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A study the effect of brittle concrete working property by developing installation parameters (Subject Review)

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Abstract: In the past tense, studies relating to concrete with high performance have shown the harmful role of excess water in concrete. The reduction of this quantity of water, by using deflocculates and by correcting granular stacking via ultrafine, has led to gains in strength and known durability. As an extension of this scientific work,
the observed improvement in the workability of these new concretes led the researchers to develop and make this property reliable. Today, in total continuity with high-performance concretes, it is a change of objectives constituting a veritable cultural revolution proposed by the self-compacting concretes: the study of the material is no longer governed solely by improving resistance and durability. However, these latter properties remain wedged at levels equivalent to or higher than those of joint concretes. In this area now, with self-compacting concretes, the ability to be easily placed work without vibration which has become priorities. These skills will have great consequences in terms of execution time, reduction of materials, quality of concreting, ease of implementation, respect for the neighborhood, and less hardship for the workers.

Keywords: brittle concrete, parameters, high-performance

Introduction :

In the 1980s and 1990s, studies relating to high-performance concretes showed the harmful role of excess water in concretes. Reducing this quantity of water, by using deflocculants and by correcting granular stacking via ultrafine, has led to gains in resistance and durability that we know [1]. As an extension of this scientific work, the observed improvement in the workability of these new concretes has led researchers to develop this property and make it more reliable.
Today, in total continuity with high-performance concretes, it is a change of objectives constituting a real cultural revolution offered by self-compacting concretes: the study of the material is no longer only governed by the improvement of resistance and durability. However, these latter properties remain set at levels equivalent to or greater than those of joint concretes. It is now, with self-compacting concretes, the ability to be easily implemented without vibration that has become a priority. These skills will have major consequences in terms of execution time, reduction of materials, quality of concreting, ease of implementation, respect for the neighborhood, and less hardship for the workers [2].
The present work aims to understand the influence of the main constituents on the behavior of self-compacting concretes in the fresh state, and above all to seek solutions to optimize a formula of self-compacting concrete based on local materials and not to explain the differences between self-compacting concrete (SCC) and ordinary concrete (BO).

2. Materials and methods

2-1. Used materials

Their characteristics are given in Table 1

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Table 1: Characteristics of the materials used

Material	(Sc)	(Sc)	G 3/6 (G3/6)	G 8/13 (G8/13)	G 15/20 (G10/20)	(F)	(C)	adj	
								BO40	BO (Sp)
Naturel	S O/D = O/2	Limestone O/D = O/4	Limestone	Limestone	Limestone	Limestone	CPJ EMC II / A 43,5	Plasticizer	Viscosifying and thinning

2-2. Formulation method

Five self-compacting concretes and one vibrated concrete (ordinary) were implemented. The chosen comparison criterion is the mechanical compressive strength at 28 days. The formulation method used to design the SCC compositions tested in this experimental study is an empirical method based on four points:

- The formulation of the SCC must meet the mechanical resistance criteria (fixed or desired) chosen from the Bolomey formula [3].
- The volume of paste must favor the flow of the concrete while reducing the cost of raw materials of this formulation [4].

For this, the volume of paste (effective water + entrained air + cement + additions + adjuvant + fine aggregates with a size of less than 80 µm) is set at 375 liters. The effective water corresponds to the theoretical total water (mixing water + water provided by the aggregates + water provided by the additives) from which the water absorbed by the aggregates is subtracted.

- The dosage of adjuvant (superplasticizer and viscosifier) is calculated in order to limit segregation and bleeding [5]. This dosage is determined experimentally from tests on fresh concrete for which the spread must be between 60 and 75 cm.
- The optimization of the constitution must reduce segregation and promote flow. For this and in order to select an appropriate combination of aggregates that improves the workability and deformability of self-compacting concrete, several proportions have been considered while keeping a gravel-to-sand (G/S) ratio close to 1.
- With regard to the formulation of the corresponding vibrated concrete, its composition was obtained from the new method while maintaining the same water-to-cement ratio (W/C) as that of the SCCs.

All the compositions studied are presented in Table 2.

