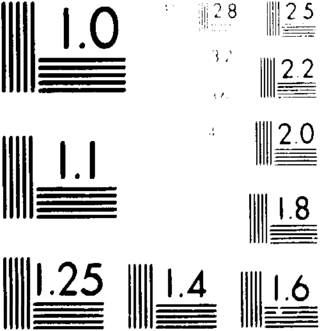
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


2.8
2.5
2.2
2.0
1.8
1.0
1.1
1.25
1.4
1.6

10558

# ASSISTANCE TO THE CEMENT INDUSTRY IN SYRIA

Terminal Report

Prepared under UNIDO Project DP/SYR/80/001

Assistance to Cement Plant Production

Prepared for the Government of the Syrian Arab Republic

Based on the work of Clifford Martin
adviser on cement production

United Nations Industrial Development Organization

Vienna

---

This report has not been cleared with the United Nations Industrial Organization which does not, therefore, necessarily share the views presented.

## Abbreviations used in this Report

| | |
|---|---|
| GOC | General Organisation for Cement. |
| ACBMC | Arabian Cement and Building Materials Co.. |
| ITRDC | Industrial Testing, Research and Development Centre. |
| G.D. | General Director. |
| T.D. | Technical Director. |
| P.D. | Production Director. |
| H.L. | Head of Laboratory. |
| Eng. | Engineer. |
| SPH. | Suspension Preheater. |
| LSF. | Lime Saturation Factor. |
| cm. | centimetres. |
| m. | metres. |
| tph | tons per hour. |
| tpd | tons per day. |
| tpa | tons per annum. |

## TABLE OF CONTENTS



------------

# TERMS OF REFERENCE

The expert will be assigned to the General Organisation for Cement and Building Materials Industry to advise and assist in the rehabilitation of the existing cement works. More specifically, the expert is expected to:

1. Advise the General Director, the personnel and plant managers on technical matters related to the production of cement, including process control and maintenance routines;

2. Assist in technical and administrative matters related to the overall implementation of technical assistance;

3. Develop training programmes for national technical personnel;

4. Initiate UNIDO fellowship training and study tours and follow up on the promotion of local skills.

The expert will also be expected to prepare a final report, setting out the findings of the mission and recommendations to the Government on further action which might be taken.

# INTRODUCTION

At the request of GCC the major emphasis of the mission was directed on production problems at the Adra plant where specific operating problems had been encountered. Attention was restricted to a detailed consideration of these problems since the overall UNIDO mission provided for experts in the electrical and mechanical engineering. Nevertheless, attention was given to the general effect of maintenance and other services without attempting a detailed study of the desired systems. The same policy was adopted in respect of other plants visited according to the programme agreed with GCC.

The time spent at GCC and on various plants was as follows:

| | | |
|---|---|---|
| GCC | ... | 3 weeks |
| Adra | ... | 5 weeks |
| Hama & Rastan | .. | 1 week |
| Musulmiyeh | ... | 1 week |
| Arabian Cement Co. | | 1 week |

The overall mission period was 3 months from 21st January 1981

In the field of production the Syrian Cement Industry is short of trained and experienced staff and requires further extensive assistance in training and plant operation. The existing and planned production capacity is adequate for the medium term demand for cement provided the full potential is realised. Without an improvement in operating methods general efficiency of the industry is likely to decline and adequate staffing and sound training is the key to achieving this.

## I. The Syrian Cement Industry. February 1981

The GOC is responsible for the whole of the Syrian cement industry which is technically based on two distinct types of process with a historical division established by the 1st development plan for the cement industry. Prior to this all plants used the wet process with unit capacities of clinker ranging from 220 to 395 t.p.d. (See Table 1).

The development of new factories was based on the dry process (Table 2) using suspension preheater kilns, initially with a common basic design and capacity of 1000 t.p.d. of clinker. These plants were of East German origin and the Adra plant is presently being increased by the installation of a third 1000t.p.d. unit. In 1979 a plant of Rumanian origin comprising two 1500 t.p.d. units was put into operation and a new plant is presently under construction at Tartous which will have four fully automated units of 1600 t.p.d. each. The first of which is due to be commissioned in 1982.

Table 1. Clinker Production

| Wet process plants | Capacity tpd Installed | | Annual Output Potential | 1980 | % effeciency |
|---|---|---|---|---|---|
| Dummar | | | | | |
| Kiln 2 | 230 | | | | |
| " 3 | 270 | 880 | 272800 | 214915 | 79 |
| " 4 | 380 | | | | |
| Rastan | | | | | |
| Kiln 1 | 370 | | 114700 | 119345 | 103 |
| Hama | | | | | |
| Kiln 1 | 395 | | 122450 | 114119 | 93 |
| El Chabha Musulmiyeh | | | | | |
| Kiln 1 | 333 | | 103230 | 105577 | 103 |
| Sheik Said | | | | | |
| Kiln 1 | 210 | | | | |
| " 2 | 210 | 630 | 195300 | 175363 | 90 |
| " 3 | 210 | | | | |
| Burgislam | | | | | |
| Kiln 1 | 252 | | 78120 | 77088 | 99 |
| Total | 2860 | | 886600 | 806407 | 91 |

Table 2. Clinker Production

| Dry process plants | Capacity tpd Installed | Planned | Annual Output Potential (1) | 1980 | % effeciency |
|---|---|---|---|---|---|
| Adra | | | | | |
| Kiln 1 | 1000 | | | | |
| " 2 | 1000 | | 620000 | 373.970 | 60 |
| " 3 | | 1000 | | | |
| Hama | | | | | |
| " 2 | 1000 | | 310.000 | 219.711 | 71 |
| Musulmiyeh | | | | | |
| Kiln 2 | 1000 | | 310.000 | 233.907 | 75 |
| " 3 | 1000 | | 310.000 | 241.309 | 78 |
| AC&BMC | | | | | |
| Kiln 1 | 1500 | | | | |
| " 2 | 1500 | | 930.000 | 60.000 (2) | - |
| Tartous | | | | | |
| 4 kilns | | 6400 | | - | |
| Total | 8000 | 7400 | 2,480.000 | 1,128.897 | 69 (3) |

1. Based on 85% running time.
2. Estimated. Plant in process of commissioning.
3. Excludes ACBMC.

Whilst output on the wet process plants is satisfactory the new kilns have failed to maintain their potential capacities.

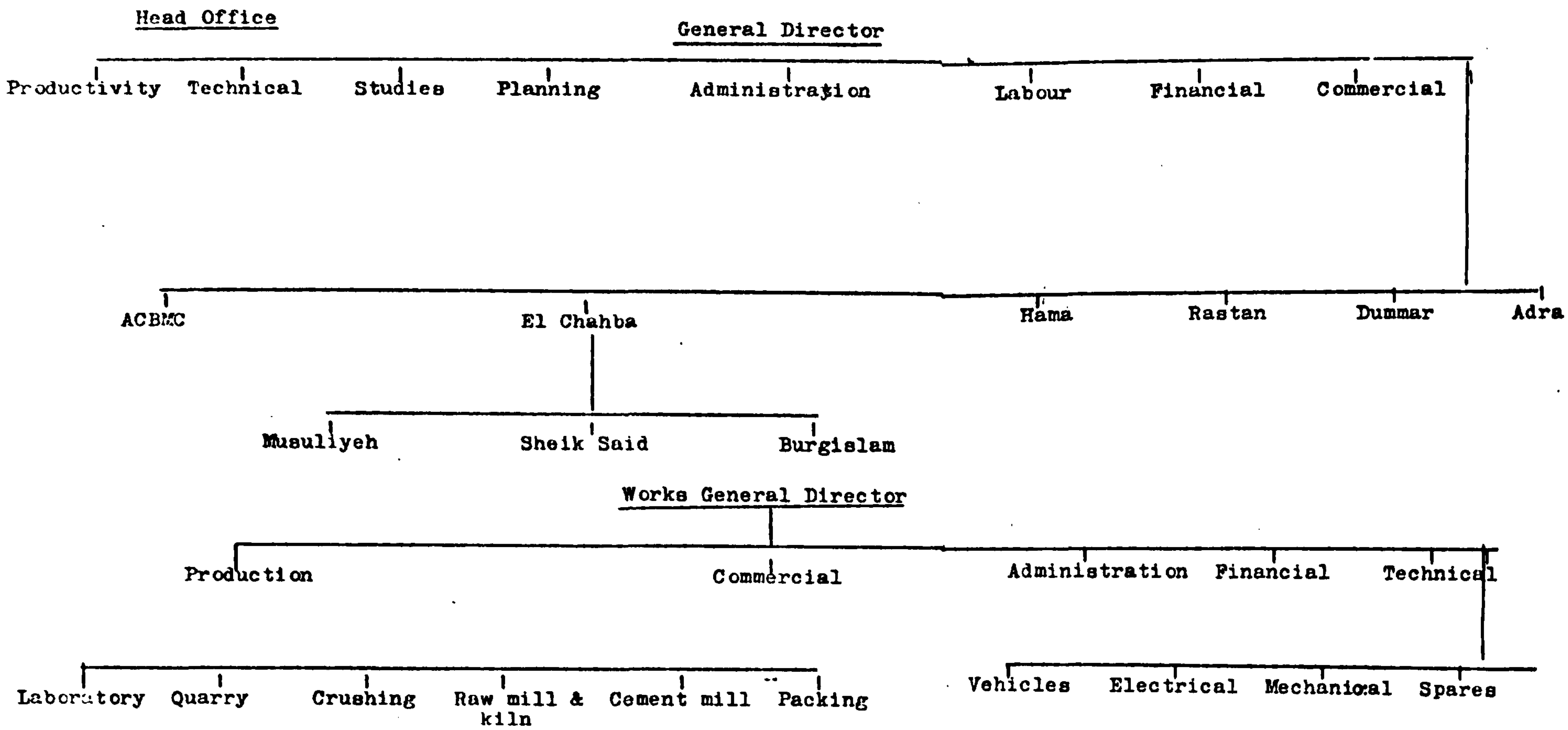
## II ADMINISTRATION AND PLANNING

The General Organisation for Cement (GCC) is responsible to the Ministry of Industry for the achievement of production targets set by the Government. A basic organisation of GCC and of the senior staff of the factories is given in Fig.1.

