

BUILDING WITH EARTH IN AUROVILLE

From the early days of Auroville, in the 1970's, different experiments have been made with earth building, with mixed results. The creation of the former Auroville Building Centre/Earth Unit in 1989, and the construction of the Visitors' Centre, started a new era in earthen architecture.

This Visitors' Centre of 1200 m² was granted the "Hassan Fathy Award for Architecture for the Poor" in 1992. Built of compressed stabilised earth blocks, it demonstrated the potential of stabilised earth as a quality building material.



Visitors Centre

Since then, the value of earth as a building material has been acknowledged for its economic advantage, as well as its comfort and quality, which promotes indigenous and sustainable development. Today, Auroville can show a wide variety of earthen projects: public buildings, schools, apartments and individual houses.

Most of the projects are built with compressed stabilised earth blocks (CSEB), as this technology benefits of half a century of research and development worldwide. In Auroville, these blocks present many advantages compared to fired bricks:

- Walls made of CSEB are always cheaper than fired bricks.
- The embodied energy is 15 times less than the bricks fired in the village.
- The strength of these blocks is most of the time higher than the local fired bricks.

Stabilised rammed earth used for walls is slowly getting known and a few projects already implemented this technique.

There are also three other earth techniques used in Auroville. These techniques are very marginally used as only 8 buildings have been built with them:

- Raw rammed earth, for only two buildings.
- Adobe blocks, the traditional sun dried mud brick, for two buildings.
- Wattle and daub which is mud plastered on a wattle made of split bamboo or palmyra tree, for 4 buildings.

Through the endeavour of the Auroville earth Institute, Auroville attempts to revive the traditional skills, which were lost during the XXth century and demonstrate that earth is still a noble building material, which can be used for manifesting a modern, harmonious and progressive architecture.

AN EARTH TO BUILD WITH

The Auroville red soil got its colour from iron oxides, which give excellent properties and make remarkable building materials. In Auroville, the earth is stabilised with about 5% by weight of cement. The lime quality around Auroville is not high enough to be used.

MANAGEMENT OF RESOURCES



Shallow percolation pit

When building with earth, one should pay a lot of attention of the management of resources. Topsoil should be scraped away, so as to be re-used for agriculture or gardens. One should always plan how the excavation would be used afterward. A proper management of the earth resources can create a new and harmonious balance between nature and the buildings, where each enriches and completes the other.

Auroville shows various possibilities for the use of quarries: as water harvesting ponds, waste water treatment ponds, pools, basement floors or shallow



Biological wastewater treatment

depressions which are used for landscape design, work or play areas, gardens, etc.

COMPRESSED STABILISED EARTH BLOCKS

CSEB is nowadays the earth technology, which is the most used worldwide, as well as in Auroville, because it represents a synthesis between traditional practices and a modern technology.



Auram Press 3000

In Auroville, CSEB are stabilised with 5% cement and have an average dry compressive crushing strength of 50 kg/cm² (5 Mpa) and a wet compressive crushing strength of 25 kg/cm². The water absorption is around 10%. Country fired bricks have resist at around 35 kg/cm² for the dry compressive strength and have a 12% water absorption rate.

The Auroville Earth Institute has designed manual presses for CSEB, which are manufactured in Auroville by Aureka, one of its steel workshops. Today, the press 3000 for compressed stabilised earth blocks is being sold worldwide – mostly in South Asia and in Africa. A few machines have also been sold in Europe, USA, Dubai and China.

STABILISED RAMMED EARTH

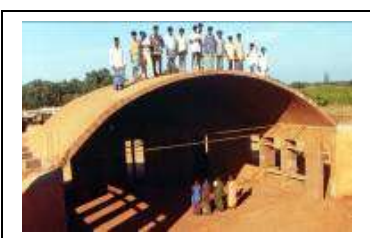
In Auroville, the earth is rammed by hand. Until 1994, Auroville had only one house made of raw rammed earth. Stabilised rammed earth was promoted since 1995, after the construction of Mirramukhi School (presently named Deepanam). Stabilised rammed earth is getting slowly more known and presents the advantage of being cheaper than compressed stabilised earth blocks.

APPROPRIATE BUILDING TECHNOLOGIES BASED ON EARTH

This research aims at making extensive use of raw earth as the main building material, thereby using a local resource to help develop technologies that are energy saving, eco-friendly and sustainable.

The main research and development is focussed on minimising the use of steel, cement and reinforced cement concrete (RCC). Most of the technologies developed have now been mastered and the present research is focussed on alternative stabilizers to cement and alternative water proofing with stabilized earth, composed of soil, sand, cement, lime, alum and tannin.

