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Workshop on Clay Building Materials Industries in Africa

Tunis, 6 - 12 December 1970

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PREFACE

On the threshold of the second development decade participants and observers from 18 developing and industrialized countries attended the Workshop on Clay Building Materials Industries in Africa.

The purpose of the Workshop, which was held in Tunis from 4 - 12 December 1970, was to review the status of the clay based industries for building materials in the countries of Africa and to work out conclusions and recommendations that could assist these countries in increasing availability and quality of clay building products.

Different levels of mechanization in the brick and tile industries were demonstrated in the factories visited during the Workshop. This gave further opportunities to the participants of the Workshop for exchange of experience and discussions.

The Workshop was organized jointly by the United Nations Industrial Development Organization (UNIDO), the Economic Commission for Africa (ECA), the United Nations Centre for Housing, Building and Planning (UNCHBP) and the Government of Tunisia, with the co-operation of S.A. Bâtiment in Tunis. Mr. Tahar AFDHAL WAHED representing Bâtiment and Mr. Sergei BOLDYREV of the Industrial Technology Division of UNIDO served as Co-Directors of the Workshop. Mr. J.O. ATTA-LAMPTEY and Mr. V. RAMANCHARLISON were elected Chairman and Vice-Chairman of the Workshop respectively. The Technical Secretary of the meeting was Mr. C.E. RYDING, UNIDO, and the Rapporteur was Mr. Z. ENGELTHALER, temporary UNIDO expert.

Appreciation was expressed to the Government of Tunisia, S.A. Bâtiment, Tunis, and to all those who worked for the success of the Workshop.

PART I

SUMMARY

1. The role which governments are called upon to play in the field of the construction industry is complex and varied in all countries, whatever their level of economic and social development. Generally, the primary role of the government is to ensure the welfare of the people and construction is a sector of the economy that contributes to the national product and accounts for a large proportion of investment. The present volume and expected expansion of housing and other building activities indicate the necessity for an appropriate growth of the building materials industries in African countries.

2. Some materials, such as cement and clay building materials, were considered to be key materials in African developing countries because they are essential in most construction and because they account for the majority of the materials used in many buildings.

3. The clay building materials made from local raw materials constitute, because of their low value/weight ratio, the traditional building materials in African countries. In order to fully satisfy the present and immediate future demand, to extend the viability of constructions made from substitute building materials (such as "chica" and semi-dried bricks), to utilise commercially good quality sedimented clays existing practically in all African countries, it was underlined that the industrial development of clay building industries, with due regard to local market conditions, had become a matter of urgency and several suggestions were presented.

4. Bricks and roofing tiles represent only part of a wide range of ceramic products that are used in construction. The developing countries of Africa are aware of this and have, besides the clay building industries, started to develop other ceramics industries for their structural as well as domestic uses, utilizing local raw materials. However, several examples have shown that if the government concerned is not properly assisted, important losses may occur and great difficulties may arise. Increase in international assistance will not only shorten the development period of the related non-metallic industries but will also promote the commercial utilization of local natural resources.

5. The low quality and efficiency of clay building and other ceramic products are common features in the majority of the African developing countries. In order to promote the technological evaluation of raw materials and manufacturing processes, to expand the assortment of the manufactured products and to increase rationalization, it was expected that UNIDO would continue to expand its activities by establishing contacts with experts, giving assistance during the initial stages of manufacture, building the necessary infrastructure, collecting statistics and distributing material of interest to the industry. The participants expressed their strong interest in the establishment of an institute for clay and ceramic products, which was regarded as urgently needed not only for the further development of non-metallic industries in Africa, but also for other infrastructure activities such as standardisation, statistical evaluation, market potentiality determination and specification.

CONCLUSIONS

1. It was considered that a regional "institute" for clay building and ceramic materials was needed to carry out research on local problems as well as to provide advice and assistance with processing problems, to test clays and products and to train personnel and foremen, operatives in brickmaking and bricklayers and other clay building materials.

2. In order to satisfy the growing construction needs in Africa, it was considered that every effort should be made to improve brick production in that continent as regards both quality and quantity. Both industrial and hand made production should be envisaged and encouraged. Stabilized soil bricks were of great interest to many African countries for low cost housing.

