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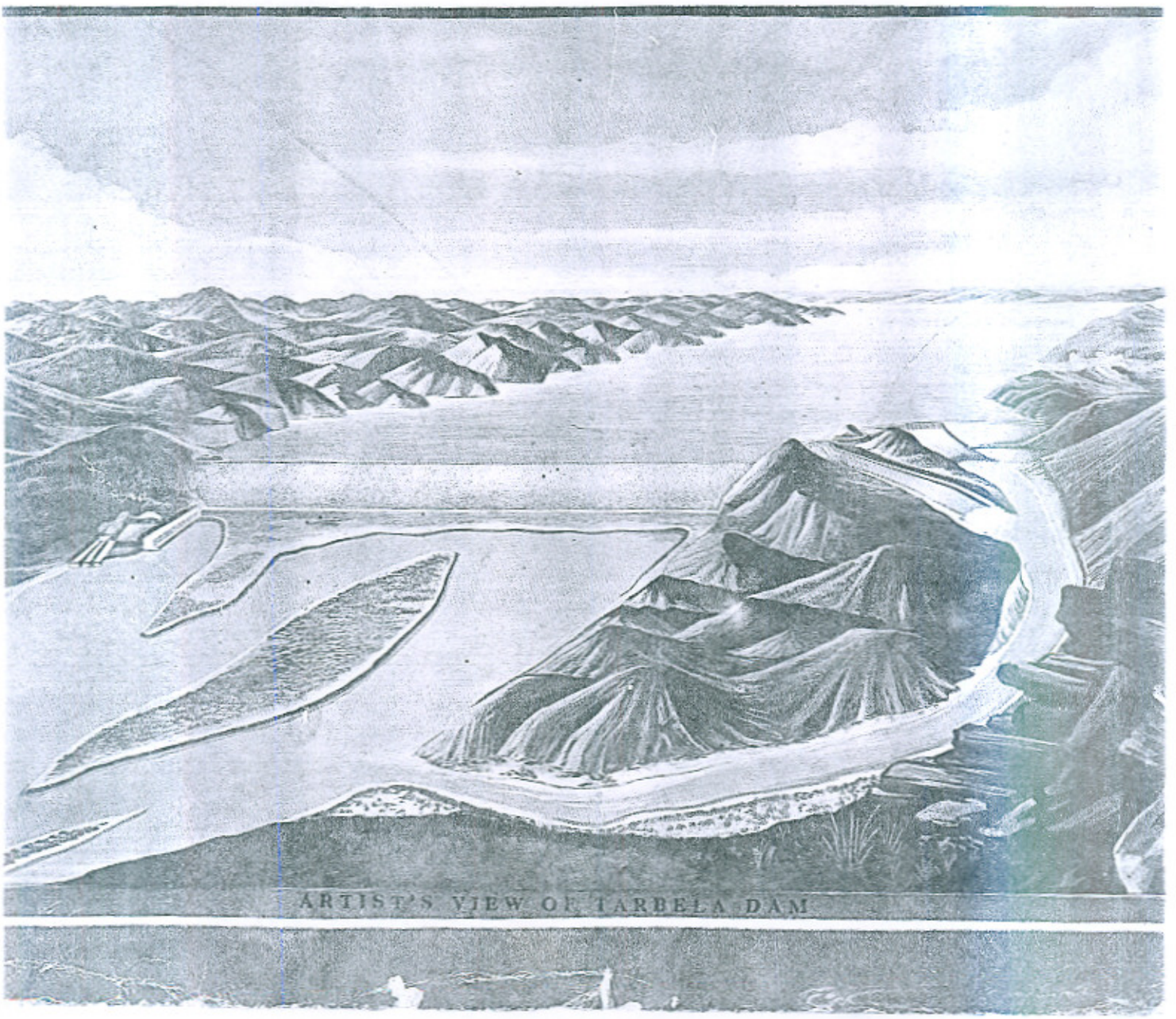

ARTIST'S VIEW OF TARBELA DAM

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In this issue

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Indus Basin Projects and the Tarbela Dam

The Indus Basin treaty with India provided that out of a total of 168.0 million acres feet (maf.) of the water resources of the Indus and its tributaries, West Pakistan will utilize 136 maf. being the average annual flow of the henceforth called Western Rivers, the Indus, the Jhelum and the Chenab.

India was to have full control on the three Eastern Rivers, the Ravi, the Beas and the Sutlej and utilize exclusively their annual flow of 32 maf.

Before the treaty, West Pakistan was utilizing 81 maf. which included 24 maf. drawn from the Eastern rivers. The loss to Pakistan was to be made good by diverting water mainly from the two Western rivers, the Indus and the Jhelum. This could only be done by constructing seven link canals, four barrages, one syphon, two dams and a vast amount of remodelling of the existing canals.

The International Bank for Reconstruction and Development undertook to arrange for the finances. An Indus Basin Development fund was set up mainly from contributions of U.S.A., U.K., West Germany, Australia, Canada and New Zealand. Pakistan and India also had to share some expenses.

The average annual flow of the Jhelum is 22.7 maf. and that of the Chenab is 23 maf. At present Upper and Lower Jhelum Canals and Upper and Lower Chenab Canals, Marala Ravi Link, B. R. B. D. Link, Haveli and Rangpur Canals are taken off from these rivers utilizing all the winter flow and a part of the summer flow which constitutes about 80 per cent of the total and a major portion of which flows during three monsoon months. Thus for the full utilization of the supplies of these rivers, storages are necessary. One at Mangla was planned early in 1953 and is under construction. This will help to regulate the supply of the river to a considerable extent. The flood flows of the Chenab cannot be stored as no suitable site exists on the river within Pakistan.

Thus although the flow of these two rivers is already fully utilized yet five link canals are being constructed on these to transport the water of these two rivers, a major portion of which will be drawn from the Mangla Dam Storage. These rivers cannot fulfil the deficiency of water. The balance has to come from the Indus and like the rest of the rivers, 80 percent of its flow of 90 maf. takes place in the six summer months and a big proportion within the three monsoon months. Hence to fulfil the deficiency, a storage on the Indus is an essential part of the treaty. For this purpose investigations had been carried out at Kot Kai, Durband, Tarbela and Makhad and finally Tarbela was found to be the most promising site and all phases of investigations for a dam construction had been carried out during the last four years at an enormous expenditure.

It is said that the International Bank of Reconstruction is now hesitant to advance money for its construction for two main reasons, the high cost of the Dam and its short life. From 1954, investigations conducted on the various sites on the Indus, close to the sources of utilization, have revealed that to control a river like Indus which ranks among the big rivers of the world, carrying 90 maf. of water, no dam will be less costly. Many factors account for the high cost of dam and for this river the geology of the region is the one reason. Secondly all sites investigated on the river have small storages as compared to the total flow and naturally the life of the dam must be short. For Tarbela it is nearly 40 years but no site on this river of the same size of storage can have a longer life. The sources of sediment of the stream are not as a result of soil erosion but disintegration and grinding of rocks by glaciers which feed this river.

Pakistan is a progressive nation. It will not wait for 40 years to see its dam silt up. Within these years many new sites will be investigated and dams constructed on these. Forty years of life with tremendous Hydro-Electric powers, with development going on all fronts, with determined efforts to fight waterlogging and salinity, the next forty years represent a very bright picture for the country and even a short life of Tarbela Dam need not deter us from its construction.

Tarbela Dam is a must for the nation. Without Tarbela, Indus Basin treaty has no meaning and in Pakistan everybody is *optimistic* that the same goodwill will prevail to see the Indus Basin treaty completed in all its phases.

Tarbela Dam Project

by **BASHIR A. MALIK, P.S.E. I**
Director (Tarbela), Indus Basin Project, WAPDA.

The author presented this paper at Pakistan Science Association meeting. It is being printed in the periodical.

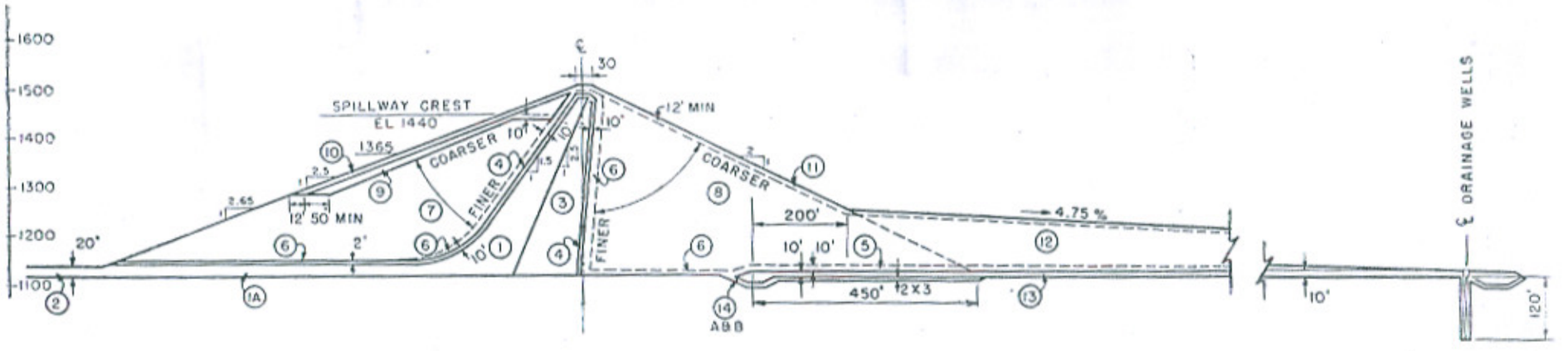
Introductory

Tarbela Dam is the most vital element of the Indus Basin Project now under execution in West Pakistan financed by the Indus Basin Development Fund established under the Indus Water Treaty of September, 1960 which seeks to settle the canal water dispute between India and Pakistan. The dam to be built on the river Indus about 30 miles upstream of Attock, will create a reservoir of 8.4 MAF which will store surplus flows in summer season to be released in the following winter months for irrigation lower down and replacement of supplies on the eastern rivers, when India diverts these supplies to her use after 1970. Water released from the lake for irrigation, will be passed through a power house to generate electricity. It will thus be a multi-purpose project.

Description

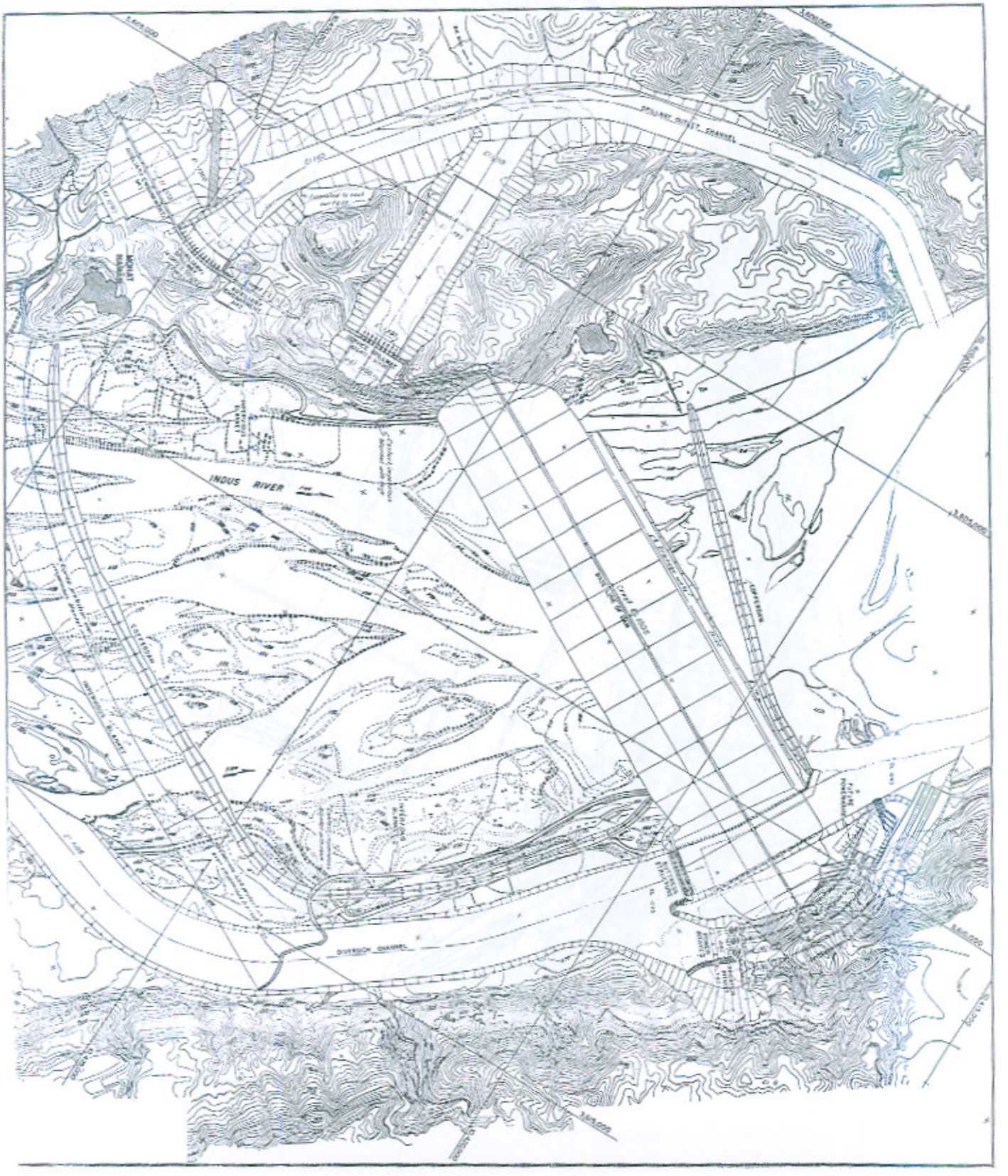
Preliminary feasibility report was drawn up in 1954 which established the technical and economic feasibility of the project. Detailed field investigations were taken in hand in August, 1959 after the project became part of the replacement plan. Three alternative sites were investigated and the final choice fell on Bara Axis which is the closest to the original (1954) site. The biggest single problem regarding the site for the dam is the existence of very deep alluvium in the river bed which goes as deep as 360 feet and over. Control of seepage through embankment and the foundation presents great difficulties. After detailed field investigations the design adopted was the use of impervious blanket which will tie up in the sloping core of the rock fill embankment and extend upstream with a total length of nearly 8000 ft. Location of the spillway has also been difficult. Initially it was thought that an old buried channel of the river on the left embankment would be a natural site for spillway. But sub-soil explorations revealed the foundations too weak to support spillway structure of contemplated height. By the end of November

TARBELA DAM CROSS SECTION



1. IMPERVIOUS CORE - CLAYEY SILT FROM BORROW.
1A. IMPERVIOUS CORE EXTENSION - CLAYEY SILT FROM BORROW
2. IMPERVIOUS BLANKET - CLAYEY SILT FROM BORROW.
3. SILT OR SILTY FINE SAND FROM EXCAVATIONS.
4. FINE FILTER - SAND FROM RIVER BED (MINUS 1½ INCH MATERIAL)
5. SELECTED GRAVEL ZONES - FROM EXCAVATIONS
6. SELECTED SANDY GRAVEL - FROM EXCAVATIONS.
7. COHESIONLESS GRANULAR SHELL - BOULDER - GRAVEL, SANDY GRAVEL FROM EXCAVATIONS.
8. RANDOM SEMIPERVIOUS - COHESIONLESS GRAVEL, SANDY GRAVEL FROM EXCAVATIONS.
9. FREE DRAINING ZONE - ROCK FILL OR BOULDER-GRAVEL (PLUS 1½ INCH SIZES) - FROM EXCAVATIONS.
10. SLOPE PROTECTION - SELECTED ROCK FILL FROM EXCAVATIONS.
11. SLOPE PROTECTION - SELECTED BOULDER - GRAVEL OR ROCK FILL FROM EXCAVATIONS.
12. RANDOM EARTH OR ROCK FILL FROM EXCAVATIONS.
13. DRAINAGE BLANKET - PLUS 1½ INCH COBBLES - BOULDERS FROM RIVER BED.
14A. GRAVEL FILTER - SELECTED FROM DAL VILLAGE BORROW.
14B. SAND FILTER - SELECTED FROM DAL VILLAGE BORROW.

PROJECT PLAN OF TARBELA DAM



1962, three years and four months after the start of field explorations a definite layout of the project was established.

The project as it stands today, comprises rockfill embankment with impervious core extending into a long upstream blanket with drainage wells on the downstream side for pressure relief. This arrangement would bring the seepage through the embankment and foundation within acceptable limits.

The dam would be 400 feet high and about 8700 ft. long at top. There will be two auxiliary dams to fill up the low saddles east of the left abutment. One of them will be 370 ft. and the other 170 ft. high. These will also be earth embankments with vertical cutoffs.

There will be two flood spillways. The main spillway will have a capacity of over 900,000 cusecs, 900 ft. long at crest with 10 gates, 50 ft. wide and 58 ft. high. This will be the spillway that will be normally in service. The auxiliary spillway which will come into operation very rarely, will have a capacity of over 600,000 cusecs with crest length of 1160 ft. and 14 gates of 50 ft. by 35 ft. Both the spillways will have flip buckets for facilitating energy dissipation.

