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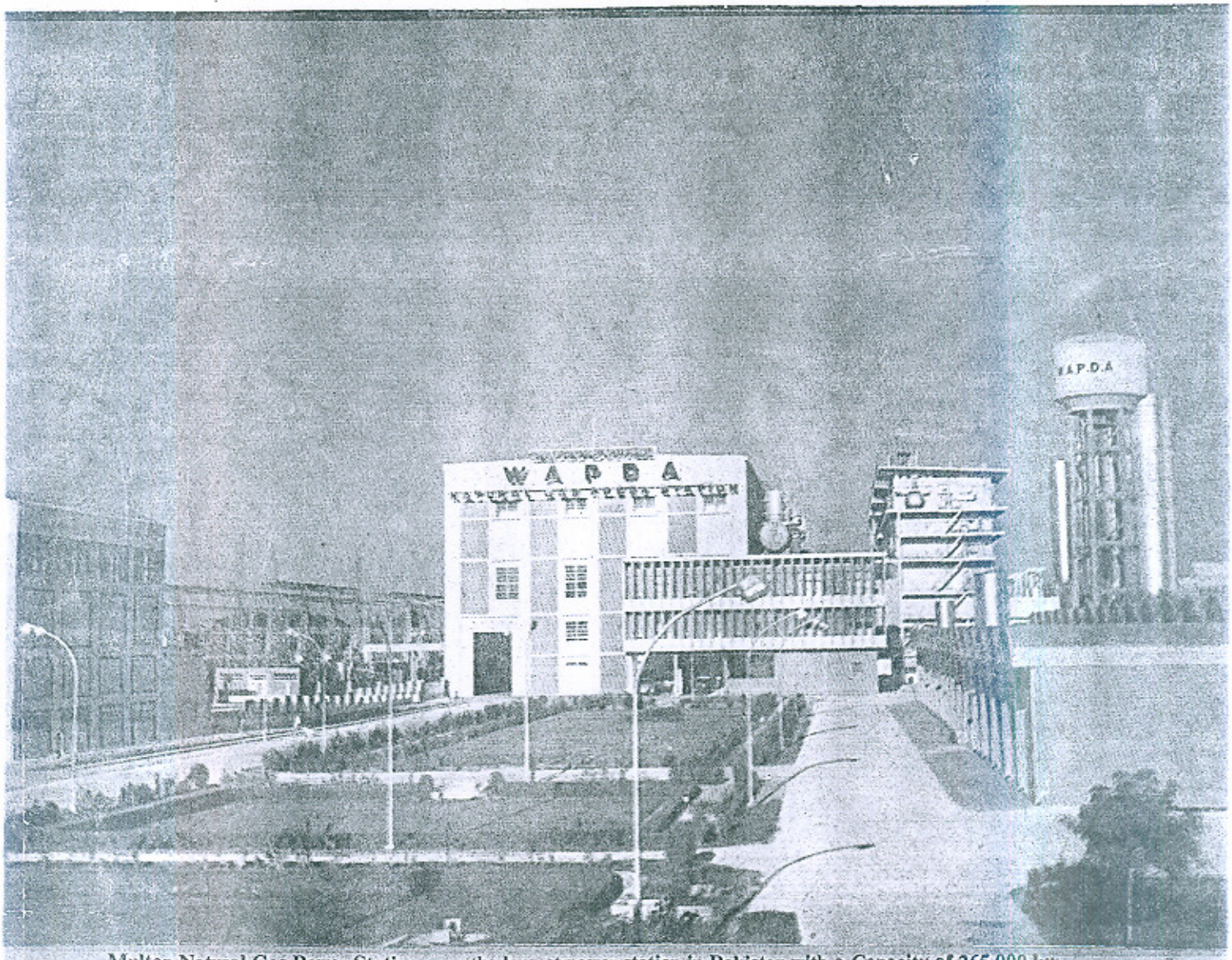
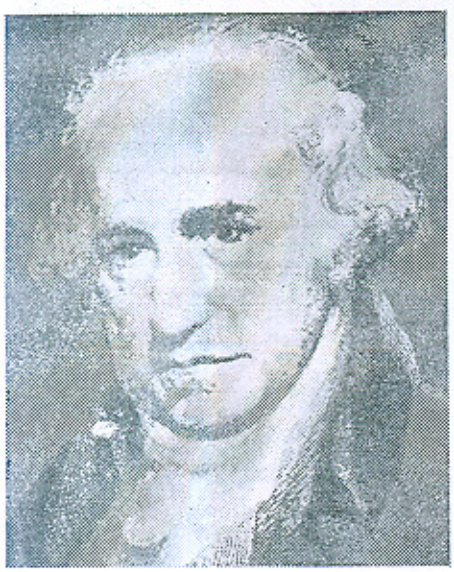


Multan Natural Gas Power Station . . . . the largest power station in Pakistan with a Capacity of 265,000 kw.

PIONEERS OF ELECTRICITY



JAMES WATT (1736—1819)

James Watt was born at Greenock, in Scotland on the 19th *January* 1736 *and began his remarkable career as a mathematical instrument maker. He made radical improvements to Newcomen's engine first by adding his parallelogram, then double action, the slide wall, a fly wheel, a centrifugal governor and finally expansion gear in* 1782. *His improvement to the steam engine and finally production of the famous "Carnish engine" made him undisputed authority of his time on mechanical driving force. Although Watt devoted most of his life to steam as a driving force and heat-transmitting medium, his early fascination for Belidor's work made him into a competent hydraulician. His achievements in this field included a study of navigation conditions in the Clyde, designing and building of dry dock at Port Glasgow and Greenock West Harbour and number of canal projects.*

The Unit of Electric power is named after him.

GEORGE SIMON OHM (1787—1854)

George Simon Ohm was born at Erlangen in Germany in 1787, *and started his career as Professor of Mathematics and Physics at the Jesuit College in Berlin and then at Berlin War College. Later on he was made Director of the Nuremberg Polytechnic School and Professor of Physics, at Munich University. He died in Munich in* 1854.

His most famous work was the "Mathematical Theory of Electric Currents" (Published in 1827) *which contains all the principal formulae for the propagation of an electric current in a whole or partial circuit. Famous Ohm's Law is named after him.*

CHARLES WHEATSTONE (1802—1875)

Charles Wheatstone was born at Gloucester. In 1823 *he published "New experiment in Sound." In* 1834 *he was elected Professor of Experimental Philosophy at King's College London, where he served for few years before turning his attention to the Science of Electricity. His first invention of the series was revolving mirror (to measure speed of electric discharge in conductor). Then followed his invention the "Submarine telegraph, polar clock, the writing telegraph, the rheostat, a photometer, the stereoscope, and wheatstone bridge which is still the basis of many measuring circuits.*

He performed research which was forerunner of modern spark photometry and method of Chemical Analysis.

He published "Physiology of Vision (1852), *the binocular Microscope* (1853), *Arithmetical Progression* (1854) *and the Automatic Telegraph in* (1859)." *He was made honorary member of the Institution of Civil Engineers in March* 1875 *and died the same year on* 19*th of October.*

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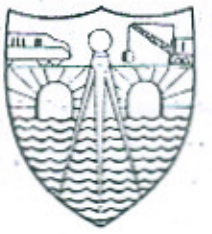
In this issue



WAPDA BRINGS POWER TO WEST PAKISTAN

Within the last five years there has been a vast augmentation in electric generation and transmission in the country. Before independence there were only two hydel power stations in Northern India. One was at Jogindarnagar, which went to India on partition, and the other at Jabban in Malakand, which fell to the share of Pakistan. Besides this, a few main towns had steam generating plants which, in general, were of insufficient capacity to meet their requirements. Such were the deplorable conditions till 1960, when two events of far-reaching effect occurred. One was the discovery of large deposits of natural gas at Sui and seven other fields in West Pakistan totalling recoverable gas reserves of 12.8×10^{13} cu. ft. The Sui gas field, alone, was found to have a reserve of 5×10^{13} cu. ft. This God-given gift is so vast and valuable that, by wise exploitation and proper utilization, the nation can benefit by it for several generations. The other important and historic event was the setting up of an organization to put this God-given gift to proper use. This is the West Pakistan Wapda. This great institution with the dynamic drive of its Chairman and Executive, is utilizing this great reservoir of energy to the best advantage. The power potential available in the country till about 1955 was barely 40,000 k.w., but at present it stands at the colossal figure of 700,000 k.w., an increase of 1750%. Of these, 265,000 k.w. are produced at Multan, 20,000 k.w. at Hyderabad, 15,000 k.w. at Quetta, 25,000 k.w. at Sukkur, 8,000 k.w. at Montgomery, 6,000 k.w. at Lyallpur, 4,000 k.w., at Kurrum Garhi, and other places. Many more new Stations and extensions to the existing ones are in the planning stage or under execution. One of the important new stations will be at Lyallpur, producing 130,000 k.w., and the Gomel Dam, when completed, will produce 135,000 k.w. Never did Wapda omit to utilize the vast hydel power potential. It was only in about 1952 that, utilizing all the resources and putting in best effort, the Rasul Hydel Station, yielding an output of about 20,000 k.w., could be completed. Under Wapda,

hydel utilization at Chichoki, Shadiwal, Nandipur, Dargai and Warsak made a further 296,000 k.w. of energy available. By 1969, Mangla will be producing about 300,000 k.w., its ultimate capacity being 600,000 k.w. West Pakistan has many more unutilized resources of hydel powers. It is estimated that about 10 m. kw. can be produced from the water potential alone. Tarbela, when completed, will yield 1.1 m.k.w., and the upper reaches of the Indus in Gilgit have a power potential of 1 to 2 m.kw.

Besides, there is a large potential at the canal falls, which is going waste at present.

Even Sind, in the Southern Zone, has a power potential of approximately 83,000 k.w. from four falls at Kalari lake, Jamroa weir, Rohri canal, Kashmore and Choti canals D.G. Khan.

This phenomenal increase of power resources can play a fundamental role in the prosperity of the nation. Nevertheless, the production of power in the country is very expensive. The reason is obvious. From 80 to 90 per cent of the necessary equipment has to be bought from foreign countries. This, and the high expenditure on the salaries of foreign experts and advisers, raises the cost of all projects. How much more prosperous the country would be if this burden of foreign exchange were lessened. However, it is gratifying to note that, making the best of a bad bargain, Wapda has put the country on the right lines of progress. It is now for the people as a whole to rise to the occasion, acquire technical skills, and produce as many electrical appliances as is possible. Wapda has set up an example of speed of development. The whole nation should gird up its loins and emulate the example.

The manufacture of electrical appliances needs skill, of a high degree, which the people of our country undoubtedly have the capacity to acquire. The example of the manufacture of household electrical appliances and equipment like fans, motors and small transformers is before us. In these we have not only attained self-sufficiency but are now even in a position to export them. Very soon, God willing, we shall become capable of producing turbines, generators, and other electrical appliances and machines essential for modern industry and modern living. It is true that we lack training institutions, proper research laboratories and, above all, qualified and trained personnel, but the people's will to progress is there, and production and prosperity will surely come.

Many polytechnics are being instituted, training institutions are being set up. Wapda has taken steps to establish an Electrical Research and Testing Institute. What is now needed is that the nation put its shoulder to the wheel, and win through by grit and perseverance.

Given the dynamic personalities at the helm of affairs and hard and devoted work by the nation, the prosperity of the country as a whole should not be far off. The example of the glorious achievements of West Pakistan Wapda is a beacon of light beckoning us towards the goal of national self-sufficiency and honour.

Power for Country's Development

By **Ch. ABDUL HAMID**
General Manager, Power, WAPDA.

This is the youngest branch of the Engineering Profession which has seen phenomenal expansion during the recent years. Before 1933, *there was no hydro-electric branch of P.W.D., and long-distance transmission of electricity was not in existence. A few big towns had their own limited electric production. At the time of independence the source of hydel power was also cut off and Pakistan had to start from a real scratch. During recent years Electrical Engineers have brought power to the country. Rasul Hydel producing* 20,000 *K.W. came in operation in* 1952, *followed by* 8,000 *K.W. at Montgomery in* 1954, 6,000 *K.W. at Lyallpur in* 1955, 20,000 *K.W. each at Malakand and Dargai,* 130,000 *K.W., at Multan in* 1960 *and another* 130,000 *K.W. is expected soon,* 20,000 *K.W. at Hyderabad,* 15,000 *K.W. at Quetta,* 25,000 *K.W. at Sukkur,* 12,000 *K.W. each at Chichokimallian,* 1959, *Shadiwal,* 1961, *and Gujranwala,* 1963. *Warsak can produce* 240,000 *K.W., thus in* 12 *years this branch of Engineering has produced* 690,000 *K.W. By* 1969 *Mangla will start producing* 300,000 *K.W. Work in fresh schemes of an aggregate capacity of* 193,000 *K.W. has started and by the end of the second five years plan, scheme have been approved to produce* 225,000 *K.W. of energy. This youngest branch has a startling roll of service to the country.*

In 1933, the Jogindarnagar Hydro-Electric Power Station of Uhl River Scheme was commissioned and power was transmitted for the first time over long distances through Extra High Voltage transmission lines to 18 towns of the Province. In those early days a good deal of canvassing had to be done to make people electricity conscious. In marked contrast to the present-day position the officials of Electricity Department had to go from door to door to persuade and enlist new consumers. The work of the field staff was adjudged from the number of applications received from prospective consumers. The public soon became aware of the advantages which electricity offered in all fields of human activity and thus the youngest branch of the PWD began to receive recognition both with the Government and the public.

The advent of war brought the industry into further prominence. Electric power

began to make an outstanding contribution to the war effort. It was not long before the supply and demand position was reversed. Whereas previously the departmental officials used to run after potential consumers, now the prospective consumers began to clamour for new connections. The Uhl River power began to be consumed quickly, so much so that Government was forced to ration electricity. New industrial connections could be given only with the sanction of a specially constituted Board. By the time the war ended the shortage of power became so acute that immediate necessity was felt for planning new schemes. Rasul Hydro-Electric Scheme was the first one conceived. Although this was primarily a scheme for tube-well pumping, the surplus power was available for supplying some of the towns along the route of the transmission lines also. Although the designs and layouts of the scheme had been prepared earlier but with the exception of the Power House Civil works, no work had actually been commenced till partition of the country took place in 1947 and Pakistan of which millions of people had been dreaming came into existence.

Shortage of Power

Among the multifarious problems which the new-born state had to face, shortage of power was one. Jogindarnagar Power Station was left in the part of the country which went to India and only a part of the transmission system fell to the lot of Pakistan. Under the partition agreement India was obliged to supply power to Pakistan for a couple of years only but as the conditions prevailed at the time no reliance could be placed on the import of power from India. It was a desperate situation. Supply to Lahore could be assured only through a small thermal station located at Shahdara. The bulk of the operating staff had migrated to India with the result that for days the station was manned by the officers of the Electricity Department assisted by whatever Muslim staff could be gathered. Warm tributes are due to the people who at the sacrifice of their comfort and health, faithfully and cheerfully went through shift duties under most arduous conditions and spent many a day and night in the power station premises to see that supply is maintained.

In order to make more power available in the shortest possible time, work on Rasul Scheme was pushed with all zeal and fervour. Efforts were simultaneously made to obtain whatever generating plant could be imported from abroad in a hurry. A second-hand steam plant of 6,000 KW capacity dismantled from Portsmouth (England) was purchased for installation at Lyallpur. An order was placed in Japan for a complete steam generating station of 6,000 KW capacity for installation at Montgomery. The position was so critical that even an old hydro-electric station located at Renala of barely 1,100 KW capacity had also to be brought into service for supplying power to consumers of the area. While all these measures were being taken supply continued to be obtained from India on the basis of yearly agreements. The quantum of power was reduced by India from year to year. It was not till 1952 when the Rasul hydro-electric station was commissioned that the Department could breathe a sigh of relief. Commissioning of the Montgomery Station followed in 1954. A diesel station of 8,000 KW and a steam generating plant of 6,000 KW capacity were commissioned in Lyallpur in 1955. Supply from India was discontinued thereafter.

Power from Frontier Area

Pakistan had to start almost from

scratch in many fields and so was the case in power generation and industrial development also. Side by side with others the problem of salinity and water-logging emerging in a menacing form had to be combated. The result was that whatever power generation was created in the old Punjab was quickly consumed and it was feared that shortage would soon appear all over again. At this stage thought was given to the possibility of drawing power from NWFP.

In that Province power stations had been created at Malakand and Dargai each of 20,000 KW capacity. At that time the requirement of power in NWFP was comparatively less. It was therefore felt that by interlinking the NWFP system with that of the Punjab, surplus power from the north could be transferred to the south. A 132 KV single circuit transmission line was accordingly installed connecting the Dargai and Rasul power stations. A special feature of this line was that it was erected departmentally (and not through a contractor) in the territories of both the Provinces. This imparted a great deal of experience to our staff which has been extremely useful to them and created a confidence in them to tackle almost any kind of line work without any outside help.

