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Impact of the Addition of Colloidal Admixture Properties When Cured Self Compacting Concrete Used In Bored Piles in Sludge

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Abstract: *Our study aims to identify the characteristics in the hardened state of self-compacting concrete designed for deep foundation: execution of bored piles in mud. Several trials in the hardened state (ultrasonic testing, mechanical strength and microstructure tests were carried out on PVC piles of 160mm diameter and 1300mm length, which were filled with Self-Consolidating Concrete admixture with a super-plasticizer noted BAP12 . Accordingly, and in the same context, the construction simulation study in laboratory is interested in the proper formulation of Self-Compacting sludge BAP12 by local and admixture materials to be subsequently applied in the field of cast foundations under water. In our study the Japanese method was used, concreting mode, preparations 7 mud mixtures (water + sand + bentonite) at different doses of sand, casting the Self-Compacting sludge in PVC tube and finally its characterization in 3 parts of the drilled pile; the basal part, the middle part and the upper part in order to follow up the percentage of contamination of Self-Compacting sludge casted under Mud (M1 = 1%, M2 = 3%, 5% = M3, M4 = 7%, M5 = 10%, = 15% M6, M7 = 20%). Seven BAP12 was casted without colloidal admixture and seven with colloidal admixture. The results show that the super-plasticizer used and colloidal admixture performed better when cured for Concrete Auto setting with colloidal admixture cast slurry (mixture M7 = 20% sand).*

Keywords: *Self-Consolidating Concrete, Bored piles, Bentonite slurry, Colloidal admixture, Sand, Ultrasonic velocity, Compressive strength.*

I. Introduction

Obviously inherent in the execution of bored piles, the workmanship is unfortunately all the more serious they are generally difficult to detect hidden defects. They are the logical continuation of existing or insufficient controls not carried out on site, both from the representative of the prime contractor as the company performing the work. We can understand the importance of defining the special requirements Workbook of the various controls that should be done. Some research work interested in piles drilling operations, but the study is still limited and incomplete vis-à-vis the formulation used for pouring concrete in bored piles and for treatment of problems encountered on site to provide solutions such us the excavation of pile by the sand during drilling. The characteristic of Self-Consolidating Concrete used for bored piles under mud when cured on the research study design is limited. This is like any technology: bored piles are dependent on proper follow a procedure in this case relating to drilling operations, where the slightest deviation can be fatal [1].

Bru.J treated the procedure but is adequate formulation of Self-Consolidating Concrete Limited [2]. Although there is no research interested in enhancing the leading role of colloidal admixture in maintaining the proper structure of Self-Consolidating Concrete designed for execution of bored piles in mud in the hardened state proved the microstructure. Sand embankments in the ground on site once contaminated concrete cast under water constitute a major problem in the degradation of the pile. This is the first time we made a simulation of the soil where the piles are drilled and mixed with mud and we did a study about the reaction of Self-Consolidating Concrete with sand and bentonite and the role of colloidal admixture in all this. Much research remains limited for the study of self-compacting concrete cast in bored piles in mud. Therefore, it is necessary to continue the on-site observations and study test station specific points or parameters to better understand the causes and significance of their effects [3].The role of admixture colloid in solving excavation stake in the sand during the pouring of concrete. Use of Self-Consolidating Concrete in the execution of bored piles still an effective technology for the good characteristics of SCC which is limited study [3]. In the literature, most authors are interested in the BAP used for cased piles which does not pose unexpected problems on site, without taking in account the existing in-situ problems in drilled tubes. The purpose of this research is to study the effect of the addition of colloidal admixture properties in fresh and hardened state of Self-Consolidating Concrete used in bored piles in mud, including the influence of the admixture colloidal and mud on the SCC12 cast in drilled piles. The Self-Consolidating Concrete poured into the bored pile under mud C7 gives the best characteristics fresh and hardened state. The results of our study will help to get a better idea about the sustainability of SCC cast bored piles under mud and also give an idea on solutions for excavation bored piles and excavation sand backfill soil piles walls on site of stonemasons and tile factories and identify the difference between the SCC with waste, a witness SCC limestone filler and an ordinary witness vibrated concrete (OVC) [4].