The factory General Directors are responsible directly to the General Director, GCC and are autonomous except for the purchase of new equipment and spare parts and the establishing of salary levels. GCC headquarters deals with these matters through a system of committees.

FIGURE 1.

GOC Organisation



## III TRAINING AND EMPLOYMENT

GOC is concious of the limitations imposed on the running of it's plants by the shortage of skilled and experienced Syrian nationals. Moreover, employment conditions applicable to the cement industry put certain constraints on the engaging of staff and on maintaining a stable force. This has a serious effect on plant operation and in spite of an incentive scheme is likely to persist. This puts an added emphasis on training of personel which consequently will be a continuing requirement in the foreseeable future. GOC has endeavoured to train staff in and outside Syria and has also used expatriate staffing to operate new plants and carry out on-the-job training. So far this has not proved a satisfactory solution. It is noted that training centres for theoretical and in-plant training are in formation at Adra andACBMC but the center of El Chaba at Musulmiyeh opened in 1976 has been closed since 1979. It is suggested that there is a need for all three centers and for a central coordination by GOC.

These centers would deal basically with the middle and supervisory grades of personel and they could be suplemented by using existing training resources both inside and outside Syria. However there is a need to afford to management staff the opportunity of development and further studies and in addition to the use of local resources, it is recommended that fellowship and study tours be set up in conjunction with overseas manufacturing organisations in the fields of maintenance, production and management techniques related to the cement industry.

## IV GENERAL PLANT OPERATION

The study of operating was concentrated on the new dry process plants and in particular, at the request of GCC, on the Adra factory for which several reports were issued.(Annex 1)

In addition to a study of production methods a broad study was made of the several factors which have an important impact on the performance of the plant and effect the quality and quantity of output. These factors are identified as follows:

A. <u>The Quality of Machinery and Equipment</u>.

In several cases major items of plant have design weaknesses or have developed manufacturing faults which have required major repairs and consequent loss of production e.g. Cement mill at Adra and the clay crusher at Hama. There could be similar unforseen problems in the future and these can only be rectified in conjunction with the equipment suppliers. In other cases expendable materials such as kiln refractories, mill linings and mill grinding media have been of relatively low quality resulting in high rates of consumption and in the case of the kilns and cement mills, serious loss of running time. Steps have been taken to purchase better quality materials and some of this is already in use with favourable results. This policy should be developed with material quality taking priority importance in purchasing assessment. A study of the true cost per ton of cement produced should then be made from actual operating data.

B. Plant design and layout

Some sections of plant have processing equipment which is unsuitable for treating the raw materials to be processed. In these cases either the equipment must be replaced, at high capital cost, or operated at low effeciency and hence high unit operating cost. Individual studies are necessary to decide on the course to be followed. Examples are the clay crusher at Hama and the marl crushing and handling plant at Adra (see Annex 1 & II).

C. General Plant Maintenance

Under this heading comes the engineering, electrical and instrumentation departments. In all the departments there is evidence of a serious shortage of skilled staff which has resulted in a virtual lack of preventive maintenance within a planned programme. Maintenance has therefore become a question of the repairing of breakdowns as and when they occur and results in major losses of plant operating time as well as frequent reductions of outputwhich could often be avoided by preventive maintenance. This subject and the methods to be used to effect an improvement will be dealt with under the U.N.I.D.C. Cement project as a separate issue outside the scope of this report. However, it is relevant to point out that the maintenance section suffers seriously from the unavailability of spare parts (see IV D). The lack of instrumentation maintenance has resulted in the central control staff for the kilns, raw and cement mills in all the factories having to work with totally inadaquate information which has contributed significantly on occasions to poor performance and damage to production equipment.

D. Storekeeping and Purchasing

These two departments are closely linked and require careful coordination with the factory operating and maintenance departments. The long delays in ordering and receiving spare parts seriously reduces the efficiency of these departments, as well as adding costs, and indicates the need for a complete reassassment and reorganisation of the systems and methods of purchasing and stockholding. Since GCC controls several identical plants in various parts of Syria, a central information and control center could be developed to coordinate therange and levels of stockholding and to ensure the optimum use of available spares. This would also permit the standardisation of spare parts.

## V. PRODUCTION AND QUALITY CONTROL

A. Production

Weaknesses in the production at the various factories are elaborated, and recommendations made in Annexes 1-V. These divide into two catergories; firstly those individual to the particular factory and usually arising from the properties of raw materials and the process design, and secondly those of a more general nature which are detailed in B, C 3&4, &E.

In general the production departments of all factories suffer from a shortage of experienced and qualified staff which seriously reduces efficiency of operation.

B. Production Efficiency

This can be simply measured by comparing the actual against budgetted output and cost based on potential plant capacity. In Syria, cement demands exceeds local manufacturing capacity so the potential capacity fixes the budget figures. The potential efficiency then relates to the following factors:

1. What is the designed capacity?
2. Have the manufacturer's guarantees been realised?
3. Have any basic machinery failures occurred?
4. Is the plant effectively maintained and available for full operation?

These factors permit the determination of the potential output, and since the cement process can be easily divided into several production and service departments it is then possible to produce a complete operating budget which will form the basis of the costing system. Such a system is essential if maximum production efficiency is to be achieved since it not only permits the setting of targets but identifies areas of inefficient operation and permits action to deal with them.

If the Syrian cement industry is to reach optimum efficiency it must adopt such a system of control. At present, budgeting is generally physical only and in a limited sense that only cement and clinker targets are aimed at. Full budgets should be available by the beginning ofthe year to which they refer. This was not the case at the factories visited.

However, an exception is at ACBMC where a documentary system of process and job control and a basic departmental cost system has been prepared which will permit full budgetary control of operating.

It is strongly recommended that this system be studied and developed and used throughout the GOC establishment.

C. Quality Control

With the exception of ACBMC, the Production Departments have full responsibility for production and quality control with the laboratory acting as a source of information only and having no powers of direct control of quality. This results on occassions in a misinterpretation of, or a failure to use information, delays in application of control and, more basically, a failure to effectively apply quality control on vital parts of the process.

A better control would be obtained if the Head of Laboratory, whilst still being responsible to the Production Director, were given authority to issue instructions on quality control directly to the departments concerned with a copy to the Production Director or his delegate. This system is adopted by ACBMC. It is essential however to have a competant and experienced Head of Laboratory and also to make effective use of the X-ray analysers installed in all the dry process laboratories.

## V1. MANAGEMENT AND COORDINATION

Considering the difficulties arising from shortages of experienced qualified staff at all factories it was noticeable that the senior personel in both Production and Technical Departments, who were generally experienced and competent, were frequently over-loaded with responsibilities often of a minor nature, which interfered with or prevented them carrying out their duties with full effectiveness. Even allowing for the existing limitations of staff availability it is possible to improve the situation by introduction of up to date management techniques and delegation of responsibilities under the overall controll and coordination of each Director whothemselves will be subject to the coordination of the General Director.

The délegation of responsibilities can be controlled by regular weekly meetings of senior personel within each department at which operating plans can be formulated and each participant can contribute. This will encourage motivation and cooperation amongst the staff but it is emphasised that there must be a systematic follow-up to ensure the realisation of the operating plan.

In order to assist in introducing such a scheme it is suggested that use be made of the existing Management Training Center in Damascus for senior personel.

## V11. FUTURE DEVELOPMENT

In view of the existing and developing production facilities it is reccommended that future development begiven the following order of priority:

1. Bring all existing plants up to optimum efficiency.
2. Study the feasibility of modifying existing dry process kilns to the Precalcination type of process. This could result in an increase in capacity of 20 to 40% depending on the type of process adopted.
3. Study the feasibility of converting wet process plants to semi-wet process. Rastan, Hama and Musulmiyeh offer the best opportunities for this.
4. Extend existing plants.
5. Build new plants.

## V111. GENERAL RECOMMENDATIONS

A. Training

1. Develop in-plant training at selected factories.
2. Use external training organisations for intermediate and Technical staff.
3. Use local and overseas management and technical study tours in cooperation with cement manufacturers to develop senior personnel and to provide an exchange of ideas. This may be done on a fellowship basis.

