Characteristic Improvement of Dune's Sand Concrete

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SUMMARY

The main objective of this study is to improve the properties and mechanical characteristics of sand concrete based on fine sand.
This is done by several methods while keeping the cement content at 350 kg/m^3. A dynamic compacting process is used without filler and then with filler in the first stage, with filler of limestone (calcareous) in the second stage and lastly with additive (plasticizers and fluidifiers) in different amount in the third stage.

Tests carried out show an important improvement concerning:

* *The compressive strength of concrete.*
* *The limit state of fluidity of concrete.*
* *Effect of filler on the best granular correction.*

Keywords: Sand Concrete, Dune Sand, Additives, Fillers, Dynamique Compacting Process, Compressive Strength

1. Introduction

Sand concrete is a construction material composed of sand, cement and a natural or industrial Filler. Sand concrete can replace succefully the traditional concrete because of its economical cost, its compressive strength that reaches (12-80 N/mm2) (C.E.B.T.P. 1986; Guettala, et al. 1997), and its high workability. Moreover, it can succefully be used where it is desired to have concrete surfaces that present a good appearance on removal of the formwork. It can also be used to produce blocks for construction. Sand concrete has been used for the first time in the third quarter of the nineteenth century by F.Coignet to construct the bearing wall Passy and F .Coignet house in Saint-Denis in France. It has also been used in U.S.S.R in the beginning of the twentieth century to construct Kaliningrad herbor and Chernavskif bridge (Chanvillard and al. 1996; Chauvin 1987).

In a country as Algeria where the desert represents about two million squar kilometers, transportation of aggregates over long distances for construction can cause excessive cost when using traditional concrete. Abundance of dune sand in all this region encourages use of sand concrete, mainly in sand reach region, as Biskra, where the present research has been conducted.

This research is carried out in order to find the best content of sand that gives a good workability and high compressive strength using dune sand with cement of type CPJ 45. Moreover it is intended to

find out the physical characteristics of dune sand concrete using a dynamic compacting process with Fillers and additives, (Plasticiezers and Fluidifiers).

2. Characteristics of Used Materials

The best use of the different materials should be supported by a prior knowledge of the physical, chemical, physico-chimical and mechanical characteristics of these materials in order to make the most out of its best characteristics (C.E.B.T.P 1986).

2.1 Sand

In the present study, the Dune Sand of the region of Biskra (south east of Algeria) has been chosen.

2.1.1 Physical Characteristics of Sand

The density: The specific density is computed by using the pyknometre apparatus on a dry samples using sieves of 2mm (ASTM D 845 5) and the apparent density is computed by using (ASTM C 71-29). Results are presented in table 1 (ASTM 1993).

Table 1 The density of sand

type of sand	Absolute density γs (g/cm ^{3})	Apparent density ρ (g/cm^3)
dune sind	2,57	1.50

Sand Grading: is a performed using standard sieve (ASTM D 422-63). It permits to find the different quantities of elements constuting dune sand.

Figure 1 represents sand grading curve and shows that the dune sand is very fine. Fineness scale Mf = 1.22

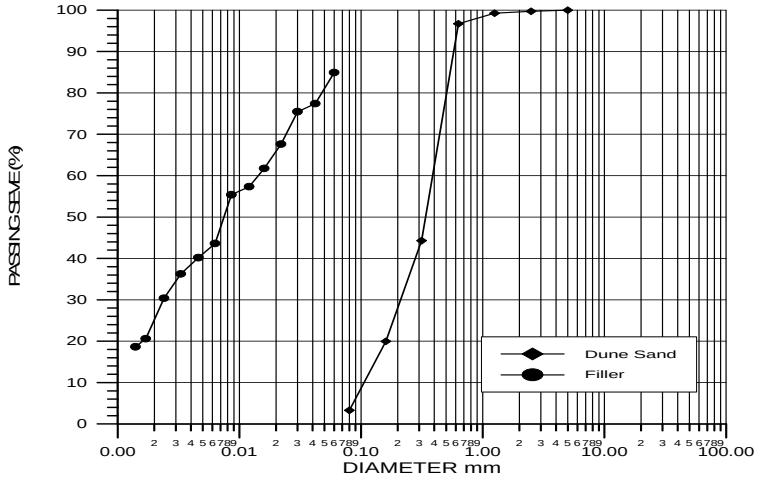


Figure 1 Sand and Filler grading curves

The sand equivalent values have been computed using the scale (NF P 186598) and test results are shown in Table2.

