unit.
- Exposed rebar or rebar that does not meet minimum coverage requirements (other than ends of a bar or wire used for centering purposes)
- Cracks through walls or slabs (other than hairline cracks)

Repairable Defects:

- Small areas of honey-combing
- Broken areas of precast unit that do not affect structural integrity.

Permissible Defects (not cause for rejection):

- Bug holes
- Chipping caused from handling
- Hairline cracks
- Exposed steel in the center of the wall used for centering cage
- Exposed steel in the center of the wall thru the cast opening where pipe is to be grouted

When precast structures are delivered to a jobsite, care should be taken to handle and unload them properly. Precast structures are provided with lift points. All lift points should be used to prevent damage to the product or injury to the Contractor's personnel. It is the contractor's responsibility to provide adequate size equipment and slings to unload precast structures. **CAUTION**: Use of short cables or slings could result in structural failure and cause injuries.

Precast Structures should be stored neat and orderly in their designed upright position. Structures should never be stored on their sides. Dunnage should be used whenever stacking is necessary in order to prevent damage to joints or finished surfaces.

Bedding material for pipes entering the structures and the structures themselves shall be as provided in the specifications.

Pipe to Structure Connection

Probably the closest inspection in the whole installation is the seal under the pipe flow line. Brick used to support the pipe should not extend completely through the seal. All pipe extending into a structure should be cut off flush with the inside face of the wall. Exposed reinforcement should also be cut off and plastered over.

Grout Connections: Precast structures are designed with oversized openings to allow the use of a non-shrink grout to seal pipe to structure. Materials used to seal openings should be DOT approved. The area beneath the pipe is very important. A minimum of 1" grout under pipe is recommended to provide a watertight seal. Do not place pipe directly on bottom of hole opening.

Filter Fabric: Check to insure that the filter fabric is properly secured around the concrete pipe entering or leaving the drainage structure.

Flexible Connector: The flexible connection is accomplished by using a rubber connector that forms a water tight seal between the pipe and the manhole. The guidelines for installation will be set forth by the specific manufacturer.

Invert

Inverts are constructed in all manholes and inlets. The invert is the slope and curvature of the floor of the structure that forms a smooth channel for the flow of the water. The invert is formed by using broken brick and concrete. The flow line of the invert should match the flow line of the discharge (outlet) pipe. The purpose of the invert is to efficiently convey the water through the structure.

Inlet and manhole installations are important drainage structures. Their inspection is an important part of your job.

QUIZ

When forms are removed from cast-in-place construction, all areas of _____ should be repaired to avoid leaks.

All precast units must have the Department's _____ to show that they are approved.

An invert is the _____ and _____ of the floor of an inlet or manhole.

YOU HAVE COMPLETED THE TRAINING COURSE IN PIPE PLACEMENT INSPECTION. BEFORE TAKING THE EXAMINATION, YOU WILL WANT TO QUIZ YOURSELF ON THE ENTIRE COURSE. CHAPTER EIGHT, THE REVIEW QUIZ, WILL SERVE THIS PURPOSE.

ANSWERS TO QUESTIONS

Page 7-5

- inlet
- manhole
- 1. Brick
  2. Concrete masonry
  3. Cast-in-place concrete
  4. Precast construction

Page 7-8

- saturated with water
- radius, staggered
- 1/4 inch, inch
- In the interior of the course
- Yes
- Joints are not staggered
- It should be removed, cleaned and reset in fresh mortar

Page 7-12

- honeycomb
- inspection stamp
- slope
  curvature

CHAPTER EIGHT

Review Quiz

Things which you learned in this course are going to help you do a better job as an Inspector. This Review Quiz is designed to help you know how well you have learned. It is also designed to prepare you for the Examination.

Listed below are instructions on how to take the Review Quiz.

1. Do not take this quiz immediately after you finish Chapter Seven of the course.

2. Do not cram the night before you take the quiz. Remember that the objective is not to test your memory. The objective is to help you evaluate how well you have learned the material and how well you can think through your every-day work problems.

3. When you take this quiz, make sure that you will not be disturbed for about one hour.

4. Attempt all questions.

5. You may refer to the course material if you get stuck on a question. But first try to reason out the problem.

6. Finally, keep track of your wrong answers. Instructions on how to grade yourself follow the Review Quiz. If you score less than 90% on the quiz, do not be disappointed. Go back and study the course materials once again and reattempt the quiz.

GOOD LUCK!

8

REVIEW QUIZ

A facility which provides an opening under the roadway for drainage is called a _____.

CP means _____.

CMP means _____.

Subsurface water at or near the subgrade may lead to structural failure of the road. One way to keep the water level below the subgrade is to install a pipe known as an _____.

Which concrete pipe is stronger, Class II or Class III? _____.

(Which CMP has a thicker shell -- one that is 8 gage or one that is 10 gage? _____).

If you find that the plans do not agree with the Standard Specifications, which document controls over the other? _____.

Listed below are the five general steps that make up most pipe installation procedures. Number the steps 1 through 5.

____ A. Trenching and bedding
____ B. Delivering and storing
____ C. Backfilling and compacting
____ D. Staking
____ E. Installing.

Does the official DOT pretested stamp on a concrete pipe mean that the pipe can be accepted on the job without being inspected? _____.

