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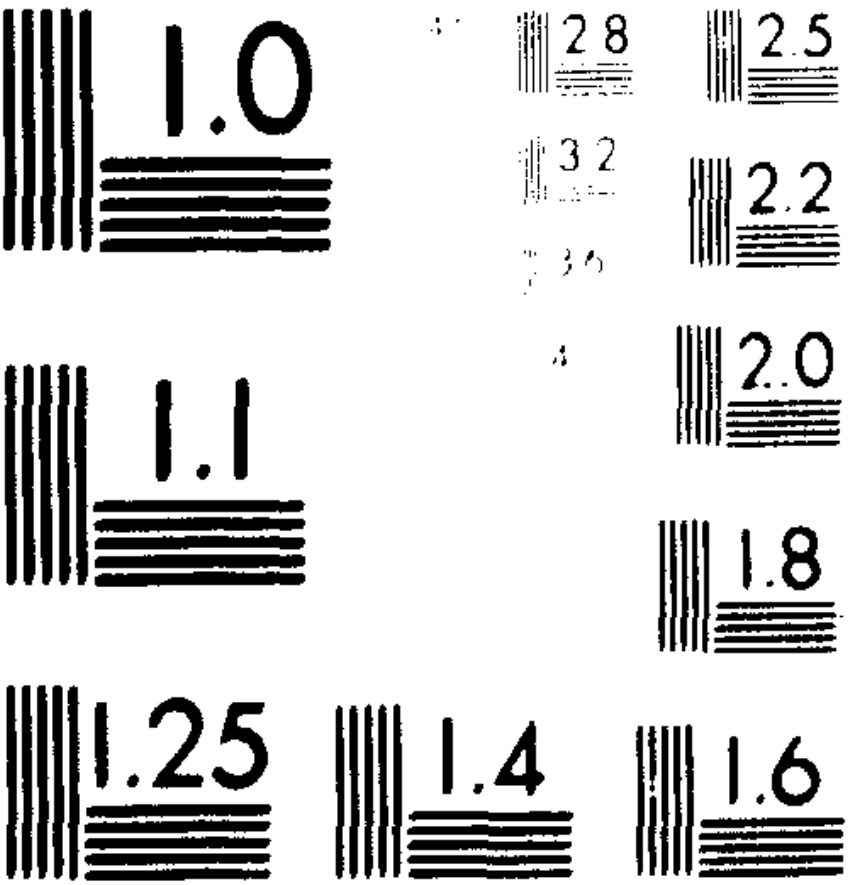
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



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INDUSTRIAL TESTING, RESEARCH AND DEVELOPMENT CENTRE

DP/SYR/77/001

SYRIAN ARAB REPUBLIC

Technical report: Assistance in Cement Plant Engineering and Cement Plant Technology *

Prepared for the Government of the Syrian Arab Republic
by the United Nations Industrial Development Organization
executing agency for the United Nations Development Programme

Based on the work of Zdenko PRIJIC, Cement Plant Engineer

United Nations Industrial Development Organization

Vienna

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Thanks to all collaborators from I T R DC in Damascus, especially to Mr. Kamal Sunbuli, Miss Hana Karkoukli and Mr. Samir Kazzaz, for their help during my assignment. The author is also thankful to the collaborators from G O C and the cement industry.

Thanks to Miss Leila Muwakki', Administrative Assistant of the Project, for secretarial assistance.

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I INTRODUCTION

1. The Industrial Testing, Research and Development Centre emerged from its earlier UN assistance starting from the UNESCO Project "Industrial Testing and Research Centre" and started functioning as an organization from January 1974.

2. The Expert was assigned to the present Project SYR/77/004 Strengthening Industrial Testing, Research and Development Centre, by letter of appointment Post No. DP/SYR/77/004/11-17/F/31.3A dated 25 July 1980 with Job Description as at Annex No. 1.

3. The Expert's Mission was from 6 August to 5 December 1980, during which he was at the duty station Damascus, S A R, from 9 August to 1 December 1980.

4. This report deals with the activities of Zdenko Prijic, UNIDO Expert in Cement Plant Engineering and Cement Technology. It covers the period of his assignment to the Industrial Testing, Research and Development Centre, between 6 August and 5 December 1980.

5. Throughout the report reference to ITRDC means Industrial Testing, Research and Development Centre, and G O C means General Organization for Cement and Building Materials.

II SITUATION EXISTING WHEN THE EXPERT ARRIVED

1. The Laboratories

1.1 The expert found that laboratories for physical and mechanical testing of cement were generally reasonably well equipped. Some deficiencies are given in Annex 2.

1.2 Chemical laboratories which is common to the whole Centre including for activities on cement are also very well equipped.

1.3 The job mostly performed in the field of cement was testing the quality of cement for conformity to the Syrian standard on cement.

1.4 Research activities and investigational work was not performed at all.

1.5 Liaison with G O C and cement industry was not strong enough.

2. The Counterparts

2.1 On his arrival the expert found the only staff were his chief counterpart Mr. Kamal Sunbuli and two assisting staff members: Miss Hana Karkoukli and Mr. Samir Kazzaz with whom he mostly worked. Dipl. Eng. Kamal Sunbuli is Chief of Mechanical and Electrical Division in the ITRDC. He graduated in Bergakademie Freiberg/La DDR in 1962 in metallurgy. He joined ITRDC at the very beginning. He is fluent in German and English.

