



Wall Building

Technical Brief

Building with Interlocking Blocks

Introduction

The research activities that ultimately led to the development of the interlocking block technique, which is gaining popularity in Thailand, as well as Malaysia and the Philippines, date back to the 1960s. In these countries, houses in the rural areas were traditionally built of timber, which was readily available in the extensive forest areas. However, the alarming rate of deforestation in Thailand – from 70% forest cover in 1936 to about 55% in 1961 (now it is less than 30%) – led the government to initiate research into alternative materials for building construction in the rural areas.

Initially, research undertaken by the Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, focused on soil-cement blocks made with the CINVA-Ram manual block press (which was developed in Colombia in 1956). The demonstration houses built with these blocks were cheaper than timber houses, more durable, resistant to water, fire and termites, and aesthetically appealing. The disadvantages, however, were that the blocks were relatively heavy, and building construction required a certain amount of masonry skills. Furthermore, the mortar joints consumed a considerable amount of cement and construction time was relatively long.

These disadvantages led to the development of the interlocking block technique by the Human Settlements Division of the Asian Institute of Technology (HSD-AIT), Bangkok, in co-operation with TISTR, in the early 1980s. The first demonstration house using interlocking soil-cement blocks was built in Thailand in 1984. Between 1986 and 1990, the Post Graduate Centre Human Settlements (PGCHS), of the Catholic University of Leuven, Belgium, assisted these institutions in optimizing the interlocking block technique, which has now reached a high degree of maturity.

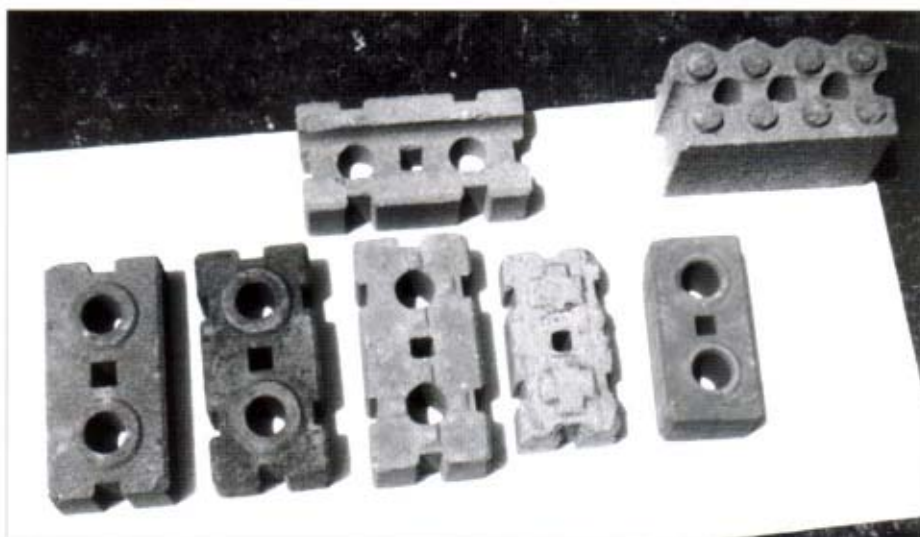


Figure 1 Various types of interlocking blocks

The interlocking block technique

The concept of interlocking blocks is based on the following principles:

- The blocks are shaped with projecting parts, which fit exactly into depressions in the blocks placed above, such that they are automatically aligned horizontally and vertically – thus bricklaying is possible without special masonry skills.
- Since the bricks can be laid dry, no mortar is required and a considerable

amount of cement is saved.

- Each block has vertical holes, which serve two purposes: 1. to reduce the weight of the block, and 2. to insert steel rods or bamboo for reinforcement, and/or to pour liquid mortar (grout) into the holes, which run through the full height of the wall, thus increasing its stability.
- The length of each block is exactly double its width, in order to achieve accurate alignment of bricks placed at right angles.



