The Development of Tunneling Technology in Myanmar and Future Prospects

Thaung Sein, Engineering Geologist

Contents

Vision:

- To become the underlying "operating system" for the intelligent application of traditional physical infrastructure,
- to help the digital and intelligent transformation of infrastructure, and
- to promote the evolution and integration of traditional physical infrastructure into digital infrastructure.

➢ 01 Development of Tunneling Technology in Myanmar

What is a tunnel?

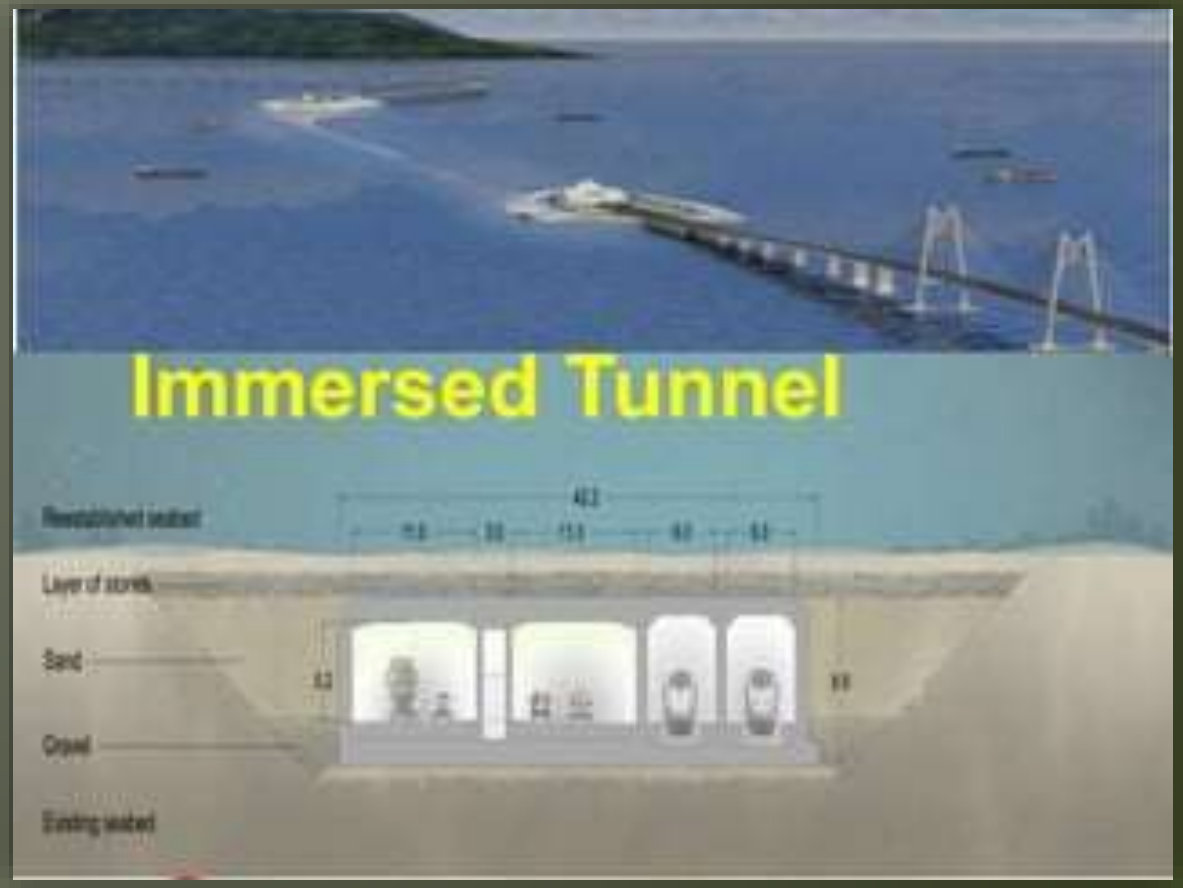
A **tunnel** is an underground or undersea passageway.

It is dug through surrounding soil, earth or rock, or laid under water.

There are three basic types of tunnel construction in common use.

- Cut-and-cover tunnels are constructed in a shallow trench and then covered over.
- Bored tunnels are constructed in situ, without removing the ground above.
- Finally, a tube can be sunk into a body of water, which is called an immersed tunnel.


Cut-and-cover
tunnel


Immersed Tunnel

A bored tunnel being dug by D and B

A bored tunnel being dug by TBM

Chongming Tunnel under the Yangtze River in China.

Many railways tunnels have since been constructed in Myanmar.

Most of them were built before World War II.

The construction of hydropower tunnels was started in 1997.

Some tunnels in Myanmar before World War II

Gokteik

Gokteik

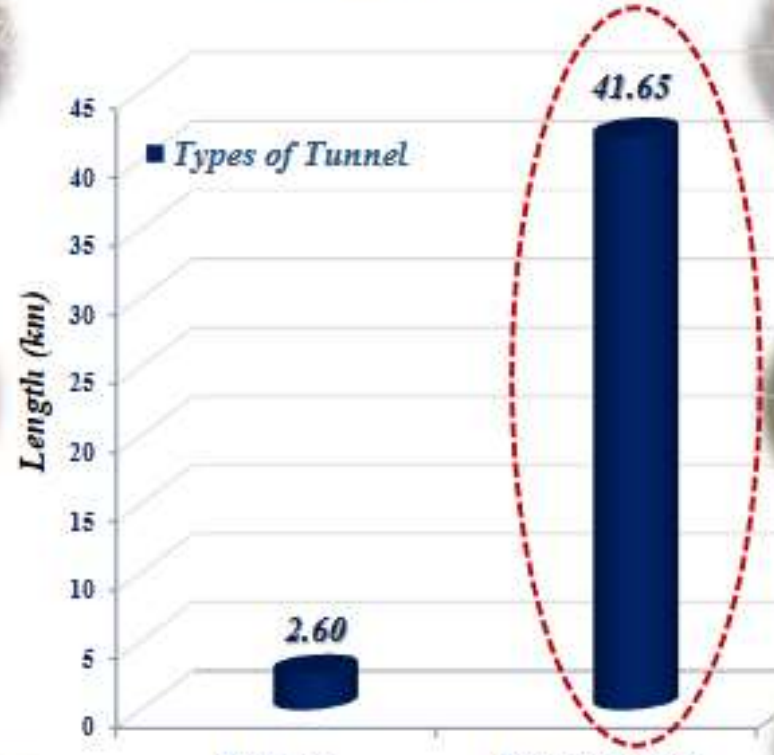
A railway tunnel on the Kalwa to Inle Lake trek, Myanmar

Some tunnels in Myanmar

The main tunnel at the Kyauksaung mine in central Mogok

Myanmar China friendship tunnel in Kachin State

Background of Tunnels Development in Myanmar



Most of railway tunnels are since pre war and hydropower tunnels start from 1997.

Tunnels of hydropower projects

For the hydropower development dam and water hydraulic structures are main components.

In the construction of dam diversion tunnel or conduit is a vital structure.

A waterway structure is essential in the power portion.

The headrace tunnel is major structure from the view points of safety, economic and environmental issue.

Tunnels are generally considered to be one of the greatest sources of cost and schedule risks for the projects.

Some photographic records of Yeywa Hydropower Project

Tunneling practices on hydropower project in Myanmar

- Most hydropower projects include tunneling works.
- In general, hydropower projects comprise power tunnel, diversion tunnel and access tunnel etc.
- Tunnel construction of the projects in the region of hard rocks is simple.
- Tunnel construction in poor geological conditions can face much complicated disturbances leading to collapse.
- Sittaung valley projects gave many lessons for tunneling in Myanmar.

➢ 02 Geotechnical Investigation for Tunneling

Geotechnical Investigation for tunneling
An investigation program

Generally, an investigation program for planning and design of a road tunnel project may include the following components:

- Existing Information Collection and Study
- Surveys and Site Reconnaissance
- Geologic Mapping
- Subsurface Investigations
- Environmental Studies
- Seismicity
- Geospatial Data Management

Geotechnical Investigation for tunneling

Existing Information Collection and Study

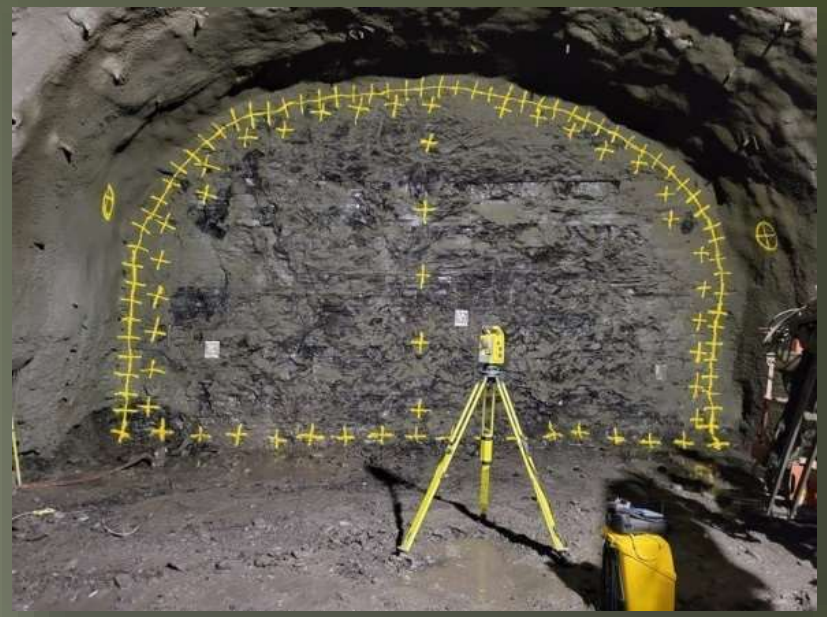
The first phase of an investigation program for a road tunnel project starts with collection and review of available information to develop an overall understanding of the site conditions and constraints at little cost.