She graduated from Damascus University in 1977 as a civil engineer, and joined ITRDC the same year and has been working in the building materials section ever since. She has started learning English

Chemist Samir Kazzaz completed a B.Sc Chemistry course at Damascus University and joined the ITRDC at the end of 1977. He is working in building materials section of ITRDC ever since he joined. He does not know English.

Up to expert's arrival both of counterparts were responsible for the work in physical and mechanical laboratory for cement testing. They were able to perform all routine work concerning the cement testing. The knowledge about cement chemistry was inadequate.

2.2 Chemists in the chemical laboratories are well trained to do analytical work.

III FIELD VISITS

1.1 During his assignment the Expert made a number of visits to Syrian cement factories together with one or the other of his counterparts. These visits were organized in close cooperation with GOC, with the senior officials of which the Expert had had a few meetings, talking about matters which are interesting for both partners (ITRDC and GOC). At all times he was well received from the top factory people and got all requested data. The interest ITRDC is taking in giving a strong industrial thrust is also reflected from the fact that on a one whole-day visit to a cement plant the Project Manager Dr. Visvesvaraya and the Director-General ITRDC Mr. Mohamed Hisham Sharafli also joined the Expert.

1.2 All the old factories, although built more than 20 years ago are still in very good condition due to proper maintenance. Their production is in excess of the installed capacity, because of effective utilization of available time and equipment.

1.3 The quality control of raw materials in all of these factories is well and properly organized, and it seems, from the only few checkings the expert made, results are reliable.

1.4 All these factories work with raw materials of very low lime saturation factor (LSF) and due to this fact the quality of cement is not as good as it could be with higher LSF.

1.5 In the Rastan Cement Factory there is an enormous amount of water in the raw material slurry.

1.6 Two new factories the expert visited were only two to four years old. According to the available data they are not working satisfactorily because of low utilization of capacity by time. It seems that the main problem in both factories is quality of equipment.

Besides, many very important instruments, especially in the kilns, do not work. It is understood that with the assistance of instrument maintenance and repair the Project is providing, ITRDC will attend to such problems.

1.7 Special problem in the factories, which are using x-ray apparatus for quality control of raw materials, is the fact that these apparatus are not used in the proper way. Besides, they are not calibrated in the proper way, and results obtained are not reliable.

1.8 All factories visited have adequately equipped laboratories.

1.9 Concerning mechanical and physical testings of cement the expert noticed that there is no uniformity in performing these tests, especially in the sand used.

1.10 The expert also observed during his visits to all factories, that knowledge about technology and chemistry of cement is not adequate.

1.11 The visits indicated clearly that there was increased need for ITRDC's interaction and assistance, because the expert was asked many times during his visits if the ITRDC could provide assistance in some problems.

IV WORK DONE BY THE EXPERT

Taking into account all aforementioned under Sections II and III, the expert made work plan for his four months period of service (See Annex 3). The expert immediately started to work according to this plan taking into account the duration of each of the items of the plan.

1.1 Program for uniform testing of cement produced in Syria was prepared (see Annex 4). Samples were taken and sent to the factories and to London. Up to the time of writing this report the results are not available for verification, so the expert could not evaluate the results, but ITRDC's staff are now trained that they can do this by themselves also.

1.2 Program for systematic and permanent control of the quality of cement produced in Syria was prepared (See Annex 5).

1.3 As a result of the meeting between ITRDC, GOC and the expert, ITRDC started, under the guidance of the expert, investigations of suitability of Syrian pozzolana for production of Portland-pozzolana cement. In this job the expert found a way to initiate some investigational work in the ITRDC, and in the same time to make some liaison between the ITRDC and GOC (cement industry). Although the results after 90 and 180 days could not be available within the short period of the mission of the expert, from the data on 3,7 and 28 days we can say that one of the pozzolamic material used in test is good, and can be used for production of Portland-pozzolana cement. (See Annex 9).

1.4 As a result of expert's visit to Rastan cement plant, and his suggestions written in the report about this visit (see Annex 7) concerning amount of water in raw material slurry, ITRDC in close connection with the factory and the expert has decided to try to solve this problem.

Although there is no apparatus for particle size measurement in the ITRDC, which is very important in the particular job, the expert has been able to identify the specific problem and provide the necessary solution even without the need for this equipment (See Annex 8).

1.5 The evaluation of the situation in the cement industry in Syria by the expert was naturally subjected to the constraints imposed by time and language but within these constraints the expert had a lot of talks with the factory personnel about many things concerning technology of cement and quality control of raw materials and cement. The expert hopes that though these talks he convinced the factory personnel about two important things:

a. That they must work with higher lime saturation factor (LSF) in the raw mix.
b. That existing x-ray apparatus are not properly used, and are not properly calibrated.

With reference to this point the expert was informed that an expert from Philips (producer of x-ray apparatus) will come to talk about the matter with the factories as well as the expert, but till the expert's departure he did not come.

