



Amelioration of Earth Bricks by Introduction of Traditional Lime for Arid Regions

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Abstract

Today to build durably means to build in such a way to create, to preserve in the world an acceptable environment where ecology, social and economic implications are in the center of future generations interest. To achieve this goal, we tried to employ local, durable, powerful ground materials which lead to limit pollution, to have long lifetime, and possibility of recycling or recovery. Using them in the most rational way makes construction technically perfect and put an end to cement invasion, since ground bricks are simple to implement and create a useful decoration, original and pleasant which enables to preserve the historical architectural heritage. This work concerns the study of environmental effects on stabilized bricks of compressed ground, traditionally manufactured containing traditional quicklime after extinction in water as a basic component which offers to brick mechanical resistance in conformity with the standards. Experimental results of compression and bending are exposed and are in conformity with the used standards.

Keywords: Characterization, BTS, Quicklime, Dune sand, Environment, Durable.

1. Introduction

Kenadsa is located at the western north of Bechar department, one of the western south cities of Algeria called before Southern Orany. The foundation of this city is allocated historically to the saint Marabout Sid-el Hadj Ben Ahmed (Master and spiritual leader of the locality at the beginning of the 6th hegira century i.e. already 8 centuries and 31 years ago which corresponds to 1180 Gregorian. As a city in this desert and arid place, Kenadsa subsist by means of its traditionally maintained palm plantation and its gardens. Moreover, some salt squares often helped in its economic support. The discovery of the coal deposits (1903) has permitted Kenadsa to be counted among the mining cities of our planet [1]. The surge of control and European manpower helped to the civilizing contribution modeling both Moslem and French cultures which permits the Kenadsian to be an advanced and cultivated man. We will try here to briefly recall the history of this industrial implantation and its consequences on the urban level, creation of mining cities and induction of spontaneous habitat districts. The city of Kenadsa, limited to its Ksar, counted approximately 2000 inhabitants at the beginning of the XXth century. The population will reach gradually 14.000 inhabitants in 1946, including 1.500 Europeans [2]. It should be noted that the mine manpower came from foreign particularly from France and Spain especially in the first years, then from Morocco and North of Algeria. In 1945, only 48% of the workers were originated from Bechar neighborhood. The share of the local labor will increase towards the end of 40th and in the 50th year (especially following the food shortage which touches the area from 1945 to 1948).

The adaptation of Ksourians and nomads to the mine conditions work posed obviously serious problems. It within this context that the implantation of the mining cities must be planned, initially intended to the reception of migrant external workers under summary conditions, they were marked then by the need of integration to the industrial lifestyle, with insertion in work of not-workers populations at first.

We find here, the conventional diagram of the mining cities in Europe at the XIXth century and the beginning of the XXth century [1]. A first “industrial village” is thus built in 1918, in the beginning of exploitation, near the mining field.

According to the photographic documents at that time (taken from 1918 to 1928), rather summary constructions at first seem more elaborated in 1928. But the true mining cities will be created only in 1942 with the realization of 1.600 residences by the H.S.O in 3 cities (two in Kenadsa and in Bechar-Djedid) equipped with various equipment: schools, dispensaries, bar restaurants, party hall, Moorish coffee, cooperative and even swimming pool...). More exhaustive studies would be necessary to determine the morphology of the cities and the building typology.

The Ksar built with mortars containing artisanal lime in hydraulic matter obtained by cooking of local limestone’s rocks in furnaces implanted in the mountains of MESSOUAR, area located at 7 km from the city, which provide wood pastures as a fuel and calcareous stone. With the discovery of coal, the Ksourians have built their lime kilns close to the deposits in order to increase the productivity. This lime kilns constituted an important source for the economy and the Ksourians took care and maintained them in good state.

There still exist ruins of old lime kilns from which emerge important bulks of limestones. Their weak productions and their intermittent characters allowed only low productivity and a painful exploitation from where the old Spanish saying: “why are you lime-burner? for lack of deny” [3].

The industrial development of the lime production led to the abdication of these traditional furnaces using more effective systems on the economic plan which ensure a product of better quality.

2. Presentation of Material

First, a traditional furnace was constructed in the same place of an old furnace. Our furnace of masonry, toub and stones has a truncated form of 5.5 m height and a 2.50 m diameter (Fig 1.), interior walls are covered by clay layers which are used for preserving and thermically insulating the furnace. He is leant to a natural slope rest which shelters it and facilitates the loading-unloading operations before and after cooking. He is built near supply places of calcareous rocks as well as of fuel. Coal layers and limestone rocks are alternate in such a way that the limestone rocks must be perfectly fixed, the largest one are placed close to fire in the center and the smallest close to the walls, the furnace is filled till the higher opening.