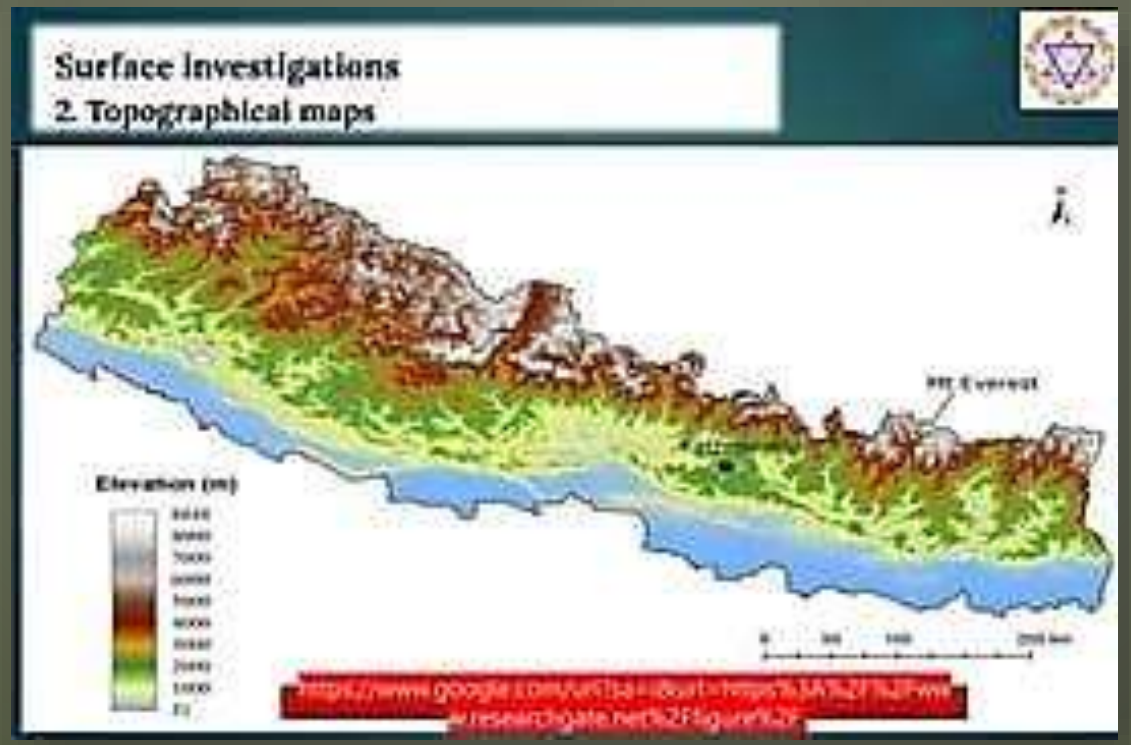
Location of the tunnel area and its satellite image.

Geotechnical Investigation for tunneling

Surveys and Site Reconnaissance

The lower-resolution contour maps are sufficient only for planning purposes. However, a preliminary survey will be needed for concept development and preliminary design to expand existing topographical data and include data from field surveys and an initial site reconnaissance. Initial on-site studies should start with a careful reconnaissance over the tunnel alignment, paying particular attention to the potential portal and shaft locations.




Surface investigations
2. Topographical maps
Elevation (m)

Geotechnical Investigation for tunneling

Geological Mapping

Geologic mapping collects local, detailed geologic data systematically, and is used to characterize and document the condition of rock mass or outcrop for rock mass classification, such as:

- Discontinuity type
- Discontinuity orientation
- Discontinuity infilling
- Discontinuity spacing
- Discontinuity persistence
- Weathering

In addition, the following **surface features** should also be observed and documented during the geologic mapping program:

- Slides, new or old, particularly in proposed portal and shaft areas
- Faults
- Rock weathering
- Sinkholes and karstic terrain
- Groundwater springs
- Volcanic activity
- Anhydrite, gypsum, pyrite, or swelling shales
- Stress relief cracks
- Presence of talus or boulders
- Thermal water (heat) and gas

The mapping data will also help in targeting subsurface investigation borings and in situ testing in areas of observed variability and anomalies.

Geotechnical Investigation for tunneling

Subsurface Investigations

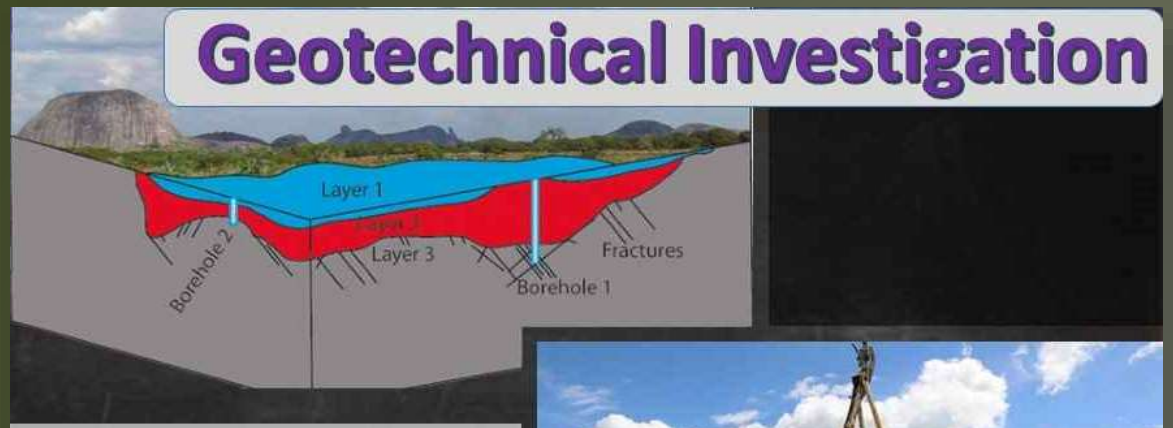
Ground conditions including geological, geotechnical, and hydrological conditions, have a major impact on the planning, design, construction and cost of a road tunnel, and often determine its feasibility and final route.

Fundamentally, subsurface investigation is the most important type of investigations to obtain ground conditions, as it is the principal means for:

- Defining the subsurface profile (i.e. stratigraphy, structure, and principal soil and rock types)
- Determining soil and rock material properties and mass characteristics;
- Identify geological anomalies, fault zones and other hazards (squeezing soils, methane gas, etc.)
- Defining hydrogeological conditions (groundwater levels, aquifers, hydrostatic pressures, etc.); and
- Identifying potential construction risks (boulders, etc.).

Subsurface investigations typically consist of borings, sampling, in situ testing, geophysical investigations and laboratory material testing.

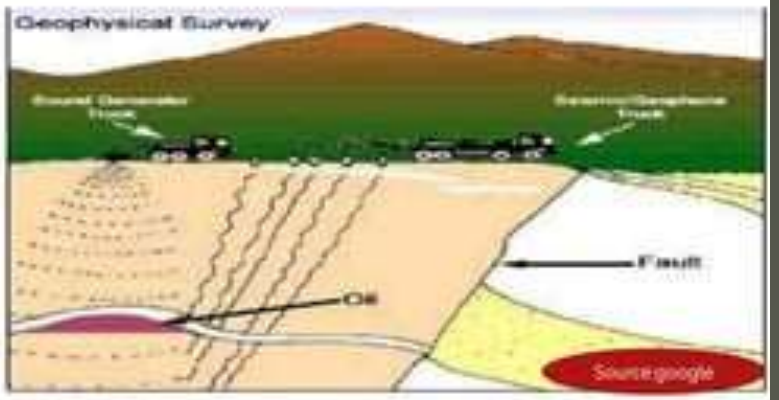
Geotechnical Investigation



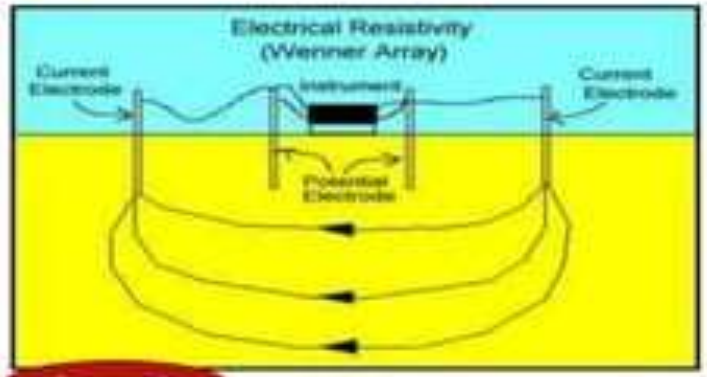
Testing


XCMG

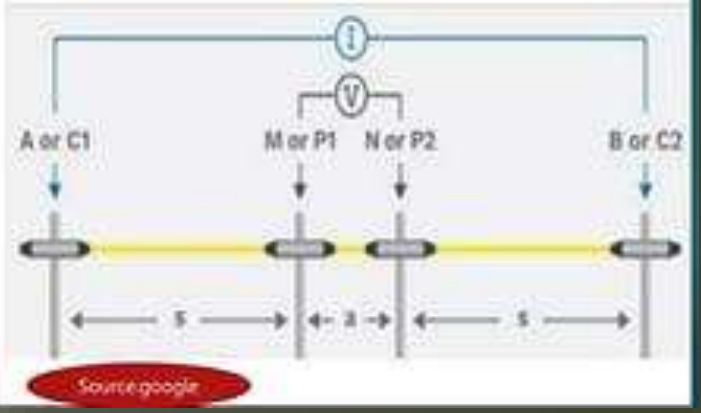
Importance of Geophysical Investigations



Electrical Methods (Wenner's method)



Electrical Methods (Schlumberger method)



Geotechnical Investigation for tunneling

Environmental Issues

Although tunnels are generally considered environmentally-friendly structures, certain short-term environmental impacts during construction are unavoidable. Long-term impacts from the tunnel itself, and from portals, vent shafts and approaches on local communities, historic sites, wetlands, and other aesthetically, environmentally, and ecologically sensitive areas must be identified and investigated thoroughly during the project planning and feasibility stages, and appropriately addressed in environmental studies and design.

"Having a full record of all the data gives us security. If we get complaints from residents we have the data to show exactly what happened. For example, it may show that the noise was only for a short period, or not a site issue."

Henry McKee, Site Engineer, McConell Dowell

Geotechnical Investigation for tunneling

Seismicity

The release of energy from earthquakes sends seismic acceleration waves traveling through the ground. The factors that can affect the response of the ground during earthquakes.

