Rock Mechanics and Tunneling
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Lecture 47
Shapes and Usages

Hello everyone. I welcome all of you to the first lecture of module 10. So, in module 10, we will discuss about the basic features of tunneling and today we will discuss about the shapes and usages of tunnels.

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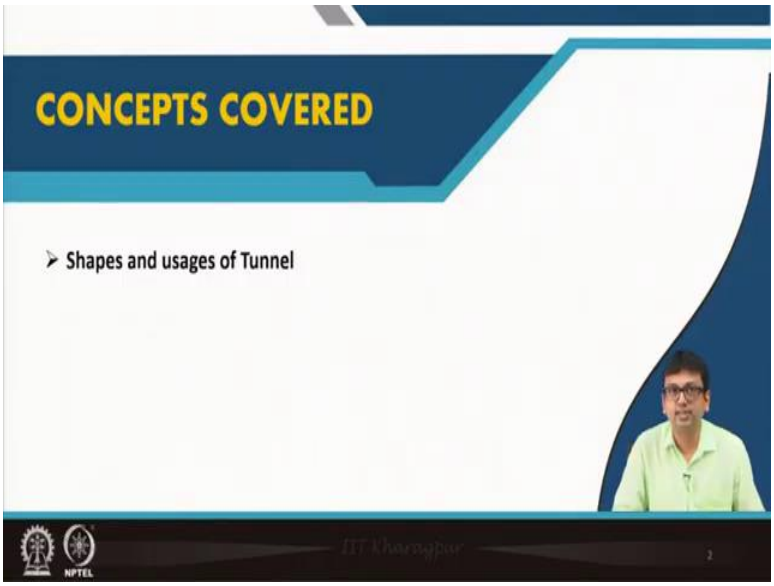

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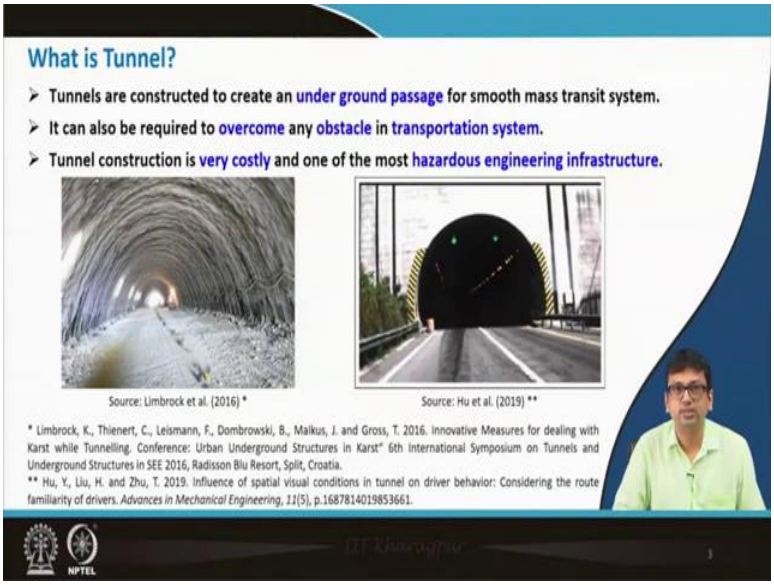

What is tunnel?

So, we must probably have seen tunnels, may be different road tunnels or rail tunnels during travelling.

- Tunnels are constructed to create an underground passage for smooth mass transit system.
- It can also be required to overcome any obstacle in transportation system, so for that also we construct tunnel.
- Tunnel construction is very costly and one of the most hazardous engineering infrastructure.

    There are lots of uncertainties actually involved with tunneling. It is a challenging area for the mainly for the civil engineers, who construct these tunnels. Obviously, mining engineers also they construct mine tunnels.

It needs to be remember that it is a costly thing to construct. So, we should learn how to design these tunnels or what are the practical problems you may encounter? So, We will discuss all those things in this module.

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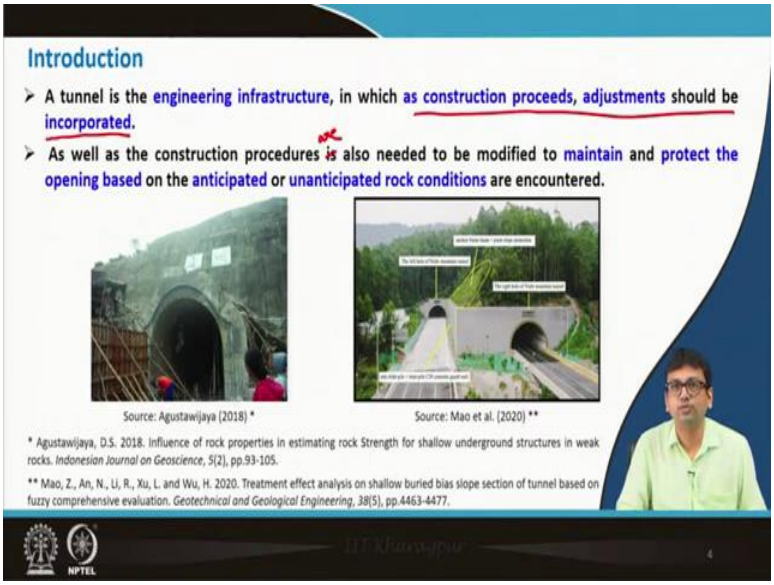

Introduction

A tunnel is the engineering infrastructure in which as construction proceeds adjustment should be incorporated. So, there are lots of uncertainties for tunneling in rock mass. Tunneling can be done in soil also. It is known that rock is highly heterogeneous.

