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In collaboration

Rhätische Bahn
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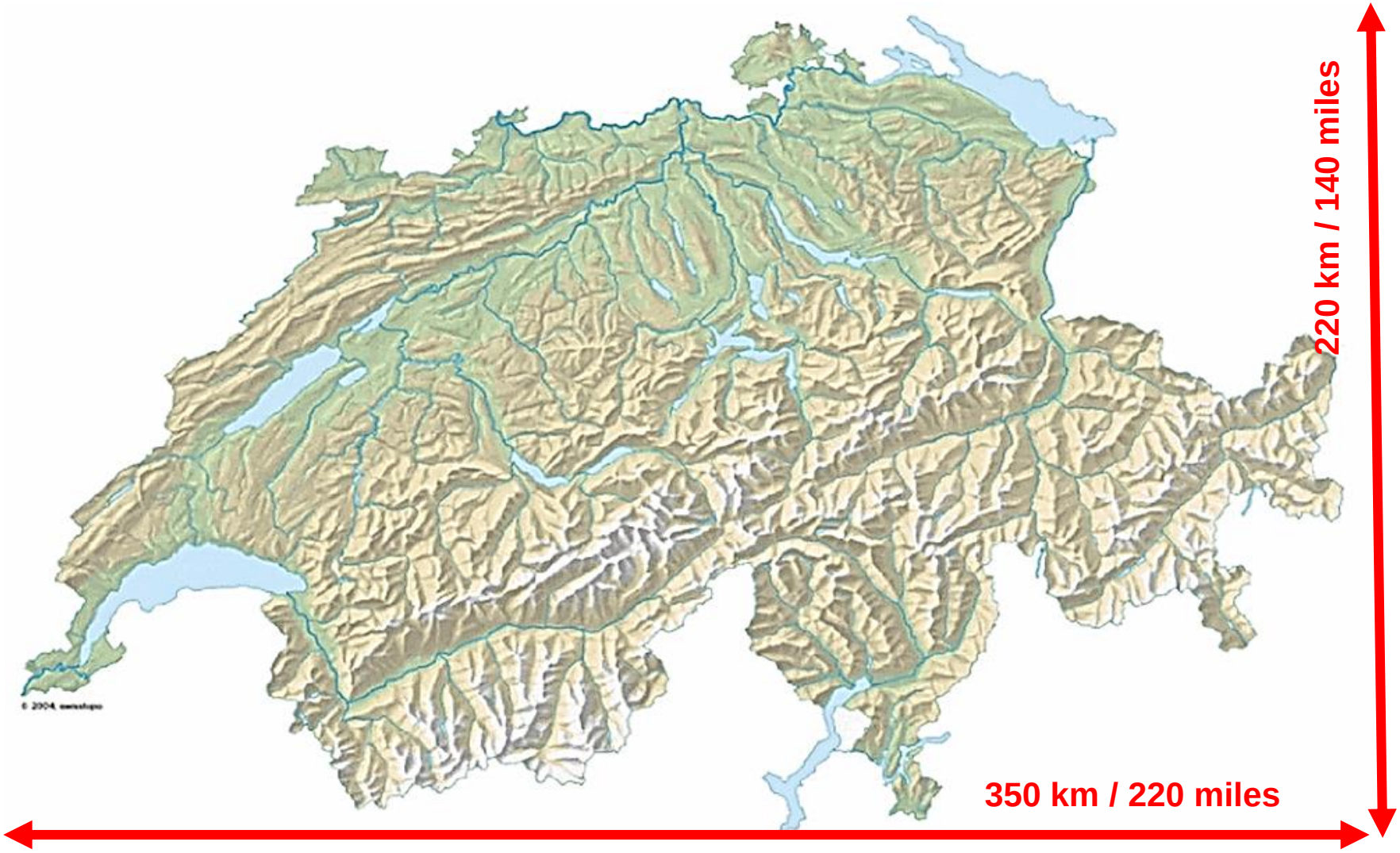
Infrastructure maintenance strategy plan of the RhB: how to preserve the patrimony of a rail network

APTA

RAIL CONFERENCE 2019

Switzerland, a small country in the heart of Europe which speaks 4 languages, …

A small country in the middle of the Alps, …

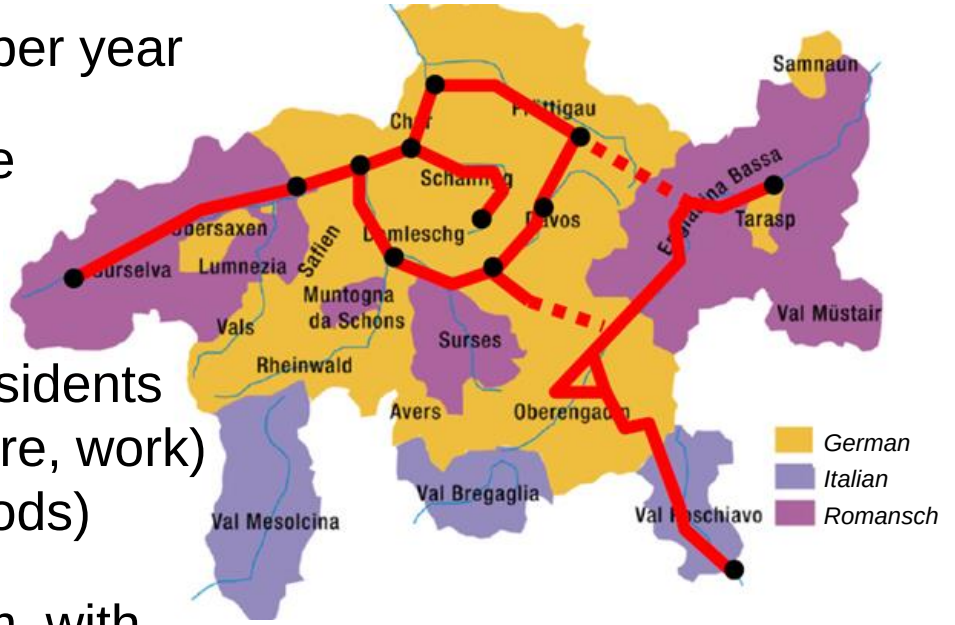


… with one of the most dense, efficient and attractive public transportation network in the world !