- Distance of the seismic source from the project site.
- Magnitude of the seismic accelerations.
- Earthquake duration.
- Subsurface profile.
- Dynamic characteristics and strengths of the materials affected.

Geotechnical Investigation for tunneling

Role of Geology (Conclusion)

Geology plays a very important role in this. Any adverse and unforeseen geological conditions may influence the safety of tunnels, loss of life, construction time and costs. When a tunnel or shaft is excavated, the rock stresses are perturbed around the opening and displacements will occur. Important aspects which needs to be considered are related to the construction works, geology, environment and operation.

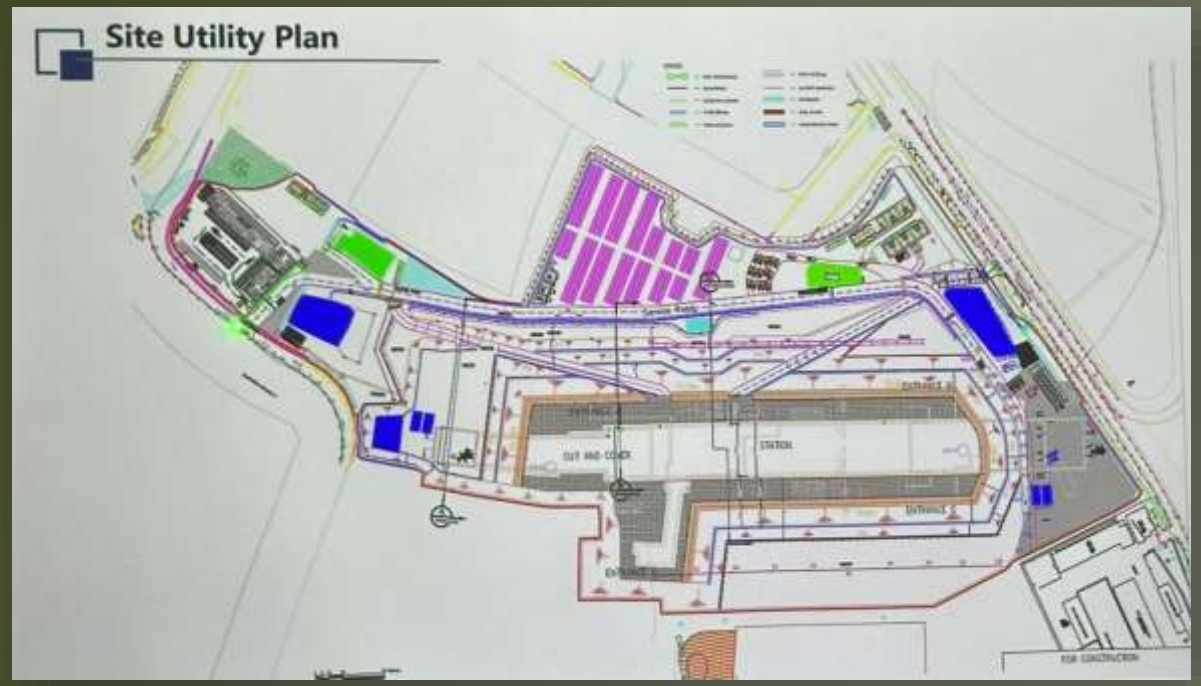
➢ 03 Design and Construction Of A Tunnel

Design Methodology for a Tunnel

The actual task of a tunnel design which includes the following steps.

- Careful evaluation of site data and laboratory data.
- Rock mass classification based on borehole logs and scan-line survey data.
- Geological map, borehole logs, in-situ test are carefully studied for this purpose.
- Design parameters are finalized.
- A preliminary excavation and support design are prepared.
- Construction methodology is finalized.
- The design is then carefully evaluated from multiple dimensions.
- The support design is then optimized with numerical analysis/computer applications
- Lining design is prepared by civil engineers.
- Cost analysis is carried out.
- Finally, the tunnel drawing is ready for the execution phase.

Site Utility Plan



1. Project Overview

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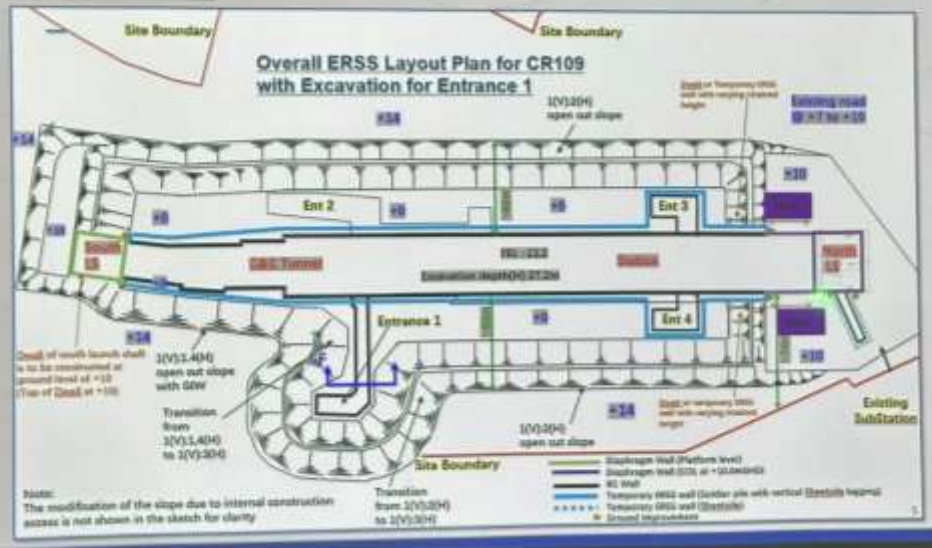
ERSS Design Scheme



Methods of Tunnel Construction

There are various types of construction techniques developed for construction of tunnels. Some of them are:

- Cut and Cover Method
- Boring Method
- Drill and Blast Method
- Pipe Jacking Method
- Box Jacking Method
- Shaft Method

Cut and Cover Method of Tunnel Construction

Cut and cover method of tunnel construction is generally used to build shallow tunnels. In this method, a trench is cut in the soil and it is covered by some support which can be capable of bearing load on it.

Bored Tunnel Method

Bored tunnel method is modern technology. In this case, tunnel boring machines are used which automatically work and makes the entire tunneling process easier. It is also quicker process and good method to build tunnel in high traffic areas. Tunnels boring machines (TBM's) are available in different types suitable for different ground conditions.

Drill and Blast Method

In this method holes are drilled in rocks and explosives are loaded. Blasting is carried out by triggering the detonator which is connected to the explosives, and then the rock particles are carried out from the tunnel.

Pipe Jacking Method

Pipe jacking method is used to construct tunnels under existing structures like road ways, railways etc. In this method, specially made pipes are driven into underground using hydraulic jacks. Maximum size of 3.2-meter diameter is allowed for tunnels.

Box Jacking Method

Box jacking method is similar to pipe jacking, but in this case instead of pipes, specially made boxes are driven into the soil. A cutting head is provided at the front side of the box. Excavated matter is collected within the box. Larger size tunnels can be excavated using box jacks up to 20 meters.

Shaft Method

In this method tunnel is constructed at greater depth from the ground surface. The shaft is built up to the depth where tunnel is required. Shaft is a permanent structure which is like well with concrete walls. At required depth, tunnels are excavated using TBM's. Shafts are provided at both inlet and outlet of tunnels. Intermediate shafts are also provided if tunnel is too long.

➢ 04 Future Prospects

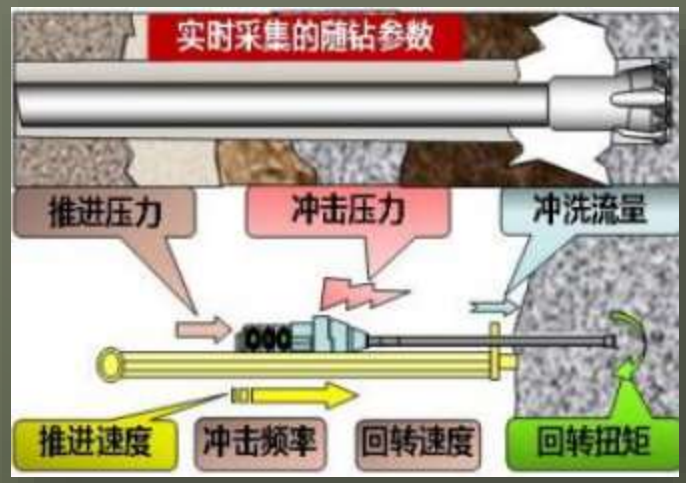
Infrastructure Smart Service System (iS3)

iS3 is an integrated intelligent decision system for data acquisition, transmission, processing, representation, analysis, and service in the whole life cycle of infrastructures.