3. The development of the building materials industries should follow the requirements of the development of the building industry in Africa. In view of the high impact of both, it was concluded that those important industries should be given high priority in the development plans of African countries.

4. When considering the brickmaking situation in the regions of Africa, it could be seen that the brickworks installed in North Africa had the capacity to satisfy the present demand for clay building materials. However, a review of the clay building materials production in some countries located in this subregion showed that brick production in these countries was at a low level.

The situation in the other three subregions of Africa appeared different from that prevailing in North Africa. The capacities of brickworks located in most countries of these subregions were insufficient to satisfy the need for clay building materials.

5. Statistical data are essential for the determination of future consumption. The present situation with regard to statistical data on local production and imports was not satisfactory.

6. The participants concluded that the development of the production of clay building materials could provide a general solution to cover the enormous lack of building materials in the majority of African countries for housing at present.

7. The participants considered that other clay products such as low porosity products were of interest to African countries.

8. The importance of homogeneous raw materials was emphasized and methods of achieving homogeniety were discussed. It was felt, however, that there should be sufficient flexibility in the plant to enable it to cope with some variation in raw materials.

9. The first task in considering the setting up of a new brickworks was to ensure that there was an adequate supply of good quality raw materials. The proven reserves should be greater than the economic life of the works.

10. Interest was expressed in the semi-dry pressed process. However, the participants concluded that the process was too expensive in capital costs, and difficulties in maintenance and repairs could arise.

11. The choice between natural and artificial dryers with necessary drying time for small and medium scale production in African countries was discussed. It was considered that natural drying was a more economical process in most of those cases.

12. The participants came to the conclusion that heavy fuel, oil, i.e. even containing a considerable quantity of sulphur, was normally the most desirable fuel for firing clay building materials because it could be easily transported and stored, had a high calorific value, and was relatively low priced. It was noted that scove kilns were best suited for small and medium-sized plants and that Bull-ring and Hoffmann kilns were the most desirable for higher level production. The use of tunnel kilns should be considered only at an advanced stage of development and when there was a high level of consumption within a limited area.

13. The participants noted that equipment that claimed to be mobile was ultimately used in stationary works in one of the African countries. However, the use of a mobile plant was discussed and participants expressed their interest.

14. The participants recognized the importance of modular co-ordination in providing a link between design, planning, the manufacture of components or building materials, and their utilization at the building site.

15. The participants recognized that at the ceramic factories safeguard of the driving belts and the protection of all the rotating parts should be kept in order and that periodic training of workers in safety technique should be carried out.

RECOMMENDATIONS

A. Recommendations to the developing countries in Africa

The Workshop agreed that the developing countries should:

1. Consider establishing "institutes" on a national-regional basis. In the latter case, after reaching agreement with at least two neighbouring countries, application should be made to UNIDO for promoting the setting up of a regional "institute" for clay and ceramic products.

2. Ensure the maximum utilization of locally available raw materials, extend the scale of building materials manufacture made of stabilized soil products, while emphasizing the manufacture of burnt bricks where resources are available.

3. Use the appropriate channels in applying to UNIDO for technical assistance (government - UNDP - UNIDO).

4. Promote brick consumption in Africa by increasing the quality of bricks, reducing production costs and by training personnel in bricklaying and making.

5. Use a proper material handling system, in order to reduce the production costs.

6. Institute and maintain quality control of raw materials, semi- and finished products in order to increase the quality of fired clay building materials.

7. Project new plants for clay building and ceramic industries by starting with complete geological and technological evaluation of the raw materials resources. Make the processing flow flexible enough to make changes in blends. Use natural dryers which are normally economical for small scale production. Use periodic kilns, such as scove kilns, for starting small-scale operations, Bull-ring kilns and/or Hoffmann kilns for higher capacities. Use tunnel kilns only for mass industrial production in areas with dense population and accordingly high consumption.

8. For firing clay building materials, use the cheapest heavy fuel oils, which can be mixed with other organic combustible waste materials.

9. Extend the statistical data of local production and imported clay building materials, in order to enable the national and international institutions and organizations to better assess the needs of the countries in technical assistance and services and in the planning of these industries.

