of new ones. Location of new inland harbour-*cum*-industrial centres have also been indicated.. It is, however, essential to have proper co-ordination between all modes of transport as well as WAPDA in order to accelerate the development of Inland Water Transport.

Model Studies in the Design of Stilling Basin of Pipe Regulators and Drainage Sluices

By M. A. Rahman

The purpose of this paper is to outline the model studies undertaken to determine the effectiveness of stilling basins design to prevent the erosion from high velocity jets and turbulance below pipe regulators and drainage sluices. The design of stilling basins for these regulators offer unusual problems when located in tidal areas where the tail water elevation is continuously changing due to reversal of tidal direction every six hours. It is not always possible to create a hydraulic jump within stilling basin and consequently the entering jet sweeps beyond the basin endsill with considerable energy for some distance down-stream. The variation of tidal elevation from low tide to high tide varies from 9 feet to 15 feet and the variation is both diurnal and seasonal. The discharge of these structures vary greatly with reversal of tide direction every six hours. It is thus obvious that careful consideration to all these factors in the design of stilling basins of these hydraulic structures must be taken into account. It was realised that model investigations provide a convenient means for the same. The model also showed the divergence of wing walls of these structures, produce considerable back flows and pronounced deep scour along the interface between slow moving water near the bank and fast moving flow in the centre.

Investigations revealed that in spite of protective measures of river bed consisting of fine soil, undertaken by lying rubble beds of graded materials, scouring did take place. It can be seen from the typical flow and scour patterns that horizontal stilling basin with shallow sloping end sill is better than sloping type of stilling basin. Model studies also point out the inherent defects and drawbacks in design of stilling basin with block or riprap type of flexible paving.

Structural Behaviour of Prestressed Concrete Beams Made of Brick Aggregate

By Dr. Wahiduddin Ahmad

The paper describes a study of the behaviour of prestressed concrete beams made of brick aggregates. For comparison the results of tests on prestressed concrete beams of the same section but of shingle aggregates are also put forth.

The investigation shows that there is very little difference between the prestressed concrete beams of brick aggregate and shingle aggregate so far as ultimate moment of resistance moments at which first cracks appears and ultimate shear are concerned although the beams with brick aggregate show lower stiffness than those of the shingle aggregate.

The brick aggregate concrete (if the mix is properly designed) can attain high compressive as well as bond strength (a prerequisite for prestressed concrete works).

The flexual capacity of beam made with these aggregates can be safely predicted with the existing theories.

The following conclusions were arrived at :

1. Concrete, made of artificial light-

weight aggregates (broken bricks), may be safely used in prestressed concrete structures.

2. For the same strength of concrete, a beam made with light-weight aggregates has the same ultimate strength as a beam made with conventional type of aggregates.

3. The modulus of rupture of concrete made with light-weight aggregates is the same as that for concrete made with conventional type of aggregates, provided the ultimate compressive strengths of the two are equal.

4. For concretes of the same crushing strength, the Young's Modulus of Elasticity of concrete made with light-weight aggregates is less than that of concrete made with conventional type of aggregates. As a result, for the same load, the deflection of a beam made with the former type of concrete will be more than that made with the latter type.

5. The strain is hereby proportional to strain at all stages of loading.

6. For under-reinforced beams prestressing does not increase the ultimate strength and the ultimate moment of resistance may be safely predicted without taking into account the effect of prestressing. For over-reinforced beams, prestressing may increase the ultimate strength.

Rainfall-Run-off Relationship for the Interior Drainage Basins in East Pakistan

By M. A. Hamid

To design the interior Drainage System of different Basins of East Pakistan it is essential to know the rainfall-run-off relationship of the proposed drainage work. To find out the exact solution of the problem, an estimate of probable peak flows is necessary. Where adequate stream flow records are available the solution of the problem may be found by the use of Regional Frequency analysis. If stream flow data are insufficient, it is better to synthesize the design flood hydrographs by other means.

Hydrograph defined in the simplest way is a graph of stage or discharge against time. The earliest method for estimating the peak-flows was the use of following empirical formulae involving various physical characteristics of the basins.

(*i*) RYVE's formula, $Q=C.M.^{2/3}$ cusecs, where Q is the maximum flood discharge, C is a constant depending upon the nature of the catchment and the intensity of the recorded Rainfall.

(*ii*) Dicken's formula, $Q=C.M.^{3/4}$ cusecs, where Q is the maximum flood discharge, C is the constant varies from 800 to 1600 according to the Area of the Catchment.

(*iii*) W. E. Fuller's Formula, $Q=C.A.^{0\cdot3}(1+0.8\log T)(1+2A-.3)$ cusecs, where Q is the maximum discharge, C is the constant varies from 1.3 to 142 (Average value 11—84).

T is the No. of years after which such a high flood discharge is likely to occur etc.

In 1932 Mr. L. K. Sherman introduced the unit hydrograph as the first basic tool for the design of Hydrologic Analysis. Designs of Hydrology of interior drainage basins are enumerated in the paper.

Rawal Dam—Its Storage Capacity and Life

By Ch. Mohammad Tahir

Rawal Dam has a designed Storage Capacity of 47,500 A. ft. at R. L. 1,752 covering a surface area of 3.2 sq. miles.

The apprehended life of the reservoir at the time of construction was 88 years at R.L. 1,710, the crest level of the offtakes.

The storage of the reservoir was started in the year 1960. The studies on the sedimentation of the dam were conducted in the year 1966, when hydrological survey of the lake was conducted with the help of Echo-sounding. This survey when compared with the contour map of the reservoir before creation helped in the evluation of the silting rate and to determine the useful life of the reservoir at different elevations. The observed silting rate is considerably greater than that contemplated. With the average rate of sedimentation during last six years of its operation the useful life of the reservoir comes to 40 years. This rate of sedimentation is, however, expected to show a fall on account of decrease in storage capacity. It is as well deemed that quite a big quantity of flood water laden with heavy silt charge at present being absorbed in the lake will be spilled over the dam with time.

Diversion of the River Jhelum at Mangla

By Mehtab Khan

The timely and safe diversion of the river Jhelum on the 16th of September, 1965, would go in the history of the project as a great event achieved under abnormal and emergent circumstances in the country.

In this paper the author has detailed all the precaution and requirements for safe diversion of the river.

Variation of Fundamental Properties of Synthetic Aggregates with Firing Temperature

By Subodh K. Das, W. B. Ledbetter

Synthetic aggregates, produced by firing clays, shales, and slates are being used extensively. In this study, selected properties of these aggregates and their variations with firing temperature were determined. Two shales were fired in furnace at various temperature between 1200 and 2400°F, and the synthetic aggregates produced were evaluated by determining bulk specific gravity, water absorption, resistance abrasion compressive strength, and modulus of elasticity. A primary finding of this study was that these properties, when compared with firing temperature, gave a sound basis for evaluating the structural quality of synthetic aggregates.

Systems Analogy of Man, Animal and Machine

By Dr. Nurulla

In this article the concept of system has been described and the analogy between man, animal, and machine based upon such notion of system has been discussed. It has been shown to some extent that machines, which are form of matter and which are agencies of performing some definite functions, are capable of imitating functions of man including self-organisation and self-reproduction.

However, it will be wrong to assume that, system wise, machine has come anywhere near man, or it will eventually replace, man. The former is not true because man itself may be regarded as the most astonishing, perfect and versatile machine ever conceivable in such a compact form. It is said that replacement of human brain only with all its complex functions with the help of computer will require a space, even at this age of miniaturization, as large as Empire State Building.

The fact that machine will eventually replace man is not true, not only because the

former is conceived and made by the latter but also because of capability of man in doing so many different tasks with such less maintenance or breakdown puts him above machine in its own game. The present trend of combined man-machine systems in industry, combined man-machine optimization of space-vehicle control, etc., are attributed to this fact.

It is possible that man's superiority over machine will remain simply because its system level overlaps with system level of that higher one, the Transcendentals and Intangibles.

Studies on Preconsolidation Characteristics of some Foundation Clays Occurring in East Pakistan

By M. Serajuddin

To the author of this paper the methods of Casagrande and of Schmertmann appear to be equally applicable to East Pakistan soils for estimating true preconsolidation as regards practical purposes. Where it is easy to find the point of maximum curvature. Casagrande method appear to be less time consuming and only in the cases, where it may be difficult to locate the point of maximum curvature, Schmertmann's method appears to be more satisfactory. Strachan also opined that he obtained results by Schmertmann's method in some cases where none could be derived by the Casagrande's method.

It has been shown from the studies on East Pakistan clays that settlement is rapid once the preconsolidation is reached during the process of loading and if it becomes possible to determine the preconsolidation load with some degree of accuracy, it becomes a great advantage in foundation design as the settlements are not likely to be detrimental to foundation pressures less than the preconsolidation load. If an area is found to be generally consolidated, it is a great help in future planning of structures in the area. The informations regarding geology and physiography of the site, whether the original ground surface was located at or above the level of the present high ground and that the water-table was fairly close to the original ground surface, are, of course, helpful if available. Where such informations are not available, laboratory method of estimating the preconsolidation is the only solution.

Problems of Water-Hammer in Waterworks Practice

By M. A. Aziz

Water hammer is a pulsation of pressures above and below the operating pressure, resulting from rapid declaration or acceleration of the velocity of flow of water in a closed pipe when a moving body of water as in a water pipe that is discharging, is suddenly reduced in velocity or stopped, as by the rapid closing valve, there is considerable but brief increase in internal pressure due to momentum of the moving water, with a resulting pulsation. Very often there is a distinct noise, as of a hammer stroke on the pipe, hence the term "water hammer". The pipe line is sometimes unable to withstand the internal pressure due to water hammer, as a result, it fails.

It is shown in the paper that water hammer is really a complicated problem in waterworks practice. It is seldom that any two cause of water hammer are exactly similar. Each cause must be studied very carefully and one or more devices or methods available for its suppression must be used alone or in combination with others.

Role of Synthetic Hydrology in Water Resources Planning

By S. M. Ataur Rahman and Prof. E. F. Schulz

Thomas-Fiering model has been found to be a useful tool for generating synthetic hydrology in water resources planning. Calculation of four statistical parameters required in the model and the generation of the synthetic hydrology itself are no doubt a cumbersome affair but the difficulties can be overcome if the run-offs are generated on an electronic computer. Fortunately enough, the computers are now available in Pakistan and they can be employed for this purpose. A programme can be developed to generate a synthetic hydrology on a computer which has been given a subroutine, which will produce values of "t_i".

Turbine Inspection of EPIDC Fenchuganj Power Station

By S. A. Zaidi

First inspection of Fenchuganj Power Station Turbines was done after five years of operation. The procedure is described step by step in details giving actual data and other relevant statistics. The work was done according to a schedule of over-hauling prepared beforehand.

Consulting Engineering Services in Pakistan

By Aolad Hosain

The country now has quite a good number of Consulting Engineering Firms but no association of their own has been established so far. It is accordingly considered desirable that an Association of Consulting Engineers should be established in the country without delay. The Association, thus formed, should lay down its code of ethics, rules and regulations. Thus will not only make the consulting engineering job more respectable but also will safeguard the interests of its members and establish close relationship and mutual understanding among them.

In the following few pages functions of the Consulting Engineers, different types of contracts for consulting services, procedure for selection of firms and fixation of their remuneration have been discussed.

A Review of Recent Developments in Triaxial Compression Testing of Soils

By Mir Sadaqat Hassan

There has been considerable development in the triaxial test apparatus in the last decade. It is very necessary for all Soil Mechanics Laboratories to have an uptodate knowledge of the existing triaxial test apparatus.

A review of the development has been made covering relatively more modern equipment produced during the last decade.

For a thorough study of the subject the following publications are recommended :

1. "Les Measures de Cisaillement dans less Laboratories Francis." A Mayer, Geotechnique, Vol. pp. 236.

2. "Investigation of Stress-deformation and Strength Characteristics of Compacted Clays" A. Casagrande, and R. C. Hirchfield, Harvard University, Soil Mechanics Series No. 61. May 1960 and No. 65 April, 1962. (Geodex No. 1963-12).

3. "Tester Buries Soil 500 feet Deep"—Engineering News Record, July 18, 1963. (Geodex No. 1963-8).

4. "Shear Strength of various Soils"—The dependence of dilation of sand on rate of shear strain, K. A. Healy, Massachusetts Institute of Technology, Research

Report R63-19, Feb. 1963. (Geodex 1963-12).

5. "An Apparatus for Triaxial Compression tests at High Pressures "H. Q. Golder and T. N. W. Akroyd, Geotechnique Vol. IV, No. 4, December, 1954.

6. "The Cell Test" E. E. De. Beer, Geotechnique, Vol. II P. 162.

7. The Measurement of Soil Properties in the Triaxial Test" A. W. Bishop and D. J. Henkel, Revised and updated 1962.

8. "The Measurement of Pore Pressure in the Triaxial Test—A. W. Bishop, Proc. Pore Pressure and Suction in Soil Conference, London, 1960.

Inducting Graduate Engineers to Professional Career

By Z. Yusuf

The Engineering Graduates after coming out of the Universities and Colleges when start professional career find that they are not familiar with the problems in the professional field and therefore face difficulties at the initial stage.

It is for this purpose there is absolute necessity to give an induction training to the budding engineers, and for which purpose this paper has been written.

Oil Leakage Problems at Hydro-electric Stations

By Syed Akhtar Niazi

Oil over the stator windings is not an uncommon occurrence in Hydro-electric by Generators. It may sometimes be in alarming quantities. The greatest single cause of Electrical failures is the breakdown of Insulation and one of the chief reasons of such failures is the presence of oil mixed with moisture, and dust over the windings demands the special attention of the maintenance engineers.

This article presents two unusual cases of oil splashing on the stator winding which the author had to encounter. One deals with Generator No. 2 at Warsak and the other with Generator No. 2 at Chichoki-Mallian Hydro-electric Station.

The diagnosis of the root cause of trouble at Warsak was really a time-consuming ordeal. The solution of the problem at Chichoki-Mallian was rendered appreciably simpler with the knowledge acquired while attending to the Warsak Generator.

Roads in Islamabad

By Syed Vazeer-ud-Din

While planning the road system of Islamabad, the following basic principles have been kept in view :—

(*i*) The residential communities are approachable through a communication system of high order.

(*ii*) Inside the residential communities, the road system is of slow speed.

(*iii*) Mostly, no vehicular approach has been provided inside the centre of any community.

A brief illustration of the above principles with their application to the road network of Islamabad is given in the paper.

Semi Conducting Properties of Some Indigenous Ores

By Dr. M. N. Azam and Mohammad Hasibur Rahman

The paper gives a brief account of the results of an experimental study of the electrical properties of some semiconducting ores found in Pakistan.

(*Continued on page 72*)

ELECTRIC POWER SYSTEM—PLANNING AND DEVELOPMENT

A. RAHIMTOOLLA

Superintending Engineer (System Planning and Design) WAPDA Electricity

Introduction

The basic criterion of a sound electric power system is its ability to meet existing and potential demand with an adequate supply of electric power of the proper quality at the lowest practicable cost. This is the main objective of an integrated system. There are many forms of energy which can be utilized to generate electric power, such as coal, natural gas, oil, water power and nuclear minerals. The integrated system covers a large area and is capable of integrating all available sources of energy that can contribute to the most economical supply of electric power. There is a greater choice of alternative sources than an isolated powers ystem will permit. The hydro potential sites can be developed in the sequence dictated by agricultural and industrial requirements. If thermal generation is an integral part of the system, the locally available gas reserves and coal deposits can also be utilized and exploited on a large scale.