D&B Data Acquisition

Tunnel axis measurement using electronic distance measuring device

Rock mechanical information gathering by drilling

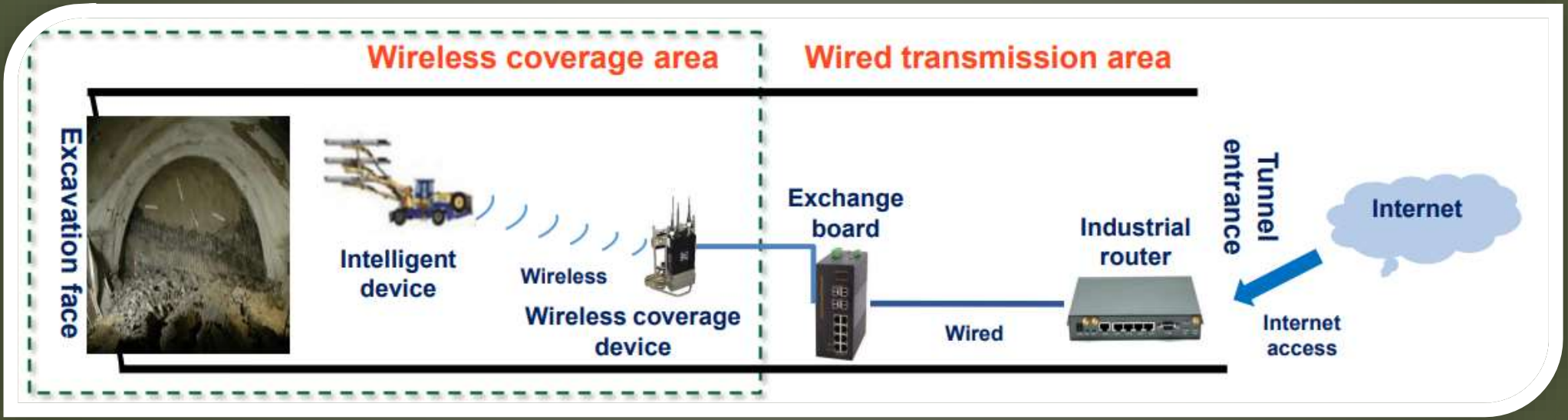


On-site testing of geo-stress and dynamic rebound

Rock mass geometric information gathering by multi-camera photogrammetry

Data Transmission

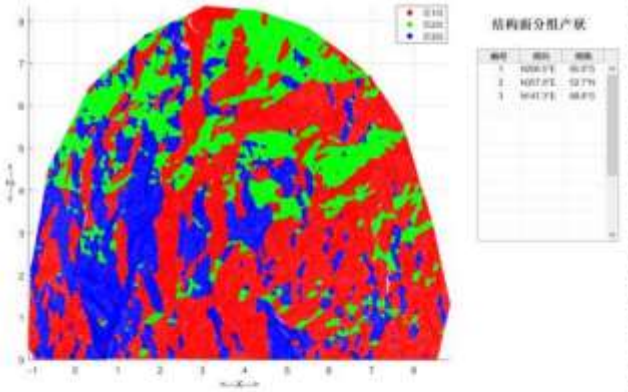
The focus of industrial network construction in tunnel sites is to achieve stable network transmission in harsh environments. The combination of wired transmission and wireless coverage is adopted.



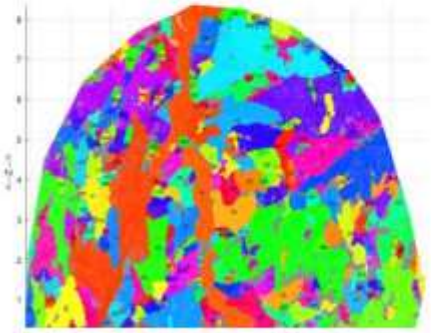
D&B Data Processing

Gathering rock mass 3D discontinuity information

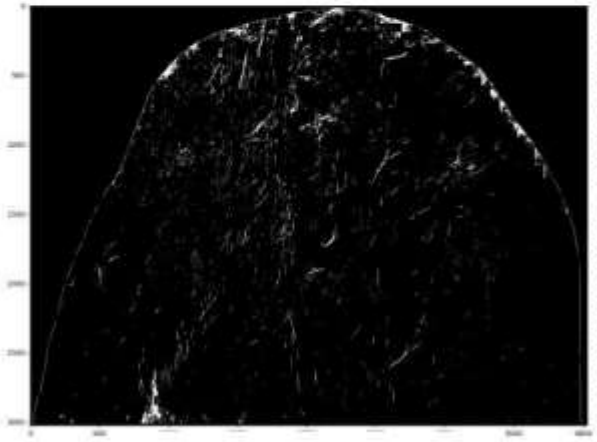
Reconstructed 3D point cloud



Discontinuity grouping

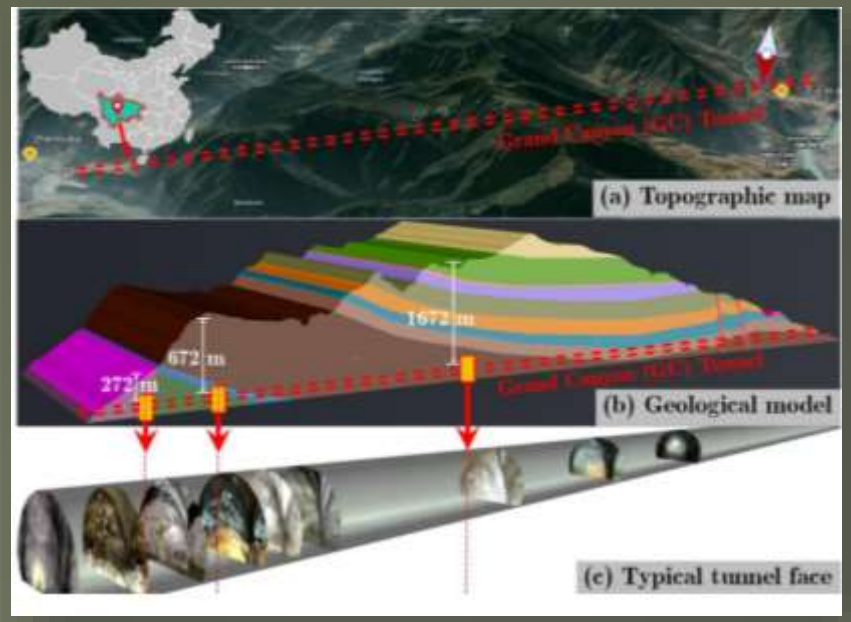


Independent discontinuity

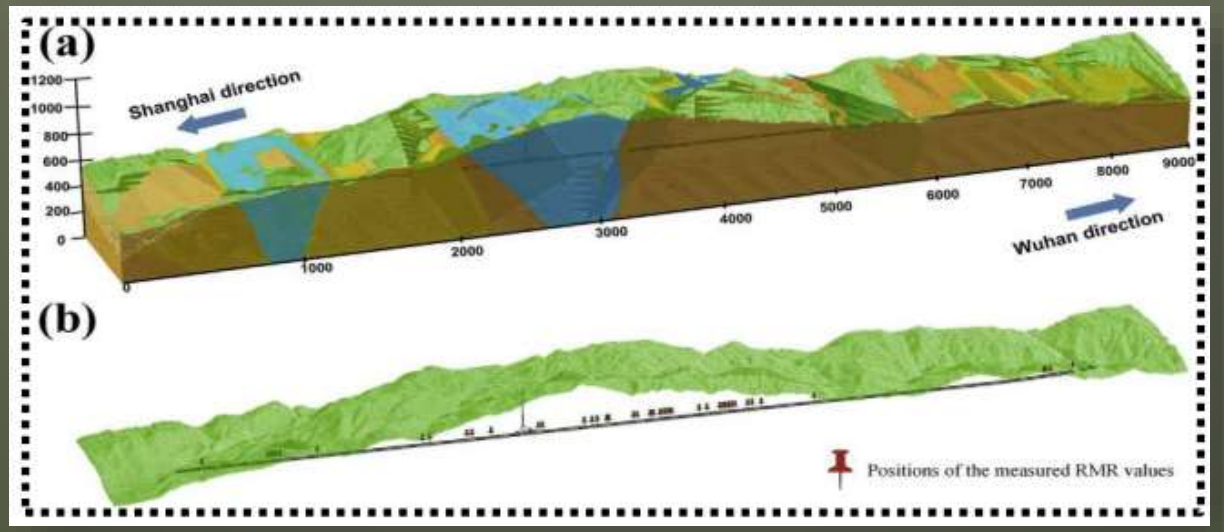


Aperture

Data Representation

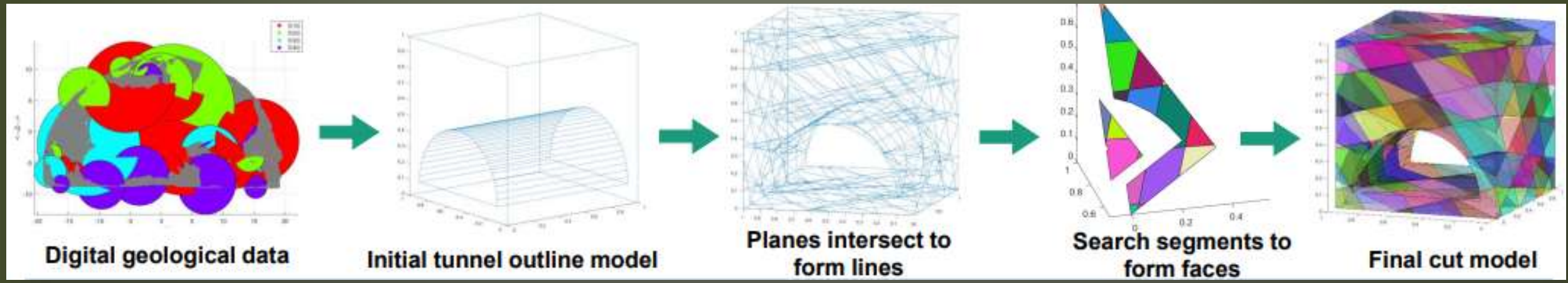


Digitalization of geological body

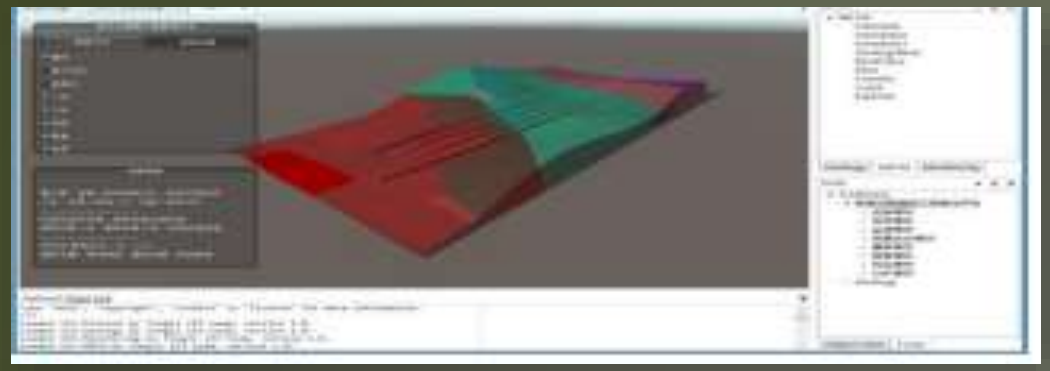


Data Analysis

Discontinuous numerical calculation: 3D analysis

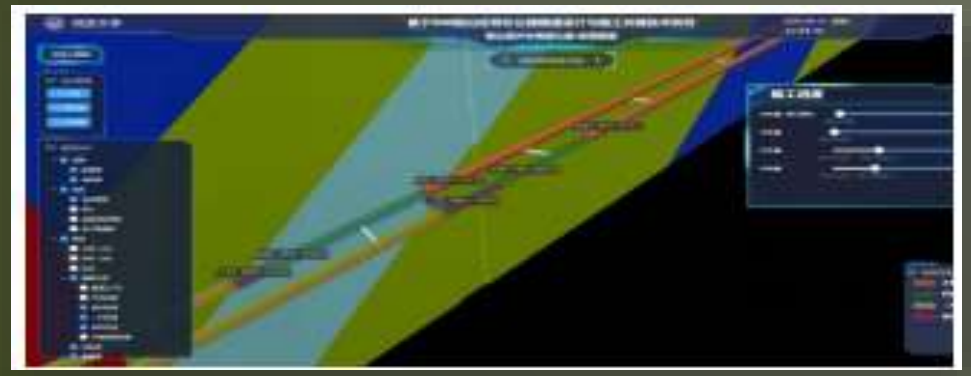


Data Service



Shidaoshan Tunnel construction and maintenance integrated platform (Shidaoshan Tunnel, 2015)