So, lot of uncertainties are present there, there may be some discontinuity planes are present in the path of the tunnel construction. So, the tunnel is the engineering infrastructure in which as construction proceeds adjustment should be incorporated. Therefore, decisions are taken immediately depending on the situation. So, adjustment should be incorporated.

As well as the construction procedures are also needed to be modified to maintain and protect the opening based on the anticipated or unanticipated rock conditions are encountered. So, depending on the situation and type of rock, the construction procedures are also needed to be modified. From pictorial representation, it can be seen that the tunnel construction is going on.

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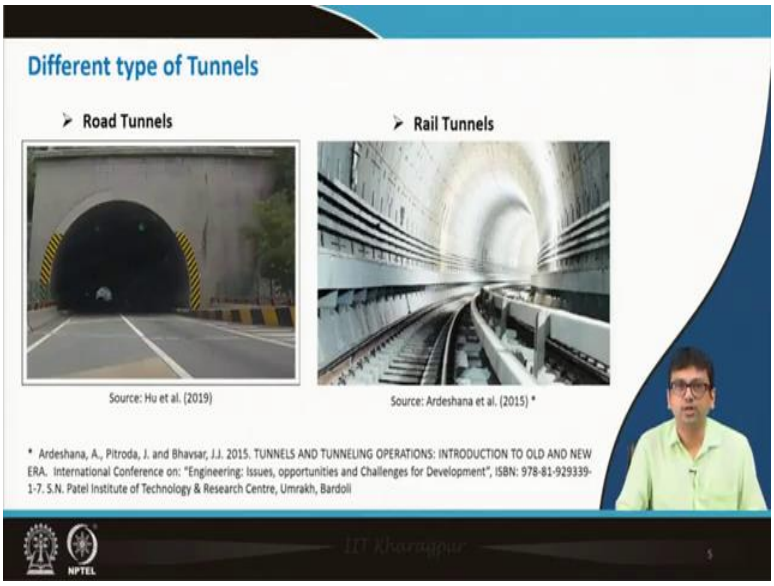

There are different types of tunnels;

- Road tunnels
- Rail tunnels

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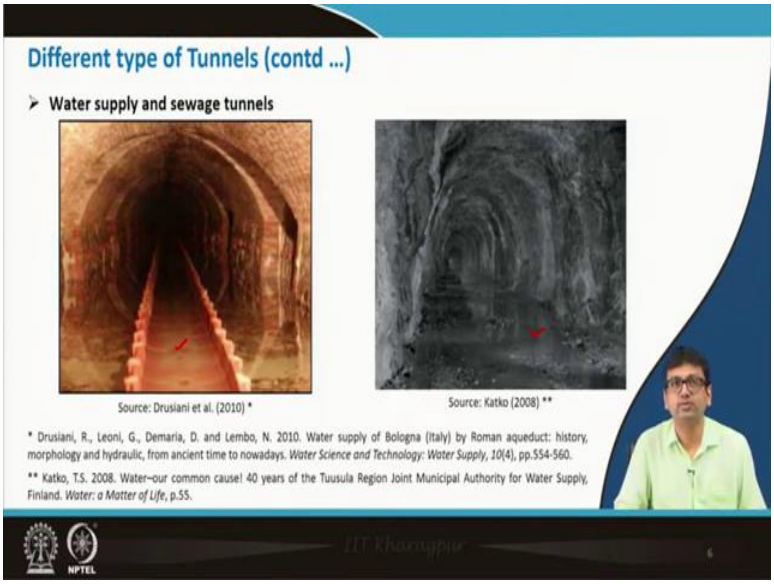

