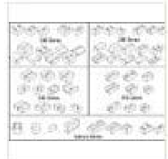
COMPRESSED STABILISED EARTH BLOCKS


1-press.3000


2-Auram.blocks


3-73blocks

A MODERN TECHNOLOGY

The soil, raw or stabilized, for a compressed earth block (CEB) is slightly moistened, poured into a steel press (with or without stabiliser) and then compressed either with a manual or motorized press. CEB can be compressed in many different shapes and sizes. For example, the Auram press 3000 proposes 16 types of blocks.


Auram hollow interlocking block 295

The input of soil stabilization allowed people to build higher with thinner walls, which have a much better compressive strength and water resistance. With cement stabilization, the blocks must be cured for four weeks after manufacturing. After this, they can dry freely and be used like common bricks with a soil cement stabilized mortar. Since the early days, compressed earth blocks are most of the time stabilised.

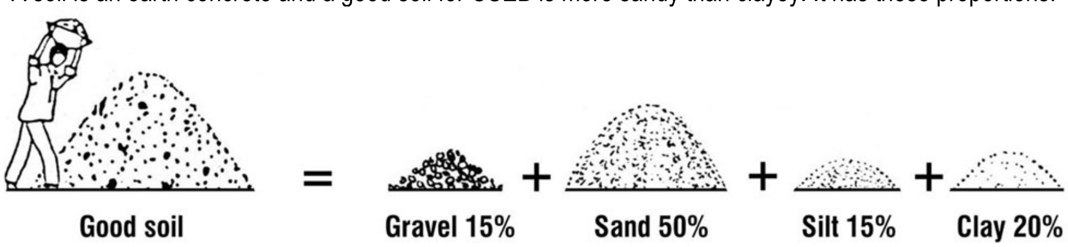
Therefore, we prefer today to call them Compressed Stabilised Earth Blocks (CSEB).

SOIL SUITABILITY AND STABILIZATION FOR CSEB

Not every soil is suitable for earth construction and CSEB in particular. But with some knowledge and experience many soils can be used for producing CSEB.

Topsoil and organic soils must not be used. Identifying the properties of a soil is essential to perform, at the end, good quality products. Some simple sensitive analysis can be performed after a short training.

A soil is an earth concrete and a good soil for CSEB is more sandy than clayey. It has these proportions:



According to the percentage of these 4 components, a soil with more gravel will be called gravely, another one with more, sand, sandy, others silty or clayey, etc. The aim of the field tests is to identify in which of these four categories the soil is. From the simple classification it will be easy to know what to do with this soil.

Soil identification

A very few laboratories can identify soils for building purposes. But soil identification can be performed by anybody with sensitive analyses. The main points to examine are:

- Grain size distribution, to know quantity of each grain size
- Plasticity characteristics, to know the quality and properties of the binders (clays and silts)
- Compressibility, to know the optimum moisture content, which will require the minimum of compaction energy for the maximum density
- Cohesion, to know how the binders bind the inert grains

- Humus content, to know if they are organic materials which might disturb the mix

Soil stabilisation

Many stabilizers can be used. Cement and lime are the most common ones. Others, like chemicals, resins or natural products can be used as well.

The selection of a stabilizer will depend upon the soil quality and the project requirements:
Cement will be preferable for sandy soils and to achieve quickly a higher strength.
Lime will be rather used for very clayey soil, but will take a longer time to harden and to give strong blocks.

The average stabilizer proportion is rather low:

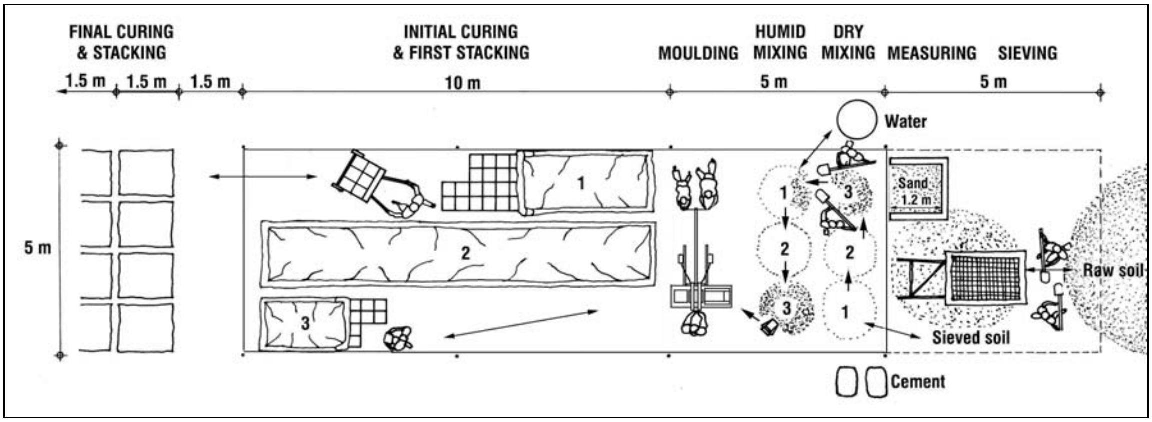
	Minimum	Average	Maximum
Cement stabilisation	3 %	5 %	No technical maximum
Lime stabilisation	2 %	6 %	10%

These low percentages are part of the cost effectiveness of CSEB.