The quicklime was obtained at exit of this traditional furnace by cooking of calcareous rocks to higher temperature within 900°c which involves the release of all carbon dioxide during ten calcinations days:



We add dune sand, and water to extinct lime according to suitable proportions to obtain a paste or mortar for different uses.



Fig-1. Furnace Photos

The cooked stones “quicklime” were sorted and kept in hermetic barrels safe from the air to avoid their carbonation which removes to lime its properties of effective binder. Then we slake the quicklime by soaking it in water within proportion of half brick weight. This hydration causes a fast disintegration of the stones and produces a strong heat release which reaches more than 100 °C (Fig 2.).

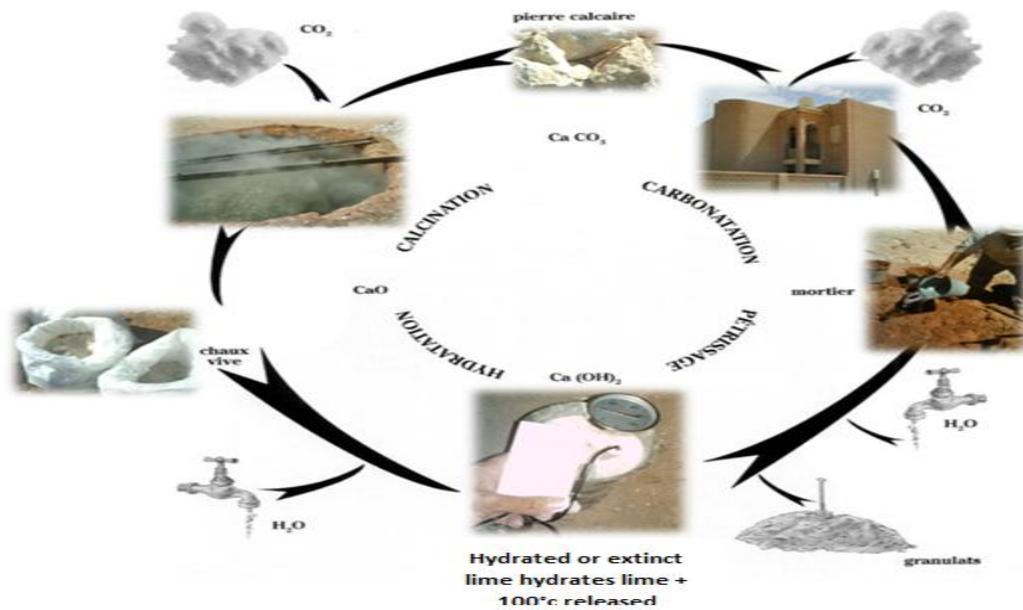


Fig-2. Lime process cycle

In the case of BTS, we adopted the following preparation method, which lasted 10 days:

- 1st day: we submerged the quicklime in vats beforehand filled with water which will be extinct after an exothermic reaction; we let then the mixture to rest up, to make sure of the total lime extinction:

N.B: To make sure of the good lime extinction degree, it is enough to insert a stick in the basin [4]:

- If the fastened lime is sticky there, the operation is good.
 - If it does not stick to it, if it runs, lime is embedded,
 - If a sort of smoke or powder is glued to the stick, lime was probably burned.
- 2nd day: we added to the mixture a sufficient quantity of water to have a good quality whitewash, and then we carry out a sifting of the contents to remove waste. The preparation of a mortar lime was done by the choice of Kenadsa dune sand (siliceous sands of good quality), by adding a sufficient quantity of whitewash in order to obtain an homogeneous paste.
- From 3rd at the 9th day: we let the mixture to rest up.
- 9th day: preparation of a quantity of extinct lime in the same way as in the first day.
- 10th day: we added to the already prepared mixture (3rd at the 9th day) the whitewash then the paste is sufficiently mixed to obtain a lime mortar ready to manufacture the brick used in the present study.

3. Test Protocol

The bricks for compression and three points bending tests are of parallelepiped form with standardized dimensions (Fig 3).