- Water supply and sewage tunnels

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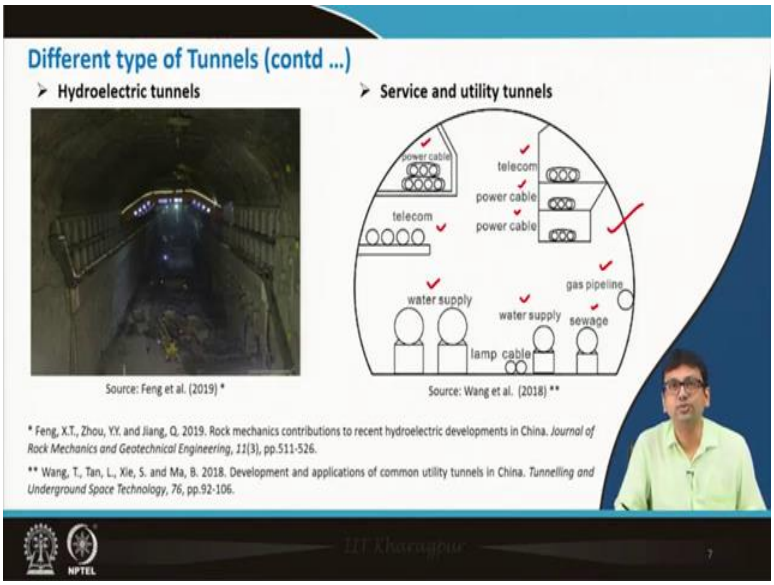

- Hydroelectric tunnels

  -Hydroelectric power projects may be there also you we construct tunnels.

- Service and utility tunnels; so service and utility tunnels;

  -It contains power cables, telecom cables, water supply, sewage, gas pipeline.

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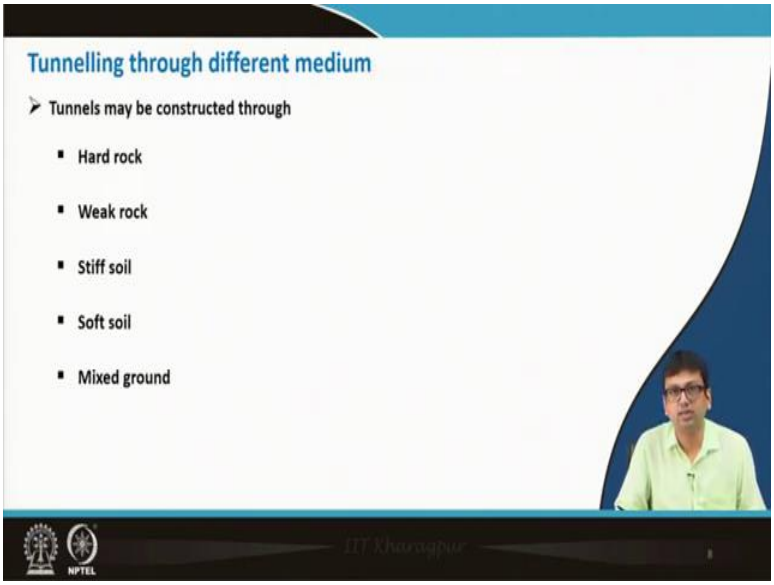

Tunneling through different medium

Tunnels may be constructed through hard rock, it may be through weak rock, it may be through stiff soil, it may be through soft soil or mixed ground. May be for some a tunnel may be some portion in hard rock, some portion may be in soft soil, some portion may be in may be the weak rock so likewise.

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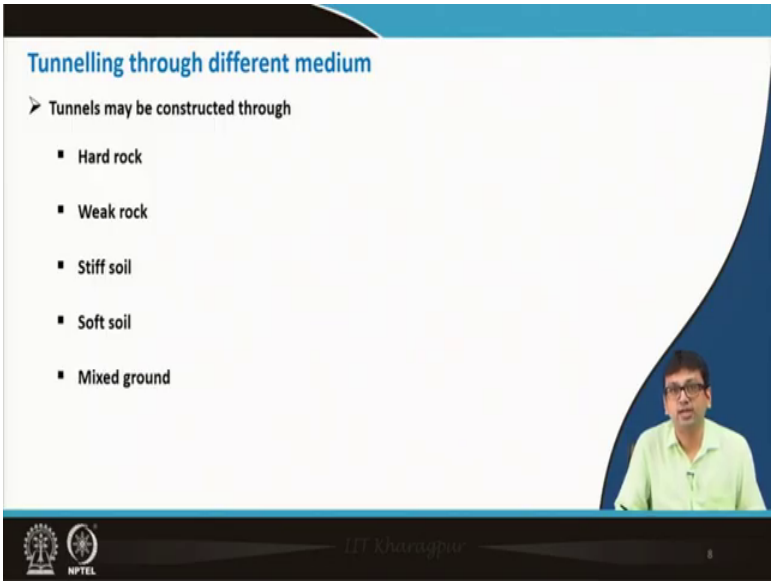

Difference between tunnels in rock versus tunnels located in soils.

So, there is obviously some added advantage of constructing a tunnel in rock and if especially if that is a good hard rock if that rock is then it becomes very much advantageous.

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Figure shows the tunnel in rock and the tunnel in soil. Clearly, the rock surface can be seen. Whereas, in case of soil, some concrete liner is provided because soil will not be able to stay there means in its own, it may fall.