B. Introduce regular production and budgetary control including a cost control system.

C. Improve the standard of purchasing and storekeeping at all factories.

D. Study and introduce at GOC headquarters a centre of information and coordination of purchasing and spares control including a system of standardisation.

E. Make quality control the direct responsibility of the factory laboratory but remaining under the overall control of the Production Director.

F. Carry out a programme of standardisation and coordination of all X-ray analysing equipment on a continuing basis and ensure that more operators are trained preferably by the equipment supplier.

G. Study the possibilities of:

1. Converting existing dry process kilns to the Precalcination process.
2. Converting certain wet process kilns to the semi-wet process.

H. Improve the standard of mechanical and electrical maintenance, particularly instrument maintenance.

I. Reorganise the responsibility for plant cleanliness and if necessary set up a department to control it.

## IX. UTILISATION OF PROJECT FINDINGS

During the factory visits extensive discussions were held with senior management and operating staff during which all the points covered in the Annexes 1 to VI were dealt with in detail. In general it is too early to assess the application of the advice given. The exception is Adra where several of the recommendations have been successfully put into operation.

It may be advisable to consider a follow-up mission in the fairly near future.

ANNEX 1

UNIDO Project No. SYR/80/001

Report on the Production of
Adra Cement Co.. Prepared by
Clifford Martin. UNIDO Expert.

ANNEX 1.

## Report on Production at Adra Cement Co. March 7th 1981

This report is based on the writers observations and discussions during factory visits covering the period January 29th - March 7th 1981.

### Factory Design

The plant consists of two production units of 1000 t.p.d. each operating on the dry process with SPH kilns. The raw material processing up to the raw mills and the cement storage and packing plants are common to both units. A detail of the equipment and capacities is given in Annex 1.

The plant is designed to use four raw materials, limestone, marl, basalt and sand, but experience has shown that the sand is not needed for correct proportioning of a cement raw mix. The quality of the raw materials is good and all are sited near to the factory thus presenting no particular transport problem.

### Limestone Quarry and Crushing

There are two types of suitable limestone in the deposit and for correct quarry development ideally both should be worked together to produce a blended crushed limestone. The crystaline limestone is of high grade (95% pure) and the chalky limestone (92% pure) which contains up to 3% alumina can probably be satisfactorily used in a proportion of up to 25 - 30%. It will be necessary to chemically control the limestone quality (see Annex 2) as well as the water content of the chalky which has a porosity of 15%.

Production and blending difficulties have been encountered due to the lack of availability of loading equipment and the current situation with one big excavator out of action for the for-seeable future could result in a reduction in limestone production to below level needed for full factory operation if the second big excavator fails. These difficulties arise mainly from lack of spares and the consequent lack of a preventative maintenance programme.

....

The crusher operates satisfactorily to 10% above it's designed capacity. Stone is transported from quarry to crusher by 25 ton dumpers. There appears to be some inefficiency in the use of these dumpers which warrants a time and motion study.

Recommendations

1. Improve equipment availability possibly by replacing one of the large excavators and generally by improving planned maintenance.

2. Carry out a study on efficient use of dumpers.

3. Check the operating schedule of the crusher to avoid running it empty or on low output.

Marl Quarry

Sampling and analysis of the various bands of marl which occur in the quarry was carried out with a view to improving quarrying technique and producing a uniform quality of marl which under present conditions is very variable.

A full report with recommendations is given in Annex 3.

Basalt Quarry

The deposit comprises a uniform section and a broken variable section in respect of quality. Care should be taken to selectively quarry to avoid the variable material which is readily identifiable and to regularly monitor the quality of the crushed basalt.

The basalt crusher operates satisfactorily.

Marl Crushing and Drying

The following factors limiting performance were noted:

1. Apron feeders overload at 80% of capacity.

2. Crushers are susceptable to blockage by wet material and are limited to 65 - 80 t.P.H.

3. No.1 crusher can deliver to both dryers but No.2 to one dryer only.

....

4. All the marl must be dried to maximum 5% water content.

Recommendations

1. Check and if necessary increase the power of the apron feeder drive.

2. Endeavor to increase the crusher output by experimenting with/hammers on the rotor. Care /fewer must be taken to keep the rotor in balance.

Raw Milling and Blending

Raw mill performance is generally satisfactory though electrical faults caused serious interuptions of running time resulting in lowered kiln output due to shortage of raw meal.

When the mills are not running it is standard practice to switch off the electrofilters to avoid the recovered dust upsetting the blended meal analysis. This results in a loss of raw meal equivalent to about 10% of the kiln feed. By correct laboratory control, it should be possible to adjust the analysis of the raw meal from the mill and avoid the need to switch off the electrofilters, thus effecting a major economy.

There is also a continuous and significant loss of dust from the raw meal silos due to inefficient dust collection. Regular maintenance of the filter plant is necessary.

Kilns

The following points have a serious effect on kiln operation:

1. Variations in the uniformity of raw materials causing variations in the raw meal analysis. This can cause difficulties in burning conditions and variable clinker quality.

2. Erratic feeding of the raw meal due to damage to the rotary feeder of the belt weigher. It is understood that some measures have been taken to rectify this important problem and they should be followed up with urgency.

....

3. Many of the instruments in the control room are not in working order. This seriously interferes with correct kiln operation. Better maintenance is called for.

4. The burners do not appear to have any written instructions on routine kiln operation and methods of dealing with interuption of normal operation. The senior German burner (due to leave in July 1981) should be required to prepare written instructions and ensure that they are fully understood and inplemented.

5. Efforts should be made to avoid excessive fluctuations in burning zone temperatures caused by excessive adjustments in the fuel oil feed. These cause quality variations in the clinker and also, by producing excessive CO in the exhaust gasses, cause the switching off of the electrofilters and consequent variations in the raw meal quality.

In general, the kilns are running satisfactorily but attention to the above points would result in a marked improvement in quality, output and life of the brickwork. The recent change to magnesitebricks for the burning zones is commended and should be very beneficial in reducing brickwork repairs.

## Cement Mills

Repairs to the mill shells appear to have rectified the material faults which had occurred.
Frequent loss of running time is caused by the failure of the cement transport system. A new system of transport is being installed using a belt conveyor but it may be possible to improve the performance of the pneumatic system by fitting time switches to the Cera pumps instead of the present pressure system.
Excessive wear of mill liners and charge have affected adversely running time and hourly output. The use of higher quality material for relining and charging one of the mills has shown a marked reduction in wear after six months running and a 15% increase in output. These advantages together with reduced stock requirements usually more than offset the increased cost of better quality material. This point should be checked by further measurements of performance. It seems most likely that the use of better quality materials will be fully justified.

....

Cement milling is a major bottleneck in production and a concentrated effort should be continued in order to remove it.

## Quality Control

A new system of material sampling has been prepared and discussed in detail with the Production and Laboratory senior staff (Annex 2). This system will provide for full control of the raw materials through each production department from quarries to cement dispatch. In particular it provides a control from quarries to raw meal silos which does not exist at present and makes it possible to ensure the production of uniform stocks of limestone, marl, basalt and raw meal. This should significantly improve kiln operation as well as output and quality. It will also make a much more effective use of the X-ray analyser.

As part of the extended chemical control, it is recommended that the direct control of quality be given to the head of laboratory who would be responsible directly to the Production Director for this.

It is also recommended that a chemical engineer with process experience be included in the Production Dept. to study and report on process improvement and development to the Production Director. Initally this job may have to be carried out by an expatriate with a Syrian counterpart as a part of a training scheme.

## Staffing

Methods of training and developing senior production staff should be introduced as soon as possible with external assistance, if possible.

## Cleanliness

The standard of cleanliness in all parts of the plant is poor and interferes with efficient operation and maintenance.

This/corrected as a matter of urgency. /should be

....

## Storekeeping

The availability of spare parts is quite inadequate and a complete reorganisation of purchasing and storekeeping is required.

## Transport

There appears to be inefficient use of dumpers which are frequently waiting long periods to discharge at all three crushers. A time and motion study should be carried out aimed at avoiding standing time and freeing dumpers for maintenance. The use of a payloader for feeding the marl crushers direct from the stock pile without the use of dumpers should be introduced.

## Statistics

Monthly production reports should be prepared by the 2nd day of each month. A suggested form is given in Annex 4.
Daily and monthly laboratory reports should be provided to the Production Director.

## Power Consumption

In 1979 power consumption was 180 Kwh / ton of cement. This compares with a normal figure of 120 - 130 Kwh / t for the type of plant and can be attributed to the following factors:

1. Equipment running under low or nil load.
2. Discontinuous operation of plant.
3. Wastage of compressed air.
4. Low outputs compared with installed unit capacities.

The recommendations made in this report will considerably improve these figures if implemented.

....

**Conclusion**

The present satisfactory operating of the factory indicates that average clinker production could be raised to 100% of installed capacity in the fairly near future.

A bottleneck which needs to be dealt with is cement milling which at present falls well below requirements and could prevent the attainment of current budgets.

Regular and timely monthly production reports should be issued and a sample pro forma is given in Annex 4.

In view of the excess capacity of the raw mills it may be opportune during the erection and commissioning of Adra 2, to discuss with the plant manufacturers the conversion of the kilns to a Precalcination system. This could increase output by 10 - 25% of the present installed capacity without major investment.

