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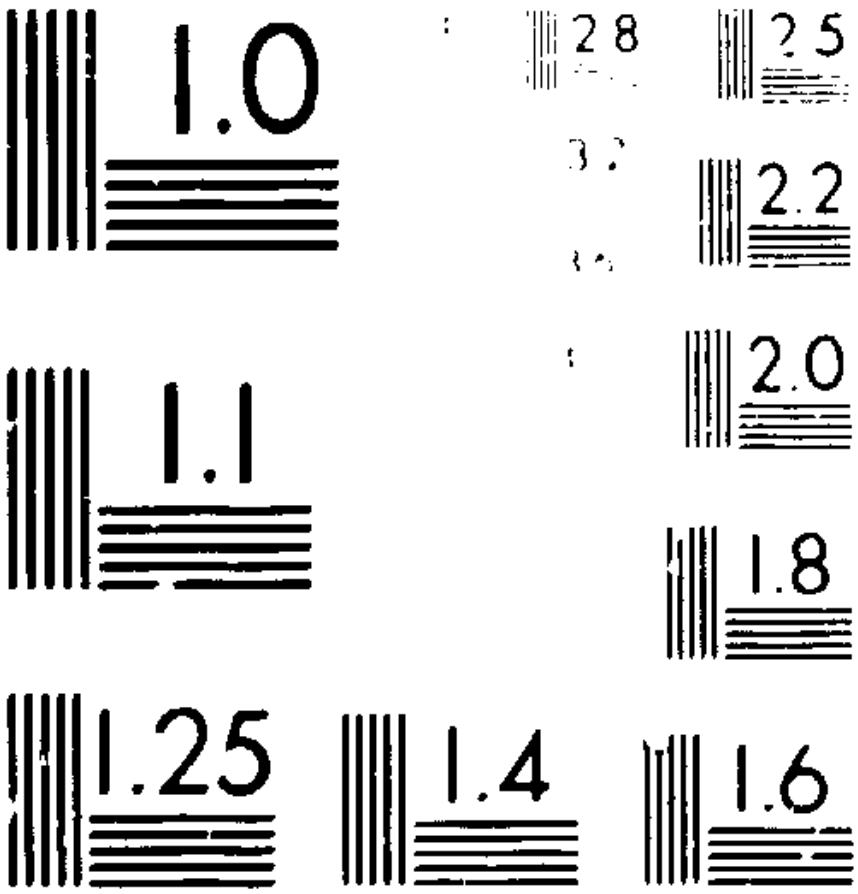
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→ Maria Dietrich

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F I N A L R E P O R T

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ESTABLISHMENT OF SMALL SCALE INDUSTRIES,

Testing and Evaluation of Clay Samples from Zaire

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I. ABSTRACT

The evaluation of two clay samples from Zaire was presented. The clay samples were submitted by Mr. Robuta Spurling, Project Manager on Proj. ZAI/71/003 through UNIDO Vienna. The quantity of the supplied samples was sufficient for preliminary tests. While all laboratory and technological tests were carried out in the Research Institute for Ceramics, Refractories and Raw Materials at Horní Bříza their evaluation was made in the co-operation with the UNIDO/CSSR Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries in Pilsen.

Apart from the chemical analysis the other preliminary tests have been carried out with the aim to find out the most appropriate utilization of the clays for the manufacture of bricks, hollow bricks, drainage pipes and roofing tiles.

Both the clays may be applied in the manufacture of the articles mentioned above as a decisive component provided that they are subjected to further treatment to increase their plasticity either by ageing or steaming or by an addition of a plastic raw material.

The test results have proved that the tested clays can be utilized in the promotion of the building material industry in Zaire.

II. TABLE OF CONTENTS

III. INTRODUCTION

The clay samples from Zaire were delivered to the UNIDO/CSSR Joint Programme by Mr. G. C. Verkerk, UNIDO Vienna Liaison Officer of the Joint Programme, on 24 November 1980 personally on the occasion of his working visit to the Joint Programme in Pilsen.

The preliminary testing of the clay samples in question was requested by UNIDO-Polytechna contract No. 80/130.

