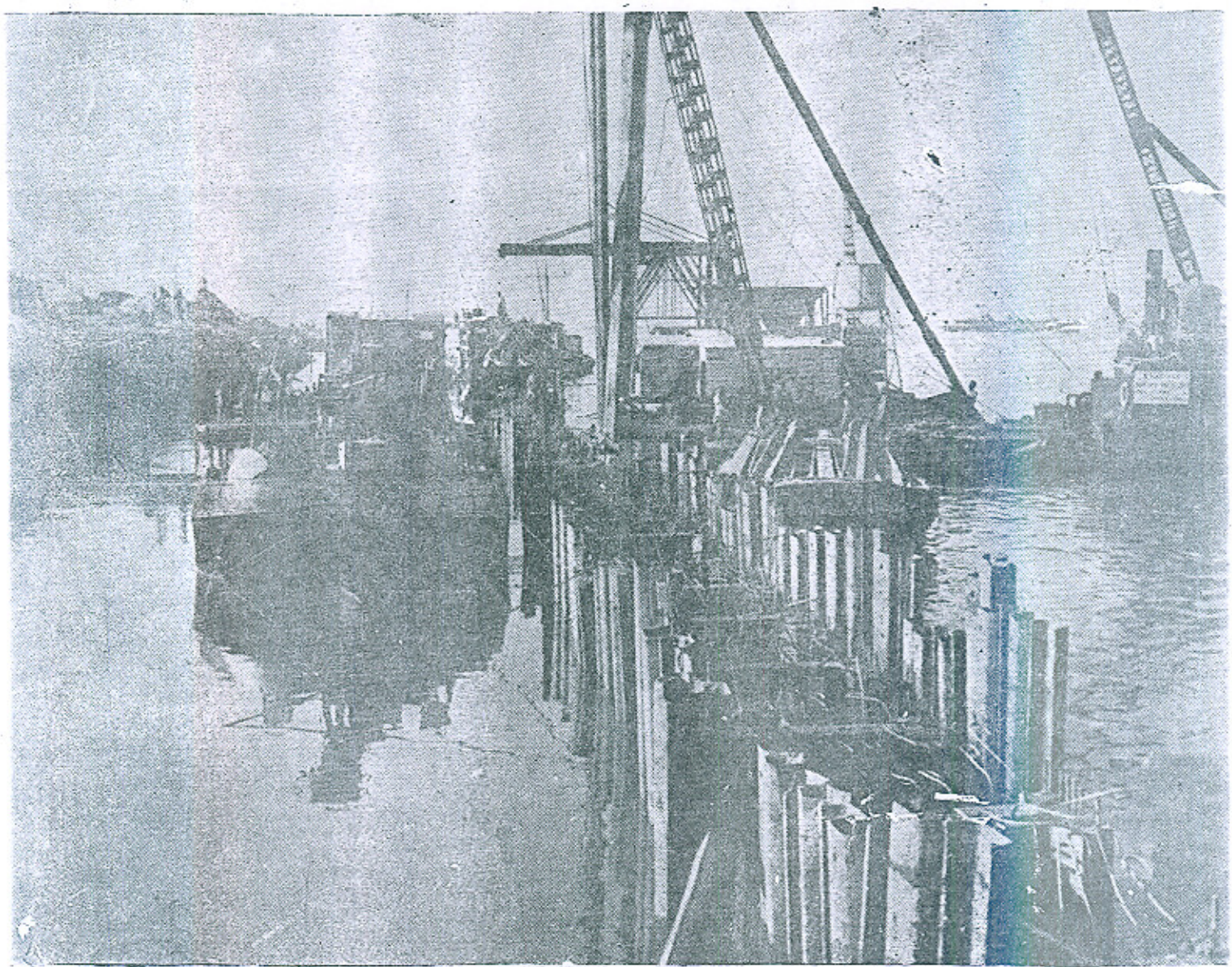
ENGINEERING NEWS

QUARTERLY JOURNAL OF THE WEST PAKISTAN ENGINEERING CONGRESS

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Prestressed concrete piles being installed at East Wharf, Karachi Port.

(FOR ARTICLE SEE PAGE 29)

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ENGINEERING NEWS

Quarterly Journal of the West Pakistan Engineering Congress

CONGRESS NUMBER

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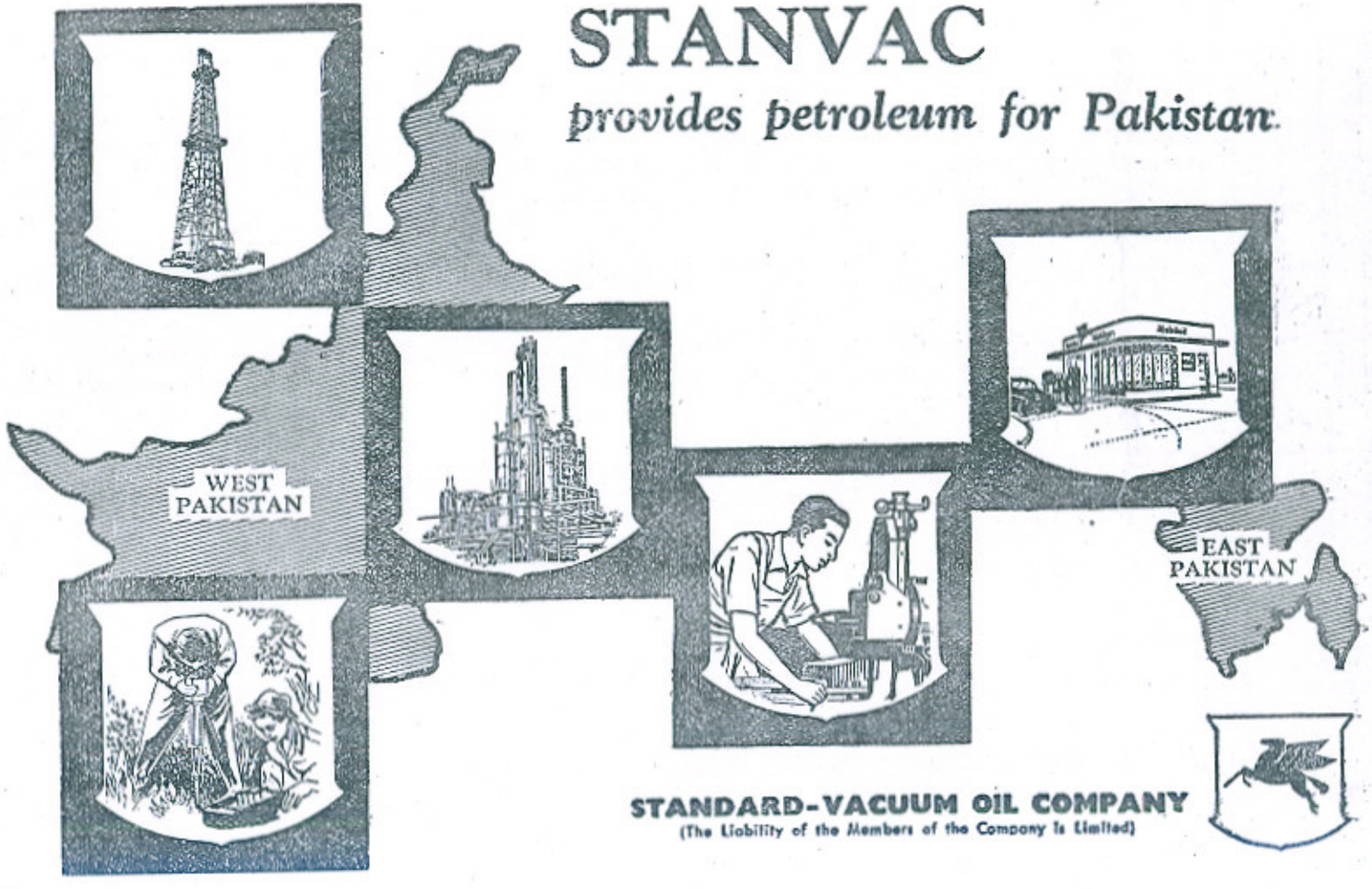
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Editorial

Sardar Majid Ullah, member, West Pakistan Public Service Commission, was voicing the feelings of every body in the country when, inaugurating the 41st session of the West Pakistan Engineering Congress in Lahore on February 14th, he appealed to the engineers to devise ways and means to make the country self-sufficient in food. The need for concerted measures and a well-planned programme for growing more food cannot be too strongly stressed. We fully share the anxiety of Sardar Majid Ullah that Pakistan is spending crores of rupees of foreign exchange on importing food grain into a country which not long ago had a sizeable food surplus.

This year's Engineering Congress was another big stride forward. The membership has risen from 464 to 571 in a year. That the session was very well-attended is in an eloquent proof of the interest our engineers are taking in Congress activities. It is a matter of gratification to find that the office-bearers and members of the Council has left no stone unturned to make this organization a success. The activities of the Council in promoting the engineering knowledge, publishing paper and holding symposium, arranging for visits to engineering works and monthly lectures and meetings, deserves our hearty congratulations.

* * *

The bold and imaginative way in which the Council has attended to the urgent problems of the profession are amply evident from the proceedings of the Congress. In his presidential address to this momentous session of Congress, Chief Engineer, Khan Inam Ullah Khan, has not just put forth the problems our country is beset with. He has in fact thrown a challenge to our youthful engineers to accept and meet it with a spirit of enterprise and mission. Our undeveloped country is not only a challenge to its builders, but it provides them with an opportunity also to come forward and show their mettle. We have every reason to be hopeful that our enterprising engineers will prove equal to the task.

* * *

The canals are not an unmixed blessing. If they have blossomed our wastes, they have given rise to the vexing problem of water logging, thur and sem. The President rightly called for immediate steps to arrest the rise of sub-soil water table which is adversely affecting the entire economy of our country. Crores of rupees of foreign exchange have been utilized in the purchase of food grains and had a fraction of this amount been spent on land improvement and reclamation, the country would have been in a far better condition. The Government had set up a Soil Reclamation Board but so far due to several reasons it has not been able to make any headway. The Government will do a real service to the country by setting up a full-fledged Reclamation Board with complete control over its funds and activities.

* * *

Flood was another item to which the President feelingly referred. The harm that a flood does needs no explaining. The problem of flood control is a most serious one and the President was of the opinion that a self-contained high-powered permanent body be set up to devise ways and means to control the floods. The President suggested that a flood control body be set up for the entire West Pakistan and its chariman

should be a highly technical man with a permanent staff to carry on the work. But the beast of flood can be a boon if properly tamed. It can fill our lands with smiling wheat crops if stored for the "non-rainy days". This brings us to the building of much-needed dams to which the President brought the pointed attention calling for a proper organization to find out dam sites and build reservoirs.

* * *

If we claim that the progress of a country depends to a great extent on its engineering education , we won't be exaggerating. That its standard must be raised is a fair and just demand. True, we have civil, electrical and mechanical engineering upto the degree standard. But is that enough? What about the same standard for chemical, automobile, textile and aeronautical branches of engineering. We agree with the President that degree classes should be opened immediately in our colleges for these subjects and M.E. and even higher doctrate facilities may be made available in the subjects of civil, mechanical and electrical engineering.

* * *

Speaking of research, the President paid a high tribute to the Irrigation Research Institute, and the useful work it is doing. We, however, agree with the President's plea to reinforce this useful Institution with more funds and staff. We whole-heartedly support the suggestion of the President for raising the standard of engineering education and expansion of the Irrigation Research Institute.

