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Workshop on Co-operation among Developing Countries in the field of Cement, Lime and Related Industries

Bangkok, Thailand, 23 - 27 February 1987

REPORT *

Prepared by the

United Nations Industrial Development Organization

in co-operation with the

Thailand Institute of Scientific and Technological Research (TISTR)

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I. INTRODUCTION

The Workshop on Co-operation among Developing Countires in the Field of Cement, Lime and Related Industries (Bangkok, Thailand, 23 - 27 February 1987) was organized by the United Nations Industrial Development Organization (UNIDO) and the Thailand Institute of Scientific and Technological Research (TISTR) in co-operation with the Department of Technical and Economic Co-operation (DTEC) and the Thailand Fellowship of Cement Manufacturers (TFCM).

With the overall objective to promote a balanced development of cement, lime and related industries in the developing countries through strengthening of co-operation among themselves in this area, the workshop concentrated on three major aspects:

- to review appropriate technologies for the development of cement, lime and related industries through co-operation among the developing countries;

- to review and exchange experience and information on the progress made in the development of small-scale cement industries, the planning and the development of lime industries, the production techniques and performance of rice-husk ash cements, the small-scale clay bricks and roofing tiles production as well as the role of building codes and standard specifications for development, and

- to elaborate concrete programmes and projects on co-operation among the participating developing countries in the above specific areas.

The workshop was attended by participants from Bhutan, Botswana, China, Egypt, Ethiopia, India, Indonesia, Japan, Jordan, Nepal, Pakistan, Papua New Guinea, Sri Lanka, Thailand and Turkey (see Annex I - List of Participants).

II. ORGANIZATION OF THE MEETING

The members of the workshop elected the following officers:

Chairman: Dr. Smith Kampempool (Thailand)

Vice-Chairman: Mr. Pratopo Soemitro (Indonesia)

Rapporteurs: Mr. Yavuz Bayar (Turkey)
Mr. Hashmat Qureshi (Pakistan)

The agenda of the workshop is attached as Annex II.

The list of documents presented at the workshop by the host country, the participants and UNIDO, is attached as Annex III.

III. SUMMARY OF PRESENTATIONS AND DISCUSSIONS

1. Opening Session

In his introductory report, the Governor of TISTR expressed his appreciation for the support received by the co-sponsoring organizations DTEC and TFCM in organising this workshop. He then outlined the background and objectives of the workshop, emphasizing the need for developing sound building materials industries in developing and least developed countries. Since the development of these industries was handicapped by many factors, international support and co-operation with other developing countries offered the appropriate frame for such development. The workshop would therefore concentrate on strengthening co-operation by reviewing appropriate technologies, on exchanging experiences and information and on elaborating concrete programme and projects for co-operation among the participating developing countries. Benefiting from experiences in established cement industries would help to diversify into lime and related industries and open up possibilities for down-stream development of lime-based industries. He finally reaffirmed the hope that the workshop would result in close co-operation and concrete agreements.

The workshop was then officially opened by H.E. Dr. Bhichit Rattakul, Deputy Minister of Science, Technology and Energy of the Royal Thai Government. He emphasized the importance of building materials industries and the crucial role of cement, lime and related industries in the construction industries. He fully supported the workshop's focus and objectives and expressed the hope that the workshop would not only encourage co-operation in the field of cement, lime and related industries, but also increase the awareness of the need to eliminate political and technical obstacles in other building materials industries. Expressing his appreciation for the continued interest of UNIDO, DTEC, TFCM and TISTR in strengthening co-operation among the developing countries, he declared the workshop open.

The delegate from UNIDO, representing the programme of economic and technical co-operation among developing countries, thanked the Royal Thai Government as well as DTEC, TFCM and TISTR for hosting and sponsoring the workshop. She underlined the need for developing sound building material industries as one of the pre-conditions for promoting employment and social welfare in the developing countries. Aware of the need for international support, UNIDO promoted improved capacity utilization of existing installations, the establishment of new industries, and the training of technicians and other personnel. Traditional technical assistance activities could be expanded by identifying additional technical resources in other developing countries. She underlined the importance of the workshop's objectives and expressed the hope that the deliberations would lead to concrete recommendations and agreements on future programmes and projects. UNIDO also had recently provided increased support to industrial development through trust fund arrangements, of which some of the most successful ones concerned the establishment and operation of cement plants. A cement training programme under trust fund arrangements was scheduled in 1987. It was hoped that this type of assistance could be incorporated into some of the agreements expected from the workshop. She finally underlined the five guiding principles considered by UNIDO as essential prerequisites for successful economic and technical co-operation among developing countries: solidarity and mutual assistance, equality and mutual benefit, stress on practical results, diversity in forms of co-operation and orientation towards concrete action and projects.

2. UNIDO activities for the development of construction and building materials industries

The UNIDO representative emphasized that UNIDO is a non-profit making organization established by governments to support the industrial development in developing countries. With the help of experts and companies, UNIDO is in fact functioning like a very large engineering consulting company.

Besides direct technical assistance to the development of industry, UNIDO also organizes supporting activities to discuss ways and means for promoting industry. UNIDO activities are normally described in project documents. It was also explained how a project was developed through project formulation and implementation and how follow-up activities could lead to continued UNIDO engagement.

Among the subjects dealt with in UNIDO projects, the following typical activities were mentioned: trouble shooting, feasibility studies, resource verification, rehabilitation, capacity utilization, performance monitoring and training.

It was further explained how some industrial projects could run into a vicious circle of deteriorating performance with increasing need for loans, resulting in the closing of a plant, sometimes only caused by weak performance monitoring. On the other side, a virtuous circle of progress and development can be promoted with performance control and monitoring and a well-developed capacity utilization. UNIDO plays a very active role in supporting industrial development in developing countries for which funding is mobilized from a variety of sources such as UNDP/IPF, UNIDO/UNIDF and UNIDO Trust Funds (third party or self-financing schemes).

3. UNIDO-TCDC activities in the developing countries

The UNIDO representative explained the concept of TCDC and the criteria distinguishing this programme from "traditional" forms of technical co-operation, and stressed the importance of the five guiding principles, as already outlined above. UNIDO's TCDC activities can be grouped into two major programme elements:

(a) The development of projects for industrial co-operation among developing countries, consisting of the following specific activities:

- Solidarity Ministerial Meetings for co-operation among developing countries, with the objective to assist in implementing industrial development projects in specific least developed countries through co-operation by the more advanced among the developing countries;
- Round-Table Ministerial and High-Level Meetings for promoting the co-operation in specific industrial sub-sectors on the basis of equality and mutual benefit;
- Technical workshops, seminars, advisory services, study tours, training and other joint industrial programmes, carried out on the basis of either requests from Governments or initiatives by the UNIDO Secretariat.

(b) The identification of new forms and new institutional machinery for industrial co-operation, consisting at present of two major programmes:

- the promotion of enterprise-to-enterprise co-operation among developing countries, and
- the establishment of multinational production enterprises in developing countries.

UNIDO's criteria and resources for the implementation of ECDC/TCDC projects were also explained.

Finally, it was pointed out that priority areas for ECDC/TCDC in the field of industry, and in particular in the cement and lime industry, were: development and transfer of technology, training of personnel, management and consultancy, and comprehensive industrial co-operation, covering all arrangements for the joint development of new or existing industrial projects.

The UNIDO representative then proceeded to explain the scope and advantages of self-financed trust fund schemes for direct technical and managerial support to industrial plants for increased capacity utilization, performance improvement and revitalization of existing industries.

4. TISTR - Study of the lime industry in selected developing countries

The TISTR representative emphasized that - sponsored by UNIDO - he himself had visited India and Indonesia with the Director of TISTR's Buidling Technology Department, in order to study the lime industries in these two countries and also to compare them with the one in Thailand. Unfortunately, the team had been unable to visit a lime factory with vertical shaft kilns in India due to restrictions imposed by the enterprise. However, a visit could be arranged to a small village where a 4 m^3-capacity lime kiln was located. It was further learned that several vertical shaft kilns, with capacities of 5, 10 and 15 tons/day of lime, designed by the Central Building Research Institute (CBRI) in Roorkee, had been well commercialized in many parts of the country.

In Indonesia, the team visited lime factories in 3 different locations near Bandung, with co-operative arrangements made by the Institute of Human Settlement. Each factory utilized different kinds of fuel, i.e. wood, natural gas and waste oil. It was found that the kilns utilizing natural gas could produce quicklime and slaked lime at lowest costs.