V TRAINING AND SEMINAR

1.1 As the counterparts were familiar with the equipment in physical and mechanical laboratory the expert has been emphasizing most strongly during his involvement with them that, at all times, the work of ITRDC's staff must be exact and carried out with precision. For this reason the expert concentrated on correct use of equipment, correct test procedure, sampling, etc. The expert held numerous discussions about aforementioned matters,

and on the more practial side, he worked with his counterparts on many tests.

1.2 Starting September 1980 for the total of 25 days during September the Expert trained four ITRDC staff members in the following tests:

a. Test for compressive and tensile strength of hydraulic cement mortars (improvement)
b. Test for normal consistency of hydraulic cement (improvement).
c. Test for setting time (improvement)
d. Test for fineness of raw material by sieves by wet methods.
e. Test for pozzolamicity according ISO Recommendation 863.
f. Test for soundness (improvement)

1.3 During his assignment expert gave numerous talks to his counterparts about chemistry of cement. He started from the very beginning that is with calculation of the raw material mix propertions and proceed on. However, here the main problem is the language and difficulties in communcation.

1.4 Towards the end of his mission the Expert participated in a Seminar and gave a talk on the research into pozzolanic cements carried out by ITRDC. This was well attended by local engineers and concrete technologists.

VI RECOMMENDATIONS

1. Industrial Services

The crux of the success of ITRDC is the quality and quantity of industrial services it renders to the cement industry for its improvement. The lines on which the following field problems were solved by the Expert should be a good demonstration for the counterparts to follow in future even after the departure of the Expert.

a. Saving fuel and increasing capacity of the cement plant at Rastan by reducing water content in slurry.

b. Increasing LST as related to the cement plant at Rastan and Hama I by altering the mix properties thus improving the final quality of cement.

c. Increasing the capacity of cement production in Syria by introducing Portland-pozzolana cement.

2. Laboratory

2.1 It is imperative that a Centre as ITRDC intended as a central laboratory correct testing conditions must be obligatory. Expert put his suggestions about this matter. (See Annex 2).

2.2. In order to continue the useful testing, research and Development work, the Expert recommends to buy apparatus for particle size measurement.

3. Staff

3.1 Staff selection is the weakest point in ITRDC. First, personnel working in ITRDC should have an interest in research and development work. It should have high standard of education and training in particular fields, to be able to solve any problem arising from request of the industry, or problems associated with research work.
It will be necessary that ITRDC sets up some sort of incentive system, so that it can attract the right professionals to join ITRDC. The Expert knows that it will not be easy, but anyhow the sooner it is implemented, the sooner ITRDC will reach its proper position, and the industry will be fully benefited from the facilities of ITRDC.

3.2 All staff connected with research and development work in ITRDC must know at least one foreign language, being able to follow the technical literature. Solution with translation services is not the best one, because it is very difficult to find

a translator with knowledge of all branches of industry, allowing him to choose which article is important, and which is not.

4. Organization

Building material industry is very well developed in Syria and developing further. Very soon it will be necessary to control the quality of all of these products. Existing organization of the building material section of ITRDC will not be able to respond to this task. Expert suggests to organize a special testing and control centre, for building material. The new Centre can be affiliated to ITRDC. Chief of the new Centre should be responsible for all kinds of testing and certificates issued, at the same time being a liaison officer between ITRDC and all branches of building material industry. It was understood that the Centre has, already suggested by the Project Manager, putting up a new block of engineering laboratories which would include a cement and building material sections. It should have the facilities given in the final report of Mr. Bozanovic.

5. Standardization

Although the Expert was not involved in the problem of standardization, he feels that it is necessary to establish a group of the experts whose task it will be to study the procedure and methods included in the existing standard, and put their observations and suggestions to improve the standard. The group must be consisting of persons from cement industry, ITRDC and standardization.

6. Training and Fellowship

The type of activities indicated in Section V should continue.

It will be profitable to send at least one person from the building material section to some institution for practice.

VI CONCLUSION

As it can be seen from all aforementioned in this expert's final report the work foreseen in his work plan has in fact been substantially performed.

According to the expert's opinion work performed in ITRDC was very useful and this work it is hoped will continue. The Expert feels that once his recommendations as aforesaid are implemented, the industrial interactions will improve and there will be even stronger linkage between ITRDC and GOC.

Cement Plant Engineering and Technology is an important area requiring to be well developed in the content of the fact that the cement industry in Syria is a major industry.

It is good that an area which was not given much attention has started to get the required attention due to the initiatives taken by the Project Manager and the interest shown by the Director General ITRDC.

The Expert has tried to do his best within his short mission of four months; he is sorry he could not stay for another two months as requested due to his official and private commitments at home. The Expert is however convinced that this is an area with high potential and a longer UN Expert assistance for a year or more would be desirable to achieve the developmental objectives.

