

DISASTER RESISTANCE

INTRODUCTION TO DISASTER RESISTANCE



Hollow interlocking block 245

The last decade of the 20th century has seen all over the world a significant increase in natural catastrophes. In a changing world, building construction patterns need also to be changed. They need to answer the demand for disaster resistance, not only for the well-known areas, which are disaster prone, but also for wider areas. The construction systems need also to address the problem of cost, which is for low-income groups a major parameter.

Since 1995, our research has been oriented towards the development of a system, which is based on reinforced masonry with compressed earth blocks that are hollow interlocking.

Three types of blocks have been developed:

- The square hollow interlocking block 245, which allows building up to 2–3 floors high. It is laid with mortar and a grout is cast into the holes.
- The rectangular hollow interlocking block 295, which is used only for ground floors. It is laid with mortar and a grout is cast into the holes.
- The rectangular dry hollow interlocking block 300, which is used only for ground floors. It is laid dry stacked and a grout is poured later on into the holes.

VARIOUS DISASTER RESISTANT HOUSES BUILT BY THE AUROVILLE EARTH INSTITUTE

These constructions implement the usual specifications for disaster resistance (Proper design, horizontal and vertical reinforcement at regular intervals, by linking the foundations to the roof with vertical ties, etc.), which have been certified by the internationally renowned expert Dr. Anand S. Arya, professor Emeritus-Earthquake Engineering Department – Roorkee, and seismic advisor to the Indian government.

The first prototype of an earthquake resistant house was built at Istanbul, Turkey in 1996. It was sponsored by UNCHS/HABITAT.

It was pre-cast in 10 days using semi-skilled labour and it was assembled in 8 days during the “1996 City Summit / HABITAT” at Istanbul – Turkey. It was done at the request of CRATerre.

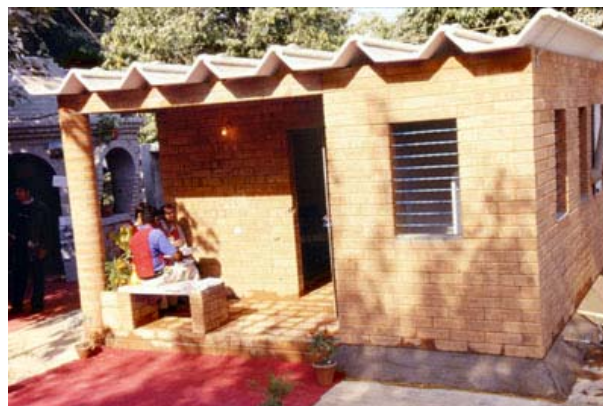
A second prototype of an earthquake resistant house was sponsored by HUDCO (Housing and Urban Development Corporation, Government of India). It was built in 1999 as a demonstration at New Delhi, India. It had been built with all facilities like water and sanitation, kitchenette and a smokeless stove. It was pre-cast in Auroville and transported over 2,900 Km to New Delhi in a single lorry of 22.5 tons. It was assembled in 66 hours by our 18-man team. This demonstration was granted a gold medal from ITPO.

In July 2001 another demonstration house was built in Gujarat to start rehabilitation programmes for the zones affected by the severe earthquake of January 2001. This model house has been simplified and built without sanitation.

It had also been improved and reinforced. It was pre-cast in Auroville and transported to Gujarat, where it had been assembled in Khavda village in 62 hours by our 20-man team.



Minimum Emergency House, Istanbul, Turkey – 1996



Aum House at New Delhi, India – 1999



Aum House at Khavda, Gujarat, India – 2001

The demonstration house which was built at Khavda village set up an example of what could be done with stabilised earth. Thus, the government of Gujarat accepted our technology and prepared some guidelines for building with stabilised earth. The NGO Catholic Relief Services (CRS) adopted this technique and the Auroville Earth Institute conducted several training courses to transfer this technology to the CRS. The Auroville Earth Institute assisted the CRS in their rehabilitation programme and the Catholic Relief Services built in a year 2,698 houses of many different types in 39 villages.

