

Summary of important points for exam preparation

Basic questions

- ✓ Requirements - criteria to justify the choice of materials? "**RDPIEE**" (Resistance, Deformability, Protection, Implementation, Environment, Economy)
- ✓ Performance of cementitious materials (fresh and hardened)?
- ✓ Influence of application on structural response
- ✓ Measuring performance (fresh and hardened)?
- ✓ Relationships between the composition/processing of these materials, their structure and their performances?
- ✓ Precautions to be taken during processing?
- ✓ Applications in new or existing structures?

Materials

- ✓ Standard concretes (placed by crane or pumped)
- ✓ Fiber Reinforced Concrete (FRC)
- ✓ Self-Compacting Concrete (SCC)
- ✓ Hardening cementitious composites - Ultra-high-performance fiber-reinforced concrete (UHPFRC)
- ✓ ECC/SHCC - Hardening materials with synthetic fibers
- ✓ Slurry Infiltrated materials (SIFCON, SIMCON)

Fundamental aspects

- ✓ *Mineral binders*: cements, mineral additions, hydration, pozzolanic reaction, effect of fineness, equivalent dosage, maturity, activation energy (effect of binder type), heat of hydration (cement and mineral additions), semi-adiabatic calorimeter, degree of hydration.
- ✓ *Fiber Reinforced Concretes and UHPFRC*: basics and applications, critical anchorage length, critical fiber dosage, tensile and flexural strain hardening, softening behavior, equivalent stresses, effective stresses f_{ctf} , residual stresses, deformability, specific fracture energy G_F , effect of fibrous mix on workability (fiber/coarse aggregate relationship), fiber orientation effects.
- ✓ *Modeling the mechanical behavior of cementitious materials*: tension-bending, structural hardening, scale effect, volume-surface dissipation, inverse analysis.
- ✓ *Rheology*: basics - rheological parameters, significance, relationship with consistency and workability tests, processing, main modes of action of superfluidifiers (dispersion, adsorption, steric effect).
- ✓ *Granular mix/compactness optimization*: objectives-motivations, structure levels, granular mix-rheological parameter relationships, wall and loosening effects.

Implementation - applications

- ✓ *Specification of concretes* with or without fibers and SCC according to properties, according to SIA 262.051 (EN-206) edition 2021, SIA 162/6.

- ✓ *Mix-design of concretes* meeting specified requirements and in particular composition limit values in accordance with SIA 262.051 (EN-206) edition 2021.
- ✓ *What cement(s)* can or should be used for structures in *chemically aggressive environments*? For example, in the presence of sulfates.
- ✓ *Specification and proposal of a concrete mix-design* suitable for *massive elements* (e.g. 2 m thick footings with low density of reinforcement bars)?
- ✓ *Calculate the probable strength of concrete* using *Bolomey's formula*. Which parameter(s) does this strength depend on? cement, water, air content, aggregates - average values and characteristic values.
- ✓ Specification and proposal of a concrete mix-design suitable for the construction of small columns with high load-bearing capacity? e.g. concrete strength class C50/60 (to be verified/proven e.g. with Bolomey formula).
- ✓ Concerning the requirement for a minimum fines content in concretes: what does it mean / definition of fines? minimum values required? possible relationship between fines content and cement dosage? usefulness / reason for these prescribed fines contents?
- ✓ What measure(s) should be taken regarding the composition of concrete, in order to limit its shrinkage and thus reduce the risk of cracking in the structure?
- ✓ Characteristic elements of the composition of normal concrete, self-compacting concrete (SCC) and UHPFRC? Cement or binder (type and dosage), quantity of cement paste, sieve curve, aggregates, W/C or W/B ratio, dosage of mixing water.
- ✓ Properties / performance of UHPFRC in hardened state, compared with ordinary concrete? Modulus of elasticity, water tightness (or permeability), durability, shrinkage, creep.
- ✓ Ultra-High-Performance Fiber-Reinforced Concrete, ECC, slurry infiltrated materials: definition, structure, composition, matrix and fibrous mix, performances (fresh and hardened), rheology, mechanical behavior, protective function, creep, shrinkage, heat of hydration.
- ✓ Parameters to choose for the composition of UHPFRC: choice of cement, binder paste dosage, relationship between sand dosage and fiber dosage, choice of fibrous mix depending on the application.
- ✓ Measurement of UHPFRC performances (in fresh and hardened states), test methods, measurement parameters, interpretation, criteria, uniaxial tensile tests, bending on plates, with/without notch, displacement or imposed force, fiber orientation effects, air permeability, water permeability, water absorption by capillarity.
- ✓ Application of UHPFRC: specification, implementation, design methods, justification.