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Wall Building
Case Study
building advisory service and information network

Vertical Shaft Brick Kiln - Technology Transfer Indian Experience - 1

1 Introduction

Sectoral Context

Shelter forms one of the basic needs of humankind next only in importance to food and clothing. With rapidly increasing population in countries like India it is a colossal task to provide shelter to the teeming millions. Government and non - governmental organisations have tried to address this problem and come out with various schemes and technologies to bridge the ever widening gap between the need and availability of dwelling units in the country.

In meeting the walling material requirement for this quantum jump in construction of dwelling units, it is expected that burnt clay bricks will continue to be the principal walling material, in spite of various alternative technologies based on local and sustainable resources propagated for providing low cost housing to the millions.

The current technologies prevalent for firing clay bricks in the country such as intermittent clamps and continuous Bull's trench kilns consume huge quantities of energy. The emissions from these kilns have high negative impact on the environment in terms of damage to the people and crops in the nearby areas, and contribution of CO_2 emissions for global warming. Thus, any technology for augmenting supply of burnt clay bricks with lower specific energy consumption and promising lower negative impact on the environment would merit consideration for adoption.

VSBK technology in China

In China, a technology claiming high energy efficiency and consequent lower emissions has been developed over the past three to four decades and has had wide dissemination in more than ten provinces of the country. It is the Vertical Shaft Brick Kiln (VSBK) technology which has spread widely in recent times. VSBK essentially consists of one or more rectangular shafts within a kiln structure, where dried green bricks are loaded at the top along with powdered fuel - coal. These move down through the preheating, firing and cooling zones and are unloaded at the bottom. The details of concept, design and operation of VSBK's have been covered in detail in other literature (References 1 to 5) and so is not repeated here. It is reported that there are more than 50000 kilns operating in China now with more than 3000 in Funan county alone. The main reasons for the success of the technology are - about 40 to 50% reduction in energy consumption, simplicity of operation and economic viability.

It was in this context that the transfer of VSBK technology from China to India and its dissemination after validating its suitability to Indian conditions was conceived.

VSBK technology route-from China to India

The first VSBK outside China is reported to have been established in Nepal. Subsequently VSBKs have been constructed in Bangladesh, Pakistan, Afghanistan and lately in Sudan. The projects in these countries have met with varying degrees of success and setbacks. The experiences have been documented in literature such as Reference 3 which deals with the experience in Pakistan. This information on lessons learnt from the earlier experiences was helpful in formulation of the current project.
This case study tries to give an account of the Indian experience detailing the steps taken to ensure effective transfer of technology to India.

VSBK Project in India - Main agencies involved

Development Alternatives, a leading NGO with concerns for sustainable livelihoods, conceived an action research programme on sustainable production systems for construction material including kilns for burning bricks. The Swiss Agency for Development and Co-operation supported the project, within its "Energy Efficient and Renewable Energy Sources" programme.

The Tata Energy Research Institute -a major Indian organisation in the field of energy and environment was another significant member of the project team, contributing to the energy aspects. SKAT and Sorane - two Swiss consulting organisations were assigned advisory and backstopping responsibilities for the project. A Chinese expert team from the Henan Academy of Sciences was engaged on a long term basis for providing the technology support.

2 Objectives - Strategy - Implementation

Four main steps and the role of the implementing agencies in the network as envisaged were:

1. Baseline studies for auditing the energy and environmental aspects of brick production in various traditional high volume brick production areas:
   - Energy Audit by Tata Energy Research Institute (TERI),
   - Environmental Audit by Environment Services Branch of Development Alternatives.

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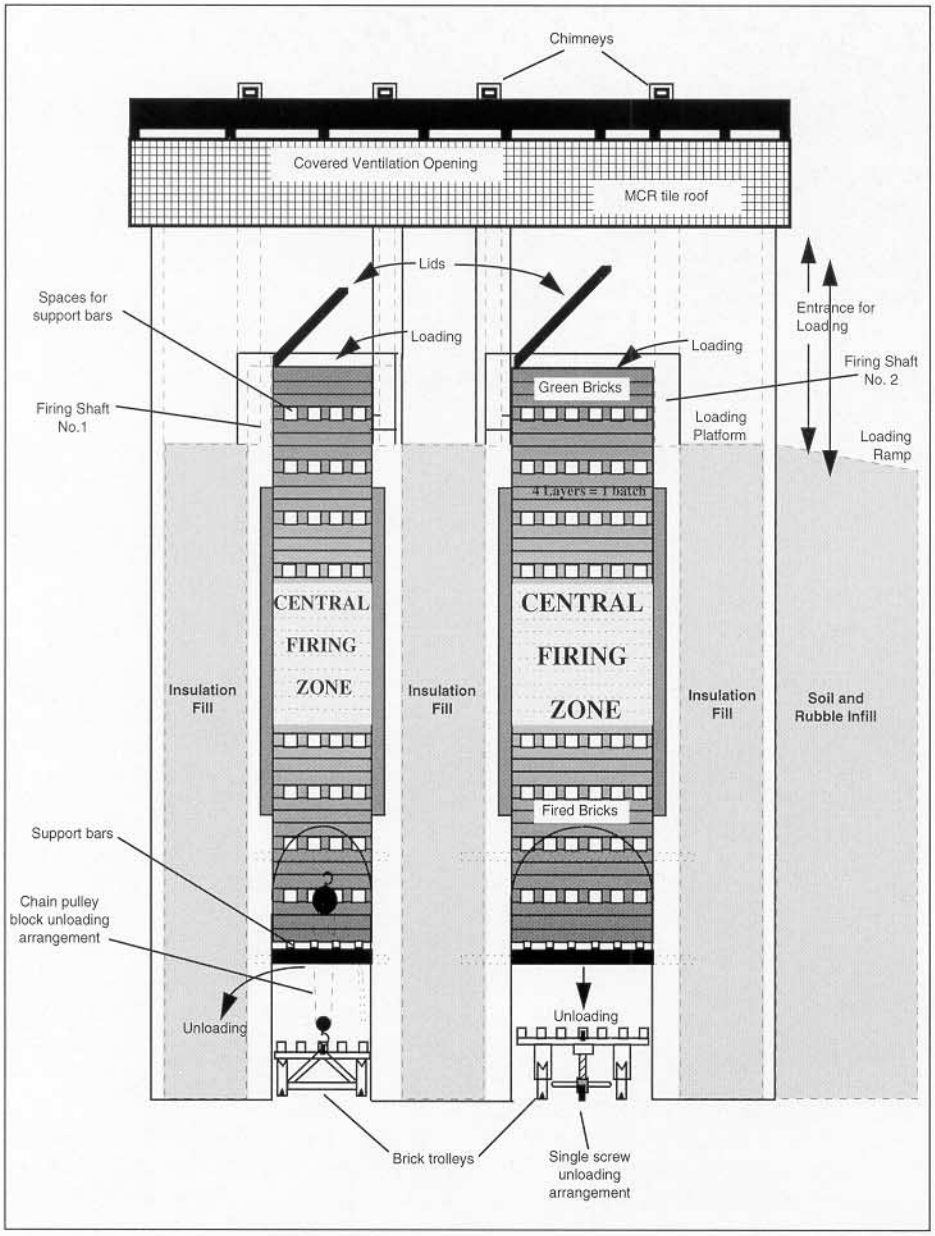

Fig. 1: A cross-sectional schematic diagram of VSBK-1

2. Design, construct and operate two pilot kilns in two distinctly different agro-climatic geographical areas:
   - association of Chinese Experts for the full period,
   - association of brick kiln entrepreneurs for construction and operation of the kiln,
   - advice of backstopping consultants through different milestones for periodic evaluation and mid course correction,
   - DA to undertake implementation and overall co-ordination.

3. Evaluation and Validation of technology:
   - Environmental Services Branch of DA for Environmental Audit,
   - TERI for Energy Audit,
   - DA for operational & economic audit and overall co-ordination in association with outside players in brick industry.

4. Market study and Large Scale Dissemination if the steps 1 to 3 pass the requirements as one moves progressively through a carefully planned decision tree.

Initially, the main objective of the sub project was to asses the potential of VSBKs against the Bull's Trench Kiln (BTKs) in terms of energy saving, environmental aspects and economic operation, and if found favourable, to study the market, validate the technology and plan for wide dissemination of the technology.

Initial Implementation

The first steps in the implementation of the project were carried out in 1995. These were the baseline studies of BTK operations in significant brick production areas in Bhognipur - Kanpur belt and in Pathankot area. Environmental Audit and Energy Audit were conducted by the respective agencies between April and October 1995.

In January 1996, a team consisting of DA coordinator and the backstopping consultants visited Peshawar, Pakistan to learn from the experience of VSBK technology transfer in Pakistan.