ANNEX 1

JOB DESCRIPTION

DP/SYR/77/004/11-17/F/31.3.A

Post title	Expert in Cement Plant Engineering and Cement Technology
Duration	Four months, with possibility of return mission
Date required	As soon as possible
Duty station	Damascus, with possibility of travel within the country
Purpose of project	

Duties

The expert will be a member of an international professional team assigned to the Industrial Testing, Research and Development Centre (ITRDC), and will work under the supervision of the Project Manager and, in close co-operation with the appropriate local specialists, will specifically be expected to:

1. Assist in supervising testing, research and development activities in the Centre with respect to cement plant engineering and cement technology, covering especially the fields of raw materials, processes, plant operation and maintenance, cement technology.
2. Participate actively in the introduction of research results into industry as well as in the elaboration of techno-economic feasibility studies related to cement industries.
3. Co-operate with the General Organization for Cement and Building Materials in studying the existing cement plants and identify their problems and how the Centre with its infrastructural facilities can assist them in meeting their needs.
4. Provide technical advisory services to cement plants for the solution of their problems with emphasis on improvement of specific unit operations.
5. Formulate recommendations aiming at improving efficiency of production in cement plants in the country.
6. Undertake work programme at the laboratories of the Centre and at the plant itself, aiming at improving production, reducing cost, and assuring quality, with special emphasis on optimum utilization of local raw materials and skills.

ANNEX 1 (2)

7. Train local personnel from the Centre and Industry in the above tasks.

8. Carry out investigational studies, collect data and information and under the guidance of the Project Manager analyze this information to formulate recommendations. Assist the Centre and Industry to implement these recommendations.

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

QUALIFICATIONS: Engineer with extensive experience in the operation, maintenance, quality control and productivity improvement of cement plants.

LANGUAGE: English: Arabic an asset.

ANNEX 2

Expert Suggestions for covering deficiences in the ITRDC's Laboratories for Cement Testing

With reference to my suggestion concerning systematic quality control of all cement produced in Syria, it is necessary to promote the work and right conditions in the Centre laboratory for mechanical and physical testing of cement, as follows:

1. Moist cabinet.

A well made moist control cabinet is essential in cement testing in order to maintain the required temperature and relative humidity. Existence of water containers does not necessarily mean high relative humidity in the cabinet, so it is important to remember that the moist cabinet must be well insulated, and protected from draft.

Now in the Centre there is no adequate moist cabinet.

2. Storage tanks.

Storage tanks for test specimens must be of non-corrosive material and must have racks for holding the specimens which should be tested. During the water storage period the specimens should be completely immersed in water. Storage tanks must have some kind of a temperature control device to keep the water temperature within the required range of $20 \pm 2^{\circ}C$.

The capacity of storage tanks here in the Centre is small, and without the temperature control device. If theCentre will follow my suggestion aforementioned they have to build a new storage tank. Sketches for the tank and moist cabinet are attached, although it is not necessary to follow them.

3. Storage for cement samples.

Now in the Centre all cement samples are kept in the paper bags. According to all known standards, the institution which checked the quality of cement must keep the samples at least three months after checking, because of possible misunderstanding, but in the air tight containers. It can be done very easily using plastic bags. Besides, all samples must be sorted in the shelves, that in the case of necessity they can be easily found.

ANNEX 2 (2)

4. Testing room (mechanical and physical laboratory)

Because the temperature and relative humidity of the laboratory have a strong impact upon the behaviour of the mixes, it is essential that testing room is conditioned by certain device, which is able to maintain temperature and relative humidity within the limits.

Containers for standard sand must be modern, metal or plastic boxes properly covered. The sand must be weighed grade after grade for only one sample, and not for many samples, because of aegregation. The samples of sand can be prepared in advance, but only if the required quantity for one sample is weighed and put in plastic bag.

Laboratory has all necessary apparatus and instruments, but all these apparatus have to be recalibrated from time to time, at least once a year. The only device which has to be replaced is existing balance for weighing cement and sand, because it is not adequate.

5. Laboratory staff

The laboratory for mechanical and physical tests of cement needs two workers, tester and his assistant. Supposing there will be 36 samples of cement from Syrian cement factories, and 6 from imported cement and miscellaneous, and that there are 22 working days in month (Friday and day before Friday because unmouding cannot be done, are excluded) it means that there will be about 2 samples a day.

Who will go to collect samples from the factories, the same as a problem of some small chemical laboratories affiliated to cement department for simple and specific tests for cement, such like free lime determination, or amount of pozzolanes in Portland-Pozzolane cements, is the question of organization of the Centre, and I am not going to interfere in it.

ANNEX 3

WORK PLAN FOR FOUR MONTHS PERIOD COMMENCING AUGUST 1980

UNIDO Expert 11-17B - Mr. Z. Prijic with Counterpart Staff

Serial No. of Activity	Immediate Objective & the Project Aim which the Activity seeks to achieve	A C T I V I T Y	Date of Commencement & Duration of Activity	Inputs other than the Project Team Expert Counterpart/s and supporting staff	O U T P U T S	R E M A R K S
1	B-3-4 B-1-8	Strengthening Standardization and Quality Control Activities				
1.1		Program for systematic control of the quality of cement produced in Syria	Mid Aug. continuous		Introduction of systematic quality control of production.	
1.2		Training of Centre's staff	Mid Aug. continuous		Know-how transfer	
2	B-1.4 (B-1-8)	Organizing Seminars Colloquia and Group Discussions				
2.1		Group discussion or Colloquia concerning Pozzolana cement	Mid Nov.		Know-how transfer	
3	B-3.6 (B-8)	Initiating and/or strengthening Centre's capabilities in testing, research, design, devel. quality control and trouble shooting in cement.				
3.1		Program for uniform testing of cement in Syria	Mid Aug. 45 days		Correct and sure of samples testing.	