In Thailand, lime kilns are manually operated, utilizing wood and lignite as fuel. Most of the lime factories are located in Saraburi and Ratchaburi where limestone deposits are available in abundance. Furthermore, in resort areas like Chonburi, coral can be used as raw material for lime production. The lime factory in Saraburi sells quicklime at a price of US$ 50/ton, which is almost equivalent to the price of cement. Quicklime is used mostly for paper industry, as well as steel and sugar industry (ratio 6:1:1). A 65-ton-capacity lime kiln requires a capital investment of US$ 10,000.

In comparison to India and Thailand, the traditional lime kilns in Indonesia appear to provide the best output performance.

5. CHINA - The present situation and prospects of mini-cement plants in China

In China, a cement plant with an annual capacity of less than 200,000 tons is considered a mini-cement plant. There are about 5,000 mini-cement plants in China with a total production capacity of approximately 130 million tons/year (80% of the country's total production). 4 different types of mini-cement plants are in operation:

1. Primitive shaft kilns - the annual capacity varies from several thousand tons to 30,000 tons. There are about 3,800 mini-cement plants of this type operated in China with a total annual production of approximately 60 million tons.

2. Mechanical shaft kilns - the annual capacity ranges from 30,000 to 200,000 tons; 1,200 mini-cement plants of this type have been put into operation, with a total annual production of approximately 60 million tons.

3. Small rotary kilns (dry process without preheater) - the capacity of this type of mini-cement plant ranges from 50,000 to 100,000 tons/year. There are 150 - 200 plants of this type operated in China, with a total annual production of approximately 10 million tons.

4. Small rotary kilns with shaft preheater or cyclone preheater or precalciner - operating with 3 different capacities, i.e. 170, 400 and 700 tons/day.

It is planned that the second and fourth type of kilns will continuously be developed and installed and assume a major part (over 80%) of the country's total mini-cement production within the next 5-year-plan (1991 - 1996).

The delegate from China then recommended 4 types of mini-cement plants for the choice by the participants:

1. Mechanical shaft kiln: capacity 100 - 150 tons/day; clinker specific heat consumption 1,000 kCal/kg; cement power consumption 95 - 100 kWh/t; investment costs US$ 2 million (including mechanical and electrical equipment, instrumentation and automation devices).

2. Small rotary kiln with shaft preheater: capacity 170 tons/day; clinker heat consumption 900 - 1,000 kCal/kg; cement power consumption 110 - 120 kWh/t; investment costs US$ 2.5 million.

3. Rotary kiln with suspension preheater or precalciner: capacity 400 tons/day; clinker heat consumption 99 kCal/kg; cement power consumption 120 - 130 kWh/t; investment costs US$ 6 million.

4. Rotary kiln with precalciner: capacity 700 tons/day; clinker heat consumption 900 kCal/kg; cement power consumption 120 - 130 kWh/t; investment costs US$ 10 million.

It was emphasized that the investment figures were rough estimates for reference only.

The delegate from China informed the audience that his country was ready to transfer experiences and technologies to other developing countries in the field of small-scale cement plants, including the supply of complete cement-plants on turn-key basis. It is China's intent to promote technical co-operation among developing countries on the basis of mutual benefit.

6. Small-scale burnt clay bricks and roofing tiles production in Thailand (Chulalongkorn University, Thailand)

Since more than 1000 years, burnt clay bricks and roofing tiles have been produced in Thailand at cottage and small-scale level. At present, approximately 325 manufacturing units, employing a workforce of about 7,000, produce 300 million pieces annually (5 pieces/inhabitant/year). Common bricks are produced at small-scale level, hollow bricks and facing bricks at medium-scale level.

Small-scale manufacturing units use old technologies, only 10 - 18 per cent dispose of modern forming machines. Technology is not advanced, particularly in the drying process. In the firing process, most factories use field kilns, updraft kilns and Taiwan kilns. Thus, the required manufacturing period for manually prepared clay and handmould products is 3 weeks, with a semi-mechanized process 2 weeks.

Raw materials are sufficiently available (plastic clay, mild clay, calcerous clay, ball cla , sand and basic glazing materials). Fuel is obtained from rice husks, wood, oil and natural gas.

Although the prices for local bricks and roofing tiles, compared to cement, are relatively high, the demand of the local product is sufficient to absorb almost fully the production. Furthermore, as resource-based and labour intensive industry, the small-scale bricks and roofing tiles production is given priority and support by the Royal Thai Government. Support services are provided by institutions such as the University and by ministerial departments.

Problems faced by small-scale clay bricks and roofing tiles production units include limited expansion possibilities because of financial constraints, deep-rooted technical problems and lack of quality control, undeveloped and uneconomic drying processes, inefficient firing processes and kilns. In view of these industries' good potential, a long-term strategy should be formulated to provide assistance in relation to production technologies, market development and development of manpower sources.

7. Lightweight building materials from indigenous resources (Dr. Naomichi Hara, Japan)

The presentation concerned co-operative research projects on building materials development among GIRIK (Government Industrial Research Institute, Kyushu, Japan) and ASEAN countries. GIRIK has been involved in co-operative research projects on building materials development in co-operation with Indonesia, Malaysia and Thailand. Two projects are still in progress in Malaysia and Indonesia respectively. Most of the projects are related to lightweight building materials development on the basis of effective use of indigenous resources. The presentation outlined the background and characteristics of research on building materials development at GIRIK and reviewed the progress and achievements of each co-operative project. Particularly, the utilization of rice husk ash for lightweight building materials was detailed along with its future viability and prospects.

The subject of each co-operative project and the counterpart institutes are as follows:

1. Quality improvement of trass-lime blocks by application of steam curing and carbonation process (1974-76), with the Directorate of Building Research, Indonesia;

2. Manufacture of bloated-trass as lightweight filler for building materials (1977-79), with the Directorate of Building Research, Indonesia;

3. Utilization of rice-husk ash for lightweight building materials (1980-82), with the Standards and Industrial Research Institute, Malaysia;

4. Utilization of agro-wastes for building materials (1983-85), with the Thailand Institute of Scientific and Technological Research;

5. Development of unburnt soil-based building materials (1985-87), with the Institute of Human Settlements, Indonesia;

6. Japan-Indonesia technical co-operation project for the development of building materials (pulp cement boards and lightweight aggregates) (1978-83), with the Directorate of Building Research and the Institute for Research and Development of Cellulose Industry, Indonesia;

7. Research and development co-operation on manufacturing of lightweight building materials from rice-husk ash (1985-89), with the Standards and Industrial Research Institute of Malaysia.

It should be noted that the years in parentheses are based on the Japanese fiscal year, which begins in April and ends in March of the following year.

8. Summaries of country monographs

a) BHUTAN

Till 1979, Bhutan, like other developing countries, imported cement at the rate of 80,000 tons/year, although the country possesses rich mineral resources, especially limestone.

The first dry-process cement plant (capacity 300 tons/day) was commissioned in mid-1979 at Penden. Production started in February 1980 with 250 tons/day. Thus, Bhutan could produce enough cement to cover its requirements. After further exploitation of limestone reserves, two units of vertical shaft kilns of 50 tons/day were added to the existing plant. At present, the daily production amounts to 100 per cent against the installed capacity, whereby 50 - 60% of the cement production are exported to neighbouring countries.

The limestone reserves are scattered throughout the country, rendering the establishment of larger plants difficult because of its mountainous nature. In 1986, one more unit of vertical shaft kilns of 30 tons/day was started at Samchi, located 60 km from the Penden Cement Plant. After discovery of another large reserve of limestone at Dungsum in the southeast of the country, the Royal Government decided to establish another cement plant of 1,200 tons/day. The necessary infrastructure is presently under construction and the plant is expected to be commissioned by 1990.

A calcium carbide factory is also planned to be established near Phuntsholing and the rejected limestone from this factory will be utilized for the cement plant in Penden.

Lime industry is still at infant stage. Two lime kilns of 2.5 m diamter and 5.5 m height were established in 1982 with a production of 5 tons/day, using traditional methods. Due to shortage of fuel, s.a. coal, these units produce only 1.5 to 2 tons/day at present.

b) BOTSWANA

Botswana, being almost entirely dependent on imports for its industrially produced buiding materials, has since the 1970's tried to locate new materials suitable to be used to establish locally based industries in the field of cement, lime and related materials.

