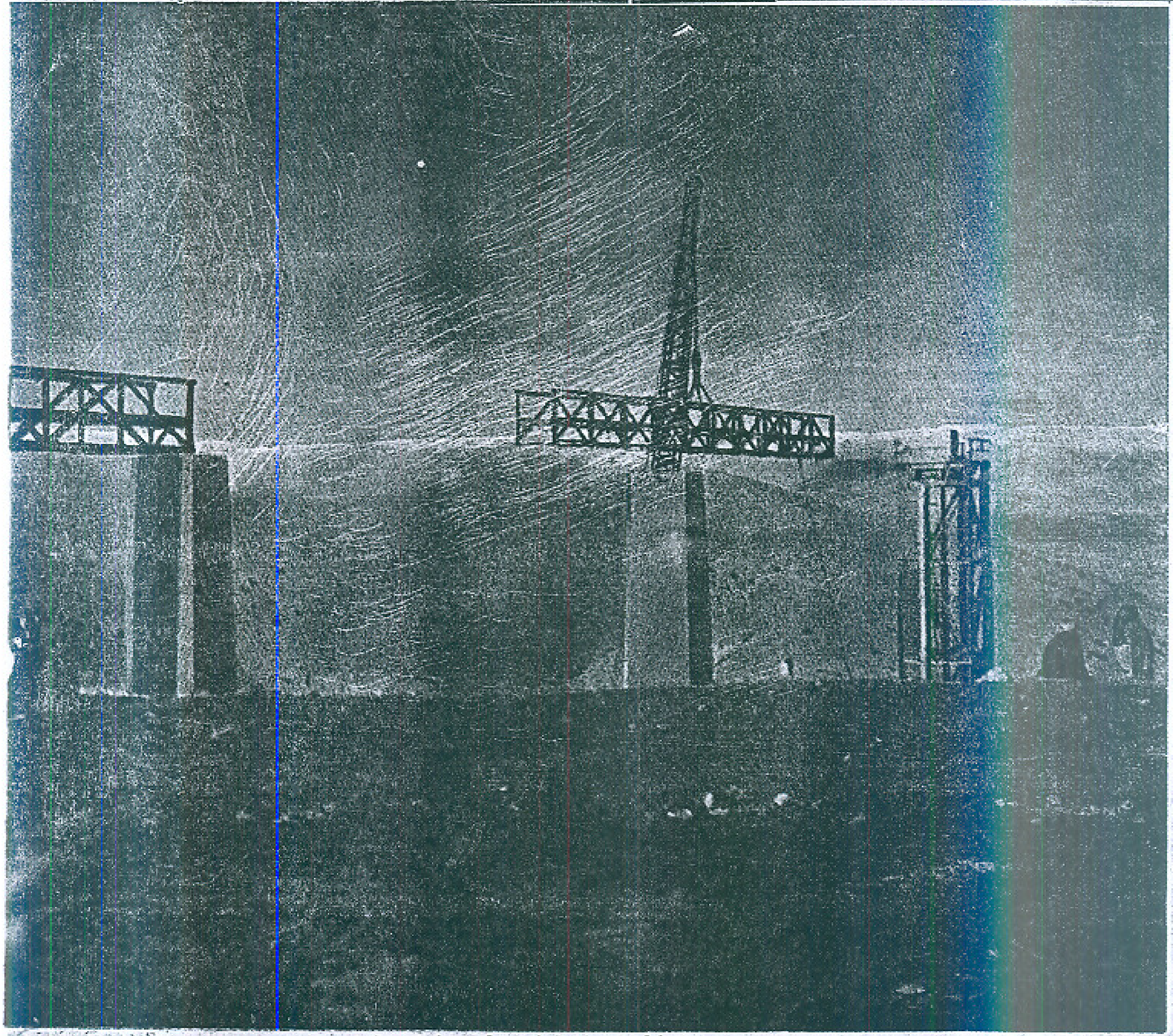
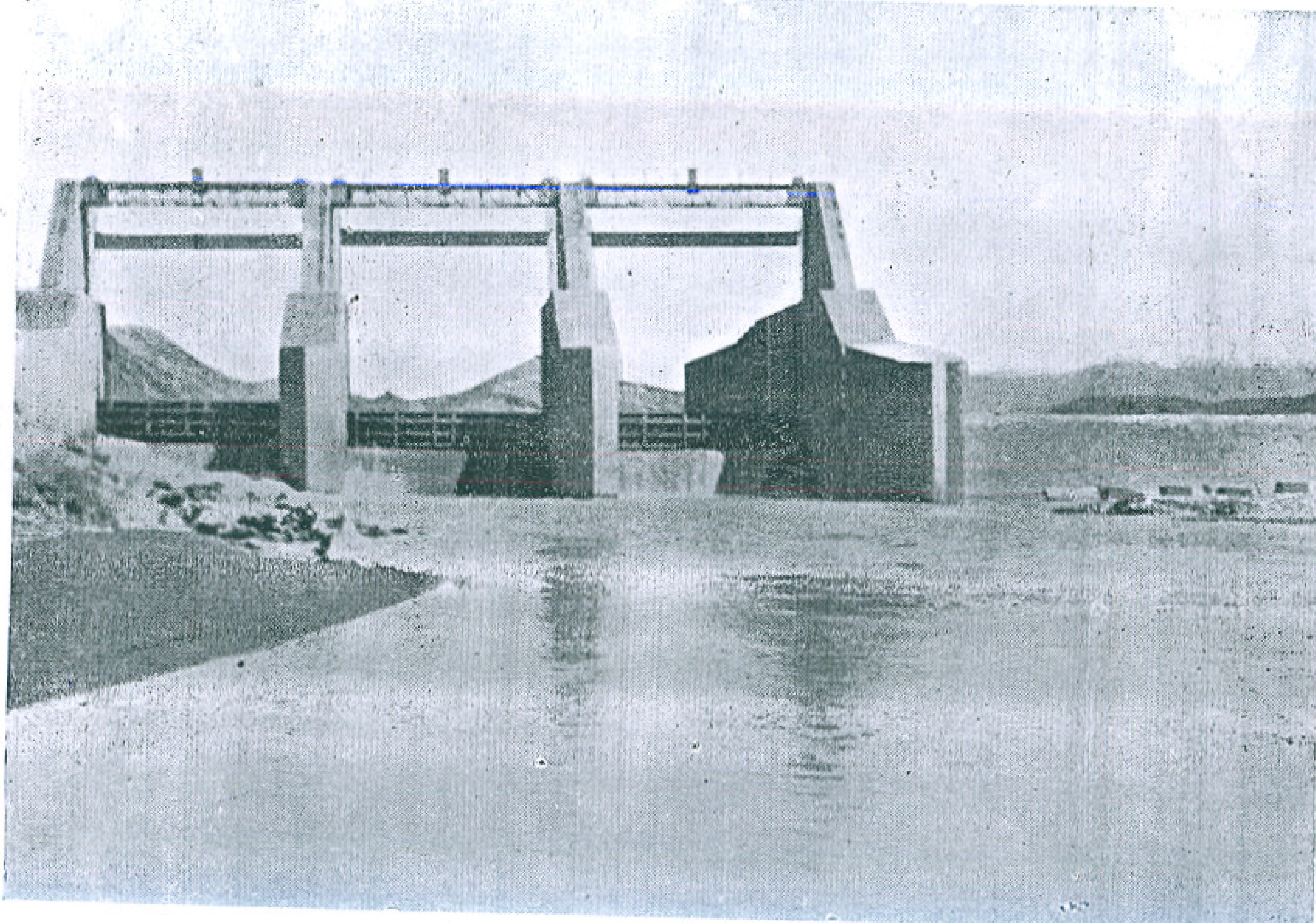
ENGINEERING NEWS

QUARTERLY JOURNAL OF THE WEST PAKISTAN ENGINEERING CONGRESS

ME 7 No. 2 | LAHORE (West Pakistan) | JUNE 1962



RRUM GHARI — INTAKE TOWER UNDER ERECTION



WEIR ON KURRUM RIVER —

SEE ARTICLE ON PAGE 22.

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All communications should be addressed to the Editor Engineering News, P.W.D. Secretariat Lahore (West Pakistan.)

Price Rs. 2/- Copy. Rs. 6/- a year in advance. Free to members of the West Pakistan Engineering Congress. Changes of address should be intimated promptly giving old as well as new address.

Contributions to this journal in the form of articles, news of engineering works, news about engineers, photographs and technical data etc. are cordially invited.

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PRINTED AT
THE LION PRESS - LAHORE

SEVENTH YEAR OF PUBLICATION

Engineering News

Quarterly Journal of the West Pakistan Engineering Congress

Vol. VII. JUNE 1962 No. 2

In this issue

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Editorial

Engineers in the Role of Policy Makers

WHEN the former provinces of West Pakistan were integrated into one unit in 1955, the Government decided, in spite of strong protests of engineers, to try members of the Civil Service as policy makers in technical departments.

This was a novel experiment in the history of the country. Even during alien rule, when the British regime was more concerned with continuing its strong hold on the country and all developments were in fact intended to strengthen the foreign rule, policy makers for the technical departments were engineers.

At last, after nine years of trial the Government has accepted the arguments of the engineers, voiced repeatedly from the platform of the Engineering Congress, and, as stated by the Governor in his presidential address, has now agreed to reinstate engineers as policy makers. We congratulate the members of the Congress on this singular success. The persistent efforts that the engineers made during the last nine years have at last borne fruit.

In 1952 Khan Azam Khan, who had foreseen the possibility of the Secretaryship being taken away from the department, said in his presidential address :

"The reason why the Panjab Irrigation Branch leads the world in the matter of Irrigation, Building and Roads Branch, leads the Sub-continent of India in matters of Buildings and Roads is, that from the very inception of the P.W.D. in the Punjab, the Chief Engineers of these Branches have been Secretaries to Government".

In 1954 also, Khawaja Abdul Ghafoor remarked :

"It is indeed unfortunate that instead of appreciation, the magnificiant performance of the engineer, without which there would have been no progress and prosperity in the country, a systematic and continued attempt, consciously or un-consciously, is under way to deprive the engineers of the position, power and prestige which they have been enjoying all along.

"In Western countries, the engineer, in recognition of his important role in the development and progress of his country, is being esteemed with increasing honour and respect and elevated to higher ranks in the administration machinery".

In 1955, Qazi Zahur Hussain requested the Government "to consider this important issue", and advised that "if they cannot enhance the prestige of engineers, they may at least do nothing to lower the status which they have rightly deserved and enjoyed in the past".

All these suggestions went unheeded and the Government took away the Secretary-ship from the departments. However, the engineers made it a point to protest against this injustice at every annual meeting of the Congress. Late Mr. Ashraf, in 1956, stated:" Last, but not least, it is once again emphasised, as has been done in many of the various technical conferences, that engineers and technicians should be given suitable places at the policy making levels without interference and pestering by others".

Muhammad Zubair (1957), Khan Inam Ullah (1958), and Mir Bashar Khan (1959) brought their views to the notice of the Government and protested against the appointment of non-techncial men as Secretary of technical departments.

Mr. Mahbub (1960), Ghulam Sadiq Khan (1961) and Mian Aziz (1962) were unanimous in protesting against this decision. Mahbub quoted extensively from the addresses of previous engineers. In 1943, Sir William Roberts defined the engineer as "one whose function is to imbue the dry knowledge of the scientist and the Mathematician with imagination and apply it to practical and economical planning for the benefit of humanity".

The Encyclopaedia Britannica describes an engineer as follows :

"Qualifications include intellectual and moral honesty, courage, independence of thought, fairness, good sense, sound judgement, perseverance, resourcefulness, ingenuity, orderliness, application, accuracy and endurance. An engineer should have the ability to observe, deduce, apply, to correlate cause and effect, to co-operate, to organise, to analyse situations and conditions, to state problems, to direct the efforts of other................"

"An engineer is a leader of men".

"Herbert Hoover, one time President of the United States, was a practicing engineer of great repute. Lord Sydenham, once Governor of Bombay, was a Royal Engineer and wrote a text book on Engineering. John Hays Herrmond, US Ambassador in England in 1911, was a well known engineer who was associated with a large number of hydro-electric enterprises and irrigation projects in America and Africa. President Soekarno, Ex-premier Dr. Dynanda of Indonesia and Minister Cassey of Australia are engineers and so was ex-premier Malenkov of Russia".

"It would be in the interests of the Government to associate engineers in their councils and not to treat them as mere technicians at the beck and call of the higher civil services with no voice in shaping the larger policies of the Government and no power to take important decisions".

In 1961 Ghulam Sadiq Khan stated : "Unfortunately, since integration engineers have been cut off from direct contact with those responsible for policy making even about works of purely technical departments".

"There is no logic in supposing that the percentage of black sheep is any higher amongst engineers as compared with other services. However unhappily situated the engineers may consider themselves to be and whatever opinion others may hold about them, there is no escape from the fact that the responsibility for rapid and economical development of these countries lies fairly and squarely on their shoulders".

Mian Abdul Aziz stated in 1962 that "at present, the prospects and chances of appointment for engineers to the highest posts in the services are extremely meagre as compared with the opportunities available to the members of the civil services. It may be revealing to know that there are approximately 75 members of the Civil Service drawing emoluments of Rs. 3000 or over while there are only half a dozen Engineers in the whole of Pakistan drawing equal salary. Apart from this their social status is also very discouraging and depressing. This huge disparity in pay, previleges and prospects needs earnest, serious and sympathetic consideration of the Government".

Thus, after nine years of arguments, protests and representations, Government has decided to reverse its previous decision. Every member of the profession will feel jubliant over this victory. We offer our heartiest congratulations to the members of the Congress and are confident that those stepping into positions of powers will infuse such spirit into the whole cadre and give such lead that the Government may be convinced of having taken the right step in according due recognition to the rights of engineers.

Their actions and decisions will justify the trust reposed in the profession by the Government.

CHEERIO, THE OUTGOING PRESIDENT

In April 1961, Mian Abdul Aziz, the President of the West Pakistan Engineering Congress handed over the responsibilities of his office to Mr. A.R. Kazi, the then Chief Engineer (Water) Wapda, another very active member of the congress. Mr. Aziz will always be remembered as during his tenure of the Presidentship the Government after eight years of experiments finally agreed to head the tecnhnical departments by technical personnels.

Mr. Aziz, a man of varied experiences with a background of 30 years of strenuous service to the Works, and Communication Department, graduated in 1932 from the Thompson College Rurkee and since then has been serving the department in different categories.

As Engineer-in-Chief, Thal Development Authoriiy, he organized a system of new roads opening up the virgin area. In his capacity as Additional Chief Engineer, Central Zone, he managed the housing of innumerable persons posted to Lahore after integration of the provinces into one Unit. As Additional Chief Engineer Social Welfare Works, he organized a new wing to handle local bodies development works. Lahore sports stadium was constructed under his supervision. He has also worked as Principal of the Punjab College of Engineering and Technology for a year.

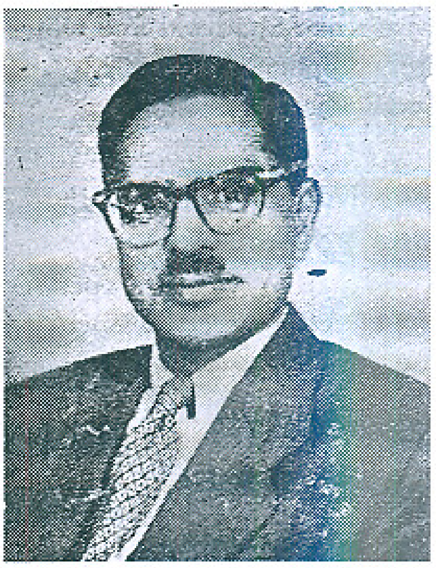
As President of the Congress, he held eleven monthly meetings in which he made special efforts to encourage the members to prepare suitable papers for presentation at the annual session. His efforts resulted in collection of subscription from the members to the extent of Rs. 12440. During the year the enrollment of the Congress rose to 666.