Welcome in the Grisons, the largest Canton of Switzerland, home of the RhB, the Rhaetian Railway

The Rhaetian Railway, key facts (1)

- More than 10 million passengers per year
- a wonderful and unique landscape
- 3 cultures and 3 languages
- An essential mobility carrier for residents (home-to-work/school travel, leisure, work) and the economy (transport of goods)
- An incredible motor for the tourism, with internationally recognized trains services such as the Glacier Express, the Bernina Express and the UNESCO World Heritage
- One of the largest employers in this mountain canton, with more than 1’400 employees



The Rhaetian Railway, key facts (2)

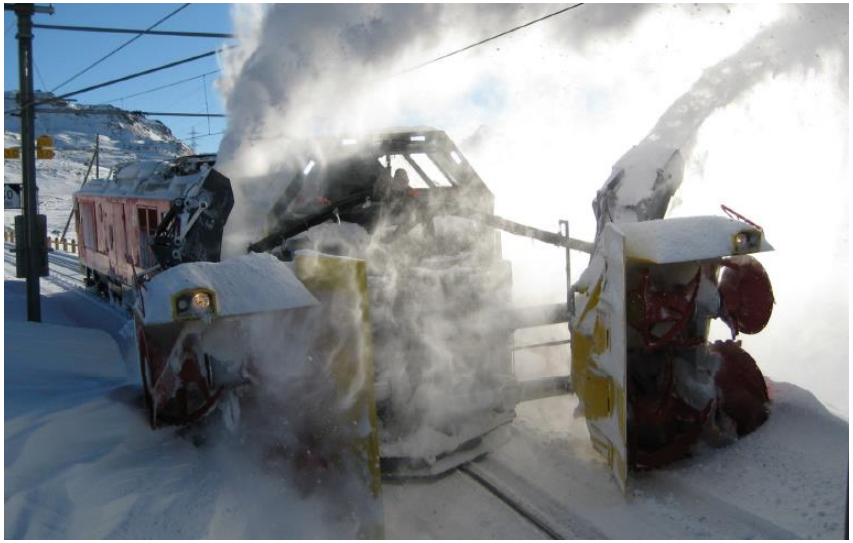
- 384 kilometer (meter gauge)
- Practically only single track
- More than 600 bridges and viaducts
- 115 tunnels (the longer 19 km)
- 103 stations
- One centralized TCC
- Locomotives ~ 60
- EMU ~ 20
- Coaches ~ 900
- Passenger Kilometers 364 Millions
- Punctuality (<5') 96%
- Degree of cost coverage 58%

The Rhaetian Railway, key facts (3)

A real mountain railway with many challenges :

- ❑ Part of the network above 1'500 m **30%**
- ❑ Part of the network in tunnel or on bridges **20%**
- ❑ highest point **2’253 meters above s.l.**
- ❑ Highest gradient (adhesion rail without rack) **70 ‰**
- ❑ Very windy and temperature to -35°

Very hard winters



A sometimes hostile environment

Incredible civil engineering structures

The biggest roundabout of the Alps

The most complex helical tunnels

Wonderful landscape

Recognized international trade marks

Rhaetian Railway

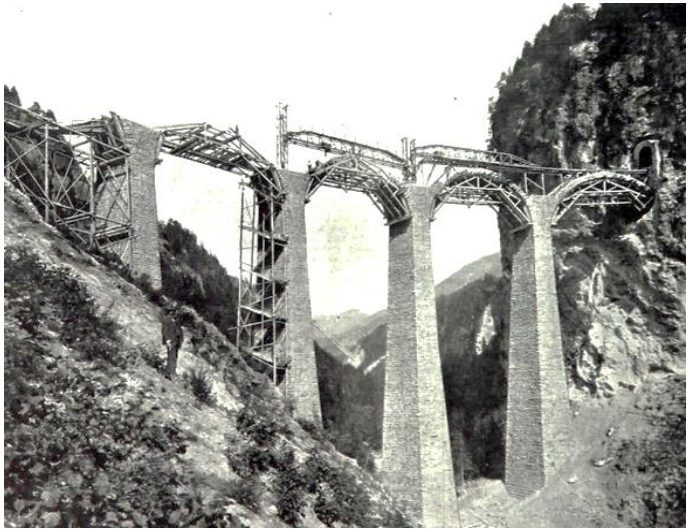
UNESCO
WORLD HERITAGE
ALBULA BERNINA

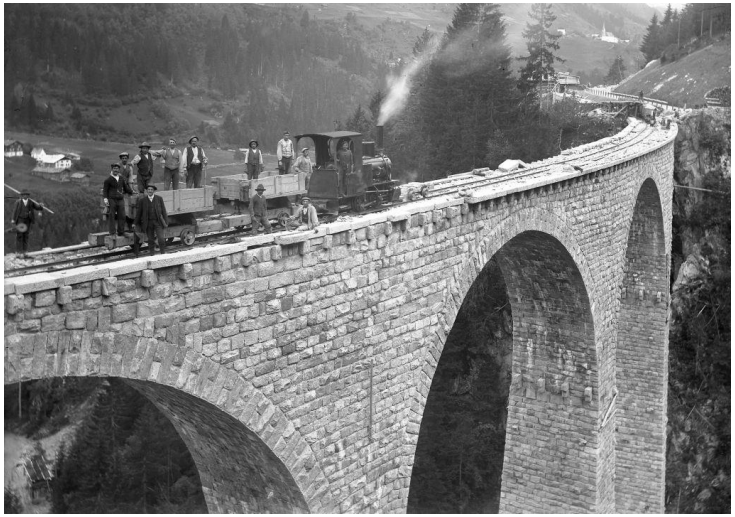
graubünden

A continues renewal and diversification of the offer and the services: for photography enthusiasts, for children, …

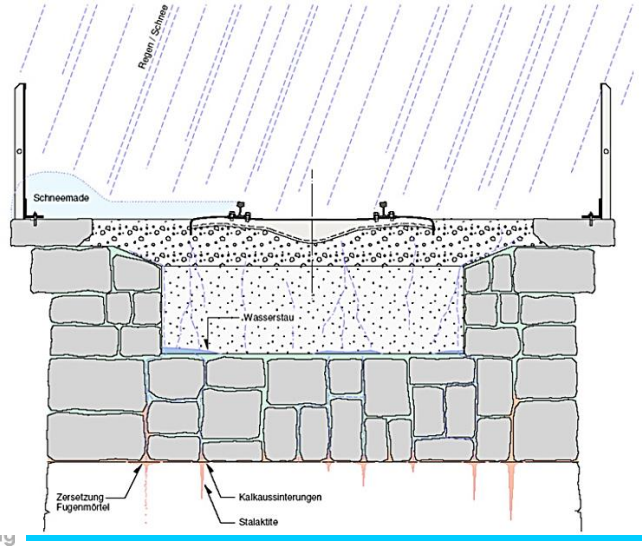
… as well as for nostalgic, romantic and tourist looking for luxury experiences.

But … this network built by pioneers in only a few decades (1889-1914) aged at the same time.