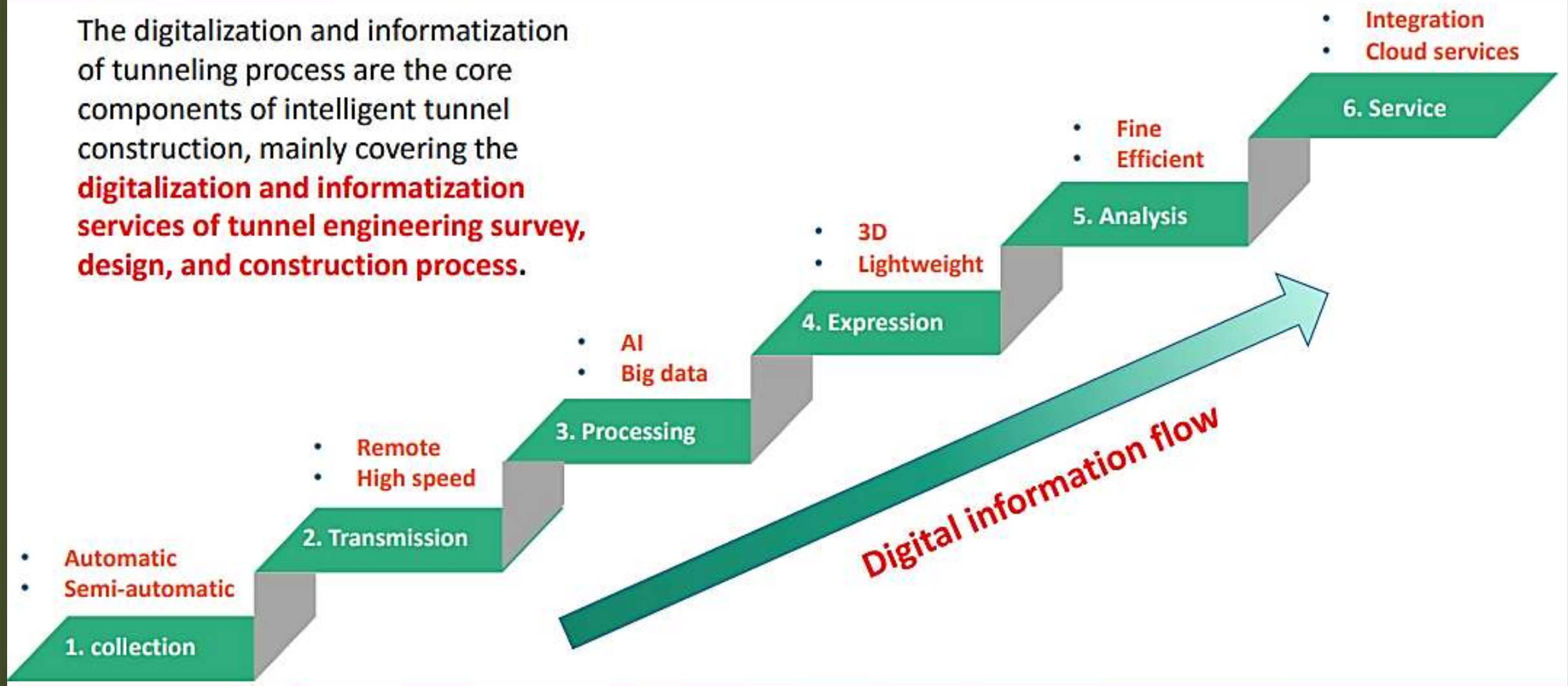
Rock tunnel remote diagnosis system (Ehan High-speed Tunnel Project, 2020.12）



Tunnel design and construction system based on BIM (Laoying Tunnel, 2020.02)

1.3 Digitalization and Informatization Foundation

The digitalization and informatization of tunneling process are the core components of intelligent tunnel construction, mainly covering the **digitalization and informatization services of tunnel engineering survey, design, and construction process.**



Recorded Photos taken during Site Visit to Cross Island Line (CR 109) Project in Singapore.


REEBONZ
CROSS ISL AND LINE - CR 1C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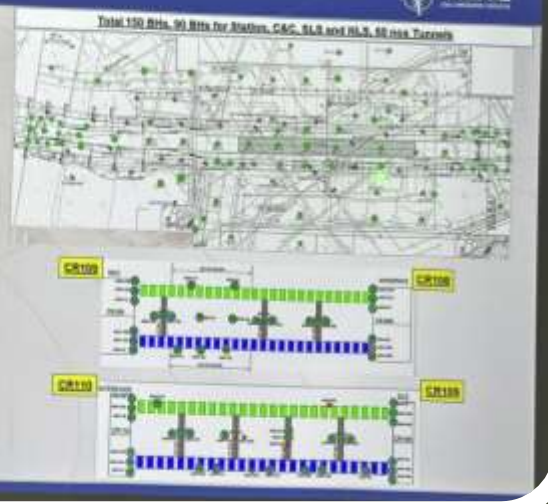
1. Project Overview

Station layout plan

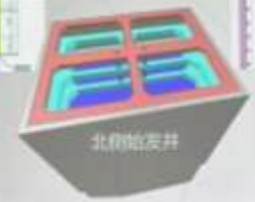
1. Project Overview

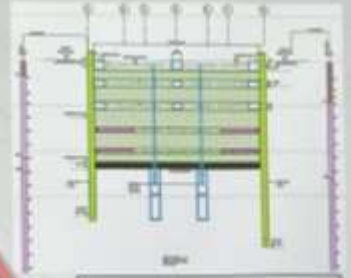
Additional Bored Holes (SI)



1. Project Overview

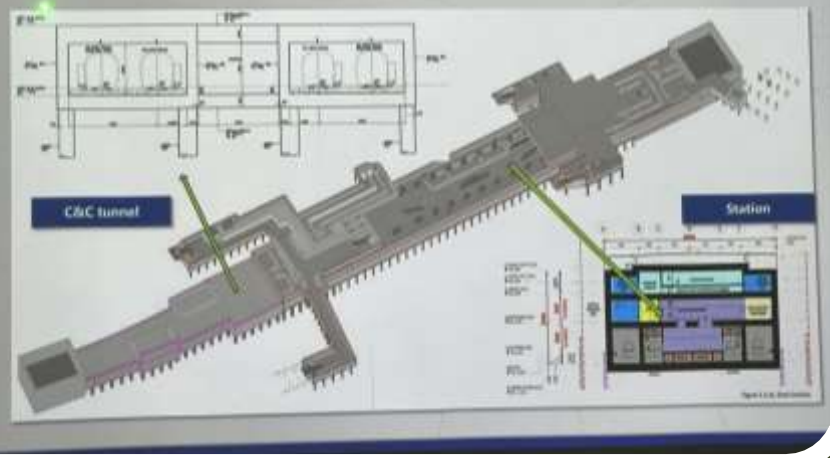
Launch shaft design scheme





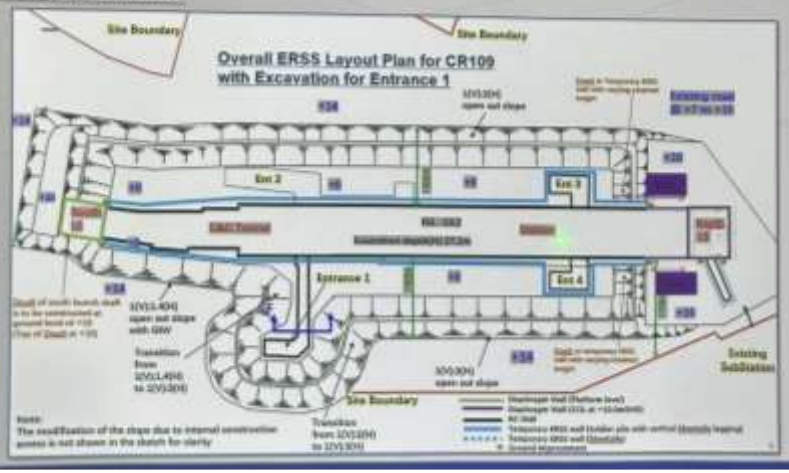
1. Project Overview

Cut & Cover tunnel and station typical cross section



1. Project Overview

ERSS Design Scheme



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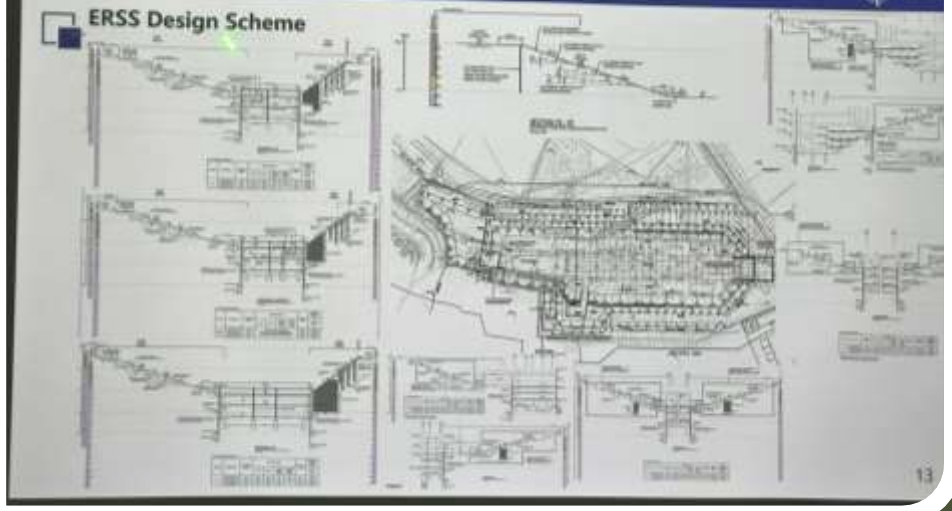

