

# Master of Advanced Studies

# “Tunnelling”

## An International Training Program

<http://lmr.epfl.ch/mas>

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EPFL-ENAC-LMR

# EPFL-ITA MAS Tunnelling

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## Objective:

**Provide advanced and practical oriented training to engineers wishing to acquire advanced knowledge and experience in tunnelling worldwide.**

## Organisation:

**An Master of Advanced Studies programme of EPFL, endorsed by ITA. MAS degree is awarded by EPFL. It is governed by EPFL School of Continuing Education and run by EPFL-LMR.**

**The Board of Direction consists of representatives of EPFL, ITA and FGU.**



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## Targeted Students:

**Motivated tunnel or civil engineers desiring advanced knowledge;**

**Mostly at middle level toward taking more responsibilities;**

**Mostly sponsored by their employers.**

## Student Requirements:

**University degree (4-5 years) in engineering;**

**Some years of working experience in tunnelling or related engineering.**

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## Students (2007):

7 (3 China, 1 Singapore, 1 Nepal, 1 Greece, 1 Italy).

2 EPFL (1 PhD Spain, 1 Master Belgium).

## Students (2008):

6 (2 China, 1 Singapore, 1 Pakistan, 1 Greece, 1 USA).

3 EPFL (3 PhD China).

## Teachers:

More than 50 individual teachers (1/4 from abroad), 3/4 from industry, 1/4 from universities.

Teaching in English.

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## Content of Training

### 1. SUPERVISED READING (6 weeks)

- Distance study of general tunnelling topics.

### 2. CLASSES (16 weeks)

- Geological investigation and ground characterization;
- Rock and soil mechanics, tunnel design parameters;
- Excavation methods including conventional methods, TBM technology, ground treatment methods;
- Support and reinforcement, including observational and classification based designs, bolts, sprayed concrete and fibre reinforcement, and segmental lining design;
- Numerical methods including FEM and DEM, risk analysis, decision aids for tunnelling;

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- Special topics such as aerodynamics, tunnel monitoring, environmental assessment , construction management and safety, ventilation, fire safety, settlements, maintenance, contractual issues, and insurance;
- Cases of tunnelling projects highlighting Gotthard and Lötschberg base tunnels, and other interesting projects.

## 3. TUNNELLING PROJECT (14 weeks)

- Project work on tunnel planning, design and risk.

## 4. ENGINEERING ATTACHMENT (>8 weeks)

- Training at a tunnelling firm/site, covering tunnel planning, design, and construction.

## 5. MASTER THESIS (>12 weeks part-time)

- Thesis with a research topic or a case study.

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## Some Highlights

- ✓ **State-of-the-art technology and experience by specialists from various sectors worldwide.**
- ✓ **Teaching from more than 50 lecturers of specialisations, particularly by engineers.**
- ✓ **Company attachment of individual choices and well organised attachment training programme.**
- ✓ **Studying TBM at manufactory factory.**
- ✓ **On-site teaching at tunnelling site, e.g., VSH.**
- ✓ **Site visits to tunnelling projects in Switzerland and Europe, e.g., Gotthard.**

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## Fees

**MAS tuition fee CHF 18,000 including administration fees, insurances and taxes.**

## Local Arrangement:

**Supporting visa;**

**Finding accommodations;**

**Access to EPFL facilities and internet.**

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## FGU Sponsor for Swiss Students

**FGU supports Swiss student with the tuition fee.**

## Flexible Schedule Swiss and Regional Students

- **Classes at EPFL (4 months, Feb-Jun) attended in blocks in 2-3 years, i.e., each year attending 1 to 2 months, so students do not need to leave their job.**
- **Company attachment at their own company.**
- **MAS thesis on a topic related to his/her work.**