2. **The self compacting concrete:**

The compacting concretes (CC) are special concrete, very smooth, uniform and stable [5]. They are set up without vibration even in the most scrapped formwork which is a great advantage for constructions. To do a self-compacting concrete is described as if it satisfies some properties in the fresh state such as fluidity, filling ability and resistance to segregation and static dynamic [6]. Today concrete compositions have increasingly sophisticated. A self-compacting concrete (SCC) contains at least six, with more components of a BO mineral additives and adjutants. We are interested to SCC formulated with limestone filler [7].

3. Drilled piles in mud:

Bored piles are made by excavation of materials and casting concrete into the ground. Depending on the nature of the terrain to be traversed, there are many drilling techniques. Various tools are used depending on the hardness of the soil (hollow auger, etc.) [8].The lands are traversed laterally turned away. Bored piles are to make a real drill with any process. The terrain to be traversed is extracted as the perforation and the concreting is performed including tip in direct contact with the ground. It is understandable therefore that the bearing capacity of bored pile depends not only on the quality of execution of drilling, but also the implementation of concrete quality of the associated drilling mode tools or machines. The drilling operation is performed by alternative vertical translations of the column associated with the jetting of the water or sludge at pressures of up to 20 to 30 bar. In the case of unconsolidated soils, a casing or the use of sludge ensures the holding of land during drilling operations [9].

4. Identification of local materials for concrete:

Local materials used in the formulation of concrete are 0/2 sand, gravel 4/15, and the cement 42.5 N HRS, the filler, the super-plasticizer and colloidal admixture. This self-compacting concrete is used for bored piles in mud [7].

II. Materials and methods

This study has two parts: the first relates to the formulation of concrete and the second simulation in situ.

1. Japanese approach: mortar Optimization Approach; Establishment of the formulation of the BAP:
The formulation of the SCC studied is summarized in Table 1. SCC12: Concrete Auto setting with super plasticizer [10].

Table 1. Formulations of tested SCCs

		Initial composition	**Correction :** final composition restraint
		SCC12	SCC12
Composition (Kg/m^3)	Cement	350	350
	Gravel	**748**	**628**
	Sand	628	628
	Limestone filler	150	150
	Efficient water	176.25	175.74
	Superplasticizer	2.8	2.8
Ratio	E/C	0.5	0.5
	G/S	**1.19**	**1**
	E/(C+F)	0.35	0.35

2. Optimization of used super plasticizer:

The curve of variation of the flow time as a function of A/C (Fig.1) shows a decrease of flow time to reach 21.3s for an A/C ratio equal to 0.8%. Beyond this value the variation of flow time is low. From these results, we can conclude that the optimum flow is given by an A/C ratio equal to 0.8% and a flow time of 21.3s [11].

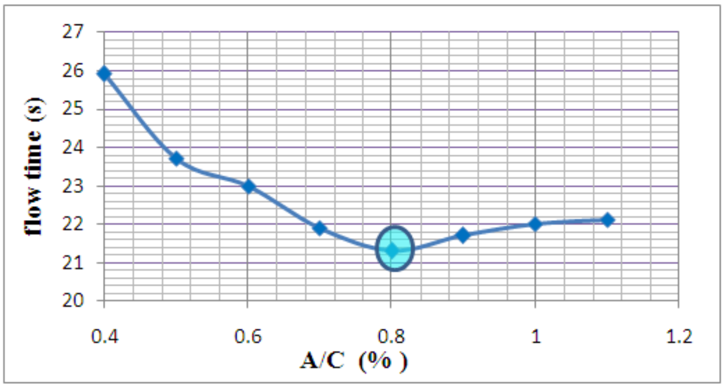

Figure 1. Optimization of the super plasticizer

3. Admixture optimization test colloid by the diving test (CRD C61)

Figure 2 shows the percentage of concrete mass loss as a function of the dosage of anti-washing admixture. From this figure we distinguish the existence of two parties; Part decreases ranging from 0 to 3% with a loss of minimum mass about 13.64%. While for larger dosages reaching 6% curve becomes almost constant. We can therefore conclude that the admixture colloid has a washout resistance given by an optimum dosage of 3% and a minimum loss of mass 13.64%.