So, the overall tunnel may be stable because of different arching action and all different thing. We are not going to the analysis part now, you know next module we will discuss about those things. It can clearly understand that rock tunnel can be kept as it is, the surface is exposed. On the other hand, concrete liners need to put in case of soil, so the tunnel should be properly protected.

So, this is one of the advantage of constructing a tunnel in rock especially if it is in hard rock.

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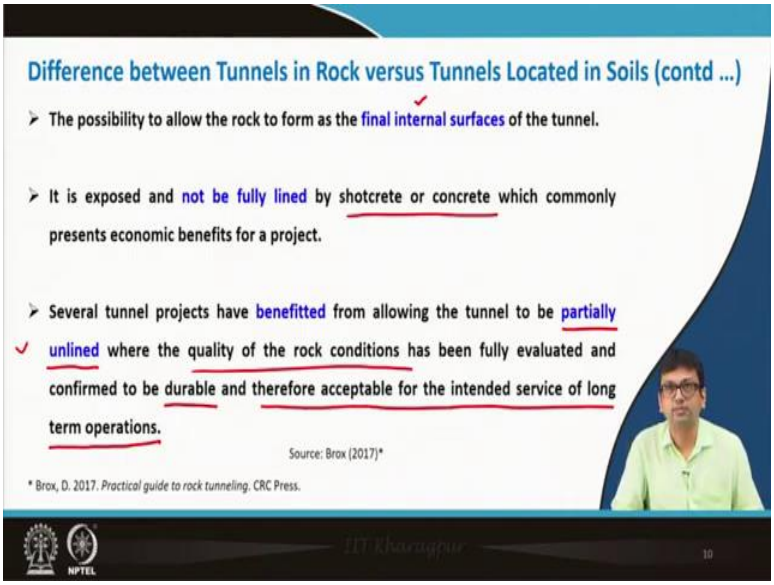

The possibility to allow the rock to form as the final internal surface of the tunnel; whereas, in soil, some liners are provided. Generally, concrete liner or shotcreting is applied. We will discuss about these terms later obviously.

It is exposed and not be fully lined by shotcrete or concrete. Therefore, it commonly presents economic benefits for a project. So, obviously no need to put extra layer of concrete liner or shotcreting. So, obviously that will reduce the cost of the project.

Several tunnel projects have benefited from allowing the tunnel to be partially lined where the quality of the rock conditions has been fully evaluated and confirmed to be durable and therefore acceptable for the intended service of long term operations.

So, in this way obviously tunnels in rock can be advantageous.

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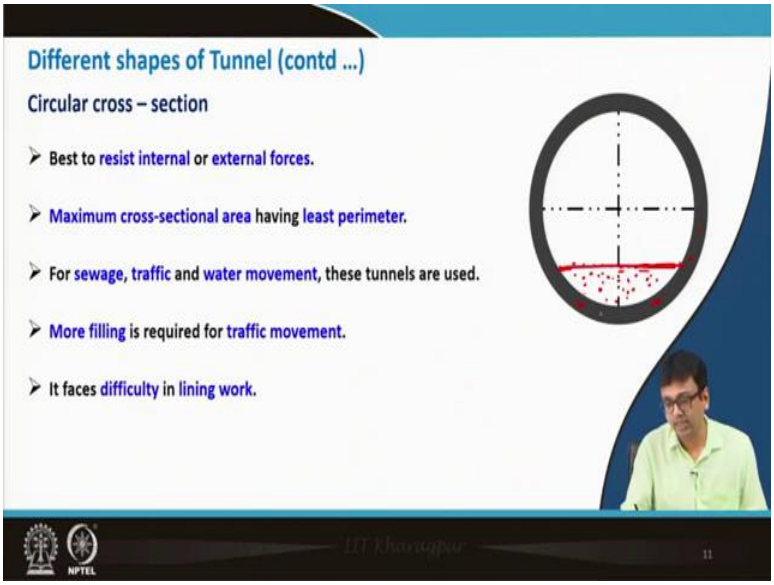

Different shapes of tunnel

- Circular cross section,
    - Very common
    - Best to resist internal and external forces because of its shape
    - The maximum cross sectional area having least perimeter. So, that is also one way advantages.
    - For sewage, traffic, and water movement, these tunnels are used.
    - More filling is required for traffic movement. If you want to make it for traffic movement purpose, by using some filling material, we have to make it like the horizontal surface. So, more filling is required over here.
    - It faces difficulty in lining work, so obviously it is circular and you need to put lining. If it is in hard rock, then still okay as you know if we can keep that as it is but for standard circular soil tunnel, we need to put the liner, then it may become little bit difficult but it is quite popular still.

