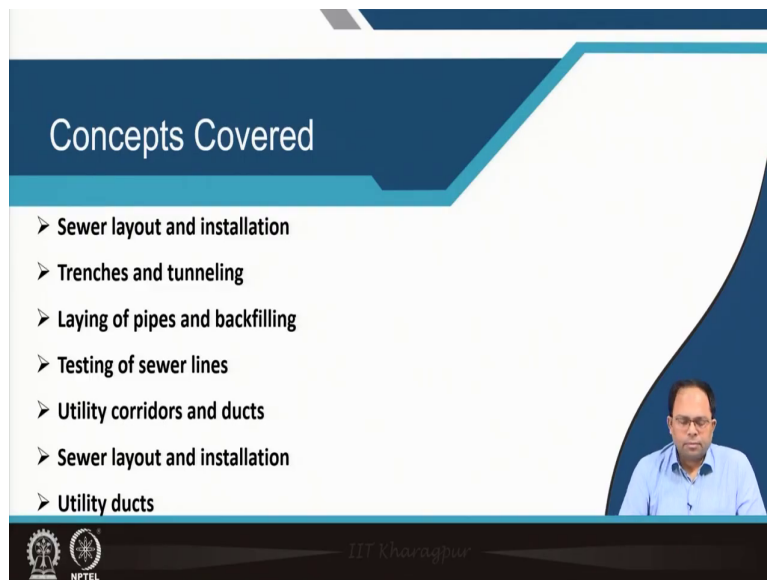


**Urban Utilities Planning: Water Supply, Sanitation and Drainage**  
**Prof. Debapratim Pandit**  
**Department of Architecture and Regional Planning**  
**Indian Institute of Technology, Kharagpur**

**Module - 10**  
**Sewer appurtenances**  
**Lecture - 50**  
**Laying of Sewers and Utility Corridors**

Welcome back. In lecture 50, we will talk about Laying of Sewers and Utility Corridors.

(Refer Slide Time: 00:34)



The slide features a dark blue header with the title 'Concepts Covered' in white. Below the header is a list of seven items, each preceded by a right-pointing arrowhead. The items are: 'Sewer layout and installation', 'Trenches and tunneling', 'Laying of pipes and backfilling', 'Testing of sewer lines', 'Utility corridors and ducts', 'Sewer layout and installation', and 'Utility ducts'. A small video inset of a man in a light blue shirt is visible in the bottom right corner of the slide. At the bottom of the slide, there are logos for IIT Kharagpur and NPTEL.

- Sewer layout and installation
- Trenches and tunneling
- Laying of pipes and backfilling
- Testing of sewer lines
- Utility corridors and ducts
- Sewer layout and installation
- Utility ducts

The concepts covered in this lecture are on sewer layout and installation, trenches and tunneling, laying of pipes and backfilling, testing of sewer lines, utility corridors and ducts, sewer layout and installation, and utility ducts.

(Refer Slide Time: 01:00)

### Sewer layout and installation

➤ Sewer construction starts from the outfall end and then progresses towards the starting end.

**Horizontal layout:** Location and direction of the sewer line  
**Slope:** Determines hydraulic carrying capacity.  
**Manhole:** Alignment of sewer in a straight line between manholes.

**Location of trench:** Offset line parallel to the sewer center line.  
**Demarcated by wooden stakes:** 15 m interval.  
**Stakes:** Tops at a specific height from trench bottom (horizontal slope line).  
Manhole centers are also marked.

**Bedding concrete:** 10 cm bedding concrete upto half the pipe so that alignment remains undisturbed.

**Pipe laying:**  
Using batter boards ✓  
Using laser beams (more accurate) ✓

(Source: <https://www.tpub.com/inteng/101.htm>)

## Sewer layout and installation

Sewer construction starts from the outfall end and progresses towards the starting end. So, first we have to design the outfall and from there we have to lay in the lines and then we have to go to the starting end. So, that should be the progression of the sewer construction.

Usually, we are concerned about the horizontal layout, which determines the location and direction of the sewer line. We have to know the slope because that determines the hydraulic carrying capacity of the sewer. Finally, manholes, at every alignment or depth change of the sewer. Usually in between two manholes, the sewer is aligned in a straight line. So, these are the three things that is required.

Once that is done, we have to determine the location of the trenches to be dug, where we will lay our sewer lines. This is done by creating offset parallel lines from the sewer center line and this is usually demarcated by wooden stakes at 15-meter interval. Manhole centers are also marked along with the sewer center line. We also try to mark the trench bottom as per the the horizontal slope or the invert level of that sewer.