10. Develop other low porosity products besides bricks and tiles, such as wall tiles, engineering bricks, paving bricks and other ceramic products.

11. Due to the importance of clay building materials industries for the economy of the countries, extensive government measures should be provided to this industry for its further promotion and development.

B. Recommendations to UNIDO

International Co-operation

1. In view of the lack of national institutions to meet the needs of countries of Africa in the establishment or development of their ceramics industries, it was unanimously recognized that UNIDO, in co-operation with UNCHIP, ECA and other regional organizations, should initiate, at the request of one of the African countries in which this industry is relatively developed, the establishment of a national-regional "institute" on ceramic industries for the technical services of African countries in this field including evaluation and testing of raw materials, preparation of feasibility studies, training of workers and foremen, collection and dissemination of technical information, etc.

2. Promote the development of clay building and ceramic materials by providing developing African countries with technical literature, such as experts' papers, clay and ceramic products data sheets.

3. As a starting point, prepare an abstract of specifications and uses of structural clay, earthenware and non- metallic products with their raw materials requirements.

4. Make available to developing countries technical assistance and advice related to all stages of the establishment and operation of ceramic plants.

5. Convene a regional Workshop for the countries of Africa covering a wide range of clay and ceramic products, such as structural and other types of ceramics in 1973 at the latest.

C. Recommendations to the developed countries

The developed countries should:

1. Devote attention to extending assistance to the developing countries in ceramic industries by supporting national institutes or the establishment of national institutes and offering fellowships, training opportunities and expert assistance through UNIDO and other international organizations.

2. Establish temporary advisory centres and assist UNIDO in field work as well as developing countries in establishing national or regional centres. Such a centre could occupy a small reserve of international experts and secure assistance at short notice.

3. Continue hosting and organizing technical seminars and workshops in order to secure a continuous transfer of know-how to developing countries.

4. Continue in financial participation by setting up ceramic industries in developing countries.

PART II

SUMMARY OF LECTURES

Problems and Potentials for the Brick Industry in Africa

by Economic Commission for Africa

On behalf of the Economic Commission for Africa, Mr. I. Horwath stated that bricks, being widely used in Africa, have become with cement products the most important building materials. Bricks are traditional building materials for African countries and various kinds are used: sun-dried bricks which are sometimes strengthened by straw; aside fired bricks made by handicraft as well as industrially manufactured bricks are available. The latter appear as full bricks, hollow bricks, hollow blocks and tiles. While in the handicraft brickworks wood and other wastes from agriculture are used as fuel, the industrial plants prefer fuel-oil and coal.

In general, quality of the bricks produced in Africa is very low and these bricks are estimated to last only 10 years due to their low mechanical properties. While about 20 - 30% of the total of the artisan production is well burnt, balance is either underfired or overfired.

The Economic Commission for Africa studied the possibility of bricks production development in three African regions: North, West and Central Africa. Based on its findings on the estimated growth of the national economies concerned, the Economic Commission for Africa concluded that within the next 15 years brick consumption will increase about five times. Since prices of red clay products are competitive with the prices of concrete blocks, there is no limitation for their use in modern constructions, if their quality is properly maintained.

Winning, Shaping and Preparation of Clay

by W.W.F. West

Brick and tile clays are heterogeneous in composition and often contain impurities, sand or sandstone, lime or ironstone nodules, gypsum and other sulfates which give rise to effluescence. Carbon present as roots, peat, coal or finely dispersed may act as a fuel, but a high proportion requires care in firing.

Different methods of clay winning were described with aspects of the homogeneity of the deposits. Clays for bricks making appear in the majority of African countries, but their production characteristics have to be evaluated before the processing equipment is decided. The factors affecting winning and haulage were given and main equipment described.

Clay preparation is the essential sequence of processes needed to bring raw clay into a form suitable for the making process. Sufficient storage capacity should be provided to ensure constant feed to the plant.

The main factors and equipment for dry grinding and plastic preparation of the masses, as well as for shaping of green products were described and discussed. Roofing tiles require better clay preparation than bricks, even better clay.