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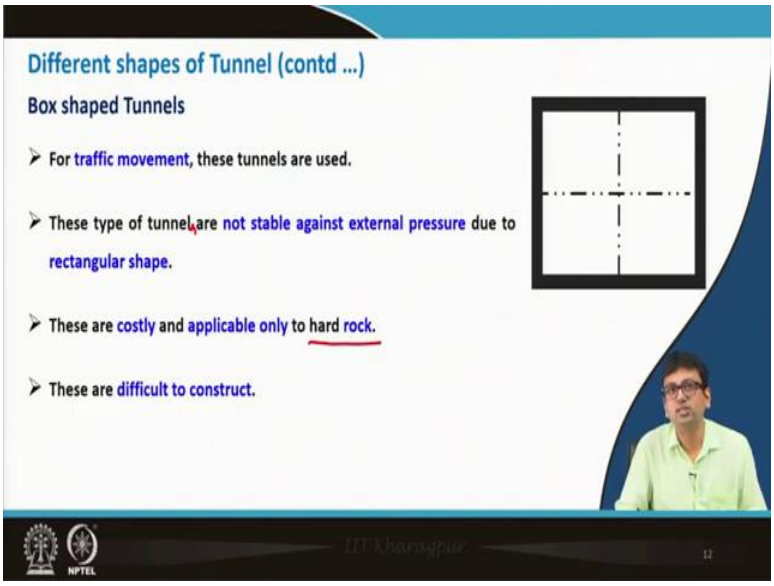

- Box shaped tunnel
    - For traffic movement these tunnels are used.
    - These type of tunnels are not stable against external pressure due to rectangular shape.
    - These are costly and applicable only to hard rock that is one of the important thing.
    - These are difficult to construct.

Obviously making this perfect shape is not an easy job because later we learn how we will go for this tunnel construction. There will see what types of machines or equipment are used. There you will optimally understand that constructing this box tunnel is definitely difficult.

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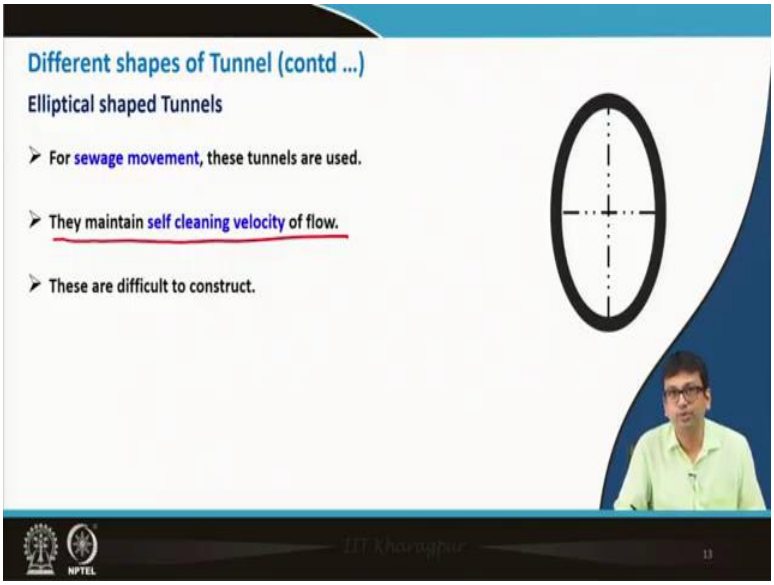

- Elliptical shaped tunnels
    - For sewage movement, these tunnels are used.
    - They mainly self-cleaning, means these tunnels actually maintain actually self-cleaning velocity of flow because of its shape. It is one of the advantageous over other tunnels.
    - These are difficult to construct

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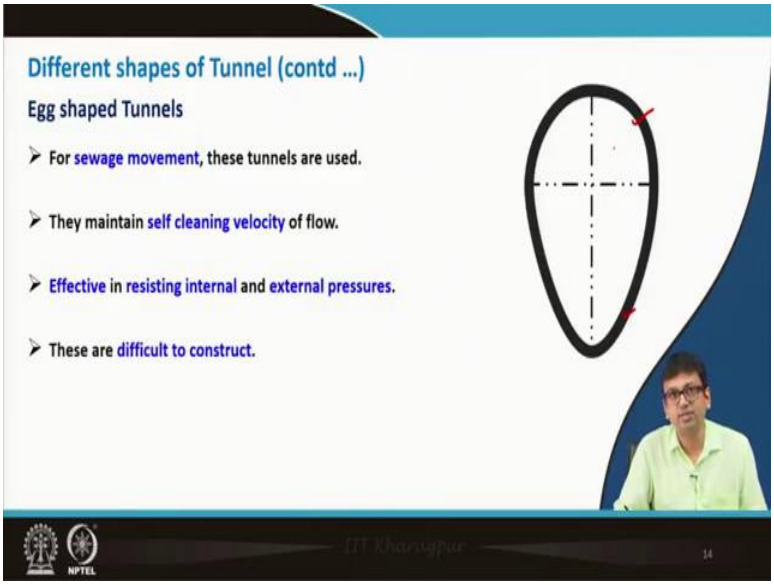

- Egg shaped tunnel
  - It is even more difficult to construct, because of the shape which looks like an egg.
  - So, for sewage movement these tunnels are used.
  - They maintain self-cleaning velocity of flow like elliptical tunnels and effective in resisting internal and external pressure.