The consumption of cement and lime in Botswana since 1981 has ranged between 140 - 173.000 tons and 5.000 to 7.600 tons respectively, entirely provided by imports. The local production - 4 tons/day by 2 small lime kilns - is not of significant economic magnitude. These 2 small lime kilns are located in remote areas (Moshaneng and Mmadinare) and represent pilot projects. At Moshaneng portland cement, fly ash and brick rejects are used to produce a pozzolanic type of blended cement, at a daily capacity of 120 - 150 bags of 40 kg each.

The Geological Survey Department is currently engaged in exploring the availability of mineral raw material resources, which could be a basis for the establishment of cement, lime and related mineral industries. Drilling/coring programmes, industrial mineral reviews and general geological field mapping are presently being undertaken.

Several carbonate deposists in the form of limestones, calcides, dolomites, marble, exist in Botswana, but so far none have been identified at sufficient quantity or quality. Those suitable for the production of lime have so far not been developed.

Other related industrial mineral deposits occur in reasonable quantities, but need to be developed, s.a. clay/mudstone and brickearth deposits, even suitable for the production of pottery and roofing tiles. Should these not be developed to provide for the aluminous and silicious components necessary for a cement production plant, fly or coal ash could be used, which are sufficiently available. Gypsum exists in economically viable quantities, but would have to be developed for mining first. Large reserves of bituminous coals, which are currently mined for local consumption, could provide the necessary fuel.

The biggest problems hindering the establishment of industry in Botswana are caused by ignorance and lack of funds. Although there are Government assistance schemes to provide for start-up capital, the prerequisite conditions are difficult to meet and ignorance and poor organizational knowledge usually abort initiatives already at the conception stages.

Should cement industries be established in Botswana, the required technical skills and infrastructural measures could be acquired through co-operation with developing countries (TCDC), where such expertise is already available.

c) CHINA

In 1985, 140 million tons of cement were produced, representing an increase of 13.8% over 1984.

The development of cement industry in China was somewhat different than in other countries. Since China is a developing country covering a vast territory, transport facilities are largely insufficient, but cement is badly needed in rural areas for agricultural uses, for local industries and for construction activities. Locally managed mini-cement plants have

therefore been developed rapidly, their production reached 100 million tons in 1985 (about 80% of total production). However, the large and medium-scale cement plants are still the backbone of the Chinese cement industry. In 1985, China disposed of around 60 large and medium-sized cement plants and more than 5000 mini-cement plants.

At present, the Chinese cement industry faces the following problems:

1. Unbalanced supply and demand, with a shortage of cement supply of about 4 million tons per year;

2. High energy consumption: The average heat consumption in large- and medium-scale cement plants is about 6,000 kJ/kg (1,435 kCal/kg clinker), the reason being that 60% of these plants are wet process plants. There are also about 100 small-sized dry rotary kilns without preheater in mini-cement plants, with an average heat consumption of 7,500 kJ/kg (1,800 kCal/kg clinker);

3. Unreasonable structure of cement varieties: 54.21% of the total production concern ordinary portland cement (with admixtures less than 15%) and pure portland cement (no admixtures), 38.4% concern blast furnace portland cement. Since mini-cement plants produce slag cement in order to match the high free-lime content in the clinker, the production of blast furnace portland cement in large- and medium-scale cement plants had to be reduced, while the production of ordinary and pure portland cement as well as high-strength and rapid-hardening cement had to be increased to meet the requirements of high-strength concrete and special engineering projects;

4. Serious dust pollution: In 1971, investigations in 49 large- and medium-scale cement plants revealed that the amount of dust emitted equals about 10% of the cement produced. Until 1981, the dust emission was reduced by 50% through installation of electrostatic precipitators and big filters, but amounts still to approx. 1.35 million tons annually. Mills, compressors, blowers, etc. cause noise pollution. Toxic emissions, such as CO, SO_2, Nox from cement kilns, are still not being effectively controlled;

5. Obsolete equipment: Some existing cement plants are too old and inefficient. Obsolete equipment should be renewed and instrumentation of existing plants should be upgraded.

The policy for developing Chinese cement industry in coming years will focus on the following priorities: conservation of energy, adoption of advanced technology, and upgrading of the technical level.

In addition to four complete cement plants which were imported from abroad, a cement plant with 2,000 tons/day capacity, using a precalcining process designed in China, will be commissioned in 1987. Several other projects are planned to use this process, which will also be introduced for modernizing existing plants. Wet process kilns will not be allowed, except in special cases. For small cement plants, mechanized shaft kilns will still be used in China in view of their low fuel consumption, but with improvements in construction and operation. Small-size rotary kilns without preheater will be improved to facilitate waste heat recovery.

d) EGYPT

The Egyptian cement industry has developed steadily since 50 years, starting in 1928 with 2 kilns in 2 factories with a capacity of 90,000 tons/year each, using the wet process technology. By 1971, Egypt disposed of 19 kilns in 4 factories with a capacity of 4 million tons/year and became a cement-exporting country. In 1972, the consumption of cement started to show a higher increase than the production and Egypt began to import cement.

In 1974, the Government of Egypt - with foreign assistance - started to collect scientific data and information to find a solution to this problem. A company was established to provide services to existing cement factories as well as technical contributions to factories to be established in the future.

In 1984, five kilns went into operation in Egypt with an estimated production of 6.5 million tons/year. Since 5 years, cement production has shown a rapid increase, so that cement imports in 1987 are expected to be reduced from 8 to 5 million tons. By 1990, an annual cement production of 20 million tons is envisaged.

Egyptian cement plants produce all types of cement and use fuel oil and natural gas for firing. The raw materials are basically of calcareous and argillaceous sources, with an addition of pyrite ash and sand.

e) ETHIOPIA

At present, there are four cement manufacturing plants run by the Ethiopian Cement Corporation, with installed capacities of 40,000, twice 70,000 and 300,000 tons/year respectively. Except the Mugher Cement Plant which started operation in July 1984, the others have been operating since over 20 years. The plant at Dire Dawa is about 50 years old and the only one producing lime (about 3,000 tons/year). It is also planned to increase the capacity of one existing plant to 600,000 tons/year and to establish a new plant with a capacity of 600,000 tons/year.

Over the period 1974 - 1986, the domestic production and imports of cement and lime in Ethiopia increased from 179,000 tons/year to 277,000 tons/year.

The first cement factory in Ethiopia, i.e. the Dire Dawa Cement and Lime Plant, was established in 1936 and is the smallest in the country with a designed capacity of 20,000 tons/year, using ground coal as fuel. A change in fuel from coal to furnace oil increased the capacity to 40,000 tons/year. A semi-dry technology with satellite coolers is used for clinker processing. A rotary kiln is used to produce clinker as well as quick lime.

The Addis Ababa and the Eritrea cement factory each apply similar processing technologies, whereby in Addis Ababa a suspension preheater and comparatively shorter kiln are used, while in Eritrea the kiln is fed cold meal and the increased kiln length serves as preheater and calciner. Grate coolers are used for clinker cooling in both plants.

The Mugher Cement Factory is the most modern among the four plants. The raw material store is equipped with stackers and bridge reclaimers. The kiln is facilitated with a suspension preheater like in Addis Ababa. A rotary cooler is used for cooling the clinker.

At present, Ethiopia's per capita consumption of cement, lime and other building materials is extremely low, even compared to other developing countries, which is a clear indicator for the country's low level of development and very low level of construction activities. However, an increase in demand for the products is anticipated due to expected increased activities in the construction industry sector.

Employees are trained either abroad or on the job, depending on the level of skill requirements and the field of training. However, the Industrial Projects Service (IPS), a Government organization administered by the Ministry of Industry, plans to provide training to experts from other developing countries in the preparation of feasibility studies. The Ethiopian Institute of Geological Surveys, responsible for undertaking mineral raw materials studies / investigations in the country, is capable of providing laboratory facilities for chemical and mineralogical analysis for other developing countries.

f) INDIA

The cement industry in India, which has shown an unprecedented growth, is poised to have an installed capacity of 64 million tons/year by 1990 and a targeted capacity of 100 million tons/year by the year 2000. At present, the Indian cement industry comprises over 140 small and large plants using rotary kiln technology and 85 plants using vertical shaft kiln technology. Due to the successful operation of many cement plants in different parts of the country, a large number of small-scale entrepreneurs has started to operate cement plants based on modern vertical shaft technology.