There will be five tunnels of 45 ft. dia. each through the right abutment. Three of the five tunnels will be used for diversion and ultimately converted for power generation. Remaining two will be for passing irrigation supplies.

Power house at Tarbela will have 12 units of 125 MW each. Total installed capacity will be 1,500 MW developed in stages as the country's requirements increased.

The site is capable of ultimate development up to 12.1 MAF storage capacity. The embankment to be constructed initially will have built-in facilities for raising the dam subsequently.

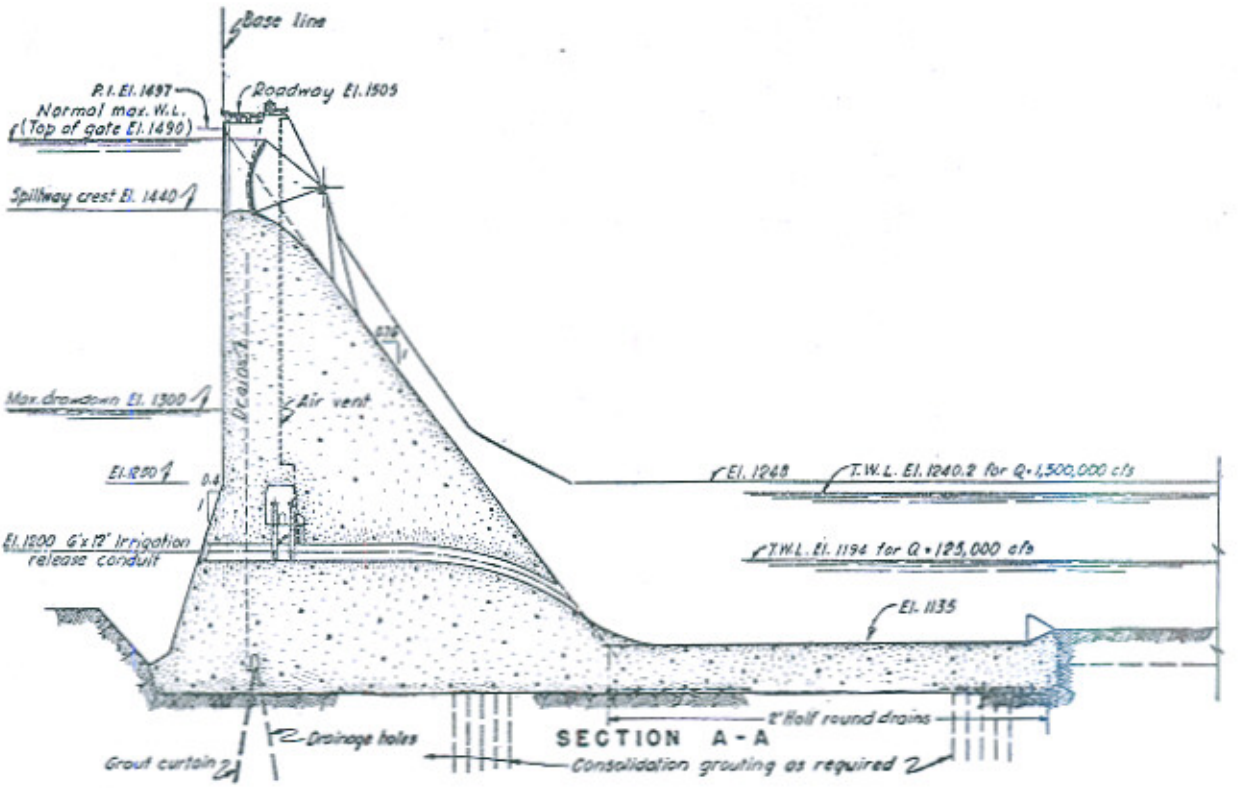
Total excavation involved in the construction of the dam would be 120 MCY and embankment fill 153 MCY. This will render Tarbela as the largest dam of its kind in the world today. Besides earthwork, colossal quantities of concrete will be required. The present estimate is 3.500 MCY which is comparable to that used on the famous Hoover Dam in U.S.A.

Reservoir Life

Total average inflow of the Indus at Tarbela is of the order of 68 MAF. The reservoir capacity of 8.4 MAF of Tarbela would thus be very inadequate for proper regulation of the river flow. Trap efficiency will be 100% initially. In other words all the sediment and silt brought in by the total flow will be dislodged in the reservoir. The life of Tarbela reservoir would, therefore, be relatively short.

There is, however, a great redeeming factor at Tarbela. If the present contemplated height of the embankment is raised by 30 ft., flow from Tarbela reservoir can be diverted into off-channel storages on the Haro and the Soan—eastern tributaries of the Indus. There are good storage sites available in the basins of these two rivers but their own flows are very insignificant. The aggregate capacity of these pouch storages appears to be of the order of 30 MAF, which after depletion of Tarbela reservoir, can be developed progressively. As these will be fed from more or less silt free diversions from Tarbela reservoir, their life would be practically indefinite. Power potential is also very large about 3,000 MW. Tarbela will thus pave the way for development of a very large water resource which will be most helpful in meeting the growing needs of the country

Section of Spillway



resulting from the explosive rate of increase in population.

Present Stage

The project stands at the threshold of entering into the definite design stage and preparation of specifications and bid documents. According to the present schedule, if the project can go to tenders next year, the contractor can be expected at site early in 1965. Thereafter, it will take 8 years to complete. To meet this schedule it is contemplated that earth-moving equipment of the latest type and of unprecedented dimensions may be used. It may also be that special type of equipment would be devised suited to the site conditions.

The project is a part of the Indus Basin Settlement Plan and will be constructed by WAPDA on behalf of the Central Government. It is expected that the finances will be provided out of the Indus Basin Development Fund. Tippetts-Abbett-McCarthy-Stratton of New York, U.S.A are the Project Consultants.

Concrete in Buildings Construction

A Summary of Two Lectures given at Lahore on 1st and 2nd April, 1963.

by **A. R. CUSENS***

Dr. Anthony Cusens, Professor of Structural Engineering and Assistant Director of Research visited Pakistan and delivered two lectures under the auspices of West Pakistan Engineering Congress at the U.S.I.S. Auditorium. The lectures were on Concrete making and Concrete in Building construction. We have reproduced briefly the two lectures for the information of the readers.

Concrete is the most versatile of all building materials available to the engineer. The raw materials necessary to make concrete are readily available in almost any part of the world. The manufacture of concrete is an apparently simple process—indeed most of us have made concrete at some time or other. This apparently simple process of manufacture is perhaps one of the gravest disadvantages of concrete—it leads to the popular misconception that the making of concrete does not require skill. The fact is that anyone can make a sort of concrete, that will set and harden and probably hold together for a while, but it takes considerable care and skill to produce a consistent concrete with predictable properties.

Properties of Concrete

Let us compare the properties of concrete with those of the material with which it is frequently associated—steel. Steel is a homogeneous material which within certain clearly defined limits behaves elastically (*i.e.*, stress is proportional to strain). It is almost equally strong in tension or compression, it exhibits a small amount of creep (inelastic deformation) under load but this is reasonably predictable. Concrete is a much more complex material. It is a heterogeneous substance, non-elastic in behaviour, strong in compression but weak in tension, which shrinks while drying, and undergoes considerable creep deformation under load.

In order to design a concrete member with any degree of accuracy it is necessary to have some fore-knowledge of the material. It is possible to relate the properties of concrete with some readily determined factor

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such as the crushing strength of concrete specimens in the forms of cubes or cylinders. Thus the ideal production of concrete would produce a series of concrete cubes or cylinders of identical strength. In practice this is impossible to achieve since very small variations in the materials or degree of compaction of the concrete cause quite large variations in cube strength. In fact the achievement of close control of quality is difficult and calls for the application of considerable skill. The production of steel is recognized as a complicated technology, to be handled only by experienced men—in the same way the production of concrete for structural use should not be relegated to untrained labour.

Batching for Good Concrete Making

The field of quality control of concrete extends over the selection, storage and batching of aggregates and cement, the mixing, transportation, placing and curing of concrete. I do not propose to deal with more than one or two salient points on quality control in these lectures. There are several excellent books (*e.g.*, 1, 2*) which deal with the subject in considerable detail.

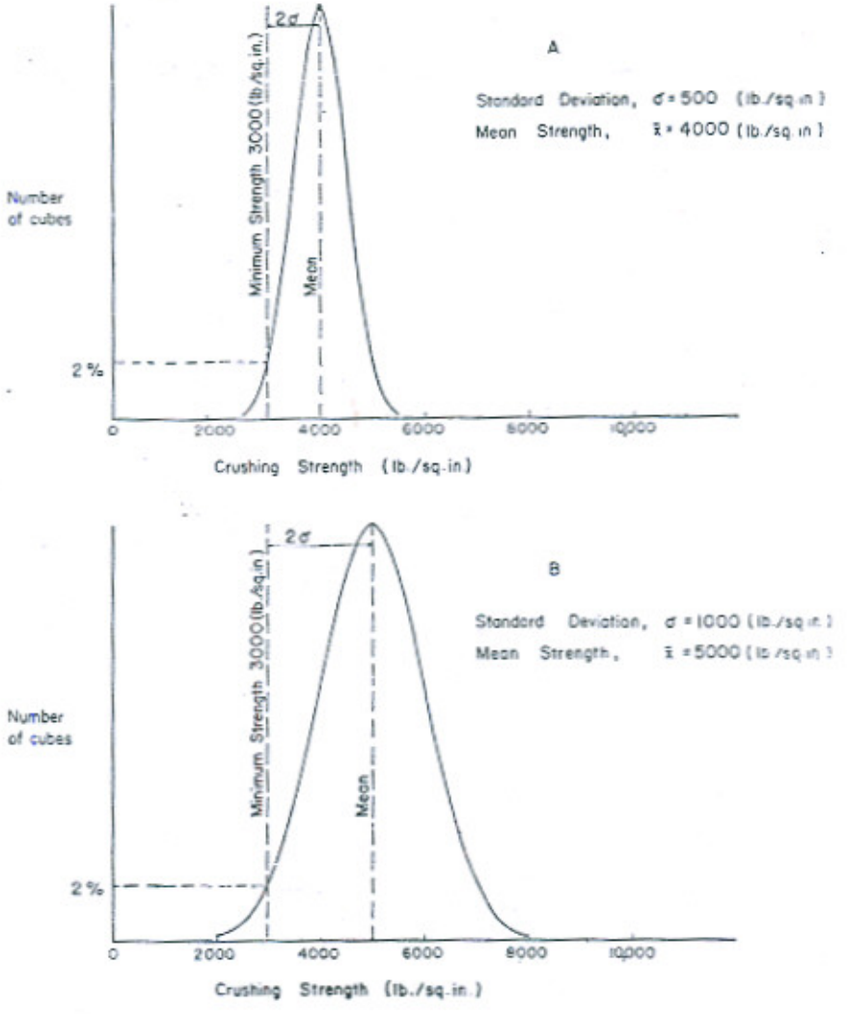


Fig. 1

First of all let me try to explode the myth

*Numbers in parentheses refer to references listed at the end of this paper.

which is often heard. Many engineers convince themselves that the procedures involved in effective quality control are too expensive for a particular contract or for their organization. In other words they cannot afford to make good concrete. My reply to that is that engineers cannot afford *not* to make good concrete. Let us consider a specific example of two large contracts. In contract A quality control was good and in the other contract, B, it was indifferent. This is demonstrated if distribution curves are plotted of the concrete cube strengths taken from the two contracts. The distribution curves show the spread of the cube results about the average value of strength. If the difference between the mean overall strength and the individual strength of each cube is x then the spread may be expressed in terms of the standard deviation

$$\text{S.D.} = \frac{\Sigma(x^2)}{n-1}.$$

where n is the total number of cubes made on the contract. Let us suppose that both contracts were aiming at the same minimum cube strength of 3000 lb/sq. in., and in practice this is interpreted as meaning that not more than 2% of cubes should have strengths below this figure. For this to be achieved the mean cube strength must be about twice the standard deviation above the minimum strength. Thus for contract A, where control is excellent and the standard deviation is perhaps 500 lb/sq. in. the mean strength will be $[3000+(2\times500)]=4000$ lb./sq. in. However, in contract B where control is poor and the standard deviation is 1000 lb./sq. in., then the mean strength $=3000+(2\times1000)=5000$ lb/sq. in. Thus in order to be sure of achieving a minimum strength of 3000 lb/sq. in. the mean strength on this contract is as high as 5000 lb/sq. in. The average amount of cement used would, therefore, be much higher in contract B and this is the cost of poor control. It would be cheaper to use more supervision and to take a little more care over the production of the concrete. This fact becomes obvious on a large job where many cubes are made and tested but the principle still applies even on small jobs where there are few cube results to drive the point home. From the points of view of either economy or safety, an engineer cannot afford not to make good concrete

The control of quality in concrete production is not a matter of installing expensive equipment. On very large contracts it may well be justifiable to install such machinery as automatic weigh batchers but in general the process of control is one of adequate supervision at all stages. Aggregates should be carefully chosen and care should be taken that supplies remain free of clay, silt, dust and organic matter. Aggregates should not be stored on bare earth but should be provided with a platform of lean concrete; coarse and fine aggregates should be positively separated during storage. Precautions should be taken against segregation of the larger stones during handling.

It is always worthwhile to make one or two trial mixes before fixing the proportions of concrete to be used in a particular job. The frequently adopted but entirely arbitrary 1:2:4 mix which is blindly specified for so many jobs can often be improved upon from the standpoint of strength or workability or economy.

As regards the batching of materials, there is no doubt that batching by weight is generally the better method but very good results may be achieved with strict supervision using

volume batching of aggregates [cf. ref. (3)]. Gauge boxes should be deep with a small plan area. Cement should always be batched by weight—where possible by the bag.

Water-Cement Ratio

Since the strength of concrete is primarily dependent on the water/cement ratio, the gauging of the water is a vital part of quality control. Some type of measuring tank is desirable but if the other materials have been batched correctly, an experienced mixer operator can judge the water content by the appearance of a mix, with a fair degree of accuracy.

Mixing of concrete should be carried out in machine mixers and the time should be adequate to obtain a uniform concrete. Transporting and placing should each be done in such a way as to prevent segregation of the concrete. In placing, free fall of the concrete should be avoided as far as possible. If concrete is allowed to fall for more than about 4 feet, segregation occurs with a consequent band of honeycombing.

Compaction of Concrete

The final strength of concrete in a structure depends on the void content. A small percentage of air voids results in a large drop of strength—5% of voids will cause a drop in compressive strength of 30%. The compaction of the concrete is, therefore, important to eliminate air voids. In recent years the use of vibrators has become widespread as an aid to compaction. For site work the internal vibrator is most commonly used. Care is necessary in ensuring that vibration is used properly. Stiff concrete mixes require vibration but a wet mix which can be compacted by hand tamping should not be vibrated, since this results in segregation as the heavy particles sink to the bottom. Formwork should be properly prepared if vibration is to be used—joints must be watertight as there is a tendency for leakage and for air to be sucked in to the concrete. Bands of segregation may also be caused if vibrators are used to move concrete along formwork. Concrete should be deposited evenly within the formwork in layers of not more than one foot at a time. Each layer should be compacted before the next is placed.

Necessity of Curing

The final stage in concrete production is the process of curing. It is fairly well understood amongst engineers that concrete only continues to gain strength if moisture is present to ensure hydration of the cement. Curing is generally effected by covering with wet sacking, ponding or frequent spraying.

If there has been adequate supervision at all these stages from the first preparation of the formwork to curing and final striking of the formwork, then the final result should be concrete which is of good appearance—concrete of dense and uniform appearance which does not prompt the contractor into covering it with plaster or rendering to hide defects. Properly made, in well prepared formwork, concrete should not be a material to be ashamed of or covered up.

Many architects in Europe and the United States set out to achieve striking surface finishes by using specially designed formwork. Most timbers leave some impression of the grain on the concrete and if the boards are carefully chosen and proportioned, a pattern may be obtained. The texture breaks up the otherwise dull surface of the concrete. Rough finishes are obtained with boards marked by sawing, with specially chamfered edges, or with boards of different thicknesses. Smooth finishes are given by formwork

lined with plywood or hardboard. Texture finishes are produced by lining the forms with rubber or thermoplastic sheeting.

Surface Finishing

Another technique much used in surface finishes of concrete is that of exposing the aggregate by removing the outer cement skin. This may be done on the surface of in situ concrete or on specially made precast panels. The production of exposed aggregate finishes may be effected by:

(*a*) Early stripping of the form and brushing and washing the "green" concrete.

(*b*) Etching. The use of an acid solution to dissolve the cement skin. The acid is washed off before it can attack the main body of the concrete. This is mainly confined to precast work.

(*c*) The use of cement retarders on the formwork to delay the setting of the cement on the surface.

(*d*) The use of hand or power tools.

