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THE DEVELOPMENT OF CLAY BUILDING MATERIALS INDUSTRIES IN DEVELOPING COUNTRIES

Report of the Interregional Seminar on Clay Building Materials Industries

Copenhagen, 12 - 25 AUGUST 1968

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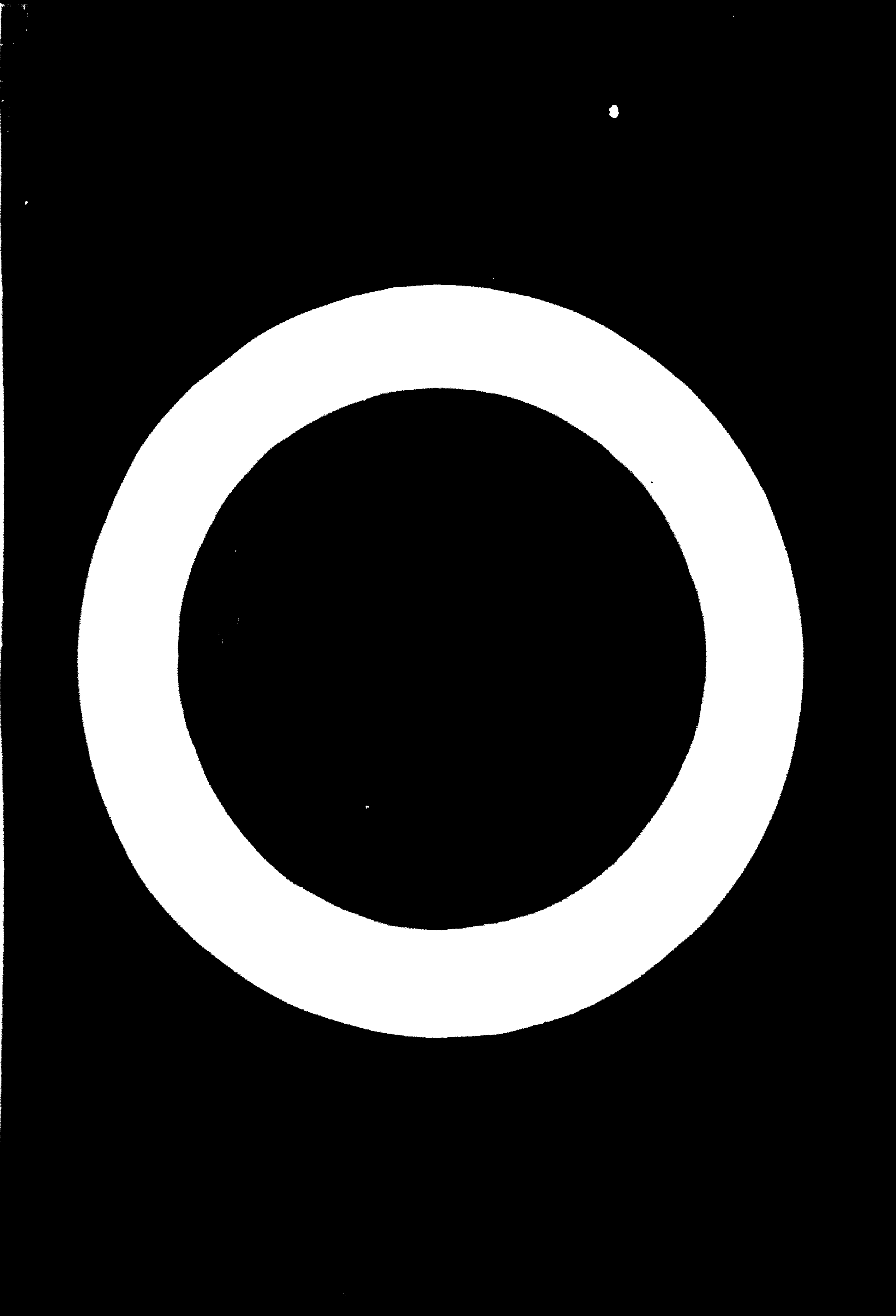

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Preface

The Interregional Seminar on the Development of Clay Building Materials Industries in Developing Countries was held in Copenhagen from 12 to 25 August 1968, under the sponsorship of the United Nations and the Government of Denmark. The programme for the seminar was developed jointly by the United Nations Industrial Development Organization (UNIDO), the Danish Board for Technical Co-operation with Developing Countries and the Danish Brick and Tile Association.

The purpose of the seminar in Copenhagen was to bring together responsible officials of developing countries from both the policy-making and technical sectors to meet clay industry experts from Denmark and elsewhere in order to discuss all aspects of plants for making clay building materials.

Participants and observers from twenty-one developing countries attended the seminar, which was held at the Scandinavian Seminar College "Bakkerne" in Holte near Copenhagen. The seminar was attended by twenty-one experts, most of them from industrially developed countries, including one representative from the United Nations Centre for Housing, Building and Planning.

Mr. Jørgen Bryrup served as Director of the seminar, representing the Government of Denmark. Mr. Janos Fath and Mr. Sergei Boldyrev, of the Industrial Technology Division of UNIDO, served as Co-director and Rapporteur respectively.

Twenty-five papers were presented by participants who were experts of established reputation in their respective fields. These were followed by discussions on the application of the subject matter to the circumstances and needs of developing countries in general, and to the specific conditions in the participants' countries. Six papers were prepared by UNIDO for the seminar; one was presented by the United Nations Economic Commission for Africa, three by the Brick Development Association of the United Kingdom, two by the British Ceramic Research Association and one by the Ethio-Swedish Institute of Building Technology. The background literature contributed substantially to the exchange of experience and ideas.

To offer further opportunities for discussions and to acquaint the participants with the operations of the clay building materials industries, visits were arranged to various plants, building sites, research and testing stations, and training institutions in Denmark.

This report consists of three main parts:

Part I — Conclusions and recommendations discussed and adopted by the participants, defining specific forms of technical assistance and offering guidance for policy makers and managers;

Part II — Summary of the lectures given at the seminar;

Annexes — Programme of the seminar; list of participants, lecturers and observers; list of papers presented to the seminar; and brief description of the plants visited.

Opportunity is taken to express appreciation to the Danish Board for Technical Co-operation for its excellent technical facilities and to the experts and staff members who worked for the success of the seminar.

PART I REPORT OF THE MEETING

1. The utilization of local raw materials is of concern to all developing countries, and its importance to the building materials industries has been widely acknowledged and emphasized. A United Nations General Assembly resolution recommends that Governments should "take all necessary measures to develop a building materials industry utilizing local raw materials to the maximum...".1/ The International Symposium for Industrial Development, held in Athens in 1967, recommended that "Developing countries should, where appropriate, give higher priority to the development of the building materials industries in order to achieve greater efficiency in their construction activities, better utilization of local raw materials resources and savings in foreign currency".2/

2. Brickworks at every stage of development exist in the participants' countries, but actual brick production *per capita* is about half that found in industrialized countries. Even this is not a complete picture of the situation because the rate at which the population grows makes it more and more difficult to obtain exact figures.

3. If the brick building industries are going to improve, international assistance has to be mobilized. Quality should be encouraged through improvements of existing technology. This would be valuable preparation for handling more sophisticated plants. Quantity should also be considered; international assistance should be concentrated on the exploitation of national resources. This dual task can be accomplished in a reasonable length of time with the assistance of international organizations that take care of undertaking raw material surveys, establishing contacts with professional experts, collecting statistics and distributing material of interest to the industry.

4. Since many problems repeat themselves in developing countries, all efforts should be mobilized to increase rationalization and quality. Many well-organized attempts for improvements have had little impact owing to a lack of capital and trained personnel. It is therefore expected that the United Nations will continue to expand activities in order to further the socio-economic situation of all countries.

1/ Official Records of the General Assembly, Twentieth Session, Supplement No. 14 (A/6014), Resolution 2036 (XX), adopted 7 December 1965, p. 39 para. 1(c).

2/ Report of the International Symposium on Industrial Development, ID/B/21, Annex 1, p. 81, Recommendation 1 (not available for distribution).

Conclusions and recommendations

Building activities in developing countries

5. The current volume and expected expansion of building activities indicate the need for an appropriate growth of the building materials industries in developing countries. Adequate housing in urban and rural areas is a social necessity. The investments in the infrastructure and the erection of public buildings require a diversified building activity claiming a major part of the total investment in virtually every developing country. Moreover, the development of a building materials industry has an increasing effect on employment and income. In such circumstances, the selection of the most appropriate building methods and materials is of crucial significance, and the establishment or extension of local building materials industries has become a matter of urgency.

Clay-based building materials

6. The present and future roles of the clay building materials industry depend on the qualitative and dimensional characteristics of its product in relation to the functional requirements of the buildings to be erected. Most of the burnt bricks produced in developing countries have a compressive strength below 50 kg/cm^2. Bricks vary in size from region to region according to local demand and traditional methods. In modern plants bricks can be produced with a compressive strength of 200-300 kg/cm^2. The qualitative characteristics of the products should harmonize with the needs of the regions while keeping pace with the industrial applications of other building materials. The establishment of appropriate standards plays an important role in ensuring that buildings are constructed of adequately durable material.

7. There are many different standard tests in use, but in some cases none are being applied. The adoption of unified methods of testing would be very helpful. It was suggested that the International Organization for Standardization (ISO) be consulted on this matter.

8. Attention was drawn to the technical and economic significance of selecting the appropriate size of clay product and to the advantages of modular co-ordination. In regions where a certain size is traditional, a gradual introduction of standards prescribing successively more rigorous requirements is advisable.