The cement manufacturing process involves the use of cement grade limestone, gypsum, clay, other corrective materials and low volatile fuel, with variations depending on the applied technology.

The CRI-MVSK technology, which was developed in India by the Cement Research Institute (CRI) of the National Council for Cement and Building Materials (NCB) in 1974 through pilot plant studies, was transferred to the cement industry through licensing of machinery manufacturers in different parts of the country, who supply machinery and establish such plants on a turn-key basis. There are 18 such machinery manufacturers licensed at present. They offer the necessary performance guarantees for such plants with support from the NCB, which also assists the entrepreneurs through these machinery manufacturers from the conception of a plant to its commissioning including training of personnel, inspection of major plants and machinery, assistance in setting up of quality control laboratories, supervision and assistance of machinery manufacturers for commissioning and post operative technical services. Since NCB offers the process guarantees, it is mandatory for entrepreneurs to obtain the project report, including geological and raw material investigations and the raw mix design report, from NCB only. To provide the necessary technical help to an entrepreneur even after the commissioning of the plant, NCB has established a technical services (operational) programme, through which it assists operating plants in improving their total factor productivity.

g) INDONESIA

Indonesia's experience shows that the development of cement and lime industries depends on the inventory of raw material resources, laboratory tests and research, and qualified personnel for planning, implementing and operating cement and lime industries.

In 1945, there was only one state-owned cement plant with a capacity of 150,000 tons/year. Subsequently, two other state-owned plants were built and later expanded; thus in 1974 the three state-owned cement palnts had reached an installed capacity of 350,000 tons/year and a real production of 825,000 tons/year of cement (87.3%).

Starting with the 1st Five Year Development Programme, which was launched in 1969, the Government of Indonesia has laid down the basic requisites for its development, s.a. investment law, mining regulations, industrial and trade regulations, rehabilitation of existing industries as well as creation of new policies on industry to enable foreign investors to join the national development.

Since then, Indonesia has encouraged the establishment of public-owned cement plants. The country now disposes of 10 cement plants, including one mini-cement plant, with a capacity of 2 X 60,000 tons/year. The total installed capacity in 1987 amounts to 17.41 million tons/year, against a national cement consumption of 11.10 million tons in 1986, so that a spare capacity of 6.31 million tons/year exists. About 2.1 million tons of cement were exported in 1986. For 1987, the cement consumption is estimated at 67.3 kg per capita. Cement consumption is expected to increase, since larger construction programmes are planned in the 4th Development Programme.

Regulations for building materials have been established in the Indonesian Industrial Standard, among others for hydraulic binding materials, s.a. portland cement, portland pozzolan cement, pozzolan lime cement; clay and cement based building material products standards were also established. Portland cement has been mandatorily introduced through certification marking schemes. Since several types of hydraulic binding materials are available, the least developed countries should select appropriate binding materials in accordance with their existing resources and capabilities.

In Indonesia, building materials made from cement are steadily increasing. The conclusion can be drawn that raw material resources, cement technology, engineering and the needed cement expertise, research and development facilities as well as the market for cement in Indonesia are well developed, with the exception of manufacturing cement production machinery.

Indonesian small- and medium-scale lime industries have developed steadily. Vertical/shaft lime kilns with improved appropriate technology, with capacity varying from 2 to 10 tons/day and continuous firing, have been developed and applied besides the operation of traditional periodic shaft kilns. The Ceramic Research and Development Institute (CRDI) under the Ministry of Industry has succeded to design and construct continuously operating shaft kilns for firing calcine or dolomitic lime, with a capacity of 10 tons/day. About 3,636 small- and medium-scale production units are spread over the country with a total production capacity of 685,000 tons/year quick lime, valued at Rp 37.3 billion (US$ 22.6 million equivalent), which provide 28,279 labour opportunities. This indicates that the promotion of labour-intensive lime industry is a policy of the Government of Indonesia. Small-scale lime industries cannot afford the high cost of investment for modern technology kilns and still prefer the appropriate technology of shaft lime kilns.

The establishment of an environment law in 1986, which will become effective in July 1987, creates a new market opportunity for lime. All industrial waste water will have to be neutralised before disposal. Lime products will then play an important role for low-cost housing construction. Several lime based building materials quality standards have also been developed.

In view of the potential and experiences of CRDI, strengthened previously by UNIDO/UNDP technical assistance, TCDC training programmes for technicians, operators, supervisors or managers of lime, building materials and ceramic industries from developing countries are offered by CRDI, which would have to be financed by UNIDO/UNDP. The curricula of TCDC training programmes in ceramic engineering, manufacturing of lime and of structural clay building materials, which have been conducted by CRDI during the last 5 years, were provided to the participants.

h) JORDAN

The cement industry in Jordan dates back to 1951 when the Jordan Cement Factories Co. was established as a shareholding company owned by both public and private sector. Caused by the rapid economic and social development of the country during the last decade, the domestic demand for cement and building materials has increased drastically, accompanied by an equally rapid expansion of building materials production. To control the quality of building materials, the Government issued and enforced appropriate national standards and adopted active quality control measures to monitor the quality of building materials.

The South Cement Co., established in 1980 with the objective of producing 2 million tons of cement/year for export, was recently merged with the Jordan Cement Factories Co. As a result, the installed capacity of the merger Co. became 4 million tons of cement/year. Currently, the domestic consumption of cement amounts to 1.6 million tons/year, i.e. 40% of the installed capacity. About 100,000 tons/year are exported to Saudi Arabia and recently a contract for exporting up to 1 million tons/year of cement to Egypt has been concluded.

The quality of concrete in Jordan is far from being perfect and not consistantly of high level. Aggregates are of inadequate quality and are mainly prepared from crushed limestone or moderate to low hardness. Other aggregates of better quality, such as wadigravel, basalt and granite aggregates, are available, but only at a much higher cost.

There are many small factories for cement bricks and floor tiles in the country, with quality ranging from good to fair.

Lime and calcium silicate industry was established in 1975. The installed capacity amounts to 32,000 tons of lime and 75,000 m^3 of calcium silicate bricks per year. Unfortunately, only 15% of the installed capacity are utilized due to rather low domestic consumption. Unless drastic measures are taken by the Government to support this industry, it will soon perish.

i) NEPAL

There are at present 4 cement plants: the Himal Cement Co. Ltd. (capacity 400 tons/day, based on vertical shaft kiln technology), the Hetauda Cement Factory Ltd. (rotary kiln with capacity of 750 tons/day of clinker), and two factories (vertical shaft kiln technology) in the private sector with a capacity of 20 tons/day and 30 tons/day of clinker.

Altogether, these factories cover 75% of the country's demand, 25% of the cement demand have to be met by imports.

The Government of Nepal is considering to commission another medium-scale plant at Udaipur in the eastern part of Nepal, and also encourages private entrepreneurs to set up mini-cement plants to bridge the gap between the national demand and the indigenous production. Because of scarce financial resources and an estimated 10% growth in cement demand, it is estimated that Nepal will depend on imports for its requirements of cement throughout this century. Limestone is available in the country in abundance.

The greatest constraint for the development as a whole, and as well as for the fuel consuming industry, is the non-availability of any type of fuel within the country. Surveys and search for it are being continuously pursued.

Rice-husk ash cement was developed by the Research Centre for Science and Technology, but was not commercially successful.

The lime industry is facing strong competition from the neighbouring country India, because of its low production costs. At present, there are only two kilns (manual feeding and discharging) with 10 tons/day installed capacity to be found in the organized sector of Nepal, producing about 2,000 tons/year for whitewashing and masonry works.

Furthermore, it should also be mentioned that Nepal has developed and installed its own standards for cement.

j) PAKISTAN

At the time of its independence in 1947, Pakistan inherited four cement factories with a total installed capacity of 0.471 million tons/year. During the following two decades, another six cement factories were established in the private and public sector, augmenting the total installed capacity to 2.535 million tons/year. After the nationalization of the cement industry in 1972, the State Cement Corporation of Pakistan established four new cement factories (dry process) and expanded the production capacity of two existing factories (also dry process), thus increasing the total installed capacity to 5.580 million tons/year in the public sector. During the current decade, four cement factories were also installed by the private sector with a total installed production capacity of 1.500 million tons/year (all dry process). Three more cement factories are now under installation and another three are being planned. When completed, the total installed capacity will increase to 8.685 million tons/year, including 0.180 million tons/year of white cement.

During the last five years, Pakistan had to import cement to meet its increasing demand, but has now become self-sufficient. The increase in demand amounts to 6 - 8% per year.