The labour requirements for the various parts of the processing were given. Modern units have total productive labour requirements of less than 2 m.h./thousand and these are units producing for less than 1 m.h./thousand. But as such works have high capital requirements, running and maintenance costs are clearly more than for less mechanised plants. For conditions in African countries the degree of mechanisation has to be weighed carefully in each particular case according to the investment costs, running costs including maintenance and skilled labour availability.

The Drying and Firing of Burnt Clay Products

by R. Burkhardt

As far as drying and firing of burnt clay products is concerned, the author stressed the following points.

The importance of determining the mineralogical type of the clay selected and studying the geological reserves in such clays before setting up high capacity plants; the author analysed the main factors in which the type of clay influences the drying and firing process.

Before suggesting driers and kilns for brick manufacture, the available type of fuel has to be evaluated with special reference to the costs and qualities of fuel oil as well as to the dangers of deforestation.

Availability of skilled workers and technical personnel plays an important role in each good quality manufacture of bricks and tiles. As the level of skilled labour in most African countries is still low, the author suggested the establishment of three training centres for training ceramic workers and bricklayers in Africa.

Taking into consideration African climatical conditions with regard to the alteration of bed rocks and clays (lateritisation), the most suitable driers and kilns were suggested for new projects considered in African countries.

Economic and Technical Characteristics of the Clay Building Materials Industries in Developing Countries

by S. Johansen

Development of building industry and building materials industries are synchronized to a great extent. Therefore, if planning, administration and standardization believed to be necessary for one of those industries will also be necessary for the other one. Because of the high impact by the combined action, these important industries must be on top of every development plan for developing countries.

The clay building materials industries might be a universal solution to cover the enormous lack of building materials in developing countries, however, this industry must demonstrate that it is convenient and efficient as far as quality and prices of products are concerned.

To demonstrate a progressive type of brick making plant, the author discussed a layout of a brick factory with stiff extrusion of the clay, natural driers, with a material handling system consisting of pallets and fork-lift trucks and, alternatively, with periodic and continuously working kilns, such as the type of a Hoffmann or Zig-zag kiln.

It was recommended that each African country has to establish its own National Committee for developing the clay building materials industries, not only to co-ordinate the efforts of the clay building materials industries with those of the building industry, but also to promote the development of clay building materials industries in order to cover the growing demands on clay products.

Environmental Characteristics of the Clay Building Materials Industries in Africa

by Z. Berhane

After briefly discussing the properties and uses of clay building materials, which are presently produced in four African regions (North-, West -, Central - and East Africa), the author dealt with past and present demands and supplies of clay building materials in Africa. The influence of other recently developed building materials such as concrete blocks and gas concrete on the clay building materials industries was considered.

The relationship between clay building materials and Portland cement products consumption in different African regions was analysed. The results have shown that future trends in the supply and demand for clay building materials is high while their supply is too low.

In order to tackle this acute problem of shortage of clay building materials in Africa, the writer made several suggestions as to how to continue in developing the international assistance and how to settle the situation in differently populated areas in Africa.

Resources for Anticipated Development

by I. Knizek

In his paper the author outlines the three available resources:

a. the clay itself,
b. the knowledge of the clay, the human intelligence to learn about it and the consequent ability to use it properly and
c. the availability of mechanical equipment suitable for the transformation of the basic raw materials into a marketable product.

The writer dealt first of all with the difference between handicraft and industrial manufacture and proceeded then to the raw materials. After a brief description of the constitution and basic characteristecs of common clays, the importance of clay testing was stressed. The approach to the determination of the ability of a clay for brick making is a technological one. Preparation and manufacturing methods were discussed in some detail, especially in relation to recent developments introduced into these processes. Drying and drying behaviour was given prominent attention and the importance and convenience of open air drying was stressed. Handicraft brick manufacture was illustrated by means of slides showing the techniques used in different developing countries. Usability of well designed scove kilns was discussed. The advantages of a Bull's ring kiln were outlined and the desirability of its introduction in Africa demonstrated.

The design and operation of Zig-zag kilns was also discussed aside the latest developments in construction and operation of tunnel kilns.

Great importance was given to the type of fuel used in firing bricks in different types of kilns. The utilization of cheaper high viscosity grades of fuel oils in developing countries was made the central point of the industrialization of firing processes. Excessive use of wood may lead to gradual deforestation.