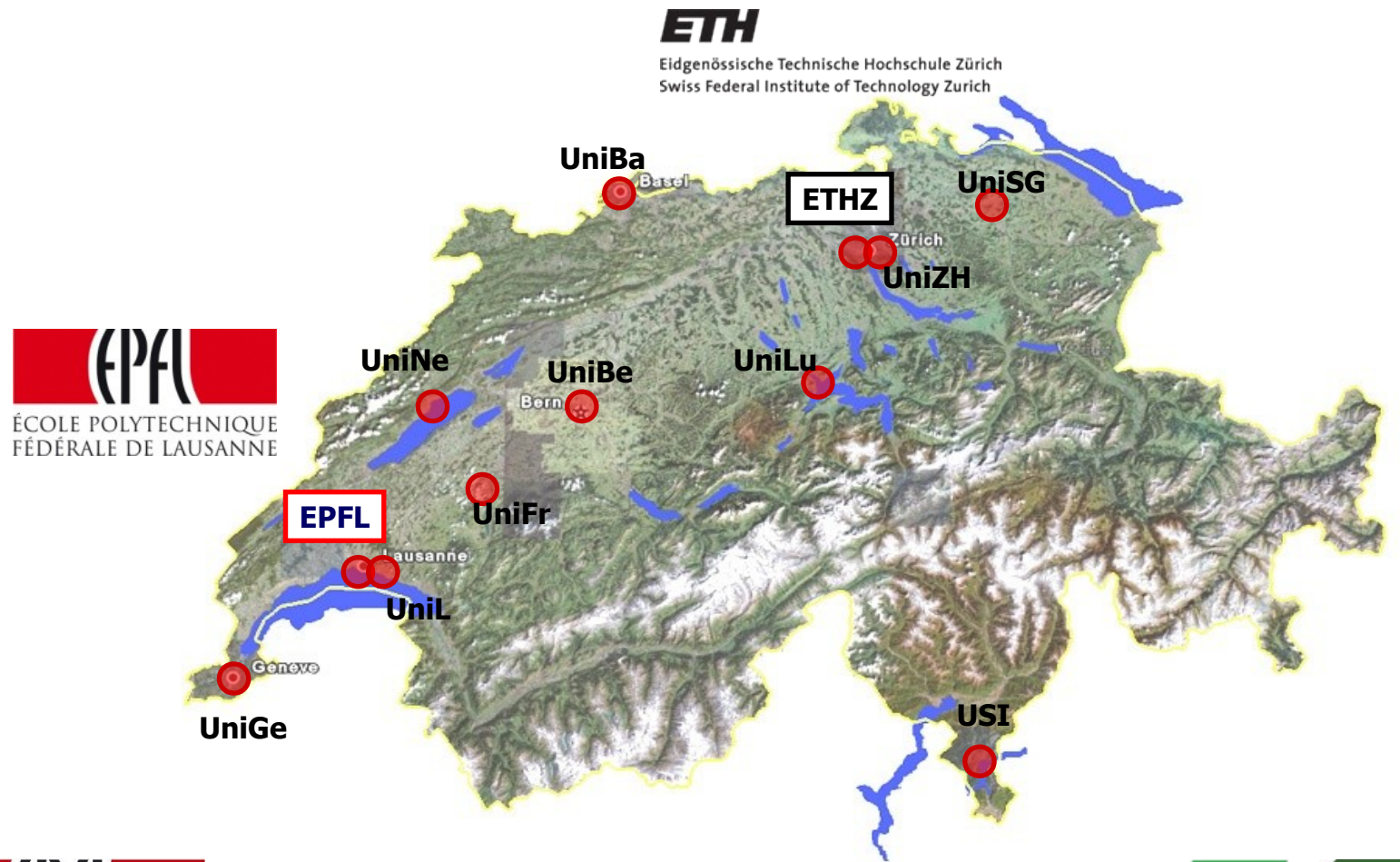
# University Education of Tunnelling

## At EPFL Switzerland

<http://lmr.epfl.ch/mas>

Jian ZHAO  
Professor of Rock Mechanics and Tunnelling  
EPFL-ENAC-LMR

# ETHZ and EPFL are two Swiss federal science and technology universities (polytechnique)



# EPFL Teaching on Tunnelling

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**Engineering teaching are done in ETHZ and EPFL, 5 years leading to a master diploma technology.**

**Engineering also done in Universities of Applied Sciences (UAS). Mostly 3 years leading to a bachelor diploma. Civil engineering are taught in most of the UAS, tunnelling is not covered well and usually are not taught as a single subject. Coverage of tunnelling is by geotechnical engineering.**

