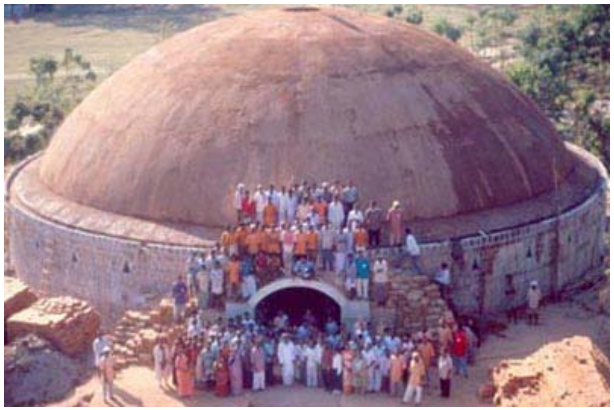
VAULTED STRUCTURES

DOME OF THE DHYANALINGA MEDITATION SHRINE

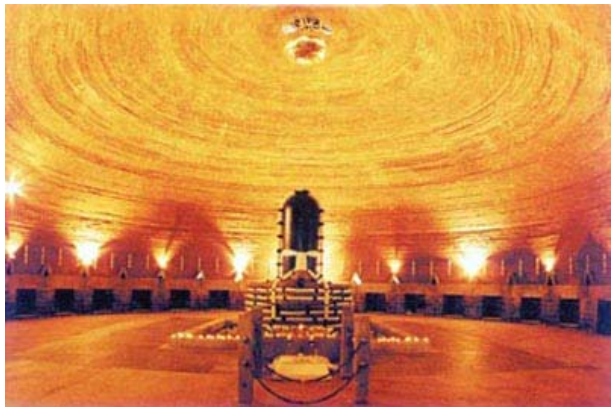


Dhyanalinga temple
Dome of 22.16 m diameter, 7.90 m rise, ~570 tons, built on 9 weeks

The Dhyanalinga is a Multi-religious Meditation Shrine created exclusively for the purpose of meditation. This dome of the Dhyanalinga Shrine was built for the ISHA Foundation, at the Foothills of Velliangiri Mountains near Coimbatore, Tamil Nadu, South India.

This dome of 22.16 m diameter has designed by the Auroville Earth Institute. It has been built free spanning in 9 weeks with a team of the Auroville Earth Institute and mostly unskilled labour.

The work on the dome started the 21st November 1998 with the construction of the entrance vault, built with granite stones and on a centering done with laterite blocks. The dome was completed 9 weeks later, the 31st January 1999.



Dhyanalinga temple from inside
With the Lingam and the 49 meditation cells

THE DOME

A tight schedule was set from the beginning by the Guru, Sadhguru Jaggi Vasudev. The dome had to be completed before a certain deadline related with his yogic practices and planetary aspects. Therefore the use of CSEB had been eliminated from the beginning. The time requested for the production, curing and drying of the blocks (3 - 4 months compulsory for arches, vaults and domes) would have been too long! Thus the choice went for fired bricks, which were laid with a stabilised earth mortar. The foundations and walls were built in random rubble masonry with granite stones in lime mortar.

Around 214,000 fired bricks were laid and the construction site had a working force of more than 220 workers (110 workers at the most on the scaffoldings, including 25 masons). The large amount of fired bricks required could not be supplied by the same brick factory. Therefore the fired bricks came from about 20 different kilns. As a result, they had different sizes and most of the time they had odd shapes (belly, cracks and other irregularities). Therefore, nearly 200,000 bricks had to be checked one by one. It became a pain to use such bricks when it would have been so easy to use the accurate CSEB produced by the Auram press 3000. In most of cultures hell is related with fire, and indeed it was a hell to build with these fired bricks!

No reinforce concrete had been used in any part of the building: neither for the foundations, plinth nor tie for the dome. Sadhguru Jaggi wanted the dome to last 1,000 years and reinforced concrete has not yet proved to be able to last so long. Therefore the dome stability has been studied in order to have only compression forces.

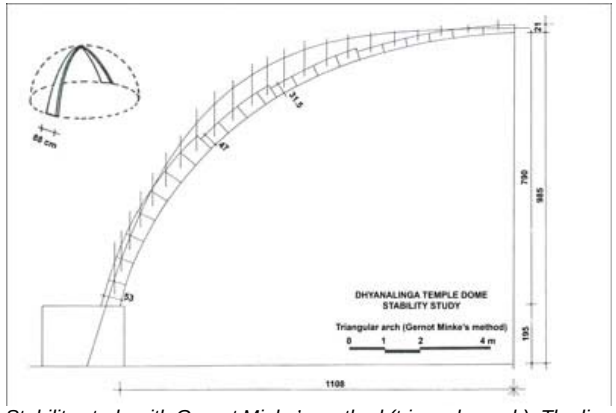
The dome presents these features:

- Section: segmental ellipse of 22.16 m diameter and 7,90 m rise.
- Thickness: 4 courses from the springer to the apex: 53 cm, 42 cm, 36.5 cm and 21 cm at the top.
- Weight: around 570 tons (brick dome = ± 420 tons + granite stone to load the haunches = ± 150 tons).