In addition to the points dealt with in this report it is emphasized that it is desirable to develop the general ability of the work force by training and the engagement of additional skilled and experienced men. Management techniques and coordination should also receive attention.

Annex 1

ADRA Plant and Equipment

| | | | |
|---|---|---|---|
| Quarry. | Limestone. | 2 x excavators | 2.7 $m^3$ |
| | | 1 x excavator | 1.5 $m^3$ |
| | | 1 x payloader | 2.5 $m^3$ |
| | | 1 x buldozer | |
| | Basalt | 2 x excavators | |
| | | 1 x buldozer | |
| | Marl | 1 x buldozer | |
| | | 1 x payloader | |
| Transport | | 19 x 25 ton dumpers | |
| Crushers | Limestone | 1 x 400 tph Hammermill | |
| | Basalt | 1 x 120 tph Hammermill | |
| | Marl | 2 x 125 tph Jeffreys type Hammermills | |
| Drying | | 1 x 80 tph dryer | |
| | | 1 x 30 tph dryer | |

Covered Store

| | |
|---|---|
| Limestone | 14.000 tons |
| Basalt | 850 tons |
| Marl (dry) | 7.000 tons |

Raw milling

2 x 100tph tube mills with air separation (Wedag type)
Raw meal delivery to bucket elevator.

Raw meal storage

2 x Blending silos 1750 tons each
2 x Storage silos 4750 tons each
Transport to kilns from belt weighers by Fullerpumps.

Kilns

2 x 1000 tpd rotary dry process kilns with Krupp type SPH comprising 3 expansion chambers a double cyclone first stage.
Fuel efficiency given as 850 - 870 K.cal/kg if conditions are good.
2 x Fuller type grate coolers.

Clinker storage

50.000 tons covered store.

Cement milling

2 x two chamber mills with air separation 70 tph each
Cement delivery by Cera pumps.

<u>Cement storage</u>
4 x 7500 ton silos

<u>Cement packing</u>
3 x 14 spout rotary packers Czech manufacture
4 ply paper bags are used.
Also there are bulk loading facilities.

<u>Power consumption</u>

| | | | | |
|---|---|---|---|---|
| <u>Theoretical</u> | Raw mill | 22 | Kwh/ton | raw meal |
| | Kiln | 21 | " | clinker |
| | Cement mill | 35 | " | cement |

Actual overall 180 Kwh/ton of cement.

ANNEX 2

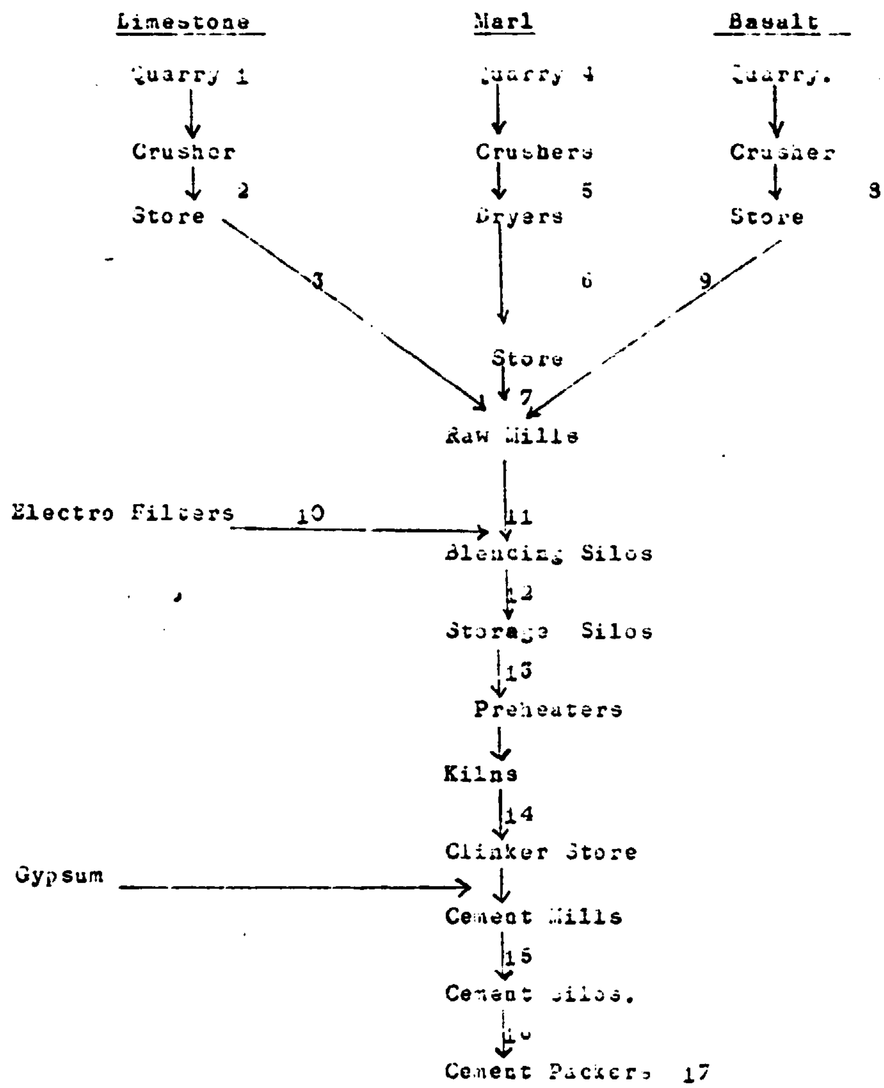
Details of Sampling and Analyses

| Sampling Point | Material Sampled | Frequency | Analyses required |
|---|---|---|---|
| 1. | Limestone Drilling Dust | One per hole | $CaCO_3$ |
| 2. | Crushed Limestone | hourly | Full on daily average |
| 3. | Crushed Limestone (schenk Feeder) | Two per shift | Full on daily average |
| 4. | Bands of Marl | Every 3months | Full each Band |
| 5. | Crushed Marl | 1 per hour | $H_2O$+ Full on daily average |
| 6. | Dry Marl | 2 per shift | $H_2O$ |
| 7. | Dry Marl (Schenk Feeder) | 1 per shift | Full |
| 8. | Crushed Basalt | 1 per hour | Full on daily average |
| 9. | Crushed Basalt (Schenk Feeder) | 1 per shift | Full |
| 10. | Electro Filter Dust | 1 per day | Full |
| 11. | Raw Meal from Mill | Every ½ hour | $CaCO_3$ |
| 12. | Blending Meal | 1 per hour | $CaCO_3$ Full on average |
| 13. | Kiln Feed | 1 per shift | Full |
| 14. | Clinker | 1 per shift | Full |
| 15. | Cement | Every 2 hours | Full on daily average |
| 16. | Cement (ex Silo) | Daily | Full per week (average) |
| 17. | Cement (from Packer) | Daily | Full per week (average) |

ANNEX 2

PROGRAMME OF SAMPLING.

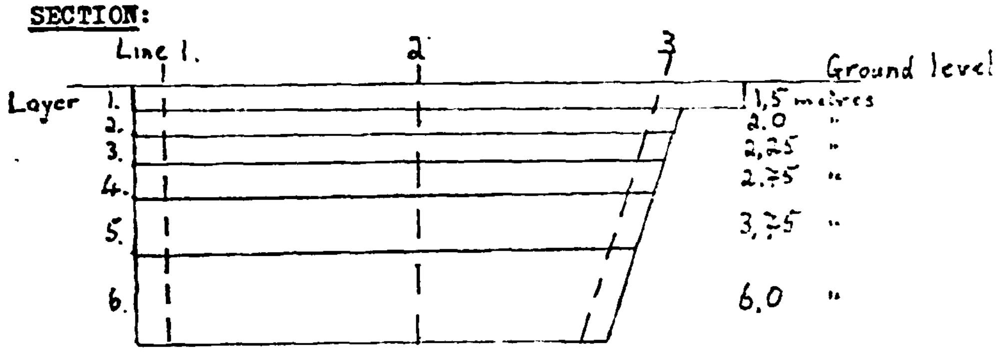
ADRA. 22.3.81



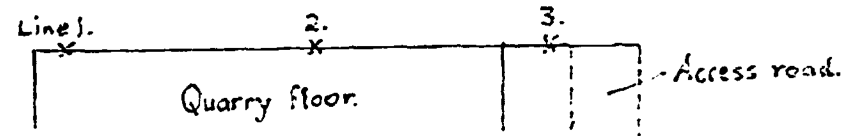
**ANNEX: 3**

**MARL QUARRY. SAMPLING and QUARRYING TEST**

**SECTION:**




**PLAN:**




Each layer was sampled along each line.

Table 1. Gives the analysees of the samples.

Table 2. Gives a schematic presentation of the silica content.

**Discussion:**

The marl provides silica content of the raw marl and the requirement is a constant quality at a satisfactory level. Layers 1 & 2 show variations compared with the general uniformity of layers 3 to 6 and a high content of chloride ( an undesirable element ). Moreover the analysis of these four layers shows the material is very suitable for use in the process having relatively constant silica and alumina / iron ratios.

It is reccommended to reject layers 1 & 2 and to change the present method of quarrying the layers separately and remixing from the stockpile.

