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Concrete

INTRODUCTION

Concrete refers to an artificial material resulting from the hardening of a mixture of binder, water, and aggregates (such as sand and crushed stone or gravel) selected in a rational manner. Before hardening, this combination of materials is referred to as concrete mix.

In concrete, the grains of sand and crushed stone form the basic structure. When the concrete mix is combined with water, the resulting cement paste coats these grains, filling the spaces between them, acting as a lubricant for the aggregates, and imparting plasticity to the concrete. Upon hardening, this cement paste binds the aggregate grains, thus forming concrete, an artificial stone.

Concrete

INTRODUCTION

Achieving high-quality concrete mixes and concretes requires a thorough understanding of technological processes, appropriate selection of components based on their qualities and optimal proportions, as well as mastery of preparation, implementation, compaction, and curing techniques. This knowledge is essential for ensuring the construction of durable, resilient, and cost-effective concrete structures. Concrete is one of the most important materials in all construction fields due to its ability to vary properties widely by using suitable components and specialized treatment methods. Its plasticity enables the creation of diverse construction elements without requiring significant labor, while its predominantly local aggregate composition makes it an economically advantageous material.

Concrete

Definition

Concrete is a mixture of : pure paste (cement + water + air); aggregates (sand, gravel, and occasionally crushed stones); possible additional products (admixtures).

Components	Water	Air	Cement	Aggregates
Percentage in absolute volume	18 to 28	1 to 6	7 to 14	60 to 78

Concrete

I.2. Concrete Components

I.2.1 Cement

Cement is the quintessential hydraulic binder. It is typically composed of limestone and clay. It is one of the main components of concrete, binding its constituents together and imparting certain essential characteristics such as strength. The composition of cement can vary depending on different types of needs, which categorizes it into several categories :

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CEM I (Portland cement) is suitable for the design of reinforced or prestressed concrete as it offers a high level of strength.

CEM II A or B (composite Portland cement) are known for their ease of handling. They are therefore used in common works such as traditional screeds or simple coatings.

CEM III A, B, or C (blast furnace cement) are suitable for harsh environments and are known for their durability.

CEM IV A or B (pozzolanic cement) are also suitable for aggressive environments, ideal for hydraulic structures. Not available in France.

CEM V A or B (composite cement) have the same physical properties as CEM III but different constituents.

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I.2.3 Mixing Water:

Mixing water is an essential element in concrete design. It allows for the hydration of cement, unlocking its binding capabilities, and also makes the application of concrete easier. The water used must be clean! (Avoid using seawater) and be careful not to add it excessively, as this could compromise the performance of your concrete. Indeed, excessive water could decrease its strength and durability.

I.2.4 Aggregates:

Aggregates, whether natural or artificial, are mineral grains of varying dimensions. As the main components of concrete, they impart certain technical and aesthetic characteristics to it, notably its strength. Therefore, the choice of aggregate type should not be taken lightly as it will have an influence on durability.

I.2.5 Admixtures: Concrete

Admixtures are chemical products added during the mixing of concrete and are dosed in small quantities during preparation (less than 5% of the mass of concrete). These products offer the possibility to improve certain characteristics of concrete such as its setting time or waterproofing. Widely used today, there are different types of admixtures that will allow you to obtain the desired concrete.

Nature and Effects

1Setting and Hardening

Setting accelerator: decreases the setting time of concrete.

Hardening accelerator: speeds up the hardening time of concrete.

Setting retarder: slows down the setting time of concrete without altering it.

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Workability of Concrete

Plasticizer: improves the workability of concrete without altering it.

Water-reducing plasticizer: reduces the water content to increase the strength of the mix while maintaining good workability.

Superplasticizer:

Fluidifying function: (normal water dosage) improves workability but decreases strength.

Reducing function: (very low water dosage) results in a significant reduction in water content while maintaining good workability.

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Modification of Certain Properties

Air-entraining agent: allows the formation of small air bubbles distributed evenly, increasing workability and freeze-thaw resistance of solid-state concrete.

Waterproofer: improves the impermeability of concrete by sealing the pores.