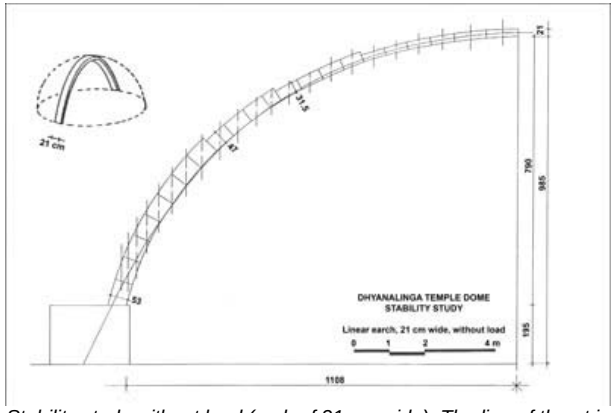
DOME STABILITY STUDY

At that time, to our knowledge, no comprehensive and sure method exited to study the stability of a masonry dome. First the method of Gernot Minke, called "Structurally optimised dome" was followed. But in fact this method was not satisfactory to optimise the line of thrust as it defines only the resultant angle of the trust: Gernot Minke does not want to use concrete ring beams and therefore his method does not define the optimised line of thrust in the dome because it does not take in account the concentric forces, which are acting in a dome and allow building it without support.

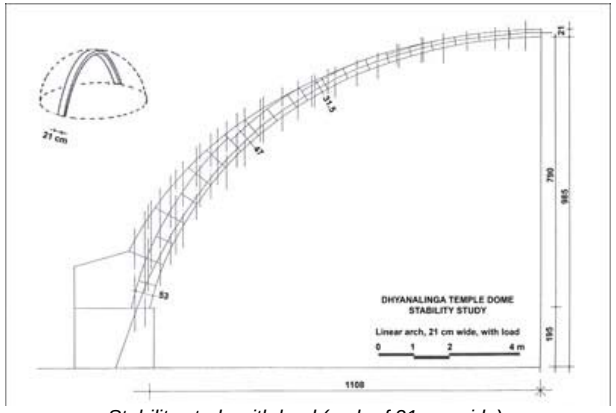
Finally the dome was studied like a vault, which is more sensitive to a wrong shape than a dome: if a vault is stable, a dome will be stable…when the opposite is not necessarily true. As no reinforced concrete was used for any tie, it was compulsory to get the resultant of the trust within the middle third of the ring wall and the foundations. To do so, granite stones were used to load the haunch of the dome.



Stability study with Gernot Minke's method (triangular arch). The line of thrust is outside. This method is not satisfactory to optimise LT



Stability study without load (arch of 21 cm wide). The line of thrust is outside the middle third. The dome has to be loaded outside



Stability study with load (arch of 21 cm wide).
The line of thrust is in the middle third and the dome is stable

MORTAR SPECIFICATIONS

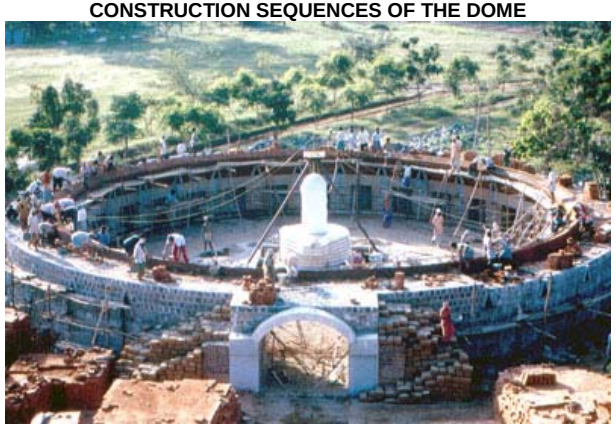
With the dome rising, the mortar specification needed regularly to be adapted: adding more soil, in 3 steps, so as to have the ideal adhesion according to the angle of the layers. The different mortars were over stabilised so as to get a fast setting and strength: 13 to 13.37% of cement and 19% of lime.

ACOUSTIC OF THE DOME

Single resonator absorbers (Helmholtz resonators) were installed in three layers, so as to absorb 12 frequencies between 120 Hz and 1.50 kHz. The result was a dome without echo but still with a certain reverberation, which was normal because of its volume. This gave also a certain sound quality.

