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15864

Distr.
RESTRICTED

UNIDO/IO/R.248
2 June 1986

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH

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# ASSISTANCE TO THE MARBLE AND STONE INDUSTRY

US/ETH/81/007

ETHIOPIA

Terminal report

Prepared for the Government of Ethiopia
by the United Nations Industrial Development Organization

Based on the work of Ion Albu,
expert in marble quarrying and processing

V.86-57839
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## Explanatory notes

The monetary unit in Ethiopia is the birr (Br).

References to tonnes (t) are to metric tonnes.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

| | |
|---|---|
| EBMC | Ethiopian Building Materials Corporation |
| ECMC | Ethiopian Construction Materials Corporation |
| ELMICO | Ethio-Libyan Joint Mining Company |
| EMI | Ethiopian Marble Industry |
| EMI Bole | Ethiopian Marble Industry, Bole Plant |
| EMI Gulele | Ethiopian Marble Industry, Gulele Plant |
| EMI Nefas Silk | Ethiopian Marble Industry, Nefas Silk Plant |

## ABSTRACT

The project "Assistance to the marble and stone industry" (US/ETH/81/007) which started on 1 January 1983 and was completed on 7 January 1986, aimed to increase the utilization of the country's marble reserves, to improve the activities in the marble-processing plants existing in Addis Ababa, to upgrade the skills of local personnel and to demonstrate the possibility of utilizing volcanic tuff as building material for low-cost housing.

The project activities which were carried out by one international expert during the entire duration of the project (36 man-months), resulted in the identification of new marble deposits and a fivefold increase of the quarrying capacity. The marble processing capacity of the three marble plants, out of which two were rehabilitated and reactivated, increased tenfold. However, due to the limited demand for marble products on the local market, only 50 per cent of the quarrying capacity and about 36 per cent of the processing capacity are being utilized at present.

The skills of the local personnel (engineers, technicians and workers) has been upgraded through various training programmes such as fellowships and study tours in Italy and Turkey, training courses and on-the-job training.

The possibility to build low-cost houses with tuff blocks cut in situ has been demonstrated. Furthermore, the project created job opportunities for 248 workers, of which 44 are filled by women.

As there are good premises for an increased utilization of the results of the project, for which further technical assistance by UNIDO will be required, the expert elaborated three project proposals, one for a continued assistance to the marble and stone industry, another for assistance in the use of tuff as building material for low-cost housing, and a third for assistance in the production of gift items from marble waste.

CONTENTS

# INTRODUCTION

## A. Project background

In the Ten-Year Development Plan of Ethiopia, in which the construction sector plays a very important role, the necessity to expand and improve the building-materials industry has been emphasized. The shortage of wood as a result of the dwindling forests, prompted the Ethiopian Government to look for other locally-made materials that would replace wood and at the same time save foreign currency.

As a consequence of the technical assistance extended by the United Nations Industrial Development Organization (UNIDO) to the Ethiopian marble industry under project DP/ETH/80/013, the Government of Ethiopia realized the substantial potential of the national stone industry, which led it to ask UNIDO for further assistance to its marble industry.

During the visit of an official of UNIDO to Ethiopia in February 1981, a meeting was held at the Ethiopian Building Materials Corporation (EBMC) to discuss future assistance to the Ethiopian marble industry. It was agreed that the assistance in the field of marble and stone, including in situ cutting of tuff blocks for low-cost housing, was of such volume that a new project should be envisaged.

## B. Official arrangements

On 31 August 1981 the Ethiopian Government submitted to the United Nations Development Programme (UNDP) at Addis Ababa a draft project proposal which was forwarded by UNDP to UNIDO on 2 September 1981. The project proposal was approved by UNIDO in November 1981.

The project effectively started on 1 January 1983 with the arrival of the expert, and ended on 7 January 1986.

The expert carried out the duties of post No. 11-01, expert in marble quarrying and processing, as well as those of post No. 11-02, expert in building-block (tuff) processing. The relevant job descriptions are reproduced in annexes I and II.

During the implementation of the project the co-operating government agencies were the following:

(a) Ethiopian Building Materials Corporation (EBMC) under the Ministry of Industry from January 1983 to June 1983;

(b) The Ministry of Construction from July 1983 to October 1983;

(c) Ethiopian Construction Materials Corporation (ECMC) under the Ministry of Construction from November 1983 up to the completion of the project.

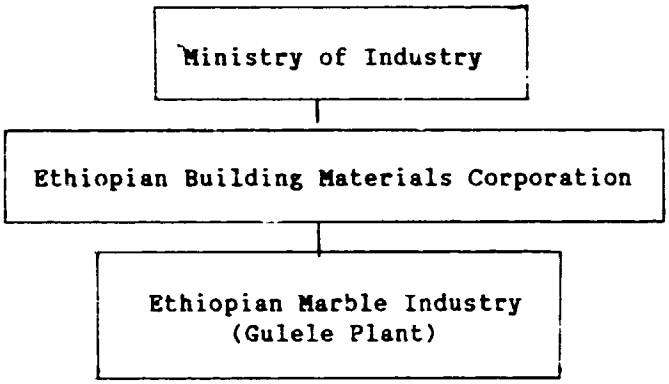
Organigrammes showing the position of the Ethiopian marble industry in the government structure are reproduced on page 7.

The marble-processing plants under the above-mentioned agencies to whom the assistance was given were:

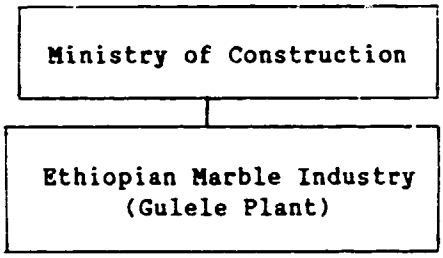
(a) Ethiopian Marble Industry, Gulele Plant (EMI Gulele) from 1 January 1983 to 7 January 1986;

Position of the Ethiopian Marble Industry in the government structure

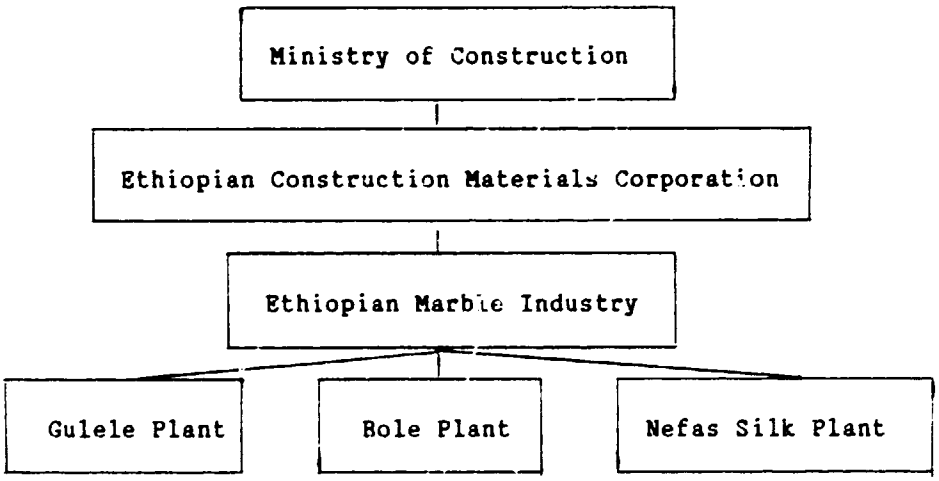
A. January 1983 to June 1983




B. July 1983 to October 1983




C. From November 1983 on



(b) Ethiopian Marble Industry, Nefas Silk Plant (EMI Nefas Silk) from 1 July 1983 to 7 January 1986;

(c) Ethiopian Marble Industry, Bole Plant (EMI Bole) from 1 July 1983 to 7 January 1986.

The counterpart staff working with the expert is shown in annex III.

## C. Contributions

The total contribution of UNIDO amounted to $US 529,000 and was not modified till the completion of the project.

The total contribution, in kind, of the Government was:

151 man-months of counterpart personnel
Birr 216,000 for foundations, construction works, transportation etc.
130,000 $m^2$ area alloted.

## D. Objectives of the project

The original objectives as per the approved project document were:

(a) Development objectives:

(i) Increased exploitation of domestic raw materials;

(ii) Creation of additional job opportunities;

(iii) Improvement of foreign exchange earnings;

(b) Immediate objectives:

(i) Better and increased utilization of marble and granite reserves;

(ii) More efficient domestic manufacture of marble and stone products;

(iii) Production of volcanic tuff blocks for low-cost housing;

(iv) Upgrading the skills of local personnel through various training programmes.

The original objectives were not revised.

All objectives of the project were attained as follows:

(a) New marble deposits were identified, a new marble quarry was opened and the production of marble blocks was more than doubled;

(b) New job opportunities were created for 248 workers (including 44 women);

(c) An improvement of the foreign currency earnings was achieved by saving the import of finishing materials for the building industry, although the export of marble products has not yet started;

(d) Marble quarrying and processing activities became efficient and for the first time a profit was achieved;

(e) The possibility of quarrying the volcanic tuff, cut into blocks, as well as its utilization for low-cost housing was demonstrated (one house has been built with tuff blocks);

(f) The skills of local personnel working in the quarries, marble-processing plants as well as in marble cladding and fixing have been upgraded, resulting in an increased productivity, a better quality of the products as well as in greater self-confidence of the personnel of EMI.

## E. Training

### Formal training

Three engineers of which one female, were awarded fellowships abroad for a total duration of 11.5 man-months. Study tours were arranged for two engineers, one architect and two technical managers with a total duration of 3.5 man-months. For details see annex IV.

Furthermore, the expert gave a series of courses for three engineers and three technical managers for two hours per week over a period of six months. Each of the 26 lessons, which focused on existing acute problems at EMI, was followed by explanations and a demonstration of the subject of the lesson in practice. The courses were held at the head office of EMI, and since a blackboard was the only training material available, the expert had to draw the necessary sketches, charts and tables with various data on that board. Standard specifications for the use of diamond tools (saw blades and discs) were distributed to all participants.

### Informal training

On-the-job training was given to the technical personnel, foremen and worker's team leaders of EMI in the field of quarrying marble blocks and tuff blocks for building, marble processing and marble cladding, during the entire duration of the project.

Through that training the personnel of EMI was, for the first time, confronted with such specific issues as the range of application of marble quarrying and processing machines and the ways in which they could be better utilized, marble quarrying methods and ways to efficiently quarry and process marble, the establishment of a marble products flow sheet etc.

## RECOMMENDATIONS

In order to further increase the efficiency as well as the competitiveness of the marble industry, the expert makes the following recommendations:

1. The activities of the various agencies involved in marble quarrying and processing should be co-ordinated aiming at the following:

(a) Avoiding parallel activities (e.g. quarrying or processing the same type of marble) and concentrating on work that is complementary;

(b) Avoiding unnecessary investment as long as the existing quarrying and processing capacities are not fully utilized. At present EMI's capacities are utilized to about 50 per cent in marble quarrying, to about 30 per cent in marble processing, and to only some 20 per cent in the processing of floor tiles;

(c) Refraining from considering the installation of new marble-processing plants which would produce 100 per cent for the export market. Even under optimal processing conditions, the inherent characteristics of marble would preclude the achievement of marble products of such quality that they could all be exported. Therefore, part of the products will always have to be sold locally;

(d) Making few investments in EMI's plants with the objective to produce thin marble slabs and to improve the quality of the marble products so that they can compete on the export market;

(e) Basing a further development of the marble industry on the present activities of EMI, because EMI already has the necessary know-how. That would save funds for the formation of new personnel or shorten the duration of their formation;

(f) Deferring the development of large-scale quarrying in newly identified marble deposits based on core drilling only. First one should start with small-scale quarrying with minimum investment and mobile equipment, so that within three to five years all necessary information concerning the characteristics of the marble as well as of the deposit could be gathered.

2. Proper repair and maintenance should be organized to ensure that all equipment is kept in normal operating conditions. EMI's equipment, though old, could be repaired with little expense. In developed countries (e.g. Italy) similarly old equipment is still being utilized on a large scale and will be further used. In that respect, the following steps should be taken as soon as possible:

(a) Assign a qualified chief of maintenance;

(b) Organize the designing of such spare parts that are frequently needed and which could be made locally;

(c) Establish a small workshop (e.g. at EMI Gulele where the compound has already been extended) with the necessary equipment to process simple spare parts;

(d) Introduce stock control for spare parts;

(e) Introduce a repair and maintenance programme for the machines.

3. Actions should be taken with a view to standardize part of the marble products and to regulate the use of marble in public buildings and houses. The focus should be on:

(a) Use of thin marble slabs of 1, 1.5 and 2 cm thickness;

(b) Standardization of the dimensions of the majority of marble products;

(c) Use of marble products in public buildings and houses wherever they could replace imported materials or local materials made of wood.

