International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol.2, Issue.6, Nov-Dec. 2012 pp-4162-4165 ISSN: 2249-6645

Influence of the Powder of Pozzolana on Someproperties of the Concrete: Case of the Pozzolana of Djoungo (Cameroon)

Michel Mbessa[1], Emmanuel Cyril Bernard Ndongo[2], HippolyteNtede Nga[3], Thomas Tamo Tatietse[4]

[1,2,3,4]*University of Yaoundé I - National Advanced School of Engineering - Department of Civil Engineering- Po Box 8390 Yaoundé, Cameroon. Tél/Fax: (237) 22 22 45 47*

ABSTRACT:*In this article, it is studied the influence of the pozzolana of Djoungo (ground to less of 80 µm) on some mechanical characteristics of the concrete. A comparative study is done on the basis of a reference concrete (% of cement) and five other variants distinguished by their percentage in pozzolana as substituting for the Composed Portland Cement class 35 (CPJ 35) CimencamFactory in Cameroon. The percentages used are: 10, 25, 50, 75 and 90%. The results obtained show that a substitution of less 25% natural pozzolana can be envisaged in the non-carrier structures.*

Key-words**:***characteristic, concrete, compression traction, natural pouzzolane, substitution.*

I. Introduction

Since more than one decade, the pozzolanicity was the subject of several studies on the much known ultrafine particles notably silica fume, metakaolinite, slag, cristobalite (farsil 10), flying ashes.., It is about the substitution/addition of these ultrafine particles to the cement for the confection of the high performances concrete. The results on the workability, the durability and the mechanical characteristics are more or less satisfactory. The popularization of these concretes is operative on mostbuilding sites in Europe [1].

Indeed, the interest of the use of these ultrafine particles in the concrete is the combination of the silica that they contain, with the lime freed by the hydration of the cement in presence of water (pozzolanic reaction) to give hydrated calcium silicates (hcs), real binder contributing considerably to the improvement of the mechanical characteristics of this concrete. The pozzolanicity is the chemical reactivity of the silica with the lime in presence of water at an ambient temperature [1, 3].

From that precedes the idea to think a priori about an improvement of the mechanical characteristics of the concrete by replacing the cement by the pozzolanaor adding pozzolana to the cement would not make a doubt anymore. However, the question that one asks is to know its degree of influence on the mechanical properties of the concrete [1].

In Cameroon, research on the pozzolanicity of the local materials has started although late and timidly. The researchers of the Laboratory of Geotechnic and Materials of National Advanced School of Engineering of the University of Yaoundé I bent on the characterization of the pozzolanicity of the materials as : burnt laterite, thermally treated clay from Dibamba, artificial pozzolana from the clay of Etoa (Road Yaoundé - Mfou) [3, 4].

In this work, we studied the influence of the ground pozzolana of Djoungo, on the mechanical characteristics of the concrete.

The tests were led on mortars and concretes with mixed binders (CPJ 35 cement and pozzolana) and with varied percentages of pozzolana, and the results are compared to those of a reference concrete (300 kg CPJ 35 Cement content percube meter) with a binder/water ratio = 2, following DREUX GORIS method.

II. Materials

The materials used for studyare:cement, ground natural pozzolana, sand, gravelandwater.

2.1 Cement

The cement used is thecomposed portland cement CPJ 35 from Cimencam factory in Cameroon. Its characteristics are presented in table 1.

Tableau 1: characteristics of the Composed Portland cement used

Commercialname	CPJ 35cement		
Color	Gray		
Absolutedensity	3,1		
Apparent voluminal mass (kg/l)	1,17		
Setting time	3 hours		
Grains diameter	80µm		
Specific area	3100		
Real resistance classat 28 days	32Mpa		
Constitutive elementsof cement	clinker	Gypsum	pozzolana
	65%	5%	30%

2.2Water

The water usedis the one produced and distributedbyCamerounaise Des Eaux (CDE).

