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High Performance Concrete

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Terminology

- ▶ NSC = Normal Strength Concrete
- ▶ HPC = High Performance Concrete
- ▶ HSC = High Strength Concrete
- ▶ FRC = Fibre Reinforced Concrete
- ▶ SCC = Self Compacting Concrete
- ▶ UHPC = Ultra - High Performance Concrete
- ▶ UHSC = Ultra - High Strength Concrete
- ▶ HDC = High Durability Concrete
- ▶ ECC = Engineered Cementitious Composite
- ▶ APC = Advanced Cementitious Composite
- ▶ RPC = Reactive Powder Concrete

Advantage

- ▶ High-quality surface
- ▶ Very slim elements
- ▶ The lower volume of material to transport
- ▶ Free shape solutions
- ▶ Long life structure

Disadvantage

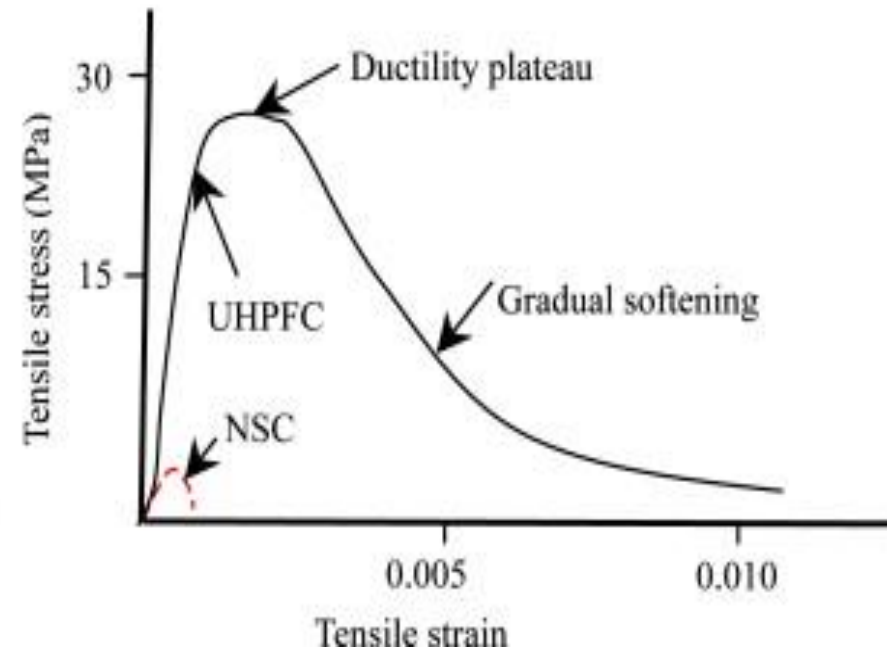
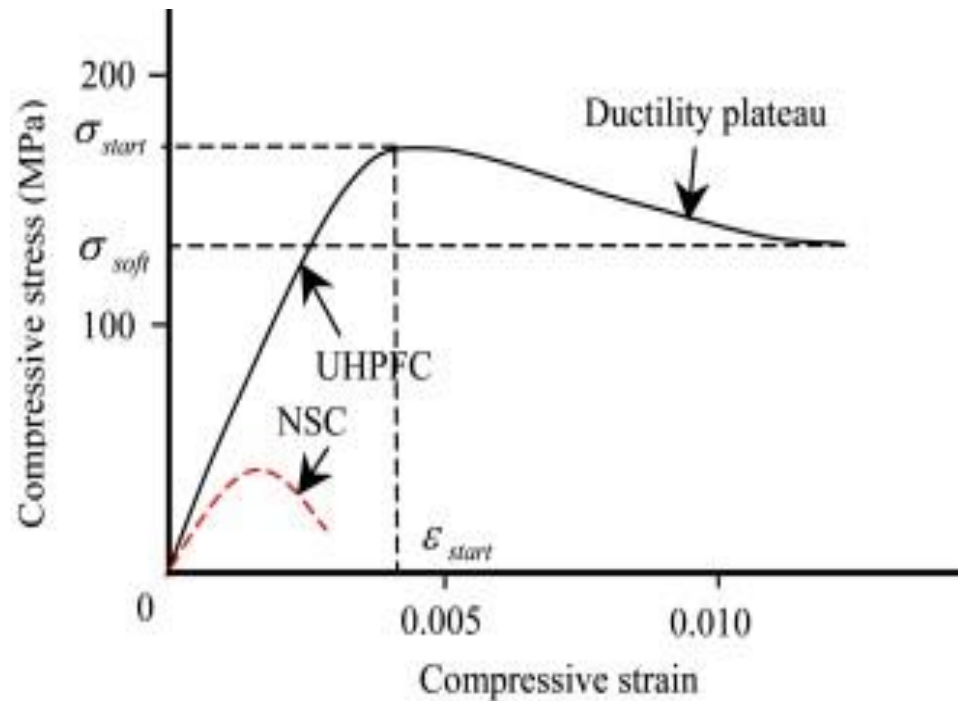
- ▶ The absence of standards for the design
- ▶ Exacting of production technology
- ▶ Low experience
- ▶ Higher price (per cubic meter concrete)
- ▶ Higher specific gravity