4. The present marble processing technology should be partially adapted for the production of thin marble slabs of 1.5 cm thickness. Since such existing machines as the diamond saw with 10 blades, the orthogonal-disc and the vertical-disc machines, with additional spare parts (hydraulic tensioner for the 10-blade saw) and equipment (cutting and dividing machines, continuous gauging-grinding-polishing machines, cutting-off machines etc.) could be used, only a relatively small investment would be required.

5. A pilot quarry for dimensioned tuff blocks should be set up, to demonstrate the technical and economical viability of the production and use of tuff blocks for low-cost housing. Based on the results achieved with that pilot quarry, an extended use of this cheap and little energy-consuming material in the areas where tuff deposits occur, could be studied.

6. According to the envisaged development of marble products, plans should be prepared in good time for the utilization of the machines in a second and third shift. With the existing machinery and few additional equipment a yearly production of approximately 120,000 $m^2$ of marble slabs can be achieved by a three-shift operation, which would give about 80,000 to 85,000 $m^2$ of finished marble slabs.

7. A workshop for the production of artisanal and souvenir items for tourists should be set up, where waste of marble quarrying and processing could be utilized.

8. The installation of a second overhead crane at EMI Gulele requires that the production of floor tiles be moved. A flow-sheet should be designed for the new arrangement, considering the following points:

(a) Enough space should be provided so that the processing capacity of the existing equipment can be fully utilized;

(b) A gradual introduction of operation in two and three shifts per day should be considered;

(c) The hardening deposit should be better organized in order to reduce the waste which at present is excessive due to an overloaded storage;

(d) The size of the tiles should be increased from 20 x 20 cm to 25 x 25 cm. That should contribute to an increase of the productivity of the machine by approximately 50 per cent as well as that of masons engaged in construction work.

9. Since transportation accounts for the lion's share in the overall cost of a block, the blocks should be cut into rectangular shapes and have smooth surfaces in order to fully utilize the loading capacity of the trucks.

10. Whenever the conditions of the marble deposits permit, blocks of dimensions as large as possible should be quarried, but keeping in mind transport capacities and, more importantly, the loading capacity of the block trimming machines. The processing of large blocks would increase the output of the block trimming machines as well as the efficiency of the processing activity.

11. The quarries should be opened in a restricted area and the marble deposit should be exploited in depth rather than by increasing the surface. That would avoid unnecessary deforestation, would reduce the cost for the removal of overburden for the construction of access roads, and would permit an easier and cheaper shaping of the blocks.

12. The permanent quarries should be equipped with loading equipment (derrick cranes) for the loading of the blocks onto the trucks, and a certain quantity of blocks should be stored at the quarry sites to prevent shortage of blocks during the rainy season.

13. For the removal of the overburden and the transport of waste in the quarries such equipment as excavators, bulldozers, dumpers etc. will have to be utilized. Considering the small extent of the quarrying activity as well as the high cost of such equipment, they should be rented for limited periods of time rather than be bought.

14. A mono-blade diamond saw should be installed at EMI Bole, in order to prepare blocks with adequate dimensions for the three existing vertical-discs block trimming machines.

15. As the implementation of part of the above-mentioned recommendations requires further assistance by UNIDO, such technical assistance should be sought. In that context the expert has prepared three draft project proposals, "Assistance to the marble and stone industry, phase II", "The utilization of volcanic tuff as building material for low-cost housing" and "Assistance to the Ethiopian marble industry" which are reproduced in annexes XIII to XIV.

# I. PROJECT INPUTS

## A. Inputs provided by the Government

### Counterpart staff to work with the internationally recruited expert

During the implementation of the project, nine local staff were assigned to work with the expert for a period of three months up to 36 months each. These were four engineers, four technical school graduates and one draftsman.

Only two engineers, one of them female, and one draftsman were assigned to work permanently with the expert. The other two engineers were specially recruited for the project, however only in February and March 1985 respectively.

### Provision of secretarial and administrative services

Secretarial and administrative services were provided by EMI whenever required.

### Provision of local transportation to the project sites

EMI has done its best to provide transportation to the expert, but due to the acute shortage of vehicles the expert's visits to the quarry sites could not be made as planned and required.

### Other contributions in kind

The Government allotted a total area of 130,000 $m^2$ for the implementation of the project as follows:

| | Square metres |
|---|---|
| For a quarry at Harer | 60 000 |
| For a quarry at Gojam-Metekele | 40 000 |
| For a tuff block quarry at Legedade | 20 000 |
| For an extension of the EMI Gulele plant | 10 000 |
| Total | 130 000 |

The Government also contributed to the implementation of the project by the following:

| | Birr |
|---|---|
| Organizing a demonstration of tuff blocks quarrying at Legedade | 34 000 |
| Access roads to Harer and Gojam quarries | 24 000 |
| Sheds at Harer and Gojam quarries | 16 000 |
| Foundation and concrete structure to install the equipment | 80 000 |
| Transporation, secretarial and administrative services | 24 000 |
| Mounting of the equipment | 38 000 |
| Total | 216 000 |

## B. Inputs provided by UNIDO

### Personnel

UNIDO provided 36 man-months assistance through one technical assistance expert, who carried out the duties of post No. 11-01 "Expert in marble quarrying and processing" as well as those of post No. 11-02 "Expert in building block (tuff) processing" as per the decision taken by the tripartite review meeting held in December 1984.

The post No. 11-03 "Expert in marble marketing" was cancelled as a marketing study had been considered premature, and the funds ($US 18,000) were transferred to the equipment component.

### Training

UNIDO awarded fellowships and study tours abroad for a total of 15 man-months (see annex IV) as compared to 13 man-months foreseen in the project document.

### Equipment

UNIDO provided non-expendable and expendable equipment amounting to $US 263,000 (annexes V, VI and VII) as compared to $US 245,000 as per initial project document. All non-expendable equipment has been installed and is in operation, except for the items listed in annex VI which had not arrived at Addis Ababa before the completion of the project.

### Evaluation of the project

The project was reviewed twice during its implementation:

(a) Tripartite review meeting held on 3 December 1984 with the participation of the Government, the project management and a representative of UNIDO;

(b) Final tripartite review meeting held on 19 September 1985 with the participation of the Government, the project management and representatives of UNIDO and the Italian embassy (donor Government).

During both tripartite review meetings a desk evaluation of the project was carried out, which was useful for the completion of the project.

## II. ASSIGNMENTS OF THE EXPERT

### A. Posts, duration and activities

The expert was originally assigned to carry out the tasks of post 11-01 "Expert in marble quarrying and processing" (annex I) with a duration of 24 months. He started his assignment on 1 January 1983 and completed it on 31 December 1984.

As per government decision the implementation of tuff block processing was posponed, although UNIDO had proposed candidates for post 11-02 "Expert in building block (tuff) processing" (annex II) in good time.

During the tripartite review meeting held on 3 December 1984, it was decided that the same expert be transferred to post 11-02 after the completion of his assignment to post 11-02. Accordingly, the expert was assigned to post 11-02 as of 1 January 1985 until 7 January 1986.

During his assignment to post 11-01 the expert carried out the marble-based activities which are described in detail in chapter III, sections A, B, D and E of this report.

At the same time he also started to prepare the tuff-based activities by:

(a) Making a comparative study of tuff block cutting machines;

(b) Selecting tuff deposits;

(c) Prepare for the opening of a quarry face for tuff blocks.

During his assignment to post 11-02, the expert carried out the activities described in chapter III, section C of this report, but also continued to extend his assistance to the marble-based activities by:

(a) Organizing the management;

(b) Giving formal training courses;

(c) Improving the quarrying activity.

### B. Strategy

Bearing in mind the initial situation of EMI as well as the priority the Government gave to marble processing over tuff, the expert chose a strategy which would lead to immediate practical and tangible results.

Quarries

At the beginning, i.e. before the arrival of the quarrying equipment provided through the project and due to the lack of technicians, the expert improved the manual quarrying technology through on-the-job training of the quarrying teams.

At the second stage, when the equipment had arrived, but sufficient technicians were still lacking, he selected and opened new quarry faces with the quarrying equipment and gave to the quarrying teams on-the-job training in drilling and wedging technology.

Later, after the assignment of the technicians (engineers), the technicians as well as the quarrying teams received on-the-job training in

drilling and wedging technology, and the technicians also attended training courses on various quarrying technologies, again focusing on drilling and wedging.

Marble processing

At stage one, until the arrival of the equipment (overhead crane and mono-blade saw) and with a shortage of technicians, an attempt was made to increase the output of the existing block trimming machines through on-the-job training of the operators, the foremen and the head of production.

After the arrival of the equipment but still without sufficient technicians, the expert:

(a) Supervised the installation of the equipment and reorganized the flow sheet;

(b) Re-activated some machines which had been idle for years due to the lack of loading equipment;

(c) Provided the operators, foremen and the head of production with on-the-job training in the operation of the re-activated machines.

During the third phase, two marble plants which had been inoperative for many years were re-activated by:

(a) Providing the necessary facilities;

(b) Forming of a nucleus team of foreman and workers from the operating plant;

(c) Gradually enlarging the team of workers;

(d) Giving on-the-job training to the production managers and to the operators.

Finally, after the assignment of the technicians, they were offered formal training courses in marble processing, followed by practical application.

Production and use of tuff blocks

With respect to the processing of tuff blocks, the expert had the following work plan:

(a) Select a tuff deposit near Addis Ababa and demonstrate in situ the production of tuff blocks;

(b) Produce a small quantity of tuff blocks which could be used as building material;

(c) Build a small house with tuff blocks to demonstrate the possibility of using tuff blocks as building material.

## III. ACHIEVEMENTS

### A. Better and increased utilization of marble and granite reserves

In connection with the above-mentioned immediate objective of the project, the expert was required to provide assistance in the identification of suitable marble and granite deposits to quarry blocks which could be used in the processing industry, to organize quarry faces applying improved quarrying methods, and to train the personnel in marble quarrying.

Identification of new marble and granite deposits

The expert, accompanied by counterpart staff, visited many marble and granite deposits. Taking into consideration the expensiveness of extended geological research and the limited quantity of marble blocks required by the existing marble industry, he decided to limit the prospecting to visual observation and the collection of rock samples which were analyzed at EMI to determine the processing characteristics as well as commercial aspects.

A number of marble and granite deposits were selected with estimated reserves that are sufficient for at least 20 years. Very small investment is required to open a quarry face.

Metekele in the Gojam region

Location: On the Injibara-Guba road, 680 km from Addis Ababa.

Description: Large-grained crystallized dolomite, white, whitish grey and grey. The deposit is mainly formed by erratic blocks of large and medium size with an apparent height of 5 to 6 m and extending over an area of some hundred square metres. It is likely that these massive rocks are enlarging with depth. It seems that inclusion of harder minerals occurs rarely and they could be easily removed when the blocks are being cut.

Preliminary estimation: The deposit is very large, covering an area of more than 7 $km^2$. The quarrying of the marble blocks could start immediately with very small investment. It is recommended to start shaping the erratic blocks and at the same time to open a quarry face by drilling and wedging the massive rocks. It is also recommended to establish a deposit of blocks arranged according to their dominant colour. The marble could be processed into slabs of a minimum thickness of 2 cm.

Berack in Harer region

Location: On a local road crossing the Addis Ababa-Djibouti railway at Shenile, 550 km from Addis Ababa.

Description: Fine-grained crystallized marble, white, grey and black with white veins. The deposit is in a hilly area crossed by a river. The marble is stratified in layers of 0.7 to 5 m height. Part of the deposit is formed by massive banks in which the white and black colours alternate in layers of 0.4 to 0.7 m height.

Preliminary estimation: The size of the deposit is some hundred thousand cubic metres. The marble is of a very attractive colour and could be processed into thin slabs. It is also possible to produce very thin marble tiles (0.7 to 0.8 cm thickness) to replace ceramic tiles. For the time being there are some difficulties to start permanent quarrying in that location.

Muger in Shewa region

Location: In the area of the new cement plant on Muger river (a tributary of the Blue Nile), 100 km from Addis Ababa.

Description: Partially crystallized limestone, beige colour. The deposit is stratified in horizontal layers of 0.4 to 2.6 m height.

Preliminary estimation: The deposit is very large (millions of $m^3$). Some quartz gravel observed in the quarry of the cement plant requires an in-depth research of the deposit before starting to quarry marble blocks.

Zhema river in Shewa region

Location: On the Addis Ababa-Lemi-Fetra road, in the vicinity of the new bridge over the Zhema river, 120 km from Addis Ababa.

Description: Partially crystallized limestone, beige colour. The deposit is stratified in layers of 0.5 to 2.0 m height.

Preliminary estimation: The deposit is very large (millions of $m^3$). The compressive strength of the rock varies from site to site. The soft one could be easily quarried and processed but should not be used in areas where abrasion is likely to occur (e.g. floors). The access to the quarry, which at present is difficult, will be improved within two to three years by a new road which is under construction.

Amaressa in Harer region

Location: In the vicinity of Amaressa town, 2 km from the Addis Ababa-Harer highway, 518 km from Addis Ababa.

Description: Granite of red colour, frequently pigmented with black. The deposit, which is a part of a granite chain of mountains, has a cupola shape surrounded by a flat dipping area with an overburden of 1 to 2 m thickness.