Table 2 Sand equivalent values

Sample	Sand Equivalent Value By Test	SAND Equivalent Value By Sight	Sand Quality
Dune Sand	58,65	67,11	Dusty Sand

2.2 Fillers

The fillers are obtained from limestone (calcareous rock) and used in order to reduce the cement ratio and improve the workability.

2.2.1 Grading

The diameter of filler's grains is (ϕ < 0,08 mm) and the aggregate analysis is computed using ASTM D 422. On Figure 1 is shown also the grading curve for the fillers for apparent surface of 2755 g/ cm2

2.3 Additives

Additives are in small quantities not grater than 5% by weight of used cement in order to improve some of the characteristics. Some of these additives are produced by Granitex Company in Algeria, among which we can mention plasticizers and Fluidifiers which are used in the present work.

2.3.1 Plasticizers (SFA)

Plasticizers are liquids that can easily be mixed in water with all kinds of cements. Their colour is brown and they have a density equal to 1.16 with pH = (7 - 8). The use of plastcizers can improve the properties of sand concrete mixes by: reducing water mixes, increasing the cube strength, increasing the placticity of concrete, produces a good workability and lastly reduces the time for setting.

2.3.2 Fluidifiers (SF)

The use of fluidifiers improves some of the characteristics of sand concrete. They favour cohesion between the sand concrete constituents, increase the workability, improve slump and strength.

2.4 Cement

A composed Portland cement manufactured in Algeria under the label CPJ 45 has been used and tested to determine the real strength using the AFNOR recommendations (AFNOR 1984). The compressive strength for 28 days is found equal to (46,6 MPa).

3. Characteristics Improvement of sand Concrete

Table 3 Reference concrete composition

Ciment (kg/m^3)	Sand (kg/m^3)	W/C	Rc_7 (MPa)	Rc_{28} (MPa)
350	1660	0,7	92	123

As a result of the work presented in (Guettala, et al. 1997; 1999) concerning the mechanical compressive strength of sand concrete using dune sand, we noticed that the strengths are weak, thus we tried to improve these results by three ways, which are firstly; adding fillers with the following percentages with respect to the total weight of sand concrete (8.4, 9.9, 11.4, 12.9, 14.4, 15.9, 17.4) and 2.5 % of additives SF and SFA, secondly stabilising the percentage of fillers to 12.9 % trying to study the effect of additives SF and SFA with (1, 1.5 , 2, 2.2 , 2.5%), and lastly a dynamic compacting has been used as follows (E_1 = 1.072, E_2 = 1.608, E_3 = 2.144, E_4 = 2.680 kj/m^3 with and without fillers.

3.1 Effect of Fillers

By adding different percentage of fillers for the same composition of sand concrete with 2.5% of additives (SF and SFA) and controlling the quality of sand concrete using the Out Flow test, the following results are obtained and shown below.

Table 4. Effect of the ratio of fillers on the workability of sand concrete

Fillers	Ratio	Compressive Strength Rc_{28} (MPa)		Workability	
(kg/m^3)	W/C	2,5 % SF	2,5 % SFA	(2,5 %) SF	(2,5 %) SFA
170	0,7	19,3	21,5	flowing concerte	flowing concerte
200	0,7	19,7	20,6	flowing concerte	flowing concerte
230	0,7	20,3	18,0	flowing concrete	plastic concrete
260	0,7	21,3	17,3	plastic concrete	plastic concrete
290	0,7	19,5	17,0	plastic concrete	plastic concrete
320	0,7	15,7	15,6	plastic concrete	plastic concrete
350	0,7	15,5	16,6	plastic concrete	plastic concrete

3.2 Effect of Fillers on the Mechanical Strength

Figure 2 shows that the compressive strength increases by increasing the fillers until reaching 11.9%, then it decreases in the case of fluidifiers SF. However the compressive strength decreases in the case of plasticizers SFA.

3.4 Effect of Time on the Mechanical Strength

It can be seen through figure 3 (a and b) that the compressive strength increases by time for all cases of sand concrete, mainly in the first week where it reaches 80% of the total strength.