Main observations and recommendation which evolved out of the mission to Pakistan are given below. Observations in Reference 3 are also relevant in this regard:

- VSBK technology is not yet sufficiently developed as an alternative to large scale brick production.

- Further basic technology development is required to optimise operating parameters and economy.

- The VSBK probably operates most successfully in a decentralized set up where owner and family are fully and continuously involved.

- The project team should construct and operate a two-shaft VSBK, preferably on its own and/or in a protected environment independent of interference from kiln owners.

- The building up of local know-how as well as basic acceptance is vital for the dissemination and sustainability of VSBK technology. For this, two teams for construction and two firing crews should be trained, DA experts must lay their hands on and work on all phases of operation while learning from their Chinese counterparts and be responsible for the operation, especially for the firing.

- First audit the energy and environmental factors and evaluate overall performance and then plan for dissemination.

- The Chinese expert team - the technology provider - should be associated with the project on a long term basis.

With the strategy revised in accordance with the above, it was decided to set up the first VSBK in India in an area where clamps are prevalent for brick making. It was also decided that the kiln would be constructed and operated by the Development Alternatives team under controlled conditions so that the technology absorption and any adaptation necessary to meet the requirements under Indian conditions, identified by the project team, could be implemented.

Implementation

The implementation on the ground started with this background. A participative approach was adopted with all the team members involved in decision making and planning and significant aspects reviewed and guided by the consultant backstoppers.

Design

The designs and drawings were prepared by the Chinese team with the DA team actively participating in the process and providing all the required data relevant to Indian and local conditions of material availability, standardisation and construction methodology. Energy experts from TERI and environmental experts from DA made significant contributions not only in their respective fields but to the development of the overall concept.

It was decided to include as many alternative features in the design of the kiln as possible so that the Indian team got familiar with the various options available and as a result technology absorption is accelerated. Thus, the two shafts (both of 8 batches height) were of two different sizes 1m x 1m and 1m x 1.5m. The unloading device for the smaller shaft (Shaft no. 1) was to be of chain pulley block design, whereas the bigger shaft (Shaft no. 2) was to have single screw unloading mechanism. Loading platform had a monitor roof for better ventilation and two chimneys per shaft were provided to evacuate the exhaust gases (Fig. 1).

Site selection

A rapid survey was conducted in the clamp areas around Jhansi initially by the DA energy team which shortlisted about 11 locations. This was reviewed by the Chinese experts, DA project team and the backstopping consultants and final decision taken to locate the first Indian Vertical Shaft Brick Kiln at Datia in Madhya Pradesh state of India. The site was to be leased / rented / bought by the project so that operations could be conducted under controlled conditions.

Construction

The construction activity was thoroughly planned with a detailed work breakdown structure and all the players in the team assigned their respective responsibilities and time schedules. In an interesting and effective planning seminar, the backstopper made sure what each team member would do and would not do.

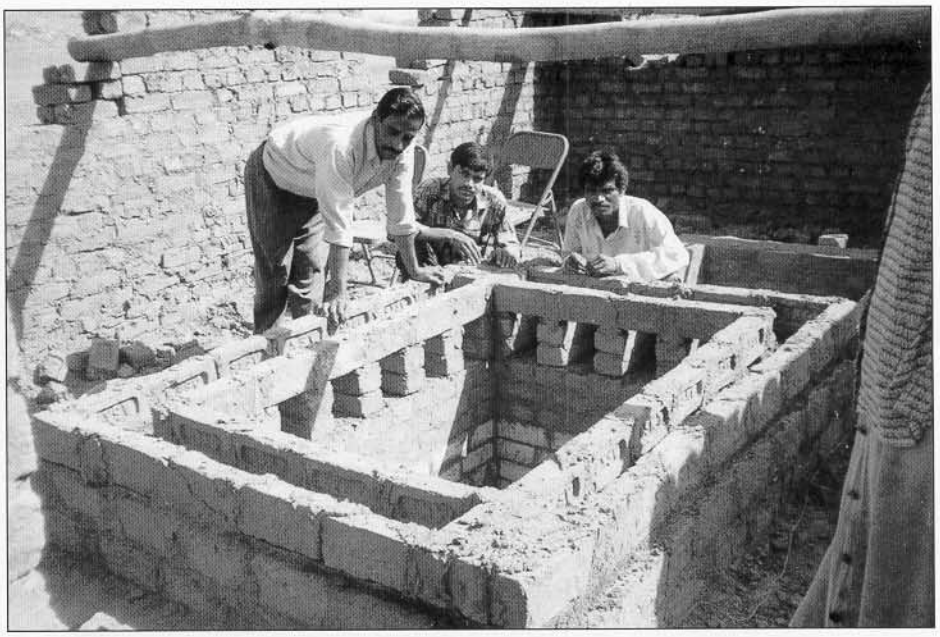

Fig. 2: Shaft No 2 showing flue passage

The construction of the kiln started on 13 March 1996. Expert masons from DA and local labour formed the main construction force. Chinese craftsmen actively participated and guided the Indian team during all stages of construction. Constant supervision was provided by the Chinese experts and DA engineers. Energy experts from TERI and environment experts from DA made periodic visits to ensure compliance with their concepts and requirements (Fig. 2).

Specialized mechanical equipment was manufactured locally (Fig 3). DA engineers planned and executed all stages of work - procurement of materials and components, fabrication, assembly and testing. DA and Chinese engineers provided periodic advice and guidance to the local manufacturer. That the local manufacturers have imbibed thorough capability in manufacture is evident from the fact that later orders for the other kiln were executed by them without any hassle.

For the actual construction of the kiln and the operating room, a team of about 5 masons and 10 helpers was engaged (not all were working at the same time). The larger number was engaged to create a group of workers who have acquired the skills of constructing the VSBK (Fig. 4).