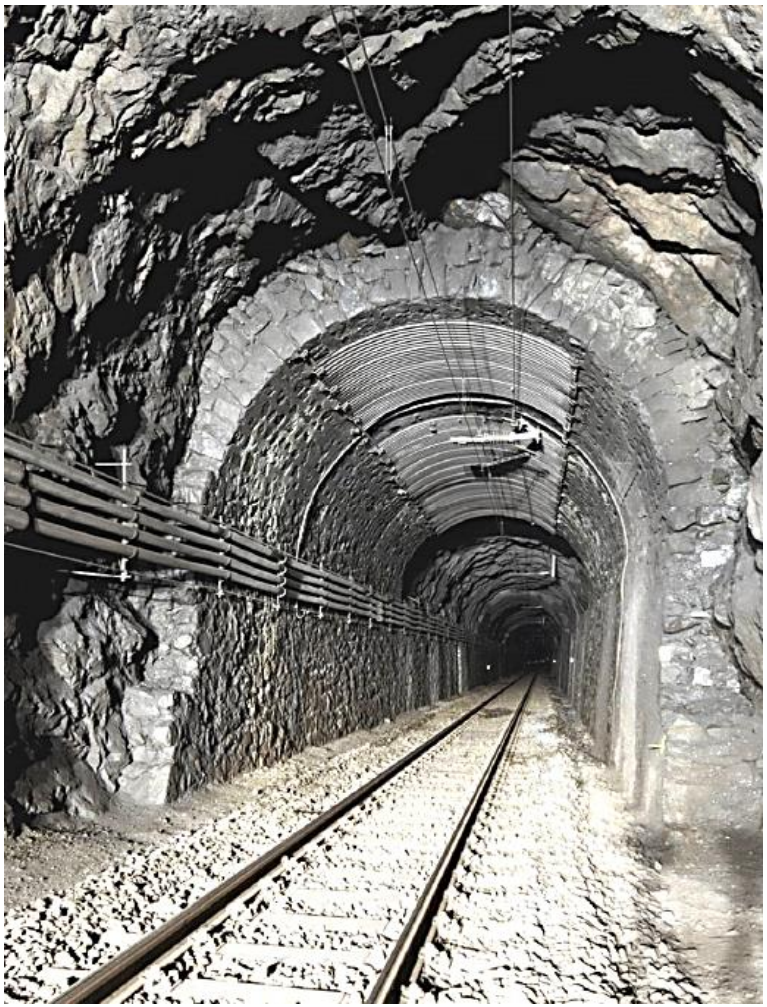


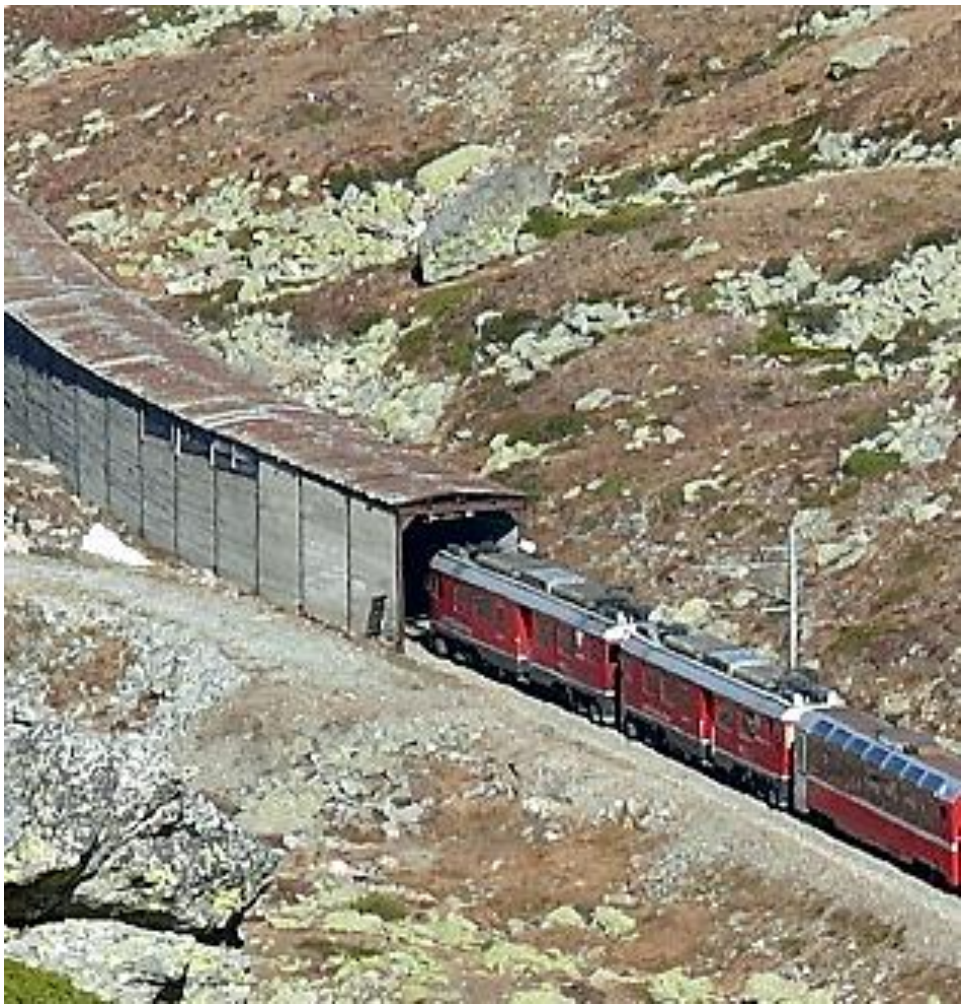


At the beginning of this century the situation of a lot of structure and equipment was not the best, …



… and due to inadequate maintenance and renewal the degradation was likely to accelerate