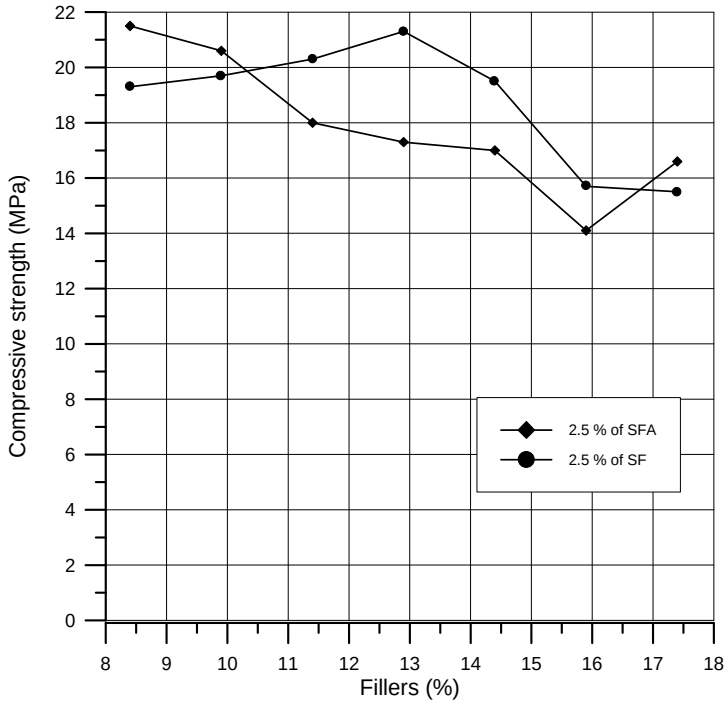
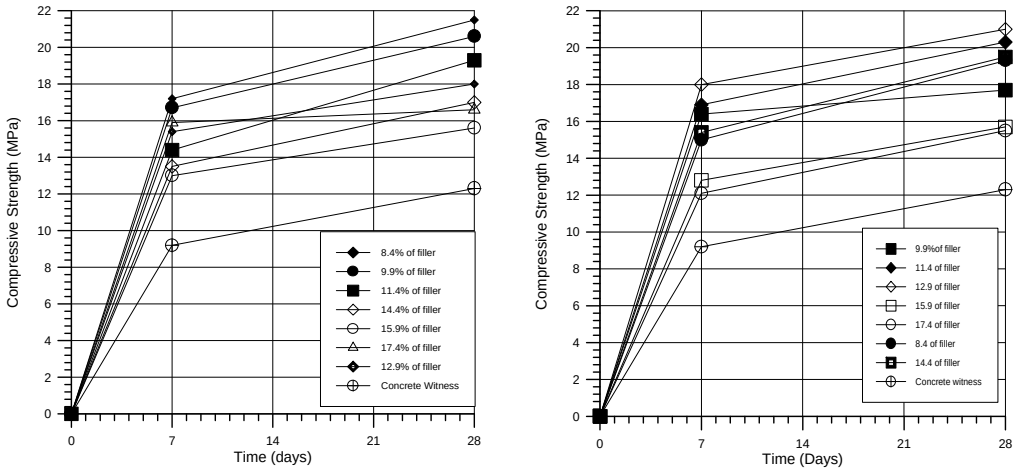


Figure 2 Development of compressive strength with time and filler ratios



a) 2,5 % (SF) b) 2,5 % (SFA)

Figure 3 Increases of compressive strength function of time and ratios of fillers

3.5 Effect of Additives (SF and SFA)

At this stage a quantity of 260 kg/m^3 of fillers has been added and the ratio of additives has been changed in order to determine their effect on the workability and the compressive strength.

3.6 Workability of Sand Concrete

Table 4 gives the results of quality control of the workability of the sand concrete using the Out Flow_Test

Table 5 Effect of the ratio of additives on the workability of sand concrete and compressive strength

Additives	Ratio	Compressive strength Rc_{28} (MPa)		Workability	
(%)	W/C	SF	SFA	SF	SFA
1	0,7	17,0	17,2	coherent concrete	coherent concrete
1,5	0,7	19,1	18,0	coherent concrete	coherent concrete
2	0,7	19,5	20,9	plastic concrete	plastic concrete
2,2	0,7	20,0	16,8	plastic concrete	plastic concrete
2,5	0,7	21,3	15,3	plastic concrete	plastic concrete

3.7 Effect of Additives on the Compressive Strength

Figure 4 shows that the compressive strength increases by adding the additives until 2 % where it gives the best value of the strength and then diminishes in the case of SFA.