Shortly West Pakistan WAPDA will be interlinking the Northern Grid System with the Southern Zone and Karachi by a 132 KV Transmission line. By 1972 WAPDA plans to build a 380/500 KV, EHV Transmission System connecting Karachi with Lyallpur *via* Mari. This EHV interconnection would mean that Tarbela and Mangla hydroelectric power could be sent to Karachi and thermal power from the south could firm up the hydroelectric stations in the north during low water periods. Thus the entire province of West Pakistan would then become a combined integrated electric system, as shown in Fig. I.

Fundamentals of Planning an Integrated Power System

An integrated system serves all customers within the area it covers including all categories of industrial, agricultural, commercial and domestic users with diverse demands. Owing to the diversity in their peak loads, the required capacity of an integrated system will be less than the aggregate capacity of individual local systems serving the same consumers. The load

factor is also much improved in an integrated system. The control power plants in such a system can use larger and more efficient generating units and avoid piecemeal development of a site. All this saves capital and operating costs.

An integrated system consisting of various types of hydro and thermal plants provides maximum flexibility of operation. It makes possible maximum operation of the most efficient thermal generating units and operation of all units at the most efficient levels. This automatically results in maximum conservation of fuel resources.

The amount of reserve generating capacity needed to provide for scheduled maintenance, for replacement of equipment in case of breakdown or emergency outage and for unforeseen load growth can be greatly reduced.

In a coordinated system greater reliability of services is obtained as the supply comes from multiple sources.

With hydro generation savings in capacity and operating cost can be realized from diversity in streamflow characteristics and from more effective use of storage facilities.

Additions of new capacity can be scheduled in such a way as to obviate temporary over-installation of generation capacity.

A large and complicated integrated system needs and stimulates high standards of technique and skill, and specialized technical personnel can be more fully utilized.

Planning Procedure

The electric power industry is a long-term business. To keep pace with the growth of population and economic development an integrated power system once established expands steadily. It takes at least three years to complete a medium-sized thermal power plant. A hydroelectric power project usually takes five to eight years from the initial investigations to completion of construction work, apart from long periods of preliminary investigations and surveys. To ensure adequate power supplies it is essential to plan power development for a sufficiently long period of time in advance. The procedure of planning usually consists of the following steps :

(*a*) Analysis of the future electric power and energy requirements;

(*b*) Appraisal of energy resources, fuel resources, water and power sites, etc;

(*c*) Study for an integrated system comprising individual power generating projects and the related transmission and distribution network needed to ensure adequacy and reliability of power supply.

(*d*) Comparison and selection of alternative programmes on the basis of technical, economic and financial criteria.

The tools employed in the planning of power systems are reliable data for load forecasting and estimating investment and operating costs, load duration curves, records of equipment performance and maintenance experience, network analysers and electronic computers.

West Pakistan WAPDA Electric Energy Comsumption

The standard of living in any country is proportional to the consumption of electricity *per capita*. Industraialised nations of Europe and America are consuming approximately 2000/5000 Kwh *per capita*.

As regards less industrialised nations in

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south-east Asia, the West Pakistan Northern Area up to 1965 had higher electric consumption *per capita* than countries like Burma, Cambodia, Viet Nam, Ceylon, Thailand and Sarawak etc. By 1990 the electric consumption *per capita* of the West Pakistan Northern Area would be higher than countries like India, Korea, Malaysia and Brunei etc.

Growth of the electric energy consumption for the WAPDA Northern Grid zone covering the Civil Divisions of Peshawar, Rawalpindi, Sargodha, Lahore, D. I. Khan, Multan and Bahawalpur is given below : (Fig. 1).

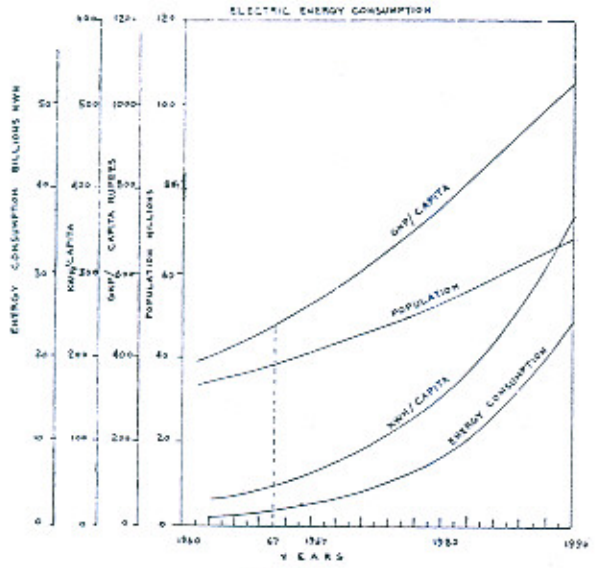


Fig. 1.

The electric energy represents the basic component and includes residential, commercial and industrial categories of electric load. Tubewell and construction power requirements are not included.

From the above table, it can be seen that for the period 1965 through 1980 the compound growth of electric energy was 9.5%, whereas for the same period the increase of gross national product *per capita* was 5.6%. This relationship shows that the consumption of electric energy *per capita* is approximately 2.5 times the gross national product, as shown in the table below —Fig. 2.

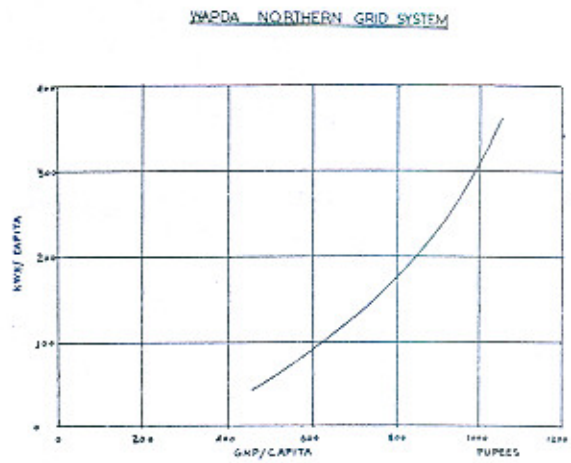


Fig. 2.

Years	1965	1970	1975	1980	1985	1990
Kwh/*Capita*	40	63	100	157	240	370
GNP/*Capita* (Rs.)	450	534	638	766	916	1052

If the efficiency of energy utilization and particularly of conversion of primary energy to electricity shows marked improvement in future, it is possible that this ratio of 2.5 could change.

The second and current Third Five-Year Plan periods are characterized by the increasing change over from non-commercial fuels to commercial fuels. Manufacturing and Industrial sectors are increasing at a faster pace than the total economy, and therefore, the electric energy consumption is also growing at a much faster rate.

Master Planning

The purpose of long-term system planning is to provide adequate power to the system for the next ten or more years at the lowest

practicable cost, including the cost of generation, transmission and distribution. There are usually combinations of power development plans based on load demand forecasts and various sources of hydro, thermal or nuclear power which can meet the requirements of growing demand.

For each system development plan, a proper transmission plan should be worked out with the help of network analysers. The network analyser is a useful tool for computing power flow, transmission line loss, voltage variations and all effects due to outage of transmission lines and generating units. It is usually sufficient to make network analyser studies at two different load levels, every three to five years until the target date is reached. When such studies are conducted for each system development plan, sufficient new transmission facilities should be installed to ensure that all plans give comparable electrical performance. The network analyser studies will provide a means of determining the transmission investment for each system development plan, and also the timing for the individual installations.

Another factor in which both economics and system reliability are closely linked is the amount of reserve generating capacity which must be provided in a system. From the point of view of reliability, it should be among the chief objectives of an integrated system to provide uninterrupted power supply of proper quality and quantity. This would call for the provision of adequate reserve generating capacity to take care of scheduled plant maintenance and forced outage of the various components of the system, such as turbines, boilers, transmission facilities, switchgear, etc. To estimate the forced outage of equipment is a problem in probability and digital computer is useful for solving this kind of problem.

Financial

After several long-term system development plans have been prepared, that can be compared on the basis of annual costs. The cost determined for each year can be converted to the present worth by using a proper interest rate. The plan with the lowest annual cost would be the economically most desirable one.

The electricity supply industry is capital-intensive and requires large funds for the year-by-year investment in additional generation, transmission and distribution facilities. The electricity supply industry is continually expanding. It has to provide new generation facilities which cost anything from about Rs. 500 to Rs. 2000 per kw on capital investment depending on the nature of the project-thermal or hydro stations—and generally the cost of transmission and distribution additions to bring electricity to the ultimate consumers will be of the order of 100 to 150 per cent of the investment in generation.

The sources used by WAPDA for financing new capital expenditure are :

(*a*) Issue of debentures.
(*b*) Internal loans.
(*c*) Foreign loans.
(*d*) Government subsidies.
(*e*) Government loans
(*f*) Self-financing

Conclusion

Electric power, being an essential prerequisite for industrial and agricultural development, should receive due considera-

tion in the planning of basic economic infrastructure and its development must be approached rationally and logically in the light of the economic prospects of the nation as a whole and of industrial, agricultural and social growth. If electric power development outstrips the development of facilities to use the energy, the reserve margin of generating capacity becomes greater than needed, trying up capital which could probably be better employed elsewhere. On the other hand, if electric power generation and transmission facilities fall short of requirements, investments in industry will be rendered idle. These considerations call for very careful planning, extensive energy resource surveys, co-ordination of the power programme with that of other sectors of development, training of technical personnel at all levels and most important, adequate to financial provision. Every nation has its problems in applying the available supply of investment money to desirable development projects. The task is particularly difficult for developing nations, which have to decide where the funds will come from, how much can be obtained from foreign sources and what are the possibilities of repaying loans. Therefore, all aspects of a project must be systematically worked out and analysed.

(*Continued from page 67*)

The present work describes the results obtained from Stibnite, Pyrite and Lead Sulphide. Values of Hall Coefficient, Magneto resistance, mobility, etc., are found out and reported in the paper.

An Approach to Solve Industrial Corrosion Problems

By Dr. Iqbal Mahmud

The old empirical and the new analytical approaches to tackling corrosion are briefly reviewed. The stress is given on the electrochemical nature of corrosion phenomena. Case studies of corrosioa in industries are presented with a view to illustrating the analytical approach for explaining corrosion in otherwise satisfactory environments. Suggestions for the prevention of such corrosion are also given.

Wapda House

By
GHULAM FAREED ZAFAR AND
MUBARAK AHMAD

A most graceful, massive structure, first of its kind, as grand as WAPDA itself, now adorns the Charing Cross. A layman onlooker is impressed by the sight of huge bird with spread out wings but to an Engineer is a marvel of design for this part of the country with soft, comparatively low pressure bearing formations. In this article besides the factual data of the Wapda House some preliminary problems of foundation and design are also mentioned.

Tallest Building in Lahore

Wapda House adorns the front page of *The Engineering News*. It is a massive, though graceful, structure that presents to the onlookers the sight of a huge bird with spread-out wings. A blend of eastern and western architecture, it occupies the corner of the Charing Cross, is flanked by the Assembly Chambers and the Free-mason Hall. Right in front of it is the newly constructed Alfalah Building.

Wapda House rises over head and shoulders every other building in the city. It is, in fact the tallest building in Lahore yet constructed. Its height is about 135 feet.

Wapda House with its dome glistening in the sun could be spotted from most of the roof-tops in the far-off corners of the city.

Like most of the other Wapda projects, the Wapda House has an impressive array of statistics. It has a built-up area of 5.5 lakh square feet, out of which 3.5 lakh is usable. The weight of the 3-foot thick corner cantilever (110 tons) will give some idea of the massiveness of the building. The building has consumed 4,500 tons of steel. It has eleven storeys, including two basements. During the peak construction period a labour force of 1,500 worked round-the-clock.

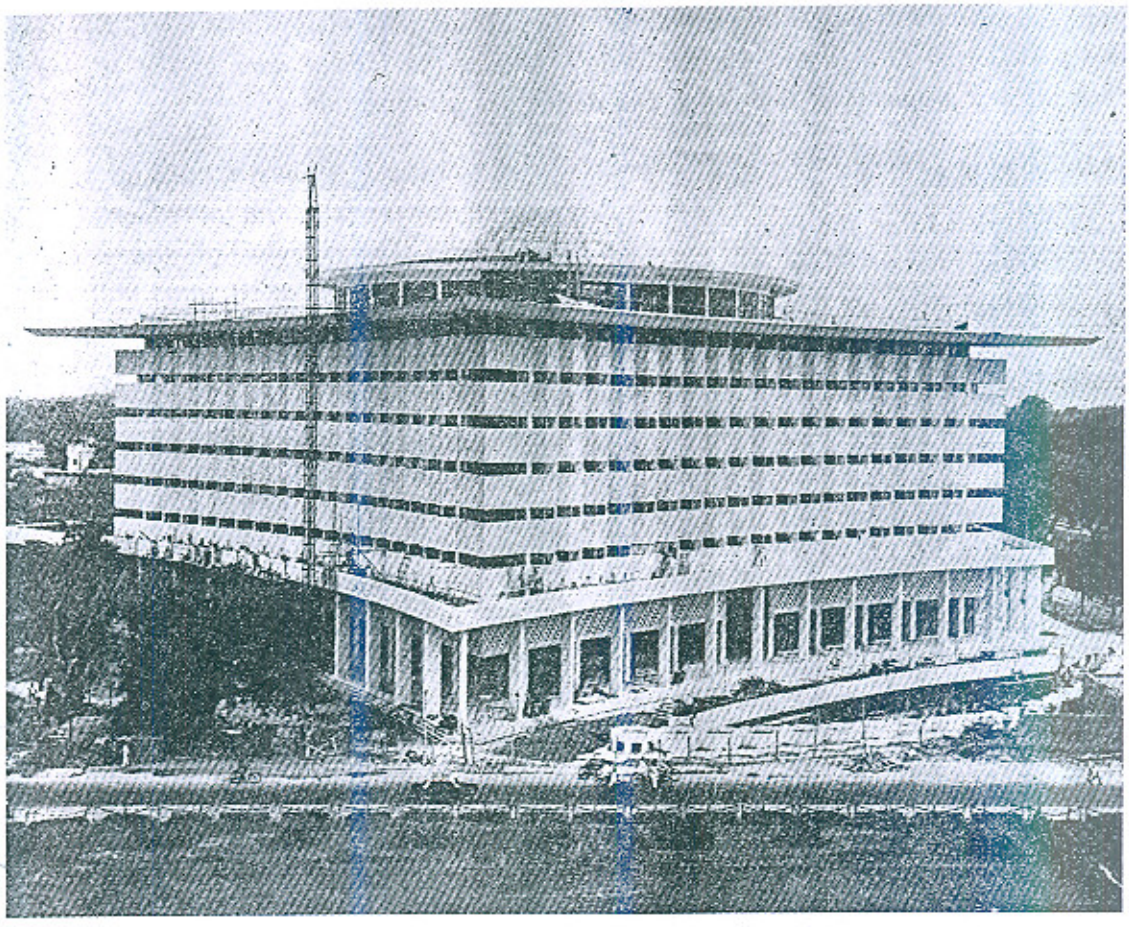
For a building of this height and expanse the provision of natural light on all the floors posed a problem. The solution, a plexiglass dome, topping a rotunda of 65-foot diameter, has enhanced manifold the beauty of the building. This entailed a greater amount of care for the air-conditioning experts, but then complete darkness had to be avoided.