Finally the necessity of the promotion of brick consumption and the impact of standardization were stressed. The brick consumption may be increased simply through improving the quality of the product. Much can be made of the fact that well made structure of fired clay products need no rendering being at the same time low on maintenance. The best way of promoting brick consumption would be the ready availability of skilled brick makers. Considerable care must be exercised in setting up quality standards.

Progress Acceleration and Standardization

by H.W.H. West

The economic situation of developing countries in Africa is considered and their present output of bricks and postulated outputs for 1980 compared with Great Britain as a country with a fully developed brick and tile industry. There is considerable potential demand for bricks and tiles as the countries develop, and ways in which the industries may be expanded are suggested.

Productivity is examined first in relation to the situation in Great Britain when more labour intensive processes were used and man-power requirements for various types of production given. Simple improvements are described and amended man-power requirements listed. Modern, highly mechanised plants can have productive labour costs of less than 1 man-hour per thousand bricks. The capital costs of new works are discussed and the increase in these costs and decrease in labour costs is demonstrated over the period 1955 - 1968. The proportion of the total running costs debitable to each part of the process is given and compared with costs derived from data suggested by the United Nations Economic Commission for Africa.

Research and development facilities for a central research facility and for works laboratories are considered together with the distribution of effort, a possible research programme, and the development of new products. Quality control tests and charts are described. Reference is given to apparatus and methods for various testing procedures.

National standards are important to the development of the industry and the requirements for a standards organization are discussed. The principles of modular co-ordination are outlined and it is concluded that the initiation of a system of standards is an opportunity to ensure that they are all related on a modularly co-ordinated basis.

While in the early years of the development of a brick and tile industry emphasis may be placed on production technology, as the products improve and the buildings become more sophisticated there is a need for research into performance in use, and the establishment of advisory facilities for the consumer.

ANNEX I

Programme of the Workshop

Sunday, 6 December	Arrival and registration of participants
Monday, 7 December	Official opening by Mr. Mohamed Masmoudi, Minister of Foreign Affairs Lectures, discussions and presentations by the authors: Problems and potentials of the brick industry in Africa. Winning, shaping and preparation of clay.
Tuesday, 8 December	Lectures, discussions and presentations by the authors: The Drying and Firing of Burnt Clay Products Economic and Technical Characteristics of the Clay Building Materials Industries in Developing Countries Environmental Characteristics of the Clay Building Materials Industries.
Wednesday, 9 December	Lectures, discussions and presentations by the authors: Resources for Anticipated Development Progress, Acceleration and Standardization. Excursion by bus to Nabeul. Visits to two brick factories with traditional processing and several artistic ceramic shops.
Thursday, 10 December	Excursion by bus to Mancubia Brick Factory, Northern suburbs - La Goulette, Sidi Ben Saïd, Gammarth and Raoued with emphasis on various kinds of masonary constructions.
Friday, 11 December	Excursion by bus to Jendouba and Telarka. Visit to modern brickworks in Jendouba and of a modern wall tiles factory at Telarka.
Saturday, 12 December	General discussion, presentation of draft reports with recommendations and conclusions. Official closing of the clay building materials workshop.

ANNEX II

Participants, Experts, Observers and Officers
from the Workshop Secretariat

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ANNEX III

Description of the Plants Visited

Manoubia Brick and Tile Factory, Tunis

Background Information

1898 - Construction of the first Hoffmann kiln
1913 - 2nd Hoffmann kiln
1928 - 3rd Hoffmann kiln
1931 - Setting-up of the Maro complex
(Manufacture of 3 hole and 6 hole bricks)
1936 - Setting-up of the chevassieux complex
(Manufacture of hollow blocks, large 8 holes and
12 holes bricks and tiles)
1937 - Construction of an artificial chamber dryer
1945 - Setting-up of the Favant complex
(vacuum and steam extrusion)
1962 - Construction of the tunnel kiln, which replaced kiln No. 3

Production

60,000 tons of extrusion-pressed red bricks, blocks and tiles per year.