The general meeting of the Congress also discussed the condition of the temporary engineers. We perfectly agree with the members in bringing the attention of the Government to the sad plight of temporary engineers. Can a department work efficiently and with confidence when 75 percent of its staff consists of temporary hands. The resolution of the temporary engineers calling upon the Government to stop direct recuritment to the permanent posts seems to be quite reasonable. These demands cannot be stressed too strongly.

* * *

How alive the engineers are to the basic needs of the country was amply evident from the topic of housing selected for symposium that was held during the session. The fast growing population and the concentration of the people in industrial areas spotlights the need for a full-fledged housing programme. There are many who cannot even dream of a house of their own and for whom the Government will have to make a move. But what about those who can afford to build. They are equally helpless and without resources. The building material is not easy to come by and that too at prohibitive prices. As a way out of of the impasse, the papers read in the symposium called for research to find out alternate materials. Some of them suggested building upwards to economise space. The articles read in the symposium were of a high order and provided food for thought. They also provided a valuable data that can be a basis for various development projects.

ENGINEERING CONGRESS SESSION

This year the Congress session was full of many interesting features. The Congress was inaugurated by Sardar Majid Ullah, Member, Public Service Commission, and was addressed by Khan Inam Ullah Khan, President of the Congress. The address of the President was followed by the speech of Sardar Majid Ullah who put forth many useful practical suggestions to the Congress. We have reproduced in this Volume, addresses of both Sardar Majid Ullah and Khan Inam Ullah Khan.

INAUGURATING the Session, Sardar Majid Ullah said : the engineers, in co-operation with the agricultural experts, have to play a great part as unless available water supply was properly organised and carefully used there was very little scope of achieving the objective.

Mr. Majidullah said Pakistan was spending crores of rupees annually on the import of foodgrains and it was something for which the Pakistanis should hang their heads in shame, specially as not so long ago Pakistan had a sizeable food surplus. During World War II the 'Grow More Food Campaign' had received an immense impetus and it was towards the later part of the war that a claim was made that the Punjab was growing enough foodgrains to feed the entire Indian army at war footing for several years.

Proceeding Mr. Majidullah said it was most shameful that in spite of the fact that the quality of seed had greatly improved and the improved variety gave a higher yield per acre and provided greater immunity against disease, the net result had not been very satisfactory and the overall production was going down from year to year.

He said the engineers, must realise that prevention of cultivable areas from further deterioration and provision of security to the country from the ravages of floods were not the only problems confronting the country as equally important and one of the most pressing need was to increase the country's food production.

TRANSPORT

Sardar Majidullah also appealed to the engineers to associate themselves more closely with the motor transport.

"The world trend is towards larger and heavier vehicles and the road engineer should acquaint himself with these requirements in order to design roads, bridges and associated works to take the heavier load. Similarly the vehicle design during the last four or five years, has undergone a radical change.

"In order to provide greater pay load, the seating capacity of the vehicles is being enlarged and lighter alloys are being used in the construction of vehicles bodies to keep the maximum laden weight within the legal limits. There is also a trend towards making greater use of trailers, both for carrying passengers as well as load.

"Very comfortable vehicles are plying on roads in Europe, showing a great ingenuity in design with excellent workmanship. If we have to lower the transportation costs, we must keep abreast with the world trend and design, and unless the engineer takes greatest interest the progress would necessarily be slow."

MOTOR FUEL

Continuing he said: "We have been very slow in the change-over from petrol to diesel and have, therefore, lost lakhs of rupees on foreign exchange. Similarly in view of our resources of natural gas, experiments are required for adopting it for use as a motor fuel.

"In some parts of Europe and America natural gases are being used as fuel for propulsion of motor vehicles. There is on reason why we should not succeed and this would open a new era for us as cheaper transport is the key to reducing cost of living as it has a direct impact on the prices of nearly everything of daily use."

FLOOD CONTROL

Sardar Majidullah was in favour of a proposal made by the President of the Congress, Khan Mohammad Inamullah Khan, that a high-powered board, armed with necessary powers and backed with adequate finances, be created for executing schemes for controlling the floods.

He added that it would go a long way towards providing security against the ravages caused by floods: "It is only the concerted efforts and co-operation that a task of such magnitude can be adequately accomplished."



Sardar Majid Ullah addressing the Engineering Congress members.

Mr. Majidullah stressed the need of imparting practical training to the students in the colleges. Practical training on works during vacation should be made compulsory and adequate arrangements should be made for a systematized training in which the engineers' knowledge of practical training, already received, was fully made use of, he said.

He deplored the fact that the staff of the most of the engineering colleges was below its reqiured strength and that the laboratories of the colleges were poorly equipped and there were no arrangements for research work.

He said he would not be disclosing any secret of the Public Service Commission that the Commission found it most difficult to attract suitable candidates for both the high er and lower posts in these colleges.

PRESIDENTIAL ADDRESS

Mr. Inamullah Khan, Chief Engineer (B. & R.) in his presidential address said: Independence has brought in its wake some very serious problems to be tackled and to be

tackled immediately. I want to bring these to the notice of the brother engineers, the scientists, the public and the Government for their immediate solution.

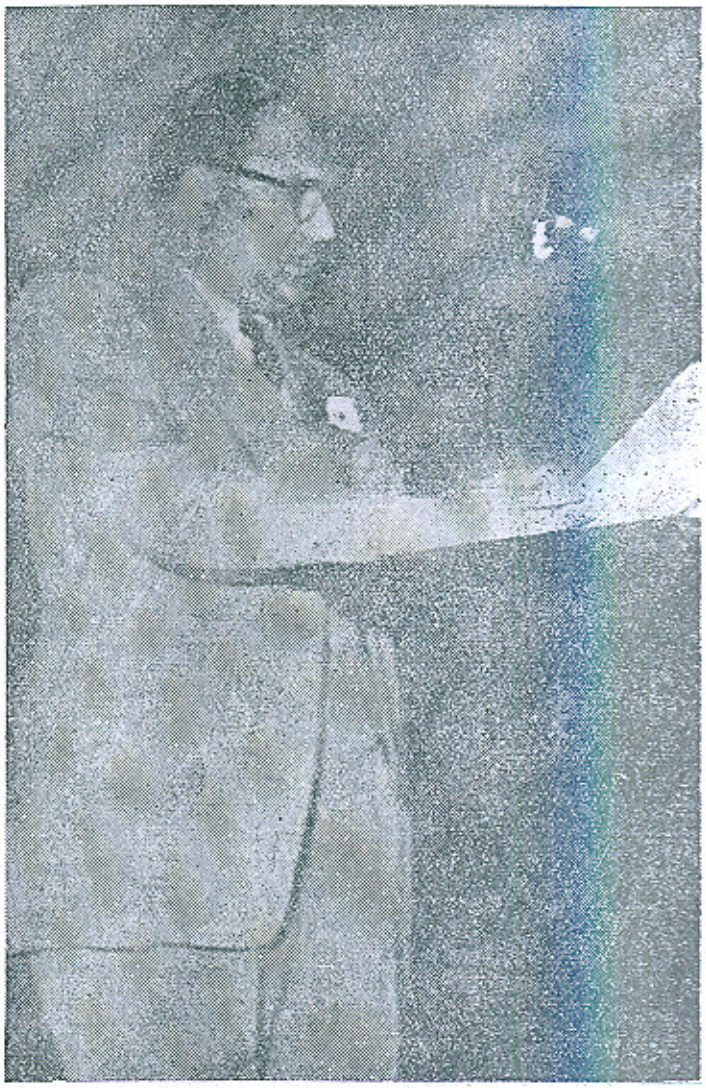
After the formation of West Pakistan in 1955, I had the opportunity to go to districts of Larkana, Dadu, Sukkur, Hyderabad and Khairpur of southern West Pakistan. I was surprised to find that in these districts the water level has risen considerably after the formation of Sukkur Barrage in 1931. The same has happened in the districts of Lyallpur, Sargodha, Sialkot and Sheikhupura and the central West Pakistan. It was with the rise of water table, that the soil has thrown up salts rendering a very big area of the culturable land unfit for cultivation. The rise in water table has made the metalled roads in this area bumpy. It was also observed that some of the roads have become so bad that it will be necessary to rebuild them at a colossal cost.

The land is fast becoming unculturable due to rise in sub-soil water table. If no immediate steps are taken to arrest it, the rise of sub-soil water table will severely and adversely affect the entire economy of our country. Our country is already deficient in food, Crores of rupees worth of foreign exchange have been utilised in this and previous years in the purchase of food grains. If part of foreign exchange had been utilised in research as to how to combat this problem, the results would have been different.

The solution of this problem requires experience and continuous research and experiments. This cannot be tackled by the existing departments of the Government, who are already too over worked. The Government of the former Punjab had set up a Reclamation Board, but I am afraid it has not been able to produce much results due to one cause or the other. The only way to produce results is to set up a permanent autonomous body with its own funds, with highly specialised scientific and technical staff under a very highpowered technical chairman. This body should have complete control over it own funds and over its own activities.

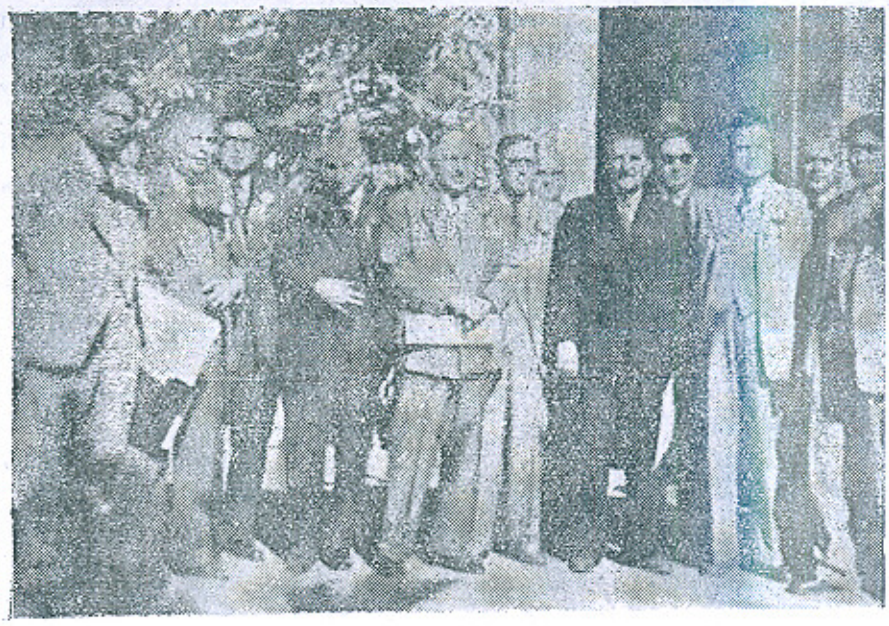
FLOOD CONTROL

The floods have become a yearly event with us, since the dawn of independence, whereas before this they were far and few. The record flood prior to 1947 was in 1929. Since the dawn of independence, we had the first



Khan Inamullah Khan delivering his Presidential address.

flood in the year of independence, when the Ravi and Sutlej were in record flood. In the year 1948, Rivers Jhelum and Chenab were in high floods. In 1950, Sutlej, Ravi and Chenab had high floods. These were followed by high floods practically every year and the last year was no exception to it. These floods do great harm to our irrigation and communication systems and require colossal amount of money to repair the damage done.