Table 2: Composition of different concretes

Compositions (kg/m^3)	Designation of concrete					
	B 1	B 2	B 3	B 4	B 5	BO
G/S	00,8	00,9	01,0	01,1	01,2	01,6
Ciment (Kg/m^3)	300	300	300	300	300	350
Limestone fillers (Kg/m^3)	100	100	100	100	100	-
Sc (Kg/m^3)	578	578	578	495	495	129
Quarry sand (Kg/m3)	333	299	249	299	249	576
Gravel 3/8 (Kg/m3)	333	366	333	333	416	204
Gravel 8/15 (Kg/m3)	416	416	499	532	499	947
Plastiment BV 40 (Kg/m3)	-	-	-	-	-	5,25
Viscocrete 20 HE (Kg/m3)	4	4	4	4	4	-
Effective water (Kg/m3)	200	200	205	205	205	175
E/C	0,6	0,6	0,6	0,6	0,6	0,6

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2-3. Comparison of the formulation studied

2-3-1. Characterization of concrete

The characterization of the concretes in the fresh state was limited to the tests recommended by the AFGC [6], namely spreading at the cone, flow at the "M" box, and stability at the sieve and bleeding.

2-3-1-1. Spread (BAP) or Slump (BO) test

This involves unmolding a DIN standardized cone (or Abrams cone) of fresh concrete and measuring the diameter of the concrete slab obtained (Photo 1). It should be remembered that is considered self-compacting, a concrete that forms a pancake with a diameter between 60 and 75 centimeters. For SCCs, intermediate flow times were measured. This is the time required to reach a diameter of 50 cm, denoted t50 [6].

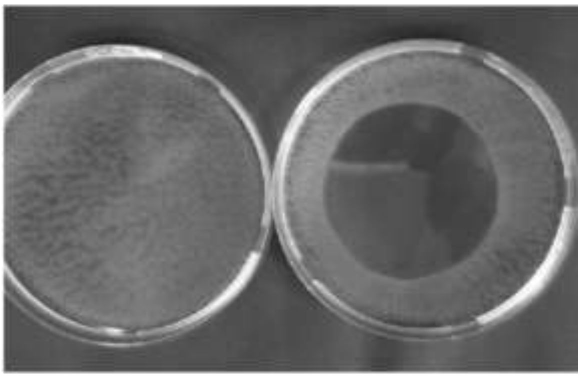

Photo 1: Spreading test

For the vibrated formulation (BO), it is the traditional Abrams cone test according to standard NF P 18-451 which replaced that of spreading.

2-3-1-2. The “M” box tests

The "M" box is used to test the mobility of concrete in a confined environment and to check that its placement will not be upset by blocking phenomena.

13 liters of concrete are placed in the vertical part and then the concrete is allowed to rest for 1 minute. The hatch is then lifted and the concrete flow inside the horizontal unite of the box into the reinforcement. in the end of the flows, the heights H1, H2 are measured and the results are expressed in term of the filling rate H2/H1 (Figure 1, Photo 2) [6].

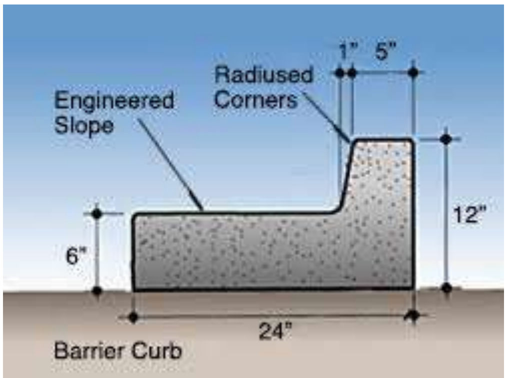

Figure 1: Measurement of parameters after stabilization

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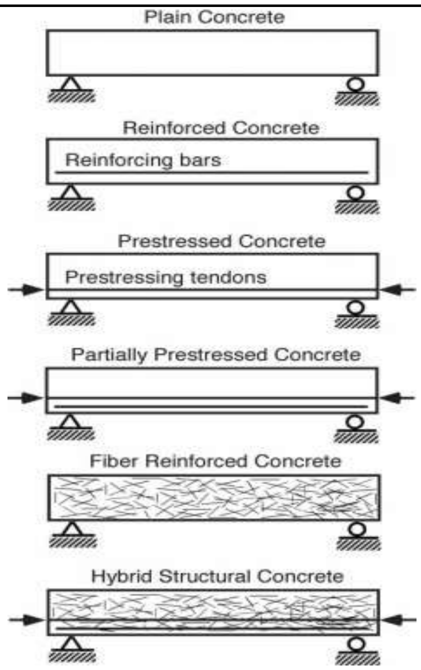