The Engineering Congress is much obliged to his efforts for promoting the cause of engineering knowledge his patronage of research and infusing new ideas.

"RING IN THE NEW"

WELCOME

Mr. A. R. KAZI
President (1962-63)



Engineering News Organization Welcomes Mr. Abdur Rashid Kazi as the president elect of the West Pakistan Engineering Congress for the year 1962-63. He will ever be remembered as the first Secretary of Irrigation and Power Department of the United West Pakistan.

Mr. Kazi is an engineering graduate of 1933 from Poona Engineering College, Bombay Presidency. He joined the Ex-Sind area, the same year. As Executive Engineer he played a leading role in strengthening the flood protection bunds of the Northern Sind and in developing new channels. This experience, he utilized to the best advantage of the province when working as Chairman of the Indus River Commission for flood protection works. He was the first Pakistani Engineer to be entrusted with the completion of Ghulam Mohammad Barrage headworks and its canals. He organized the mechanical construction system and took measures to Line the first major canal with cement concrete in Lower Sind. His important assignments included the construction of Guddu Barrage which was entrusted to him in 1953. As Chief Engineer and Secretary to Government of Ex-Sind he personally designed the barrage and its vast canal system. The completion of the barrage in 1962 goes to his credit and is a great achievement of which the country is proud.

Mr. Kazi has the good fortune to be always entrusted with new assignments, newworks and new organizations and he has come out always very successful as a result of his engineering talent and zeal to work.

When West Pakistan Wapda was created, he headed the Engineeing Division dealing with water projects. Under his impetus, Wapda undertook an ambitious programme of the development of the water resources of the country. Mr. Kazi played an important role, right from the planning and investigating stages to the design and construction stages. He looked after the projects from the Southern most end of the country, from Hub river near Karachi, to the Gomal in the North West, to the Kunhar in the North and the Kurrang (Rawal Dam) near Islamabad. Hydroeletric Projects like Shadiwal and Chichoki Mallian were completed during his tenure of the office.

As Chief Engineer Wapda, his duties also included the spade work for the Indus Basin Projects.

A man of varied experience, with 30 years of very active life spent on all types of huge engineering undertakings and construction, with extensive background of engineering works of the world, seen and studied during his several tours of America, of the continent and of the Far East, has recently been entrusted with yet another greater responsibility to work as Secretary Irrigation and Power Department of West Pakistan. Here he has started infusing his great technical knowledge and engineering skill to the world's biggest irrigation system.

Socially Mr. Kazi is respected by his colleagues, by his subordinates and all those who have a chance to work with his charming personality. When the West Pakistan Engineeing University was in trouble, he was found to be the most suitable to take over as Vice-Chancellor to handle the difficult situation and created congenial educational atmosphere.

Mr. Kazi with long and varied experience of undertaking the new onerous jobs and successfully completing them, may have to undertake yet another one, the greatest job of his life dealing with the celebration of the centenary of the Public Works Department and the Golden Jubilee of the Engineering Congress. It will be a huge undertaking and the Congress is lucky to have a man of the drive of Mr. Kazi who will succeed to see the Golden Jubilee and the centenary celebrated in a befitting manner.

The Engineering News wishes him the most cordial welcome.

THE PRESIDENT AND THE COUNCIL

FOR

The Year 1962-63

The West Pakistan Engineering Congress elected the following office bearers, and Council members.

Presidents.

(1) Mr. A.R. Kazi S.S.E.I., Secretary to the Government of West Pakistan, Irrigation and power department, Lahore.

Vice Presidents.

(2) Mr. Mohd. Akram S.S.E.I. Member Central Public Service Commission, Karachi.

(3) Mr. Abdul Hamid, General Manager, Electricity WAPDA, Lahore.

(4) Mr. B.A. Khan, Government Inspector of Pakistan Railways, Lahore.

(5) Mr. A.R. Qureshi, Chief Engineer, Central Zone B & R, Lahore.

(6) Dr. Mubashar Hussain, Ex. Professor Engineering University P.O.B. No. 730 Lahore.

Honorary Secretary.

(7) Mr. Shamim Ahmad P.S.E.I., Project Director, Land and Water Management Project No. 1, WAPDA, 18/19 Lytton Road, Lahore

Honorary Joint Secretary

(8) Mr. Mazhar-ul-Haq Saeed Ahmad, Research Officer, Buildings and Roads Depertment, Lahore.

Honorary Publicity Secretary

(9) Mr. Amanullah Khan, Project Director (Coordination) Indus Basin Project WAPDA, Lahore.

Honorary Editor "Engineering News"

(10) Dr. Nazir Ahmad, Physicist, Irrigation Research Institute, Lahore.

Honorary Auditor.

(11) Mr. Ashfaq Hussain, Director Research, Buildings & Roads Department, Lahore.

Honorary Business Manager.

(12) Mian Mazhar-ul-Haq, Technical Officer, Central Zone, Buildings & Roads Department, Lahore.

Honorary Treasurer.

(13) Mr. Mazhar Ali, P.S.E.I., Section Officer (Manuals) Irrigation & Power Department, Lahore.

Council Members.

(14) Mian Abdul Aziz P.S.E.I., Secretary C & W Government of West Pakistan.

(15) Mr. Saeed Ahmad, Chief Engineer B & R Department Quetta.

(16) Mr. Hamid-ud-Din, Chief Engineer B & R Deptt. Hyderabad.

(17) Mr. M.A. Waheed, Chief Engineer B & R Deptt. Bahawalpur

(18) Mr. A H. Qureshi, Chief Engineer P.A F. Air H. Qtrs Peshawar.

(19) Mr. Sayyid Hamid, C.E., Ground Water Reclamation Div. WAPDA. Lahore.

(20) Mr. A.A. Jamal-ud-Din, Director (Bridges) C & W Deptt. Lahore:

(21) Mr. A.R. Zubair, Superintending Engineers B & R Department, Abbottabad.

(22) Mr. S.S. Kirmani, Chief Engineer, Indus Basin Project, Lahore.

(23) Mr. M.H. Trimzi, Deputy Secretary (operation) I & P Deptt, Lahore.

(24) Mr. T. Phailbus, S.E. Mechanical WAPDA Tipton & Kalmbach, Inc. 17 Davis Road Lahore.

(25) Mr. Abdul Latif, Assisstant Director Remodelling, Lahore.

(26) Mr. Iqbal Ahmad Shahab, XEN Civil Works, 5 Court Street, Lahore.

(27) Mr. Mazhar-ud-Din, Divisional Engineer P.W.R. Rawalpindi.

(28) Nisar Ahmad, Superintending Engineer (Remodelling) Lahore.

(29) Mr. H. J. Asar P.S.E.I. Chief Engineer, Remodelling, Lahore.

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PRESIDENTIAL ADDRESS

TO

WEST PAKISTAN ENGINEERING CONGRESS

46th ANNUAL GENERAL MEETING

4 — 11 April 1962.

Annual Meeting :

The 46th session of the West Pakistan Engineering Congress, the oldest engineering Institution of the country having 800 engineering members, held its Annual General meeting this year from 4 to 11 April 1962. The conference was opened by Malik Amir Muhammad Khan, the Governor West Pakistan. Mian Abdul Aziz, the President, read the address. The session included discussion of four papers and a symposium on Sediment Problems as a result of Indus Basin Works on which eleven outstanding papers were contributed. This year the visit to engineering works included the Sukkar Railway bridge, the Karachi development works, Port trust, Water supply, the State Bank Building, the Quaid-i-Azam mausoleum, etc. In this issue the activities of the congress are briefly described.

Presidential Address :

After thanking the Governor for the honour he had done in gracing the occasion, inspite of his multifarious engagements. Mian Abdul Aziz described the activities of the Engineering profession during theyear.

WAPDA is entrusted with the implementation of the huge programme of the Indus Basin Treaty. This work includes two dams, seven link canals and five barrages. Wapda is preparing a unified, coordinated master plan for water and power resources. The Rawal Dam is nearly complete and so is the Shadiwal Hydel project. Considerable progress has been made in the construction of West Pakistan High Tension Grid.

THE IRRIGATION DEPARTMENT continued to maintain the huge irrigation system besides completion of the Warsak High level Canal and Kurrum Ghari multipurpose projects. Work on flood control, drainage and reclamation continued.

PAKISTAN WESTERN RAILWAY HAS COMPLETED THE ROHRI BRIDGE IN PLACE OF LANDSDOWN BRIDGE, NEAR SUKKUR.

The work on the installation of centralized traffic control between Karachi Cantt. and Landhi Stations has been finished. The work of the construction of Karachi Circular Railway from Drigh Road to Khadda is progressing satisfactorily. Improved facilities for manufacture of cast iron, concrete sleepers and railway wagons at Moghalpura Workshop are also underway.

A separate PUBLIC HEALTH ENGINEERING DEPARTMENT has been created to look after the water supply both for urban and rural areas and sewerage schemes of various towns.

THE BUILDINGS AND ROADS DEPARTMENT had in hand about a thousand building projects of the Second Plan relating to various departments scattered throughout the country at various stages of implementation. Work at the new Divisional Headquarters at Khuzdar is also well in hand.

About 106 miles of new roads have been completed, and 22 miles of roads improved. Two major bridges of pre-stressed concrete have been completed, one across Deg Nullah near Sharakpur and the other at Wazirabad. The bridge across Leh Nullah at Rawalpindi is progressing. The exploration work for Jhelum and Ravi Bridges is underway for detailed designs.

In West Pakistan, we inherited 16,423 miles of roads on independence, out of which only 5700 miles had "black top". By 1960 the total mileage had increased to 19,176 out of which 8,772 miles was black top. This gives an increase of 54% over the pre-independence figures in "black top" roads which carry bulk of motor traffic.

Soon after independence, roads overflowed with traffic, heavier vehicles moved in greater number at higher speeds. Glancing over the figures of transport vehicles, it is seen that whereas there were 35,000 registered vehicles in 1948, there were 112,000 in 1961, showing an increase of 220%. Fuel consumption figures show an increase from 16 million gallons in 1948 to 92.6 million gallons in 1961, an increase of 480%

In the recent past the condition of some of our important existing pucca roads has deteriorated rapidly as a result of deterioration in sub-soil conditions due to salinity and waterlogging; heavy increase in traffic intensity over certain sections not designed to carry such heavy loads; continued shortage of funds for maintenance and repairs; damage due to frequent floods in the past few years; and inadequacies of research and testing facilities for proper design and construction of roads. Steps were continued to be taken to over come as many of these causes as possible.

Financing of road construction at present is done from :—

(*a*) Central Road Fund allocation out of the duty on petrol and oil etc., which gives about Rs. 1½ crores annually for both wings and is used for the construction or substantial improvement of arterial roads only.

(*b*) The Central Government's adhoc grant of about Rs. 5 crores to finance 20% cost of construction of certain roads of national importance is the second source. The other financing sources include the Centre's special grants of Rs. 2.8 crores out of counterpart funds; development loans to the Provincial Governments for approved road projects (about Rs. 29 crores during last 12 years.)

(*c*) Provincial Government's own resources for construction, maintenance, and Local Bodies funds.

In the second five years plan provision is limited to Rs. 25 crores for West Pakistan. This needs augmentation. The idea of toll roads and bridges has been strongly supported as sources of income. A large number of high class roads and bridges have been built on toll facilities in the United States.

Finally speaking about OURSELVES, the President suggested to the senior members of the profession to strive hard to guide the less experienced new engineers to raise their standard. A similar advice was tendered to the young engineers to work hard for the profession.

The engineers and technicians are the builders of the country. Out of a total of 2300 crores of second five years plan, about 50% is earmarked for irrigation, power, communications, housing, health, education and other departmental schemes. These schemes are to be handled by engineers. Thus there are heavy responsibilities on the shoulders of the engineers.

It is, therefore, in the most vital interest of the country to attract the very best talent into the technical services. This is possible only if they are given proper official and social status, and emoluments to enable them to lead a life of honour, dignity and reasonable comfort.

At present the prospects and chances of appointment of the engineers to the highest posts in the services are extremely meagre as compared with the opportunities available to the members of the Civil Service. It may be revealing to know that there are approximately 75 members of the Civil Services drawing emoluments of Rs. 3,000 or over, while there are only half a dozen such engineers in the whole of Pakistan. Apart from this the social position given to engineers in the warrant of precedence is also very discouraging and depressing. This huge disparity in pay, privileges and prospects needs earnest, serious, and sympathetic consideration of the Government.

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MALIK AMIR MUHAMMAD KHAN

GOVERNOR WEST PAKISTAN

ADDRESSES

THE WEST PAKISTAN ENGINEERING CONGRESS

It has been my privilege for the last couple of years to be associated closely with the engineering activities of the Government. During this period, I have had occasion to learn something about the activities of your Congress which provides a very useful forum for the discussion of engineering problems by talented engineers from all over the province. Some of the literature produced by the Congress has, I dare say, made original contribution to engineering science.

Engineers have to play a challenging role in developing the physical resources of the province as programmed in the revised Second Five Year Plan.

My dream of well-developed and progressive West Pakistan is that this historic area extending from Chitral to Karachi, which can be rightly called the heart of Asia, should have its rich lands seasonally carpeted with abundant food and cash crops, lined with smoothly flowing canals, dotted with well-planned villages, towns, cities and criss-crossed with good roads and railway lines. I believe that it is within our competence to convert this dream into reality. God has endowed us with necessary resources in men and materials.

In the revised Second Five Year Plan and the Indus Basin Settlement Plan we already have the blue-prints for putting our province on the road to progress and prosperity.

The engineering profession has a key role to perform. As you are aware, engineers will in future be associated with Government policy making. **It is my sincere hope that those of you who will henceforth be responsible for formulating policy and directing the activities of the various engineering departments and agencies will exercise vision and imagination and achieve** in co-ordination with colleagues in other fields the goal of bringing nearer the day when the province would serve as a model of economic prosperity to other parts of the world.

The problems of poverty, lack of capital and of foreign exchange, water-logging and salinity, timely replacement of the waters of the three Eastern rivers of the former united Punjab, and growth of population and urbanization consequent upon the industrialisation of the province, are indeed gigantic. If Engineers have to make their cotribution in solving these problems they will **need to realize that their real task is to serve as master designers and practical engineers rather than as mere supervisors or office heads.**

In highly competitive world, our engineers cannot afford to lag behind in acquisition of fresh knowledge. Scientific investigations and **research play a very important role in the present day world. It should be your duty towards the country to stimulate original thinking to introduce latest techniques of designs and construction and at the same time devise methods of making the best use of native materials and our abundant man-power.**

There is a great deal that we can learn from the experience of other nations in as-much as science is **international; but we must not lose sight of the important fact that eventually it is we who have to find solutions to our unique problems.**

It is only by matching the moral zeal with technical efficiency that real dynamism can be achieved.

I wish all success to your deliberations and now have great pleasure in declaring this Session of the Congress open.

SYNOPSIS OF PAPERS DISCUSSED

at

The Annual General Meeting of the Congress.

This year the Executive Committee accepted only four papers for discussion at the Annual General Meeting. Below is given a brief summary of each paper.

Paper No. 351

Design of Alluvial Channels as Influenced By Sediment Charge

by

Mushtaq Ahmad and A. Rehman

Channels in alluvium are self-formed, in which the whole perimeter is actively taking part in the flow. It is easy to assume that in such channels, width, depth and slope are all variables and sediment transport makes the problem more complex. An appreciation of regime relations as developed in the Indo-Pakistan sub-continent in the last four decades, is given and examined in relation to mean silt charge and silt diameter. New equations have been developed, that determine V,D and S in relation to charge for all types of regime flow channels carrying 1 p.p.m., to 40,000 ppm or 1/100° gr. per litre to 40 gr. per litre.