2.3 Aggregates

The 0-5 sand, is extracted from the Sanaga stream of Ebebda(Lekiè division in Center Region of Cameroon), apparent density.5 and specific weight 2,6.

The 12,5/16 gravel, is from the stone pit quarry ofNkometou (Lékié division and Center region in Cameroon). Its apparent densityis 1,7and itsspecificweight is 2,6.

3.4 –Natural pozzolana of Djoungo

The pozzolana used is from Djoungo in Littoral Region of Cameroon (Mungo Division). Grey color, it was finely ground by the mechanical grinder in the Laboratory of Geotechnic and Material of National Advanced School of Engineering of the University of Yaoundé I. The chemical characteristics are presented in table 3, compared to those of the cement.

After sifting with the help of the electric sifter, passersby to the sifter of 80 µm have been retained and kept in waterproof boxes.

Tableau 3: Comparison of the chemical composition of the pozzolana and the CPJ 35 cement.

Chemical composition(%)	CPJ 35	Pozzolanaof Djoungo
SiO_3	19.5	45.79
$AI2O_3$	4.79	11.68
Fe_2O_3	2.74	12.83
MnO	0.04	0.17
MgO	1.26	6.16
CaO	60.42	9.60
Na_2O	0.18	3.54
K_2O	0.93	1.39
TiO_2	0.25	2.84
P_2O_5	0.51	0.60
Loss to fire	0.02	0.31
Pozzolana	10	

III. Experimentation

3.1 Test on concrete

3.1.1Composition of the concrete

The Method used is the one of Dreux - Goris [2] and as hypothesis, the percentage of pozzolana mentioned doesn't take in account the proportion already incorporated in the CPJ 35 cement.

The compositions of the concretes are presented in table 4.

Tableau 4: compositions of the concrete (forone cube meter)

Cte	Ct CPJ 35 (Kg)	Pz		Sd(kg)	Gl (kg)	Wr (kg)
		%	Masse kg			
Ref.	300	0%	0	780	1170	150
C10	270	10	30	780	1170	150
C25	225	25	75	780	1170	150
C50	150	50	150	780	1170	150
C75	75	75	225	780	1170	150
C90	30	90	270	780	1170	150

Cte: Concrete**; Ct:** Cement;**Sd:** Sand**; Gl:** Gravel and**Wr:** Water

3.1.2 Equivalent composition

Table5: Composition of the concretes forthe cylindrical 16x32 cm test-tubes

Cte	Ct CPJ 35 (Kg)	Pz		Sd (kg)	Gl	Wr (kg)
		(%)	M (kg)			
Ref.	7,2	0%	0	19,1	19,1	4,7
C10	6,5	10%	0,72	19,1	19,1	4,7
C25	5,4	25%	1,8	19,1	19,1	4,7
C50	3,6	50%	3,6	19,1	19,1	4,7
C75	1,8	75%	5,4	19,1	19,1	4,7
C90	0,7	90%	6,5	19,1	19,1	4,7
Total	25,137		17,96	19,1	114,5	28,08

Cte: Concrete**; Ct:** Cement**; Sd:** Sand**; Gl:** Gravel and **Wr:** Water

3.1.3 Consistency test

The consistency test was achieved according to the P 18-451 norm [2]. The results of settling to the Abrams cone are presented in table 7.

3.1.4 Compression test on cylindrical 16x32 cm test-tubes

Thetest was achieved according **to** NF P 18-406 norm.The results are presented in table 8.

3.2 Tests on mortar

3.2.1 Composition of mortars

The compositions of the six (06) types of mortar arepresented in table 6.