There is a sunken garden about two feet

below the basement level. It is a beautiful combination of classic and modern building science. A large number of fountains fed by a pool in the basement will play in front of the building. Water will be lifted from the pool by means of a pump only to flow back to it afterwards. An auditorium for 300 persons fitted with most modern equipment has been built for purposes of meetings, seminars, film shows, etc.

Wapda House will pay its cost in ten years

Wapda House was conceived in the interest of economy and better co-ordination of work. Before the construction of Wapda House, its offices were scattered all over the town where all sorts of buildings and bungalows had been rented. Their shifting to Wapda House would save a rent of Rs. 6.5 lakh, apart from curtailing telephone and transport expenses, not to speak of a smooth conduct of work. The ground and first floors with a built-up area of 140,000 square feet have been reserved for renting out to business houses and would be a source of revenue to the Authority. When fully rented out it will bring in a revenue of Rs. 8.40 million per year. The annual working expenses for Civil, Electrical, Mechanical and air-conditioning works are Rs. 3.40 million and thus there will be a net revenue of Rs. 5.00 million per year; thus redeeming the cost of the project in 10 years.



Wapda House in final stages of completion.



Fig. 1. Arrangement for load settlement test at site.

The sub-basement has arrangement to park 90 cars, and for conducting them into the sub-basement a 20 feet wide ramp has been built on the Egerton wing side. The sub-basement also provides an area of 18,000 square feet to serve as computer's centre and the central record room of the West Pakistan Water and Power Development Authority, and 2,000 square feet for housing air-conditioning plant, electrical installations and stores.

Foundation Problem of Wapda House

When the Wapda House was to be constructed, there were so many problems of design to be solved. The foremost problem pertained to the bearing pressure on the foundations. It was to be a first tallest building ever constructed on the soft alluvium foundation as exist in this part of the country. The nature of soil formation had thus to be fully explored, so a load settlement test as shown in figure 1 was carried out at selected points at the building site. The formation at the site is a typical of that met with in this part of the country. The Picture in figure 2 shows that the top formation up to a depth of 15 to 25 ft. consists of clay and silty soil. The sand formation exists below this depth right up to about 90 ft. below the natural surface. There exists only one thin 2 ft. thick layer of silty clay which was a source of some worries to the designers. The Irrigation Research Institute had to be approached to conduct a complete investigation with regard to the properties of soil formation below Wapda House and its behaviour when subjected to the loading of the structure itself. The formation was to be subjected to a total pressure of 63,200 tons spread on an area of about 53,000 sq.

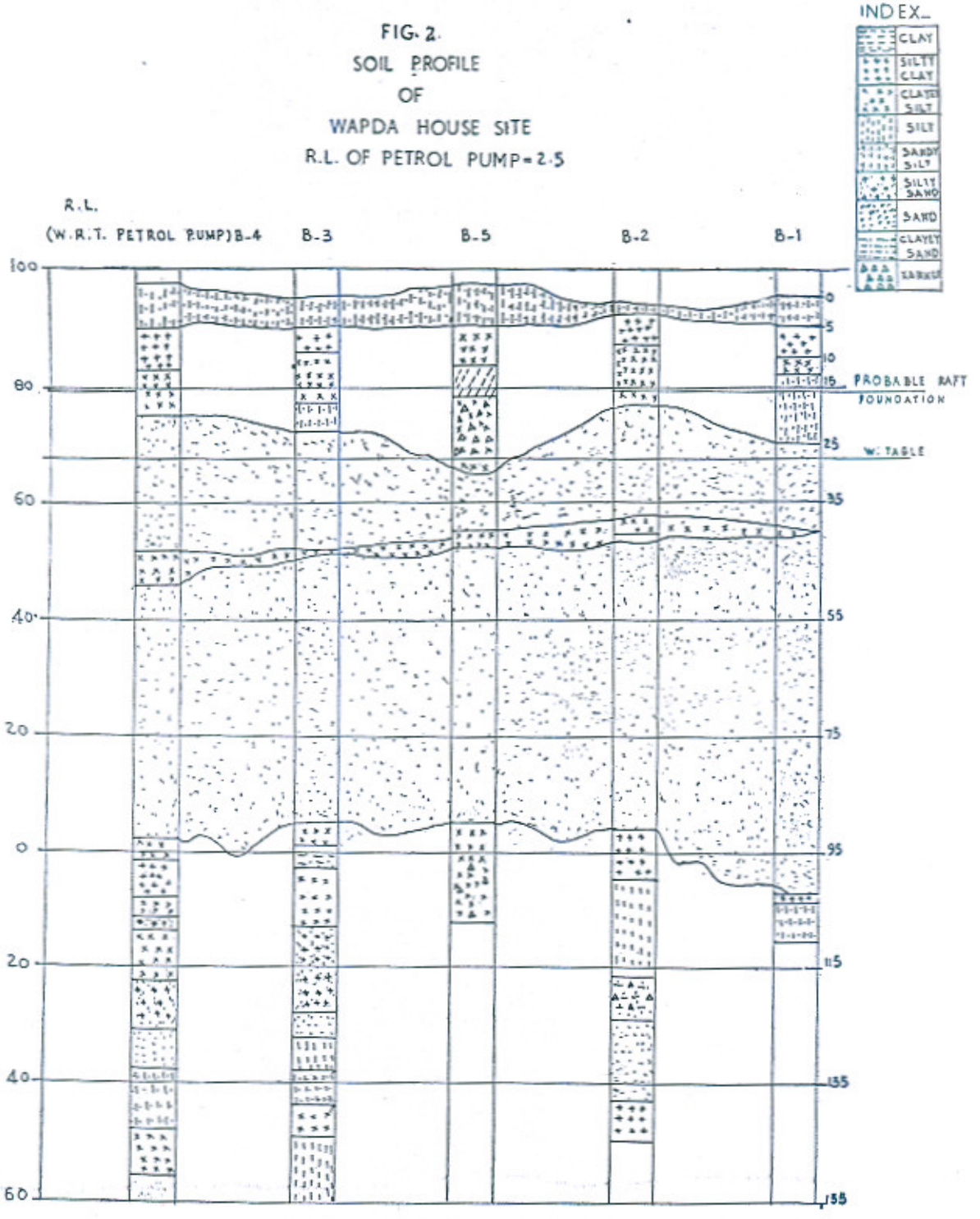
FIG. 2.

SOIL PROFILE

OF

WAPDA HOUSE SITE

R.L. OF PETROL PUMP = 2.5



WAPDA HOUSE
TOWER SECTION RAFT FOUNDATION
COLUMN LOADS IN KIPS
⊗ POINTS INDICATE OBSERVATION SPIKES

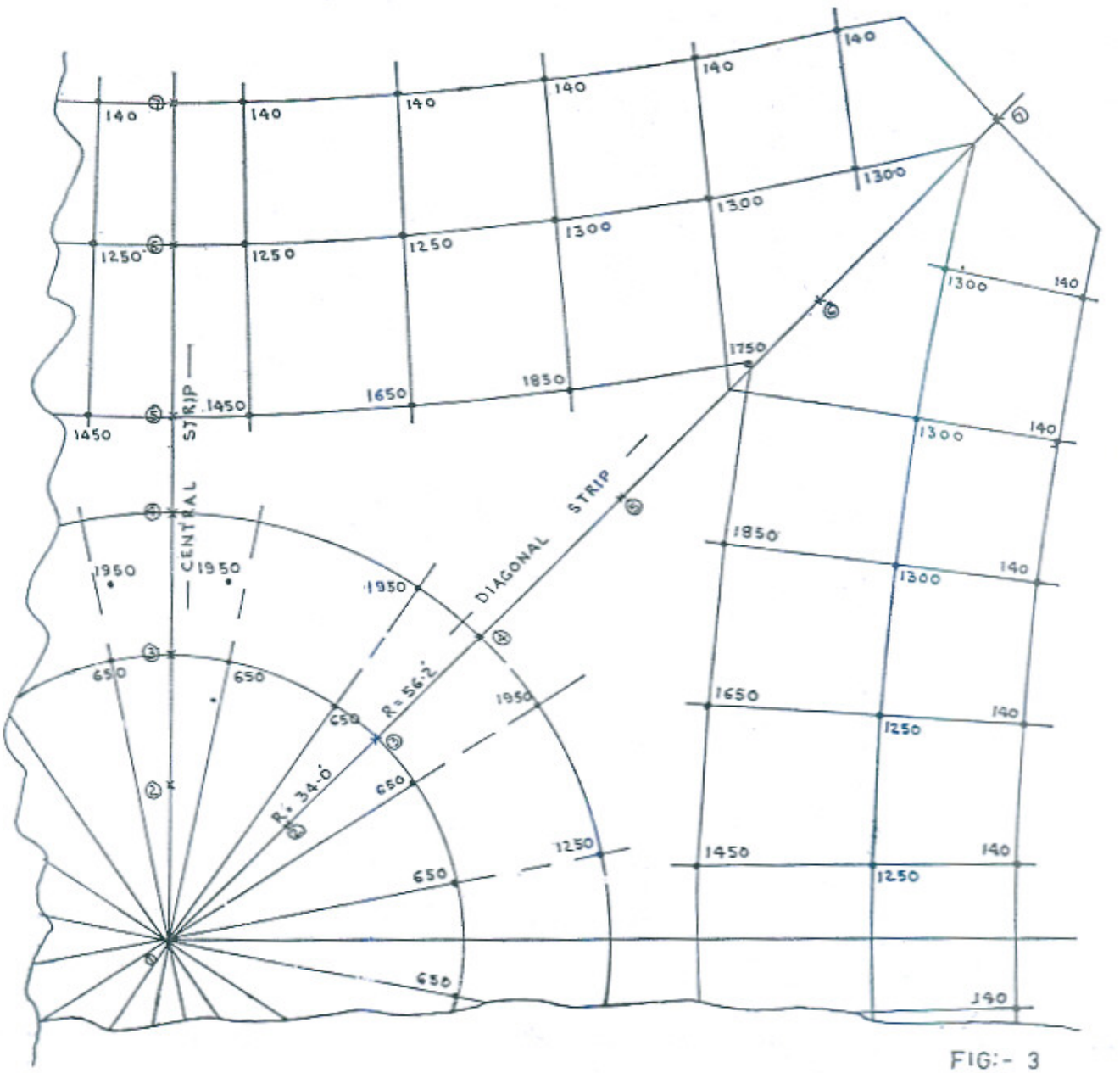


FIG:- 3

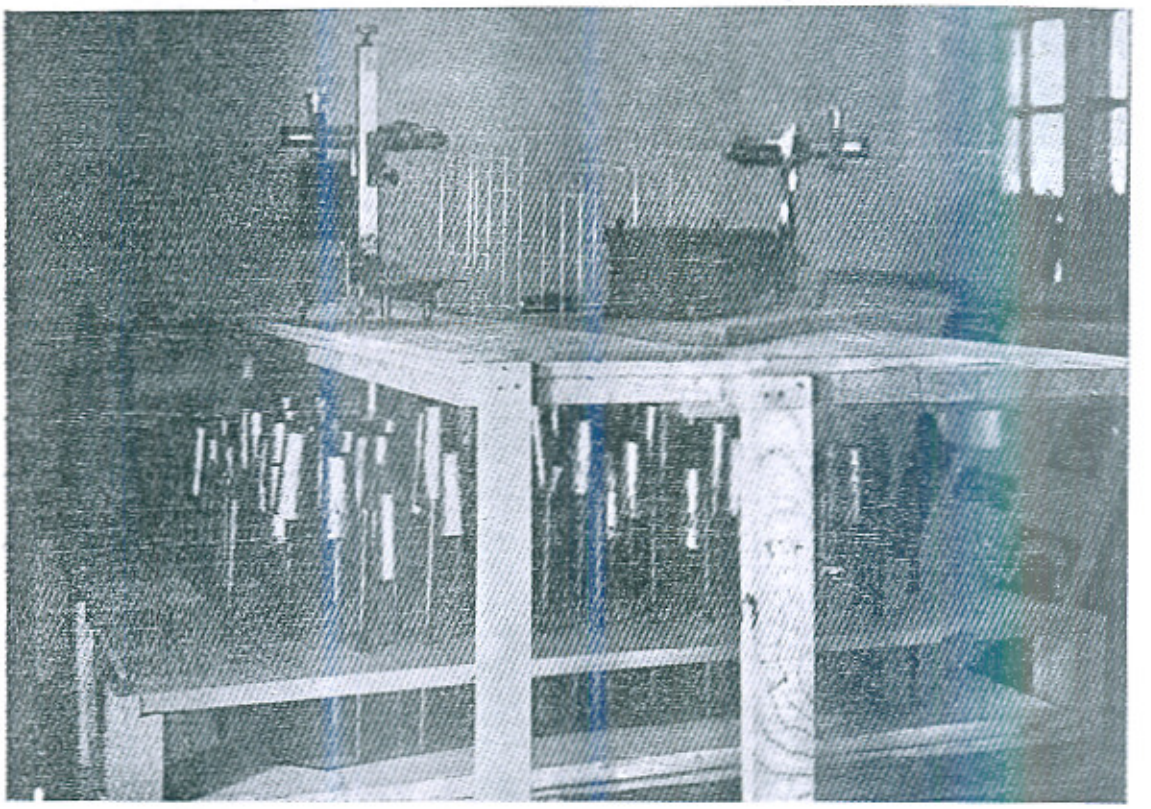


Fig. 4. Wapda House Raft Foundation experimental set up.

ft. Several load bearing tests were thus conducted at site and it appeared that the safe pressure for this type of formation was of the order of 1.8 tons per sq. ft. Under the heavy load of the structure there was a possibility of settlement of the order of about 1.7 inches, which was within the safe limit. A great care and consideration was given to the thin silty clay layer which existed 25 ft. below surface. Its consolidation under load had to be given serious consideration. Keeping in view the load-bearing capacity and the nature of the soil formation under Wapda House, it was suggested to take down the foundation about 20 ft. below natural surface. This was one reason for the construction of two basement under the main Wapda House. The designers took extra care with regard to the construction of this tallest building in Lahore, the first of its kind with respect to the load intensity on the formation. Various alternations to spread the load intensity were considered and ultimately reinforced cement concrete raft five ft. thick was adopted.

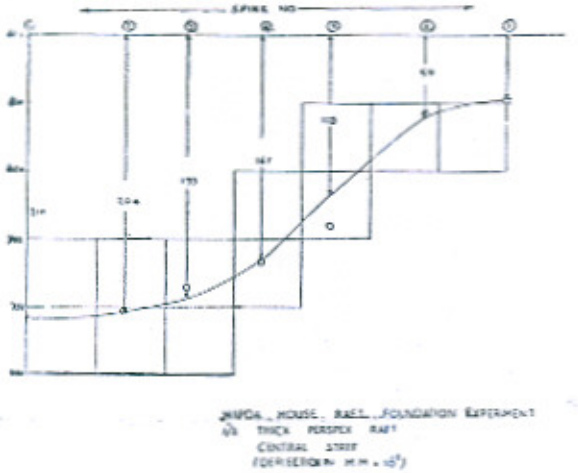


Fig. 5-*a*.

The load intensity was thus decreased to the order of 1.1 ton per sq. ft. This was an extra precaution against the possible settlement of the building.