Preliminary estimation: The deposit is large enough to quarry up to 10,000 $m^3$ with little uncovering work. The quarrying could immediately start on the big uncovered cupola (some ten thousand $m^3$).

Welega in Welega region

Location: In an area 35 to 45 km west-north-west of Mendi.

Description: Medium-grained crystalline marble, white and whitish grey. There is a very large area where marble could be observed out of which eight small hills were identified as suitable for exploitation. The processing of some samples collected on the surface of that deposit gave a uniform polishing which could be caused by the presence of quartz as a mineral component of the rock. Some marble blocks which were trimmed into slabs showed frequent inclusions of quartz (grains of 1 to 7 cm).

Preliminary estimation: It is estimated that the volume of marble varies from 100,000 $m^3$ to 800,000 $m^3$ per hill. The colour is very attractive. However, the uniformity of polishing may be a problem and the frequent presence of quartz inclusions in the marble blocks will require considerable research before making any substantial investment.

The expert was informed that at Welega a small-scale quarry has recently been started under the Ethio-Libyan Joint Mining Company with a group of Italian experts. This activity is not related to the present project. It was also reported that this company intends to install a new plant for the processing of marble slabs for export only.

Increase and improvement of marble quarrying

At the beginning of the project only one quarry at Harer was permanently operating (beige-coloured marble blocks) and two others (Harer - black marble and Aysha - red/yellow marble) were occasionally operating. In all three places quarrying was done manually with hand tools. The marble blocks were separated from the day stones appearing on a very large area which implicated extensive deforestation. The marble blocks were not cut in regular shapes which made their transportation and their further trimming into slabs uneconomical. The irregular shape also made it impossible to determine their volume, and the capacity of the trucks was utilized only 60 to 65 per cent, whilst EMI had to pay for 100 per cent.

One $m^3$ of marble block yielded only 12 $m^2$ of finished marble slabs. At that time the annual quantity of marble blocks quarried was approximately 600 $m^3$.

During the implementation of the project the expert, in co-operation with the counterpart staff, aimed at improving the quarrying methods and at increasing the quarrying capacity to 3,000 $m^3$/year of well-shaped marble blocks. In that respect the following activities were carried out:

(a) A new marble quarry was opened at Metekele in the Gojam region. Part of the quarrying equipment provided through the project was installed at the quarry site and a small quarrying team was transferred from Harer quarry. The quarrying activity started with the shaping of the erratic blocks and at the same time a quarry face was opened on one of the massive rocks found near the Ingibara-Guba road. The quarrying method used in that quarry face was mechanical drilling and wedging;

(b) The manual quarrying methods previously used at Harer quarry were changed to mechanical drilling and wedging, using the quarrying equipment provided through the project. The quarry face was limited to an area of 12,000 $m^2$ and the blocks are quarried in steps formed by the natural benches of the deposit;

(c) On-the-job training was given to the quarry workers as well as to EMI's head of production who accompanied the expert during his visit to the quarry sites;

(d) Charts giving the weight of the blocks in relation to their dimensions as well as indicating desirable dimensions were drawn up and distributed to the quarries;

(e) Charts indicating the frequence of various maintenance operations for each piece of quarrying equipment were established and distributed to the quarries.

As a result of those activities the following achievements were obtained at the end of the project:

(a) The range of marble types has been increased from four to nine, plus one type of granite, out of which five are being processed at present;

(b) Two marble quarries were reorganized to operate with mechanical technology;

(c) The skill of the personnel involved in quarrying was upgraded which resulted in an increased productivity and an improved quality of marble blocks. The productivity increased from 37.5 $m^3$/man/year of unshaped marble blocks to 48.5 $m^3$/man/year of well-shaped blocks (30 per cent increment);

(d) Out of 1 $m^3$ of well-shaped marble blocks 18.5 $m^2$ of finished marble slabs are obtained at present, compared to 12 $m^2$ at the beginning of the project (54 per cent increment);

(e) The utilization of the transport capacity increased from 60 to 65 per cent at the beginning of the project to 80 to 85 per cent at present (30 per cent increment);

(f) The quarrying capacity increased from 600 $m^3$/year to more than 3,000 $m^3$/year at present (400 per cent increment). Unfortunately that capacity could not be fully utilized due to the low level of domestic demand in 1985 which is a result of the redistribution of investment funds at the country level in order to improve the situation of the regions affected by draught. However, the actual quantity of marble blocks quarried in 1985 was 1,650 $m^3$ as compared to 600 $m^3$ at the beginning of the project (175 per cent increment);

(g) The number of workers in the quarries increased from 16 at the beginning of the project to 34 at present, i.e. 18 new job opportunities were created. Details on the development of the personnel component are contained in annex VIII.

## B. Increase of efficiency in the local manufacture of marble and stone products

At the beginning of the project only one marble processing plant (EMI Gulele) was operating in Addis Ababa, producing 7,700 $m^2$/year of finished marble slabs and 11,000 $m^2$/year of floor tiles. Out of seven block-trimming machines of various types, only four were operating at a very low rate of productivity. The other three block-trimming machines have been idle for 7 to 8 years mainly due to the lack of loading facilities and spare parts.

The hourly output of the block-trimming machines was very low due to poorly skilled personnel and frequent breakdowns. In the floor-tiles department inadequate organization of the work flow, insufficient space as well as frequent breakdowns of the machines were responsible for the poor productivity.

Two other marble processing plants in Addis Ababa, EMI Bole and EMI Nefas Silk, had been idle for 6 to 8 years. The equipment of all three plants was of the hand-operated type, old, and most of the block-trimming machines had not been used for many years. The technical personnel of EMI consisted of EMI's manager and one production manager.

To improve the marble processing methods and to increase the yearly production capacity to 60,000 $m^2$ of marble slabs and 140,000 $m^2$ of floor tiles, the expert, in co-operation with the counterpart staff, carried out the following activities:

(a) A plan including all necessary actions (spare parts, repairs, personnel and other facilities) for the reactivation of the two idle marble plants was established;

(b) Part of EMI Gulele's operators were transferred to the newly reactivated marble plants;

(c) Intensive on-the-job training was given to the two technical managers as well as to the newly employed operators

(d) A new flow-sheet for EMI Gulele was elaborated;

(e) The equipment provided through the project (overhead crane and mono-blade diamond saw) was installed at EMI Gulele;

(f) Some marble cutting and polishing machines were removed from the area near the disk block-trimming machines;

(g) Two vertical-disc block-trimming machines were reactivated;

(h) The water and electricity supply was modified accordingly;

(i) The flow-sheet for the floor-tiles department was redone for the same restricted area. Palettes were prepared and the previous transportation of the finished floor tiles by wheel barrows was replaced by transportation by fork lift (provided through the project);

(j) Intensive on-the-job training was given to the personnel (technicians and operators) to operate the marble-processing equipment in order to reach the average attainable productivity of the machines. In this respect the expert demonstrated to the staff how to operate each type of machine most efficiently.

At the end of the project the following was achieved:

(a) Two marble-processing plants were reactivated (EMI Bole and EMI Nefas Silk) and one marble plant (EMI Gulele) was reorganized, all three being in operation at present;

(b) The skill of the personnel of EMI was upgraded which resulted in increased productivity. The operators are now confidently operating the machines at the attainable productivity;

(c) The average output of marble slabs increased from 2.82 $m^2$/hour at the beginning of the project to 15.40 $m^2$/hour at present (446 per cent increment) and could be further increased up to 23.75 $m^2$/hour when all machines will be repaired and in good operating conditions. (For details see annex IX.) In addition, each of the processing machines temporarily exceeded the average attainable hourly output during a month of peak production in 1985;

(d) The increased hourly output of the block-trimming machines will allow an annual production of 80,000 to 85,000 $m^2$ of finished marble slabs, if two- or three-shift operation were introduced (see annex X);

(e) The actual production of finished marble slabs increased from 7,700 $m^2$ at the beginning of the project to 28,000 $m^2$ in 1985 (264 per cent increment). The average attainable capacity could not be utilized due to the low demand in 1985 as a consequence of the afore-mentioned reasons;

(f) The average processing capacity of floor tiles of 20 x 20 cm increased from 18 $m^2$/hour at the beginning of the project to 23 $m^2$/hour at the end of the project. This could be further increased to 38 $m^2$/hour by making tiles of 25 x 25 cm size;

(g) Due to the difficulties which the counterpart faced in moving the floor-tiles production to a larger area where it could have been reorganized on a three-shift basis, the average attainable capacity of 140,000 $m^2$/year could not be achieved. In the existing restricted area the annual production increased from 11,000 $m^2$ at the beginning of the project to 30,000 $m^2$ at present (172 per cent increment);

(h) With that increased production capacity an annual production of 140,000 $m^2$/year of tiles sized 20 x 20 cm could be achieved if a larger area were made available and a three-shift operation introduced. By increasing the size of the tiles to 25 x 25 cm, the annual capacity could reach 200,000 $m^2$/year with a three-shift operation. Additional space for an extension of EMI Gulele's compound has now been obtained so that the plan for the reorganization of the tiles department could be gradually implemented;

(i) The number of workers in marble processing increased from 146 (out of which 8 were women) at the beginning of the project to 297 (out of which 38 are women) at present. Thus new job opportunities were created for 151 workers out of which 30 are female;

(j) The number of block-trimming machines operating at present increased to ten machines as compared to four at the beginning of the project (see annex XI);

(k) The number of technical personnel working with EMI increased from two technicians at the beginning of the project to seven (out of which four engineers and three technicians) at present (see annex XII).

Despite the technical and economical progress that EMI has achieved through the project, marble products are still expensive which could impede a larger consumption of these products.

The expert considers that the following factors have a major negative impact on the cost of marble products:

(a) Maintenance and repair, which is still far from satisfying EMI's needs. The poor organization of that activity, EMI's lack of any type of mechanical workshop equipment to make simple spare parts, the difficulty of having such spares produced in other workshops, as well as the shortage in foreign currency to import, contribute to keeping machines idle for very long periods of time, which in turn negatively influences the productivity and the production costs.

Some machines were and still are idle, such as:

Sand saw No. 1 at EMI Gulele - since 3 years
Sand saw No. 2 at EMI Gulele - since 15 months
Orthogonal disc-cutting machine at EMI Gulele - since 8 months
Orthogonal disc-cutting machine at EMI Nefas Silk - since 2 months.

The average downtime of equipment is extremely high, i.e. 26 per cent of the working time.

Unless repair and maintenance will be properly organized, EMI's activities will dramatically deteriorate and become uneconomical with all

negative consequences arising out of that situation;

(b) The unnecessary thickness of marble products (3 cm), which normally should be 1, 1.5 or maximum 2 cm thick;

(c) The lack of standardized sizes for marble products which causes difficulties in their production and an increased waste;

(d) The uneconomical use of marble waste from the quarries, but mainly from the processing plants, which incorporates an important share of the transport and processing costs. At present part of it is used as raw material for marble gravel. Therefore the long-distance transport costs as well as part of the processing costs are lost. From part of that marble waste artistic souvenir items (ashtrays, vases, penholders, chess sets etc.) could be made;

(e) The lack of regulations for the consumption of marble products in public buildings and houses, which makes the annual local requirement uncertain. During the past three years it was approximately one third of EMI's full production capacity. However, such expenses as administration, depreciation of machines and buildings, land and building taxes etc. are more or less constant whether the plants are operating at full or one-third of their capacity, and the lower the output, the higher the share of costs per unit of product;

(f) The insufficient supervision of the quarrying, because of shortage of transportation as well as of specially assigned technical personnel. There is no permanent communication with the quarries, the visits of the technical personnel to the quarry sites are rare and too short. The marble blocks are manually loaded onto the trucks which takes too long and creates problems with the drivers. The result is marble blocks which are not properly shaped and which dimensions do not allow a full utilization of the transportation as well as the block-trimming capacities.

### C. Production of volcanic tuff blocks for low-cost housing

As Ethiopia has a large number of volcanic tuff deposits in the highlands of the country, the project aimed at demonstrating the possibility of utilizing that material, cut in situ into dimensioned blocks, for low-cost housing.

The expert, in co-operation with Mr. Getinet, professor of geology at Addis Ababa University, made a summary geological survey to locate adequate tuff deposits in the vicinity of Addis Ababa. A number of tuff deposits were identified (Entoto Mountain, Legedade, Mojo, Langano etc.) out of which the Legedade deposit was selected for the demonstration, because of its proximity to Addis Ababa.

That deposit is formed by a less compact volcanic tuff of light grey colour. The overburden was cleared away, an area flattened to open a quarry face, and the tuff cutting machine was installed. Approximately 200 $m^3$ of tuff blocks of 40 x 20 x 20 cm were cut of which 100 $m^3$ of adequate quality were selected.

The low yield of only 50 per cent is due to the fact that the blocks were cut from the upper layer of the deposit which was weathered. Cuts made to explore a second layer produced a more compact tuff and promise a much higher yield of 80 to 90 per cent.

