IfcTunnel Scope proposal

Experts panel review (#1 - 2019-11-21)

bSI IfcTunnel Team

(CH-AMBERG, SLO-ELEA, CH-ILF, I-GEODATA, JPN-OYO, F-MINnD, N-NTUN, D-RUB, CH-SBB, S-STV, D-TUM)

IfcTunnel Scope – Project aim

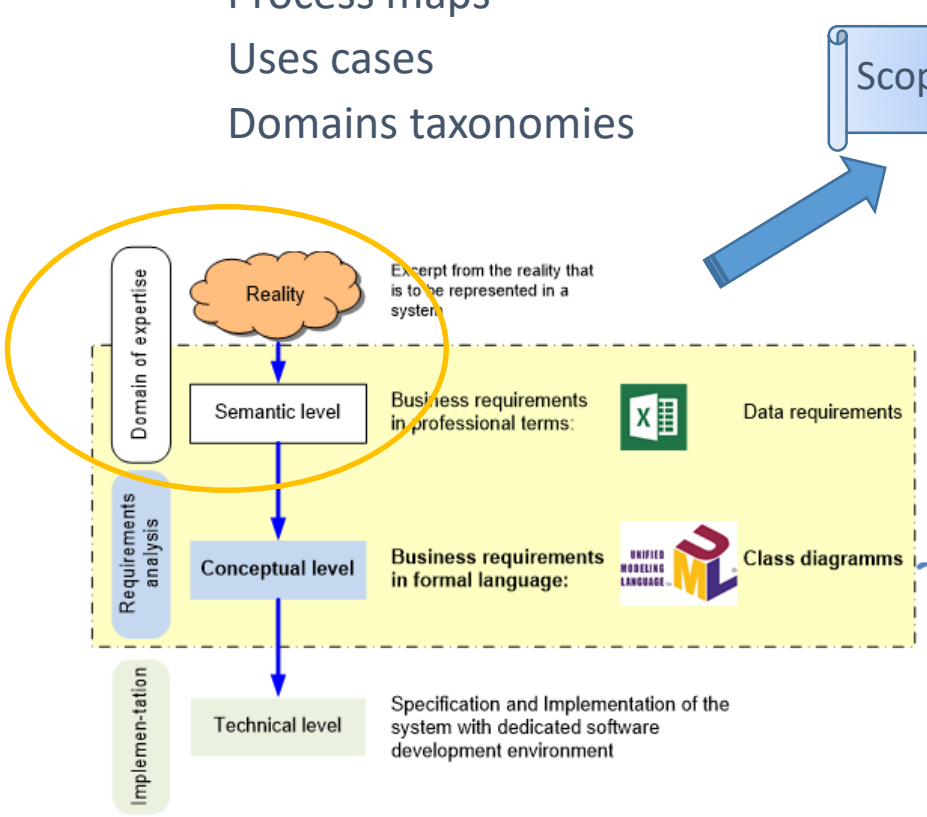
- To create … *"… A comprehensive neutral data schema capable to present semantic and geometric aspects to enable data exchange and open access in the context of planning, realization and maintenance of tunnels."*
  (IFC Tunnel Project Proposal, 2019)

- *provide an open BIM "Structured Information Container" (ISO 19650-1) to exchange information and serve as a common, software-independent, documentation and archiving format*

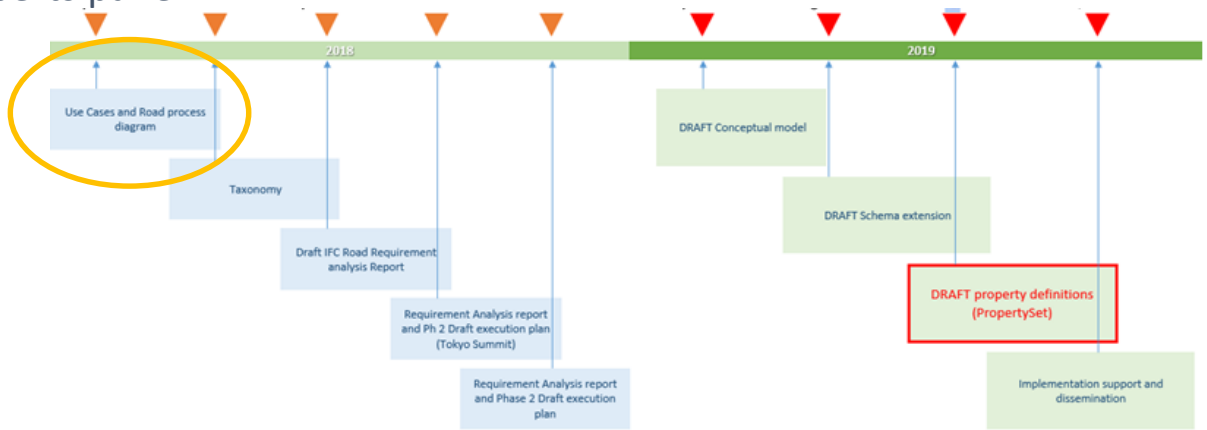
IfcTunnel – The objective

IfcTunnel WP2 - Requirement analysis

- Scope
- Process maps
- Uses cases
- Domains taxonomies

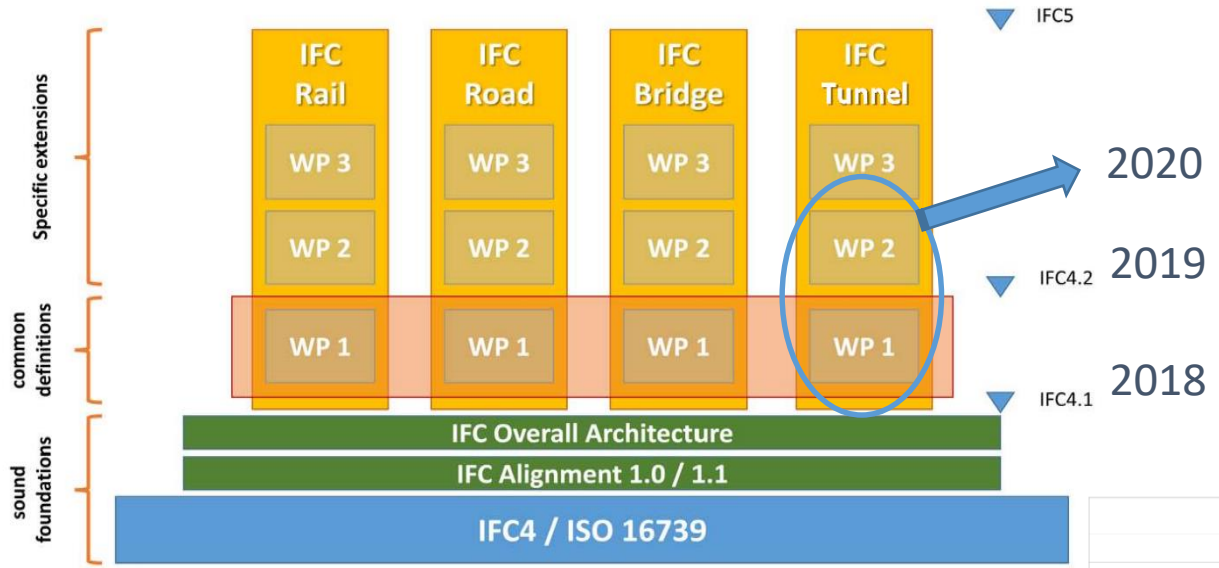


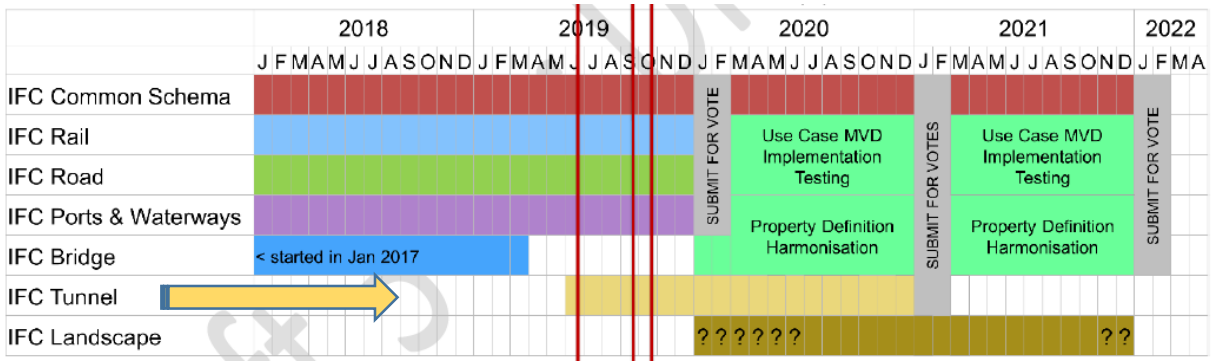
Experts panel #1



IfcTunnel Scope – The big picture

bSI Infraroom road map





IfcTunnel Scope – The big picture

IfcTunnel project must describe:

- Functions
- Geometries
- Domains semantics

exchanged during the tunnel life cycle:

- Planning
- Engineering
- Procurement
- Construction
- Handover
- Asset management, maintenance & operation

Definitions of Tunnels

*Artificial underground passage (**Oxford Dictionary**)*
*Underground/underwater structures (**DIN 1076**)*
*Underground structure excavated to create a communication (**UIC**)*
*Long enclosed transport route (**PIARC**)*
*Underground tunnels, shafts, chambers, passageways, cut and cover excavations as well as those that create conditions (hazards) characteristic of underground construction (**OSHA**)*

Identify entities, elements and components required to cover the scope and establish whether they:

- Can be mapped to existing IFC schema
- Are covered in on-going common schema projects, or should be part of the common schema
- Require new IFC entities to be introduced as part of the IFC Tunnel project