Clay bricks are only manufactured in small, old-type conventional brick kilns in the private sector. The production of cement blocks is largely governed by economics. Their use is more popular in the area of Karachi, where clay is not available. The use of tiles is increasing; small- and medium-scale plants have been established by the private sector throughout the country. Prefabricated concrete industry is still in its infancy, but gaining ground increasingly. A number of plants manufacturing roof tiles, wall panels and beams have been established adjacent to cement factories in recent years. Precast members are mostly used in low cost housing.

Burnt lime, which is mostly used for whitewashing, is produced in old-type small shaft kilns which are installed throughout the country near the limestone deposits.

A Cement Research and Development Institute was established in 1983 by the State Cement Corporation of Pakistan, to carry out research and development in the field of cement and concrete. This institute is now being expanded with a World Bank loan.

k) PAPUA NEW GUINEA

Concrete construction has proved to be the most durable system for tropical climates such as in Papua New Guinea and finds application in all sectors of the economy. Concrete also offers a potential for savings in the energy investment for construction materials, such as bricks.

The entire demand for cement in Papua New Guinea is met by imports. Over the past 20 years, the average imports of cement amounted to 60 - 70,000 tons/year. The highest imports were recorded in 1970/71 with 90,769 tons resulting from the construction work on Bougainville Copper Ltd., the country's largest copper mine. Papue New Guinea is now experiencing a similar period for increased cement consumption due to construction work on another large copper and gold mine.

New Zealand is the major supplier of portland cement, followed by Japan and Australia. Small quantities are imported from Singapore, South Korea, Federal Republic of Germany, UK and USA.

Numerous studies have been carried out on the possibility of establishing a cement plant with an appropriate technology that could produce cement at a scale which would satisfy the fairly stagnant domestic demand of about 70,000 tons/year. These studies revealed that the vertical shaft kiln technology would be technically feasible when establishing a cement manufacturing plant.

In summary, it can be stated that there is a market for a mini-cement plant; ample raw material supply and appropriate technology are available to build such a plant.

Papua New Guinea is very rich in mineral resources such as copper, gold and oil deposits. Currently these resources are under exploration and in some cases, construction work has started. Therefore, the future demand for cement in Papua New Guinea is undoubted.

Papua New Guina has very rich limestone deposits which are well distributed throughout the mainland and the associated islands. The limestone ranges in age from permian to the present, in composition from almost pure to highly arenaceous and argillaceous, in texture from coarsely crystalline to fine grain, in compactness from soft coralline to hard, dense, massive and bedded types and in colour from white to almost black.

There is also reasonable market for lime in Papua New Guinea. Currently, lime is being used in building and construction of roads and bridges, and for bricks and blocks for building purposes. The later could be expanded to a large-scale activity because of the annually increasing construction of brick buildings. Although the present demand for lime is small, it could rise considerably, if lime became available reasonable cost.

So far, there has been little exploration of the tremendous lime resources of Papua New Guinea. The ready availability of lime could lead to improved construction and maintenance of roads and to reduced construction and maintenance costs of buildings, to better technology and to an increase in the overall building activities.

Production facilities that are available in Papua New Guinea are of a more advanced technology, as clinker is used for crushing lime for the copper mine in Bougainville. To a lesser extent, cement bricks, blocks and pipes are used in Papua New Guinea. These are mostly made on mechanical presses on a small- to medium-scale level.

The future demand for lime in the building industry will be dictated by the need for cheaper building and road construction as well as the vast mineral resources which are currently under exploration. Other uses for lime must also be considered for the long-term planning of such industry.

The technical co-operation required by Papua New Guina from other developing countries (TCDC) would be in the fields of technical assistance, trade, investments, training and feasibility studies to establish cement/lime manufacturing plants at reasonable cost.

e) SRI LANKA

Cement industry is the only well established building materials industry in Sri Lanka, which incorporates reasonably up-to-date technology.

The only product manufactured presently is ordinary portland cement (standard BS 12, 1978).

There are three major companies manufacturing cement and one which imports bulk cement and distributed the cement in bulk or in bags. A number of firms also import and distribute bagged cement.

The Sri Lanka Cement Corporation, with a total installed capacity of 850,000 tons/year, is the largest of the producing organizations and has three production facilities. The oldest factory, Kankesan Cement Works, was established around 1950 and has presently two production facilities, encompassing all the functions from quarrying to packing. The two kilns have a capacity of 350 tons/day and 500 tons/day respectively and are of the 4-stage suspension preheater type, with coal and oil firing capability. The Puttalam Cement Works also have all the facilities from quarrying to packing with two suspension preheater kilns of 650 tons/day each and oil firing. As third, the Ruhunu Cement Works dispose of grinding and packing facilities with a capacity of about 120,000 tons/year.

Lanka Cement Limited is a Government funded private company and has a complete production line installed in 1983 with a total capacity of 500,000 tons/year. It is a modern 4-stage preheater plant with facilities for later conversion to dual lines with precalciner.

There are also two private organizations in Sri Lanka, one with a grinding and packing plant of 200,000 tons/year and the other with only a packing plant of about 100,000 tons/year capacity.

Although the installed capacity in Sri Lanka is considerably above the present consumption, about a third of the country's cement requirements have to be imported, due to the curtailment of production in plants located in the northern areas affected by terrorist activities.

Massive hydro-electric development and housing construction projects as well as the functioning of a relatively free economy, have caused the cement demand of the country to register an average increase of over 9% per year, and this trend is likely to continue in the foreseeable future.

Other building material industries, s.a. tiles and bricks manufacture, use relatively old or primitive methods, but the output suffices to meet the country's requirements.

m) THAILAND

Thailand produces each year some 4 million tons of rice husk, i.e. about 20% of the total paddy crop remain after the rice is processed for consumption. A small amount of this husk is used as cattle fodder, fuel, etc., the remainder so far has been a waste material.

Development of technologies for the utilization of rice husk appropriate to the developing countries help in providing a cheap source of new building material products.

Traditional building materials in Thailand, besides timber and lime, are bricks (80%) and cement.

Brick manufacturing methods are rudimentary. Of a total of 305 brick, tile and earthenware factories registered in 1982, 275 produced bricks (standard size). With the exception of the pressing operation (hand moulding and hand operated screw press), the manufacturing process is manual. The bricks are burnt by direct contact with live wood fire in beehive kilns. Most of the bricks produced in Thailand are hand-made small-sized bricks.

Thai standard specifications fix two modular sizes of common building bricks. The change of size involves only a slight, inexpensive modification of wooden forms. Small-size hand-made bricks are usually made with plastic clay, hand-moulded, sun-dried and then filled into simple updraught kilns, or just covered with rice-husk and fired.

Cement production has expanded rapidly during recent years, owing to a growing demand based on increased private and public sector construction activities. The first cement factory in Thailand was established in 1913, and cement production has risen steadily since. Cement is mostly manufactured by the wet process using marl, clay and gypsum as raw materials.

The Siam Cement Company produces three types of cement: ordinary portland cement, rapid hardening cement and silica cement.

Two important building materials were recently developed with the Thailand Institute of Scientific and Technological Research (TISTR), a non-profit Government enterprise, under the Ministry of Science, Technology and Energy:

1. Ferrocement: A form of reinforced concrete made of cement mortar plastered on wire mesh reinforcement, with unique qualities of strength and serviceability. Having long been proved with boat building, it has many other applications in agriculture, industry and housing. Results of research work done in marine structure at TISTR indicated that construction cost of a 30-feet long vessel built of ferrocement is about 20% less than that of the same size boat built of steel plate or timber. Cheap, airtight bins made of ferrocement were considered to be a solution to storage problems. Other potential applications would be prefabricated building components, water tanks, etc. TISTR has developed a 3.4 m^3

capacity ferrocement water tank to collect rainy water, suitable for a family of 5 persons in rural areas where scarcity of drinking water is a severe problem. In addition, ferrocement flooring elements and load-bearing wall elements have been fabricated and tested with very promising results.