So, this is one of the good things. The upper part is almost circular. So, this is effective in resisting internal and external pressure.

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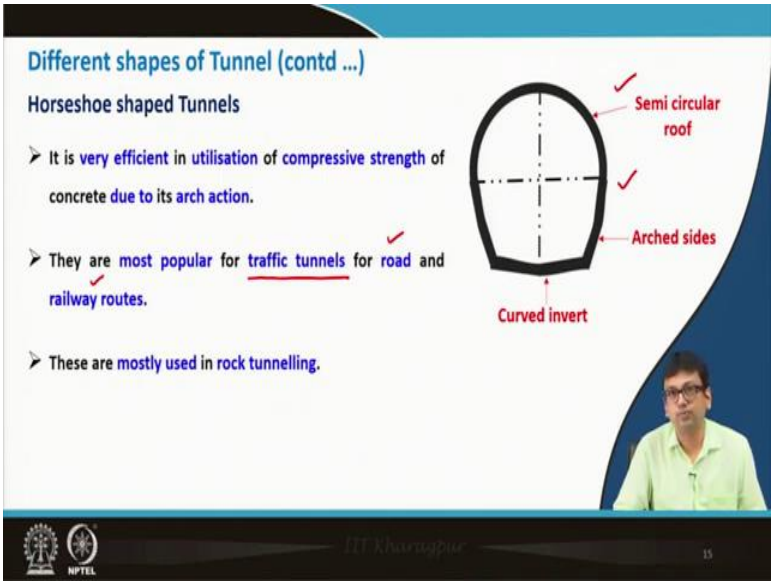

- Horseshoe shaped tunnels
  - The upper part is semi-circular roof, then it has arched sides and lower part is curved invert, these are the different components.
  - It is very efficient in utilization of compressive strength of concrete due to its arch action.
  - They are most popular for traffic tunnels, for road and railway routes.
  - These are mostly used in rock tunneling, so that is another additional information.

So, we have understood there are different shapes like circular, box, then elliptical, egg shaped, horseshoe and different tunnels have different utilities, and we have seen horseshoe tunnel is very much used in for traffic purpose and it is generally construct, it is mainly constructed in hard means in rocks mean, primarily hard rocks.

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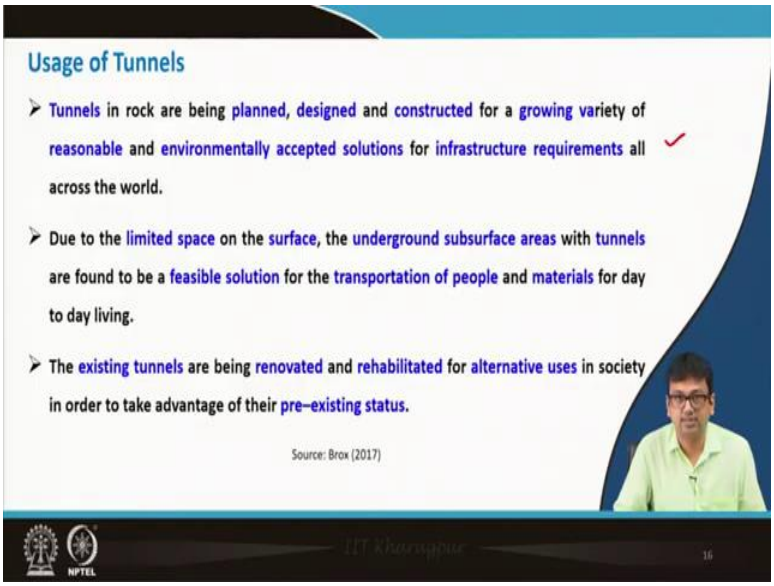

Usage of tunnels

- Tunnels in rock are being planned, designed, and constructed for a growing variety of reasonable and environmentally acceptable solutions for infrastructure requirements all across the world.
- Due to the limited space on the surface, the underground sub-surface areas with tunnels are found to be a feasible solution for the transportation of people and materials for day to day living. Nowadays like metro rail, so underground metros are very useful for transporting people from here to there because of the scarcity of ground.
- The existing tunnels are being renovated and rehabilitated for alternative uses in society in order to take advantage of their pre-existing status. So, I will show you one nice picture also for that.