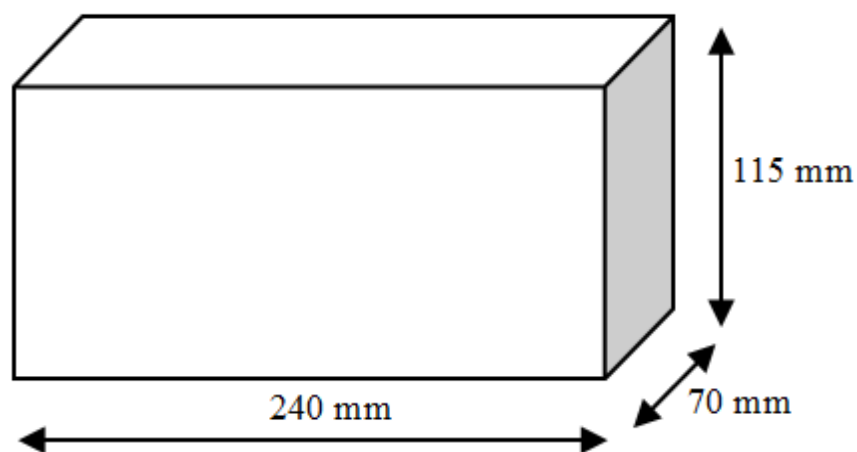


Fig-3. Brick dimensions

The compaction of the mixture for the fabrication of the BTS is a manual compaction by a standardized punner in three layers on a shock table [5]. Then the bricks let to dry in the sun during 45 days

The Fig 4. shows a BTS bricks carried out at the laboratory:



Fig-4. Photo of studied brick

The bricks manufactured are weighed and measured to determine the material density. The construction materials undergo efforts and react to simple compression or traction efforts. First, they undergo the effects of their own weights in addition to the loads which have to support. They react to the ground reaction forces which prevent them to sink [6]-[11]. The weight tends to crush materials, to compress them. The first quality of a construction material is thus to resist to this pressure without deformation. The tensile strength measures the capacity of a material to resist to wrenching. Indeed, it is the effort strictly opposed to compression. The materials which resist well to compression do not resist necessarily as well to traction [12]-[13].

In order to simulate experimentally these efforts, we choose to study the influence of environmental parameters on the brick resistance to compression and the three points bending in the two directions, transversely weak and transversely strong (Fig 5. and Fig 6.).

So these tests are applied to a population of four samples which simulates the following environmental effects:

- E1: bricks in natural state after drying.
- E2: bricks emerged in water during 28 days.
- E3: bricks exposed to the sun for two months.
- E4: bricks posed in a drying oven at a temperature of 48°C.
- E5: bricks under a wet ground.

The whole tests were carried out on 72 bricks



a) Transversally weak



b) Transversally strong

Fig-5. Photos of compression test

According to a direct reading of the Fig 5. which represents the results carried out on the BTS with the incorporation of several environmental parameters, we note that in the case of weak transverse direction, the three following parameters:

The total immersion of brick in water during 28 days, the exposure of brick in the sun for two months (April, March) and brick staying in a drying oven with temperature from 45 to 48 °C (strong heat

of the arid regions hot season) act in favor of sample material to study in compression resistance. The immersion in water gives a better performance in term of mechanical resistance; on the other hand moisture at the very high rates penalizes material in compression resistance

