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IN ASSOCIATION WITH ARCHITECT FERNANDO PINTO

INTELLIGENT SERVICES
WORDWIDE

Purpose	**Building with earth - adobe**
Target	**Housing and self - construction**
Aim	**Technical support for social construction**
Core	**Constructive quality**
Date	**June de 2018**

W W W . I S - C O M . B I Z

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Provision of services, training, consultancy, engineering and architectural projects for construction of social housing.

Reduced presentation on adobe advanced technology for social construction and self-construction of houses in BTC's

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1 THE NEW TECHNOLOGIES

Product of the natural evolution of the adobes, the BTC's are basically solid bricks manufactured in mechanical presses at the site where needed, from local clay earth, usually additive.

This additivation consists in the addition to clay earth, in a minimum percentage to be determined case by case, of a product that contributes to its stabilization and good performance.
The most commonly used as additive is lime (or cement), in a percentage that rarely exceeds 6%.

The bricks or blocks thus obtained, given their physical characteristics and the fact that they are massive, have self-supporting characteristics.
This means that the construction built with BTC's does not require any structure (reinforced concrete or other), thus drastically turning cheaper this type of construction and making it easy to spread into regions where obtaining cement is neither easy nor cheap.
However, in special cases of buildings (either bigger or with other requirement), BTC's can be used as solid bricks, in pillar-beam reinforced concrete structures.

The fact that these are solid blocks made of uncooked clay soil gives BTCs excellent insulation characteristics and reaction to thermal and hygrometric variations (if properly coated) that are not negligible in any climate.

Existing the clay earth to be used in this type of construction practically everywhere at a much reduced cost (being a free material, its cost is reduced exclusively to the transport, treatment and additivation), it becomes possible to build in wide scale moving the manufacturing units to the places where they are needed.

With this process the transport costs are reduced to the equipment displacement and to additives prices (in very small quantities), in addition to materials manufactured as used in infrastructure (pipes, wiring, etc.), and other housing equipment (sanitary , kitchens, doors, windows, etc.) .
Covering materials (such as tiles, stalks or other) and coating (such as lime or derivatives, suitable for this type of construction) may, as long as existing at the site be manufactured locally.

The technologies applied in the manufacture of these constructions, provided that the necessary training actions are undertaken, become the domain of the users, so that the actions of future maintenance of the constructions can be carried out by the users themselves, thus facilitating their conservation in good conditions.

The existence of water is essential for the implementation of urban housing nucleuses (NU's), although the quantities required during construction are considerably lower than in traditional concrete and brick construction, since the entire manufacturing method is carried out dry.

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Our experience suggests that it is advisable that the houses are on a single floor and also have some adjacent land that allows the adaptation of the population to the countryside and rural life and to facilitate the city transition, as well as any eventual future home enlargement needs (housing unit) .

The adjacent land to the house (backyard) should allow each family to grow a vegetable garden and raise animals for use in their nourishment.

Therefore, we believe that the following steps must be established in advance:

1. Definition of the regions (or cities) of deployment and the number houses required to be developed;

2. Definition of minimum and maximum dimensions of urban housing nucleus (UN) to be developed;

3. Definition of the minimum parcel of land to be allocated to each housing unit (UH), and the evolutionary typologies to be contemplated (eg from T2 to T5);

4. Definition of autonomous infrastructures and services to be included in each housing nucleus (UN): water reservoir and mini-tanks, (if necessary), water networks, separate domestic and storm drainage networks, electricity, television and communications networks, road network, and also UN management unit, mini market including pharmacy (if necessary), etc.

5. Project of the Housing Management Center facilities, police station and the fire stations to be built with BTC's and estimate the necessary resources for each one;

6. Plans for of land allotments, including infrastructures to be built by local construction companies;

7. Training actions for analysis and soil additivation and also for equipment assembly at the construction site and operation of the equipment for BTC's production;

8. Evaluation of the means required for the housing units construction (UH), assuming either self-construction (with the supply of BTC's and other materials) or construction by small local companies (in particular of the support constructions facilities and services);

The size and type of machinery to be used in the BTC's plant varies with local requirements and conditions, as well as with the required flow of blocks, and will have to be the subject of a

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particular study.

2 THE COMPRESSED SOIL BLOCKS (BTC'S) AND ASSOCIATED EQUIPMENT FOR THEIR PRODUCTION

5.1. BLOCKS OF COMPRESSED SOIL – BTC

The BTC's or blocks of compressed soil are a technological evolution of the traditional adobes. They were developed essentially in Europe and America (North and South), but also in Australia.
Its performance is much superior to the performance of common adobes, while maintaining all its good characteristics.