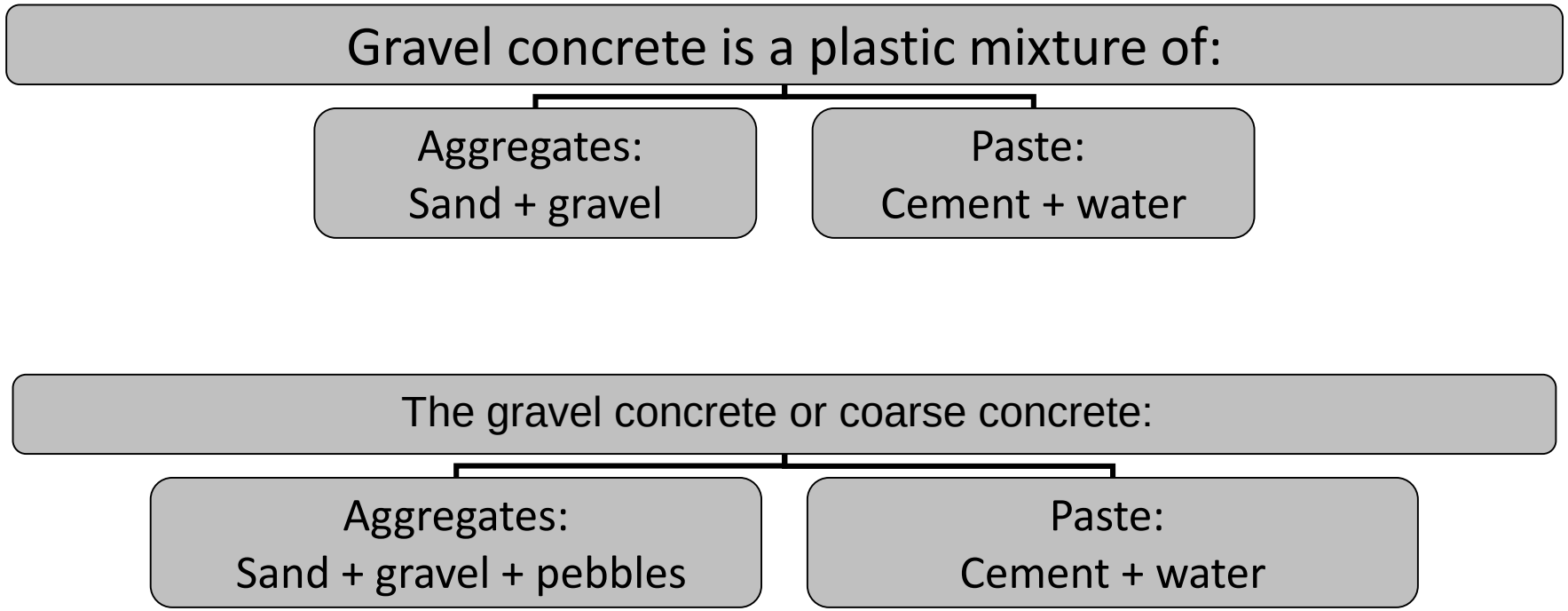
Pigments: offer the possibility to change the color of concrete.

Curing Products:

Applied to the surface of fresh concrete, they protect it against potential risks of drying out.

Concrete

Components



Concrete

Classification of Concrete

The classification of concrete is based on several criteria: **density, type of binder used, mechanical strength, frost resistance, and final application.**

The primary classification of concrete is based on its density; thus, we distinguish between: **heavyweight concrete** (with a density exceeding 2500 kg/m^3), **normal-weight concrete** (with a density ranging from 1800 to 2500 kg/m^3), **lightweight concrete** (with a density of 500 to 1800 kg/m^3), and **ultra-lightweight concrete**, with a density below 500 kg/m^3 (used for thermal insulation).

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Depending on the size of aggregates used, concrete is subdivided into fine aggregate concrete, with aggregate dimensions not exceeding 10 mm, and coarse aggregate concrete, with maximum aggregate dimensions ranging from 10 to 150 mm.

The most important characteristics of concrete are its **mechanical strength and durability**. Based on compressive strength, concrete is divided into strength classes. Heavyweight concrete has strength classes ranging from 100 to 600, lightweight concrete from 25 to 300, and ultra-heavyweight concrete from 100 to 200.

Concrete

Classification of Concrete

Concrete durability is assessed based on its frost resistance, with frost resistance marks (Rg) ranging from 50 to 300 for **heavyweight concrete** and from 10 to 200 for **lightweight concrete.**

Depending on the type of binder used, several types of concrete are distinguished:

- Cement concrete, made with hydraulic binders such as Portland cement and its variants.

Concrete

Classification of Concrete

- Silicate concrete, composed of lime binders in combination with silicates or aluminates.
- Gypsum concrete, using anhydrite plaster binders.
- Organic binder concrete.

Concrete based on mineral binders is further subdivided:

- Heavyweight concrete is formed of cement and ordinary compact aggregates.
- Lightweight concrete uses cement with natural or artificial porous aggregates.

Concrete

Classification of Concrete

- A variety of lightweight concrete is cellular concrete, a mixture of binder, water, dispersed alumina components, and a substance promoting pore formation, with a porosity of 80 to 90%.
- Silicate concrete is produced from a mixture of lime and quartz sand, with subsequent hardening of shaped products in an autoclave, under pressure and at high temperature.

Concrete

Classification of Concrete

Depending on their final use, several types of concrete are distinguished: **ordinary concrete** (for load-bearing elements in concrete and reinforced concrete), **hydrotechnical concrete** (for dams, locks, canal linings), **lightweight concrete** (for walls and intermediate floors), for floors, coverings, and road foundations, and **special-purpose concrete**, such as acid-resistant concrete, heat-resistant concrete, and ultra-heavyweight concrete, made with cement and special high-density aggregates.

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Establishing the Concrete Composition Project

The establishment of concrete composition aims to determine the quantity of materials required per cubic meter of fresh concrete, ensuring the attainment of a workable paste, concrete with the required strength, and in some cases, necessary frost resistance, impermeability to water, and endowed with special properties.

The composition of fresh concrete is defined by a ratio of masses (rarely volumetric ratio, less precise) between the quantities of cement, sand, and crushed gravel (or gravel), with the indication of the water-cement ratio.