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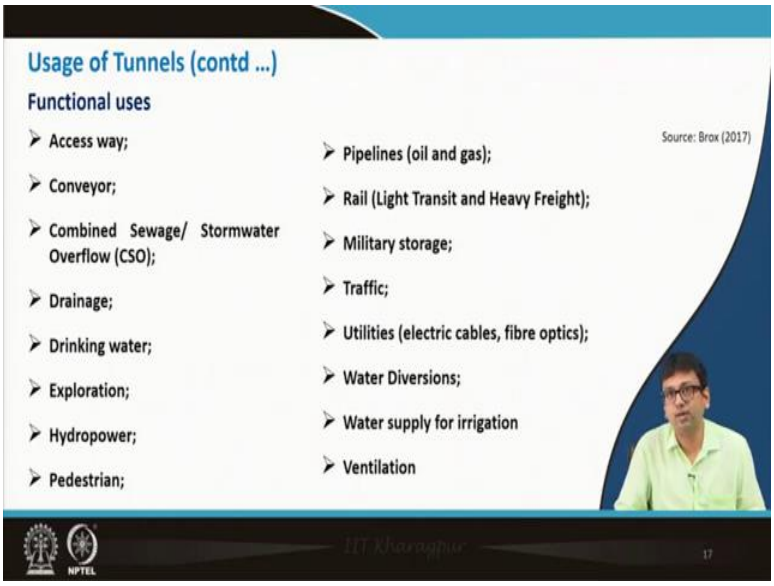

Functional uses

- Access way,
- Conveyor;
- Combine sewage or storm water overflow
- Drainage purpose tunnels
- Drinking water transportation for that also, then exploration for that also. Hydropower project there also we construct tunnels.
- Pedestrian tunnels
- Pipelines, oil, and gas, natural gas transportation tunnels
- Rail tunnels, light transit and heavy freight
- Military storage purpose
- Traffic (means road traffic, electrical cable, fiber optics)
- Water diversions
- Water supply for irrigation
- Ventilation (mining operation)

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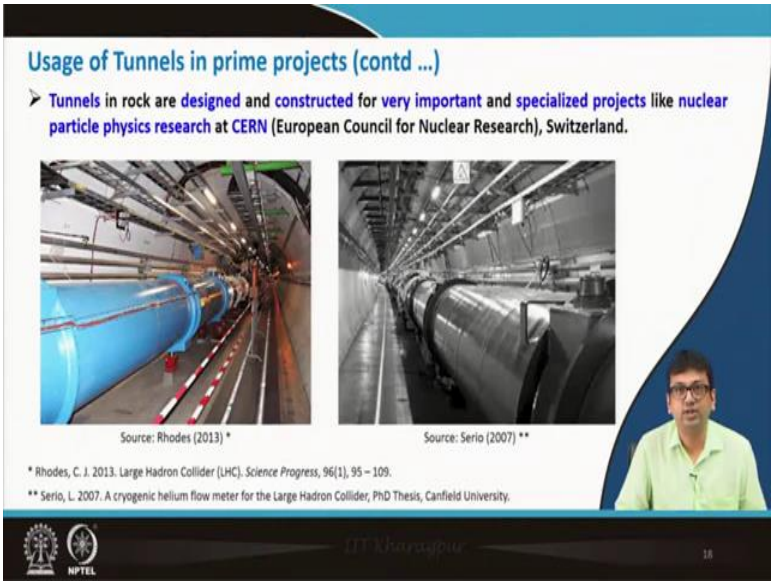

Usage of tunnels in prime projects

- Tunnels in rock are designed and constructed for very important and specialized projects like nuclear particle, physics research at CERN, C E R N European Council for Nuclear Research, Switzerland, as shown in picture.

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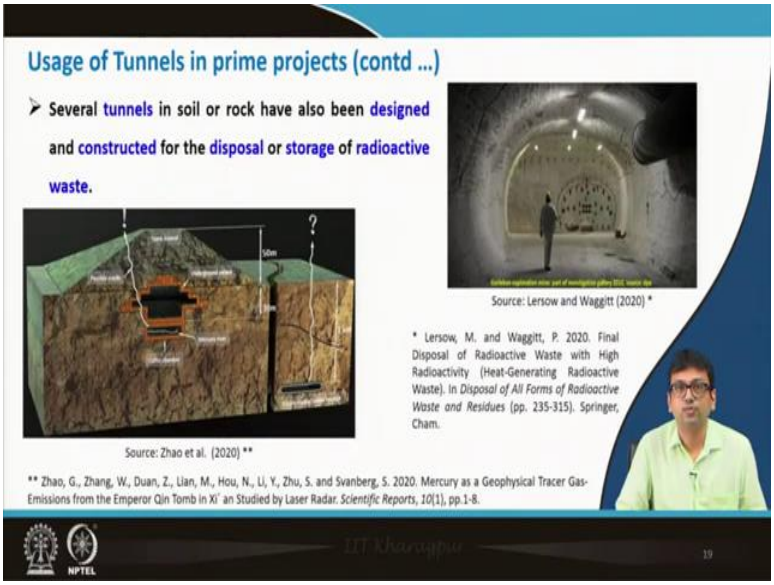

- Several tunnels in soil or rock have also been designed and constructed for disposal or storage of radioactive wastes.

