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Concrete

Establishing the Concrete Composition Project

The quantity of cement is used as the unit of measurement. Thus, typically, the composition of concrete is expressed by the ratio cement: sand: crushed gravel = 1:2:y for W/C = z (for example, 1:2; 4:4.35 for W/C = 0.45).

Two concrete compositions are distinguished:

the nominal composition (from the laboratory), based on dry materials,

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Establishing the Concrete Composition Project

and the exploratory composition (on-site), based on materials at natural humidity. Before proceeding with the composition calculation, it is necessary to determine the quality of the original materials: cement, water, sand, and crushed gravel (gravel), in accordance with standards.

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The formulation of concrete composition,

involving the proportion of cement, water, sand, and gravel or crushed stones, begins with a calculated estimate, which is then refined through experimental dosage tests.

The process of calculating concrete composition follows these steps:

first, the ratio between cement and water is established to ensure the desired strength of the concrete. Then, the necessary amount of water is determined, followed by the calculation of the required amount of cement, gravel (or crushed stones), and sand.

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The process of calculating concrete composition follows these steps:

The fluidity and consistency of the mixture are then checked against the project specifications, and the composition is adjusted if necessary.

Subsequently, samples are prepared to assess the strength, and tests are conducted within the specified timeframe. Finally, a new evaluation of the composition is carried out.

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The process of calculating concrete composition follows these steps:

1-The ratio between cement and water is determined according to the

following expressions:

a) For concretes with C/W ratio ≤ 2.5

$$C/E \leqslant 2{,}5$$

$$R_b = AR_c\left(\frac{C}{E} - 0{,}5\right),$$

Hence, the following results:

$$\frac{C}{E} = \frac{R_b}{AR_c} + 0{,}5;$$

b) For concretes with C/W ratio > 2.5

$$C/E > 2{,}5$$

$$R_b = A_1R_c\left(\frac{C}{E} + 0{,}5\right),$$

Hence, the following results:

$$\frac{C}{E} = \frac{R_b}{A_1R_c} - 0{,}5.$$

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The process of calculating concrete composition follows these steps:

2-Determining the water quantity: The optimal amount of water in a concrete mix (l/m3) must ensure the necessary fluidity (or consistency) of the mixture.

3-Determining the cement quantity: After defining, using the formula, the value of C/E, which represents the cement-to-water ratio, and knowing the required water quantity E for the concrete mix, the approximate amount of cement per m3 of concrete is calculated as follows: $C = C/E * E$.

The cement quantity per m3 of concrete must not fall below the minimum limits allowed by standards. If the cement quantity is below the permissible level, it is necessary to increase it to meet the standard or introduce a finely ground admixture.

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The process of calculating concrete composition follows these steps:

4-Determining the aggregate quantity (sand and crushed stones or gravel per m3 of concrete): To determine the quantity of sand or crushed stones (gravel), two conditions must be met:

1-The sum of the absolute volumes of all components of the concrete (in liters) equals 1 m3 (1000 liters) of the compacted concrete mixture:

$$\frac{C}{\rho_c} + \frac{E}{\rho_e} + \frac{S}{\rho_s} + \frac{PC}{\rho_{pc}} = 1000,$$

C, E, S, PC represent respectively the content of cement, water, sand, and crushed stones (gravel), in kg/m3; (Pc, Pe, Ps: specific mass densities of these materials, in kg/m3).

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The process of calculating concrete composition follows these steps:

4-Determining the aggregate quantity (sand and crushed stones or gravel per m3 of concrete):

2-The cement-sand solution fills the voids between the coarse aggregates with a certain spacing of the grains.

$$\frac{C}{\rho_c} + \frac{S}{\rho_s} + E = V_{\text{cav pc (gr)}} \frac{PC\ (GR)}{\gamma_{\text{vol pc (gr)}}} \alpha .$$

By simultaneously solving these two equations, we obtain the expression to determine the necessary quantity of crushed stones or gravel.

$$PC\ (GR) = \frac{1000}{V_{\text{cav pc (gr)}} \frac{\alpha}{\gamma_{\text{vol pc (gr)}}} + \frac{1}{\rho_{\text{pc(gr)}}}},$$