The PWD Electricity Branch of the Punjab during the eight years after independence *i.e.*, from 1947 to 1955, saw many upheavals. It started off with a Chief Engineer who was also Secretary to Government, but certain developments took place subsequently which resulted in the Branch being placed under Secretary to Government, Irrigation Department. Later on the Secretariat status was taken away from the Chief Engineer, and C.S.P. and others were appointed as Secretaries from time to time. In 1955, integration of the provinces took place and the entire West Pakistan Province comprising of NWFP, the Punjab, Sind, Baluchistan and the States of Bahawalpur, Khairpur, etc., was placed under one Chief Engineer, Electricity.

At the time the new Province of West Pakistan was formed the country was witnessing a considerable progress in industrial and agricultural development. This progress could not, however, be further accelerated without making adequate power available throughout the Province.

Discovery of Sui Gas

The discovery of natural gas near Sui pointed a way towards fulfilling this need. In 1934, at the instance of the Punjab, the Central Government entrusted the PIDC with the framing of a scheme for setting up a large power station in the Punjab using Sui gas as fuel. The PIDC steered the scheme through various Governmental channels and orders for a thermal generating plant of 130,000 KW, to be installed at Multan, was placed in 1956. Simultaneously, the scheme of laying a gas pipe line from Sui to Multan was also engineered by PIDC.

In 1958 it was realised that in view of the larger areas of which the new Province comprised and the rapid growth of development in various sectors it would not be possible for Government departments to plan and execute large water and power schemes, which were essential in order to create the requisite infrastructure for promoting the economic uplift of the country. An Act was accordingly passed by the Provincial Legislature whereby the Water and Power Development Authority came into existence. The authority settled down to earnest work in the beginning of 1959. The nature of the problems connected with electric supply industry

were such that it was considered expedient that the PWD Electricity Branch be transferred to the WAPDA. This was done in April 1959.

The staff then in the employment of the Electricity Department was considered as on deputation to the Water and Power Development Authority. The staff to be recruited after the transfer was to come on WAPDA cadre and was to be subject to WAPDA conditions of service. Multan Power Station Project and Multan-Lyallpur 220 KV transmission line scheme were also transferred to WAPDA by PIDC. An organisation for the co-ordinated development and operation of the electric supply industry throughout West Pakistan (except Karachi) thus came into being.

The progress made in power development during the past 4 to 5 years has been phenomenal. Thus can best be illustrated by giving brief details of the works undertaken and completed.

Power Station

(*i*) Multan 130,000 KW Thermal Power Station on which construction had been started in PIDC time was brought into commercial operation in 1960.

(*ii*) Immediately after the completion of the above Project it was felt that further generation would have to be provided at Multan if the anticipated growth of demand during the following 3 years was to be met. A scheme for duplicating the capacity of Multan Power Station was therefore prepared. The extension was to consist of two 65,000 KW generators to match with the two of the first phase of the Scheme. This timely action has enabled the capacity of the station to be raised to 2,60,000 KW as the two additional machines have since been installed and will be brought into commercial operation in November this year.

(*iii*) Hyderabad Thermal Power Station with a capacity of 20,000 KW comprising two steam generating units of 7,500 KW each and one gas turbine of 5,000 KW was commissioned in October 1961. Although this scheme was sanctioned by Government prior to the creation of WAPDA its implementation was held up because of delays in the procurement of material and equipment. The scheme originally provided for only the two steam generating units. The gas turbine had actually been purchased for Multan but was shifted to Hyderabad to augment the power availability in the Southern Zone of the Province.

(*iv*) A scheme for a Thermal Power Station of 15,000 KW was got sanctioned for Quetta. The foreign exchange cost was to be financed from AID loan. The work on the Power Station was started in 1962 and according to the present schedule it will be in commission by June 1964.

(*v*) A scheme for a 25,000 KW Thermal Power Station to be located at Sukkur was prepared and got sanctioned. This Scheme was picked up by the Canadian Government for financing the foreign exchange cost. The work on this Scheme is in progress.

(*vi*) Simultaneously with the above another scheme has been prepared for duplicating the capacity of Sukkur. This Project has received Government sanction and it is hoped that the Canadian Government will finance this scheme as well. They have evinced interest in this connection and it is hoped that implementation of the Scheme will be taken up within the current Five-Year Plan.

(*vii*) A Scheme for augmenting Hyderabad Power Station with two more machines of 7,500 KW each is also underway. The foreign exchange requirements in this case will come from U.K. loan. The work of supply and erection of plant has already been felt out and it is expected that the additional generation at Hyderabad will be available by the end of the current 5-Year Plan.

(*viii*) Taking into consideration the needs of the region a Steam generating plant of 8,000 KW capacity originally ordered for Lahore, is also being shifted to Hyderabad. Together with this the additional generation at Hyderabad will go up to 23,000 KW raising the total installed capacity of the Station to 43,000 KW.

(*ix*) While implementation of the above Schemes was progressing WAPDA launched a country-wide survey of potential power requirements. The work has been undertaken by WAPDA's general Consultants M/s. Harza Engineering Co. The survey has since been completed and results recorded in a Report named Power Market Survey, prepared by the Consults in collaboration with the Power Wing of WAPDA. As a result of this survey a shortage of power was indicated in the Northern Grid area by the year 1965. Since Mangla was scheduled to be completed by 1968, provision for additional generation had therefore to be made to meet this gap. Accordingly a scheme for locating a Thermal Power Station of 130,000 KW capacity at Lyallpur and another of 72,000 KW capacity at Lahore was prepared. Government has already accorded its approval to the additional generation of 200,000 KW and necessary financing is now being arranged for the two plants.

(*x*) On the Hydro side canal fall schemes were completed at Chichokimallian, Shadiwal and Gujranwala, each with an installed capacity of 12,000 KW. Chichokimallian was commissioned in 1959. Shadiwal in 1961 and Gujranwala (Nandipur) in 1963.

(*xi*) The Mangla Dam Scheme is a part of the Indus Basin Project. According to official schedule two machines of 100,000 KW each will be commissioned in 1968 and one more of the same capacity in 1969.

It will be evident from the above that in the past 5 years alone Schemes of an aggregate generating capacity of 186,000 KW have been commissioned. Besides, work on fresh Schemes of an aggregate capacity of 193,000 KW has been started and additional schemes of 225,000 KW capacity have been got approved for implementation during the remaining part of the Second 5-Year Plan.

The development in the Southern Zone of the Province is particularly noteworthy. By the end of Second Five-Year Plan no less than 108,000 KW of additional generating capacity will have been provided in this Zone and Quetta region.

Distribution Network

Extensive network of Transmission and Distribution lines had to be laid out to carry large blocks of power generated in the Power Stations mentioned above, to the ultimate consumers. The following Schemes were undertaken to achieve the end.

(*i*) *Primary Grid.* Connecting Warsak Hydro Electric Station at one end and Multan Thermal Station at the other, with some 750 miles of 132 KV lines and 130 miles of 220 KV lines, together with large grid stations at Lyallpur, Sargodha, Daudkhel, Peshawar, Wah, Rawalpindi, Kharian and Kot Lakhpat (Lahore). This scheme is now complete

except for a few minor works and finishing touches. The foreign exchange cost of the above Scheme was financed from DLF/AID loan.

(*ii*) *Secondary Transmission and Distribution Scheme.* This Scheme comprises approximately 240 miles of 132 KV, 834 miles of 66KV and 57 miles of 33 KV lines and about 60 E.H.T. Grid Stations. In addition it covers the distribution of 102 towns for which 1.133 miles of 11 KV lines will have to be laid.

One of the important components of this scheme is the renovation of the existing distribution system in nine major towns of the Grid area.

A large amount of work under this Scheme has been completed. The rest is scheduled to be completed during the year 1964. The renovation work has presented numerous problems but it is beginning to be streamlined now and further progress on it is expected to be made at a much greater pace. Due to the extensive layout of the Scheme and its numerous components the actual expenditure on the scheme is showing excess on the originally sanctioned amount. It is expected that the final expenditure on it will be of the order of 29 crores.

(*iii*) *Tube-Well Electrification.* For supplying power to the 1,800 tube-wells installed under Rechna Salinity Control and Reclamation Scheme a vast network of transmission and distribution lines had to be laid and a number of sub-stations put up. The cost of Electrification of these tube-wells would be about 7.0 crores of rupees.

(*iv*) In the Southern Zone local networks of 33 KV and 11 KV lines were installed within a radius of about 70 miles from the Power Station at Hyderabad. This has resulted in a number of local diesel generating plants being discarded.

(*v*) At Quetta and Sukkur, independent Transmission and Distribution lines are being installed to convey power to consumers over long distances.

(*vi*) Alongside the above development schemes the day to day activity of the department has continued in the distribution of power to the consumers. The number of consumers has gone up 5,20,000 and the revenue receipt to 14.77 crores from 2,70,000 and 5.16 crores respectively in 1950.

It is difficult in an article of this type to go into greater details of the extent of development that has taken place in the electric supply field. Although the PWD Electricity Branch does not presently exist as such, the department having been transferred to WAPDA since 1959, yet essentially it continues to be a Public Utility of much the same type as the two other Branches. We, therefore, take equal pride in rejoicing the PWD Centenary Celebrations that are going to be held next week.

Although we are the youngest of the three branches, the strides made by us in the recent years has brought us abreast with our sister branches in size of works, strength of establishment, annual expenditure etc. This is the age of electricity and the coming years hold great prospect of advancement in this line. Our country's development is largely dependent on how fast and to what extent we can make more and more power available.

Preliminary Studies on Behaviour of Jute (Corchorus capsularis) Under Different Soil and Water Table Conditions

By **MUHAMMAD HUSSAIN**
Director, Land Reclamation,
West Pakistan, Moghalpura, Lahore.

Jute cultivation industry, being a major foreign exchange earning source, has gained great popularity after the inception of Pakistan. First separate mention of Jute as an article of export was made in 1828, when only 364 cwt. of this fibre was exported to Europe. According to latest figures available for the year 1962, the value of exports of raw jute and jute manufactures from Pakistan is Rs. 1087 million. The average production for the 15 years ending 1961-62 is 993000 tons or 5558000 bales[1].

The other important exchange earning crops are cotton and rice, the value of their export for the year 1962 being Rs. 263.4 million and Rs. 115.9 million respectively. Fortunately these crops are summer crops, and if for some physio-chemical changes in the soil it may not be possible to cultivate one crop, the other one can be substituted in the cropping pattern to maintain economic return and foreign exchange income. Cotton is the main foreign exchange earning crop in the West wing of Pakistan, but unfortunately the cotton production during the last 20-30 years is almost stagnant. There has been no increase in area under cotton during the last two-three decades in spite of a considerable increase in the total area under other crops during the same period. This is attributed to both physical and economic factors. Amongst the physical factors, rising water-table had a pronounced influence on the comparative decline of cotton acreage in different regions of West Pakistan. Secondly, due to better income from other Kharif crops such as rice and sugarcane, the cultivators have been tempted to divert the part of area from cotton to rice and sugarcane. During 1959-62, fine and coarse rice gave income of Rs. 449/- and Rs. 212/- per acre respectively against Rs. 218/- obtained from one acre of cotton. Similarly sugarcane has become much more profitable. Gross income from one acre of sugarcane during the period 1959-62 works out to Rs. 830/- against Rs. 440/- from two acres of cotton. It is, therefore, more profitable for the farmers to grow one acre of sugarcane than two acres of cotton. But in respect of foreign exchange earning, Pakistan loses Rs. 250/- for every two acres of cotton diverted to one acre of sugarcane. In case of fine rice and cotton,

the foreign exchange earning per acre for the period 1959-62 is Rs. 318/- and Rs. 325/- respectively. But in terms of foreign exchange, earned from the use of a given amount of irrigation water, which would be able to grow less area under rice than cotton, rice can not compare with cotton. The value of foreign exchange from 84 acres of cotton and 47.5 acres of fine rice, matured on one cusec of water supply, comes to Rs. 27,300/- and Rs. 15,000/- respectively[2].

In tracts, where rising water-table had adversely influenced cotton cultivation, substitution of Jute as an alternate crop is advocated in certain quarters in the former Punjab Area. The reason advanced in its favour is its better commercial value. The gross income from jute is shown as Rs. 600/- to Rs. 875/- against Rs. 350/- to Rs. 500/- per acre from cotton. The average acreage and production figures for the 15 years ending 1961-62 for Jute and cotton also support the above assertion. The total production in case of Jute from 16.0 lakhs acres (average figure for last 15 years ending 1961-62 works out to 55.58 lakh bales against 15.33 lakh bales from 32.54 lakh acres under cotton. Thus the per acre production of jute is approximately 3.47 bales compared with 0.47 bales of cotton lint.

Taking into consideration the cost of production and water requirements under similar soil and meteorological conditions, the study of the economic aspects of the three crops, viz. Rice, Cotton and Jute will be of great interest. Sufficient data in this regard is not available. It is yet to be seen if jute can thrive under true water-logged and water-logged saline conditions and if it can replace cotton under various soil and meteorological conditions.

The water requirements for jute in the old Punjab area[3] are reported to be 14-16 regular irrigations of 3 inches each, in addition to about 10 inches of rainfall during the crop growing period. Thus the water requirements of the crop would come to 52" to 58", which is more or less equal to rice. Labour requirements of Jute crop are also quite heavy[1] and it requires rich loamy inundated soil which needs excessive manuring both organic as well as inorganic. Corchorus Capsularis variety is a poor salt tolerant variety, whereas Corchorus olitorius is reported to be quite salt tolerant under East Pakistan conditions. Corchorus Capsularis variety is said to be a great success under water-logged conditions as those prevail in Jaranwala Tehsil of Lyallpur District. In order to study the behaviour of this crop at experimental Stations of Directorate of Land Reclamation seed of Capsularis variety was obtained from Agricultural Department in 1964.

The trial was carried out under high water-table conditions in two adjacent plots A & B at Chakanwali Reclamation Farm, District Gujranwala where there is adequate arrangement of drainage by open drainage system. The soil in both the plots is loam type. The analysis results of soil samples taken from these plots before sowing of the crop are tabulated as below:—

Plot A (Site No. 1)

Depth	pH	T.S. %	
0"— 6"	8.20	.13	Non-Saline Soil.
6"—12"	8.10	.09	
12"—24"	8.10	.11	
24"—36"	8.18	.10	

Plot A (Site No. 2)

Depth	pH	T.S.%	
0"— 6"	8.08	.20	Non-Saline Soil.
6"—12"	8.16	.12	
12"—24"	8.30	.13	
24"—36"	8.28	.11	

Plot B (Site No. 1)

Depth	pH	T.S.%	No_2%	Humus Mg./gm.	
0"— 6"	8.35	.15	.1064	3.9	Non-Saline Soil.
6"—12"	8.50	.14	.0672	3.51	
12"—24"	8.28	.14	.0504	2.24	
24"—36"	8.26	.13	.0672	3.12	
		Plot B (Site No. 2)			
0"— 6"	8.82	.22	..	1.95	Saline-Alkaline Soil.
6"—12"	9.00	.28	.0448	1.56	
12"—24"	9.08	.24	.0784	2.34	
24"—36"	8.78	.18	.0224	1.95	

The crop in both the plots was sown on the second day of May in a well prepared and manured seed bed. Germination of the crop was satisfactory and almost alike in whole of the field. The seedlings in both the plots grew up to 3" to 4" height with similar vigour without showing any variation in their colour or size due to differences in salinity status of the soil.

After the above stage, the plants in plot B site No. 2 (with saline alkaline profile) turned pale and began to show signs of weary and stunted growth. With the passage of time a considerable number of plants died before maturity and only a few survived. The survivals even did not attain height of more than 3' to 4' as seen in Fig. No. 2. Flowering and fruiting of these plants was also very thin and poor.

The crop in plot A, which had salinity-free profile, developed with full vigour and was dense in growth, dark green in colour and 14 to 15 feet in hight (Fig. No. 1). The flowering and fruiting of the crop was also profuse and satisfactory.

From the observations made it is clear that though salines showed little effect at germination but in later stages the difference in the growth and development of plants in non-saline and even mild saline soil became more conspicuous. The crop was dense, tall, and dark green in the former but was thin, stunted and pale in case of the latter. The stand and growth of the crop in plots under trial in saline and good soil patches is illustrated in Fig. No. 3. The analysis results of soil samples, taken from the plots after harvest of the crop in the month of December 1963 are given as below:—

Analysis results of soil samples from non-saline soil showing good growth in plot A site 1 & 2.

Site No. 1

Depth	pH	Salt concentration in millimhos/cm.
0"— 6"	8.85	4.1
6"—12"	8.90	1.7
12"—24"	8.82	1.4
24"—36"	8.78	0.9

	Site No. 2	
0"— 6"	8.85	1.1
6"—12"	8.88	1.2
12"—24"	8.95	0.9
24"—36"	8.9	1.0

Analysis of soil samples taken from patch showing dense and reasonable growth of crop in plot B Site No. 1.

Depth	pH	Salt concentration in millimhos/cm.
0"— 6"	9.14	4.0
6"—12"	9.17	1.5
12"—24"	9.12	1.5
24"—36"	9.10	1.2

Analysis of Soil Samples taken from patch sowing thin and stunted growth of crop in plot B Site No. 2

Depth	pH	Salt concentration in millimhos/cm.
0"— 6"	9.15	11.0
6"—12"	9.2	4.90
12"—24"	9.35	3.2
24"—36"	9.00	1.9

From the trials conducted at Chakanwali Reclamation Farm representing waterlogged conditions, it is indicated that for successful cultivation of jute, it is very necessary that the soil should be perfectly non-saline and alkaline reaction of soil should also be within permissible limits.