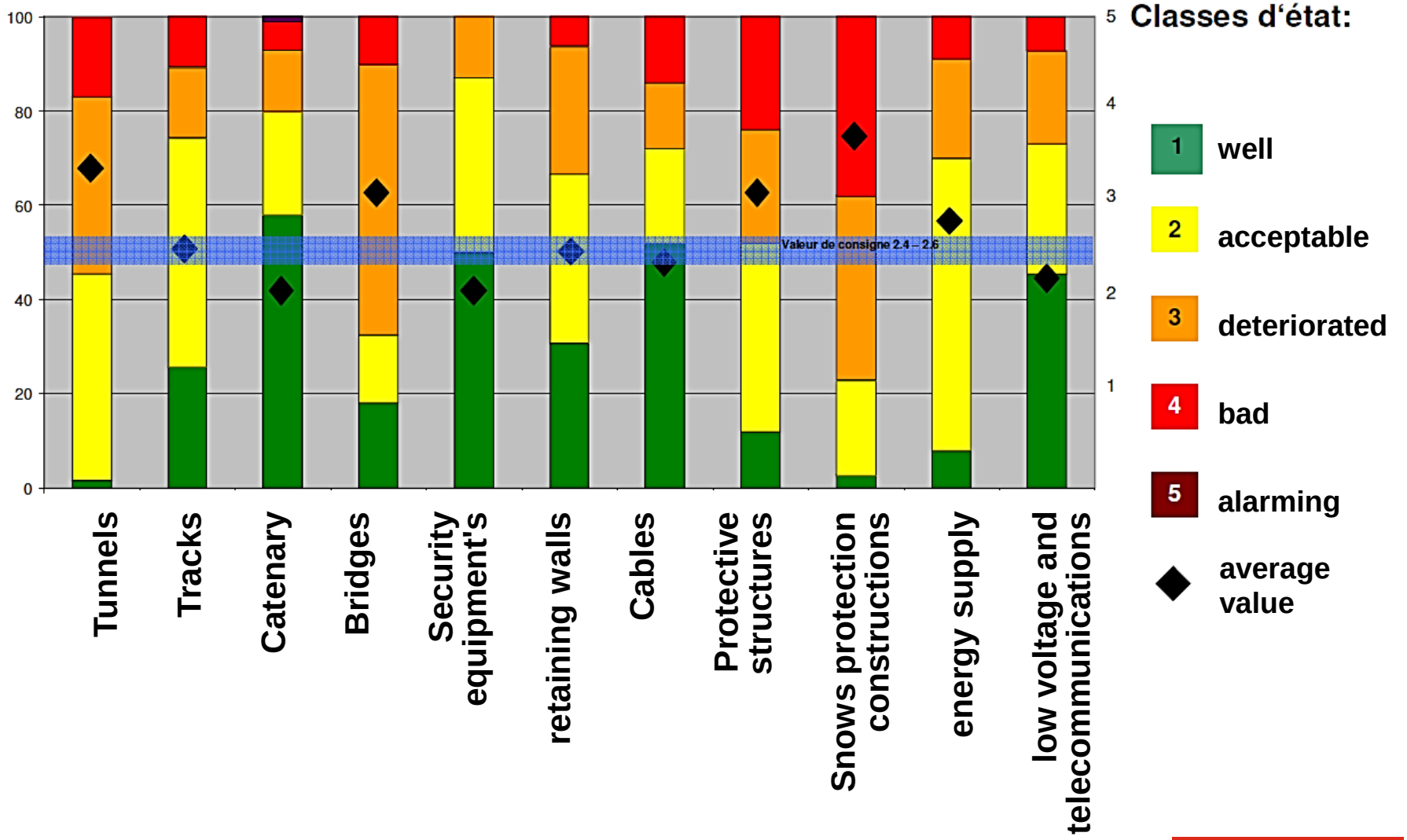




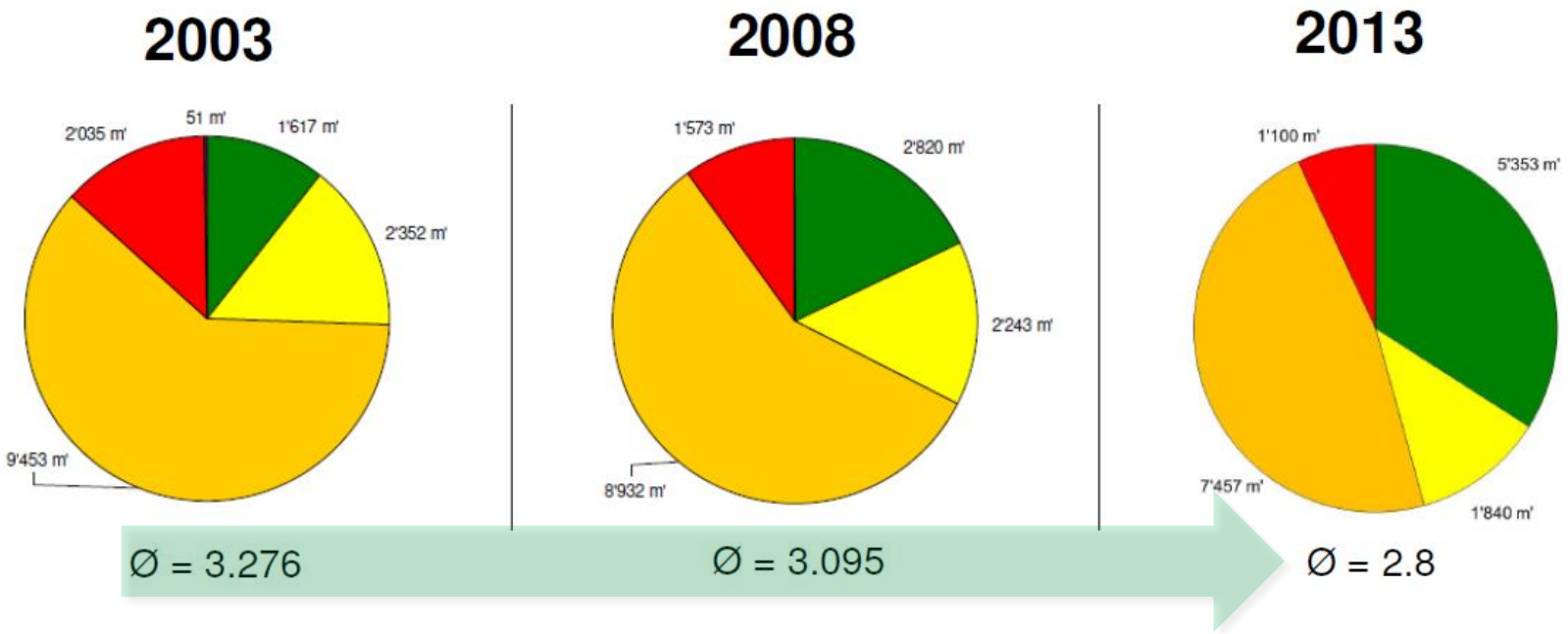
What to do? And how to react?

- Define a new **maintenance and renewal strategy plan**
- Check in details the state of the infrastructure and other equipment thanks to external specialists (**asset analysis**)
- Define how to ensure the **evolution between the observed state and the target objective**
- **Optimize investments**, which must be made at the right time (**not too early, not too late**)
- Plan the **distribution of interventions/investments** on the network
- Imagine a new method of renewal with "**standard constructions**" to ensure uninterrupted service (on a single track network!)
- Even if the basic objective is to ensure uninterrupted service (on a single track!) **introduce when absolutely necessary the "clustering" approach,** with total closure of certain lines.

Definition and classification of the assets with a clear evaluation methodology and 5 classes (situation 2012)



Example of application of the new strategy: evolution of the state of bridges between 2003 and 2013

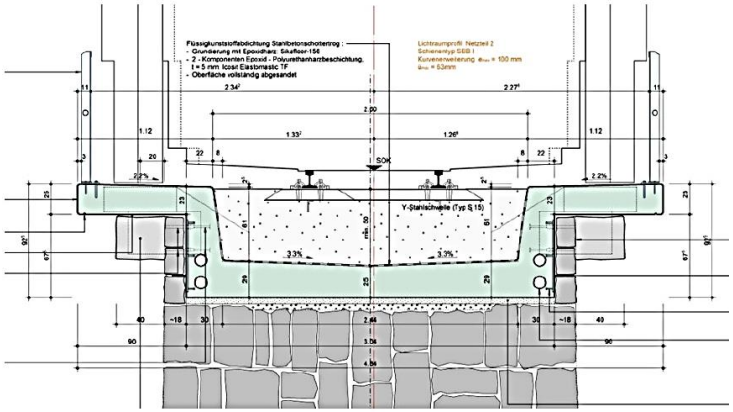


Classes d'état:

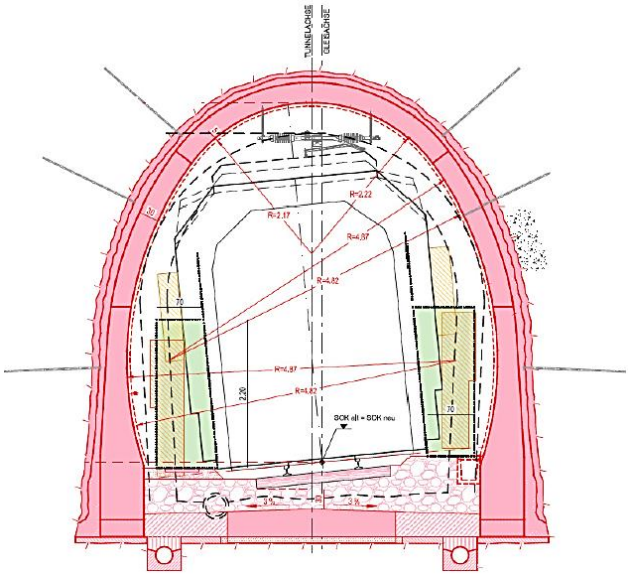
1	**Well**	
2	**Acceptable**	**renewal in about 50 years**
3	**Deteriorated**	**renewal in 25 to 30 years**
4	**Bad**	**renewal in 5 to 10 years**
5	**Alarming**	**immediate renewal**

The new “Standard Construction” approach, to ensure a better and more efficient result

The RhB has developed a new uniform method of repair dubbed "**standard construction**", which guarantees **compliance with regulated building procedures** and low**er costs than with previous methods**, while allowing renovation work to take place **with the railway in operation**.

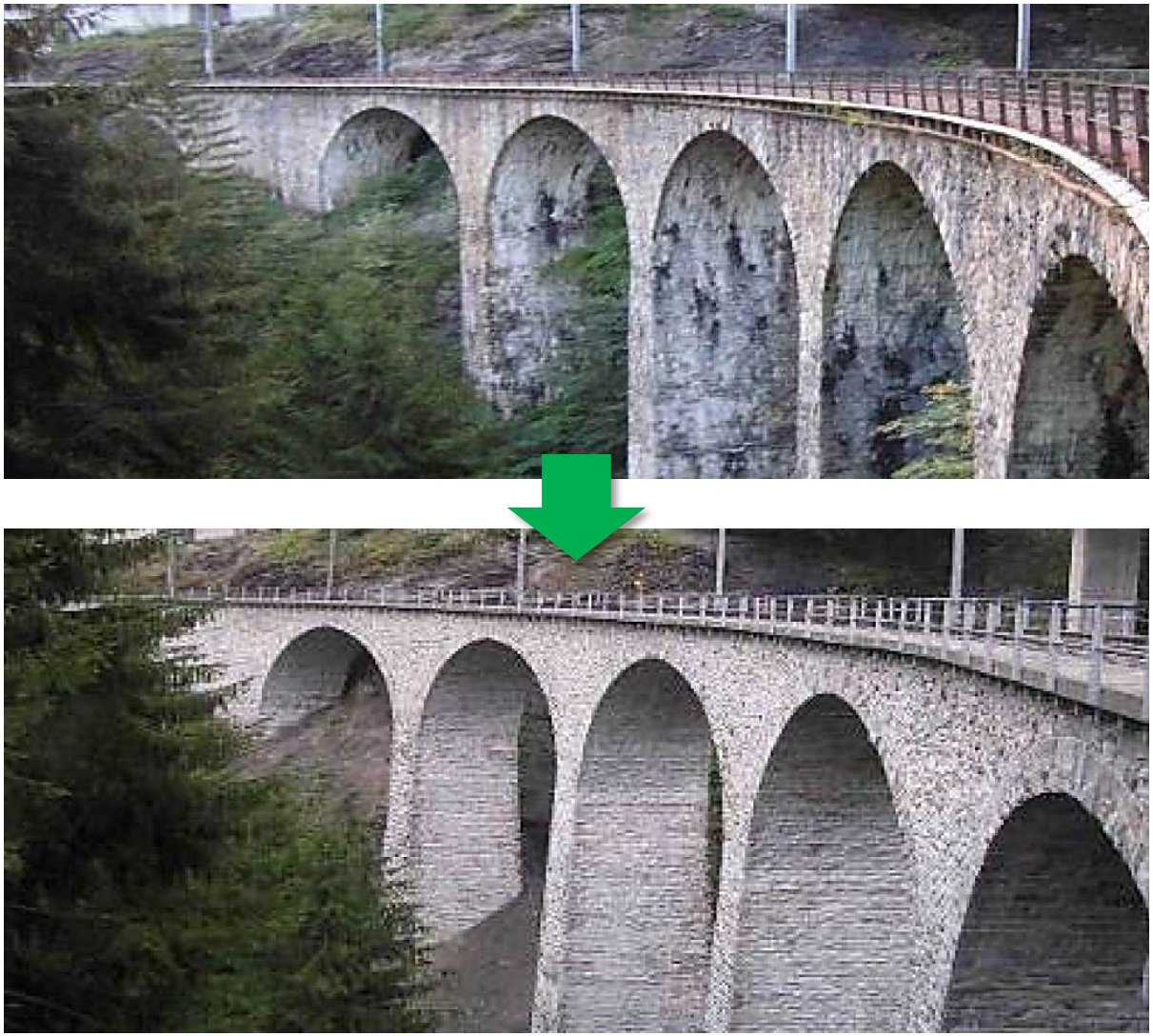


Thanks to the newly developed standard construction procedure, **the quality and cost-effectiveness of tunnel and bridge repair work are both set to be improved**; accompanied by increased safety standards and a lengthening of service life from the current average of 30 to 50 years to 70 to 100 years.