To consolidate the blocks cut from the first layer, they were painted with cement slurry, which allowed their handling without waste. That measure will not be necessary for tuff coming from other deposits, such as Entoto Mountain or Langano.

A small house made of tuff blocks was designed, and the house was erected at the Legedade quarry site.

The expert trained technicians and workers on-the-job in the quarrying of tuff blocks.

A preliminary estimation indicates that the cost of 1 $m^3$ of tuff blocks, including the cement slurry paint, could be 40 to 50 per cent less, and the energy consumption 80 to 85 per cent lower than that of bricks.

## D. Upgrading the skills of local personnel through various training programmes

The training activities have been described in the "Introduction", section E, and in annex IV of this report.

The expert would, however, like to mention some difficulties which he faced in carrying out that activity:

(a) None of the three local fellows who were sent on a study tour financed by the project was afterwards directly involved in marble processing. Only one of them, architect Wouhib Kebede, occasionally came in touch with the problems of the marble industry;

(b) The two engineers, assigned specifically to be trained so that they would be able to carry out the technical activities of EMI in the future, arrived very late and could not get the kind of in-depth training which would enable them to further improve EMI's activities;

(c) The shortage of technicians at the beginning of the project prompted the expert to give on-the-job training to the workers, but he faced considerable difficulties due to the language problem. However, the frequent practical demonstrations given by the expert have proven to be very fruitful in increasing the skills as well as the productivity of the workers. The expert wants to express his satisfaction about the willingness as well as the ability to improve their skills demonstrated by the workers.

## E. Other fields

### Marble cladding

At the beginning of the project EMI had a small team of masons, who were laying out the marble slabs in the constructions. During the implementation of the project that team was reorganized and enlarged to cope with the increased quantity of marble products.

At the same time some important constructions were erected in Addis Ababa, the Teglachin monument and the congress house, which required the designing and fixing of big quantities of marble slabs. The expert was therefore requested by the counterpart, in addition to his duties as per job description, to assist the group of local designers in designing the cladding of the marble.

The expert also trained the team of marble masons (technicians and workers) on-the-job in laying out marble in such important buildings, a type of work which was carried out for the first time by local personnel. The skills of the technicians and workers involved were thus considerably increased so that they can now confidently carry out similar work.

The number of personnel involved in masonry increased from 30 at the beginning of the project to 117 at present, which means that 87 new job opportunities were created, out of which 14 are filled by women.

Organizing of the management

Since EMI Bole and EMI Nefas Silk were reactivated, a head office was established to manage all of EMI's activities, i.e. quarries, marble-processing plants and mason work.

The expert advised the counterpart on:

(a) The distribution of the targets according to the processing capacity and efficiency of each plant;

(b) How to calculate the required number of personnel for a given period of time according to the targets and the capacity of the processing machines;

(c) The provision of the necessary quantity of materials according to the targets and the specific consumption for each type of product;

(d) The preparation of the annual budget;

(e) The establishment of a production recording and reporting system;

(f) How to establish maintenance schedules for the machines provided through the project;

(g) How to design spare parts for and assemble some of the marble processing machines;

(h) How to organize a technical library with technical books, magazines, leaflets, operating and maintenance manuals for the equipment etc.

The main part of the above projects were implemented and are effectively contributing to the improvement of EMI's management.

There are now 43 staff working in EMI's head office. All 43 are new jobs, and 10 are filled by women.

## F. Utilization of project results

With the new marble from Gojam, the range of marbles available has been enriched by white, white and grey, and grey ones. The demand for that new marble is steadily increasing and it is expected that the quarrying capacity will soon have to be expanded accordingly.

The slabs of that beautifully veined Gojam marble can be arranged to form very attractive patterns. The expert demonstrated this, and some patterns were exhibited at the construction exhibition in November 1985. A prerequisite is, however, that blocks with similar colour and veins are grouped together at the quarry site as well as in the plant's deposit.

The yearly consumption of marble products increased from 7,700 $m^2$ to 28,000 $m^2$ within the last three years, which corresponds to an average annual rate of increase of 88 per cent. With that rate, together with the country's programme for public building and house construction, one can safely assume that the domestic demand will continuously rise. Bearing in mind that the application of marble is saving foreign currency for the purchase of other finishing materials, the consumption of that domestic product should be favourably influenced by taking measures to make marble products cheaper. This could be achieved by a standardization and regulation of the consumption of marble products in the construction of public buildings and private houses as well as by producing thin marble slabs.

The amount of foreign currency saved in the afore-mentioned two constructions (Teglachin monument and congress house) by using local marble slabs and by having the design and mason work executed by local personnel, is approximately $US 360,000. With an increased construction activity, the savings of foreign currency will increase proportionally to a higher consumption of local marble products.

The possibility of using tuff blocks as building materials for low-cost housing was demonstrated in the last months of the project, because the Government had given priority to marble quarrying and processing. Therefore, the results of that demonstration have not yet been utilized. However, the future utilization of tuff blocks depends also on the demonstration of the economical viability of the undertaking, which could not be achieved within the limited funds and duration of this project.

## IV. NEW AGENCY INVOLVED IN MARBLE QUARRYING AND PROCESSING

Under a joint-venture agreement, a new company, the Ethio-Libyan Joint Mining Company (ELMICO) has started marble quarrying activities in the Welega region. According to unconfirmed information, that company intends to extend its quarrying activity to other marble deposits, in some of which EMI has already opened a quarry face, and to install new marble-processing plants, with the main aim of exporting marble products.

The Ethiopian part of ELMICO is under the Ministry of Mines. No assistance has been requested either through UNDP/UNIDO or directly from the expert in the field, concerning that new agency.

Although the expert is not familiar with the exact present as well as future aims of ELMICO, he would like to highlight some aspects to which EMI should give due consideration:

(a) Undesirable parallel activity could occur by:

(i) Opening new marble quarries at deposits where EMI's quarrying capacity is not yet fully utilized;

(ii) Installing new marble processing plants although EMI's marble-processing capacity is not yet fully utilized;

(b) An excess of marble blocks as well as marble products could accumulate, which would depreciate if stored for extended periods of time;

(c) With less investment EMI could improve the existing marble quarrying and processing facilities and at the same time achieve a quality and price of their products that would be competitive on the export market.

Furthermore, it should be borne in mind that investment aiming at the export of marble products should be based on a market study, including a careful examination of the profitability of such exports.

In connection with the export of marble products EMI would face difficulties in the following areas:

(a) The deposits of high-quality marbles which would be competitive on the export market are located very far from the port. Therefore, a very high cost for land transport has to be considered;

(b) Marble products require careful packing in strong wooden cases, which entails a high consumption of wood products;

(c) The packed marble products require large enough deposits in the port;

(d) The marble products require a careful handling and transport in order to avoid waste through breakage;

(e) The export of marble products also calls for an increased domestic marble consumption, because only part of the products will be suitable and competitive for export purposes.

A further development of the marble quarrying and processing activity should be based mainly on the existing personnel who have already reached a certain level of know-how.

## V. CONCLUSIONS

As a result of the activities and the achievements of the project, the under-mentioned conclusions can be drawn.

Despite the old and some idle equipment, EMI's marble processing capacity has considerably increased thanks to the few machines provided under the project, but mainly on account of a better organization of the work flow, a reactivation of the idle equipment and most of all as a consequence of the training which has increased the skills of the personnel.

The present quarrying and processing capacities are not fully utilized due to the still low domestic demand. Whenever necessary, the output could be increased, without further investment, by operating the machines on a two- or three-shift basis, which would yield an annual production of 80,000 to 85,000 $m^2$ of finished marble slabs and up to 200,000 $m^2$ of floor tiles.

The poor and unorganized maintenance of the equipment impedes the achievement of a higher efficiency. There is no doubt that without a substantial improvement of maintenance the activities of EMI will deteriorate dramatically.

The economical situation of EMI has improved, and EMI is now making annual profits. However, the cost of marble products is still high which is one of the reasons for the existing low demand.

The high cost is attributable to the following:

(a) The unnecessary thickness of the marble slabs (3 cm). Thinner slabs (1, 1.5 and 2 cm) should be produced;

(b) The lack of a standardization for marble products which increases waste in processing;

(c) The uneconomical utilization of the marble waste;

(d) The fact that the marble blocks are still not well enough shaped and dimensioned so that a better utilization of the capacity of the trucks as well as of the trimming machines could be achieved;

(e) The absence of regulations for the consumption of the marble products in public buildings and urban houses.

For a continued improvement of EMI's activities further assistance from UNIDO will be required.

The volcanic tuff can be utilized as building material for low-cost housing in rural as well as urban areas. To demonstrate the technical and economical viability of a related project, a pilot quarry should be opened with the assistance of UNIDO.

The high potential of the beautifully coloured marbles of Ethiopia should be carefully examined in view of their future exploitation for export. However, the very long distances from the marble deposits to the port will probably be an important handicap in the export of marble products.

Annex I

JOB DESCRIPTION (POST 11-01)

Post title: Expert in marble quarrying and processing

Duration: 24 months (discontinuously, in missions of three up to six months each)

Date required: As soon as possible

Duty station: Addis Ababa

Purpose of project: To increase the utilization of marble and stone resources, to improve the utilization of volcanic tuff with small energy input as well as to improve the export of marble products.

Duties: The expert will be attached to the Ethiopian Building Materials Corporation under the Ministry of Industry and shall carry out the following duties:

(a) Supervise the overall development of the project;

(b) Advise on the identification of marble, granite and tuff deposits, as well as on their qualities, utilization and commercialization;

(c) Train local personnel in marble, granite and tuff quarrying and processing;

(d) Advise on the technological organization and follow up the production (quarries and plants);

(e) Make a study regarding the export possibilities of marble products;

(f) Organize model factories in some marble and tuff deposits and start training of technicians in marble quarrying.

The expert is expected to submit a final report with his conclusions and recommendations in regard to the further actions and further technical assistance to be sought from UNIDO.

Qualifications: The candidate should be an engineer with considerable experience in the quarrying and processing of natural stone as well as in the designing of marble quarries and plants.

## Annex II

JOB DESCRIPTION (POST 11-02)

| | |
|---|---|
| Post title: | Expert in building block (tuff) processing |
| Duration: | 12 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa with travel in the country |
| Purpose of project: | To improve the production of building blocks of volcanic tuff with small energy input. |
| Duties: | The expert will be attached to the Ethiopian Building Materials Corporation under the Ministry of Industry and shall carry out the following duties:<br><br>(a) Advise on the development of selected tuff deposits;<br><br>(b) Train Ethiopian technicians in the quarrying of tuff building blocks;<br><br>(c) Assess production costs of tuff building blocks, and advise on the selection of the area to be exploited.<br><br>The expert is expected to submit a final report with his conclusions and recommendations in regard to the measures to be taken to improve the efficiency of quarrying tuff building blocks. |
| Qualifications: | The expert should be an engineer with considerable experience in designing and supervising marble and stone quarries, especially with rock cutting machines. He should also be able to assess production costs. |

Annex III

CONTERPART STAFF

| | | |
|---|---|---|
| Kassa Betretsadik | Manager of EMI | January 1983 to September 1985 |
| Brehane Zewolde | Manager of EMI | October 1985 to January 1986 |
| Aschinek Kebede | Head of production, EMI | October 1983 to January 1986 |
| Mohamed Saleh Ali | Technical manager of EMI Gulele | January 1983 to January 1986 |
| Mulatu Tufa | Technical manager of EMI Nefas Silk | November 1983 to January 1986 |
| Amare Wodajo | Technical manager of EMI Bole | November 1983 to September 1985 |
| Hagere Yitbarek | Assistant head of production, EMI | March 1983 to January 1986 |
| Abenet Kebede | Assistant head of production, EMI | February 1985 to January 1986 |
| Yilma Eshete | Draftsman | January 1985 to January 1986 |

Annex IV

FELLOWSHIPS AND STUDY TOURS AWARDED

| Name of fellow | Position | Field of study | Duration | Date | Place |
|---|---|---|---|---|---|
| Kebede Wouhib | Architect, EBCA design group | | 1 month | Sept./Oct. 1983 | Italy |
| Zewdie Solomon | Engineer, Ministry of Construction | Marble and granite quarrying and processing technologies, machinery and equipment | 1 month | Sept./Oct. 1983 | Italy |
| Haile Yilma | Engineer, Ministry of Construction | | 1 month | Sept./Oct. 1983 | Italy |
| Kebede Aschinek | Engineer at EMI, head of production | | 6 months | Sept. 1983 to April 1984 | Italy |
| Yitbarek Hagere | Engineer at EMI, assistant to head of production | Marble quarrying and processing technologies, machinery and equipment | 2 months<br>3 weeks | Sept./Oct. 1985<br>Nov. 1985 | Italy<br>Turkey |
| Kebede Abenet | Engineer at EMI, assistant to head of production | | 2 months<br>3 weeks | Sept./Oct. 1985<br>Nov. 1985 | Italy<br>Turkey |
| Tufa Mulatu | Technical manager of EMI, Nefas Silk | Architectural utilization of marble, marble quarrying and processing technologies | 8 days | Dec. 1983 | Yugoslavia |
| Wodajo Amare | Technical manager of EMI, Bole | | 8 days | Dec. 1983 | Yugoslavia |