Members of the Council with Sardar Majid Ullah.

The former Punjab Government had a part-time Flood Relief Commissioner of the rank of Financial Commissioner to tackle this problem. As the name shows his job was to give relief to flood stricken people and works. This system has been carried out even after integration of the province. This officer, being part-time, has limited powers and time. The result has been that nothing tangible has been done to control the floods.

Similarly, I understand that former Sind Government had an organisation which tackled the flood problems.

It was also heard that the Central Government was going to set up a high-powered Flood Control Board, but nothing material has come to notice yet.

This problem of flood control is very serious and in my opinion the only way to tackle it is that a self-contained high-powered permanent body be set up to devise ways and means to control the floods. This body should be self-contained and autonomous, with its own funds and own chairman and a panel of highly specialised staff. It will be futile to expect this body to produce any results immediately. Its task will be long and arduous in the shape of collecting data and devising ways and means for controlling the floods.

The Government of Pakistan set up a Flood Commission in 1950. This Commission submitted its report. The report being secret, the public does not know much about it. If it is desired to produce results in this direction, this flood control body should be a permanent institution for the entire West Pakistan and its chairman should be a highly technical man and should have permanent staff to carry on the work. I understand similar bodies exist in other countries affected by floods.

CONSERVATION OF FLOOD SUPPLIES IN STORAGE WORK

After the completion of Taunsa and Gudu Barrages, the normal flow of all the rivers (with the exception of excess flow of brief flood period) will be utilised by the various barrages. But the flow water of the rivers is insufficient for meeting the Rabi requirements of irrigation system already planned, not to speak of any future development. For the fast increasing population of in West Pakistan, the production of wheat has

to be increased. This will require additional water during Rabi, which is not available from the flow supplies of the rivers. The only way to get it is to store the flood water during rainy season and utilise it during winter. For this purpose it is high time that the Government started a proper organisation for detailed and thorough investigations of dam sites over selected rivers and built reservoirs in West Pakistan.

FOOD CROP MATURING IN 60 TO 70 DAYS

Due to India's action on our eastern tributaries of Indus River viz. Ravi, Sutlej and Beas, sufficient water is not and will not (when Bhakra Dam is completed and start functioning) be available for Kharif crop. In normal year there is sufficient water available for a period of 60 to 70 days in Kharif season. Pakistanis should, a living nation, make research and produce some food crop which can mature in 60 to 70 days, so that our lands should grow this and overcome food shortage to some extent.

ENGINEERING EDUCATION

In a backward and developing country like ours, it is essential that the standard of engineering education in our engineering colleges be raised and arrangements made for the training of engineers in more subjects than being done at present. At present we can only produce Civil, Electrical and Mechanical Engineers upto Degree standard. The Degree classes in Mining Engineering have been started at Government College of Engineering and Technology, Lahore and the first batch will be due for the degree in 1957. There is no arrangement for training of Chemical Engineers. Automobile Engineers, Textile Engineers, Aeronautic Engineers, in West Pakistan. It is essential that Degree classes in these be opened in our Engineering colleges immediately. It is also essential that M. Sc. classes in Civil, Electrical and Mechanical Engineering should also be started as early as possible, so that we may be able to produce engineers of higher standard to serve the needs of the country.

No country in the world can progress without research. In other countries the amonnt spent on research is colossal and this is why these countries are progressing. In our country we have a Research Institute for Irrigation. This used to be and is still the best in this part of the country, but it is not enough. It should be reinforced with more funds and staff.

Ours is basically an agricultural country. The canals have been and are being constructed to irrigate the barren areas. With the irrigation and cultivation of an area, so many allied problems arise in due course.

SUB-SOIL WATER

When the thirst of the mother earth is quenched the subsoil water starts rising, throwing out salts and making the land unfit for use. This needs measures to check the rise in subsoil water level which are costly and must be taken up at the proper time, so that no land is made unculturable and no road made unserviceable. Again the coordination in the construction of sources of water supply, i.e. barrages, and weirs or storage tanks with the construction of service lines, i.e. canal irrigation channels should be such that all should be completed simultaneously; so that water starts flowing immediately. In a multiple project delivery of water for irrigation and generation of electricity and the construction of electric generation machinery, transmission lines, distribution lines and the distribution system should be so arranged that all work at the proper time and no benefit or return of the money is delayed a minute more than is necessary.

It is seen that in some projects completed in this country the projects have given irrigation water, communication, etc., but no provision exists for anti-subsoil water table rising and activities for reclamation of the land. The result is that no funds are available for this costly item and people are suffering. Again if a barrage is completed the completion of the canal and irrigation channels have been delayed. Again in some projects no provision exists for communications, for providing shelter for new settlers,

for providing seeds, implements, etc. so very necessary for a new settler, for medical facilities, for marketing facilities, etc. The result is that provision of these is delayed.

The only way, in my opinion, to properly and quickly develop a new area is that as soon as Government decides to develop a new area by providing a barrage or storage reservoir, an authority be set up with whole-time members and their ownstaff. This authority should be an autonomous body with its own funds and responsible to render accounts to the Government for the funds alone. This authority should be responsible for construction of the barrages, reservoirs, canals, irrigation channels, communications, for settling people on the land, for medical facilities, for providing building for law and order, for providing building for all departments required, for the area, for research in agriculture, for supply of electricity, for anti-sub-soil water table rising measures, etc. In fact this authority should convert a barren tract into a fertile area with all modern facilities. This authority should estimate the cost of all works to be done in this area and divide it over the land to be benefited. This should and is known as betterment tax. This betterment tax be paid back in 20 years or so by the owners of the land along with the land revenue.

LOAN FOR AUTHORITY

The authority should be given loan to start the work and as the time goes on they will be getting their own income and completing their project. It should be left to the authority as to how and from where they should get work done. They may employ Government departments or get it done from firms or create their own agencies. The members should have long terms of employment to be removed only in case of serious breach of trust. This is the only way to develop the area properly and quickly. This system has been tried in other countries and those of us who have been to the United States have seen an example of it in Tannesse Valley Authority known as T.V.A. This authority has produced wonders in a short time and in my opinion, this is the only way to develop a barren area quickly and economically. I appeal to those in power to try this method in one of the new areas which are being developed in West Pakistan.

REVIEW OF WORKS

It has been customary to review the work done by the different branches of engineering in the Province in the Presidential address, but I have already taken plenty of your time, so I will in brief touch on these for your information.

At the dawn of independence there were only 4,982 miles of metalled roads in the Province of West Pakistan after 100 years of foreign rule. During the first 9 years of independence, we have added 2,904 miles of metalled roads in this area, bringing the total to 7,886 miles. This amounts to an increase of 58 per cent over figures of pre-independence period. The roads, as they are, have a wide scope of improvement. The first 5-Year Plan provides for 2,024 miles of new roads and 2,833 miles of improvement to the existing roads. When these are completed, it will greatly improve the roads position in West Pakistan.

This department has also completed the development of about 20 satellite towns in the Province. Besides the above, there is a heavy building construction programme in hand. In Lahore alone the department has completed buildings costing about Rs.1 . 3 crores this year.

The irrigation department has completed the construction of big Marala Ravi link and opened it in Kharif of 1956.

BARRAGES

The work on three major life giving projects viz. Taunsa, Ghulam Muhammad and Gudu Barrages is in progress. The work on multiple project of Kurram Garhi has also made good progress during the year. Besides the above, the work is in progress on other small projects.

In West Pakistan, there are at present 3 major hydro-electric power stations, Viz. 2



CONGRESS IN SESSION

at Malakand and one at Rasul besides a number of thermal stations at Lyallpur, Lahore, etc. The peak requirements of Lyallpur and Lahore thermal stations are more than the hydel surplus. The thermal stations have been connected up with the hydel system and all the surplus in hydel system has been utilised in the thermal area thus making a saving of Rs. 40 lakh in foreign exchange in the purchase of coal.

There is great shortage of power in the Province. To relieve this, Montgomery Thermal Grid has been connected with Hydel Grid by constructing 80 miles of 66 KV line from Okara to Lahore in a short period of 3 months. This will enable the utilisation of the whole generating capacity of Montgomery Steam Station, commissioned in 1955, thereby avoiding shedding of industrial load during winter months.

The 132 KV grid sub-station at Rawalpindi, Wah, 66 KV grid station at Montgomery Arifwala, etc., have been constructed and operated during the year.

The new steam station at Lyallpur with installed capacity of 14,000 KV has been brought into operation in December last year.

The construction work on various hydel schemes at Chichoki Malian, Gujranwala and Kurram Garhi has progressed a good deal. The work of constructing upper grid to connect Warsak and Multan Power Stations to utlize the energy available has been started this year.

RAILWAY ENGINEERING

In order to conserve foreign exchange and to provide more employment in the country, the N.W.R. has decided to build 162 passenger carriages in their workshops at Moghalpura on under-carriages imported from abroad. Out of it, 51 have been placed on line. The N.W.R. has also decided to build 25 cold storage cans and 2 air-conditioned saloons in their workshop at Moghalpura. Twenty-six open type wagons have also been built in the same workshops and more are being built. This will greatly ease the position of wagons and carriages in this country in due course.

In order to overcome the shortage of timber for the railway sleepers, the N.W.R. has evolved a suitable modern design of rigid type of sleepers. The beginning has been made and it is hoped to set up a factory which will manufacture about one lakh concrete sleepers per year.

One hundred and seventy-nine miles of track on the main line and 35 miles on the branch line consisting of old and worn out rails and sleepers were replaced with new rails and sleepers.

DEPARTMENTAL REORGANISATION

For over hundred years the Public Works Department engineers were their own policy-makers in their own departments in the area now known as West Pakistan. This system was examined for over a dozen times during this period. The last time it was examined, by the Punjab (Pakistan) Government in 1954. The decision every time was in favour of this system.

Even in the United Kingdom the Ministers are called Secretaries and the Heads of the official organisations known as permanent Under-Secretaries are always the most senior members of the services. The Minister is responsible to the Legislature and the country both for policy execution and this responsibility must be discharged at official level by the Secretary, who is next to him in the administrative organisation. In all progressive countries the technical personnel are responsible both for policy and execution.

This system, which has prevailed in this area for over 100 years has been changed recently. This instead of adding to the efficiency and expediency of the functions of these departments, has made them go slowly and has a dampening effect on the spirit of engineering personnel. It is time it was reconsidered and the Engineering personnel incharge of execution associated with policy making.

In order that an engineer should be able to deliver the goods, which are so essential to the development of the country, it is essential that his status and pay should not be less than anyone else. In the development of a welfare State,technical personnel plays more part than anyone else. Unless right type of men are attracted to the technical side, it will not be possible to develop our country. The only way to do it is that the status and pay of technical services should not be less than anyone else. Recently certain things have happened, which have placed engineers inferior in status to others; whereas in the British raj, which was not a welfare State raj, the engineer was not below any one in status. In order to allow the engineer to take equal part in the development of his country, these anomalies should be removed—sooner the better.

INDIA DECIDES TO BUILD NAGARJUNA SAGAR DAM IN RUBBLE MASONRY

In backing construction of $157.5 million multipurpose project of Nagarjuna Sagar Dam, the Indian Central Water and Power Commission has overruled the suggestion of Mr. Harvey Slocum, Superintendent, Bhakra-Nangal Project, to construct a concrete dam by importing 1,200 skilled workers from the U.S.