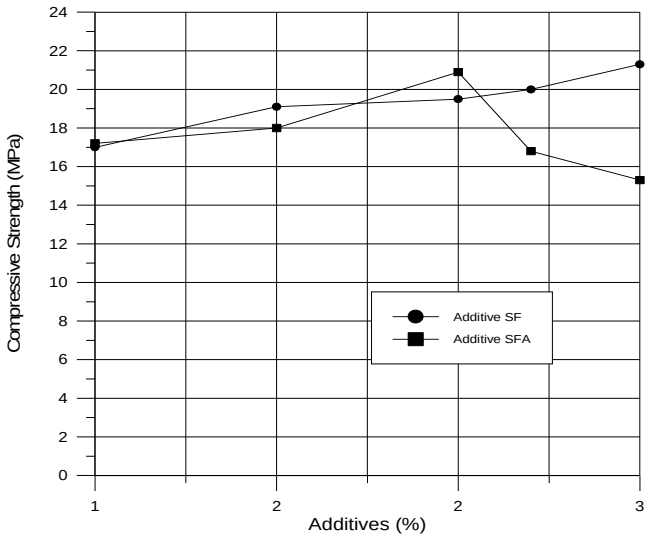


Figure 4 Effect of additives on strength

3.8 Strength improvement by a dynamic compacting

Using the proctor apparatus on two types of sand concrete with 12.9 % of fillers and without fillers the strength results are obtained and shown in Table 6 and Figure 5.

Table 6 Effect of dynamic compacting on the density and the strength of sand concrete with and without fillers

	(without filler)		(with filler)	
Energie (kj/dm^3)	Dry density γs (g/cm 3)	Rc_{28} (MPa)	Dry density γs (g/cm 3)	Rc_{28} (MPa)
E_1 = 1.072	1,836	21,5	1,900	24,0
E_2 = 1.608	1,865	22,0	1,908	24,9
E_3 = 2.144	1,920	22,5	1,915	28,2
E_4 = 2.680	1,925	22,8	1,964	30,3

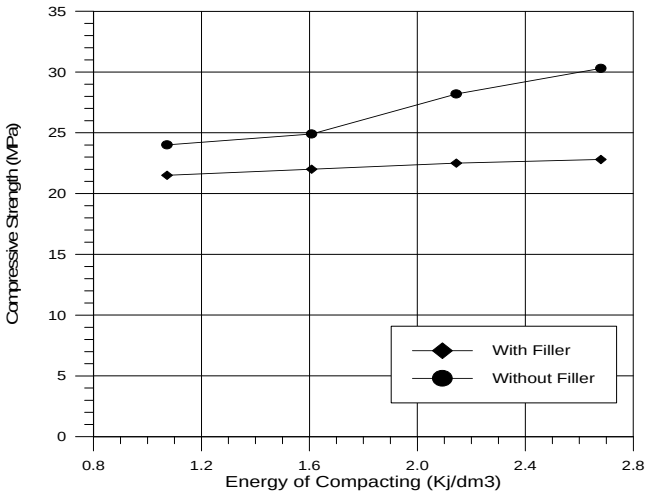
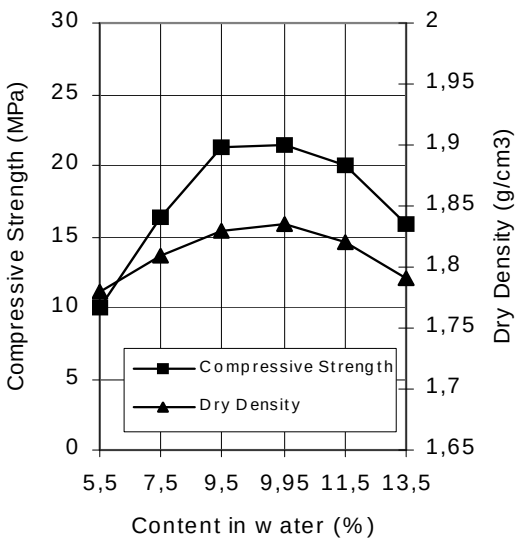