The clay samples were identified in the memorandum sent to the UNIDO/CSSR Joint Programme as for the use in making of bricks, hollow bricks, drainage pipes and roofing tiles.

A sufficient quantity of the samples (about 5 kg each) has been received to carry out the preliminary testing the results of which are being presented.

The colour of the two clay samples did not differ much.
One was dark red-brown and the other was dark red in colour. The raw materials were rather unhomogenous with apparent admixtures (light and dark grains).

The raw materials are of claycy origin containing a large amount of free silica and developed magnetite crystals. The prepared body is easily workable but it cracks after drying.

IV. CONCLUSIONS AND RECOMMENDATIONS

a) Conclusions

1. According to the respective Czechoslovak Standards for ordinary bricks the tensile strength is to be 17 kp.cm^{-2} and minimum 15% water absorption. In view of these two criteria both the raw materials have been found suitable as a decisive component of the blend to be used in the manufacture of bricks, hollow bricks, drainage pipes and roofing tiles.

2. The plasticity of the raw material is to be increased either by ageing or steaming and by the addition of a plastic raw material (the optimum proportion is to be determined by verification tests). If these raw materials are used in the manufacture of bricks a considerable attention should be paid to their dressing. The dressing of the clays must not be done superficially only i. e. without such basic operations like piling and wetting, ageing for more than a week, perfect grinding and optimum addition of grog components. It should result in a homogenous plastic body which will not be sensitive to drying, will be well workable and will obtain optimum strength and insulation properties after firing.

b) Recommendations

1. It is recommended to carry out geological prospection to find a plastic raw material of low vitrification point as a compositive material to be added to these clays.

2. The plastic clay resulting from the geological prospection should be subjected to preliminary tests, too.

3. Laboratory tests of supplied clays, including that one resulted from the geological prospection, are recommended to be conducted in order to find out the optimum blends for

   - the manufacture of bricks, hollow bricks, drainage pipes and roofing tiles;
   - the manufacture of glazed wall tiles based on the red body.

V. TESTING AND EVALUATION OF CLAY SAMPLES

1. Description of the supplied raw clay samples - visual estimation of their appearance on delivery.

The two clay samples have differed only little in colour. One clay sample was dark red-brown and the other was dark red. The raw materials were not homogenous but showed apparent admixtures - light and dark grains. The darker raw clay samples was marked A and the lighter one B. The clay samples have been subjected to chemical analyses, wet sieve analyses, simple firing test, plasticity test, hydrochloric acid test and a glazing test.

The test results are shown in Table Nos. 1 and 2.

2. Description of the applied tests

a) Simple firing test

At first the clay samples had been dried at a room temperature for several days, then crushed to maximum 1 mm grain size and bodies were prepared by addition of water. During this process the workability was observed and the formation water determined.

The shaping of laboratory bricks was performed by means of a laboratory anger extruder providing bricks of 75x39x15 mm overall dimensions.

The laboratory bricks were dried at a room temperature for three days at first, then in a laboratory drier at 110°C temperature for 24 hours. Subsequently, the drying shrinkage was measured and determined.

The drying and firing shrinkage, water absorption and bending strength were measured and evaluated depending on different firing temperatures.

b) Wet sieve analyses

The clay samples have been washed and screened on the 0.09 mm mesh sieve. The rest on the screen has been dried, determined and subjected to microscope analysis.

c) Hydrochloric acid test

The clay samples have been subjected to the hydrochloric acid test. The acid has been diluted in 1 : 1 ratio .

d) The chemical analysis has been carried out according to Czechoslovak Test Standards.

e) Determination of water of plasticity

After a workable paste had been prepared and matured test bricks were made. Their moisture content was determined by wetting and drying.

f) Determination of a plasticity No. according to Pfefferkorn

Small rolls made of a paste with different moisture content were deformed in an instrument according to Pfefferkorn. The plasticity No. corresponding to the deformation ratio 3.3 was calculated from the deformation ratios and the respective relative moistures.

g) Drying shrinkage

As soon as the test bricks had been moulded each was measured by means of a slide calliper at 2 marked points. They were measured after drying again and the shrinkage calculated.

h) Firing shrinkage

The firing shrinkage was determined similarly as that of the drying but the test brick was heated to a specified temperature and the firing shrinkage was calculated from the measurements made before and after the firing.

i) Water absorption

Water absorption was determined on fired test pieces which were dried first at 105°C temperature, then immersed in a distilled water, boiled for 2 hours and weighed afterwards. The amount of absorbed water was calculated.