9. In most countries it is possible to diversify production in order to provide the building industry with a wide range of heavy clay products, for example hollow blocks, perforated bricks, land drains, prefabricated clay wall panels, roofing tiles, floor tiles, paving bricks and expanded clay products.

10. The non-traditional use of bricks was discussed, including reinforced slabs, wall panels with or without concrete, bricks laid on flat slab roofs to protect them against weather and extreme temperature changes and so on. These uses show the need for co-operation with the building industry, since any development in the characteristics of clay building materials must be scrutinized within the context of the efficiency of the entire building process. Non-traditional uses of clay building materials demonstrate the compatibility of this ancient building material with modern methods of industrialized building.

11. In several countries there would be a greater demand for clay building materials if production costs and selling prices were lower. In many regions handmade clay products are able to compete with the products of modernized plants because their market prices correspond to the minimal requirements for those consumers who have low purchasing power. Transport costs also limit the area of sales of products from sizable mechanized plants. At the same time, clay products should be competitive in price and quality with other building materials, which means that bricks and tiles from mechanized plants are exposed to competition from handmade bricks, as well as from other materials.

12. The volume and continuity of building is a sensitive indicator of economic health, and the clay building materials industry follows very closely the variations in building activity. It was felt that the clay building materials industry has been treated as a low priority industry in development programmes and in the allocation of financial aid. It must be recognized that there is perhaps a greater-than-average risk in investing in highly mechanized plants for clay building materials. An investment credit or tax incentive system might be necessary to ensure development. Indeed, there might well be many circumstances where direct government financial assistance is essential. The international agencies that generally give higher priority to the financing of infrastructure projects should consider extending their credit facilities to the building materials industry.

Consumption and production of clay building products

13. The consumption and production of clay building materials in absolute figures might seem impressive, but the picture is less favourable if the figures are considered in relation to population, even when climate, availability of other building materials and traditions are taken into account. New projects for modernized plants have been reported in the majority of countries along with parallel improvements in the traditional sectors. In other countries more emphasis has been placed on the development of the traditional brickworks, because lack of capital, higher overheads, differences in wage rates and lack of appropriate transport facilities make it uneconomic to concentrate production. With regard to the consumption and production figures, the statistics from most countries do not satisfactorily cover the clay building products industry. Improvement of the statistical services was recommended.

14. Because changes in the production and use of clay building materials take place slowly, it may be expected that the traditional and modernized sectors would continue their progress together for some time in all developing countries. Development would be partly the result of an increased share of the total sector being taken over by modern plants, and partly through improvements in the traditional processes. Considering the life expectancy of a modern plant and the impact its erection might have on its environment, it was suggested that a strategy be elaborated for the development of the whole sector, giving careful consideration to future demand, to the existing production potential, and to the need to increase the efficiency and diversity of production. The starting point and immediate objectives in countries commanding a high level of technical resources and infrastructure would not be the same as those in countries with sizable natural resources other than clay, or in countries with a low per capita income.

15. The production of unburnt clay materials was not considered, although it has been suggested that stabilized clay blocks represent an inexpensive and useful building material with a satisfactory life. The development of an industry producing durable building materials might, however, be considered crucial to economic development.

Production processes and plants

16. Knowledge of raw materials resources is generally inadequate. In many cases, even the general location of clay deposits is not known. Local surveys should be carried out in potential development areas, and the deposits should

be described. This might be done at first by simple field tests aimed at identifying the most promising materials for laboratory tests. A full-scale clay report should be prepared and an expert evaluation of the resources should be carried out before any investment is made in plant and machinery.

17. Considerable interest was expressed in the first stages of mechanization, i.e. the installation of simple, inexpensive machines in existing manually-operated plants. There was a need to assess the requirements more exactly and perhaps to design a simple forming machine capable of producing perforated bricks and hollow blocks. Such products are not only light and inexpensive to transport, but can be made in large sizes for more economical laying, and the voids can improve the thermal transmittance of the wall. Hollow blocks can be used for making inexpensive and effective roof decks.

18. A major topic of the seminar was the process of natural drying. Improvements in this field should be exploited and publicized in developing countries. The transition from seasonal to year-round operations is important in providing continuity of construction, production and employment. Some consideration should be given to the use of artificial dryers. Natural drying is less efficient when the humidity is relatively high. Where possible, more extensive use should be made of the waste heat from cooling kilns.

19. Simple clamps and kilns will continue to be used in small-scale rural operations, but the more widespread use of continuous kilns would significantly improve quality and output. Interest has been shown in the methods of conserving fuel, especially wood, which is scarce in many areas. As far as possible, the use of other kinds of fuel should be encouraged. If wood is used, however, appropriate programmes of afforestation should be initiated.

20. The general absence of the danger of frost attack in developing countries seems to have put the average firing temperature at a point too low to develop a good ceramic bond. This accounts, at least in part, for the generally very low strength. Flexibility of kilns is important, and the firing facilities should ideally accommodate fluctuations in demand so that a plant can reduce its production without serious economic consequences. Some participants expressed an interest in obtaining information about a more efficient periodic kiln for small outputs.

21. Near large urban areas, particularly capital cities, the demand for building materials of all types will probably warrant the erection of one or more modern factories for making bricks, tiles, sewer pipes, sanitary goods, and

wall and floor tiles. Such factories may appropriately be highly mechanized, but there is a general need to consider the best balance between mechanized and manual operations. An over-all plan should be drawn up to avoid problems in later stages. Studies should be made of the best way to rationalize production methods in different areas, and alternative plans which would have widespread applicability should be formulated.

22. Equipment imported into a country may not always fill the requirement because local conditions may lead to operation at less than optimum efficiency. Impartial advice is needed to ensure that the most appropriate equipment is obtained.

Sectoral infrastructure

23. The clay building materials industry, like any other industrial sector, needs an appropriate sectoral infrastructure of research and testing facilities, technical information services, training institutions and professional associations. Depending on the magnitude of the industry, these institutions may be established as independent units or as branches of already existing organizations. Their concerted activities in close co-operation with the building industry and housing authorities are prerequisites for the continued growth and efficiency of this industrial sector.

24. Information and testing services, particularly testing to ensure compliance with the national standards for building materials, need priority. In the early stages of development, existing research and testing facilities in other countries can be used, and direct co-operation with these countries should be sought. Experts might well provide a service which could later be expanded.

25. The establishment of national and regional centres is regarded as important in providing specialized advice and assistance on local problems, thus raising the general level of technical awareness in the area.

26. The training of professional people and possibly also technicians may best be accomplished at established centres. In countries where none exist, facilities in other countries may be used until a nucleus of trained men is available to establish a centre. At other levels, in-plant training is essential. This may necessitate establishing a central "training factory" with national and international support. This factory could also serve as a pilot plant for processes and products new to the existing industry.

27. National and regional associations of manufacturers should be promoted to provide a useful platform for the exchange of information and advice, and to help in maintaining stable marketing conditions. Professional associations of architects, building contractors, ceramic technologists and engineers provide focal points from which developments and innovations arise. In addition, co-operation among the associations should lead to improvements in productivity and techniques in the building industry.

International co-operation

28. It was suggested that an experts' meeting or workshop on the development of clay building materials industries in various regions be held in Africa, Asia and the Far East, and Latin America. Such a meeting could be organized by UNIDO and the regional economic commissions. It was also suggested that interregional meetings be held every four years; in the intervening years, regional meetings should take place in each of the developing areas.

29. UNIDO was asked to assemble international experts, in order, on request, to assist the developing countries to rationalize their clay building materials industries, to introduce technical and organizational improvements, and to prepare feasibility studies for major ventures.

30. UNIDO and the United Nations Centre for Housing, Building and Planning were asked to assist, on request, in establishing national and regional institutions serving the special needs of the clay building materials industries and the use of these products in housing construction.

31. The establishment of regional research, technical information and training institutes for heavy clay products in Africa, Asia and the Far East, and Latin America was proposed to serve the needs of these regions. It was also suggested that missions from the United Nations be sent to interested countries to analyse needs and to prepare draft projects for the institutes.

32. UNIDO was asked to transmit relevant technical information on organization, processes and equipment to developing countries.

33. UNIDO was asked to assist, on request, in the erection of pilot and demonstration plants for the clay building industry.

34. It was felt that the organization of an international information bureau serving in particular the needs of developing countries should be carefully studied, and appropriate suggestions submitted at one of the next international

meetings organized for the clay building materials industry. This bureau should be located in a developing country and should be responsible for standardization, development of testing methods, collection of production statistics, and the production and distribution of information on raw materials. It should also establish contacts between experts and responsible leaders in planning and industry.

35. The United Nations Centre for Housing, Building and Planning, in co-operation with the Government of Denmark and UNIDO, was asked to provide technical information on selected designs of low-cost housing for countries using heavy clay building materials.

36. UNIDO was asked to organize a three-months in-plant training programme for foremen and works managers in the heavy clay building materials industry in 1970. Denmark and the United Kingdom could be invited to act as host countries.

37. The United Nations was asked to provide assistance where required in searching for and surveying suitable raw materials for the production of heavy clay building materials.

PART II SUMMARY OF LECTURES

The role of the clay building materials industries

by Peter Hartmann

38. The speaker based his lecture on his experience at his own plant - discussed at greater length in TBE 1952-1962[3] issued to all participants - and also on his general knowledge of industrial conditions in Europe. Some factors determining the role of the clay building materials industries were mentioned. Highly varying conditions make if difficult and sometimes dangerous for one country to follow the example of another. Exchange of experience is nevertheless always useful and inspiring and can at least illustrate what should not be done.