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The process of calculating concrete composition follows these steps:

4-Determining the aggregate quantity (sand and crushed stones or gravel per m3 of concrete):

After defining the quantity of crushed stones or gravel, we calculate the quantity of sand in kg/m3 as the difference between the volume of the concrete mixture defined by the project and the sum of the absolute volumes of the coarse aggregate, cement, and water.

$$S = \left[1000 - \left(\frac{C}{\rho_c} + E + \frac{PC\,(GR)}{\rho_{pc\,(gr)}}\right)\right]\rho_s.$$

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The process of calculating concrete composition follows these steps:

4-Determining the aggregate quantity (sand and crushed stones or gravel per m3 of concrete):

If the gravel or crushed stones consist of several fractions, it is essential to establish beforehand the optimal ratio between them, using the optimal granulometry diagram or by choosing a composition where the void quantity is minimized.

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The process of calculating concrete composition follows these steps:

Control of the fluidity of a concrete mixture:

After performing the preliminary calculation of the concrete composition, a trial mix is conducted to determine the slump cone's collapse. If the mixture is not sufficiently fluid, a certain quantity of cement and water is added without altering the cement-to-water ratio. If fluidity increases, sand and coarse aggregates are gradually added while maintaining their constant ratio. This approach allows achieving the required fluidity.

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The process of calculating concrete composition follows these steps:

Development of the theoretical composition of concrete using trial mixtures:

A theoretical composition of concrete is established through trial mixtures. For this purpose, trial concrete mixes are prepared for three different values of the water-to-cement ratio, one of which is the calculated theoretical ratio, while the other two differ from it by 10 to 20%. The quantity of cement, water, sand, and crushed stones (or gravel) for a concrete mix with a water-to-cement ratio different from the theoretical ratio is determined using the method described earlier.

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The process of calculating concrete composition follows these steps:

Development of the theoretical composition of concrete using trial mixtures:

Three specimens, 20 x 20 x 20 cm cubes, are prepared from each mixture and stored under normal conditions. These specimens are then subjected to tests for 28 days, during which the concrete's strength class is determined (or at other specified intervals). Based on the results obtained, a diagram of concrete strength as a function of the water-to-cement ratio is plotted. This diagram is used to select the water-to-cement ratio that ensures the attainment of the desired concrete strength class.

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Types of Concrete

Table of Different Types of Concrete			
Concrete Types	**Characteristics**	**Examples of Mixtures for 1m³ of Concrete**	**Applications**
Lightweight Concrete	**Composed of low-density aggregates, possible use of air-entraining admixtures. Hollow blocks, partitions, renovation of old buildings, fillings**	**Cement: 400 kg; EPS Beads: 350 L; Sand: 950 kg; Water: 170 L; Admixture: 1 to 4%**	**Hollow blocks, partitions, renovation of old buildings, fillings**
Heavyweight Concrete	**Composed of high-density aggregates (lead, magnetite, hematite)**	**Cement: 250 kg; Hematite 0/1 mm: 1000 kg; Hematite 0/5 mm: 900 kg; Hematite 8/25 mm: 1700 kg; Water: 120 L**	**Radiation shielding, production of counterweights**

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Types of Concrete

Table of Different Types of Concrete			
Concrete Types	Characteristics	Examples of Mixtures for 1m³ of Concrete	Applications
Self-Compacting Concrete	Addition of admixtures such as super plasticizers and viscosity agents in the mix. Very fluid concrete that sets in place without the need for vibration	Cement: 350 kg; Sand: 800 kg; Gravel: 900 kg; Fines: 200 kg; Water: 180 L. Slabs,	foundations, industrial floors
Fiber-Reinforced Concrete	Addition of fibers of various natures, dimensions, and shapes. Uniformly distributed in the mix, these fibers enhance certain characteristics of concrete (tensile strength, fire resistance).		. Slabs, industrial floors, beams, pipes