CONSTRUCTION SEQUENCES OF THE DOME

Starting the dome and the granite vault on the 21st November 1998

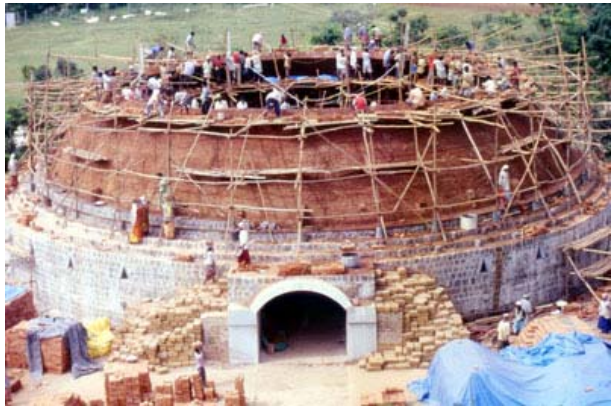


Granite vault completed and dome after 1 week

Dome after 2 weeks

Dome after 3 weeks

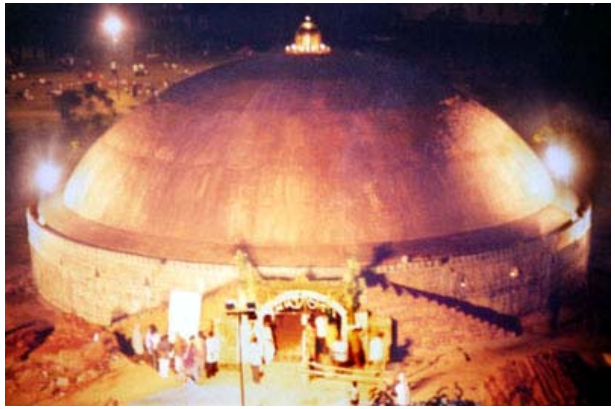
Dome after 3.5 weeks, under the rain



Dome after 5 weeks

Dome after 7 weeks

Dome after 8 weeks



Dome after 9 weeks

CONSTRUCTION DETAILS OF THE DOME

Starting the entrance vault with granite blocks

Block touching the springer at the intrados

Keystone touching at the intrados

Beginning the dome

Dome with the Linga and the ropes to check the elliptical shape

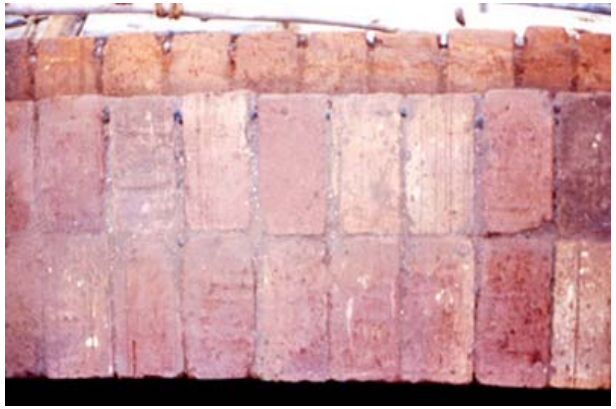
Laying keystones

Grouting the stabilised earth glue in the joints

Filling tightly mortar with stone chips

Starting the dome with 29 cm thick blocks

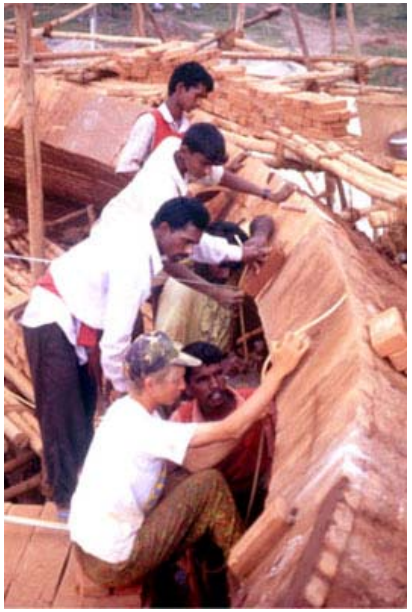
Bonds of the first of courses, 53 cm thick



Bonds of the second rows of courses, 42 cm thick

Bond for the third rows of courses, 31.5 cm thick

Bond for the fourth rows of courses, 21 cm thick



Checking the level of the courses

Grinding the parts of the course which are too high

Plastering the parts of the course which are too low

Inserting the pipe for an acoustic corrector to absorb 220 Hz

Closing the pipe of an acoustic corrector

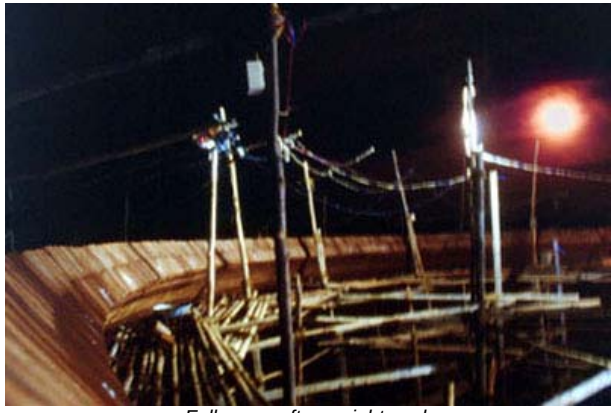
Inserting a pipe for an acoustic corrector to absorb 620 Hz