High Performance Concrete - mechanical properties

- ▶ Compressive strength (6x more NSC)
- ▶ Tensile strength (5x more NSC)
- ▶ High modulus of elasticity
- ▶ Ductilita

- ▶ Waterproof
- ▶ Frost resistance
- ▶ Chemical resistance (XF4)

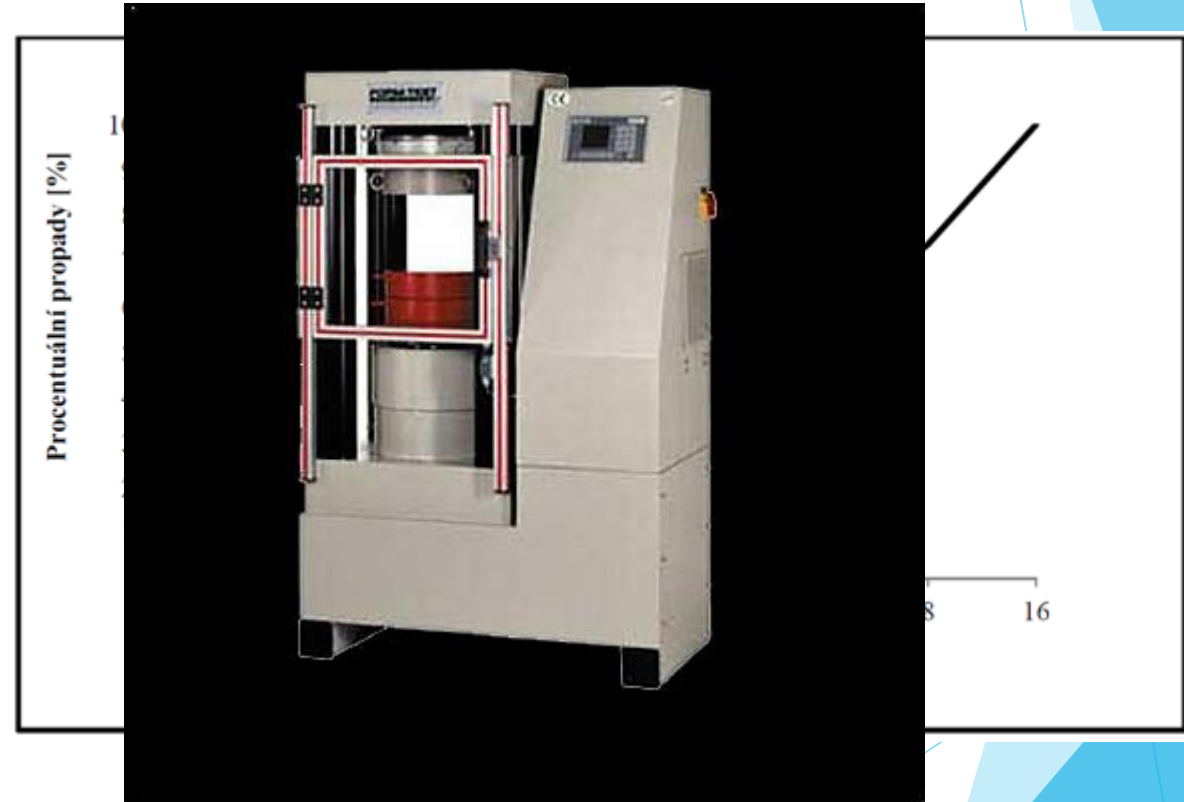
High Performance Concrete - mechanical properties