Similar trials were also carried out in Jaranwala Tehsil District Lyallpur at Jagattan Reclamation Farm. The same variety of jute was sown in loamy type of non-saline soil in the last week of April, 1963. Water-table at this site ranged from 9 to 10 feet from natural surface during the crop growth period. The crop was heavily manured and was given 12 irrigations of 3 inches each which including 6.50 inches rainfall amounts to 42.5 inches delta.

Analysis results of soil samples taken from the field before sowing the crop are given as below:—

Depth	pH	T.S.	N_2%	Humus mg/gm.
0"—12"	8.38	..	..	3.12
12"—24"	8.12	..	..	3.51
24"—36"	8.25	.18	.0168	1.95
36"—48"	8.18	.20	..	2.24
48"—60"	8.20	.24	..	..

Germination of the crop was quite normal. It developed satisfactorily and attained 16 feet height in the month of October. Flowering and fruiting of the crop was also quite normal.

The analysis results of the soil samples taken after the harvest of the crop are as under:—

Depth	pH	TS.	N_2%	Humus mg/gm.
0"—12"	8.45	.15	..	4.68
12"—24"	8.52	.12	.0336	5.07
24"—36"	8.48	.11	.0672	3.51
36"—48"	8.68	.14	..	2.92
48"—60"	8.58	.12	..	2.45

Fig. 1
Showing good growth of Jute (4 months age) in Non-Saline Soil
(Plot A Sites 1 & 2) at Chakanwali Reclamation Farm.

Fig. 2
Showing patchy growth of Jute (4 months age) in Salinity Affected Soil
(Plot B Sites 1 & 2) Chakanwali Reclamation Farm.

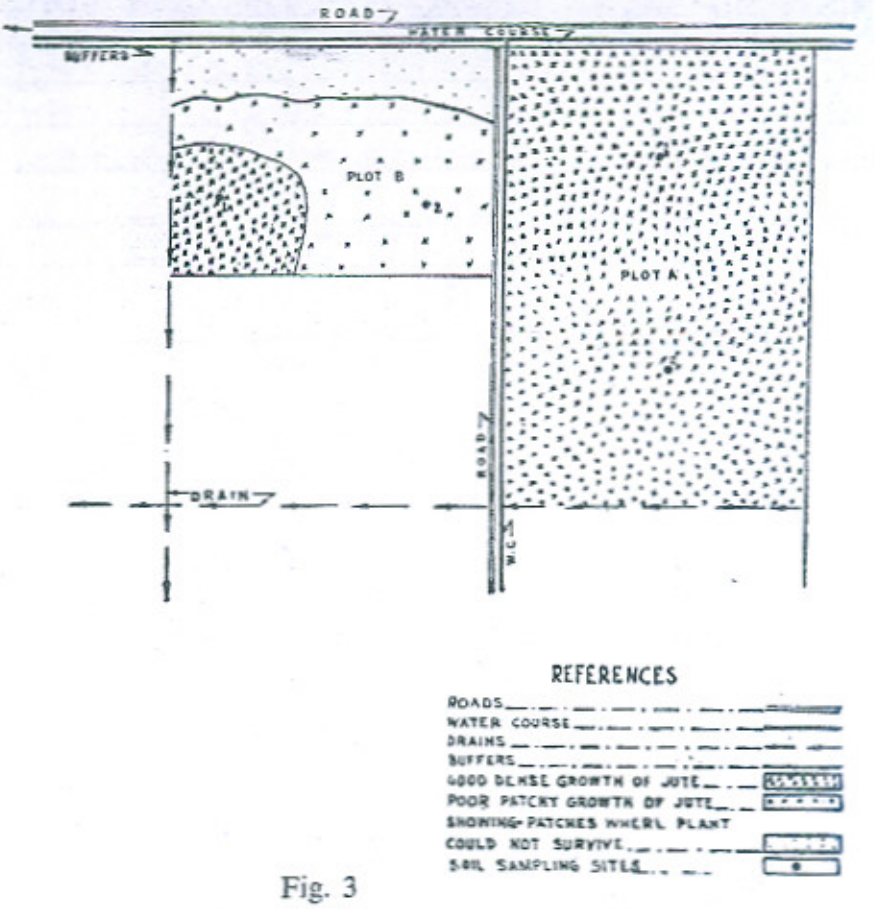


Fig. 3

Showing the density of plant population in the area under Jute at Chakanwali Reclamation Farm.

Although the water-table during the growth of the crop remained 1'—2' from natural surface at Chakanwali Reclamation Farm, yet the jute cultivation proved quite successful under efficient drainage system existing at the farm. From the above observations it can be deduced that jute cultivation in waterlogged areas is quite successful provided drainage system is efficient and the soil is free from salinity. As such for the successful cultivation of this variety non-saline soil and free drainage arrangement looks to be quite essential. The behaviour of this variety in waterlogged non-saline soil having no drainage arrangement is still under observation. In this connection the experiments are in hand, both in the Laboratory and at the field experimental stations to further verify the above findings and to ascertain the effect of varying water-table and salinity conditions on the growth of crop and quantity and quality of fibre.

ACKNOWLEDGEMENT

The author is thankful to Mr. Muhammad Ashraf, Reclamation Supervisor who helped in processing the data.

REFERENCES

1. Economic Survey, Government of Pakistan 1962—63.

2. Some Physical and Ecoromic Determinants of Cotton production in West Pakistan. The Pakistan Development Review, Vol. III No. 4 Winter 1963.

3. Dr. A. Rahim Chaudhry, Jute a New Economic Crop for West Pakistan.

4. Instruction Sheet, Department of Agriculture (Mr. Shafi Gill).

Manufacture of Village Cement

By **Maqsood Ahmad Mirza,**
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Portland cement is a mixture of lime (CaO), silica (SiO_2), alumina (Al_2O_3), iron (Fe_2O_3) and some Magnesia (Mg_2O_3). Its manufacture requires elaborate machinery for maintaining high and constant temperatures during calcination and for fine grinding. Its raw material also consists of a special selected rock and is uneconomical if manufactured on a small scale. Cartage of cement to far off areas of Pakistan like Chitral, Gilgit, Tribal territories and Kalat is very costly, therefore its manufacture at site seems reasonable. Manufacture of village cement from ordinary lime in brick kiln is described in this note. It is halfway between lime and cement. In places like Chitral, Gilgit, and North-western tribal belt materials similar to pozzulane can be discovered and these when burnt with lime yield as good a cement as portland cement.

INTRODUCTION

During the last great War manufacture of cement was limited and its shipping was hazardous. This caused exploration of ways and means for cheap and small scale manufacture of cement. The scarcity of cement is again being felt due to the large scale development projects in the country. Every country has developed its own silica cement. In Pakistan if serious exploration is carried out, it will be possible to discover some types of silicious materials which can be used to manufacture cement. Parts like Chitral, Swat and other hilly locations, where the cost of transportation of cement is very high, are prospective discovery sites. In Plains Jhama Bricks can be a substitute for the silica cementic materials.

Kinds of Cement

There are three kinds of commonly known cements:—

Natural cement.
Pozzuolan cement.
Portland cement.

Natural Cement

Natural cement is made from the rocks as quarried from a particular site. The type of rocks most suitable are clayey limestone, which when burnt to drive off carbonic acid gas, produces a clinker. It is then finely grinded. This natural cement has hydraulic qualities. It is quick setting and is of relatively low strength. It can not be used for Reinforced concrete. The tensile strength of this cement after 7 days,

(1 day in moist air, 6 days in water), is 75 lbs/sq. in. and after 28 days, (1 day in moist air, 27 days in water), is 150 lbs/sq. in.

Pozzuolan Cement

The earliest cements, and especially those used by the Romans, were a mixture of slake lime and pozzuolana or volcanic ash containing silica. This cement is of great value in the making of mass concrete. The Romans used it as a mortar in the vast constructions throughout their empire. Pozzuolan cement is still manufactured in some countries but not in Pakistan.

Portland Cement

Portland cement is obtained by mixing and burning to incipient fusion two raw materials, one consisting largely of lime (CaO) and the other a clayey or argillaceous material containing silica (SiO_2), Alumina (Al) and iron (Fe). The two materials are ground to extreme fineness and are then mixed in definite proportions. The mixture is then burnt to incipient fusion or clinkering condition. The clinker is again mixed with about 3 per cent gypsum added by weight and is then finely pulverized. The finished product should contain 1.6 parts minimum and 2.3 parts maximum by weight of lime, one part of silica and a small percentage of alumina and iron-oxide. The raw mix is analysed several times each hour during manufacture, to maintain the composition within proper limits. The finished product may contain up to 1 per cent of proved harmless materials.

A factory manufacturing Portland cement contains a crusher which crushes the limestone into small pieces, a grinding mill which grinds the limestone pieces into fine palpable powder or paste and mixes it with requisite proportions and a furnace for producing clinker. Then the material is heated to a temperature of 1200 to 1400 C.

All these equipments are very costly and a small scale cement manufacting mill cannot be constructed.

Natural Pozzalana Cement

The Pozzalana Cement is commonly used in Southern Europe. In this cement, lime in presence of water readily combines with silicates. Its action is similar to that of Portland Cement.

Various natural and artificial materials like Pozzalana, Trass, Kaisalguhr, Pumice, Tufa, Santoreri earth, Granulated slag etc. contain active Silica.

Natural Puzzolano is a naturally burnt earth of volcanic origin found at Pozzuli, near Visuvius and in other parts of Southern Europe. It is found in the form of powder, more or less coarse in grain of a brown colour, sometimes passing into red, grey, yellow and white. They are clayey earths containing 80 to 90% of clay with a little lime and small quantities of magnesia, potash soda, oxide of iron or manganese.

The Italian Puzzolano had the following approximate composition:—

SiO_2	..	45%
Fe_2O_3	..	11%
Al_2O_3	..	22%
CaO	..	10%
Loss	..	10%
		98.0

The Chemical contents of Puzzolano, however, differ considerably from place to place.

Their cost is low and these make a useful addition to the lime mortar. The best result is produced when the granulated slag or other similar material is ground with the lime until both materials are intimately mixed. Puzzolanic cement will attain a strength

equal to Portland cement. The bulk of puzzolanic materials also acts as an aggregate instead of active constituent of the cement.

Manufacture of Village Cement: Datta Experiments

During the last great War Mr. A. K. Datta devised a cheap and a simple process for the manufacture of indigenous cement. He prepared a mixture of lime and clay and burnt this in an ordinary lime or brick kiln attaining a temperature of 800 to 900°C. He thus obtained a good hydraulic lime or cement according to the NATURE OF MIXTURE AND NATURE OF BURNING. The whole mixture was ground and a small percentage of gypsum or plaster of parts was added. This process obviated the necessity of costly crushers, Raw Mill and furnaces as needed for making portland cement.

Mr. Datta further conducted a number of experiments with various mixtures of lime and clay, and moulding bricks out of these got them burnt in brick or lime kilns at Dalmia Nagar. These bricks were burnt to a yellowish colour and were finally ground without much difficulty. When the burning was conducted in lime kiln, these bricks were cut into smaller lumps and were charged in the lime kiln containing alternate layers of lime and coal. After burning lime and cement, clinkers were formed. These were separated and grounded to the fineness of cement after mixing with small quantity of gypsum. This cement was found to give a much higher strength than the hydraulic lime. In case 25 per cent of portland cement clinkers were mixed with 75 per cent of the clinkers by the process of Mr. Datta, the resulting strength was as high as that of portland cement.

This hydraulic cement can be made in brick and lime kilns. This cement, when thoroughly ground with hard-burnt or over-burnt surkhi, produced a mortar comparable in strength to the best portland cement. This was confirmed in many tests conducted on lime with surkhi and sand. Datta's results with 3 parts surkhi, 1 part lime (by volume) were found to be 256 lbs/sq. inch after 28 days, 399 lbs/sq. inch after 3 months and 428 lbs/sq. inch after six months. The results with equal quantity of sand and lime (by volume) were however as under:—

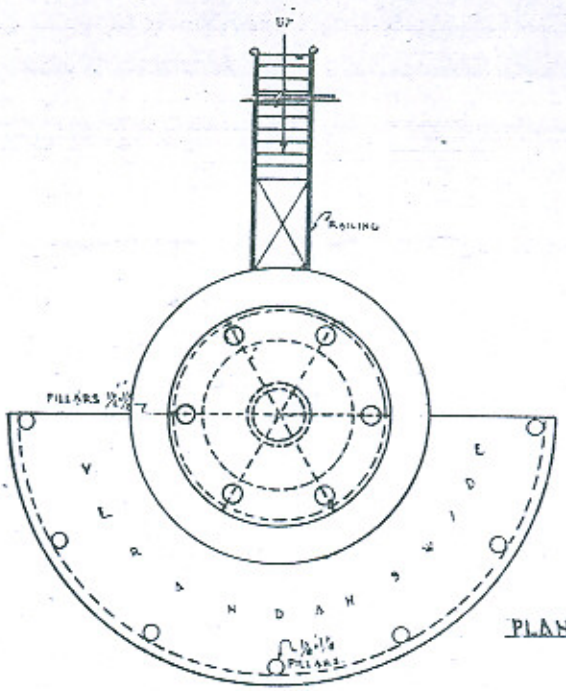
	Tensile strength with equal parts of lime and sand.	with 3 parts of surkhi & one part of lime.
14 days	17 lbs/sq. in.	..
28 ,,	23 ,,	256 lbs/sq.in.
3 months	47 ,,	399 ,,
6 ,,	52 ,,	428 ,,

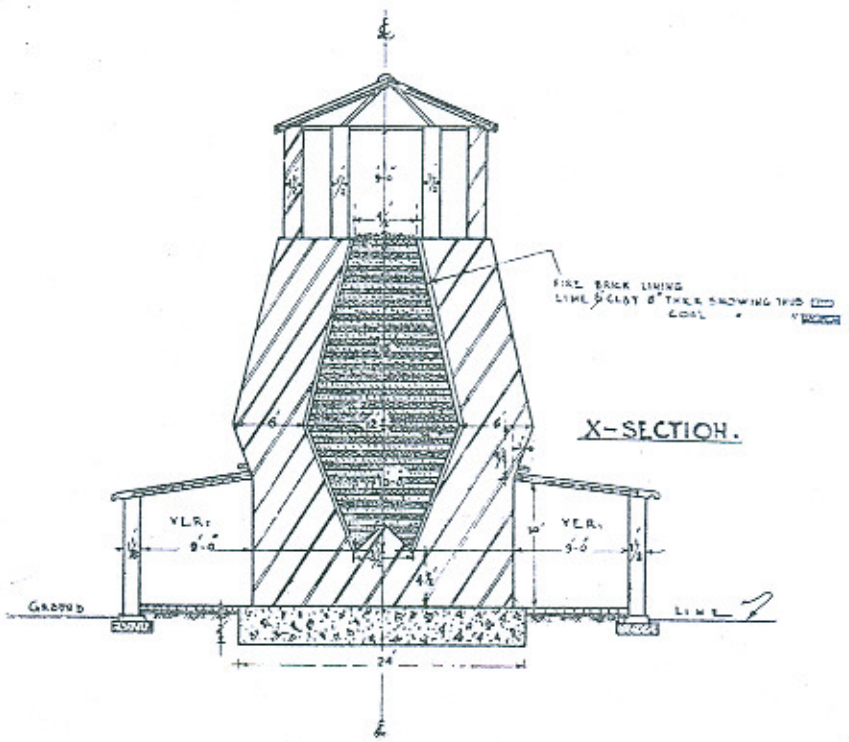
These results indicate hydraulic action between lime and surkhi so that the strength was 10 times the strength of sand lime mortar. This indicated a good cementic action.

By burning lime with clay, part of lime combines with clay forming calcium silicate and calcium aluminate being similar to the case of Portland cement. The uncombined clay after being burnt contains a lot of active silica which easily combines again with free lime and forms calcium silicate which in turn sets very hard. Surkhi made of over-burnt bricks is a sort of artificial Puzzolana. The cement produced by these manipulations was termed by Mr. Datta as "Village Cement or Hydraulic Cement".

The main difficulty in the manufacture of village cement is to obtain a right class of clinkers and secondly, grinding it to the fineness of cement specifications. Actually a village cement is half-way between cement and lime. The other difficulty is the slow setting time of the village cement which

SMALL SCALE KILN FOR MANUFECTURE OF VILLAGE CEMENT





cannot, therefore, be applied in roof or such like constructions. To prepare "Village Cement" to the Portland Cement Specifications, a mixture of 2 to $2\frac{1}{2}$% parts of lime and 1 part of clay is thoroughly mixed. This lime clay mortar has little strength. It is then burnt; the silica and alumina become active and combine with lime in the presence of water to form compounds of silicate and aluminates of calcium.

Some experiments were conducted on this lime cement concrete. It gave good results.