Working with an average of 25 masons

Loading the haunches with granite stones

Smoothening the granite steps with an earth concrete

Smoothening the earth concrete with a stabilised earth plaster



Full moon after a night work

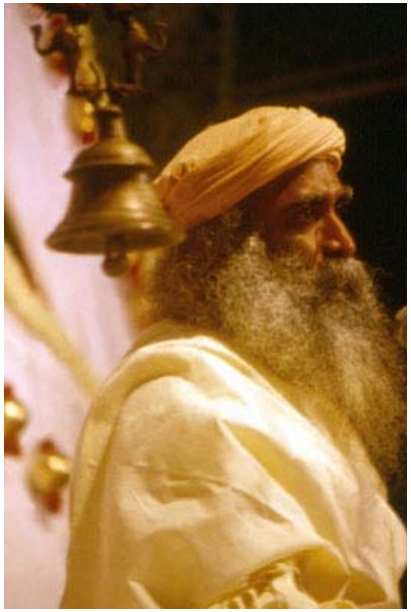
Adjusting the compass for the upper courses

Laying the last courses, 21 cm thick

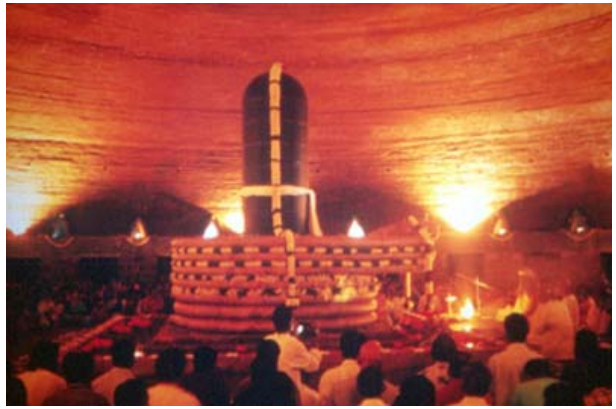
Dome near completion

Sadhguru Jaggi laying the last brick

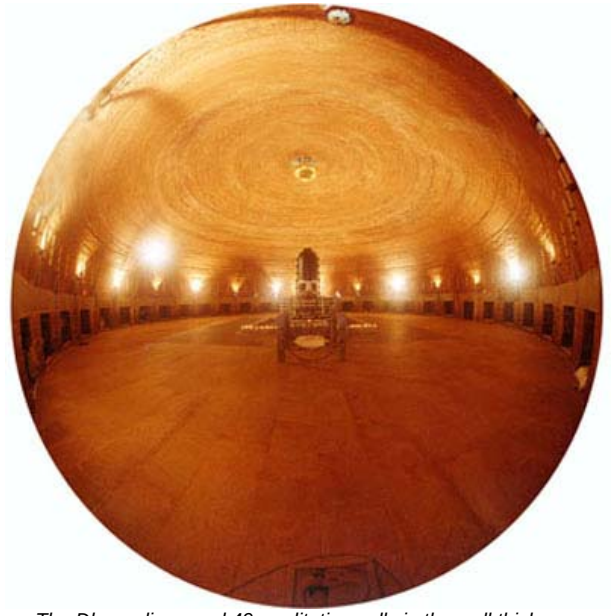
The last team who completed the dome on the 31st January 1999



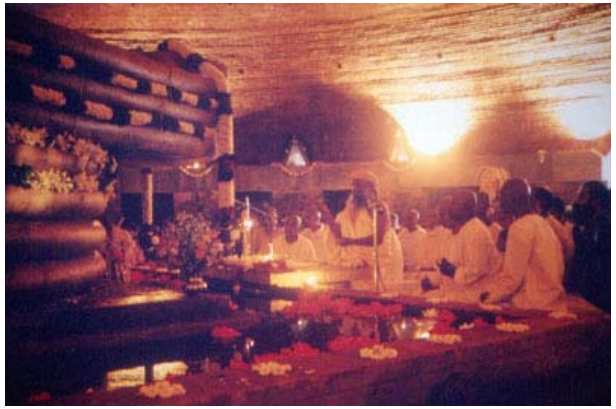
Sadhguru Jaggi during the first consecration of the temple



Celebration ceremony, after completion



The Dhyanalinga and 49 meditation cells in the wall thickness



Celebration ceremony by Sadhguru Jaggi