This is usually done using two techniques: One is called a batter board, other is using a laser beam which is more accurate. This actually helps us in laying of the pipes or determining the

invert level of the pipes. But before we do that, we also need to provide bedding concrete at the bottom of the trench.

The standard design of the bedding concrete is 10-centimeter bedding concrete up to half the pipe, so that alignment remains undisturbed. The pipeline is thus properly secured into this bedding concrete, and the slope is also maintained.

In this particular image, we can see the batter boards along the trench and top line.

Batter boards are supported by two stakes at the sides of the trench, and within the batter board the center point is marked using a nail. From there, we drop a plumb bob (a string connected with a weight) that actually helps us in determining the depth of the invert from the top of the sewer line.

So, based on that we can understand the profile of the sewer line or the longitudinal profile of the sewer line, and accordingly we can keep digging the trenches or adjusting the trenches or keep doing the bedding concrete and determining the invert levels of the sewer pipe.

(Refer Slide Time: 05:03)

**Trenches and tunnelling**

**Trench**

- Trench width is restricted in developed areas both due to space and cost of restoring surface.
- Sides of trench are supported by shoring.
- Trenches sometimes need to be drained to remove water.
- Dewatering trenches is required for placement of concrete bedding and laying of pipe sewer or construction of concrete or brick sewer till curing.

Width depends on:

- Sewer line diameter and its bedding.
- Type of shoring (single stage or two stage).
- Working space required inside the trench.
- Type of soil and ground below the surface.
- Adjoining services and nearby structures.

**Tunnelling** Economical in certain cases depending on soil (soft), the depth (10 m) of the sewer and activities above ground.

Shafts to gain access to tunnels and removal of excavated material.

*(Handwritten red annotations: a circle around 'soft', a line under '10 m', and a diagram of a tunnel with a shaft and a pipe.)*

*(Small video inset of a man in a blue shirt.)*

## **Trenches and tunnelling**

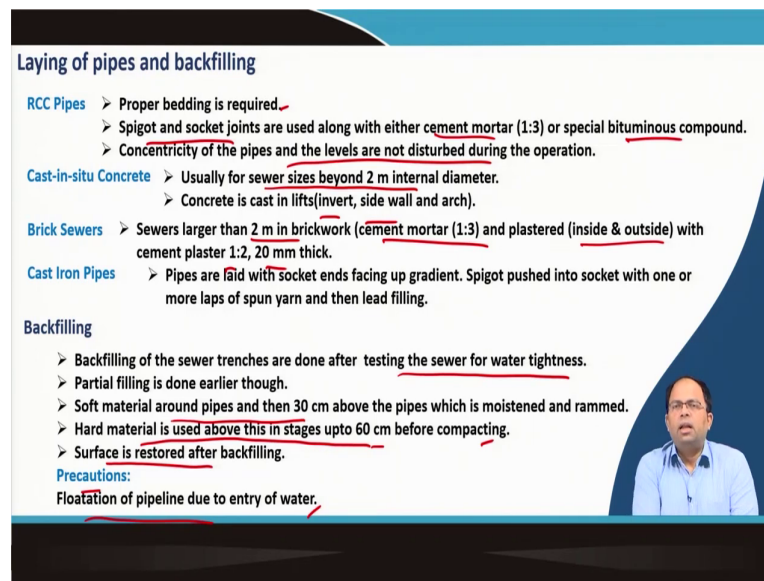
There are two ways of laying sewer lines: via trenching or via tunneling. The trench width is restricted in developed areas both due to space constraint and cost of restoring surface. The

trench is made as small as possible because the more we cut, the more we have to fill, and more the surface has to be restored which will increase the cost. However, the size of trenches depends on many things. First of all, trenches have to be supported via shoring for which there are different techniques. Trenches sometime needs to be drained to remove water because whenever we dig, if the groundwater table is at a higher level, then it gets filled with water and for that we need to do dewatering of trenches with the help of pumps. This is pertinent because we have to do a concrete bedding for laying of pipes, and to ensure that the concrete is properly cured, we need to dewater trenches.

So, the width of trench depends on many things. It depends on the sewer line diameter, the kind of bedding used and on the type of shoring. The different kinds of shoring used are single stage storing and two stage shoring. The width of trench also depends on the working space required inside the trench. Then, type of soil and ground water below the surface also determines the width. Adjoining services and nearby structures also determines the size of the trench.