2. Soil cement: A composite material consisting of sandy soil (e.g. lateritic soil), small amounts of cement and water; with the help of a manually-operated pressing machine, this mixture is transformed into a solid block, i.e. a "soil cement block". TISTR has developed this material for rural housing application through a joint project partly financed by the Girl Guides' Association of Thailand. The purpose of this project was to demonstrate how a low-cost house could be constructed through utilization of soil cement blocks in a rural area. The results showed that about 30% of construction costs by conventional method could be saved. Such method, utilizing indigenous materials like lateritic soil, is presently used throughout the country.

n) TURKEY

The Turkish cement industry represents one of the most successful industry sectors in the country. Starting with a kiln capacity of 20,000 tons/year in 1911, it has attained the status of the 13th largest produced in the world and 5th among Cembureau countries within a short period. The total cement production has reached 17.7 million tons/year and 20.5 million tons of installed capacity, 73% of which were realized in 1985. 39 cement plants are operating mostly with dry process and coal firing systems.

In 1972, Turkey began to export cement at an average of 2 million tons/year, both in bags and in bulk, mostly to middle east and north African countries. Turkey has achieved a good level of technical know-how and manufactures over 85% of the machinery parts of a cement plant domestically. Supporting industries, s.a. paper bags manufacture, refractories, iron and steel production, cover the needs of cement industry.

In order to cope with the requirements of the rapidly developing cement industry, s.a. the collection of data and information and assistance in finding solutions to problems likely to arise, the Cement Research and Development Centre (CRDC) was established. Since 1979, this Centre has organized in-plant group training programmes in the field of cement industry for developing countries' engineers. These programmes are UNIDO/Turkish Government/CRDC joint projects and take place twice a year. The Centre disposes of instrumental analysis equipment and audio/visual aids for research and training purposes.

Raw material for brick production is available throughout Turkey (except the Gaziantep region), producing companies are mostly of medium size. Production processes and capacities are fully adapted to the domestic conditions and sufficient for domestic use. In 1985, 5.6 billion bricks were domestically used in construction.

There are three production systems used in Turkey: modern, semi-modern and traditional. One sixth of the production is achieved by 126 modern and semi-modern plants, the remainder is produced by traditional methods.

Although lime is a hydraulic binding material, the Turkish Cement Manufacturers' Association is indirectly involved in the country's lime industry. Some of the private cement producing companies also produce lime, but for regional use only. In 1985, 7.7. million tons of lime were exported. The

lime production capacity meets the local consumption, imports are not practised. As wtih the brick production, the producing companies are mostly private and of medium size. The main production systems are of modern, semi-modern and traditional structure. 29% of the production are carried out in 79 modern and semi-modern plants. The remainder is produced by traditional methods.

9. Statements made by Observers

The representative of the ESACP/TCDC Service informed the workshop participants that the most successful TCDC and ECDC activities promoted by it were through the setting-up of a group of developing countries having common interests and facing common problems. The successful experience of the Silk Exporters Group, an association of commodities producing countries, was cited. He further stated that the most serious problem in expanding TCDC activities in the ESCAP region was the provision of local costs by the participating countries. He suggested that assistance in the identification of specific TCDC needs, particularly in least developed, landlocked and island developing countries, could be provided by the United Nations development system in close co-operation with the relevant national institutions.

IV. RECOMMENDATIONS AND CONCLUSIONS

After reviewing country monographs and considering TCDC needs and offers of individual countries (see Annex IV), the group came to the conclusions that the developing countries possess enough indigenous technology, know-how and experience suitable to answer each other's needs in terms of cement, lime and related industries.

Despite the existence of this great potential, only limited TCDC action has come out in the past in the field of cement, lime and other related industries, although some considerable work had been carried out under UNIDO/UNDP programmes. *)

Failure encountered in previous attempts to TCDC actions led the group to place greater emphasis on the factors that prevent TCDC. The following categories of constraints are identified as responsible for the modest outcome so far, and the following courses of action are proposed to remedy these constraints:

1. Sufficient knowledge on TCDC needs and potentialities might not have been available.

   It was proposed that UNIDO dispatches TCDC questionnaires to the developing countries requiring or offering technical co-operation in the field of cement, lime and related industries and urges them to define specifically their requirements or potentialities in detail. The information resulting from this study may then be distributed to all

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*) For background information and information about previous activities to bring out TCDC actions, see attached proposal for technical co-operation among the developing countries in the field of lime and clay-based building materials industries.

developing countries, who may thus have a better chance to co-operate when gaining more insight into existing TCDC possibilities; efforts to encourage developing countries to use each other's indigenous technologies and know-how might bear more fruitful results.

2. The potential TCDC partners might not have been sufficiently enlightened about the necessity, importance and advantages of borrowing indigenous technologies from fellow developing countries instead of obtaining sophisticated technologies from industrialized countries. The idea of TCDC should be promoted by beneficiaries and decision-makers.

Decision-makers have to be convinced that technologies acquired as a result of TCDC action will suit the need of the borrower much better and stand greater chance to be functional and operational in the country, where they are to be implanted. Sophisticated technologies require an environment resembling to the one they were created within, to be fully effective and efficient.

It is advisable that UNIDO provides theoretical as well as practical evidences that would back up the idea by the decision-makers and displays the advantages of TCDC action against obtaining sophisticated technologies from industrialized countries.

To reach the right level of decision-makers, the potential of national focal points and pilot institutions have to be put into use. National research institutes should serve this purpose very effectively.

3. Lack of funds initially required for the TCDC action may have acted as a hindrance to co-operation among developing countries. In relations with industrialized countries, some of the initial costs can be deferred to later stages and certain preliminary services are free of charge. In TCDC actions, this generally is not possible as the offering country herself may not be better off then the receiving country.

The group advises that the benefiting country should at least be willing to cover the local costs. If the beneficiary is lacking the necessary funds, she should approach UNIDO or a third-party donor for a possible alternative solution rather than abandoning the idea of TCDC.

In addition to the above, some other actions were also proposed, such as:

a) Information on previous successful TCDC activities should be disseminated as incentive for future TCDC action;

b) The help of regional and sub-regional organizations should be enlisted for TCDC;

c) Another workshop or an expert group meeting should be held at a later date to review the actions taken and the progress gained in promoting TCDC action;

d) Special emphasis should be placed on lime industry which seems to be a promising field for TCDC, as its present state is relatively primitive and neglected in developing countries; hence it would be open to improvement with small modifications at relatively low cost.

With due consideration to the above recommendations and conclusions and to the specific problems faced by lime and clay-based building materials industries, the group agreed on a detailed proposal for technical co-operation among developing countries in this field (see Annex V).

ANNEX I

Workshop on Co-operation among
Developing Countries in the field
of Cement, Lime and Related Industries

Bangkok, Thailand, 23 - 27 February 1987

LIST OF PARTICIPANTS

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Workshop on Co-operation among Developing Countries in the field of Cement, Lime and Related Industries

Bangkok, Thailand, 23 - 27 February 1987

ANNEX II

AGENDA OF WORKSHOP

Sunday, 22 February 1987		Arrival and Registration
Monday, 23 February 1987	9:30	Official Opening
		- Ministry of Science, Technology and Energy
		- Thailand Institute of Scientific and Technological Research (TISTR)
		- UNIDO
	10:45	1. Work Session
		- Election of Chair persons and Rapporteurs
		- UNIDO: Activities for development of construction and building materials industries
	13:30	2. Work Session
		- UNIDO: TCDC activities in the developing countries
	15:45	3. Work Session
		- TISTR: Study of the lime industry in selected developing countries
		- China: Small-scale cement industry in China
Tuesday, 24 February 1987	9:00	4. Work Session
		- India: Small-scale cement industry in India
		- Presentation of country monographs by their authors
	10:45	5. Work Session
		- Chulalongkorn University: Small-scale bricks and roofing tiles production in Thailand
		- Country monographs

	13:30	6. Work Session - Country monographs - Questions and discussions
	15:45	7. Work Session - Country monographs - Dr. N. Hara, Japan: Lightweight building materials from indigenous resources
Wednesday, 25 February 1987	7:00	Industrial Excursion - The Siam Cement Co. - Local lime kiln
Thursday, 26 February 1987	9:00	8. Work Session - Country monographs - Questions and discussions
	10:45	9. Work Session - Working group on future TCDC activities
	13:30	10. Work Session - Round-table discussions - Formulation of proposals and reporting
	19:00	Official Dinner and Cultural Programme
Friday, 27 February 1987	9:00	11. Work Session - Rapporteur: Summary of findings and recommendations - UNIDO: Presentation of TCDC proposals - Rapporteur: Presentation of draft final report
	11:45	- Closing Ceremony

Workshop on Co-operation among
Developing Countries in the field of
Cement, Lime and Related Industries