ANNEX 3 (2)

Serial No. of Activity	Immediate Objective & the Project Aim which Activity seeks to achieve	ACTIVITY	Date of Commencement and Duration of Actity	Inputs other than the Project Team Expert Counterpart/s and Supporting Staff	OUTPUTS	REMARKS
3.2		Fundamental Work in Cement Chemistry	End of Aug. Continuous		Transfer of results of study from Centre to the Industry	Apparatus for particle size measurement
3.3		Investigate suitability of Syrian pozzolama for production of pozzolama cement	Mid Sep. 2 months		Close cooperation in research, design and development activities.	
3.4		Field visits to some cement factories in Syria	End of Aug. 3 months		Assistance and Collaboration in Extension Services and in commercialization of R and D results. Close liaison in identifying industrial needs. Assistance in trouble shooting in industries. Interaction between Centre and Industries. Assistance to Industry in Testing and Quality Control.	

ANNEX 4

EXPERT'S PROGRAM FOR UNIFORM TESTING OF CEMENT PRODUCED IN SYRIA

With reference to my visit to the General Organization for Cement as well as the discussion which has been held here in the Centre and also in the GOC concerning quality control of cement, I do recommend what follows:

1. About 250 kg of Portland cement random taken should be thoroughly mixed and then 50 samples of 5 kgs each from this batch should be prepared using air tight containers (plastic bags).

2. 35 kgs of each of the three grades of the standard aand should be thoroughly mixed separately for each grade. Out of the three batches 81 plastic bags should be filled up each with 400 g of sand giving together 3 x 81 = 243 samples. The total weight of all these samples will be 97.2 kgs.

3. Send to each one cement factory in Syria 3 samples of the cement mentioned under Point 1, marking them 1.2 and 3 respectively, and 6x3 that is 18 samples of sand, so that the factories should be able to make the complete mechanical tests with the sand, we sent them. With the third sample they have to make mechanical test using his own sand.

   In the same time they have to make full required chemical and physical tests on each one sample of cement sent to them. In the Centre complete chemical, physical and mechanical test will be done on two samples parallelly.

   Finally, at least three samples of cement must be sent to the three separate laboratories outside Syria, for testing according to three different standards (one of them must be the French standard) in all aspects (chemical, physical and mechanical).

   After receiving all results, and finding that some of them differ significantly from the average, we shall try to improve the work in the pertaining places. After that we shall send another sample for testing there, to find out that they really use the proper procedure.

   Reason for this job is unification of the procedure bringing to the equalization of results in all cement factories in Syria.

   The results from the outside will help the Centre to know what is the real relation between the new Syrian Standard, and some other world's standards relating to cement.

ANNEX 5

EXPERT'S PROPOSALS FOR SYSTEMATIC AND PERMANENT QUALITY CONTROL OF CEMENT PRODUCED IN SYRIA

With reference to my visit to the General Organization for Cement, as well as to the discussions which have been held in the Centre and in the G O C concerning quality control of cement I have recommended procedure for unification of cement quality test.

After this procedure will be duly performed the next steps should be systematic quality control of all cement produced in Syria. The control has to be done by the Centre, as the only independent organization which is able to do impartially such a job.

A representative from the ITRDC must visit each factory without notice at least three times each month and draw random samples in the presence of factory personnel from the packing machine. One half of the sample should remain in the factory for complete testing, while the second half will be sent, in an air tight container to the Centre, which will make all required testing according to the existing Syrian standard.

For the initial few months Centre may just warn factory that its cement did not meet the standard requirements, and eventually advise it what is wrong with the produced cement. Later on, if some of the factories would not meet specification, they have to undertake necessary changes in the technology. It is also possible that Syrian standard for cement may introduce two or three different grades of cement, with different strength requirements (of course the price shall reflect these differences).

The payment should not be a problem, because both organizations, namely ITRDC and GOC are under the same ministry.

ANNEX 6.

PROCEDURE MANUAL FOR TESTING POZZOLAMIC CEMENT

Prepare following amount of listed materials for every one sample of different pozzolamic, or different clinker (it means if we have to test two different samples of pozzolama with one sample of clinker we must prepare double amount of clinker and gypsum and as well as only the indicated below amount of each one pozzolama and vice-versa.

50 kg of clinker
2 kg of gypsum
5 kg of pozzolama

From this material, which is uniform in each one separate case the following mixtures have to be prepared. Remove: Before mixing pozzolama must be air dry.

	(1)	(2)	(3)	(4)	(5)
Pozzolama	- kg.	0.5 kg	1.0 kg	1.5 kg	2.0 kg.
Gypsum	0.3 kg	0.3 kg	0.3 kg	0.3 kg	0.3 kg
Clinker	9.7 kg	9.2 kg	8.7 kg	8.2 kg	7.7 kg
Total	10.0 kg	10.0 kg	10.0 kg	10.0 kg	10.0 kg

Sample No. 1 (Reference sample) ground in the small laboratory ball mill for 20 min. After 20 min. check the fineness of product on 900 and 4900 sieve. If the fineness is normal (it means the residue on 900 sieve is about 0.5% and from 3 to 8 on 4900 sieve) stop the grinding. If the fineness is not good enough proceed with grinding but check every 10 min. The fineness until above figures are approached. The resulting time is a grinding time for all other batches.