Figure 2 House built with concrete interlocking blocks

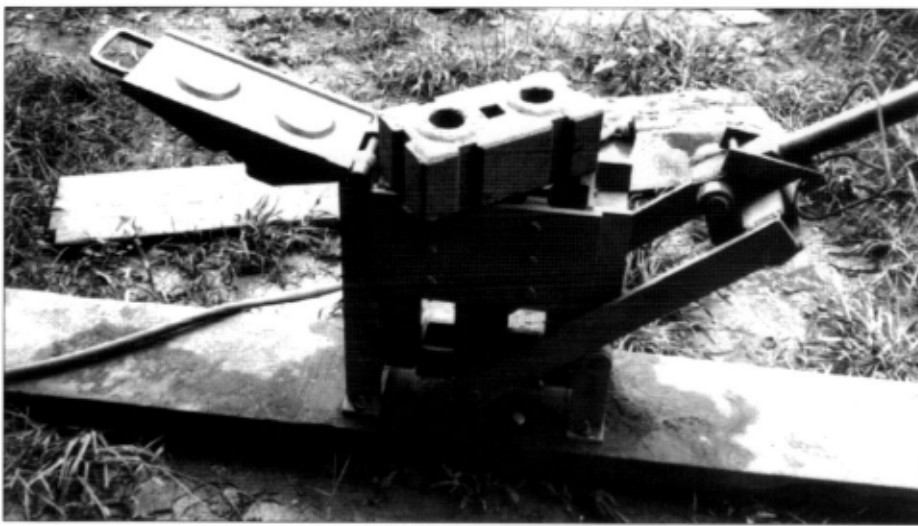


Figure 3 Modified CINVA Ram block press for making interlocking soil-cement blocks

Types of interlocking blocks

A variety of interlocking blocks have been developed during the past years, differing in material composition, shape and size, depending on the required strengths and uses:

Different materials

- Soil-cement blocks

Depending on the soil and cement qualities, the cement-to-soil ratio usually lies between 1 : 6 and 1 : 10, by volume. (Laboratory tests are essential).

- Rice husk ash (RHA) cement blocks

The cement-to-RHA ratio is generally 1 : 4, by volume. Two types of blocks can be produced:

white blocks, with a compressive strength of 4 N/mm², using ash (amorphous silica) from field kilns, burnt below 900°C;

black blocks, with a compressive strength of 1.4 N/mm², using boiler ash (crystalline silica), burnt up to 1200°C;

- concrete blocks

A typical mix proportion of cement-to-sand-to-gravel is 1 : 5 : 3.

Different shapes and sizes

- Full blocks (300 x 150 x 100 mm) for all standard walls (single or double brick thick)
- Half blocks (150 x 150 x 100 mm), which can be moulded to size, or made by cutting freshly moulded full blocks in half.
- Channel blocks, same sizes as full and half blocks, but with a channel along the long axis, into which reinforcing steel and concrete can be placed to form lintels or ring beams.
- The vertical sides of the blocks can be flat or have recesses, and the vertical grout holes can be square or round.

Production of interlocking blocks

Interlocking blocks are produced in special moulds, in which compaction can be done by hand or mechanically, depending on the type of block, material used, required quality and available resources. The blocks can be made directly at the building site, or on a larger scale in a production yard.

Soil-cement blocks are commonly manufactured in manually operated block presses (modified CINVA Rams). Two workers prepare the soil mix, shovel it into the mould box and close the lid. Compaction is done by a third worker, who pulls down a long steel handle (lever arm), which pushes up the base plate. After opening the lid and ejecting the block, it is removed by a fourth worker and stacked in a shaded place for curing and hardening.

Rice husk ash and concrete blocks need tamping, or better still vibration, for proper compaction. Therefore, the manual block press is not suitable. Manual tamping is

done by jabbing the mix with a piece of wood or dropping the filled mould several times on a hard surface. Higher compaction and greater strengths are achieved by placing the mould on a vibrating table, or holding a portable vibrator against the sides. After demoulding, the blocks are carried away on pallets for curing.

Wall construction

Before placing the first course in a mortar bed, the blocks must be laid dry on the foundation around the entire building, in order to ensure that they fit exactly next to each other (leaving no gaps), and that an exact number of full blocks are used, otherwise the system will not function. When laying the first course in the mortar bed, care must be taken that the blocks are perfectly horizontal, and in a straight line, or at right angles at corners.