Load Intensity tested by Model

While working load intensity in case of such complicated structure having 140 columns bearing thef ull load of the structure, the amount of deflection at various position of the raft are worked out. The designer often needs some confirmation of his calculations. Here also a small-scale laboratory model came to the rescue. In the Irrigation Research Institute we set up a structural model of the raft represented by a *perspex* sheets, 1/2' thick cut according to the bottom shape of the raft foundation, as shown in figure 3. In this figure only one quarter segment of the raft is shown. The soft soil formation was represented by means of one inch thick layer of foam rubber. This rested on a rigid one inch thick glass plate fixed on an experimental table. The columns were represented by an iron rod. These were loaded with lead weights. One section of the raft was selected and under loaded and unloaded conditions deflection expected at various points were measured. The deflections were measured with the help of a microscope focussed on spikes which rested at various places on the raft.

The experimental set-up is shown in figure 4. Some of the deflections measured after loading are shown in figure 5 (*a*, *b*, *c*). The same are plotted on the figure 1 of the raft. These experimental determinations of deflections were found to correspond with the actual calculations. Now when the

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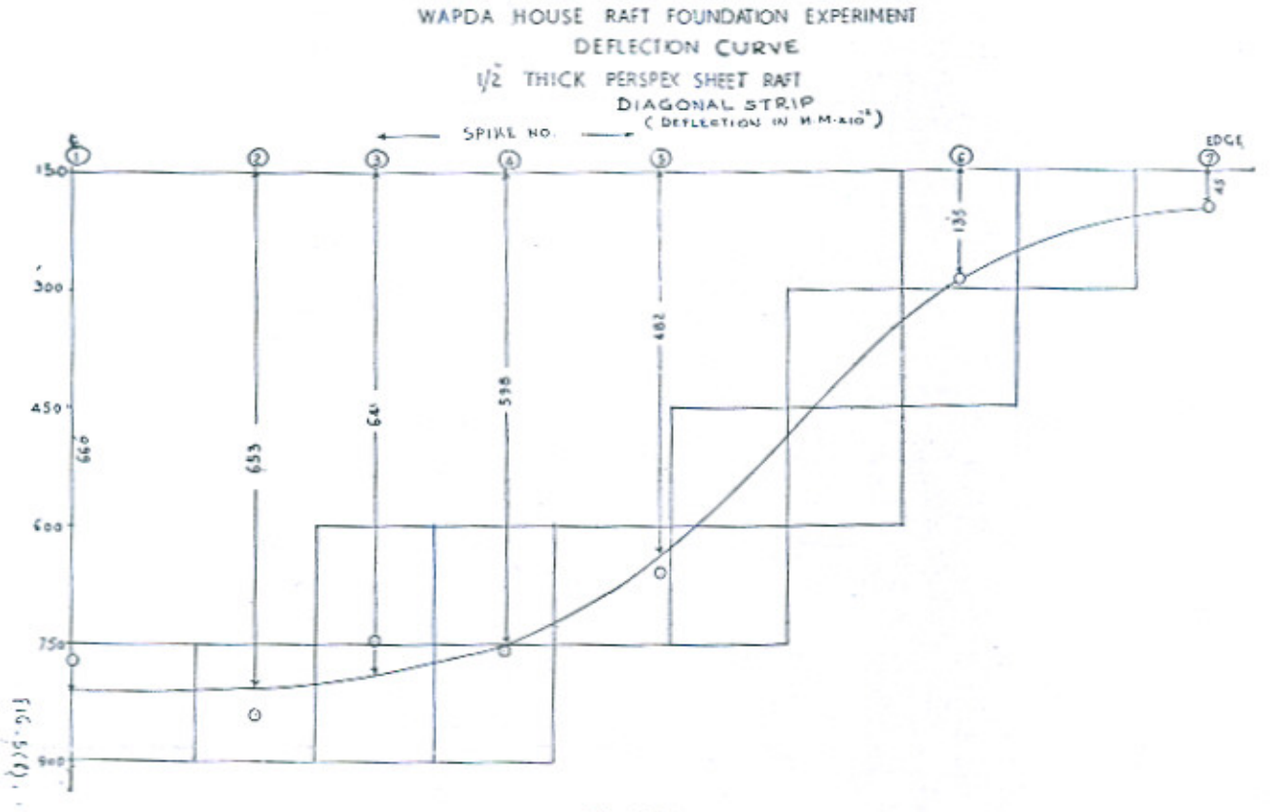


Fig. 5-*b*.

Wapda House is completed, it will be a useful confirmation of the calculations and the experimental results to determine the actual deflections on the structure itself. The readers will appreciate the difficult problem which the designer have to face and very often insignificantly small inexpensive experimental models of structure can give convincing proof for the design calculations where millions of rupees are involved.

WAPDA HOUSE RAFT FOUNDATION EXPERIMENT
DEFLECTION CONTOURS
(1/2" THICK PERSPEX SHEET RAFT)
(DEFLECTION IN M.M.X10^{-2})

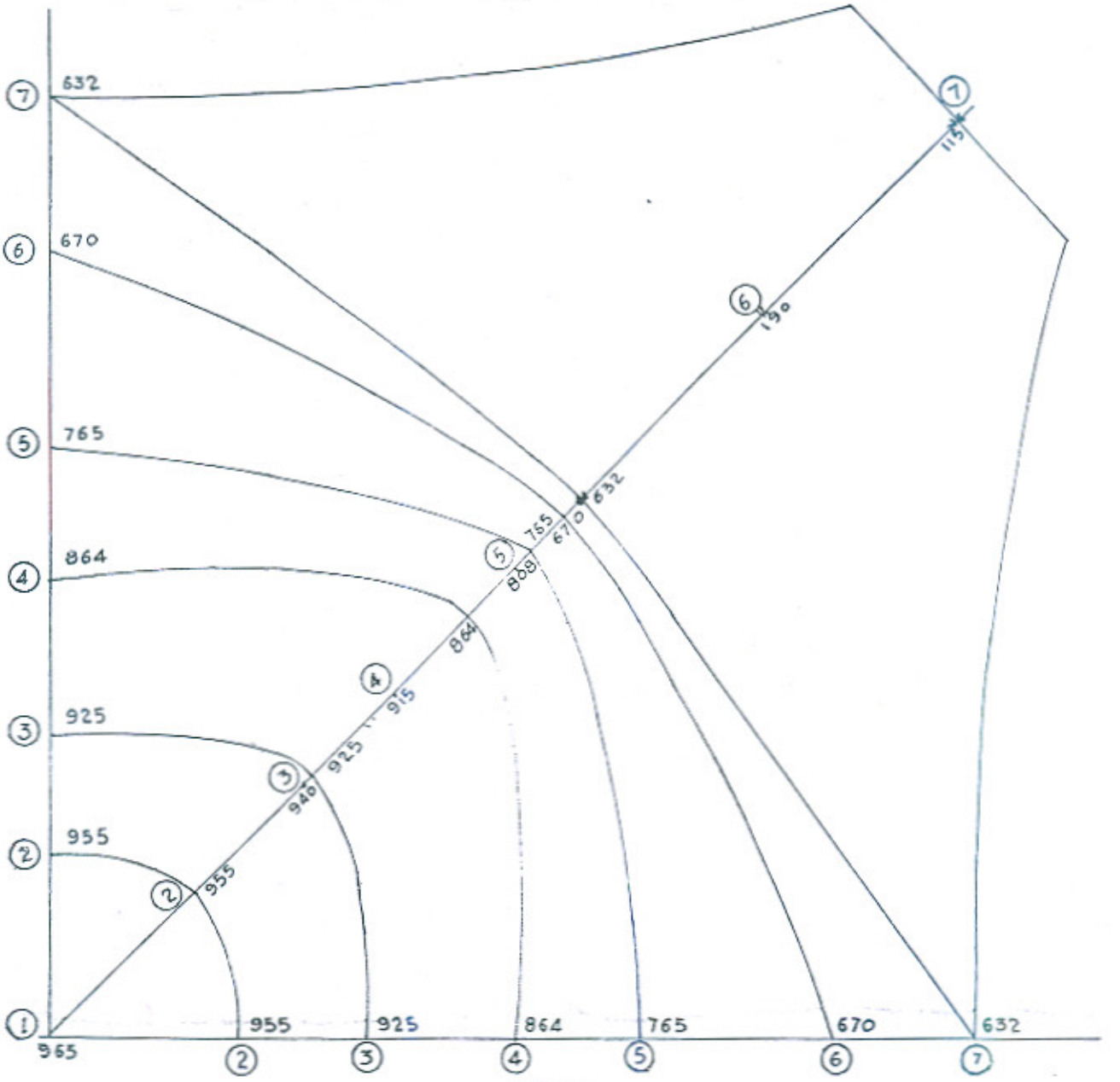


Fig. 5-c.

Reclamation & Drainage Programme for Lower Rechna Doab (Project No. 5)

West Pakistan WAPDA has issued its fifth Project for Reclamation and Drainage of the Northern Regions of West Pakistan. The Project starts where the scarp No. 1 ends. It extends up to the land area bounded by the confluence of the rivers Chenab and Ravi.

WAPDA'S consultants have already issued four such Reclamation and Drainage Projects called scarps. Scarp No. 1 covered the central portion of the Rechna Doab, Scarp No. 2 extends to the whole area of Chej Doab. Scarp No. 3 is for the area of Lower Thal up to the confluence of the Indus and the Chenab rivers. It is the area served by the Muzaffargarh Canal taking out from the left bank of Taunsa Barrage and the Rangpur Canal taking out from the right bank of Trimmu Barrage. Scarp No. 4 is meant for the Upper Region of Rechna Doab extending upwards of Scarp No. 1.

The present is the Project Report for the 5th scarp. In figure 1, the location of various scarps is shown. We have extracted important observations from this Project Report.

Main outline of the proposals

The Project report is for an area of 2.7 million acres of which about 2.2 million acres are culturable. The area is commanded by the Lower Chenab and Haveli canal systems. In addition to the authorised canal supplies for the area, the water requirements are supplemented by about 3200 privately owned tubewells and that drawn from about 7000 Persian-wheels. The cropping intensity yet attained is about 114 per cent. The basic problems which have suppressed the Development of Agriculture in this area are principally the outgrowth of water factors which are improperly timed, insufficient and unreliable. Delivery to the fields is inadequate, and surface drainage of the irrigated lands is nonexistent. This results in the under-irrigation for optimum production and appearance of soil salinity and waterlogging which have affected about 20 percent of the area.

The Project area is underlain by highly permeable alluvial sediment and about 60 percent of the area possesses excellent quality of groundwater. About 20 percent of the area has water of unsuitable quality. The remaining 20 percent is underlain by water of intermediate quality which can be used for irrigation by mixing with canal water.

This Project is designed to exploit the groundwater reservoir and to mix this water with the present distribution system to

LOWER RECHNA DOAB
STATUS OF
RECLAMATION PROJECTS
LEGEND
PROJECTS IN PLANNING STAGES
PROJECTS UNDER CONSTRUCTION
PROJECT COMPLETED
PROJECT NO 2 CHAJ DOAB
LOWER JHELUM SUB PROJECT
(CHAJ Z-B)
PROJECT NO 3 LOWER THAL DOAB
RANG PUR UNIT
PROJECT NO 4
UPPER RECHNA DOAB
PROJECT NO 5
LOWER RECHNA DOAB
PROJECT NO 6
SARGHAD COMMAND
PROJECT NO 2
CHAJ DOAB
UPPER JHELUM SUB PROJECT
PROJECT NO 3
LOWER THAL DOAB
ALLIPUR UNIT NOT KOU UNIT
PROJECT NO 4
UPPER RECHNA DOAB
MANGTAH WALA UNIT
PROJECT NO 1
CENTRAL RECHNA DOAB
LAHAH UNIT MONA UNIT
KHAIRI UNIT
PROJECT NO 2
PROJECT NO 5
PROJECT NO 4
PROJECT NO 6

obtain the maximum benefit.

(*a*) It is thus proposed that in a zone which coincides with the fresh groundwater, the surface delivery will be maintained at their historic rate and groundwater will be pumped liberally.

(*b*) An intermediate zone in which the surface water deliveries will be increased over-historic rate and groundwater of less desirable qualities will be pumped at controlled rate.

(*c*) The inner zone overlying the saline groundwater in which no pumping will be done but in which surface deliveries will be raised to the maximum rate permitted by the existing distribution system.

(*d*) The Project involves the construction of about 2300 tubewells to pump about 8770 cusecs. The estimated capital cost of the Project is Rs. 32,83,00,000 of which Rs. 12,80,37,000 *i.e.*, 39 percent of the total will be in foreign exchange for equipment, materials and **services not available** in Pakistan. The pumping will depress the watertable sufficient to eliminate sub-surface, drainage hazards.

It will increase the crop acreage of about 3.2 million acres representing a cropping intensity of 147 percent.

The Project will yield a benefit cost ratio of more than 8 to 1.

An alternate method of development, on the basis of private tubewells by promoting electrification of the area, has been considered and it has been determined that :—

(*a*) Consequent increase in the number of private tubewells or the area of land they command is not expected.

(*b*) Marginal utility will operate to suppress private development over much of the area.

(*c*) The cost of the electrification is inordinately high.

(*d*) No level of private activities will satisfy the attempts to the Regional Development of the Northern Plains. It is thus concluded that the optimum development of the Lower Rechna Doab cannot be accomplished by private tubewells.

EXTRACTS FROM THE MAIN REPORT

Rachna Doab and the Project Area

Rechna Doab comprises an area of about 7.6 million acres (11875 sq. miles). The length of the Doab from Jammu and Kashmir Border to the confluence of the rivers Ravi and Chenab is about 230 miles, the maximum width of the area being 65 miles. The gross area of the Project is 2.74 million acres of which about 2.18 million acres are culturable. Main canal system serving the Rechna Doab together with their authorised supplies are shown in Table 1.

The Lower Chenab canal is the major source of irrigation supply for Lower Rechna Doab, it serves a culturable commanded area of about 3 million acres of which 1.8 million acres are in the Project area and receive perennial supply. The Lower Chenab Canal was opened for irrigation on July 9, 1887 as an Inundation Canal. Weir Control was added in 1890. In Table 2, the design capacity of the canal taking out at Khanki Headworks is given together with the authorised full supply discharges for its branches. The discharge supplied to the Project area is also given.

TABLE 1

Canal Systems Serving Rechna Doab

Canal System.	Culturable Commanded Area.		Authorized Full Supply.		Irrigation Supplies 2.	
	Non-perennial (Thousand acres.	Perennial (Thousand acres).	Non-perennial (cusecs)	Perennial (cusecs)	Kharif (Thousand A. F.	Rabi (Thousand A. F.)
Marala Ravi Links ..	105	..	870	..	258	..
Upper Chenab Canal ..	832	613	5,340	1,840	1,593	602
Lower Chenab Canal ..	190	2,800	11,500	10,400	3,776	2,894
Haveli Canal ..	86	71	500	750	208	107
Koranga Feeder ..	..	37	..	120	38	32

Notes. 1. According to remodelled design.
2. Marala Ravi Link, assuming full supplies for five months.
Upper Chenab Canal—ten years average (1953-62).
Lower Chenab Canal—eighteen years average (1947-64).
Haveli Canal (Rechna Supplies only)—thirteen years average (1952-64).
Koranga Feeder—thirteen years average (1952-64).

TABLE 2

Canal and branches	Authorized full supplies, cusecs	Discharge delivered to project area, cusecs
Lower C. C.	13000	..
Jhang B_2.	2988	2562
Rakh B_2.	1145	..
Mian Ali B_2.	665	..
Bhawana	413	..
Lower Jhang B_2.	1209	..
Upper Gugera B_2.	5163	..
Lower Gugera B_2.	2075	1785
Burala B_2.	2338	2120

The lower reaches of the area are supplied by the Haveli branch and by the Koranga Feeder. The Haveli canal with a capacity of 5200 cusecs, diverts 750 cusecs in Kharif and 500 cusecs in Rabi, at heads of distributaries, to irrigate 108,000 acres of CCA with perennial supplies and 86,000 acres with non-perennial supplies. The total water delivered to this area by the three canal systems is 6700 cusecs during Kharif and 6450 cusecs during Rabi seasons. The actual diversions/AFS are about 90 percent.