In the construction scheme now planned cement mortar with a 1 : 4 ratio will serve as the binding agent where principle compressive stress does not exceed 15 ton per sq. ft. On the dam's upstream face, a richer mixture about 1 : 3 to insure water-tightness will be applied even though the stress be less than 15 tons per sq ft. Where stress is between 15 to 20 tons per sq. ft. Rubble masonry with a 1: 3mortar will be employed. Stresses over 20 tons will require the use of monolithic concrete construction to insure adequate safety factor.

The design staff of the Central Water & Power Commission has yet to establish the thickness of the high abrasion concrete to be placed on the face of the dam's spillway. Mechanical equipment will be used for batching, mixing and transporting the concrete, which will contain an air-entraining agent to reduce water content.

The overall Nagarjuna Sagar picture—involving 410 miles of canals and power-house works—will have an estimated ultimate completion cost of $244 million. When finished, about 1965, its 9.3 million acre ft., reservoir will help to irrigate 3.2 million acres.

BRIEF ACTIVITIES OF THE COUNCIL DURING THE YEAR 1956-57

WE have reproduced brief account of the activities of the outgoing council in the pervious issue of the Engineering News. In his annual report, the Secretary referred to a few interesting features which we have reproduced below :—

During the year 1956, the Council held 16 meetings in which the budget for the congress as well as the Engineering News was discussed and approved. Arrangement for a monthly meeting of the members at Lahore was made and seven well-attended meetings were held during the session at which expert both foreign and local, gave useful talk on engineering subjects.

The Council has arranged for a temporary head-quarter in Nedous Hotel where the members can hold meeting, arrange social gatherings. Arrangements are being made for a good reading room and a library. The council has also tried its best to collect the unpaid subscriptions from the members.

During the year two sub-committees were formed consisting of Messers S. A. Rahim (convener), Saeed Ahmad and A. A. Jamal-ud-din for approaching the Government for exemption of one house per family for income tax, property tax and house tax and another committee consisting of Qazi Zahur Hussain (Chairman), Kh. Abdul Ghafoor, Mian Abdul Aziz, Mr. R.F.T. Farrant & Syed Nazir Ali Shah was set up for the establishment of an Engineering Acadamy for training young engineers.

During the tenure of this council, one hundred and three new members were enrolled bringing the total membership on December 31, 1956 to 571.

The closing balance in December 1955, was Rs. 19,568/8/3 and inspite of several new activities of the Congress, during the year 1956 the closing balance stood at 19,587/6/9.

The Congress Medal for the year 1956 was awarded to Dr. Mushtaq Ahmad of the Irrigation Research Institute, Lahore.

The Council gave special consideration to the advancement of engineering knowledge so that out of 11 technical papers submitted for printing, five were selected and printed for discussion in 1957 Congress session. An important feature of this year's meeting was a symposium on housing problems of West Pakistan. We have reproduced in this volume a brief list of the papers as well as that of symposium.

An important item of this year's session was a visit to engineering works in Lahore and Karachi and a brief account of the site visited is given elsewhere.

THE OUTGOING COUNCIL

The following members served as office-bearers and Council members during the year 1956-57.

President :—Khan Muhammad Inamullah Khan, I.S.E., Chief Engineer, B & R. Department, West Pakistan.

Vice-Presidents.—(1) Mr. M. M. Zubair, Chief Engineer, N.W.R. Lahore
(2) Mr. Mir Bashir Khan Addl. Chief Engineer, I. B. Lahore.

Honorary Treasurer. Dr. Mustaq Ahmad, Hydraulic Officer, Irrigation Research Institute, Lahore.

Honorary Business Manager.—S. Mehdi Shah, P.S.E.I. Executive Engineer, Construction Division, B & R Branch, Lahore.

Honorary Auditor.—Mr. S. A. Rahim, Town Planner, Lahore Improvement Trust, Lahore.

MEMBERS

1. Mr. Abdul Aziz, M.B.E., P.S.E.I, Addl. Chief Engineer, B & R. Central Zone, Lahore.
2. Mr. A. M. Malik, M.B.E., P.S E.I., Addl. Chief Engineer, B & R. Branch, Bahawalpur.
3. Mr. M. S. Toori, P.S.E.I., Superintending Engineer, Provincial Circle, Multan.
4. Sh. Irshad Ahmed, P.S.E.I., Executive Engineer, Shadiwal Hydel Division, Gujrat.
5. Mr. I. A. Zafar, P.R.S.E., Assistant Chief, Planning Board, Karachi.
6. Mr. Saeed Ahmed, P.S.E.I., Superintending Engineering, Lahore Provincial Circle, B & R Branch, Lahore.
7. Mr. A. A. Jamal-ud-Din, P.S.E.I., S.E. Rehabilitation Circle, Lahore.
8. Mian Muzaffar Ahmad, Director Irrigation Research Institute, Lahore.
9. Mr. H. J. Asar, P.S.E.I., S.E., Project Circle, Lahore.
10. S. Allah Bakhsh, P.S.E.I., S.E., L.C. West Circle, Lyallpur.
11. Mr. Muhammad Ahmad, S.E., L.C. East Circle, Lyallpur.
12. Mr. S. A. Haque, S.E. 3rd Circle Electricity Branch, Gujrat.
13. Mr. B. A. Malik P.S.E.I., Asst. Director, Admn. B & R Lahore.

CO-OPTED BY THE COUNCIL

1. Mr. A.R. Qureshi, P.S.E.I., S.E. Provincial Circle, B & R, Lyallpur. (Hony. Publicity Secretary).
2. Ch. Abdul Hamid, P.S.E.I., S.E. Dams Investigation Circle, Lahore (Hony. Editor-in-Chief).
3. S. Nazir Ali Shah P.S.E.I., S.E. Electricity Branch, Lahore.
4. Mr. A.M. Soomro, P.S.E. II, Chief Design Officer, Hyderabad Region, Hyderabad.
5. Dr. Nazir Ahmed, Physicist, I.R.I. Lahore.

THE NEW COUNCIL

1. Mr. M.M. Zubair, C.E. (N.W.R.), Lahore—President.
2. Mr. Ghulam Sadiq Khan, C.E. (Electricity), Peshawar, Vice President.
3. Khan Mir Bashar Khan, A.C.E. (Irrigation), Lahore.—Vice President.
4. Mr. A.M. Malik, A.C.E. B & R, Bahawalpur, Vice President.
5. Mr. A. H. Qureshi, Director, Works (GHQ) Rawalpindi.—Vice President.
6. Mr. S. A. Rahim, Town Planner, (L.I.T.,) Lahore.—Vice President.
7. Dr. Mushtaq Ahmed, Hydraulic Officer, (I.R.I.) Lahore—Hony. Treasurer.
8. Mr. Mehdi Shah, XEN, Construction Div., (B & R,) Lahore—Hony. Business Manager.
9. Mr. A.R. Qureshi S.E. Lahore Prov. Circle, (B & R). Lahore,—Hony. Auditor.
10. Khan Muhammad Inamullah Khan, C. E. (West Pakistan B & R), Lahore (Ex-Offico.)
11. Mian Abdul Aziz, A.C.E. (B&R), Lahore.
12. Mr. A.G. Sheikh A.C.E. (Southern Zone, B&R), Karachi.
13. Khan Sarwar Jan Khan, D.C.E. (Irrigation) Peshawar.
14. Mr. A. A. Jamal-ud-Din, S.E. (Rehabilitation Circle, B & R.), Lahore.

15. Mr. A. R. Zubair, S.E. (Rawalpindi Provl. Circle, B&R), Rawalpindi.

16. Mr. Sayyid Hamid, Director Ground Water Development Organisation, Lahore.

17. Mr. H. J. Asar, S.E. Project Circle, Lahore.

18. Mr. Ikram Ullah Khan, S.E. (B&R) Bahawalpur.

19. Sardar Allah Bakhsh, S.E. L.C.W. Circle, Lyallpur.

20. Mr. M. A. Wahidi, Divisional Engineer, (NWR), Karachi.

21. Mr. S.M. Ayoob, Technical Officer, (Lahore Region, Lahore.)

22. Mr. Saeed Ahmed Khan D.C.E. (B&R) Quetta.

23. Ch. Abdul Hamid, S.E. (Dams Investigation Circle,) Lahore, Ex-Offico.

RECENT PAPERS OF ENGINEERING INTEREST

HYDRAULICS AND HYDRODYNAMICS

1. A probability theory of Dam and storage system modification of the release rule, by Mr. Moran P.A.P. Aus, Jm. of App. Science Vol. 6. No. 2 Jan. 1955.
2. Boysen Dam Diversion and outlet works, by Mr. Whennerah R.W. Pro, Am. Soc. C.E. Vol. 81, March, 1955.
3. Stabilizing the Mississippi Banks with articulated concrete mattress, by Mr. Coodrum, John World Const, Vol. 8, No. 3 1955.
4. The refacing of four concrete dams with gunite, by Mr. Ternan W.G.M. Water and water power Eng, Vol. 60, No. 719 July, 1956.
5. The raising and strengthening of steenbaas dam, by Mr. Morris S.S. and Garrett W.S. P. Int. of C.E. Vol. 5, No. 1 1956.
6. Pore pressure and shear strength tests on earth dam materials by Mr. Watt A.J. Newzealand Engineering Vol. 10. No. 11 Nov, 1956.
7. Protective systems for seepage control in earth dams, by Mr. Hosking A.D. Newzealand Engineering Vol. 10. No. 11, Nov. 1956.
8. Flow of water through rock fill and its application to the design of dams, by Mr. Wilking J. K. Newzealand Eng. Vol, 10 No. 11, Nov, 1956.
9. Soil permeability determinations carried out for the river Mourne hydro-electric project, with particular reference to a discharging well test, by Mr. Gosschalk E.M. Proc. Int. C.E. Vol. 4, No. 3, Dec. 1955.
10. Hydraulic model performance of spillway and outlet works Peligre dam, by Messrs, Harleman D.R.F. Gooch R.S. Vulgaropulos A.A. Mass, Int. of Tech. and Lab. Tech Report No. 17, Ap. 1955.
11. Installation and operation of piezo-meter system in Cobb earth dam, by Mr. Burt E.J. Newzealand Eng. Vol. 10.
12. Construction pore pressure in the Cobb Earth Dam, by Mr, Collins N.W. Newzealand Eng. Vol, 10.
13. Recent progress in theoretical studies on the behaviour of ships in a seaway, by Mr. Weinblum Georg P. Eup. Ship-building Vol. 3, No. 4, 1954.
14. The seasonal oscillation in sea level, by Messrs Pattulo June, Munk Walter, Revelle Roger and Strong Elizabeth. Jour. Marine Res. Vol. 14 No. 1, 1955.
15. Current measuring in shallow Waters by towed electrodes, by Mr. Vaux David Jour, Marine Res. Vol. 14 No, 2, 1955.
16. Critical flow meter, by Mr. Ballofet A. Pro. Am. Soc. of C.E. Vol. 81, 1955.

THE WEST PAKISTAN ENGINEERING CONGRESS, AN INTRODUCTION.

THE West Pakistan Engineering Congress was established as the Punjab Engineering Congress in 1912 to promote engineering science and knowledge by reading papers, holding sympsoium and visit to important engineering works. During the last 40 years it has faithfully promoted its moto of Progress and Prosperity. Its 41st meeting was held on 14th February, 1957.