39. In all countries there is a large unexploited reserve of capital and labour which is available for planning, designing, erecting and equipping buildings, and for indicating the most effective use of clay building materials. In principle, it should be the price, quality and life (as well as utility value and maintenance costs) of the material that determine the choice of material or building method. An emotional, long-standing feeling for the material should not be the motive for selection, nor should the wish to adopt new ways at any price by an acceptable reason.

40. Many tested possibilities exist for the use of industrially produced components, for example floors, stairs, doors, windows, cabinets and service units, in buildings with partitions and outer walls of clay building materials. In some countries there is a trend towards the use of prefabricated wall units of burnt clay. Clay building materials therefore play an important role in industrialized building. To maintain, and in many countries to increase, this role, it is essential to make use of technical development at a pace and to an extent that corresponds to practical possibilities in individual countries. In this way, production increases, and the quality of the products improves. At the same time, an effort can be made to educate bricklayers, to improve the planning of the building process, and to introduce further standardization and the modular system.

3/ European Federation of Brick and Tile Manufacturers, 1952-1962, Langkjærs Bogtrykkeri A/S, Copenhagen, 148pp.

41. The methods of production and use of clay building materials are known and appreicated in most countries. It is possible to expand production and consumption and to improve the quality of these materials at a relatively low investment. Limited economic resources should not be spent on the erection of single super-modern prestige plants, such as those built in Europe where wages are far higher than in developing countries.

Prospecting for raw materials

by Peter Hartmann

42. The lecturer evaluated the step-by-step approach in surveying an area for raw materials. Such areas should not be too far from an existing or proposed plant. Transport possibilities and the state of public roads are also important deciding features. When a suitable raw material deposit is found, the ground water should be examined and drainage possibilities carefully considered before the final agreement for utilization is signed.

43. All technical features have to be translated into economic terms and considered before the clay area is contracted for. It is desirable to secure enough clay land for at least twenty years. After the rights to a certain area have been secured, a more careful examination of the raw material deposit should be undertaken. A drilling grid should be chosen where the samples to be analysed can be drawn.

44. If, for example, the area is 10 to 20 hectares, one hole should be drilled in each corner and one in the middle, down to a depth of, for example, 5 metres. What must be ascertained is the thicknesses of the overburden and of the clay in a vertical direction to the nearest metre.

45. However, if it is obvious that substantial variations in thickness exist, it might be necessary to reduce the spacing of the drill holes to a grid of 20 metres.

46. Of the varied drilling equipment considered, the most simple, primitive, but at the same time often sufficiently good machine is the hand soil-auger that is operated by two men. (This cannot be used in hard material.) With such an auger it is possible to obtain samples up to a depth of about 7 metres. More expensive drilling equipment, possibly mounted on a jeep, can expedite the investigation.

47. Although reliable information can be obtained from a variety of physical and chemical tests on the samples, it is important to carry out pilot tests on the actual process before all economic data are submitted.

Examining raw materials

by Henry Dührkop

48. The ability of wet clay to yield to pressure, assume a given shape and maintain the shape when the forming pressure is removed, is the basic property that makes clay different from other materials. Because plasticity is a fundamental property for the traditional use of clay in the building materials industry, the testing of plasticity is particularly important.

49. Shrinkage is a physical property possessed to some degree by all types of clay. It is tested by taking a sample that is measured just after forming and again after drying. Based on these results, it is easy to calculate the drying shrinkage. By burning the test specimen and measuring it once more, the percentage burning shrinkage can be determined.

50. Tensile strength affects the behaviour of the products during treatment at the brickworks, from the end of the moulding process to the completion of the produot. It is difficult to indicate how strong the bricks have to be, but if a clay has to be selected from two or more types, it can be useful to determine the tensile strength by bending tests in a laboratory. In most cases, however, it is best to subject the brioks to a treatment similar to that to which they will be exposed at the brickworks, and to observe and test them after firing.

51. Fusibility is a very important property in the heavy clay industry. One way to test it is with an electric kiln shaped like a tube with an outside covering made so that there is a temperature drop of about 300°C from the middle of the tube towards each end; by inserting thin clay rods so that one end is at the centre of the cross section of the tube - the point of highest temperature - it is possible from the location to judge the temperature at partial vitrification and at viscous fusion. Moreover, by marking the clay rod in advance with lines of a centimetre scale, it is possible to judge the variation of the burning shrinkage in relation to the temperature. Burnt rods may also offer information on the influence of the burning temperature on the colour of the finished product and possibly also on its tendency to expand.

52. Only in exceptional cases are chemical properties examined outside of the laboratory. The risk of lime-blowing is examined in the laboratory by placing the burnt product in an autoclave and exposing it to steam under a certain excess pressure for a number of hours. Mineral pyrite may cause the same kind of damage as the lime grains, since the pyrite grains disintegrate easily in contact with oxygen and water; this disintegration is accompanied by an increase in volume. The pyrite grains are often dark and rust-coloured; any clay found containing such grains should be examined in a chemical laboratory.

53. It is possible that a high enough salt content in the raw clay may cause efflorescence on the burnt products, making it advisable to develop the efflorescence on test bricks burnt in the kiln of the brickworks so that the salts can be analysed. The prevention of efflorescence must then be determined in consultation with the chemical laboratory.

Clay winning and preparation

by H. Juel Andersen

54. The manufacture of bricks begins with winning of the clay, just as the attempt to make a first quality brick starts in the clay pit. If the clay is stratified, a preliminary mixing in the pit using the proper machines can be undertaken. The equipment and the mine profile depend on the raw material deposit. The equipment used in the pit and the distance between the pit and plant are important in deciding the means of transport.

55. The process of tempering brings about a uniform penetration of moisture in the mass, an additional mixing of the raw materials, and an increase in the plasticity and tensile strength. Using this process, the raw materials are mixed and prepared and then stored in a silo or sumping plant.

56. The preparation of clays encompasses a threefold task: the homogenization of the materials, the purification of the clays, and the development of plasticity. If the process of mixing involves simply the use of one material of practically constant physical and chemical constitution, the problem is simplified. If the process involves the mixing of dissimilar substances, such as two different clays, or shale and clay, it is important that the materials be thoroughly mixed in order to obtain a uniform product.

57. In most cases, the choice between a wet and a dry process is based on the material to be prepared. The selection of the individual machines depends primarily on the raw material.

Brick moulding

by H. Juel Andersen

58. Bricks are formed or moulded by one of three processes: "soft-mud", "stiff-mud" or "dry-press". The preliminary mixing processes are fundamentally the same, except that the water content varies from considerable in the soft-mud to practically none in the dry-press process.

59. Handmade bricks are formed in a soft-mud process, but in many countries, the process has been partly mechanized. This process is based on the concept of reducing the moulder's work to the moulding machine itself, and treating the other steps in the operation as a problem of handling materials. The production per man-hour can be raised further when slop-moulding presses or box-mould presses are used.

60. In the stiff-mud process, the clay is forced by means of a worm screw through a die. In the stiff-mud process, an important development, de-airing, is accomplished by a vacuum chamber attached to the worm screw machine. The advantages of de-airing are increased workability, plasticity and strength in the green (undried) brick. The products can be modified further by sanding, finishing or decorating the brick before it is cut by a wire cutter.

61. In the dry-press process, the brick units are moulded at a high pressure. The major advantages of the dry-pressed process are that pre-drying is not required and that the bricks are accurate in size. A disadvantage is the low output rate of the single presses.

Clay drying

by C. Falk

62. Knowledge of the theory of clay drying is important to those concerned with the drying of newly moulded clay products at the brickworks. One must be aware of the quantity and variation in the content of water and of the distribution of water in a newly moulded product, as well as the reaction of clay during the evaporation of the water.

63. The water content of the clay is eliminated by drying in an air flow, where the correct combination of temperature, relative humidity and velocity of the air produces optimum drying conditions. The state of the air, i.e. the drying conditions, ought to be modified during the drying process. In this connexion, it is possible to determine in a laboratory the optimum drying conditions even

though they are different for each type of clay. These experiments should be undertaken with recently moulded products made in the machines of the brickworks and not with samples moulded in the laboratory.

64. For most types of clay, the drying shrinkage is practically complete when approximately one half of the water content of the clay has evaporated. This means that afterwards the products can lose much more water without any risk of cracks forming. The Mollier diagram and its use in the drying of clay can be examined as a practical example of this process.

65. There are various forms of drying plants for both natural and artifical drying. One can refer to the construction principle and the procedure for chamber and tunnel-drying plants. There are also new forms of quick-drying plants in which steam-heated, thin-walled clay products are dried in a few hours.

Firing heavy clay products in intermittent kilns

by A. E. Aldersley

66. The characteristics of the fuel used in firing must be considered, for example, the relationship between the temperature and the viscosity of fuel oil. Chimney draught is important and therefore wickets must be carefully sealed. Loss of draught in a kiln system must be avoided by suitable choice of size of flues, floor openings and so on. The reactions occurring in a bed of solid fuel should be studied. Sufficient secondary air and grate area are needed in kilns hand-fired by solid fuel.

67. There are both advantages and disadvantages to oil firing. Breaking down the clay molecule and burning out any carbon and sulphur directly influence the firing. The on-load contraction test is important. The process of firing can be divided into three stages - water-smoking, preheating and vitrification. The theoretical flame temperature and the effect of excess air must be considered, and the firing must be carefully controlled during the stage at which carbon is oxidized in the body. Excess air can be used to reduce the temperature of combustion products. Pressurization to kiln floor level is effective in preventing leakage of cold extraneous air into the kiln. Thermocouples can be used and cumulative heat can be measured. The flue gas can be analysed by an Orsat apparatus.