Annex V a/

NON-EXPENDABLE EQUIPMENT PROVIDED BY UNIDO

| Item No | Qty | Unit | DESCRIPTION | US-Dollars Equipment | Purchase Order | REMARKS |
|---|---|---|---|---|---|---|
| 1 | 1 | EA | Over-head Crane 10t/14m with rails and electric cable | 16,190 | 15-2-E-1317 | Operating at E.M.I. Gullele |
| 2 | 1 | EA | Diamond Gang Saw Simple Blade Mod MS-3600/82 with carriage and rails | 25,100 | —,,— | —,,— |
| 2.1 | 1 | SET | Diamond Blades (Consumable) for M S 3600/82 | 1,540 | —,,— | —,,— |
| 3 | 2 | EA | Air Compressors 6000 lt/1'-7.0 Atm Mod MC 65/L | 22,600 | —,,— | Operating at E.M.I. Harer Quarry |
| 4 | 6 | EA | Rock-Drills kg 20-2000 lt/1'-6. Atm Mod P-388 | 5,340 | —,,— | —,,— |
| 4.1 | 1 | SET | Consumable accessories for Rock Drills P-388. (Rubber air pressure, drilling bars, line lubrcator) | 7,746 | —,,— | —,,— |
| 5 | 1 | EA | Dragging Winch Mod AT 450 | 4,300 | —,,— | —,,— |
| 5.1 | 1 | SET | Consumable accessories for AT 450 (Steel rop, fixed orienting system, mobile pulley) | 1,495 | —,,— | —,,— |
| 6 | 1 | EA | Vehicle TOYOTA Model 4FD20 Diesel engine Fork lift truck with spare parts Frame No 4FD25-23,002 Engine No. 2J 193963 | 10,637 | 15-3-E-1065 | Operating at E.M.I. Gullele |
| 7 | 2 | EA | Automatic Quarry Bars (Drill Block Cutters) Q.B.2 doted with 2Hammers 388 HD 24 | 15,800 | 15-3-E-1101 | Operating-one at E.M.I. Harer Quarry<br>-one at E.M.I. Gojjam Quarry |
| 7.1 | 2 | EA | Horizontal devices for Q.B.2 | 500 | —,,— | —,,— |
| 7.2 | 2 | SET | Spare parts Kit | 1,580 | —,,— | —,,— |
| 8 | 1 | SET | Hydraulic Spliting Wedges Jack containing: | —,,— | —,,— | —,,— |

continued

a/ This annex has been reproduced without formal editing.

Annex V (continued)

| Item No. | Qty | Unit | DESCRIPTION | US.Dollars Equipment | Purchase Order | REMARKS |
|---|---|---|---|---|---|---|
| 8.1 | 4 | EA | Diamond D.S.230/3 W.L. Hydraulic spliting cylinders air operated | 11,880 | —,,— | Operating at E.M.I. Quarries |
| 8.2 | 1 | SET | Hoses manifolds distributors and accesories for D.S. 230/3 W.L. | 2,120 | —,,— | —,,— |
| 8.3 | 1 | SET | Spare parts for D.S. 230/3 W.L. | 1,400 | —,,— | —,,— |
| 8.4 | 1 | SET | Hand wedges N34 x 350 | 650 | —,,— | —,,— |
| 8.5 | 1 | SET | Hand wedges L34x600 | 400 | —,,— | —,,— |
| 9 | 6 | EA | Racklifting jacks (hand mechanical) 10t | 900 | 15-3-E-4101 | Operating at E.M.I. Gojjam Quarry |
| 10 | 1 | EA | Dragging Winch Mod AT 450 | 5,000 | —,,— | —,,— |
| 10.1 | 1 | SET | Consumable accessories for AT 450 (steel rope, fixed and mobile pullies, hook) | 1,400 | —,,— | —,,— |
| 10.2 | 1 | SET | Spare parts for AT 450 | 490 | —,,— | —,,— |
| 11 | 6 | EA | Rock drills P 388/HD24 | 5,610 | —,,— | —,,— |
| 11.1 | 1 | SET | Spare parts for P.388/HD24 | 1,440 | —,,— | —,,— |
| 11.2 | 6 | EA | Air lubricator for P.388/HD24 | 360 | —,,— | —,,— |
| 12 | 2 | EA | Air Compressor M.C.65 Diesel 8,000lt/1'- 7Atm. | 23,600 | —,,— | —,,— |
| 12.1 | 2 | SET | Spare parts for M.C. 65 | 2,400 | —,,— | —,,— |

continued

Annex V (continued)

| Item No. | Qty | Unit | DESCRIPTION | US-Dollars Equipment | Purchase Order | REMARKS |
|---|---|---|---|---|---|---|
| 13 | 1 | E A | Hydraulic disc cutting machine for tuff and soft stones Mod S-T-120 SUPER | 27,000 | — „ — | Operating at Legedade tuff quarry |
| 13.1 | 1 | SET | Consumable for S-T-120 SUPER (horizontal discs, vertical discs, rails, Widia bits) | 6,948 | 15-3-E1101 | — „ — |
| 13.2 | 1 | SET | Spare parts for S-T-120 SUPER | 4,000 | — „ — | — „ — |

We certify that the quantities of Non-expendable Equipment has been provided to E.M.I. through UNIDO project US./ETH/81/007 Assistance to the Marble & Sone Industry. All above listed Equipment was installed and is operating at present.

Project Expert: _____
Ion Albu

Received by, Counterpart: _____
Brhane Zewolde
Manager of E.M.I.

Annex VI a/

NON-EXPENDABLE EQUIPMENT ORDERED BY UNIDO BUT NOT YET RECEIVED

| Item No | Qty | Unit | DESCRIPTION | US Dollars Equipment | Purchase Order | Date of P.O | Delivery Terms | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | EA | Double girder over-head Crane 15t/16m | 14,900 | 15-5-E-1094 | 10 Sept 85 | Dec. 1985 | Forseen date of arrival February 1985 |
| 1.1 | 1 | SET | Spare parts | 1,070 | —"— | —"— | —"— | —"— |
| 1.2 | 1 | SET | Full electrical feeding line | 1,330 | —"— | —"— | —"— | —"— |
| 2 | 1 | EA | Electropump (Mud pump) | 1,241 | 15-5-E-1367 | 12 Nov. 85 | —"— | Forseen date of arrival January 1985 |
| 2.1 | 1 | SET | Spare parts for the electropump | 355 | —"— | —"— | —"— | |

We certify that actions have been initiated for the installation and further operation of the above listed equipment as soon as possible after its arrival in Addis Ababa, accordingly to the forseen dates of arrival.

Project Expert _____
Ion Albu

Government Counterpart _____
Brhane Zewolde
Manager of E.M.I.

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Annex VII a/

EXPENDABLE EQUIPMENT PROVIDED BY UNIDO

| Item | DESCRIPTION | Cource of Acquisition | Qty. | Unit | US-Dollars Equivalent | RECEIVED | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Qty | M | Y | by | Signature |
| 1 | Electr. Impuls Counter | F.P.O. 005471 MOD. 25-3-4742 | 2 | EA | 128 | 2 | 1 | 85 | E.M.I.'s Store | |
| 2 | Stone Massons Saw | —"— | 4 | EA | 120 | 4 | 1 | 85 | —"— | |
| 3 | Measuring Instruments: Depth Gauge, Vernier Caliper, Inside Caliper, Right-angle Square | —"— | 1 | SET | 100 | 1 | 1 | 85 | —"— | |
| 4 | Marble Grinding Tools | F.P.O.005472 MOD. 25-3-4742 | 1 | SET | 185 | 1 | 1 | 85 | —"— | |
| 5 | Half Mask with Filter | —"— | 10 | SET | 140 | 10 | 1 | 85 | —"— | |
| 6 | Lens Magnifier | —"— | 1 | SET | 11 | 1 | 1 | 85 | —"— | |
| 7 | Measuring Instruments: Tape, Micrometer | —"— | 1 | SET | 101 | 1 | 1 | 85 | —"— | |
| 8 | Stationary Goods | F.P.O. 005473 MOD. 25-4-4754 | 1 | SET | 374 | 1 | 2 | 85 | Projects Team | |
| 9 | Spare parts | F.P.O. 005474 MOD 25-4-4754 | 1 | SET | 415 | 1 | 6 | 85 | E.M.I's Store | |

Project Expert _____
Ion Albu

Government Counterpart _____
Brhane Zewolde
Manager of E.M.I.

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Annex VIII a/

INCREASE OF STAFF EMPLOYED BY EMI

| PLANT | PERSONNEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 January 1983 | | | 31 December 1985 | | | Increament | | |
| | Male | Female | TOTAL | Male | Female | TOTAL | Male | Female | TOTAL |
| E.M.I. Head Office | - | - | -, | 33 | 10 | 43 | 33 | 10 | 43 |
| E.M.I. Gullele | 146 | 8 | 154 | 155 | 8 | 163 | 9 | - | 9 |
| E.M.I. Bolle | - | - | - | 42 | 8 | 50 | 42 | 8 | 50 |
| E.M.I. Nefassilk | - | - | - | 29 | 12 | 41 | 29 | 12 | 41 |
| Massons | 30 | - | 30 | 103 | 14 | 117 | 73 | 14 | 87 |
| Quarries | 16 | - | 16 | 34 | - | 34 | 18 | - | 18 |
| TOTAL | 192 | 8 | 200 | 396 | 52 | 448 | 204 | 44 | 248 |

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Annex IX a/

DEVELOPMENT OF HOURLY OUTPUT OF MARBLE BLOCK TRIMMING MACHINE

| PLANT | MACHINE | $m^2$/hour of marble slabs | | | | | |
|---|---|---|---|---|---|---|---|
| | | Average attainable | Average 1 January 1983 | Average 31 December 1985 | Increament | Average realized in the peack month | REMARKS |
| E.M.I. Gullele | Sand Saw | 1.25 | x | x | - | x | x Machine idle |
| | Sand Saw | 1.25 | 0.30 | x | - 0.30 | x | |
| | Sand Saw | 1.25 | 0.30 | 1.00 | + 0.70 | 1.40 | |
| | Diamond Saw (10 blades) | 1.50 | 0.42 | 1.20 | + 0.78 | 1.69 | |
| | Hortogonal Disks | 2.60 | 1.80 | x | - 1.80 | 2.65 | |
| | Vertical Disk ∅ 1600 | 2.20 | x | 2.00 | + 2.00 | 2.23 | |
| | Vertical Disk ∅ 1600 | 2.20 | x | 2.00 | + 2.00 | 2.25 | |
| E.M.I. Bolle | Sand Saw | 1.25 | x | 0.95 | + 0.95 | 1.20 | |
| | Sand Saw | 1.25 | x | 0.95 | + 0.95 | 1.20 | |
| | Vertical Disk ∅ 1200 | 2.20 | x | 1.90 | + 1.90 | 2.00 | |
| | Vertical Disk ∅ 1200 | 2.20 | x | 1.90 | + 1.90 | 2.00 | |
| | Vertical Disk ∅ 1600 | 2.20 | x | 0.90 | + 0.90 | 1.40 | |
| E.M.I. Nefassilk | Hortogonal Disk | 2.60 | x | 2.80 | + 2.60 | 2.90 | |
| TOTAL | | 23.75 | 2.82 | 15.40 | + 12.58 | | |

x Machine idle

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Annex X a/

DEVELOPMENT OF ANNUAL MARBLE SLABS PRODUCTION CAPACITY

| Plant | Machine | Average Annually Capacity Utilized at 1 January 1983 | | Average Annually Capacity Utilized at 31 December 1985 | | Average Annually Attainable | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Shifts | Capacity m² | Shifts | Capacity m² | Shifts | Capacity m² | |
| E.M.I. Gullele | Sand Saw | - | - | - | - | 3 | 7,500 | |
| | Sand Saw | 3 | 1,800 | - | - | 3 | 7,500 | |
| | Sand Saw | 3 | 1,800 | 3 | 6000 | 3 | 7,500 | |
| | Diamond Saw 10 Blades | 3 | 2,520 | 3 | 7,200 | 3 | 9,000 | |
| | Hortogonal Disk | 2 | 7,200 | - | - | 2 | 10,000 | |
| | Vertical Disk | - | - | 1 | 4,000 | 2 | 8,800 | |
| | Vertical Disk | - | - | 1 | 4,000 | 2 | 8,800 | |
| E.M.I. Bolle | Sand Saw | - | - | 3 | 5,700 | 3 | 7,500 | |
| | Sand Saw | - | - | 3 | 5,700 | 3 | 7,500 | |
| | Vertical Disk | - | - | 1 | 3,800 | 2 | 8,800 | |
| | Vertical Disk | - | - | 1 | 3,800 | 2 | 8,800 | |
| | Vertical Disk | - | - | 1 | 1,800 | 2 | 8,800 | |
| E.M.I. Nefassilk | Hortogonal Disk | - | - | 1 | 5,200 | 2 | 10,000 | |
| Marble Slabs TOTAL | | | 13,320 | | 47,200 | | 120,500 | |
| Finished Marble Slabs | | | 7,700 | | 28,000 | | 80,000 - 85,000 | |