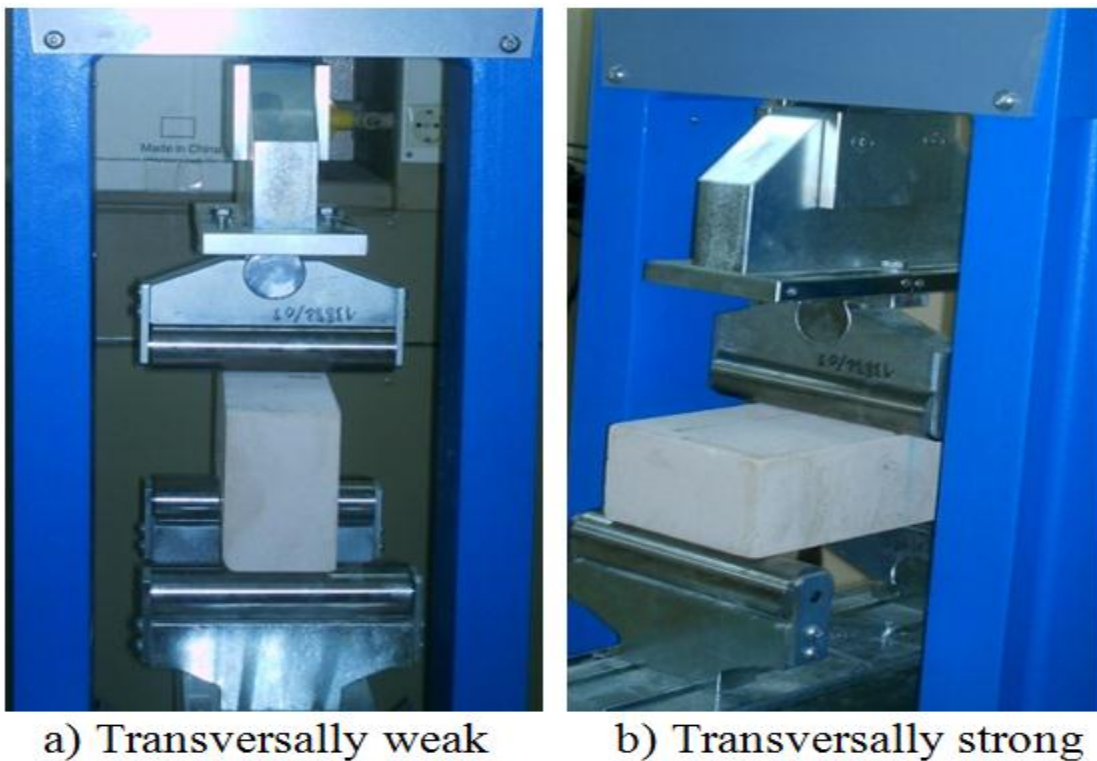


Fig-6. Photos of three point bending test

4. Results and Discussions

The results are represented in Fig 7. and Fig 8. which respectively represent the variation of compression and bending resistance of material with variation of environmental parameters.