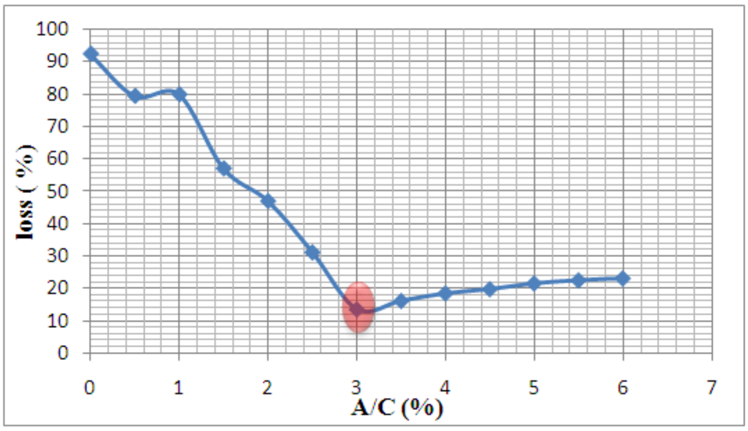

Figure 2. Optimization of colloidal admixture

The mud used:

These bentonite-water mixtures of sand and water at different dosages in sand, mud seven mixtures are prepared. (M1 = 1%, M2 = 3%, 5% = M3, M4 = 7%, M5 = 10% = 15% M6, M7 = 20%). We have casted 7 SCC12 without colloidal admixture and 7 concrete with colloidal admixture. Bentonite used density of bentonite is of the order of 1.05g / cm3, which is the equivalent of 30 g bentonite per liter of water. In our work we have interest at 7 mixtures prepared by substituting a fraction of bentonite by a given percentage of sand (Table3). Bentonite used is produced by the company SOFAP Tunisia. It is in the form of a greenish powder with the chemical and mineralogical characteristics are shown in Table 2. The main physical properties of bentonite are:

Bentonite
- PH: 8.5
- Water content (%): 6-8
- Actual Density (g / cm3): 2.5

Table 2. Chemical and mineralogical characteristics of bentonite

Chemical properties		Mineralogical properties	
Al_2O_3	16 -17%	Montmorillonite	85-93%
SiO_2	61-63%	Calcite	3-4%
MgO_2	2-3%	FeldSpath	1-3%
Fe_2O_3	3-4%	Quartz	1% max
CaO	3-3.5%		

Table.3. Assays of bentonite per 1 liter of water

Mixtures	Assays for 1l water
Mixture 1 : 5% sand	0.3g sand+29.7g bentonite
Mixture 2 : 5% sand	0.9g sand+29.1g bentonite
Mixture3 : 5% sand	1.5g sand+28.5g bentonite
Mixture4 : 10% sand	2.1g sand+27.9g bentonite
Mixture5 : 10% sand	3g sand+27g bentonite
Mixture 6 : 15% sand	3g sand+27g bentonite
Mixture 7 : 20 sand	6g sand+24g bentonite

4. Preparation of PVC tubes

The preparation of 14 PVC tubes is to first build PVC piles 1m 30 cm long each one and 16 cm in diameter. This study helps to bring the site work in the laboratory, it is a simulation. First, PVC tube has been prepared with a length of 1.30m mortar 5cm base acting as a stopper, not to leave the cast-in point of contact with the ground. This base is composed of MAT12 mortar made with cement CPA (C = 350g, S = G = 628g, 150g F = E / C = 0.56), and second, these tubes clogged with mortar, are left to the outdoors 3-4 days (Photo.1).

Photo 1. Closure PVC pipes with 5 cm mortar.

Third, we fill the tube 1000mm with the mixture of bentonite (initial viscosity measured before casting) (photo 2) and a drop height of about 5cm we pay the required volume of BAP12 which fill 1.25 m of the tube. This test is repeated twice without colloid and colloid (photo 3). [12].