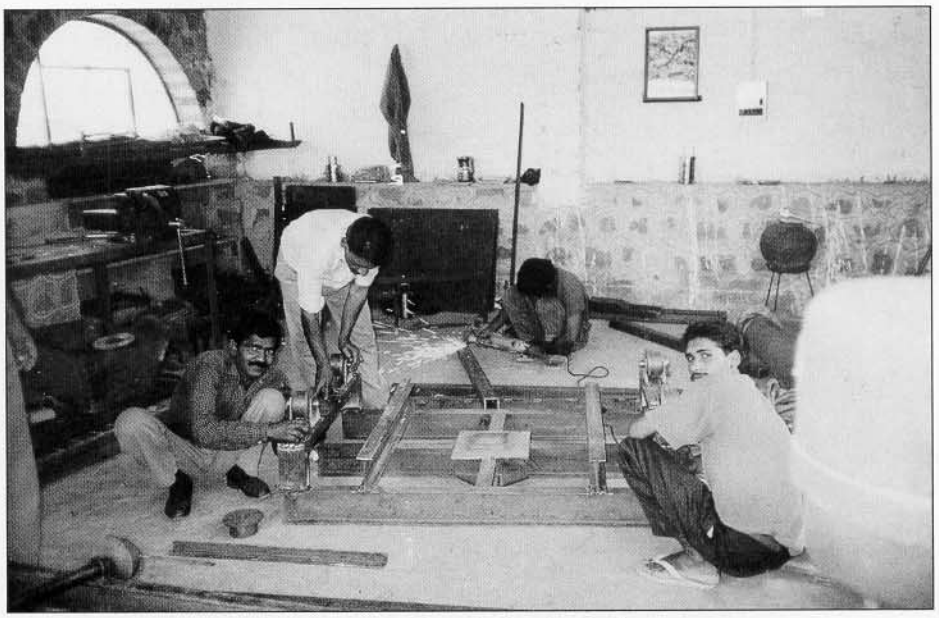

Fig. 3: Manufacture of trolleys at ATC workshop in Orchha

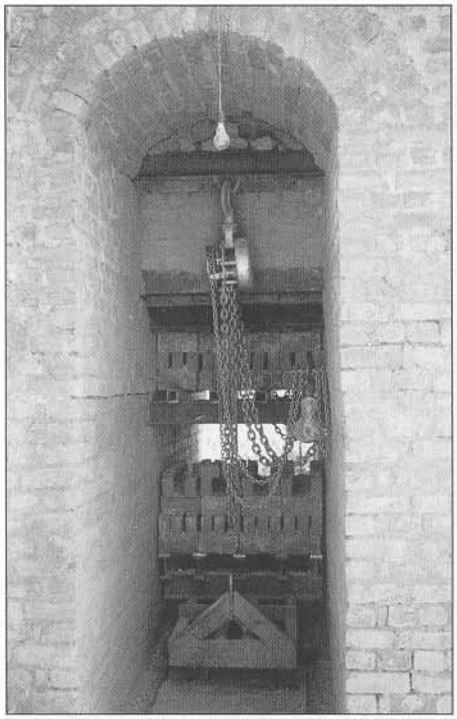

Fig. 4: Shaft 1: Chain pulley unloading arrangement

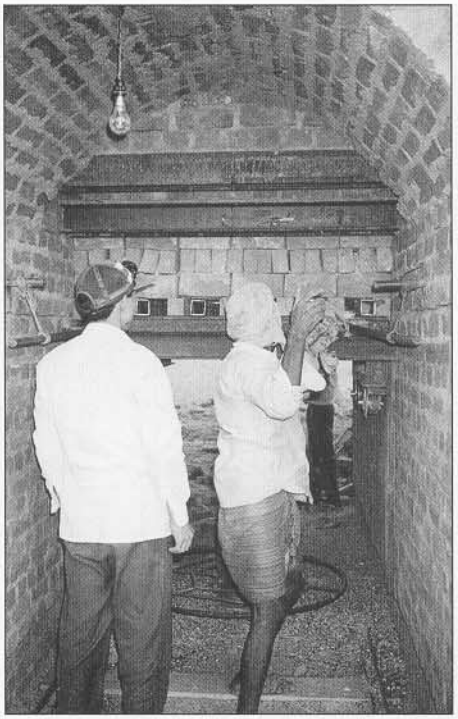

Fig. 5: Single screw unloading mechanism

The construction had a smooth run apparently due to the thorough planning done in the beginning, and was completed in about 45 days. The first shaft was fired on 30 April 1996 (Fig. 5).

Operation

Green brick supply was planned through the conventional methods prevalent in the area, to enable evaluation of performance of firing in VSBK in comparison with the clamps, keeping the other parameters in brick production similar. The conventional method employs winning clay by manual means, mixing with wheat straw and coal ash (from power plants and foundries) with the clay, and hand moulding using wooden steel- lined moulds. Green bricks were dried in the open and carried to the loading platform using animal power - donkeys. Coal from Jharia fields was procured from local sources, of size less than 6mm. A team of about 18 firemen was engaged locally for operating the kiln, who worked under the guidance and supervision of the Chinese expert and technicians. Facilities were created for the Chinese and DA technicians to stay at site during the operation phase to ensure attendance throughout day and night.

Variety was adopted in initial firing also. The Shaft No. 1 was lighted from the bottom (on 30 April 1996) and Shaft No.2 was fired from the top (on 10 May 1996).

The DA operating team members worked hand in hand with their Chinese counterparts, staying throughout the operation at the site. The Indian firemen had no difficulty in acquiring the requisite knowledge and skills for operation of the kiln and the confidence for facing any exigency arising therein. Those firemen who showed good performance and leadership qualities were upgraded as firemasters.

The operation of the kiln continued till 25 June 1996 when it was shut down for the rainy season. Various campaigns of operation, with different clays and various mixes of clay for moulding, were conducted. Environmental conditions were monitored by the ESB team of DA and Energy Audits conducted by the TERI team.

3 Results and learnings from VSBK 1

The overall findings after this phase of operation were as follows:

- Quality of bricks produced - better than those produced in nearby clamps in terms of ring and colour. But the

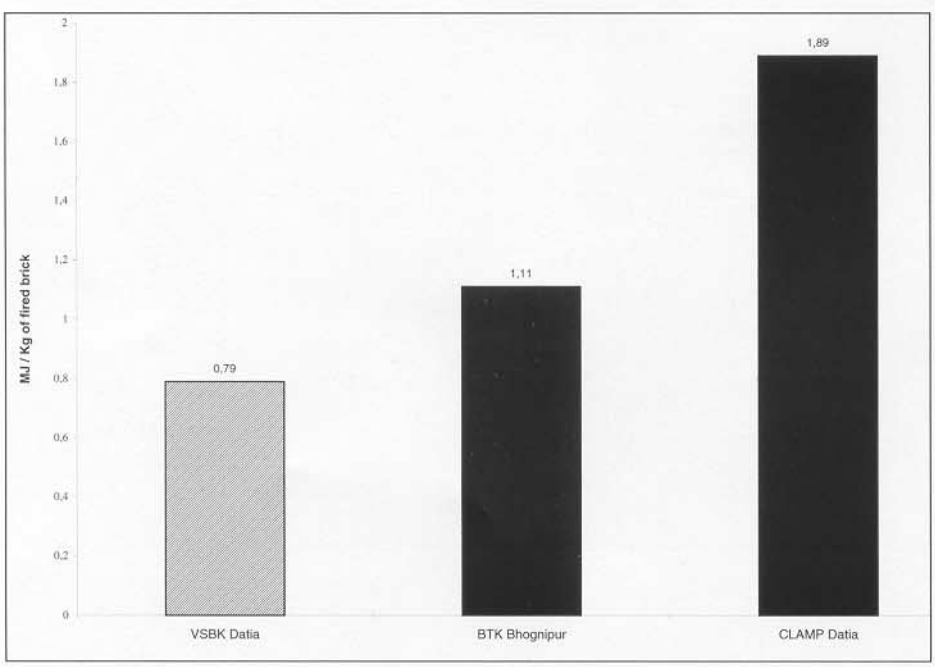

Table 1: Specific Energy Consumption - A comparison

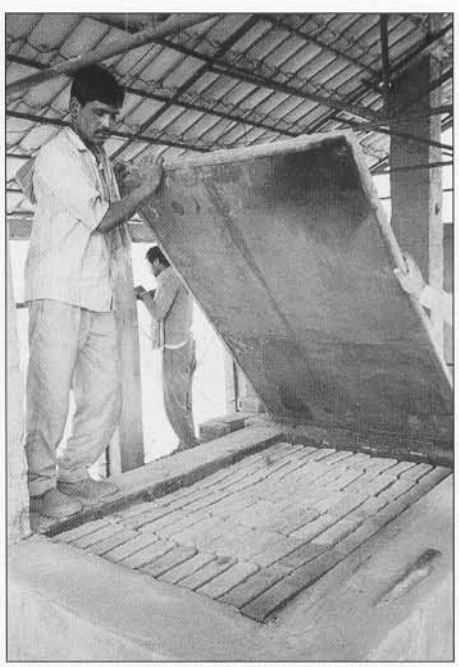

Fig. 6: Top of shaft showing Lid arrangement

quality is not as good as in traditional BTK areas, ostensibly due to inferior clay quality.

- The compressive strength (between 65 kg/cm^2 and 110 Kg / cm^2) and water absorption (around 15%) is functionally sufficient.

- The breakage of bricks during the firing is only about 2 to 4%.

- Lower level of emissions - within acceptable limits. But there is scope for improvement for working environment at the loading platform.

- Energy saving is confirmed (about 30% compared to BTKs and 60% compared to local clamps – see histogram attached - Table 1).

- Technology is viable with reasonable margins for the entrepreneur. As VSBK 1 is an experimental kiln, the cost figures obtained could only be indicators. Scope for increase in margin identified - by reduction in cost of green bricks, reduction in capital cost and increase in scale of operation.

- There is no problem envisaged in the absorption of technology by the Indian personnel.