In this paper two functional relations for silt transport in suspension, are put forth These are $q^{2/3} S^*/w^{1/2} = 0.5+5 (C)^{2/3}$

Where C=silt charge in gm. per litre.

q=discharge intensity.

*s=slope per thousand.

w=fall velocity of mean size of bed material.

(*ii*) $(T)/(r-r_1)\ d = 0.05 + C^{1/3}$

Where

t=tractive force.

r=sp. wt. of material.

r_1=sp. wt. of water.

d=mean silt diameter in ft.

C=silt concentration gr.per litre.

These functions are considered to be applicable to all channels where the bed is alluvial and the bed particles are free to change the bed pattern or form roughness as influenced by the flow characteristics :—

Utilising Lacey's equation

$P = 2.67\ Q^{1/2}$

$q = 0.4\ Q^{1/3}$

Seepage drains to carry very low silt charge, or channels, carrying normal or a little more charge can be designed. Even ejector, escape channels, to carry super silt charge can be designed from the proposed relations in a rational way.

Thus it is now possible to design a channel in relation to its silt carrying capacity. The functions cover a fairly wide range from a lower regime of plane bed when there is almost no silt to a higher regime of flow in which case 10 to 40 gramms per litre of silt is carried by the flow.

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Paper No. 352

Artificial cut off at Islam Headworks

By

Khalid Mahmud and Abdul Basit Akhtar

Islam Headworks is a diversion weir on River Sutlej situated at Longitude 72°-33E, Latitude 29°-50N in the district of Bahawalpur. The Headworks is 23 miles away from the Vehari Tehsil Headquarters and 67 miles from Bahawalpur. Three canals, namely Bahawal, Qaim and Mailsi take off from the Headworks with authorised full supply discharges of 5400, 463 and 4883 cusecs. The Bahawal canal is a perennial canal while the other two canals are non-perennial.

Formation of horse-shoe bends, in meandering alluvial streams, takes place, when the downstream arm of a bend, in its downwards travel, is obstructed by a hard patch. Such bends would naturally eliminate themselves, at the climax, when the river cuts across the neck. A natural cut off, thus formed in a river, has serious repercussions.

Malshah loop was a bend of river Sutlej upstream of Islam Headworks, which developed into a horse-shoe bend. The existence of the bend created immense pressure on the retired embankments and vitiated the river approach to the Headworks. Considerations of the problems and the fear of unfavourable consequences of a natural cut off which seemed imminent, led to the decision of making an artificial cut off.

As a result of the short circuiting of this major loop, which developed very rapidly, the silt load, in the river increased manifold. Mailsi canal, the non perennial canal on the right, having unfavourable approach condition, received the main brunt of the silt load.

This paper describes the development of horse shoe bends in meandering rivers and the considerations which led to the decision for the artificial cut off. Data observed during the development of the cunnette is presented, as well as the result of excessive silt entry into Mailsi canal.

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Paper No. 353

Prestresed Concrete Road Bridge at WAZIRABAD

by

Mohammad Aslam

This paper describes the various features of bridge construction. It is divided into five parts describing the physical aspect of the site, causes of repeated breaches and their remedies. After consideration of all aspects, it was found necessary to have a new bridge at this site.

The general features of the bridge finally decided were to have a discharging capacity of 100,000 cusecs through four span bridge, each 108 ft. in length giving a total length of 432 ft.

The overall width of the roadway is 26 ft. In each span seven prestressed beams are to be located.

The type of foundation, size and shape of wells, their sinking etc., have been described in the third part. Under super structure, the description is given of prestressing units, cables, sheathing, anchorage cone, etc.

This paper deals with all the engineering aspects of the bridge construction.

Paper No. 354

Hydrological Studies on Zhob River and Stream of the Kachhi Plain

by
Sarfraz Khan Malik

In November, 1957 the Government by publication in the Gazette, notified the setting up of a Flood Commission for West Pakistan. One of the terms of reference of the Commission was to assess the adequacy of the existing data regarding precipitation, river discharges, river regimes, etc., and the agencies engaged on its collection and to prepare a comprehensive programme for further survey and investigation collection of further data as may be required for formulation of flood control projects with full utilization of the multipurpose benefits of such projects.

For the efficient discharge of its duties it was envisaged that the Commission would need basic data in regard to river discharges, rainfall run-off, silt loads, etc. The existing hydrological data available in the Irrigation Department being inadequate in certain respects and no data being available for regions like Baluchistan, it was decided to create a Directorate of Hydrology within the Irrigation Department.

A Hydrology Division was opened by the author within this Directorate at Quetta in October, 1958 to undertake hydrological studies for the assessment of surface water potential of the former Baluchistan, henceforth to be called "Baluchistan."

The data in this paper shows that :

(*i*) The total annual run off of the streams of the Kacchi plain is 19,48,502 acre feet or approximately 2 million acre feet. If all the supplies could be utilized, a maximum area of about 5,50,000 acres could be brought under irrigation, assuming a water allowance of 5 cusecs.

(*ii*) The heavy sediment loads in all these rivers rule out the possibility of constructing large storage dams on them. Instead an answer will have to be found in a series of small spate breaker dams in the higher catchment of each of these rivers.

(*iii*) The extremely hot climatic conditions require that due allowance be given to evaporation loss in assessing water usage from all schemes on the rivers of this area.

(*iv*) The formation of irrigation schemes and their proportionate benefits should be limited by the position of available supplies in various rivers of the Kachhi and Zhob area during different seasons of the year.

(*v*) Over-ambitious schemes should be reconsidered in the light of hydrological information made available now.

COMPLICATED PROBLEMS OF KURRUM GARHI

Solved by HYDRAULIC MODELS

By

CHAUDHRI MOHAMMAD ALI,

The forty-one years old Irrigation Research Institute, the only one of its kind in the whole of Pakistan is playing an important role in the execution of intricate problems of Irrigation Department and WAPDA Projects. The Institute renders valuable advice about problems connected with the flow, control and utilization of water. Ch. Mohammad Ali, Hydraulic Officer gives in the paper instances of a few problems where Hydraulic Models have been made use of to solve complicated problems of the Kurrum Garhi Projects.

A hydraulic model is a scaled replica of the prototype built in the laboratory. It may be that of a river, a barrage, a training work, a harbour or a spillway. In the laboratory cycles of floods, waves or tides, as the case may be are generated to a certain time scale, water levels are reproduced, movement of silt is stimulated by injecting silt at pre-determined rate, adjustment of control gates are made, and the effect of correcting works or alterations in design is investigated. From the results obtained in the laboratory, predictions are made about the behaviour of river and the hydraulic structure on the prototype. The following are a few instances where the help of hydraulic model was taken to solve problems of Kurrum Garhi

1. Sediment Exclusion

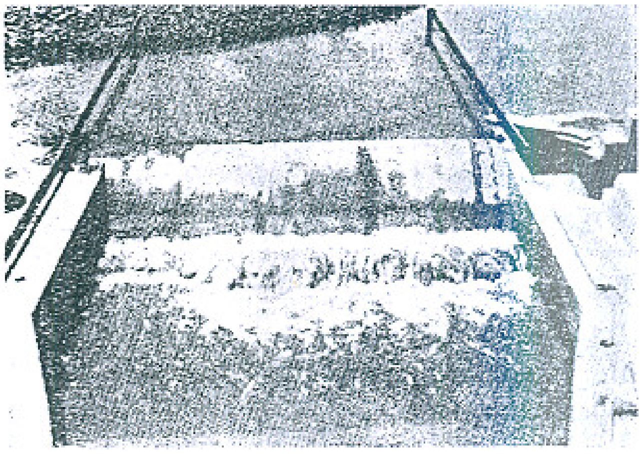
The mechanics of fluvial sediment transport is extremely involved and is not at present fully understood as the factors involved are many and vary haphazardly. The control of silt at the intake of canal determines the maintenance cost of the canal system. In case of river Kurrum at Kurrum Garhi, the river slope is very steep and the order of the velocity during high floods is about 20 ft per second, and so the competency of the river to transport shingle is high. The main canal being at

a flatter slope and carrying a small discharge, is not capable of transporting shingles at a rate at which these are transported by the river. This canal feeds a power generating station and the Baran reservoir, so that the shingle entry into the canal is drastic for the turbines and the life of the storage besides reducing the hydraulic capacity of the canal.

Natural method to exclude the silt from the offtaking canals and to deflect it back into the parent channel, is to locate the intake of the offtaking canal on the outside of a concave curve. Clear water is drawn from the outside of the curvature and the sediment which collects on the inside of the curvature remains in the parent channel. To induce a regular curvilinear river approach on to the regulator, it was suggested as a result of model experiments to construct a 1,400 ft. long curved stone guide wall on the right bank of the river. The main channel was thus made to hug along the guide wall with the result that head regulator drew clear water and the shingles that move along the inner side of the curve were deflected away from the head regulators of the canal.

2. Control of Optimum Level

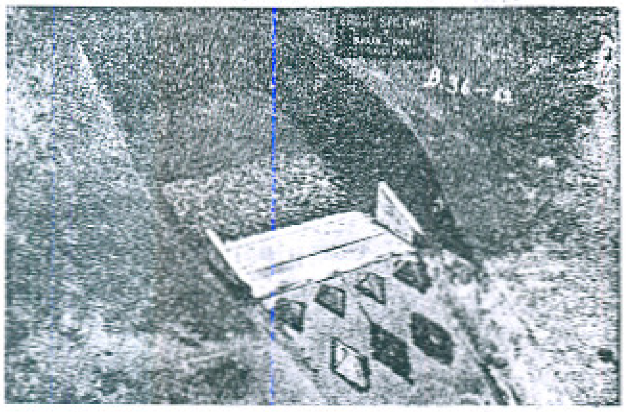
There is an optimum permissible level to which the reservoir water can be raised. To prevent an excessive rise of water level above the normal operating level caused by the incoming storm water of the Baran Nallah, which enters directly into the Baran reservoir, and to avoid over-topping of the main dam, it was imperative that some structure could be designed to control the water level in the reservoir. If the storage area was small and the intensity of flood in the river was high, the rate of rise of level in the reservoir would be very rapid. Therefore, the device should be such as to control the water level in the reservoir as quickly as possible without allowing the water level in the reservoir to rise above a pre-determined level. It was obvious that the ejection of the surplus discharge should be as quick as possible. The best device to achieve the above objective was a single or a multi-barrel



syphon spillway with fixed crest. A syphon spillway develops a negative pressure in this barrel and this vacuum sucks water from reservoir. The width of saddle in hills on the right flank of the Baran Dam was such that only a battery of syphon spillways commensurated with the minimum excavation could be constructed A most efficient type of a syphon spillway was thus evolved as a result of model studies. The design of the syphon was an improvement over the type of low head syphon spillways constructed in other countries. The syphon spillway constructed is likely to prime as soon as the water level in the reservoir rises by a foot or so above the crest level of the syphon.

3. Experiments on Chute spillway

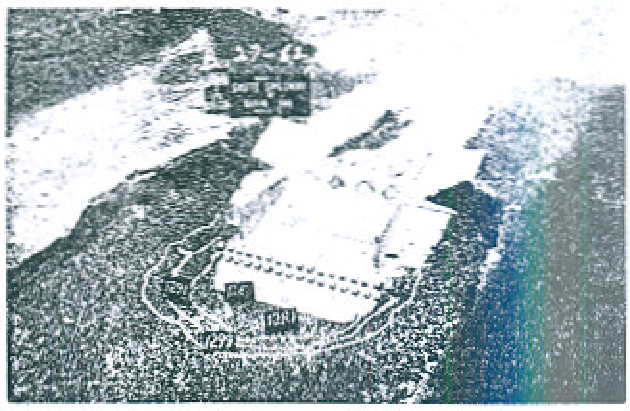
Another problem that was solved by the help of model studies was about the carrier channel called Chute Spillway that was to carry a discharge of 45,000 cusecs from syphon spillway and deliver it to the Baran river, a thousand feet below, thereby lowering the water elevation through a drop of 86 ft. The bed slope of the Chute Spillway was so designed, after model experiments, that the water surface in the Chute was below the natural surface at every point. The flow in the Chute Spillway was expected with a velocity of about 60-70 ft. The experiments were conducted to lower the velocity



of the Chute Spillway, at its tail end from 70 ft. to about 10 ft. before the water entered the Baran Nullah. It was shown by model experiments that the surplus energy of flow could be dissipated by the formation of a hydraulic jump in a water pool about 50 ft. deep and 200 ft. in length. A steep, 75 ft. deep lining on the sides of the stilling pool presented an imposing problem especially when the banks of the cistern were over-loaded by the over-burden. It was desired by the Chief Engineer to find out an alternative solution to the problem. Experiments were taken up in the laboratory to find a solution of the problem with-out concrete-lined stilling basin. The flow section was expanded by suitable splitter deflectors at the end of the Chute Channel and the standing wave was confin-ed to the glacis joining the tail of the Chute Spillway and the stone lined stilling basin by means of 70 long vanes on glacis on the two flanks of standing wave.

4. A fixed discharge escape Channel

It was desired to arrange for a fixed discharge to flow down the right bank canal below the junction of the escape channel from the intake tower and right bank canal from the Kurrum Weir. At the head of the escape channel discharge could be any thing from 0 to 2,000 cusecs whereas the variation of discharge in the right bank canal was from 0 to 800 cusecs. The right bank canal below the junction could not carry more



than 800 cusecs. The Institute proposed an automatic regulator below the junction of the escape Channel and the right bank canal and spill weir on the left flank of the channel and immediately below the junction. The design of the valve below the intake tower was later on modified to disallow variations in the escape channel.

KURRUM GARHI MULTI PURPOSE PROJECT

By
MOHI-UD-DIN KHAN

On 15th of April, 1962, the President of Pakistan, Field Marshal Mohammad Ayub Khan, inaugurated the 9.64 crores Baran Dam Project by releasing water into the Marwat canal on the right bank of Kurrum river in Bannu District. This was the last phase of Kurrum Garhi Multi-purpose Project, which was started in 1951. The first two phases namely, the Kurrum Garhi weir with canals and two-hydro-electric stations were commissioned in 1954 and 1958 respectively. This article brings out some highlights of this project.

The Project

The Kurrum Garhi weir and canals for the old area of the Bannu District were completed in 1954. Two Hydel Stations were commissioned in 1958. The rest of the phase of the project which included the Baran Dam and the right bank canal has taken a long time to complete.