IfcTunnel – The objective

IfcTunnel WP2 - Requirement analysis

- Scope
- Process maps
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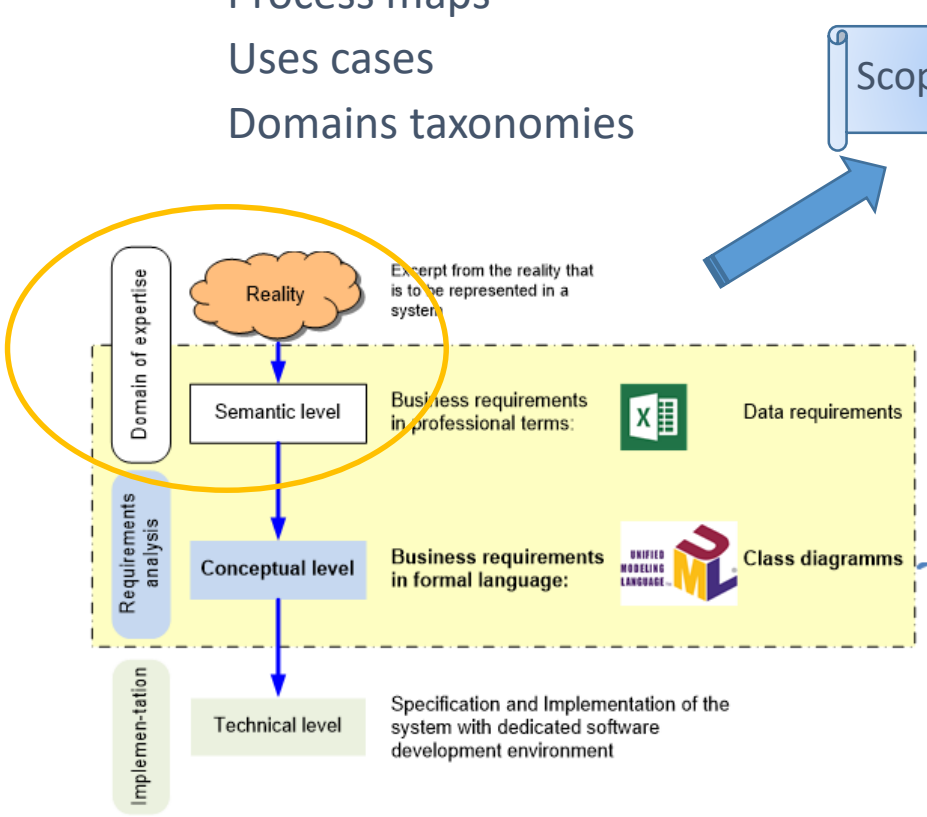
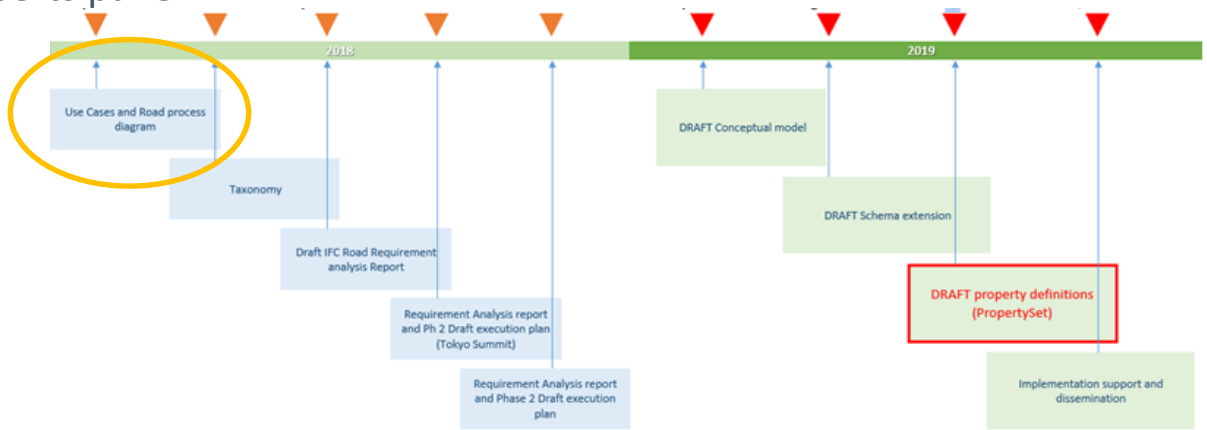


Experts panel #1



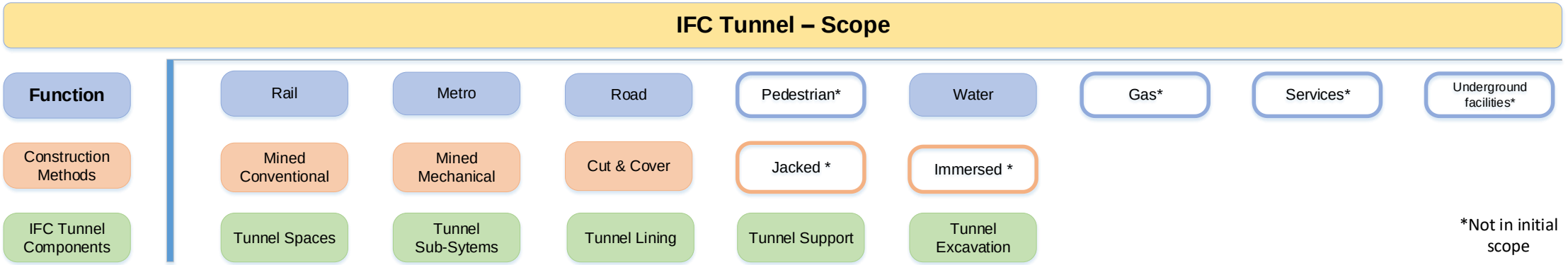
IfcTunnel Scope – Common Scope

- 2019 in collaboration with Common Schema:
- Geotechnics
- Spatial Structure (Kinematic Envelopes)

- 2020 on-going collaboration with Common Schema, require interaction with other projects:
- Geothermal
- Drainage
- Earthworks

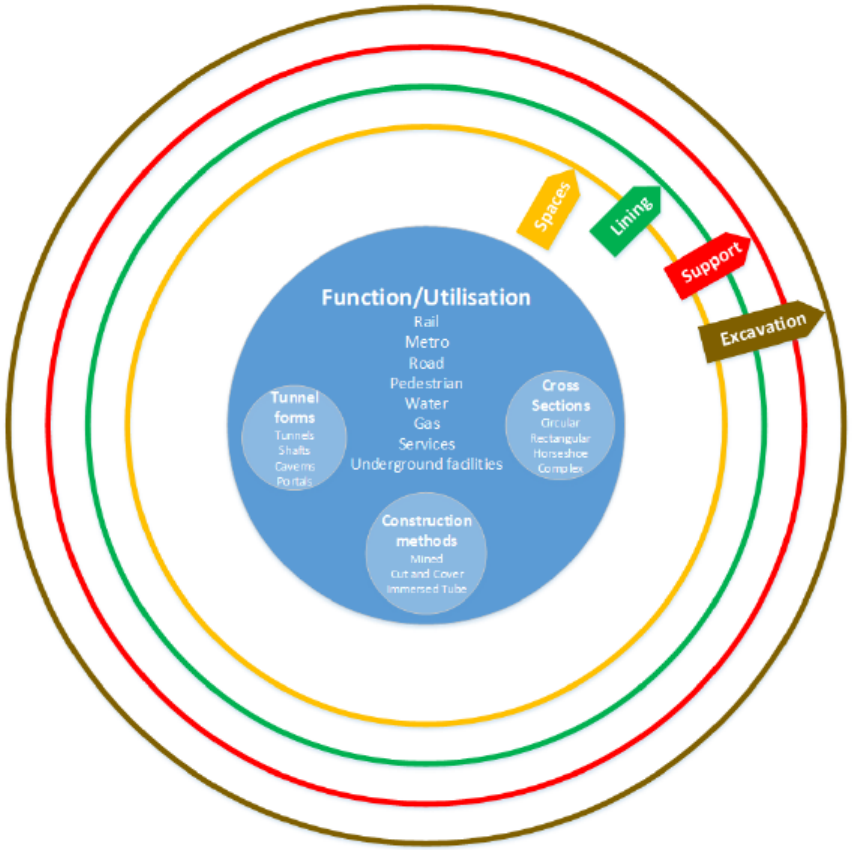
IfcTunnel Scope – Types

- Based on their function
- Based on their construction method(s)