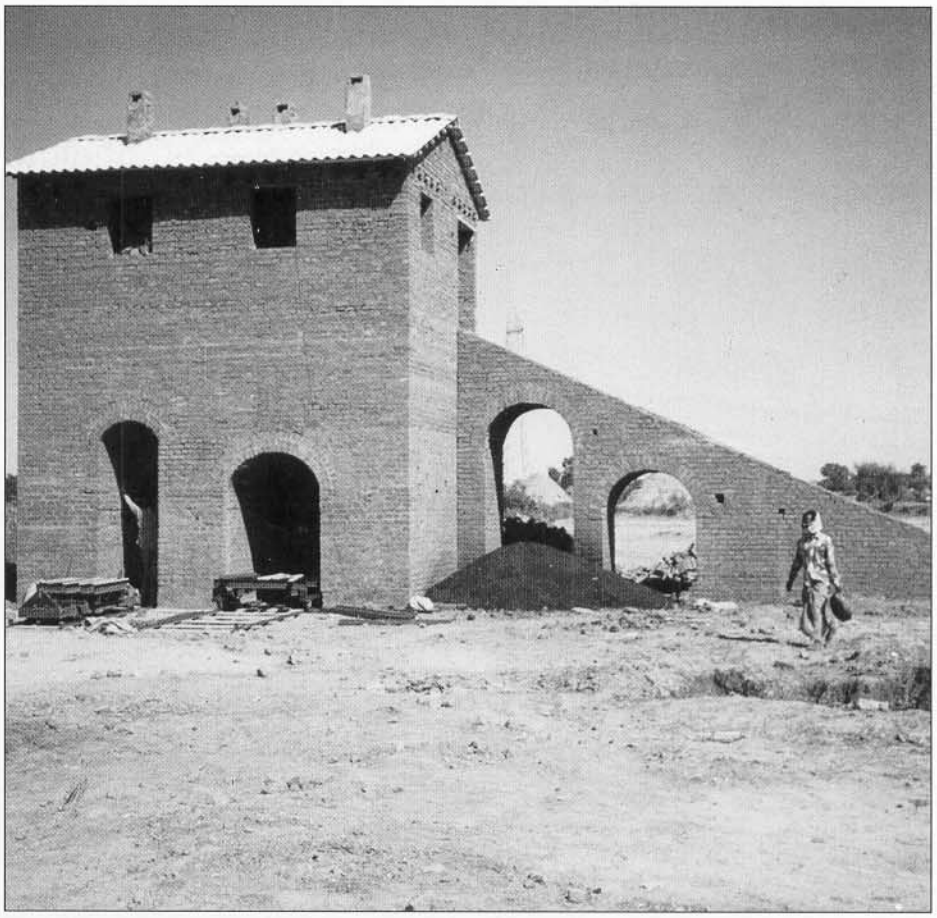

Fig. 7: Kiln after completion of construction before modification

Mid Course Review and Modifications

At this stage a workshop an "Status and Review of VSBK technology in India" was held on 27-28 June 1996 with participation of stakeholders, project team members and backstopping consultants. The group deliberated at length on all aspects of the technology transfer and performance of the project. Some ideas for further improvement in the energy and environment aspects evolved during the discussions and it was agreed to incorporate some modifications to the kiln to achieve these benefits. The major changes identified for implementation are:

- Open out the loading platform by replacing the walls with columns and grills,
- Increase height of shafts by one batch from 8 to 9,
- Increase the height of stack by about 1 metre,
- Increase the gap in roof monitor from 350mm to 700mm,
- Provide flues and dampers at two levels at the top of the shaft,

Fig. 8: Kiln after modification

- Provide lids for the shafts which can be kept closed while not loading bricks (Fig. 6).

These modification were incorporated in the kiln during October - November 1996 within the idle period of shut down due to rainy season (Fig. 7 and 8).

The workshop also evolved guidelines for setting up the second VSBK in India through a partner organisation to DA. The experience of this VSBK 2 forms the subject for case study 2.

Second phase of operation

The second phase of operation started by the end of December 1996. It is a measure of confidence in their learning that the DA team fired the shaft on their own pending arrival of the Chinese team.

The operation of the kiln was continued as in the first phase with various campaigns of different clays, different mixtures for green brick production etc. The energy and environmental aspects were monitored at different intervals. The kiln was shut down again for the rainy season by the end of May 1997.

The overall results show that the improvement in energy efficiency over the first phase is marginal whereas there is definite improvement in the environmental aspects at the work place which meet the national standards for the various parameters such as SPM, SO_2 , NO_2, CO etc.

Achievements

The following can be considered to have been achieved as a result of the VSBK technology transfer experience:

- Energy efficiency of VSBK established - other aspects of operation are also promising.
- Design improvements so that the working environment meets the relevant national standards.
- Groups of masons, firemasters, firemen and supervisors trained on the job.
- Indigenous capability built up for fabrication and manufacture of specialised mechanical equipment such as unloading device, trolleys, lid systems etc.
- An efficient energy monitoring and feed back system has seen established with TERI and for environment monitoring with DA.
- Through this monitoring system, the needs and potentials for further improvement have been identified.
- R & D work was conducted to further improve energy and environment efficiency of VSBK and further possibilities identified.
- VSBK design, construction and operation guideline documents have been prepared.
- A very good project team and cooperation between different actors and organisations has been established.

Further work

The performance of the project was reviewed in the Analysis and Outlook Workshop held during 3-5 June 1997 with wide participation. It was mainly planned to continue the good work done with the aim of further improving the performance of VSBKs in terms of quality, volume of production and economic viability. Earlier a mission consisting of DA and TERI experts and backstopping consultant visited VSBKs in China mainly for understanding the factors leading to their wide dissemination and the methodology. The findings were presented in the workshop. Some of the actions agreed during the workshop are: improving the quality of green brick production by installing extruders, building kilns with larger shafts for higher volume of production in an area with good quality clay availability, and monitoring and optimising economic performance.

Conclusion

The project team received appreciation from the stakeholders and backstopping consultants during the periodic review and evaluation missions. This greatly encouraged the team to put in greater efforts to achieve the aim and objectives of the project. The concerned officials of DA, SDC and TERI provided constant support and guidance to the project team. The project team acknowledges this as of great value in successful implementation of the project.

Text by

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Vertical Shaft Brick Kiln - Technology Transfer Indian Experience - 2

1 Introduction

The sectoral context for the transfer of Vertical Shaft Brick Kiln (VSBK) technology to India to augment supply of walling materials for meeting the demand for reasonable housing requirements for the millions is explained in the first case study. Development Alternatives (DA) with the support of Swiss Agency for Development and Cooperation (SDC) had embarked on an action research programme in 1995 of which improved performance of kilns used for firing clay bricks was an important component. Planning the strategies for the project and the activities leading to the establishment of the first pilot vertical shaft brick kiln (VSBK 1) at Datia in Madhya Pradesh state have been covered in the case study, on "Indian Experience-1".

The main objective of the project was to establish under Indian conditions the energy efficiency and lower emission of polluting gases attributed to the VSBK technology, developed in China, compare with conventional brick production methods; and once established, to devise plans for wide dissemination. The operating experience of the VSBK 1 in Datia confirmed appreciable reduction in energy consumption and emission levels. It was also established that the technology would be economically viable and better working environment could be achieved. Some modifications in this regard were identified. It was decided to go ahead with the construction of the second VSBK in a different agro-climatic zone.

2 Objectives and strategy for the second VSBK

The objective of the VSBK 2 was to establish the economic viability of the technology in an area with different agro-climatic conditions, with a higher volume of production, while further confirming the energy efficiency and lower emission levels.

At this time during the course of the project, it was felt that in the interest of building capabilities for wider dissemination of technology at the appropriate time, the establishment of the other VSBK in India should be done by another organisation - working as a partner to Development Alternatives. This case study deals with the experience of the establishment of the second VSBK 2 through a partner organisation, Gram Vikas (meaning-village development), in Orissa state.

3 The Project Partner

A set of well defined criteria for the selection of the partner was evolved by DA and the backstopping consultant. These are:

- It should be a development organisation/institution of repute, having technology development experience for some years.
- It is desirable that it has worked in the areas of building materials, and has access to an existing network of partners/organisation.
- It should have expressed concern for energy efficiency and environmental consideration.
- It should have in-house technology capacity to co-operate with and absorb the VSBK technology.
- On successful completion of the pilot phase, it should have the capability to undertake replication/dissemination of the technology through entrepreneurs within its network.
- If satisfying all or most of these conditions, the partner should agree to actively participate in the selection of site, setting up of the kiln and running operation of the kiln.
- Preferably be involved in enterprise development.
- Not be a one-man show.
- Not be religion based/politically active.
- Not be contradictory to DA + SDC objectives.
- Should be in search of new, innovative building materials producing technologies.
- Not favour subsidy policy.
- Should work in an area where coal firing is prevalent for firing bricks.

Searching for a suitable partner was done taking into consideration the project guideline that the second VSBK should be established in an area with different agro-climatic conditions than Datia. After initial consideration of more than 40 possible partners all over India, eight organisations were shortlisted for detailed evaluation. Finally Gram Vikas was chosen to be the partner organisation in this endeavour.

Gram Vikas

Gram Vikas (GV) is a grassroots voluntary organisation with headquarters at Mohuda village near Berhampur in Ganjam district of Orissa state. The main mission of Gram Vikas is integrated rural development encompassing the various components of rural life such as habitat, health & hygiene, drinking water & environmental sanitation, basic education, natural resource management, livelihood generation and community action for development.