Tunneling is taken up in case the depth is higher than 10 meters, and the soil is soft, which does not support shoring or it may result in caving of the trenches. It also depends on the activities on ground and if these cannot be disturbed, then also we will go for tunneling. So, whenever we have tunnels, we have to create access shafts to the tunnel to gain access and for removal of excavated materials.

(Refer Slide Time: 08:19)



**Laying of pipes and backfilling**

- RCC Pipes**
  - Proper bedding is required.
  - Spigot and socket joints are used along with either cement mortar (1:3) or special bituminous compound.
  - Concentricity of the pipes and the levels are not disturbed during the operation.
- Cast-in-situ Concrete**
  - Usually for sewer sizes beyond 2 m internal diameter.
  - Concrete is cast in lifts (invert, side wall and arch).
- Brick Sewers**
  - Sewers larger than 2 m in brickwork (cement mortar (1:3) and plastered (inside & outside) with cement plaster 1:2, 20 mm thick.
- Cast Iron Pipes**
  - Pipes are laid with socket ends facing up gradient. Spigot pushed into socket with one or more laps of spun yarn and then lead filling.

**Backfilling**

- Backfilling of the sewer trenches are done after testing the sewer for water tightness.
- Partial filling is done earlier though.
- Soft material around pipes and then 30 cm above the pipes which is moistened and rammed.
- Hard material is used above this in stages upto 60 cm before compacting.
- Surface is restored after backfilling.

**Precautions:**

- Floatation of pipeline due to entry of water.

### Laying of pipes and backfilling

Different kind of pipes could be laid as storm water sewers such as RCC pipes, cast-in-situ concrete pipes, brick pipes and cast-iron pipes. For RCC pipes, we need to provide proper bedding with either spigot and socket joints used along with cement mortar (1:3) or special bituminous compound. The concentricity of the pipes and the levels are not disturbed during the operation, so that it is laid properly.

Then we have cast-in-situ concrete pipes which are used when the sewer diameter is more than 2 meters. Concrete is cast in lifts; first do the invert level, then the side walls, then the arch and then the top arch. So, gradually different levels could be cast for this particular concrete pipe section.

The brick sewers are laid when the sewers are larger than 2 meters in diameter. Brickwork is laid in cement mortar of 1: 3, and these are plastered both inside and outside with cement plaster 1: 2 and these are 20 millimeters thick.

Lastly, we have cast iron pipes. These pipes are also laid with spigot and socket joints.

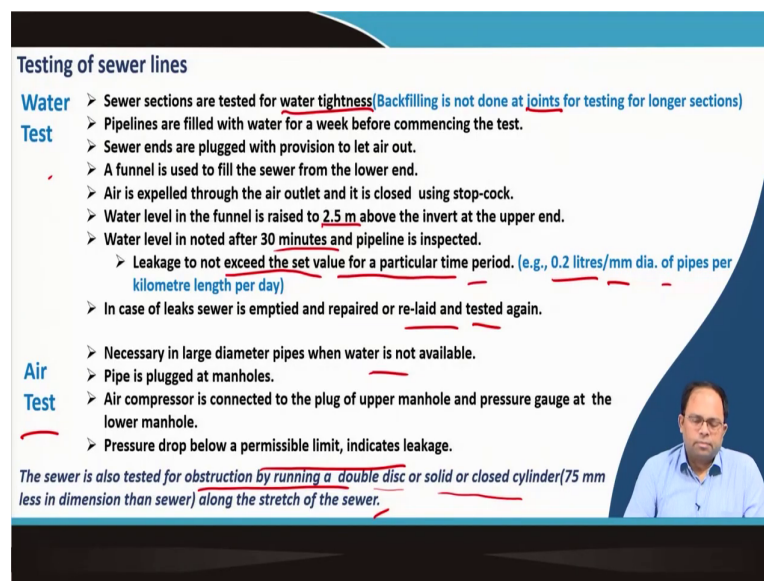
So, once we have laid in the pipelines or we have constructed the pipelines in situ, then the next job is to backfill. And then we do the surface and complete this particular task. Initially

partial backfilling could be done, but full backfilling is only done when the sewer has been tested for water tightness. Partial filling actually helps us make the pipeline fixed, so that there is no movement of the pipelines, and the invert levels are also fixed.