68. The intermittent and continuous methods of burning can be compared. The down-draught is more efficient than the up-draught, and the kiln size affects the fuel consumption per unit of product. Application of insulation, interconnexion of kilns, methods of minimizing the loss of heat in the flue gases, and

waste heat recovery are all problems that must be considered. A current trend is towards rapid firing which affects the kiln design.

Continuous kilns

by K. Carsten Pedersen

69. There are many aspects that must be considered in determining the type and capacity of a kiln. The kiln is normally the principal part of a brickworks because it is the most expensive structure in the plant, and of all the various bottle-necks encountered in the process of brickmaking, the kiln would be the most costly to expand. For this reason it ought to be constructed with an adequate reserve capacity in relation to the rest of the works.

70. There are several types of continuous kiln that are used today. The annular kiln has a ring-formed chamber in which the fire advances continuously, during which time green bricks are stacked in it and burnt bricks are taken out. The car-tunnel kiln has a fixed firing zone, and the bricks are carried through the kiln on cars equipped with refractory decks.

71. The fuel in all types of kiln may be coal, oil or gas (manufactured or natural) fed from the top or from the sides of the kiln by mechanical or automatic methods.

72. The choice of type and capacity of the kiln is based on a series of conditions concerning the financing of the construction, the economy of the production, local markets, accessible raw materials, the quality requirements of the products and so on.

73. A highly mechanized plant needs a constant power supply, a large stock of spare parts, and easy access to skilled employees who can service the electrical and mechanical equipment. This kind of plant is ideally located in districts where some industrial development has already taken place.

74. If, on the basis of a market analysis, a kiln of a certain capacity has been decided on, a production budget for various types of kilns can be set up. The production costs (and even profits) vary with increasing degrees of mechanisation and automation. Local prices and wages determine which kiln is most economical. However, after considering the local conditions, it is often advantageous to construct the works in such a way that the degree of mechanization can be increased at some later date without major alterations in the plant.

75. The kiln capacity is also determined by the demands that already exist or will be created by development initiated by private or public sources in the area within which the bricks can be transported at a reasonable cost.

Handling methods and layout of brickworks

by H. W. H. West

76. The process of brickmaking has generally not progressed at exactly the same rate in each developing country. Until recently there was a tendency to improve one or another part of the plant without giving much thought to the over-all development of the process. Consequently, although works might have been effective when erected, replacing individual machines with better and later models, without considering the effect that these changes would have on the subsequent stages of the process, has led to a decrease in the efficiency of the plant.

77. Among the important characteristics of a properly planned modern factory are production balanced throughout the process and a suitable volume of hoppers provided at critical points to ensure that temporary fluctuations in supply do not affect the average rate of production. Central to this planning is recognizing the handling methods available to transport materials and products through the process, and knowing the principles of good layouts which lead to minimum labour costs. A variety of handling equipment for brickmaking is available, including automatic setting machines, and many types of "ideal layouts" have been adapted in modern factories.

78. Labour-saving devices and situations should be studied in order to identify certain problems in planning an efficient modern works where labour is an expensive commodity and capital is relatively plentiful. An alternative solution could be the use of manual labour, which may be preferred in developing countries. Nevertheless, the path towards completely mechanized plants must also be demonstrated, since such factories not only reduce the labour costs of operation, but also establish such rigorous control that a consistent high quality product results and waste is reduced to negligible proportions.

Final products: characteristics, control and testing

by Henry Dührkop

79. The properties considered important in a finished clay product can be divided into two groups: the aesthetic and the technical properties.

80. Technical properties include weight, apparent and true specific gravity, and resistance to water and vapour penetration. A design engineer is most concerned with these properties in his evaluation of the product. The figures are used for determining the permissible stresses that are used in the calculations.

81. Strength is the resistance to rupture under an increasing load. But a brick in a wall under load is subjected to pressure, tension, bending, and perhaps also to shearing. As these influences cannot be imitated in a simple way by the testing of a single brick, it is very difficult to determine the resistance to rupture for every form of load.

82. Compressive strength is determined by loading the bricks one by one into a testing machine between steel plates ground plane. The tensile strength is determined by placing the brick as a beam supported at both ends and loading it in the middle until it breaks.

83. Shape and size are important both aesthetically and technically. In most countries tolerances have been adopted for the variation in brick size, and many countries have also introduced modular systems to ensure that all horizontal and vertical measurements in the building comply with a modular unit. The purpose of this is to help the industrialization of building construction.

Organizing production

by Peter Hartmann

84. The importance of having a "clear aim" in modern management is often mentioned. One cannot, however, be satisfied with only one aim for a plant. There are many aims to be combined - economic, social, technical, organizational and human. It is here that the challenging side of management problems appears. Among the tasks of management are to think out possible aims and to introduce them at the right time as a part of the process of planning ahead.

85. Every plant should have a plan of organization comprised of the plant's aims and policy, job and functional descriptions, specifications of responsibility and competence for all employees with leading functions, an outline of forms and working reports used, as well as their application, and a clear outline of the structure of the organization. Basic to the organization of production are the three "m's": <u>m</u>en, <u>m</u>achines and <u>m</u>aterials.

86. The production manager must possess, among other things, technical qualifications adapted to the size of the plant and its technical level. It is very important that leaders on all levels are competent. If at the beginning they do not have the qualifications needed for their jobs, they must try to become qualified.

87. It is also important that, depending on its situation and equipment, the plant maintains a suitable repair shop with personnel who are trained not only in repair work, but also in preventive maintenance.

88. A good relationship between management and workers is very important. The foremen in particular have a significant mission. A capable foreman should possess the following qualities: firmness and authority combined with natural kindness, a knowledge of human nature and humanity, a sense of justice and patience, pedagogical qualities and a way of expressing himself clearly, conscientiousness, and readiness and ability to co-operate. Some of these qualities should be natural, others can be learned or developed through training and education.

89. In the following remarks, the Danish viewpoint is used as a basis, that is: every person working in a plant not only represents a factor in production costs, but is also regarded as a colleague.

90. A chasm often exists between the interest and duty of the management to produce as cheaply as possible on the one hand, and the employee's interest to earn as much as possible for his work on the other. It is therefore the business of organizations of the labour market and government to try to build a justifiable and secure bridge over that chasm according to the economic development in the country. The following factors must be considered: wages and wage systems, working conditions, instruction and training, possibilities of further education, and the atmosphere at the place of work.

91. The human factor - even in spite of increasing mechanization - still is and undoubtedly will continue to be decisive both to the economy and the quality of production, no matter whether wages are on a high or a low level. Every "wheel" in an organizational machine must be turning properly, and co-operation on every level and between all levels should be a fundamental aim in every organization.

Planning projects for the clay industry

by Hans Petersen

92. The most important step in planning projects is to analyse the complete situation and investigate other plants and productions compared to the demand in the area in question. For this analysis, it is convenient to draw up an outline. It might be possible to have this prepared by persons who do not have special experience in the clay industry, but those with know-how and the right attitude are preferred.

93. When all the information has been collected, the situation should be discussed with local experts and professionals from the clay industry. If specialists are not available locally, they can be invited from abroad.

Building design with clay products

by Henrik Nissen

94. The use of clay products in different types of construction has increased steadily through the years. One aspect of recent development is the modular co-ordination of brickwork, brick panels and hollow clay-block slabs. The size of the Danish brick fits the M-module of 10 cm (4 in), but in countries with no brick tradition, a larger size than that of 11 x 23 x 5.5 cm is desirable. (See also the lecture on clay-based materials in low-cost housing.) Completed projects that illustrate the use of modular co-ordination include family houses and high apartment buildings.

Plans for building site, workers and materials

by E. Vestergaard

95. The buildings in Denmark contain a great variety of materials which, converted into their total weight, correspond to 100 to 150 tons of materials per dwelling. A considerable part of these materials consist of concrete and clay products. It is not a matter of indifference in which sequence and in what quantities they arrive at the building site, or where and how they are placed on the building site before and during construction of the structure. In order that the economic results are reasonable to all parties, it is necessary to plan thoroughly each project regardless of its size.

96. A plan of the building site is necessary to show where various materials and pieces of equipment are to be placed and when they have to be there.

Drawing up a layout of a building site of this kind may, for important constructions, become a complicated matter. However, it is not enough merely to know how the materials are to be placed on the site; it is also essential to have a time plan showing how the building is to be made. Together with the time plan of the project, order and supply plans are also suggested, indicating the times of delivery and the quantities of articles such as the bricks to be delivered. A plan of workers, which shows when and how many workers of the various categories are to be used, is also frequently required.

97. In the same way, it may also be necessary to have a plan of machinery showing how many machines are required and when they have to be used. Most of the plans mentioned above are mainly of interest to the contractor, but in the relations between the contractor and the proprietor it is also necessary to have a plan devoted to economic matters. An economy plan of this type shows the importance of investment at various stages of the building period.

98. Although there are probably great differences between conditions in Denmark and in other countries, the principles of planning could very well be the same. Therefore, the presentation of the "Danish way" is expected to be of general interest.

Progress in the brick building industry in Denmark

by E. Bindner Jensen

99. The use of clay products was introduced into Denmark in or about 1161 by monks coming from southern Europe. Some of the constructions, such as the church in Sorø, are still to be seen. They were built by workers trained for the purpose. In the Middle Ages, around the fourteenth and fifteenth centuries, the craft guilds were organized. Periods of apprenticeship and journeyman tests, just as they are known today, were introduced.

