

Title: Materials and Structures (CIVIL -532)

Teacher: Prof. Emmanuel Denarié (ED)

Schedule: Tuesdays, 8:15 a.m. to 11 a.m. - Room CM 013 + GIS structures hall according to notice

Session	Date	Contents	c	e	Demo	Teacher
<i>Part I: Introduction - basics</i>						
1	09.09.2025	<u>Introduction</u> Motivation for the course, presentation of materials, requirements, exposure classes, performance - internal structure - composition relationships, structural functionalities, "Materials-Structures" relationships, examples.	3			ED
2	16.09.2025	<u>Cement and mineral additions</u> Types, hydration reactions, pozzolanic reaction, hydration kinetics and influencing factors, thermal effects. <u>Exercise 1</u> : calculating heat release and maturity from test results.	2	1		ED

3	23.09.2025	<p><u>Rheology of fresh cementitious materials</u>: basics, test methods, applications, concrete admixtures: operating principles and influencing factors.</p> <p><u>Exercise 2</u>: Rheology - analysis of application examples.</p>	2	1		ED
<i>Part II: Conventional concretes and self-compacting concretes</i>						
4	30.10.2025	<p><u>Conventional concretes – mix-design</u>: theoretical aspects, granular mix and mixing water, aggregates, required qualities, grading curves, fines content, water demand, and required workability.</p> <p><u>Exercise 3</u>: study of concrete recipes.</p>	2	1		ED
5	07.10.2025	<p><u>Self-compacting concrete - SCC</u> History, formulation, fresh and hardened properties, testing, specification.</p> <p><u>Exercise 4</u>: mix-design study for self-compacting concrete.</p>	2	1		ED
<i>Part III: Fiber-reinforced concretes - FRC</i>						
6	14.10.2025	<p><u>Fiber-reinforced concretes - general information, mechanical principles and main fiber types</u> History, fiber types, orientation effects, effects on fresh concrete composition and properties, effects on mechanical behavior, and durability.</p>	3			ED
7	28.10.2025	<p><u>Fiber-reinforced concrete - mechanical behavior, mechanical testing, mix-design and processing</u> Methods for testing and designing with fiber-reinforced concrete, with examples of applications.</p> <p><u>Exercise 5</u>: analysis of test results and application to calculating a structural element.</p>	1	2		ED

<i>Part IV: Strain Hardening cementitious composites</i>					
8	04.11.2025	<u>Ultra-high-performance fiber-reinforced concrete (UHPFRC), structure and properties - 1</u>	2		ED
		History, bases of mix-design and mechanical behavior <u>Exercise 6:</u> Comparative analysis and classification of UHPFRC performance.			
9	11.11.2025	<u>Mixing test demonstration: SCC + UHPFRC - lab and video presentation</u>		1.5	ED
		<u>Exercise 7:</u> analysis of mixing tests, performance prediction (SCC, UHPFRC).			
10	18.11.2025	<u>Ultra-high-performance fiber-reinforced concrete (UHPFRC), structure and properties - 2</u>	2		ED
		Tensile and flexural mechanical behavior: modeling and testing. <u>Exercise 8:</u> inverse analysis of a bending test on UHPFRC plates, calculation of a structural element.			
11	25.11.2025	<u>Ultra-high-performance fiber-reinforced concrete (UHPFRC), structure and properties - 3</u>	2		ED
		Delayed effects (viscoelasticity, shrinkage), heat of hydration, protective properties. <u>Exercise 9:</u> dimensioning a UHPFRC element.			

12	02.12.2025	<u>Structure and properties of hardening cementitious composites - 4</u>				
		Presentation from Lionel Sofia (LMC/STI) – and discussion “ASR in concrete structures, actual knowledge”	1.5			LS
		Synthetic fiber materials (ECC/SHCC), slurry infiltrated materials (SIFCON, SIMCON), principles, properties and applications.	0.5			ED
		Specification and application of concretes and UHPFRC: requirements, selection parameters (performance and composition), fiber orientation effects, performance characterization	1			
<i>Part V: Outlook, synthesis and conclusions</i>						
13	09.12.2025	<u>Exercise 10</u> : Specification of materials for applications (normal concretes, SCC, FRC, UHPFRC, etc.) - group work - preparation for presentation.		1.5		ED
		<u>Solution of exercise 10</u> - group presentation - discussion (oral exam simulation).		1.5		
14	16.12.2025	<u>Presentation of UHPFRC applications</u>		1.5		ED
		The future - tension-hardening UHPFRC with synthetic fibers + environmental impact assessment		1		ED
		<u>Synthesis and conclusions</u> : material-structure synergies, summary and answers to questions.		0.5		ED