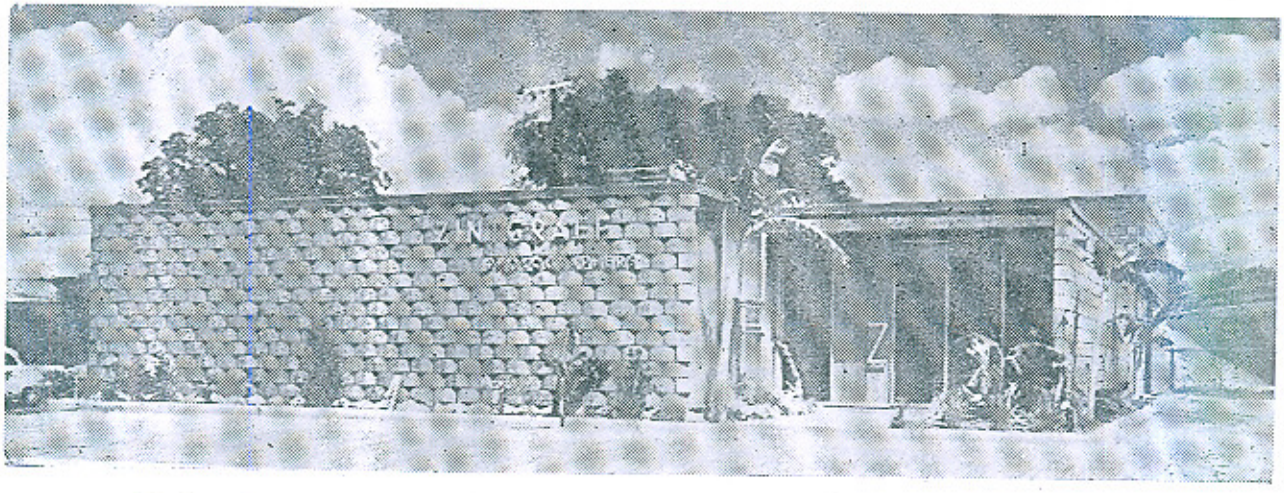
(*e*) Grinding.

(*f*) The use of a process known as "aggregate transfer" whereby pieces of aggregate are stuck to boards which are positioned as linings to the formwork. When the formwork is struck, the boards are stripped off.

In Scandanavia, where much of this type of work has originated, a particular method of making concrete is used known as *Naturbetong*. The forms are filled with coarse aggregate and a sand/cement mortar is then injected. After the forms have been removed the surface is immediately sand-blasted.

Concrete in Building Construction

The true versatility of concrete in buildings has only been appreciated by most engineers and architects in recent years. The work of pioneers such as Torroja and Nervi has led to the realisation that the concrete in a building can take other forms than conventional beam and slab construction. Concrete offers enormous scope to the designer with imagination, and with recent developments he now has a wide range of design methods and construction techniques at his disposal. With the advent of shell roofs and folded plates, the safe adoption of higher design stresses, the use of lightweight concrete (particularly in the United States),



The imaginative use of concrete blocks to produce a small building of good appearance

and the arrival of prestressed concrete as a practical proposition, concrete construction no longer entails the massive heavy structural members of the past. Precast concrete members made under factory conditions are being increasingly employed and a number of standard precast systems both in reinforced and prestressed concrete have been developed for various types of buildings. Such systems can simplify and speed up site construction to a considerable extent.

Prestressed concrete has become much used in composite floor systems in buildings. Such floors may consist of:

(*a*) pretensioned beams of T or double T section with a topping of *in situ* concret;

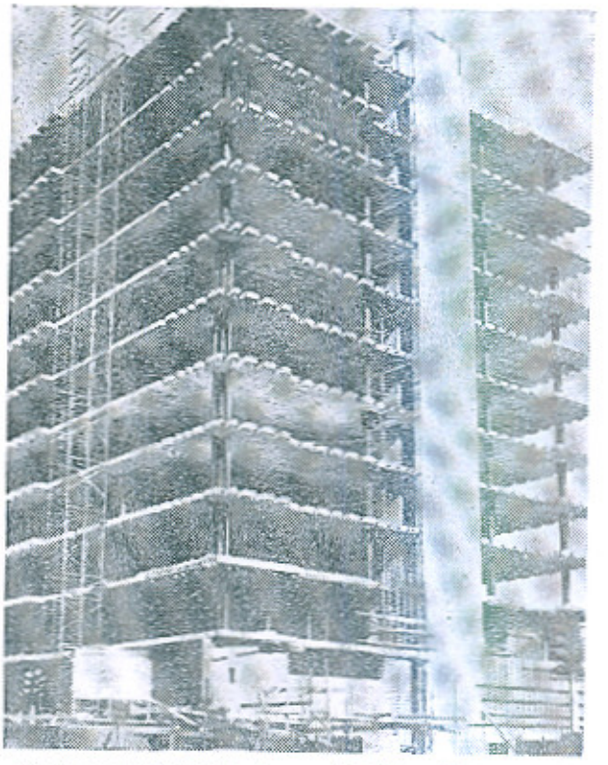
(*b*) pretensioned hollow box beams with an *in situ* topping;

(*c*) pretensioned beams of I or inverted T section with hollow clay tiles laid between them. An *in situ* topping is laid to form a composite T-beam system;

(*d*) grid systems such as the British Intergrid system consisting of precast sections made up into inter-secting beams post-tensioned on site.

Precast prestressed concrete roof trusses and bowstring girders are being used in place of their steel equivalents. With high buildings such as aircraft hangars and workshops; they have the advantage that accessibility for maintenance purposes is not required.

Even for buildings wholly constructed with *in situ* concrete, design and construction have undergone many changes in recent years. The *flat slab* floor, with its great flexibility in planning due to the elimination of floor beams, has developed further with *waffle slabs*. In *lift slab* construction the columns are erected initially and the floor slabs cast one on top of another on the ground. The slabs are separated by paper or plastic sheets. The slabs are then jacked into position and welded in place to the columns.



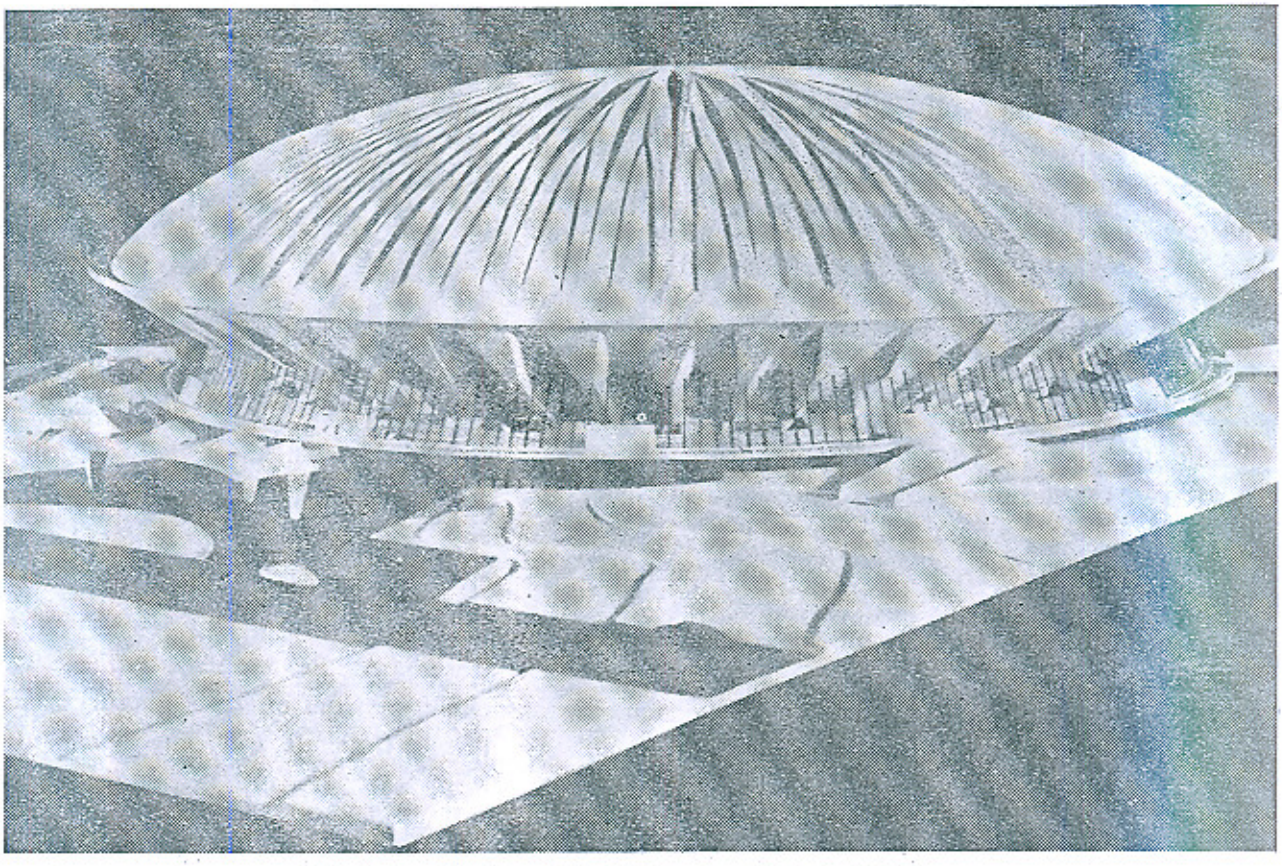
Prestressed Flat Slab floors of light weight concrete jacked into position in lift-slab construction in San Francisco (PCA)

For simple housing and one-storey industrial buildings *tilt-up* construction has become quite popular in the United States. The floor slab is cast first and then used as a base to cast the walls in a horizontal position. After the concrete has gained sufficient strength, the walls are then raised to a vertical position and either joined to an existing column or braced until an *in situ* column is cast.

Shell Roof

The most devious change of form in concrete building is of course due to the increased use of *shells* and *folded plates* for roof construction. Barrel vaults, domes,

hyperbolic, paraboloids and corrugations have become almost commonplace. An interesting structure in this category is the indoor stadium under construction at the University of Illinois which has the shape of two saucers put together. The diameter of the dome is 400 ft. and it has a corrugated



The Indoor Stadium at the University of Illinois (PCA)

form. The ring girder was post-tensioned to lift the dome off the formwork and some idea of the scale of the project was given by the fact that 600 miles of high tensile wire were used in the ring girder.

Light Weight Concrete

Lightweight concrete is playing an increasing part in building construction in the United States and Europe. The naturally occurring lightweight aggregates such as pumice and some manufactured aggregates such as vermiculite (expanded mica) lack the necessary strength to be employed in structural concrete and find a use primarily for insulation purposes. Foamed slag from blast furnaces is used mainly in lightweight concrete blocks. The most suitable lightweight aggregates for structural purposes are expanded shales, clays and slates. The raw material is crushed and passed through a kiln at about 2000 degrees Fahrenheit. With careful control a good grading can be obtained and a strong concrete can be made with a weight of less than 110 lb/cu. ft. Such aggregates are even used in prestressed concrete and result in a considerable saving in material and cost over long spans. These lightweight aggregates are preferred for

such work even in areas where natural aggregates are readily available. Thus there should be a ready market for expanded clay aggregates particularly in parts of East Pakistan where natural aggregates are expensive and difficult to find.

Concrete in Bridge Construction

A very high percentage of the major bridges constructed during the last fifteen years have been of concrete and a majority of these have been in prestressed concrete. The largest span in prestressed concrete is 500 feet on the bridge over the Medway at present under construction in England, although Morandi in his long bridge over Lake Macaraibo in Venezuela has achieved spans of 770 ft. by using suspension cables for intermediate support. The bridge over the Paramatta in Sydney, Australia, is a concrete arch of hollow box section with a span of 1000 ft. which will be completed shortly. Thus concrete has taken over even in the field of long span bridges as well as on the more familiar short spans.

In Europe and the United States, precasting yards are manufacturing ranges of standard section pretentioned beams for highway bridges of spans up to 80 ft. These simplify the task of the designer and the contractor and although the use of precast beams presupposes good transport and lifting facilities, it does eliminate much of the expense of formwork. Precast beams are made for bridges of higher spans but tend to be designed for a particular job.

Some of the concrete bridges of the last decade are outstanding examples of the art as well as the science of design. Prestressed concrete has made possible the achievement of strong bridges with graceful lines. Engineers have exercised considerable ingenuity in designing the best bridge for a particular set of circumstances and in many cases have succeeded in achieving an aesthetically pleasing result compatible with economy.

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Feasibility of Sewage Disposal in W. Pakistan

"Sewage Stabilization Lagoons"

by **MOHAMMAD NAWAZ TARIQ***
B.Sc. (Engg.), D.S.E.

Sewage Stabilization Lagoon is an economical method of waste disposal and is receiving increasingly widespread and popular interest in the United States of America. Vast literature on research and experiences in the design, construction, operation and maintenance of Sewage stabilization Lagoons has recently been published. The paper reviews this method of waste disposal with a view to determine its feasibility for conditions prevailing in West Pakistan.

Introduction

There are two primary objectives in any form of sewage treatment and disposal (1) to eliminate the menace of infectious organisms to human health by destroying them; and (2) to prevent the development of a nuisance by transforming putrescribe organic materials into stable compounds and microbial cells. In this note we are discussing an oxidation pond of engineering design sometimes called a lagoon which is constructed to receive raw sewage from a municipality for waste treatment.

The choice of methods of a sewage disposal and industrial waste water treatment is determined by an economic consideration within the framework of sanitary needs. It also depends upon local conditions, climate, resources, skill, materials and habits of people, as well as the utility of end products to the community. Besides, the machinery used should be such as could be simply and capably manufactured at home, without recourse to much foreign exchange investment.

Existing Conditions

In West Pakistan only three cities—Karachi, Lahore and Lyallpur have partial sewerage. It also exists in a dozen satellite towns, near the major cities and a number of Government and other housing estates. There are a couple of treatment plants in military installations. In a number of villages and town facilities exist for conveyance of waste water in the form of surface drains leading to pumping stations where

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it is utilized for irrigation. In rural areas such drains discharge into open tanks.

Population

West Pakistan covers a territory of 310,378 square miles with a population of 42.85 million, of which 8.00 millions live in urban cities and the remaining 34.85 million live in rural villages. The type, character and size of the village vary according to the land formations and fertility of the soil.

Topography

West Pakistan can be divided into three main physical divisions, the hilly areas, the Indus Basin with plenty of subsoil water, and the arid plains. The population of West Pakistan is mostly concentrated in the Indus Basin and the arid plains.

Climate

The data regarding climate of West Pakistan, as collected by the Meteorological Central Observatory, Lahore, for important places is given. It shows max. and min. temps., cloud-formation, sunshine hours, wind velocity, rainfall and evaporation rate; data regarding intensity of sunshine (langleys) is not available.

Soils

Most soils in West Pakistan are sandy and clayey. This property together with high temperature could be relied upon for the reduction of pathogenic organism, if during treatment of sewage antibiotic organisms in the form of algae are provided.

Feasibility of stabilization lagoon for West Pakistan

The stabilization lagoon is a real, practical revolutionary advancement in the art of sewage treatment and has become an effective answer to the costs of sewage treatment for a great percentage of municipalities all over U.S.A. Many health authorities in that country have accepted the premise that a stabilization lagoon is a proved method of waste disposal, which should receive the same consideration as other methods of treatment when engineering and economic analysis are being made. Practices and criteria regarding design, construction and operation have been formulated. It is certain that sewage stabilization lagoons in the warm and sunny climate of West Pakistan are a timely answer to sewage disposal problems in the regions where land is readily available or can be acquired at reasonable rates. This in no way limits its application to small communities. It has been demonstrated to have a very real place in meeting the needs of our expanding metropolitan areas.

Industrial Wastes

In West Pakistan industrial progress is taking place at a rapid pace. Some solution has to be found for waste of such industries as textiles, tanneries, metal and ferrous industries. Industrial waste treatment by lagooning merits consideration, and may be a method for disposal of the industries waste.