Raw Materials

The clay is excavated in the neighbourhood of the plant. Sand's quarry is in the suburb of Tunis, 7 km from the plant. Fired rejects are pre-crushed, ground and screened and used as a grog in blends for potential products.

Clay Preparation

Clay from the deposit is transported to a station in which its first crushing is made. Clay is loaded into small funicular railway cars by a belt and transported into the plant. Before the second step of clay preparation is proceeded with, clay is blended with sand and grog.

Extruding Plant

Vacuum extruding press is emuipped with a fully automatic Frey cutter.

Transport

is made by a chair lift devise.

Drying

Aside an artificial chamber type, open-air dryers are used.

Firing

One modern tunnel kiln and two Hoffmann kilns are used for firing the following products:

small bricks (4 holes)	4.5 x 10.5 x 21.5 cm
(6 holes)	6.5 x 10.5 x 21.5 cm
large bricks (8 holes)	10 x 20 x 30 cm
(12 holes)	15 x 20 x 30 cm
hollow blocks (Roger type)	12 x 20 x 33 cm
	16 x 20 x 33 cm
	10 x 20 x 33 cm

flat ridge tiles, called "Marseille" tiles

extruded solid bricks

pressed solid bricks

Firing temperature amounts to 950° Centigrade.

Personnel

The factory employs 243 workers, 18 employees and 2 technicians.

Maintenance

Maintenance of the equipment is done by a well equipped workshop forming part of the factory.

Jendouba Brick Factory, Jendouba

Background Information

This modern factory was built in 1966 and began to operate at the beginning of 1967.

Production

15,000 tons of extruded red bricks and blocks per year.

Raw materials

These are transported to the plant from two quarries:

a. limy clay with horizontal extraction located next to the factory

b.. excellent non-calcareous clay at 25 km from the factory.

The limy clay deposit is not a homogeneous one and fluctuation of impurities in the clay is one of the factors which requires attention in proper production control.

Clay Preparation and Extrusion

The manufacturing process is a modern one being based on the following equipment:

jaw crusher, crushing rolls, tempering mixer, vacuum extruder and automatic cutter.

Transport

The material handling system consists of cars with floors and fork-lift trucks.

Drying Plant

Italian type dryer in chambers equipped with fans and fed by warm air by a hot air generator.

Firing

Modern tunnel kiln, 63 meters long, fed by burners using heavy fuel oil No. 2. Firing temperature amounts to 900° Centigrade.

Personnel

The factory employs 75 workers, 2 employees and 1 technician.

Maintenance

Maintenance of the equipment is done by a workshop forming part of the factory.

Talarka Tile Factory, Talarka

Background Information

This modern wall tiles plant was built in 1966 and began to operate in May 1967. The production is on a high technological level. This plant operates 150% from the projected capacity and proves high economic results.

Production

3,150 tons of white, coloured and decorated wall tiles, dimensions 150 x 150 mm and 75 x 150 mm, per year. Aside this main manufacturing programme, fritts are melted in the factory, not only for its own use, but also to meet the demands of other local kitchenware manufacturers and small ceramic shops.

Raw Materials

The four raw materials used in the processing of wall tiles body are: white kaolin, dolomite, sand and grog.
Raw materials are stored in a roofed area in front of the main production hall and their drying, if needed, is made in open air.

Body Technology

The wall tiles technology is based on crushing of raw materials, dry grinding of the batch, granulating of the mass in a granulator by adding water and regulating the moisture content at the same time. This is followed up by semi-dry grinding in dry processing edge runner mills, and screening before storing the mass in two bins.

Pressing

Tiles of both formats are pressed by 3 friction presses, 2 automatic and 1 semi-automatic. Mechanical strength of green body excellent. Pressed tile edges are cleaned after pressing, the pressed tiles are piled and loaded on biscuit kiln cars.

Drying

To decrease the pressing moisture under 1% from the total, tiles loaded on biscuit kiln cars are dried in a double tunnel drier for 43 hours.

Bisquit Firing

A tunnel kiln 50m long is installed for bisquit firing of wall tiles. It is equipped with 16 side firing burners using heavy fuel oil No. 2. The bisquit firing temperature corresponding with the dolomite-silicious body composition, amounts to 1050° Centigrade.