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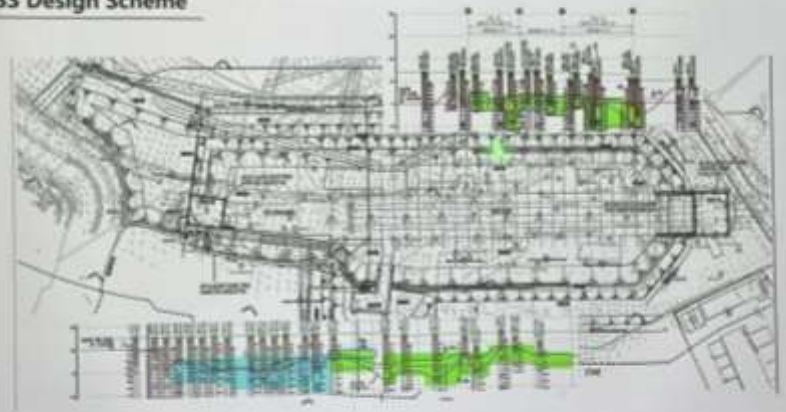
1. Project Overview

ERSS Design Scheme



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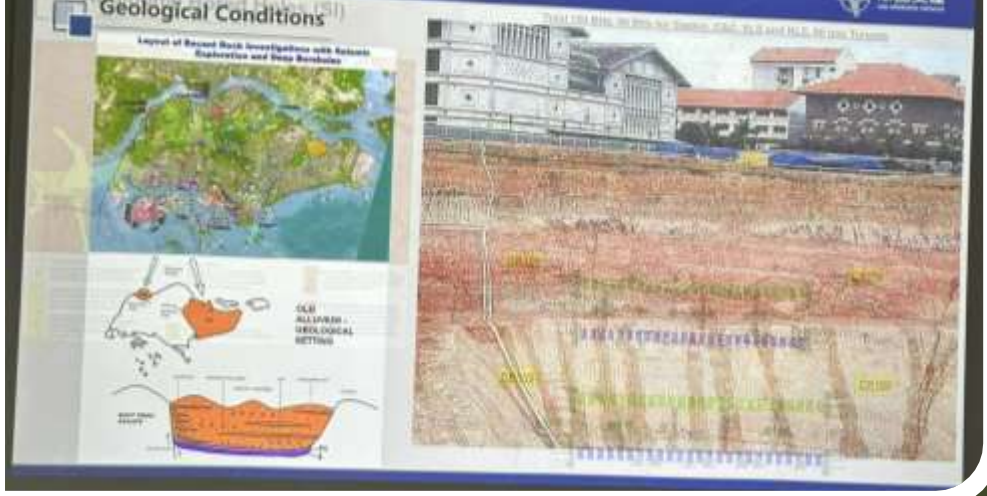
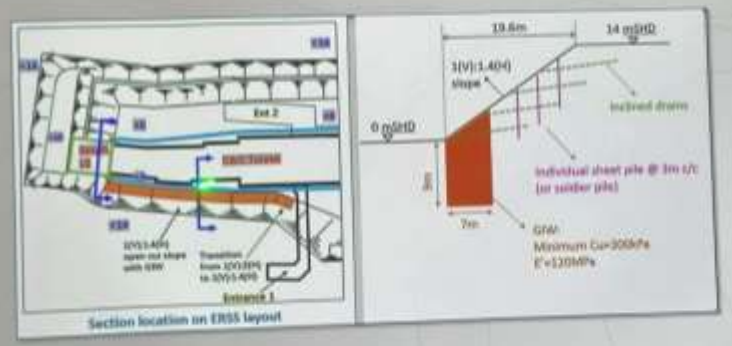
1. Project Overview

Geological Conditions



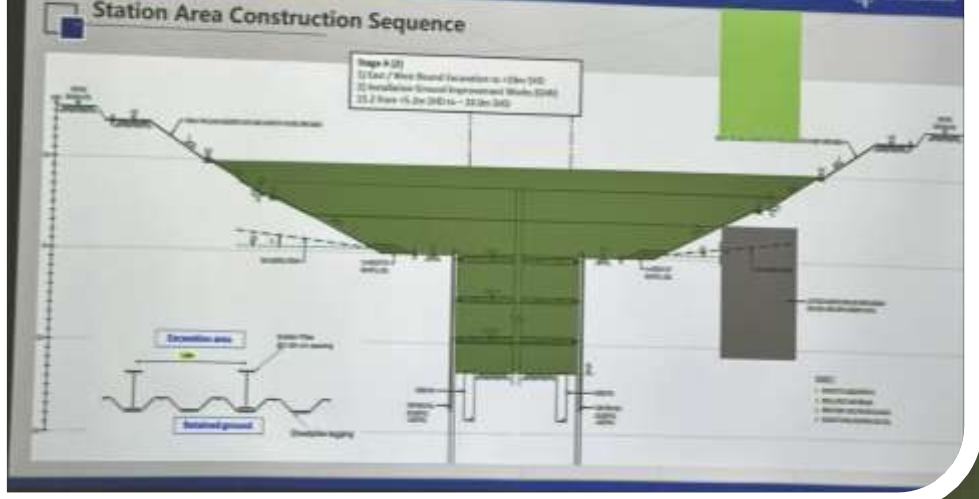
1. Project Overview

Cut & Cover Tunnel Design Scheme



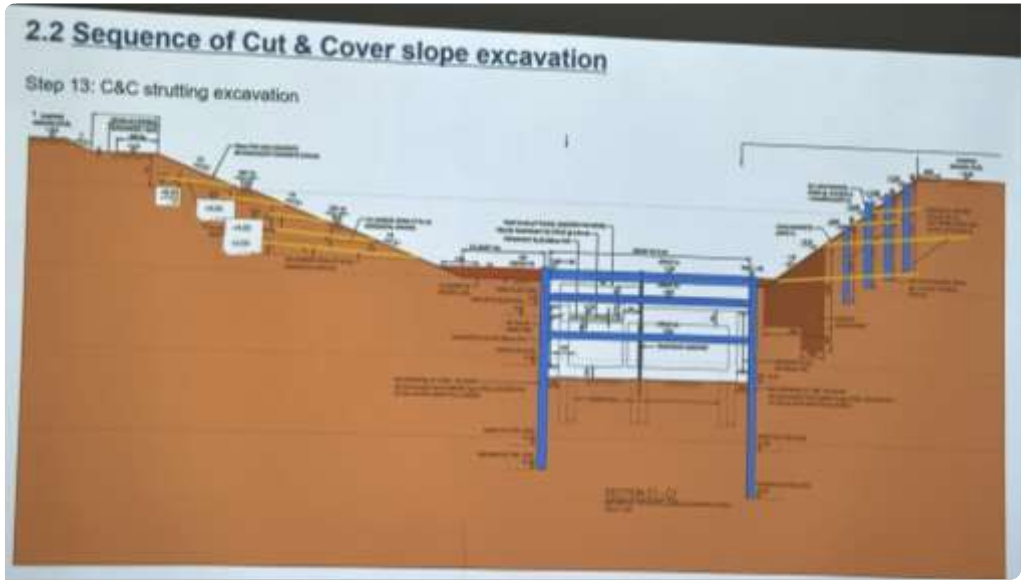
2. Construction Methodology (LS / Cut & Cover / Main Station)