Every year, the Congress President, who usually is an eminent engineer, addresses the members on important engineering problems in hand, and papers are read and discussed in the session. So far, the Congress has discussed 328 papers on various subjects shown in the list on next page. An index of subjects together with the numbers of the papers is listed separately.

In order to encourage research, the Congress awards medals for the best papers of the year. Such papers are marked with *M* in the list of Congress publications.

KENNEDY Medal, is awarded to the best paper on any of the following subjects :

1. (a) the distribution of the water for irrigation.
   (b) the condition and flow of sub-soil water with its connected problems of seepage.
   (c) the flow of water, the transportation of silt by currents of water, and the prevention of silting of irrigation canals.
   (d) and generally any kind of research leading to conservation of water for irrigation or the improvement of canal system and remedy of harmful effects of irrigation.

2. The competitions are open to all domiciled engineers, retired or in service, official or private.

3. The paper submitted for competition must have been published in some engineering or scientific journal or read at some such society, conference, congress, or institution before the closing date of the competition.

4. The committee has the absolute power to admit the papers for competition and to award the medal.

5. The competition is held annually provided sufficient number of entries are received. Entries are received upto October 1, of each year.

6. Papers for the competition and correspondence are addressed to the Hon. Secretary, Kennedy Medal Fund, Public Works Department, Irrigation Branch Secretariat, Lahore.

This medal has so far been awarded to the following persons :—

1918 Mrs. Kennedy (complimentary).

1924 Mr. F. H. Burkit.

1928 Sh. Minhaj-ud-Din for his paper on "Bend Outlets".

1930 Mr. Gerald Lacy for his paper on "Design of Channels".

1933 Mr. A. N. Khosla for his paper on "Pressure pipe observations at Panjnad Weir".

1936 Mr. M. Montagu for his paper on "Fluming".

1940 Mr. R.B., A. N. Khosla for his paper on "Design of Weir on Permeable foundations".

1943 Mr. S. I. Mahbub for his paper on "Lining of Channels".

1944 Messrs. S. I. Mahbub and N. D. Gulhati for their Paper on "Irrigation Outlets".

The Pakistan Industrial Development Corporation, Karachi, have also donated a gold medal, known as "Pakistan Industrial Development Corporation Gold Medal".

(i) The medal will be available for award annually for the best paper on "Engineering aspects of industry", read in the annual session of the Punjab Engineering Congress.

(ii) The competition is open to all members of the Punjab Engineering Congress.

(iii) No paper previously published will be considered for the competition.

(iv) The Council of the Punjab Engineering Congress shall have the absolute power to admit a paper for competition, and to award the medal or not.

(v) The papers and the correspondence shall be addressed to the Honorary Secretary, Punjab Engineering Congress, Lahore.

The award so far has been made in 1952 to Mr. I. A. Zafar, I.R.S.E. for his paper on "Engineering Planning for Industrial Development in Pakistan".

ENGINEERING NEWS

BRITAIN'S POST-WAR HOUSING PROGRAMME

Over the 10 years since 1945, almost 2,250,000 permanent houses and flats have been built in Britain at one new dwelling for every 23 persons. An examination of the annual total figure places this achievement in even better perspective.

From 56,000 in 1946 (the first full post-war year), when many other equally urgent demands were being made on limited supplies of labour and materials, the annual total figure rose to 141,000 in 1947, to 232,000 in 1948, and settled down over the following three years to an average of 204,000 which was in line with the resources then available. The upward trend began again in 1952, with 248,000 dwellings completed, followed by 327,000 in 1953, and the record of 354,000 in 1954.

Considerable resource has been applied to the whole gigantic task. New methods of building have been encouraged and applied including various methods of prefabrication and greater standardization of materials and fittings.

Architects, designers, builders, and the building and equipment industries have co-operated to achieve economical planning of floor space improved amenities and better insulation and lighting, and to improve standards of finish. They have considerable and active encouragement from the Government, which has sponsored research and planning, beside the invaluable facilities being provided by the Building Research Station.

On the financial side, the local authorities have been able (until recently), to raise all the money through a central lending agency, the Public Works Loan Board. There has been no shortage of funds for private ownership. Building societies, insurance companies, and other bodies have been advancing larger and larger amounts at competitive rates of interest.

The Government has also helped, the local authorities, for example, if they choose, can lend up to 90 percent on houses valued at not more than £5,000.

GREATER KARACHI BULK WATER SUPPLY SCHEME

This year the Congress members visited important engineering works in Lahore and Karachi. On the 15th afternoon BECO Works were visited and its various constructional details were studied. On the 16th afternoon the members left for Karachi, visiting Mohenjodaro in the way.

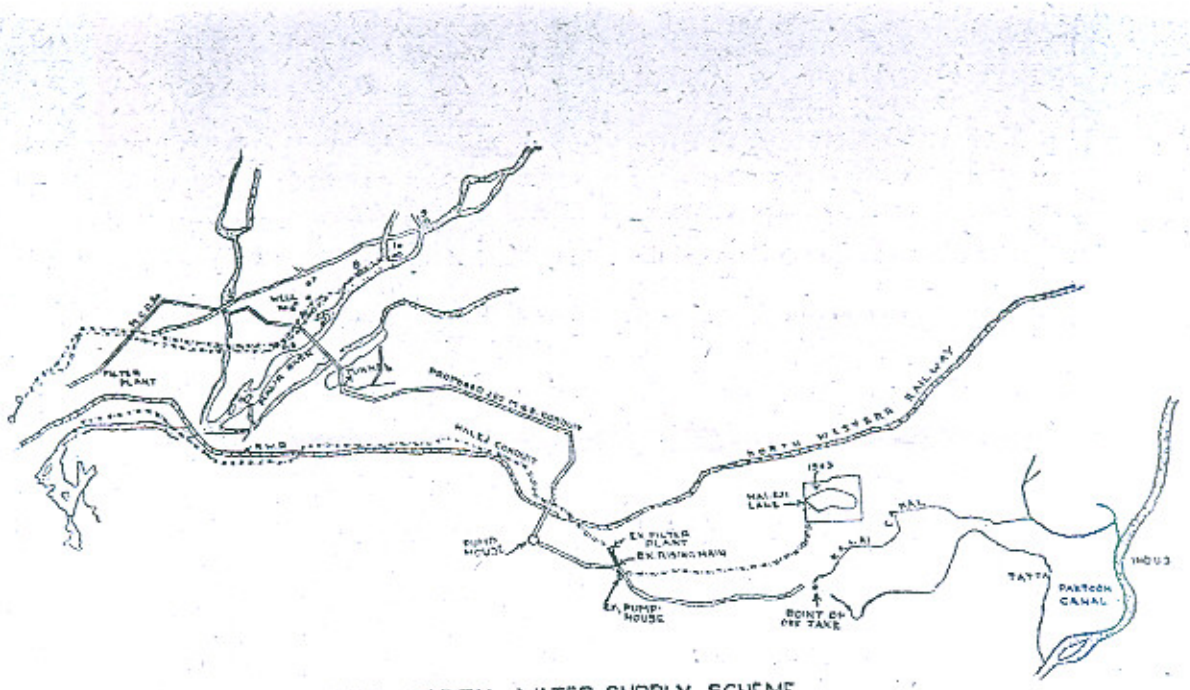
The next three days (Feb 18, 19 and 20) were spent visiting important engineering works under construction at Karachi. In this issue we have reproduced outlines of the important works visited mainly for the interest of the members. We shall endeavour to print details ef each work in some other issue of the magazine. The works, information about which is given in this issue are Greater Karachi Water Supply with detail of its engineering construction, Port of Karachi, Shipyards and Engineering Works.

SITUATED at the edge of a desert where the average annual rain-fall is about 7" and away from any large rivers, Karachi has always presented a critical water supply problem. Ground water in the immediate vicinity of Karachi being unsuitable, the earliest source of water supply was located at Dumlottee at a distance of 20 miles, where the highly previous alluvial sand and gravels of the *Malir river* become thicker and yield water of a good quality. This source of supply which was first tapped in 1884 *to supply* 1.2 M.G.D. from two wells only, has been gradually developed by sinking, more and more wells and at present supplies Karachi with 10 M.G.D. right wells at Dumlottee which are 30 to 40 ft. in diameter and 37 to 83 ft. deep are located along the right bank of the Malir river in a stretch of 12 miles and some of them are connected with ground water collecting galleries. The water is pumped from the wells direct into gravity conduits of 15 M.G.D. capacity and 16.5 miles long. Immediately after the rains, however, the water table rises to such an extent that no pumping is necessary for a few months and water from two wells and an underground gallery flows directly into the connected conduit.

The water from the wells is untreated except for chlorination. Apart from the Dumlottee wells which yield upto 10 M.G.D. six shallow wells have been located along the Malir river in the immediate vicinity of Karachi. These wells add another 5 M.G.D. to Karachi water supply. The yield of the Malir river alluvium being limited, the near-by sources viz the Hub river, the small Lyari river and the deep strata were explored without much success. The demand for additional supply was met in 1943 and again in 1953 from the Indus sources by bringing water from a distance of 65 miles. The Greater Karachi Bulk Water Supply Scheme to bring in additional 70 M.G.D. of water to Karachi now under execution also has its source in the river Indus.

INDUS WATER SUPPLY

The first scheme to bring 10 M.G.D. of water from Indus called the Haleji Scheme, was completed in 1943 and this was duplicated in 1953 to increase the supply to 20 M.G.D. by the so-called *Hilaya Scheme*. In the Haleji Scheme, *Haleji Lake* was re-



FEDERAL CAPITAL WATER SUPPLY SCHEME
INDEX PLAN
SCALE 1·4 MILES

moulded into an artificial reservoir covering about 9 sq. miles and having a storage capacity of 13,013 million gallons. Water is fed in the lake from the Kalri Inundation Canal which extends from the river Indus near Thatta. Entering the lake with a high turbidity, at the north-east corner, the water passes relatively clear (7 p. p.m.) at the south west corner into a masonry gravity conduit which has a carrying capacity of 20 m.g.d and extends 13.5 million to a pumping station at Gharo. The evaporation and seepage losses from the Haleji lake being of the order of 70% additional water had to be obtained from the River Indus for which in the Hilaya Scheme a Pontoon Pumping Station was established near Baghar Ferry, 5 miles south of Thatta and pumped water was conveyed through a canal connecting with the masonry conduit from the Haleji lake thus utilizing its ultimate capacity of 20. M.G.D.

Two Pumping Stations, each of 10 M.G.D. at Gharo, lift the raw-water 186 ft. through two cast iron rising mains each three miles long to two rapid sand filtration plants. From the filtration plants the water flows by gravity through a concrete hume pipe conduit of 20 M.G.D. capacity for a distance of 33.5 miles to Drigh Road Pumping Station in the immediate vicinity of Karachi. Here the water is again lifted 186 ft. through cast iron rising mains to reservoirs in the distribution system.