It was found that this mixture can even be used for the construction of road. It will lower their cost. A suitable proportion for road making concrete will be 1 cement, 1 lime, 5 sand and 8 ballast. Similarly "Village cement with certain percentage of portland cement can give good results in road construction. The constituents burnt at temperature from 1200 to 1400 C, in ratory kilns, limestone loses CO_2 and is reduced to lime. Clay on being burnt becomes Jhama at high temperatures both enter into a combination.

Lime and surkhi have got the same ingredients as the cement. If lime and well-burnt surkhi is ground to the cement spefications, and adding a small percentage of gypsum, the resultant mixture will set like cement.

Use of Jhamas Bricks for Manufacture of Cement

Mr. Datta in 1943 presented a paper to Indian Roads Congress. He stated that he has evolved a High Silica Portland Cement which can be easily made in brick kilns. In the manufacture of this cement "Jhamas Bricks" were ground to cement specifications and mixed in a proper proportion with Portland cement to produce the High Silica Portland cement. If village cement clinkers are to be added then the necessary quantity of gypsum is also to be added. The cement Jhama ratio can be determined from the lime content present in Jhama. The ratio can be 2/3rd and 1/3rd, or of equal proportion in some other proper mixture. Jhama Bricks which are obtained by burning clay, a large portion of silica and alumina of clay is turned into active silica and alumina and still a large portion remains inactive. By adding some lime or limestone powder to clay and by thoroughly mixing the two together and then burning them to form bricks or lumps with excessive amount of coal, we get a type of Jhama which contain a large portion of soluble silica and alumina. This forms much more active and can be used in the manufacture of cement similar to High Silica Portland cement. This shows that the village cement if manufactured on the foregoing lines, has a great scope and a future. The quality and strength of the 'village cement' will improve considerably which can thus be reliably used in the construction of the concrete roads.

SUMMARY

(1) Portland cement requires elaborate machinery for grinding and high temperature kilns which is very expensive.

(2) Village cement can be manufactured on small scale in ordinary kiln attaining temperatures of 900 to 1000°C. A type of this kiln is shown in the diagram.

(3) No elaborate grinding is involved in its manufacture ordinary medium size roller is sufficient to crush and grind the clinkers of village cement.

(4) Where rock material is not available for mixing with lime, ordinary clay can be mixed and calcinated with heavy charge of coal to manufacture this type of cement.

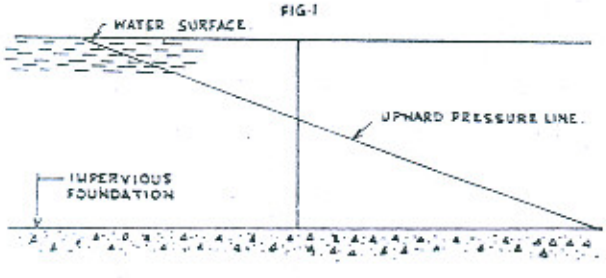
Prevention of Undermining of Structures on Pervious Foundations

By **K. B. Pir Mohammad Ibrahim Qureshi, I.S.E.**

Structures on pervious foundations are subjected to a head of water. Their stability is worked out on the understanding of the Exit Gradient. In this paper the Exit Gradient is explained on the basis of the author's "Laws of Liquid Flow". Only those structures are discussed which are without downstream filter.

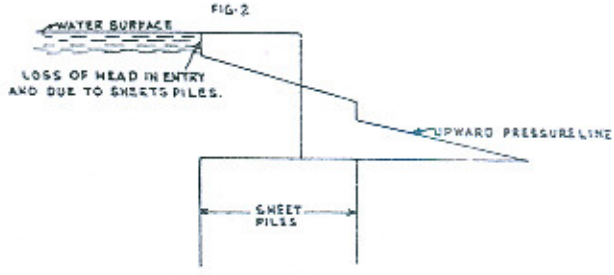
What is an Exit Gradient?

1. The stability of an impervious work founded on a pervious bed and subjected to a head of water across, is determined on the basis of the uplift pressure on the work. Bligh stated that this upward pressure, which can be recorded by observing water levels in pipes piercing the impervious floor and located in the pervious medium will be a straight line. The pressure (neglecting head at entry) at up-stream end of the floor will be the maximum and zero at the down-stream end. This is explained in Fig. 1.



In other words the flow in the pervious strata will be similar to the flow in a pipe.

2. The bottom of the impervious floor is seldom uniform and straight as shown in the Fig. After taking these inequalities of the bottom surface of the impervious work into consideration, Mr. Khosla redrew the pressure gradient as shown in Fig. 2.



The upward pressure at the downstream end of the impervious work was called as an "Exit Gradient". The safe order of this Gradient was taken as 1:1 for all soils. Explaining the exit gradient Mr. Khosla stated that:

"A factor of safety must take note of the class of material. The specific weight and pore space have been considered. The angle

of repose at which the class of sub-soil will stand, should also be considered. No work has so far been done to correlate the critical gradient and the angle of repose for soils. This will be a useful study. Till further information is available it is proposed to apply the following factors of safety to critical values of exit gradients.

Shingle	..	4 to 5
Coarse Sand	..	5 to 6
Fine Sand	..	6 to 7 inches.

Mr. Khosla's explanation was for an impervious structure constructed on a pervious strata of uniform porosity throughout the length of the structure.

What does the Exit Gradient Stand for?

Water under pressure percolates through a medium. The velocity of flow in most soils is small and is "stream-lined". The formulae connecting the velocity of flow are as under:

$$V = \frac{U}{32} g\, G_e\, d^2 \quad \ldots(1)$$

$$= C\, G_e \quad \ldots(1\text{-a})$$

where U is the viscosity of the fluid

g is the acceleration due to gravity

'd' the diameter of the average pore-space and

'G_e' the gradient of the upward pressure at exit.

$\frac{U d g}{32} = C$ is called the transmission co-efficient of the soil.

It is a constant for a given soil having a given composition.

It is thus proved that the velocity of flow under a work is directly proportionate to the gradient of flow in the sub-soil. The velocity of flow at the exit is proportional to the Gradient G_e. The Exit Velocity (V_e) is, therefore, directly proportional to Khosla's Exit Gradient (G_e) so that:—

$$V_e = CG_e \quad \ldots (2)$$

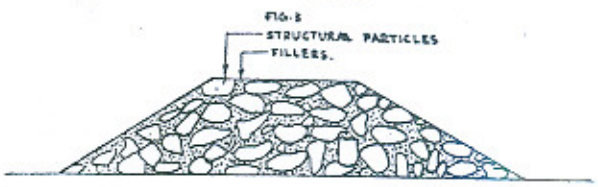
In case the sub-soil flow is turbulent, The velocity of flow will be proportional to the square root of the gradient, *i.e.*,

$$= \sqrt{F^2\, g\, G_e\, d} \quad \ldots (3)$$

$$= C_1 \sqrt{G_e} \quad \ldots (3\text{-a})$$

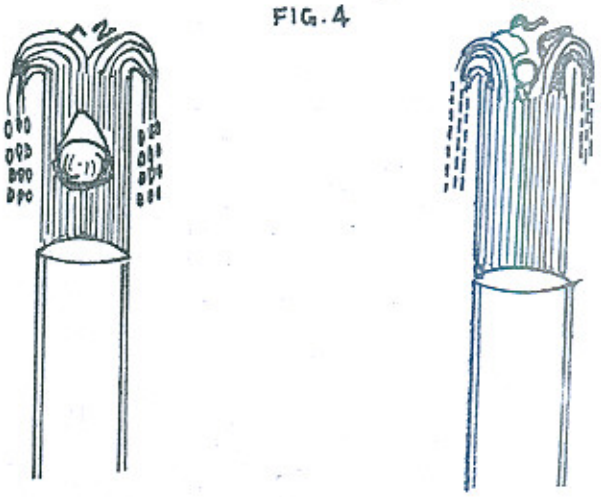
Why should the Exit Gradient Vary with different Soils and Grades

A soil mass consists of irregular particles of various sizes. Imagine a dam consisting of boulders small pebbles in the voids (see Fig. 3). The pebbles are so small that these can be removed without causing the dam to settle. Let us call the boulders as the "Structural Particles" and the pebbles as "Filler Particles". A heap of soil is also an example of miniature dam.



2. It has been shown that the exit velocity is proportional to the percolation co-efficient and the Exit Gradient. The dislodgement of a particle at exit end can be caused if the velocity is capable of bodily lifting the particles against the gravity. It is like a ball floating on the jet of a fountain (see Figure 4) of water. Its position depends

FIG. 4



in the jet depends upon the size and the weight of the ball. If density of the ball is constant than a smaller the ball will stand higher than the big ball on the same jet. If the ball is sufficiently big, it will settle on the fountain and will not move. The example is similar to the particles of the soil floating on a jet of the Exit Velocity.

3. Thus the Exit Velocity or the Exit Gradient under a work for a given soil should be less than the velocity which can dislodge particles of the soil.

Diameter of Soil Particles as Determined by Settling Velocity

A soil particle when placed on the surface of water, settles with a uniform velocity, which is called the settling velocity of the particle. This velocity for big particles is higher than those for the smaller ones.

This is the principle on which the "Siltometer" developed by West Pakistan Research Institute works.

The Settling Velocity of a sphere is given by Stokes Law which states that:—

$$V_s = \frac{1}{18} \times \frac{g}{u}(p - p_1)d^2 \quad .. \quad (4)$$

where V_s = Settling Velocity

g = Acceleration on due to gravity

p = Specific gravity of the sphere

p_1 = Specific gravity of the fluid.

d = Diameter of the sphere.

and u = Absolute viscosity of the fluid.

Knowing the Settling Velocity of a particle and its density, the diameter of the particle can be calculated. It may be added that Stokes Law holds as long as Reynolds number, vd/u is less than 0.71. For higher value of Reynolds number, Qureshi's Law of Liquid flow has to be applied.

Correlation of Soil Particles to Safe Exit Velocity

If the velocity of the jet at the exit is less than the Settling Velocity of a particle of soil, the particle will not get dislodged. This Velocity can thus be called the Floatation Velocity.

The Exit Velocity of a soil is thus a function of Exit Gradient. For a given soil, Exit Gradient should not be steeper than the Gradient which creates Settling Velocity or Floatation Velocity for the smallest Particles of the soil.

How to Determine the Settling Velocity for Particles

Take a U-Tube and add the soil in the portion marked L in Fig. 5. The soil is to be packed similar to as keep levels of the soil in the two legs equal. Slowly fill in water simultaneously in the two legs of the pipes from a tank and establish the flow of water. Raise the head slowly till the particles just start moving. This is the safe gradient. For safety the exit velocity should be less than the settling velocity.

Method of Design

To work out a safe design of a structure:

(*a*) Determine the settling velocity (V_s) for the smallest particles of the soil.

(*b*) Find the Transmission Coefficient (c) of the soil from which the filler particles have been removed by use of the device mentioned earlier in Fig. 5.

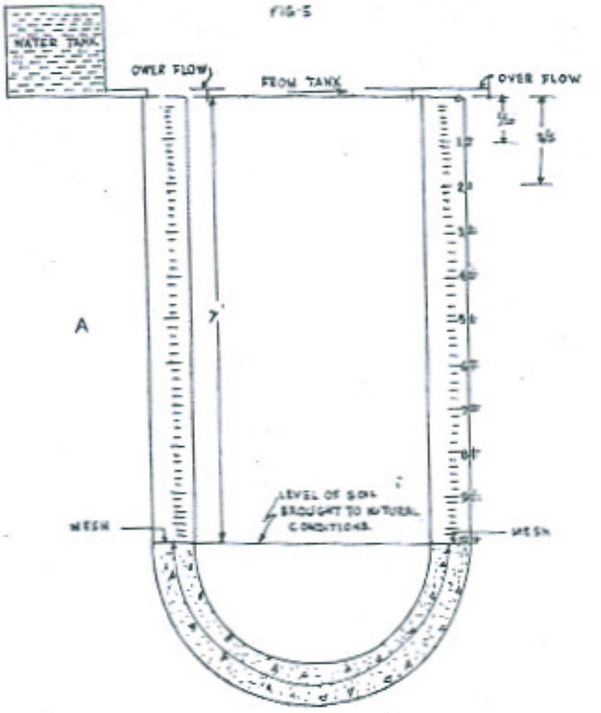
(*c*) Calculate the steepest safe gradient (s) of the soil from the relation:

$$V_s = C_s \quad .. \quad (5)$$

(*d*) Design of work by Khosla's method

in such a way that the actual Exit Gradient is less than (s) as calculated by the relation mentioned above.

This will give a structure which will be safe even when the filler particles of soil are washed out in due course.



Water Requirements for Irrigation

By **Mr. WAYNE D. CRIDDLE**
Special Lecturer for SEATO Graduate School of Engineering.

Over the ages, man has congregated where water is available for quenching his thirst and that of his animals, and for raising the crops needed to satisfy his needs for food and fibre. Without water, neither animal nor plant life can long exist. However, although water can be a blessing if available as needed, it can also become a curse when not controlled. Over the years, terrible losses of life and property are reported because water is uncontrolled.

In 1887, the Hoang-Ho river in China flooded and 900,000 people were reported to have perished. Two years later, the Johnston Pennsylvania flood occurred in the United States, and 2,200 people lost their lives. In 1952, the Messouri, Red and Mississippi Rivers went on a rampage. As a result of modern rescue equipment and organization only 3 lives were lost but 100,000 were made homeless and 2.5 million acres of land was flooded. In your own country of Pakistan, relatively frequent flood causing many deaths and heavy loss of property are well known.

Land Benefit from Irrigation

Controlling a river system costs money, that must be repaid, usually by the beneficiaries of such a service. In the arid areas of the world, irrigation is usually the largest direct beneficiary and must carry a large portion of the costs. Thus over-design cannot be tolerated by those having to pay for the development. Under-design may be even more serious since the needs of the water user must be fully met for optimum production.

Modern Irrigation

For well over a hundred years, we have been practising so-called "modern irrigation" in the United States. But only recently have we begun basic research on water requirements of crops as a guide for use in planning, designing and operating over irrigation systems. The interaction of water, fertilizers plant varieties and proper arrangement is still to a large extent a matter of estimating. For many years irrigation research was directed towards the gross irrigation water needs of a particular crop

under a particular climatic condition. Investigators did not measure the basic water needs of the crops, determine how much of those needs were being supplied from natural sources, and how much of the irrigation water supplied would be consumed by the crop, recognizing that water cannot be applied at 100 per cent efficiency.

Eventually, it was discovered that the basic consumptive requirement of a particular crop could be related to the climate, particularly the seasonal requirement, providing growth was not limited by lack of water or fertility. Several simple methods were developed whereby water requirement data might be transferred from one area to another taking into consideration climatic differences. Estimating consumptive use and irrigation water requirements of crops is not an exact science. But research and detailed analysis of our climate-soil-water relationships will allow us to safely and rather accurately estimate these values.

From what I have seen of your work here in Pakistan, I feel that I am sure you are attacking many of the fundamental problems of water requirements. But no country that I can think of has more at stake in obtaining such basic data and then properly utilizing it to produce maximum yields from the lands having such a high potential because of soils, climate and water.

In order to speed up results, research should be fully co-ordinated throughout the country. Your agronomists, soil physicists, soil chemists, land classifiers, hydrologists and designing engineers should all be called on to outline needs, design research and adopt and utilize the results. Consumptive use and irrigation water requirements should be known and understood by many in a country such as yours that is so dependent upon the artificial use of water for your very existence.

Waterlogging & Salinity in West Pakistan

BRIEF EXCERPTS OF SYMPOSIUM PAPERS

This year West Pakistan Engineering Congress held a Symposium on waterlogging and salinity problem of West Pakistan. The subject was very well contributed so that 14 different papers were submitted covering all the aspects of the problem. In this volume we are producing brief excerpts of all these papers for the benefit of the members. This is only an introduction and a means to create interest to study the actual papers.

PAPER No. 1

History and Magnitude of Waterlogging and Salinity Problems in former Punjab, West Pakistan

By M. A. Latif and R. A. Shamsi.

The problem of Waterlogging first appeared in 1951 in the Western Jamna Canal. It was later on reported in Sirhind Canal in 1870 in the Bari Doab in 1880 and in the Lower Chenab in 1900. Systematic observations on water level in wells in the Sirhind Canal area were started as early as 1870 and later on well lines were established for the whole of the Punjab in 1885. In the Engineering Congress there are several contributions dealing with the earliest attempt to study the problem. Papers of Schonemann (1917), Elsdon (1921), Middleton (1922), Iqbal Hussain (1922), Wilsdon (1928), Taylor (1933), Natha Singh (1937), Mehta (1938), Khangar (1947) are all useful pre-independence contributions.

Several of the measures undertaken included seepage drains of which by 1947 about 2300 miles were laid. Lining of canal was tried since 1913, and tubewell installation on large scale was carried out in 1945.

The salinity problem was given attention after 1917 when drainage boards and enquiry committee were constituted resulting in establishing of the Irrigation Research Institute and later on Land Reclamation Department. In this paper the magnitude of the salinization of soil as results of reports from various agencies is included.