Photo 2: Filling the concrete upstream of the reinforcements

2-3-1-3. Sieve stability test

Which is established by measuring the proportion of π of fine concrete elements that pass through a sieve with an aperture of 5 mm in order to qualify the concrete with regard to the risk of separation and to reach whether the tested concrete has acceptable stability or not. The acceptance criteria for BAP formulation fall into 3 parts:

1-0% < π (milt) < 15%: satisfactory stability,
2-15% < π (milt) < 30%: critical stability,
3-π (milt) > 30%: very poor stability (systematic segregation, unusable concrete).

2-3-1-4. Penetrant testing

For the bleeding test, this involves measuring the quantity of liquid brought to the surface of a 30 x 15 cm test piece after three hours (Figure 2).

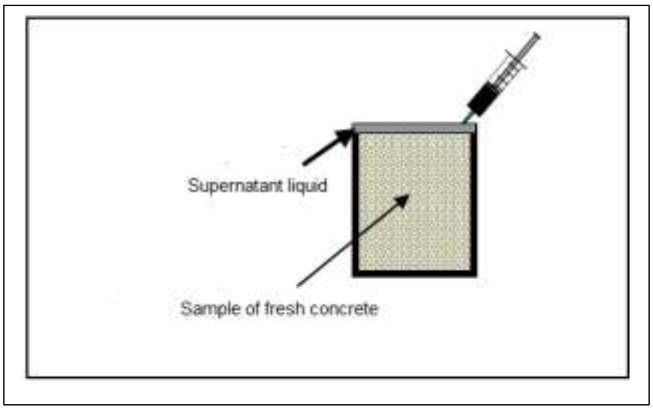

Figure 2: Penetrant testing

2-3-1-5. The occluded air

With specific equipment, the aerometer, the air content of concrete is determined according to standard NF P 18-353. The principle is to fill a determined volume of concrete, to pressurize the hermetically sealed container located above, to bring the two containers into contact and the value of the occluded air content is accessed directly. The samples used to determine the mechanical compressive strength of the various concretes studied are cylindrical specimens with a diameter of 11 cm and a height of 22 cm. Once removed

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from the mould, they undergo rectification and are stored in water in a room at 20°C and 95 ± 5% relative humidity for up to 28 days.

2-3-2. Results and analysis

The responses of the characterization tests carried out on the ready-made concretes are presented in Table 3.

We can see that all of the self-compacting concrete meets the spreading criterion. The specified spread is respectively between 70 cm (B3) and 74.5 cm (B5).

Although no limit is given for the spreading times, the times measured to reach a wafer of 50 cm in diameter (t50) are close to the values commonly encountered (3 seconds) [6].

Table 3: Characterization of the study concretes (SCC and BO)

TESTS \ CONCRETE		B 1	B 2	B 3	B 4	B 5	BO
SAG (cm)		-	-	-	-	-	8
SPREAD	Dmoy (cm)	84,0	83,0	80,0	82,0	85,5	-
	t 15(s)	3,5	3,3	3,0	3,0	3,8	-
m-BOX	H1/H2	1,94	1,92	1,88	1,90	1,96	-
	T30 (s)	4,0	4,1	4,5	4,3	4,0	-
SIEVE STABILITY π (%)		22,85	23,60	8,68	9,45	24,50	-
Flow (‰)		2,46	2,52	2,15	2,26	2,58	-
ENCLOSED AIR (%)		2,8	2,4	1,9	2,2	3,2	1,6
Rc at 28 days (MPa)		37,9	38,6	41,0	39,8	37,1	36,5

For all the SCC compositions, the milt halo at the periphery of the concrete slabs was absent or very weak (from 1 to 2 mm). In addition, the large aggregates were always carried correctly by the cementations matrix and did not remain piled up in the middle of the concrete slabs.

On the consistency of ordinary (vibrated) concrete: no condition had been set beforehand. The subsidence class obtained is class S2 (plastic concrete: from 5 to 9 cm according to standard NF EN 206-1).

On the dynamic segregation of SCCs, the results shown in Table 2 are consistent with what can be expected from a self-compacting concrete. However, the most important thing in this test is that the concrete under test flows through the reinforcement correctly. On this point, there is no problem to report since all the BAPs have fill rates greater than 0.80. The values of the workability assessment parameter of SCC T40 are close to those commonly found (3 to 5 seconds).