The new method should use a retroshovel or dragline excavator operating from the top of the quarry face and working the face in three stepped benches of about 5 meters depth each.

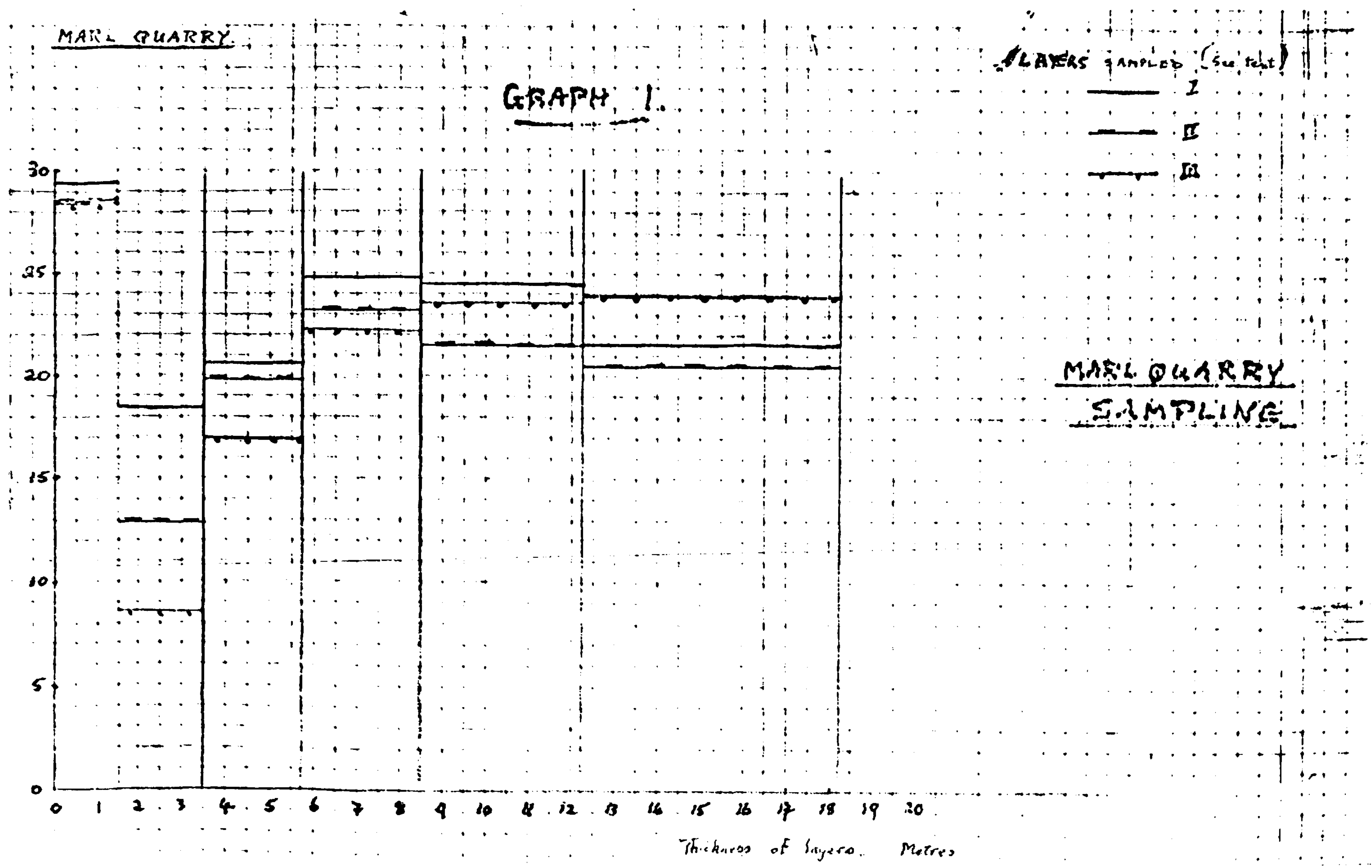
Marl would be loaded into dumpers and delivered directly to the crusher. This method of quarrying would permit working during wet weather and avoid the present double handling.

Since Liebherr 941 retro shovel was available on the Adra 2 site, a trial quarrying test was arranged. See attached reports and reccommendations.

TABLE I.

# MARL ANALYSES

| LAYER | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LINE | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| $SiO_2$ | 21,72 | 23,61 | 23,37 | 78.37 | 72,93 | 5,63 | 20,56 | 79,50 | 76,91 | 24,89 | 23,14 | 22,17 | 24,57 | 21,54 | 23.15 | 21,54 | 20,54 | 23,94 |
| $Al_2O_3$ | 5,47 | 5,72 | 5,26 | 3,78 | 2,14 | 1,33 | 3,74 | 3,74 | 2,67 | 3,53 | 2,97 | 2,75 | 2,83 | 2,34 | 2,45 | 2,94 | 1,53 | 2,53 |
| $Fe_2O_3$ | 5,40 | 5,23 | 5,40 | 3,05 | 2,31 | 1,22 | 3,73 | 3,52 | 2,95 | 5,15 | 3,50 | 3,08 | 3,42 | 2,84 | 3,36 | 2,47 | 2,57 | 2,54 |
| CaO | 24,53 | 24.87 | 24,92 | 34,85 | 39,80 | 43,68 | 31,94 | 33,32 | 36,79 | 24,61 | 31,64 | 33,27 | 32,61 | 34,64 | 32,75 | 36,99 | 38,09 | 34,70 |
| MgO | 3,73 | 3,39 | 3,35 | 3,09 | 3,72 | 3,57 | 2,81 | 3,20 | 2,64 | 3,05 | 2,52 | 1,96 | 2,58 | 2,23 | 2,96 | 1,93 | 1,49 | 2,52 |
| $Na_2O$ | 0,28 | 0,29 | 0,28 | 0,23 | 0,19 | 0,20 | 0,22 | 0,26 | 0,15 | 0,26 | 0,22 | 0,18 | 0,18 | 0,16 | 0,16 | 0,16 | 0,16 | 0,16 |
| $K_2O$ | 1,01 | 0,97 | 0,95 | 0,71 | 0,44 | 0,19 | 0,47 | 0,43 | 0,58 | 0,26 | 0,20 | 0,10 | 0,17 | 0,73 | 0,23 | 0,001 | Neg | 0,13 |
| $SO_3$ | 0,29 | 0,18 | 0,37 | 0,32 | 0,40 | 0,57 | 0,32 | 0,42 | 0,26 | 0,20 | 0,19 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,18 | 0,19 |
| $Cl^-$ | 0,24 | 0,40 | 0,57 | 0,53 | 0,47 | 0,75 | 0,16 | 0,37 | 0,19 | 0,17 | 0,14 | 0,03 | 0,07 | 0,04 | 0,03 | 0,02 | 0,02 | 0,03 |
| Total | 70,21 | 69,76 | 69,57 | 64,31 | 61,74 | 60,43 | 63,40 | 64,5 | 63,77 | 66,55 | 64,75 | 65,12 | 64,76 | 64,70 | 66.30 | 64,22 | 64,52 | 66,22 |
| $CaCO_3$ | 43,79 | 44,39 | 44,46 | 62,77 | 71,04 | 77,97 | 57,07 | 59,48 | 65,61 | 52,83 | 56,45 | 59,79 | 58,25 | 61,83 | 58,46 | 64,24 | 67,91 | 60,87 |


MARL QUARRY
GRAPH 1.
LAYERS SAMPLED (see text)
I
II
III
MARL QUARRY
SAMPLING
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Thickness of layers. Metres

Adra 23.2.81

Excavator Trial in Marl Quarry. 23.2.81

Equipment used:

1x Liebherr Retro Shovel with $1\frac{1}{4}$ $m^3$ bucket. Type 941

2x 25 ton Dumpers.

The excavator was sited on top of layer no. 4 at the western end of the quarry face. A trench 2metres wide and 4 metres deep was dug starting from the edge of the quarry face. No problems were encountered in digging the marl. Maximum reach of the excavator is stated to be 4.75 metres.

Loading ra e — 6 minutes to load one dumper = 250t.p.h.

Bucket capacity approximately 2 tons.

Round trip for dumper from quarry to crusher and back to quarry, loading and discharge ...20 minutes.

Equivalent to 75 t.p.h. per dumper.

Output with 3 dumpers:- 225 t.p.h.

Recommended

1. To purchase a Retro Shovel with a reach of 6.25 metres and a 1.5 to 2.0 $m^3$ bucket. capacity minium 300 t.p.h.

2. To operate the quarry in three equal benches using only layers 3,4,5 and 6. i.e 15 metres depth. Layers 1 and 2 to be dumped.

Advantages

1. Simpler quarrying and material handling.

2. Lower operating costs.

3. Better quality control.

4. Possibly one shift operating in the quarry.

Opk.

ANNEX 4.