See the case study page [Gujarat rehabilitation after the earthquake](#)

GOVERNMENT APPROVAL

The technology for disaster resistance, which has been developed by the Auroville Earth Institute, has been approved by three governments:

- The government of Gujarat, India, as a suitable construction method, up to two floors high, for the rehabilitation of the zones affected by the severe earthquake of January 2001 in Kutch district.
- The Government of Iran (Housing Research Centre) as a suitable construction method, up to 8 m high (two floors), for the rehabilitation of the zones affected by the 2003 earthquake of Bam.
- The Government of Tamil Nadu, India, (Relief and Rehabilitation) as a suitable construction method for the rehabilitation of the zones affected by the 2004 tsunami of Indonesia.

APPROVAL FROM THE GOVERNMENT OF GUJARAT, INDIA, AFTER THE 2001 EARTHQUAKE OF KUTCH

**GUIDELINES FOR
CONSTRUCTION OF COMPRESSED STABILISED
EARTHEN WALL BUILDINGS
[First Revision]**



The Gujarat State Disaster Management Authority
Block – 11, 5th Floor, Udyog Bhavan, Sector – 11, Gandhinagar
☎:- 23259220, Fax:- 23259275, 23259289.
Website: www.gsdma.org
[July, 2003]

Guidelines published by the government of Gujarat for the rehabilitation



National Council for Cement and Building Materials

(Ahmedabad Unit)

Building Rehabilitation Clinic

(Under Ministry of Commerce and Industry, Govt. of India)

4th Floor, Khemka House,
Drive-in Road, Thaltej,
Ahmedabad-380 054, Gujarat.

Tel. : (079) 7444228, TeleFax : (079) 7444229
E-mail : brcnb@rediffmail.com
Website : www.cementresearch.com

TEST RESULTS

1. SAMPLE : MUD-BLOCK
2. SOURCE OF SAMPLE : C/O: HUDCO , K.V.K., RBC Centre , Mundra
3. LAB. REF. NO. : SL-717/A
4. TESTED AS PER : IS: 3495 (IS: 1725)
5. IDENTIFICATION NO. : ~

Sr. No.	Sample No.	Test Caried Out	Results
1.	SL- 717/A	1.Compressive Strength(Kg/Cm ²) [Dry strength]	1-A 65 1-B 73 1-C 86 Average 75
		2. Density (Kg/m ³)	1-A 1755 1-B 1775 1-C 1665 Average 1732

Sample collected and send to Lab. by Party.

[Signature]
Sign. Of Lab. Incharge:
National Council for Cement
& Building Materials
Stationary Lab. Bhuj

[Signature]
Tested By:
(KAILASH VASHISTHA)

NCB UNITS

- Transit House** : E-32, Akash Tower, Beside Chief Justice's Bungalow, Premchand Nagar Road, Vastrapur, Ahmedabad-380015, Tele/Fax: (079) 6879153
Offices At : Plot No: 46A, "NIDHIKA", Garbi-Chowk, Samkar Nagar, BHUB-370-001, Tele/Fax: (02892) 50185 S. Yogendraji Park, Bhuj.
: 501, Gitanjali Apartment, Navapur Road, Morvi-363641. સુભાસ્કર નેચરલ ગેસ ટાંક, ભુજ.
Corporate Office : A-135, Defence Colony, New Delhi-110 024. Tel.: (011) 4697498, 4697499, Tele/Fax: (011) 4631150, 4631153
Laboratories At : 34 Km. Stone, Mathara Road, Ballagarh-121004. Tel.: (0129) 5242051-56, Fax: (0129) 5242100, 5246175 Ph. 24880
: NCB Bhawan, Old Bombay Road, Hyderabad-500008. Tel.: (040) 3000861, Fax: (040) 3000343

Test result certifying the quality of blocks for the rehabilitation

APPROVAL FROM IRAN FOR THE RECONSTRUCTION OF BAM WITH CSEB, AFTER THE 2003 EARTHQUAKE OF BAM

In the name of GOD

The Islamic Republic of Iran
 No: 3-5688
 Ministry of Housing
 Building and Housing Research Center (BHRC)

Date: 07.12.2004

In the attention of: Mr. Engineer Havai
 Head of Reconstruction – Ministry of Housing

According to the application of Bam Reconstruction Center and International Blue Crescent Relief and Development Foundation (IBC Turkey), regarding the testing of the compressed stabilized earthen blocks and structural behaviors in earthquake, the results are as following:

Tests	Results
Water absorption	11%
Strength (kg/cm ²)	57
Erosion resistance	Resistible
Density (g/cm ³)	1.83

According to the table of results, the blocks are standard.