On static segregation, all SCCs have a segregation rate of less than 15%, synonymous with correct stability. Significant bleeding is the sign of a deterioration in the aesthetic quality of the facings and in the durability. The recommended bleeding limit values must be less than or = 3% in volume. All our concrete meets this condition.It can be noted that the resistances between BAP and BO are not very different. The reasons for the small differences observed are various:

• The high strengths of SCCs are linked to the large volume of paste.

• The use of the "viscocrete 20HE" superplasticizer in self-compacting formulations can have a beneficial influence on the mechanical resistance.

• The presence of a large quantity of limestone filler as an addition in the SCCs can also have a positive effect on their compactness and consequently on their mechanical resistance.

2-3-3. Balance sheet

A first remark could be made on the performance obtained by self-compacting concretes. It is visible that good concretes are obtained in terms of mechanical resistance (essentially due to high compactness - admixture, high fines dosage). There are many possibilities for varying the study parameters for SCCs (use of different dosages of mineral additions, viscosity agent, superplasticizer, variation in paste volume, G/S ratio, W/C ratio, etc.). All this generates a case-by-case view of each property studied and does not allow the observations made to be generalized to a wide range of mechanical resistance. This being the case, the best way to ensure and best achieve the targeted properties of a SCC in the fresh state is undoubtedly to attach particular importance to the influence of the composition parameters and to arrive at a formulation optimal.

3. Influence of composition parameters on the behavior of SCC in the fresh state

We propose to study the effects of the composition parameters of a SCC formula on the fresh state characteristics. We chose to work on BAP3 which presented the best results in comparison with the other BAP formulas.

The formulation parameters studied are as follows:

• The super plasticizer dosage (%): Sp,

• The ratio of the mass of water to the mass of cement: W/C,

• The ratio of the mass of addition to the mass of cement (fines on cement): F/C,

• The proportion of paste [C (cement)+F (addition)+E (water)+Sp (superplasticizer)] of the concrete (%): Vpaste,

• maximum gravel diameter (mm): Φmax.

The ranges for each parameter are given in Table 4.

Table 4: Ranges of composition parameters of a BAP formula

parameters	Min	Intermediate	Max
Sp(%)	1,6	1,1	2,6
E/C	1,5	1,6	1,7
F/C	1,21	1,26	1,31
V_{dough} (%)	46	38,6	42
Φ_{max}(mm)	26	-	21

4. Conclusion

at the end , we can note that it is possible to manufacture SCC with local materials having the same basic components as ordinary concrete and thus making it possible to obtain the same characteristics as those known internationally. However, the requirements that a self-compacting concrete must satisfy compared to a vibrated concrete are significantly higher with regard to its formulation and its characterization in the fresh state. The formulation of SCC requires a precise study, in particular in the choice of constituents, and the optimization of the parameters influencing in particular the W/C and F/C ratios, the dosage of superplasticizer, the volume of paste and the maximum diameter of the gravel:

- A superplasticizer content of around 0.5% with W/C = 1.6, F/C = 1.36 and Vpaste = 37.5%, making a BAP is almost impossible.

- The W/C ratios =0.4 and W/C = 1.6 (F/C = 1.36, Vdough = 37.5%) influenced positively on the stability with resistance to segregation of SCC.

- The SCC with a W/C ratio = 0.6 (constant F/C and Vpaste) has the particularity of generating poor stability with respect to the flow.

- The addition of limestone filler helps to reduce the viscosity of the SCC (increase in the spreading diameter).

- When the dosage of fine limestone exceeds 25% (critical value), it causes an increase in viscosity resulting in a decrease in the H2/H1 filling rate.

- A paste quantity content of the order of 35% (constant W/C and F/C) does not make it possible to obtain a SCC meeting the requirements of the AFGC.

- The SCC at 40% pulp volume (constant W/C and F/C) is at the limit of the self-compacting range.

- The SCC with aggregates of maximum size Φmax = 15 mm favored the best workability and deformability.

- The BAP at Φmax = 20 mm is in a low self-compacting limit.

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To support our research, a second part will be started. This is the study of the influence of composition parameters on the behavior of SCC with respect to shrinkage. Various tests relating to the mechanical domains and that of the microstructure will be carried out.

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