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Annex XI a/

IMPROVEMENT OF EMI'S MARBLE PROCESSING EQUIPMENT

| No | DESCRIPTION | TYPE | Year (Made) | SITUATION OF THE MACHINE | | REMARKS |
|---|---|---|---|---|---|---|
| | | | | At the begining of the project | At the end of the project | |
| | AT E.M.I. Gullele | | | | | |
| 1 | Block triming machine | Sand Saw Barsanti | Approx. 1940 | Idle since 1977 | Idle | Lack of spare parts |
| 2 | -"- -"- -"- | -"- | -"- | Operating | Idle since Augaust 1984 lack of maintenance | |
| 3 | -"- -"- -"- | -"- | -"- | Operating | Operating | |
| 4 | -"- -"- -"- | Diamond blade ALPE | Approx. 1960 | Operating | Operating | |
| 5 | -"- -"- -"- | Diamond disk SALIN | -"- | Idle since 1978 lack of loading possibility | Operating | |
| 6 | -" -"- -"- | -"- | -"- | Idle since 1978 lack of loading possibility | Operating | |
| 7 | -"- -"- -"- | Hortogonal disk MORDENTI | Approx. 1970 | Operating | Idle since April 1985 lack of maintenance | |
| 8 | Slabs sawing machine | Hand operated MORDENTI | Approx. 1960 | Operating | Operating | |
| 9 | -"- -"- -"- | -"- | -"- | Operating | Operating | |
| 10 | -"- -"- -"- | -"- | -"- | Operating | Operating | |
| 11 | -"- -"- -"- | -"- | -"- | Operating | Operating | |
| 12 | -"- -"- -"- | Hydraulic GREGORI | Approx. 1940 | Idle since 1977 | Operating | |
| 13 | Grinding-Polishing machine | Articulated arm MORDENTI | Approx. 1960 | Operating | Operating | |
| 14 | -"- -"- -"- | -"- | -"- | Operating | Operating | |

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continued

Annex XI (continued)

| No. | DESCRIPTION | TYPE | YEAR (Made) | SITUATION OF THE MACHINE | | REMARKS |
|---|---|---|---|---|---|---|
| | | | | At the begining of the project | At the end of the project | |
| 15 | —//— —//— —//— | —//— | —//— | Operating | Operating | |
| 16 | —//— —//— —//— | —//— | —//— | Operating | Operating | |
| 17 | —//— —//— —//— | —//— | —//— | Operating | Operating | |
| 18 | —//— —//— —//— | —//— | —//— | Operating | Operating | |
| 19 | —//— —//— —//— | —//— | —//— | Idle since 1970 | Operating | |
| 20 | Floor Tiles press | Semiautomatic OCEM | Approx. 1960 | Operating | Operating | |
| 21 | Floor Tiles grinding | Semiautomatic OCEM | —//— | Operating | Operating | |
| 22 | Stone crusher | —//— | Approx. 1930 | Operating with very frequent break down | Operating with very frequent break down | |
| 23 | Stone mill | Unknown | Approx. 1930 | Operating with very frequent break down | Operating with very frequent break down | |
| 24 | Dragging winch | Unknown | Approx. 1940 | Operating to load bloks on all triming machines | Operating to load blocks on blade triming machines | Critical for hazardeous accidents |
| 25 | Overhead Crane 10t / 14m | Double grinder PELLEGRINI | 1984 | — | Operating to load blocks on the disk triming machines | -Allowed rehabilitating machines 5 and 6 -Provided through the project |
| 26 | Block triming machine | Monoblade PELLEGRINI | 1983 | — | Operating to prepare blocks for machines 5,6 & 7 | -Provided through the project |
| 27 | Fork lift | TOYOTA | 1983 | — | Operating at floor tiles department | Provided through the project |
| 28 | Overhead Crane 15t / 16m | Double girder PELLEGRINI | 1985 | — | Not yet installed should operate to load block triming machines 1,2,3 and 4 | |
| 29 | Mud pump | Mobile BELLIN | 1986 | — | Not yet installed should operate to clean the slurry settless | |

continued

Annex XI (continued)

| No. | DESCRIPTION | TYPE | YEAR (Made) | SITUATION OF THE MACHINE | | REMARKS |
|---|---|---|---|---|---|---|
| | | | | At the begining of the project | At the end of the project | |
| | AT E.M.I. Bolle | | | | | |
| 30 | Block triming machine | Sand saw SALIN | Approx. 1970 | Idle since 1977 | Operating | |
| 31 | —"— —"— —"— | —"— | —"— | Idle since 1977 | Operating | |
| 32 | —"— —"— —"— | Diamond disk SALIN | —"— | Idle since 1977 | Operating | |
| 33 | —"— —"— —"— | Diamond disk SALIN | —"— | Idle since 1977 | Operating | |
| 34 | —"— —"— —"— | Diamond disk SALIN | —"— | Idle since 1977 | Operating | |
| 35 | Slabs swing machine | Hand operated SALIN | —"— | Idle since 1977 | Operating | |
| 36 | —"— —"— —"— | —"— | —"— | Idle since 1977 | Operating | |
| 37 | Grinding-Polishing machine | Articulated arm SALIN | —"— | Idle since 1977 | Operating | |
| 38 | —"— —"— —"— | —"— | —"— | Idle since 1977 | Operating | |
| 39 | —"— —"— —"— | Articulated arm MORDENTI | —"— | —— | Operating Transfered from E.M.I. Nefassilk | |
| 40 | —"— —"— —"— | —"— | —"— | —— | Operating Transfered from E.M.I. Nefassilk | |
| 41 | Traveling Crane | Local made | | Idle since 1974 | Operating | |
| | AT E.M.I. Nefassilk | | | | | |
| 42 | Block triming machine | Hortogonal disks MORDENTI | Approx. 1977 | Idle since 1980 | Operating | |



continued

Annex XI (continued)

| No. | DESCRIPTION | TYPE | YEAR (Made) | SITUATION OF THE MACHINE | | REMARKS |
|---|---|---|---|---|---|---|
| | | | | At the begining of the project | At the end of the project | |
| 43 | Slabs sawing machine | Hand operated MORDENTI | Approx. 1960 | Idle since 1980 | Operating | |
| 44 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Operating | |
| 45 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Operating | |
| 46 | Grinding-Polishing machine | Articulated arm MORDENTI | —"— | Idle since 1980 | Operating | |
| 47 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Operating | |
| 48 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Operating | |
| 49 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Operating | |
| 50 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Transfered at E.M.I.Bolle | |
| 51 | —"— —"— —"— | —"— | —"— | Idle since 1980 | Transfered at E.M.I.Bolle | |
| 52 | Overhead Crane | Monogrinder Local made | | Idle since 1980 | Operating | |

Annex XII a/

INCREASE OF EMI'S TECHNICAL PERSONNEL

| No. | POST | SITUATION | | | | REMARKS |
|---|---|---|---|---|---|---|
| | | At the begining of the project | | At the end of the project | | |
| | | Qty | Formation | Qty | Formation | |
| 1 | Manager of E.M.I. | 1 | Technican | 1 | Engineer | |
| 2 | Head of Production | - | - | 1 | Engineer | |
| 3 | Assistant head of Production | - | - | 2 | Engineers | |
| 4 | Production Managers | 1 | Technician | 3 | Technicians | |
| | TOTAL | 2 | | 7 | | |

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## Annex XIII

## PROJECT PROPOSAL - ASSISTANCE TO THE MARBLE AND STONE INDUSTRY, PHASE II

### PART A - BASIC DATA

| | |
|---|---|
| Country: | Ethiopia |
| Project title: | Assistance to the marble and stone industry, phase II |
| Project number: | |
| Scheduled start: | As soon as possible |
| Scheduled completion: | |
| UNIDO contribution: | $US 1,238,000 |
| Government contribution: | In kind |
| Currency required for UNIDO input: | US dollars |
| Origin and date of official request: | |
| Government counterpart agency: | Ethiopian Construction Materials Corporation |
| UNIDO substantive backstopping section: | Chemical Industries Section |
| Programme component code: | |
| Proposal submitted by: | |
| Date of submission: | |

## PART B - NARRATIVE

### 1. BACKGROUND AND JUSTIFICATION

Ethiopia has embarked on a ten-year development plan, in which the construction sector plays a very important role. It is envisaged to construct buildings ranging from small low-cost houses to multi-storey buildings as well as agro-industrial complexes.

To this end the expansion and improvement of the building materials industry has been given a high priority. Cement, cement products, bricks, ceramic products, marble products etc. will have to be produced in appreciable quantities to meet the growing needs of the construction sector. The shortage of wood products, as a result of the dwindling forests, has further increased the demand for stone-related products, all of which should be produced locally, as the country's foreign currency reserves will not permit the import of any one of them.

For those reasons the expansion of marble-processing facilities has become a priority objective, but also in view of the fact that Ethiopia has abundant deposits of marbles of various types and colours which are at present exploited only on a low scale, and because of the promising beginning of marble processing.

At present the plants do not produce thin and standardized slabs which can compete with other building materials. Furthermore, the old machinery and equipment which causes frequent and costly breakdowns has not helped to reduce production costs, which are quite high compared to those of other building materials.

However, despite those adverse factors, quarry operations have been improved and their capacities increased and processing plants have also been rehabilitated and expanded through the technical assistance of UNIDO. This project comes to an end by 31 December 1985.

It is in the light of this background that further technical assistance for the marble industry is sought. The use of thin and standardized marble products would help to overcome a problem which has become a bottleneck in the use of marble products for low-cost housing and residential buildings.

Phase I of the project has contributed to the strengthening of the operations of the marble industry by providing certain essential equipment, management training, locally and abroad, and to the streamlining of the production process. While the project has come to a successful end to the mutual satisfaction of all concerned, the results call for an extension of the project in order to bring what has already been effectively started to full fruition. This is expected to be achieved by phase II of the project.

### 2. OBJECTIVES

#### 2.1 Development objective

To promote the use of local raw materials for building with a view to replacing imported materials.

#### 2.2 Immediate objectives

To promote the use of standardized, thin marble slabs in housing construction with the aim of replacing imports of floor and wall tiles.

To reduce the production costs of the local marble industry to enable it to offer cheaper products.

To strengthen the repair and maintenance activities at factories and quarry sites.

3. PROJECT OUTPUTS

3.1 Regulations for the use of marble products in urban buildings.

3.2 The production of standardized marble plates.

3.3 The establishment of a pilot plant with a capacity of 10,000 $m^2$ per year of thin marble plates.

3.4 Well organized repair and maintenance at factories and quarry sites.

3.5 Local technicians trained in the production of standardized thin marble plates.

3.6 Improved marble quarrying.

4. PROJECT ACTIVITIES

| | Starting date (month after CTA'S arrival) |
|---|---|
| Related to output 3.1 | |
| (a) The CTA shall contact local authorities responsible for the design of housing, buildings and other construction work, to investigate the use of marble products; | 1 to 3 |
| (b) The expert shall prepare a list of the areas where standardized marble products should be used in public buildings and houses. | 4 |
| Related to output 3.2 | |
| The marble expert shall: | |
| (a) Study the design of various types of houses for which marble products should be used; | 4 to 5 |
| (b) Prepare a list of standardized marble products; | 6 |
| (c) Design the production of the standardized marble products by using the existing equipment and prepare a list of additional equipment; | 7 to 9 |
| (d) Supervise the installation of the additional equipment and assist in the production of the standardized marble products. | 20 to 30 |
| Related to output 3.3 | |
| The marble expert shall: | |
| (a) Prepare the production layout for the pilot plant for 10,000 $m^2$ of thin marble plates per year and a list of equipment; | 1 to 3 |

| | Starting date (month after CTA's arrival) |
|---|---|
| (b) Assist in the preparatory work to be performed by the counterpart for the installation of the pilot plant; | 8 to 12 |
| (c) Assist in the installation of the equipment; | 13 to 19 |
| (d) Assist in the production of thin marble plates. | 20 to 30 |
| Related to output 3.4 | |
| The expert on repair and maintenance shall: | |
| (a) Study the marble quarrying and processing equipment and establish a work programme and a list of spare parts; | 1 to 3 |
| (b) Assist national technicians in the design and drawing of spare parts; | 3 to 15 |
| (c) Assist in the setting up of the repair workshop and prepare a list of related equipment; | 3 to 4 |
| (d) Assist in the installation of the equipment and the production of spare parts; | 15 to 18 |
| (e) Strengthen the planned maintenance and repair of the marble quarrying and processing equipment. | 15 to 18 |
| Related to output 3.5 | |
| (a) Training courses in marble processing for engineers and technicians; | 1 to 20 |
| (b) On-the-job training of the technical staff in marble quarrying, processing and maintenance. | 15 to 30 |
| Related to output 3.6 | |
| (a) Plan the quarrying in two marble depots (Harer and Gojjam); | 3 to 6 |
| (b) Assist in the installation of the equipment in the quarries; | 15 to 21 |
| (c) Assist in the quarrying activities. | 6 to 30 |
| Preparation of reports | |
| (a) Progress reports; | 6, 12, 18, 24 |
| (b) Terminal reports: | |
| Mechanical expert | 18 |
| CTA | 29 to 30 |

5. PROJECT INPUTS

5.1 Government inputs

(a) In co-operation with the Ministry of Housing and Urban Development:

(i) Establish an initial list of standardized marble products;

(ii) Regulate the use of the marble products in urban constructions.