Mix Design - Aggregate

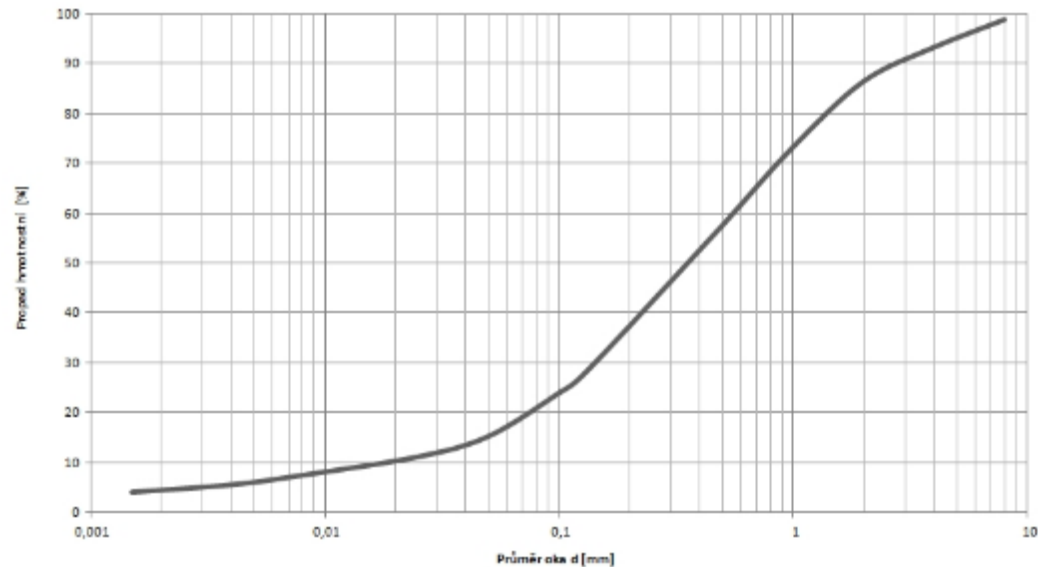
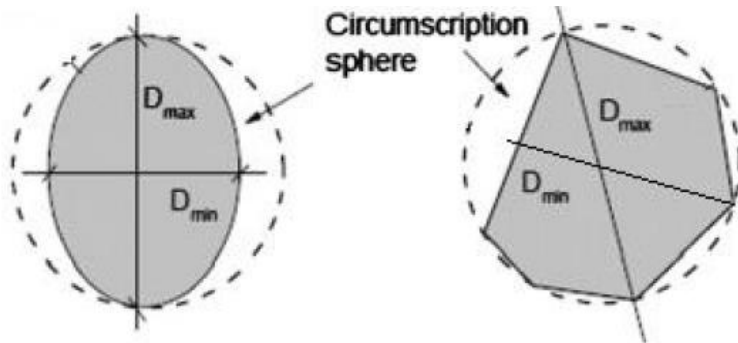
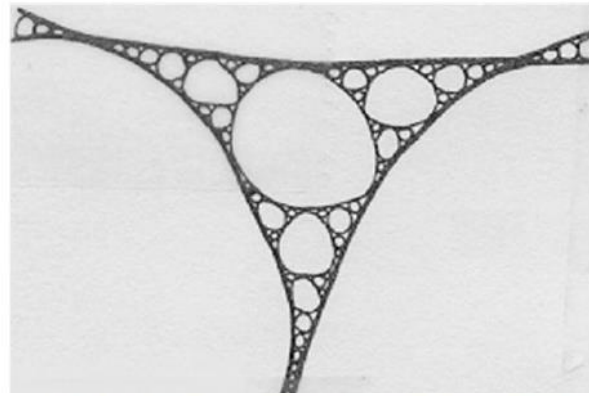
Basic properties