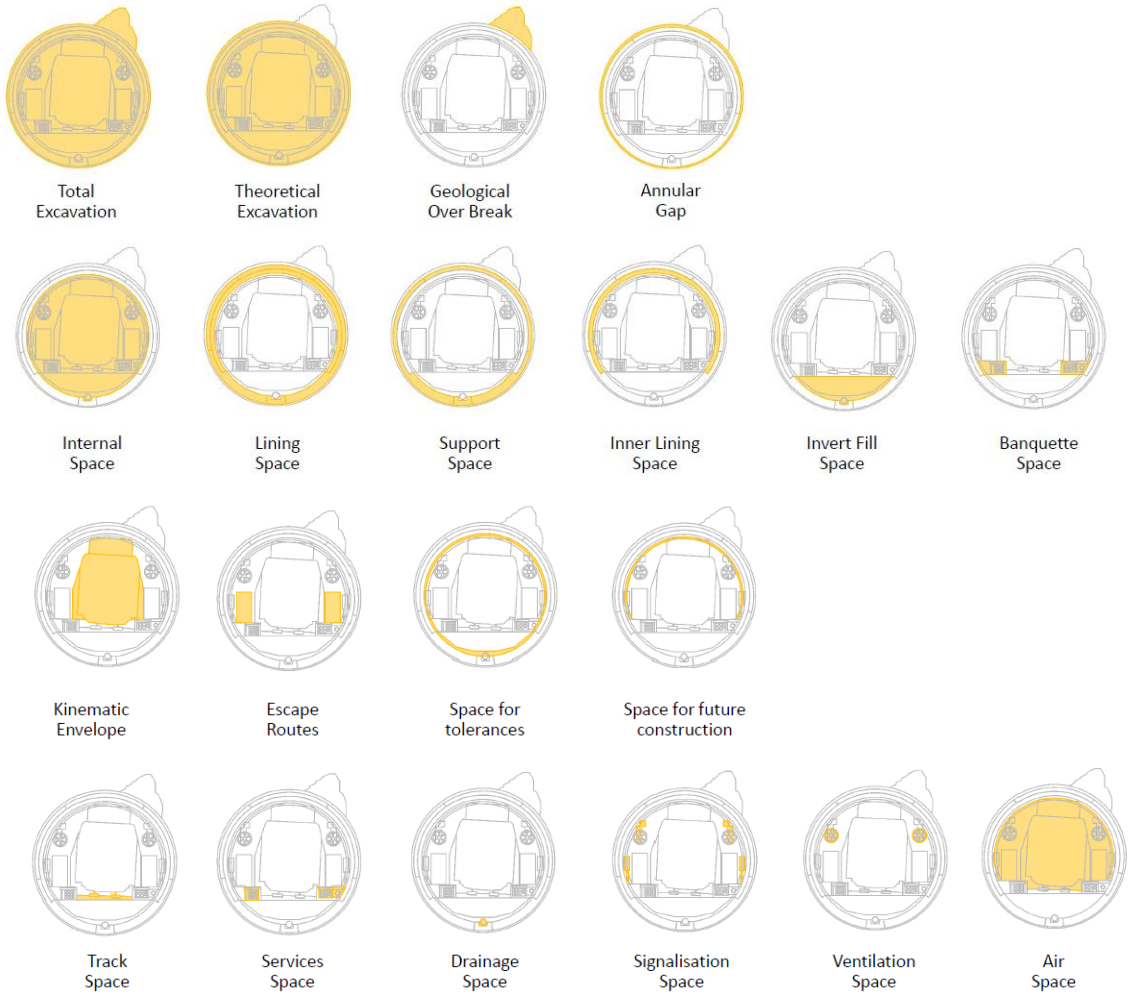


IfcTunnel Scope – Components

- Other topics currently addressed by project team:
- Geology (jointly covered with common schema)
- Excavation
- Support
- Lining components
- Tunnel Sub-Systems and Equipment



IfcTunnel Scope – Components



Spaces that reflect the excavation and the construction process

Spaces that host the sub-systems equipments

IfcTunnel Scope – Geotechnics

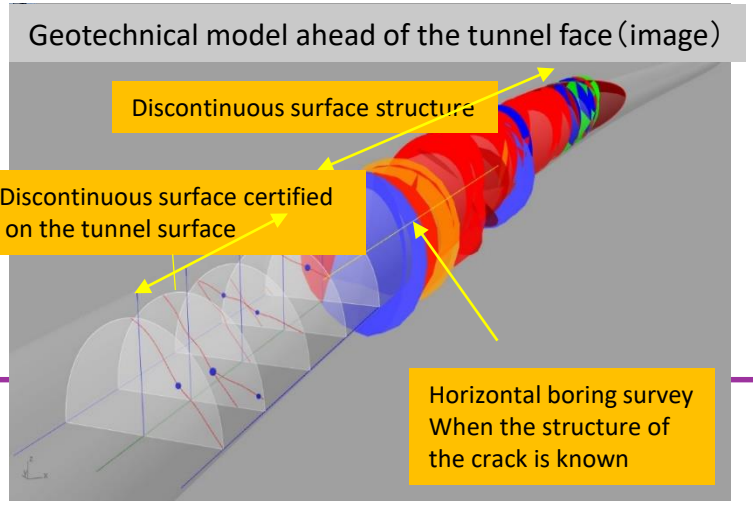
IfcTunnel scope – Geotechnical environment & uncertainties

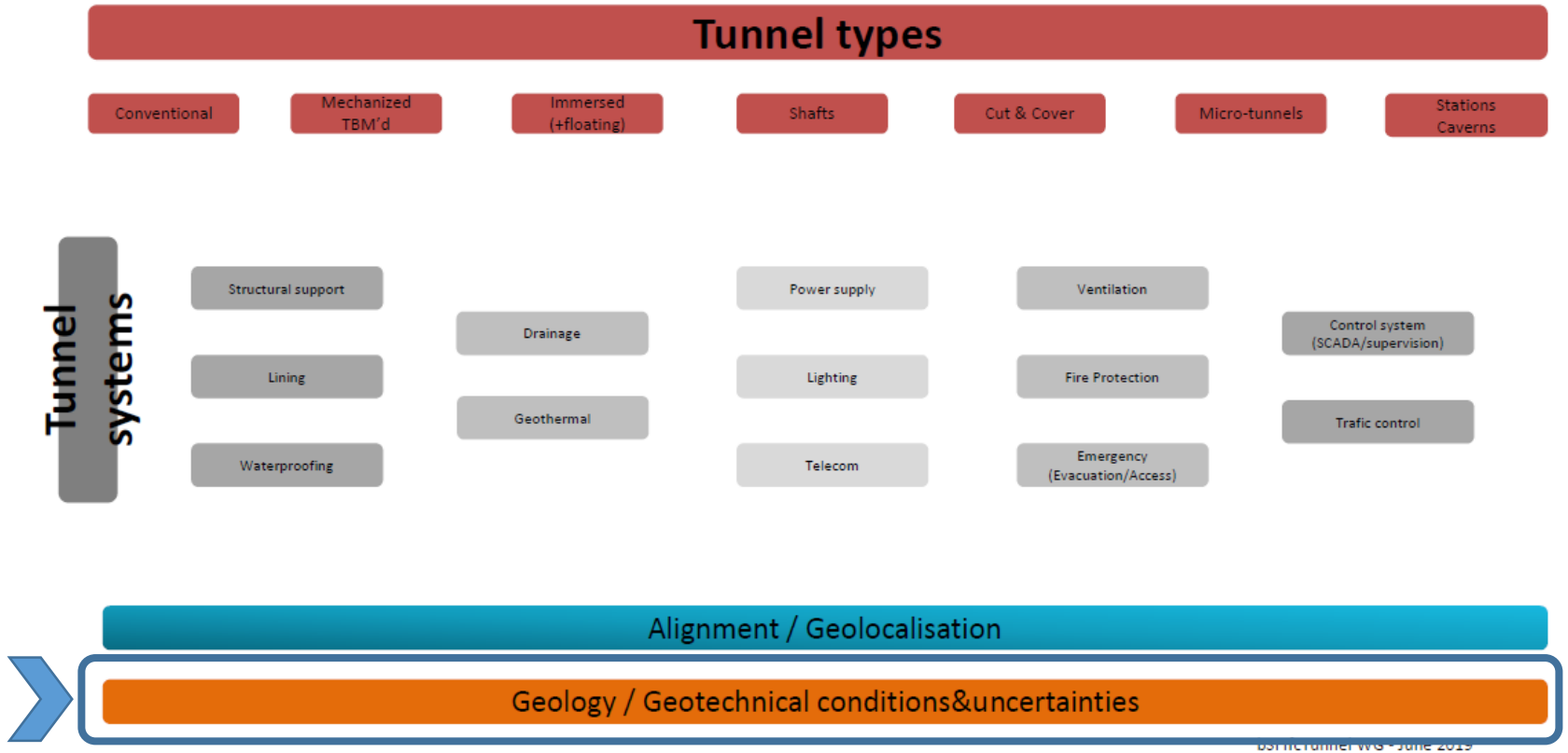
Proposed P1:

- Geologic structure
- Classification
- Ground water

Proposed P2:

- Topsoil deformation
- Geophysics

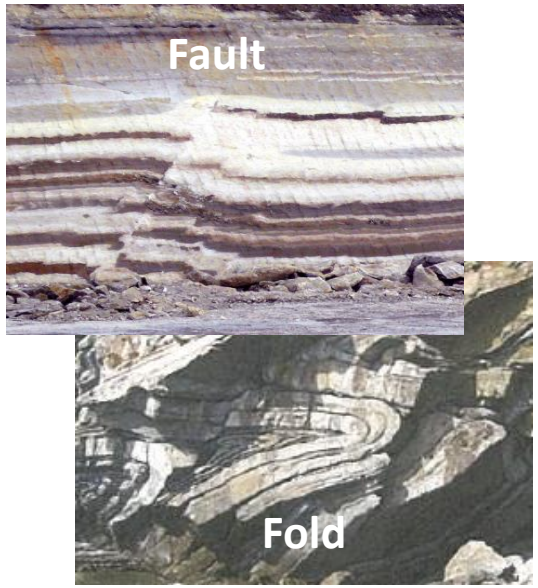


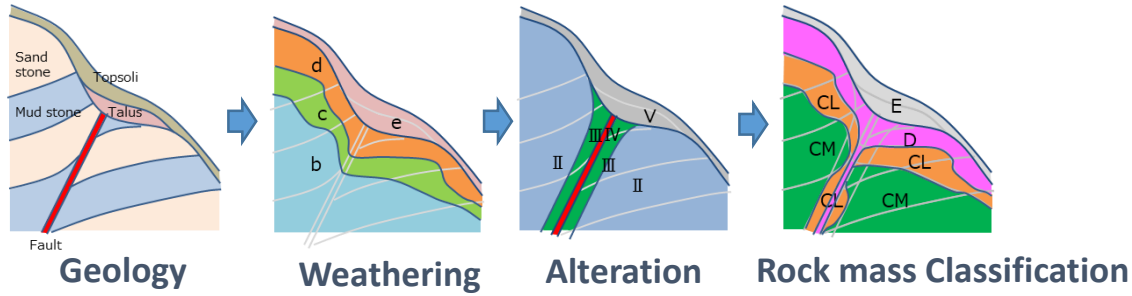


IfcTunnel Scope – Geotechnics (1/2)