(b) All necessary preparatory work for the installation of the pilot plant and the equipment at the quarry sites;

(c) Preparation of the workshop area where the equipment shall be installed;

(d) Counterpart staff to work with the experts:

(i) Technicians, designers and draughtsmen to be trained in the repair and maintenance of the equipment;

(ii) Technicians to be trained in the production of thin, standardized marble plates.

5.2 Inputs by UNIDO

(a) One expert in marble quarrying and processing for 30 man-months;

(b) One expert in repair and maintenance of marble quarrying and processing equipment for 18 man-months;

(c) Two fellowships for 3 man-months each;

(d) A study tour for two locals and one expert, one month each.

6. PROPOSED EVALUATION

The project will be evaluated by both UNIDO and the Government during its implementation.

7. ENVISAGED FOLLOW-UP

Two tripartite monitoring reviews and a final tripartite review will be arranged.

## Appendix 1

LIST OF EQUIPMENT

1. Hydraulic drilling machine
2. Derrick cranes
3. Four-wheel drive car
4. Radio communication system
5. Automatic diamond wire cutting machine
6. Diamond saw, multiblade (30 blades)
7. Bridge cutting machine
8. Cutting/dividing machine
9. Continuous gauging/smoothing/polishing machines
10. Automatic chamfering machine
11. Abutting machines
12. Conveying table on rolls
13. Mud pumps
14. High-speed lathe
15. Milling machine
16. Drilling machine
17. Mobile workshop
18. Measuring instruments

## Appendix 2

### PROJECT BUDGET PROPOSAL

Project title: Assistance to the marble and stone industry, phase II

| Budget line | Item | Total m/m | Total $US | 1st year m/m | 1st year $US | 2nd year m/m | 2nd year $US | 3rd year m/m | 3rd year $US |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Project personnel | | | | | | | | |
| 11 | Experts/Post title | | | | | | | | |
| 11-01 | Expert in marble quarrying and processing and project manager | 30 | 225 000 | 12 | 90 000 | 12 | 90 000 | 6 | 45 000 |
| 11-02 | Expert in repair and maintenance of marble quarrying and processing equipment | 18 | 135 000 | 12 | 90 000 | 6 | 45 000 | | |
| | Sub-total | 48 | 360 000 | 24 | 180 000 | 18 | 135 000 | 6 | 45 000 |
| 15-00 | Experts' travel | | 12 500 | | 5 000 | | 5 000 | | 2 500 |
| 16-00 | Other personnel costs (mission costs) | | 9 000 | | 3 000 | | 3 000 | | 3 000 |
| 19-00 | Total personnel component | 48 | 381 500 | 24 | 188 000 | 18 | 143 000 | 6 | 50 500 |
| 30 | Training | | | | | | | | |
| 31-00 | Fellowships | 6 | 18 000 | | | 6 | 18 000 | | |
| 32-00 | Study tours | 3 | 9 000 | 3 | 9 000 | | | | |
| 30-00 | Total training component | 9 | 27 000 | 3 | 9 000 | 6 | 18 000 | | |

continued

Appendix 2 (continued)

| Budget line | Item | Total m/m | Total $US | 1st year m/m | 1st year $US | 2nd year m/m | 2nd year $US | 3rd year m/m | 3rd year $US |
|---|---|---|---|---|---|---|---|---|---|
| 40 | Equipment | | | | | | | | |
| 49-00 | Total equipment component | | 800 000 | | 350 000 | | 150 000 | | |
| 50 | Miscellaneous | | | | | | | | |
| 51-00 | Operations, maintenance | | 16 000 | | 3 000 | | 10 000 | | 3 000 |
| 52-00 | Reports | | 6 000 | | | | | | 6 000 |
| 53-00 | Sundries | | 8 000 | | 2 000 | | 4 000 | | 2 000 |
| 59-00 | Total miscellaneous component | | 30 000 | | 5 000 | | 14 000 | | 11 000 |
| | Project total | | 1 238 500 | | 552 000 | | 625 000 | | 61 500 |

Appendix 3

JOB DESCRIPTION

| | |
|---|---|
| Title: | Expert in marble quarrying and processing and CTA |
| Duration: | 30 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa, with travel in the country |
| Purpose of the project: | Strengthening of the local marble industry with a view to lower the production costs and to produce cheaper marble products. Promotion of the use of marble products in urban housing. Strengthening the repair and maintenance activities of the Ethiopian Marble Industry. |
| Duties: | The expert will be part of a group of international experts attached to the Ethiopian Construction Materials Corporation, under the Ministry of Construction, and shall carry out the following duties:<br><br>(a) Supervise the overall progress of the project;<br><br>(b) Assist in the standardization of marble products to be used in public buildings and houses;<br><br>(c) Assist the formulation of regulations on the use of marble products in public buildings and houses;<br><br>(d) Design and assist in the production of standardized marble products by using existing as well as additional equipment;<br><br>(e) Design a pilot plant to produce 10,000 $m^2$/year of thin marble plates and assist in their production;<br><br>(f) Assist in the further improvement of the marble quarrying activities;<br><br>(g) Train local technicians in the quarrying of marble blocks and the production of standardized, thin marble tiles.<br><br>The expert will prepare a final report with his conclusions on the implementation of the project as well as his recommendations for the future development of the marble industry. |
| Qualifications: | The expert should be an engineer with considerable experience in marble quarrying and processing and in the planning and designing of operations related to these. |
| Language: | English |

## Appendix 4

### JOB DESCRIPTION

| | |
|---|---|
| Title: | Expert in repair and maintenance of marble quarrying and processing equipment |
| Duration: | 18 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa, with travel in the country |
| Purpose of the project: | Strengthening of the local marble industry with a view to lower the production costs and to produce cheaper marble products. Promotion of the use of marble products in urban constructions. Strengthening the repair and maintenance activities of Ethiopian Marble Industry. |
| Duties: | The expert will be part of a group of international experts attached to the Ethiopian Construction Materials Corporation under the Ministry of Construction and shall carry out the following duties:<br><br>(a) Set up a workshop for the production of some of the spare parts for the marble quarrying and processing equipment;<br><br>(b) Assist a local team of designers in preparing drawings of the spare parts;<br><br>(c) Assist in the production of the spare parts;<br><br>(d) Plan the regular maintenance and repair of the marble quarrying and processing equipment and the stocking of spare parts;<br><br>(e) Train local technicians in organizing the repair and maintenance activities.<br><br>The expert will prepare a final report with his conclusions and recommendations for the repair and maintenance activity. |
| Qualifications: | The expert should be a mechanical engineer with experience in setting up workshops, in designing spare parts, and in organizing repair and maintenance activities. |
| Language: | English |

Annex XIV

PROJECT PROPOSAL - UTILIZATION OF VOLCANIC TUFF AS BUILDING MATERIAL FOR LOW-COST HOUSING

PART A - BASIC DATA

| | |
|---|---|
| Country: | Ethiopia |
| Project title: | Utilization of volcanic tuff as building material for low-cost housing |
| Project number: | |
| Scheduled start: | July 1986 |
| Scheduled completion: | June 1988 |
| UNIDO contribution: | $US 513,000 |
| Government contribution: | In kind |
| Currency required for UNIDO input: | US dollars |
| Origin and date of official request: | |
| Government counterpart agency: | Ethiopian Construction Materials Corporation |
| UNIDO substantive backstopping section: | Chemical Industries Section |
| Programme component code: | |
| Proposal submitted by: | |
| Date of submission: | |

## PART B - NARRATIVE

### 1. BACKGROUND AND JUSTIFICATION

To improve the life of peasants in the rural areas, the Government of Ethiopia has started a programme for settling these people in well-organized villages, where they will be provided with schooling, health care and other social facilities. To this end the construction of new dwellings and service facilities has become a main part in achieving that objective.

The traditional house of a peasant, a "tukul", is made of wood and mud. It has a short life, and its construction has become a major problem due to the scarcity of wood. The fire hazard involved has also made the use of wood rather uneconomical.

To halt the deforestation process and to provide the rural population with better and longer-lasting dwellings, the Government has been exploring the use of other raw materials for the construction of peasant houses. One of those materials is tuff whose low-cost production justifies its application in these housing schemes. Houses made of tuff blocks will last long and provide better comfort to the rural population.

In the highlands of the country there is an abundance of volcanic tuff deposits. The blocks which can be cut in situ are similar to concrete blocks. The operation is simple, and the costs involved are very low compared to those of producing bricks or concrete blocks. This makes them very attractive for use in low-cost housing projects.

With technical assistance from UNIDO which financed the expert assigned and the necessary equipment, a demonstration project has been set up near Addis Ababa. The results are promising but the activities could not be carried out over a long enough period of time to prove the economic and technical viability of the project on a large scale.

There is therefore a need for a pilot project based on a larger quarry area. This requires expert assistance and proper equipment. Some typical rural houses have to be built with tuff blocks and the results closely followed up.

It is with this perspective in mind that an extension of the tuff project is sought, to enable the Government to find a better and cheaper source of building material as part of its development objectives in the rural areas of the country.

### 2. OBJECTIVES

#### 2.1 Development objective

To develop a building raw material to be used for low-cost housing in the rural areas of the country.

#### 2.2 Immediate objective

To use dimensioned tuff blocks affording low production costs.

### 3. PROJECT OUTPUTS

3.1 To establish a pilot quarry with an annual capacity of 3,000 $m^3$ of tuff blocks for use in low-cost housing schemes.

3.2 To build at least 50 low-cost houses with tuff blocks.

3.3 To train national technicians in the quarrying of dimensioned volcanic tuff blocks.

4. PROJECT ACTIVITIES

4.1 To identify volcanic tuff deposits in the vicinity of Addis Ababa and select a pilot quarry.

4.2 To advise and supervise the establishment of the pilot quarry.

4.3. To assist in the design of typical low-cost houses to be built from tuff blocks.

4.4 To assist in the production of dimensioned blocks.

4.5 To assist in the construction of 50 low-cost houses from tuff blocks.

4.6 To advise on the design and production of containers for the transport of tuff blocks from the quarries to construction sites.

4.7 To train national technicians in the quarrying of tuff blocks.

4.8 To prepare a comparative study of production costs of tuff blocks and other building materials.

4.9 To prepare a final report with recommendations on the use and further development of tuff blocks in low-cost housing projects.

5. PROJECT INPUTS

5.1 Government inputs

(a) Co-operation with the Ethiopian Institute of Geological Surveys in the identification and selection of tuff deposits;

(b) The necessary work to open the pilot tuff quarry;

(c) Locally made containers for the transport of tuff blocks;

(d) Counterpart staff (technicians and accountants) to work with the international experts;

(e) Designs for various types of low-cost houses to be built with tuff blocks;

(f) Access to the land where the houses will be built;

(g) Provision of funds to quarry the tuff blocks and build 50 houses from tuff blocks.

5.2 Inputs by UNIDO

(a) One expert in the quarrying of the dimensioned volcanic tuff blocks for 24 man-months;

(b) One expert in geological surveying for 6 man-months;

(c) Two fellowships for two man-months each;

(d) A study tour for three local staff and the tuff-quarrying expert, one month each;

(e) A four-wheel drive vehicle and equipment for the pilot quarry as listed in appendix 1.

6. PROPOSED EVALUATION

The activities and results of the project will be evaluated by tripartite review meetings.