## 5 Main Schools

**School of  
Architecture, Civil  
and Environmental  
Engineering, ENAC**

**School of  
Engineering**

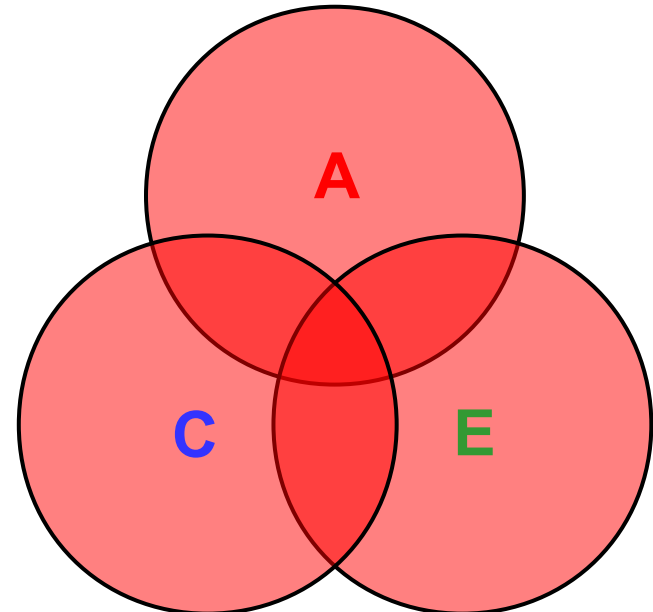
**School of Basic  
Sciences**

**School of Life  
Sciences**

**School of  
Information &  
Computing**

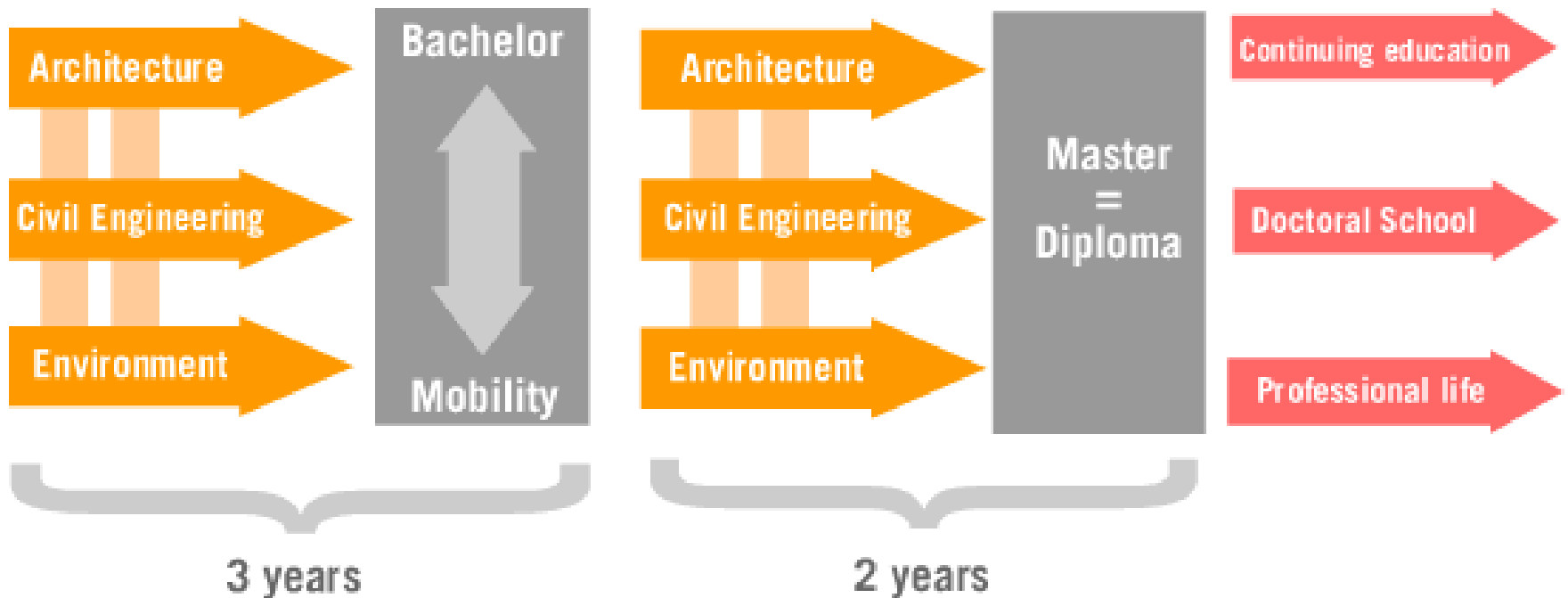
## Civil Engineering

Rock, soil mechanics, geology, road and transport, hydraulic, hydropower, GIS, GPS, structural mechanics, concrete, steel, timber structures, construction management, building and energy, town planning, ...



# EPFL Teaching on Tunnelling

## Teaching in ENAC



# EPFL Teaching on Tunnelling

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## Typical 5 Year European Master Program

**Year 2: Engineering Geology, Soil Mechanics, Rock Mechanics.**

**Year 3: Tunnel Analysis and Design (35-45 students).**

**Year 4: Underground Construction Technology (15-25 students), Ground-Structure Interaction, Geotechnical Engineering II (include cut-and-cover).**

**Year 5: Master thesis on tunnelling technologies (2-3)**

# EPFL Teaching on Tunnelling

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## Tunnel Analysis and Design (45 hours)

- 1. Introduction** (Types of Tunnels, Scope of Tunnel Engineering, Development of Tunnelling Technology, Tunnelling in Future)
- 2. Geomechanics and Tunnelling** (Rock and Soil Behaviour, Rock and Soil Mechanics related to Excavation and Tunnel Support)
- 3. Stresses and Displacement** (Stress at Opening and Plastification, Effects of Shape, Size, Excavation Sequence and Time)
- 4. Ground-Support Interaction** (Ground Response, Convergence–Confinement Method, Ground–Support Interaction)
- 5. Numerical Techniques (FEM)** (FEM Modelling Techniques and Parameters, Excavation and Support Modelling)

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## Tunnel Analysis and Design (II)

6. **FEM Solutions for Ground Analysis** (Use of FEM for Ground Response Curves, Shape and Sequence Optimisation)