Economy of the area

Agricultural and Industrial economy of the area can be seen with reference to two tables No. 3 and 4. Agricultural products worth 634.18 million rupees is produced annually of which wheat and sugarcane are predominant crops.

Similarly out of 1940 Industries in the area, Textile and related Industries constitute 1597. About 75 percent of the Industrial workers are employed by Textile Industries.

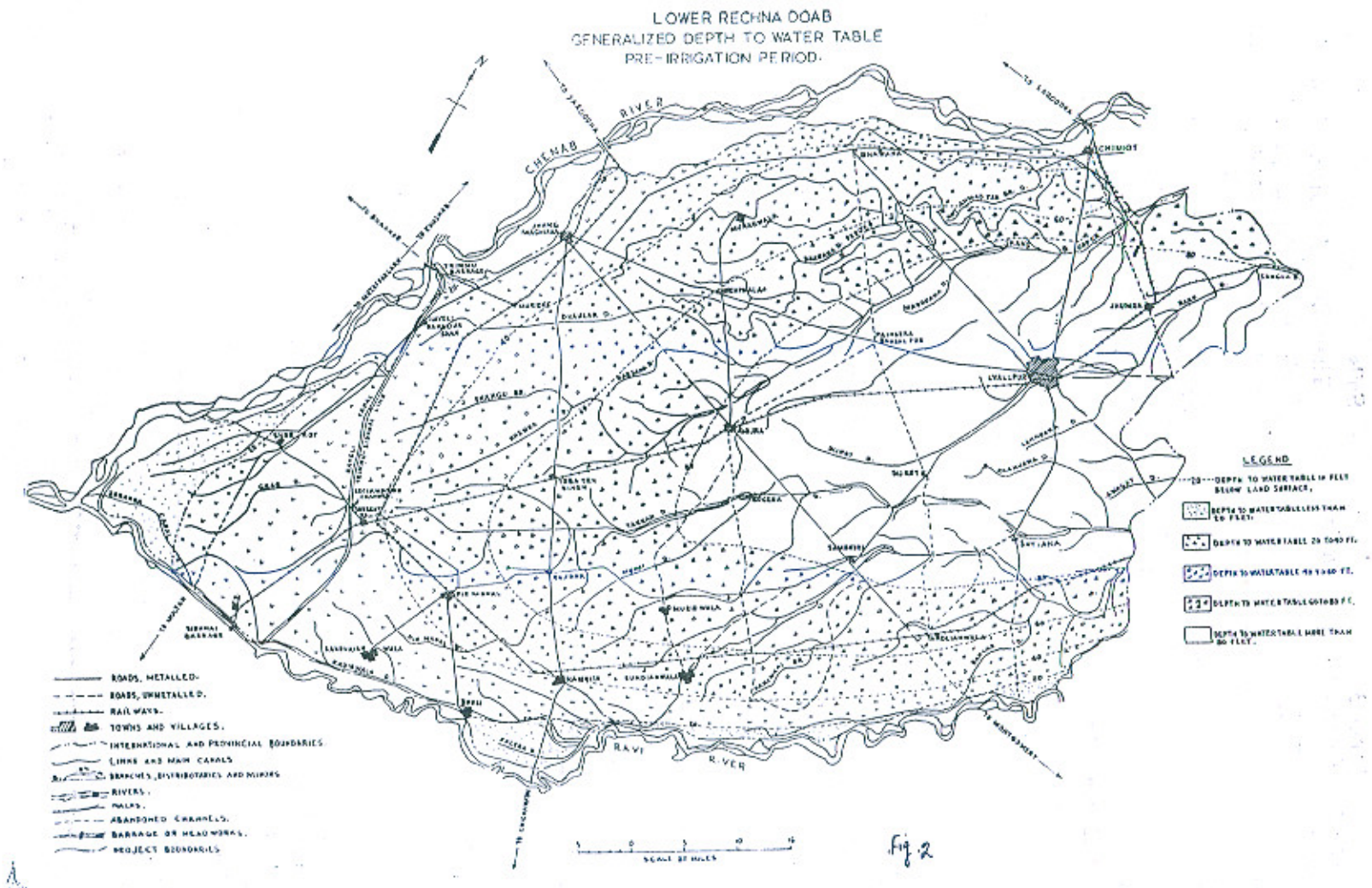

LOWER RECHNA DOAB
GENERALIZED DEPTH TO WATER TABLE
PRE-IRRIGATION PERIOD.
CHENAB RIVER
RAVI RIVER
LYALLPUR
CHINIOT
JHANG
SARGODHA
SHAHKOT
SHEIKHUPURA
SANGLA
TOBA TEK SINGH
GOJRA
SAMUNDRI
FAISALABAD
JHANG BRANCH
GOGERA BRANCH
LOWER BARI DOAB
LOWER CHENAB CANAL
LEGEND
DEPTH TO WATER TABLE IN FEET BELOW LAND SURFACE.
DEPTH TO WATER TABLE LESS THAN 20 FEET.
DEPTH TO WATER TABLE 20 TO 40 FT.
DEPTH TO WATER TABLE 40 TO 60 FT.
DEPTH TO WATER TABLE 60 TO 80 FT.
DEPTH TO WATER TABLE MORE THAN 80 FEET.
ROADS, METALLED.
ROADS, UNMETALLED.
RAILWAYS.
TOWNS AND VILLAGES.
INTERNATIONAL AND PROVINCIAL BOUNDARIES
LINKS AND MAIN CANALS
BRANCHES, DISTRIBUTARIES AND MINORS
RIVERS.
NALAS.
ABANDONED CHANNELS.
BARRAGE OR HEADWORKS.
PROJECT BOUNDARIES
SCALE OF MILES

Fig. 2

TABLE 3
Quality and value of Agricultural Production

Crop.	Production	Value
	1000 mds.	Rs. 1,000
Wheat	12,740	191,094
Sugarcane (gur)	7,516	127,772
Cotton (seed cotton)	3,110	99,534
Fodder crops	..	118,595
Maize	1,590	23,843
Pulses	1,097	18,648
Fruit	..	14,961
Rice (paddy)	697	13,950
Vegetables	..	10,746
Oilseeds	329	8,563
Millets	301	4,219
Miscellaneous	..	2,252
		634,177

TABLE 4
Classification of Industries (Large and small scale)

Industry	Number
Textiles and related Industries	1,597
Chemicals and Chemical Industries	78
General engineering	63
Vegetable, ghee, oil and general mills.	41
Machinery, except electrical	40
Food processing	21
Footwear and leather goods	21
Printing press	19
Furniture	11
Ice and cold storage	9
Electrical machinery and appliances.	9
Transport equipment	7
Ceramics and non-metallic mineral products.	6
Beverages and drinks	2
Agricultural engineering	2
Plastic products	1
Chemicals and fertilizers	1
Clocks and watches	1
Sugar and distillery	1
Sawmill	1
Rubber products	1
Sport and athletic goods	1
Saddle covers	1
Tobacco	1
Miscellaneous	4
Total	1,940

Soils

The soils of the area, classified according to the soil series groups, belong to Jhang and Farida series which are coarse textured soils. Thus 78.4% of the culturable acreage constituting 1.706 million acres belong to this group. The rest 19.9 percent constituting 0.432 million acres belong to medium textured soils designated as Buchiana series. Fine textured soil constitute 1.7 per cent or 38,000 acres only.

The waterlogging and surface salinity of the soil in the area is represented in table below.

TABLE 5

Classification	Thousands of Acres	% Area
Less than 0.2% salt	1750	80.4
0.2 to 0.5% salt	206	9.5
More than 0.5% salt	204	9.4
Waterlogged	16	0.7
Total	2176	100

About 80.4 percent of the area constituting 1.75 million acres contains salts less than 0.2 percent.

Groundwater Hydrology

The alluvial aquifer in the region consists of approximately 70 percent sand within a depth of 3 to 4 hundred feet. Clay occurs largerly in particular forms. Bed rocks even close to the outcrop hills is fairly deep. Boring to a depth of thousand feet or more have never reached the bed rock except close to out-crops.

Investigations for hydraulic properties of the formation has shown that the average lateral permeability of water bearing sand and silt of the alluvium is 0.0025 cusec per sq. ft. Vertical permeability gave an

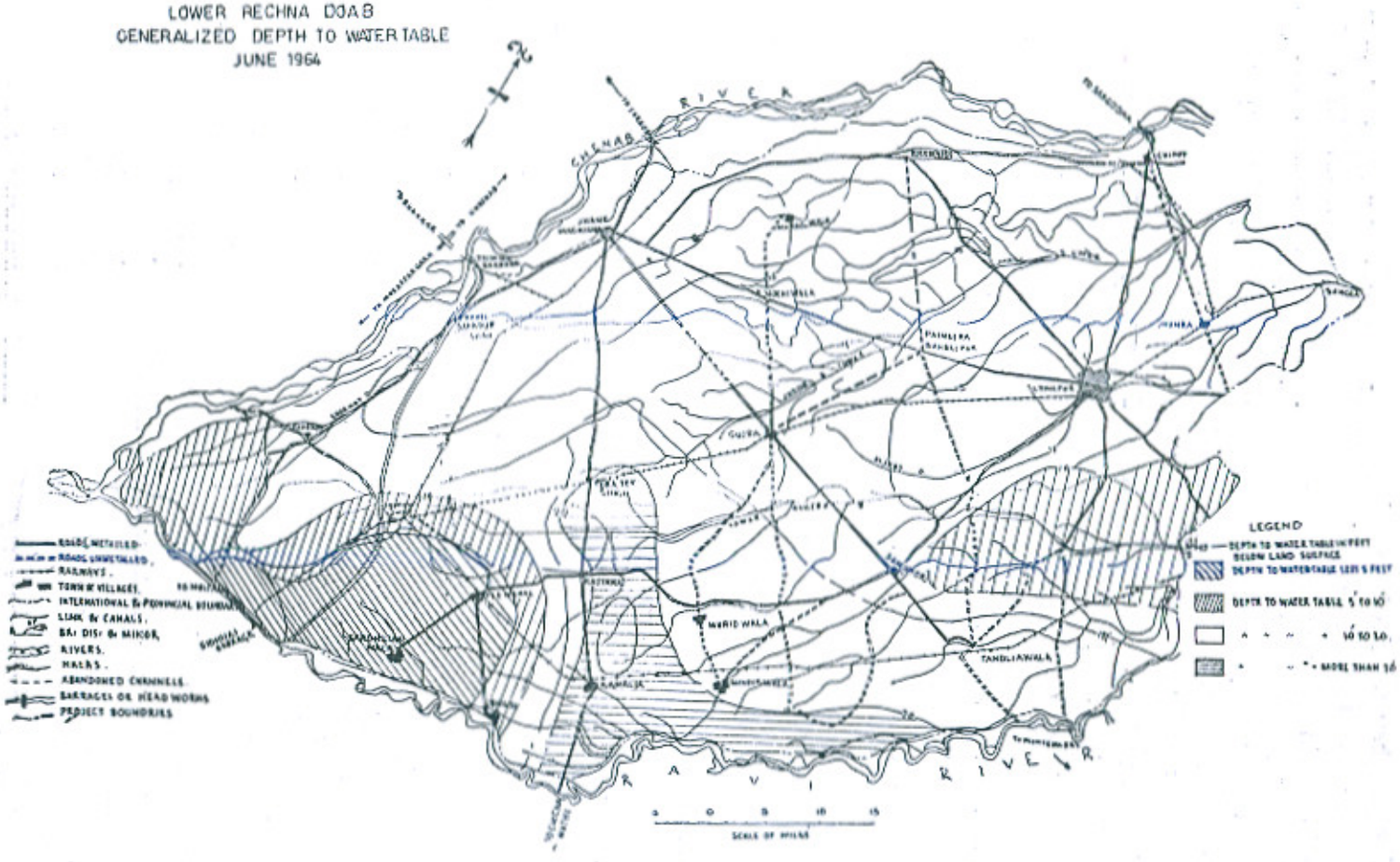

LOWER RECHNA DOAB
GENERALIZED DEPTH TO WATER TABLE
JUNE 1964
CHENAB RIVER
RAVI RIVER
LEGEND
SCALE OF MILES

Fig. 3.

average value of 0.001 cusec per sq. ft. The specific yield range between 0.02 to 0.26 giving an average of 0.14 percent. The earliest groundwater in the area, as represented in Figure 2, was very deep in the central region. As soon as the Irrigation canals started to flow, the groundwater started to rise. The average annual rate in ft. in ten years group after the opening of the Lower Chenab Canal is shown in Table 6 below.

TABLE 6

Period	Average annual Rate of rise in feet.
1900-1910	1.32
1910-1920	0.90
1920-1930	0.60
1930-1940	0.61
1940-1950	0.61
1950-1960	0.44

The present depth of groundwater is shown in Fig. 3.

Assuming a specific yield of 0.30 and considering the data for the early years of the Irrigation when the maximum changes in storage occurred, the potential rate of groundwater recharge from the irrigation system is about 0.4 ft. per year. Since the inception of irrigation, accretion to groundwater storage has totalled more than 30 million acre feet.

In this area seepage from the Irrigation system is the dominant component of the groundwater recharge.

In table 7 the recharge estimated by T and K is given in Appendix A. The total recharge is estimated equal to 1400.0 cusecs of which 495 cusecs or 3,60,000 c. ft. per year is the recharge in scarp 5 areas.

TABLE 7

Distribution of Recharge from Branch Canals of the Entire L.C.C. System

Design AFS of the Reach (Cusecs)	Length of Reach (Miles)	1/ Recharge Rate (Cusecs/Mi.)	Total Recharge within the Reach (Cusecs)
150	5.5	0.86	4.73
180	10.2	0.95	9.69
220	7.3	1.05	7.67
400	34.4	1.41	48.50
460	18.8	1.50	28.20
520	10.5	1.61	16.91
600	21.9	1.72	37.67
740	37.7	1.92	72.38
825	14.3	2.02	28.89
890	55.0	2.10	115.50
945	3.9	2.16	8.42
1,120	9.3	2.40	22.32
1,280	9.6	2.49	23.90
1,350	13.6	2.60	35.36
1,480	7.0	2.67	18.69
1,550	4.0	2.76	11.04
1,740	17.9	2.92	52.27
1,870	3.0	3.02	19.06
1,970	17.2	3.08	52.98
2,120	17.6	3.23	56.85
2,200	15.1	3.28	49.53
2,580	29.1	3.58	104.18
2,930	24.4	3.81	92.96
4,540	12.7	4.74	60.20
4,820	11.6	4.89	56.72
5,290	11.8	5.05	59.59
5,680	9.3	5.28	49.10
5,950	11.0	5.38	59.18
9,550	4.0	6.87	27.48
11,230	24.4	7.36	179.58
Total System	472.1		1399.55

LOWER RECHNA DOAB
QUALITY OF GROUND WATER

Fig 4

Groundwater quality

The groundwater quality of the area is represented in Figure 4. There are two types of water, native groundwater and the recharge. In native groundwater near the recharge area the range of concentration of dissolved salts is bout 200 to 500 ppm and the dominant ions in solution are calcium, magnesium and carbonates. In waters with concentration of dissolved salts between 500 to 2000 ppm, the native water is of mixed type. Sodium is the dominant cations, bicarbonates and sulphates are equally distributed among the anions. Where the concentration of dissolved salts exceeds 4000 ppm. Sodium and Chloride commonly comprised 75 percent of the ions. It is thus concluded that well drilled to a depth of 200 to 400 ft. and yielding 2 to 5 cusecs with capacity of 0.2 to 0.3 cusecs per foot of draw down, can be constructed almost anywhere within the project area.