100. The actual method of laying bricks has not altered during the centuries. In Denmark bricks are laid by skilled bricklayers assisted by unskilled labourers who bring the materials and erect the necessary scaffolding. Even the method of delivering the materials was, until about fifteen years ago, the same as in the Middle Ages, with the exception that in recent high buildings, lifts had been installed to transport the materials.

101. The tools of the bricklayer are still the same: a bricklayer's hammer, a trowel, a plumb rule, a ball of string, a joint trowel, and possibly a scraping iron.

102. Progress for bricklayers has been extremely limited, an indication that this handwork cannot be done much more rationally. However, great progress has been made in methods of delivery. There has been a definite attempt to rationalize the process of loading, unloading and transporting bricks. When the bricks leave the brickworks, they are placed on pallets.

103. After the Second World War, there was in Denmark, as in other places in the world, a great need for all kinds of buildings. As brick construction, which had until then composed about 90 per cent of all building work, was not able to cope with this peak quantity of work, other forms of building were created, in particular concrete panel construction. When the branch of construction using bricks encountered the new competition on the market, it was necessary either to rationalize the brick-built construction methods or to introduce new methods.

104. In collaboration with the Ministry of Housing in Denmark, an extensive brick-built project was started. About 800 dwellings were to be planned and rationalized to an extent hitherto unknown. The aim was the completion of two or three dwellings per day. As a new method in Denmark, the facing walls were to be built overhand. Another detail of the modern brick building technique was that all inner walls were built so that only thin plaster had to be applied, in contrast to the ordinary, traditional brick-built construction, where a thorough plastering of the walls was required.

105. This method was one of the steps towards a rationalization of the traditional brick-built construction. The first 500 dwellings were completed at the rate of two dwellings per day; it appears that in the last phase, three dwellings per day can be constructed.

106. As the period of construction on the building site lasts a relatively long time in the traditional brick-built construction, further steps were taken to reduce the construction period by trying to produce brick-made panels in a factory. (See lecture on structural clay wall panels.) All bricklaying work, including the delivery of materials, has been evaluated for pricing and is executed on the basis of piece-work rates.

Cost and quality considerations in the choice of building materials

by Ole Dybbroe

107. The development of brick-manufacturing techniques and construction methods based on the use of clay products has little meaning unless it is seen in the full context of the general building situation in the location or country

in question. The objective of the industry should not be merely to produce cheaper buildings or buildings of a higher quality or simply to use clay. "Cheap" is usually interpreted as "low initial costs", and "quality" means "solidity", i.e. how well the building will stand up to hurricanes and earthquakes - or to the building regulations, which is often the same thing.

108. Looking at the building industry from this narrow perspective is very dangerous, in particular for brick producers in a developing country who have no support from skilled masons and bricklaying contractors. Such assistants might be able to develop the production techniques beyond the stage at which it was inherited from Europe 100 years ago or more. Some important factors are excluded which, thoroughly analysed, might be the very sources of inspiration to new and better results.

109. The costs of the building materials are relatively small items on the building account when compared with the over-all labour costs, which in many cases amount to one third of the total cost. It is necessary to recognize the relative importance of the various elements which together constitute building costs, to compare their importance, and to analyse where the greatest savings can be made by reasonable means. Operational planning is a prerequisite to the development of new building techniques and materials, and based on this, there are many possible conclusions for the clay building industry in developing countries.

Clay-based materials in low-cost housing

by Alvaro Ortega

110. In the construction of low-cost houses, clay-based products form one group of basic building materials that need to be produced in sufficient quantity and quality in all developing countries. Clay products are used traditionally in the construction of walls, roofs, floors and drainage systems.

111. The necessity of making maximum use of the financial resources available for solving the housing problem in developing countries requires the reduction of construction costs without endangering the quality of the finished dwelling.

112. In order to obtain a clear idea of the cost of the different phases of a house, seven components should be considered: foundation, floors, walls, roof, sanitary equipment, electrical installations and carpentry. The percentage of total cost of the seven components in a typical low-cost house in order of importance is as follows: (a) walls, 33 per cent, (b) roof, 17 per cent

(c) sanitary equipment, 13 per cent, (d) carpentry, 12 per cent, (e) and (f) foundation and floors, each 10 per cent, and (g) electrical installations, 5 per cent.

113. When clay tiles are used as a roofing material, 30 per cent of the cost of the roof is spent on tiles, or approximately 4 per cent of the total cost of the dwelling. The material required for clay-tiled floors represents 6 per cent of the total cost of the house.

114. Burnt clay bricks are the usual choice if they can compete economically with other materials. The adequate durability, strength, stability, resistance to rain penetration, thermal insulation, fire resistance, sound insulation, the possibility of eliminating expensive rendering, and low maintenance costs make the clay-based products appropriate for low-cost housing construction.

115. The reduction in the cost of brick production and the increase in productivity for erecting the wall element are two basic considerations in expanding the use of clay products. This can only be achieved through rationalization.

116. For this reason, modular co-ordination, a system devised to correlate the size of materials and components, should be used. Modular co-ordination provides a link between design, planning, the manufacture of components or building materials, and their erection at the building site. All building components should be manufactured using only multiples of a basic dimension, or basic module. The basic module adopted is equal to 100 mm.

117. To initiate the use of modular co-ordination, high priority should be given to the production of a few basic building materials and elements required in the construction of low-cost houses, for example, clay bricks, cement blocks, pre-cast walls and floors, roofs, doors, windows and closets. Bricks should be produced in sizes of 1 x 1 x 3 module and also 1 x 1 x 2 module. The actual size should be 90 x 90 x 290 mm and 90 x 90 x 190 mm in order to allow 10 mm for joints.

118. In relation to the size of bricks and blocks, it is recommended that two successive modules, such as 2 and 3 or 3 and 4, be used in the production of clay products. By producing two lengths, it is possible to combine them and increase by only one module the size of the rooms, corridors and so on. One of the objectives of modular co-ordination is to produce a minimum of different elements, but at the same time to allow maximum flexibility.

Structural clay wall panels

by Jørgen Bryrup

119. The lecturer described most of the existing structural clay wall panels and mentioned in particular developing brick facing wall panels in Denmark, where eight independent firms have each developed a brick wall panel system. These systems compete very well with traditional masonry constructions and with wall panels of other materials.

120. Not all of these systems are of interest to developing countries but the systems that operate with low installation and equipment costs might very well be adapted in almost any country. Cuba, for example, has developed an interesting light-weight brick wall panel.

121. Although the building industry in developing countries will be concentrated for some years on progress in the traditional sector, it is expected that the non-traditional section, i.e. the panel industry, will not be completely neglected.

122. Investments in the brick industry should offer the best possibilities for expanding the building activities in both the traditional and the non-traditional section.

Visit to the School of Bricklayers

by Poul Andersen

123. Bricklayers in Denmark are usually trained during a four-year apprenticeship. In order to give the apprentices an opportunity to work with skilled bricklayers, short periods of training at the School of Bricklayers have been found to be of great value.

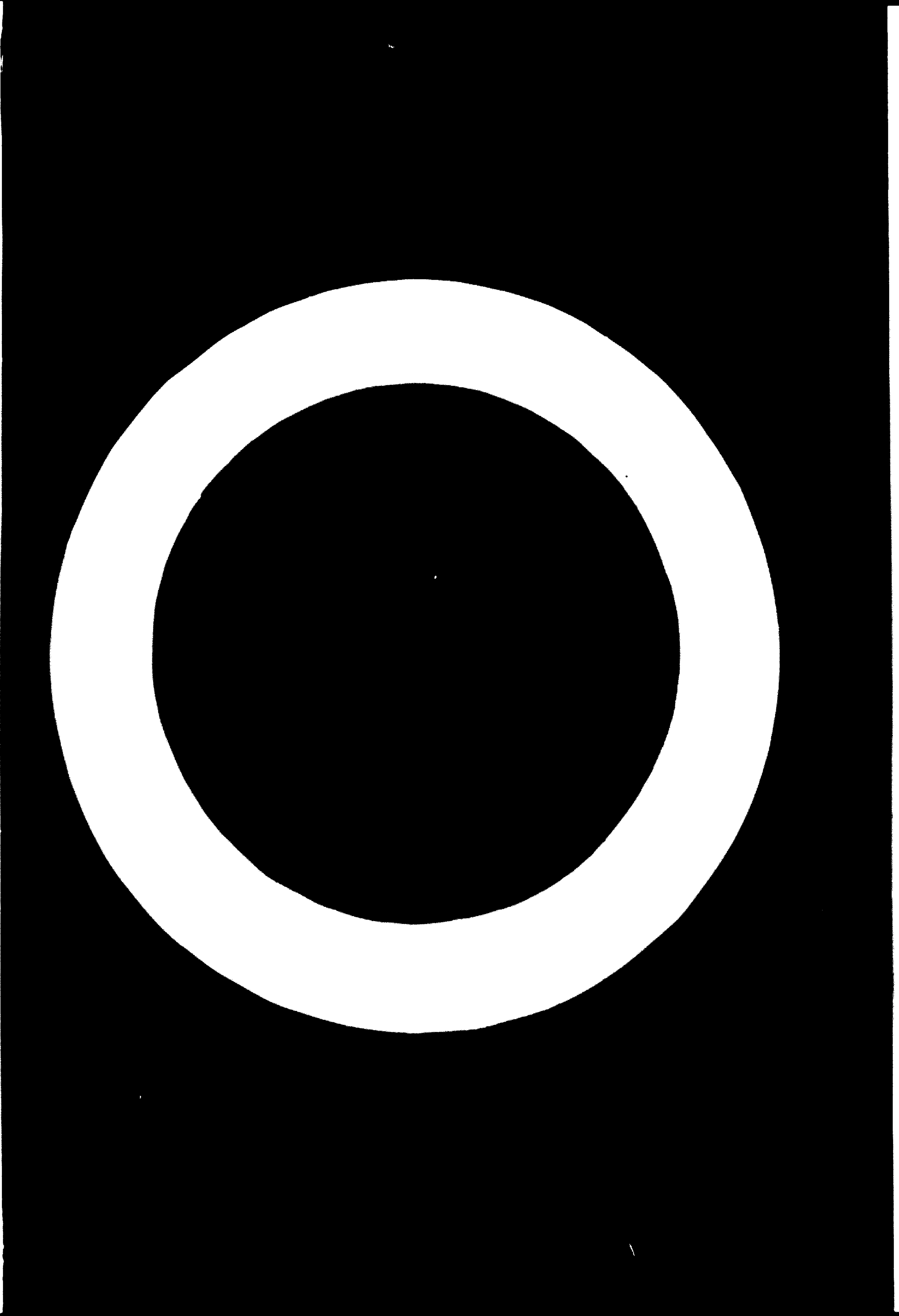
124. During this period, all existing types of masonry and joints are shown to the pupils. Also included in the school programme are the following subjects: plastering, bricklaying, floor and roofing tiles, and reading of drawings. Some general education, including various calculations, is also given.