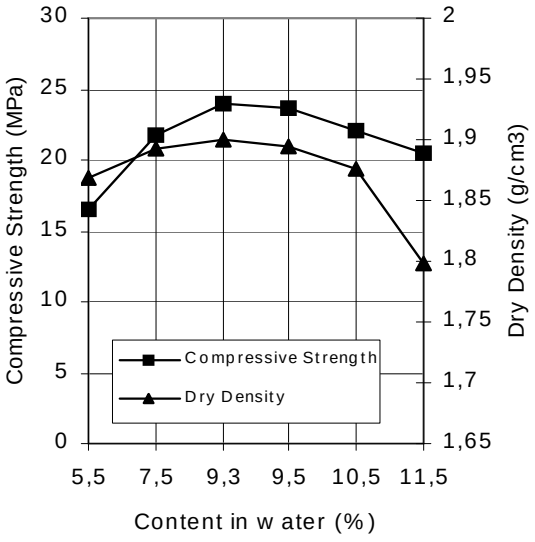
Figure 5 Effect of Dynamic compacting on strength

3.9 Effect of the Dynamic Compaction and Water Ratio on the Strength and Density

Figures 6, 7, 8 and 9 show that the strength and the dry density change function of the ratio of water and that water ratio that gives the best strength gives the best density.

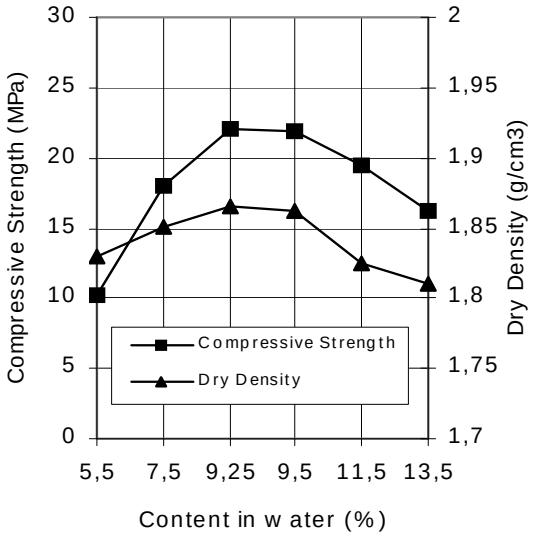


a) Without Filler

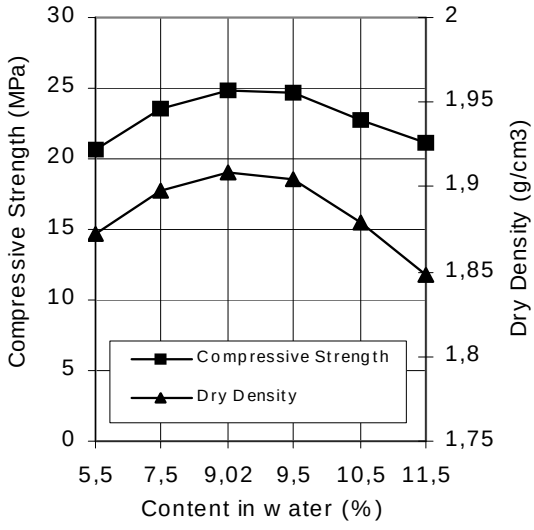


b) With Filler

Figure 6 effect of water ratio on the compressive strength and dry density of sand concrete under dynamic compacting E_1 = 1,072 kj/dm^3