VAULTED STRUCTURES



Segmental vault, 10.35 m span

This R&D seeks to increase the span of the roof, decrease its thickness, and create new shapes. Note that all vaults and domes are built with compressed stabilised earth blocks which are laid in “Free spanning” mode, meaning without formwork. This was previously called the Nubian technique, from Egypt, but the Auroville Earth Institute developed it and found new ways to build arches and vaults.

DISASTER RESISTANT BUILDINGS



Aum House built in 62 hours

Since 1995, research has been oriented towards the development of a cost-effective technology which is based on reinforced masonry with hollow interlocking CSEB.

Two types of blocks have been developed: the square hollow interlocking block 245, which allows building up to 2 storeys high, and the rectangular hollow interlocking block 295, which is used only for ground floors.

EARTH VERSUS OTHER BUILDING MATERIALS



*Half CSEB 240
(24 x 24 x 9 cm)*



*Wire cut fired brick
(22 x 10.5 x 7.2 cm)*



*Country fired brick
(± 22 x 10.5 x 6.5 cm)*

The traditional building material used around Auroville is fired brick. Villagers fire their own bricks in country kilns, which are not very efficient. They consume a lot of wood, pollute a lot and give at the end poor quality building materials. Good quality fired bricks are also available from factories and they are called wire cut bricks.

Walls made of compressed stabilised earth blocks are already cheaper than fired bricks (18 to 20 %), but stabilised rammed earth walls are even cheaper than CSEB masonry. The material for CSEB or stabilised rammed earth is the same, but the difference comes from the fact that the blocks have to be cured on the ground, lifted and built by masons later on. In the case of stabilised rammed earth, the walls are made by semi skilled labour and they stand in place at the end of the day. Therefore, a finished m³ of rammed earth wall is 40 to 45 % cheaper than CSEB wall, and 50 to 60 % cheaper than fired bricks.

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 (5 or 15 times less) and pollutes much less (2.4 or 7.8 times less) than fired bricks.

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 rammed earth are much more eco-friendly. They have these advantages compared to fired bricks:

Pollution emission (Kg of CO₂ /m²)	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

(Source: Development Alternatives, New Delhi, 1998)

COST EFFECTIVENESS

Earthen buildings have the advantage of using local resources and being labour intensive. Therefore, most of the time, they cost less than conventional materials and technologies. The final cost of a building will depend mainly on the design, the type of finishes and the project management. In all cases, the technologies implemented will be cost effective.

In the context of Auroville, a finished m³ of CSEB masonry is always cheaper than fired bricks: 23.8% less than country fired bricks and 44.5 % less than wire cut bricks (January 2006).

Walls made of compressed stabilised earth blocks are already less costly than fired bricks, but stabilised rammed earth walls are even lower in cost than CSEB masonry. The material for CSEB or rammed earth is the same, but the difference comes from the fact that the blocks have to be cured on the ground, then lifted and built by masons later on. In the case of rammed earth, the walls are made by semi-skilled labour and they stand in place at the end of the day.

Therefore, a finished m³ of rammed earth wall costs 22.9% less than CSEB wall, 41.2% less than country bricks and 57.2% less than wire cut bricks.