Glazing

Due to relatively low shrinkage during the bisquit firing process, no special calibration is needed. However, edges of bisquit tiles are "cleaned" by whetting them on a transport belt before glazing. Two double waterfall glazing machines are installed in the plant. About 30 gr of a raw white glaze are applied on a bisquit tile measuring 150 x 150 mm. One piece of glazing equipment is used for the manufacture of decorated tiles. A bisquit tile after being glazed proceeds gradually to three automatic screen-printing machines, each of which prints one colour of a design. The glazed and decorated tiles are then inserted by hand from the belt directly into saggars erected on muffle kiln cars.

Preparation of Glazes

Fritts, needed for the glaze preparation, are melted from their components in a stationary rotary kiln at the temperature of 1,400° Centigrade. After the melting process is finished fritts are cooled in water. Glazes are ground wet in ball mills from fritts and other additives, such as kaolin. Only opaque glazes are used in the wall tiles manufacture and the used opacifier "Zirconsiliente" is melted in fritts.

Glost Firing

Glazed tiles, loaded on muffle tunnel cars, are wheeled into the muffle tunnel kiln and then fired at 980° Centigrade. This kiln also uses heavy fuel oil No. 2.

Sorting of Wall Tiles

Fired wall tiles are discharged from the saggars by hand and they are sorted either on sorting belts or by hand into the Ia, IIa quality and rejects.

Packing

Sorted tiles are packed into boxes for transportation.

Laboratories

The wall tiles plant is equipped with a laboratory for production control, tests and research. A photo laboratory produces screens with different designs for screen printing machines.

Personnel

The wall tiles plant employs 105 workers, 5 employees and 4 technician.

Maintenance

Maintenance of equipment is done by a workshop forming part of the plant.

Nabeul Brick and Pottery Factories

In order to demonstrate traditional processing in brick and pottery manufacture, the Tunisian Government invited participants to Nabeul to see two artisanat brickworks and two artistic ceramic shops one of which was a Governmental Pilot Plant for ceramics

The traditional brick processing was based on simple clay preparation in cylinder mills shapping products in an extruder. Open air dried hollow bricks were then fired in periodical kilns, heated by wood and agricultural wastes. Due to high content of limestone in clays, firing temperature amounted to 850° Centigrade only. Two of the brickworks visited form part of a company, with 220 workers, which produces 20,000 tons of bricks and hollow bricks per year. Aside the main processing programme, also twice fired sanitary pipes and fittings are produced in the company.

Artistic ceramic shops were developed on a good technological level. In spite of simple body preparation, different attractive shapes of products are casted into plaster moulds and shaped on pottery wheels. Decoration of products is made by engraving green bodies, using underglaze decors with transparent glazes, engobes and opaque glazes with handpainting. Aside the open fire and muffle kilns, heated by wood, periodical small sized electric kilns were also applied for firing products. While the biscuit firing temperature amounted to about 950° Centigrade, the glost firing temperature was applied by about 900° Centigrade. Finished products are nice, glazes do not craze, colours applied are plain and, due to national motives applied in designs, artistic ceramics are of high interest to tourists.

ANNEX IV

List of Documents issued

Symbol	Language	Title and Author
ID/WG.81/1	E, F	Provisional Agenda
ID/WG.81/2	E, F	Problems and Potentials for the Brick Industry in Africa - UN Economic Commission for Africa, Addis Ababa, Ethiopia
ID/WG.81/3 and SUMMARY	E, F F	Progress, Acceleration and Standardization - H.W.H. West, Head of the Heavy Clay Division and Officer in Charge, Mellor-Green Laboratories, Shelton, Stoke-on-Trent ST1 4LZ, United Kingdom
ID/WG.81/4	E	Production Technology - Mining, Preparation and Shaping of Clay - H.W.H. West, Head of the Heavy Clay Division and Officer in Charge, Mellor-Green Laboratories, Shelton, Stoke-on-Trent ST1 4LZ, United Kingdom
ID/WG.81/8	E, F	The Drying and Firing of Baked Clay Products - R.G. Burkhardt, United Nations Development Programme, P.O. Box [illegible], Tananarive, Madagascar
ID/WG.81/9 and SUMMARY and Corr. 1 and Add. 1	E F E E	Resources for the Anticipated Development - [illegible].O. Knizek, Consultores Cerámicos Para La América Latina, Pasteo 105, Mexico 5, D.F.
ID/WG.81/10	E, F	Economic and Technical Characteristics of the Clay Building Materials Industries in Develop-Countries - S.B. Johansen, Apartado de Correros 29, Premia de Mar, Barcelona, Spain
ID/WG.81/12 and SUMMARY	E F	Environmental Characteristics of the Clay Building Materials Industries in Africa - Z. Berhane, Head, Materials Research and Testing Department, Ethio-Swedish Institute of Building Technology, P.O. Box 518, Addis Ababa, Ethiopia
ID/WG.81/13	E/F	Provisional List of Participants
ID/WG.81/14	E, F	Provisional List of Documents
ID/WG.81/25	E, F	Draft Final Report