3. Results and discussion

The complete survey of the measured and evaluated properties of the two clay samples is shown in Table Nos. 1 and 2.

The two clays have shown neither carbonates nor carbonate concretions (agglomerates of limestone of different shapes) according to the hydrochloric acid tests. It is very favourable to use these clays for the manufacture of brickware.

The small laboratory bricks after firing tests have been dark brown-red with a considerable amount of cracks. The colour of the body was brown-red. The appearance of the small laboratory bricks after firing is shown in the attached pictures. The colour of the test pieces was homogenous without runnings and coloured specklings.

The plasticity Nos. of A and B clay samples are 27.36 and 24.99 respectively the water of plasticity being 25.4% and 23.6% respectively. The silica sand contained in the tested specimens acted as a sufficient admixture of grog. Hence, no more grog was added. Though there was enough grog the products suffered from cracking during drying. It is recommended to make further mineralogical analysis to determine the type and content of clay minerals. The respective tests could not be made on the supplied specimens

because they were of insufficient quantity.

The plasticity of the existing clay may be improved by maturing of the raw material, by its steaming and perfect milling. After the raw material has been carefully dressed this way the tests are to be repeated with the use of various types of grog.

The dressing of clays described above and an addition of another plastic clay may help to make a homogenous plastic body which will not be so sensitive to drying and will obtain optimum strength and insulation properties after firing.

The rest on the 0.09 mm mesh sieve is 78.4% and 63.95% relating to samples A and B respectively. The residue on the screen of clay sample A consists of quartz grains of different sizes both clear, transparent and coloured to brown shade. Apart from these quartz grains the rest includes also quite a considerable quantity of nicely developed grains of magnetite.

d) The magnetite presence in the fired specimens did not result in any runnings or coloured specklings.

Same findings as found at sample A apply to clay sample B only less magnetite crystals are finely dispered therein and the sample contains also organic matters (dry grass, reed).

The drying shrinkage is 8.4% and 9.1% respectively and the firing shrinkage at 920 to 1060°C temperature has been ranging from 0.6 to 5.0%. The drying shrinkage of the tested clays corresponds with that of stoneware clays. However, it is too high for a brick manufacture and may cause cracking by drying. The firing shrinkage is very low and it is favourable for the brick manufacture.

VI. FINAL NOTE

Both the clays from Zaire are suitable for the manufacture of bricks, hollow bricks, roof tiles and drain pipes as well as glazed wall tiles provided that specific technology is adhered to and another plastic clay added into the body.

In view of the fact that there are reserves of clays of sedimentary origin in Zaire it will not cause any problem to find a clay suitable as a supplement to the clays having been tested.

VI. REFERENCES

1. UNIDO-Polytechna contract No. 80/130

2. UNIDO letter ref. 662/1 (9) of 27 May 1980 with an attached memorandum sent to the UNIDO/CSSR Joint Programme, Pilsen

3. Research Institute for Ceramics, Refractories and Raw Materials, Pilsen - Test Report on Clay Samples from Zaire No. 51007/113

VII. APPENDICES

Table No. 1	Preliminary Tests, Clay Sample A, Zaire
Table No. 2	Preliminary Tests, Clay Sample B, Zaire
Table Nos. 3, 4 and 5	Pictures of Firing Tests Clay Samples - Zaire

Table No. 1 — Preliminary Tests
Clay Sample A, Laire +

1. Water of plasticity — 25.4%

2. Plasticity No. — 27.36 according to Pfefferkorn

3. Wet sieve analysis /%/

2.5 mm	-	0.315 mm	3.5
2.0 mm	-	0.2 mm	3.1
1.0 mm	2.7	0.09 mm	7.7
0.8 mm	1.6	smaller than 0.09 mm	78.4
0.4 mm	3.0		