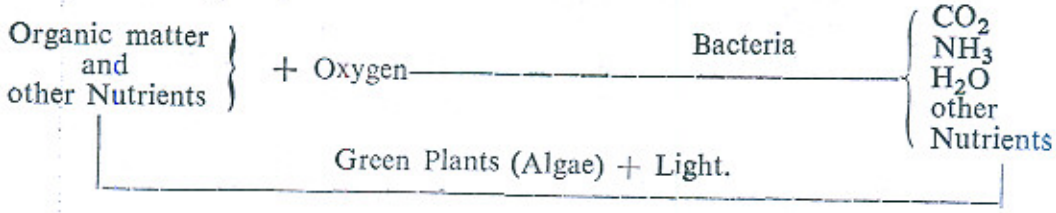
Principles of Operation

When sewage or waste waters containing organic matter are held in a pond under partially aerobic conditions, natural processes will reduce the biochemical oxygen demand and considerably lower the coliform bacterial content thus producing a relatively stabilized effluent free from odour and often supersaturated with oxygen. The basic process depends largely on the inter-action of bacteria and algae. Bacteria convert the decomposable organic matter to more stable

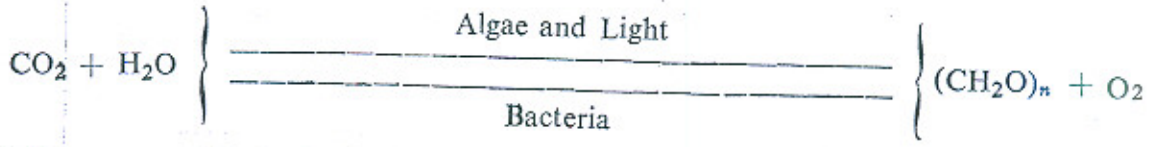
Meteorological Table

Serial No.	Station	No. of years of observations up to 1950	Co-ordinates Lat. N	Co-ordinates Long E	R. L.	Mean daily Temp. °F Max.	Mean daily Temp. °F Min.	Cloud tenths	Mean Yearly Total Rain inches	Mean Wind Vel. knots	Mean Yearly Total Sunshine Hours
1	2	3	4	5	6	7	8	9	10	11	12
1.	Lahore ..	50	31° 35′	74° 20′	702	89	61	2.2	19.21	1.5	3,065
2.	Rawalpindi ..	50	33 36	73 07	1674	84	58	2.4	36.37	1.7	
3.	Murree ..	50	33 55	73 23	7113	64	47	2.9	59.36	4.2	
4.	Gilgit ..	..	35 55	74 22	4890	72	52	3.8	5.18	0.8	
5.	Parachinar ..	40	35 55	70 04	5673	70	48	2.3	29.25	2.1	
6.	Skardu ..	44	35 18	75 37	7505	63	40	3.7	6.3	2.9	
7.	Jhelum ..	10	32 56	73 44	765	88	62	..	31.26	2.1	3,120
8.	Bannu ..	20	33 00	70 36	1264	87	62	1.7	11.11	..	
9.	D. I. Khan ..	60	31 49	70 55	570	90	63	1.7	9.09	1.3	
10.	Bahawalpur ..	15	29 24	71 47	384	92	64	1.6	5.65	2.7	
11.	Khushab ..	50	32 18	72 22	612	90	64	2.0	15.18	3.6	
12.	Leiah ..	5	30 58	70 56	490	88	70	1.1	..	..	
13.	Miranshah ..	9	32 59	70 07	3026	80	58	1.8	12.84	4.3	
14.	Lyallpur ..	25	31 26	73 06	605	89	63	2.5	12.06	1.9	
15.	Montgomery ..	50	30 39	73 08	558	91	64	1.5	10.04	3.1	
16.	Multan ..	60	30 12	70 31	413	90	65	1.5	12.50	1.5	
17.	Sialkot ..	60	32 30	74 32	830	87	62	2.0	31.83	1.4	
18.	Peshawar ..	50	34 01	71 35	1164	85	61	3.0	13.56	1.6	

products (stabilization) and in so doing liberate nutrient elements necessary for algal growth. The algae utilize these abundant nutrient materials and through photosynthesis produce the surplus oxygen required for aerobic bacterial oxidation. These basic reactions may be illustrated simply in the form:



Or when considering only carbon; hydrogen and oxygen, this may be represented by the reversible reaction:



$(CH_2O)_n$ represents both the dead organic matter in sewage which is oxidized, and the live organic cell material which is synthesized.

The allowable organic load on a pond is a function of the rate at which the various biological processes dispose of the load without nuisance and hence its magnitude is the sum of all such biological removal processes. The initial biological process, acting upon organic matter entering a pond, is usually biological oxidation, which is dependent upon the presence of suitable organisms, and sustained continuity of optimum pH (7-9), temperature 15°—20°C, sufficient time to develop a stable population, the presence of oxygen, 2-10 ppm. and the availability of organic matter. Of major concern is the availability of oxygen from the atmospheric reaeration and photosynthesis. Without special mixing of a pond by artificial means atmospheric reaeartion will introduce about 40 pounds of oxygen per acre per day. It has been shown that under satisfactory conditions of illumination, temperature and nutrition, photosynthesis may give rise to 200 pounds of oxygen per acre per day. Photosynthesis is thus the main driving force in the working of a sewage stabilization lagoon.

Design Considerations

Ponds are lagoons which rely upon photosynthesis by oxygen is dependent upon light and availability of plant nutrients. To maintain odourless conditions oxygen production should exceed demands of organic decomposition. Thus there is a ratio between light and sewage load that will assure oxygen in excess of demands. Observations and experimentations have shown that there should be at least $1\frac{1}{2}$ langleys of solar radiation (1 langley = 1 gram calorie per cm^2) per day for each pound of B.O.D. applied per acre of lagoon surface per day.

Another factor affecting lagoon performance is the area-depth relationship that

will promote full circulation. Thus prior to construction, a variable outlet structure permitting operation at selected depths is recommended.

Efficiency

Optimum sewage treatment is realized only when all liquid of the lagoon comes under the influence of photosynthesis, by complete wind driven circulation. If the area-depth relationship of a lagoon does not allow complete mixing, it soon stratifies and nutrients needed for photosynthesis become confined to layers below the level of effective light penetration. Stratification can be eliminated by heavy rain and high wind and return to complete circulation will release odours previously confined to deeper waters.

Properly designed lagoon of a single chamber usually reduces B.O.D. more than 80%, removes total nitrogen by 90%, alkalinity more than of 40%, phosphorus 70% and coliform-type bacteria more than 99%. Operation of two or more lagoons in series increase purification. A two cells effects the following percentage reductions—B.O.D. (with algae present) 90, total phosphorus 93, total nitrogen 97, alkalinity 45 and coliform-type bacteria 100.

Operational Problems

This type of treatment process, however, is not free from operational problems. These are those of odour due to excessive growth and decay of blue green algae, insect breeding (generally flies, mosquitoes and others) attributed to weed growth, and excessive percolation in pervious soils resulting in operational difficulties.

Research Work

The Public Health Engineering Department, West Pakistan, has proposed sewage stabilization lagoons for Lyallpur, Sargodha and other places. In this connection Mr. Abdur Raoof has developed mathematical relationship to calculate the size of a stabilization lagoon for a particular community under specific climatic conditions. It being planned to carry out studies on an experimental stabilization lagoon located in the Main Block of the Engineering University. Data will be collected on Raw Sewage load in pounds per acre per day, its Range of pH, Temperature, Evaporation, Light penetration, Percentage B.O.D. reduction at various loadings.

Coliform bacterial removal at various loadings, rate of algal growth, seepage, sludge deposit etc. will be studied together with prevention measures for breeding of flies, mosquitoes etc.

Economic Returns From Sewage Lagoons

Probabilities for realization of some returns of the energy contained in sewage lie in utilization of lagoon effluent waters and in harvest of marketable form of life that may be produced in a lagoon system. It appears that lagoon effluents can be utilized for irrigation. Algae have a high nitrogen content and can constitute feed for livestock. Experiments with fish rearing in secondary and tertiary chambers shows promise of financial return.

Acknowledgement

The author acknowledges the sincere advice and help received during the preparation of this paper from Messrs. Rafi Ahmad Sheikh, Abdur Raoof Sheikh, Syed Arshad Ali and Mohammad Akram.

Inches of Evaporation for 24 Hours for Lahore

Month/Year	1957	1958	1959	1960	1961	Remarks
January ..	0.04	0.05	0.05	0.05	0.04	The area of the tank used is 4 square ft.
February ..	0.07	0.04	0.03	0.07	0.07	
March ..	0.07	0.07	0.06	0.12	0.12	
April ..	0.08	0.11	0.11	0.16	0.18	
May ..	0.22	0.17	0.15	0.21	0.23	
June ..	0.18	0.23	0.21	0.23	0.28	
July ..	0.28	0.25	0.23	0.17	0.29	
August ..	0.26	0.21	0.18	0.17	0.20	
September ..	0.22	0.17	0.12	0.17	0.14	
October ..	0.12	0.11	0.13	0.05	0.14	
November ..	0.09	0.09	0.07	0.09	0.07	
December ..	0.06	0.06	0.05	0.06	0.06	

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West Pakistan Wapda Commissions Central Rechna Reclamation Project

Twenty-ninth of March, 1963 will ever be remembered as an auspicious day in the history of West Pakistan when the first waterlogging and salinity control project for the Central Rechna Doab was inaugurated by the President of Pakistan, Field-Marshal Mohammad Ayub Khan. The Chairman WAPDA, Ghulam Ishaq Khan presented his address of welcome giving the brief history of the Project, its objectives and the success achieved. We have reproduced here full text of Chairman's address in his own words.

It gives me great pleasure to welcome you on behalf of the West Pakistan Water and Power Development Authority to the formal commissioning of the Central Rechna Reclamation Project. This occasion has a special significance and several distinctive features which, with your permission, I would like to underline.

The first, Sir, is the honour you have done Wapda by agreeing to commission this major project hardly four weeks after you journeyed to Gudu to inaugurate another major Wapda project—the new barrage on the Indus. Including these two projects, Wapda in less than five years of its existence, has, apart from initiating work on a large number of water and power projects which currently are in various stages of development, actually completed 10 projects costing approximately Rs. 1000 million. While this has been made possible by the policy of your Government of allowing Wapda to function with a wide measure of autonomy, of providing it access to adequate funds, and of allowing it to tap the world for the various skills needed to supplement the numerically meagre technical talent available within the country for the speedy execution of the gigantic development programme on which the nation has embarked, it also demonstrates the wisdom of the decision to adopt the public corporation as a management device for the execution of large public sector projects. In presenting this report card to you, Sir, I feel a new surge of confidence in Wapda's ability to pass with honours the more severe tests that still lie ahead of it in bringing to successful completion the overall programme for the control of waterlogging and salinity, projects under the Indus Basin Settlement Plan, and the numerous other infra-structure projects required for the fuller development of the agricultural and industrial potenital of Pakistan.

Tubewell Operations

Another feature of this occasion will be our effort, Sir, to focus your attention on the

President Field-Marshal Ayub Khan, unveiling the commemoration plaque installed for the inauguration ceremony of Central Rechna Reclamation Project

statistical rather than the physical characteristics of the Central Rechna Project. This because the physiognomy of this project, is evidence here only in the shape of this small pump-house, cannot create the same dramatic impact as, for instance, the mile-long Gudu barrage astride the Indus. Perhaps, if we could array the nearly 1800 tubewells of this project at one place, our claim that the Central Rechna Project is the biggest of its kind in the world would be believed more readily.

The fact, however, is that these tubewells are located in an area of approximately 2,000 square miles. The total drilling involved in their construction comes to about 100 miles, the length of the power lines about 1,500 miles, the steel pipe used weighs 6,000 tons and the fine hard gravel used in shrouding the wells 80,000 tons. The aggregate pumpage capacity of these tubewells is about 54,00 cusecs which if worked round the year will fill a reservoir of almost the size of Mangla with nearly 4 million acre feet of water. These, Sir, are but some of the features of this project which took about four years to investigate and three and a half years to construct.

The results achieved during the first year of its operations have built up our hopes that the proper planning, implementation and, more particularly competent, dedicated and informed management of such projects, will, in not too long a time, transform the entire economic life of West Pakistan. We know, Sir, how deeply you are concerned with the

present conditions of low agricultural productivity and the progressive deterioration of the agricultural lands over the entire province and in the completion of this first major reclamation project, Wapda is proud to present and demonstrate what can and must be done to provide the basis for agricultural regeneration.

Sir, the history of this project starts in 1954. In that year, with United States technical assistance a large scale programme of investigations was started in three areas of the Punjab—the Rechna, Chaj and Thal Doabs. In 1958, when Wapda was created, these investigations were still under way but they had progressed to a point that the first major salinity control and reclamation project could be prepared. The project was submitted to the United States Development Loan Fund in February, 1959, and a loan of 15.2 million dollars obtained to help finance its construction.

The project as constructed covers an area of 1.2 million acres located in the central part of Rechna Doab. This area originally comprised some of the best canal colony lands but by 1958 about 15 per cent of the area had completely gone out of production and another 20 per cent was in varying degrees of deterioration because of salinization. The ground-water was within 3 to 6 feet from the land surface in most of the area, and the incidence of malaria was one of the highest in the country.

Project History

The planning and project preparation for an area of over a million acres was done in a record time of 4 months starting in September, 1958 and actual construction was taken in hand in March, 1959, the month following the signing of the loan agreement. In all, 1796 tubewells have been installed, covering the areas of Shahkot, Zafarwal, Sangla, Beranwala, Khanqah Dogran, Harse Sheikh, Shadman and Hafizabad in the districts of Gujranwala, Sheikhupura and Lyallpur. These tubewells vary in capacity from 2 cusecs to 5 cusecs and in depth from 225 feet to 300 feet. One thousand and seventy-four of them were constructed under contract by Harold T. Smith, Incorporated, an American construction firm specialising in tubewell construction, and the remaining 722 tubewells were constructed departmentally by WAPDA with hand boring tackle and drilling rigs supplied by Australia under the Colombo Plan. Harold T. Smith started their construction in January, 1960, and completed their total contract in July, 1961. At one time this firm achieved the progress of drilling 104 tubewells in one month.

The electrification of the tubewells was done by the Power Wing of WAPDA. It involved the construction of 80 miles of 66 KV lines, 1225 miles of 11 KV and 163 miles of 400 volt lines, besides the building of 9 sub-stations with an installed capacity of 67 MVA and 1415 distribution transformers with an aggregate capacity of 64,000 KVA. In the distribution network serving the tubewells we have made a provision for 30 per cent extra load carrying capacity to facilitate future rural electrification in this area. The tubewell part of the project has cost Rs. 95 million and the electrification an additional amount of Rs. 71 million. Combining both costs, tubewells and their electrification, the investment has been about Rs. 140 per acre.

On full development the annual increase in food production in Central Rechna is estimated at half a million tons. For the farmer the net increase in income per acre on full development is estimated to be Rs. 130 *per acre per*

year which almost equals the total capital outlay per acre.

In arriving at this net increase figure we have taken full account of the water charges that will have to be paid by the farmer and also the additional farm improvement costs that will have to be incurred by him.

President replying to the address presented by Chairman WAPDA

Rolls Royce and Mini Minor Cars

At this stage, Sir, I would like to refer to the misgivings that seem to exist in certain quarters regarding the cost of these tubewells. We are asked at times why our tubewells cost two to three times more than the ones usually installed by private owners. Comparing the two tubewells I will submit, Sir, it is like comparing the Rolls Royce and Mini Minor cars. The basic reason is that the two type of wells are altogether different in design features, efficiency, capacity and durability. Most private owners when quoting the figure of Rs. 12,000 or Rs. 15,000 per tubewell are obviously referring to shallow wells worked by centrifugal pumps with which they are familiar. An average centrifugal pump draws water from about 20 to 25 feet; most of the private wells have a capacity of between half to one cusec, have a very limited life and are heavy consumers of power. A turbine pump which alone, incidentally, even when manufactured within the country, cost as much as the alleged price of a private well ranges in capacity from 2 cusecs to 5 cusecs and draws water from depths of 30 to 70 feet while the tubewells are as deep as 225 to 300 feet. These pumping depths are well beyond the range of centrifugal pumps of the type usually installed by private owners. Under the circumstances, even if we ignore the markedly superior hydraulic efficiency of the reclamation tubewells compared to shallow private irrigation wells, their low operational costs and their longer life because of their specially designed features to minimise sand entry, clogging and encrustation, the fact that they are capable of delivering several times more water than the private wells alone will justify proportionately higher costs. The additional fact that these wells have been constructed on the basis of international bidding is a further guarantee that

they could not have been constructed more cheaply.

World's largest irrigation system

Land and water, Sir, constitute the two principal resources of West Pakistan. During the last 70 years these resources have been developed extensively and in the 33 million acres now under irrigation command we have the world's largest irrigation network from a single system of rivers. For sustained and productive agriculture, efficient management of the two resources, land and water, is vital. Our irrigation system was built on the concept of bringing the maximum area of land under irrigation with the minimum possible use of water. The two-fold requirement of water, for consumptive use of crops and for salt balance in the soil is, therefore, not being met generally. The water allowances as at present allowed are far too inadequate to meet this two-fold need of the crops and the soils. In result the lands are rapidly becoming salinised. And since the ground water levels are already very high more water cannot be applied to the lands to leach out the salts without effective land drainage. The project has been conceived to perform the dual purpose of removing the deficiencies of water and drainage in an area of 1.2 million acres. This large area will now have all the physical facilities available to it for a concerted effort to be made at intensive agricultural development though the simultaneous and concentrated application of the various factors which by interaction produce the optimum results in the shortest time.

Sir, the Provincial Government, in particular the Governor of West Pakistan who has the modernization of agriculture and improvement of the lot of the rural masses closest to his heart, and we in the Authority have been much concerned about the follow-up and management programme in the project area. Compared to the physical construction of the project its successful operation and management which calls for the coordination and unified direction of the efforts of more than one department of the Government is a more difficult task. And yet on the success of such operations depends the entire future of our programme for the control of salinity and waterlogging. The present project has evoked world-wide interest and is being looked upon as the proving ground for the techniques that are being for the first time tried on such a vast scale for the control of salinity and water-logging and as an end result for revolutionizing our agriculture. We owe it, therefore, no less to the world than to ourselves to ensure that organizational weakness do not jeopardize the success of the project. I am happy to say, Sir, that the institutional arrangements recently considered by the Government and approved in principle will, when fully implemented, ensure the speedy realization of the optimum potential of the project.