Once the base course is properly hardened, the blocks are stacked dry, with the help of a wooden or rubber hammer to knock the blocks gently into place. Up to 10 layers can be placed at a time, before the grout holes are filled with a liquid mortar – 1 part cement to 3 parts sand (or soil or rice husk ash) to 1 part water.

It is advisable to place channel blocks around the building, at window sill height, to install a ring beam. They should also be placed directly above doors and windows to install lintels, and directly below the roof to finish the walls with a ring beam. For increased structural stability, especially in earthquake regions, steel rods or bamboo should be inserted in the vertical grout holes, especially at corners, wall junctions and on either sides of openings.

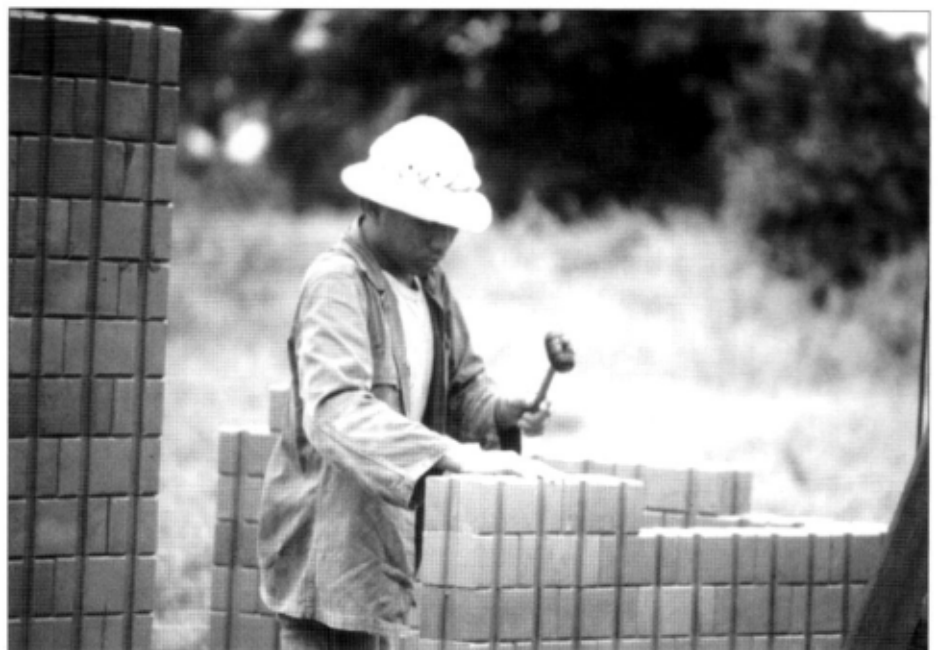


Figure 4 Dry assembly of interlocking block walls in Thailand (Photo: DESWOS, Köln)