BASIC DATA ON CSEB

Dry compressive strength at 28days (+10% after 1 year + 20% after 2 years)	4 to 6 Mpa = 40 to 60 Kg/cm^2
Wet compressive strength at 28 days (after 3 days immersion)	2 to 3 Mpa = 20 to 30 Kg /cm^2
Dry bending strength (at 28 days)	0.5 to 1 Mpa = 5 to 10 Kg /cm^2
Dry shear strength (at 28 days)	0.4 to 0.6 Mpa = 4 to 6 Kg /cm^2
Water absorption at 28 days (after 3 days immersion)	8 to 12% (by weight)
Apparent bulk density	1700 to 2000 Kg/m^3
Energy consumption (Ref. Development Alternatives 1998) (To be compared with kiln fired bricks (wire cut) = 539 MJ and country fired bricks = 1657 MJ	110 MJ

TYPICAL BLOCKYARD ORGANISATION



ENERGY EFFECTIVENESS

Costs are too often limited only to a monetary value. Another important aspect is the energy consumption involved in the material. The production of earth-based materials consumes much less energy and pollutes much less than fired bricks. CSEB and stabilised rammed earth are much more eco-friendly.

They have these advantages compared to fired bricks:

Pollution emission (Kg of CO_2 /m^2)	Energy consumption (MJ)
2.4 times less than wire cut bricks	4.9 times less than wire cut bricks

7.9 times less than country fired bricks	15.1 times less than country fired bricks

Ecological comparison of building materials				
Product and thickness	No of units (Per m²)	Energy consumption (MJ per m²)	CO_2emission (Kg per m²)	Dry compressive crushing strength (Kg/cm²)
CSEB – 24 cm	40	110	16	40 – 60
Wire Cut Bricks – 22 cm	87	539	39	75 – 100
Country Fired bricks – 22 cm	112	1657	126	30 – 50
Concrete blocks – 20 cm	20	235	26	75 – 100

Note: Wire Cut bricks are also called Kiln fired bricks. (Source: Development Alternatives – 1998)

COST EFFECTIVENESS

CSEB are most the time cheaper than fired bricks. This will vary from place to place and specially according to the cement cost. The cost break up of a 5 % stabilised block would depend on the local context. It would be within these figures, for manual equipment with an AURAM press 3000:
Labour: 20 - 25 % Soil & sand: 20 - 25% Cement: 40 - 60 % Equipment: 3 - 5 %

The strength of a block is related to the level of compression and to the quantity of stabiliser. This implies that to reduce the cost of a block one should try to reduce the quantity of cement but not the cost of the labour with unskilled people. One should also not cut down the cost of the press with cheap quality machines, which would not last and would not give strong blocks.

In the context of Auroville, a finished m³ of CSEB masonry is always cheaper than fired bricks: 19.4% less than country fired bricks and 47.2 % less than wire cut bricks (March 2004). See comparison of building materials in Auroville.

ADVANTAGES OF CSEB

A local material
Ideally, the production is made on the site itself or in the nearby area. Thus, it will save the transportation, fuel, time and money.

A bio-degradable material
Well-designed CSEB houses can withstand, with a minimum of maintenance, heavy rains, snowfall or frost without being damaged. The strength and durability has been proven since half a century.
But let's imagine a building fallen down and that a jungle grows on it: the bio-chemicals contained in the humus of the topsoil will destroy the soil cement mix in 10 or 20 years… And CSEB will come back to our Mother Earth!

Limiting deforestation
Firewood is not needed to produce CSEB. It will save the forests, which are being depleted quickly in the world, due to short view developments and the mismanagement of resources.

Management of resources
Each quarry should be planned for various utilisations: water harvesting pond, wastewater treatment, reservoirs, landscaping, etc. It is crucial to be aware of this point: very profitable if well managed … disastrous if unplanned!

An adapted material
Being produced locally it is easily adapted to the various needs: technical, social, cultural habits.

A transferable technology
It is a simple technology requiring semi skills, easy to get. Simple villagers will be able to learn how to do it in few weeks. Efficient training centre will transfer the technology in a week time.

A job creation opportunity
CSEB allow unskilled and unemployed people to learn a skill, get a job and rise in the social values.