Brick and tile industry in developing countries: Model for a brick plant in a developing country and some general views regarding industrialization (two papers)

by Svend B. Johansen

125. When natural drying is applied in a brick plant, quality bricks may be produced at the lowest price with an annual production of 12 million standard

bricks. Based on these conclusions, a project for a brick plant with a proposal for rationalization of many handling operations was presented. With a total investment of US$250,000 to $350,000, bricks are produced at a price of US$10 per 1,000 bricks. The market price in the area is US$20 per 1,000 bricks. Such a brick plant must be regarded as an attractive investment and a sound industry, but only when the project is carefully planned from the beginning.



Annex I

Programme of the seminar

12 August	Presentation and distribution of documents Official opening of the seminar Lectures and discussion: The role of the clay building materials industries Prospecting for raw materials Examining raw materials
13 August	Lectures and discussion: Clay winning and preparation Brick moulding Clay drying
14 August	Lectures and discussion: Firing heavy clay products in intermittent kilns Continuous kilns Handling methods and layout of brickworks Final products: characteristics, control and testing Films: The Danish Brick and Tile Laboratories at work Training of bricklayers Building site operations
15 August	Visits to Bjeverskov Brickworks (facing bricks, tunnel kiln) and Knabstrup Brickworks (facing bricks, common bricks and roofing tiles in Hoffman kiln)
16 August	Lectures and discussion: Organizing production Planning projects for the clay industry
17-19 August	Excursion by bus and ferry to Jutland and Funen: Visits to the laboratories of the Danish Brick, Tile and Lime works in Aarhus, the Tommerup Brickworks II (facing bricks, tunnel kiln) and the Prefanova Brick Wall Panel Factory Sightseeing with special emphasis on various kinds of masonry construction

20 August	Lectures and discussion: Building design with clay products Plans for building site, workers and materials Progress in the brick building industry in Denmark Cost and quality considerations in the choice of building materials Clay-based materials in low-cost housing Structural clay wall panels
21 August	Lectures and discussion: Training of bricklayers (visit to the School of Bricklayers) Brick and tile industry in developing countries
22 August	Lectures and discussion: Brick and tile industry in developing countries Presentation and discussion of reports from working groups
23 August	General discussion, formulating recommendations and conclusions Official closing of the seminar

Annex II

Participants, lecturers and observers

Director:	Mr. Jørgen Fryrup, Information Director, Teglindustriens Tekniske Tjeneste (T.T.T.), Copenhagen
Technical Secretary:	Mr. C. E. Rydeng, Civil Engineer, Institute of Silicate Industries, Technical University of Denmark, Copenhagen
Technical Advisers:	Mr. Svend B. Johansen, Ceramics Expert, Danish Ministry of Foreign Affairs, on exchange to Instituto de Investigaciones Tecnológicas, Bogotá, Colombia
	Mr. Ulf A. Halvorsen, Civil Engineer, Ethio-Swedish Institute of Building Technology, Addis Ababa, Ethiopia
	Mr. Ivan Horvath, Economic Affairs Officer, United Nations Economic Commission for Africa, Addis Ababa, Ethiopia
	Mr. H. W. H. West, Head, Heavy Clay Division, Officer-in-Charge, Mellor-Green Laboratories, British Ceramic Research Association, Shelton, Stoke-on-Trent, England
	Mr. Alvaro Ortega, Technical Adviser, United Nations Centre for Housing, Building and Planning, New York

UNIDO staff members assisted in the conduct of the seminar as follows:

Mr. Janos Fath, Chief of the Industrial Sector Development Section, Industrial Technology Division of UNIDO, served as Co-director.

Mr. Sergei Boldyrev, Industrial Development Officer in the Industrial Technology Division of UNIDO, introduced the participants' papers and served as Rapporteur.

Lecturers

Mr. A. E. Aldersley, Experimental Officer,
Mellor-Green Laboratories,
British Ceramic Research Association,
Shelton, Stoke-on-Trent, England

Lecturers (continued)

Mr. H. Juel Andersen, Civil Engineer,
Frederiksholms Teglværker A/S (Frederiksholms Brickworks),
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Mr. Poul Andersen, Principal, Master Builder,
Technical School of Masons,
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Mr. Jørgen Bryrup, Information Director,
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Mr. Henry Dührkop, Chief of Laboratory,
Kalk- og Teglværkslaboratoriet (Danish Brick, Tile and Lime Works Laboratory),
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Mr. Ole Dybbroe, Architect,
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Hedehus Teglværke A/S (Hedehus Brickworks),
Hedehusene, Denmark

Mr. E. Bindner Jensen, Director,
Einar Kornerup A/S,
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Mr. Svend B. Johansen, Ceramics Expert,
Danish Ministry of Foreign Affairs,
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Mr. Alvaro Ortega, Technical Adviser,
United Nations Centre for Housing, Planning and Building,
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Mr. K. Carsten Pedersen, Managing Director,
Nivågård Teglværk (Nivaagaard Brickworks),
Nivå, Denmark

Mr. Hans Petersen, Consulting Engineer,
Ølst,
Randers, Denmark

Lecturers (continued)

Mr. E. Vestergaard, Engineer,
København Murer- og Stenhuggerlaug (Mason Contractors Association of Copenhagen),
Copenhagen

Mr. H. W. H. West, Head, Heavy Clay Division,
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Participants

Afghanistan	Mr. Abdullah Ali, Vice-President, Central Authorities for Housing and Town Planning, Kabul
Brazil	Miss Carmen Ruth Stangenhaus, Architect, Department of Technical Assistance, Centro Nacional do Pesquisas Habitacionais (CENPHA), Rio de Janeiro
	Mr. Carlos Frederico Hirsch, Co-ordinator, Ministry of Planning and General Co-ordination, Rio de Janeiro
Cuba	Mr. José Lozano, Chief, Ceramics Division, Ministry of Construction, Havana
	Mr. Rolando Samuel, Architect, Ceramics Division, Ministry of Construction, Havana
Dominican Republic	Mr. Vicente J. Munne, Vice-President of brick factory, Alfarería Dom. C por A, Santo Domingo
	Mr. Joaquin R. Priego, Technical Director, Centro Nacional de Artesanía, Santo Domingo
Ethiopia	Mr. Zawde Berhane, Director, Materials Research and Testing Department, Haile Selassie I University, Ethio-Swedish Institute of Building Technology, Addis Ababa

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Ethiopia	Mr. Eshetu Muhe, Research Engineer, Materials Research and Testing Department, Haile Selassie I University, Ethio-Swedish Institute of Building Technology, Addis Ababa
Ghana	Mr. Joseph O. Ania-Lamptey, Managing Director, State Brick and Tile Corporation, Accra
Honduras	Mr. José W. Mena Burgos, Manager, Vibrobloc Factory, Tegucigalpa
	Mr. Paul Wiemer Romero, Owner of brick factory, Department de Choluteca, Comayaguela
India	Mr. Rabindar Singh, Director, National Building Organization, Regional Housing Centre for ECAFE, New Delhi
Indonesia	Mr. Sumardi Kartomidjojo, Chief, Building Materials Division, Materials Testing Institute, Djakarta
	Mr. Muljo Harsono, Department Director, Institute for Industrial Research and Training, Ministry for Basic Light Industry and Power, Djakarta
Iran	Mr. D. Afshar-Ghassemlou, Head, Department of Architecture, Ministry of Housing and Development, Tehran
Morocco	Mr. Driss Kettani, Department Chief, Investment Services, Ministry of Commerce Arts, Industry and Mining, Rabat
Peru	Mr. Jacobo I. Kugler Ludmir, General Manager of brick factory, Ladrillera Kar SA, Lima
Poland	Mr. Mieczyslaw Janiak, Chief of Study Board, Designing Office of Building Ceramics Industry, Poznań

Participants (continued)