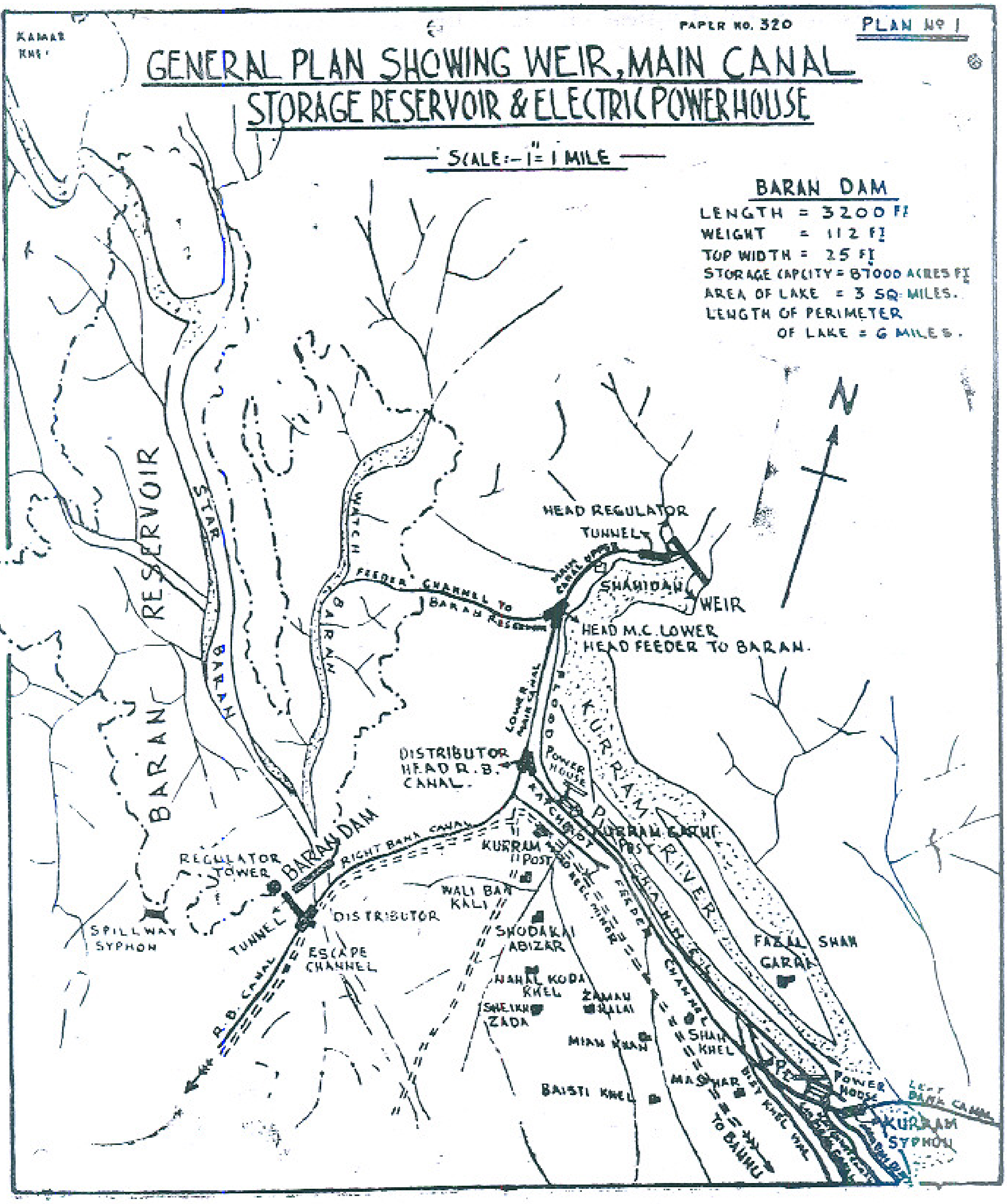
This phase of the project aside from being the most difficult undertaking, accounts for half the cost of the project. The construction of an earthen dam was a new experience for the Irrigation Department and as such the Deparment had to face a number of difficulties. The quantity of earthwork involved in the dam is 96 million cubic feet. The foundation treatment of the dam was another difficult job. Unless the site is visited, the magnitude of the work involved cannot be fully visualised and appreciated.

The size of the Baran Dam is comparable with Karnafuli Dam in East Pakistan which has taken more or less the same time to complete. The redeeming feature about the Baran Dam storage reservoir is that unlike Karnafuli Dam, the entire work has been constructed by the Irrigation Department, the construction work and design of the spillway was an important part of the work.

Irrigation System

The present irrigation system of Bannu area dates back to pre-British time and was evolved by the people themselves. It is limited to the Kurrum Gambiela Doab which is a sort of triangle running through the district with two narrow fringes on the northern bank of the Kurrum and the southern bank of the Gambiela, comprising more or less 52,000 acres in the head reaches and 60,000 acres in the tail of the canal. This irrigated tract occupies about 1/6th of the total area of the district and contains more or less 2/3rds of its population.

The flow pattern in the Kurrum river, the source of irrigation in the Bannu district, is very erratic in that, it varies from about 100 cusecs in spring to a maximum recorded discharge of 150,000 cusecs


PAPER NO. 320
PLAN Nº I
GENERAL PLAN SHOWING WEIR, MAIN CANAL STORAGE RESERVOIR & ELECTRIC POWER HOUSE
SCALE:- 1" = 1 MILE
BARAN DAM
LENGTH = 3200 FT
WEIGHT = 112 FT
TOP WIDTH = 25 FT
STORAGE CAPCITY = 87000 ACRES FT
AREA OF LAKE = 3 SQ. MILES.
LENGTH OF PERIMETER OF LAKE = 6 MILES.
N
HEAD REGULATOR
TUNNEL
SHAHIDAN
WEIR
FEEDER CHANNEL TO BARAN RESERVOIR
HEAD M.C. LOWER
HEAD FEEDER TO BARAN.
BARAN RESERVOIR
STAR
BARAN
WATCH
BARAN
KURRAM RIVER
LOWER MAIN CANAL
DISTRIBUTOR HEAD R.B. CANAL.
POWER HOUSE
KATCHA POT
KURRAM GARHI
BARAN DAM
RIGHT BANK CANAL
REGULATOR TOWER
KURRAM POST
WALI BAN KALI
DISTRIBUTOR
SPILLWAY SYPHON
TUNNEL
ESCAPE CHANNEL
SHODAKAI ABIZAR
FEEDER CHANNEL
FAZAL SHAH GARAI
R.B. CANAL
NAHAL KODA KHEL
ZAMAN KALAI
SHEIKH ZADA
MIAN KHAN
SHAH KHEL
MASHAR
BAISTI KHEL
TO BANNU
POWER HOUSE
LEFT BANK CANAL
KURRAM SYPHON

The present irrigation system is in consequence based on the "Saroba Paina" rights *i.e.* the irrigators on the upper reaches have a prior right to the water in the Kurrum river than those whose lands are situated lower down. Brushwood boulder diversion bunds were used to be constructed across the perennial creek for feeding the existing canals.

In practice, however, especially during periods of low supply, the "Saroba" channels take the entire water leaving nothing for the "Paina". The "Saroba" people have, therefore always been opposing a scheme which would give them and the others fixed shares in the supplies of the river for the simple reason that under the present uncontrolled system they can have as much water as they like, even to the extent of wasting it when not required.

Every time a flood comes down, which happens several times a year, the brush-boulder bunds were washed away, and the mouths of the channels got silted up. Considerable number of "Tinga" (free and compulsory) labour had to be turned out not only to repair these bunds, but also to silt clear the mouths of channels before water could be taken down at a time when it was most needed for the crops. The interruption on account of failure of the temporary diversion bunds amounted to as much as 40 to 60 days during a year.

The idea of construction of a weir at Kurrum Garhi and remodelling and extending system of irrigation was first mooted by Mr. J. C. Davis, Executive Engineer, in 1907. His original proposal was to construct a diversion weir in Kurrum River about 1,000 yards above the Kurrum Garhi gorge to feed 3 canals for the area on the right bank and one canal for the area on the left bank of Kurrum River. This scheme was proposed in view of great hardship faced by the irrigators in diverting Kurrum river water into their irrigation channels. Mr. Davis expected to double the area under irrigation on completion of this scheme.

Saving Sub-surface Flow

The bed of Kurrum River is of loose boulders and shingle and forms quite a thick layer, which absorbed a large portion of the flow. The estimated loss by this way was about 14 to 50 cusecs which if retrieved was very valuable in days of keen demand. The construction of an impervious weir was bound to check this sub-surface flow which could ultimately be used for irrigation purposes.

Salient Features of the Project

The Kurrum Garhi Project consists of the following works.

(*i*) A weir, an under sluices and a canal head-regulator in the Kurrum gorge on Kurrum River.

(*ii*) A 500 ft long tunnel and a main feeder channel on the right bank of Kurrum River for a capacity of 5,000 cusecs out of which 2,000 cusecs could be utilised for direct irrigation and 3,000 cusecs for storage in Baran reservoir.

(*iii*) A link channel to take 600 cusecs out of 2,000 cusecs for irrigation of area of 1,07,000 acres and a new canal known as the Right Bank

Canal with a capacity of 800 cusecs and 43 miles in length to feed the new area of 1,50,000 acres. The new area was proposed to be irrigated through a net-work of channels of a total length of 119 miles.

(*iv*) Two hydro-electric power stations with a total drop of 120 feet and installed capacity of 4,000 k.w. on the link channel.

(*v*) An earth dam 3,600 ft. long and 130 ft. high on Baran Nullah to create a storage of about 1000,00, acre foot of water.

(*vi*) A syphon across the Kurrum river to feed the left bank area of the Kurrum River.

(*vii*) Remodelling of existing canals.

(*viii*) A Drainage system to cover the entire area.

Benefits of the Project

The scheme is multipurpose and has the following main benefits :—

1. Irrigation of 2,57,000 acres of land (1,07,000 acres of old and 150,000 acres of new lands).
2. Production of 4,000 k.w.
3. Afforestation of 20,000 acres.
4. Providing drinking water to Marwat area.

Economic Impact of the Project

1. Increase in value of land.

The present-day price of land in the new area to be irrigated is about Rs. 25 to Rs. 100 per acre. The market value of the same after it receives irrigation water will go up at least to Rs. 500 per acre. This will increase the capital value of the land as follows :-

(*a*) New area of 1,50,000 acres at Rs. 500 per acre amounting to Rs. 7,50,00,000.

(*b*) Old area of 60,000 acres at Rs. 300 per acre previously receiving intermittent supply up to Rs. 1,80,00,000 so that the increase will be Rs. 9,30,00,000.

The appreciated value, as worked out above equals almost, the capital outlay of the project.

2. *Production of Hydroelectricity.*

Two falls each of 60 ft. drop are available on the canal with a discharge varying from 650 cusecs to 400 cusecs. This will help to generate 4,000 k.w. of cheap electricity. The hydro-electric generating stations producing cheap power, commissioned in March, 1958, have been connected to the West Pakistan grid, and have helped the industries and agriculture in the area.

3. *Afforestation and Reclamation*

(*a*) There are about 20,000 acres of Saradarga area alone which are commanded but rendered unculturrable due to retrogression. The processs is further extending. By terracing these areas, irrigated afforestation, can be developed on the whole of the existing unculturable land and further retrogression stopped.

(*b*) If sufficient land width along the canals is acquired now for afforestation, it will be very helpful in increasing our forest wealth.

Contd. on page 27.

KURRUM GARHI HYDEL STATIONS

By
SAIF-UD-DIN MALIK
Assistant Director, Irrigation West Pakistan

In this article brief information is given about the two Hydel Stations producing 4000 K.W. of firm power as a part of Kurrum Garhi Project.

Two Hydel Stations

Two power stations exist on Kach Kot Link Canal, which off-takes from the Kurrum Garhi main canal near Kurrum Garhi Fort, about 5½ miles north west of Bannu. Station No. I is very near the bifurcation point while station No. II is about 2½ miles down-stream. (See plan on page 23). The topography of the area is such that Kurrum river flows through a hilly terrain in this reach. The off-taking canals have, therefore, to travese steep natural slopes. Kach Kot Link canal, has a fall of 120 ft. in a length of 14,100 ft. from its offtake to its outfall into the existing Kach Kot canal. In order to avoid excessive excavation this fall of 120 ft. has been utilized for hydel Power generation. The channel feeding these stations, has a capacity of 665 cusecs but as the supply is erratic, the average available supply is assumed equal to 500 cusecs. The two power stations are almost exactly similar in all respect. Each Station is fitted with two generating sets of 1,000 kwts. each, making a total installed capacity of 4000 kwts. A spillway, capable of passing the full supply discharge of 665 cusecs is provided at each station for the purpose of bypassing the channel discharge in the event of the tripping of the turbines. Thus uninterrupted flow is ensured in the Kach Kot canal for irrigation even during the closure of hydel station, which may be necessitated for repairs or inspection etc. Although the sketches for the civil works were supplied by M/s. Siemens of Germany, the manufacturers of the electrical plants, the detailed design of the intricate structure of the generating stations and the by pass channels were worked out by the Irrigation Department Officers.

Electrification of Bannu Area

Power supply from these hydel stations has been utilized to electrify 95 villages and township in Bannu, 30 vilages in D.I. Khan and 15 in Miran Shah agency. Thus so far about 140 villages and townships have been electrified more important among which are Bannu, Sarai Naurang, Taja Zai, Lakki, Ghaznikhel, Pezu, Tank, Kulachi and D.I. Khan. Besides the electrification of villages and townships the power from these hydel stations has been supplied to Bannu Woollen Mill and about 150 tubewells installed for irrigtion and drinking water supply purposes in the two districts. It is expected that another 80 villages shall be electrified and 100 tube-wells energised by 1964-65 with the power from Kurrum Garhi Project. In order to ensure continuity of power supply, the transmission line carrying the power to D.I. Khan has been grided up to the Main Grid of West Pakistan.

Cheap Power

The commissioning of these power stations is a land mark in the development and rehabilitation of this most backward area. The old un-economical and dilapidated diesel generating sets working in some towns like Bannu, D.I. Khan and Tank, which had practically outlived their useful lives, have been done away with and instead cheap hydel electric supply is being fed to far and wide places in the D.I. Khan Division.

In view of availability of cheap power and assured supply, the Government has already sanctioned a Sugar Mill for Bannu and Textile Mill for D.I. Khan, which is only the beginning.

(*Contd. from page 25*)

4. *Flood Control.*

A considerable damage occurs annually to roads, lands and other properties by floods in the Kurrum, Baran and other Nullahs. The construction of Baran Dam will provide a measure of flood control over the river and Nullahs.

5. *Drinking Water.*

At present Marwat area is very sparsely populated and has no drinking water supply. Since there is no underground water within a depth of 400 ft. people have to depend for their drinking water supply on ponds which are unhygenic and get contamination. For lack of alternative source, the inhabitants use this contaminated water, and a good proportion of the population suffers from thread worms which disable them for months.

An interesting legned is attached to the four pillars of stone on a hill, over-looking the Baran Dam. Story goes that these four columns were originally four virgins bringing drinking water back home from a far off well. They saw some bad characters pursuing them. Girls prayed to God to turn them into stone so that bad characters might not harm them. Their prayer was granted and the four were transformed into pillars of stone. The columns are called, "Lakely keen ...." meaning girls turned into stone.

6. *Political and Social*

Large number of Wazir tribesmen from North Wazirastan are at present a political and social problem. They can be rehabilitated on the new land.

FOUNDATION TREATMENT OF BARAN DAM

By
MOHI-UD-DIN KHAN,

The Baran Dam site in Bannu is located in recent alluvial deposits o clay, silt, sand and boulders resting on bed rock of Siwalik age. The conglomerate rocks are generally considered impervious. In the middle of the dam the conglomerate rock is buried under 100 feet thick alluvium from which a seepage of 30 cusecs was estimated, as such it was decided to grout the formation. This article on foundation treatment of Baran Dam is a resume of paper No. 320—West Pakistan Engineering Congress 1956. The paper was contributed by late D.M. Khanzada, Superintending Engineer, Southern Circle, Bannu. Summary of the paper with introduction has been prepared by Mohi-ud-Din Khan, Deputy Secretary (Development), Irrigation and Power Department for the Engineering News.