Photo 2. Bentonite dosing Preparation **Photo 3.** Fill the tube with the SCC12

Fourteen tubes made without colloid and with colloid are allowed to stand in a stable position for 14 days. Finally we get every three cylindrical tube 16 * 32cm (top, middle, bottom part) (photo.4). These specimens were subjected to surfacing sulphur (according to NF P 18-416 standard). Finally passes to the recovery of the test pieces of length 32cm and 16cm diameter for the hardened concrete characterization tests.

Photo .4. Recovery of three specimens of each mixture

III. Results and Discussion

5. Concrete Characterization BAP in the hardened state:
5.1. Non-destructive testing: ultrasonic speed:

Ultrasonic velocities are zero for SCC12 cast in mud within 7 mixes. So you could say that SCC12 made without colloidal admixture are heterogeneous. (photo5).

Photo 5: Structure of the specimen 5 after crushing

The mixtures are with colloid of the ultrasound velocity measurements of different moulds 7 shows that the mixture has the most homogeneous medium. The mixture 7 contains 20% sand; this homogeneity confirms the major role of colloidal admixture which gives the Self-Consolidating Concrete uniform crystalline structure even in the presence of a large percentage of sand. The admixture anti-washing participates to avoid contamination of the concrete by the grains of sand that weakened the concrete structure. SCC12 made with the colloid exhibit good granular distribution along the tubes. This homogeneity is approved by experimental measurements ultrasonic speeds (Fig.3). Thus, the colloid admixture anti-washing gives the cured concrete a crystal structure denser and more compact. The Fig 3 shows that the mixture 7 has the best ultrasonic speed. This mixture 7 has a high density and excellent uniformity (20% higher than sand) with a sound velocity of about 4125m /s.

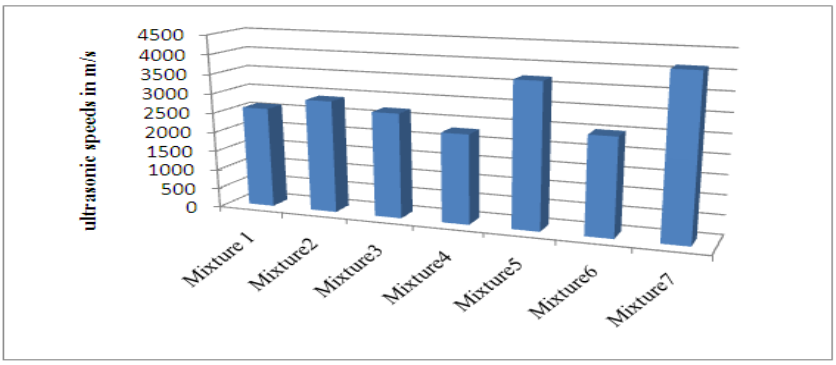

Figure .3. Histogram ultrasound speeds SCC12 cast underwater 14 day

Based on Fig 3, we find that the mixture 7 has the best mechanical properties (homogeneity and compressive strength).

5.2. Destructive testing: the compressive strength

The compressive strength measured on samples made up in SCC12 cast underwater without colloid are very low for the seven mixtures. Yet, the best resistance is obtained for the 6th mixture (15% sand) in the order of 5 MPa (mixture which presented the lowest difference between the initial viscosity and viscosity after casting) [11]. This low compressive strength is essentially due to leaching of the binder phase in the development of concrete in tubes filled with the mixture of bentonite (lean concrete). Whereas with colloid we obtained significant values of compressive strength at 14 days with a maximum resistance equal to 16.7 MPa for the 7th mixture (mixture that has the lowest percentage of bentonite and the largest percentage of sand "20% ") (Fig.4). This can be explained on the one hand, by a relative enrichment of the concrete by the sand originally contained in the tube and on the other hand, by the stickiness of the admixture colloidal preventing the leaching of the cementitious matrix and the sand.