Although the alluvial aquifer is highly anisotropic groundwater is essentially unconfined to depth of 400 feet or more. Withdrawal of groundwater can thus effectively control sub-surface drainage. The chemical quality of groundwater of about 60 percent of the project area is satisfactory. The recharge potential is considerable so that mining will proceed slowly if at all it does.

Problems of Irrigated Agriculture

Of all the factors of water supply, drainage and salinity dominate the problems of irrigated agriculture. The canal water supplies are distributed among the farmers by a water distribution schedule called a Varabandi, commonly between 7 to 10 days each acre owned gets a water supply. The farmer has free use of the water during his turn and may ply it to whatever crop or whatever number of acres he desires. A Varabandi on a typical distributary allots the farmer 15 minutes' turn per acre each week. Thus providing 1½ acre inch of water per acre per week, from an outlet of the capacity 2.05 cusecs. Under these conditions farmers historically have supplemented inadequate canal supplies with groundwater. In 1965 about 7000 Persian-wheels were in operation in the project area. In the same year nearly 3200 tubewells were in operation in Lower Rechna. The rate of private tubewells installation reached a peak in 1963 and since then it is declining. (See Fig. 5). Private tubewells are very profitable as they pay off their cost of installation in 2 or 3 years of operation if more than 50 acres is commanded.

The average command of tubewells in Lower Rechna Doab is 100 acres and each tubewell supplies about 200 acres feet of water. On the average, the cost of water from the tubewells is 24 rupees from a diesel unit and 15 rupees from an electric installation. The break-up of the cost is shown in Table 9.

The initial cost of the tubewell is quite high, the average diesel installation costs the farmer more than 9500 rupees and an electric tubewell costs nearly 7,400 rupees. Farmers with small holdings seldom are able to finance this initial cost and the higher fixed costs per acre make the tubewell somewhat less profitable to the small farmer.

The statistics for distribution of private well ownership verify that only the larger farmers are installing tubewells. Farms larger than 50 acres represent only one percent of the holdings and 9 percent of the farm area, but have two-thirds of the total tubewells. On farms larger than 150

TABLE 8

Installation of private Tubewells Lower Rechna Area

Year	Number Installed Annually			Total Number Installed		
	Saline 1/	Non-saline	Total	Saline 1/	Non-saline	Total
Before 1947	2	10	12	2	10	12
1947	..	6	6	2	16	18
1948	..	3	3	2	19	21
1949	..	9	9	2	28	30
1950	1	22	23	3	50	53
1951	..	21	21	3	71	74
1952	1	24	25	4	95	99
1953	3	57	60	7	152	159
1954	..	33	33	7	185	192
1955	3	69	72	10	254	264
1956	1	59	60	11	313	324
1957	5	107	112	16	420	436
1958	5	125	130	21	545	566
1959	4	132	136	25	677	702
1960	14	273	287	39	950	989
1961	18	279	297	57	1229	1286
1962	29	425	454	86	1654	1740
1963	23	547	570	109	2201	2310
1964	34	440	474	143	2641	2784
1965	35	372	407	178	3013	3191

1. More than 2,000 ppm TDS (not the "Saline Area" of this Project.

TABLE 9

Private Tubewell Costs-Lower Rechna Annual cost of Operation (in rupees)

Cost Item	Diesel		Electric	
	Total	Annual	Total	Annual
Capital Cost, Complete ..	..	9,560	7,382	..
Depreciation (except bore and strainer) 15 years.	..	534	..	389
Interest at 796 ..	..	335	..	258
Operational Costs 1/ ..				
1. Fuel/Electricity 2/ ..	..	2,126	..	1,589
2. Lubricant ..	..	451	..	74
3. Maintenance ..	..	225	..	194
4. Engine Overhaul ..	..	361	..	..
5. Operator ..	..	852	..	540
Total ..	9,560	4,884	7,382	3,044
		24		15

1/ With groundwater production at 204 acre feet/year.

2/ Diesel: 10 percent combined efficiency from fuel to water and 30 feet head, or 6.27 imp. gal/af at Rs. 79.80 per 48 gal. drum.

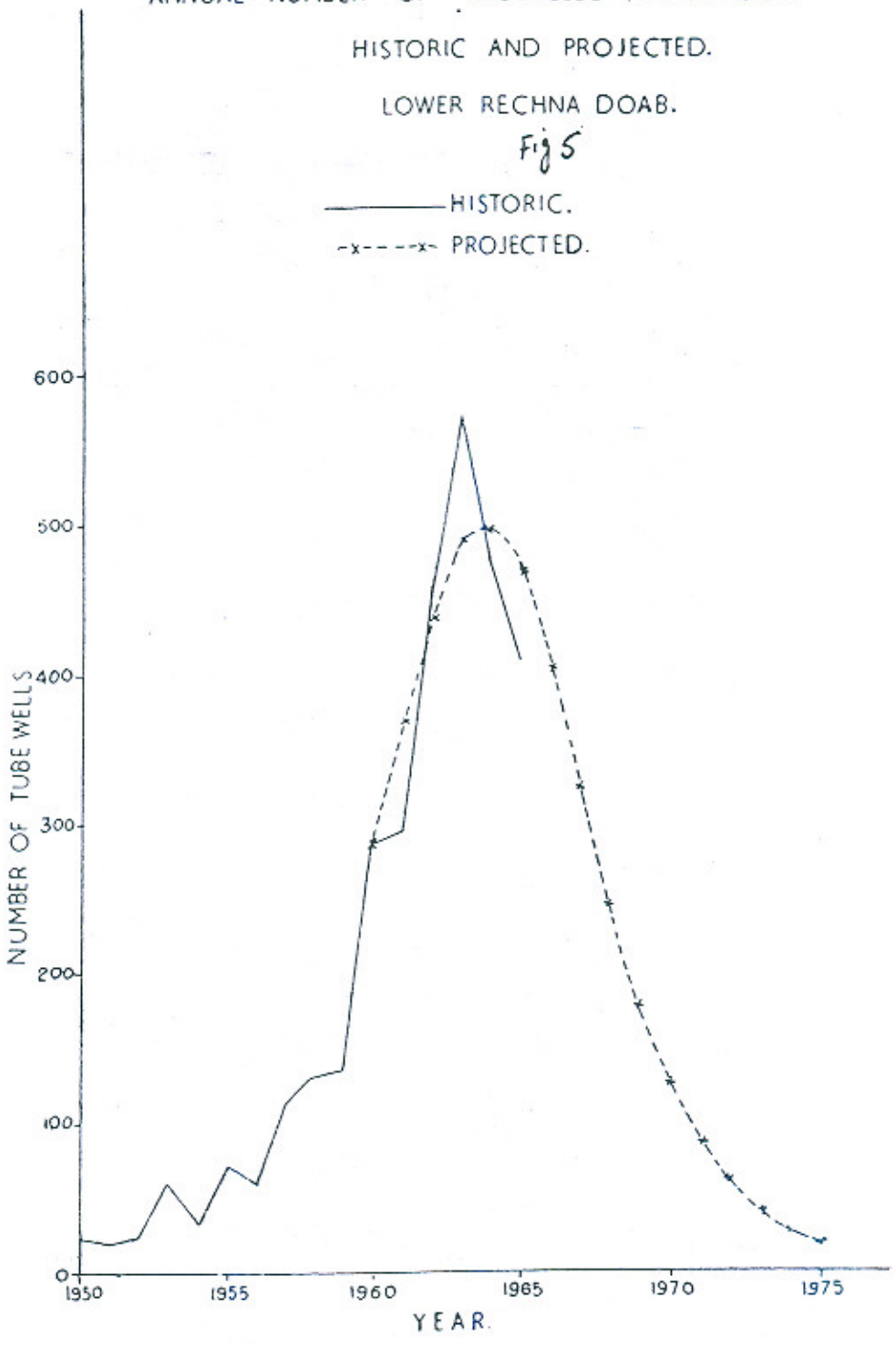
Electric: Combined efficiency is estimated as 32 per cent, and consumption is estimated at 19,860 KWH at Rs. 0.08/KWH.

ANNUAL NUMBER OF INSTALLED TUBEWELLS

HISTORIC AND PROJECTED.

LOWER RECHNA DOAB.

Fig 5



acres there is an average of 4 tubewells per farm and 6 farms out of 10 between 50 and 150 acres in size have tubewells. Only 4 percent of the farms between 25 and 50 acres have tubewells and of the farms smaller than 25 acres only one in 365 has a tubewell and these are predominantly on the special farms near Urban Centres. Thus it is apparent that even though tubewells are very profitable, only the wealthiest farmers can afford the initial cost of installation.

As most of the tubewells are in the non-saline groundwater areas it is likely that few large farms in those areas remain without tubewell supplies at the present time. The decline of private tubewell installation (see Figure 5) which has occurred since 1963 reflects this fact. The future rate of tubewell installation is uncertain but in 1966 it will probably not involve more than about 1.5 percent of the culturable lands of the entire project area. And the rate will continue to decline and will probably dwindle to inconsequence within a very few years as the supplemental irrigation requirements of the farms larger than 25 acres are met. Farms of this size that overlie fresh groundwater comprise less than 25 percent of the culturable area of the project, thus even if all of these farms had tubewells by far the largest part of the total area would remain uncommanded.

As to the problem of salinization as judged from inspection of the area, interpretation of laboratory data and discussions with farmers and local agriculturists, about 60 percent of the 4,10,000 acres of salt-affected land can be reclaimed by simple conventional methods (mainly leaching), approximately 30 percent will require leaching for a long period of time or leaching plus organic matter or small amounts of amendments and about 10 percent will require chemical amendments and skilled reclamation practices.

It should be emphasized again that the unfavourable supply management, and miscellaneous factors are largely the consequences of stagnation in agricultural development rather than the roots of the problem.

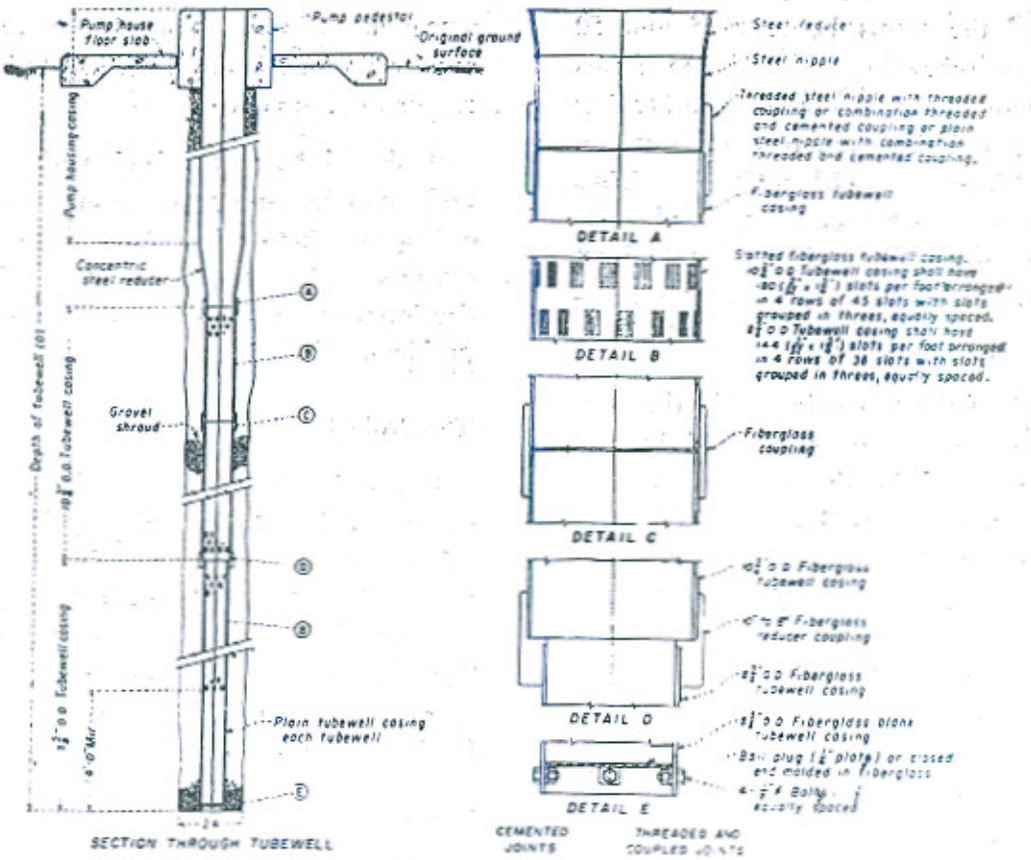
The Project

The project is based upon the installation of tubewells which will supplement the existing water supply. It also deals with the details of the Electrical Energy to be transmitted for operating tubewells remodelling of tubewells and canal structures will be necessary. Detail of each of these items is discussed in brief.

Tubewells

It is proposed to install about 2300 tubewells ranging in capacity from 2 to 5 cusecs. They will have a total installed capacity of 8760 cusecs, or 6.34 maf. per year. When the Project is fully developed, the tubewells will pump about 3.6 maf. annually from the groundwater reservoir, resulting in a utilization factor of about 65%. The tubewells will be sited and located on outlet by outlet basis.

The design of tubewells to be adopted is shown in Figure 6. The tubewells will be drilled by reverse rotary method to a diameter of 24 inches. They will range in depth from about 200 to 400 ft. depending upon the capacity required and the occurrence



VARIABLE CHARACTERISTICS AND DIMENSIONS

Tubewell capacity - cusecs	2.0		3.0		4.0		5.0	
Pump - head - ft	50	70	55	75	60	80	70	90
Column pipe dia - in	8	8	8	8	10	10	10	10
Column pipe length - ft	50	70	55	75	60	80	70	90
Bowl dia - in	12	12	12	12	15	15	15	15
Motor horsepower	20	20	30	40	40	50	60	75
Approximate lengths of casing - ft								
Pump housing casing - 16 "	0	0	0	0	80	105	90	115
Pump housing casing - 14" "	70	95	80	95	0	0	0	0
Slotted tubewell casing - 10 3/4" "	0	0	0	0	60	60	100	100
Blank tubewell casing - 10 3/4" "	0	0	0	0	10	10	10	10
Slotted tubewell casing - 8 3/4" "	100	100	120	120	100	100	100	100
Blank tubewell casing - 8 3/4" "	10	10	15	15	10	10	10	10
Approximate average depth of tubewell - ft	180	205	215	230	260	285	310	330

NOTES

All slotted tubewell casing to have minimum wall thickness of 0.20 in. All blank tubewell casing to have a minimum wall thickness of 0.18 in. Length of sections of both blank and slotted tubewell casing and their location in the tubewell string is to be determined in the field.

WEST PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
GROUND WATER AND RECLAMATION PROGRAM
PROJECT NO 5
LOWER RECHNA DOAB

TYPICAL TUBEWELL CONSTRUCTION WITH FIBERGLAS TUBEWELL CASING

Fig 6

of non-water yielding sediments encountered in drilling. Water will be used as a drilling fluid instead of mud. Blank casing and screen will be manufactured from epoxy-bonded fibre-glass, as is being used in Rechna, Chej and Thal Doab Projects. The screen will utilize centering guides and will be shrouded with a selected careful shroud. It will consist of well-rounded siliceous particles, sized in relation to the aquifer material and screen openings to provide a maximum permeability and effective well radius and to prevent an excessive amount of formation sand from entering the well during pumping. The casing for pump house will be of mild steel with a wall thickness of a one-fourth inch.