Also the results for structural tests are as following:

This system is the same as masonry structures of Iranian earthquake standard (2800) with reinforcements. In this case it is possible to construct the 2 stairs buildings with the height of maximum 8 meters from the ground level. The sample house which was built in the Exhibition site in Bam is just one stair building and for reconstruction projects in Bam this system with one stair building is recommended.

Dr. Tabibe Parhizgar
 Head of BHRC

In the attention of: Mr. Engineer Sadeghian, Head of Bam Housing Foundation In the attention of: Miss Ana Oprisan, Head of IBC Projects in Bam



Certificate from the Ministry of Housing for the quality of CSEB for the reconstruction of Bam



AUROVILLE EARTH INSTITUTE



UNESCO CHAIR

Earthen Architecture

TSUNAMI RECONSTRUCTION

CONCEPT PLANS OF MODEL HOUSES

MAY 2005

**Satprem Maini
Architect**

*Certified for use
in Tsunami Reconstruction
in Tamil Nadu
A.R. Santhakumar
- 4/7/05*

PROF. A. R. SANTHAKUMAR
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IIT (Madras), Chennai-600 036

For approval for the reconstruction



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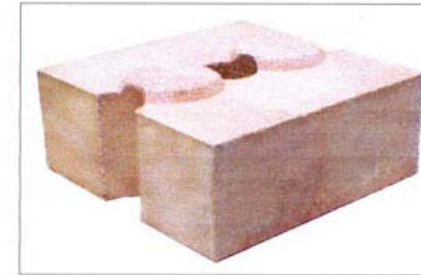


UNESCO CHAIR
Earthen Architecture

AUROVILLE EARTH INSTITUTE

EXTRACT FROM

**EARTHQUAKE RESISTANT BUILDINGS
WITH HOLLOW INTERLOCKING BLOCKS**



**TRAINING MANUAL
FOR ARCHITECTS AND ENGINEERS**

For approval in the guidelines

*Certified for use
in Tsunami Reconstruction
with Santha Kumar
4/7/2005*

PROF. A. R. SANTHAKUMAR
Department of Civil Engineering
IIT (Madras), Chennai-600 036

Mr. Satprem Maini
Architect- Director Earth Institute
BASIN Network- Partner South Asia
Auroville Earth Institute
Auroshilpam Auroville-605 101

Reference Auroville CSEB tech dated 04-07-2005

Subject: Evaluation of model mhouse and CSEB technology within the guidelines for reconstruction
Reference: 661 P 103 SANTHA KUMAR 0511 dt 11-05-05

Dear Sir,

I have evaluated the following base on your request:

1. The design of model house as per your document submitted is safe for the tsunami prone areas with the modifications mentioned there in for the foundation depth and to suit the local terrain. The extra depth and level of basement to be fixed based on local conditions
2. The CSEB technology is approved based on the guidelines and training manual Submitted by you and as per the guidelines of TN Govt.

The blocks handed over by you were tested in wet and dry condition. The results are as follows

Dry Compressive strength	5 to 6.5 MPa	Average 5.85 MPa
Wet Compressive strength	4 to 4.5 MPa	Average 4.22 MPa

Blocks have to be tested and a record as to be kept for field application as strength may vary depending on local soil condition

A.R. Santhakumar
IIT (Madras)

A.R. Santhakumar
PROF. A. R. SANTHAKUMAR
Department of Civil Engineering
IIT (Madras), Chennai-600 036

Certificate for the quality of blocks for the rehabilitation after the tsunami

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Approval for the manual on earthquake resistant done by the Auroville Earth Institute