Put the samples in air tight containers and from each one undertake the following tests:

1. Complete chemical analysis
2. Complete physical tests for cement
3. Test for tensile and compressive strength for the period of 3, 7, 28, 90 and 180 days. Three specimens shall be prepared for each age at which a strength test is desired.
4. Pozzolamicity test (ISO recommendation R 863/1968)

ad 1) Procedure for chemical analysis are the same as for normal portland cement, except that the amounts of oxides have to be expressed on ignited baze (The ignited material from the loss on ignation determination may be used for the sample).

ad 2) All physical tests are the same as for normal portland cement: Remark: Take into account that water requirements for normal consistency test will be higher.

ad 3) Tests are the same as for normal portland cement. Remark as above:

ad 4) See Annex.

When tests for compressive and tensile strengths, and tests for pozzolamicity are performed, and if they are satisfactory, then the preparation of pozzolana cement have to be done in factory in the normal mill. The samples of the factory should be tested in the same way and results obtained in such a way can be put in Syrian standard for pozzolamic cement.

ANNEX 7

EXPERT'S REPORT ABOUT PLANT VISITS

I visited some Syrian cement factories, namely: Adra on 30 and 31 August accompanied by Miss Hana Karkoukli (ITRDC) and Mr. Hassan Aloush (GOC), Rastan and Hama I and II on 20 and 21 of September accompanied by Mr. Ezzeddine Karkash (ITRDC) and Mr. Adnan Shebeeb (GOC).

My comments do not include technical data on machinery used, numbers of employees, capacity, etc., because this information is recorded elsewhere. They outline my observations and put some recommendations.

a. All old factories, although built more than 20 years ago are still in very good condition due to proper maintenance. Their production is in excess of the installed capacity, because of effective utilization of available time and equipment.

b. The quality control in all these factories is well and properly organized, and comparing various parameters it is evident that results are reliable.

c. All these factories work with raw materials of very low lime saturation factor (LSF) and due to this fact the quality of cement is not so good as it should be.

To explain why it is like this, according to my opinion, let me tell something which is well known.

The relative order of the theoretical heat requirements involved in the various stages of clinker burning is as follows:

	kcal/kg clinker
Heating raw material from 20°C to 450°C	170
Dehydration of clay at 450°C	40
Heating materials from 450°C to 900°C	195
Dissociation of $CaCO_3$ at 900°C	475
Heating de-carbonated material from 900°C to 1400°C	125
Net heat of melting	25
Total	1030 kcal/kg

It is very easy to notice that about 46% of total heat is required for dissociation of $CaCO_3$, and because the consumption of calories is always critical during the taking over a factory, the supplier is trying to keep $CaCO_3$ as low as it is possible during this period.

Because of aforementioned I recommend to raise content of $CaCO_3$ inall old factories to LSF level from 94 to 96.

d. Cement plant Rastan works with extremely high amount of water in the slurry, reaching as much as 52%, To understand what it means for heat consumption, and in the same time for kiln capacity, it is enough to know that each percent of water reduction in the slurry decreases the heat requirements for clinker burning by about 1%, and increases the kiln capacity by about 1.5%. I think that these figures do not need any special comment, and that staff in Rastan must find a way how to reduce this amount of water.

Although I personally never work in the cement plant with wet process technology, and my experience in the field is quite limited, I shall state what is well known.

There are generally two ways to reduce the water content in the slurry:

a. Chemically, by addition of slurry thickness (probably worth while to use in Rastan Cement Plant).

b. Mechanically, by slurry dewatering, using proper filters. (according to my opinion not worthwhile in this case because the factory is rather old).

Cement slurry is a heterogenous mixture of water and solids, which are present as very fine dispersed particles. Every one mixture has a specific viscosity which can be measured by many different slurry viscosimeters (Southard viscosimeter, F.L. Smith viscosimeter, etc.).

The role of slurry thinness are to reduce water content of the slurry maintaining the same viscosity.

Using slurry thinness we must take in mind that the effect of slurry thinness depends much on the physico-chemical properties of the slurry, so that it is necessary experimentally ascertained for each raw material which slurry tinners is the best.

The correct concentration of the thinning agent in the slurry is of great importance. Each thinning agent is characterized by a peak concentration paint. Exceeding this point you can get adverse result (for example an addition of 0.33% of NaOH reduces the water requirement of a slurry from 40% to 34.6%, After increasing the amount of NaOH however, the slurry becomes firmer).

There are two groups of slurry thinness:

1. Alkaline electrolytes: sodium silicate Na_2SiO_3 (water glass); sodium hydroside NaOH; sodium carbonate Na_2CO_3 (Soda).

2. Surface-active, mostly organic substances, ligmin derivates, human acids, sulfite liquor; calcium - ligmin sulfonate, carbonaceous additives, molasses, etc.

Remark:

Calcium-ligmin sulfonate and sulfite liquor are by-products of the paper industry. Usual addition is from 0.3 to 0.4% of dry substances. These additions make possible to reduce the water content in the slurry by 3-4%, and in some cases up to 8%.