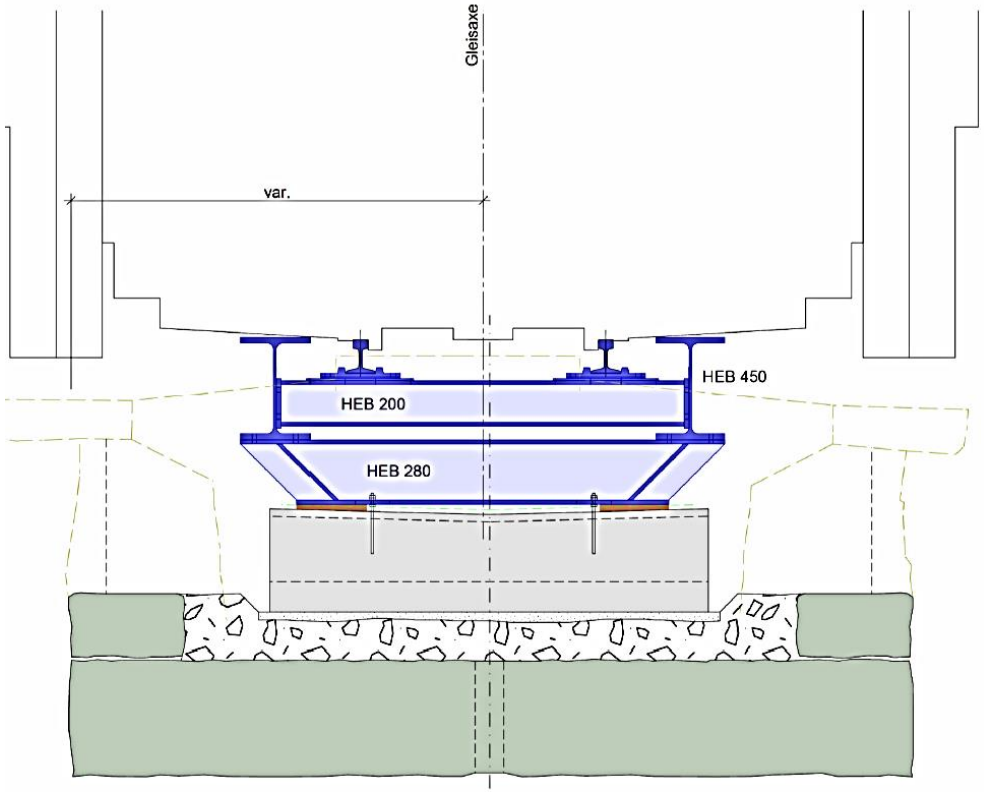


The service have to be ensured during the day: track interception time between 5 and 9 hours in the night

Standard Construction for bridges



Standard Construction for bridges
Phase 1 : auxiliary bridge



Preliminary work

- ❑ Scaffolding
- ❑ Temporary track

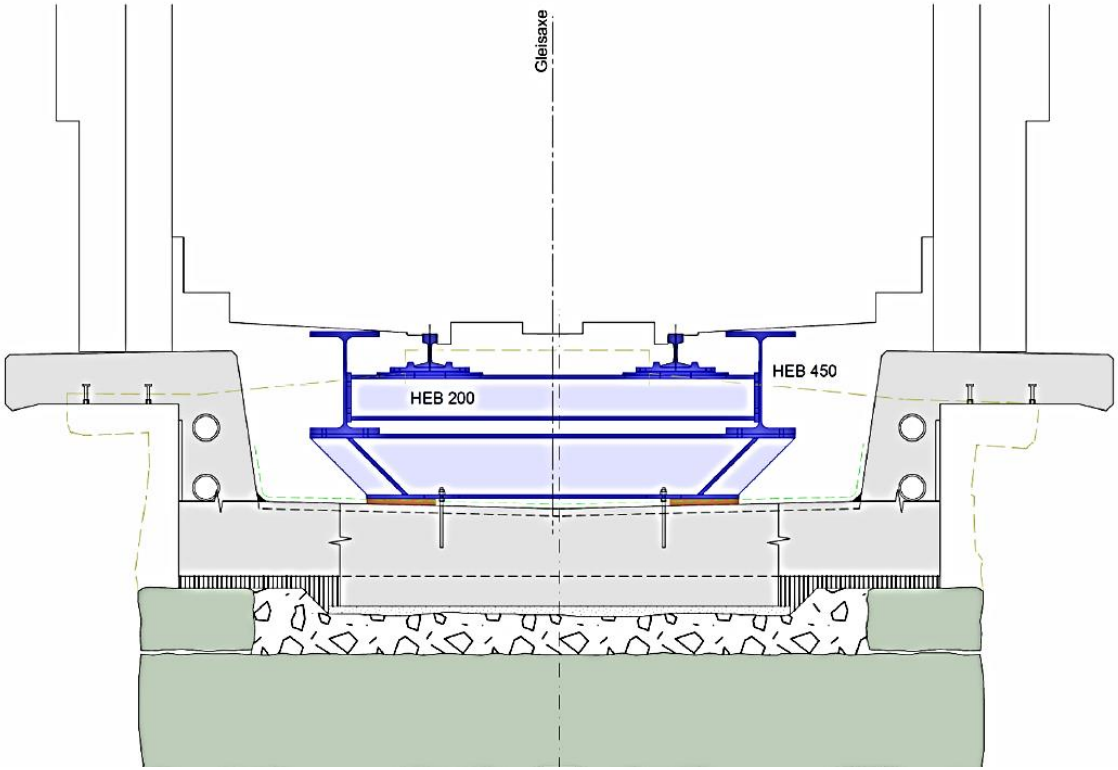
Phase 1 (auxiliary bridge)

- ❑ Bodywork demolition
- ❑ Track dismantling
- ❑ Excavation
- ❑ Installation of prefabricated foundations
- ❑ Installation of auxiliary bridges