OTHER SOURCES

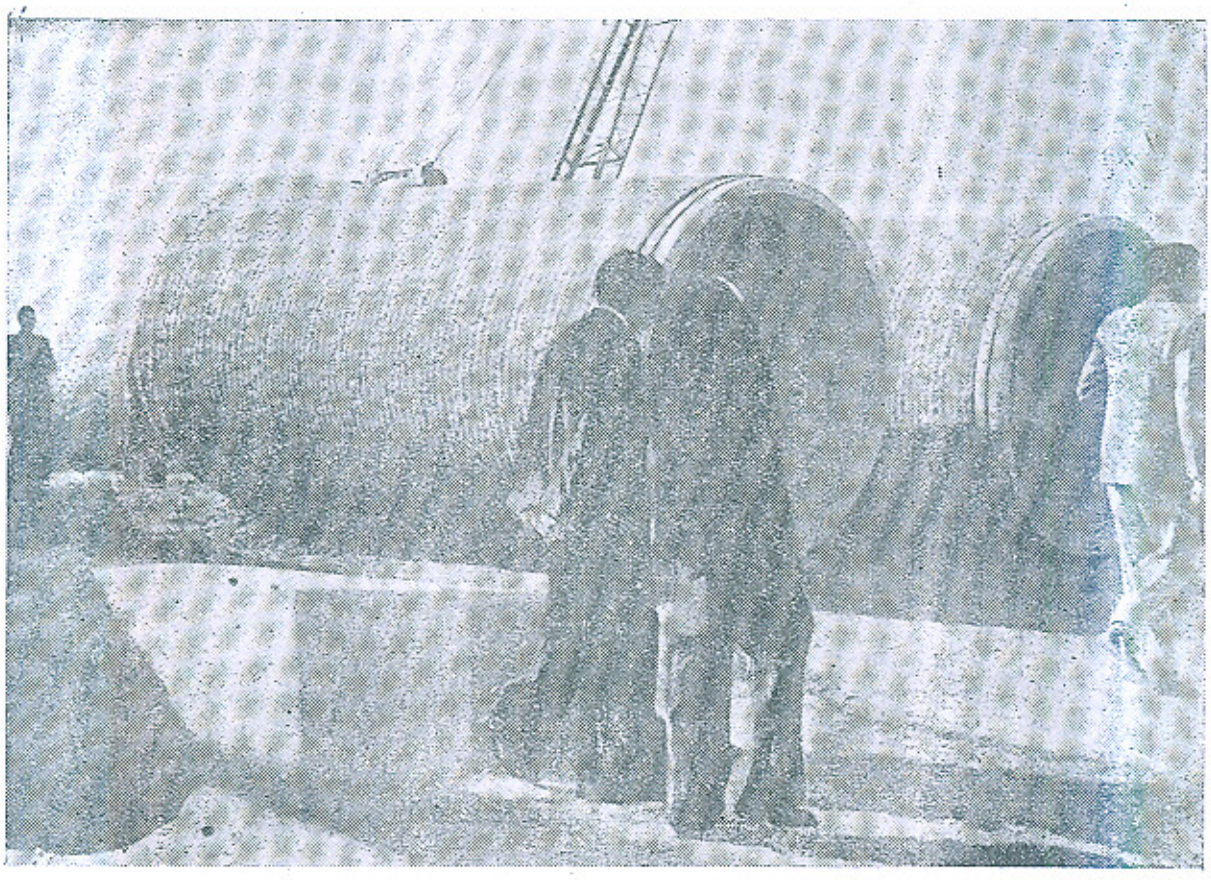
At present Karachi with a population of about 15 lakhs is being supplied with 35 M.G.D. of which 20 M.G.D. is obtained from the Indus sources, 10 M.G.D. from the Dumlottee wells and the balance of 5 M.G.D. from other wells located in the lower reaches of the Malir River.

Filtered water from Gharo and untreated water from Dumlottee is brought to Karachi and is stored in three service reservoirs, low service reservoir, 9 M.G.D. at F.S.L. 98.5, Sydhnem Reservoir, 6 M.G.D. at F.S.L. 65.5 and Temple and Currie Reservoir 5.3 M.G.D. at F.S.L. 61.5, before it is supplied to the consumers during intermittent periods. The low pressure and the short period of supply have necessitated house to house ground and overhead storage and pumping arrangements. A High Service Reservoir of 20 M.G.D. capacity at F.S.L. 150 which serve the present and future systems is, however, to be put in commission shortly which will eliminate ground storage and pumping by the ultimate consumers.

GREATER KARACHI BULK WATER SUPPLY SCHEME

To remedy the present critical water supply position to Karachi and to meet the growing needs adequately, the Greater Karachi Bulk Water Supply Scheme has been launched. This scheme which aims at bringing 70 M.G.D. to Karachi from the Indus source in the first phase has been formulated after taking into consideration not only the immediate but also the future requirements for a total population of 3 million @ 75 gallons per capita per day (45 gallons per capita for domestic use and 30 gallons per capita for industrial and other uses.) On this basis the average supply per day works out to 225 M.G.D. and the maximum day supply 40% in excess, that is 315 M.G.D. With 35 M.G.D. available from the existing sources, the new Scheme was designed to supply ultimately 280 M.G.D. and it was proposed to phase it in four stages of 70 M.G.D. each. The first phase, however, incorporates conduits for 280 and 140 M.G.D. capacities as it was found that it would be more economical in the long run if provision was made initially for the enhanced capacities. The essential features in which this scheme differs from the existing supply systems from the Indus sources is that duplicate pumping has been eliminated and restricted to only one location thus eliminating large recurring operational expenses.

With the completion of the Ghulam Muhammad Barrage and Kalri lake and its system of canals, prennial flow will be available in the Kalri Canal from which the water supply to Karachi will be obtained at head works located at Gujjo.



Prestressed Concrete pipes ready for transport to the site of installation.

PROJECT'S MAIN FEATURES

The main features of the project are shown on the sketch attached and are briefly described below:—

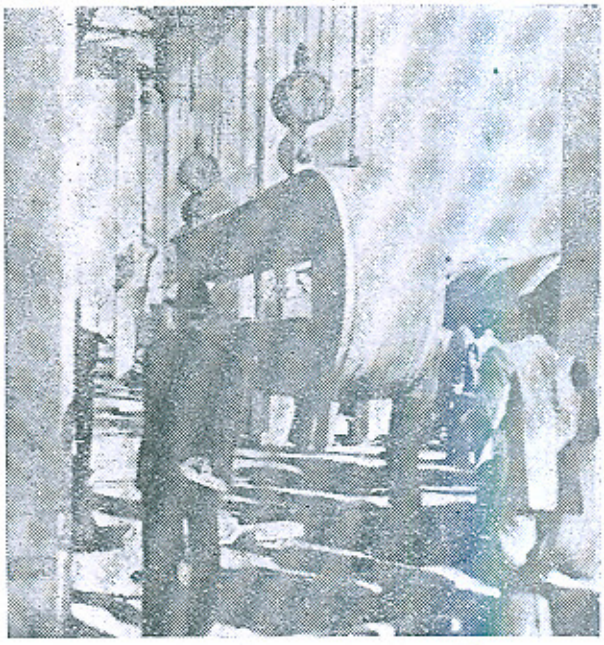
From the off-take point at Gujjo an 8-mile long open canal located on a ridge runs parallel to the Jam Sub Branch of the Kalri canal. This canal with a carrying capacity of 520 cusecs will be lined with a 4" thick reinforced cement concrete lining in order to avoid seepage loss and to ensure safety in operation. The canal starting with F.S.L. 23.3 terminates near Khanwah into a covered conduit flowing under gravity. From Khanwah to Dhabeji water will flow through a Los-Angels type of cut-and-cover conduit 10 miles long and having a carrying capacity of 280 M.G.D. At Dhabeji a Pumping Station with an initial capacity of 70 M.G.D. will raise the water through a 16500 ft. long 72" dia prestressed cement concrete pipe rising main from R.L. 11.60 to R.L. 202.38.

Two rising mains have been provided in the Scheme initially to safeguard against any failure in the large prestressed pipes of 72" dia. The choice of the prestressed pipes was made on economical considerations and with a view to saving foreign exchange. These prestressed pipes are being manufactured locally at the Prestressed Pipe Factory established under the Karachi Joint Water Board and for which machinery has been obtained from Australia under the Colombo Plan. For the initial pumping of 70 M.G.D. 5 single entry centrifugal pumps each of 24 M.G.D. capacity have been provided which will be run by dual fuel engines of 1490 H.P. each.

From the end of the rising main a Los-Angeles type of cut-and-cover conduit, 17 miles long and 290 M. G. D. capacity will convey the water to the portal of a tunnel 7000 ft. long. The tunnel will also have a carrying capacity of 280 M. G. D. and will have a horse-show section. From the end of tunnel the capacity of the conduit has been reduced to 140 M. G. D. as it is proposed to utilize this point as a distribution centre in the future development. The 140 M. G. D. conduit from the tunnel now under construction will terminate at a filtration plant near Karachi. a distance of 21 miles. The F.S.L before filtration will be R.L. 166.0 and after filtration water will be available for distribution at R. L. 153.0.

The conduit will be constructed with cement concrete 1 : 3 : 6 and reinforcement has been provided only at locations where the soils is bad or the super-loads are heavy. The average cover at the top of conduit is about 3 feet. The gradient in straight stretches is 1 in 10,000 and in curves 1 in 7,000 The tunnel gradient however is 1 in 2,500. The velocity for 280 M.G.D. and 70 M.G.D. flow is 3.18 and 2.41 feet/Sec respectively in the 280 M.G.D. conduit and for 140 M.G.D. and 70 M.G.D. flow is 2.67 and 2.41 feet/Sec in the 140 M.G.D. conduit.

Along the 48 miles length of the conduit where rivers and nullahs and other natural



Hoist for lifting prestressed concrete pipes.

drainages intereset the alignment inverted syphons of a total length of 11 miles are proposed. These syphons will be constructed with 84" dia. prestressed concrete pipes, the carrying capacity of each pipe being 70 M.G.D. The pipe will be locally manufactured in the Prestressed Pipe Factory established under the control of the K.J.W.B. Initially it is however proposed to lay only one line of 84" dia. syphons of 70 M.G.D. capacity.

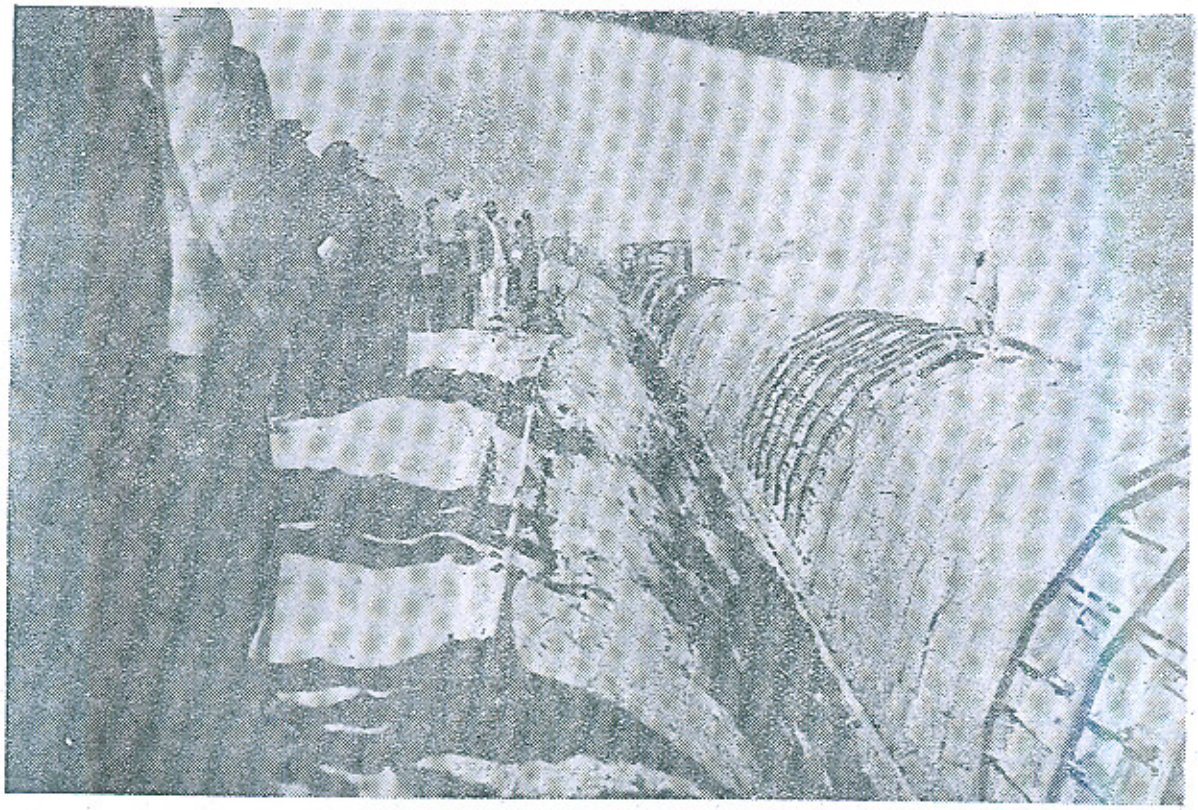
The 70 M.G.D. Purification plant installed at theC.D.O. Hill near Karachi will be a modern sand filtration type and the largest single unit of its kind in Asia and Western Europe. It is being supplied by M/S Wage of Germany. The raw water carried through the conduit will be initially treated in three circular clarifiers equipped with flocculating arrangement. The water flowing from these clarifiers will then be carried to filter beds for final treatment.