A mixture of sulfite liquor and sodium carbonate (ratio 1:1) added to the slurry in an amount of 0.6 - 0.8% (dry substance) reduces the water content of the slurry by 5-8%.

In one case, mentioned in the literatur an addition of 0.075% Na_2CO_3 made it possible to reduce the water content from 42 to 31.4% without impairing the flowability of the slurry.

Naturally in each case, care must be taken to assume that the cost of the slurry thinners is lower than the savings resulting from reduced fuel consumption and improved kiln capacity.

My recommendation is to try to apply available slurry tinners taking into account all aforementioned.

Wash mil will make easier and more accurate quality control. This will help, may be a little bit to decrease the waterrcontant in the slurry, and for sure will cut the stoppages of slurry pumps which is now a bottle-neck in production.

Two new plants I have already visited were built four and two years ago. They are not working very good because of low utilization of capacity by time. It is partly understandable for Adra Cement Plant, because such a big plant needs at least two years of experience for proper and normal running, but it is not so with Hama II. It seems that the main problem in both factories is quality of equipment. I am not going to look after this, because it is a field of maintenance and not technology, but because it is not possible for clear division I must point some things.

ANNEX 7 (4)

1. Many instruments of the kilns do not work. I think that it is not necessary to explain in detail what is the role of instruments and especially in such a big kiln, where it is very important how quick one can intervene, and the instruments are the only guide. From my experience I know that in such a way, to be on safe side, the staff works with smaller capacity and with the excess of fuel.

2. The problem is even bigger, because of the fact that the feeding devices in kilns are not reliable, changing capacity in the big scale without any influence of the working staff.

   I am positive that only with the all necessary instruments these factories can produce good portland cement clinker, and the due capacity and fuel consumption. On account of this I recommend to repair all instruments, because this is for sure worthwhile.

3. Special problem in the factories, which are applying x-ray apparatus for quality control is the fact that these apparatus are not used in the proper way,

   To work smoothly with such a big kiln the raw material mix must be uniform. For this reason all new factories have a tube post and x-ray apparatus, so that the staff can intervene very quickly in preparing a uniform raw material mix. It means that the checking of raw materials must be continuous 24 hours. In the factories I visited it is not like this.

   I strongly recommend to organize checking of raw material in such a way that there is a permanent control 24 hours a day.

   The second existing problem is a fact that these apparatus are not calibrated in the proper way, and of course the results obtained are not reliable.

   After installing organization as aforementioned, and proper calibration the factories will have a full benefit of them.

4. I observed, during my visits to all factories, that knowledge about cement chemistry is not adequate.

Because the production of cement is a chemical process, and only knowing this process one can influence it, it is necessary to improve the knowledge about it. There are so many excellent books about this matter available in the libraries of factories, and also in the ITRDC, only staff in the factories must make use of them.

ANNEX 8

EXPERT'S REPORT ABOUT TESTS PERFORMED WITH RAW MATERIAL OF RASTAN CEMENT PLANT CONCERNING AMOUNT OF WATER

With reference to the tests performed in the laboratories of ITRDC under my guidance, concerning the problem of water in the slurry of Rastan cement plant, I have to inform you about findings.

1. Original slurry sample taken in the factory during visit has following characteristics:

   a. Amount of water 51.5%
   b. Fineness:

      Sieve No. 70 (900 mesh) 7.7% (see note)
      Sieve No. 170 (4900 mesh) 5.3%

   Note: so high residue was due to the inclusion of three pieces of dimension exceeding few mm in size.

   Taking into account that "normal" amount of water should be from 35 to 38%, and that existing fineness is too high, (sieve residue is too small) being normal from 1 to 3% at the sieve No. 70, and from 16 to 20% at the sieve No. 170, we started to work.

2. From the samples of limestone and clay, also taken during visit, we prepared two batches of each one, with differences only in fineness.

   The first batch (indicated later as No. 1) has a following fineness clay:

   Sieve No. 70 3.7%
   Sieve No. 170 9.5%

   Limestone:

   Sieve No. 70 3.5%
   Sieve No. 170 17.6%

   it means fineness which can be supposed almost "normal".

   The second batch (indicated later as No. 2) was ground more finer having fineness of 0 (zero) for clay and limestone on both sieves.

   As first we try to find out how much of the water needs clay and limestone separately to produce similar slump.

ANNEX 8 (2)

Slump, as a practical measure for viscosity was tested on the original apparatus borrowed in the Rastan factory.

Clay and limestone of sample No. 1 with 50 and 37.5% of water respectively, produced a slump of 2 to 2.5 which can be considered as almost the same.

Clay and limestone of sample No. 2 with the same amount of water produced the slump of less than 1 to 1, which can be also considered as almost the same.

It shows to us that fineness of the raw mix can influence a lot on the required amount of water in the slurry.

3. Taking into account fact that the existing factory transport facilities are able to manage slurry with the slump of 1 to 1.5 we prepared sample of raw material-mix of adequate chemical composition, and with appropriate fineness (3.3 on No. 70 and 16.5% on No. 170 sieve). This sample with 36.3% of water produce slump of 1.5.