Tableau 6: Composition ofmortars

Cte	CPJ 35 Ct (Kg)	Pozzolana		Sd (kg)	Wr (kg)
		%	M (kg)		
Ref.	2,70	0%	0,00	8,10	1,35
M10	2,43	10%	0,27	8,10	1,35
M25	2,03	25%	0,68	8,10	1,35
M50	1,35	50%	1,35	8,10	1,35
M75	0,68	75%	2,03	8,10	1,35
M90	0,27	90%	2,43	8,10	1,35
Total	9,450		6,75	48,60	8,10

Cte: Concrete; **Ct:** Cement;**Sd:** Sand;**Gl:** Gravel and**Wr:** Water

3.2.2 Four points bending test on 4x4x16 cm prismatic test-tubes

The test was achieved according to EN 196-1 norm on a machine of 10 KN power and a speed of setting in load 50 N/s.
The test results are presented in table 9.

3.2.3 Compression test on prismatic test-tubes

The compression test on prismatic test-tubes was achieved according to NE P 15-45 norm [2], on the pieces obtained after the four points bending test. The press used was 150 KN power and the speed of setting in load was 2400 N/s.

The results tests are presented in table 10.

IV. Test results

4.1 On the concretes

4.1.1 Setting on the Abrams cone (consistency test results)

Table7:Consistency test results

Concrete	RC	C10	C25	C50	C75	C90
A in cm	3	3,5	2,5	2,5	2,5	2,0

4.1.2 Compression resistances on 16 x 32 cm cylindrical test-tubes

Table8: compression test Results on 16 x 32 cm cylindrical test-tubes

Concrete	compression Resistance (Mpa)
Ref.	13.43 ± 1.3
C10	12.41 ± 0.4
C25	9.77 ± 0.9
C50	5.15 ± 0.0
C75	3.20 ± 0.1
C90	0.96 ± 0.0

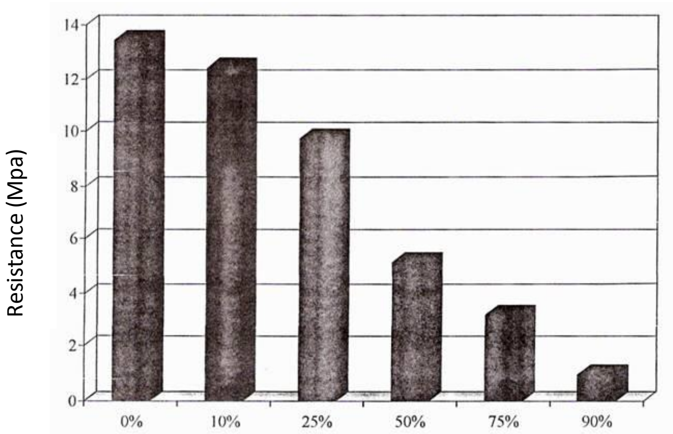

Figure 1:strips diagram of the compression resistances of the cylinders.

4.2 Test on mortars

Table 9: Four point bending test results on 4x4 x 16 cm prismatic test-tubes

Age	Mortars	Bendingresistance (at 28 days)
28 days	Reference	4,36
	M10	4,43
	M25	3,62
	M50	2,37
	M75	1,76
	M90	0,65

Table10:compression test Results on prismatic 4 x 4 x 16 cm test-tubes at 28 days

Mortars	Compression resistance (MPa)
Reference	19.87
M10	18.29
M25	12.62
M50	8.13
M75	7.14
M90	2.14

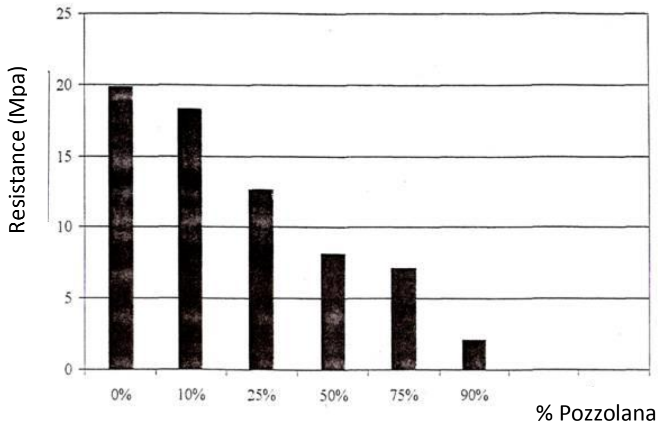

Figure2:strips diagram of thecompression resistances of the prisms according to their percentages in pozzolana.