COMPARISON OF BUILDING MATERIALS IN AUROVILLE January 2007

	WIRE CUT BRICKS	COUNTRY FIRED BRICKS	CSEB 240	RAMMED EARTH	
PRODUCT INFORMATION	Brick size (L, W, H, in cm)	22 x 10.5 x 7.2	22 x 10.5 x 6.5	24 x 24 x 9 (Wall cast in situ)	
	Volume of brick	1.66 Litres	1.50 Litres	5.18 Litres (Wall cast in situ)	
	Weight per unit	3.12 Kg = 1876 Kg/m ³	2.81 Kg = 1871 Kg/m ³	10.00 Kg = 1929 Kg/m ³	± 1950 Kg/m ³
	Stabilisation	Fire	Fire	5% cement	5% cement
	Wastage of raw material	3 %	12 %	5 %	0 %
	Units per m ³ (raw material)	601 No.	666 No.	193 No.	No bricks
	Pollution emission (CO ₂) *	39 Kg / m ³	126 Kg / m ³	16 Kg / m ³	16 Kg / m ³
	Energy consumption *	539 MJ / m ²	1657 MJ / m ²	110 MJ / m ²	110 MJ / m ²
	Dry crushing strength	100 Kg / cm ²	35 Kg / cm ²	50 Kg / cm ²	50 Kg / cm ²
	Water absorption	9 to 11 %	10 to 14 %	9 to 12 %	8 to 11 %
WALL DETAIL	Wall thickness	22 cm	22 cm	24 cm	24 cm
	Mortar used	1 cement: 5 sand	1 cement: 5 sand	1 cement: 6 soil: 6 sand	No mortar
	Mortar Qty per m ² of wall	72.4 Litres	76 Litres	36.1 Litres	No mortar
	Units per m ² of wall	98 (with 1.5 cm mortar)	106 (with 1.5 cm mortar)	40 (with 1 cm mortar)	No bricks
	Daily output per team	3.3 m ² = 320 bricks	4.6 m ² = 490 bricks	3.8 m ² = 150 blocks	8 m ²
COST	Unit (Brick) on site	4.25	2.18	5.83	No bricks
	Raw material per m ³ **	2632 per m ³	1585 per m ³	1181 per m ³	1231 Per m ³
	Mortar per m ³	1849 per m ³	1849 per m ³	930 per m ³	No mortar
	Finished wall per m ³	3504 per m ³	2498 per m ³	1851 per m ³	1366 Per m ³
	Finished wall per m ²	771 per m ²	550 per m ²	444 per m ²	328 Per m ²
DATA	Sieved sand	400 per m ³	Mason : 240 per day	Labour male : 150 per day	
	Sieved soil	120 per m ³	Helper : 140 per day	Labour female : 75 per day	
	Cement (43 grades)	195 (50 Kg bag)			
NOTES	All costs are in Indian Rupees		Value: Auroville, January 2007, 1 US \$ = ~ 44 Rs.		
	* Source: Development Alternatives, New Delhi, 1998		Wire cut bricks are also called kiln-fired or chamber bricks		
	** The cost of raw material include the wastage		Country fired bricks are also called village bricks		
	All material costs includes the delivery on site		The CSEB price is the production cost on site		
	Blocklaying team = 1 mason, 1 helper, 1/2 labour male, 1/2 labour female		Team for producing CSEB = 9 labour male		
	The labour cost includes the yearly bonus and the employee providence fund		Rammed earth team = 5 labour male		

	ENVIRONMENTAL COST	MONETARY COST	STRENGTH
SUMMARY	CSEB and rammed earth are more eco-friendly than fired bricks	CSEB and rammed earth always cost less than fired bricks	CSEB and rammed earth are:
	Pollution emission: 2.4 times less than wire cut bricks 7.9 times less than country fired bricks	A finished m³ of CSEB wall is: 25.9 % cheaper than country fired bricks 47.2 % cheaper than wire cut bricks	1.4 times stronger than country fired bricks
	Energy consumption: 4.9 times less than wire cut bricks 15.1 times less than country fired bricks	A finished m³ of rammed earth wall is: 26.2 % cheaper than CSEB wall 45.3 % cheaper than country fired bricks 61.0 % cheaper than wire cut bricks	0.5 times weaker than wire cut bricks

TOWARDS THE FUTURE

Building with earth has a great past, but also a promising future, especially in Auroville. It is definitely an appropriate, cost and energy-efficient, and eco-friendly technology which can promote a sustainable future. Obviously, one has to master the material the techniques so as to obtain the optimum possibilities for a harmonious, durable, agreeable and efficient architecture. One can note these advantages of earth as a building material:

- The earth is a local material, contributing to sustainable development.
- The production of the building components demands a lot of semi-skilled manpower.
- The technology is easily adaptable and transferable.
- The monetary and environmental costs are much lower than that of most other materials.
- The thermal comfort and vibratory atmosphere are very positive.

One has also to master the disadvantages of the material which, normally, are variations in the soil quality, and hence the block quality and the production of blocks on site. These reductive aspects can be underlined:

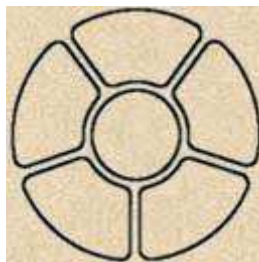
- Mechanical qualities are less regular.
- Sensible building details are required.
- The constraints of organizing and managing the production of one's own building material on site.

Despite the possibilities and advantages offered by stabilised earth materials, building with earth in Auroville is still not the common practice. Either people don't want to acknowledge the advantage of this material or they don't want to get the burden to organise the block production on their site and manage everything themselves.

The generalised use in Auroville of compressed stabilised earth blocks and other earth techniques needs a centralised production of blocks and a coordinated management of resources – physical and human. This development step would insure a controlled and more regular quality of raw materials and finished products. This is one of the aims for the next years to come.

The Challenge in front of us:

How to realize architecture full of light, suppleness, simplicity, imagination and beauty with a heavy and formless mud? This is what we are trying to achieve in Auroville and what we are proposing to the World.



"Auroville, the city the earth needs"