Gram Vikas has since 1971 played a vital and effective role in integrated tribal and rural development in the area. Major achievements of Gram Vikas include the large number of village based credit institutions now operating under the ownership and management of communities. These facilities have greatly reduced the dependence of the tribals on moneylen-

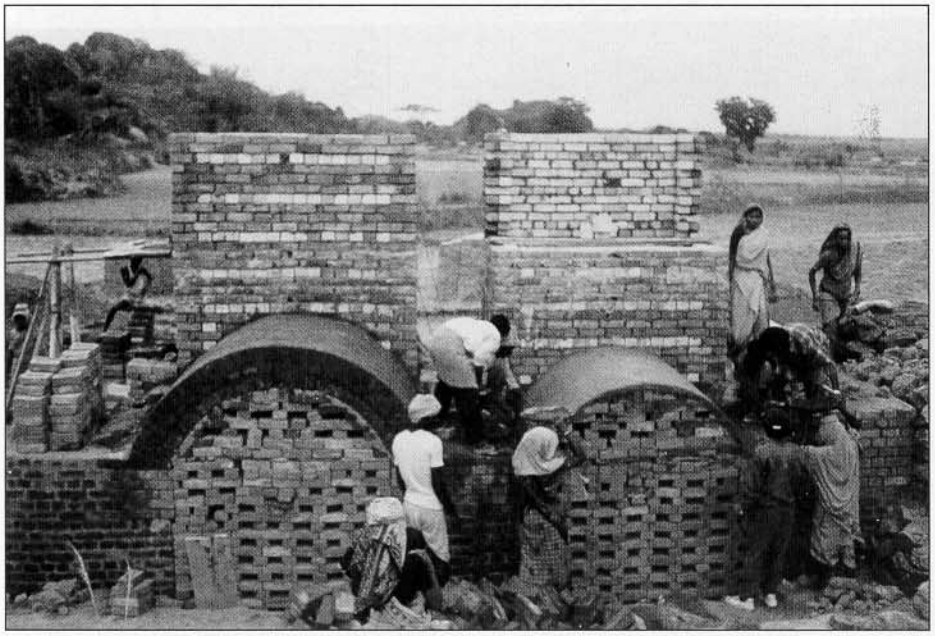

Fig. 1: VSBK 2 under construction; view showing construction of 2 arches in front of the 2 shafts

ders. Gram Vikas is a key player in the National Biogas Extension Programme under which it has installed nearly 60 000 biogas plants, representing about 75 % of plants installed in Orissa. Gram Vikas has taken up a number of schemes to provide low cost houses to the rural population in areas of their work.

4 Implementation and results

A protocol of collaboration and a specific Memorandum of Understanding for the VSBK technology between Development Alternatives and Gram Vikas were signed between the heads of the two organisations on 25 February 1997 in presence of senior officials of Swiss Agency for Development and Cooperation. A mission consisting of DA coordinator, Chinese expert and the backstopping consultant visited the Gram Vikas setup immediately thereafter. The mission went round various places in the area to understand the prevalent aspects of brickmaking. A few prospective sites for the location of VSBK 2 were selected for detailed consideration and logistics. Finally it was decided to locate the kiln at Kankia village about 7 km from the Gram Vikas headquarters at Mohuda. Various aspects of design, construction, firing, green brick production, manpower planning and training were considered during the mission and a time schedule for activities by various agencies responsible for taking action was drawn out.

Planning

The main thrust at this stage of technology transfer was that DA experts and craftsmen who had gained experience in the various activities for the establishment of VSBK 1 by working closely with the Chinese team, would fully participate in the training of their counterparts in the partner organisation. However, a skeleton team of Chinese experts would be available during the process of south-south transfer of technology, so that they could work through and support the DA trainers trained by them earlier. It was envisaged that all the activities would be planned for implementation so that brick production is started in the kiln before the end of the brick season in 1997.

Design

From the outset, it was decided that the recommendations and plan of action evolved during the VSBK Status and Review Workshop held in June 1996 with participation of all groups of the project team, all the backstopping consultants and the stakeholders, based on the experience of VSBK 1 at Datia, and keeping the project aims and objects in mind, would be incorporated in the design of VSBK 2. The main thrust was to improve performance and economic viability by reducing construction costs and boosting production capacity, and also provide features to improve energy efficiency and environmental aspects. The professionals of Tata Energy Research Institute (TERI) offered valuable inputs to the design concept.

It was decided to have two shafts of 1m x 1.75m size to yield about 6000 to 7000 fired bricks per day (Fig. 1). In order to reduce the ramp height, the unloading area was kept 0.72 m below ground level (as is common in China). This will also reduce the effect of wind and sudden chilling of hot bricks on unloading. The location of the kiln ensured using a natural grade separation to build the ramp for lifting green bricks, which entails less cost. The shaft height was designed to provide for 9 batches. However, the roof height provides for an increase to 11 batches. The shaft wall thickness was kept at 230 mm (Fig. 2). To reduce cost, the refractory bricks were laid on face accounting for 10 cm of wall thickness. The flues are designed to facilitate operation with lids. The inside dimensions of the chimney were kept at the enlarged figure of 170 mm x 410 mm. Single screw unloading device which operated very well in Datia was adopted for both the shafts. The loading platform is airy and well ventilated with a gap of 0.75 m in the monitor of the sloping roof. The eaves level is kept at a height to accommodate 11 batch operation (Fig. 3).

Construction

The detailed planning done in the very beginning helped smooth progress of the construction of the kiln. Masons from Gram Vikas and local labour formed the main workforce. Support was provided by other sections of Gram Vikas such as mechanical workshop etc. An engineer and masons from Development Alternatives who had gained experience during construction of VSBK 1 at Datia worked with Gram Vikas staff, training and guiding them throughout. The Chinese expert and one craftsman were at site providing further support to the construction team. Problems and hurdles faced during the progress of construction were overcome with cooperative effort.

Development Alternatives took the responsibility to provide the specialised mechanical equipment required for incorporation in the kiln construction. To widen the area of indigenous capability in this regard, it was felt that this should be manufactured at Berhampur. Accordingly, the trolleys were fabricated locally at Berhampur, under constant guidance and supervision of the DA mechanical engineer. The single screw unloading mechanism, which could not be manufactured at Berhampur, was fabricated at Jhansi and transported to Kankia.

The construction started on 7 April 1997. Local materials with the traditionally relevant methods were used for the construction of the ramp and buildings.

The kiln with the operating room and stores etc. was ready by 24 May 1997 (Fig. 4).

The Gram Vikas team for the construction, besides the coordinator, consisted of 2 site engineers (not for full duration of construction), 4 masons and 10 helpers.

Operation

Green brick production: The green bricks were produced by the traditional methods prevalent in the area. This involves mixing of some rice husk along with the clay and hand moulding in wooden or steel moulds. Initially it was decided to train some unskilled local men and women with the objective of providing livelihoods to the local people. The Chinese team tried to train some persons from the villages nearby. Though some of the trainees learnt the trade fast, it was found that their productivity was low and would not match with the requirements for high volume of production in the kiln (about 7000 bricks per day). Finally families of traditional brick makers had to be utilised to supply the requisite green bricks.

The green bricks are dried in the open, with provision to be covered with wide polythene sheets in case of untimely rain. The dried bricks are lifted to the loading platform by workers carrying them on their heads up the ramp. Coal from the Talcher coalfields was used for firing the kiln.

The unloading mechanism performed smoothly. The operation started on 24 May 1997 (Fig. 5). It was fired from the bottom using firewood for lighting. The operation continued till 24 June 1997 when it was shut down for the rainy season. It produced 269 batches amounting to about 80 000 bricks. Various campaigns with clays from different areas of the brickfield and also from a nearby BTK area were tried. The bricks from the BTK clay were of good colour, ring and strength. The bricks from the local clay were not so good, but with clay from some other areas were better than bricks produced in local clamps. The overall breakage rate was about 4 to 5 %.

Fig. 2: View showing flue details

3 firemasters and 12 firemen from Gram Vikas were trained in operation. DA firemaster and supervisor participated in this and the training of the Gram Vikas staff. The Chinese expert and the technician provided valuable support in the training.

Monitoring

The energy consumption and efficiency were evaluated by the TERI team which conducted an energy audit in May 1997. The audit confirms the energy efficiency of the VSBK technology with an average specific energy consumption of 0.833 MJ/kg of fired brick.

5 Conclusion and further steps

The establishment of the kiln has attracted great attention from the brickmakers and development officials in the area. The energy efficiency and cleaner production in VSBK technology have created an initial impact.

The methodology of setting up pilot units under a technology transfer programme through a partner organisation has been well established and may be replicated for further units.