Station Area Construction Sequence



2.2 Sequence of Cut & Cover slope excavation

Step 13: C&C strutting excavation



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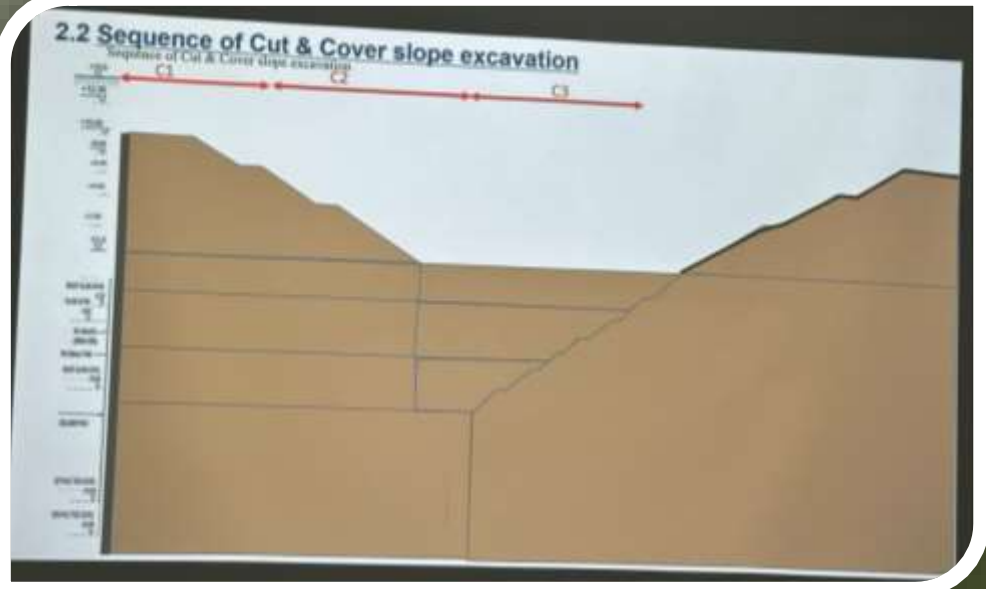
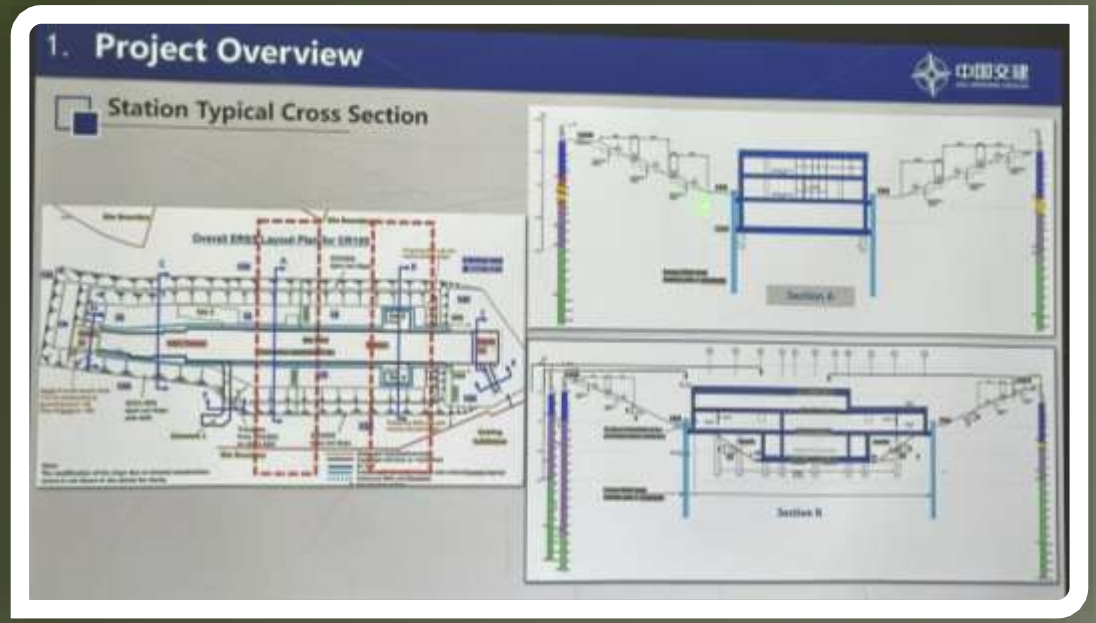
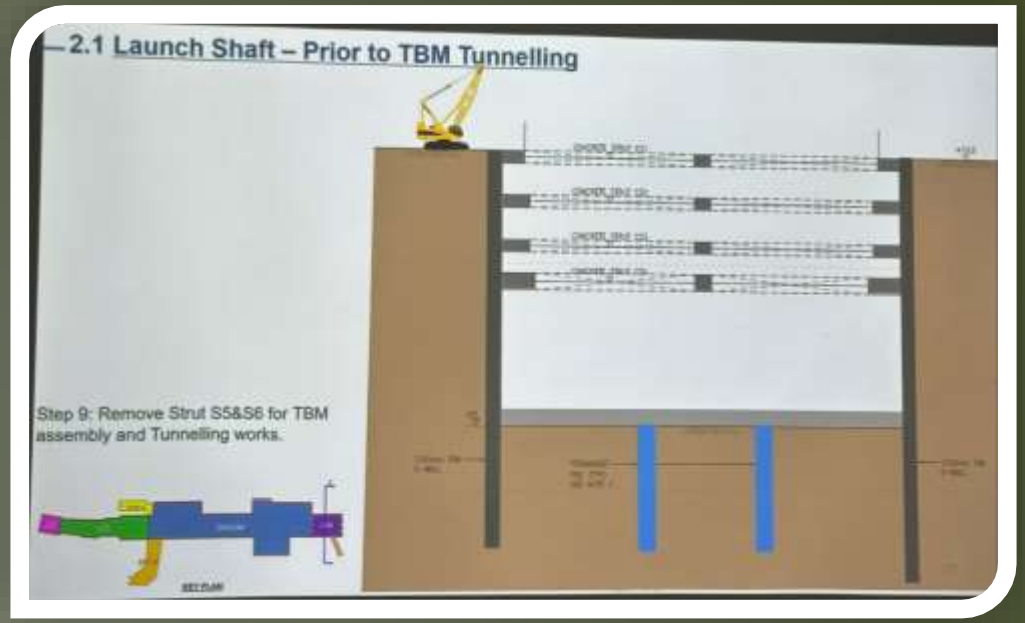
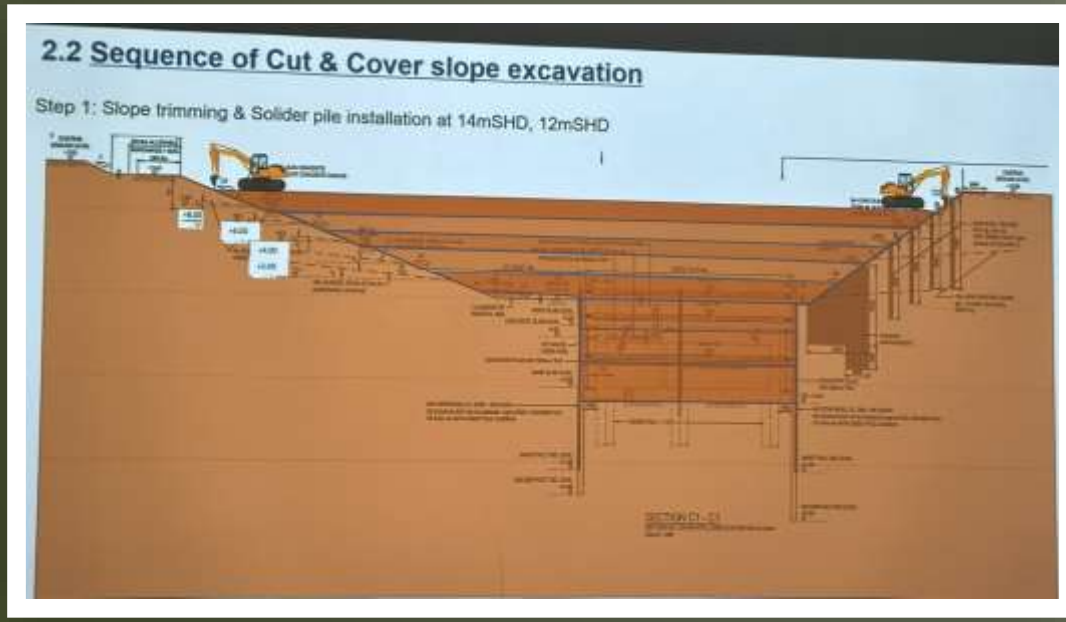
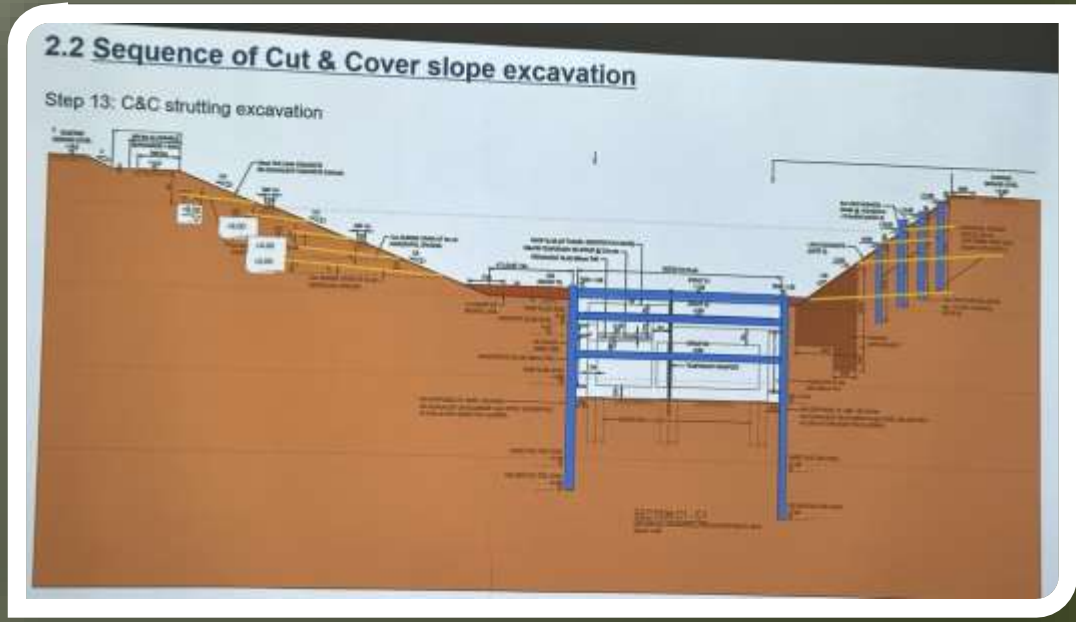