Although we have to take into consideration the fact that particle size distributions of raw material grind in the laboratory mill and in the commercial one, should not be necessarily the same, the performed tests are a good base for the next (proceeding) research in the field, and support our opinion that the fineness of raw mix is responsible for such a high amount of water in slurry.

Although for the moment ITRDC are not able to determine particle size distribution and get a 100% reliable results, I suggest however to decrease fineness of slurry in the Rastan plant (increase the residue on the sieve) till afore-mentioned figures concerned as "normal" and I am sure that the results will be satisfactory.

ANNEX 9

RESULTS OF TEST WITH POZZOLANIC MATERIAL PERFORMED IN ITRDC

With reference to the tests performed in the Laboratories of ITRDC under my guidance, concerning the suitability of Syrian pozzolamic material for production of Portland-Pozzolama cement, I have to inform you about work which is already finished with obtaining data.

We prepared the samples of clinker, gypsum and 5, 10, 15 and 20% of pozzolamic material respectively as it is proposed in Procedure Manual sent to you on 16.9.1980.

Samples are prepared with two clinkers, from Aleppo and Adra cement factories and with two different types of pozzolamic material from Shahba and Adra regions, it means all together 18 samples.

Third sample of clinker from Hama was not the good one because of high amount of free lime, and the factory will send another sample of clinker for test.

All samples were ground in batches of 10 kgs in the Laboratory ball mill of Dummar cement factory. Samples with Aleppo clinker were ground two hours and with Adra clinker one and half hours, trying that specific surfaces (Blaine) obtained with both clinkers are similar.

All tests are performed to the proposals from aforementioned procedure manual.

Original sample of pozzolamic material from Shahba region had 9.5% of moisture, while the sample of pozzolamic material from Adra region had no moisture at all.

Results:

Chemical analysis of clinker and pozzolamid material

Sample	L.01	Ins.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	C_3S	C_2S
Aleppo Clinker	1.66	1.32	20.15	5.09	3.83	64.08	1.70	2.10	62.1	10.9
Adra Clinker	0.94	0.58	21.11	5.97	3.49	63.05	2.16	2.51	44.4	27
Shahba Pozz. Mat.	0.71	2.72	42.92	28.05	13.58	8.08	7.46	NIL	-	-
Adra Pozz. Mat.	1.34	43.71	23.18	9.17	10.18	3.53	9.33	NIL	-	-

Fineness of reference samples (samples of clinker and 3% of gypsum) marked as sample 1 and 1E are 4260 cm2/g for Aleppo and 3910 cm2/g for Adra respectively. For all other samples we made only sieve tests for fineness on No. 70 and No. 170 sieve. All results are almost the same.

Amount of water for requirements of normal consistency are almost the same for reference samples and all samples with pozzolamic material ranging from 26% to 26.5% for Aleppo clinker and from 23.7% to 24% for Adra clinker.

Setting time is quite normal.

Tensile and compressive strength and test of pozzolamicity. For all 18 samples prisms for 3, 7, 28, 90 and 180 days are already prepared, but only 3.7 and 28 days results are available up to now. Since both samples show the same trend, the results obtained for the Aleppo clinkder only are described.

	Sample	Tensile Strength kg/cm2			Compress.Str. kg/cm2			Pozzolanicity ISO R863
		3d	7d	28d	3d	7d	28d	
1	97% of clinker Aleppo 3% of gypsum	60	65.8	78.8	314	432	516	-
2	92% Clinker Aleppo 3% Gypsum 5% Pozz.Shahba	61	60.7	79.2	315	403	556	+
3	87% Clinker Aleppo 3% Gypsum 10% Pozz. Shahba	60	62.6	78.6	318	392	508	+
4	82% Clinker Aleppo 3% Gypsum 15% Pozz. Shahba	55	59.6	77.1	282	372	533	+

+

ANNEX 9 (3)

Sample	TENSILE STRENGTH kg/cm²			COMPRESS.STR. kg/cm2			Pozzolanicity ISO R 863
	3d	7d	28d	3d	7d	28d	
5 77% Clinker Aleppo 3% Gypsum 20% Pozz. Shahba	49	60.3	71.3	226	339	453	+
2b 92% Clinker Aleppo 3% Gypsum 5% Pozz. Adra	56	58.4	76.1	309	377	482	-
3b 87% Clinker Aleppo 3% Gypsum 10% Pozz. Adra	54	60.3	75.6	287	353	465	-
4b 82% Clinker Aleppo 3% Gypsum 15% Pozz. Adra	49	58.6	69.4	258	326	447	-
5b 77% Clinker Aleppo 3% Gypsum 20% Pozz. Adra	45	50.0	62.0	211	245	357	-

It is evident from all performed tests that only material from Shahba region are pozzolamic one, and can be used in amount up to 15% as ingredient for production of portland-pozzolama cement. I emphasized here strongly that factory intended to produce portland-pozzolama cement must equalize the quality of clinker and produce clinker with minimum 55% of C_3S (tricalcium silicate).

Production of pozzolama cements (cements with more than 30% of pozzolamic material) for specific uses, like it is low heat cement or sulphate resisting cement must be solved by ITRDC through proper tests-trial procedure in the future.