

Module Nr.	Credits	Workload	Semester	Frequency	Duration
SE-CO-4	6 CP	180 h	3	Yearly (WS)	1 semester
Courses			Contact time	Self-study	Group size
a) Systems & concrete technology			2 h/week	60 h	no restriction
b) Design			2 h/week	60 h	
<h2 style="color: green;">Design of Tunnel Linings</h2>					
Learning outcomes					
The Students					
<ul style="list-style-type: none"> • possess a deepened understanding of concrete technological conception as well as the concrete works in tunnel- and subsurface engineering • are able to apply and validate important material laws and normative rules for concrete executions in relation to tunnel construction processes • are able to derive fundamental concrete aspects for tunnel constructions on the basis of material science and to independently work on concrete technological and planning issues • are able to derive sectional forces of reinforced concrete (RC) tunnels in lateral (ring) or longitudinal direction incl. the setup of suitable static systems • learn how to design the tunnel in Ultimate Limit States (ULS) as well as Serviceability Limit States (SLS) • learn the detailing of reinforcements for tunnels with segmental linings, frame or shell structures 					
Content					
a) Systems & concrete technology					
<p>The design and conception of concretes for tunnels with different properties and environmental conditions is the subject of this course. The utilization of special concrete constituents and the resulting material properties as well as current production processes and construction methods are presented. The main topics of the event are as follow:</p> <ul style="list-style-type: none"> • Basics of concrete technology • Sprayed Concrete for Tunnel Linings • Open Construction • Base Concrete • Inner-Shell Concrete Tunnel Lining • Precast Lining Elements • Annular Gap Mortar 					
b) Design					
<p>For usual tunnels in soft rock having trough or frame structures, segmental linings or curved shells, methods for calculating sectional forces, deformations and stresses within the tunnel will be presented. Moreover, basic design methods will be developed. They include the conceptual design of the tunnel itself, ULS and SLS design methods as well as the detailing of reinforcements.</p> <ul style="list-style-type: none"> • Static systems for tunnels with frame structure, segmental linings or shell lining • Sectional forces in ring and longitudinal direction incl. stability checks • Design methods using M/N-interactions, strut-and-tie modelling and crack control • Detailing methods for hybrid reinforcements 					

Teaching Methods/ Language Lectures (4 h/week) / English
Modes of assessment written examination (120 min)
Requirements for the award of credit points Passed module final examination: Written examination (120 min)
Module applicability (in other study programs) -
Weight of the mark for the final score 5 %
Module coordinator and lecturer(s) a) Univ.-Prof. Dr.-Ing. habil. Peter Mark (coordinator) b) Univ.-Prof. Dr.-Ing. Rolf Breitenbücher
Other information Knowledge of building materials technology and construction physics presupposed Further literature will be announced during the lecture