Extent of the Dam

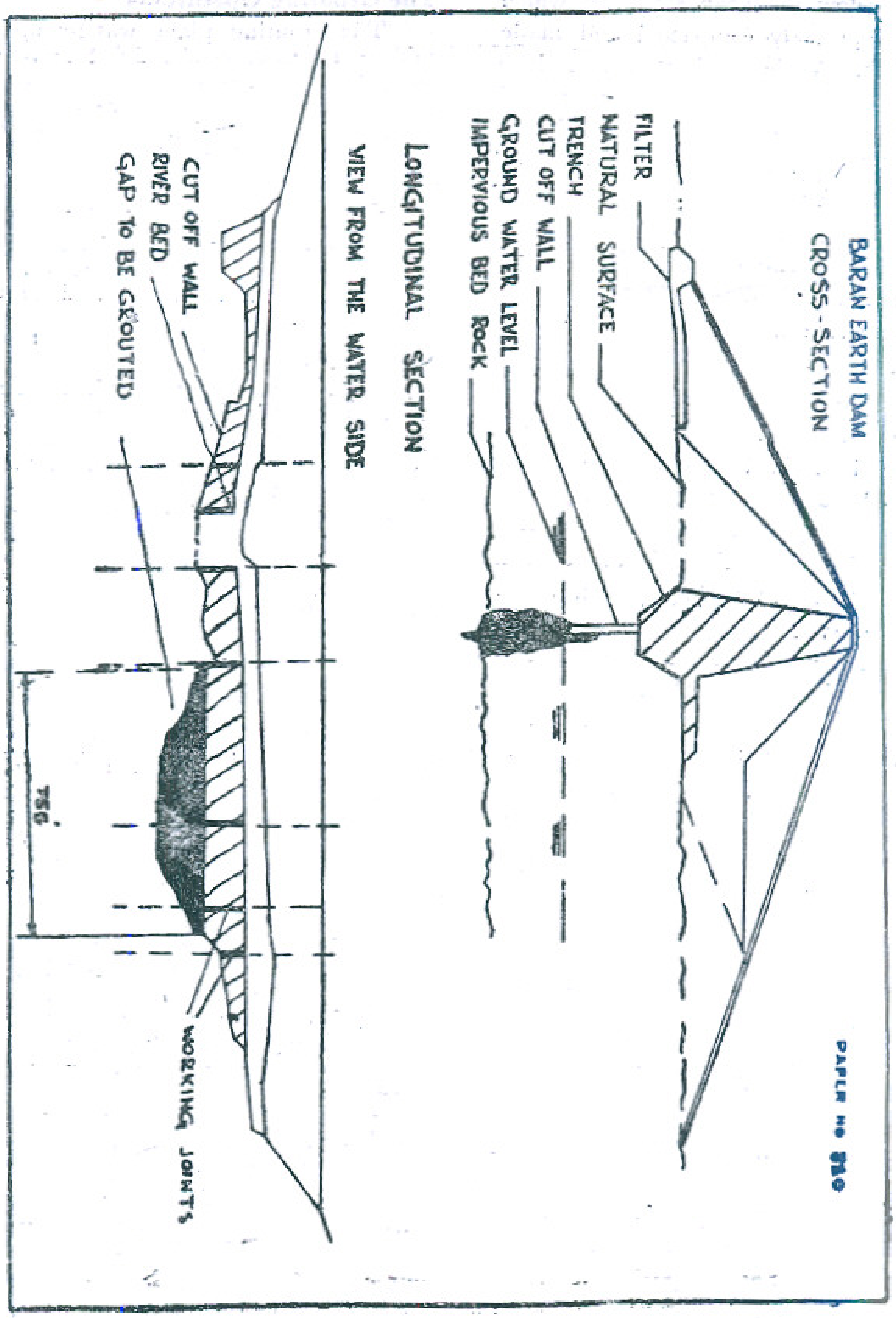
The Baran Dam is situated 8 miles from Bannu on Baran Nallah which is a non-perennial tributary of Kurrum river. The length of the dam at the crest is 3600 feet and the maximum height above natural ground is 130 feet with a base width 640 feet. The dam rests on conglomerate rock on both the flanks, and is founded on loose river alluvium in the middle. The impervious core of the dam was taken to the conglomerate rock on the flanks, which is available close to the ground level. The middle 755 feet of the dam rests on deep alluvium over 100 feet thick.

The Foundation

The Dam site and the reservoir are of recent alluvial deposits of clay, silt, sand, gravels and boulders resting uncomfortably on the bed rock of the "Siwalik age". These bed rocks are conglomerate, pseudo-conglomerate sand stones, silt stone and clays which can be considered sufficiently impervious to exclude the possibility of heavy losses through percolation. Both shoulders of the dam are on conglomerate rocks. In the valley, bottom conglomerates are buried under a thick layer of alluvium attaining at certain points 100 feet thickness. The main problem is the water losses as the capacity of the reservoir is already very limited and the conservation of stored water is of the utmost importance. The 30 cusecs, calculated to be the loss through the alluvia under full head of water were reduced, to negligible quantity through grouting treatment.

Foundation Treatment Necessary

As natural soils vary considerably, every dam site has its own peculiar foundation problems and as such special techniques both for design and construction have to be considered after detailed investigation of the foundation. For instance, in the case of Kaptai Dam on Karnaphuli river, there were places where the river had eroded


BARAN EARTH DAM
CROSS - SECTION
FILTER
NATURAL SURFACE
TRENCH
CUT OFF WALL
GROUND WATER LEVEL
IMPERVIOUS BED ROCK
LONGITUDINAL SECTION
VIEW FROM THE WATER SIDE
CUT OFF WALL
RIVER BED
GAP TO BE GROUTED
WORKING JOINTS

100 feet below the mean sea level which had to be properly compacted and made water tight. As dewatering such a deep hole was not feasible, an unusual method adopted was to fill these holes with selected sand by sluicing from barges and compact them by putting explosive charges after dewatering the fill. In the case of Baran Dam the foundation treatment involved injection of cement and clay slurry to seal the porous strata in the middle portion of the dam.

Adding Clay Cut off

The average permeability of the alluvia was determined by means of five large field permeability tests. It gave permeability equal to 0.697 cm. per sec. To control the seepage through the dam a large central trench was dug upto a depth of 30 feet below actual ground level. The central trench was 70 feet wide at the top and 30 feet wide at the bottom. From the bottom of the central trench a cut off 5 feet wide was dug through the pervious alluvium to a depth of 50 feet. The cut off trench was filled back with suitable and tested red clay in horizontal layers and concreted at the optium moisture content according to Proctor.

Grouting Treatment

Towards the middle of the dam the impervious cut off wall could not be placed on the bed rock because alluvium was more than 50 feet deep and because the ground water at this depth could not be pumped out for various reasons. This gap of 755 feet length was left which was braced before the refill between the bottom of the cut off wall and the impervious bed rock was to be treated carefully and thoroughly with grout.

The Grouting Operations

The grouting plant was set up in the middle of the section of 755 feet to be grouted. In order to provide sufficient water for grouting and drilling, a water compensation tank was erected at site. The dry clay was broken, pulverised and placed in suspension tanks. The clay from bed deposits in the main canal was also used for grouting.

The grouting work in the alluvia was carried out with high pressure, while the grouting work in the cut off was done under low pressure.

Grouting Tests Efficiency

In order to check the efficiency of grouting for the foundation to be treated a large number of grouting tests must be carried out. The tests determine the following important items :—

(*a*) The permeability of the subgrade in different depths before treatment ;

(*b*) The best density of the grout according to the grain size of the subsurface ;

(*c*) The most economical spacing of the grout holes ;

(*d*) Reduction of the permeability of the sub-surface after treatment by grouting.

The total length of borings for grouting operations was 16775 feet and the total quantity of clay and cement grouted was 1421 tons.

With grouting, the permeability of the alluvia was reduced by 70 to 100 times.

The ground was groutable in all the stratification because no great differences were observed on the absorption of all the borings.

It was noticed at some places in the cut-off wall that water used for drilling was lost due to fissures and shrinkage of materials as a result of settlement and lateral earth pressure. After grouting at low pressure these fissures were sealed with the alluvia.

WIND POWER

ITS POSSIBILITIES IN WEST PAKISTAN.

By

NAZIR AHMAD

The United Nations arranged a world symposium on New Sources of Energy. It was held in Rome on 21st to 31st. August, 1961, when SOLAR ENERGY, WIND POWER and GEOTHERMAL ENERGY were discussed. The registered attendance of 447 persons was representative of a very wide range of professional discipline and organizational back-grounds and was drawn from seventy four countries and territories in all parts of the world except Pakistan which sent no representative. The primary concern of the conference was the needs of power in less developed countries and one third of the participants came from such countries. Unfortunately little attention is given to the utilization of cheaper sources of energy in the country. West Pakistan has more than 10,000 sq. miles of its territories constituting Lower Sind area where winds of intensity blow practically through-out the year, yet no attempt has ever been made to utilize this bounteous gift of nature. In the matter of Solar Energy, we have the hottest sun, long clear bright days, yet never have we thought of using this inexhaustible source of energy. We are entering the field of Geothermal energy, although very late, with limited resources but wind energy is such as can directly be adapted for use in the country.

In this article some information has been given on the use of Wind Power which was discussed in very great detail in the Conference, where 40 papers were contributed. At a later date we will reproduce some of the papers on the subject.

Some Basic Concepts and Factors

Simple wind-mills have of course been used for many centuries, without much concern about the science of wind power and its utilization. Simplicity is still desirable. Modern techniques, however, provide the tools for designing more effective wind plants and for better utilization, including provision of energy in the form of electricity, as well as a better comprehension of the complex underlying principles.

One of the basic factors is the nature of wind energy, which is based on mass (air) in motion. The energy increases with the density and the velocity of the mass. Air has low density compared with, for example, water, whose energy therefore is about 8 times greater at the same rate of flow. Consequently one has to seek compensation in greater velocity or by a larger cross-sectional area of interception (swept area) of the mass flow, or both.

Wind power varies as cube of Velocity

The power (P) in the wind is proportional to the cube of the wind speed (V), and the swept area (A). It is expressed by the formula $P=KAV^3$ where (disregarding variations in air density) K is a constant with a value depending on the units used to measure A and V. The speed is usually measured in miles per hour or metres per second (one m.p.h. being equal to 0.447 m/sec.)

The significance of wind speed is shown by the fact that if the swept area or interception area is 100 square feet (about 12 ft. dia.) and the wind speed 10 m.p.h. the power available for extraction is 0.53 K.W. while at wind speeds of 30, 50 and 100 m.p.h. it jumps to 14.3, 66.3 and 530 K:W. respectively.

Simple Design of a Wind Mill

The wind is intercepted by sails or blades on a rotor, which may be either vertical or horizontal. The vertical axis system has the advantage that it can accept wind from any direction and transmit the power directly to the ground, but it is inherently less efficient and is not used in modern machines.. The horizontal axis system has to be supported by a tower of a height at least sufficient to clear the rotor blades from the ground and it must have some orientation device such as a fantail to keep the blades turned into the wind. It must also have, in the case of mechanical power, some kind of gearing and drive-shaft to transmit the power to the ground, while electric generators can be mounted on top of the tower and even be directly coupled to the rotor, the energy being taken out through electric wires. A variation of the horizontal type is the so-called Andreau machine designed in France and currently used in Algeria. It is based on a hollow tower and hollow blades of propellers, the latter being rotated by the wind throwing out air to create a depression near the bottom of the tower where air is drawn in and driving a turbo-generator on the ground.

With a given wind speed, the plant capacity may be raised by increasing the size of the propeller blades. The propeller or rotor diameter currently ranges from 30—35 meters in the largest machines,, requiring a correspondingly high tower and extra investment. Conversely, and this is more important, the capacity of a machine having a given size can be increased by finding a windier site.

Cut in Speed Mills

The capacity of a wind plant is thus determined not only by its physical size but also by the wind speed to which it is geared or "rated". Machines are designed to give their full output at a certain chosen or "rated" wind speed, energy in a wind of greater velocity is wasted. A high rated speed can be chosen, even as much as 40 m.p h., to take advantage of the very high winds occur rarely and machines reaching their capacity at those speeds would be very inefficient or inoperative at much lower speeds. Attention thus must also be paid, especially in the case of electric wind plants, to the so-called "cut-in" speed at which the machine starts to operate and below which it may even, unless properly arranged, drain electricity from a battery or grid in a reverse operation. At the other extreme, there are breaking devices and a "cut-out" speed to prevent over-running and damage to the plant.

Another basic consideration, in addition to the capacity determined by rotor size and rated speed (and conversion efficiently), is the annual output which can be obtained from that capacity. The number of kilowatt-hours produced per unit of capacity (specific output) is also a function of the rated speed of the plant (decreasing with increase in rated speed) and of the wind regime in the particular locality, which is shown by local wind power surveys usually resulting in so-called velocity duration curves and power duration curves. The number of hours in the year with wind of speeds in the operating range of the machine thus determines the maximum output which can be obtained. Again the importance of selecting specially windy sites is indicated by the fact that they permit a larger number of operating hours at a given rated speed as well as the choice of a higher rated speed. Both have influence on capital investment and energy cost.

Cost of Plant and its Maintenance

Plant investment varies with capacity and of course, with location. The capital cost per killowatt installed generally declines with increase in capacity, particularly when a greater capacity is achieved by a higher rated speed but also as a result of economy of scale in the case of a larger rotor diameter. Broadly speaking, the cost may still be as in the 1957 study mentioned in the introduction, be estimated at some $420 to $560 per killowatt for small electric plants, including battery, at $280 to $420 per killowatt for medium size plants with a capacity of 10 to 100 killowatts and at $140 to $280 per killowatt for larger plants.

The cost per kilowatt hour depends on the number of Kwh produced per Kw, on the rates of interest and amortization applied to the investment and, to a small extent, on annual operating and maintenance costs. For most of the plant, a depreciation period of twenty years may be reasonable, so that with an interest rate of 5-6 percent, the annual charge, including maintenance, would be about 9 to 15 percent of the investment, with the higher range applying to small plants with battery.

Size of Wind Power

In the industrialized countries, such as the United States, whose rural areas now enjoy the benefits of highly developed transmission networks, thousands of wind power plants once helped to pave the way for electrification and a different way of life. Notable progress has been made in the last few years.

India to Install 200 Mills

The energy situation is quite different in the less developed areas, as pointed out in an earlier section. There may well be considerable scope for wind plants of all kinds in those areas, for small plants of both the traditional mechanical and the electric types on individual farms, for medium size plants (10-50Kw) in villages and even for larger installations in grid areas. Wind power, as noted by Thacker, "is a source of power well suited for programmes of rural community development in under-developed countries in Asia, Africa and elsewhere and calls for systematic and organized work on a large scale in these areas". This belief is supported by action being taken for example, in India, where 200 wind mills of domestic design are to be installed shortly at selected sites on an experimental basis.

India sets up a Wind Power Committee

India is one among several countries that has set up Wind Power Committees or similar organization at government or private initiative. They exist in both industrial and less developed countries and are devoted to different aspects ranging from broad scope to wind surveys in the early stages.

Large Power Wind Mills

Wind power plants are being developed in Europe, where several national organizations are active and have installed relatively large wind plants (40 Kw and up). Among the plants in current operation the largest one known, reaching a maximum capacity of about 600 Kw, has been installed recently in France, while 200/Kw unit is operating in Denmark since 1957. Plants of 100 Kw have been installed in recent years in Germany and the Isle of Man in the United Kingdom and also in Algeria, the latter one having been transferred from the United Kingdom. Hungary has started on a 200-Kw unit, while in the USSR efforts seem to be concentrated on medium size units, such as at the experimental station at Istra near Moscow, as well as on water pumping and on grouping of generators to overcome problems of intermittent supply. In the Netherlands, long famous for wind power utilization, a traditional Dutch wind mill has been converted to produce some 40 Kw of electricity. Several of these countries also have modern wind power plants of medium size ; most of these countries, as well as Australia, Canada, Japan, South Africa and the United States have small electric wind mills in commercial production or actual operation. Many small units have of course been imported into other areas, from Alaska to the Antarctic.