The tubewell will be developed by surging, overpumping, and back washing until it has reached a maximum specific capacity and is essentially free of sand and suspended sediments.

Deep turbine pumps will be used throughout the Project. The pump will be selected to pump at the desired rate at the pumping level anticipated near the end of their projected life. The pumps, however, will pump at more than the design rate during the initial period and for some years thereafter until the anticipated pumping levels are reached. The pump will be driven by vertical hollow shaft electric motors. The motor, starters and controls will be designed to provide maximum-protection to the motor from all kinds of electrical variations and faults. Components of pumps, motors, electric controls etc., will be standardized to permit interchange-ability of parts and to reduce the need for excessive stocking of spares.

IT IS ESTIMATED THAT THE IRRIGATION TUBEWELLS WILL HAVE A MINIMUM LIFE OF 40 YEARS.

When provided with normal maintenance the pumps, motors, and motor controls will be replaced once during this period.

The number and capacity of tubewells for non-saline and intermediate area is given in table 10 below.

TABLE 10

Summary of Tubewell Numbers and Capacities.

Tubewell capacity (cusecs)	Number of tubewells		Total
	Non-saline area	Intermediate area	
2	155	89	244
2½	..	52	52
3	461	86	547
3½	..	48	48
4	581	73	654
5	679	19	698
Total	1,876	418	2,294
Installed capacity (cusecs)	7,412.0	1,350.5	8,762.5

The spacing between the tubewells along the distributaries and minors will vary in accordance with outlet spacing, but commonly will be in the order of 3000 feet.

As to the electric facilities an arrangement for an installed capacity of 92,000 horsepower will be required for the tubewell. Average kilowatt per tubewell will be 41.5 which include 40 horsepower for the motor of each tubewell. Considering installation of 1000 private tubewells in the saline area, additional 10,000 horsepower will be needed, increasing the total to 102,000 kw. for the entire Lower Rechna area.

Surface Supplies

It is proposed that for the intermediate and saline area an increase of 130 percent of the existing authorised full supply for ten months of the year will be made. This will be made up by diversions of about 0.23 million acres feet of water from Upper Rechna during the period of October through May and the balance 0.22 million acres feet will be allocated from the rivers. This water will be utilized primarily by distributary off taking from Lower Chenab and Lower Gugera Branches. A detailed review of the carrying capacities of affected branches and distributaries indicates that major remodelling work will not be required to accommodate the increased flows.

FEASIBILITY OF THE SCHEME AND COST-BENEFIT RATIO

Hydrology of Groundwater

A study has been carried out about the recharge and withdrawal from groundwater. It indicates that the annual groundwater discharge will exceed recharge from Irrigation system by about 8,00,000 acres feet. It is estimated that in the future equilibrium, conditions will develop, the projected groundwater depth after 20 years of project operation are shown in Figure 7 so that the average decline of groundwater after 20 years of pumping will be 27 ft. and after 50 years of pumping about 40 ft. It is estimated that the groundwater below saline area will begin to decline after 5 to 10 years of project operation and future minimum depths will range between 5 to 20 feet. It is demonstrated that the maximum velocity of groundwater migration will be only about ninety feet a year. Such a low order of migration of water cannot pose practical threats to successful operation of the project. It is also estimated that due to the effects of private tubewells, pumpage and evapo-transpiration from crops, the decline of watertable in saline area may probably occur sooner than postulated.

Chemical quality of Irrigation supplies

In the intermediate area the salinity of groundwater will vary from 970 ppm to a maximum of 2200 ppm. In this area there will be 821 Chaks and in only 98 of the Chaks' the groundwater salinity will exceed 1500 ppm. This area comprised 35,800 culturable acres and is only 10 percent of the total intermediate area. In the saline groundwater area there are 178 privately owned tubewells working in groundwater of more than 2000 ppm. With the increase in surface delivery as provided in the project, recharge of fresh water will increase and more tubewells can be installed. It is estimated that tubewells up to 1000 of 1 cusec capacity can be installed by private farmers.

Direct Agricultural Benefits

In the recent years private tubewells have been installed in nearly 3,20,000 acres. It is estimated that with the reclamation

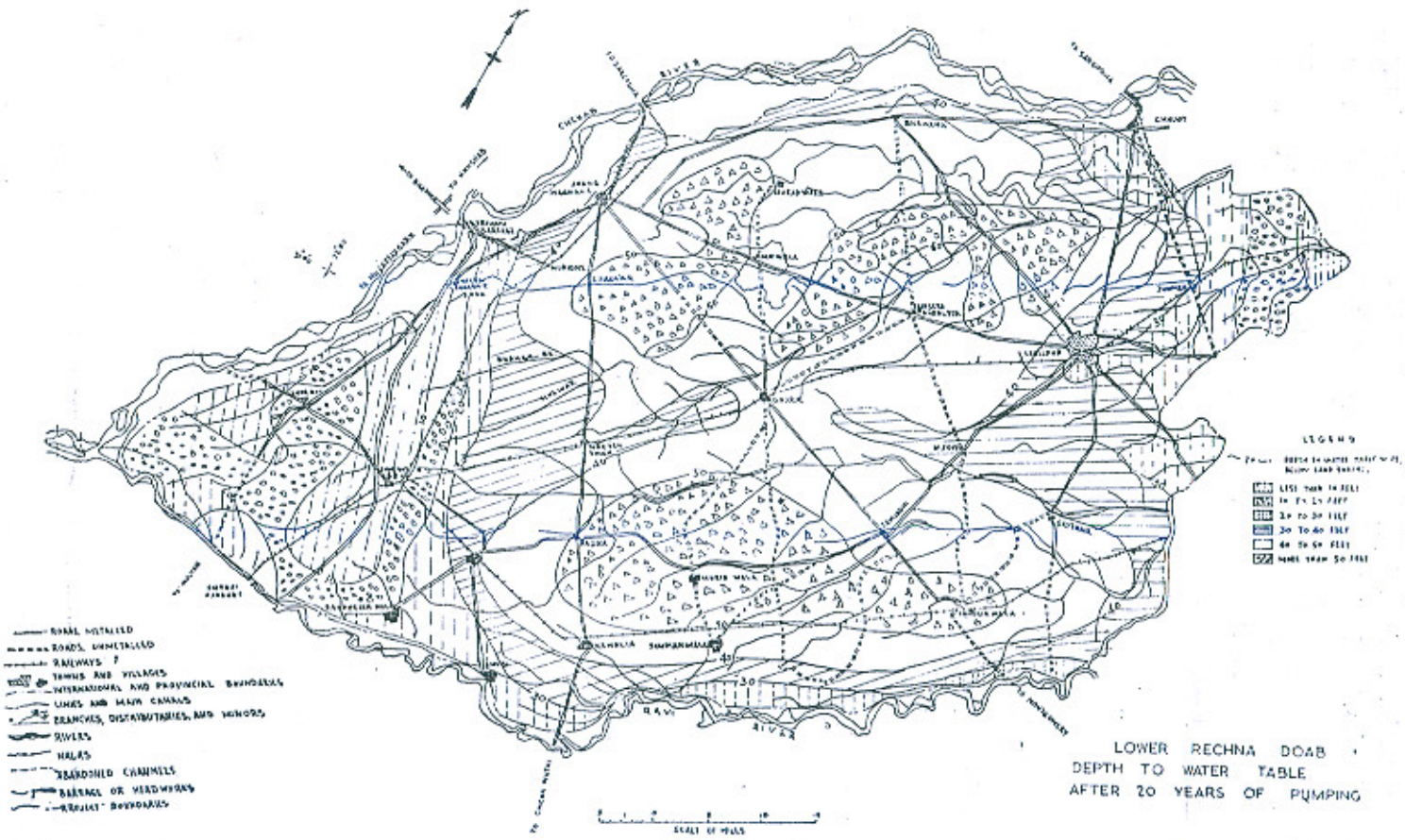

LOWER RECHNA DOAB
DEPTH TO WATER TABLE
AFTER 20 YEARS OF PUMPING
LEGEND
METALLED ROADS
UNMETALLED ROADS
RAILWAYS
TOWNS AND VILLAGES
INTERNATIONAL AND PROVINCIAL BOUNDARIES
LINES AND MAIN CANALS
BRANCHES, DISTRIBUTARIES AND MINORS
RIVERS
NALAS
ABANDONED CHANNELS
BARRAGE OR HEADWORKS
PROJECT BOUNDARIES
RAVI RIVER
CHENAB RIVER

Fig. 7.

project, by 1970, private tubewells supply will extend to about 4,70,000 acres which will show an increase of 6 percent per year from the present level of development.

After the introduction of Project No. 5, 4,26,000 acres of culturable and presently salt affected or waterlogged will be brought into full production. Land under cultivation will increase five percent and irrigated acreage will increase nearly 30 percent *i.e.*, from the present 2.5 million to 3.2 million acres per year. The average cropping intensity for the Project area will increase from 114 percent to 147 percent. The gross value of crops will increase 63 percent from 634 million rupees to 1035 million rupees per year. The long terms prospective increase in capital income of Lower Rechna is compared with the whole of Pakistan and West Pakistan in table below

	1965	1970	1975	1980	1985
Perspective (Pakistan).	386	467	577	727	932
(West Pakistan)	442	531	627	750	932
Lower Rechna	370	500	775	975	1175

Economic evaluation

The total construction cost of the Project is estimated at 328.3 million rupees, 203.7 million for tubewells and other works and 124.6 million rupees for electrification. The detail is given in two statements in Tables No. 11 and 12.

Of the total construction cost 128 million rupees slightly less than 40 percent, is in the form of foreign exchange. It is required for electrification. The annual payment required to amortize the loan for tubewell construction, interest during construction, and interest during development is 13.6 million rupees. Twenty-six percent of this amount is for the foreign exchange component.

Cost-Benefit ratio

In the absence of the Project, the present worth of the return to land and family labour over the same period of time would be 4,963 million rupees. The present worth of Project benefit is the difference between these values, of 5,682 million rupees. The benefit-cost ratio for the Project is 8.3 to 1.

TABLE 11

Estimate of Capital Cost—Electrification
(Foreign Cost expressed in U.S. Dollars)

SCHEDULE ONE

		$ (1000)	Rs. (1000)	Eq. Rs. (1000)
1.	Construction of power facilities			
(*a*)	Transmission line	180	360	1,217
(*b*)	Substations (less transformers)	2,520	5,550	17,545
(*c*)	Power transformers	810	675	4,531
(*d*)	Distribution lines	5,250	15,000	39,990
(*e*)	Transformers and services	2,110	3,338	13,382
(*f*)	Capacitors	..	570	570
(*g*)	Land	..	69	69
	Total	10,870	25,562	77,304

2. Construction plant, equipment and facilities furnished; by WAPDA.				
(a) Camps and facilities	..	5	400	424
(b) Transportation equipment	..	..	220	220
(c) Spare parts	..	6	10	39
(d) Engineering equipment	..	3	3	17
Total	..	14	633	700
3. Administration, engineering and supervision	..	1,632	3,929	11,697
4. Contingencies	..	1,632	3,929	11,697
5. Customs duties and sales-tax	..	..	13,950	13,950
6. Interest during construction	..	..	9,298	9,298
Total Capital Cost	..	14,148	57,301	124,646

TABLE 12

Estimate of Capital Cost—Reclamation Items
(Foreign Cost expressed in U.S. Dollars)

		$ (1000)	Rs. (1000)	Eq. Rs. (1000)
1. Tubewells and appurtenant works				
(a) Tubewell construction	..	6,988	32,513	65,776
(b) Pumps, motors, controls	..	2,458	26,550	38,350
(c) Spare parts	..	164	3,120	3,900
(d) Pumphouse and quarters	..	..	10,323	10,323
(e) Water distribution works	..	..	5,735	5,735
(f) Land	..	..	860	860
Sub-total	..	9,610	80,601	126,344
2. Canal repairs and stabilization	..	..	1,500	1,500
3. Outlet remodelling	..	..	1,500	1,500
4. Construction plant, equipment and facilities furnished; by WAPDA :				
(a) Camps and facilities	..	72	5,657	6,000
(b) Transportation equipment	..	..	1,980	1,980
(c) Spare parts	..	54	90	347
(d) Engineering equipment	..	30	30	173
Sub-total	..	156	7,757	8,500
5. Administration, engineering and supervision (15%)		1,465	13,479	20,452
6. Contingencies (15%)	..	1,465	13,479	20,452
7, Customs duties and sales-tax	..	..	11,200	11,200
8. Interest during construction	..	..	15,293	15,293
9. Total Capital Cost	..	12,696	143,309	203,741
10. Investigations, planning and project preparation (1-1/2%).		190	2,150	3,056
11. Less salvage of construction vehicles and equipment		..	2,500	2,500
12. Net Book Capital Cost	..	12,886	142,969	204,297

News and Notes

PROCEEDINGS OF SOUTH EAST ASIAN REGIONAL CONFERENCE ON SOIL ENGINEERING

This Conference was held recently at Bangkok. Its proceedings are now available for $20. Orders for the proceedings may be addressed to the Conference Committee, South East Asian Regional Conference on Soil Engineering, P. O. Box 2754, Bangkok, Thailand. At the time of the Conference a Soil Engineering Society was formed representing various countries including Pakistan. The membership of the Committee has now exceeded one hundred. It is open to interested engineers. The annual subscription fee is $5.

SEATO GRADUATE SCHOOL OF ENGINEERING NEWS ASIAN INSTITUTE OF TECHNOLOGY

In August 1965, it was proposed to change the Seato Graduate School of Engineering into an independent Regional Institution. This proposal was approved by each of the eight founding countries. The Constituent Assembly of Thailand also enacted it into a law.

The idea of having a Graduate School of Engineering for South East Asia was conceived by His Excellency, Mr. Pote Sarasin, the first Secretary-General of SEATO. The establishment of the Graduate School was authorized at Wellington in 1959 and Bangkok (Thailand), was selected as a desirable central locations. It was established on 30th July 1959 by a Royal Decree of the Thai Government.

The first classes were started on 8th September 1959. During the eight years of its existence as a Graduate School, the enrolment of students have climbed from an initial group of 19 students to the present level of 151. To date, 175 students have received the Master of Engineering degree.

The Asian Institute of Technology, will now operate as an independent entity aiming to alleviate the critical shortage of engineers and technologists in South East Asia.

The power to manage the affairs of the Institute is vested by the Charter in the Board of Trustees consisting of not less than nine and not more than sixty members. The Board elects one of its member to serve as Chairman. The Chief Executive Officer of the Institute will be the President responsible for conducting the affairs of the Institute. The present Member of the Board of trustees includes His Excellency Mr. P. M. Chaudhuri, Pakistan Ambassador to Thailand, Dr. M. A. Rashid, Vice Chancellor, East Pakistan University of Engineering and Technology Dacca and Mr. A. R. Zubair,

(*Continued on page* 105)

Building Department Separated from Highways

WEST PAKISTAN HIGHWAYS DEPARTMENT

MIAN SAEED AHMAD

First Director General Highways



The old Buildings and Roads Department was again bifurcated from first October 1967 into two independent departments of Highways and Buildings. A few years earlier a similar separation of Public Health Department from the B & R Department took place.