The paper mentions the investigations being conducted by Ground Water Development Organization now working under Wapda as Wasid. The progress of their

work up to June, 1963 is given in the form of a table which is reproduced below: —

Progress of Work of Wasid up to June, 1963

S. No.	Particulars		Rechna	Chaj	Thal	Bari	Total
1.	Test drilling. No. of test holes drilled	..	311	259	212	139	921
2.	Depth drilled in feet	..	186,600	150,190	139,787	103,270	579,867
3.	Test Wells installed	..	44	27	29	21	121
4.	Well inventory	Number	78,678	28,052	39,905	..	146,635
5.	Well observation	Number	176	109	103	..	388
6.	Aquifer tests	Number	61	45	47	21	174
7.	Tests analysed	Number	61	45	47	21	174
8.	Soil Survey in Million acres	..	6.3	3.4	6.4	1.6	17.7
9.	Water Chemistry Survey, No. of samples analysed		27,075	5,029	4,526	7,369	43,999

PAPER No. 2

Salinity and Ground Water Conditions in the Lower Indus Plains

By T. N. Jewitt

The total designed commandable cultivable area of the Lower Indus Plains is 12.2 million acres along the right bank of the Indus in the combined Sukkur and Guddu Canal zones. The salinity range of the area is as under :

Salinity class	Acres CCA	Percentage	Effect on Crop Growth
1	738,000	16.3	No effects.
2	1,042,000	23.0	Noticeable effect on some crops.
3	951,000	21.0	Serious effects on all field crops.
4	1,237,000	27.3	Unsuitable for any crops other than dates.
5	562,000	12.4	Unsuitable for any crops and reclamation slow and expensive.

At present an area equal to 1.78 million acres of salinity Class I and II is in use. The unused land is of higher classes of salinity.

Ground Water Level

The Ground Water levels have been studied both for Khairpur and Sukkur-Gaddu right bank area. In 1959 the area under irrigation in Khairpur had watertable within

6.7 ft. The depth of watertable in areas were as under :—

Depth to Ground Water		*Area*
0—3.3 ft.	..	76,000 acres
3.3—5.0 ft.	..	55,000 ,,
5.0—6.7 ft.	..	208,000 ,,
Deeper than 6.7 feet	..	311,000 ,,

The depth in 1933 varied from 25 ft. to 5 ft. During the last 26 years the deeper water has arisen by 16 ft. and shallower one by 5 ft. only.

As for Sukkur-Guddu right bank the earliest depth of ground water was at 10 ft. and the present depth is at 7 ft. There is fluctuations in ground water with seasons. In this area the presence of hydrogen sulphide has been demonstrated and this substance is known to be very damaging to rice. This might be the season for the practice of 'Pancho' water with continuous flow over the field. The high ground water is also a cause for the giving up of the cotton crops. As a result of this study the author considered that both on the left and the right banks area it will be dangerous to enforce a reduction in water duty without drainage.

PAPER No. 3

Waterlogging and Salinity as Factors Limiting Agriculture Production in West Pakistan

By Mohammad Hussain and Nur-ud-Din Ahmad

The authors have discussed the effects of salts in soil on the growth of plant. Presence of large quantity of salts in t e root zone of the plants gre tly reduces their power of absorbing water. The leaves of crop become dull coloured, turn bluish green and often become coated with a wax desposit. The salts in soil increases the osmotic pressure of the soil solution and the plants are unable to draw their nourishment. The salts decrease the crop yields. An example of the decrease in three crops is shown below :—

Crop		Yield Mds./acre 1947-48	Yield Mds./acre 1958-59
Gram	..	6.8	5.8
Rice	..	10.5	9.2
Sugar-cane (as gur)	..	35.2	30.0

The salt tolerance studies undertaken in the Laboratories of Land Reclamation showed that the limit of 0.2% total soluble salt commonly taken as the critical value between a good and a deteriorated soil is not correct for all kinds of salts and all types of crops. For wheat C 591, the critical order of sodium chloride is 0.3% and of sodium sulphate between 0.7 and 0.8%. For equal amount of presence of both these salts, the critical value is between 0.4 and 0.5%. The table below gives a good idea about the conductivity and the yield of some common crops.

Crops	Conductivity m mhos/cm.	Fall in yield percentage
Wheat	3000 to 5000	10
Cotton	1500	6
,,	8000	60
Sugarcane	1500	6
,,	8000	50
Berseem	1500	4
,,	8000	52
Gram & Barley	1500	5
,,	10000	55

The presence of high moisture causes disappearance of oxygen and increase of carbon dioxide and hydrogen. It was observed in paddy soil in India that the principal gases produced after submersion were Methane, Carbon Dioxide, and Nitrogen. In a drained soil, the nitrogen is released upon the decomposition of organic matter. In this paper sufficient information is given on the effects of high watertable on the yield of crops. The results of field experiments at Chakanwali farm and Lysimeters are explained. A system of crops rotation is also given.

PAPER No. 4

Sodium Hazard of Punjab Ground Waters

By C. A. Bower and M. Maasland

This paper discusses the chemistry of the ground water. It discusses the conception of Eaton about the residual sodium carbonate, and it explains the use of a modified Langelier index in combination with the SAR for evaluating sodium hazard. The main conclusions arrived at in this paper are as under:—

"It has been firmly established that carbonates in irrigation waters may precipitate in soils as $CaCO_3$, that the precipitation en ance the tendency of the soil to accumulate exchangeable Na from the water. The fraction of carbonate applied in irrigation water which precipitates in soil is variable and is influenced by several factors including the relative and absolute concentrations of $Ca+Mg$ and CO_3 HCO_3 in the water, the $Ca+MgCO_3$ and pH status of the soil and the degree to which the ionic concentrations of the soil solution increases owing to loss of water by evapotranspiration. The extent to which exchangeable Na accumulates in soils irrigated with high carbonate waters depends upon the SAR of the water as well as upon the fraction applied carbonate that precipitates as $CaCO_3$. Moreover, a steady state condition with respect to accumulation of exchangeable Na may not be attained, short of nearly complete saturation of the exchange complex for the following reasons. As exchangeable Na accumulates, the pH of the soil usually increases and this enhances the precipitation of $CaCO_3$. With additional precipitation of $CaCO_3$, the proportion of Na in the soil solution and on the exchange complex increase further, leading to an additional increase in pH and a repetition of the above described process. The data of Wilcox, *et al* (1954), showing the pH and ESP of soil following 42 and 86 Irrigation with water No. 20b, illustrate this point.

For evaluating the usability of waters containing CO_3+HCO_3 in excess of $Ca+Mg$, the "residual Na_2CO_3" concept of Eaton seems to have some merit. However, for waters containing high amounts of carbonates but no "residual Na_2CO_3" the concept is unsatisfactory. The empirical equation $ESP+2SAR$ (8, 4-pHc) involving the SAR and a modified Langelier index appears to be reasonably satisfactory for predicting the Na hazard of high carbonate water regardless of whether they contain "residual Na_2CO_3." The equation should be used on a tentative basis, however, pending further study of its reliability.

If the 74 tubewell waters considered in this study are representative of a substantial fraction of Punjab ground waters, then by either the "residual Na_2NO_3" concept or the empirical equation a potential sodium hazard is involved in the use of many of these waters for irrigation. It seems evident that if some of the ground waters are used as the sole source of water for irrigation, the soil will

accumulate injurious amounts of exchangeable Na with time. On the other hand, if hazardous ground water is used to supplement surface water for irrigation by dilutation or by alternate use, no excessive accumulation of exchangeable Na may occur. Rainfall, where appreciable and effective, may also be expected to have a retarding effect on the accumulation of exchangeable Na from hazardous waters. It is evident that the Na hazard of Punjab ground waters needs further study with particular attention being given as to how surface waters, ground waters, and wells can be managed so as to prevent harmful accumulations of exchangeable Na. In any case, changes in the ESP and permeability of soils over time resulting from the use of ground waters of various qualities should be measured as a means of acquiring information on the Na hazard of the ground waters.

PAPER No. 5

Results of Geologic and Ground Water Investigation in the Punjab Plain, West Pakistan.

By Z. U. Kidwai and W. V. Swarzenski

This paper describes the Geological formation of the Punjab Plain. It is stated that the formation up to almost a depth of 1000 feet or more consists of unconsolidated alluvium predominantly of medium—to fine-grained sand, silt, and clay. The entire Punjab Plain is believed to be underlain by saline water at variable depths. Fresh water exists everywhere close to the river and in the upper parts of the doab, where recharge is greater and ground-water is of acceptable quality. The dissolved solids content is generally less than 1,000 ppm. Assuming an effective porosity of the alluvial sediments of 20% from a depth of 450 ft. about 2 billion acre feet of water of acceptable quality is available. The alluvial deposits of the Punjab Plain are highly permeable with permeability coefficient between 0.5 to 1.0 per ft. and with storage coefficient varying from .001 to .01.

The Punjab Plains have a buried ridge which expect for the outcrops lies at a depth more than 500 to 1000 ft. in depth.

In the earliest stages seepage from the river and the canal was towards the central axes of the doabs. The rise of water in the alluvium has been to such an extent that now the flow direction is from the doab towards the river.

About 30 million acres is underlain by highly permeable strata and large capacity wells yielding 4 cusecs can be developed at any site. Underneath about 21 million acres, water of acceptable quality to a depth of 450 ft. is available. It is stated that in about 25 million acres constructing 30,000 to 40,000 tubewells of 2 to 5 cusecs capacity ground water will be pumped out. It is believed that considering the recharge within a period of 40 to 50 years no appreciable change in the water quality is anticipated.

PAPER No. 6

The Programme of Investigations in the former Sind

By A. P. S. Forbes and G. R. Hoffman

The Sind Region which includes fourteen million acres of grass commanded area, irrigated by three barrages at Gudu, Sukkur and Kotri, possess salinity and water-logged areas so that agricultural productivity is very low. Hunting Technical Services undertook a programme of investigation in 1960 and they intend to produce a preliminary development plan for the whole

area by mid 1965. Their investigations are split into three main heads dealing with waters, land and farming. The investigation in connection with water, includes meteorology, geo-hydrology, hydrology, irrigation, drainage, consumptive use, surface storage and run of hill torrents including the flow of the Indus river. In case of land their studies will be directed towards the nature of the soil and its salinity. In this connection the present land use and the reclamation methods will also be studied. As for farming, they propose to carry out agricultural surveys, conduct study of agronomy, including agricultural economy and general methods of agriculture. On these bases it is intended to put forth a development plan. These studies will enable recommendations to be made for a balanced programme of agricultural and industrial development for the whole region.

PAPER No. 7

Economic Investigation as related to Drainage with special reference to Khairpur

By P. E. Naylor

In this paper the problems connected with the economics of drainage programme in Sind are discussed. Special attention is given to the Drainage of Khairpur area where for the gross culturable area of 0.8 million acres in which watertable exists at 7 ft. within an area of 0.355 million acres, a scheme for the construction of 570 tubewells is being implemented. Assessing the financing implication of drainage, the author has worked out the annual benefits and their costs. Overall calculations for Khairpur work out the benefit at Rs. 310 lakhs and the expenditure at Rs. 151 lakhs giving a ratio of 2 : 1.

A detailed study has been carried out for the payment capacity of the tenants, landowners, and owner operators. It is concluded that repayment position of the farmers in Khairpur is not optimistic and for the possibility of repayment of the loan, more attention to repayment capacity of the farmers is obviously required.

PAPER No. 8

Wapda Programme of Waterlogging and Salinity Problem of West Pakistan

By M. Badr-ud-Din

This paper as the name employs gives briefly the programme initiated by Wapda to reclaim the lands. The programme covers both the upper and lower Indus Plains extending to about 33 million acres. It is proposed that in the upper Indus Plains about 18.7 MAF. of water for Irrigation-*cum*-Drainage and 5.8 MAF of water for drainage alone will be pumped out. Tables are given which give the name of the Projects, their gross area, means of drainage, and the total cost. These are the same which were reproduced in the *Engineering News*, Volume 6, No. 4. According to the estimate the reclamation programme will cost Rs. 3,400 million and power system will cost Rs. 2,500 million making a total of Rs. 5,900 million. An amount of Rs. 3,416 million will be in Foreign Exchange. The annual cost of the Reclamation work will be of the order of Rs. 400 million. Cost benefits ratio has been worked out on the assumptions of the increase of the production and the average ratio is given as 1 to 2.25. In the upper Indus Plains it is proposed to lower the watertable to a depth of 100 ft. in 30 years pumping 46 million acres ft. of water annually. By 1975 it is estimated that all the land of Indus Plain will be provided with drainage measures.

It is claimed that the overall co-ordination of construction for development of West Pakistan will be the responsibility of Wapda which with its consultants have a broad-based capability for design and construction of large civil works. Construction of other Government Agencies may not prove wholly effective unless it fits with the Master Plan and area development plans.

PAPER No. 9

Development of Groundwater in the Indus Plains

By M. Maasland, J. E. Priest and M. S. Malik.

This is a very useful paper considering overall ground water potential available in the Punjab, Bahawalpur and Sind areas. It gives information about the assumed leakage, quality of ground water, ground recharge from various sources and the chemical analysis of the salts present. It also deals with the ground water withdrawal and salinization. In this excerpt we have rerpoduced the principal conclusions of the authors as arrived at for Punjab, Bahawalpur as well as for Sind. Principal conclusions are as under:—

Punjab and Bahawalpur

1. Of the total area of 34 million acres on the Indus left bank, 25 million acres of the Punjab and Bahawalpur are underlain by ground water containing 2000 ppm or less of salts and 21 million acres of land are underlain by ground water containing less than 1,000 ppm of salts.

2. The available water supply for the Punjab could be used on land underlain by good quality ground water, and the need for disposal of highly-saline native ground water into the rivers would thus be limited.

3. Many ground waters of 300 to 3,000 ppm. of salts contain harmful concentrations of CO_2 and HCO_3 anions, requiring dilution by mixing with surface water. This problem cannot be resolved by using gypsum because the quantities required are too large.

4. Since high-carbonate ground waters are a major problem, it is advisable to prepare maps showing the area with high carbonate ground water. Maps showing high-sodium ground waters should also be prepared.

5. Existing canal commands do not always coincide with the zones of good-quality ground water.

6. The present uneven distribution of ground water recharge and quality makes it desirable to adjust the development programme to fit ground water hydrologic conditions.

7. Areas along the rivers are all underlain by ground water of good quality. Tube-well development along the rivers will increase the total water supply by decreasing non-beneficial evapotranspiration.

8. The extensive ground water reservoir can be exploited as a flexible source of water supply and regulation.

9. Increased recharge by over-irrigation of kharif crops or increased rice growing on permeable soils should be investigated as means of using the aquifer to conserve flood waters and of improving the quality of the ground water. Costs of required increases in canal capacities must be considered in the analysis.

10. Withholding of early flood flows to fill reservoirs, and increasing river seepage resulting from lowering the water table by ground water pumping, can adversely affect water supplies for areas dependent on surface water, particularly in the early and

late parts of the kharif season. Additional reservoir storage, controls on filling of reservoirs, and increased use of available ground water may be required to avoid difficulty.

11. The need for pumping of highly saline ground water should be minimised, particularly during the non-flood season. Consideration must be given to :—

(*a*) Desalinization of the ground water;
(*b*) Skimming of upper "fresh" ground water; or
(*c*) Reduction in recharge by canal-lining, curtailment of rice growing, or restrictions on cropping intensities in saline ground water areas.

12. It may be necessary to dispose of saline and moderately saline ground water zones from with ground water of usable quality, in 10 to 20 years after the beginning of ground water development, to maintain water quality. This point requires further study.

13. The estimated annual recharge of 36.3 million acre-feet in the recharge budget is conservative.

14. Rainfall recharge will contribute at least 3.5 m.a.f. per annum under future conditions of irrigation water supplies and intensities.

15. A lowering of present water table levels will increase canal seepage and decrease available surface supplies in downstream areas of canal commands, if surface water inputs are not increased.

Sind

1. There are about four million acres in the Sind underlain by usable ground water. About 2.7 million acres of this area are situated outside the river bunds.

2. The area lying between the bunds along the Indus River is also significant in plans for developing the ground water resources in the Sind. This area is subjected to occasional flooding and has ground water of good quality. Exploitation of this ground water would require expensive facilities, if this water is to be transported to areas outside the bunds. It is estimated that about 15 per cent of this area is flooded only infrequently and is not subject to river meander changes. Crops and forests are, or can be, grown there.

3. It appears that there will be a problem with high sodium bicarbonate in the areas with ground water of low salinity, particularly in the Larkana-Shikarpur area on the Sukkur-Gudu Right Bank.

4. More detailed information is required on ground water quality before a firm plan of development can be prepared for the fresh ground water zone in the Sind. Preliminary evidence indicates that, in the fresh ground water areas, wells of at least 200 to 250 feet in depth will pump fresh ground water, especially near the Indus River. This depth may have to be reduced for wells farther from the river because the depth of the fresh ground water layer decreases with the distance from the river.

5. The amount of recoverable recharge in the fresh ground water area in the Sind is presently estimated to be about 7.5 million acre feet annually.