Bangkok, Thailand, 23 - 27 February 1987

ANNEX III

LIST OF DOCUMENTS PRESENTED TO WORKSHOP

A. Documents presented by UNIDO

1. "Mini-Cement Plants: a technological information package" (IS/INQ.6)
2. "Lime in industrial development: a UNIDO guide to its uses and manufacture in developing countries " (UNIDO/IS.555)
3. "Lime in industrial development: a directory of organizations and a bibliography" (UNIDO/IS.555/Add.1)
4. "Use and conservation of energy in the cement industry" (UNIDO/IS.540)
5. "UNIDO's programme to promote economic and technical co-operation among developing countries" (PPD.1)
6. Working paper on "UNIDO activities for the development of construction and building materials industries"
7. Working paper on "UNIDO technical assistance to the development of lime industry"
8. Working paper on "Receiver financed UNIDO technical assistance to industrial capacity utilization, industrial in-depth surveys and rehabilitation"
9. Working paper on "UNIDO technical assistance to industrial promotion and performance monitoring"
10. Newsletter on "UNIDO provides direct support to industry through trust funds"
11. Proposal of a training programme in cement industry under trust fund arrangements
12. Case study on the Development Perspectives for Portland Cement Industry in Botswana

B. Documents presented by TISTR/Thailand

1. Country monograph of Thailand (TISTR)
2. Small-scale clay bricks and roofing tiles production in Thailand (Chulalongkorn University)
3. Lightweight building materials from indigenous resources (co-operative research project GIRIK*/ASEAN countries)
4. Potential usability of rice-husk and rice-husk ash for industry (GIRIK)
5. Utilization of agro-wastes for building materials (TISTR/GIRIK)

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* Government Industrial Research Institute Kyushu, Japan

C. Documents presented by Participating Countries

1.	Botswana	- Country monograph
2.	China	- Information about China's cement industry - China's small-scale cement industry - The present situation and prospects of mini-cement plants in China
3.	Egypt	- Country monograph
4.	Ethiopia	- Country monograph
5.	India	- Country monograph and paper on small-scale cement industry in India
6.	Indonesia	- Country monograph on the development of cement and lime industries and its related down-stream products
7.	Jordan	- Country monograph
8.	Korea *	- Country monograph
9.	Nepal	- Country monograph
10.	Pakistan	- Country monograph
11.	Papua NewGuinea	- Country monograph
12.	Sri Lanka	- Country monograph
13.	Turkey	- Country monograph

* The country monograph of Korea was distributed at the Workshop, although the participant did not arrive.

Workshop on Co-operation among
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ANNEX IV

SUMMARY OF TCDC REQUIREMENTS EXPRESSED AND OPPORTUNITIES OFFERED BY PARTICIPANTS

1. BHUTAN

a) Requirements

- Plant automation and monitoring systems at existing plant
- Manpower development planning
- Know-how for coal beneficiation (high ash content)
- Lime industry know-how in hilly areas where coal is not available
- Know-how for gypsum-based industry
- Pre-calciner technology and its possible utilization at existing rotary kiln
- Quality improvement of limestone with very high magnia oxide content
- Setting-up of vertical shaft kiln in isolated areas where fuel is not readily available
- Know-how for producing coke breeze for vertical shaft kiln.

b) Opportunities

Nil.

2. BOTSWANA

a) Requirements

- Building materials and other industrial minerals: technical assistance in the establishment of such industries, including training of local personnel in operation and administration of such industries.

b) Opportunities

- Botswana offers co-operation in any area deemed useful by a potential co-operating country.
- Botswana has an open policy of foreign investments; thus a co-operating country, which offers assistance, may identify and/or develop raw materials for export or processing into finished products.

3. CHINA

a) Requirements

Nil.

b) Opportunities

For cement plants of the following type:

- Mechanical skaft kiln with 100 - 150 tons/day capacity
- Small rotary kiln with shaft preheater and 170 tons/day capacity
- Rotary kiln with precalciner or cyclone preheater and 400 tons/day capacity
- Precalciner kiln, 700 - 2,000 tons/day capacity;

Co-operation and assistance is offered in the following areas:

- Supply of mechanical and electrical equipment
- Eng'neering consultancy and design
- Feasibility study
- Establishment of turnkey-plant
- Management and production processes
- Maintenance and spare part supply
- Training.

Also other requirements, as considered necessary by the co-operating countries, can be met, if possibilities exist in China.

4. EGYPT

a) Requirements

- Training: provision of training facilities and materials, such as films, video-tapes etc. for new cement technologies.

b) Opportunities

- Training at companies' training centers
- Participation in seminars
- Participation in technical meetings and preparation of related documentation.

5. ETHIOPIA

a) Requirements

- Study tour for management personnel in the field of proper supervision of cement factories (preferably to China)
- Information exchange in technical areas
- Training and orientation programme in the field of ceramic industries for engineers (preferably in Indonesia).

b) Opportunities

- Information exchange in technical areas.

6. INDIA

a) Requirements

Nil.

b) Opportunities

- Transfer of technology (CRI-MVSK) for cement plants, including geological raw material investigations and raw mix design, preparation of feasibility studies, selection of equipment/machinery, coordination during the project implementation, training of operating and laboratory personnel, assistance in plant operation during pre-commissioning and post-commissioning periods
- Sponsoring of short/long-term training programmes for operators/supervisors from cement and building materials industries, including practical training on full-scale computerized cement plants at simulator training facilities
- Know-how for CRI-designed precalcinator systems, including techno-economic feasibility studies and systems design for precalcinator and pre-heater towers with horizontal cyclones
- Design of high-ash coal burners for cement rotary kilns
- Design of continuously operated lime kilns (daily capacity 25, 50 or 100 tons), as well as preparation of techno-economic feasibility study and assistance until the stage of commissioning
- All studies related to geological and raw materials investigations and computerized mine planning for limestone deposits
- Assistance in improving the total factor productivity of existing cement and building materials industries.

7. INDONESIA

a) Requirements

- Improvement of training facilities for TCDC in Cement Research and Development Institute (CRDI) of Indonesia, i.e. construction of dormitories for 25 participants, additional equipment for practical work (s.a. testing apparatus), instructional equipment (s.a. audio visual aids, library, etc.)
- Exchange and dissemination of R&D results, technology information and experience through TCDC newsletter, periodic seminars and technical meetings, and exchange of experts through the establishment of a consultative group of directors of cement, lime and R&D institutes
- Training programmes in refractory engineering and improvements of skills for fine/new ceramics, with practical work in the respective industries (minimum duration 1 year), possibly under the guidance of experts from developed countries.

b) Opportunities

- TCDC training programmes in lime processing, ceramic engineering and structural clay building materials (offered by CRDI, proposed to be financed by UNIDO/UNDP), for a duration of 3 months (40% theoretical training, 60% practical training, plant visits and discussions)
- Provision of expert services to assist in the construction and operation of small-scale lime, building materials and ceramic industries.

8. JORDAN

a) Requirements

- Training: provision of training equipment such as films, video-tapes and printed materials related to cement technology,
  training of trainers,
  guidance for training programmes,
  assistance in conducting training courses in Jordan with the co-operation of Jordanese cement factories.
- Marketing: identification of potential markets for surplus quantities of cement (over one million tons/year).
- Spare parts: identification of sources of spare part supply, which would offer their products at lower prices than traditional suppliers in developing countries;

  advise and assistance for the manufacture of spare parts in the workshops owned by Jordanese cement plants;

  disposal of the spare parts from three decommissioned kilns, which could be obtained at relatively low price.

b) Opportunities

- Training in the training centres of Jordanese companies
- Preparation and presentation of documentation for seminars and technical meetings
- Experts services for the preparation of feasibility studies, raw material assessment, rehabilitation of plants, trouble-shooting, recommendations on improvements on existing facilities and product lines.

9. NEPAL

a) Requirements

- Solutions to improve the low calorific value and high ash content of breeze coke (imported from India)
- Practical advice on productivity improvement and energy saving possibilities, as well as assistance in the realization of such advice
- Exchange of experience in the field of utilization of low-titer limestone in cement industries (rotary kiln)
- Improvement of spare parts production and supply in the region, including efficient post-sales services.

b) Opportunities

- Feasibility studies for the survey and assessment of limestone reserves and development of mining plans
- Feasibility studies for the survey and assessment of clay deposits
- Upgrading the operations and assistance in problem solving of vertical shaft kilns to achieve improved clinker and cement quality
- Assist in the establishment of vertical shaft kiln operations, including raw material assessment and selection of appropriate equipment.