Results achieved

In the interim period of about a year and a half that WAPDA has been operating the project tubewells they have given very encouraging results. If you will recall, Sir, you last visited the project area about two years ago to see the actual construction of the tubewells. At that time the ground water was disturbingly close to your feet. Today, I am happy to report that—not counting this raised dais—the ground water is more than five feet lower than it was on that occasion! The general report is that not

only ground water levels are going down and the salts gradually leached from the soils but also that lands out of production are being brought back under the plough, the condition of the crops is healthier and the farmers are regaining confidence and hope. The area under crops in Central Rechna has increased by 50,000 acres in the past year and the food production is estimated already to have increased by about 200,000 maunds. This, Sir, is most encouraging and all those who have been responsible for conceiving, implementing and managing, as an interim measure, this gigantic reclamation project are justly proud of the achievement.

Services acknowledged

The completion of projects on which they have worked is in itself the best reward and an occasion for deep personal gratification. It is never possible to mention all of them by name but there are always individuals in various groups whose contributions at various stages are so outstanding as to be capable of personal recognition. My pleasant duty now is to record the appreciation of the West Pakistan Water and Power Development Authority for such services.

First, Sir, I would like to mention Mr. Sayyid Hamid, our Chief Engineer, in charge of the Ground Water and Reclamation Division. He has been associated with the project from the very beginning; first during 1954-58 when he was in charge of investigations and later under Wapda when he took charge of the overall planning, construction and operations. His expert knowledge of the problem, efficient leadership, patient attention to details and qualities as a co-ordinator were an important contribution to the successful completion of this project.

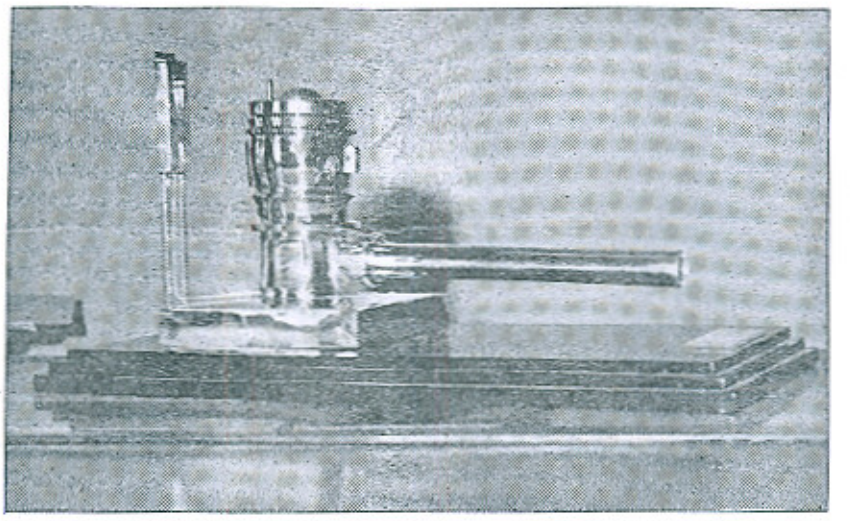
In the construction of the tubewells he was ably assisted by Chaudhry Mohammad Nazir, Superintending Engineer, who was constantly on the move in this rambling project and with his years-long experience provided guidance to his staff and the construction crews in the field. Equally important was the contribution of Mr. A. Wahid, Chief Engineer, Construction, of the Power Wing for the electrification of the tubewells; and of Mr. S. M. Said, Chief Engineer of the Water and Soils Investigation Division, whose organisation is responsible for the collection of the basic data and the surveys and investigations on which such projects are based and who has been acting as an engineering auditor and monitoring the performance of the Central Rechna tubewell since they came into operation. The equally meritorious services rendered by others in comparatively junior positions are being acknowledged separately. A category apart is that of the consultants who deserve our special thanks for their services—Messrs Tipton and Kalmbach Incorporated of Denver, U.S.A., for the engineering and supervision of the tubewell construction, and Messrs Miner and Miner of Greely, U.S.A., for similar services for the electrification of the project.

Chronologically speaking, some of the earlier credits belong to the U. S. Geological Survey team of advisers whose services were lent by the United States Government through what was then known as the I.C.A. technical assistance programme. Mr. George Laroque and Mr. David Greenman who headed the hydrology team and Mr. D. Burtelson who led the soils group set an example by their hard and methodical work which resulted in the setting up of the soils and water investigation organisation and in the training of our engineers and others in this field. For this our thanks are due not only to

Mr. Laroque, Mr. Greenman and Mr. Burtelson personally but also to the United States Government.

The United States Government has, in fact, taken a close and continuing interest in the problem of waterlogging and salinity in West Pakistan and, Sir, through your personal contacts with President Kennedy this interest is now directed from the White House itself. The panel of scientists and other experts appointed by the President of the United States to study the problem has spent over a year examining and analysing its various aspects. Its report is now in its final phases and Dr. Roger Revelle, Chairman of the White House, panel was here with us only a few days back on his third visit for final discussions on the panel's draft report.

Our thanks are due also to the Australian Government for help under the Colombo Plan for the Central Rechna project. They have supplied 600 transformers, 400 motors, control panels and other electrical equipment and also about 150,000 feet of tubewell pipes.



A Silver Replica of the Tubewells installed in Rechna Doab presented to the President of Pakistan

Finally, Sir, allow me to thank you not only for gracing this occasion and dedicating this project to the service of the nation but also for the pioneering interest that you have been taking in this serious problem of waterlogging and salinity. As a result of your persuasive salesmanship, international attention has been focussed on this problem. As a token of our gratitude and appreciation allow me, Sir, to present to you as a souvenir of this occasion, a small model of a WAPDA tubewell now in the service of the nation.

New Horizons for Engineers in Pakistan

by **A. R. KAZI**
President Engineering Section All-Pakistan Science Association, 20th March 1963

Mr. A. Rashid Kazi, addressed the Scientists and Engineers of All Pakistan who have assembled to attend the deliberations of the All Science Conference held on 19-23 March, 1963 at Lahore. Mr. Kazi advised the Engineers of Pakistan to explore and strive to attain the new horizons. He said: "All we have to do is to shake off the inertia, fight back the gravitational force of lethargy, and rise above the present inhibitions and lack of interest to perceive and pervade through whole new vistas of engineering skill. Each gain in science and technology increases the certainty of further advance. Let us not brood over the by-gone days or chant only the glories of our achievements in the past. The future of engineering is not to be gauged by the past but by the problems still unsolved and the possibilities yet to be conceived and explored. Let us, therefore, rise and seek New Horizons for Engineers in Pakistan."

Permit me, gentlemen, to thank you most sincerely for electing me to preside over the deliberations of Engineering Section of the Fifteenth Pakistan Science Conference. It is a very great honour indeed and I most humbly pray to God to enable me to justify the choice.

It is customary for the President to speak on a particular project with which he has been sufficiently acquainted. Today, however, I crave your indulgence to deviate from the routine and to describe the problems arising out of the developmental activities in the field of Engineering. They are a challenge that face the engineering profession; those in it have to play their full and effective role with pride in the progress and prosperity of our beloved country.

I do not intend to tax your patience in trying to enumerate problems or point out opportunities in every field of engineering, it is simply not possible. Nor I am going to talk of implications of the jet age or the nuclear age or the missile age ; frankly, I have no idea what the really new horizons are in these directions. All I propose to do is to raise a few pointers to stimulate the imagination with a hope to set that process of creative thinking which is the essence and the backbone of creative engineering. I especially seek attention of those young engineers, who have not long in the pro-

fession or who have yet to enter the profession, to look around and explore new areas for the fuller application of their latent creative capabilities in the service of the country.

Water and Land Potential

Development of water resources for irrigation and other purposes is an important function of the engineering profession all over the world. In a country like Pakistan which is mostly arid, and where the water resources are also meagre compared to its land resources, the country faces a difficult problem of feeding the rapidly increasing population, this field of engineering is of primary importance. The Pakistani Engineers have not failed to realise it. The ingenuity and resourcefulness of our forerunners and fellow engineers have given us one of the world's most elaborate and extensive systems of irrigation works. They have tamed the mighty rivers and have diverted their life giving waters into thousands of miles of big and small canals that today serve more than thirty-three million acres of land in West Pakistan. These irrigation works now utilize almost the entire perennial flow of our rivers so that any future development or improvement in existing irrigation facilities must await conservation of flood flows, that go waste into the sea. We have to develop the hitherto unexplored water resources not only for their most efficient use but most economical as well. It does not necessarily mean most cheaply, but in a manner that would yield the greatest benefit to the country as a whole.

Optimum use of limited resources is becoming more complex and will continue to do so. As demands grow and projects develop the undeveloped resources go on shrinking. Demands for Irrigation and power often run counter to one another. Flood control measures or works have to be suitably dovetailed. A multi-purpose approach therefore becomes obligatory. A river system and the subsurface potential in a hydrological unit from an organic body which yields maximum benefits only when developed ion a unified and co-ordinated basis. It demands fullest application of the engineering talent and complete understanding of the economic as well as social aspects involved. A stereotype or assembly line approach is no longer an engineering accomplishment.

This factor alone has ushered us in an era of intense and diverse activity in the field of water engineering which encompasses practically all the branches of the profession.

To utilize the surface and subsurface potentials we need to construct storages, and to construct leading canals or install tubewells. To work the tubewells we need power. It can be produced more cheaply from the water stored behind the dams. All these projects need the services of good foundation engineers, engineering geologists, soils and material experts, designers, hydraulics and hydropower engineers and a dozen other trades. These trades would again have many sub branches. For example design engineers alone would include those who specialize in earth or rockfill structures, concrete gravity dams, arch dams, prestressed structures etc. etc. Each of these trades and even some of the sub trades require a life long devotion to acquire a mastery. Very rapid advancement in almost every field of technology makes the mastery even more difficult. Engineers have to continuously strive to keep themselves abreast of the new advances in the field of pure science and

technology and not only apply but develop those in the solution of their own practical problems. An engineer—be he a civil, electrical or a mechanical—is the bridge between the pure science and its practical manifestation in the form of specific projects, and finished products.

Irrigation Practices

The foremost demand on our water resources is irrigation—new irrigation, improvement to it, or its further extension. The techniques of design of Irrigation works are still undergoing changes for soundness and economy. We need much more specialisation to maintain in working order, the canal system in the alluvium plain under changing regimes. It is not enough for an engineer that the canals are in a good state of maintenance ; his professional obligations must transgress these purely routine matters to encompass all kinds of studies for the optimum benefits from the precious water he has taken pains to bring to the fields.

Today our agriculture is plagued by the twin menace of waterlogging and salinity and our crop yields otherwise too are chronically low, being less than one-third of the world's averages. Considerable work has been done in diagnosing the malady of salinization but this has not yet touched even the fringe of the problem. Lot more is still to be done to know more about irrigated soils or those which are proposed for irrigation; we have to know more about their chemical and physical properties, internal and external drainage problems, leaching requirements and texture ; and we have to know more about crops and cropping patterns, their water requirements, rates of evaporation and transpiration, beneficial and non-beneficial consumptive uses and allied matters.

Lack of proper manuring and fertilization and the pesticides are other causes of low yields. We need to know more about artificial fertilization and its effect on yields as well as on water requirements.

On the economic side we need much more information and statistics on the cost of farming, and farm expenses, marketing values of farm produce and techniques of farm management. You may say that these are more in the province of agriculture than engineering and you will be correct ; but only partially. An irrigation engineer, who is to supply water for irrigation has to know all this and much more in order to discharge his obligations satisfactorily.

A planning engineer too needs this information to properly design the irrigation facilities and prepare a feasible irrigation project. Engineering economics plays a big role in scientific planning and the analysis for realistic returns. Not many have cared to specialize in this subject so far.

Water Budgets

I visualize that in not too distant a future the operation of Irrigation works would become quite a scientific problem. In fact each irrigation engineer would be more or less a research worker. In addition to surface flows there is an appreciable ground water storage in certain areas of the Indus plain, which can be operated in combination with flow supplies, not only for increasing the intensity of cultivation but also for reclamation and salinity problem. With pumping of this source in the waterlogged areas the water-table would be lowered sufficiently to permit leaching down of salts from the root zones. These dissolved salts would gradually increase the salt content of the

groundwater resource itself. In order to keep the salinity under control so that this water remains fit for irrigation it will be necessary to export certain percentage of the saline water out of the area, to mix it with fresh water wherever available. Engineers have to prepare a very careful water budget. This water budget should take into account all the water coming into the area by way of canal supplies, tubewell supplies and precipitation ; the water used by crops through evapotranspiration and non-consumptive uses ; evaporation from fallow lands or marshes ; deep percolation and other factors and then determine the water to be exported out of the area.

Those of us who have some experience with the rotational operation of five linked canals in the former Punjab realise how complex the operation of the irrigation system would become, when we bring into it the huge storages and the link canal system now under construction, or to be added later. If on top of these one superimposes the operation of numerous tubewells and various hydel and thermal stations, the drainage requirements of the area, the minimum needs for navigation, the mixing and dilution of saline water with fresh water supplies in correct proportions, the prevention of the intrusion of saline zones into sweet water zones, and the quantity of saline water to be exported out of the area, one gets some idea of the complexities that are to be faced by the person regu'ating the irrigation system.

The enormity of this problem becomes more apparent when it is visualized that these operations must affect the water as well as power supply over the whole of the Basin. Processing of the data covering all the aspects and factors, forecasting the demand for power as well as for water, the operation of the surface storages and the tubewells, cannot all be accomplished or determined by the conventional methods. The operation of such a comb'ned system would be something new in the history of Irrigation Engineering anywhere in the world. Only electronic computors could take into account all the available factors and the changing parameters to provide quick answers to the problems of regulation.

Operation of the system on the basis of computor studies provides an entirely new field for the Pakistani engineers. It is time we start getting acquainted with the factors involved and be able to feed the data into the computors for correct solutions.

Inland Navigation

Pakistan is a land of rivers and canals spread like arteries in the length and breadth of our vast country. A cheap means of transport which these canals and rivers could provide has remained unexploited. The land routes are already overtaxed. If western Europe can connect the English Channel with the Black Sea through a series of links, lakes and if Russia can connect the Baltic Sea with the Caspian or even approach the borders of Afghanistan for navigational uses, it is inexcusable for us not to have developed the waterways up till now. It is even worse that navigational facilities are not being provided in the new canals and links under construction. Inland navigation has a big future and calls for a special attention by the engineers.

Power Demand and Power Potential

We have already started utilising more and more electricity every day. Apart from the few diesel or thermal stations serving isolated urban cities, the hydropower until

recently developed only as a by-product of the Projects executed or under execution with a primary aim of sustaining irrigation. Time has arrived when projects have to be undertaken with a primary objective of generating power. There is immense potential of hydro-electric power in the Northern Region. Indus alone has about 30 million KWTs potential while Jhelum and its distributaries have another 10 million KWTs or thereabout. The load centres are located far in the south. Fortunately the largest natural gas field in the country is also available in the south which enables thermal units acting as base or peaking stations to be located at suitable sites along the grid extending from North of the country to the South. Economic transmission over such long lengths requires many careful considerations. Power surveyors have to collect a herd of data for the loads of the future. The use of 'Network Analyser' as well as research are essential to provide an economic and stable Grid.

The length of the Grids and transmission voltages are increasing rapidly throughout the world. A 550 KVA line is no longer considered impracticable. Even higher voltages and longer lines are now possible. The planning, designing, erection and maintenance of such an electric system demands a specialised technique. Pakistani engineers have to catch up with the time.

While we keep in view the complex problem arising out of the large stations and a complicated Grid our immediate requirements of isolated areas where such Grid cannot be extended economically are not to be lost sight of. The Electric Industry of the country should be able to develop and improve the high head pelton wheels or medium head turbines that can serve areas of promise for quick development in the isolated and remote valleys in the north.

Power Distribution an Engineering Problem

Next to the power development and transmission, the distribution system, that ultimately serves the consumer in the remotest corner of the country provides a wide field of study and practical application to the Pakistani engineer. They have to develop a system for the special socio-economic conditions prevailing in the country.

Wind and Solar Energies

There are yet more sources of power and energy inadequately tapped so far. The coastal areas of West Pakistan present a very good promise for the use of wind power. In these backward regions the windmill can be an ideal and economic means of service for the small jobs, both in the agricultural and industrial fields.

The solar energy is a good source for the whole country but in the absence of other sources the backward areas can derive the much needed small benefit from developments in this field. For places like Gwader and Pasni the solar energy could perhaps be utilised to produce potable water from the sea.

Arid Zones

Arid Zones of West Pakistan, particularly the Kalat and Mekran, call for a special research and pioneer work in the development of available potential. I have in view the scope for producing artificial rain. It can be a practical proposition. A new hydrology could convert the vast barren lands into green fields.

In these areas the outmoded and wasteful use of water potential through Kariza

system could be scientifically improved. A unit of water in these zones has many times more value than the same unit in the Indus Basin.

Lately we have been building in these arid zones, diversion weirs to utilize the surface flows. A much better use can be made of the water potential if it could be conserved by means of subsurface weirs or perhaps by other means. Not much study has gone into this up till now.