PAPER No. 10

"Conjunctive use of Surface-Water and Ground-Water Supplies in the Principal Canal Irrigated Areas of West Pakistan."

By Charles S. Hazen

To start with, the author has given brief information about the area, cropped during the year April 1960 to March 1961 in the principal canal commands. In the Northern

Zone out of 23 gross M.A. 19 M.A. are culturable. Similarly in Southern Zone out of 14 M.A. gross area 13 M.A. are culturable. During the above mentioned year about 23.6 M.A. of irrigated land were cropped with 17 million acre ft. of stream flow, a considerable part of which came from the Beas, Ravi and Sutlej rivers.

Water Resources of West Pakistan

In the table maximum, minimum and medium discharges of three Western rivers are given :—

Individual —River Data

River		*Runoff in Millions of Acre-Feet*			
		Maximum	Year	Minimum	Year
Indus	..	110	(1924)	72	(1951)
Jhelum	..	31	(1957)	15	(1946)
Chenab	..	38	(1959)	19	(1940)

Combined Data—Three "Western" Rivers

River		Average	*Runoff in Millions of Acre-Feet*		
			Maximum	Minimum	Median-Shortage Year
			1959	1951	
Indus	..	93	106	72	94
Jhelum	..	23	31	21	24
Chenab	..	26	38	22	25
Total	..	142	175	115	143

Preliminary operation study

The preliminary conjunctive surface and ground-water operation is prepared on the following assumptions :—

1. Waters of the Indus, Jhelum and Chenab Rivers available.
2. All link canals in operation.
3. Mangla and Tarbela reservoirs, totalling 11.4 maf. active storage capacity, in use.
4. Areas under crops in Northern zone 19 MA irrigated, 28 MA cropped and in Southern zone 8 MA irrigated and 8 MA cropped.
5. Assuming irrigation water requirement for 36 M.A, amounting to 98 maf.
6. Constant reservoir release.
7. River gains and losses and deep percolation losses assumed.

Working on this basis a deficiency of 40 maf is found out as worked out in table below :—

Ground Water Availability

In West Pakistan about 2,000 miles of river channels, 40,000 miles of channels of varying sizes, 380 miles of new link canal are the sources of percolation. From a preliminary operation study the following orders of conveyance and deep percolation losses are worked out.

Ground-water recharge and non-beneficial losses amounts to 84 maf, of water 57 maf for Northern zone and 27 maf, for the Southern Zone. In Northern Zone with their regional areas of some 34 million acres about 27 MA are underlain by good quality ground water, having concentrations of 3,000 ppm. or less. This 34 million acres include a gross irrigation command of about 23 million acres with a culturable command of about 19 M.A. and which have about 16 M.A. underlain by usable ground-water. Taking into account the future annual recharge the good quality water in the gross irrigated commands area is estimated at about 32 maf.

Item		*Zone*		
		Northern	Southern	Total
Net river loss	..	9	6	15
Link canal loss	..	6	0	6
Irrigation system loss	..	17	11	28
Water course loss	..	7	3	10
Sub-totals—				
Conveyance losses	..	39	20	59
Deep percolation and leaching	..	18	7	25
Total	..	57	27	84

Discussion

For 36 million acres of cropped area and with 143 maf. of river supply regulated by 11.4 million acre feet of active storage, about 92 maf. of surface water can be diverted to give 58 maf. delivered at the crops. In order to make good about 40 maf. from ground water, about 44 maf. will be pumped from 19 ma. of the area resulting in a draft of 2.3 acre foot per acre good quality aquifer. Assuming 32 maf. replenishing into the aquifer a net annual overdraft of 12 maf. or about 0.6 ac. ft. per acre will be necessary. Assuming a storage coefficient of 20% about 3 ft. will be the fall over the entire area. This is just a preliminary appraisal and many other complicated factors shall have to be given consideration.

PAPER No. 11

Review of Reclamation Activities and Methods, and suggested measures for Waterlogging and Salinity Control

By Mohammad Hussain and H. A. Nishat

The irrigation supplies factor undertaken in Indo-Pak sub-continent was on the basic of one cusec for 352 acres crop intensity of 25% in Kharif and 50% in Rabi. With the increase of population, the same quantity of water is applied on more acres with the result that there is a decrease in delta of about 40%. The quantity of water applied per unit area is too inadequate to keep the salt movement downward. Problem of soil salinity of West Pakistan is discussed at same length. It is stated that this is not a problem for West Pakistan alone. India, Egypt, Iraq, U.S.A. etc., have the same problem of soil salinity.

The authors have discussed the probable causes of water-logging and have given attention to rainfall, seepage from irrigation system, from field and from floods obstruction to sub-soil flow. The existence of subterranian ridge is also considered. The paper gives the average rise of water-table as related to rainfall. Belench and Kennedy data about seepage losses being 47% of the head supplies are again referred.

Cotton, Wheat, Gram and Maize are stated to be the crops which take up soil moisture and Sugarcane, Berseem, Rice add to the ground water. The effects of each item are discussed in the paper. A table which is reproduced below gives the 1959 statistics of the depth to watertable in various zones of West Pakistan.

		0-5′	5′-10′	10′-15′	Beyond 15 ft.
Peshawar Region	..	20,787	182,067	106,496	17,313,690
Chaj Doab	..	432,200	1,926,400	442,000	423,400
Rechna	..	483,400	2,982,800	1,886,400	1,563,400
Thal and Derajat	..	250,000	1,650,000	950,000	9,936,173
Bari Doab	..	16,783	1,365,903	1,780,838	3,390,076
Bahawalpur	..	240,000	990,000	1,210,000	8,227,187
Sind	..	572,621	3,346,152	1,286,349	30,720,958
Quetta & Kalat	..	..	..	..	..
Part Pindi & D. G. Khan Region	..	..	..	..	..
Karachi	..	..	..	..	..
Total	..	2,015,791	12,643,322	7,664,283	71,579,488

As a result of malpractices of the irrigation methods, salinity problem has cropped up in the whole of the country. The authors has referred to the various estimates of the thur affected area and a table below gives some idea about the land affected by salt up to the year 1961-62:

While discussing the measures adopted to reclamation the saline alkali soils, the authors have suggested the removal of surface deposit, lowering of the toxic concentration of salts in the surface soil, cultivation of salt resistance plants, use of chemical amendments, addition of organic matter, flushing of the soil and drainage and combination of some of the above methods. In this paper the results of all these measures are explained. Detail information is given about the cropping arrangement for reclaiming saline soils. The reclamation methods and their success is also discussed.

Name of Region	Total area surveyed	Never Cultivated Thur	Thur abandoned	Thur under cultivation partially affected	Total
1. Former Punjab	17,008,158	704,141	557,314	1,746,691	3,008,146
2. Former N.W.F.P.	891,509	15,612	8,721	8,841	33,174
3. Former Bahawalpur	4,081,205	128,823	66,490	146,529	341,842
4. Former Sind	12,711,864	899,500	381,866	603,636	1,885,002
Total	36,492,736	1,748,076	1,014,391	2,505,697	5,268,164

PAPER No. 12

"Efficacy of and Dependence on Tubewells as a means of Providing Additional Supply Necessary for Controlling Salinity and Reclaiming waterlogged areas."

By Sarwar Jan Khan

The author starts his discourse with a brief history of the canal system and appearance of the problems of water-logging. He has given a brief history of the various organizations set up by the Government to counteract this measure. The author has pointed out to the Wapda authorities towards the realistic dependable quantity and quality of groundwater and the life expectancy and economics of tubewell pumping in the areas highly impregnated with injurious salts. He has put forth the experience of irrigation tubewells which were of 2 cusecs and which within 10 years have got reduced in yield to about 1.4 cusecs with corresponding increase in depression head from 12 to 17.5 ft. In Dera Ismail Khan where 60 tubewells of 3 cusecs capacity were installed in 1959 have declined in the discharge by about 14% and the salinity index has risen from 300-700 to an alarming degree in certain cases. It has also been pointed out that within one year watertable has declined by 3.67 ft. which shows that within 20 years, the watertable will fall to, pre-irrigation level of 80 ft. instead of 40 years period as assumed by the consultants. In other words the economic pumping limit of 40 ft. pumping head would be reached in 10 years.

There are instances of heavy incrustation on the strainers in the case of some of the tubewells installed in the Chaj Doab. It is

thus difficult for the Irrigation Department to accept Wapda estimate of life expectancy of 40 years and consequently the financial forecast of salinity and reclamation project.

From this discussion it was stated by the author that it clearly emerges that till such time as the outstanding controversial issues, like yield of aquifer, depletion of watertable, cost of pumping and other allied matters, like the action of salts on the tubewell machinery, have been resolved on the basis of working experience of Project No. 1, it would be advisable to go slow with the further implementation of the Wapda Salinity Control Project No. 2 in Chaj Doab. The Department would also like to have experience with :—

(1) Deep seepage drains.
(2) Tubewells.
(3) Shallow open percolation wells and
(4) Tile drains.

to be convinced of the effectiveness and economics of pumping. It is possible that different devices may have to be used in different areas.

PAPER No. 13

"A Study of the rise of Ground Water and its Salinity in the Irrigated Areas of Indus Plains."

By Dr. Nazir Ahmad

In this paper the author has examined the ground water wells records of Thal, Chaj Rechna, and Bari Doabs. He has examined the rise of ground water from wells located at different points within the floods plains and away from these plains into the central axes of the doab. He has studied the slope of the sub-soil water as it existed before the introduction of the irrigation and those which existed at present. His conclusions of this study are summarised as follows :—

(*i*) After the introduction of canal irrigation, ground-water, from a depth of 30 ft. and more rose at the rate of 1.0 to 1.7 ft. per year.
The ground water from a depth between 15 to 30 ft. rose at the rate of 0.3 to 0.7 ft. per year. If ground water was less than 10 ft. deep it rose at the rate of 0.1 ft. per year. At a depth of 5.0 ft., the ground-water stabilized showing only seasonal fluctuations.

(*ii*) Rise of water in one doab served by a given canal system has been of the same order in extensive area. Deeper regions have not shown in general greater rise, the exception being those doabs in which the ground water was deep as to give a steeper gradient as compared to the natural surface slope. As soon as the gradient was reversed with the rise of watertable, the water started rising in the area as a whole.

(*iii*) Canal irrigation in one doab resulting in rise of ground water has not affected the ground-water of the adjoining doabs. May be, the rivers have been working as mositure piles and do not allow high ground water of one doab to move to the adjacent doab having deeper ground-water.

(*iv*) Rise in ground-water in Upper regions of a doab has not affected the rate of rise of ground-water in the lower regions, proving thereby insignificant under-ground flow.

(*v*) Obstruction to the natural drainage of streams and Nullahs by rail, roads and other developments, resulting in longer detention of the

flood water, or by the imposition of canal crossing the doab, like U.C.C. has caused a rise in ground water even before the introduction of canal irrigation. This rise has generally been in areas below foothills such as those of Thal, Chaj and Rechna Doabs.

(vi) In certain cases the sub-soil water gradient between river water and the water of the deeper regions was more than the natural surface slope. This could cause infiltration into the deeper regions. It was possible in Chaj, Rechna and Bari Doabs, so that this flow washed the soluble salts in the deeper regions, raising their conductivity sometimes above that of the sea water. Such conditions existed before development of irrigation, so that the salts of the flood plains seem to have been washed down into the deeper regions having steep gradient of ground-water. Chaj Doab possessed the steepest sub-soil water gradient, followed by Rechan and Bari Doabs.

In case of Thal, the salinity in the northern area seems to be a result of infiltration from the salt range and washing of formation from Indus towards the Jhelum. In its south the saline zone is a result of washing of salts from the flood plains of the two rivers. Deep ground-water of Thal, did not possess such a sub-soil gradient as to accumulate the infiltering water into the deeper regions.

PAPER No. 14

Performance of Salinity Control and Reclamation Project No. 1, Rechna Doab.

By Shamim Ahmad, Badr-ud-Din and Zaidi

In this paper the results of performance of salinity control Project No. 1 are given (Scarp 1). The scheme went into full-scale operation in 1962 when 12 contiguous schemes areas constituting a gross area of 1.2 million acres was started to be drained by about 2,000 tubewells constructed by Wapda. The total pumping capacity of this tubewell system is over 5,600 cusecs equivalent to a depth of about 3.7 feet of water spread over the gross area or nearly 3.5 times the capacity of the existing canal system of the area. The tubewell pumping will draw ground water to suppress the watertable below the root zones thereby eliminate surface drainage problem and the related salinity hazards.

Well design

The design of tubewells installed in this area has a screen of mild steel, 10 inches in diameter perforated with slots equal to $\frac{1}{16}''$ wide and $2\frac{1}{2}''$ in length to provide 30 square inches per ft. of open area. This much area is sufficient to keep the sub-soil entrance velocity below 0.15 feet per second. The screen is shrouded and each well has a turbine pumping set. Typical yield of well is between 110 to 130 gpm/ft. of drawn-down. After six months of their operation sample testing of well has been carried out and there is no perceptible decline of yield or incidence of failures of wells.

Quality of Tubewell Supplies

Waters of 1,022 tubewells have been analysed three times and there has been no significant change in the quality of water.

Salinity Control

Wasid has established about 400 tests plots to determine the changes in soil salinity which before the start of tubewell operation was highest within the top six inches of the profile. The results shows that there is almost universal response of the soil to the reclamation measures, regardless of their texture, the extent of salinity and quality of tubewell waters.

Sub-surface Drainage

The watertable in the year ending April, 1962 declined at an average of about 3.45 feet in most areas where the tubewells were in operation for the full year.

Agriculture

There seems to be considerable increase in the farm commodities. Table below gives the market statistics of Chuharkana for the last six years.

Chuharkana Market Statistics

Farm Commodities Marketed (Maunds)

Year	Wheat	Rice	Sugar	Cotton	Oilseeds	Fodder	Gram
1958	60,000	83,800	24,000	8,900	10,000	1,000	700
1959	63,000	83,000	22,909	9,000	9,500	690	..
1960	69,892	90,000	26,012	11,998	10,011	1,090	895
1961	82,107	96,997	38,006	14,011	13,025	1,200	1,200
1962	92,672	132,000	48,788	17,015	15,988	1,400	1,350
1963	97,996	140,015	60,093	18,988	17,895	1,509	1,488

Thus we have every reason to be optimistic about the future prospects of maintaining permanent irrigated agriculture in the Punjab.

Engineering Pakistan's Future

By **E. C. ITSCHNER**

On 8th October after a Lunch by Packages Ltd., General Itschner addressed the Engineers gathered for Jubilee and Centenary Celebrations.

The General stated that "It is to my disadvantage that I must follow so many eminent engineers in the program of the 50th Anniversary meeting of the West Pakistan Engineering Congress. Realizing that you probably are satiated with both food and facts I have selected a general subject which I shall present quite briefly: Engineering Pakistan's Future.

Perhaps I am presumptuous to speak on this subject after being in Pakistan only two and one-half years, but I am familiar with the history of engineering in my own country, and I judge that Pakistan lies today on the threshold of a period of intensive development comparable to that occurring in the United States after the Civil War almost a century ago. Many of you have spent some time in countries which are more highly developed than your own, and you, I am sure, agree that the problem is not so much to determine what engineering and constructive work is required, as it is to determine priorities for many competitive essential works.

Pure Water and Sewage Disposal

Surely high on such a priority list must come the construction of sanitary sewer and sewage disposal system for the cities of Pakistan, so that each family has at least one bathroom. As the country develops, manpower (now overly abundant) will become too scarce to allow a preventable loss caused by disease stemming from inadequate or non-existing sewage systems. Water supply must be extended to provide outlets to every city family, furnishing them with pure water at good pressures twenty-four hours a day. Houses for millions of families should be rebuilt over the next few decades to minimum modern standards. Spreading out industries along roads, such as is happening today along the Grand Trunk Road north of Lahore, will reduce population pressures on the large cities and give the people a better life than they would have in some crowded old city.

Great Demand for Power

I think you will find that the demand for electric power will increase so greatly that for many years any amount that can be produced will be absorbed quickly. Both hydel and thermal plants, the latter using natural gas for fuel, will be constructed. The gas pipeline system will require extension

to Peshawar and its capacity will soon need to be increased.

Road Improvement Essential

Much needs to be done to the road system. Many more roads should be paved and those which now have only one paved lane should be widened to two. Some of the pavement is very rough, indicating the need for complete reconstruction with a thicker base course. At the same time many miles of road should be regraded with more cut and fill to eliminate sharp crests. Even the Grand Trunk Road where it now is two lanes wide would be considerably improved if a strip of Portland cement concrete eighteen inches or two feet wide were placed on each berm. This would greatly reduce maintenance, eliminate much of the dust caused while overtaking vehicles, and reduce the hazard to pedestrians and cyclists. One-lane bridges should be replaced on principal roads. I understand that the replacement of the Jhelum River bridge on the G. T. Road is programmed for the near future. Also, grade separations at railway crossings on important roads will be required. New, all-season roads to remote areas, such as Gilgit, Chitral and Skardu, would open up vast areas to commerce, and permit development of some of the world's most scenic areas for highly profitable tourism. They would be very expensive to build, of course.