- ▶ Compressive strength
- ▶ Shape index
- ▶ Water absorption
- ▶ Resistance to abrasion
- ▶ Specific gravity
- ▶ The particle size distribution



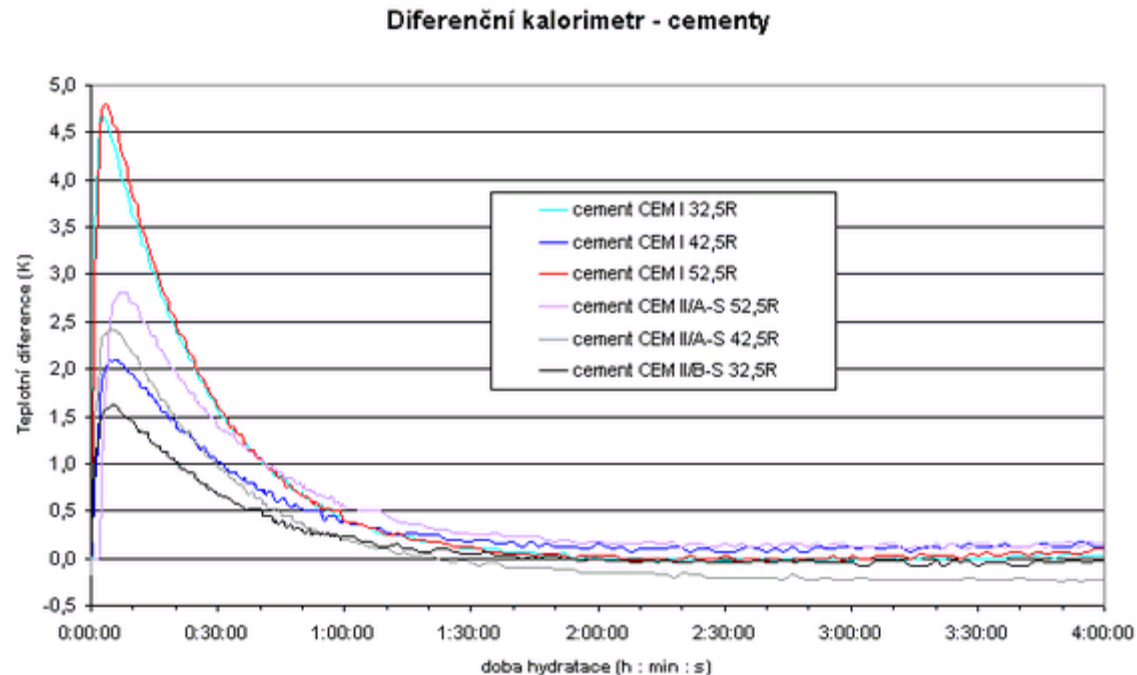
Mix Design - Aggregate

- ▶ Volcanic rocks
- ▶ Globular grains (quarry stone)
- ▶ Ideal grading curve
- ▶ Maximum grain size 8mm



Mix Design - Binder

- ▶ Portland cement CEM I
- ▶ Strength class 42,5 MPa
- ▶ Dosage 450 - 700 kg/m³
- ▶ Fast curing cements are suitable