Compression test

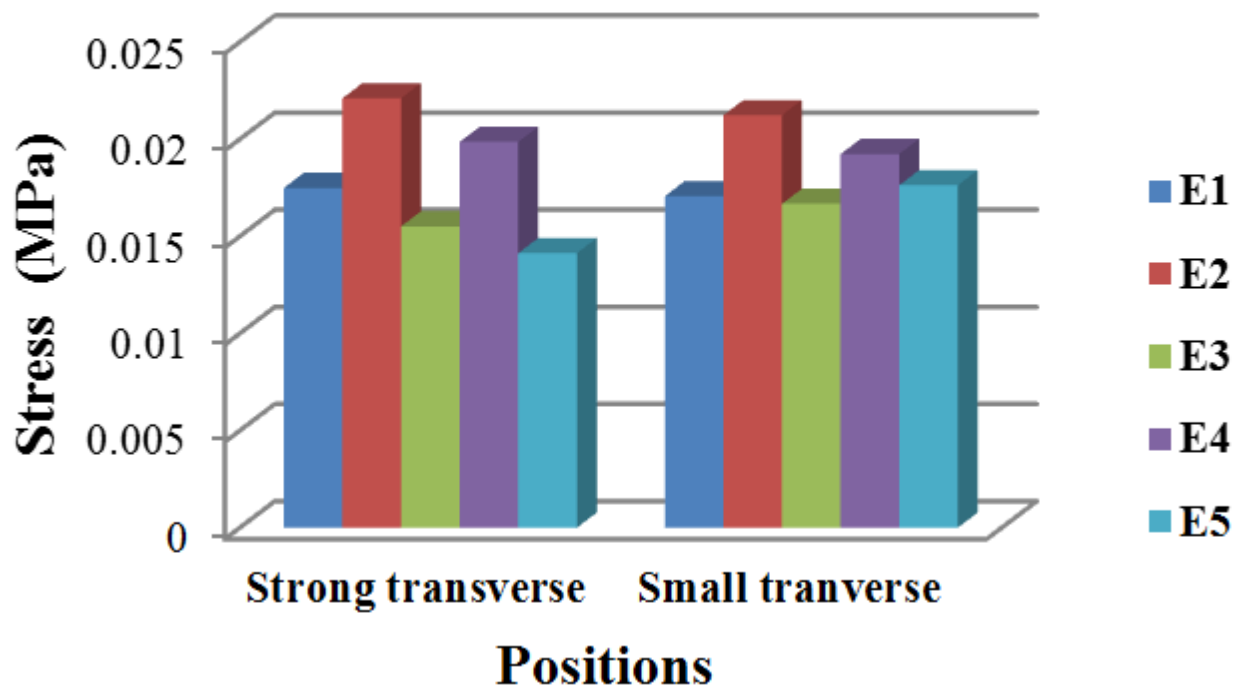


Fig-7. Compression test Results

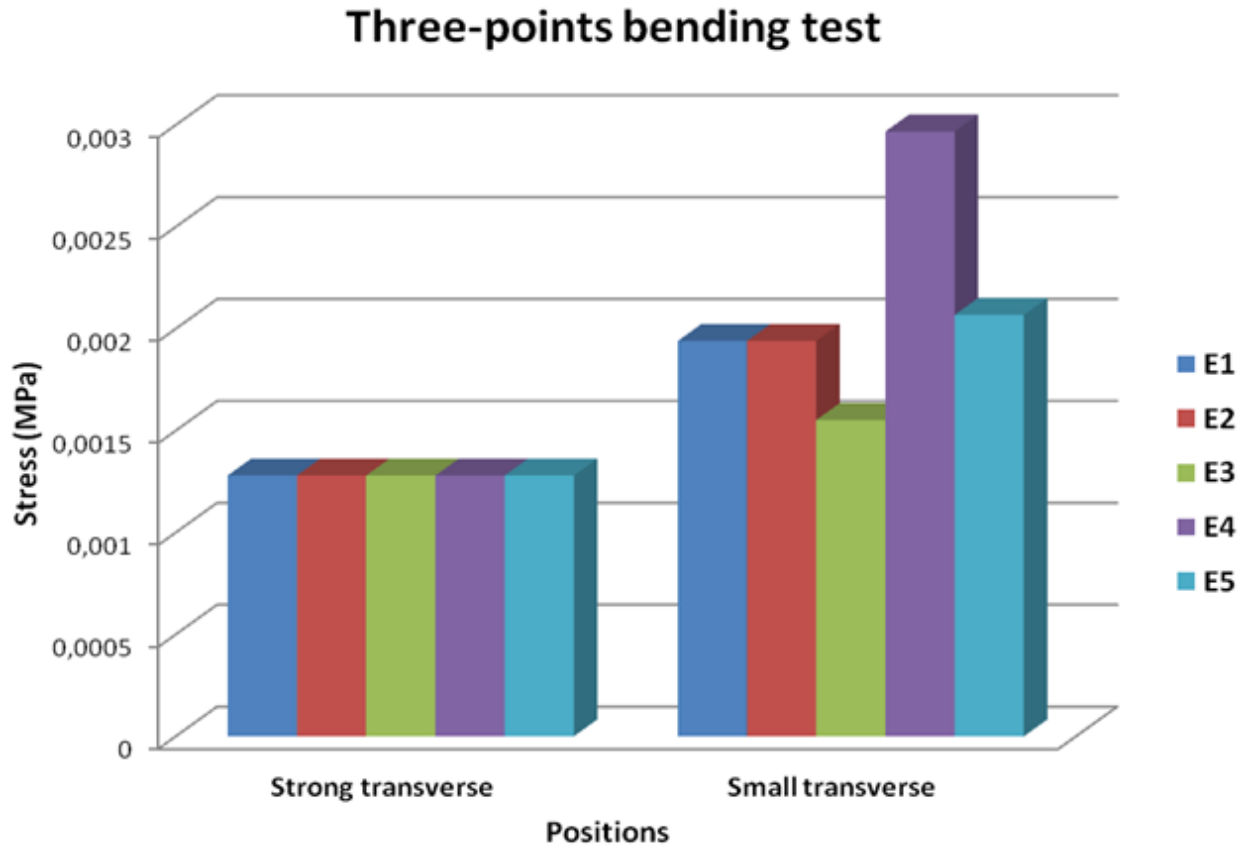


Fig-8. Bending test Results

The same remarks were noted for the case of the strong transverse direction, nevertheless the position of brick has an important influence on the resistance of the BTS.

We can also note from the Fig 8. that no influence of the five environmental parameters on the flexural strength was appeared in the case of the weak transverse direction, on the other hand in the case of the strong transverse direction, the appearance of the positive influence of the immersion in water and the staying of the BTS at 48 °C on bending resistance is very clear.

5. Conclusion

This experiment has enables us to develop our local material “quicklime of Kenadsa” like durable material recommended in use as construction material, particularly to manufacture economical and ecological BTS bricks.

Other essential points were concluded:

- The sensitivity to water, condition which determines BTS durability is appreciated thanks to dry and after immersion compression tests.
- The BTS with quicklime of Kenadsa is more sensitive to variations of the water content than conventional materials.
- For better BTS mechanical resistance, they should be exposed to the sun at least eight weeks of drying.
- The reactions being rather slow, the BTS with lime continue a long time to gain in resistance, especially at very high temperature. It is thus more interesting to manufacture them right before the hot season to greatly profit of strong heats.
- The BTS employed should never be in contact with very wet grounds.
- In construction, the BTS must be laid according to the supported stress type.

Finally, the brick of stabilized ground of Kenadsa is simple to implement and creates a useful decoration, original and pleasant. It enables us to preserve the city historical architectural heritage.

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