## MONTHLY PRODUCTION REPORT 1981

| | LIMESTONE | MARL | BASALT | RAW MEAL | CLINKER | GYPSUM | CEMENT | FUEL OIL | PAPER BAGS |
|---|---|---|---|---|---|---|---|---|---|
| OPENING STOCK | | | | | | | | | |
| PRODUCED OR RECEIVED | | | | | | | | | |
| USED | | | | | | | | | |
| CLOSING STOCK | | | | | | | | | |
| PHYSICAL STOCK | | | | | | | | | |
| BUDGETTED PRODUCTION | | | | | | | | | |

ANNEX 11

Syrian Cement Co. Hama

Visited 9th - 16th March 1981

There are two production lines which operate independently except for quarrying. Only Hama 1 operated for two days during the visit.
Hama is a Smidt wet process started in 1964 and runs satisfactorily though quality variations were noted.
Hama 2 is a dry process of 1000 tpd clinker capacity identical to Musulmiyeh 2 and started in 1978.
Both plants use local limestone and clay with Nabk sand as raw materials.

Limestone

This is somewhat porous of medium hardness. It is crushed at the quarry by a 400 tph rotor crusher and transported to the factory by belt conveyor. The crushed limestone averages 5-7% moisture rising to 10% in winter and packs badly in the raw material store causing problems with extraction which affect raw mill feed control.

Clay

The quarry is a shallow open pit which cannot be worked in wet weather. The moisture content of the clay is 25 -35% in winter and 15-20% in summer. It has a high plasticity and the hammer crusher, designed for basalt crushing is completely unsuited to crushing clay.and it's rotor has been removed. Clay is fed to the 30 tph rotary dryer through a 20 sq. cm. grid. Quartzite is handpicked from the dryer feed belt and dried clay generally has a maximum of 10 cm. Due to the size some difficulty is experienced in extracting dried clay from the store.

Nabk Sand

This is put into stock as received.

Raw Milling and Blending.

The raw mill uses kiln gas for drying and air separation. It has an electro-filter which is very inefficient and is stated to operate only 5-10% of the time. This could not be verified due to the shut down but the same trouble occurs at Musulmiyeh. The only solution appears to be to modify it to the same design as Adra.
The difficulties of raw material handling cause serious problems in maintaining uniformity of mill feed.

This causes wide fluctuations in the raw meal composition which often cannot be corrected by blending and lead to variations in the composition of raw meal fed to the kiln which has a detrimental effect on burning and quality. This was clearly observed from the laboratory records.

Kiln.

An internal examination of the grate cooler, kiln and first stage cyclones of the preheater was made. The grate plates of the cooler were being renewed and it was said that according to the original drawings the plates had been wrongly fitted when the plant was errected in that the fixed plates were installed where the movable plates should have been and vice versa. This is now being corrected. It was noticed that many new plates were badly cast with many under-sized holes. This will cause poor operation and overheating and should be corrected.
The reported overheating of the under grate drag chain is certainly due to wear of the grate and also jamming of flap valves of the spillage hoppers. This causes loss of cooling air and inefficient cooling.
It is recommended that the fitting of side bridging plates in the cooler be considered and a descriptive report on this was given to the Technical and Production Director.
There was also evidence of over heating in the kiln and preheater which had damaged the inlet shute and one of the first stage cyclones. This is due to bad kiln control resulting from a lack of instrumentation on which mainteneace seems inadequate. Attention should be paid to correct control of temperature and exit gas analysis. Instrument maintenance appears to suffer from lack of spares and a shortage of skilled staff and requires urgent attention.

Laboratory.

Chemical Control.
It appears that almost total reliance is placed on chemical analysis for process control and that the X-ray analyser is not effectively used. The X-ray analyser programmes should be checked and extended to include the determination of alkalis and chlorine. The analyser operator should be sent on a training course.
Raw milling and blending is controled by conventional calcium carbonate estimation. Difficulty is often experienced in achieving good blending due to fluctuations caused by erratic mill feeding but there is also a variation in LSF which may arise from the somewhat variable silica content of the limestone. This could be controlled by introducing analysis of quarry samples taken during drilling which would permit selective quarrying.

The effeciency of blending should be verified by analysis of samples taken during the discharging of the silos. The free lime in the clinker is very frequently excessive and is the result of poor material control and poor burning. It is most probably the cause of the low flexion strengths of the cement.
In the same context attention is also drawn to the wide fluctuations in slurry and clinker compositions in Hama 1; the silica modulus varies between 2.6 and 3.3 which must cause wide variations in cement quality.

Physical Tests.

The flexion strengths of Hama 2 cement are often below specification whilst on the same sample the compressive strength is satisfactory. A series of tests were carried out during the visit which eliminated a suggestion that test methods or the testing machine were at fault. Examination of clinker showed high free lime and this is the most likely cause of low quality. It should be eliminated by the methods previously suggested in this report.

Recommendations.

1. Many sections of the plant required considerable cleaning and a programme for carrying this out regularly should be introduced. This would improve access for operating and maintenance, improved performance and reduce wear and tear on the equipment.

2. There is a shortage of skilled and experienced men which calls for an extensive training scheme.

3. The quality control staff are somewhat inexperienced and the Production Director would be wise to give attention to improving their effectiveness.

4. Material handling should be improved. This could be achieved in respect of the present raw materials by:
   a. Drying the crushed limestone.
   b. Replacing the present clay crusher by crushing rolls. Alternatively a major improvement could quickly be made by installing a vibrating screen at the delivery end of the clay dryer to remove over sized material. This oversize material can be crushed in a hammer mill of 10 to 15 tph capacity which could be sited to discharge directly into the boot of the existing dry clay elevator. The hammer mill could be fed directly from the screen.

ANNEX 111

Rastan Cement Co., Rastan

Visited 14th March 1981.

Rastan has a 370 tpd single unit wet process plant built by Rheinstahl in 1960. It uses local limestone and clay with Nabk sand and these materials are of uniform quality. The clinker analysis indicates a silica modulus of 2.3 - 2.4 and a rather low LSF of 0.84. The cement is ground rather fine (5-6 % residue on 4.900 mesh) and quality is satisfactory. The plant is clean and orderly.

The following points were discussed:

1. High water content of slurry.

A report on this problem at Rastan was prepared by UNIDO expert Prijic Zdenko in December 1980 and is available at GOC.
The water content averages 49% under normal circumstances and has been reduced by 2-3% by the addition of about 1.5% sodium silicate. The cost may outweigh the saving in fuel but in any case it seems that very little further reduction will be achieved though experiments with organic surface active agents should be tried. Also the proposal of Prijic to grind less finely should be examined though it may cause problems with cement quality. The slurry should also be subjected to filtering tests to determine whether the process could be converted to semi-wet by the use of filter presses. If the results are favourable this could reduce the water content of material fed to the kiln from 49% to 15-18% and result in a big saving in fuel cost. An economic and technical feasibility study should then be undertaken.
Such a process is used at the Ewekoro plant of Blue Circle Cement in Nigeria and it may be worth while approaching them to make a study.

2. Cement Milling

The mill is an open circuit two chamber tube mill; diameter 240cm with chamber lengths of 650 and 750 cm separated by a double diaphragm. Out-put is 18 tph. During operating it suffers overheating and blockages. It was noted that there was provision for water cooling of the mill shell but this was not in use. The blocking could arise from overheating and water cooling should reintroduced. It is also recommended to use cool clinker, check regularly the amount and the grading of the grinding media, which should be about 32% of the mill volume, and install a sonic ear over the first chamber.

Whenever the mill blocks it may assist in clearing it to introduce into the second chamber either two to three buckets of water or coal or similar carbonaceous material. This helps to dissipate the electrostatic charge on the cement which builds up during blockages and often will clear the mill.

3. Ground Vibration from Blasting

The limestone quarry face is 26m deep. It may be advisable to operate it at two levels of half this depth and by using millisecond delay blasting techniques excessive vibration should be avoided.

4. Clinker Quality

Operating conditions are stable and quality satisfactory so thereis no reason to vary the present parameters of control. However, the LSF is low and if experiments in coarse grinding of slurry are carried out as recommended by Prijic it may be advisable to increase the LSF to 0.91 - 0.93 to counteract any effect of lower clinker burning effeciency this may cause.

ANNEX 1V

El Chaba Co., Aleppo

Visited 16tt - 24th March 1981.

The company operates two factories, one at Musulmiyeh which has one old wet process unit and along side it two dry process units. Both of these processes use the same raw materials which are limestone and basalt at sites adjacent to the factories. They also use sand imported from Nabk.
The company also has a factory at Sheik Said with three identical wet process units and which operate separately from the ACBMC plant.

Musulmiyeh.

The raw materials are of good uniform quality.
The limestone quarry operates on a face of 15 - 22m depth in which there are some patches of high magnesia limestone which are avoided. The average quality is about 95% calcium carbonate; The basalt is also uniform deposit separated from the limestone by a distinct fault 2 in the rock. It tends to be hard but weathers very quickly; no secondary/is necessary, the large rocks are/blasting pushed to one side and left to weather. It has a fairly high absorbtion and care has to be taken in winter to avoid loading wet material.
The crushing system is identical with Hama, with a double rotator of 400 tph for limestone and a single hammer mill for basalt. No particular problems arise in crushing. There are rotary dryers for both limestone and basalt but only the limestone is dried. There are storage silos between the limestone crushing and the 70tph dryer. These present some problems due to packing of wet limestone and this also occurs to some extent in the dry limestone store. The basalt dryer is not used and the material passes direct to store.
Storage of basalt is limited due to the failure of the conveyorsystem on the top of the store which limits the useful capacity.
Limestone storage is limited by the packing of material which reduces recovery and a bulldozer is used in the store to move the material.
Sand causes no problems, and is used as received.