The dimension and development objectives of the current and future five year plans has posed an impressive challenge, to both the departments of Highways and Buildings. A road system to develop and maintain to foster the economic development and integration of West Pakistan to maximize, the economic return of road investment was being felt since a long time. The present radical change is a step towards that end.

Mian Saeed Ahmad, a dynamic member of the profession, previously Chief Engineer Highways, now heads this new Department as Director General. Since July 1961, Mian Saeed has functioned as Deputy Chief Engineer, then for four years as additional Chief Engineer followed by Chief Engineer Highways in addition to Director General Housing and Settlement agency and finally the present assignment of the Director General, Highways.

Mian Saeed has now about 24 years service in the parent Department. After graduating from the Punjab Engineering College, he joined the department in October 1942. In July 1949 he was taken in class I and worked as Superintending Engineer from October 1953. and later was promoted as Deputy Chief Engineer in 1961. During his long service he worked for several years as Secretary West Pakistan Engineering Congress, has attended administration Staff College and other important programmes.

In his head office at Lahore Mian Saeed, is assisted by three directors of the rank of Superintending Engineers. Seven Assistant Directors, nine Assistant Engineers and other officers.

He also controls the functioning of the Directorate of Bridges and Research. The

bridges directorate is getting constructed five bridges, on Jhelum near Jhelum town, on Sutlej near Bahawalpur, on Ravi near Chichawatni, Kabul near Jehangira and Liari near Karachi. The planning of bridges over Chenab near Talibwala, over Jhelum near Khushab, over Ravi near Mari Pattan over Indus near D. I. Khan is in hand.

Karachi Hyderabad Highways has entered the construction stage and three superior type of highways the Lahore-Sheikhupura, Lyallpur-Sheikhupura, Sargodha-Khushab and Lahore-Multan are in advance stage of detailed design.

The Director General controls five regional offices headed by Chief Engineers, Deputy Chief Engineer. The regions with their chiefs having

(1) The Chief Engineer, Highway, Northern Region, Peshawar (Peshawar and D. I. Khan Civil Divisions).
(2) The Chief Engineer, Highway, Western Region, Quetta. (Quetta and Kalat Civil Divisions).
(3) The Deputy Chief Engineer, Highway, Central Region, Lahore (Lahore, Rawalpindi and Sargodha Civil Divisions).
(4) The Deputy Chief Engineer, Highway, Eastern Region, Bahawalpur (Bahawalpur and Multan Civil Divisions).
(5) The Deputy Chief Engineer, Highway, Southern Region Hyderabad (Hyderabad, Khairpur and Karachi Civil Division).

WEST PAKISTAN BUILDINGS DEPARTMENT

M. A. WAHEED

The Buildings and Roads Department is now split up into two independent Departments of Buildings and Highways headed by two separate Director Generals. The bifurcation took place on 30th September 1967. Mr. M. A. Waheed P.S.E.I., now heads the Buildings Department. Mr. Waheed Graduated from United Kingdom and started his carrier as a temporary engineer on first September, 1937, in the Irrigation Department. He later on went over to the former B & R Department on 16th April, 1940. He was appointed as Superintending Engineer on 12th July, 1950 and later on in November, 1959 was promoted as Chief Engineer.



In 1951 he participated as a member of the Pakistani Mission of Highways and Bridges to Canada. He spent about three months on this assignment. Recently he was a Chief Delegate of the Pakistan Mission to Iran on the same subject.

Mr. Waheed now heads an organization spread into five Regions. The three Chief Engineers are incharge for the Central Region at Lahore, another for Eastern Region at Bahawalpur and the third for Southern Region at Hyderabad. There are two Deputy Chief Engineers, one for the Northern Region at Peshawar and the Second for Western Region at Quetta. The other attached organizations include the Building Research Station at Lahore and the Chief Consulting Architect. There are five Regional Consulting Architects attached to each Region. The new assignment of Mr. Waheed has thus been vastly expanded responsibility for Buildings Construction.

Mian Muzaffar Ahmad Chief Engineer, Irrigation Quetta Retires

Mian Muzaffar Ahmad retired after 30 years of strenuous service in the Irrigation Department. Having graduated from Sheffield University he joined the Central Public Works Department in 1934. After three years he joined the Irrigation Department and worked on various assignments connected with investigations and surveying of dams sites in addition to maintenance and running of canals. In 1945 he was appointed as Executive Engineer and his field duties included the construction of Thal Canal. In 1951 as Superintending Engineer he undertook a difficult job of construction of Balloki Suleimanki Link lined canal. Five years later in 1955 he took over as Director, Irrigation Research Institute, Lahore, where besides administrative control, he directed the research activities of the Institute. He showed keen interest in the problems of design of Irrigation Works, Waterlogging and Salinity and such other allied problems being investigated in the Research Institute.



In August, 1959, he was promoted Deputy Chief Engineer with responsibility to Plan Irrigation and Drainage Schemes, Remodelling of Marala Ravi Link and River Training Works at Marala and Balloki Headworks. In 1962 he took over as Chief Engineer, Quetta Region with responsibility to develop the water resources for this arid area of West Pakistan.

Mian Muzaffar Ahmad had a chance to visit many foreign countries in the continent. He visited the Drainage Works in Egypt, Netherland and France. As a representative of West Pakistan Government he attended World Power Conference at Belgrade. He was also a Member of the Technical Survey Mission to Saudi Arabia.

As a scientific engineer, he has about 15 publications submitted to various scientific and engineering societies. Mian Sahib's interest in the profession still remains. After retirement he has now taken over as Managing Director of National Consulting Engineers. We wish him success in his new undertakings.

Mr. Habib Ullah Jalal-ud-Din Asar, Chief Engineer, Remodelling Retires

Mr. H. J. Asar has recently retired from the Irrigation Department as Chief Engineer, Remodelling Organization. Mr. Asar obtained his Engineering education from N. E. D. Engineering College, Karachi. In 1934, his first assignment was as an Assistant District Engineer inTharparkar Sind. In 1939, he took over as Assistant Engineer in the Ex-Punjab Government, where he started as Sub-Divisional Officer. At the time of Independence Mr. Asar was stationed at Patiala holding a Division. On migration he was placed Incharge of Major Construction of Thal Main Line Lower. He lined 25 miles length of the canal which is an excellent piece of constructional work. For a short period he worked as Under Secretary to the Government of Ex-Punjab in 1951 before taking over as Superintending Engineer Project Circle. He investigated several storage schemes and prepared a Pilot Project of preventing erosion in the upland districts. During this period he investigated three alternative links alignments extending from Durband to Panjnad. He worked on the Project of Chiniot Dam. In January 1960 he was Deputy Chief Engineer, Irrigation Incharge of operation and maintenance of canal system before taking over as the Project Director, Remodelling in October of the same year. He prepared twelve different Projects of Remodelling of existing canals barrages and canals. The Remodelling of Marala Weir, Balloki Headworks remained active under his scrutiny and suggestions for alternative proposals. About 18 heavy works of Remodelling were carried out on Lower Bari Doab within a short period of 21 days. All the various constructions connected with Marala Ravi Link, B. R. B. D. Link and B. S. Link were his responsibility as Chief Engineer, Remodelling. He was the real co-ordinating link between WAPDA and Irrigation Department where all the Indus Basin Projects prepared by WAPDA's Consultants were reviewed.



It was the remodelled B.R. B.D. Link which with-stood the onslaught of enemy attack in September 6, 1965, and the canal remained flowing throughout the period of hostilities as well as after cease fire.

With regards to his technical attainment in the profession he served as Honorary Secretary of the West Pakistan Engineering Congress for three years. He remained as Vice President of the Institute of Engineers for two terms from 1959 to 1963. Later on he was the Chairman of the Lahore Centre of the Institute of Engineers for 2 years. Due to his active interest in the promotion of the Engineering knowledge he got the A. M. I. E. Examination recognised as equivalent to any other Engineering degree for recruitment to all Engineering Services.

He is a nominated member of the Institute of Engineers, Pakistan to the Irrigation and Flood Control Research Council, Government of Pakistan.

During his long service of thirty-three years he has served the interest of the profession. We are sure due to his vast experience of the Engineering profession, keen interest and deep knowledge, he will be far more successful as Director of National Consulting Engineers which is his new interest after retirement.

We as member of the profession which he has served so long, so efficiently and successfully, wish him a long life of happiness, prosperity and good health.

Continued from page 100

Vice Chancellor West Pakistan University of Engineering and Technology Lahore.

The curricula includes five Engineering subjects in which Master degrees can be obtained after conducting training and research. The subject of study includes, Hydraulic Engineering, Public Health Engineering, Soil Engineering, Structural Engineering and Transportation Engineering.

Recently the Asian Institute of Technology has issued its catalogue for the year 1968-69 and can be had by reference to the Academic Dean, Asian Institute of Technology, Henri Dunant Street, Bangkok, Thailand.

The Graduate School has now a record number of admission. At present 151 students are on its roll, eighty-seven were enrolled as first year students, while 64 were completing their second year study. The school presently has 24 Pakistani students on role. The other students belong to Hong Kong-2, Malaysia-4, Taiwan-14, Philippines-35, Thailand-69 and Vietnam-2.

Do You Know That

Abstracted from Civil Engineering, monthly Journal of American Society of Civil Engineers, New York, U.S.A.

Certain plants are so sensitive to air pollutants that they can be used as warning devices of a worsening air situation? Robert H. Daines, Plant pathologist at Rutgers University, reports that ethylene gas is highly toxic to orchid and carnation flowers and causes tomato plants to bend down. Each air pollutant-sulfur dioxide, nitrogen oxides, products of the photochemical reaction between pollutants and the air-is injurious at very low concentrations to certain species.

—o—

Some 6,000 lives a year might be saved by improving roadside design ? Improvements are needed in these areas—removal of objects such as trees and posts too near the roadway, and changing poorly designed or exposed ditches, embankments, slopes and guard rails. Trees and utility poles alone account for one-third of single car, off-road fatalities, reports anatomist Donald F. Huelke, of the University of Michigan.

—o—

About 80 per cent of all earthquakes occur in a belt surrounding the Pacific Ocean? This belt, called the "Ring of Fire," follows in a general way the border between continents and oceans, coinciding with zones in which mountain-building processes are still taking place. The U. S. Geological Survey estimates that from 3 to 5 million lives have been lost in the past 1,000 years from earthquakes and volcanoes. On the basis of past events, a catastrophic earthquake will strike the earth about once a year, and its energy will be equivalent to that of thousands of atomic bombs.

—o—

You can buy London Bridge? The famous multiple-arch bridge, soon to be replaced, will be put on sale by the City Corporation, the governing body of London's financial district. The present London Bridge is the third. The first was a wooden span built across the Thames by the Romans; the second London Bridge, the one that falls down in the nursery rhyme, was begun in 1176. The present, five-arch, four-lane

bridge, opened in 1831, was built by Sir John Rennie. It will be replaced by a six-lane crossing that can handle more traffic. Demolition of the present structure will not start until November 1968, and the new bridge will be completed in 1970.

—o—

There are elephants under the sea? A large population of Ice Age elephants—mastodons and mammoths—roamed on what is now the submerged Atlantic Continental Shelf from 25,000 to 11,000 years ago, according to Geological Survey scientists. An increasing number of fossil bones—particularly teeth weighing several pounds each—are being discovered in continuing sea bottom samplings off the East Coast by scientists of the Survey and the Woods Hole Oceanographic Survey. The two agencies are making a joint five-year study of the sea bottom from Georges Bank, off Cape Cod, to off the Virginia Coast.

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Germs cause rust and can also destroy roads? Bacteria called desulfovibrio-isolated in the Army's secret germ-warfare laboratories at Fort Detrick, Md. were found to contribute to a considerable extent to metal corrosion both beneath the ground and in water. Oddly enough, the same bug is said to be eating bitumen roads in parts of western Australia by destroying the oily substance that makes the bitumen elastic and resistant to weather. Though these new things have been discovered about desulfovibrio, the bug itself is not new. It has been known as a bacterium in soils for 100 years. Its new found destructiveness was reported in the *Washington Post*.

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Experts are trying to keep the Leaning Tower of Pisa from falling? Hundreds of scientists and engineers from all over the world have answered an appeal made by the Italian Ministry of Public Works and have submitted plans they think will keep the famous tower from leaning further. For various reasons (often cost) the technical commission appointed by the Ministry has been obliged to reject all plans so far advanced. All agree, however, that there is real danger of the tower's coming down at any time, as the tilt continues to increase each year.

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The Russians are going to drill deep into the earth? In their counterpart of the Mohole Project, they are working on plans for an enormous drilling rig that will penetrate the earth's crust to a depth of 10 miles or more. The hoisting tower, as now planned, will be almost 250 ft. high, about twice the height of rigs currently being used to sink holes of 4 or 5 miles. The purpose of the four-year project is to obtain a cross-section of the earth's crust beneath Soviet territory and to determine the role of the mantle beneath it in distilling metallic ores out of deep rocks.

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If the world's ice melted, results would be disastrous? Hydrologists with the U. S. Geological Survey estimate that about 2 per cent of the earth's water is stored in the icecaps and glaciers that cover about 10 per cent of the earth's land surface. A slight rise in world temperature would melt this ice, raising the sea level between 200 and 250 ft. and drastically changing the map of the U. S. Much of the East Coast, especially the Chesapeake Bay area, Florida and the rest of the Gulf Coast would be under water; Seaports would spring up in such unlikely places as Rochester, N. Y., and Columbia, S. C.

From Here and There

LARGEST WALKING DRAGLINE BEGINS STRIP MINING IN AUSTRALIA

What is reported to be the world's largest walking dragline began work this summer on the Moura coal mine in Australia. A marion 8,900, the 7,000-ton unit has over 18,000 hp. It is equipped with a 130 cu yd dragline bucket that will strip overburden in 196-ton bites. A four-man crew operates the machine, which can travel up to 800 ft. an hour.

TRANSPORTATION OF SOLIDS BY PIPELINES

Low cost is speeding the use of pipelines for transporting solids? Pipelines for the transport of natural gas and oil have been found to offer so many advantages over batch delivery that they are now being tested and installed for moving such solids as sulphur, coal and potash, which can easily be treated to make them suitable for piping. While the initial cost of building the pipelines is high, their opefators say the advantages are worth the expense for large-quantity movements. For instance, it costs $2 to pile a ton of liquid 1,000 miles, compared to $4 for carrying by roailroad tankcar. In addition, both producers and users are able to cut storage fees as well as traffic and weather delays.

ASWAN DAM

One Aswan High Dam turbine is in operation. On October 15, the Nile River flowing through a huge tunnel started the first of the twelve hydroelectric turbines that will produce cheap power for Egypt. By January 9, the eighth anniversary of the start of construction, three turbines will be feeding 300,000 kw of electric energy into the lines already built to transmit the power to Cairo, 500 miles away. The dam is 80 per cent built, and completion is expected before the start of the Nile flood season next August.

GUARD RAILS PROMOTE HIGHWAY SAFETY

Impressive safety records were established in 1965 on express highways of four or more lanes that have protected their median malls with resilient steel safety barriers—usually deep-beam guard rail to prevent cross-over head-on collisions. This fact is brought out in the 1965-66 Annual Report on Steel Highway Safety Barriers, compiled by the American Iron and Steel Institute.

Reductions in motor-vehicle traffic deaths, ranging from 30 to almost 90 per cent, were recorded on highways of four or more lanes after installation of guard rails. On many of these highways, fatalities resulting from cross-over head-on collisions have been almost eliminated.

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