Support of professionals at various levels of DA, TERI and Gram Vikas, and frequent review and advice from the backstopping consultants, periodic evaluation and guidance from SDC officials have

Typical Operation Details

Size of Bricks:	235 x 110 x 66 mm.
Approx. weight of fired bricks:	3.00 kg.
Internal fuel: Rice Husk per brick:	0.025 kg.
External fuel: Coal per brick:	0.157 kg.
Breakage rate:	4 to 5 %
Specific energy consumption:	0.833 MJ/kg fired brick

Table

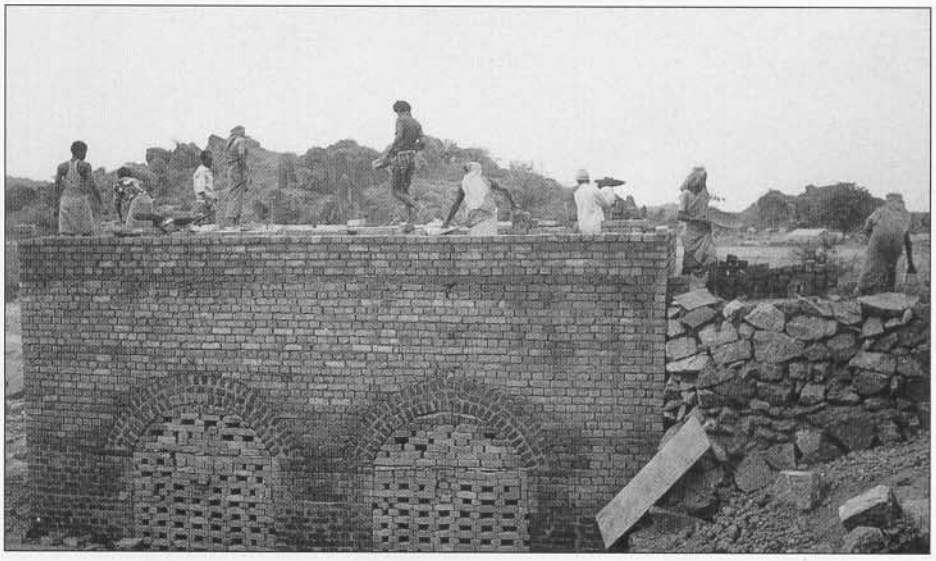

Fig. 3: Kiln construction at the level of the loading platform

Fig. 4: Kiln construction nearing completion May 1997

contributed to the smooth progress of the project.

The "Analysis and Outlook Workshop" of the project held in May - June 1997 led to the consensus that in the next phase VSBK 2 at Kankia will operate on commercial basis. Local operators and firemen will be trained by DA and the partner organisation, Gram Vikas, will be involved in all the aspects. This will allow institutional anchoring of know-how right from the initial stages

The workshop also identified the need to increase the brick production output in VSBK. It was also decided to compile a VSBK technology package with regard to economics, energy, environment, quality and scale of operation for early validation. For further improving the quality of bricks, it was felt that the project should enlarge from just the firing technology to the wider brick production system. The introduction of the extruder system for green brick production was identified for adoption in this regard. The need to anchor the technology in a different mode - through a well established commercial organisation was also recognised. One such organisation, Comtrust, in south India which has more than 150 years experience in clay products production and is a pioneer and leading maker of fired clay roof tiles was selected as the partner for setting up VSBK 3.

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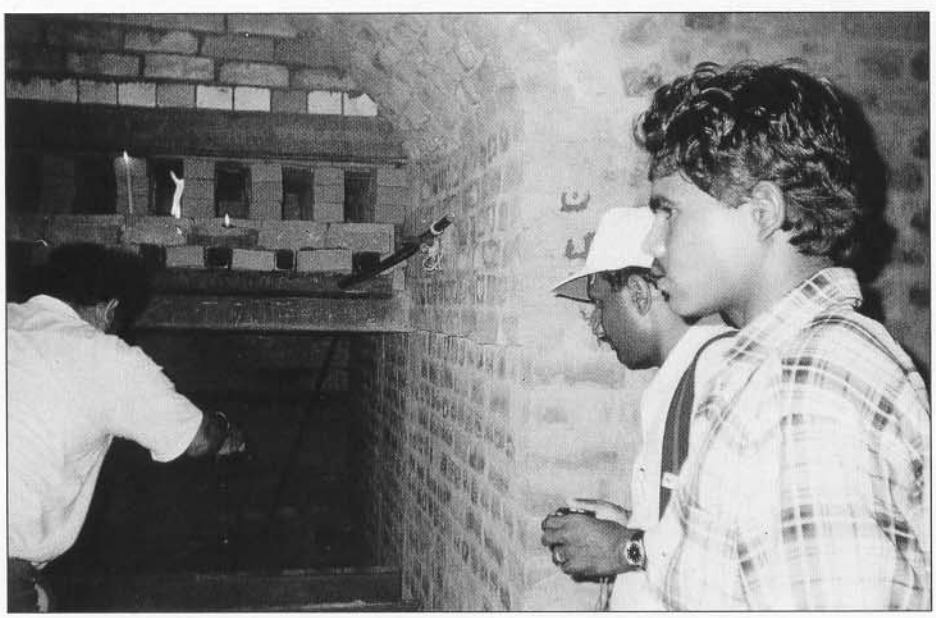

Fig. 5: Start of firing the kiln in May 1997.

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What is basin?

The building advisory service and information network (**basin**) - of which GATE/GTZ is one of the founding members - was set up in 1988 to provide information and advice on appropriate building technology and to create links with know-how resources in the world for all those in need of relevant information.

basin attaches importance to giving individual specialised support to its clients whilst balancing this with the comprehensive view that comes from the long and diverse experience of its partner organisations.

basin porvides a comprehensive range of expertise, experience, knowledge and skills for the support of new initiatives in the low-cost building sector.

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Wall Building

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The Vertical Shaft Brick Kiln: A Problematic Introduction into Pakistan

Introduction

This is a case study of a technology transfer and focuses on how it was conducted in Pakistan between 1993 and 1996. It is not really a success story and because of this is worth telling. There are many lessons that already have, and are still to be learnt from a technology transfer such as this. Poor project management and a lack of technical expertise combined with no initial knowledge of the prevailing brick production and firing technologies, all played a part in the problems connected with this transfer. It was also never monitored or evaluated. This could have redirected the technology away from what became a confrontation between the new and old brick firing methods in the country.

The vertical shaft brick kiln

The vertical shaft brick kiln (vsbk) represents a relatively low cost, energy efficient, low pollution method of firing bricks.

With the global focus on energy efficiency and more environmentally friendly industries, the vsbk is an ideal technology for global dissemination. This is especially relevant when the technology used to fire bricks in most developing countries from the environmental and fuel efficiency standpoint still leaves a lot to be desired.

The technology that was transferred is not a new one, though it is quite revolutionary in that no one had thought of firing bricks in this way before. It was developed in China in the late 60s during the cultural revolution or "great step forward". It was a period when the cities of China were emptied of people who were sent to the countryside to work on the farms, or to labour on large construction projects. There was a great demand for fired bricks in the rural areas and this brought about the development of the vsbk. The kiln is ideal for the widespread small scale (4,000 to 7,500 bricks per 24hrs) brick production and is to be found in China usually on the edges of agricultural land near a canal or river.

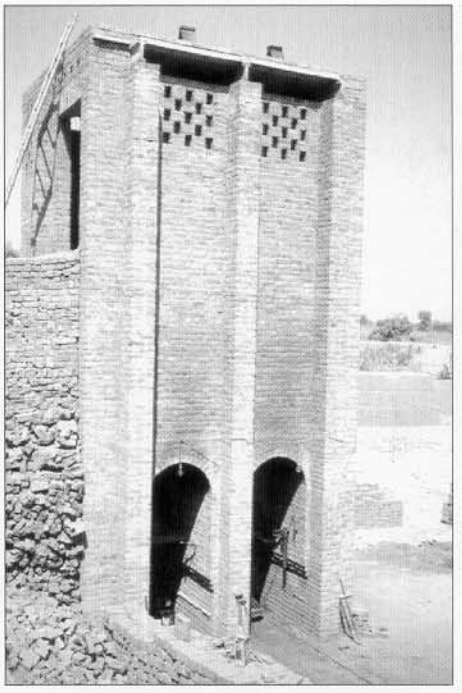

Figure 1 The first prototype vsbk built in Peshawar

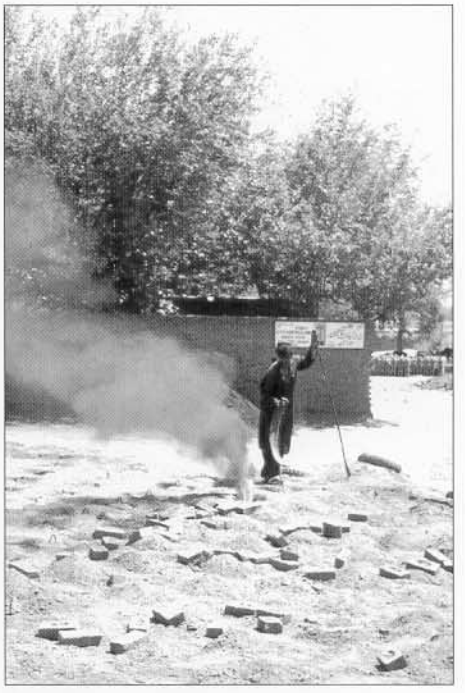

Figure 2 Fuelling a large Btk with rubber (old tyres)

The vsbk is similar in principal to a lime kiln, where limestone and coal are loaded into the top of a shaft, and ash and lime are removed from the base. In the vsbk green bricks and coal are loaded at the top of a rectangular shaft and fired bricks removed at the base. Temperature in the shaft is controlled by the amount of fuel added and the speed at which the fired bricks are removed. It is a simple efficient process and there are tens of thousands of this type of kiln currently operating in the rural areas of China. Many more are presently being built each year to meet the large demand for building materials during the country's current "free market" expansion. (For more information on the vsbk, refer to "The Vertical Shaft Brick Kiln", 1995, Technical Brief of this Wall Building Series).