Wind Availability and Site Selection

General wind observations have long been collected by national meteorological stations, airports and other installations, for purposes of their own ranging from weather forecasting to interest in wind as a meteorological phenomenon. This work is now co-ordinated at the international level by the World Meteorological Organization (WMO), which is represented with a survey of existing wind observational information. Wind measurement in meteorology is further described by Perlat.

Meteorological data gives a good first general indication of wind areas or regions and should certainly be taken fully in o account. The large body of data clearly reflects the importance of trade winds and the fact that coastal regions and islands generally are much windier than inland regions. In and around Africa, for example, some of the windiest areas are to be found in North-West Africa, in the Canary Islands, Madagascar and the Red Sea Coast while central and equatorial Africa may be characterized as less windy. Similarly, the coastal stations generally the highest wind readings Australia and in the western hemisphere, where the unobstructed plains east of the Rocky Mountains also are relatively windy. Eurasia is strongly under the inflence of the seasonal heating and cooling of the huge land mass and, for example in south Asia, the shifting monsoon. Some of the windiest areas are to be found in North-Western Europe, especially in the winter, when the demand for electricity also happens to be at its peak and the river flow feeding hydro-electric stations is often at their lowest.

The metrological observations available usually calculated on the mean monthly or annual wind speed but sometimes also with a frequency distribution of wind speeds are thus useful for a general assessment, but they are not adequate for those interested in wind as a source of power. This limitation is recognized by the meteorologists and the WMO, which notes that conclusions as to the practicability of tapping the wind " are left for the engineer or the economist ".

Wind Intensity Measurement in Pakistan

Naqvi, Director Metrological Service, Pakistan has analysed the wind data collected by his organization. Recently, he contributed a few papers. At present, observations of wind velocity are being conducted at several sites. The most important sites of observation are shown in Map No. 1. On the basis of records of a few years, contours of mean wind velocity are plotted for four periods in a year.

These are for the month of March, June, September and December and illustrated in Fig. 2.

The observed data for six stations are shown in Table 1. The average of each month is given.

Except Sukkur, right upto Nawabshah, the maximum wind speed for five or six summer months is more than 6 m.p.h. The average during June, July and August is 7 to 12 m.p.h. as illustrated below.

Speed m.p.h.	Karachi	Hyderabad	Badin	Chhor	Umarkot	Nawabshah	Sukkur
max.	12.3	11.2	7.0	9.7	9.9	8.9	5.1
min	4.1	4.0	1.5	2.5	3.7	2 3	2.5

There may be other areas of West Pakistan, such as the Thal or in the Cholistan desert adjacent to Bahawalpur Region, where the wind intensity may be suitable to work wind-mills, but this needs further study.

Wind Surveys

The inadequacy of the meteorological data for power purposes is due to several factors, among them being the very location of meteorological stations interested in representative regional data rather than extremely windy sites. In wind power studies, on the other hand, the primary objects are to find especially windy sites related to power needs, to obtain data on the probable power output and the wind structure there and sometimes special information related to wind power plant design and performance.

Consequently, special surveys have usually to be undertaken and at least temporary measuring stations set up to establish

Fig. No. 1

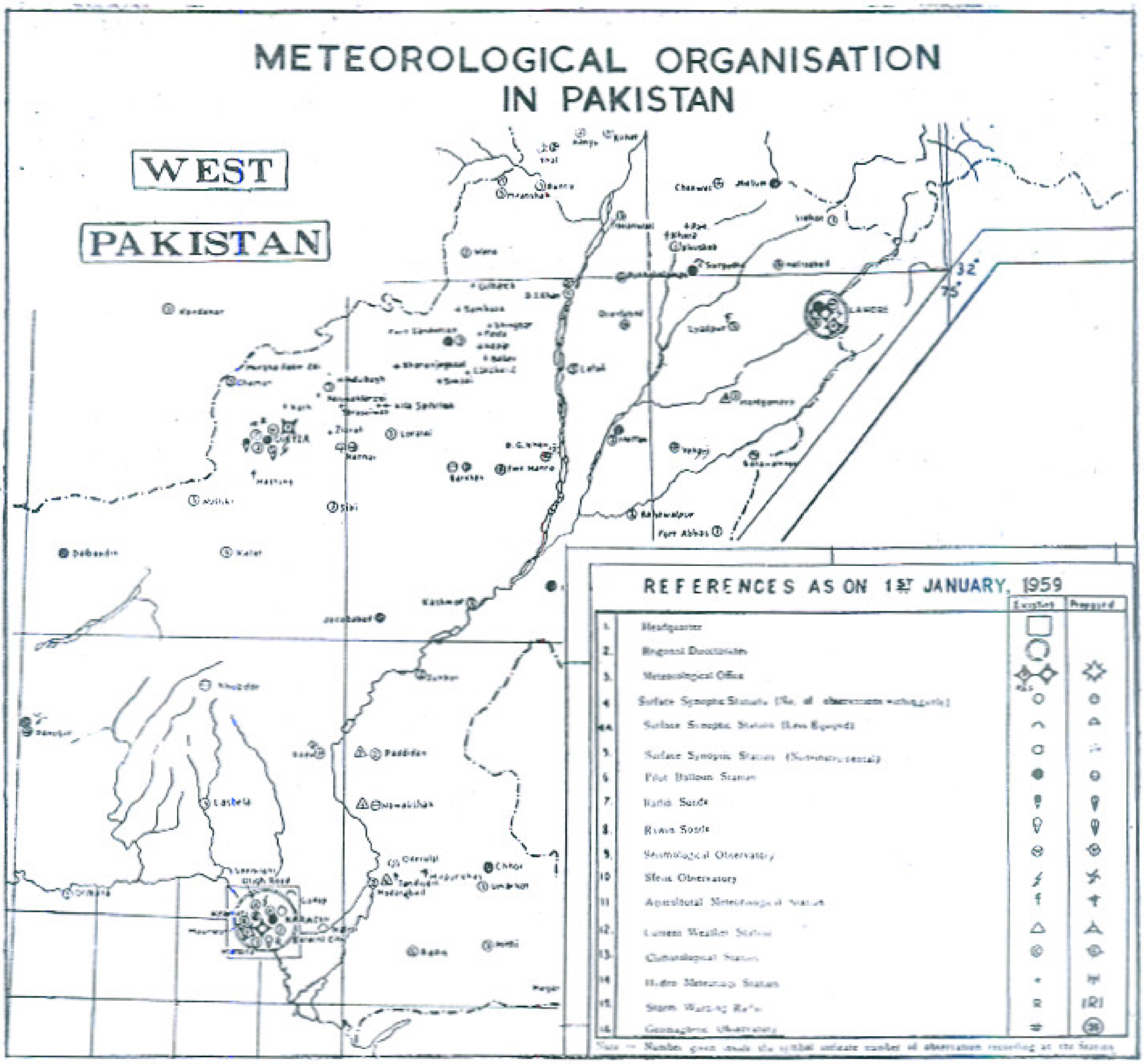


Table No. 1

Means Monthly Wind Volocity in M. P. H. at different Station in Sind

SITE	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Karachi	5.52	5,863	7.36	9.43	32.305	13.45	14.14	13 34	11,100	6.009	4.715	4.175	8.165
Hyderabad	4.1	4.0	4.9	6.6	8.8	11.2	10.7	10.3	8.4	5.0	3.5	4.0	6.8
Nawab Shah	3.69	3.315	4.26	5.06	6.785	16.235	9.2	8 28	5.535	3.68	2.645	2.97	5.8
Chhar	2.4	7.3	3.5	5.0	7.3	9.7	2.7	7.7	5.8	3.0	1.5	1.5	4.5
Umar Kot	3.7	3.6	4.2	5.4	8.4	9.9	9.7	7.6	6.1	3.6	2.7	8.1	5.7
Sukkar	2.8	3.9	3.5	3.9	3.9	4-8	5.0	5.1	4.0	2.9	2.6	2.5	3.7

specific wind power possibilities. Such surveys in less developed countries have already been referred to above and are well illustrated, for example, by Soliman. They have also been undertaken in several industrialized countries, sometimes on a large scale. Argand, for example summarizes pertinent data and results for 181 stations in France as well as 140 in Africa and some others, expressed as the mean theoretically recover-able wind energy in kwh/m/ year and obtained directly in that form through an ingenious French measuring device.

The special wind survey, which requires carefully planning and proper execution to give reliable information on the wind regime, provides data which may be analysed in such terms as short term variations (important for plant designer), diurnal and seasonal variations, frequently and duration of low wind spells and other wind factors affecting the technical and economic possibilities of power production. At least hourly records may be needed for a year or two, and they may then be extrapolated by correlation with longer-term meteorlogical data, which should be put to full use "because the general features of the wind regime for an area will hold also for particular sites within it". Moreover, and this is highly significant, so-called velocity duration and power duration curves constructed from the data have been found in several surveys to be remarkably similar in their distribution in relation to a particular mean annual wind speed so that the latter figure may often go a long way in the preliminary estimates. The wind data on the site may be obtained through a variety of measuring instruments, ranging from simple cup-counter anemometers to complex registering and integrating devices described in the technical papers. It is sufficient to note here that the choice of instruments has to be made in relation to what is to be measured and that care has to be taken in noting their height above the ground since the wind speed generally increases with altitude.

For geographical placing of the instruments, and the ultimate power plants, proper account has to be taken with view of local topography, advantage of the compression and higher speed of winds over certain types of hills and mountains, as discussed for example by Frenkial, Lange and Petteressen. Such careful site selection may give a mean wind speed that is several miles per hour higher than in nearby locations and that may make it possible to obtain an increase of at least 50 percent in power output. Thus, site selection aims at finding such windy spots, whether on the coast or inland, as are reasonably accessible and near the point of use.

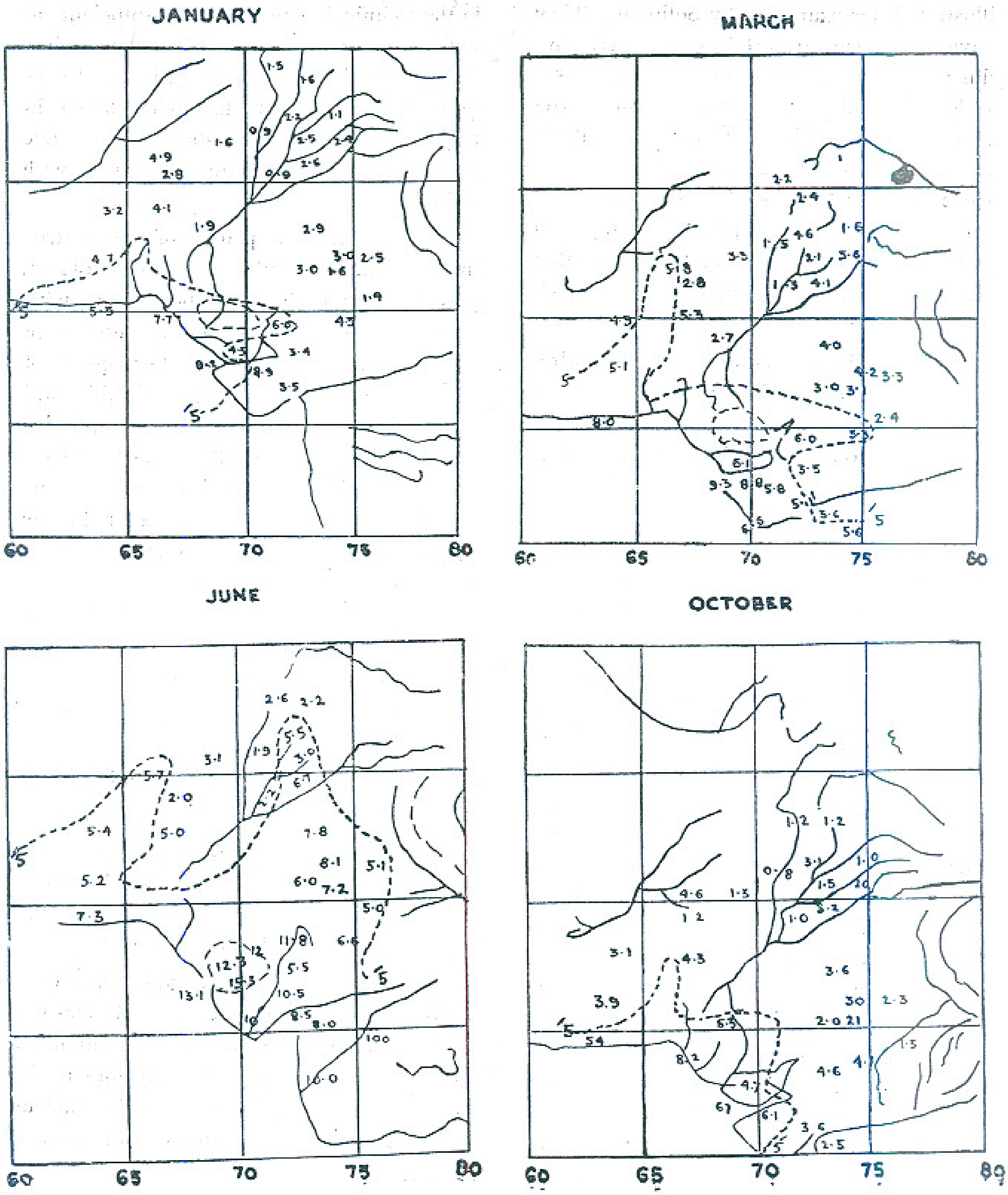
Design and testing of wind power plants

The designing and testing of wind power plants are in the realm of the engineer. As illustrated by several of the technical papers, he has many choices.

They cannot be considered in detail beyond noting a few variations and stressing the profound influence of the intended utilization and the local conditions to be taken into account. A study of the various contributions listed at the end of the note

Fig 2

MONTHLY MEAN WIND VELOCITY IN M.P.H., AT DIFFERENT STATIONS IN WEST PAKISTAN



can further help those who want greater detail.

For certain purposes, notably water pumping, improved versions of the simple mechanical windmill may still be the best solution in particular localities. They can often be made wholly or largely from locally available materials and with local labour, incorporating such materials as bamboo and reed mats for rotor sails. The classical Dutch windmills, for example, were made almost entirely from wood and were either of the horizontal rotor type with a geared vertical shaft or arranged in a sloping position directly connected with a so-called Archimedean water screw for shallow pumping. They still have a future in less developed countries, if adapted to the skills, materials and tools of the local tradesmen. Modern technology can make a significant contribution to such adaptations as pointed out by Stam. The conventional steel windmill may in fact be too advanced for the villagers.

Design of Indian Mill

An example of adaptation by India, where mechanical windmill (costing about Rs. 2,500 with a pump) has been developed Designed for 5-8 m.p.h. winds, it has 12 blades with a rotor diameter of 18 feet and is able to lift some ten million gallons per year (depending on depth). The mechanical mills often have a large number of such rotor blades, and may have either a slow-running wheel connected with a piston or high-speed rotor with a propeller pump or centrifugal pump.

Many refinements have been included in wind power plant. Much improvement is due to the advances made in aerodynamics

Wind power cost and Applications

Household and other uses require only small plants-which are readily available commercially in the range of 0.25 to 3 Kw with full battery storage to make the unit self contained and able to carry over calm spells. The users of such plants thus take advantage of local energy and free themselves from the cost of transmission or, more commonly, from the lack of a transmission network.

Small electric plants have been sold by the thousand, especially in the industrialized countries. For one such plant of 2.5 Kw. the total factory cost is indicated to be $1,0 .5 (including $360 for battery and $275 for tower) or about $400 per Kw, to which have to be added shipping and installation costs. Records for more than one thousand of these plants show repair costs to average less than $5 per year. Hundreds of them are used for cathodic protection of underground steel-pipe-lines, while the more usual application to the power output from small plants naturally are for lighting and other domestic amenities and for grinding, mixing, refrigeration and other small power uses.