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Types of Concrete

Table of Different Types of Concrete			
Concrete Types	Characteristics	Examples of Mixtures for 1m³ of Concrete	Applications
Decorative Concrete	Their composition varies depending on the desired characteristics.	Washed concrete: Cement: 300 kg; Aggregate: 800 kg; Semi-fine sand: 400 L; Water: 160 L.	. Walls, terraces, slabs, driveways, sidewalks
High-Performance Concrete	Concrete with increased strengths, very low porosity. More durable.	. Depends on the HPC	. Bridges, nuclear power plants, large-scale structures

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Formulation Method:

1. Bolomey Method.
2. Fuller Method.
3. Valette Method.
4. Faury Method.
5. Sherbrooke University Method in Canada.
6. Computer Method (BétonlabPro software from LCPC).
7. Dreux – Gorisse Method.

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La propriété essentielle du béton:

The essential properties of concrete are primarily related to two aspe

1-The placement of concrete.

2- strengths, primarily compressive strength.

Workability

Workability is the essential property of concrete in its fresh state, which allows it to be maneuverable while maintaining its homogeneity. In practical terms, this translates into ease:

- of placement in formwork;
- of encasing reinforcement steel;

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•of achieving an acceptable surface finish, whether it be horizontal or vertical.

Workability depends on:

•the proportion of fine materials,
•the cement content,
•the water content, without excess,
•the rounded shape and size (coarseness) of aggregates.

Workability or maneuverability can be assessed in various ways, particularly through plasticity measurements.

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Measurement of workability:

There are numerous tests and various methods available for measuring certain characteristics on which workability depends. We will mention only two of them, which are the most commonly used in practice.

1-Abrams cone slump test: 2- Slump flow test

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1-Abrams cone slump test:

This test is standardized under NFP 18-451, and we outline below only its essential principles: concrete is filled into a truncated metal cone mold (D = 20 cm, d = 10 cm, h = 30 cm); filling is done in three compacted layers using a 16 mm diameter steel rod with a rounded end, with 25 strokes per layer; the mold is then carefully lifted, and the slump is measured. Assessment of concrete consistency.

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1-Abrams cone slump test:

Assessment of concrete consistency.

Consistency Class	Slump (cm)	Tolerance
Stiff S	0 to 4	±1 cm
Plastique P	5 to 9	±2 cm
Very plastique VP	10 to 15	±3 cm
Fluid F1	16	

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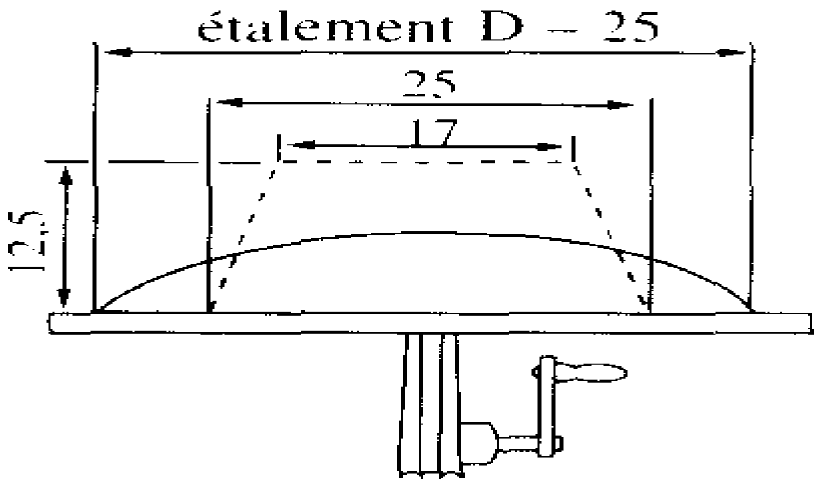
2- The table spread test :

The table spread test (Flow-test) involves using a shock table, equipped with a vertical movement metal plate. On this table is placed a truncated cone mold along with the material under study, whether it's mortar or concrete.



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2- The table spread test :

After leveling and demolding (by lifting the mold), the table is subjected to fifteen shocks in fifteen seconds, activated by a crank. The material spreads to form a disc with two perpendicular diameters measured. The spread (in %) is calculated using the following formula:

$$E = \frac{D - 25}{25} \times 100$$