Only at one point is the rendering of the BTCs worse: whenever negative temperatures are reached, their tendency to crack is greater.
All its other qualities are enhanced, namely the load capacity, the great speed of manufacture and its immediate availability for use, with very short drying times or even nonexistent.

The construction of buildings with more than three floors **is not** advisable, but it is advisable, to use them in single or double-storey buildings.

This way it will be possible to further enhance the good characteristics of thermal, acoustic and hygric behavior of the earth material.

Projects must, however, always be drawn up by professionals with their own competence and the use of BTCs should be a starting point in their preparation.

5.2 THE PRODUCTION UNIT

Estimating the costs involved in an operation as proposed, implies the prior definition of the number and type of units to be used.

The use of manual presses is not recommended except for their use in training, or in subsequent test of the mixtures (ground stabilizer) and eventually in the execution of pieces with special formats (which is not usual).

It will also be necessary to previously define what kind of support to the populations is intended and the desired rhythms of construction, in order to be able to establish the level amd kind of production units to elect (Class 4 or preferably Class 5 in the Table below).

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The table below uses Belgian-made equipment, but there is others equipment from other sources.

INVESTISSEMENT ET COÛT DE PRODUCTION

Investissement
Le volume de l'investissement nécessaire pour lancer une unité de production dépend surtout du choix de l'équipement et de la taille de l'unité de production :

	Classe 1 manuelle	Classe 2 manuelle	Classe 3 motorisée	Classe 4 motorisée	Classe 5 motorisée
Production/jour blocs pleins 29,5 x 14 x 9	600-700	1 200-1 400	1 400-2 000	1 400-2 000	2 800-4 000
Equipement : presse malaxeur pulvériseur bande transporteuse transpalette chariot élévateur	1 manuelle	2 manuelle 1 x 250 l	1 motorisée	1 motorisée 1 x 250 l 1 manuelle	2 motorisée 1 x 500 l 1 3 1 manuelle 1
Main-d'oeuvre	9-10	11-13	12-14	9-10	9-12
Aire de production totale (m^2)) esp. clos esp. couvert plein air	380 10 30 340	530 15 100 515	800 20 90 700	800 15 40 745	3 250 30 90 3 130

Between classes 3 and 4 the difference is the inclusion of a land crusher; between classes 4 and 5, the differences are the doubling of the number of compression presses and the inclusion of all the support equipment, which allows faster production rates, that is, it allows the production to approach the upper limits more easily pointed out.

As an example, we can estimate a house with 90 m2 of deployment area (large living room, kitchen, bathroom and two bedrooms) with walls of 2.80m high will be built with single wall inside and double outside.

Depending on the regions (larger or smaller thermal amplitudes), the double block of the outer wall can be mounted transversely or longitudinally (thus varying the thickness of the wall.) In each of these cases, we will have the following estimated number of blocks:

House with 90 m2 and walls of 2.80 m height

A With double wall 30 cm exterior and 10 cm interior 8 500 BTC's

B With double wall of 15 cm exterior and 10 cm interior 4 700 BTC's

This means that a production unit of Class 5 would take 2.1 days to produce the required BTCs in case A and 1.2 days in case B, which should be the most common.

Storage areas must exist once the production ability of the equipment far exceeds the capacity of absorption of the blocks manufactured by the constructors.
BTC production should initiate at the very beginning of the works (infrastructures, streets etc.) to be stored outdoors to dry and thus remain suitable for use.
We must not forget that there are already presses that produce from 8 000 to 17 000 BTCs per day.