On a typical Indian farm using a wind-electic plant (rated at 6-8 Kw. but giving 2-4 Kw. under the given wind conditions) without battery for water pumping, the cost is estimated at less than one-third of that based on a diesel engine there. Another paper from India also stresses water pumping by means of equipment which must be simple and cheap to be suitable, and records the demand for electricity as secondary.

Proceedings of the Conference

The Proceedings of the Conference which had formed the basis of this note was officially opened at 5 p.m. on Monday, the 21st and the General Session started on Tuesday, the 22nd, August.

The discussion on Wind power took place at 4 p.m. on Thursday the 24th, 10 a.m. on Friday the 25th and at 4 p.m. the same day, and 10-30 a.m. on Monday, the 28th. The Chairman of the various sessions were:—

1. Prof Valentin A. Baum
   Deputy Director,
   Krzhizhanovsky Power Institute
   Head of Heliolaboratory
   Leninsky Prospect 19
   Moscow, USSR

2. Dr. K. Lango
   Chief, Technical Division
   World Meteorogical Organization
   Geneva, Switzerland.

3. Mr. Peder Gerhard Poudsen Hansen, General Manager
   Association of Danish Electricity Works.
   Chairman, Danish Wind Power Committee.
   Livjaegergade 22
   Copenhagen, Denmark.

4. Dr. Ulrich Hutter
   Professor, Technische Hochschule Stuttgart.
   Holzgartenstrasse 9A
   Stuttgart-N., Wuertemberg
   Federal Republic of Germany.

5. Dr. Louis Vadot
   NEYRPIC SOGREAH
   Grenoble (Isere), France.

6. Professor M.S. Thacker
   Director-General
   Council ot Scientific and Industrial Research, New Delhi, India.

As to the papers there were general (GEN) and specific contributions pertaining to wind power (W), besides Solar Energy (S) and Geothermal Energy (G).

Below are listed subjects and headings of general contributions and those pertaining to wind energy only.

AGENDA ITEM II.B.I :—Studies of wind behaviour and investigation of suitable sites for wind-driven plants. GENERAL REPORT, Rapporteur E.W. Golding, CR/6(W).

Measurement of the Characteristic parameters of wind power for the selection of favourable sites for wind-driven generators. A.G. Argand (France), W/35.

Speculative methods in wind surveying : M. Ballester (Spain), W7.

Prospecting for wind power with a view to its utilization : J.A. BARASOAIN and L. Fontan (Spain), W/16.

Wind measurements in Southern Argentina and remarks on wind and solar energy in that country: E.CAMAILARGIU (Uruguay), W/10.

Wind flow over hills (in relation to wind power utilization) : J.H. FRENKIEL (Israel), W/33.

Wind measurements : M.JENSEN (Denmark)) W/14.

Some aspects of site selection for wind power plants in mountainous terrain : K. O. LANGE (U.S.A), W/28

Wind measurement in meteorology : A.PERLAT (France), W/13.

Some aspects of wind profiles : S. PETTERSSEN (U.S.A.), W/26

Wind power resources of India with particular reference to wind distribution : K.P. Ramakrishnan and S.P. VENKITESHWARAN (India), W/19.

Wind measurement techniques : M. SANUKI (Japan), W/2.

Studies of wind behaviour and investigation of suitable sites for wind driven plants : K.H. SOLIMAN (U.A R.), W/1.

Wind measurements in relation to the development of wind power : J.R. TAGG (U.K.), W/12.

Survey of exising wind observational information : WORLD METEOROLOGICAL ORGANIZATION, W/11.

AGENDA ITEM II B 2 : The design and testing of WIND POWER PLANTS

GENERAL report, Rapporteur L. Vadot, GR/7(W).

1.B.2 (*a*) DESIGN

Regulating and control system of an experimental 100 Kw. wind electric plant operating parallel with an AC network :— S. Armbrust (Germany), W/34.

Classical designs of small drainage windmills in Holland, with considerations on the possibilities of their improvement and adoptation in less developed countries : A. Having a (Netherlands), W/32.

The aerodynamic layout of wing blades of wind-turbines with high tip-speed ratio : U. Huttek (Fed. Rep. of Germany), W/31.

The design of wind power plants in Denmark : J. Jyul (Denmark), W/17.

Wind Power plants suitable for use in the national power supply network : A.Ledacs-Kiss (Hungry), W/36.

Wind turbines of a new design in (Japan) : T. Moriya and Y. TOMOSAWA (Japan), W/5,

Consideration on a natural aspect of harnessing of wind power. P.P. SANTORINI (Greece), W/30.

A wind driven electrical generator directly coupled into an A.C. network. The matching problem ; L.H. STERNE Belgium), and G. FRANGOIANIS (Greece,) W/30

Small wind electric plant with permanent magnetic generator : F. VILLINGER (Fed. Rep. of Germany), W/27.

I.B.2 (*b*) Testing.

Testing of the Gedser Wind Power Plant:—V. ASKEGAARD (Denmark) W/15.

Various relationships between wind speed and power output of a wind power plant: G. Calusnizer (Fed. Rep. of Germany), W/3.

Test methods applied to the Andreau-Enfield 100 KW wind-driven generator at Grand Vent: F. DELAFOND (France), W/9,

The testing of wind power plant.: J.G. MORRISON (U. K.) W/24.

AGENDA ITEM II.B3 Recent developments and potential improvement in wind power utilization

GENERAL REPORT, Rapporteur U. Hutter, GR/S(W).

II.B. 3(*a*) FOR HOUSEHOLD AND OTHER INDIVIDUAL USES

Wind power plant in Eilat: J.H. FRENKIEL (Israel), W/6

Experience with Jacobs wind-driven electric generating plant, 1931-1957 : M.L. JACOBS (U.S.A.), W/22

Small radio, powered by a wind-driven bicycle dynamo : H. Stam, H. Tabak and G.J. VAN VLAARDINGEN (Netherlands), W/38.

Adaptation of wind mill designs with special regard to the needs of the less industrialized areas :

H. Stam (Ntherlands), W/40

Operation of Allgaier, type (6-8 k.w. wind electric generator at Porliander India: S.P. VENKITESHWARAN (India), W/25.

A method for improving the energy utilization of wind driven generators, and their operation with conventional power sets : J.G. WALKER (U.K.), W/18.

Utilization of random power with particular reference to small-scale wind power plants : J. G. WALKER (U.K.) W/29.

II.B. 3(*b*) FOR COMMUNITY PURPOSES (ISOLATED UNITS AN DUNITS IN COMBINTION WITH CONVENTIONAL POWER SETS)

Developments and potential improvements in wind power utilization : J.T. ARNFRED (Denmark), W/1,

Windmill types considered suitable for large-scale use in India : P.NILAKANTAN, K.P. RAMAKRISHNAN and S.P. VENKITESHWARAN (India), W/25.

II.B. 3(*c*) FOR USE IN CONNECTION WITH ELECTRICAL NETWORKS.

Problems of automatic coupling of a wind-driven generator to a network : F. DELAFOND (France), W/8.

Recent developments and potential improvement in wind power utilization for use in connection with electrical networks in (Denmark) J. JUUL (Denmark) W/20/Rev.

Economy and operation of wind power plants : J. JUUL (Denmark), W/21.

WATER RESOURCES DEVELOPMENT

By
ABDUL HAMID CHOWDHRY
Director General, Works, Capital Development Authority

Pakistan's Fourteenth Science Conference was held at Peshawar, from 29th March to 3rd April 1962. Chowdhry Abdul Hamid was the president elect for Section of Engineering, Irrigation, Hydel Power, Hydraulics, Communication, Electricity and Public Health. He discussed water resources of the country. His address is partly reproduced below.

Multipurpose Projects

Ever since 1860, the Government has carried on with the programme of developing the country's water resources. Irrigation facilities were the main objective, but after Independence (1947), several other objectives such as hydel power, flood control, supply of water for domestic uses, recreation facilities, etc. also come up for consideration.

Till recently, the Irrigation Department was responsible for the planning, execution, maintenance and operation of the river valley projects. The Department has very useful knowledge and developed technique of constructing barrages on alluvium foundations and earthen regime canals. This technical know-how and the century-old traditions make the department still the leading agency in the design of canals, their maintenance and operation as also open drains to check waterlogging.

History of Canal Development

The foundation of the present concept of the river valley projects was laid by Emperor Shah Jahan, who in 1630-40 diverted water from river Ravi and brought it to irrigate the famous Shalimar Gardens in Lahore. Later the Sikhs reconditioned this canal to carry water to the Golden Temple of Amritsar, and called it Hasli canal. Soon after the British occupation of the Punjab, the British Government started surveys for what is now the Upper Bari Doab Canal on the alignment of the old Hasli canal, the object being the settlement of the disbanded soldiers. A substantial portion of this system, now called the Central Bari Doab Canal, lies in Pakistan. Sidhnai, Lower Chenab and Lower Jhelum canals followed. The Lower Bari Doab canal was opened in 1913 and the feeder Canals, Upper Chenab and Upper Jhelum were opened in 1912 and 1913 respectively. The Sutlej Valley Project aimed at conversion of inundation canals into weir control which were completed in 1921-33. Almost simultaneouly, the first barrage on the Indus was put up at Sukkur. Haveli and Thal Canal Projects were also completed before Independence.

The post-Independence developments since completed are the Ghulam Mohammad and the Taunsa Barrages on the Indus. A few linkc anals have also been constructed, primarily to improve the water supply of the Sutlej Valley canals. These are Bombanwala-Ravi-Bedian, Balloki Sulemanki, and Marala-Ravi links.

After Independence, industrialisation also received attention. Some hydroelectric stations on the existing canals came into being. These are :

Name of Station		Installed Capacity in K.W.
Rasul	...	20,000
Malakand	...	20,000
Dargai	...	20,000
Chichoki	...	12,000
Gujranwala	...	12,000
Shadiwal	...	13,200

River Valley Projects on scientific lines in Pakistan started about a century ago. Development prior to Independence, however, was slow and mainly confined to irrigation. The ruling principle was economy in construction cost, time of completion being of secondary importance. As there was little to learn from the outside world, the country evolved its own practice and technique in the field of weirs and canals with the result that Pakistan has one of the finest irrigation system in the world.

The Irrigation Department worked on a self contained basis. It designed and planned its own projects and supervised the construction of all work. The work done was so economical that in spite of the water rates recoverable from the consumer being the lowest in the world, the capital expenditure has been recovered several times over, as will appear from the following table.

Statement showing Capital Outlay on some Running Canals and Accumulated Profits by them as of March, 1946.

S. No.	Name of Canal		Capital Outlay in m. Rupees	Accumulated Profits in m. Rupees
1.	Upper Bari Doab	...	1,4,8,91	10,5.5,23
2.	Lower Bari Doab	...	2,3,9,54	18,1.8,47
3.	Upper Chenab	...	4,3,3,10	1,6.1,40
4.	Lower Chenab	...	5,0,1,63	58,7.8,06
5.	Upper Jhelum	...	4,7,1,58	...
6.	Lower Jhelum	...	2,6,7,29	11,0.8,36
7.	Dipalpur	...	2,28,86	...
8.	Pakpattan	...	3,1,3,18	5,02,80
9.	Mailsi	...	2,2,5,40	...
10.	Haveli Canals	...	3,7,8,40	2,0.6,08

Soil Reclamation Board :—

As the system of canals spread over arid lands, complication started side by side with prosperity. Water-logging and salinity increased and the situation became so serious that as much as 70,000 acres per year started going out of cultivation in the central part of West Pakistan alone. The Government had to constitute a semi-autonomous Soil Reclamation Board under the Chairmanship of one of the Additional Chief Engineers with members drawn from Agriculture, Forest, Co-operative and Revenue Departments. This Board was set up in 1952 under an Act to provide for speedy reclamation and improvement of areas damaged by salinity and waterlogging and preventing further damages.

Pakistan Appoints Consultants

As the dependable flow in rivers was almost completely utilised, for further development the Government had to look around for conservation of flood waters going waste to the sea by storage dams, and tapping the underground resources which needed cheap hydel power. As this field of engineering was new to Pakistan and the world had far advanced in the concerned technique, Pakistan for the first time considered the appointment of Consulting Engineers, engaged soon after Independence (1948).

Flood Commission.

There have been several floods of high magnitude in the past thirteen years. Flood Commissions were instituted, one each for the two wings of Pakisan. The terms of reference included :—

(*i*) To asses the flood problems as a whole.

(*ii*) To assess the adequacy of the existing data and

(*iii*) To prepare an integrated flood control plan.

The Planning Commission

The Government of Pakistan realised the importance of development from the outset. In 1948 a Development Board was set up. In 1953 the Government set up a Planning Board which was later converted into a Planning Commission.

Government Sets up East and West WAPDAS.

In order to cope with the multiplicity of development problems, the Government set up two corporate bodies to operate on semi-autonomous basis.

Their charter included :—

(*i*) To prepare comprehensive plans for development and utilization of water and power resources for irrigation, water supply, drainage, etc.

(*ii*) Generation, transmission, distribution of power ; construction, maintenance, etc.

(*iii*) Flood control and watershed management.

(*iv*) Prevention of water-logging and reclamation of water-logged and salted land.

(*v*) Inland navigation, etc.

West Pakistan WAPDA Programme

The programme of West Pakistan WAPDA can be divided into three categories.

(*a*) Development.

(*b*) Salinity Control and Reclamation.

(*c*) Replacement Works.

The development works in hand are :—

(*i*) Guddu Barrage, to provide irrigation for 2.5 million acres through four main canals.
The project is to be completed this year at a cost of Rs. 370 million.

(*ii*) Karachi Irrigation Project is to dam Hub river, store 864,000 acre feet to irrigate 100,000 acres near Karachi at a cost of Rs. 70 million.

(*iii*) Rawal Dam on Kurang river to store 53,000 acre feet by 80 ft. high dam. The purpose is to irrigate 15,000 acres and to supply water to Rawalpindi and Islamabad. The cost estimate is Rs. 6 million.

(*iv*) Banda Tanda Dam, height 200 ft. capacity 230,000 acre feet, will irrigate 63,000 acres at a cost of Rs. 42 million.

(*v*) Darwat Dam, height 110 ft, storage 60,000 acre ft. will irrigate 32,000 acres at a cost of Rs. 6·4 million.

(*vi*) Gulkatch Dam, height 250 ft. storage 56,000 acre feet, will irrigate 50,000 acres and generate 7500 K.W. Estimated cost is Rs. 43 million.

(*vii*) Kalangi Dam on the Swat will irrigate 2 million acres and generate 250,000 K. W.

(*viii*) For Baluchistan about 20 schemes are being planned.

(*ix*) It is being planned to install 100 pumps to lift water and irrigate about 22,000 acres lying in the form of small pockets in the northern regions.

Salinity Control and Reclamation

For removing waterlogging and leaching salts from the soil, 2,000 tubewells are underway which will provide 7,000 cusecs water for leaching salts. This will result in reclamation of 1.5 million acres, raising food production by 700,000 tons. In the 2nd five year plan, 5,000 more tubewells are to be sunk.

Replacement Works.

With the signing of the Canal Water Treaty between India and Pakistan, West Pakistan WAPDA has been called upon to undertake the construction of a billion dollar replacement works in the Indus Basin. The programme of Replacement Works consists of two major dams, 7 link canals, and some tubewells, all to be completed by 1970.

These works are :—

(*i*) Mangla and
(*ii*) Tarbela Dams.

The new canals are

1. Trimmu-Sidhnai link.
2. Sidhnai-Mailsi-Bhalwal, Link.
3. Rasul-Qadirabad Link.
4. Qadirabad-Balloki Link.
5. Balloki-Suleimanki Link II.
6. Chashma-Jhelum Link.
7. Taunsa Panjnad Link.