These seemingly long discourses of a few fields in the engineering profession are by no means exhaustive. I have not even described the need for intensive hydrological studies and the important research that alone provide the basic data of our potential for correct planning. These include not only surface and subsurface water studies but snow surveys too.

It is not possible to include in this short talk the new horizons in the fields of other very important subjects, Town Planning, Architecture, Highway Engineering, Public Health Engineering, Buildings, Structural Designs, Industrial Work and many more, which all have a tremendously vast scope for scientific approach and research. Not the least important for us here is the subject of Engineering Economics.

It would be unfair if I do not refer here to the importance of research and the scientific as well as economic design of works in all the fields of engineering whether referred to here or not. Unfortunately the young engineer is not generally attracted to these subjects. He is more keen to go out to the field without acquiring a mastery over anything. It is true the research worker, particularly in the engineering field has today limited privileges and of these too not in keeping with the devotion to duty and the dedication expected of him. I, however, visualize an early correction of this position and would suggest to the younger element with special aptitude to dedicate their service for progress in this country.

Other Horizons

There are many more fields in which the creative genius of Pakistani engineers have to make new inroads and open up new avenues. Even within the old avenues there are innumerable by-lanes and each by-lane has several problems of face lifting, remodelling and renovation. To count all these is well-nigh impossible. One can only say that never under-estimate the future of engineering progress. Each new discovery opens up tremendous vistas of future invention and application. The quickening tempo is logarithmic and the pace of progress is like an expanding series in mathematics which never approaches a limit but must continue to expand to infinity. Sky is not the limit any more.

Each new generation, building on the past, sees more progress in science and engineering. Each new invention of wide-spread adoption for travel, tele-communication or even pleasure and entertainment creates new problems and generates new jobs. As long as human ingenuity and engineering resourcefulness exist, one need never fear depletion of our present natural resources as a threat to our survival. The resources of God's universe and the resources of human mind are unlimited. All we need is the vision to see beyond the horizon.

Horizons are not boundaries. The horizon is merely the line of tangency circumscribing that which is immediately visible. When we stand on the seashore

our horizon is an area of three-mile radius. When we ascend on the top of a multistory building our horizon is enlarged and our field of view is increased manifold. There are always much vaster areas beyond the horizon. All we have to do is to shake off the inertia, fight back the gravitational force of lethargy, and rise above the present inhibitions and lack of interest to perceive and pervade through whole new vistas of engineering skill. Each gain in science and technology increases the certainty of further advance. Let us not brood over the by-gone days or chant only the glories of our achievements in the past. The future of engineering is not to be gauged by the past but by the problems still unsolved and the possibilities yet to be conceived and explored. Let us therefore rise and seek New Horizons for Engineers in Pakistan.

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PIROGOV, A. V.

French low head power development.

Vol. 213, No. 5539, March, 1962.

Development planes for the lower Mekong Catchment.

Vol. 213, No. 5540, 30 March, 1962.

Geothermal Power Development in New Zealand.

Vol. 213, No. 5540, 30 March, 1962.

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WATER POWER, GREAT BRITAIN.

DENOOR, 4, RAMBAUD, 4, TASCHER, C.

The Karobe IV Penstock.

Vol. 14, No. 2, February, 1962.

ZIENKIEWICZ, O. C., GERSTNER, R. W.

Design Procedures for prestressed dams.

Vol. 14, No. 3, March, 1962.

LAGINHA SERAFIM, L.

Shiroro gorge model tests.

Vol. 14, No. 3, March, 1962.

MATTIOLI, 4.

Tunnel Clearance Operation at Aswan.

Vol. 14, No. 4, April, 1962.

List of Papers

PRESENTED IN THE ENGINEERING SECTION OF ALL PAKISTAN SCIENCE CONFERENCE

19-23 MARCH, 1963

Engineering Section of the All Pakistan Science Conference has often lacked contributions. This session which was held on 20-23 March, 1963 was successful as never before. There were 22 contributions from various quarters dealing with various aspects of Engineering so much so that it became difficult to present all the papers within time. The attendance of the audience was unexpected. Those having the success of engineering profession in this country at heart must be grateful to the organizer, Mr. Monawar Ali, whose untiring efforts made this session very attractive and interesting. Throughout the three days of the conference, papers continued to attract large attendance of Engineers of home and foreign countries. In this issue we give below the heading of the papers presented and the name of the authors. The synopsis of paper are printed in the form of Abstracts by the Secretary Pakistan Science Association and we shall be reproducing some of these papers off and on in the Engineering News.

1. Statistical study of the Mechanical Properties of General Purpose Structural Steel under Pakistani Re-rolling Mill conditions.
   By Shafaat Ahmad Khan, Department of Mechanical Engineering, University of Peshawar.
2. Water Supply of Gwader.
   By Nazir Ahmad Jiabajee, Buildings & Roads Department, West Pakistan, Lahore.
3. Feasibility of Sewage/Waste Water Disposal by Oxidation Ponds.
   By Mohammad Nawaz Tariq, West Pakistan, University of Engineering and Technology, Lahore.
4. Importance of Demineralization of Water to West Pakistan.
   By S. M. Rafi Ahmad, Department of Public Health, West Pakistan, Lahore.
5. Tarbela Dam Project.
   By B. A. Malik, Tarbela Dam Project, WAPDA, Lahore.

6. A Study of inter-relations of slope-discharge and sediment concentration at Regime Sites.
   By A. K. Bhatti and Mohammad Altaf, Irrigation Research Institute, Lahore.

7. Floods in River Indus, their Frequency and Magnitudes.
   By A. K. Bhatti and Nazir Ahmad, Irrigation Research Institute, Lahore.

8. A Study of Soil Temperature.
   By Nazir Ahmad, Sarfraz Ahmad and Mohammad Akram, Irrigation Research Institute, Lahore.

9. Experiments on the Use of Cathodic Protection for Tube Well Strainers.
   By Nazir Ahmad and Mohd Asghar Qureshi, Irrigation Research Institute, Lahore.

10. Problems of Irrigation Agriculture in the Indus Basin.
    By M. A. Hafeez Khan, Agricultural Development Corporation, Lahore.

11. Utilization of Waters of Desert Streams.
    By M. H. Zaidi, Planning and Investigation Division, Wapda.

12. Basin Study Approach to the Planning of Water Resources Development with particular reference to the Kabul-Swat-Chitral Basin.
    By Ehsan-ul-Haq, Planning and Investigation Division, Wapda, Lahore.

13. The Estimate of Recorded and possible Floods for the design of the New Marala Barrage.
    By Barkat Ali, and M. A. Lateef, Remodelling Organization, Design Division, Lahore.

14. Ripple or Wave effect on Haigh's Depth Sounder.
    By Fazal Karim Khan, Planning and Investigation Division, Wapda, Lahore.

15. Story of Brick-Evaluation of New Size.
    By Ashfaq Hasan, Building Research Institute, Lahore.

16. Study of Roof Ventilation by Hydraulic Analogue.
    By Mian M. Hanif M. Sc., Building Research Institute, Lahore.

17. Flow Expansion in Transition Drop Structure.
    By A. Rahman, S.R.O., Irrigation Research Institute, Lahore.

18. A Study on Gap Graded Concrete.
    By G. F. Zafar, Irrigation Research Institute, Lahore.

19. Possibilities of creating artificial glaciers and ice dams for storage of water.
    By Mohi-ud-Din Khan, Irrigation and Power Department, West Pakistan, Lahore.

20. Compaction Study-Coastal embankment Area Khulna and Barisal in East Pakistan.
    By M. A. Rahman, Mohd. Serajuddin, Mohd. Abdul Hai.

21. Sediment Transportation in the Ganges and Teesta River.
    By M. A. Rahman, A. M. Zahural Islam, Irrigation Research Institute, Lahore.

22. Lining of Water Courses, Minors and Small Distributaries.
    By Abdul Hamid Chowdhry, Director-General Works, C.D.A

New Delhi Symposium on Timber and Allied Products (abstracts) 18-22 May, 1959

An International Symposium was sponsored by the National Building Organization, Ministry of Works, Housing and Supply, Government of India, New Delhi from 18-22nd May, 1959. It was attended by more than 100 delegates connected with the Timber resources, Industry, Utilization and Research. Foreign experts also participated. Fiftyfour papers were read out. The recommendations of the Symposium are put forth in the form of abstract which are being published for the information of the engineers of this country. These abstracts have been received through the courtesy of Mr. Ashfaq Hassan, Director Building Research, West Pakistan, Lahore.

National Policy for Forestry Development and Utilization.

In the light of present and likely future demand for timber and wood products, India's forest resources are strictly limited and everything possible must be done to augment these resources and to utilise them to the very maximum.

The policy decisions in connection with the forestry developments and utilisation should be on a national basis rather than on a State basis. Timber and timber products which were considered by the Planning Commission as one of the five basic raw materials, should be considered, primarily from a national rather than a local point of view.

Intensive afforestation.

Planned afforestation should be intensified. Further research on an intensive and extensive sale would help to augment the resources, *e.g.*, bamboo areas are reported to yield 5 tons per acre in Japan whereas in India it is less than a ton. Therefore, the possibility of intensifying the cultivation of bamboo in farm forestry, its use for structural and other purposes and cheap methods of treatment for its preservation should also be developed.

Improved extraction techniques.

The wastage involved up-to-date in the extraction and processing of timber has been significant.

Modern methods of extraction, techniques of felling transportation and conversion are yet to be introduced on a large scale. Improved tools and techniques must also be introduced. Portable small saw mills for conversion near felling sites should be considered. The use of mechanised or

semi-mechanised equipment such as ropeways slipways etc., for transportation and haulage must be considered for increased use under suitable conditions.

Proper stocking yards would help drying and to reduce wastage.

Better communications.

Unless communications between the forest interiors and the nearest road or rail are improved the resources cannot be utilised fully. Recovery by uneconomical methods of felling and transport also inhibit the marketting of secondary species.

Full utilisation.

There must be fullest possible use of existing resources, secondary species must be extracted, treated and utilised in a regular programme. There are several little known but useful species of timber available in our forests. Without these timber coming into the market, replacement of hitherto used better known species cannot be possible.

The supply position of naturally durable timber is acute not only in India but in other countries also. Therefore, it is necessary that use of secondary species of timber has to be resorted too. It was considered desirable to encourage the establishment of factories of laminated boards so that the use of solid timbers of scarce species is avoided as far as possible.

Timber Identification.

In the interest of wider utilisation of secondary species of timber, it is very necessary that there should be means for proper identification and recognition of different species of timber. Steps towards easy identification of species have been undertaken by the Forest Research Institute and identification cards bearing all the diagnostic characteristics of timber have been published. There is a great need for publishing the utility of these cards. It was suggested that the National Building Organization should accomplish this task in collaboration with the Forest Research Institute.

Use of secondary species.

It has been brought out that secondary species of timber should be gainfully employed to construct good superior structures by resorting to the use of laminated wood and sandwiched construction. There is no trend at present in the country towards such type of construction; therefore, it was recommended that the scope for it may be determined and knowledge of these constructions may be widely disseminated.

Engineering Classification.

It has been suggested that grouping of species should be done on the basis of combination of all the mechanical properties rather than working stress has also suggested.

The importance of avoiding over-size prebores was emphasized and it was agreed that bore holes should not be greater than 5/6 diameter of the nail.

The desirability of field tests for calculating the factors of safety has been mentioned.

Rational Use and designs.

There must be a more rational use of timber through seasoning, preservation, processing, better timber engineering and wood waste utilisation. Waste products must be turned into useful products such as boards of various types.

Improved structural designs, jointing methods etc., as advocated after trials by the Forest Research Institute should find more extensive application in India. Instead of

huge and long sections employed in the past, the newer techniques of using short length and small sections would result in saving of timber up to 50 percent in most structural elements. The Forest Research Institute has evolved a series of designs, and tests conducted on full scale structures have shown that they are sound and economic. These should be tried out.

Design Codes.

It has been suggested that the wind tunnel experiments on effects of wind on timber structures should be carried out expeditiously at Bangalore with a view to examining the possibility of revising the existing codes of practices for wind loads as may be found necessary.

The use of non-conventional (secondary species) structural timber should be encouraged. Use of short length (9′ and below) and small dimensions (3″ × 1″ to 6″ × 4″ timber) should be encouraged in order to effect economy in timber construction.

Fasteners.

Manufacturers in the country should be induced to produce more effective and better fasteners of all kinds such as nails, wood screws, sheet metal nails and other connectors. Their introduction and the use of improved nailing procedures will result in more economical utilisation of wood.

Nailed joint construction is the simplest way of building a wooden structure. As such, the investigations now being carried out into nailed joints, made with various species of timber, should be continued and the results of such investigations be made known.

Seasoning and Preservation Plant.

It has been emphasized that the seasoning industry needs encouragement at the State level. The responsibility for developing the timber industry should be taken over by Forest Organisation of the Central Government and a Central Timber Control Board was considered desirable. It has been viewed that timber-consuming departments would do well to set up seasoning and preservation plants. Considering that the life of timber will be enhanced appreciably by seasoning and preservation treatment, it was felt that the increase in the cost due to this process will not be waste but in the long run will effect economy in the overall cost of construction.

It was felt that high cost of seasoning and preservation plants and difficulty of foreign exchange came in the way of setting up such plant and, therefore, such equipment should be indigenously manufactured in the country.

It was mentioned that all Government construction agencies should insist on the use of secondary species of timber after proper seasoning and preservation and only such supplier should be encouraged, while procuring timber.

Standardization.

The importance of standardization in the field of extraction, conversion and utilisation of timber has been high-lighted. It is expressed that many conventional standards could be modified in the light of recent statistical quality control studies. It is stated that there existed different standards, which were followed by different departments. The desirability of standards also for shorter or longer pieces than those required by the Railways has also been suggested.

Termite Control.

The destruction of building components by termite attack is a serious problem in certain

parts of the country and no effective means are adopted up to date in the design of houses and the preparation of the ground for termite proofing. In the post-independence period of a very large volume of work was done on termite control with regard to agricultural crops but not sufficient work was done towards finding means of termite proofing of buildings. It was recommended, therefore, that the National Building Organization should constitute a Termite Committee composed of Construction Engineers, Architects, City Planners and Termiteologists who should immediately undertake the following tasks:

(*a*) To make and standardise termite proofing design for various types of buildings and structures.

(*b*) To suggest regulation, local or otherwise, to enforce such termite proofing standards.

(*c*) To assess means to encourage research on all aspects of termites such as description, biology, ecology, physiology and control methods particularly of those species which destroy buildings.

Timber Engineering.

Timber structures should be designed according to modern timber engineering techniques in order to achieve lighter structures and saving in timber.

Timber Control Board.

In order to cut down the cost, the timber industry should be properly organised at all stages. A Timber Control Board is required to be set up to impress on the State Governments to reduce the cost of timber by economic working of forests, increasing production and making available secondary species of timber.

International Conferences

FIFTH INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE, TOKYO (JAPAN)

The fifth Conference of International Commission was just held in May, 1963. As usual this meeting of the Commission was of great interest to scientists of the world who had collected in Tokyo to present papers on four important questions.

QUESTIONS 15: Economics and financing of Irrigation, Drainage and Flood Control Works.

Thirty-six papers from twenty-one countries were contributed on this subject. Mr. Floyd E. Doming, Commissioner, Bureau of Reclamation, U.S.A., was the General Reporter. He grouped the papers into four general subjects:

1. Economic evaluation by analysis of benefits and costs.
2. Selection of optimum plans by economic and other criteria.
3. Allocation of project cost among the purposes served.
4. Financing, repayment, and cost sharing.

Report No. 28 by Mohy-ud-din Khan, Deputy Secretary, Development and Report No. 31 by Kanwar Sain of India related directly to conditions in Pakistan.

The reporter stated that according to Mohy-ud-din Khan, "The economics and financing of ground-water pumping in West Pakistan, where tubewells may help to meet the challenges of a rapid rise in population, a serious water shortage, and the twin menace of salinity and waterlogging. It is proposed that existing rules, commercial in concept, should be relaxed in favour of a "no profit, no loss method" for recovery of costs without a profit. It is also proposed that water charges be kept within the payment capacity of the cultivators at a flat rate on the total cultivated area irrespective of the type of crops. Because of high capital and operating charges, some lift irrigation schemes, particularly in backward and tribal areas, will require government subsidies to cover costs beyond the payment capacity of the cultivators.

The benefit-cost comparison should consider social benefits and costs rather than financial transactions. This involves price subsidies, foreign exchange, unemployment, uncompensated damages, and other adjust-

ment. Analysis of economic and social impacts must consider the growing food shortage, a dependency load of 40 to 45 percent unproductive population supported by a largely unskilled labour force, the need for accelerating investment, and epidermic malaria.

Pakistan's per capita income is the lowest among 15 countries of South and Southeast Asia, which together contain one-fourth of the world's population in one-sixteenth of the world's land area. The urgency of social need is illustrated by Pakistan's goal of raising the level of living to ensure at least two square meals a day to all its population. In such a setting, a rapid, effective and substantial program to control salinity and waterlogging, unhampered by outmoded codal rules, is essential to avoid the fate of ancient Mesopotamia."