Soft material around the pipes up to a height of 30 centimeter is first put in and then they are moistened, and rammed, and solidified, and after that hard material is used for a height of 60 centimeter and then compacted. So, this is raised to height of 60 centimeter. Once compacted, the surface is restored.

If the groundwater table is high in this particular area, we need to check that the pipelines do not float due to entry of water. So, if that is the case, then the ramming and backfilling, has to be done following some other methods also.

(Refer Slide Time: 11:51)



**Testing of sewer lines**

**Water Test**

- Sewer sections are tested for water tightness (Backfilling is not done at joints for testing for longer sections)
- Pipelines are filled with water for a week before commencing the test.
- Sewer ends are plugged with provision to let air out.
- A funnel is used to fill the sewer from the lower end.
- Air is expelled through the air outlet and it is closed using stop-cock.
- Water level in the funnel is raised to 2.5 m above the invert at the upper end.
- Water level is noted after 30 minutes and pipeline is inspected.
- Leakage to not exceed the set value for a particular time period. (e.g., 0.2 litres/mm dia. of pipes per kilometre length per day)
- In case of leaks sewer is emptied and repaired or re-laid and tested again.

**Air Test**

- Necessary in large diameter pipes when water is not available.
- Pipe is plugged at manholes.
- Air compressor is connected to the plug of upper manhole and pressure gauge at the lower manhole.
- Pressure drop below a permissible limit, indicates leakage.

*The sewer is also tested for obstruction by running a double disc or solid or closed cylinder (75 mm less in dimension than sewer) along the stretch of the sewer.*

## Testing of sewer lines

Before the backfilling, we need to carry out certain tests. Only partial backfilling is done before we conduct these tests. The sewage sections are primarily tested for water tightness, and backfilling is not done at the joints and it is left open.

The pipelines are filled with water for a week before the test is done, so there is time for the water to actually move into every corner to check for leakages. Then the sewer ends are

plugged with provision of air outlets. A funnel is used to fill the sewer from the lower end so that we can raise the water to a particular height of around 2.5 meter in the funnel and we leave the water there for 30 minutes and then check the water level in that funnel. If the water level has gone down, then there is leakage. But there is a certain volume of leakage in the sewer pipeline which is expected. For different diameters of the pipeline, for different time period, there is a value for allowed leakage. If it is more than that then we should be concerned, and then we have to actually re-lay the pipeline and then we have to test it again. So, the allowed amount of leakage is around 0.2 litres per millimeter diameter of pipe per kilometer length per day. If it exceeds than that, then we have to again re-lay the pipeline.

In case it is a large diameter pipe line and water is not available to test it, we can do an air test and that is when the pipe is plugged at the manholes. We use an air compressor to plug the upper manhole and then the pressure gauge is provided at the lower manhole. The pressure drop below a permissible limit indicates leakage.

However, the water test is more conclusive. Whereas in an air test there may be chances of air leakage from many ways. Sometimes, in case water is not available this is the only way that we can use to test pipes.

Finally, the sewer is also tested for obstruction. The sewer is laid manually and there are chances for some materials are left inside or there may be blockage. We have to check for the same before we seal the entire trench. For this purpose, we can roll a disc or a solid cylinder of 75-millimeter diameter, less than the diameter of the sewer. If it passes on easily from one section to another, one manhole to another, then it shows there is no obstruction.

(Refer Slide Time: 16:15)

**Utility corridors and ducts**

- Provision of utilities along ROW is a challenge considering space required for pedestrians and bicycle tracks.
- In absence of available and restricted space load bearing concrete utility ducts can be provided below carriageway.
- Soil acts as a barrier among various utilities in open utility corridor.

**Ministry of Road Transport and Highways (MoRTH) :**  
Policy guidelines for accommodation of Public and Industrial utility services along and across NHs, 2016.

- Two meter wide strip of land (edge of RoW).
- Utility ducts (600 mm diameter pipe across the Project Highways)
- 2 mt wide utility duct has also been provided in some stretches of highways  
(Delhi Meerut Expressway: 2mt wide utility duct, Delhi Meerut Expressway: 6 X 50 mm pipes on either side).

**Cost:**  
2-mtr wide Utility Duct (non-load bearing): Rs. 2.5 crore per running km.  
Load-bearing duct (Depth/height:2.5 mtrs and Width:4 mtrs): Rs. 10.00 crore per running km.  
Cost recovery: Lease rentals by utility providers.