Mix Design - Water

Function

- ▶ Chemical - hydration
- ▶ Physical - workability of concrete

Without organic substances

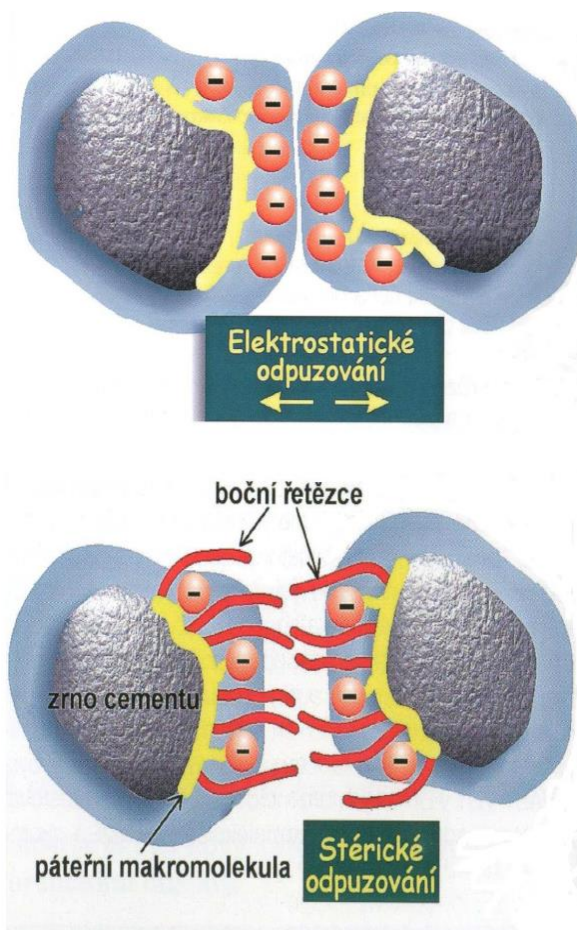
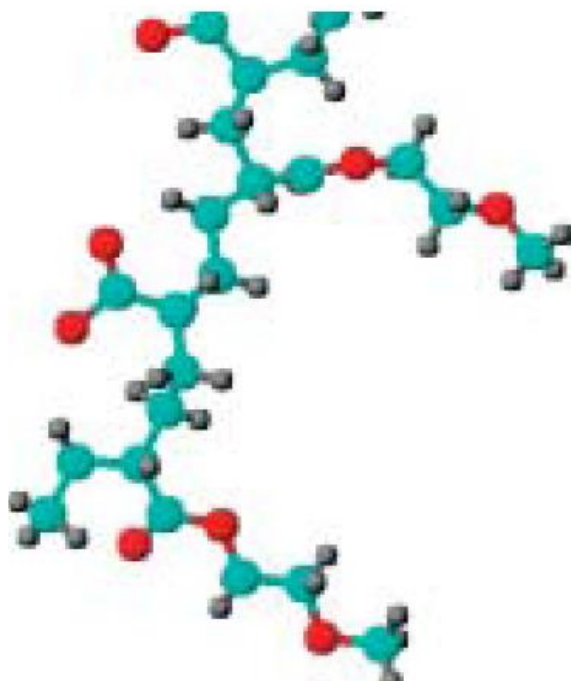
Water-cement ratio

- ▶ Stoichiometrically min. 0,23
- ▶ Workability min. 0,38
- ▶ $SPF < 0,2$ (ordinarily 0,25 - 0,35)



Mix Design - Superplasticizer

Polikarboxylát



Mix Design - Superplasticizer

- ▶ Compatibility with cement
- ▶ Slow down the hydration
- ▶ Improve the workability
- ▶ Dosage max. 40 kg/m³ Concret



Mix Design - Microfiller

- ▶ Does not enter the hydration
- ▶ Adjusts fine granularity
- ▶ Reduces the amount of cement
- ▶ Improve the workability
- ▶ Dosage max. 200 kg/m³ Concrete