## Appendix 1

### LIST OF EQUIPMENT

| Number | Item | Quantity | Cost ($US) |
|---|---|---|---|
| 1 | Tuff cutting machine | 1 | 40 000 |
| 2 | Fork lift | 1 | 13 000 |
| 3 | 10-t truck with 2.5-t crane | 1 | 90 000 |
| 4 | Rotating building crane (diesel) | 1 | 50 000 |
| 5 | Four-wheel drive car | 1 | 13 500 |
| 6 | Water pump | 1 | 2 000 |
| 7 | Stone saws | 30 | 1 200 |
| 8 | Others | | 6 300 |
| | Total | | 216 000 |

## Appendix 2

### PROJECT BUDGET PROPOSAL

Project title: Utilization of volcanic tuff as building material for low-cost housing

| Budget line | Item | Total m/m | Total $US | 1986 m/m | 1986 $US | 1987 m/m | 1987 $US | 1988 m/m | 1988 $US |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Project personnel | | | | | | | | |
| 11 | Experts/Post title | | | | | | | | |
| 11-01 | Expert in quarrying of the dimensioned volcanic tuff blocks and project manager | 24 | 180 000 | 6 | 45 000 | 12 | 90 000 | 6 | 45 000 |
| 11-02 | Expert in geological surveying | 6 | 45 000 | 3 | 22 500 | 3 | 22 500 | - | - |
| 11-99 | Sub-total | 30 | 225 000 | 9 | 67 500 | 15 | 112 500 | 6 | 45 000 |
| 15-00 | Experts' travel | | 10 000 | - | 3 000 | - | 5 000 | - | 2 000 |
| 16-00 | Other personnel costs (mission costs) | | 6 000 | | | | 3 000 | | 3 000 |
| 19-00 | Total personnel component | 30 | 241 000 | 9 | 70 500 | 15 | 120 500 | 6 | 50 000 |
| 30 | Training | | | | | | | | |
| 31-00 | Fellowships | 4 | 14 000 | | | 4 | 14 000 | | |
| 32-00 | Study tours | 4 | 16 000 | | | 4 | 16 000 | | |
| 39-00 | Total training component | 8 | 30 000 | | | 8 | 30 000 | | |
| 40 | Equipment | | | | | | | | |
| 49-00 | Total equipment component | | 216 000 | | 60 000 | | 145 000 | | 11 000 |

continued

Appendix 2 (continued)

| Budget line | Item | Total m/m | Total $US | 1986 m/m | 1986 $US | 1987 m/m | 1987 $US | 1988 m/m | 1988 $US |
|---|---|---|---|---|---|---|---|---|---|
| 50 | Miscellaneous | | | | | | | | |
| 51-00 | Operations, maintenance | | 12 000 | | | | 8 000 | | 4 000 |
| 52-00 | Reports | | 6 000 | | | | | | 6 000 |
| 53-00 | Sundries | | 8 000 | | 1 000 | | 5 000 | | 2 000 |
| 59-00 | Total miscellaneous component | | 26 000 | | 1 000 | | 13 000 | | 12 000 |
| | Project total | | 513 000 | | 131 500 | | 308 500 | | 73 000 |

## Appendix 3

JOB DESCRIPTION

| | |
|---|---|
| Title: | Expert in quarrying of tuff blocks and CTA |
| Duration: | 24 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa, with travel in the country |
| Purpose of the project: | To produce volcanic tuff blocks to be used as building material for low-cost housing in rural areas. |
| Duties: | The expert will be part of a group of international experts attached to the Ethiopian Construction Materials Corporation under the Ministry of Construction and shall carry out the following duties:<br><br>(a) Supervise the overall progress of the project;<br><br>(b) Assist in the identification of several tuff deposits and select a tuff deposit for the pilot quarry;<br><br>(c) Assist in preparing the area where at least 50 houses should be built with tuff blocks;<br><br>(d) Advise on the selection of the necessary equipment for the tuff pilot quarry;<br><br>(e) Advise on and supervise the preparatory work for the opening of a pilot tuff quarry;<br><br>(f) Assist in the designing of some types of houses to be built with tuff blocks;<br><br>(g) Assist in and supervise the quarrying of the tuff blocks;<br><br>(h) Assist in the construction of houses from tuff blocks;<br><br>(i) Train local technicians in the quarrying of tuff blocks.<br><br>The expert will prepare a final report with his conclusions in regard to the efficiency of using tuff blocks as building material for low-cost housing and make recommendations for the future development of that activity. |
| Qualifications: | The expert should be an engineer with considerable experience in the operation of stone quarrying equipment, including *in situ* tuff cutting machines. |
| Language: | English |

## Appendix 4

JOB DESCRIPTION

| | |
|---|---|
| Title: | Expert in geological surveying (especially in deposits of rocks for dimensioned stones) |
| Duration: | 6 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa, with travel in the country |
| Purpose of the project: | To produce volcanic tuff blocks to be used as building material for low-cost housing in rural areas. |
| Duties: | The expert will be part of a team of international experts attached to the Ethiopian Construction Materials Corporation, under the Ministry of Construction and shall carry out the following duties:<br><br>(a) Geological surveying of several tuff deposits in the proximity of Addis Ababa;<br><br>(b) Advise on establishing the technical characteristics of tuffs of the surveyed deposits;<br><br>(c) Evaluate the extent of the surveyed tuff deposits;<br><br>(d) Visit other regions indicated by the Government in order to identify the potential of the tuff deposits to be used as building material.<br><br>The expert will prepare a final report with his conclusions and recommendations with regard to the extent of the tuff deposits in the surveyed regions. |
| Qualifications: | The expert should be a geologist with experience in the surveying of rock deposits. |
| Language: | English |

Annex XV

PROJECT PROPOSAL - ASSISTANCE TO THE ETHIOPIAN MARBLE INDUSTRY

PART A - BASIC DATA

| | |
|---|---|
| Country: | Ethiopia |
| Project title: | Assistance to Ethiopian Marble Industry |
| Project number: | |
| Scheduled start: | March 1986 |
| Scheduled completion: | February 1987 |
| Origin and date of official request: | |
| Government counterpart agency: | Ethiopian Construction Materials Corporation |
| Government contribution: | In kind |
| UNIDO contribution: | $US 152,500 |
| Currency required for UNIDO input: | United States dollars |
| UNIDO substantive backstopping section: | Chemical Industries Section |
| Programme component code: | |
| Proposal submitted by: | |
| Date of submission: | |

## PART B - NARRATIVE

### 1. BACKGROUND AND JUSTIFICATION

Ethiopia has a wide range of marble deposits of various colours: white, whitish grey, dark grey, red, yellow, pink etc. Their exploitation, which started a few years ago in order to provide the necessary raw materials for the existing marble processing factories, called for an increase of the quarry sites, an improvement and strengthening of the processing capacities of the factories by expanding the technical operations, and for suitable on-the-job training of marble technicians.

In their efforts to rehabilitate the three existing marble factories at Addis Ababa and to improve the marble quarrying operations, the technical assistance extended by UNIDO to the marble industry played a very effective role and enabled the industry to reach its present level of operations. The project US/ETH/81/007 which helped to improve the performance of the industry started in January 1983 and was completed in December 1985.

Because the above-mentioned factories are employing rather old technologies, various efforts to reduce the amount of rejects met with limited success. At present part of the rejects is being crushed into marble chips and utilized for the production of 27,000 $m^2$/year of mosaic floor tiles. Throughout the implementation of the afore-mentioned UNIDO project, the annual production of mosaic tiles increased from 11,000 $m^2$ to 27,000 $m^2$.

The Ethiopian Construction Materials Corporation (ECMC) is seeking assistance to expand the product range of the Ethiopian marble industry through a better utilization of marble rejects for the production of tourist gift items such as toys, vases, pen holders, ashtrays, lamp stands, kitchenware, small tables etc. The market potential for such items is considered to be high in view of the large number of foreigners visiting Addis Ababa for official and business purposes.

The new production department for gift items, to be attached to the Ethiopian marble industry, is planned to employ mainly female managers, technicians and workers, to intensify the participation of women in the industrial sector.

### 2. OBJECTIVES

#### 2.1 Development objectives

To strengthen and to increase the productivity of the building-materials industry in Ethiopia through effective utilization of indigenous natural and human resources.

To enhance the effective participation of women in appropriate subsectors of the industry.

#### 2.2 Immediate objectives

Expansion of the performance of the Ethiopian marble industry through the establishment of a new department producing marble gift items utilizing the rejects of marble factories.

### 3. SPECIAL CONSIDERATIONS

Under the UNIDO project US/ETH/81/007, 30 female workers have been trained in the operation of marble polishing machines, and one female engineer

who has received training in marble-processing technologies, is expected to assume fully her technical duties within the management of the Ethiopian marble industry in the course of 1986.

The policy of employing women in the marble-processing industry was encouraged by ECMC to enhance the government policy to increase the share of women participating in the industrial sector. The subject project is also aiming at the training of a group of young and destitute women to upgrade their skills in the production and marketing of marble gift items.

Under the same project, female workers will be engaged in training programmes for the finishing of such marble products as window sills, window and door frames, edges of stairs etc., with the intention of improving the quality of smaller marble products.

4. PROJECT OUTPUTS

Establishment of a production department for marble gift items, to fulfil the following functions and production targets:

(a) Production of 10,000 pieces of marble gift items for the local tourist market;

(b) Training of 60 female workers in the production of artisanal marble gift items and in the manual finishing of marble building components.

5. PROJECT ACTIVITIES

5.1 Identification of the building and equipment requirements of the new department;

5.2 Preparation of an initial set of designs for various gift items;

5.3 Installation of the equipment;

5.4 Preparation of training programmes in the use and maintenance of equipment, the selection of marble pieces, and the design, production and marketing of gift items;

5.5 Training of group leaders who will be responsible for future training activities and supervise the production and marketing activities of the new department;

5.6 Preparation of a final report, including recommendations for a further improvement and expansion of the activities of the department.

6. PROJECT INPUTS

6.1 Government inputs

(a) Preparation of required facilities to accommodate the operations of the new department;

(b) Selection and employment of female staff to be trained as production, marketing and training supervisors;

(c) Employment of female workers to be trained;

(d) Assignment of counterpart management staff to work jointly with the international expert to be assigned to the project;

(e) Provision of secretarial and administrative assistance to ensure a smooth implementation of the project activities.

6.2 UNIDO inputs

(a) One expert in marble processing for 12 man-months;

(b) Two fellowships, for 2 man-months each, to participate in training programmes in Italy in the design and marketing of marble gift items;

(c) Provision of equipment for training and production purposes ($US 50,000).

7. PROPOSED EVALUATION

The activities and results of the project will be evaluated by tripartite review meetings.

Appendix 1

PROJECT BUDGET PROPOSAL

| Budget line | Item | Total m/m | Total $US | 1986 m/m | 1986 $US | 1987 m/m | 1987 $US |
|---|---|---|---|---|---|---|---|
| 10 | Project personnel | | | | | | |
| 11 | Experts/Post title | | | | | | |
| 11-01 | Expert in marble processing | 12 | 90 000 | 10 | 75 000 | 2 | 15 000 |
| 15-00 | Experts' travel | | 2 000 | | 1 650 | | 350 |
| 16-00 | Other personnel costs (mission costs) | | 3 000 | | 3 000 | | |
| 19-00 | Total personnel component | 12 | 95 000 | 10 | 79 650 | 2 | 15 350 |
| 30 | Training | | | | | | |
| 31-00 | Fellowship | 4 | 4 500 | 4 | 4 500 | | |
| 39-00 | Total training component | 4 | 4 500 | 4 | 4 500 | | |
| 40 | Equipment | | | | | | |
| 41-00 | Total equipment component | | 50 000 | | 50 000 | | |
| 50 | Miscellaneous | | | | | | |
| 51-00 | Operation, maintenance | | 2 000 | | 1 800 | | 200 |
| 53-00 | Sundries | | 1 000 | | 800 | | 200 |
| 59-00 | Total miscellaneous component | | 3 000 | | 2 600 | | 400 |
| | Project total | | 152 500 | | 136 750 | | 15 750 |

## Appendix 2

LIST OF EQUIPMENT

| Number | Item | Quantity |
|---|---|---|
| 1 | Drilling and shaping machine for interiors and exteriors | 1 |
| 2 | Column drilling machine | 1 |
| 3 | Small marble cutting machine | 1 |
| 4 | Bench lathe | 2 |
| 5 | Air compressor set | 1 |
| 6 | Pneumatic hammers | 12 |
| 7 | Grinder for tools | 1 |
| 8 | Grinding machine for ashtrays | 1 |
| 9 | Hand tools | |
| 10 | Abrasive paper | |
| 11 | Polishing materials (oxalic acid, sulphur, tin anhydride, felt) | |
| 12 | Glue for marble | |
| 13 | Other materials | |

## Appendix 3

### JOB DESCRIPTION

| | |
|---|---|
| Title: | Expert in marble processing and CTA |
| Duration: | 12 months |
| Date required: | As soon as possible |
| Duty station: | Addis Ababa, with travel in the country |
| Purpose of the project: | To make use of the rejects of the Ethiopian Marble Industry by producing artistic gift items, and to train women in the finishing of small marble products for the construction industry. |
| Duties: | The expert will be attached to the Ethiopian Construction Materials Corporation, under the Ministry of Construction, and shall carry out the following duties:<br><br>(a) Supervise the overall progress of the project;<br><br>(b) Assist in the identification of the equipment to produce marble gift items;<br><br>(c) Advise on the preparation of a workshop on the production of artistic marble gift items;<br><br>(d) Advise on and supervise the preparation of an initial set of designs for various gift items;<br><br>(e) Train a group of women in the production of marble gift items as well as in the finishing of small marble products for construction works;<br><br>(f) Advise on the selection of the trainees with the right aptitude for producing artistic marble gift items.<br><br>The expert will prepare a final report with his conclusions and recommendations. |
| Qualifications: | The candidate should be an engineer with considerable experience in marble processing |
| Language: | English |