Report No. 31 by Kanwar Sain draws a sharp distinction between the financial aspect and the economic or strategic aspects of irrigation projects in India. Financial criteria fixed 80 years ago were designed to safeguard loan capital by requiring a minimum return, after deducting all working expenses, on the capital cost of construction plus arrears of simple interest by the tenth year of project operation. The minimum is now 4 percent but previously was 5 and 6 percent. The requirement is restrictive under present conditions.

From the national view-point, the objectives of water resource development include self-sufficiency in food on a long term basis and stimulating a cumulative growth by providing productive factors now in short supply: water, power, navigation, and prevention of flood losses. Such long-term investments are not attractive under the short-run remunerative criteria of private enterprise. A rational conceptual framework reflecting the social goals and complex interactions is needed.

The traditional yard-stick of Static efficiency in terms of marginal costs and marginal returns, does not evaluate economic growth. Demand for agricultural wealth is a better indicator than financial return. Increased food production has great national value because enormous sums in foreign exchange are spent on food imports.

Very useful suggestions and ideas were put forth in the rest of 34 reports which were mainly from Europeans, Americans and Japanese.

QUESTION 16: Efficiency of water distribution and use on the land.

On this question 29 reports were put forth from 13 different countries. There was one contribution for India and none from Pakistan.

The subject matter of the paper together with the author and his country is listed below:—

R-1. Surface irrigation research in Israel.
By E. Rawitz (Israel).

R-2. Economic analysis of input-output relations in irrigation.
By D. Yaron, H. Biolorie, U. Wachs and J. Putter (Israel).

R-3. Efficiency of water distribution and use on the land.
By H. Olivier (U. K.).

R-4. Analysis of border irrigation.
By D.A. Farrell (Australia).

R-5. Local rainfall variation and their effect on water needs.
By H. T. Ashton (Australia).

R-6. Hydraulic consideration of furrow irrigation in Japan.
By Dr. Kazushi Oshima (Japan).

R-7. Mean drop size and maximum drop size of sprays emitted by the sprinkler.
By Hiroo Inoue (Japan).

R-8. Suggestions for improving irrigation efficiency.
By Dr. Yoshikazu Fujioka (Japan).

R-9. Irrigation Efficiency.
By George D. Clyde (U.S.A.).

R-10. Effects of irrigation methods and system management on water application efficiency.
By Claude H. Pair (U.S.A.).

R-11. The hydraulics of small, rough irrigation channels.
By E. G. Kruse (U.S.A.).

R-12. The element of cost in relation to efficiency of irrigation.
By Olin Kalmbach (U.S.A.).

R-13. Improved irrigation efficiencies in a river basin.
By Leon W. Hill (U.S.A.).

R-14. The value of coefficient of the hydraulic permeability of assuit soils and the effect of some treatments on its magnitude.
By Hilmy El Gibaly (U.A.R.).

R-15. Investigations on irrigation water use in the United Arab Republic.
By M. A. El Madany (U.A.R.).

R-16. Formules rationelles pour le calcul hydraulique des longs sillons d'irrigation par Ing. 1.
By Valdimirescu (Rumania).

R-17. Contribution a la determination des elements techniques dc la method darrosage par sillonspar par L. Uncianschi, S. Renea et M. Botzan (Rumania).

R-18. Irrigation efficieny in Sorraia and Sado Valley Irrigation Schemes.
By Carlos Azambuja Martins and Antonia Lousada dos Santos (Portugal).

R-19. Organisation and demonstration of furrow method of irrigation.
By Z. F. Kathein (Israel).

R-20. Irrigation efficiency with surface irrigation in Hungary.
By J. Balogh (Hungary).

R-21. Comparison of irrigation efficiency indices on international level.
By M. Frank and I. Oroszlany (Hungary).

R-22. Possibilities of considerable reduction of total water requirements for flood irrigation by means of utilization of outflowing water within a system.
By Prof. Dr. Zygmunt Sochon (Poland).

R-23. L'efficacite du planning et l'efficacite des methods aux-niveaux du transport, dc la distribution et de I' application au terrain des eaux d'irrigation—par Ing. F. Consolo, E. Giuliani et Prof. E. Romano (Italy).

R-24. Use of meteorological factors for determination of time of irrigation.
By Ing. Dr. Miloslay Pycha (Czechoslovakia).

R-25. Optimum use of irrigation waters by the determination of water requirements of crops in Uttar Pradesh.
By A. P. Bhattacharya (India).

R-26. Surface irrigation.
By M. Ram (Israel).

R-27. Surface irrigation in the beisan area.
By Ch. Dan (Israel).

R-28. An investigation of the hydraulics of border flow irrigation with allowance to the change of infiltration in time.
By K. Bozoky—Szeszich (Hungary).

R-29. The efficiency of the water distribution system.
By J. Csoma and Z. Szigyarto (Hungary).

The general reporter Mr. Baleshwar Nath of Planning Commission, Government of India, has listed the papers under several sub-heads.

His concluding remarks were :— "The issues that emerge out of the reports under review and the points raised above do, in no way, provide a complete synthesis of the subject. The question of water distribution and use on the land involves a large number of variables. It is accordingly extremely complex. We have, therefore, to recognise the great variety of problems presented in the reports and their apparent unlikelihood that they will be the same in any two cases. We may, however, have a diagnosis appropriate to each, and prescribe remedies only in relation to the causes diagnosed. Nevertheless, there are some fundamental common threads, which when spun together in an international gathering like todays, may form a cord of concord and semblance, providing an anchorage to many a drifting idea applied to the growth and development of a balanced and healthy irrigated agriculture over vast areas of this our home-planet, and (who knows) not in the very distant future, even on the Mars.

QUESTION 17: Control of Watertable in Prevention of overdrainage.

Drained lands—

Here again 21 reports were submitted by 15 countries of the world.

These are listed below:—

R-1. Method of measuring watertable depth and pressure levels.
By T. Talsma N. S. W. (Australia).

R-2. The most economic and safe method of utlising underground water by pumping from the aquifer of fresh water floating on bodies of salt water.
By M. G. El-Din Zaghloul (U.A.R.).

R-3. Underground water in the Nile Dalta after construction of the high dam.
By M. G. El-Din Zaghoul (U.A.R.).

R-4. The natural and artificial cycles of ground water reservoirs with special reference to the Nile Delta reservoir.
By A. Shukry and H. Y. Hammad (U.A.R.).

R-5. Abnormalities in the characteristic graphs of pressure aquifer—Their study and practical applications.
By E. T. Salmeron (Spain).

R-6. The influence of soil colloids on the value of the contact angle and on the capillary rise of water in soils.
By M. Kutilek (Czechoslovakia).

R-7. Peat bog of Hokkaido and overdrainage.
By T. Nakamura (Japan).

R-8. Measurement and evaluation of watertable elevations.
By L. E. Myers and C. H. M. van Bavel (U.S.A.).

R-9. Water-table fluctuations resulting from irrigation development.
By H. T. Nelson (U.S.A.).

R-10. Water management of organic soils.
By J. H. Sutton (U.S.A.).

R-11. Reaction des nappes a une realimentation.
By F. Bazin (France).

R-12. Le controle du niveau des nappes phreatiques en terrain draine-par.
By F. Bazin (France).

R-13. Position of ground-watertable and potential of velocity.
By K. Zanker (Federal Republic of Germany).

R-14. Control of the watertable in grounds affected by ground-water-runoff.
By S. Trevijano (Spain).

R-15. Some aspects of peat soil overdrainage in Poland.
By H. Okruszko and J. Szuniewicz (Poland).

R-16. Ground-water-level depth during the vegetation period in a region with the supplementary irrigation need.
By J. Benetin (Czechoslovakia).

R-17. Drainage irrigation systems in the Ukranian Soviet Socialist Republic.
By M. Kuznets (U.S.S.R.).

R-18. Drainage with plastic pipes.
By A. W. de Jager (Neitherlands).

R-19. Experiences with plastic drainage in the Zuiderzee Polders.
By J. C. de Koning and J. H. van Kampen (Neitherlands).

R-20. The control of the watertable in drained soils.
By H. Press (Federal Republic of Germany).

R-21. Les effects nocifs de l'assechements excessif surtout dans les sols tourbeux-methodes pouvant prevenir ce tarissement-par.
By V. Montanari, G. F. Baldini et F. Felicori (Italy).

Takashi Ogawa of Japan summarised the content of their reports. He divided the subject matter into:

(*i*) Optimum vertical range and frequency of fluctuation in the watertable under different climatic and soil conditions and cropping practice, and method to control watertable in accordance with the above condition.

(*ii*) Harmful effects of overdrainage (particularly in peaty soils) and methods of preventing such overdrainage, and

(*iii*) Methods for measurement of the position of the methods for watertable.

The reporter also invited attention to questions 4 and 6 of the second general conference (1954) on "The behaviour of sob-soil watertable under a system of irrigation and drainage" and "Ground water its use for irrigation, safe yield from a unit area or basis artificial recharge of supply and planned utilization of underground reservoirs".

These present reports when studies with the background of their questions, could become of great interest.

QUESTION 18: Flood Prevention and control by surface and sub-surface retention or spreading.

On this question eleven papers from 7 different countries were reviewed by the

General report Dr. Mohammad A. Salim of U.A.R. National Committee.

Unesco/India Symposium on environmental Physiology and Psychology in Arid conditions.

A symposium on the environmental Physiology and Psychology was organized jointly by Unesco and the Central Drug Research Institute of India. This International Meeting was held from 7 to 13 December, 1962 in the historic Chattar Manzil Palace in Lucknow where forty seven scientists from thirteen countries assembled to present and discuss fifty four papers in ten working sessions.

The proceedings are being published as Unesco Arid Zone Research series. The nine sections of the symposium each having a chairman together with the number of papers were as under:—

Section I. Medical Climatology—Chairman: Dr. C. S. Leithead—3 papers.

Section II. Water and electrolytes-Chairman: Dr. W. V. Macfarlane—8 papers.

Section III. Nutrition and Heat—Chairman: Dr. F. Grande—4 Papers.

Section IV. Physiological Authropology-Chairman:Dr. C. H. Wyndham. —5 Papers.

Section V. Performance and confort standard.—Chairman: Prof. B. Metz. —8 Papers.

Section VI: Comparative Physiology-Chairman: Dr. K. Schmidt-Nielsen.—7 Papers.

Section VII. Significance of Solar radiation in the heat balance—Chairman: Dr. D. H. Lee.—5 Papers.

Section VIII. Neurophysiology of heat enposure—Chairman: Dr. J.—5 Papers.

Section IX. Psychological aspects of life in hot climates—Chairman: Prof. F. Sargent—4 Papers.

The reviews of Research on Environmental Physiology and Psychology in Arid conditions which served as background information for the symposium, are now in press and will be published shortly.

Scientific Conference on the Arid Regions of Latin America.

Unesco and Argentine authorities will hold a scientific conference from 16-24 September, 1963 at Buenos Aires.

It will discuss the problem of Arid Zones of Latin America although the conference will be opened to Scientists of the world who will be invited to attend it.

Further information can be had from Dr. A. Establier, Chief Unesco Science Cooperation Office for Latin America.

News and Notes

NEW UNESCO PUBLICATION

Unesco Arid Zone Research Centre has just issued volume XIX of their publication on Nomad and Nomadism of the Sahara. Price $3, pages 195, Language French.

* * *

EIGHTH INTERNATIONAL CONGRESS OF SOIL SCIENCE.

Steps are being taken to hold the Eighth International Congress of Soil Science in Bucarest, Rumania from 31 August to 9 September, 1964. It will be followed by a field excursions in Rumania and the U.S.S.R.

Enquiries should be addressed to Professor N. Cernescu, President of the International Society of Soil Science, Geological Institute Soseaua Kiseleff 55, Bucharest Rumania.

* * *

University of Roorkee, India Water Resources Development Training Centre.

United Nations Economic Commission for Asia and the Far East (ECAFE) and the Government of India have jointly set up a Water Resources Development Centre at Roorkee since November 25, 1955.

This training centre has been set up with a view to bring together engineering talent from the countries of Asia and Africa for first hand understanding and appreciation of each other's problems.

The course extends over 12 months, starting from 1st July, 1963 and ending June 30, 1964.

The prospectus for this session has been issued and can be had from the University of Roorkee.

* * *

Hungary's Symposium on Sodic Soils.

The Hungarian Academy of Sciences is organizing a Symposium on Sodic Soils in Collaboration with Unesco at Budapest from 9 to 16, August, 1964.

Enquiries may be addressed to Dr. I. Szaboles, Director of Research Institute of Soil Sciences and Agricultural Chemistry of the Hungarian Academy of Sciences. Herman-otto-ut, 15, Budapest, Hungary.

* * *

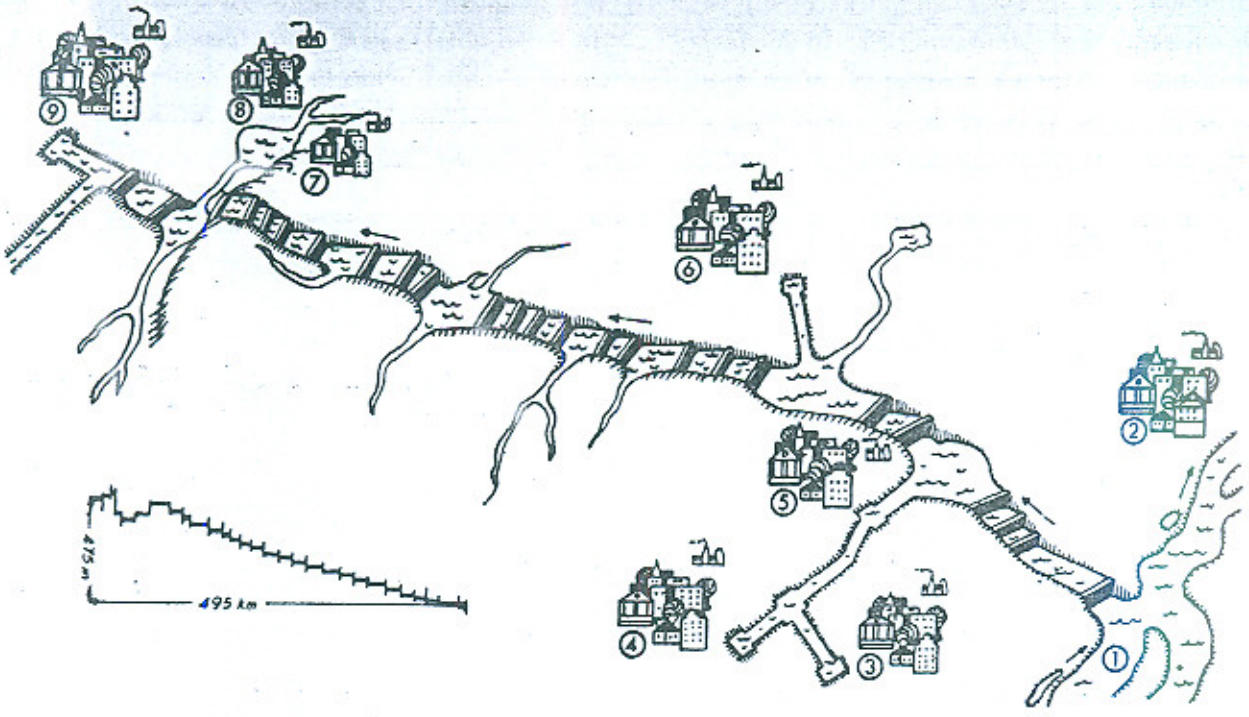
U.S.S.R.

LIFTS A RIVER, 15700 ft.

(*Extracted from Water and Water Engineering Vol.* 67 *No.* 805 *March*, 1963)

Central Kazakhstan is lavishly endowed by nature with its mineral wealth and fertile soil.

It has coal, where the seam in Ekibastuz is up to 500 ft. thick and total deposits are estimated at 12,000 million tons. Another deposits of 5000 million tons lie close to surface in Maikuben Region.



Its copper deposits cover 1500 tons, refineries exist at Jezkazgan and Balkash. It has lead, zinc, tungsten, manganese and iron ore. It produces chemicals, cement and has electric power, so that by 1965, it will be generating nine times as much power as all Russia did in 1913.

By dint of hard, dedicated work, its land which have lain idle for centuries have been converted into a major granary.

Some 250,000 people are working in the different industries and on construction projects in this vast industrial district. Another 168 industrial enterprises will be commissioned there under the current Seven-Year Plan (1958-65) alone. However, the Central Kazakhstan is very short of water, and most of the small rivers dry up in summer and freeze solid in winter. Ground waters are also insufficient. The local water resources, even if tapped in full in the next few years, would meet only a third of the requirements. Plenty of water will be needed. In 1965, for instance, Central Kazakhstan will require 940 million cubic metres (206,800 mg.) a year, and in 1985—2,660 million cubic metres (585,200 m.g.), which is double the water resources of the Moscow "Sea" for example.

The country needs water. It is to come from a mighty river, the Irtysh which flows along Kazakhstan's north eastern border, carrying water to the north, to the boundless expanses of Siberia, at the rate of 900 cubic metres per second (31,780 cusecs). Now it will have to give up a part of this water for the droughty Kazakh steppes. The Irtysh-Karaganda canal will provide water for an ever-growing population, satisfy all the needs of a swiftly expanding industry and water newly developed virgin lands.