Republic of Korea	Mr. Dae Ro Kim, Chief, Housing Construction Section, Seoul Metropolitan Administration, Seoul
Saudi Arabia	Mr. Jameel A. Jishi, Industrial Engineering Specialist, Industrial Studies and Development Centre, Riyadh
Somalia	Mr. Mohamed Noor, Administrative Manager, Somali Brick and Tile Manufacturing Company Ltd, Mogadiscio
Sudan	Mr. Mutasim El Zamzami, Ceramics Technologist, Sudan Industrial Research Institute, Khartoum
	Mr. Mohamed El Fatih Osman Khider, Assistant Inspector, Department of Industry, Ministry of Industry and Mining, Khartoum
Thailand	Mr. Kamthorn Sitaputra, Works Manager, Clay, Firebrick and Refractory Plant, Siam Iron and Steel Company Ltd, Bangkok
	Mr. Charoen Vashrangsi, Scientific Officer, Department of Science, Ministry of Industry, Bangkok
United Arab Republic	Mr. Mohamed Kamel Zeitoun, General Director, Research Department, Ministry of Housing, Cairo, Egypt
	Mr. Farouk M. Shaalan, Assistant Director, Research Department, Ministry of Housing, Cairo, Egypt
Uruguay	Mr. Heber Freirfa, Assistant Professor, Department of Clay, Faculty of Engineering and Land Survey, Montevideo
	Mr. Jorge Sapelli, Director, Cerámica Artigas Mendes Hnos SA, Montevideo

Observers

Colombia	Mr. Gabriel Morales, Instituto de Investigaciones Tecnológicas, Bogotá
Peru	Mr. Ernesto Huita Girón, Instituto de Investigaciones Tecnológicas, Ayacucho
Union of Soviet Socialist Republics	Mr. N. Z. Shinkaruk, Ministry of Building Materials Industries, Kiev, Ukranian SSR

Annex III

Background documents and participants' papers presented to the seminar

UNIDO documents prepared for the seminar

ID/WG.16/1	Production and utilization of lightweight aggregates by H. S. Wilson, Department of Energy, Mines and Resources, Ottawa, Canada
ID/WG.16/2	Testing and evaluation of brick clays by V. Lach, Czechoslovakia, revised and expanded by T. Chvatal
ID/WG.16/4 1/	Structural clay products, prepared by ECAFE
ID/WG.16/5	Development of lightweight aggregate industry in the ECAFE region, prepared by ECAFE
ID/WG.16/6	The ceramic industry in Australia by J. S. Hosking, Australia, submitted by ECAFE
ID/WG.16/7	The development of a brick and tile industry in developing countries, by H. W. H. West, British Ceramic Research Association, United Kingdom 2/

Other background documents 3/

Fuels, combustion and heat transfer
by A. E. Aldersley, British Ceramic Research Association, United Kingdom

The drying of bricks
by R. W. Ford, Brick Development Association, United Kingdom

Clay preparation and shaping
by F. J. Goodson, Brick Development Association, United Kingdom

Quality of clay bricks produced in the Addis Ababa area
by U. A. Halvorsen, Ethio-Swedish Institute of Building Technology, Ethiopia

The clay and ceramic industry in Africa
by I. Horvath, United Nations Economic Commission for Africa, Ethiopia

1/ ID/WG.16/3 was not published.

2/ To be printed as a UN Sales Publication in 1969 (ID/15).

3/ Not available for distribution.

The firing of bricks
by E. Rowden, Brick Development Association, United Kingdom

The layout of brickworks
by H. W. H. West, British Ceramic Research Association, United Kingdom

Participants' papers[4/]

The development of clay building industries in Afghanistan
by Abdullah Ali, Kabul

Clay in building materials industries
by Carmen Ruth Stangenhaus, Rio de Janeiro

Some observations on the Brazilian clay building materials industry
by Carlos Frederico Hirsch, Rio de Janeiro

Construction materials in Cuba
by José Lozano and Rolando Samuel, Havana

The situation of the clay industry in the Dominican Republic
by Vicente J. Munne, Santo Domingo

The situation of the clay industry in the Dominican Republic
by Joaquin R. Priego, Santo Domingo

The present situation of the building materials industry in Ethiopia with special emphasis on the clay building materials industry
by Zawde Berhane and Eshetu Muhe, Addis Ababa

The situation of the clay brick industry in Ghana
by Joseph O. Ania-Lamptey, Accra

The situation of the clay industry in Honduras
by Paul Wiemer Romero, Comayaguela

Clay building materials industry in India
by Rabindar Singh, New Delhi

Aims and activities of the clay building materials industries in Indonesia
by Muljo Harsono and Sumardi Kartomidjojo, Djakarta

A short description of the past and present situation of clay materials in Iran
by D. Afshar-Ghassemlou, Tehran

4/ Not available for distribution.

The situation of the clay industry in Morocco
by Driss Kettani, Rabat

The production of bricks in Peru
by Jacobo Issac Kugler Ludmir, Lima

The building ceramics and stove tile industry in Poland
by Mieczyslaw Janiak, Poznań

Clay building materials in Korea
by Dae Ro Kim, Seoul

Report on the clay building materials industry in Saudi Arabia
by Jameel A. [illegible]ishi, Riyadh

The situation of clay building materials in Somalia
by Mohamed Noor, Mogadiscio

Note on the burnt brick industry in the Sudan
by Mutasim El Zamzami, Khartoum

Short account of the clay building materials in the Sudan
by Mohamed El Fatih Osman Khider, Khartoum

Clay building materials industries in Thailand
by Kamthorn Sitaputra, Bangkok

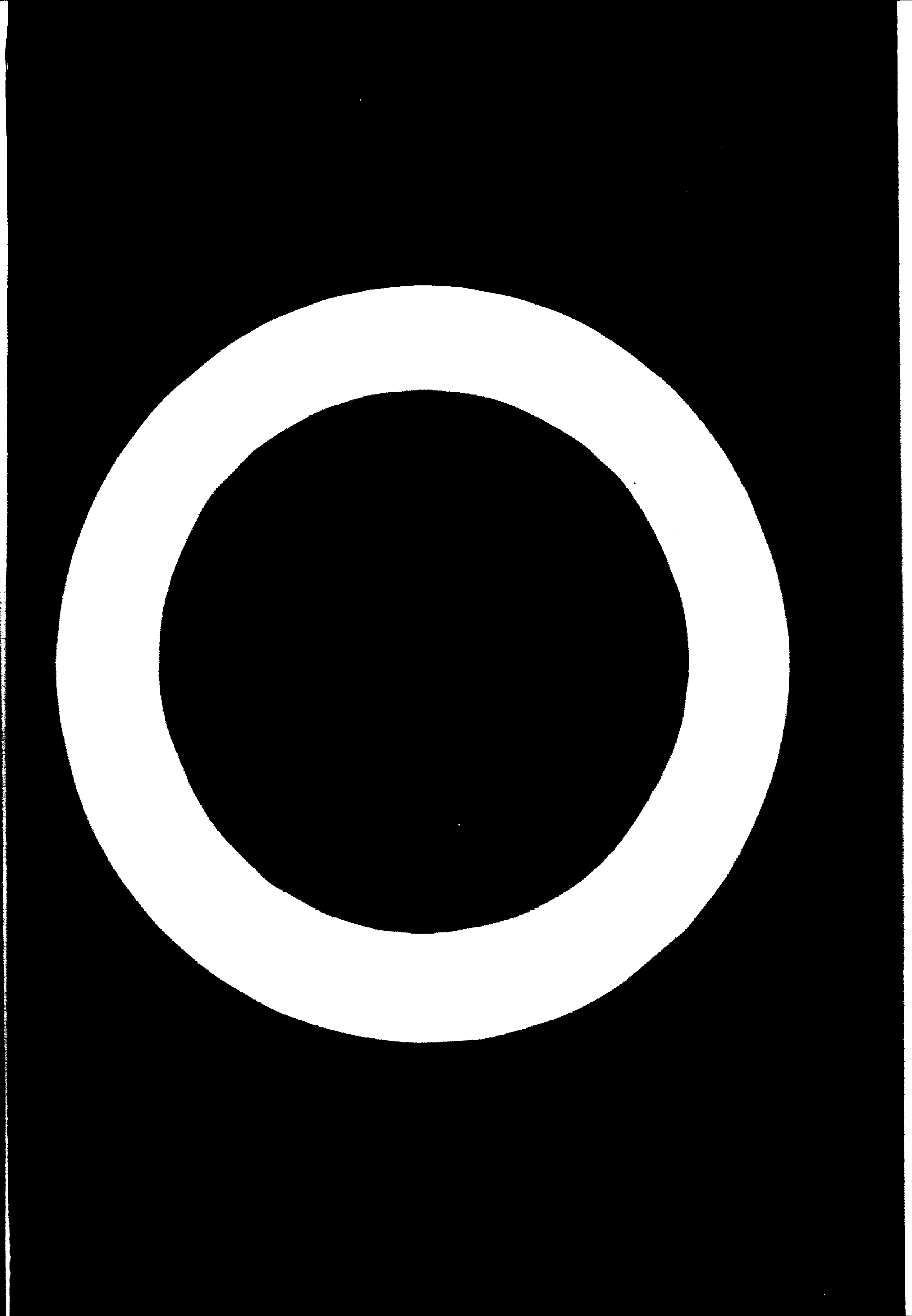
Brick, tile and related clay building materials industries
by Charoen Vashrangsi, Bangkok

Prospects of clay bricks industry in the United Arab Republic
by Farouk M. Shaalan and Mohamed Kamel Zeitoun, Cairo

The existing situation of the building materials industry based on natural clays
by Heber Freirfa, Uruguay

Observer's paper

Production technology of clay wall and roofing materials in the USSR
by N. Z. Shinkaruk, Kiev



Annex IV

Description of the plants visited

Tommerup Brickworks

Production

Eight million extrusion-pressed yellow bricks per year.
Four million extrusion-pressed red bricks per year.

Clay excavation

The clay is excavated in the neighbourhood where there is clay from ice-dammed lakes. The clay is excavated with an excavator from 1968 and loaded onto lorries, which transport the clay to the soaking pit.