4. Shrinkage

b Drying shrinkage /%/ — 8.4

Firing shrinkage /%/

at 920°C/24 hrs	3.6
940°C/17 hrs	0.6
970°C/24 hrs	1.2
1060°C/56 hrs	5.0

5. Physical properties after firing

Water absorption /%/

at 940°C/17 hrs	22.9
920°C/24 hrs	22.5

+ Reference No. 3

970°C/24 hrs	19.0
1060°C/56 hrs	16.3
1260°C/120 hrs	15.1

Bending strength /kp.cm^{-2}/

at 940°C/17 hrs	24.2
920°C/24 hrs	22.1
970°C/24 hrs	26.1
1060°C/56 hrs	32.1
1260°C/120 hrs	32.0

6. Chemical composition /%/

Loss on ignition 10.15

SiO_2	53.82	MgO	0.57
Al_2O_3	19.37	CaO	0.53
Fe_2O_3	11.50	Na_2O	0.15
TiO_2	2.74	K_2O	1.17

7. Hydrochloric acid test

- Carbonate concretions were not found.

8. Appearance of the material after firing
Colour of the small bricks - dark brown-red, considerably cracked, colour of fracture - brown-red.

9. Classification
Recommended firing temperature of 1060°C for the manufacture of bricks, hollow bricks, drainage pipes and roofing tiles.

Glazing test has proved that glazed wall tiles may also be considered to be manufactured from the clay when an appropriate plastic clay is added to the body.

Table No. 2 **Preliminary Tests**
Clay Sample B, Zaire +

1. Water of plasticity 23.6%

2. Plasticity No. 24.99 according to Pfefferkorn

3. Wet sieve analysis /%/

2.5 mm	0.1	0.315 mm	6.95
2.0 mm	0.7	0.2 mm	6.6
1.0 mm	5.8	0.09 mm	10.2
0.8 mm	2.3	smaller than 0.09 mm	63.95
0.4 mm	3.4		

4. Shrinkage

Drying shrinkage /%/ 9.1

Firing shrinkage /%/

at 920°C/24 hrs	2.6
940°C/17 hrs	0.7
970°C/24 hrs	0.7
1060°C/56 hrs	3.9

5. Physical properties after firing

Water absorption /%/

at 940°C/17 hrs	22.6
920°C/24 hrs	24.2
970°C/24 hrs	19.6
1060°C/56 hrs	17.5
1260°C/120 hrs	16.2

+ Reference No. 3

Bending strength /kp.cm^{-2}/

at 940°C/17 hrs	19.1
920°C/24 hrs	17.7
970°C/24 hrs	26.0
1060°C/56 hrs	21.2
1260°C/120 hrs	24.2

6. Chemical composition /%/

Loss on ignition 7.57

SiO_2	61.28	MgO	0.62
Al_2O_3	18.93	CaO	0.44
Fe_2O_3	6.51	Na_2O	0.26
TiO_2	1.57	K_2O	2.00

7. Hydrochloric acid test

Carbonate concretions were not found.

8. Appearance of the material after firing

Colour of the small bricks - dark brown-red, considerably cracked, colour of fracture - brown-red.

9. Classification

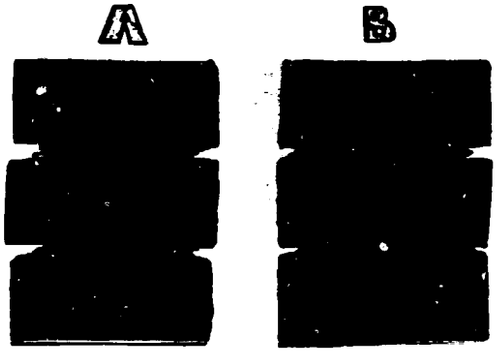
Recommended firing temperature of 1060°C for the manufacture of bricks, hollow bricks, drainage pipes and roofing tiles.

Glazing test has proved that glazed wall tiles may also be considered to be manufactured from the day when an appropriate plastic clay is added to the body.