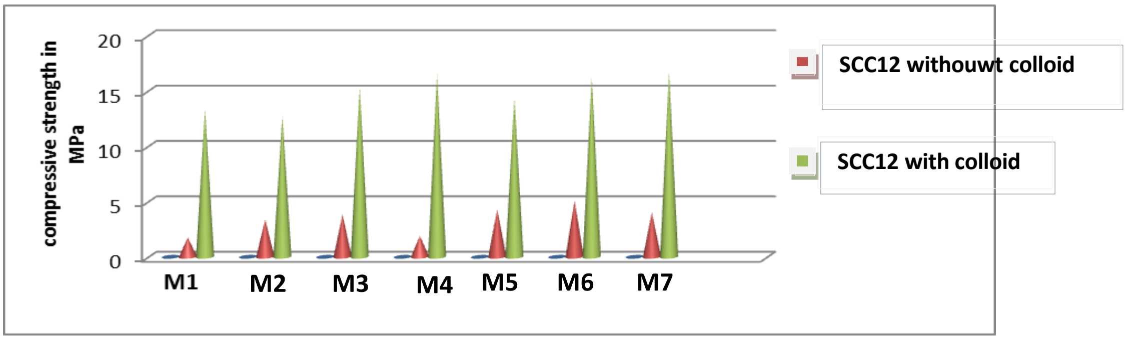

Figure.4 Histogram of the compressive strengths at 14 days of SCC12 cast underwater

Or for the seven mixtures, we noted that 16 * 32cm recovered basal portions of the tubes are very fragile such ways that we have not been able to calculate their compressive strength. This is explained by the contamination of the basal part of the tubes by the decanted bentonite. The latter participates in the embrittlement of the microstructure of the concrete. The values of compressive strengths obtained for the three parts of the tubes are shown in Figures 5 and 6.

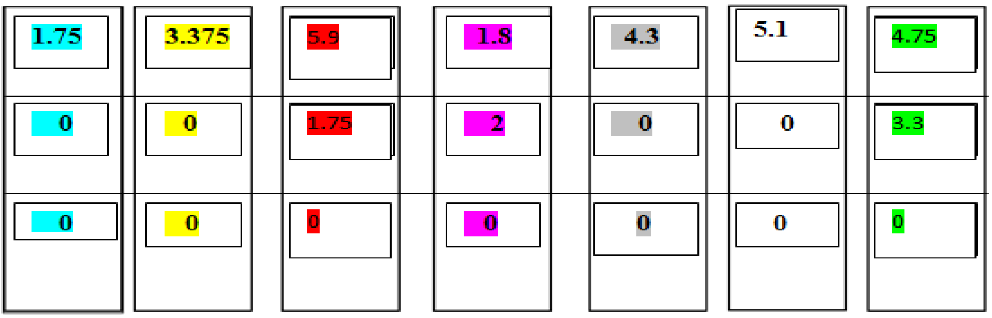

Figure. 5. Diagram showing the values of compressive strength in MPa obtained at the top, middle and basal piles SCC12 without colloid

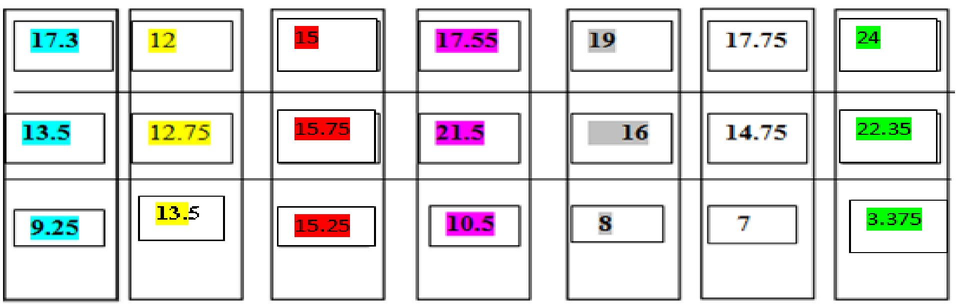

Figure.6. Diagram showing the values of compressive strength in MPa obtained on three levels piles in SCC12 with colloid

According to these results we find that:
• The presence of bentonite and sand alters the foundation piles;
• The addition of colloid reduces the effect of the presence of bentonite and sand in the basal parts of the pious;