Old Factory Kiln M 1.

The raw materials and semi-processed materials are stored in an open store and generally the plant appears to be in good condition though it operates at slightly below it's rated capacity. The major problem is in the kiln section dueto the failure of the electrofilter and the lack of a chimney. This is dealt with separately.

New Plant Kilns M 1 and M 2

The factory operates from a central control room.
Line M 2 is identical with Hama and has the same problems particularly with the electrofilter. This is due to be modified to the same as line 3 which operates satisfactorily. During the visit M 2 had just been lighted after re-bricking of the burning zone and M 3 was stopped on 20th for re-bricking the burning zone. They use magnesite bricks and get a life of 6 -9 mths. This is poor and suggests poor kiln operation. It was stated that the instrumentation was not in good order and M 2 was worse thanM 3. During tours of the factory neither the cement mills nor the raw mills were seen operating.
The cleanliness of the plant left much to be desired and no positive action seems to be taken to deal with or cure this problem of dust accumalation and spillage. From comments made by the senior staff the effeciency of the general workforce is very low with no motivation. There is a lack of supervision stemming from a failure to co-ordinate the central control with the general factory requirements. Like Hama and Adra this plant would benefit from a separate system of cleaning since it is obvious that the production department do not carry this out.
On the packing plant there was excessive breakage of bags which was said to be due to using bags not properly matured. There was also evidence of bad manufacturing of bags which should be taken up with the supplier.

Quality Control

The laboratory appears to be well equiped and run.
The head of laboratory is well experienced with a capable and qualified staff but as on other plants the laboratory operates largely as a service department. The acting Production Director controls the X-ray analyser and there is a definite conflict between him and the head oflaboratory as to who is controlling quality. The question was asked by management - was it nesessary to have a classical system as well as X-ray analysis? It is on this point that the conflict arises. The solution is to expand the programmingof the X-ray analyser to make maximum use of it but to retain sufficient classical analyitical cover to provide regular analyses for standardisation and for revision of X-ray programmes and also to cover any possibility of the X-ray analyser breaking down.

At present there are between 5 and 7 analysts this could probably be cut down to 3 or 4 and the Head of Laboratory made responsible for all analyitical control including the X-ray analyser. Whoever holds the post should be an experienced chemist.

M 1 Kiln - Dust Problem.

The kiln output is 13 tph approximately and the kiln has a direct draught chimney which when used will allow a production of 7 tph; Normally the backend fan delivers the kiln gas to an electro-static filter which does not work and acts merely as a settling chamber for the kiln dust in the gas stream. The filter is open at the top and is a considerable dust nuisance. The recovered dust is removed through shutes knocked into the bottom of the hopper and taken away in lorries after being watered. It is an extremely crude and messy system and the company wish to do something about it. They have put forward the following possibilities:

1. To feed the dust to the blending silo of M 2 and alternatively-
2. Lurgi proposal
   To install a new electro-filter and feed the recovered dust into the firing end of the kiln.

This proposal from Lurgi who state that they have successfully installed it elsewhere.

The possibilities were discusssd at length with
Messrs Halak - Technical Director.
Chalabe - Acting Production Director and
Saraf - Head of Laboratory.

Possibility 1

There was no accurate information available about the composition of the dust, though one chemical analysis had been carried out which did not include alkalis or chlorine. The analyses carried out on the X-ray analyser were unreliable since there is no programme for the dust. However, from the information available, it appears that the dust is a partly calcined raw meal and/a combined /has alkali content of about 1%. It is unlikely that chlorine will present a problem since it is not excessive in the raw materials. Recovered dust amounts to about 1 tph which is 5% of the dry raw material fed to the kiln. This compares with 70 - 80 tph of raw meal fed to M 2 kiln so that the addition of the dust to M 2 blending silo would represent about 1.5% of M 2 kiln feed. This should not cause any problems provided it is not fed into the system when the raw mill is not operating.

It remains to decide how M 1 can be modified to reduce the present dust loss, to increase dust recovery and how and where to feed the recovered dust into line M 2. The following possibilities exist:

a. To build a taller chimney with a dimension sufficient to improve the recovery of dust from the existing electro-filter.

b. To put in a system of mechanical removal of the kiln dust using the existing screw conveyors and elevator and to convey the dust to the raw mill of M 2. The dust could then be fed into the raw mill elevator of the air separator or into the outlet of the separator. This would avoid the need for pneumatic conveying directly into the blended meal silo which has been suggested but which the Technical Director considers would not work satisfactorily using a Fuller pump. The type of dust conveyor remains to be decided and also the route for this conveyor. The problem of disposing of the dust when M 2 is not running would still remain.

Possibility 2.

Lurgi proposal

This includes a new electro-filter, new chimney and a system of feeding the dust into the firing end of kiln M 1. Some doubt exists as to how effeciently the electro-filter would work on a wet process kiln since it is well known that the high humidity of the exit gases can give considerable trouble. A firm guarantee would be required. However the main doubt is the effect of feeding the dust back into the kiln. This could lead to encrustations or damage to the kiln linings and possibility affect quality. Lurgi say they have successfully installed this system on cement kilns in Iraq. Quite apart from a study of the Lurgi offer it is necessary to arrange visits to inspect installations made by them in order to determine their effeciency and any problems which have arisen.
A third possibility is to install the system of feeding the kiln dust back into the kiln without installing a new electro-filter. The existing electro-filter would require a new chimney as suggested previously but it would be necessary to determine whether the re-introduction of dust into the burning zone would affect kiln operation. Inspection of the Lurgi system is essential to assist in making this decision. It would also be feasible to make trials on kiln M 1 with a simple dust feeding system and a fan using the dust presently collected.

Cement Mill Spillage.

The leakage of cement through the bolt holes in the mill shell is a purely mechanical problem and can only be corrected by systematic and regular attention to retightening the bolts as soon as leakage occurs. This is relevant to the question of cleanliness in the plant and should be tackled as a matter of urgency. General cleaning of the plant is apparantly not covered by the present activities of either the production department or the technical department and this should be rectified.

The beneficial effect on plant maintenance, production and reduction of damage to plant is strongly emphasised.

ANNEX V

Arabian Cement and Building Materials Co. Sheik Said, Aleppo

Visited 24 - 30 March 1981

The company has a new two unit dry process plant which is presently being commissioned and has not yet been completely handed over. Responsibility for the plant and it's operation is the manufacturers although certain parts are run by the ACBMC staff.

Four raw materials are used in the following approximate proportions:

Limestone
Basalt
Sand
Iron ore

The basic equipment is as follows;

Crushing

| | | |
|---|---|---|
| Limestone, basalt and iron ore | .... | 4 X 300 tph single hammer mills |
| Gypsum | .... | 1 X 60 tph hammer mill |
| Sand | .... | Screening only |

Covered raw material storage

| | | |
|---|---|---|
| Limestone | .... | 30,000 tons |
| Basalt | .... | 12,500 tons |
| Sand | .... | 1,000 tons |
| Iron ore | .... | 600 tons |

Raw milling ... 2 X 130 tph closed circuit tube mills with crusher dryers and air separation

Kiln ... 2 X 1500 tpd rotary kilns with Humboldt preheaters and horizontal grate coolers.

Cement mills ...2 X 80 tph tube mills with closed circuit air separators.

Cement packing ..3 X 90 tph FLS rotary peakers.

The cement is manufactured to ASTM specification Type 11.

## Commentary on Plant Operation

### 1. Quarry

The limestone and basalt quarries are adjacent to the factory with the limestone overlaying the basalt. The limestone face is 20m. in depth and blasting has been by lines of 9 vertical holes. The explosive used is ammonium nitrate and gelignite but charging of the holes is apparantly not strictly controlled to obtain uniformity and instantaneous blasting is used. This has resulted in much throw of material.
The basalt underlies the limestone and the exposed face varies from 2 -6 meters in depths. Obtaining uniform material has been a problem and at present the basalt being used in the process comes from the excavations for the construction of the plant.
The limestone is of medium hardness and good quality (av.90% pure).
Moisture content is a problem in material handling of both limestone and basalt and is normally 9 - 12%.

### 2. Crushing

There are three crushers for limestone and one for basalt and iron ore.
Gypsum is imported and crushed separately.
Crushed raw material is stored in a covered store with a scraper recoverer for the limestone and an under-store extractor for basalt.
No particular problems arise with the limestone, but the basalt is difficult to recover in entirity and moreover tends to show some variations in quality which it is suggested could be avoided by filling along the full length of the store using a moving tripper on the overhead delivery belt. This coupled with the existing method of recovery should result in a more uniform material fed into the proportioning bunkers.
Problems arise with the extraction of materials from theproportioning bunkers of the belt weighers feeding the raw mills due to the moisture in the raw materials. It is suggested that it may be better not to fill the bunkers completely but this would need a very tight control to avoid bunkers running empty during use.
The sand imported from Nabk is processed by screening. It is suggested that sampling of sand be made after the second screening to obtain a more representative sample than by sampling at the receiving point as at present.