Firing bricks in Pakistan

Pakistan produces more bricks per head of the population than any other country in Asia. It was, therefore, an ideal choice for the introduction of a brick firing technology that is so successful in China.

Peshawar in the North West Province of Pakistan, because of its low annual rainfall and large deposits of clay, is surrounded by brick producers supplying the Northern areas of the country. In Pakistan the bricks are handmade by slop moulding, then sun dried and traditionally fired in a Bull's trench kiln (Btk). This kiln was developed in 1873 by a Mr Bull near Delhi in India. It is a low cost version of the Hoffmann kiln that was used extensively in Europe at the time. The Btk can be built in a variety of sizes and configurations to produce from 7,000 to 28,000 bricks a day. (Ref.: Technical Brief "Bull's Trench Brick Kiln", 1995).

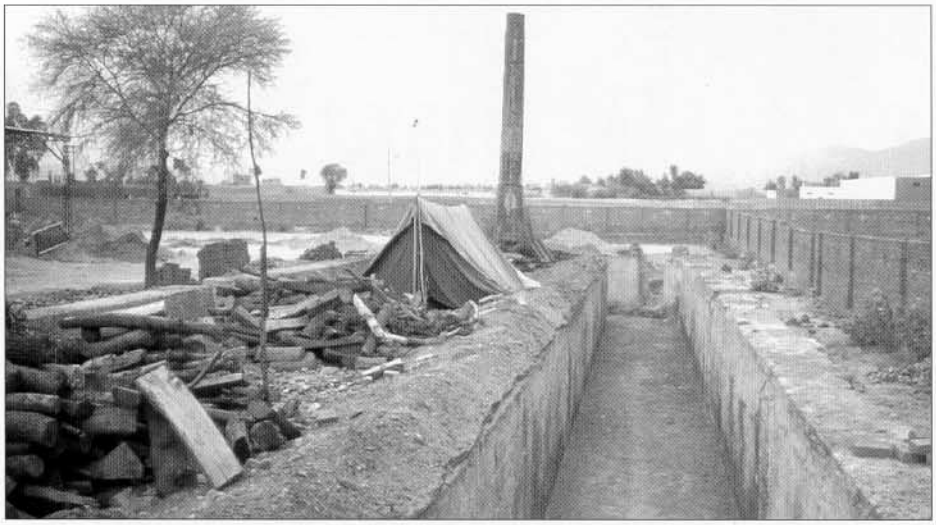

Figure 3 A small single chimney Bull's trench kiln

Its advantages are that it is relatively simple and cheap to build especially when its large firing capacity is fully utilized to obtain the economies of scale. All loading and unloading unlike the vsbk can be conducted during the day with only the firemaster and his crew remaining to stoke the kiln during the night. It is a tried and tested technology and despite its drawbacks its operation and the bricks it produces have been the accepted norm in Pakistan for over 100 years. Disadvantages are that the Btk burns large quantities of wood and also rubber in the form of old tyres and also used engine oil. The wood, which is becoming an increasingly scarce resource, is used to move the fire through the bricks as it provides a long flame length. The rubber and oil are used as a cheap fuel substitute to boost the low heating power of poor quality coal. The Btk can run without the rubber and oil on the superior qualities of coal that are available, but this is more expensive. At the moment in Pakistan the prevention of air pollution by industries such as brick making is, despite being on the statute books not enforced.

The Btk though is not very efficient as a considerable amount of heat is lost through the roof and walls and floor of the firing chamber as the fire moves through the kiln. This type of kiln takes up a lot of space which is now becoming more of a problem. Smaller models of the Btk use one or two metal chimneys which are manually moved along the kiln as the firing progresses, these chimneys are expensive and are replaced every 3 to 5 months as they quickly burn out. Otherwise construction and maintenance costs are low. It is not difficult to run a Btk badly by over stoking, and unfortunately most of them around Peshawar are. Where this is the case, profits drop as brick wastage increases, and the air pollution from an excess of poorly combusting fuel becomes horrendous.

The introduction of the vsbk

It was in competition to the Btk that the vsbk was introduced into Pakistan in Peshawar in 1991. Things did not go well for the vsbk from the start. Three Chinese engineers from the Energy Research Institute Henan came to build the prototype kiln. For some reason they built an older design that had prior to their arrival in Pakistan already been improved upon in China.

The latest model developed in China has a larger firing shaft and is both more energy efficient and economical as it produces more bricks with less fuel for a lower initial outlay. Unfortunately the Chinese engineers also spent too short a time in Pakistan, leaving soon after constructing and running the kiln for only a few weeks. This turned out to be a mistake and was due to the overconfidence of the local brickmakers, and their desire to have control of the kiln as soon as possible, coupled with the decision of the management to save money by returning the Chinese as early as possible.

The project was therefore left with an older type kiln, that had been run for too short a time and some partially trained local brickmakers. The kiln was then run for several short periods over a couple of years. There were continual staff changes during this time, so no experienced kiln management or operating team was established. Apart from a very short period, when external consultants managed the kiln, it never came near expectations. The kiln was very difficult to control, producing a high percentage of overfired, underfired or broken bricks. This was due to the poor and inconsistent management, lack of any in-house technical know-how, and the wrong kiln operating technique. This as well as the low quality of the coal and the poorly handmade bricks resulted in big problems.

Despite the obvious operational failure of the first vsbk, a dissemination programme was instigated without a prior evaluation and another 4 vsbks were built around Peshawar. Although these kilns were expensive to build and failed to work properly, the dissemination went on. But it had already become obvious that the vsbk was not an economical proposition for the local brickmakers, when compared with the existing Btks.

Why the vsbk technology did not transfer

In China the kiln is used by small scale entrepreneurs who produce up to 7,500 bricks a day, usually as an addition to their farming activities. The vsbk was designed to replace the old brick clamps and very simple intermittent updraught kilns found in the rural areas. It was never designed to replace the large Hoffmann kilns built on the outskirts of major Chinese cities or the Btks of Pakistan, where the daily yield is far higher (Ref.: Technical Brief "Hoffmann Kilns", 1995).

The clay in the areas where the vsbks are used in China is of a very good quality for producing bricks. It comes straight out of the ground and is fed into small portable diesel brick extruders. There is no souring, no mixing, no crushing, and no sand or grog added. If any additional water is required, it is dripped onto the clay and mixed in the extruder. The size of the bricks produced are smaller than those in Pakistan, requiring less firing time. All the green bricks are smooth and regular in size, of even consistency and a lot stronger than those found in Peshawar. This also applies to the bricks used in the vsbk now being introduced into India, which are also handmade, but to a much higher standard. Chinese coal is of a much better quality than that found in Pakistan and the coal fines can be purchased for less than lump coal, so the extra expense of crushing the coal is not required.

In Peshawar the quality of fired bricks is poor. This is because the clays available are not very pure, containing stones and other impurities, such as limestone. Also the method of manufacture does not help. The clay is not mixed correctly, is not allowed to stand long enough and the majority of stones and dry clay lumps are not removed. Too much sand is used to release the bricks from the mould and this gets unevenly mixed into the bricks, making them weaker. The result is a low quality often unevenly dried and shaped green brick. The coal is of poor quality containing as much as 25% impurities in the form of stones and clay soil.

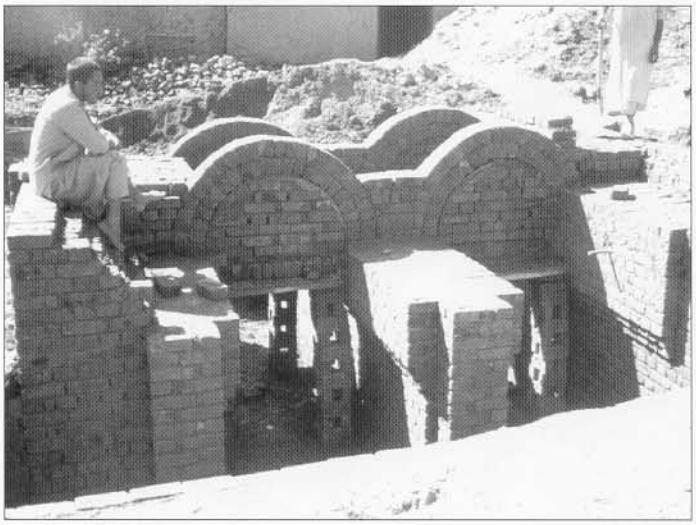

Figure 4 Construction of the third prototype vsbk in Peshawar

Figure 5 The fourth prototype vsbk in operation

To build a four shafted vsbk capable of producing the 7,000+ bricks a day that a small Btk is capable of would cost 50% more than the equivalent Btk. This is due to the extra cost of the supporting iron work, trollies, rails, screw jacks or chain pulley blocks needed. A very skilled and therefore more expensive mason is required to build a vsbk as the construction has to be accurate, or problems within the firing shaft will be experienced.