It appears from these results that a percentage of sand 2 to 3% to improve the results of compression in the bases. But a higher content can give greater results in the upper and middle parts of the piles 1300 mm. Measuring the compressive strength shows that the mixture 7 presents the strongest mix and this is thanks to the role of colloidal admixture. 7 The mixture is cast under water in a bentonite cure dosage equal to 20% sand. The colloidal admixture fought against the contamination of the concrete sand and bentonite existing in the cure which explains the extent of the high compressive strength. For mixtures provided colloid mix 2 submitted in a course of 3% sand has the highest compressive strength because the concrete is not sticky so cast so vulnerable and exposed to contamination by sand and clay. Therefore the most% of sand is large more resistance to compression is small. From the above, it is well seen the role of colloidal admixture in concrete bored piles in the foundation sunk underwater. So bentonite slurry thus playing the role of impervious wall for bored piles implementation alone without adding colloidal admixture may adversely roles on the concrete; it can enter the structure of the weakened concrete and increases the% of fading and cracking and therefore the segregation Rating Decrease compressive strength.

IV. Conclusion

From all the above, it is noted that the self-compacting concrete used in bored piles under mud formulated by the Japanese method gives excellent characteristics once the concrete is cured. But control of the properties of cast concrete under water requires great attention. The characteristics of concrete cast under water have been studied: workability, resistance to washing and segregation, homogeneity, the strength of concrete in compression. As part of this work the concrete cast under water is the SCC12. The concrete ultrasonic speeds cast underwater SCC12 made with colloid are larger than those of the concrete containing no admixture anti-wash, for the samples tested in 14 days. The anti-washing admixture colloid provides the hardened concrete a denser and more compact crystal structure. Super plasticizer SP 12 anti-washing and admixture did not disadvantage the homogeneity of the material. Arguably admixture and 42.5 HRS IN cement used in the design of concrete cast under water are compatible.

References

[1]. AASHTO, L. (2007). Bridge Design Specifications. Customary U.S.Units, 4th Ed., p 1510.
[2]. Kulhawy, F.H. & Chen, J.-R,. (2007). Discussion of Drilled Shaft Side Resistance in Gravelly Soils by Kyle M. Rollins, Robert J. Clayton, Rodney C. Mikesell, and Bradford C. Blaise, Journal of Geotechnical and Geoenvironmental Engineering. ASCE, Vol. 133, No.10, p 1325-1328.
[3]. De Larrard, F. (1999). Concrete Mixture Proportioning – A Scientific Approach, Modern Concrete Technologie, Series 9, Mindess S. and A. Bentur, Editors, E & FN SPON, London, UK,.
[4]. Bartos, Sonebi, &Tamimi. (2002). Workability and Rheology of Fresh Concrete. Compendium of Tests Report of Rilem Technical Committee TC145 WSM.
[5]. Lecomte, A, Mechling, J-M, and Diliberto-Jeannot, C. (2009). Compaction index of cement paste of normal consistency. Constr Build Mater 23, p 3279–86.
[6]. Andrew, Mc Leish., (1994). Underwater concreting and repair.Head of Structural Appraisal. WS Atkins Structural Engineering, Epson, Surrey UK, p.1-19.
[7]. Bonavetti, V., Donza, H., Menédez G., Cabrera O, and Irassar, EF (2003). Limestone filler cement in low w/c concrete: a rational use of energy. Cem Concr Res; 33, p865–71
[8]. Chen, Y-J, and Kulhawy, F.H. (2002). Evaluation of Drained Axial. Capacity for Driled Shafts. Géotechnical. Spetial Publication No. 116, Deep Foundations., M .W. O' Neill and F.G. Townsend, Editors, ASCE, Reston, VA, p 1200-1214.
[9]. AFNOR. (2010). Exécution des travaux géotechniques. Pieux forés NF EN 1536, p 94-310
[10]. Khayat, K.H. (1995). Effects of anti-wahout admixtures on fresh concrete properties. ACI Materials journal, vol. 92, n°2, p 164-171.
[11]. EFNARC, (2002). Specifications and guidelines for self-compacting concrete. 32 pages.
[12]. Felekoglu, B., Yardimci M. Y. and Baradan B. (2003). A comparative study on the use of mineral and chemical types of viscosity enhancers in self-compacting concrete. Proceedings of 3rd International RILEM Symposium on Self-Compacting Concrete (PRO 33), Reykjavik, Iceland, p 446-456.