The treated water will be stored in a 10 M.G.D. reservoir adjacent to the filter beds. A portion of the treated water will be pumped 70 ft. to a high level reservoir with F.S.L. 220 ft. for distribution to the high level areas of the city.

For the distribution of water a trunk main distribution scheme has also been sanctioned by the Government and is under execution by the Karachi Joint Water Board. The existing and the proposed new reservoirs will be utilized and a 24 hour supply with a minimum head of 80 ft. will be available to the consumers.

To cope with this increased supply a scheme for sewerage and sewage disposal has also been sanctioned by the Government and is under execution by the Karachi Joint Water Board.

The Greater Karachi Bulk Water Supply Scheme is estimated to cost Rs. 15 Crores and the rate for the bulk water supply after filtration at the filter plant is estimated as Rs.--/7/3 per thousand gallons for the first phase of 70 M.G.D. supply.



Conduct for 140 million gallons per day water supply under construction at site.

JOINT WATER BOARD KARACHI

The following are the Engineering details of construction work on the Karachi Joint Water Board cut-and-cover Conduit and Tunnel Project Ghaggar to Karachi

THE portion of the condut which is under construction liesi between Ghaggar and Karachi, a distance of 26 mlies which is split as below.

Length of conduit	1,00,032 feet.
Length of tunnel	7,000 feet.

Part of the conduit from Ghaggar to Tunnel, a length of 6 miles has a capacity of 280 Million gallons per day. The gradient has been kept at 1 in 10,000 throughout except the bends where it is 1 in 3000 with coefficient of roughness as 0.012 (N). The capacity of the Tunnel is 280 M.G. per day with a gradient of 1 in 2,500.

The total cost of the conduit is approximately Rs. 1.5 crore giving an average cost of Rs. 150 - per foot length of the completed conduit. The cost of the tunnel is about Rs. 30 lakh.

A brief detail about the nature of various phases of the work is as under.

STONE QUARRY:—

The daily requirement of coarse aggregate for concrete work is 12,000 c.ft. when concreting at full capacity. This coarse aggregate is made up of 50% of crushed stone and 50% of river gravel.

The crushing plant has a capacity of 8,000 c.ft. per day. The natural gravel is lipped directly by bricks in a primary gyroscopic type crusher and the product as a whole is belt conveyed into a secondary gyroscopic crusher. This twice crushed product is elevated to a vibratory screening unit where it separates into 2 different gradings, namely, $2\frac{1}{2}$" (pass) to $\frac{3}{4}$" (ret) and $\frac{3}{4}$" (pass) to 3.16" (ret) oversize materials and the fine materials are rejected. The stone in use is of a high quality having an average specific gravity of 2.75 with an absorption factor of 0.1, both of these qualities ensure a sound and watertight structure.

INVERT PREPARATION

Before concrete is poured, the subgrade is prepared by compacting it with a 10-ton road roller and then dressing it by manual labour to the required shape. Lining concrete strips are made on the sides on which rails are fixed for gantries meant for the removal of forms and for the movement of screen. All the levels of the conduit are maintained by controlling the levels of these rails.

FORM FIXING.

The concrete is poured in specially designed steel forms which are aligned against the rails as mentioned above.

The conduit is designed to be cast in two stages. Forms for the invert (the lower portion) are aligned, levelled and oiled ahead of concreting in 35 ft. alternate sections with an 8 inch wide M.S. strip in between which is meant to ensure a watertight joint. The crowns (top portions) follow in four day's time and are poured again in alternate sections of 35 ft. with 8 inch wide M.S. strip welded to the strip of invert.

CONCRETE PLACING.

Mixed concrete is carried off the batching plant in 2 cubic yard concrete buckets placed on trucks. Maximum travelling time of mixed concrete is limited to under five minutes.

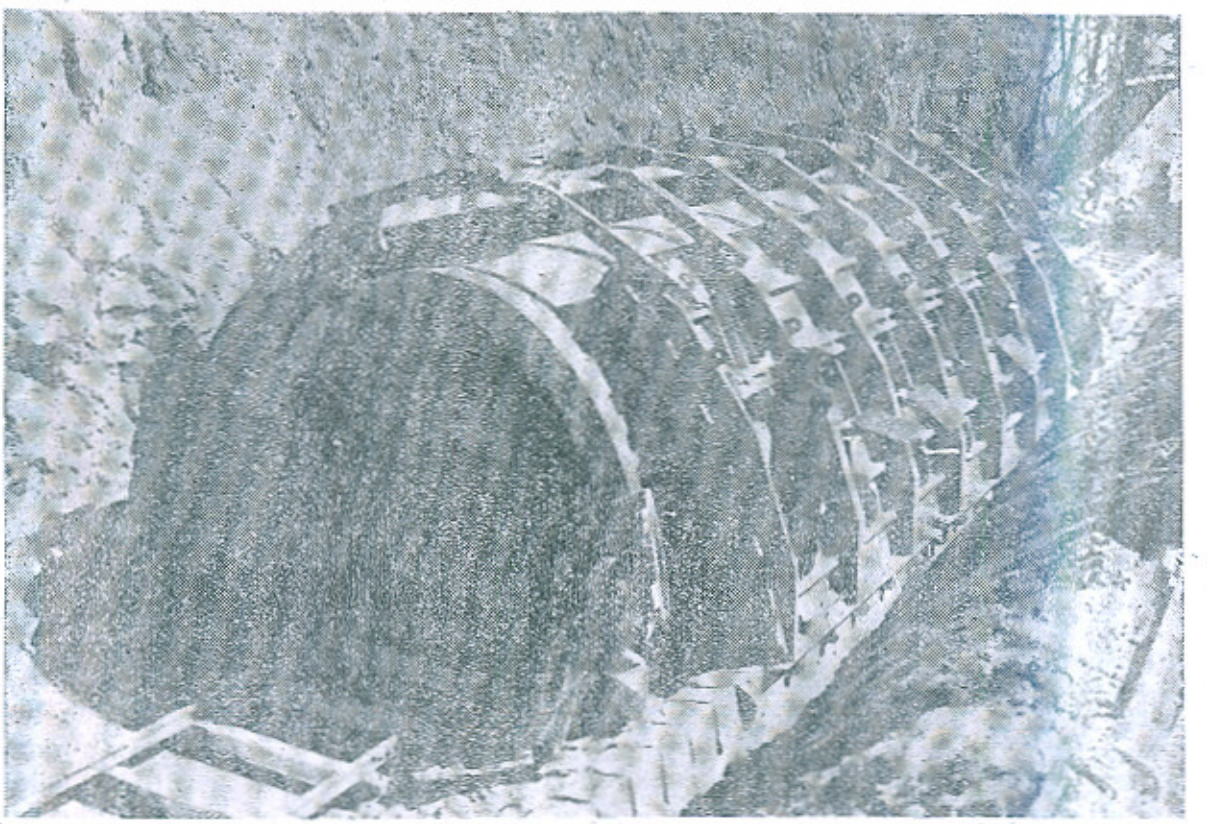
The concrete buckets are off loaded from the trucks and lowered into the trench by means of a crane R.B. 43 (originally a drag line). The concrete deposited in the forms is distributed by manual shovelling and is consolidated by means of high frequency internal electric vibrators and subsequently the invert is surface vibrated by means of a screen which has an Electrical high Frequency vibrator mounted on it. The screen serves a dual purpose of vibrating and surface forming.

Final finishing of the screen surface is done manually in two stages—first by a wood float and afterwards by steel travelling to give a highly smooth surface.

The correct levelling of the invert is crufical in view of the gentle gradient of 1 in 10,000. Of special interest is the speed and smoothness with which the mixed concrete is handled to avoid premature setting on account of holdups.

In crown the concrete is poured in level layers and vibrated through windows provided in the forms, in lower layers and from top for upper layers.

A water tight joint in between invert and arch portions is ensured by providing a uniform 1/8" to 1/4" thick layer of the same mix, as the main concrete, missese the course aggregate prior to pouring concrete in the crown.



Forms in position ready for receiving concrete to make 140 *M.G.D. Conduit.*

BATCHING AND MIXING.

A two cubic yard completely mobile and automatic WINGET Batching and mixing plant is provided at site. The capacity of plant, the only of its kind in this region, is 60 cubic yards per hour. All the controls are done by compressed air and the various parts operate on electricity generated by a 75 K.V.A. generator. The ingredients are elevated to the top bins by elevators and the predetermined proportions by weight are batched and directly loaded into the mixer. Mixing time allowed is 1½ to 2 minutes and after this time, the mixed concrete is unloaded into an electrically operated skip hoist. By the time the hoist skip reaches its top a truck with a bucket on it is ready underneath to receive the mixed concrete. After this, off goes the truck with a loaded bucket.

FIELD CONTROL.

At the batching plant strict watch is maintained on the process of batching and mixing. Water cement ratio is kept as low as possible. To attain a workable mix and the best possible concrete, slump tests are carried out every half an hour as the water cement ratio increases for the same slump as the temperature rises and vice versa. Besides cubes are made frequently from the concrete that comes out of the mixer to determine the strength and specific gravity. It will be interesting to note that with all these controls we have attained an average 7 days strength of 3,000 lbs/ square inch for a 1 : 3 : 6 mix and specific gravity as 152 lbs for cubic feet.

CURING OF CONCRETE

Soon after the concrete sets, it is cured by covering it with gunny bags and keeping them wet.

LABORATORY

A well equipped laboratory for testing of concrete, cement, and aggregates has been established in the work shop building.

TUNNEL

The excavation of tunnel is carried out by blasting electrically and the work on the tunnel has recently been started and has progressed only 750 ft. At the moment work on only one postal is being done and the second postal will be opened up by the middle of March, 1957.