V. Resultsinterpretation

5.1 Observations on the cool concretes.

- The phenomenon of sweating was the more observed on the B25 concretes, B50, B75 and B90. Itisessentiallyowed to the lack of the fine particles in the mixtures;
- The malleability of the concretes varies from hard for the reference concrete and B10 to very hard for the other concretes;

The presence of a whitish layer on the surface of thetest-tubes after removal puts in inscription the insufficiency of the degree of pozzolanicity of the pozzolanaused: a good quantity of free lime at the time of the hydration of the cement remained always free.

5.2 Observations on the hardened concretes.

The gray color of the test-tubes for pozzolanacontent up to 25% is an inheritance of the color and the proportion of the material used;
- The concretes having more than 50% pozzolanacontent resist less to the wear; they crumble easily to the finger;
- The relative presence of the pores on the pozzolanic concretes puts in inscription the accentuated character ofthe sweating phenomenon of the concretes evoked above.

5.3 Bending and compression test

The interest of the substitution by the pozzolana for the improvement of the resistances in bending is only observed at 10% of pozzolana. Beyond this value, one moves away more and more the values obtained on the reference concrete.

The gap of resistances obtained on identical test-tubes is not high.

Considering the bending test results (resistances), it is possible toenvisage the substitution of the powder of the CPJ 35 cement by the one of the pozzolana of Djoungo in the order of 10 to 25% for works solicited in bending.

The compression tests don't present an increase of the resistance.

Until 25% of substitution, the resistances obtained are all upto:

* 12.5 Mpa for the 4x4x16 cm prismatic test-tubes;

* 9.5Mpa for the 16x32 cm cylinders.

This decrease of the compression resistances proves that the pozzolana didn't fully play its role that is at a time granular and pozzolanic [1]. It would be judicious to reinforce the grinding of the pozzolana.

VI. Conclusion

In the framework of the promotion of the use of the local materials in the construction in Cameroon, we studied the substitution of a part of cement by a powder of pouzzolane ground to 80 µm maximal diametersin the composition of the concrete and mortars. The main objective of these works was to analyze the influence of such a substitution on some mechanical properties of the concretes. The results obtained during the bending test show that a weak proportion (lower to 25%) of usual cement powder can be replaced by the one of pozzolana of Djoungo (Cameroon). The analysis of the compression resistancepresents some values up to 12.5 Mpa for active substitutions until 25%. An increase of the compression resistance is not observed, what doesn't fill our waiting. The formulation of a concrete with ordinary cement basis, finely ground pozzolana and lime would complete the present research. Such a study would make appear the economic factor in the works of civil engineering and the factor time of drying (90, 180 and 240 days) of the test-tubes in the assessment of the resistances.

Références

[1] Mbessa M., Rôle des ultrafines dans des bétons industriels à hautes performances. *Editions Universitaires Européennes*, 2011, 172 pages.

[2] Dreux G., Guide pratique des bétons, *Presses de l'Ecole Nationale des Ponts ET Chaussées*, Paris, 1995.

[3] Iyambe P., *Réactivité pouzzolanique des matériaux argileux ET étude des ciments de pouzzolane artificielle: cas de l'argile de Dibamba.* Mémoire de fin d'études ingénieur. Ecole Nationale Supérieure Polytechnique, Yaoundé, 1996

[4] NdiguiBillong. *Investigations sur les propriétés pouzzolaniques de quelques déchets de briques et de tuiles cuites.*Mémoire DEA de chimieinorganique, Université de Yaoundé I, 2000.