7. **Support Design based on Observation** (Tunnel Failure Mechanisms, Observational Methods, NATM Support Design)
8. **Rock Support Design using Q-System** (Q Classification System, Support Design using Q-Chart, Wall and Temporary Support)
9. **Rock Support Design using RMR** (RMR and Adjustment for Tunnelling, Support Guide, Unsupport Span and Stand-Up Time)
10. **Numerical Techniques (DEM)** (Treatment of Discontinuities in DEM, Model Parameters and Input, Modelling of Stability and Support)

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## Tunnel Analysis and Design (III)

- 11. Segmental Lining Design** (Elements of Segments, Segmental Lining Design Procedure, Loads Calculations and Structural Design)
- 12. Tunnel Excavation Methods** (Conventional Mining and Blasting, TBM, Pipe-Jacking, Cut-and-Cover, Immersed and Submerged)
- 13. Settlement in Tunnelling** (Sources of Settlement, Ground Losses and Settlement Equations, Settlement of Twin Tunnels)
- 14. Risk Analysis and DAT** (Risk Analysis Methods, Risk Management, Decision Aid for Tunnelling and Applications)

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## Underground Construction Technology (45 hours)

1. Geo-Planning of Underground Space
2. Geological Exploration
3. Mechanised Excavation and TBM
4. Conventional Excavation and Drill & Blast
5. Ground Improvement and Treatment
6. Methods of Rock Tunnel Support
7. Methods of Soil Tunnel Lining

**Tunnel Project:**  
Route selection,  
Excavation method,  
Support design,  
Presentation.

# EPFL Teaching on Tunnelling

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## Underground Construction Technology (II)

8. Tunnel Monitoring and Instrumentation

9. Tunnel Construction Management & Safety

10. Tunnel Maintenance and Refurbishment

11. Mountain Tunnels: Case Studies

12. Urban Tunnels: Case Studies

13. Cavern and Hydropower Tunnels: Case Studies

14. Under-Water Tunnels: Case Studies