3. Raw Mill

The airswept raw mills can grind and dry raw materials with a maximum of 7% moisture content to the acceptable maximum of 1% in the raw meal using kiln waste heat only. Since the moisture usually is of the order of 12% the auxillary furnace must be used. This requirement of added heat was given as 100 kcal/kg of meal which suggests that the heat balance in the milling system is not correct and that useful heat from the kiln is being wasted.
It is recommended that a careful reassessment of operating conditions be made in conjunction with the commissioning team in order to achieve the correct heat effeciency.

4. Kiln

The 1500 tpd kilns have Humboldt type preheaters with double cyclones at the first stage and three large cyclones at stages 2,3 and 4. Trouble has occured due to blocking in the third and particularly the fourth stage.
Samples of the encrusted material from the cyclones show a very high $SO_3$ content (35-40%) which clearly derives from the fuel oil which contains 4,5% S.

The temperature in the riser pipes was given as 850-900°C which seems high. It was also stated that the clogging in the fourth stage had begun after the burner pipe had been pushed further into the kiln during the early stages of startup of the plant. This was done to avoid the build up of a snowman in the cooler shute. It was also stated that the excess oxygen at the kiln outlet was 10% which is extremely high. Improvements in flame conditions had been achieved by raising the oil temperature from 105°C to 120°C. It is recommended that the temperature in the riser pipe should be reduced by 50°C and in the third stage cyclone not exceed 730°C. The excess oxygen should be maintained at 2 - 3% maximum.
The kiln has magnesite and chrome magnesite bricks in the burning zone and transition zone respectively. There is no excessive buildup of coating although there was a considerable ash ring on the nose of the kiln. There was also evidence of overheating of the nose ring plates. Continual trouble is experienced from the buildup of snowmen in the cooler shute. The cooler is a grate type with five undergrate chambers and five fans. Both kilns had been modified by fixing the first three rows of cooler plates. No.1 is being further modified by the fitting of side bridging plates covering at least the first chamber and possibly part of the second.

It is recommended to check that the bridging plates cover complete undergrate chambers and not part of chambers. This is most important. Secondly to check the capacity of the chambers 1 & 2 fans to ensure that they are capable of maintaining an adequate airflow through the thickened bed of clinker. Also that the first three rows of plates be reinstalled and made moveable as originally. This coupled with the fitting of bridging plates and the thickening of the bed of clinker in the first two chambers should reduce the buildup of snowmen.
It is also recommended to prevent wear of the roof brickwork by installing a plate above the present protection arrangement over the clinker crusher.
In the first undergrate section the seal on the end of the bearing shaft allows leakage of air and dust causing overheating and problems with lubricating. The seal retaining spring was found to be jammed and this requires cleaning and repositioning.

5. Cement Mill

It was reported that the two mills produce cement of different fineness, one satisfactory and the other low. The separation systems were examined and an explanation given to the mill superviser on how to make adjustments to fineness. The mills were started and it was noted that there was a difference in pressures between the two systems. Adjustments were made to equate conditions to those of the satisfactory mill. Subsequent tests showed both mills to be producing at the same output and fineness.
It is recommended that full operating instructions be obtained from the mill commissioning team and that the mill staff discuss them with the team. No alterations should be made to the separators without fully recording existing settings of classifying blades.
It was also reported that poor performance was being experienced with mill media. In view of the good wear characteristics of media and lining plates purchased from new sources and used at Hama and Adra it is recommded to use the same sources.

6. Cement Handling

Difficulty is experienced in extracting cement from the silos and transporting it by airslide conveyor.
It is recommended to clean the silos at six month intervals and if necessary reposition the porous plates in the silo bottom to give a steeper angle to the outlet point.
Airslide operation can be improved by ensuring they

are fed with clean air and that the air extraction system operates satisfactorily. The porous base should be cleaned from time to time.

7. Blending of Low Quality Cement.

It was reported that 10,000 tons of cement held in stock was 20% below standard quality. Since normal quality is about 40% above minium standard the sub-standard cement could be fed back into the mill system at a constant rate of up to 10% of mill output by feeding it into the mill elevator. Product quality must be carefully controlled and the addition restricted to maximum tolerance in respect of both quality and separator capacity.

8. Quality Control

Process control at ACEMC differs from other GOC plants in that the laboratory has direct responsibility for quality control under the authority of the Technical andProduction Director. This system is the one recommended to be adopted at other plants.
The chemical and physical laboratories are well equiped with a competent and adequate staff. There is an X-ray analyser but this has not yet been satisfactorily put into operation by the supplier.
All aspects of the system of sampling and quality control were discussed and are generally sufficient. The one area where additional analysis could be beneficial is in the control of the quality of blended meal since variations, sometimes wide, do occur in the raw meal delivered by the mill due to the difficulties experienced in regulating the mill feed. This may necessitate longer blending periods and it is recommended to systematic sample and check the uniformity of blended meal at regular intervals during the discharge of each silo. A study of the effect of electrofilter dust additions is also necessary.
The quality of cement is uniform and well above ASTM type 2 minimum standard. From the point of view of economy it is recommended that the clinker LSF be reduced to 0.9 - 0.92 with a silica modulus between 2.3 - 2.4. This should also improve burning conditions and assist with control of blockages in the preheater whilst still producing a high quality cement.

9. Management and Control

The system of management was discussed at length with senior staff. It is based on universally accepted methods and is well documented. The major problem will be in implementing it since the factory has only 30%

of it's full complement of staff and is having serious difficulties in finding supervisory and skilled grades. However, from observation, it should be possible by delegation of responsibilities and regular group discussions to develop a sound management team. Management training courses are desirable and necessary. Such a development will relieve the present pressure on senior management, assist them in applying the desired system and encourage and motivate the staff generally.
In one respect a serious situation could arise during the next year due to the lack of workshop facilities. At all other plants in Syria indifferent maintenance adversly effects plant operation. An interim solution must be found at ACBMC pending the completion of the workshop otherwise the condition and performance of the plant will rapidly deteriorate. At the same time care should be taken to build up stocks of spares and a storekeeping system.
The question of cost control was discussed. ACBMC have prepared a basic system which can easily be developed to provide full departmental costing at monthly intervals. This would provide a highly desirable management tool. A sample scheme of such a costing system covering both production and service departments was handed to the Financial Director.
In conclusion the opinion was formed that ACBMC is developing along sound lines and if this progress is encouraged and maintained the company should realise its ultimate potential.

ANNEX V1

## Standardisation of X-ray Analysers

Each dry process plant has an X-ray analyser. Effective uss is not made of this equipment for some or all the following reasons:

1. Lack of an effective sampling programme.
2. Lack of confidence in the accuracy of the analyser.
3. Apparent discrepancies in performance between the several machines.
4. Lack of consultation and coordination between the four laboratories concerned.
5. Shortage of skilled operators.

In an effort to improve the situation a new sampling and quality control procedure was recommended at Adra. A standard sample of raw material was also prepared at Adra and tested at each of the four laboratories concerned. The results are given in Table 1.

## Discussion of Results

1. The variation in $SiO_2$ of the Hama analyser is excessive.
2. The discrepancies between the different X-ray analysers and in comparison with the chemical analyses calls for a coordinated/of all programmes and analysers. standardisation
3. The differences between the chemical analyses calls for a check on analyitical accuracy and methods.
4. The continuation of classical chemical analysis is essential both for a period confirmation of X-ray analyses and to take over the quality control in the event of a breakdown of the X-ray analyser.
5. After verification of the accuracy of the X-ray analysers the process control can be based on their uss with considerable advantage.
6. It should be recognised that without a regular verification there is a danger of losing control of the manufacturing process with disasterous results to quality and output.

| Laboratory | Adra | | Hama (a) | | | | Musulmiyeh (b) | | | ACBMC (b) |
|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | Chemical | X-ray | X-ray | | | | Chemical | X-ray | | Chemical |
| | | | 1 | 2 | 3 | 4 | | 1 | 2 | |
| Insoluble Res. | | | | | | | | | | 1,03 |
| $SiO_2$ | 12,24 | 13,90 | 13,26 | 13,32 | 13,45 | 13.52 | 12,75 | 14,29 | 14,40 | 12,45 |
| $Al_2O_3$ | 3.31 | 3.31 | 2.30 | 2.30 | 2.34 | 2.39 | 2.97 | 2.96 | 2.91 | 3.11 |
| $Fe_2O_3$ | 2.79 | 2.39 | 2.04 | 2.03 | 2.03 | 2.04 | 2.49 | 2.25 | 2.24 | 2.11 |
| CaO | 43.46 | 42.72 | 42.06 | 42.10 | 42.02 | 42.02 | 43.18 | 43.63 | 43.40 | 43.36 |
| MgO | 2.22 | 2.08 | 2.65 | 2.67 | 2.69 | 2.75 | 1.41 | 1.56 | 1.58 | 2.34 |
| L.o.I. | 3505 | - | - | - | - | - | 34.85 | - | - | 35.17 |

**Notes;**

a. The Hama results are for 4 repeat analyses on the same prepared sample. The analyser is not programmed for alkaloi and chlorine.

b. Musulmiyeh analysis 1 is the avarage of six repeat analyses and analysis 2 of 4 repeats on the second sample. The variations in each set were minimal.

c. The X-ray analyser of ACBMC was not operating due to an electrical fault.