Double Tracking of Railways

Pakistan has an excellent railway system, and I am not familiar with its requirements for engineering improvement, but I am sure double tracking, extending service to more remote areas and other improvements will have to come.

Need for Development of Water Resources

Pakistan already has a highly developed irrigation system which will be continued with the completion of the Indus Basin Project. Storage is essential if the system is to be improved and expanded, and Tarbela Dam, as the key storage project, absolutely must be built. With Tarbela run-of-the-river projects for power could follow at Attock and Kalabagh, and off-channel storage projects holding great promise could be constructed in the Soan River valley. They would be fed by gravity diversions from Tarbela reservoir. Upstream of Tarbela a storage dam will some day be built at Skardu which will greatly lengthen the effective life of Tarbela reservoir. Many other smaller irrigation projects will be developed on tributaries. Tens of thousands of tubewells will reclaim land from waterlogging and salinity and at the same time contribute substantially to the supply of irrigation water. Means of disposing of excess saline water must be devised.

Pakistan Engineers need to rely completely on their own

All of these essential works constitute a great challenge to Pakistani engineers. Unfortunately, Pakistan is not a country in which engineering is simple. On the contrary, as an example, I doubt if we would have built a Mangla Dam in the United States, and certainly we would not consider a Tarbela Dam, but since there are no better alternatives in Pakistan, they must be constructed, difficult and costly as they may be. While no doubt friendly nations will assist you in meeting this challenge, you must expect this aid especially in the form of grants, loans at low or even negligible rates of interest and pegging the rupee at an unrealistically high rate, to taper off gradually and finally stop. Then you Engineers will be more completely on your own.

I am sure you will meet this challenge, and meet it well. To do so, there are certain actions, I believe, you should take today in order to be better prepared for the future.

Improve Education of Engineers

First, the education of Engineers should be improved. The change from a three-year course to one of four years was a forward step, but we are about at the point now where five years at college level is required to produce a reasonably good junior engineer. His education should be a broad one, so that he can express his thoughts well and participate on an equal footing with graduates from arts, law and other courses in the affairs of the community and government.

Give Junior Engineers a Sense of Responsibility

Engineers must learn to delegate authority to their juniors. This releases the head man from routine work so that he can devote more time to creative thinking, and it gives the juniors a sense of responsibility which prepares them for advancement. Every senior engineer necessarily is an executive, and he should always have a deputy who is fully authorized to act for him when he is absent. I consider this failure to delegate authority, this insistence that the most minute and unimportant details be decided by the man at the top, to be one of the greatest obstacles that you Pakistani engineers must overcome in meeting the great challenge of the future.

Reduce Paper Work

Another burden you should try to reduce is the enormous amount of paper work. Civil services of all nations have the same problem. In our country our files are much smaller than yours because we do not keep the comments of every person who expresses himself on a particular case. For instance, we keep the incoming letter, the answer, and rarely a memorandum explaining why the position was adopted.

Paper is a poor construction material and it does not mix with water. I concluded that I had not been drastic enough. Only the most important papers should pass through more than two officials before reaching the officer who signs it.

Pakistan needs Creative Engineering

To meet the challenge of the future you must be receptive to new methods. Civil Service employees in any country tend to adopt the theory that if they try something new and it fails they will be in trouble, whereas if they just follow past practice they will have a record without either blemishes or brilliancy, and in the long run they will prevail over their more venturesome contemporaries. That is not the type of philosophy that Pakistan requires if it is to accomplish the tremendous engineering program required of it in the next few decades.

Cooperate for Developing Pakistan

A very serious fault that absolutely must be overcome if Pakistan is to be successful is the harmful rivalry and lack of cooperation existing among some individuals in different Governmental agencies in most countries. A problem of an agency is a problem of the Government, and therefore all other agencies should cooperate to the fullest possible extent to help in its solution. I regret to say I have known of some cases where full, wholehearted cooperation with WAPDA has not been forthcoming from lower echelons of other Government agencies. We must go to the Chief Engineer (or the

equivalent) or even to the Secretary, and they have always been most cooperative and helpful. Our common purpose in developing Pakistan should not be hampered by petty jealousies and grievances.

In the spirit of cooperation all agencies concerned should get together and develop common general conditions of construction contract and specifications for frequently used construction processes, such as mixing and placing concrete. Standard general conditions should be printed so that they can be used in that form as part of all contract documents.

There are many other things that will occur to you that you must do if you are to meet the challenge to engineers that Pakistan's future development poses.

Pakistan has developed engineers, only follow President Roosevelt's advice.

When I consider that Pakistan has developed engineers like Mr. Kazi and Mr. Kirmani, who would be top-flight in any country, I feel assured that Pakistan will meet this challenge, and meet it well.

In doing so, I hope that you will follow the good advice of one of America's greatest Presidents, Theodore Roosevelt, who held office in the first decade of this century. He said:

It is not the critic who counts—not the man who points out now the strong man stumbled, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood who strives valiantly, who errs, and comes short again and again; who knows the great enthusiasms, the great devotions; who spends himself in a worthy cause who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so his place shall never be with those cold and timid souls who know neither victory nor defeat.

The Private Practice of Consulting Engineering

By **GERALD T. McCARTHY**
Partner of Tippetts-Abbett-McCarthy-Stratton

An excerpt from his address given on the 8th of October 1963.

"It gives me great pleasure to return again to Pakistan and especially at this time to attend the West Pakistan Engineering Congress and to join with you in celebrating its Golden Jubilee in commemoration of the notable achievements of the first half century of its existence and of the first century of the Public Works Department of the Government of West Pakistan.

I have enjoyed your technical sessions and the very interesting papers presented during the past two days. You are to be complimented on the excellent organization of this Congress.

In 1938 I left the United States Army Engineers and entered the private practice of consulting engineering. I have found it to be a challenging and engrossing profession. Two Associations of Consulting Engineers of Great Britain and the American Institute of Consulting Engineers were founded in 1910 and incorporated in November 1913. These two movements were entirely independent and arose from the necessity to define and clarify the duties and responsibilities of the Consulting Engineer.

Since the standards and policies of these and other national consulting engineering societies have had an important bearing on development of the practice of consulting engineering, I shall describe briefly the one with which I am most familiar, the American Institute of Consulting Engineers. Its objectives are:

(*a*) To encourage the practice of engineering as a profession.

(*b*) To promote ethical principles and practice.

(*c*) To advance the interests of engineers in all branches of the profession with particular application to matters having a bearing on the activities and interests of consulting engineers, and

(*d*) To increase the usefulness of the profession to the public at large.

There are 350 members of the American Institute of Consulting Engineers; they are principals of over 200 engineering firms employing over 10,000 engineers; they render engineering services in 74 classifications. The Institute is run and serves the profession through highly organized committees.

Present Level of Consulting Engineering Activity

Private practice has grown with the expansion of world technology and industry. It gained impetus in the public engineering field during World Wars I and II by handling engineering planning, design and technical supervision beyond the capacity of Government engineering staffs. In the United States, consulting engineering firms perform from 40 to 100 per cent of the Federal Government engineering work for such agencies as the Army Engineers, Bureau of Yards and Docks of the Navy, other branches of the Department of Defence, Atomic Energy Commission, Agency for International Development, National Aeronautics and Space Administration, and Public Building Service. Our profession also has engineered all of the toll highways and about half of the state highways. At the municipal public works level, consulting engineers handle over half of the work. A substantial part of the engineering for industry is done by consulting engineers.

In the United States, construction is our largest single industry; it has an annual volume of over $80 billion, about one-third of which is housing and other light construction and two-thirds is for heavy construction. The consulting engineer serves principally in the heavy construction field. He must earn and maintain the respect and confidence of his clients and of the profession at large by rendering a superior quality of service and by adhering to high and ethical standards of conduct and professional practice. He must also justify his existence by rendering his services efficiently and economically.

The profession policies itself through its societies by self enforcement of its standards.

The Canons of Ethics adopted by the American Institute of Consulting Engineers and many other important engineering societies constitute an inspirational guide for all phases of professional action. Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitute the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life. It is his duty to practise his profession according to these Canons of Ethics. These are separated into several sections. There are two sections for professional life, five for relations with the public, eleven for relations with clients and employers and ten for relation with engineers.

Turn-Key Package Engineering and Construction by a Contractor

It is to the client's interest to separate the engineering and construction functions. Unless the design has been fully completed, either to the extent of bidding plans in certain cases or complete contract drawings and specifications as in the majority of cases, there is no proper basis on which to evaluate bids and make the selection of a construction contractor. Where bids are received for turn-key jobs requiring both design and construction by a contractor, each bidder submits a quotation based on his own concept of job requirements.

With respect to supervision and inspection of construction, the advantages of engaging an independent consulting organization to control, supervise and approve the work are obvious.

Cooperation with Government Agencies on Government Engineering

We feel that there is a need and place for both Government staffs and consulting

engineers, which is summarized in the Position Paper prepared by the Coordinating Committee representing our two national consulting engineering societies, the American Society of Civil Engineers, the National Society of Professional Engineers, and the Engineering Division of the American Road Builders Association.

The Business Organization of a Consulting Engineering Firm.

To those of you who are consulting engineers or who may contemplate entering the consulting field some day, I would like to suggest several principles that have been important to our success:

(*a*) Limit the scope of your activities to that within the experience of your principals and key staff. Do not attempt to cover the waterfront.

(*b*) Accept work only on such a basis of responsibility and compensation that permits you to perform it properly.

(*c*) Establish sound personnel policies including recognition for meritorious work, adequate compensation, training and development of junior staff, tenure of employment for key staff during periods of slack work within the limits of your financial reserves for this purpose.

(*d*) Maintain close liaison with your clients.

(*e*) Establish and maintain a good system of accounting and cost control.

(*f*) Build up working capital as your business grows to be able to finance adequately your operations.

(*g*) In negotiating contracts define carefully the scope of work and basis of payment. Check upon the legal authority of the client and upon the availability of funds. Do not assume responsibility for matters beyond your control.

(*h*) Estimate your work carefully and maintain close budgeting control as well as quality control by careful checking of your analyses and computations.

(*i*) While carrying out your responsibilities be fair to contractors, suppliers, manufacturers and other third parties.

(*j*) Keep from getting involved in non-professional activities such as politics.

(*k*) Concentrate on the jobs that you have and don't worry about the ones that got away.

The Future of Consulting Engineering in Pakistan.

Today there are several national firms of consulting engineers in Pakistan who are gradually expanding their practice. There are also a large number of outstanding foreign consulting engineering firms with world-wide reputation who are serving the Water and Power Development Authorities of West and East Pakistan and other agencies of your Government as well as private industry.

There should be many opportunities in the future for national engineering firms to carry out works within the scope of their experience and in association with foreign engineering firms, to carry out works that require a broader experience. Foreign consulting engineering firms will be needed in Pakistan for many years to come. I am sure that they will be happy to assist in the training and development of national engineers to prepare them for private practice. As in other countries, over the years there should be a gradual trend in which the national engineering firms assume a progressively greater role in this field.

In competitive private practice, engineers and technicians generally receive higher compensation than in the public service. This stimulates salary increases for government engineers and accordingly has a beneficial effect on the egineering profession.

Private industry will benefit because they can be served by consulting engineers whereas government engineering departments are not available to them.

It can be expected that many national consulting engineers will heed the call to return to high posts in the public service and will be drafted for important positions in industry and construction.

The trained technical mind that has undergone the discipline of running a profitable engineering business is in demand in almost all segments of our complicated modern society. A reservoir of such personnel adds to the strength of any country.

A well-established national profession of consulting engineering will attract a greater proportion of talented students to the engineering profession and will provide an outlet and challenge to their ambitions.

(*Continued from page* 54)

A list of failures of earth dams attributed to the conditions set up during draw-down is given in a Table.

Stability charts are presented to facilitate the computation of the factor of safety of earth slopes during rapid draw-down. As the reservoir level is lowered, the factor of safety decreases if it be assumed that no dissipation of pore pressure occurs during draw-down. Pore pressures during draw-down have been estimated by assuming that B is unity and stability calculation for the range of sections and soil parameters commonly encountered in earth dam practice have been carried out using an electronic computer in order to obtain the data given in the charts.

Abstracts of Interesting Papers

BISCHOFF, W. C.

'Foundation and Scour Problems Associated with Various Methods of closing an estuary'.

LA Houille Blanche, March-April, 1963, *Page* 143.

The beds of Dutch estuaries are made up of very fine materials, which are very vulnerable to wear by currents resulting from the closing of a sea inlet. Considerable scour may be expected to occur and, in turn, upset the equilibrium of the deeper bed layers. This unsatisfactory state of affairs is quite likely to be made worse by the occurrence of unstable local sand accumulations which, by causing excessively high water pressures in the deeper bed layers during the construction work, are liable to affect the shear strength of the materials and upset the equilibrium of the bed layers at an earlier stage.

This article discusses the merits and disadvantages of various estuary closure methods in the light of these factors.

VENIS, W. A.

'Scour due to eddy streams'

LA Houille Blanche, March-April, 1963, *Page* 159.

The bed and toe wall scour caused by the eddy streams forming at the ultimate closing stage of a dyke is usually more serious than that associated with "purely two-dimensional" flows. The degree of scour depends on the intensity of the eddy stream, the effects of which have been investigated in comparative studies carried out on movable bed models. Owing to the bed roughness, more representative eddy trails are obtained with a distorted scale model in certain cases.

Despite the considerable difficulty of determining the time scale in scour tests on a movable bed model, some indication of its magnitude can nevertheless be obtained by comparing the model and prototype results.

VINGE, J. J.

'The Similitude of Hydraulic Conditions Down-stream of a Sill'

LA Houille Blanche, March-April, 1963, *Page* 178.

Two very important questions must be answered before a scale model investigation of erosion and bed protection stability down-stream of a sill is undertaken. They are the following:—

1. Will the configuration and characteristics of the turbulence on the model be representative of prototype conditions?
2. Will they remain so when erosion

develops? Systematic research on these points is now in progress, with sills of varying roughness and permeability, and different model scales.

PRINS, J. E.

'The time scale in Scour Model Research'.

LA Houille Blanche, March-April, 1963, *Page* 183.

Research at the author's laboratory has shown that the model is representative of prototype conditions during a certain phase in the development of scour. The important thing to know in practice is the ratio required between the model and prototype times in order to achieve the same relative depth of scour on the model. This time scale is very difficult to determine, especially if the prototype bed materials are very fine (200μ). Research is now in progress in which the effect of each parameter determining the development of scour is being studied separately.

SVANTESSON NILS L. and SUNDBERG-FALKENMARH M.

'Flow analysis with Radio Isotopes'.

LA Houille Blanche, May-June, 1963 *No.* 3, *Page* 255.

The relative dilution method combined with a radioactive remitting tracer, has been used to determine the flow through a power plant with low head and short waterways. To counteract the incomplete mixing, measurements were performed at 20 different points for each of which two determinations were made. The accuracy of the final value in this first trial was estimated at about 4%. It is pointed out that the accuracy attainable with this method is mainly a question of enlarging the number of measurements (injection number multiplied by detector number). The concentration records made at the mouth of the draft tube, using "in situ" scintillation detectors as probes, were also used to localize flow disturbances, e.g. separation from the ceiling of the draft tube. The constructor of the power plant is hereby given a possibility to check the quality of the conduit shape more exhaustively than is possible in model studies. An analysis of flow parameters has been performed for a straight hypothetical tube giving the same dispersion as the actual waterway. The quality of the water way shape has been expressed as the friction coefficient of this tube. A trial has been made to calculate parameters for small scale as well as large scale eddies.

PUYO, A.

'Hydraulic Turbine Development during the last few years'

LA Houille Blanche, May-June, 1963, *Page* 269.

The technique of hydraulic turbines originated many years ago, but it has nevertheless been possible to make amazing progress in the course of the last fifteen years. In conjunction with the progress made by generator manufacturers as well as on the civil engineering side, the future prospects for hydraulic power are extremely promising despite the competition from other sources of energy. Progress has been made principally with regard to improved economy, greater case of operation and longer equipment life. This has led, on the one hand, to spectacular results such as increased unit outputs and rotational speeds and a reduction in the weight of the equipment; and on the other hand, to less obvious improve-

ments, mainly in the technological field, the incidence of which is none the less remarkable with regard to machine performances. Furthermore, we have seen the creation and the development of new types of machines, such as vertical-shaft impulse turbines, bulb units and pump-turbines. These new solutions will without doubt contribute towards making hydraulic power more competitive in the course of the coming years.

ENGELUND FRANK

'Three dimensional flow in open channels'

LA Houille B'anche, October 1963, *Page* 665.

The paper deals with the deduction of a general equation for the shape of the free watertable in open channel flow, taking account of non-hydrostatic pressure distribution and gradual irregularities of the bottom. It may be considered on extension to three dimensions of the classical Boussinesq-theory for gradually varied flow.

POUNDY, C. A. P. and HONDROS, G.

'Rapid Field Assessment of Strength of Concrete by accelerated Curing and Schmidt Rebound Hammer'.

Journal of the American Concrete Institute, January, 1964, *Proceedings Vol.* 61 *No.* 1, *Page* 77.