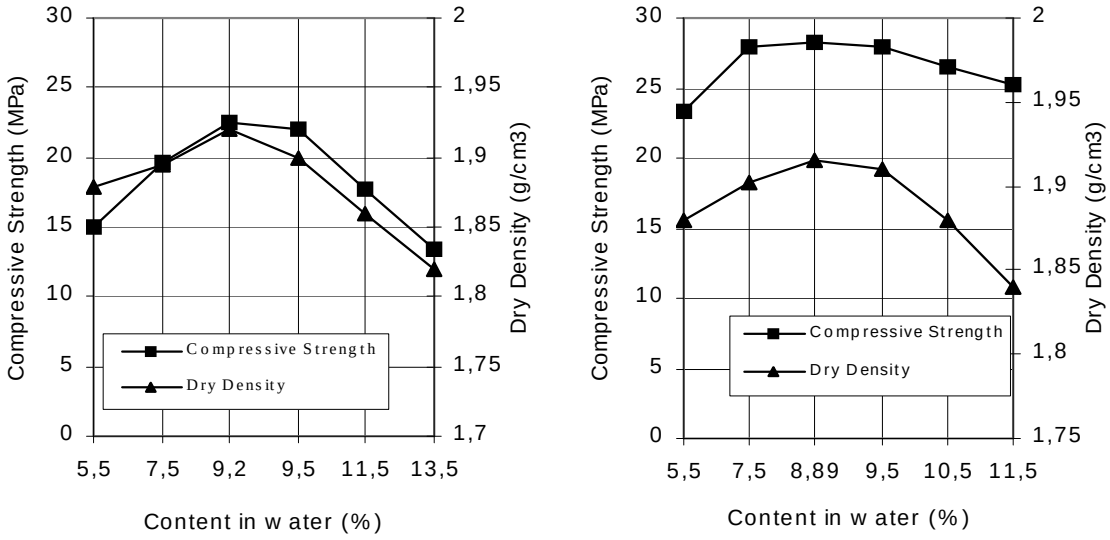


a) Without Filler



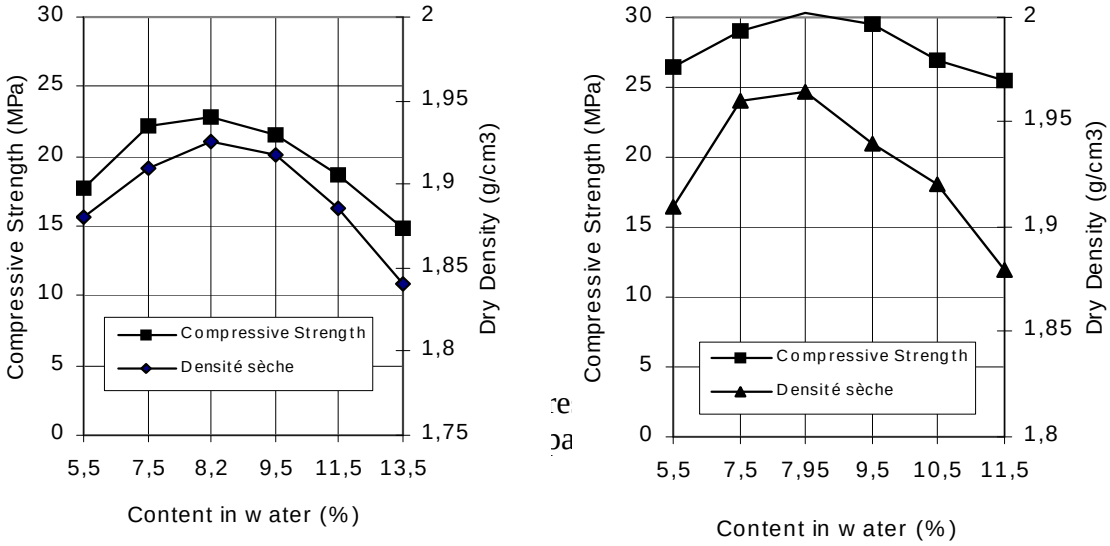
b) With Filler

Figure 7 effect of water ratio on the compressive strength and dry density of sand concrete under dynamic compacting E_2 = 1,608 kj/dm^3



a) Without Filler b) With Filler

Figure 8 Effect of water ratio on the compressive strength and dry density of sand concrete under dynamic compacting E_3 = 2,144 kj/dm^3



a) Without Filler b) With Filler

Figure 9 Effect of water ratio on the compressive strength and dry density of sand concrete under dynamic compacting E_4 = 2,680 kj/dm^3

3.10 Effect of Compaction the Strength

Table 7 Relative strength increases with

(%) of increase in the strength			
E=2,680 kj/dm^3	E=2.144 kj/dm^3	E= 1,608 kj/dm^3	E= 1,072 kj/dm^3

85.3	82.9	78.8	74	without fillers
85%	73%	52.7%	47.2%	with fillers

4. Conclusion

The present work shows that sand concrete using dune sand has a similar compressive strength as the ordinary concrete when adding fillers, compacting and adding also additives, it reaches (30 MPa) when using (350 Kg/m^3) of cement.

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