Background Documents

Symbol	Language	Title and Author
ID/WG.81/5	E, F	Proposal Concerning Setting Up Brickworks in Libya - UN Economic Commission for Africa, Addis Ababa, Ethiopia
ID/WG.81/6	E, F	Proposal Concerning the Setting Up of a Plant for Ceramics Production - UN Economic Commission for Africa, Addis Ababa, Ethiopia
ID/WG.81/7	E, F	Proposal for the Construction of a Ceramics Factory in the Ivory Coast - UN Economic Commission for Africa, Addis Ababa, Ethiopia
ID/WG.81/11 and SUMMARY	E F	Technology of Clay Building Materials Manufacturing - N.Z. Shinkarouk, Ministry of Building Materials Industry of the Ukrainian SSR, USSR
ID/WG.81/15 and Add. 1	F F	Contribution of Niger - K.A. Labo, Civil Engineer, Cement Corporation of Niger, B.P. Box 355, Niamey, Niger
ID/WG.81/16	F	- The Development of Clay Building Materials Industries in Tunisia - T. Abdelwahed, Président Directeur Général de la Société Bâtiment, Tunis, Tunisia
ID/WG.81/17	E	A Monograph on the Clay Building Materials Industry in Ghana - J.O. Ahia Lamptey, General Manager, Brick and Tile Division, Ghana Industrial Holding Corporation, P.O. Box 107, Kaneshie-Accra, Ghana
ID/WG.81/18	F	The Baked Clay Industry in the Tananarive Area: Present Techniques and Immediate Prospects - V. Ramangahalison, Président Directeur Général, Société malgache de briqueterie, P.O. Box 540, Tananarive, Madagascar
ID/WG.81/19	E	Clay Building Industry in UAR - K. Zeitoun, Architect, Ministry of Housing and Public Utilities, Ismal Abaza Street, Cairo, United Arab Republic
ID/WG.81/20	E	Notes on Investigations of Clay Resources of Libya - A.A.S. Breni, Head of Executive and Supervising Department, The Industrial and Real Estate Bank of Libya, P.O. Box 2297, Tripoli, Libya

ID/WG.81/21	F	Contribution of Morocco - A. Affia, Laboratory Engineer, Research and Training Centre, 8 rue de Ciguig, Rabat, Morocco
ID/WG.81/22	F	Pilot Plant for Ceramics in Dahomey - T.F. Mito-Raba, Civil Engineer, Ministry of Public Works, P.O. Box 351, Cotonou, Dahomey
ID/WG.81/23	F	Use of Congolese Clays in Building - D. Mouyi-Cickasso, Professeur de dessin d'architecture, P.O. Box 459, Brazzaville, Congo
ID/WG.81/24	F	Baked Clay in Togo - P. Dansou, Chemical Engineer, Chief, Laboratory Section, Building and Housing Centre, P.O. Box 2095, Lome, Togo
ID/15	E, F	The Establishment of the Brick and Tile Industry in Developing Countries - H.W.H. West
ID/28	E, F	The Development of Clay Building Materials Industries in Developing Countries (Report of the Interregional Seminar on Clay Building Materials Industries, 1968)
ID/WG.16/2	E	Testing and Evaluation of Brick Clays - V. Lach

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