Mix Design - Steel of fibres

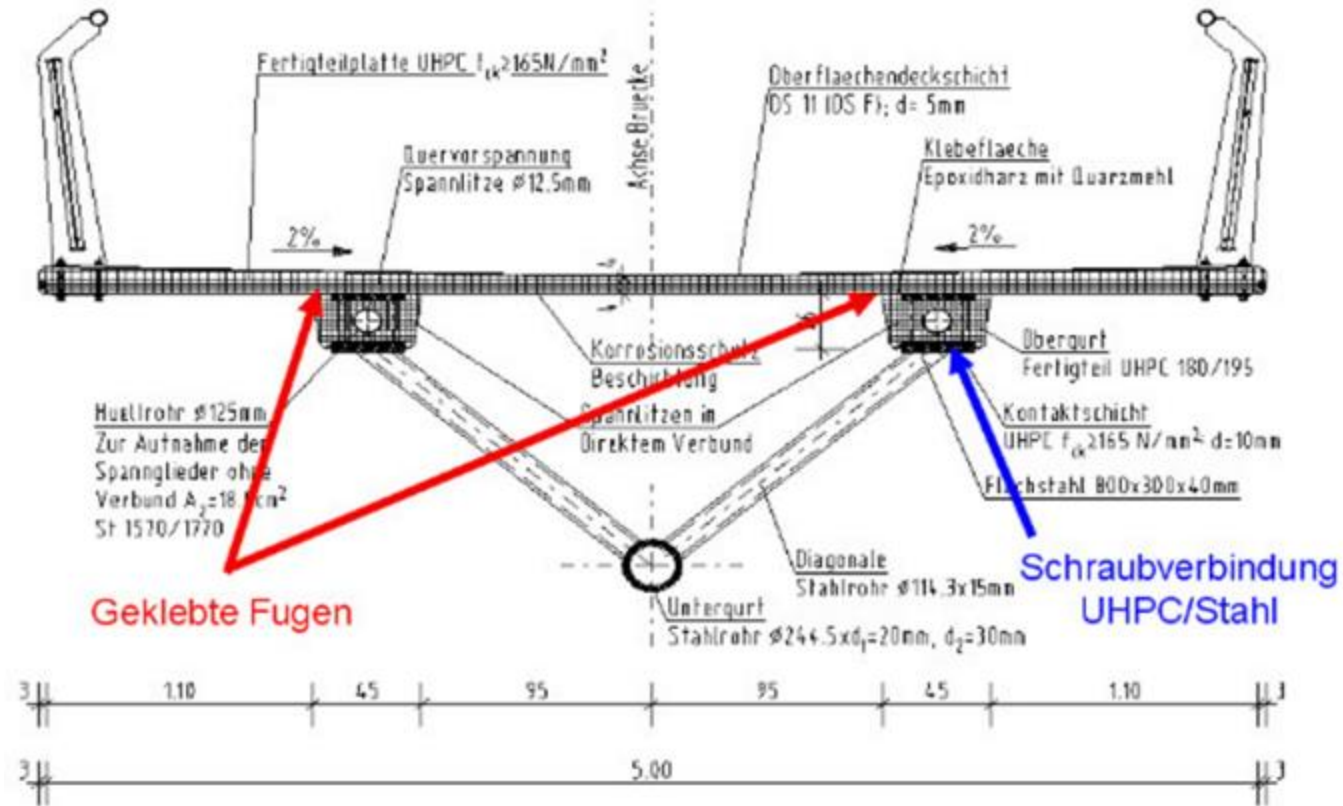
- ▶ Improves the mechanical properties (strength, ductility)
- ▶ Dosage max. 160 kg/m³ Concrete (bulking!)
- ▶ Tensile strength > 1600 MPa
- ▶ Maximum length 30 mm

Application



Bridge Gärtnersplatz in Kassel
(Germany)

Application



Bridge Gärtnerplatz in Kassel
(Germany)

Application



Jakway Park Bridge (USA)

Application



MuCEM Marseilles (France)

Theoretical basis of presented results were gained in support of the project FRVČ 915/2013 “Nástroje pro výuku navrhování betonových a zděných konstrukcí v anglickém jazyce”.