Geologic structure

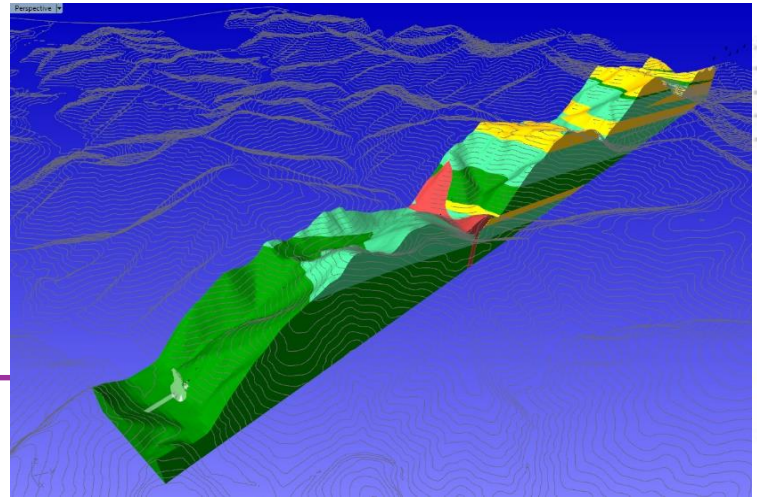
- Boundary of geologic unit
- Sequence boundary
- Intrusive boundary
- Fault
- Fracture
- Fold





Geotechnical classification:

- Discontinuity
- Weathering
- Alteration
- Degree of consolidation
- Rock mass classification



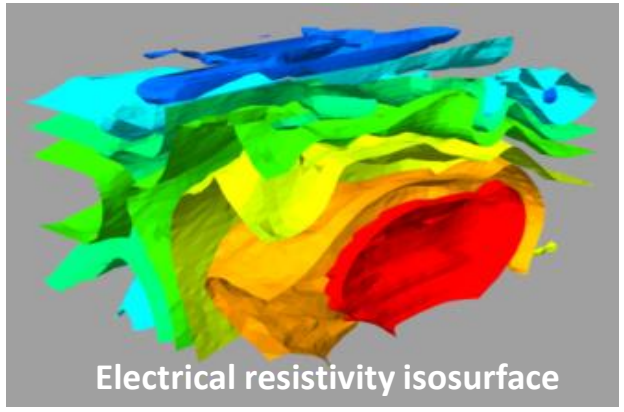
IfcTunnel Scope – Geotechnics (2/2)

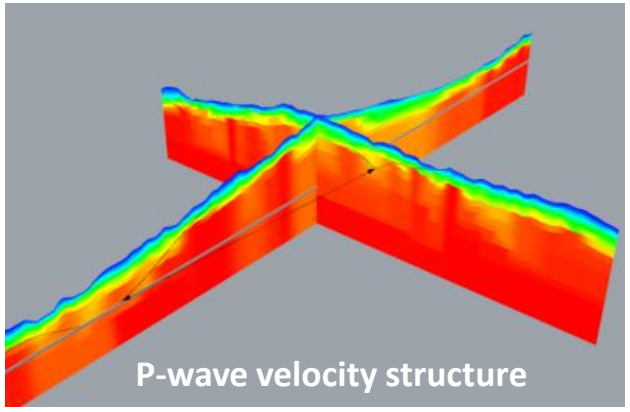
Geophysics:

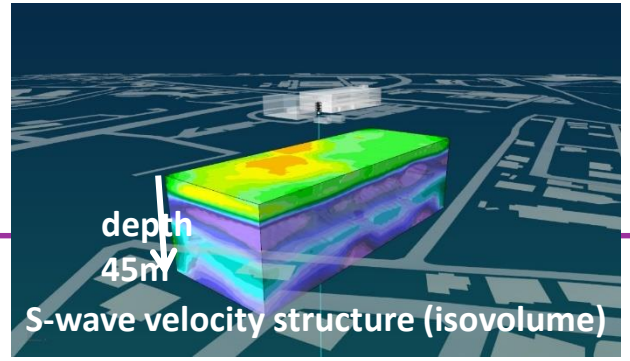
- P-wave velocity(km/s)
- S-wave velocity(km/s)
- Ultrasonic velocity
- Electrical resistivity
- Density

Ground water:

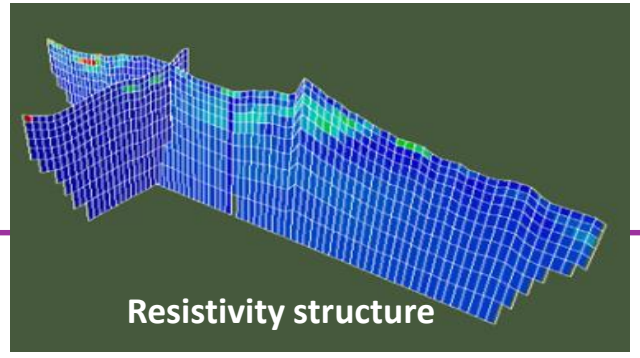
- Aquifer
- Groundwater level
- Hydrological conductivity
- Water pressure
- Uncertainty (link'd with calculation methods)

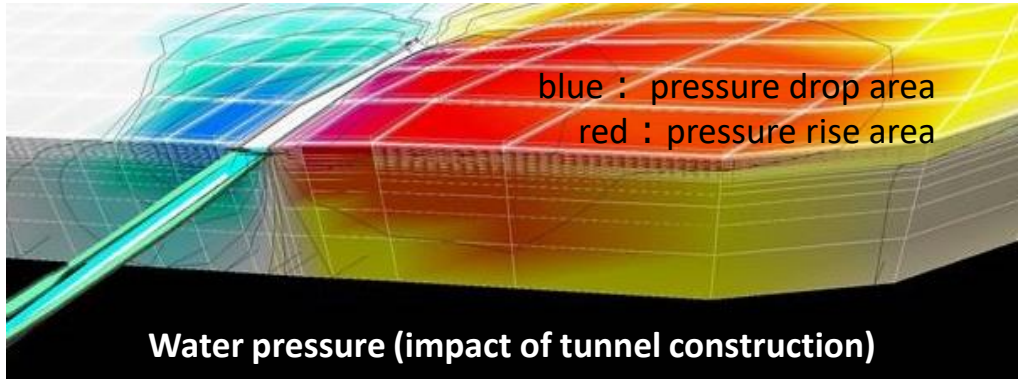

Electrical resistivity isosurface


P-wave velocity structure



S-wave velocity structure (isovolume)


Resistivity structure



Water pressure (impact of tunnel construction)

IfcTunnel Scope – Construction methods

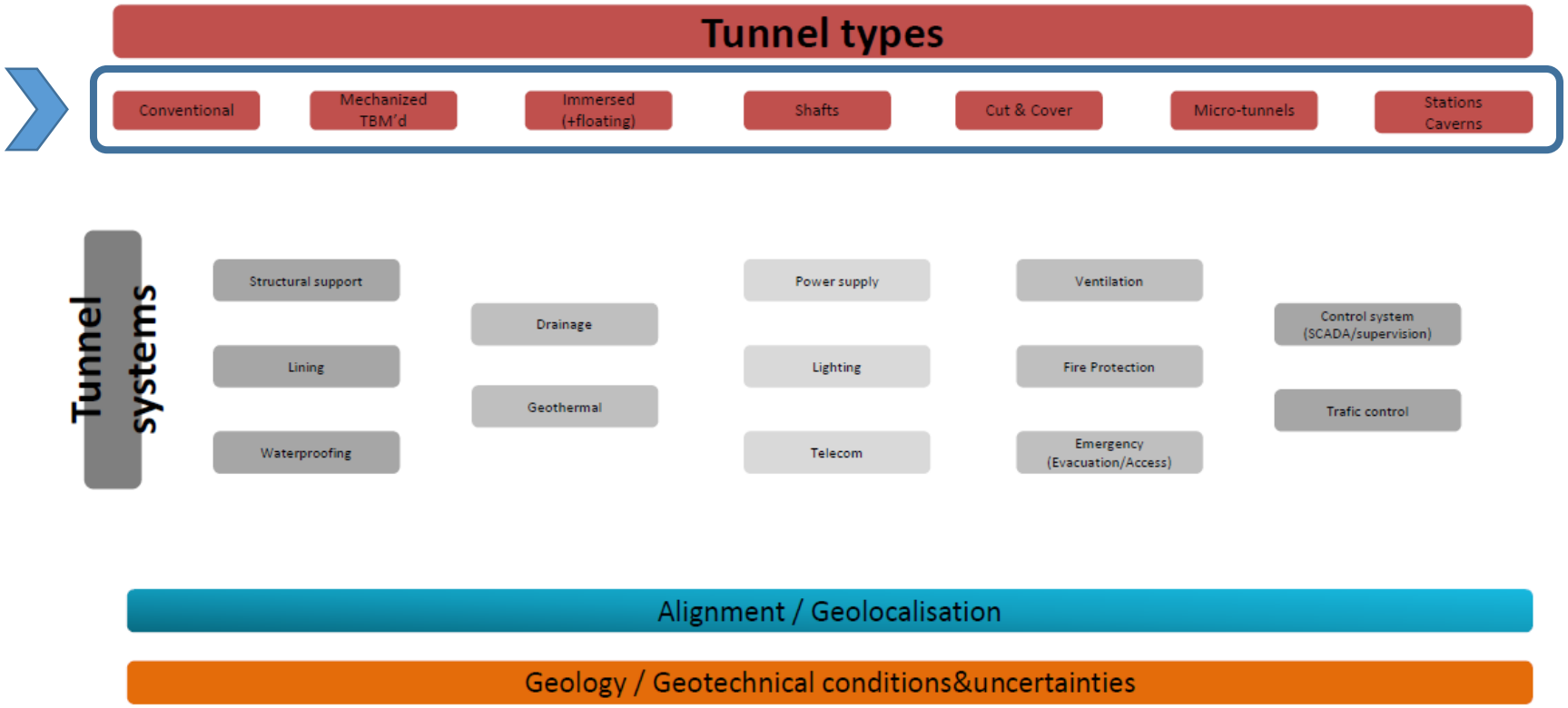
IfcTunnel scope – Design, excavate & build