Constriction of a canal linking the River Irtysh and Karagaada has begun. It will be a giant project the like of which has never yet been undertaken in the Soviet Union. A canal some 310 miles long, having an

overall variance in height of 15,700 feet will be constructed. The canal will be 16-23 feet deep, over 13 feet wide at the bottom and 132 feet wide at the water level. It will have a discharge of 2,650 cusecs and will carry 1.4 million acre feet of water a year.

The canal will not be navigable, as 25 pumping stations will break it up into isolated split level sections. Once it is completed, the water requirements of Central Kazakhstan will be satisfied in full. These pumping Stations will consume 312,000 K. W. of electric power which is equivalent to the output of the Kakhovka hydro-power station on the Dnieper.

For the sake of comparison, it may be noted that the Moscow canal is only 80 miles long, it has a water level differential of 135 feet and five pumping stations, while the figures for the Volga-Don canal are respectively 63 miles, 145 feet and three stations.

Through the Irtysh—Karaganda canal will considerably surpass both the Moscow and the Volga-Don canal with the Tsimlyansky hydro-engineering project and irrigation canals for overall length and height to which the water will be raised, it will require one and a half times less earthwork, and nine times less concreting. This is because the route chosen for it makes good use of the terrain and incorporates a 125-mile stretch of the River Shiderta.

* * *

WORLD SOIL MAP

Progress made in preparing soil maps of East and West Europe, the Near East, South America and Africa was commenced by the advisory panel to the project, holding its second meeting here this week.

The advisory panel to the joint FAO/UNESCO (Food and Agriculture Organization/United Nations Educational, Scientific and Cultural Organization) project stated in its report that the completed world soil map would provide basic documentation for the appraisal of world soil resources.

The panel composed of renowned soil scientists from many countries, including the Soviet Union—stated that the map would lay the foundation for transferring knowledge and experience in the fields of agriculture, forestry, animal production and others, between regions with similar enviroments.

It would thus, the report continued, be of great potential value in agricultural development and land-use planning and in the final analysis, in incresing food production for the rapidly growing world population.

The panel recommended that the various draft soil maps should be prepared for display at the 8th International Congress of Soil Science, to be held in Bucharest, Rumania, in 1964.

"Soil correlation work is essential for obtaining uniform soil classification and a comparable appraisal of land-use capabilities," stated Dr. Rainer Schickele, Director of FAO's Land and Water Developmet Division. "This classification could then be applied to soil surveys, which were essential for effective agricultural planning."

* * *

DEVELOPMENT OF NEW BRICKS AND THEIR INFLUENCE ON ECONOMY.

Mr. Ashfaq Hasan, Director Building Research Station presented a paper on the above subject at the 15th All Pakistan Science Conference, held in Lahore from 19-23 March, 1963. This paper has been printed and circulated by the author who stated that "The conventional bricks, $9'' \times 4\frac{1}{2}'' \times 3''$, have been found to be uncon-

omical for use in buildings. They consume more space, more mortar, more fuel in burning and give less output than the new bricks proposed of 8″×4″×4″. The new bricks have been found, in almost all aspects, superior to them in use besides these reduce the cost of construction by about 2% to 5%. In this paper several illustrations and photographs are added to explain the points of superiority.

* * *

TENTH INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH CONGRESS IN LONDON.

The 10th Congress of the I.A.H.R. is schduled to be held in London from September 1-15, 1963. The British Organizing Committee has received intimation of 150 papers to be presented at the meeting.

The Secretariate address in London is c/o the Institution of Civil Engineers, Great George Street, Westminster, London S.W. 1. England.

* * *

TECHNICAL JOURNAL

International Association for Hydraulic Research announces the publication of a Technical Journal on Hydraulic Research. The Secretariate request's for manuscripts both in English or French, from members and non-members.

* * *

SYMPOSIUM ON CAVITATION AND HYDRAULIC MACHINERY.

A symposium on Cavitation and Hydraulic Machinery was held in Japan in 3-5 September, 1962 under the sponsorship of the Committee on Hydraulic Machinery Equipment and Cavitation. Professor F. Numachi emeritus Director of the Institute of High speed Mechanics at Tohoku University in Sendai Organized this symposium, where 28 papers were presented and discussed. The proceedings of the symposium are printed and can be had for 2000 Yen ($5.50 U.S.) from I.A.H.R. Symposium on Cavitation and Hydraulic Machinery c/o Institute of High speed Mechanics, Tohoku University Sendai Japan.

* * *

CHILE HOLDS AN INTERNATIONAL HYDRAULICS AND FLUID MECHANICS SEMINAR.

Hydraulic Laboratory of the University of Chile organized an International Seminar on Hydraulics and Fluid Mechanics at Senitiago from August, 20-25, 1962. It was attended by Scientists of all countries of the Latin America. The U.S.A., was represented by Dr. A. T. Ippen.

* * *

WORLD POWER CONFERENCE, SIXTH PLENARY MEETING, MELBOURNE.

The World Power Conference held a meeting from 20-27 October, 1962, on "The Changing Pattern of Power". One thousand participants from 45 countries attended, in addition to 21 International Organizations whose interest allied to those of the World Power Conference.

The publication is available from the Australian National Committee, World Power Conference, 2nd Floor G. A. Building 1, Collins Place, MELBOURNE C. I. Victoria, Australia for 65 Australian Currency post-paid.

* * *

Recent Interesting Papers

JOURNAL OF FLUID MECHANICS GREAT BRITON

GRANT, H. L., STEWART, R. W., MOILLIET, A.
Turbulence spectra from a tidal channel.
Vol. 12, Part 2, February, 1962.

LONGUET-HIGGIN, M. S.
Resonant interactions between two trains of gravity.
Vol. 12, Part 3, March, 1962.

TOWNSEND, A. A.
The behaviour of turbulent boundary layer near Separation.
Vol. 12, Part 4, April, 1962.

LEES, L. RESHOTKO, E.
Stability of the compressible laminar boundary layer.
Vol. 12, Part 4, April, 1962.

BRETHERTON, F. P.
Slow viscous motion round a cylinder in a simple shear.
Vol. 12, Part 4, April, 1962.

GLAUERT, M. B.
The boundary layer on a magnetized plate.
Vol. 12, Part 4, April, 1962.

ABERNATHY, F. H., KROUNAUER, R. E.
The formation of vertex streets.
Vol. 13, Part 1, May, 1962.

GREENSPAN, H. P., BUTLER, D. S.
On the expansion of a gas into vacuum.
Vol. 13, Part 1, May, 1962.

MAGARVEY, R. H., OUTHOUSE, L. E.
Note on the break-up of a charged liquid jet.
Vol. 13, Part 1, May, 1962.

FAYERS, F. J.
Some theoretical results concerning the displacement of a viscous oil by a hot fluid in a porous Medicine.
Vol. 13, Part 1, May, 1962.

SAFFMAN, P. G.
On the Stability of Laminar flow of a dusty gas.
Vol. 13, Part 1, May, 1962.

OBOUKHOV, A. M.
Some Specific features of Atmospheric turbulence.
Vol. 13, Part 1, May, 1962.

MILES, J. W.
Transient Gravity waves response to an Oscillating Pressure.
Vol. 13, Part 1, May, 1962.

THE INSTITUTION OF CIVIL ENGINEERS, GREAT BRITAIN

ISCHY, E., GLOSSOP, R.
An introduction to alluvial grouting.
Vol. 21, Session 1961-62, March, 1961.

SETHNA, T. R.
Uniform flow of water in alluvial channels.
Vol. 21, Session 161-62, Paper No. 6524, January, 1962.

ANDREWS, F. M.
Some aspects of the hydrology of the Thames basin.
Vol. 21, Session 1961-62, Paper No. 6568, January, 1962.

KENNARD, J., KENNARD, M. F.
Selset Reservoir:-Design and Construction. Vol. 21, Session 1961-62, February, 1962.

BISHOD, A. W., VAUGHAN, P. R.
Selset Reservoir:-Design and Performance of the Embankment.
Vol. 21, Session 1961-62, February, 1962.

PACKSHAW, S.
Selset Reservoir:-Cofferdams.
Vol. 21, Session 1961-62, February, 1962.

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WATER AND WATER ENGINEERING GREAT BRITAIN

RENAUD, A.
Warragamba Dam Augments Sydney's Water Supply.
Vol. 66, No. 792, February, 1962.

BENEDICKT, W.
Destratification of impounded water, result achieved by use of aero-hydraulic guns.
Vol. 66, No. 793, March, 1962.

ABADIJAN, K. A.
Tittes Worth Reservoir Scheme of the Staffordshire Potteries Water Board.
Vol. 66, No. 793, March 1962.

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NUCLEAR ENGINEERING, GREAT BRITAIN

ROGERS, P. R.
Pressure seals for reactor mechanical drives, Development and application for Hunterston and Tokai Mura Stations.
Vol. 7, No. 70 March, 1962.

LEVEQUE, P.
Rast reactors: A Soviet outlook.
Vol. 7, No. 71, April 1962.

ALLEMANN, M., BENZ, H.
Design of EDF-1 Blower.
Vol. 7 No. 72, May, 1962.

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THE ENGINEER, GREAT BRITAIN

NASSIF, M. H.
Transient flow of gas in a pipe of variable area.
Vol. 212, No. 5514, 29 September, 1961.

ENGEL, F. V. A., STAINBY, W.
On the meaning of unified equations related to weirs for measurements of open channel flow.
Vol. 212, No. 5514, 29 September, 1961.

BOURGIN, A.
Development of the river Rhone.
Vol. 213, No. 5532, 2 Febuary, 1962.

BOURGIN, A.
Aschach Power Station.
Vol. 213, No. 5534, 16 February, 1962.

(*Continued on page* 36)

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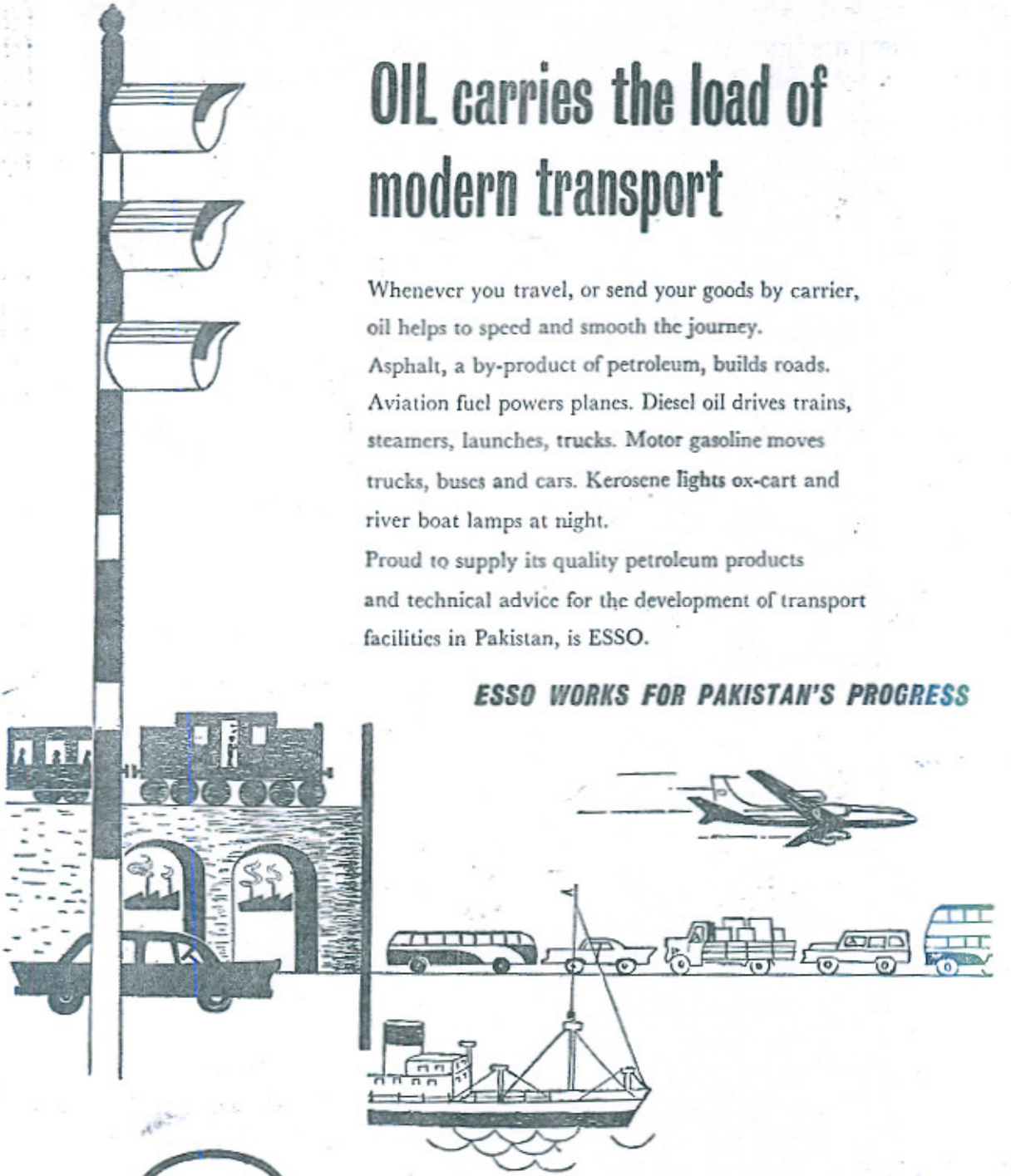

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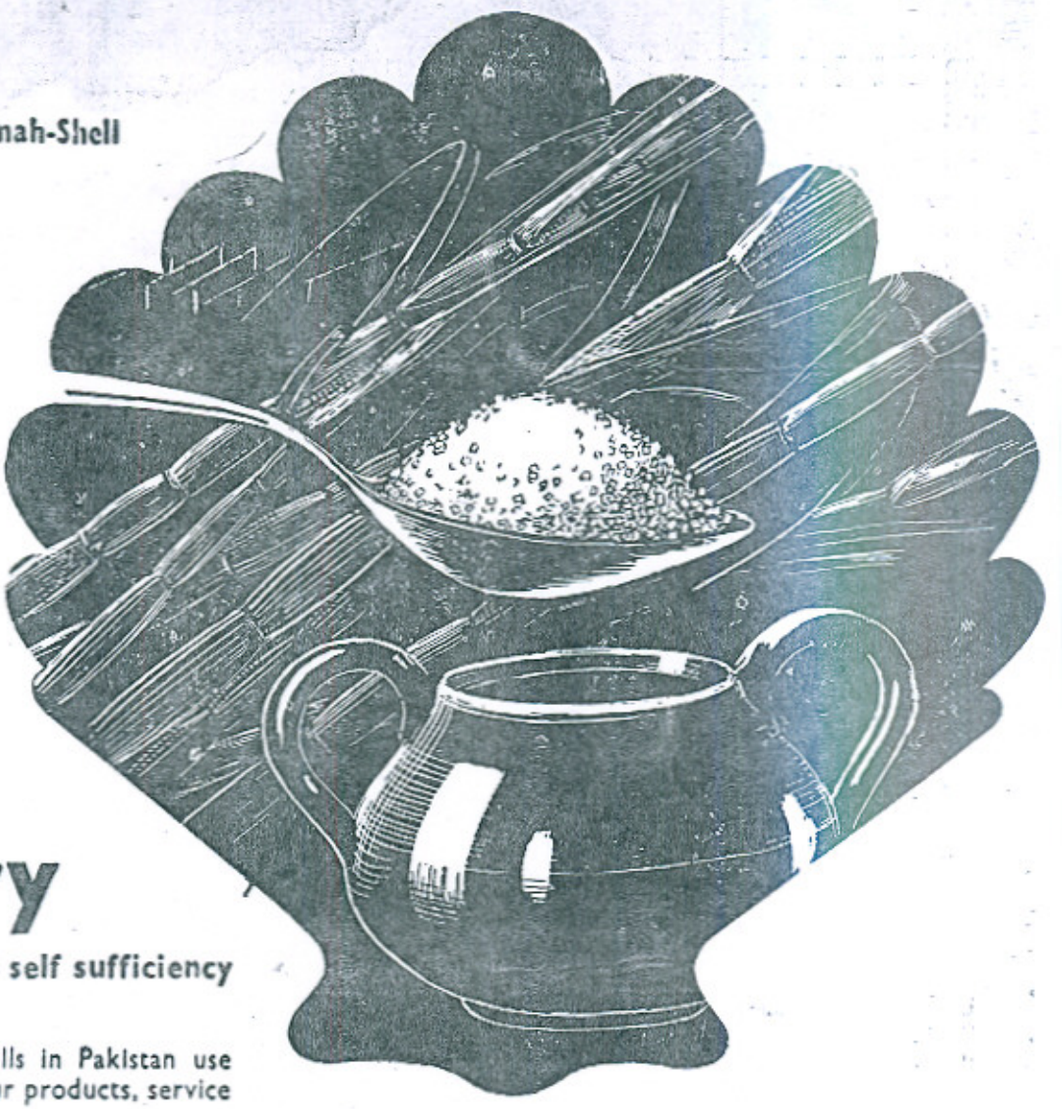

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