10. PAKISTAN

a) Requirements

- Operation of 3,000 tons/day dry process kilns with precalciner, of coal-oil mixed firing burners and of on-line X-ray analysers
- Maintenance of electrostatic precipitators, of instruments and of grate coolers
- Transfer of know-how in relation to efficienty of electrostatic precipitator V/S bag filters, and roller presses
- Research and development in the field of slurry thinners and utilization of high sulphur coals
- Training in the field of repair of instruments and trainers' training
- Development of lime kilns.

b) Opportunities

- Feasbility studies for the establishment of cement plants
- Quarry development plans
- Energy conservation and energy audits
- Studies for the analysis and suitability of raw materials
- Analysis of coal with a view to its fuel quality.

11. PAPUA NEW GUINEA

a) Requirements

- Training of personnel in the field of cement, lime and related building materials
- Consultancy and feasibility studies to determine the most suitable size of technology in establishing cement, lime and related building materials manufacturing plant
- Exposure visits to developing countries utilizing advanced cement and lime technologies to study their experiences and the types of technology and operations being used
- To establish trading links in order to import cement, lime and related building materials from developing countries, where such products are produced in surplus quantities
- To seek investors in the field of cement, lime and related building materials, who would also transfer experiences, know-how, technology, etc. to Papua New Guina.

b) Opportunities

Nil.

12. SRI LANKA

a) Requirements

- Implementation of a suitable preventive maintenance programme using the facilities of mini-computers
- Manufacture of low cost building materials using cement and also locally available materials, s.a. paddy husks, coir fibres, etc.
- Training in the fields of cement industry in all aspects of operation, maintenance, and quality control; the standards should be for supervisory executives, technical and managerial staff, and should relate to the present level of technology in Sri Lanka or to levels within reach
- Training in low cost techniques for the utilization of the country's ample dolomite resources for the lime industry
- Training in energy auditing, conservation methods and use of locally available alternative fuels in the cement industry
- Training in low cost pollution control techniques in the cement industry
- Training in the use of x-ray fluorescence and spectrophotometer techniques in quality control, especially their use in a non-automated manner for systematic quality control (cement industry).

b) Opportunities

Nil.

13. THAILAND

a) Requirements

- Exchange and dissemination of R&D results, technologies and experiences in lime, cement and related materials, including the exchange of experts and the participation in periodic seminars and technical meetings, etc.
- Improvement of training facilities for TCDC at TISTR, particularly supply of additional equipment for practical work, s.a. testing apparatus, etc.

b) Opportunities

- TCDC training programme for the production and utilization of soil-cement (offered by TISTR, proposed to be financed by UNIDO/UNDP, duration 1 - 2 months).

14. TURKEY

a) Requirements

Nil.

b) Opportunities

- Co-operation is offered in the following areas:

  Cement industry, production of pre-cast/pre-stressed concrete, of ready mix, of wall-bricks, of roofing tiles and of lime

- The co-operation can take the following forms:

  Supply of turn-key plants,
  Supply of machinery, equipment and spare parts,
  Rehabilitation of existing plants,
  Provision of consultancy and engineering services,
  Training of personnel,
  Carrying-out of scientific research,
  Solutions to specific problems, and
  Provision of information.

Workshop on Co-operation among
Developing Countries in the field of
Cement. Lime and Related Industries

Bangkok, Thailand, 23 - 27 February 1987

ANNEX V

PROPOSAL

TECHNICAL CO-OPERATION AMONG THE DEVELOPING COUNTRIES
IN THE FIELD OF LIME AND CLAY-BASED BUILDING MATERIALS INDUSTRIES

A. Background Information

Development of industry is a necessity for the development of employment and social welfare.

Some industries, however, attract rather modest attention either because their financial rate of return is low or because they are predominantly small-scale industries. As a result, such industries in many developing countries can be classified as forgotten industries. In the field of building materials industries, cement production appears as a well promoted and appreciated industry while lime industry and to some extent also the production of clay bricks and tiles are much less popular. These less popular industries are therefore often not developed further in accordance with actual possibilities and sometimes even replaced by other industries. In this respect, both the lime industry and the brick and tile industry have been under certain pressure from the cement industry, which,in some cases, has successfully promoted the use of cement mortar instead of lime mortar, of conrete blocks instead of bricks, and of fiber-reinforced cement roofing materials instead of clay tiles. Nevertheless, traditional lime and clay based building materials still deserve attention as good and healthy building materials and the existence of appropriate installations for their production can help to promote rural development and facilitate the development of modern pyro-processing technologies, essential for a balanced industrial development.

Apart from the strong position of the cement industry, the reasons for lime and brick industries to be forgotten industries are also based on the lack of information about the possibilities for establishing well functioning appropriate installations as well as on a general shortage of funds for their promotion. In order to reactivate the development of such forgotten industries, it will be necessary to motivate decision makers through an awareness campaign, explaining possibilities and advantages of the production and use of lime and clay-based building materials.

At the national level such an industrial promotion will only be possible in close co-operation with local institutes and experts. In this respect, it should be noted that the required technology is not normally available in industrialized countries, since their technologies have been developed - under the influence of the necessity for economies of scale - into very large units, which are not readily adaptable to conditions in developing countries.

The resource countries for such industries are therefore such developing countries, which have successfully kept alive the traditional industries and have developed them without expanding the units beyond the capacity of existing market conditions. In order to make use of the availalbe appropriate technology, the following proposal for TCDC activities has been recommended. For further information, the initial TCDC proposal which had served as basis for discussions leading to the present proposal, is also attached.

B. Outline of TCDC Activities for the Development of Lime and Clay-Based Building Materials Industries

(a) Collection of information at the national level: For this task, the existing Asian Network project should be invited to participate in order to benefit from the support from national institutes (focal points) with good experience in co-operation with UNIDO and the respective UNIDO-ESCAP Division covering building materials industries.

(b) Review of available technologies in participating developing countries with the help of a TCDC expert group meeting held in co-operation with the Asian Network Project's administration:

Particular emphasis should be given to improve existing installations and to identify or develop appropriate technologies well suited for a demonstration installation within a pilot-cum-training plant in a country interested in receiving this support. Emphasis should also be given to increase the awareness and the understanding for energy conservation in order to facilitate the replacement of inefficient installations with more economic units.

(c) Elaboration of modification feasibility studies for improvement of existing installations and normal investment feasibility studies for green field projects.

(d) Organization of study tours for interested entrepreneurs to appropriate installations, where the proposed technology will be in use.

(e) Modification of selected plants and erection of green field pilot project(s).

(f) Elaboration of reports describing the experience gained and the performance of the new installations.

(g) Further development work as required.

Proposal for Technical Co-operation among the Developing Countries for the Development of Lime Industries

(discussion paper)

Phase I: Collection of information at the national level:

- Classification of number, capacity and type of installations available;
- Detailed description of selected efficient small- to medium-scale lime processing technologies (UNIDO will provide sample descriptions of existing or proposed small-scale lime plants).

Phase II: Review of available technologies in participaring developing countries with the help of a TCDC experts group meeting organized with UNIDO support:

- Presentation and discussion of selected technologies with review and calculation of design parameters and structural details;
- Visit to selected plants in a host country singled out as most appropriate meeting place considering the objective of the development activity;
- Selection of host country for elaboration of a TCDC feasibility study for an appropriate pilot-cum-training lime processing installation;
- Selection of host institute and TCDC experts for working group to elaborate feasibility study and to build and start-up of a plant with training of personnel and detailed reporting of results and experience.

Phase III: Elaboration of feasibility study and building and start-up of pilot plant.

Phase IV. TCDC workshop to evaluate the experiences resulting from the development of the pilot project and comparison between the pilot installation and other selected plants with near-to satisfactory performance.

Phase V: Discussion of the results at the national level in individual countries and examination of the future lime requirements as well as elaboration of proposals for how to cover the (increasing) lime demand with existing and/or new installations.

TCDC experts group meeting to elaborate feasibility study (studies) and subsequent fielding of selected experts for the necessary studies in close co-operation with national experts.

Building and start-up of plants with training of personnel.

Privatization of most efficient installations and use of incoming funds for development of new installations or modification of existing installations.

Phase VI: Organization of TCDC meeting to report on results and the capabilities established and to select technical areas for further TCDC co-operation which could benefit from the experiences gained during the development of several lime production installations.