Proposed P1:

- Mechanized (TBM)
- Conventional
- Cut&cover

Proposed P2:

- Jacked
- Immersed
- Shafts
- Micro-tunnels
- Caverns



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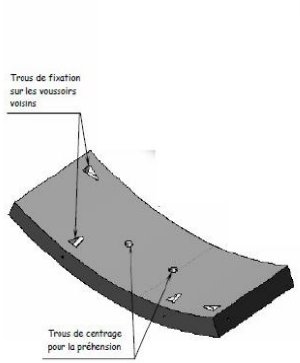
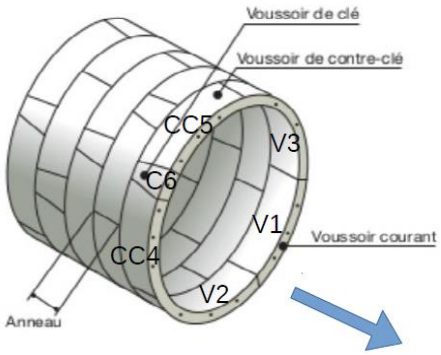
IfcTunnel Scope – Construction methods (1/3)

Mechanized (TBM) Construction variants

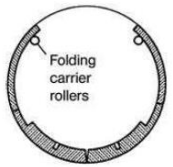
Eight single segments and a keystone



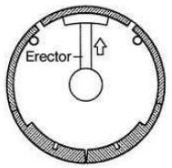


Five-piece segment lining with keystone at the bottom

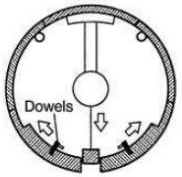
Withdrawal of thrust pressure ring and installation of invert segments



Installation of left and right side segment



Installation of top segment

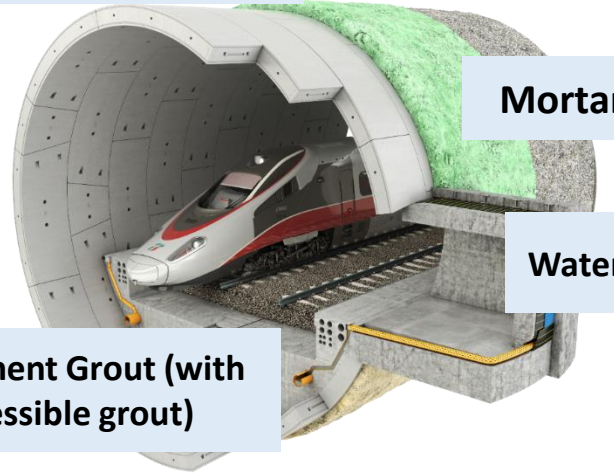


Spreading of invert segments and insertion of keystone

Move thrust pressure ring forward and filling of annular gap with pea gravel

Pea Gravel injected with Grout

Draining Pea Gravel



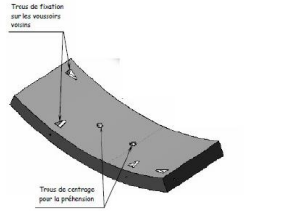
Mortar grouting

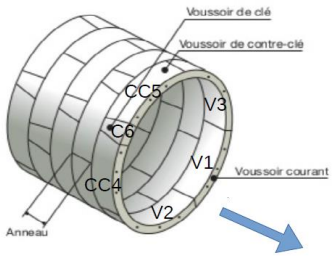
Waterproofing

Bi-Component Grout (with compressible grout)

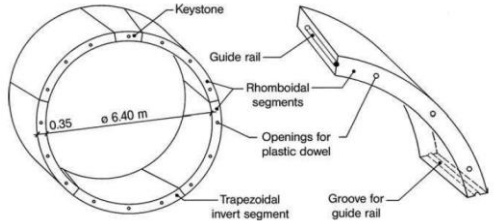
IfcTunnel Scope – Construction methods (1/3)

Mechanized (TBM)
Segment types

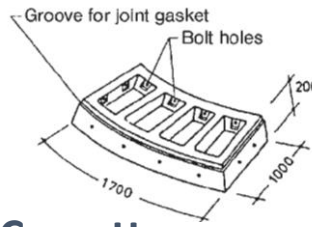


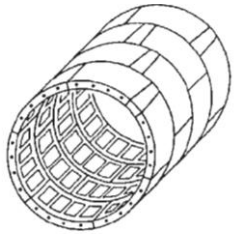


Block segments

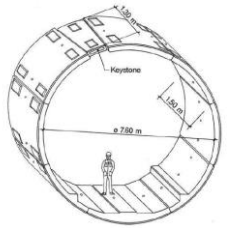


Rhomboidal & trapezoidal segments

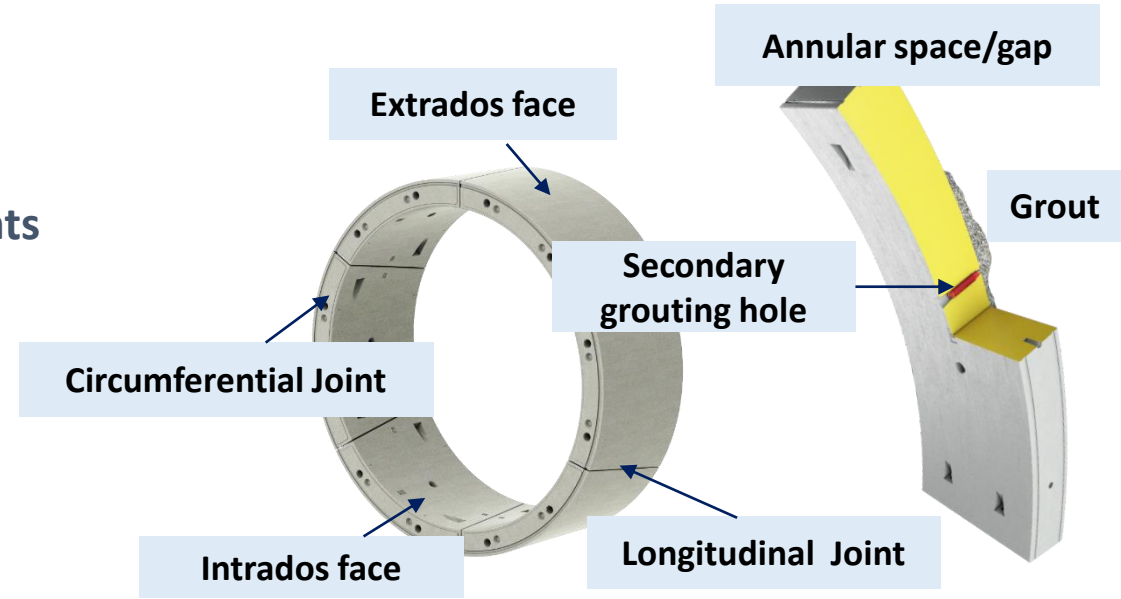




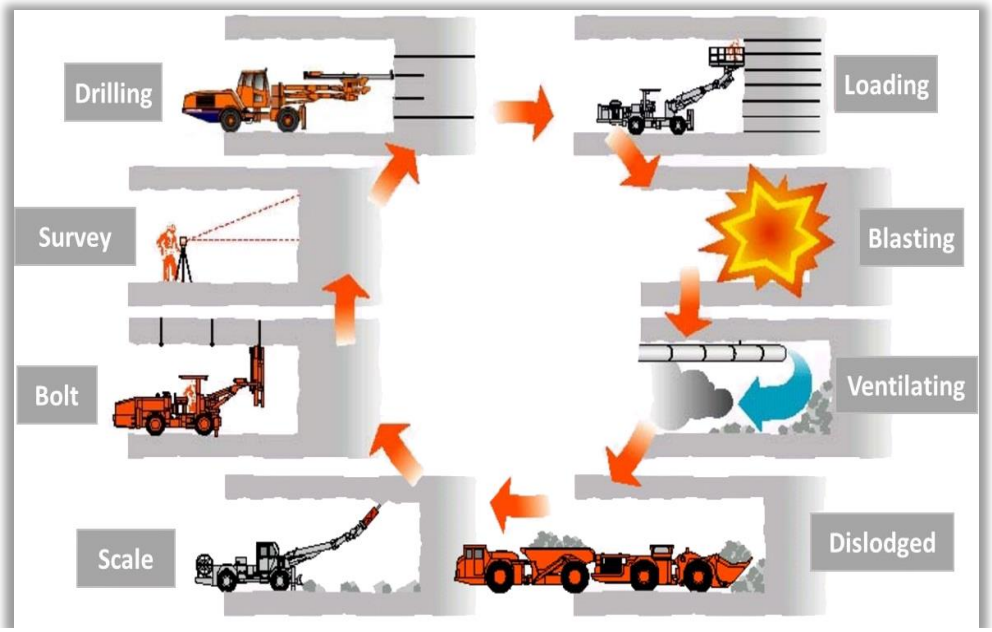
Cassette segments

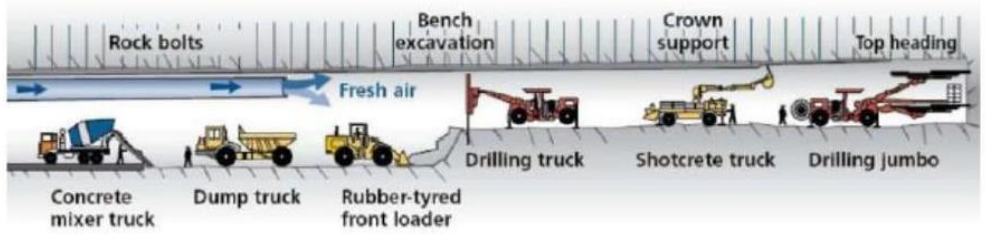


Expanding segments

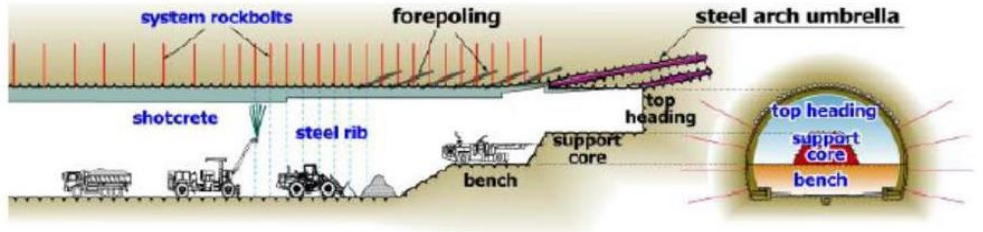


IfcTunnel Scope – Construction methods (2/3)