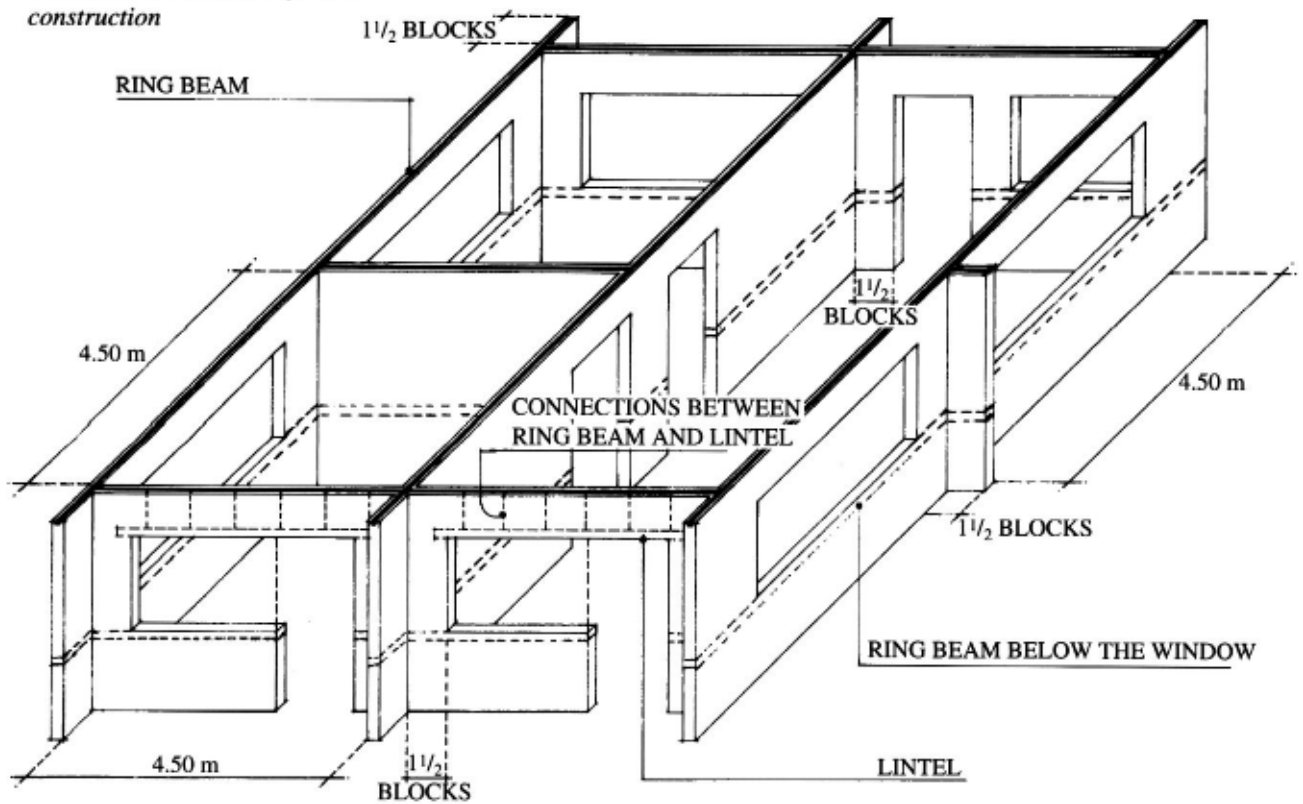
Interlocking blocks are ideally suited for load-bearing wall constructions, even for two or more storeyed buildings, provided that the height of the wall does not exceed 20 times its thickness, and wall sections without buttresses or cross walls do not exceed 4.5 m length (to prevent buckling).

Though less economic, non-loadbearing constructions are more common. The walls are constructed in the same way as load-bearing walls, but merely serve as infills between the reinforced concrete frame (post and beam) structure, which supports the roof. Care must be taken to achieve a good bond between the walls and framework.



Figure 5 The German School in Chiangmai, Thailand, under construction with load-bearing interlocking concrete block walls

Figure 6 Principles of interlocking block construction



Building design

Almost any type of building can be constructed with interlocking blocks, the main design constraints being that the plan should be rectangular and all wall dimensions and openings must be multiples of the width of the block type used. All other principles of design and construction, such as dimensioning of foundations, protection against rain and ground moisture, construction of ceilings and roofs, and the like, are the same as for other standard building types.

Figure 7 Typical construction site of an interlocking soil-cement block house in Thailand

Advantages

- The materials required for block production and building construction are usually locally available in most regions; therefore, in areas in which timber is scarce and expensive, construction with interlocking blocks has environmental advantages (no deforestation, low energy requirement for block production and transportation).
- Unlike the case of timber constructions, termites cannot cause damage to the blocks.
- Compared with conventional masonry, the dry assembly of interlocking blocks saves construction time and a large amount of mortar, which would otherwise be required for the horizontal and vertical joints.
- Without the need for high-waged skilled masons (except for the base course), by saving cement (less mortar) and with the speed of construction, the building costs are lower than for standard masonry construction. Additional costs are saved by building loadbearing walls, instead of infill walls between a structural framework.
- The structural stability and durability of interlocking block constructions can be far greater than for comparable timber constructions. Grout holes and channel blocks provide means to insert steel reinforcements in vulnerable parts of buildings for increased wind and earthquake resistance.
- Interlocking blocks can be produced on a small scale on the building site (for self-help construction), or on a large scale in centralized production units.
- The interlocking block technique is suitable for the construction of multi-storeyed buildings, in the same way as for standard masonry constructions.