1. Project Overview
Station Typical Cross Section

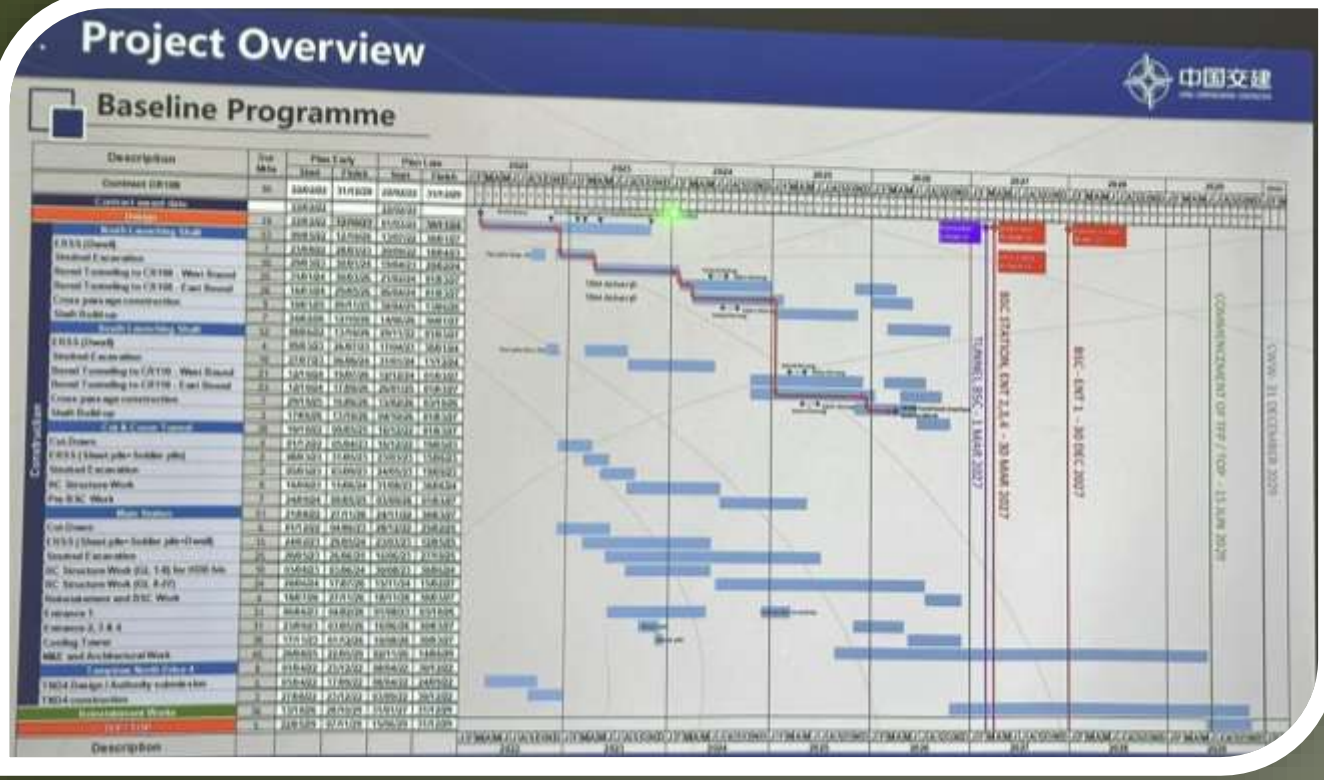

2.1 Launch Shaft – Prior to TBM Tunnelling
Step 9: Remove Strut S5&S6 for TBM assembly and Tunnelling works.


2.2 Sequence of Cut & Cover slope excavation
Step 1: Slope trimming & Solider pile installation at 14mSHD, 12mSHD


2.2 Sequence of Cut & Cover slope excavation
Step 13: C&C strutting excavation

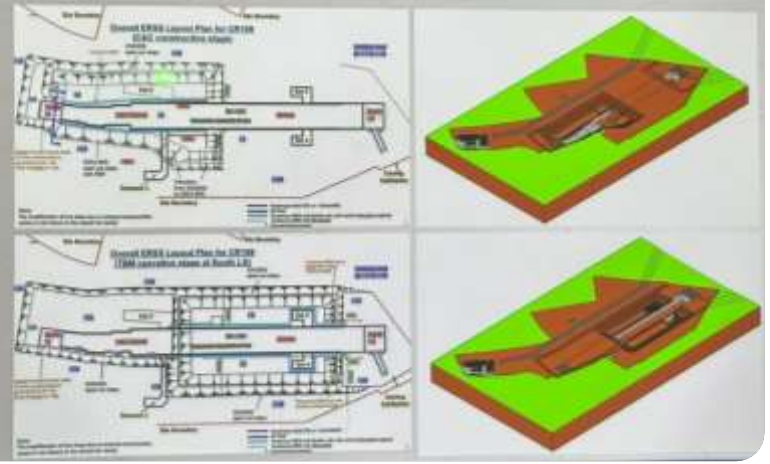
Project Overview

Baseline Programme



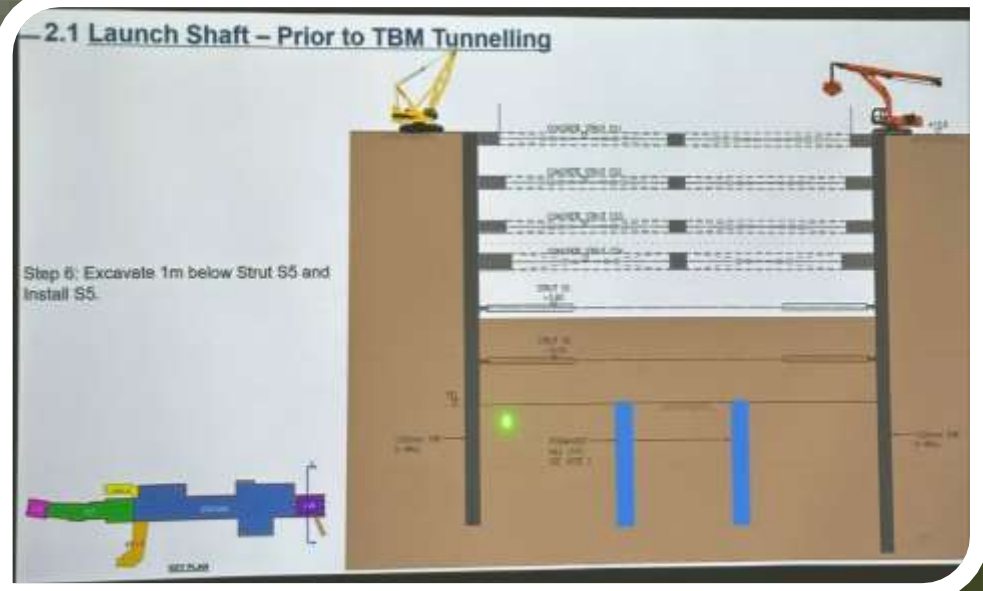
2. Construction Methodology (LS / Cut & Cover / Main Station)

Overall Construction Stage

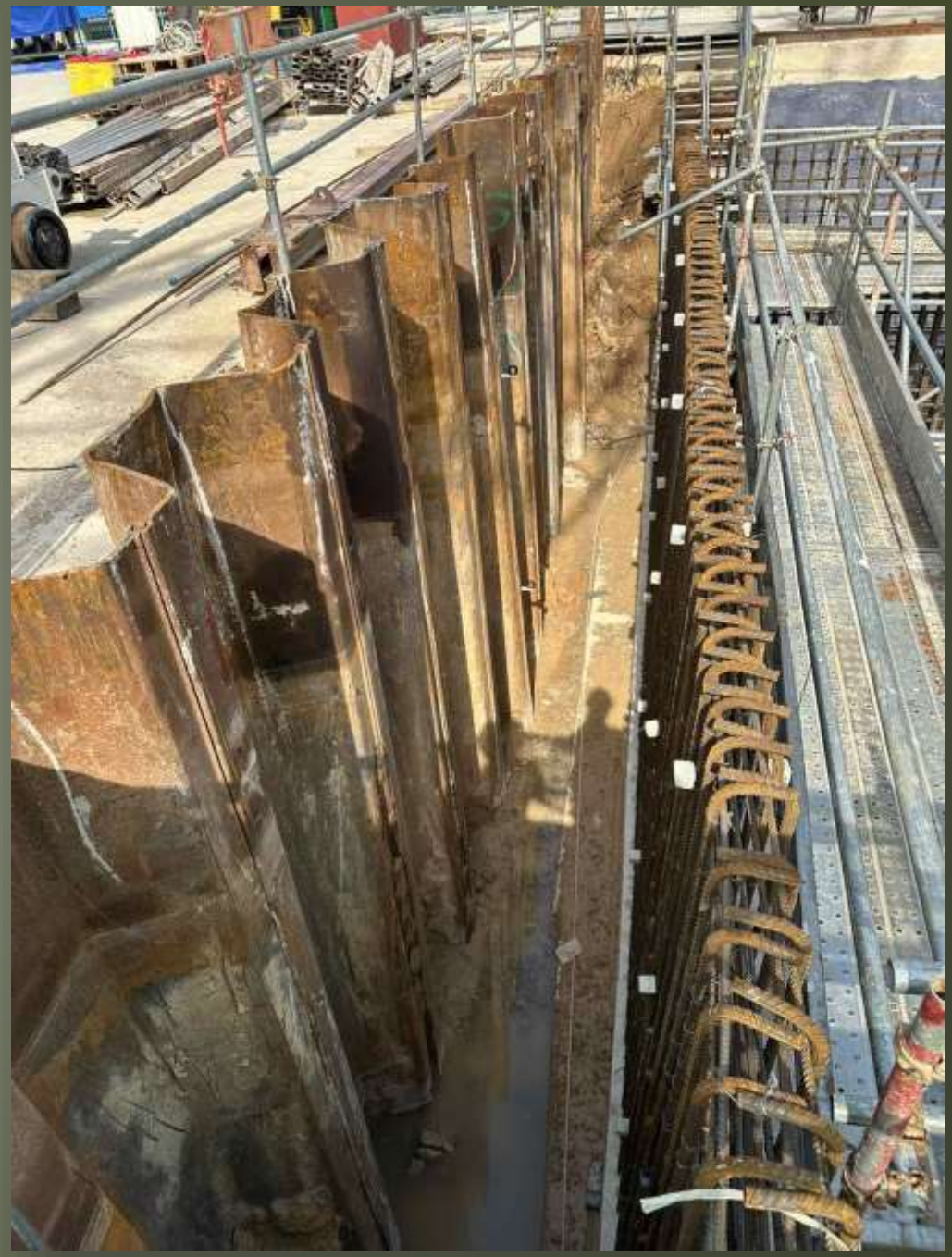


2.1 Launch Shaft – Prior to TBM Tunnelling

Step 6: Excavate 1m below Strut S5 and Install S5.




中国交建




HITACHI


XCMG

2. Construction Methodology (LS / Cut & Cover / Main Station)

CR109 Drone video

Recorded Photos taken during World Tunnel Congress 2024 in China.


8
20
HEADROOM


Welcome


LNS
Tunnelling for a Better

Conclusions

- The tunnel construction technology in Myanmar is in the stage of traditional physical infrastructure development.
- Given the characteristics of a "concealed construction environment and continuous closure of operations" in tunnel construction, a new construction mode should be proposed using new-generation information technology as the means, geological perception as the basis, in future.

Thank You For Your Kind Attention