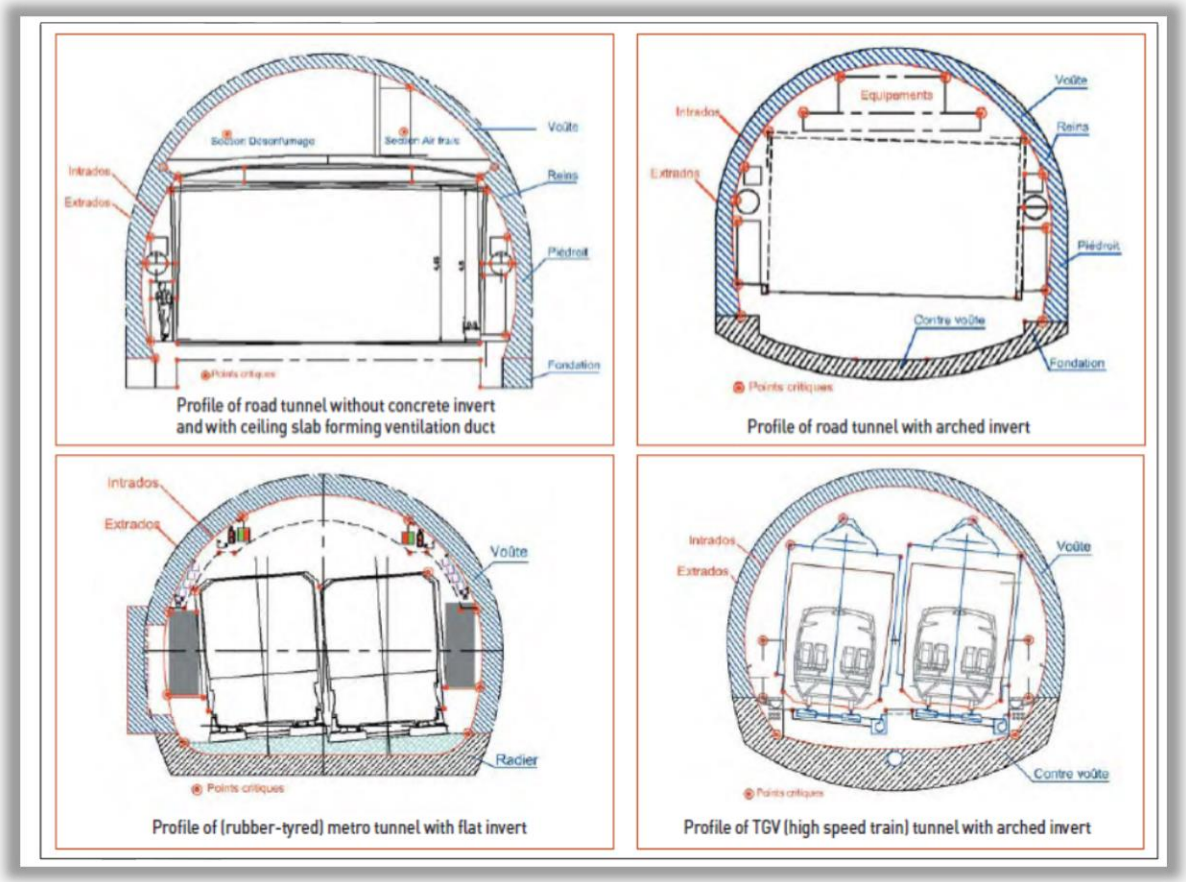


In rock



In softsoil

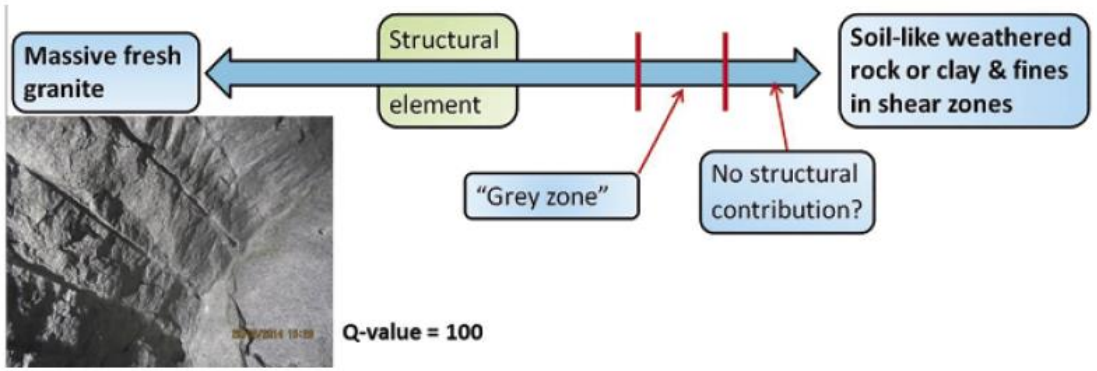
Conventional (drill & blast)



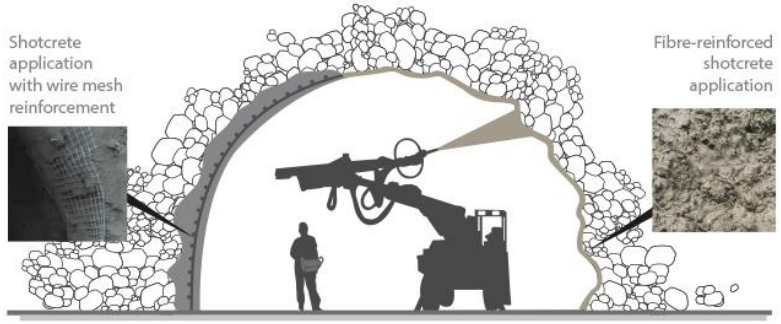
IfcTunnel Scope – Construction methods (2/3)

Rock support

- Good rock condition: rock bolts and fiber/rebar reinforced shotcrete
- Weak condition: bolts/shotcrete (until concrete lining is installed)
- Rock support (on-site/at face) based on mass classification (Q-system / RMR)

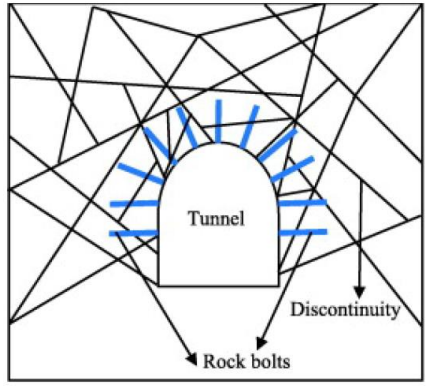


Ground quality and need for measures to create stability



Rock support classes	I	II	III	IV	V
Rockmass quality	Good	Intermediate	Poor	Very poor	Extremely poor
Class	A/B	C	D	E/F	G
Q-verdi	Q ≥ 10	4 ≤ Q < 10	1 ≤ Q < 4	0, 01 ≤ Q < 1	Q<0,01
Bolting in roof c/c and length	2,5m x 2,5m L=4m	2,0m x 2,0m l=4m	1,7m x 1,7m l=4m	1,3m x 1,3m l=4m *	Casted concrete
Bolting in wall c/c and length	Spotbolting L=3m	Spotbolting l=3m	2,0m x 2,0m l=3m	1,5m x 1,5m l=3m	
Shotcrete roof (mm)	80mm	80mm	100mm	150 mm + reinforced shotcrete arches	Special design
Shotcrete Wall (mm)	Scaling	80 mm 1,5 m over sole	80 mm 1,5 m over sole	100 mm	

Figure xx: Typical diagram for description of rock support given by mapping using the Q-system.