Standard Construction for bridges
Phase 1 : auxiliary bridge

Standard Construction for bridges
Phase 1 : auxiliary bridge

Standard Construction for bridges
Phase 2 : concrete formwork

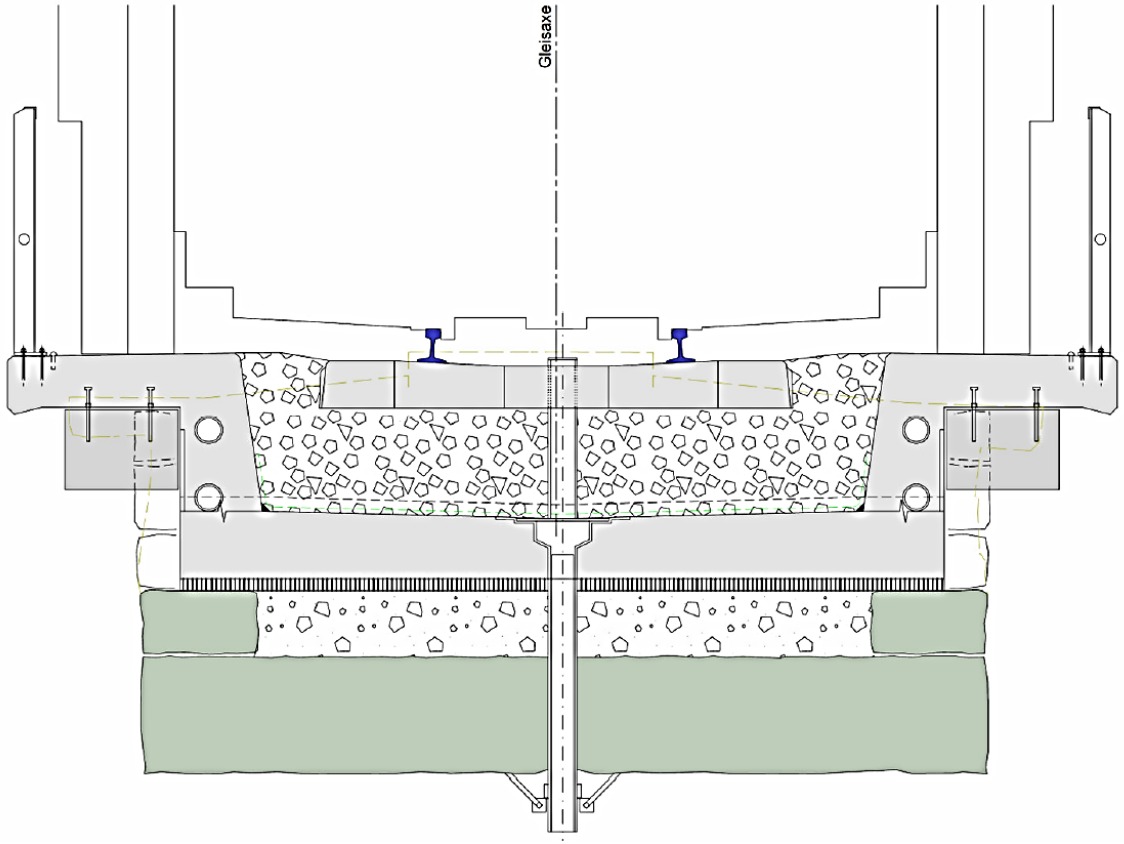


Phase 2 (auxiliary bridge)

- reinforcement of the formwork
- concrete pouring during night closure (per train transport, usually no road access)
- application of waterproofing

Standard Construction for bridges
Phase 2 : concrete formwork

Standard Construction for bridges
Phase 3 : finalization



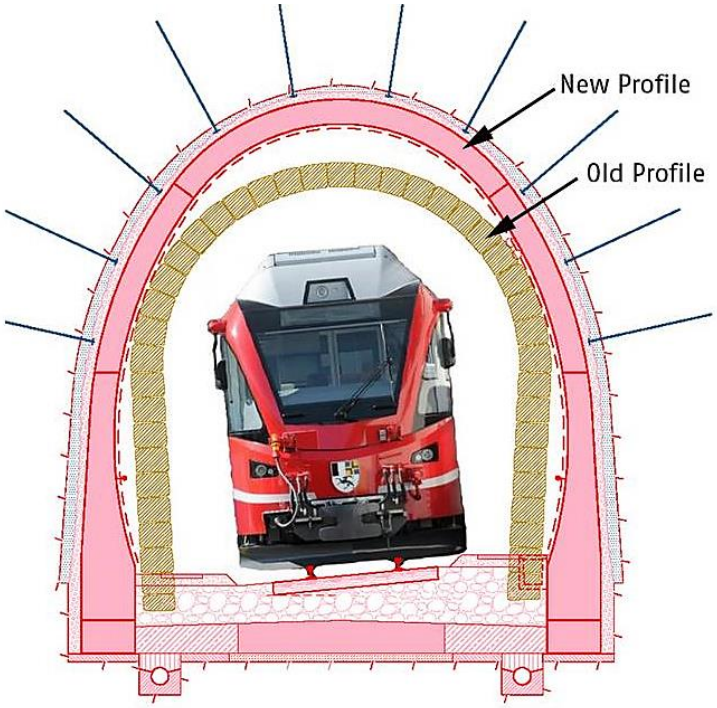
Phase 3

- ❑ disassembly of the auxiliary bridge
- ❑ installation of gravel, sleepers and rails
- ❑ wall cladding with natural stone
- ❑ installation of corbels and guardrails

For this final part you have to submit to the rules of the UNESCO, and ensure that the final aesthetic will be exactly like the previous one

Standard Construction for bridges
Phase 3 : finalization

Standard Construction for tunnels : the idea

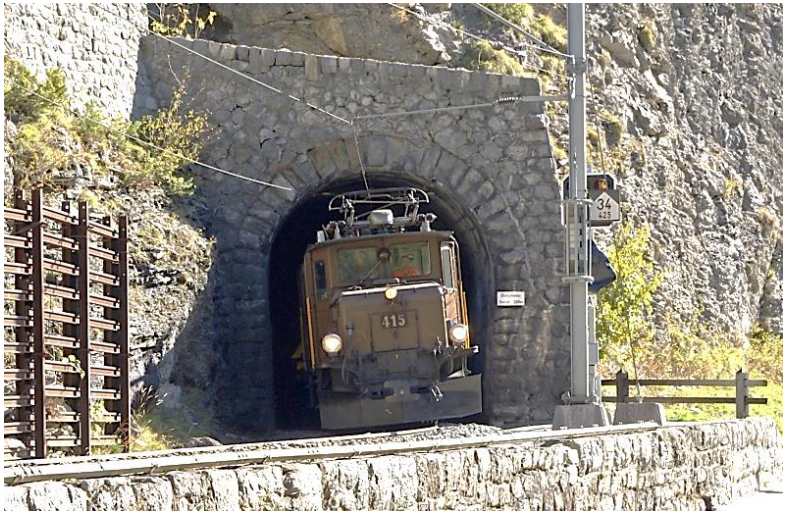


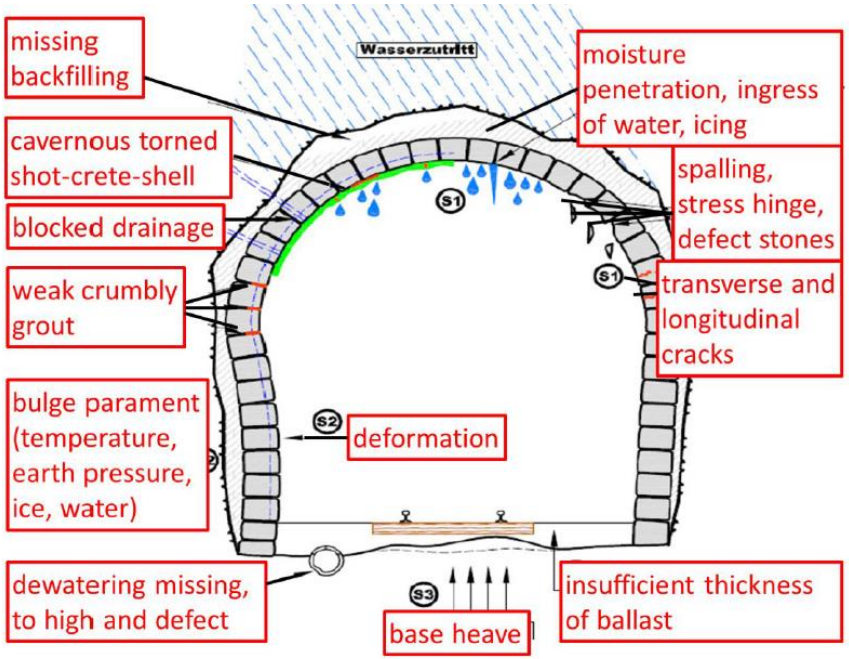
This new procedure entails full replacement - rather than "mere" restoration - of the walls of the tunnels concerned.