The main purpose of batterboards is to support a _____ directly over the centerline of the proposed pipe.

Should a change be made in the planned pipe location if the planned pipe bottom is lower than the actual drainage bottom? _____.

Pipe laying should start at:

____ A. The inlet end
____ B. The outlet end
____ C. The center of the trench.

Where bell and spigot pipe is used, recesses must be formed in the bedding to receive the _____.

May shoring, sheeting or other bracing be required to hold the sides of deep trenches? _____.

Immediately after placing each pipe section, the section should be checked for _____ and _____.

The loose depth of each layer of backfill should not exceed _____ inches.

In the first stage of backfilling, the backfill is compacted beneath the _____ of the pipe using hand tamps.

When the pipe -- other than flexible culvert -- is located under the roadway, the backfill must be compacted to at least _____% of the maximum density of the material as determined from the lab proctor.

Inspectors should continually watch for conditions that may require underdrains. When can these conditions best be observed?

_____ A. Before or after clearing grubbing? _____.
_____ B. Before or during grading? _____.
_____ C. During which time of the year? _____.
_____ D. During or after heavy rains? _____.

Which of the following are purposes of underdrains?

____ A. To cut off water from springs, before it gets under the pavement.
____ B. To relieve hydrostatic pressure behind a retaining wall.
____ C. To collect surface water in roadside ditches.
____ D. To cut off subsurface seepage which may cause a slide.
____ E. To provide an opening under the roadway, so that surface water can pass from one side of the roadway to the other.

As a Technician, you should compare the markings on a CMP with the pipe's _____ papers.

Should you accept a reinforced concrete pipe which has only one crack that passes through the pipe wall? _____.

Damage to pipe ends is cause for _____.

Larger pipe may have_____for lifting it.

The keys to effective joints are good _____and _____.

Who should decide what actions are taken when pipe locations do not fit field conditions? _____.

Backfilling and compacting should be:

____ A. Completed on one side of the pipe before they are done on the other.
____ B. Completed at least 65% of the way up one side of the pipe before they are begun on the other side.
____ C. Alternated on each side of the pipe.

The second stage of the backfilling operation is continued until the backfill is at least _____ above the top of the pipe.

Layers are placed at a maximum of _____ inches loose backfill to produce a compacted layer of _____ inches.

When pipe backfill is compacted in areas not under the roadway or embankment, the required density is:

____ A. 85% of maximum density of the material
____ B. Same as the original adjacent ground
____ C. 100% of maximum density of the material.

Horizontal alignment can be checked by using a _____.

Pipe must be laid with the handling holes at the _____.

As the Contractor installs a culvert, the Technician should check three things to ensure proper alignment. Name them.

_____.
_____.
_____.

The lubricants used on gaskets must be on the Department's _____.

Three types of concrete pipe joints are used by the Department. Name them.

_____
_____.
_____.

If the joint will not stay "home," what are two possible causes?

_____.
_____.

Department specifications require that mastic adhesive be applied to both the _____ and _____.

With a mastic adhesive joint, is "squeeze out" a good thing? _____.

For CMP that must be watertight, are gaskets used? _____.

CMP laps are strongest when they are placed on the:

_____ A. Side of the pipe
_____ B. Bottom of the pipe
_____ C. Top of the pipe.

The purpose of an inlet is to provide a means for _____ to enter a pipe system.

A _____ is constructed at locations in a system for cleaning and inspection.

_____ in inlets and manholes ensure a smooth flow of water.

ANSWERS TO QUESTIONS

Page 8-2

- culvert
- Concrete Pipe
- Corrugated Metal Pipe
- underdrain
- III
- (8 gage)
- Plans

Page 8-3

- A. 3
  B. 2
  C. 5
  D. 1
  E. 4
- No
- string line
- Yes
  B

Page 8-4

- bells
- Yes
- grade, alignment
- 8
- haunches
- 100
- A. After
  B. During
  C. Spring
  D. After

Page 8-5

- A, B, D
- certification
- No
- rejection
- handling holes
- lubricant, gaskets
- Project Engineer

Page 8-6

- C
- 1 foot
- 8, 6
- B
- string line
- top

page 8-7

- String line
  Pipe bed
  Flow line
- approved list
- O-ring gasket
- Preformed mastic adhesive
  Concrete collar
- Gasket is not rotating
  Uneven gasket tension

Page 8-8

- bell, spigot
- Yes
- Yes
- A
- runoff water
- manhole
- Inverts

NOW, TO GRADE YOURSELF ON THE REVIEW QUIZ, TOTAL YOUR INCORRECT ANSWERS. THERE ARE ABOUT 65 ANSWERS IN THE QUIZ.

IF YOUR SCORED LESS THAN 90% -- THAT'S MORE THAN 7 INCORRECT ANSWERS -- GO BACK AND STUDY THE PARTS OF THE COURSE THAT GAVE YOU TROUBLE. THEN, TAKE THE REVIEW QUIZ AGAIN. WHEN YOU CAN ANSWER THE REVIEW QUIZ QUESTIONS CORRECTLY, YOU SHOULD HAVE NO TROUBLE WITH THE EXAMINATION.

SUBJECT INDEX