[Source: <https://www.unescap.org/sites/default/files/Presentation%20by%20Ministry%20of%20Road%20Transport%20%26%20Highways%20%20India.pdf>, [https://morth.nic.in/sites/default/files/circulars\\_document/JUS-2012.07.26-UNDER%20GROUND%20UTILITIES%20SERVICE.pdf](https://morth.nic.in/sites/default/files/circulars_document/JUS-2012.07.26-UNDER%20GROUND%20UTILITIES%20SERVICE.pdf)]

## Utility corridors and ducts

Utilities include, water supply, storm water, sewer lines, television lines and power lines. So, there has to be space reserved along the ROW for laying this utility networks but finding space is a challenge. In that case, we may think of some other way of laying these utility lines.

The normal method is whatever space is available at the side of the roads, that part is left open and we can lay the lines at certain distances at certain depths in that particular zone. But if the space is not adequate, then the alternative is to go for utility corridors or ducts.

So, in the absence of available and restricted space, load bearing concrete utility ducts can be provided below carriageways, and soil which acts as a barrier among the various utilities in open utility corridors.

But in case where we are doing a duct, we have to make sure that some amount of segregation is there in the pipeline which we have to create artificially. The ministry of road transport and highways in India have given certain policy guidelines for accommodation of public and industrial utility services along the national highways. It states that 2-meter-wide strip of land has to be reserved at the edge of the right of way, so that we can lay utility lines.



Utility ducts could be also provided, using 600-millimeter diameter pipe across the project highways.

For example, in Delhi-Meerut express way, 2 meter wide utility duct has been laid. It also involves six 50-millimeter-diameter pipes on either sides of that utility duct.

So, let us look at the cost of these ducts and utility corridors. A 2 meter wide, non-load bearing utility duct costs around rupees 2.4 crores per running kilometer. Whereas, load bearing ducts, depth and height around 2 to 2.5 meters and width 4 meters comes to around 10 crores per running kilometer.

Some ways to recover the cost is by lease rentals by the utility provider. So, if the lines are for a 30-year periods, at the end of the day some amount of rental has to be paid per month by the utility provider.

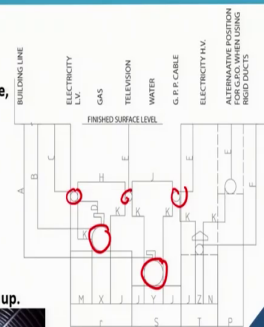
So, these are expensive infrastructure. However, sometimes these are essential, and some sewer lines has to cross other utilities such as electricity, water line, gas line, pipes, telecommunication cables etc. and for that we need to maintain some amount of segregation.

(Refer Slide Time: 20:20)


**Sewer layout and installation**

**Cross drainage:**  
Sewer line has to cross other utilities such as electricity, water line, gas pipes, telecommunication cable etc.


- Sewer lines above electric power cables and horizontal clearance of 30 cm.
- Sewer lines always below water line.
- Sewer lines above gas lines to ensure sewer gases doesn't accidentally trigger ignition of the gas line.
- Lateral separation of 30 cm with telecommunication cables.
- In case of river or stream crossing pumping station may be set up.




**English Trench Design**  
(Source: FHWA/TX-03/4149-1, 2002)



Steam Tunnel with Utilities



Utilidor: Heated tunnel housing all utilities in cold areas.