Soaking pit

The soaking pit is fully covered and contains enough clay for a fortnight, or approximately 700 m^3. The lorries unload onto movable bridges which distribute the clay. Further mixing takes place during semi-vertical digging by a bucket-chain excavator. It is in series with the following machines.

Clay preparation

Pre-mixer:	One-shaft mixer, Svendborg, Denmark (25 h.p.)
Stone separator:	Svendborg, Denmark (20 h.p.)
Pre-roller:	Roller diameter and length, 600 mm and 450 mm
	Width of opening, 3-10 mm (2 x 20 h.p.)
Fine roller:	Roller diameter and length, 800 mm and 450 mm
	Width of opening, 0.6 mm (30 h.p. and 35 h.p.)

Extruding plant

The Weserhütte vacuum extruding press is equipped with a fully automatic Frey cutter. The capacity is about 6,500 bricks per hour. (Pre-mixer, 55 h.p.; extruding press, 55 h.p.)

Transport

Traf traversing and setting car. Capacity: 600 bricks per load.

Drying plant

The drying plant consists of ten double chambers each with a capacity of 2 x 7,500 bricks, or 150,000 bricks. The drying is manually controlled, by "Rotomixair", and the drying time varies from 60 hours for yellow bricks to 72 hours for red bricks.

Firing

The Walter kiln is designed for approximately 250,000 bricks per week. The length is 84 m, width is 3 m. The car dimension is 2.8 x 2.8 m and contains 3,000 bricks. The oil has a Redwood viscosity of 1,500 seconds after pre-heating to 90°C. The kiln is equipped with 63 burners, which have a total consumption of 20 tons per week.

Knabstrup Brickworks

Production

Twelve million extrusion-pressed solid yellow bricks per year.

Clay excavation

The clay is dug nearby from ice-dammed lake clay and moraine clay. The clay is excavated with a bucket-chain excavator (Halle) and is loaded on dumping wagons which transport the clay to the factory.

Clay preparation

Reception:	Four box feeders discharging onto conveyor (5 h.p.)
Pre-mixer:	One pre-mixer (25 h.p.)
Stone separator:	Roller diameter and length, 450 mm and 480 mm
	Width of opening, 5 mm (for h.p. see the following rollers)
Pre-roller:	Roller diameter and length, 750 mm and 480 mm
	Width of opening, 2 mm (power of stone separator and roller, 2 x 25 h.p.)
Fine roller:	Roller diameter and length, 1,000 mm and 480 mm
	Width of opening, 1 mm (50 h.p.)
Intermediate mixer 1:	Double-shaft mixer (25 h.p.)
Intermediate mixer 2:	Double-shaft mixer (35 h.p.)

Extruding plant

The Händle vacuum extruding press is equipped with a fully automatic Svendborg (Denmark) cutter. The capacity is about 6,000 bricks per hour.

Transport

Keller traversing and setting car. Capacity: 2 lots (300 bricks) per load.

Drying plant

The chamber drying plant was constructed in two stages. The oldest plant, the Keller, has five double chambers with a setting capacity of 2 x 6,600 bricks per double chamber, or 66,000 bricks. The new drying plant is being constructed and consists of seven single chambers with a capacity of 6,600 bricks per chamber, or 46,000 bricks. The complete drying plant therefore has more than 100,000 setting places.

Firing

The new kiln is still being run in and is built to fire about 230,000 bricks per week. The kiln consists of six parallel chambers and a return chamber. The firing zone moves through the kiln labyrinth in an endless movement corresponding to the principle of a Hoffman kiln. The individual chambers are 22 m long and 3.20 m wide and are high enough for a fork-lift truck to load and unload in them.

Bjeverskov Brickworks

Production

Fifteen million machine-moulded yellow bricks per year.

Clay excavation

The clay is dug by excavator a few hundred metres from the works in four or five campaigns every year; in a relatively short time, three months consumption is excavated. The clay is transported by means of four Fordson Major tractors with trailers.

Soaking pit

The soaking pit is fully covered and divided into crane pit and homogenization pit. The pit contains three months consumption or about 7,000 m^3. The crane, with a 2 m^3 capacity bucket, distributes the clay arrivals in the crane pit as it arrives and fills the homogenization pit as required. From the homogenization deposit, the clay is dug with a Petersen or Smøl chain-bucket excavator and the clay passes on a conveyor for further preparation.

Clay preparation

Pre-mixer:	Händle one-shaft mixer (25 h.p.)
Box feeder:	Box-feeder with automatic stop provides an absolutely even consumption of material for the succeeding parts of the plant.
Stone separator:	Roller diameter and width, 450 mm and 550 mm Width of openings, 3-4 mm, Petersen, Smøl, (2 x 20 h.p.)
Chaser mill:	Roller diameter and width, 1,000 mm and 650 mm Width of opening, 1 mm (60 h.p. and 40 h.p.)

Extruding plant

The Händle extruding press is equipped with a fully automatic Frey cutter. The capacity is about 7,500 bricks per hour (pug, 50 h.p.; extruding press, 75 h.p.)

Transport

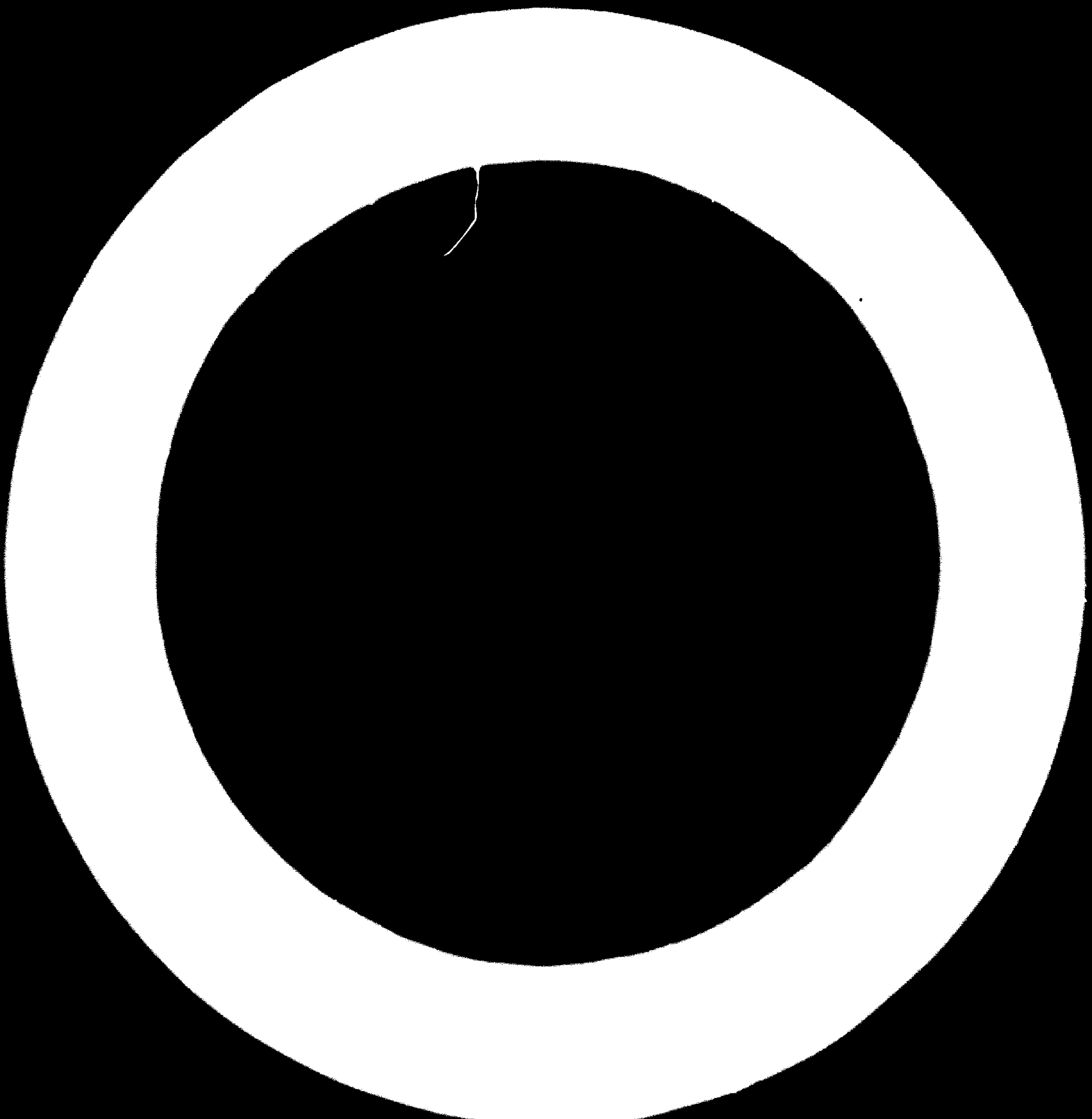
Keller traversing and unloading truck. Capacity: 1,000 bricks.

Drying plant

The drying plant consists of ten double chambers each with a capacity of 2 x 10,000 bricks, or 200,000 setting places. The drying is automatically controlled and the drying time is 62 hours. Efficiency: 1,200 kcal per kg of water.

Firing

The Gibbon kiln is made for about 300,000 bricks per week. The kiln has a length of 104 m and a width of 3.6 m. The cars are 3 x 3 m and hold 3,900 bricks. The oil has a Redwood viscosity of 850-1,000 seconds after preheating to 70°C. The kiln is equipped with 57 burners which have a total consumption of approximately 28 tons of oil per week. The heat consumption is 360 kcal per kg of bricks.



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