Despite the poor coal and quality of green bricks they are still successfully fired in the Btk resulting in an 8 to 10% breakage. In a Btk the bricks are fired a lot more slowly taking days rather than hours. In the vsbk the bricks are stacked a lot higher than in the Btk, this is not a problem with the superior green bricks made in China, Nepal and India, but in Peshawar the vsbk breakage rate never fell below 12%, with far too many bricks being underfired.

The breakage rate and underfiring was considerably reduced and the uneven firing corrected on a research and development vsbk built in Peshawar with ODA funding after the problems which occurred in the 5 previous kilns. The main technical problems were sorted out and the kiln ran well.

However, the vsbk is still not an economical proposition when put in competition with the Btk in Pakistan under present conditions. The construction costs are higher for the equivalent yield and this outweighs the fuel savings.

If the air pollution in Peshawar is to be reduced and the laws enforced, it would mean that 4 or 6 shafted vsbks would be an option. The trouble is that, apart from reports from Herat in Afghanistan that five 6 shafted vsbks are being successfully used to replace brick clamps, the vsbk has never been developed for the large scale production of bricks. If the Btks were ever phased out for a less polluting and more economical kiln in Pakistan, the vsbk would then become an option if it was scaled up. At the moment it remains a fuel efficient and less polluting technology, highly suitable for replacing brick clamps in the small scale production of bricks, especially in rural areas.

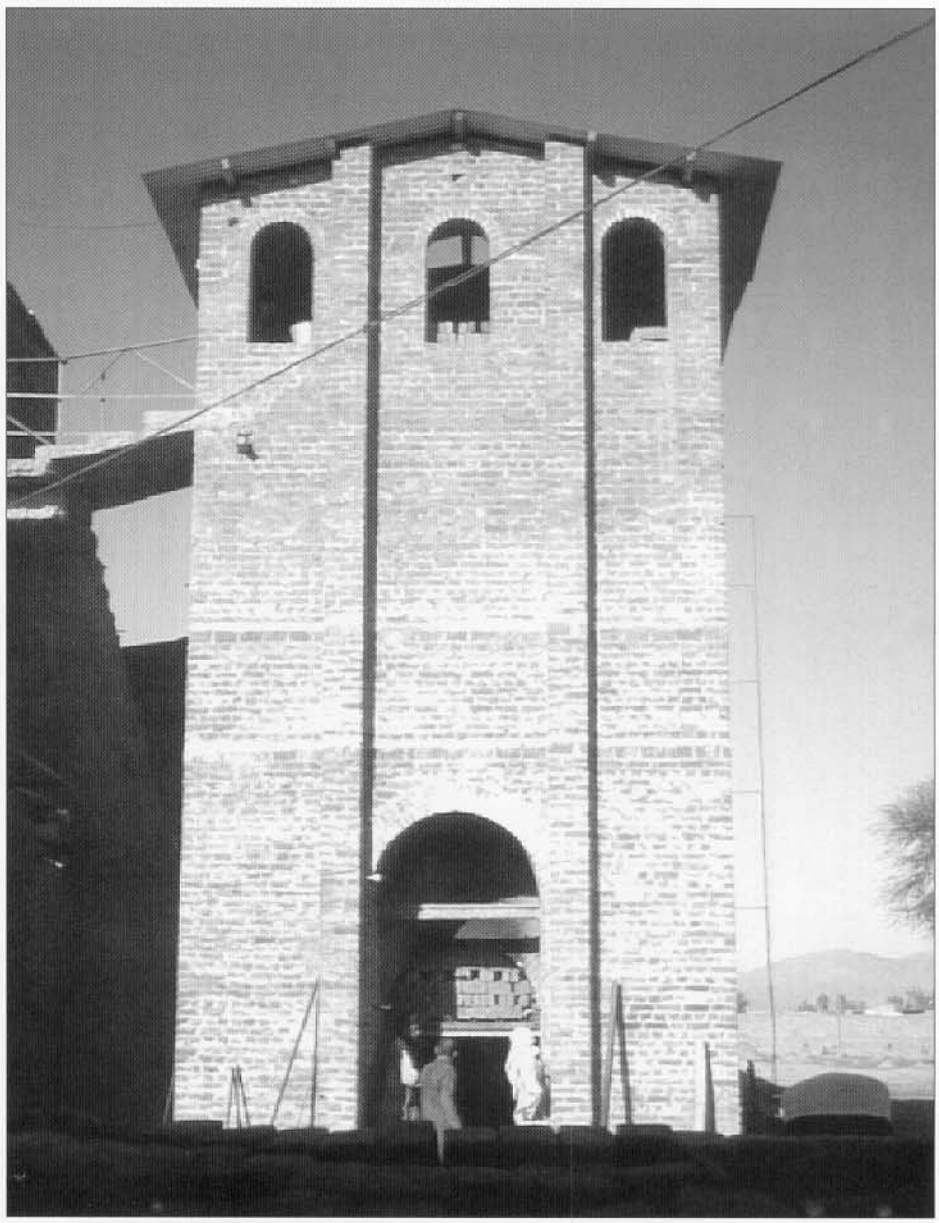

Figure 6 The research and development vertical shaft brick kiln built in Peshawar with ODA funding

What are the problems with this technology transfer

1. The first model of vsbk built in Pakistan was not the latest developed in China.

2. The Chinese engineers did not stay long enough to run the kiln correctly or to complete the necessary training required for a successful hand-over.

3. The problems with the kiln's operation and output were never satisfactorily solved before dissemination.

4. Continual staff changes meant that an experienced dissemination team was never established.

5. Failure to fully evaluate the Btk when compared with the vsbk early on. The vsbk was never designed to replace the Btk. It does not have the daily capacity in its present form and is more expensive to build.

6. Informing the local Brick Makers Association that all the Btks had to be replaced with vsbks as soon as possible caused a lot of bad feeling, resulting in the brickmakers' reluctance to accept the vsbk.

The vsbk technology now has a rather poor reputation in Pakistan. The opportunity for a better planned and executed vsbk introduction has not been used.

Lessons learnt

Despite the problems experienced in Pakistan, the lessons learnt there have contributed to the kilns recent successful introduction into India. There the Chinese engineers and firemaster spent six months building the latest model of vsbk, and fully trained the Indians to operate it. The efficiency of the kiln is up to and in some cases beyond expectations. The pollution produced by the kiln is very low and work is being done to reduce it still further. Brick breakage is down to acceptable and economic levels, and the bricks produced are highly marketable. The kiln is being aimed at small scale brick entrepreneurs, who are currently using brick clamps or scove kilns, not Btks. There is no question of disseminating the vsbk technology until a second kiln has been built and tested under differing conditions in another area.

The technology transfer into Pakistan was problematic but the vsbk technology moves on. There are plans for its introduction into Bangladesh and Zimbabwe which will benefit greatly from the Pakistan experience. The technology involved in a technology transfer will not be successfully adopted in isolation. Careful planning and sensitive management, combined with suitable technical know-how, are also vital for sustainability of the technology.

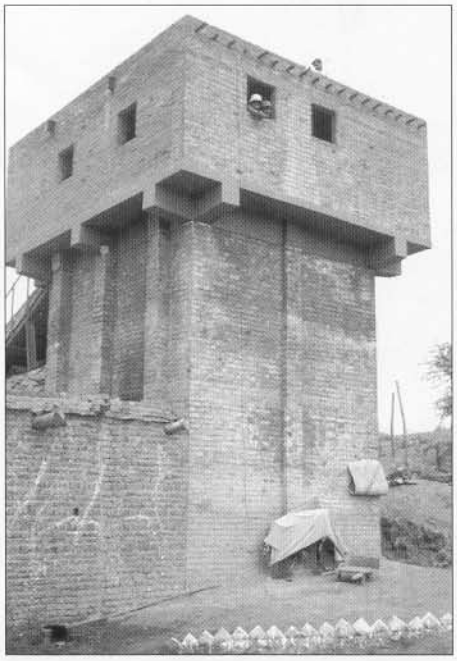

Figure 7 The second prototype vsbk built in Peshawar

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