The track is lowered for this purpose, increasing the cross-section of the tunnel; a new drainage system is added, new walls made of prefabricated concrete sections are installed and the tunnel entrances are rebuilt. All this allows the tunnel to be repaired with the railway in operation.

The first tests were made a few years ago in an old unused tunnel of a quarry

Standard Construction for tunnels : The first realization, the Glatscheras Tunnel





Tunnel length: 334 m

Single-lane metre gauge

Part of the famous Albula Railway Line (UNESCO)

1,350 m above sea level

Former Construction time: 1903 / 1904 → 144 days (drill & blast)

Present Construction time: Sep. 2014 – Nov. 2016 (night shift; winter)

275 m natural stone masonry (incl. two portals), 59 m unsupported rock

Strongly bended railway line (Rmin = 108 m)

Track bed is made up of ballast

old cross-section: 27 m2

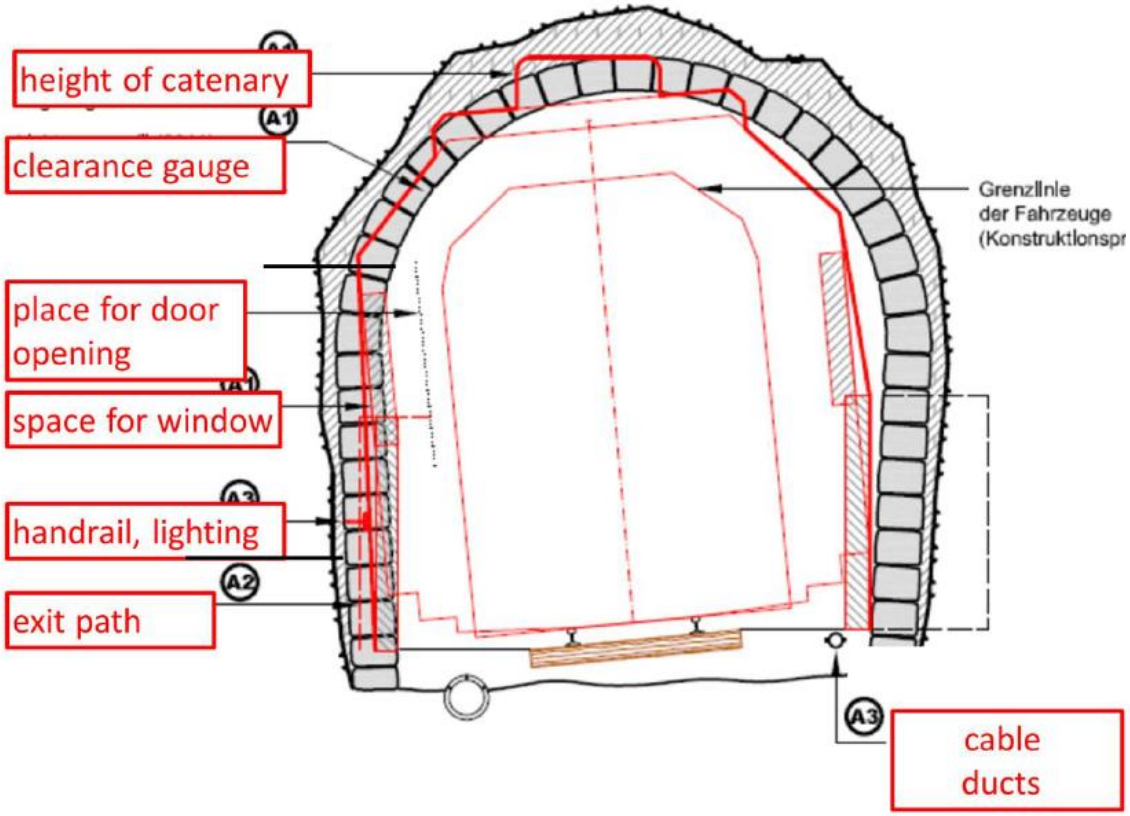
horseshoe profile

structural damages, but structural safety is usually not reduced

usability is partly restricted

Standard Construction for tunnels : The first realization, the Glatscheras Tunnel

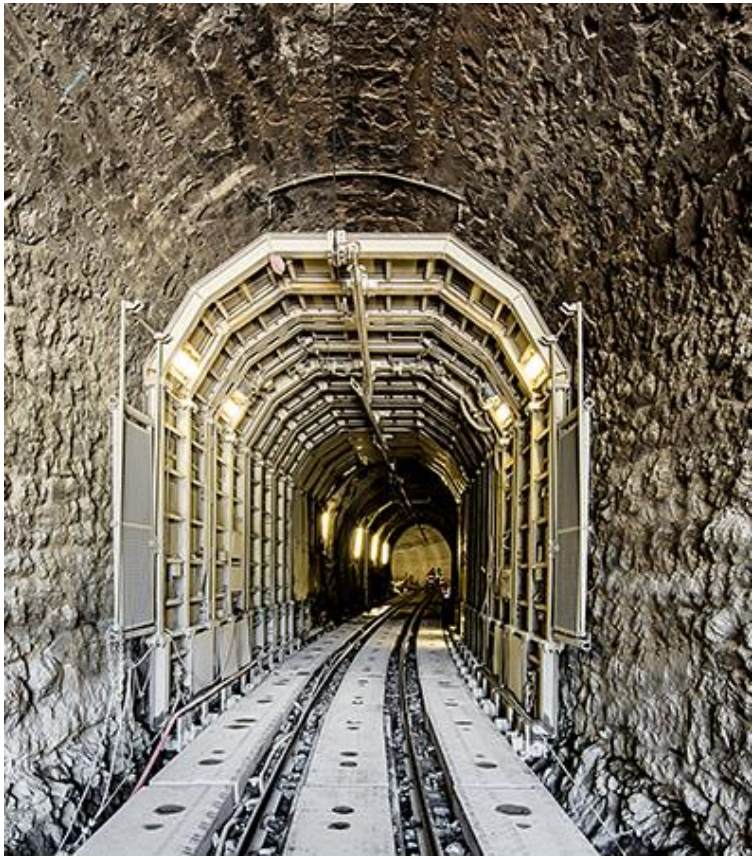
The new standard tunnel construction procedure was used for the first time in the repair of the 334-metre-long Glatscheras Tunnel under Bergün, which is some 108 years old. This involved lowering the track by 52cm. The operation have to be ensured during the day (night shift) !



- doesn't fulfil superior requirements
- necessity of widening the profile (tunnel and portals)
- remediation portals observing the conditions of UNESCO

Standard Construction for tunnels : The first realization, the Glatscheras Tunnel

The tunnel's cross-section was enlarged by drilling and blasting, … followed by the installation, from goods wagons on the track, of prefabricated concrete sections.



Standard Construction for tunnels : The first realization, the Glatscheras Tunnel

… followed by the installation, from goods wagons on the track, of prefabricated concrete sections.

Standard Construction for tunnels : The first realization, the Glatscheras Tunnel

Standard Construction for tunnels :
The first realization, the Glatscheras Tunnel

The Rhaetian Railway, something different !