Table No. 3 Pictures of Firing Tests

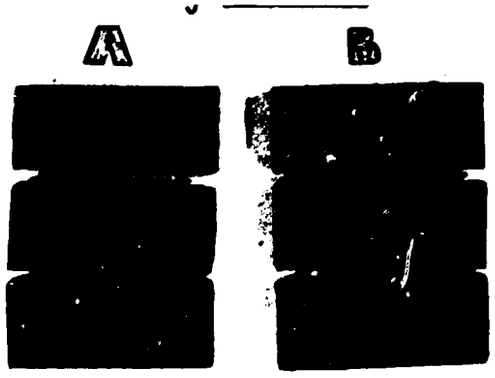
Clay Samples - Zaire

Small laboratory bricks - at 920°C/24 hrs



920°c/ 24 hod.

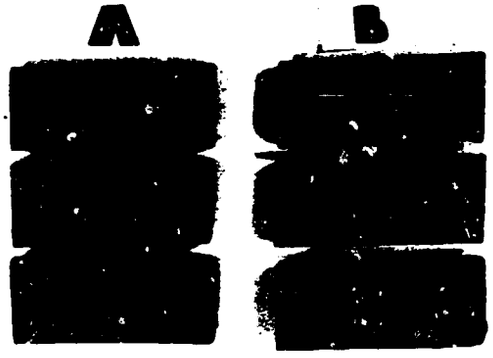
Small laboratory bricks - at 940°C/17 hrs



940°c / 17 hod.

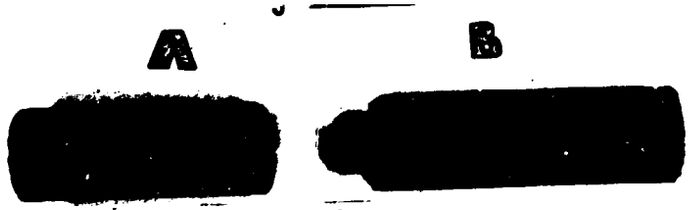
Table No. 4 — Pictures of Firing Tests
Clay Samples - Zaire

Small laboratory bricks - at 970°C/24 hrs

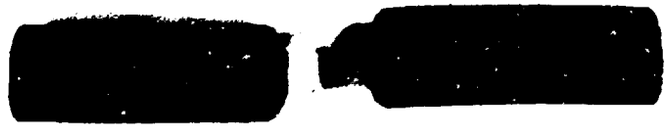


970°C / 24 hod.

Small laboratory pipes - at 940°C/17 hrs
at 970°C/24 hrs



970°C / 24 hod.

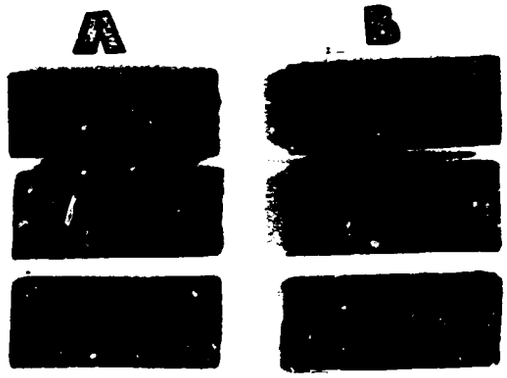


940°C / 17 hod.

Table No. 5 Pictures of Firing Tests

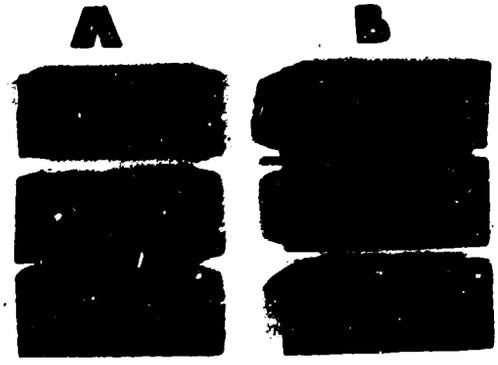
Clay Samples - Zaire

Small laboratory bricks - at 1060°C/56 hrs



1060°c / 56 hod.

Small laboratory bricks - at 1260°C/120 hrs



1260°c / 120 hod.