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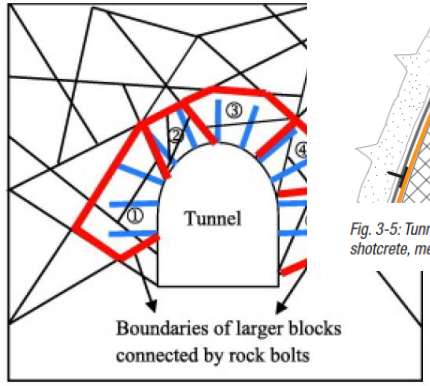


b

Lining types

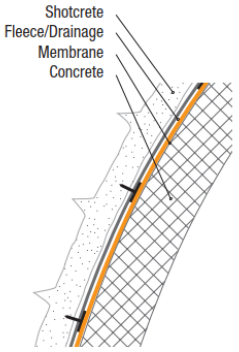


Fig. 3-5: Tunnel lining with shotcrete, membranes, concrete

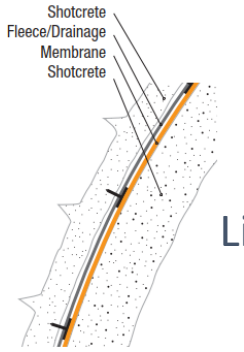


Fig. 3-6: Tunnel lining with shotcrete, membranes, shotcrete

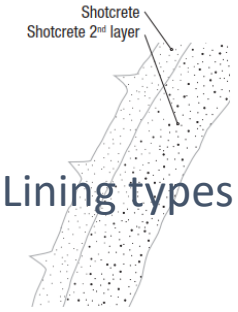
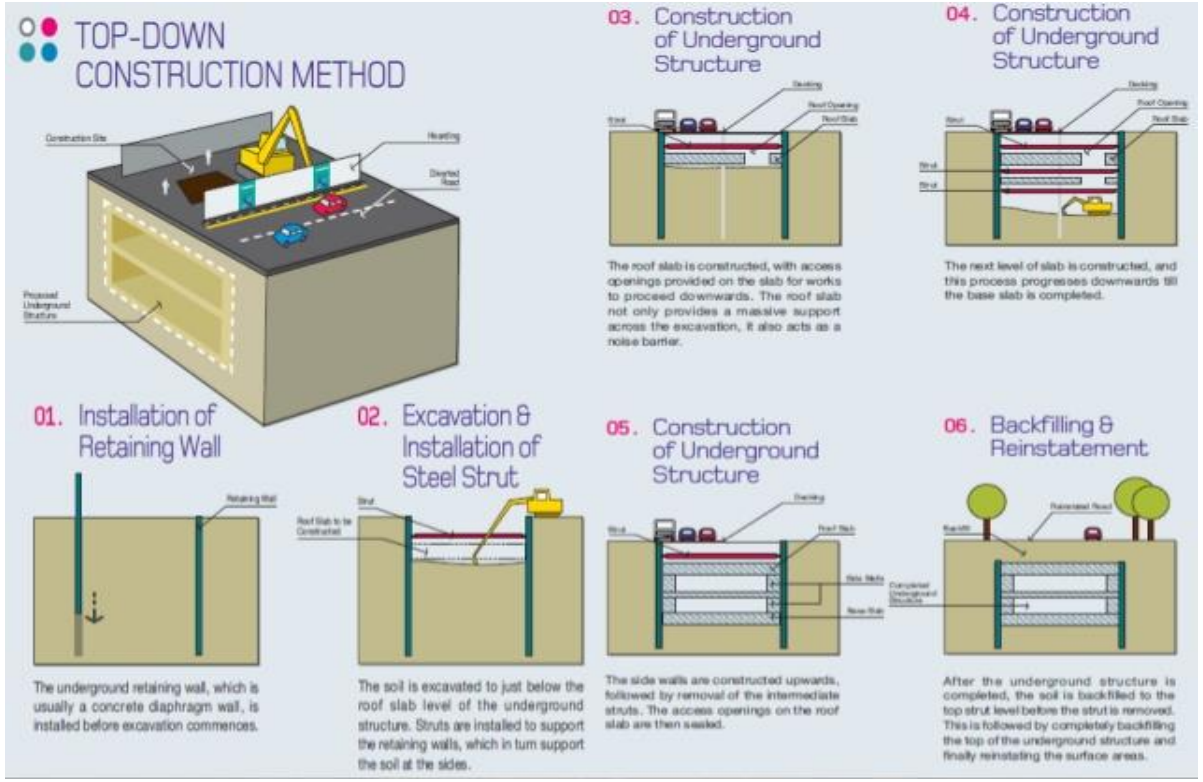


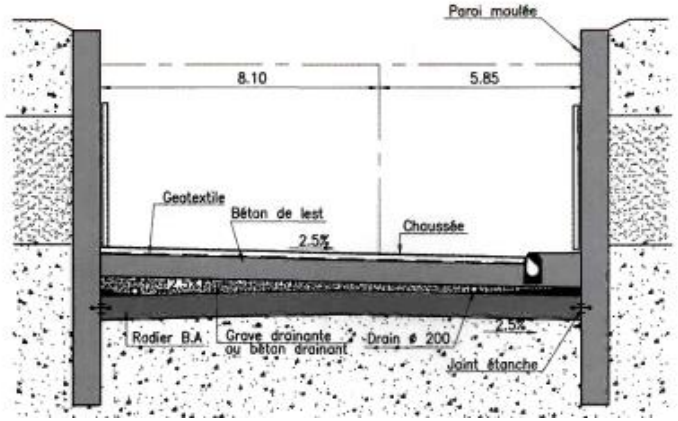
Fig. 3-7: Tunnel lining with shotcrete

IfcTunnel Scope – Construction methods (3/3)

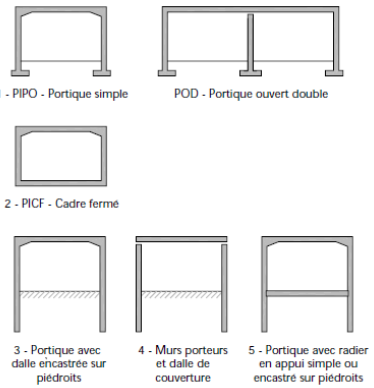
Cut&cover



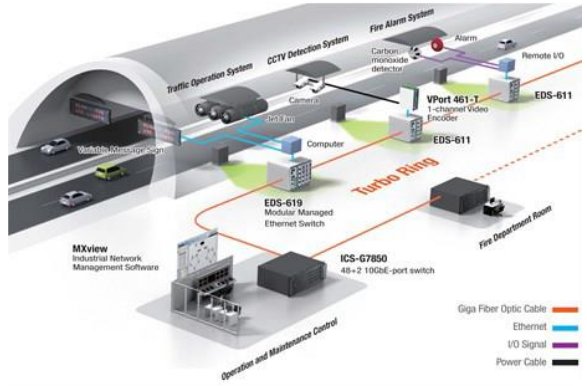
Retaining walls



Covered structures



IfcTunnel Scope – Sub systems



IfcTunnel scope – sub-systems organic structure

Proposed P1:

- Supervision
- Ventilation
- Lighting
- Fire protection
- Emergency & safety

Proposed P2:

- Drainage
- Power supply
- Geothermal

Tunnel types

Conventional | Mechanized TBM'd | Immersed (+floating) | Shafts | Cut & Cover | Micro-tunnels | Stations Caverns

Tunnel systems

- Structural support
- Lining
- Waterproofing
- Drainage
- Geothermal
- Power supply
- Lighting
- Telecom
- Ventilation
- Fire Protection
- Emergency (Evacuation/Access)
- Control system (SCADA/supervision)
- Trafic control

Alignment / Geolocalisation

Geology / Geotechnical conditions&uncertainties

IfcTunnel Scope – Sub systems (1/3)

Ventilation

- Civil engineering associated to ventilation
  - Air ducts Civil engineering : galleries, shafts, tunnel ducts, branches
  - Premises, units, factories, cenytral ventilating
  - Arrangements in tunnel, bosses
- Electromechanical
  - Electro-fan (and its control accessories)
  - Accelerator (and its control accessories)
  - Disconnecting devices: registers, motorized hatches, valves, doors
- Sensors
  - Air quality: CO, NOx
  - Air quality: opacimeter
  - Anemometer
  - Tunnel air temperature sensor
  - Weather station
- Other
  - Organs of Acoustic attenuation

LowVoltage / Energized Equipements

- Power supply
  - High tension
  - Transformation
  - Low tension
  - Wiring
- Lighting
  - Devices
  - Junction box
  - Sensors
  - Runway lights
- Networks
  - Optical Fibre junction box
  - Optical Fibre cable
  - Switch
  - Network Supervisor
- Centralised Technical Management system / Oversight
  - Programmable logic controllers
  - Remote output input module
  - Supervisory server
  - Archiving server
  - Supervision
  - Maintenance station
- Video surveillance
  - Shooting equipment
  - Automatic Incident Detection
  - CCTV system
  - Visualization system
- Emergency Call Network
  - Business Continuity Plan (BCP)
  - Emergency Call Station
  - Server of Emergency Call Station
  - radiating cable
  - Mast
  - Antenna
  - Transmitter / receiver
  - Radio station

IfcTunnel Scope – Sub systems (2/3)

Fire protection

- Fire Water supply
  - From the public network
  - Water connection point and counting
  - Storage / Cistern
  - Group of Pressurizing
  - Room for Pressurizing Group
- Delivery
  - Description of the network
  - Underground pipe
  - Culvert
  - Overhead line
  - Description of the freeze protection
  - Insulating
  - Electric tracing
  - Axis
  - Pressurizing Pressurizing
  - Device to prevent pressure chocks
  - Pipe (object / branch of network for calculation)
  - Canalization (node)
  - Pipe (interface)
  - Pipeline (product / range)
- Restitution
  - Recess for a fire hydrant or surge
  - Fire hydrant
  - Surge
  - Connector
  - Taps (Product / Range)
  - Instrumentation
  - Electrical tracing
  - Corrosion protection

- Signage and Safety Equipment
  - Closing and signaling
  - Auto evacuation
  - Security niche
- Various local
  - Ventilation ducts
  - Technical premises
  - PAU and possibly sound device
  - Signage (after the tunnel gate to the assembly point)
- Shelters with tracking
  - Sas
  - Waiting area
  - Geometry related to pedestrian traffic (connection with the outside, for users and rescue)
  - Doors
  - Ventilation of the shelter (including overpressure)
  - Ventilation of the path (direct connection with the outside)
  - Lighting
  - Fire resistance
  - PAU
  - Sound system (speaker)
  - Signage (after the tunnel gate to the assembly point)