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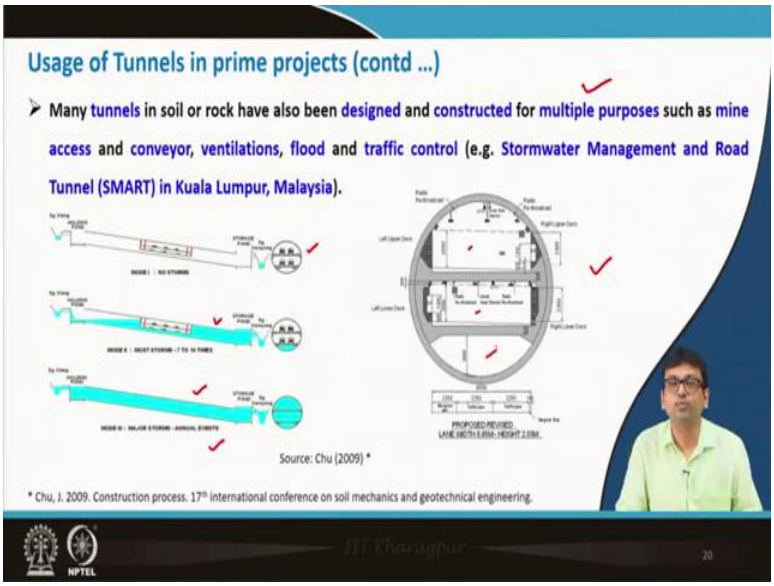

- Now a days many tunnels in soil or rock have also been designed and constructed for multi-purposes such as mine access and conveyor, ventilation flood and traffic control. For example, like storm water management and road tunnel in Kuala Lumpur, Malaysia. From figure, it can be seen that it is an actually multi-purpose tunnel.

Depending on the requirement, the same tunnel can be used for multi-purpose operation, so this is a nice project which was means executed in Kuala Lumpur, Malaysia.

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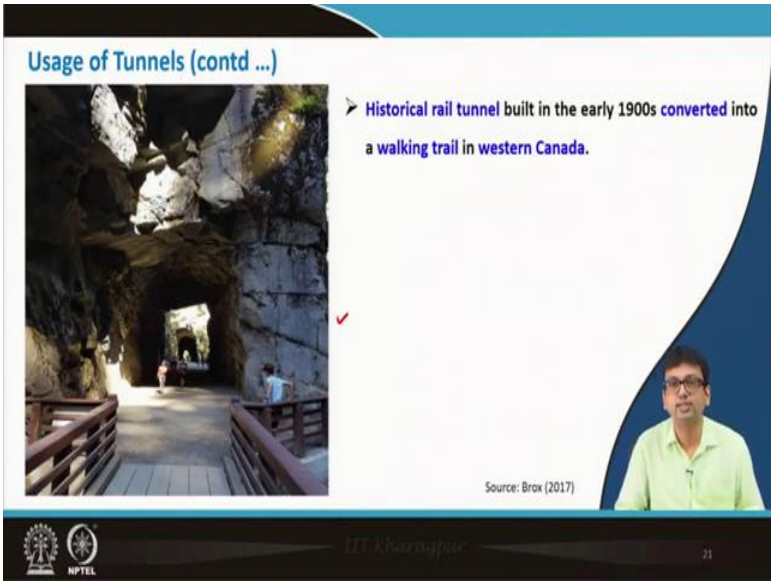

In addition, historical rail tunnel built in early suppose 90s converted into walking trail in Western Canada. Therefore, likewise, the tunnels can be used for different purposes and we have learnt about the different shapes of the tunnels.

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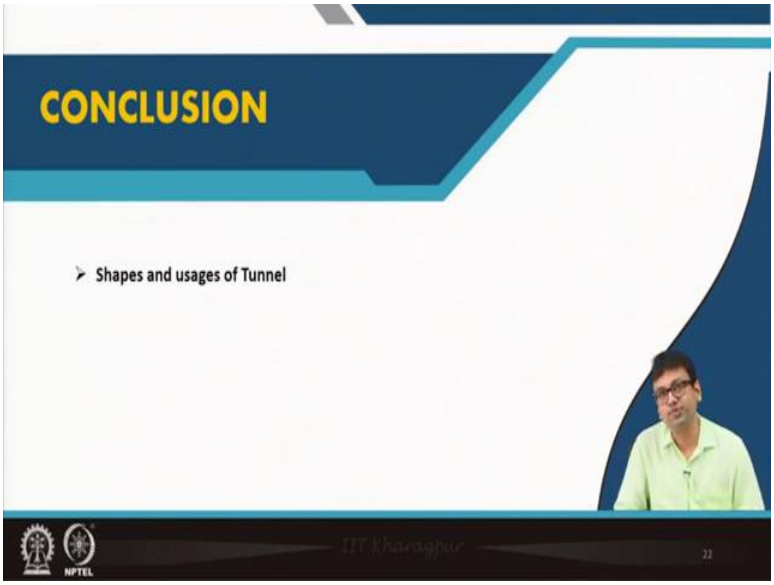

And with this let us conclude our todays lecture. Thank you.