Tests were made on 6-in, cubes from 17 different batches of concrete. Some of the cubes were cured in water and tested in a standard compression machine. The remaining cubes were steam cured and tested with the rebound hammer prior to being loaded to failure in compression testing machine.

The results suggest that the rebound hammer may be used in conjunction with some method of accelerated curing to provide a rapid and convenient field method for estimating the strength and quality of concrete.

POPOVICS SANDOR

'Tables for Concrete Mix Proportioning'.

Journal of the American Concrete Institute, January 1964, *Proceedings Vol.* 61 *No.*1, *Page* 45.

Existing methods of selecting proportions for concrete usually offer tabulated values as guides in approaching the optimum amount of water, cement, and aggregates. For more accurate estimates, tables are presented in this paper which were developed recently for the State Highway Department of Alabama.

One of these tables refers to the adjustments in water content for slump. In other tables, cement factors, in bags per cubic yard, are presented as a function of mix proportion, grading and average specific gravity of mineral aggregate.

Further tables are offered to obtain the average specific gravity of mineral aggregate when a mixture of two materials of different specific gravities are used. Numerical examples illustrate the use of the tables presented. While these tables are not a self-sufficient method of concrete mix proportioning, they will reduce the number of trial mixtures required.

PINUS, E. R.

'Method of bonding new and old concrete (In Russian)

Journal of the American Concrete Institute January, 1964, *Proceedings Vol.* 61, *No.* 1, *Page* 114.

Describes a comparative study on the bonding of fresh concrete to laboratory samples cured for at least 2 months. Tests after 50 to 100 freezing and thawing cycles indicated that a stronger and more

durable bond is achieved with cement slurry than with high molecular materials such as rubber latex, epoxide resin, and polyvinyl acetate emulsion.

ZINGONE, G.

'Corrosion Phenomena in reinforced concrete structures site observations and experiments'.

Journal of the American Concrete Institute, January, 1964, *Proceedings Vol.* 61, *No.* 1, *Page* 126.

Describes the appearance of some reinforced concrete structures severely damaged through corrosion of the reinforcement, in relation to their distance from the sea and the stresses to which the various structural members were submitted. In addition, the results are reported of laboratory tests carried out on two series of reinforced concrete beams (made from Types 680 and 500 portland cement with Aq 59-60 and Aq 42-50 reinforcement respectively) to determine the effect on the corrosion process of stressing to the ultimate strength of the concrete. Finally the fall in flexural strength of the corroded beams is found by experimental determination of the cracking moments.

JAIN, G. S. MOHAN D. and KUMAR V.

'Load Bearing Capacity of Piles'.

Geotechnique Vol. XIII, March 1963, *No.* 1, *Page* 76.

The paper presents an approach to the prediction of the bearing capacity of piles in advance of piling operations by the use of static cone penetration tests. The study was carried out on cast-in-situ driven concrete piles. The distribution of skin friction and point resistance at various loads was determined during the tests by measuring strains with wire resistance strain gauges. The values of total skin friction and point bearing were also determined independently at different loads by adopting a cyclic load test technique. Pull-out tests were made to determine the frictional resistance under pulling, and the values obtained were found to be less than those obtained under pushing during the load test. The coefficients of earth pressure were also determined from the friction values obtained during the load tests and were found to decrease from a value equivalent to the passive earth pressure state at the top to a lower value at the bottom.

A compilation of data already available on the frictional resistance of piles was also made. It revealed that in soils of average stiffness (cone penetration values of 10-100 kg/sq. cm.) the value of unit skin friction of a pile was roughly 2% of the average cone penetration resistance along the pile length.

MORGENSTERN NORBERT

'Stability Charts for Earth Slopes during Rapid draw-down'.

Geotechnique Vol. XIII, June, 1963, *No.* 2, *Page* 121.

1. A sufficient number of failures of earth dams under drawn-down conditions have been recorded to demonstrate that it is important, if not critical, to investigate the stability of the structure under these conditions. The details of four earth dam failures which occurred due to the draw-down of the reservoir have been given by Mayer (1936). Draw-down failures have also been described by Schatz and Boesten (1936), Reinius (1948) Sherard (1953) and others.

(*Continued on page* 50)

BOOK REVIEW

Waterlogging Saline and Alkaline Land

MOHAMMAD HUSSAIN,

Director Land Reclamation.

Director Land Reclamation, West Pakistan has issued a research publications volume II No. 9, 1963. A printed volume comprising 181 pages, in which whole work of the Land Reclamation Directorate conducted during the last 33 years is reviewed. Out of the seven chapters, the first four are devoted to general information on the subject reviewing the reclamation activities, methods and measures for control of waterlogging and salinity. A discussion of the probable causes of waterlogging in the area, and the history of counter-measures undertaken are explained in the first chapter. The effects of high watertable and the excess of salinity of the soil on the water-crops are discussed in the next chapter and the two ensuing chapters give information on the scientific conception of irrigated agriculture, its practical applications to West Pakistan in the light of methods in vogue in this country.

Brief information of the results of the Laboratory and Field Experiments conducted by the Land Reclamation Directorate are given in the next two chapters. Soils survey had been conducted by this organization since the last quarter of a century.

Details of the sites and the results are also included in this book. It is a useful publication giving information on all the studies which have been conducted by Land Reclamation Department during the last 33 years.

A unique contribution both for the new aspirants in the field of Reclamation science and a piece of reference for the well versed. A good intoduction for the seekers to gauge the achievements of a department which has tried to solve a complicated problem of the country.

'Soil Science'.

A. A. RODE.

Published in Moscow, 1955, *Translated by A. Gourevitch, Jerusalem*, 1962.

This book is based on lectures delivered at the Bryansk Institute of Forestry between 1938 and 1948 and is intended chiefly as an aid in forest husbandry. The interest for engineers concerned with soil lies mainly in the background it can provide to some specialized aspects of their work. Understanding of the geotechnical properties of soils, particularly in shallow foundations has been helped in recent years by pedology, a subject which has been pioneered by the Russians. The book provides a reasonably brief account in English of their contributions, from that of Dokuchaev onwards (he completed the 14-volume soil and land use survey of Nizhnii-Novgorod Province in 1886). Current views on weathering, soil formation and morphology, and the mechanical, mineralogical and chemical composition of loose rocks and soils are recorded. A chapter on the organic matter in soil reflects the work of Tyurin and, latterly, Madame Kononova.

News and Notes

DIRECTORY OF WORLD ROAD RESEARCH

West Pakistan Road Research Institute has produced a World Directory of Road Research. It contains national organizations of 72 countries. It provides information about the pattern of Road Research, type of organizations, their location and work conducted by these Institutions. The directory is intended to promote facilities of co-operation amongst the Organizations engaged in the study of highways construction, traffic engineering and allied problems in different regions of the world. It can be a medium to establish contact amongst the various research Institutions to exchange publications and experience under similar or different conditions. The directory constitute a booklet of 92 pages in which 115 organizations are listed. It is a useful piece of information for research workers on the subject. It is available from Director Road, Research Institute 2, Lake Road Lahore Pakistan.

THE ARTESIAN BASINS OF NORTH AFRICA

Unesco Arid Zone Research Advisory Committee had appointed a mission of three persons to investigate the possibilities and the existence of fresh water in Northern Region of Africa. The countries investigated included U.A.R. Sudan, Chad, Upper Volta, Niger, Mauritania, Mali, Morocco, Algeria Tunisia, and Libya.

The mission has found out existence of fresh-water under many of the states at a depth ranging up to 3 to 5 thousand meters. They have recommended detailed investigations for exploitation of these sources of fresh water.

ELECTRICAL DISCHARGE USED TO CONSOLIDATE SANDY GROUND

Prof. G. M. Lomizye has described field experiments on consolidating loose sandy ground by passing high voltage electrical discharge. The detail is issued in Gidrotekhnicheskoye Stroitel'stvo No. 7, July, 1963. The equipment used for the field tests consisted of a skid-mounted 60-70kV impulse generator and a battery of high voltage condensers on wheels. These were connected to an electrode mounted on the drill pipe used to sluice the assembly into the ground. A 60m^3 /h capacity pump enabled the electrode to be lowered to a depth of 5m in 1-2min The article presents formulae for selecting. the pump and computing the radius of the zone affected by a single discharge. In one site tests with the electrode at a depth of 1-2m, the radius of consolidation after 50 impulses was 2.7m, consolidation was effective to a depth of 2.5m, and the bulk

density of the sand increased from 1.58g/cm³ to 1.66 g/cm³. At the same time the ground surface subsided 14cm near the electrode, 11cm at a distance of 45cm and 9cm at a distance of 90cm. The results of the various experiments and the conditions under which they were performed are given in various tables and graphs.

SYMPOSIUM ON CONCRETE-DAM MODELS

This symposium was organized by National Civil Engineering Laboratory and International Commission on Large Dams. It was intended as a forum at which research workers and engineers engaged in the field of model studies could exchange information upon the latest developments in the subject. The attendance of over 100 delegates from some 20 countries ensured the necessary variety of views and at the same time permitted the discussions to be conducted in a relatively informal atmosphere.

The conference, following it almost a year later was held at the same place, the subject of which was the use of computers in civil engineering, contrasted the use of physical rather than mathematical models for the solution of problems of dams. The interest in the present conference demonstrated that at the moment many areas still remain in which actual "hardware" models permit either an easier or the only solution to the questions posed.

A total of 29 papers dealing with various aspects of model analysis were presented in five working sessions. Although some difficulty was experienced in classifying the various contributions they fall roughly under the following six headings:

1. Materials and techniques of loading of structural models.
2. Applications of photoelasticity.
3. Models for thermal stress determination.
4. Models for solution of seismic problems.
5. Ultimate behaviour of dams and foundations.
6. Some results of model tests and the philosophy of model applicability.

AN ALTERNATIVE TO THE ASWAN HIGH DAM

The seventh edition of a report entitled "Optimum Management of Nile Discharge" has been prepared by the International Students Association for Optimum Nile Control, Zurich. The authors consider that the Aswan High Dam scheme is technically unsound for two reasons. In the first place, the reservoir will arrest the Nile silt which is an essential fertilising element for agriculture in the irrigated areas, and they believe that the use of silt-free stored water will result in soil erosion; secondly, they consider that the losses from the reservoir due to underground seepage will be much more serious than has been estimated, and that in fact there are potentially dangerous uncertainties on hydrological grounds.

An alternative scheme is proposed in which the storage would be held in the Wadi Gabgaba, and in which a specially constructed intake at Abu Hamed would divert low-silt-content water to Gabgaba and allow high-silt content water to flow down the existing river bed. Hitherto the practical difficulty in the way of implementing such a scheme has been the difficulty of constructing a 320 km diversion canal between the Nile and Gabgaba, but on advice from the Lawrence Radiation Laboratory of the University of California, it is maintained it would be both feasible and economic to excavate this canal by means of clean nuclear underground explosions.

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BIBLIOGRAPHY

A. General

of first waterlogging and salinity control Project for Central Rechna Doab).

B. Symposium on Water and Power Resources

Abstracts of papers read in Symposium on "Water and Power Resources of West Pakistan" Organised by USIS.

A. RASHID KAZI
Modernizing of Water & Power Resources.
Vol. VIII, No. 1, March 1963.

DR. CHARLES, M. ELKINTON
Economic Development in Prospective.
Vol. VIII, No. 1, March 1963.

DR. NAZIR AHMAD
Water Potential of West Pakistan, Its present development.
Vol. VIII, No. 1, March 1963.

H. J. ASAR
Irrigation Practice of Pakistan.
Vol. VIII, No. 1, March 1963.

SARDAR ALLAH BAKSH
Irrigation Practice.
Vol. VIII, No. 1, March 1963.

C. All Pakistan Science Conference

DR. I. H. USMANI
Science for Survival.
Vol. VIII, No. 1, March 1963.
(Presidential address delivered at the 15th All Pakistan Science Conference).

A. RASHID KAZI
New Horizon for Engineers in Pakistan.
Vol. VIII, No. 2, June 1963.
(Presidential address at the Engineering Section of 15th All Pakistan Science Conference).

CHAUDHRY MOHD HUSSAIN
West Pakistan Agricultural Potential, The Problems and their Solutions.
Vol. VIII, No. 1, March 1963.
(Pesidential address at the Agricultural Section of the 15th All Pakistan Science Conference).

D. Jubilee Session of the Engineering Congress.

Brief summaries of the papers presented in the previous sessions of the West Pakistan Engineering Congress.

Abstract of Papers on Canal Lining.
Vol. VIII, No. 3, September 1963.

Discussion on Lining of Canals.
Vol. VIII, No. 3, September 1963.

Waterlogging and Salinity.
Abstracts of papers presented to the West Pakistan Engineering Congress.
Vol. VIII, No. 3, September 1963.

Engineering Congress Contribution to Waterlogging and Salinity Problems of West Pakistan.
Vol. VIII, No. 3, September 1963.

Exploitation of Groundwater by Tubewells Main features as put forth in the Congress papers.
Vol. VIII, No. 3, September 1963.

Engineering Congress Contributions on Tubewells and Water supply.
Vol. VIII, No. 3, September 1963.

Presidential Address of Mr. A. R. Kazi, President West Pakistan Engineering Congress.
Vol. VIII, No. 4, December 1963.

President Ayub Addresses the Engineers. (on the Golden Jubilee Session of West Pakistan Engineering Congress).
Vol. VIII, No. 4, December 1963.

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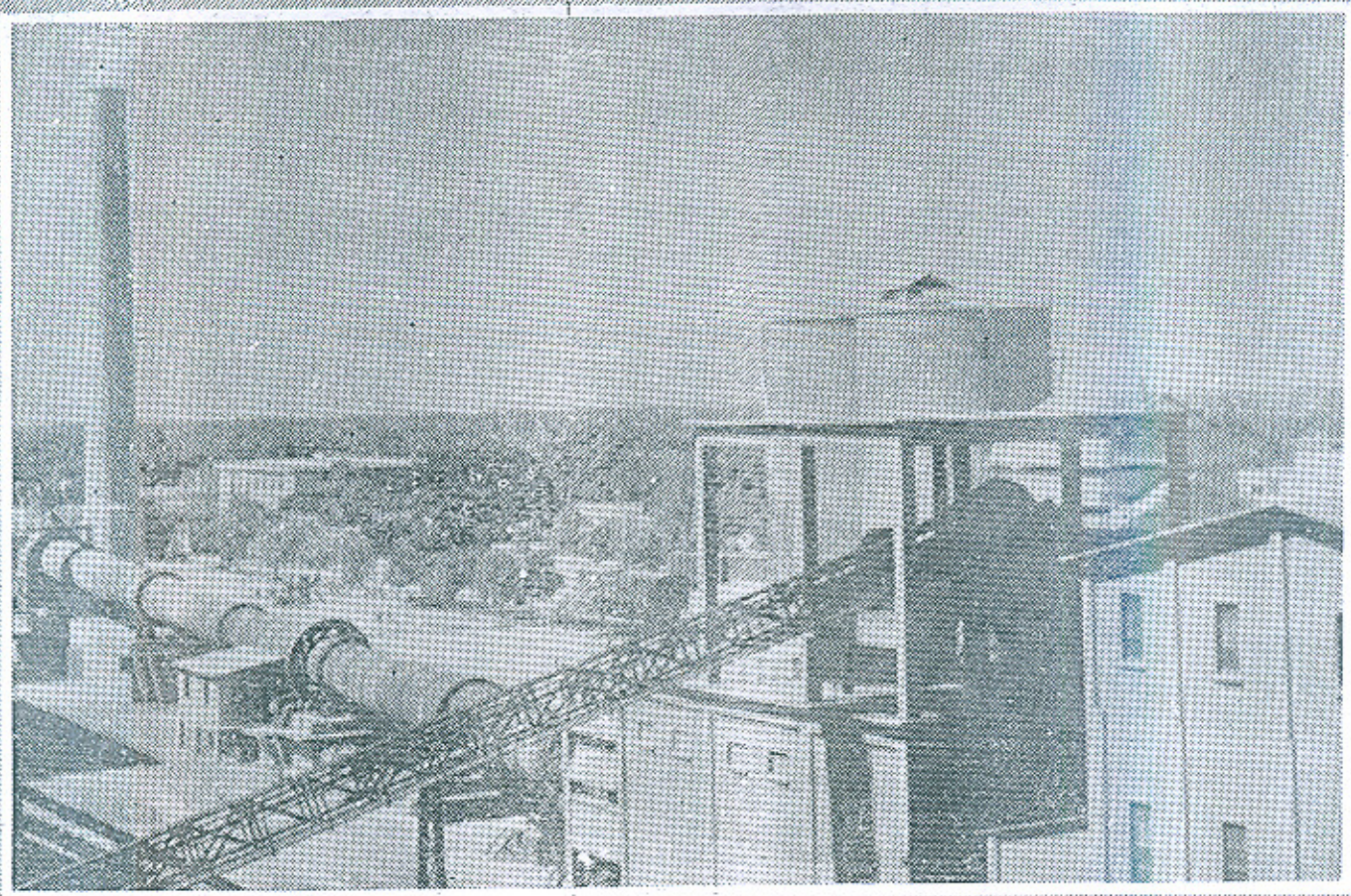

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