Disadvantages

- The technology being relatively new, people may be reluctant to apply it. Hence, a well co-ordinated dissemination strategy to introduce it to potential builders is vital.
- Although skilled masons are not needed for constructing walls, a certain amount of training is required to ensure that the walls are properly aligned and no gaps are left.
- Also in the production of the blocks training is needed not only in determining the correct type of soil, correct mix proportion and moisture content, but also in producing uniform sized blocks (that is, avoiding under or over-filling the block moulds before compaction).
- Even with the greatest care in assembling the walls, the joints are not entirely resistant to wind and rain penetration, therefore, plastering the interior wall surfaces is usually necessary.

Further reading

- *Building with interlocking blocks in a loadbearing system*, Technical handout by Weinhuber, K., Rossmoosweg 34, D - 82549 Königsdorf, Germany, 1993
- *Compressed earth blocks - Volume I: Manual of production*, Rigassi, V.; CRATerre-EAG, Aus der Arbeit von GATE, Vieweg, Braunschweig, 1995
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- *Interlocking Soil-Cement Bricks - A modified Cinva Ram Brickmaking Machine*, HSD Working Paper No. 8, Etherington, A. B., Asian Institute of Technology - Human Settlements Development Division (AIT-HSD), Bangkok, 1983
- *Small-scale manufacture of stabilised soil blocks*, ILO/UNIDO, Technical memorandum No. 12, International Labour Office, Geneva, 1987
- *Soil-cement technology for low-cost housing in rural Thailand*, An evaluation study, Itebeke, M.; Jacobus, P., Low-cost housing project, Catholic University Leuven (PGCHS), Belgium, and Asian Institute of Technology (AIT), Bangkok, 1988
- *Using interlocking soil cement blocks*, Report on a National Training Workshop, 17-19 December 1985, Thailand Institute of Scientific and Technical Research (TISTR), Bangkok, 1985

For further information on building with interlocking blocks, please contact

Karl Weinhuber
Rossmoosweg 34
D - 82549 Königsdorf
Germany

(All illustrations, except Figure 4 by K. Weinhuber)

Published by



German Appropriate Technology Exchange
Dag-Hammarskjöld-Weg 1
Postfach 51 80
D - 65726 Eschborn
Federal Republic of Germany
Phone + 49 - 6196 - 79-3190
Fax + 49 - 6196 - 79-7352

(1995)

What is BASIN?

Building materials and construction technologies that are appropriate for developing countries, particularly in the low-income sector, are being developed, applied and documented in many parts of the world. This is an important prerequisite for providing safe, decent and affordable buildings for an ever-growing population.

But such new developments can do little to improve the building situation, as long as the information does not reach potential builders. The types and sources of information on standard and innovative building technologies are numerous and very diverse, making access to them difficult.

Thus, in order to remedy this drawback, GATE, ITDG, SKAT and CRATerre are co-operating in the Building Advisory Service and Information Network, which covers four principal subject areas and co-ordinates the documentation, evaluation and dissemination of information.

All four groups have a co-ordinated database from which information is available on Documents, Technologies, Equipment, Institutions, Consultants as well as on Projects and Programmes. In addition, printed material or individual advice on certain special subjects is provided on request. Research projects, training programmes and other field work can be implemented in co-operation with local organizations, if a distinct need can be identified and the circumstances permit.

BASIN is a service available to all institutions and individuals concerned with housing, building and planning in developing countries, but can only function efficiently if there is a regular feedback. Therefore, any publications, information, personal experiences, etc. that can be made available to BASIN are always welcome and will help BASIN to help others.



WAS / BASIN
GATE - GTZ
P.O.Box 5180
D - 65 726 Eschborn
Germany
Phone + 49 6196 793190
Fax + 49 6196 797352



ITDG
Myson House
Railway Terrace
Rugby CV21 3HT
United Kingdom
Phone + 44 1788 560631
Fax + 44 1788 540270



SKAT
Vadianstrasse 42
CH - 9000 St. Gallen
Switzerland
Phone + 41 71 237475
Fax + 41 71 237545



CRATerre - EAG
Maison Levrat, Rue du Lac
BP 53
F - 38092 Villefontaine Cedex
France
Phone + 33 74 95 43 91
Fax + 33 74 95 64 21