Market opportunity
According to the local context (materials, labour, equipment, etc.) the final price will vary, but in most of the cases it will be cheaper than fired bricks.

Reducing imports
Produced locally by semi skilled people, no need import from far away expensive materials or transport over long distances heavy and costly building materials.

Flexible production scale
Equipment for CSEB is available from manual to motorized tools ranging from village to semi industry scale. The selection of the equipment is crucial, but once

Energy efficiency and eco friendliness
Requiring only a little stabilizer the energy consumption in a m^3 can be from 5 to 15 times less than a m^3 of fired bricks. The pollution emission will also be 2.4 to 7.8 times less than fired bricks.

Cost efficiency
Produced locally, with a natural resource and semi skilled labour, almost without transport, it will be definitely cost effective! More or less according to each context and to ones knowledge!

done properly, it will be easy to use the most adapted equipment for each case.

Social acceptance
Demonstrated, since long, CSEB can adapt itself to various needs: from poor income to well off people or governments. Its quality, regularity and style allow a wide range of final house products.

To facilitate this acceptation, banish from your language *"stabilized mud blocks"*, for speaking of CSEB as the latter reports R & D done for half a century when mud blocks referred, in the mind of most people, as poor building material.

SOME LIMITATIONS OF CSEB

- Proper soil identification is required or lack of soil.
- Unawareness of the need to manage resources.
- Ignorance of the basics for production & use.
- Wide spans, high & long building are difficult to do.
- Low technical performances compared to concrete.
- Untrained teams producing bad quality products.
- Over-stabilization through fear or ignorance, implying outrageous costs.
- Under-stabilization resulting in low quality products.
- Bad quality or un-adapted production equipment.
- Low social acceptance due to counter examples (By unskilled people, or bad soil & equipment).

DIVERSITY AND SELECTION OF THE PRODUCTS

The development of CSEB proposes nowadays a wide range of products, from different size and shapes. To select the most adapted product to one's need, one should pay specially attention to these factors:

Module of the block	It is the block size plus the mortar thickness. Choose preferably an easy module, in the decimal system, to avoid wasting time for the design calculations. Select also the module with the thinnest mortar joint possible.
Possibilities of different wall thickness	According to the module of a block, which thickness of wall can be achieved with easy bonds? According to the thickness, one can know if a block can be load bearing or not.
Area of the block	The bigger it is, the weaker the block will be. A large area will require great compaction energy: a manual press with 15 T. capacity will not be able to compress properly more than 600 cm².
Plain, hollow or Interlocking blocks…?	Each of them has different possibilities: plain ones will be laid with a thick mortar (1 to 1.5 cm); hollow ones will be laid with a thin mortar (0.5 to 1 cm); the interlocking blocks will require a thin mortar (0.5 cm) and very special details.
Mould possibilities	Whether a mould can do full size, 3/4 of half block. To do proper bonds, one needs to use these 3 sizes in order to achieve a good quality, without breakage.

DIVERSITY AND SELECTION OF THE EQUIPMENT

Many attempts were tried to use concrete equipment to produce CSEB. All failed, as the requirements of the materials and the working conditions are different. Today, available on the market are a wide range of specialized equipment adapted to each need and scale of production. Today one can find manual presses, light or heavy, motorised ones where the compression energy is given by an engine. One can also find mobile units, which also integrates a crusher and a mixer in the same machine.

A cheap manual press, thus light and attractive in price, will not be so long lasting. A motorized press will present the advantage of a high productivity, with a better and more regular quality. But it will require energy and a more complicated maintenance, and its cost will have no comparison with a manual press. Besides a press, one should not forget all the other equipment required: sieve, maybe a crusher, wheelbarrows, maybe a mixer, quality control devices, all small tools, PVC sheets, etc.

Therefore, it appears that in the Indian context, manual and heavy presses are better adapted than motorised ones, as they would employ more people and would produce quality materials at cheaper rates.

OPTIMIZATION OF INVESTMENT / OUTPUT / QUALITY RATIO

Light manual equipment presents the advantage of being cheap, but the disadvantage of a low durability, a low output and not very well compressed blocks. Heavy manual equipment presents a more interesting ratio, with more output, more durability and more strength for a subsequent increase of costs.

Motorized equipment steps into another category of cost: it will produce better quality blocks with more output, but more expensive. Therefore, heavy manual presses are most of the time the best choice in terms of optimisation for the investment/output/quality ratio. Mobile-units are always coming far behind.

Industrialization is not adapted to the production of CSEB. Semi industrialization is the best: it offers the advantage to be more flexible and easily adapted to a local context. It increases the quality without increasing tremendously the cost of a block. Semi industrialization should be understood here as a centralized production, but rather with manual presses than motorized ones.