Remodelling of existing works and canals includes Marala Ravi Link, Marala Headworks, Bombanwala-Ravi-Bedian, Depalpur Link, Balloki-Suleimanki Link, Sidhnai canals, Depalpur canal, Fordwah canal, Mailsi and Pakpattan canal system.

The replacement plan includes the construction of a few barrages. These are Mailsi on Sutlej, Sidhnai on Ravi, Qadirabad on Chenab, Rasul on Jhelum and Chashma on Indus river.

Foreign Consultants

Till recently all the river valley projects were the responsibility of the Irrigation Department, who did their own designing and supervision of works. Now that integrated development schemes have come up requiring much more diversified specialised knowledge, the need of Consulting Engineers is acutely felt. No country can develop under exclusive foreign advice. **The foreign experts who have come of necessity or may be coming to Pakistan to help the country should remain in the country only for the minimum possible time. Foreign advice cannot always be the most economical as the foreigners may not fully appreciate local problems nor can they be in a position to fully utilise the country's natural resources to the fullest and most economical extent.**

Suggestions to Government.

The following suggestions were made to Government about the future Engineering works :—

(*i*) All foreign Consulting Engineers and contractors should be allowed to bring only their top experts to this country and the rest of the technical and office staff should be drawn from within the country. As soon as the Pakistani staff can replace them in due course the experts should be withdrawn.

(*ii*) Those senior engineers who may like to retire prematurely from Government service to go to consultants or contractors should be given proportionate premature pension based on the period they have already served the Government.

(*iii*) The foreign contractors should associate with local contractors and sublet work to local contractors.

(*iv*) Construction and Engineering must be recognized by the Government as industries and facilities of credit (both rupees and foreign exchange) afforded to develop them as applicable to other industries.

(*v*) No contractor should be awarded work unless he is a qualified engineer himself or he has qualified engineers in his regular employment.

(*vi*) Applied research must progress in the country to make maximum use of indigenous construction material in the most economical manner.

News and Notes

REGIONAL TRAINING COURSE ARID ZONE HYDROGEOLOGY

Unesco South Asia Science Co-operation Office, New Delhi, organised jointly with the Government of Pakistan regional training course in Arid Zone Hydrogeology at Lahore, March 26th to April 21st 1962. The Course was sponsored under the Expanded Programme of Technical Assistance. It was held at the Water and Soil Investigation Division (WASID) Laboratories Moghalpura, Lahore.

Prof. G. Filliat of France, Mr. W.T. Stuart of U.S.A. and Prof. G.V. Bogomolov of USSR conducted the course. The course was directed by Mr. S.M. Said Deputy Chief Engineer, WASID PAKISTAN. Dr. Nazir Ahmad of Irrigation Research acquainted the participants with the cheap and durable methods of dealing with high ground water and installing tube wells. Beside lectures, a demonstration of actual installation of the wells was held in the field.

About 25 participants from Burma, Ceylon, India and Pakistan participated.

Unesco Aid for Pakistan

Unesco is giving 2.2 million dollars technical assistance and technical installation to West Pakistan in 1962.

This includes, the entire foreign exchange requirements for equipment of three new technical institutes to be opened this year at Hyderabad, Khairpur and Bahawalpur.

The West Pakistan Engineering University will be provided with equipment worth $ 500,000 ; Engineering College, Peshawar, $ 200,000 ; Polytechnic Institute, Karachi, $ 50,000 ; Rasul Overseers School, $ 100,000 ; and Irrigation Reseach Institute, Lahore $ 100,00.

Five institutes at Hyderabad, Khairpur Sialkot, Peshawar and Bahawalpur will be provided with equipment worth $ 70,000 each.

Unesco has also placed the services of 13 technical experts at the disposal of West Pakistan Engineering University, Engineering College, Peshawar, and Polytechnic Institute, Karachi. Of these five have already arrived and started working, while the remaining are expected soon.

Unesco India Symposium on Environmental Physiology and Psychology in arid conditions.

Origin and Aims of the symposium

At its fourteenth session the Unesco Advisory Committee on Arid Zone Research recommended the establishment of a special sub-committee to advise on the establishment of a detailed plan of activities in

Arid Zone News letter, 15th March, 1962.

the field of human physiology. At its meeting in Paris in 1959, the sub-committee, which included representatives of WHO and FAO, recommended that reviews of research on human physiology and psychology in arid conditions be prepared, to be followed by a symposium on the same subject, where individual research papers would be presented and discussed. The reviews of research which are now in the press, will serve as background information for the symposium, for which the Indian Government has offered to act as host.

Date and place of the symposium.

The symposium will be held at Naini Tal, in the foothills of the Himalayas from 27th August to 1st September 1962. Foreign participants will assemble in New Delhi, on 26th August and proceed to Naini Tal by bus, early on the morning of 27th August.

All correspondence concerning the scientific organization of the symposium should be addressed to Unesco, Department of Natural Sciences, Place de Fontenoy, Paris-7 (France).

The Indian Government is setting up an organizing committee under the direction of Dr. B. Mukerjee, Director, Central Drug Research Institute, Lucknow. Co-ordination will be effected by the Unesco South Asia Science Co-operation Office, and all correspondence concerning local arrangements should therefore be addressed to Mr. J. Swarbrick, Chief, Unesco South Asia Science Co-operation Office, 100, Sundar Nagar, New Delhi (India).

Programme.

The sub-committee drew up the following programme for the symposium and this programme was endorsed by the Advisory Committee at its seventeenth session.

Medical climatology of arid zones (relationship of climatic conditions to the incidence of disease in arid zones).

Physiological anthropology (differences in physiological responses of ethnic groups to environmental conditions characteristics of arid zones.)

Comparative physiology of arid lands (critical comparison of animal and human responses to characteristics conditions of arid zones : temperature, aridity, etc).

Nutrition and heat (influence of exposure to heat on human nutritional requirements).

Water and electrolytes (water, salt and other electrolyte requirements in hot conditions, and the effect of deficiencies in any of these on man).

Neurophysiology of heat exposure (changes in central and peripheral nervous functions in hot conditions and possible reasons for this).

Significance of solar radiation in the heat balance (extent to which incident solar radiation affects the heat balance of persons exposed, and the mechanisms involved).

Performance and comfort standards (resume of existing standards of performance and comfort and how performance and comfort are affected by climate).

Psychological aspects of life in hot climates (relationship of observed behovoural patterns to characteristic physical conditions of arid zones).

For each section a leader will be appointed well in advance to prepare an opening paper and to invite two other scientists to prepare complementary papers. Additional short contributions will also be accepted in each section.

Scientific paper.

The reviews of research will be circulated beforehand to those taking part in the symposium, so that the various sections of the programme may be properly balanced. Those intending to present papers are requested to send the title of their paper, together with a summary of about 250 words, in English or in French, to the Department of Natural Sciences, Unesco, Place de Fontenoy, Paris-7, not later than 1st April, 1962. Manuscripts of papers should be reproduced only in the original language. Participants who wish to prepare their paper in any other language are requested to supply English or French translation themselves. The working languages of the symposium will be English or French, with simultaneous interpretation from one language into the other.

Unesco proposes to publish the proceedings of the symposium in its arid zone Research series.

A STEP TOWARDS AN INTERNATIONAL PROGRAMME OF HYDROLOGICAL RESEARCH.

At the last session of the Council of the International Association of Scientific Hydrology, held in Athens on the occasion of the Symposium on Ground Water Resources, the American representatives suggested the launching of a long-term international programme of co-ordinated hydrological research. The association's secretary was asked to study the question and to undertake the necessary consultations with the international organizations concerned, including Unesco.

Again, in the course of the examination by the Executive Board of Unesco at its sixtieth session, in November 1961, of the Proposed Programme and Budget for 1963-64, the Board had a proposal from the United States delegate that the necessary preliminary action may be taken for making a programme of international co-operation in hydrology. The proposal was warmly welcomed, in particular by the delegates of the Federal Republic of Germany, India, Pakistan and the United Kingdom, and the Board adopted the following resolutions :—

(*i*) that the population of the earth is increasing rapidly and is concentrating in large metropolitan areas, and hence that the feeding of these people and providing them with sufficient water of good quality for their social, domestic and industrial needs, presents an eno mous problem,

(*ii*) that a thorough, co-ordinated scientific study of the water resources of the world is essential for this purpose,

(*iii*) that hydrology, the science of the waters of the earth, will have a beneficial impact on the society,

(*iv*) that the occurrence and distribution of water in any country is a consequence of the circulation of water in the whole planet and therefore that water, among all the world's resources, occupies a position especially adaptable to international co-operation.

It was thus recommended .

(*i*) that the Acting Director-General included provisions in the Programme and Budget for 1963-64 to convene an inter-governmental conference to explore the ways in which Member States might co-operate in developing co-ordinated international research and training programmes in the field of scientific hydrology ;

(*ii*) that this conference should be preceded by an inter-governmental preparatory meeting of experts ;

(*iii*) that these meetings should be convened in close consultation with the United Nations, the World Metrological Organization, the Food and Agriculture Organization and other United Nations Specialized Agencies and appropriate international non-governmental scientific organizations, including the International Association of Scientific Hydrology.

A HANDBOOK ON PRACTICAL MICROCLIMATOLOGY

A training course on arid zone microclimatology, organized jointly by the Unesco South Asia Science Co-operation Office and the Pakistan Metrological Service, was held in Quetta from 3rd to 25th August 1959. The course was directed by Dr. S. N. Naqvi, Director, Pakistan Meteorological Service, and Dr. R. O. Slatyer of the Commonwealth Scientific and Industrial Research Organization of Australia.

This course was followed by an essentially similar one for Middle Eastern countries held in Cairo from 5th November to 1st December 1960 and organized jointly by the Unesco Middle East Science Co-operation Office, and the Ministry of Agriculture, United Arab Republic. The course was directed by Mr. I. C. Mellory.

Both courses consisted largely of lectures discussion, and practical work. Since many other workers in these field are unable to attend such courses, Unesco arranged for Dr. Slatyer and Mr. Mellroy to prepare a manual of microclimatology. This volume has now been published under the title Practical Microclimatology with Special Reference to the Water Factor in Soil-Plant-Atmosphere Relationships. It has been prepared and reproduced by CSIRO, Australia and a few copies are available on request from Unesco, Department of Natural Sciences, Place de Fontenoy, Paris-7 (France).

INTERNATIONAL SOIL CONFERENCE.

An International Soil Conference will take place in New Zealand in November 1962. This will discuss Soil Fertility and Plant Nutrition, Soil Genesis, Classfication and Cartography. The conference programme includes meetings, lectures at the Massey Agricultural College, Palmerston North, from 13th to 22nd November and tours of both the North and South Islands from 2nd to 12th November and 23rd November to 1st December. The Advisory Committee of the joint FAO-Unesco World Soil Map Project plans to meet in New-

Zealand at the time of the conference when they will report progress and there will be discussions on the work done. All inquiries concerning the conference should be addressed to the Secretary-General, International, Soil Conference, P.O. Box 8001, Wellington, New Zealand.

DEMINERALIZATION OF SALINE WATER

1. The United Nations is conducting a survey of the potential economic applications of demineralized sea water in representative arid or semi-arid coastal areas of newly developing countries experiencing water shortages. The project is being carried out, with the aid of a Ford Foundation grant, by the United Nations Department of Economic and Social Affairs. A number of consultants will be sent to selected areas on fact-finding missions, and the governments of the areas to be studied will also co-operate in the scheme. An economic analysis of costs, prices and value of water from different sources in the various environments considered will be linked to the possibilities offered by desalinized water, mainly for domestic and industrial use.

2. Two new technical reports of the Office of Saline Water, United States Department of the Interior, have been published by the Office of Technical Services, United States Department of Commerce, Washington 25, D.C., from which office they can be purchased. These are entitled "A New Process for the Production of Fresh Water from Sea water" and "Investigation of Supersaturation in Salt Water Conversion."

3. The European Federation of Chemical Engineering is sponsoring the first European symposium on 'Fresh Water from the Sea', to be held in Athens from 31st May to 3rd June 1962. The themes to be discussed are: evaporation processes; electro-dialitic processes; desalting of brackish water. The lectures will be published in the form of a special pamphlet immediately after the meetings, together with the most important contributions to the discussions. Further information on the symposium will be supplied on request by the Union des Chimistes Hellenes, P.O. Box 1199, Omonoia, Athens, Greece, which is organizing the meeting, or by DECHEMA (Deutsche Gesellschaft fur chemisches Apparatewesen), Frankfurt-am-Main, Federal Republic of Germany.

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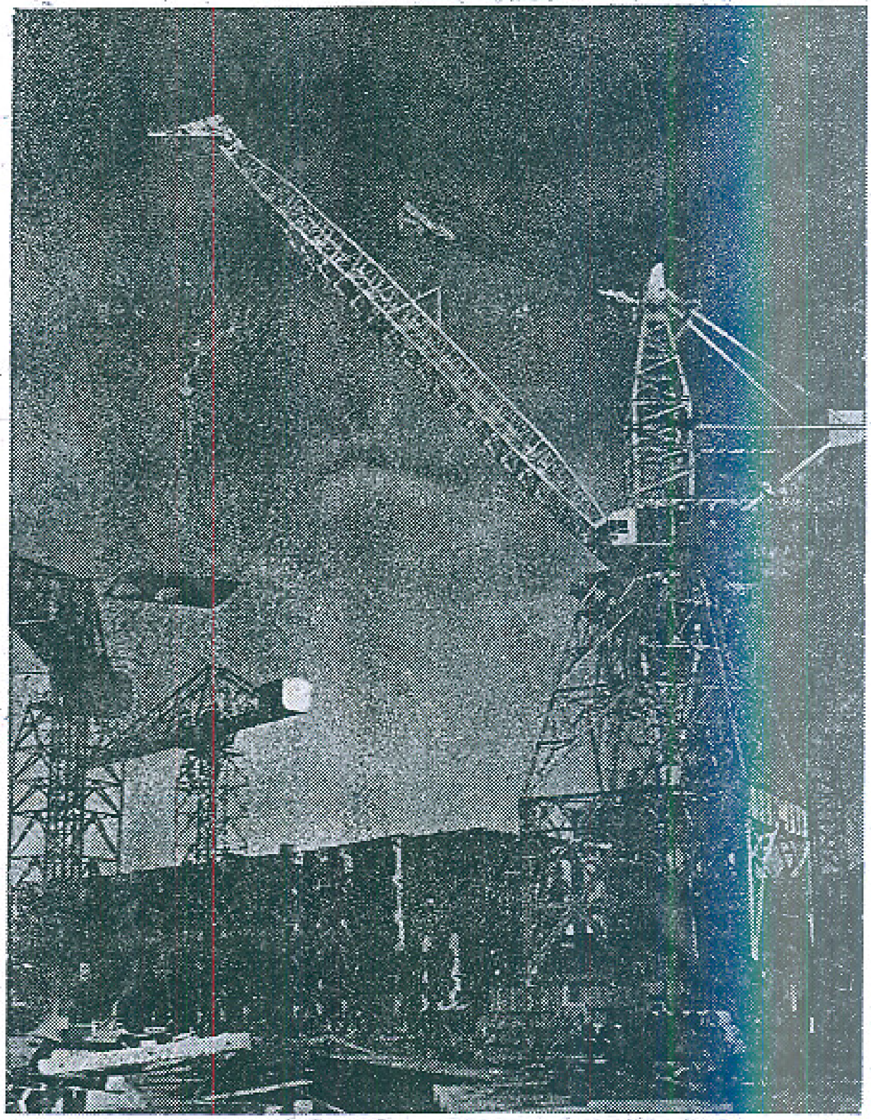

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