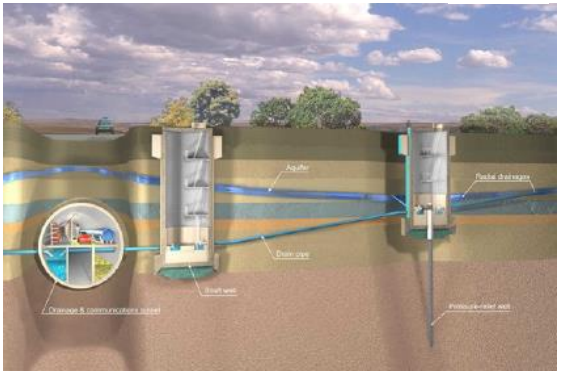
Safety / Evacuation

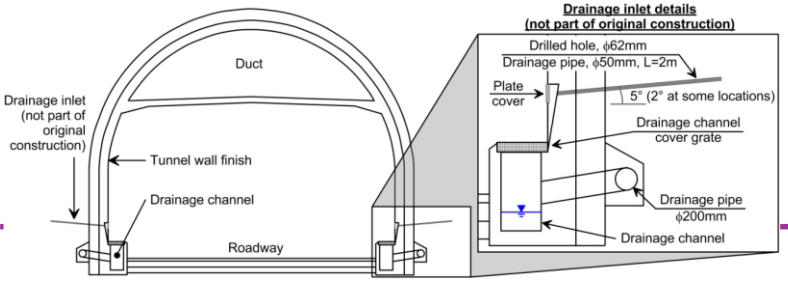
- Specific equipment in tunnel
  - Flash fire
  - Guide chevron
  - Neons
- Lighting in case of evacuation
  - Positioning of the flash lights
  - Positioning of the rafters
- Sound system
  - Positioning
  - Characteristics
  - Sirens
  - Sound beacon
- Airlock
  - Dimensions
  - Characteristics
  - Ventilation
  - Doors
- Waiting area
  - Dimensions
  - Characteristics

IfcTunnel Scope – Sub systems (3/3)

Drainage

- Network of Drainage - Sanitation
  - Identification data of drainage-sanitation network
  - Typology of drainage-sanitation network
  - Information of network control
  - Information of network Implementation (Implementation
  - Information of network construction (activities)
  - Information of Network Maintenance (Activities)
  - Information of Network dismantling (activities)
  - Transport of effluents
  - Absorption of effluents (terminals)
  - Acces to the Network Sewing
  - Management of effluent
- Drained Space
  - Typology of drained space
  - Typology of effluents
  - Liaisons between objects
  - Topological data of collected surface
  - Hydraulic surface data collected
- Water point
  - Typology of water point
  - Data of water point identification
  - Liaisons between objects
  - Hydraulic data of water point





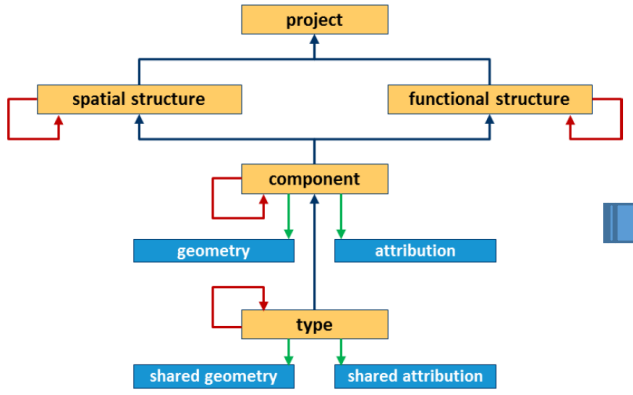
HighVoltage / Traction

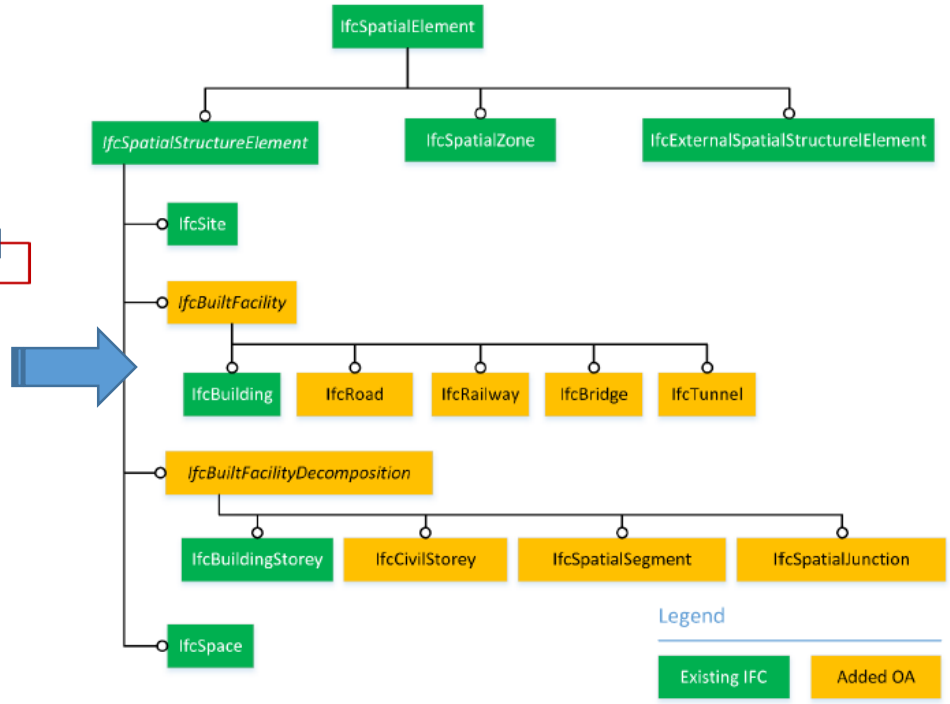
- Aerial Hight Voltage
  - Delivery post of Aerial High Voltage
  - Artery of Aerial High Voltage
- Low Voltage Distribution
  - Force Lighting Station / Force Station
  - Low Voltage Distribution
  - Emergency power - Uninterrupted power supply and generator (room for battery and generator)
  - System protection and grounding system
- TRACTION
  - Traction Substation + Sectioning Station
  - Traction Distribution
  - Traction Current Feedback Circuit
  - Braking energy recovery systems
- Autonomous system
  - Autonomous production plant
  - Low Voltage Distribution

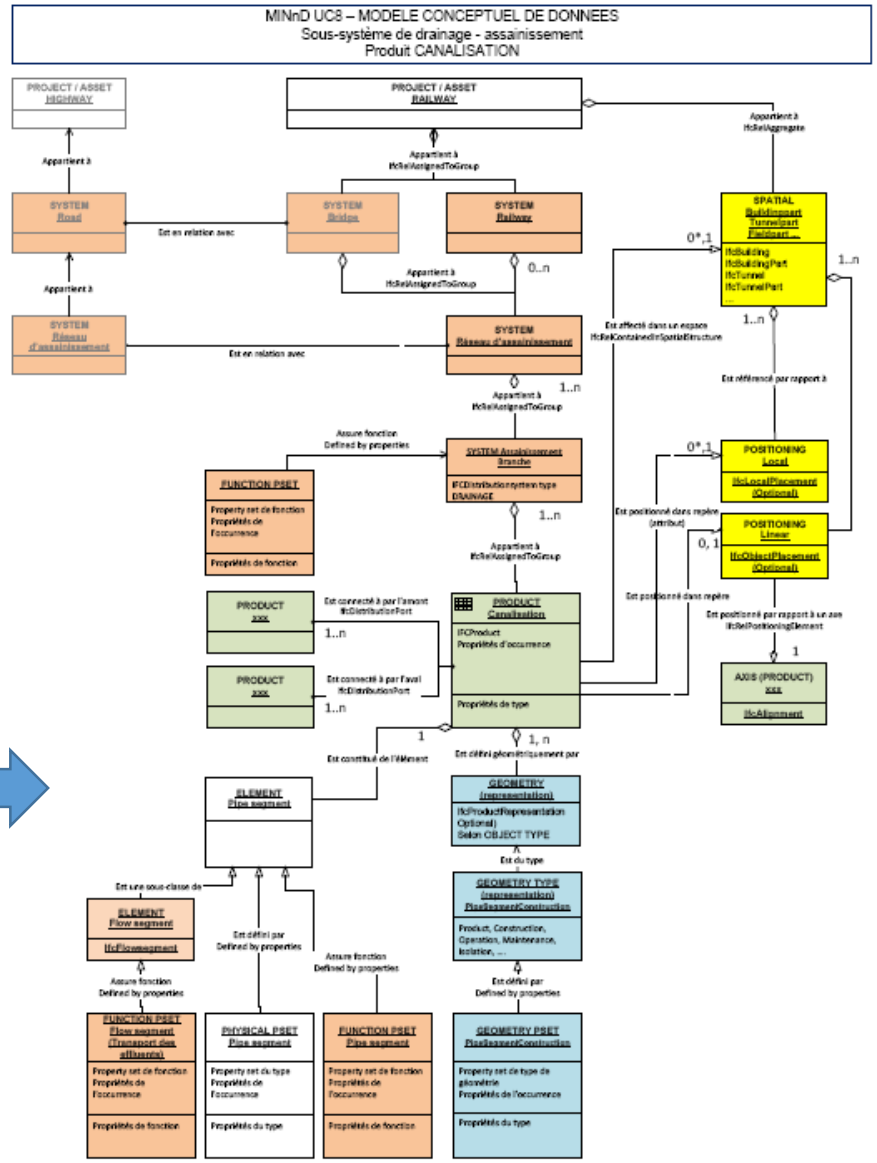
IfcTunnel Scope – Next steps

#2.From scope to taxonomies

#3.From requirements to conceptual model







IfcTunnel project is to describe:

Functions

Geometries

Domains semantics

IfcTunnel Scope proposal

Experts panel review (#1 - 2019-11-21)

bSI IfcTunnel Team

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