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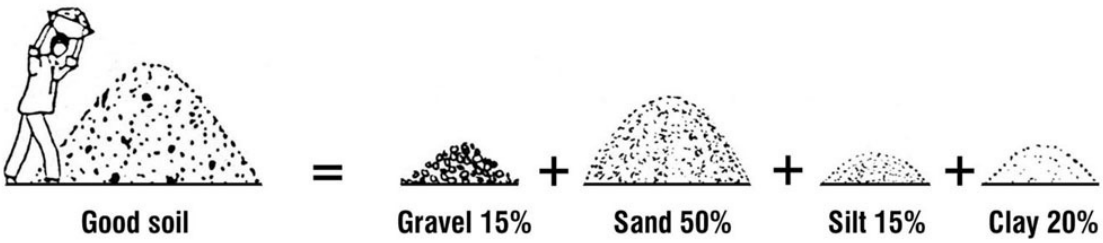
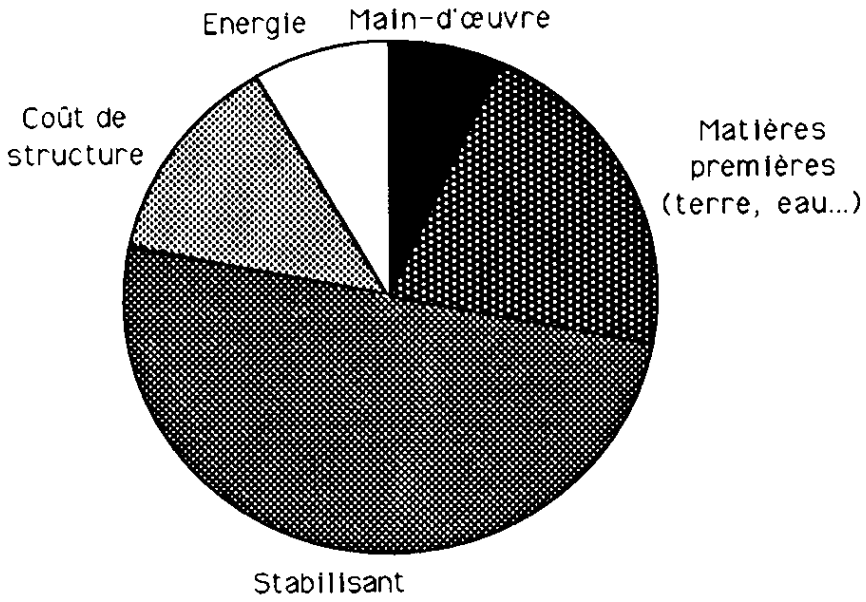
The soil to be used should have the following percentages:



However the soil seldom has such characteristics. Should it happens adding a stabilizer becomes necessary to "correct" the performance of the soil.

This being taken into account an estimate of the costs of BTC block production was made, which varies essentially according to the following diagram:



The cost variation is very large from local to local and from land to land type, and in the case above, just less than 50% of the cost of each block resides in the stabilizer (additive).
Although is not always necessary, it is advisable to include a margin to be attributed to the stabilizer, which can be either lime or cement, fibers, sand or other suitable material, and which varies with the constitution of the soil to be corrected.

The price or even free of water and land (very common) will reduce the price of the

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block drastically, reducing it to the price of the stabilizer (if any), labor, energy and amortization of the equipment itself.
In case of self-construction the value of the manpower shall be zero.

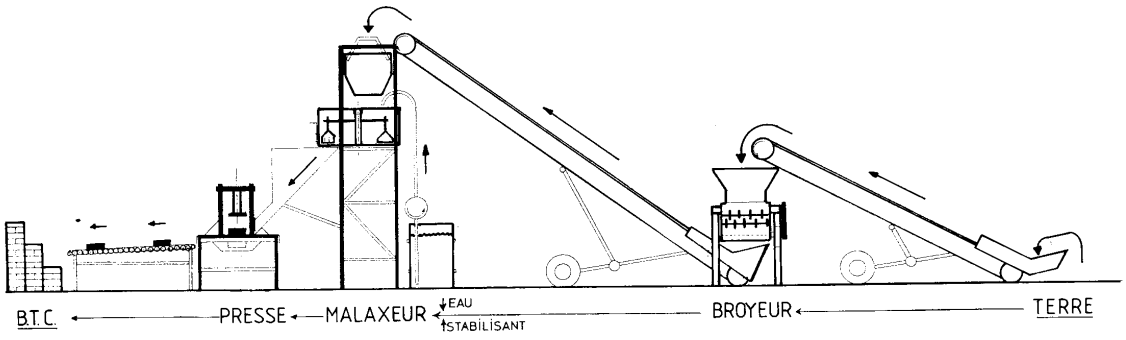
The variation of these factors greatly implies the variation of the block final price.

Resuming the estimates, considering the construction of social housing or self-construction, a Class 4 production unit served by a team of 6 workers and a foreman, and lime or cement stabilization at 6%, the cost of every 1,000 blocks was estimated at US $ 168. If we withdraw a substantial part of the labor value from these accounts, the amount to be determined must necessarily be less than US $ 100

Some valuations regarding the production of BTC's in India indicate these blocks as 73.5% cheaper than the corresponding solid bricks cooked in ceramic allowing an energy saving of around 57% and reduced CO2 emissions, including the emissions by transport.

Schematically, the mechanized production chain operates according to the scheme below:

e.



In this case this production chain uses few workers once the whole process is quite simple. Transporting soil to the first conveyor belt and the collection and storage of the parts manufactured at the end of the chain is the main job.

It is essential to monitor the entire grinding, hydration and mixing process with the stabilizer, in addition to the pressing of the blocks. Also training all the staff is always essential and critical for the good operation of the equipments.

House construction is also quite simple and effective.

The interior finishing can be made with any materials, from the best and noblest to the most modest.

However the buildings will always have an excellent quality in terms of duration, thermal comfort and sound insulation, despite such a low construction price.

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