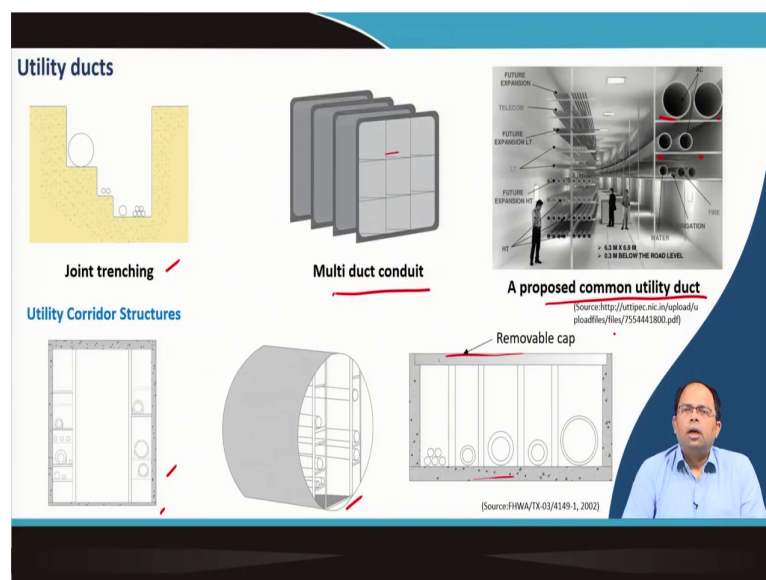
## Sewer layout and installation

Whenever multiple utilities are laid together, sewer lines are kept above electrical power cables and horizontal clearance of 30 centimeter is maintained. The sewer lines should always be above the water line, and then sewer lines are above gas lines to ensure sewer gases does not accidentally trigger ignition of the gas line. Lateral separation of 30 centimeter with telecommunication cables needs to be provided. In the case of a river or stream crossing, pumping station may also be required to be set up.

In an English trench design different kind of utility ducts such television lines, gas lines, electricity lines, water supply lines and other cables are being laid separated by soil at different depths.

These are other examples of underground structures or corridors with utility pipes segregated to a certain extent. And then, there are utilidors which are heated tunnel housing all the utilities in cold areas.

(Refer Slide Time: 22:46)



## Utility ducts

There could be different ways to have this utility corridors or ducts. In joint trenching, the lines are laid at different depths with some amount of segregation so that we can save on cost.

Then, there are utility multi duct conduits through which we have separate channels. A proposed common utility duct has got several lines going through it, with the entire chamber going throughout the road network. Then there are other designs; rectangular design, round circular design, and a box with a removable cap which could be removed for maintenances.

So, these are designs of utility corridors or utility ducts which could be also designed for urban areas.

(Refer Slide Time: 24:02)

**Conclusion**

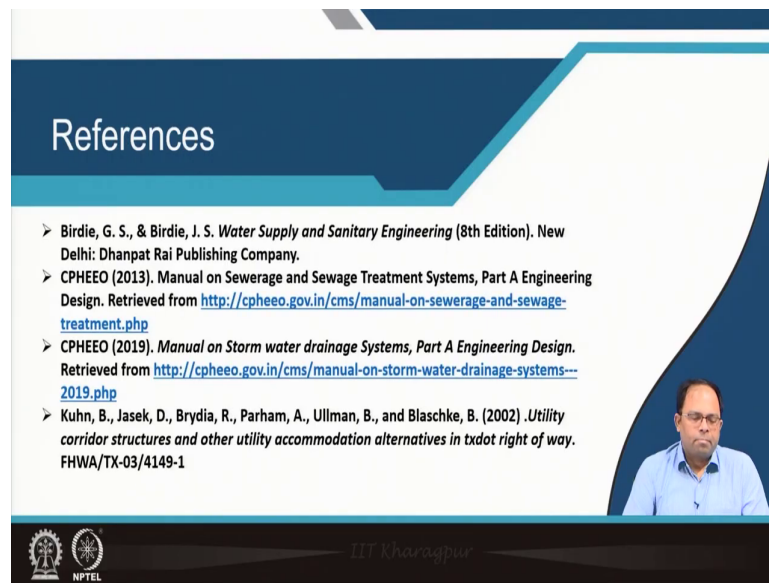
- Sewers need to be tested for water tightness and obstruction after their laying and initial installation.
- Load bearing concrete utility ducts can be provided below carriageway in absence of space along ROW.

IIT Kharagpur  
NPTEL

### **Conclusion**

So, to conclude sewers need to be tested for water tightness and obstruction after their laying and initial installation. Load bearing concrete utility ducts can be provided below carriage ways in absence of space along ROW.

(Refer Slide Time: 24:18)



## References

- Birdie, G. S., & Birdie, J. S. *Water Supply and Sanitary Engineering* (8th Edition). New Delhi: Dhanpat Rai Publishing Company.
- CPHEEO (2013). *Manual on Sewerage and Sewage Treatment Systems, Part A Engineering Design*. Retrieved from <http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php>
- CPHEEO (2019). *Manual on Storm water drainage Systems, Part A Engineering Design*. Retrieved from <http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems--2019.php>
- Kuhn, B., Jasek, D., Brydia, R., Parham, A., Ullman, B., and Blaschke, B. (2002). *Utility corridor structures and other utility accommodation alternatives in txdot right of way*. FHWA/TX-03/4149-1

IIT Kharagpur

NPTEL

So, these are some of the references that we can use. Thank you.