This excavation is done by electric blasting. Holes are drilled by pneumatic tools. The charge to be placed in each hole is determined on the site according to the strata encountered. On the average about 50 lbs of 40% strength dynamite is required for blasting the entire face which gives a lead of about 6 feet.

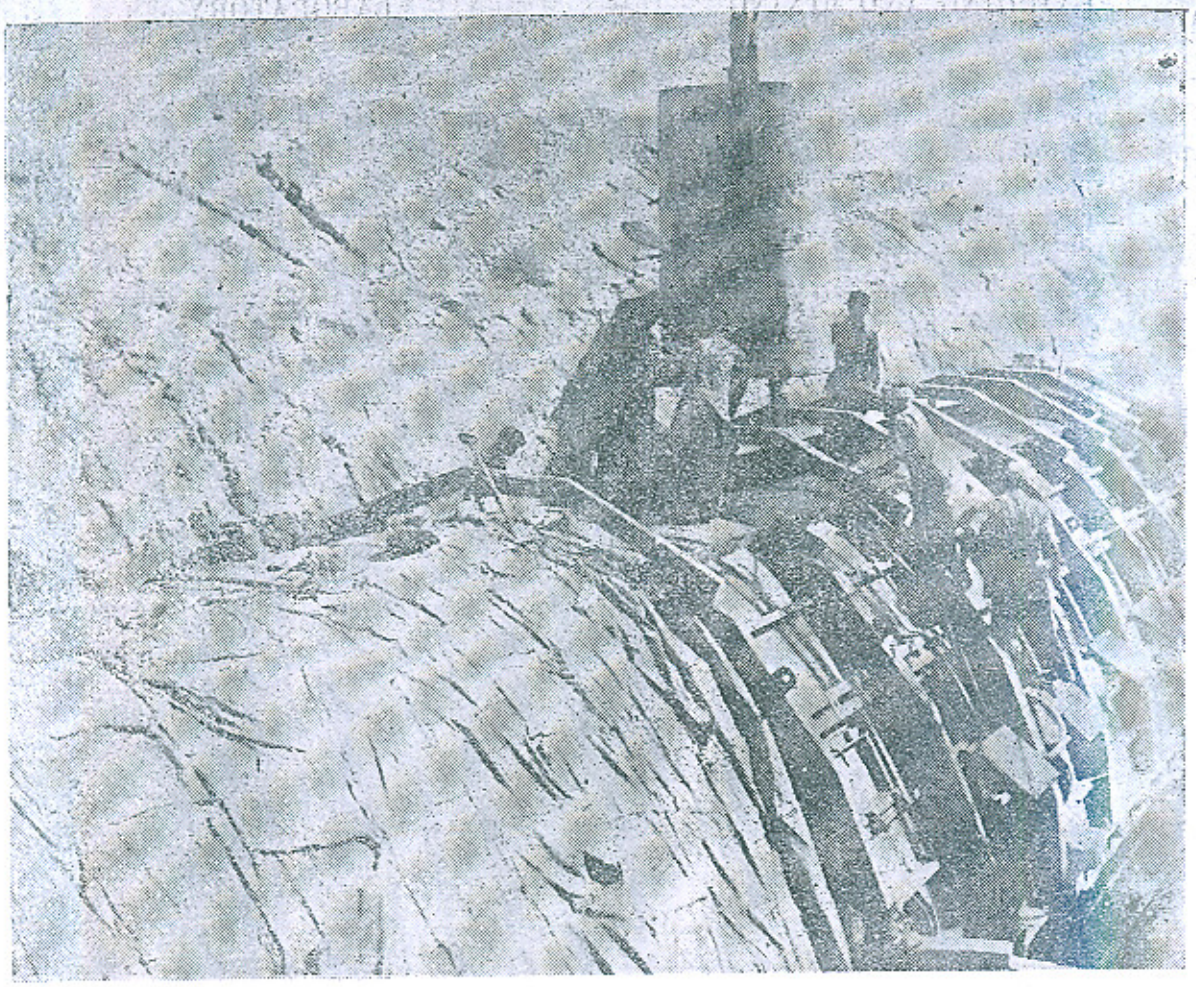
The blasted stuff is shovelled into the muck carts and handed out by means of an electric loco.

As soon as blasted face is cleared of muck, timber supports are immediately provided to avoid any accidents. The over break is either racked with excavated stuff or additional wooden supports are provided to avoid any falling of materials over the main supports.

Fresh air to the workers is provided by an electric fan. The air is lead into the tunnel by means of collapsible canvas bute suspened on the supports.

The backbone of the work of the tunnel, is the workshop situated about 1,000 feet away from the tunnel where all the machinery has been installed.

Generators, compressors, battery charging units and timber work shop are the main equipment worth mentioning.



Two cu. yards bucket delivering cement concrete in steel forms.

THE PORT OF KARACHI

A BRIEF INFORMATION ABOUT THE PORT FACILITIES

LOCATION :

Latitude 24° 47′—37″ North
Longitude 66° 58′—38″ East.

The Port of Karachi, protected from the vagaries of the S. W. monsoon by the promontory of Manora, is a natural harbour developed by the protective works and by means of dredging. Until 1842, however it consisted merely of a safe anchorage for vessels drawing upto 12 feet and is said to have provided shelter for the fleet of Alexander the Great, under Admiral Nearchus, in 326 B. C. during the monsoon. Steps to develop this natural harbour into a modern port were taken after 1834.

The Port can handle upto 12,000 tons of cargo daily. The total imports and exports during 1944/46 amounted to 2,800,000 tons, while the peak figure of 34,72,721 tons was handled in the year 1951/52.

The main commodities imported through the port are: piece goods, cotton twist, metals, sugar, spices, silk, tea, liquors, kerosine oil, petrol, liquid fuel, coal, railway plant, iron and steel, cars, manufactured goods, and machinery.

The exports are : grain, oilseeds, cotton, wool, hides and skins, salt, fish, carpets and dry fruit.

ACCOMMODATION

1. *The shipping channel:*—Within harbour limits, is divided into three parts, viz :

(*a*) *Entrance Channel*—Length 2,900-ft : width 1,300-ft, sanctioned depth (below Karachi Harbour Works Datum level) at L.W.S.T.=29-ft.

(*b*) *Main Channel Lower Harbour*—Length 9,650-ft ; it varies in width and the minimum being 600-ft., sanctioned depth at L.W.S.T.=27-ft.

(*c*) *Main Channel Upper Harbour*—Length 10,000-ft : Width 700-ft : to 950-ft : sanctioned depth at L.W.S.T.=27-ft.

(2) There are five swinging moorings with a draft of 24′ and radius 350-ft. to 450-ft. and 13 fixed moorings with a draft of 27-ft : to 32-ft :. Their length is 500-ft : to 600-ft.

SHIPPING BERTHS

(*a*) *West Wharf*—These berths were constructed in 1927 and 1929 with foundation consisting of a line of cement concrete monoliths, each measuring 30-ft. square in *plan*. Their depth below low water varies from 42 to 48-ft. The total cost was Rs. 80 lakh. Berths 18, 19 and 20 are 575-ft long with 32 ft, deep water alongside. Berth No. 21 is 600 ft. long with 34 ft. deep water. Lightrage Berths Nos. 22 is 519-ft. long with 10-ft. depth of water and No. 18-A is 327-ft. long with 6-ft. of water. The last two were constructed during the World War II.

There are 16 electrically operated Luffing Cranes of two-ton capacity each, one steam travelling scotch derrick of 5-ton and one fixed 25-ton electric derrick. In addition, the Port possesses one self-propelled 30 ton floating crane—"PAHLWAN II", and one Dumb 60 Ton floating crane, 'KING KONG" There are also two covered transit sheds for cargo storage with a total area of 84,800 sq., ft., and one double storeyed transit shed at berth No. 21, floor area 1,44,000 S. ft.

(*b*) *Ship Repairing Berth*—Length 300-ft. between Dolphins, Depth of the water is 16 feet.

(c) *East Wharves*—These 17 berths were constructed during the period 1888-1910. They are supported on solid steel screw pile 5 and 6 inches in diameter, while the decking of built-up girders and joists covered with 6″ timber planks in two layers. These berths have 26-ft to 29-ft. of water alongside. Berths No. 3 to 10 are 550-ft. long, berths No. 14, 15, and 16 are 500-ft. long, 1 Berths No. 2 is 470 feet-long. Berth Nos. 1, 12 and 13 are 450-ft. long, berth No. 1 is 430-ft. long and berth No. 17 is 400-ft. long. These berths are served by hydraulically operated cranes of which there are 87 cranes of 35-cwts, one of 14-ton and one of 30-ton lifting capacity. Due to their age, 13 berths, Nos. 5 to 17 are scheduled to be reconstructed on modern lines with pre-stressed R.C.C. H. Piles. Some of them are already broken up and their construction is well in hand. Out of these 13 newly constructed berths 6 will be 550-ft. and the remaining ones of 484 ft. length with 2, 345 ft. deep water alongside. The out-dated hydraulic cranes will be replaced with 3 ton electric level luffing cranes—4 at each berth.

(d) *Boat Basin* :—It consists of the Commissariat Wharf—length 150-ft : and depth of water 8-ft: with one 35-cwt. hydraulic crane and one 1-ton hand crane, passenger landing pier, length 450-ft : and depth of water 6½-ft : Railway Wharf, length 800-ft : and depth 10-ft :

(e) *Return Wharf* :—is 325-ft, long with depth of water 18-ft.

(f) *Bulk Oil Pier* :—Constructed in 1909 is 403-ft : long, but a tanker of 550-ft : can berth alongside, the depth of water is 31-ft. In continuation of the present pier another length of 600-ft. is being added for extending the facility so that two tankers may be put alongside the pier simultaneously. Pipes are laid from the pier to oil installations nearby. Liquid fuel pipes and connections are available from Return Wharf and berths 1 to 11 and are connected to oil installations permitting two ships to be bunkered with oil fuel simultaneously, or one ship being bunkered and one tanker discharging simultaneously, in addition to the service from the oil pier.

DRY DOCK

(4) *Dry Dock*—This graving dock with sloping sides and wooden gate in two *leaves* was built in 1901. Its length on blocks is 236-ft., breadth at entrance is 50-ft., still level 3′-3″ below datum, the depth of water on sill at H.W.S.T. is 12.3/4-ft.

(5) The Port Trust operates a workshop at Manora for the repairs and maintenance of their crafts. Naval and *communial refits* are also carried out.

Some 16,000,000—Tons of sand and silt are dredged annually. Dredging is necessary for

(a) Deepening the navigable channel and the water alongside the berths, and

(b) Removing the silt that accumulates at these points. The Port Trust owns two ladder bucket dredgers, viz : the "BARBUS" and the "THOMAS COAD" and one large grab hopper dredger, "THOMAS DOWNIE"

The Keamari Groyne, constructed in 1865 is about 1½ miles long and protects the main channel from silting up from the East.

The Manora Breakwater—Constructed in 1873, is about 1550 ft. long and helps to maintain the depth of water in the entrance channel due to tidal action in the waters of the harbour and also helps in protecting the harbour water during the monsoons.

(9) *Manora Lighthouse*—was constructed in 1909. It is a Hyperradial (focal distance: 52: 36 inches) light of 1,200,00 candle power with a flashing light—the flash occuring at regular intervals of 7½ seconds. The source of light is an incandescent mantle. The flash is visible in clear weather at a distance of 18 miles, while the 100m′ is visible upto 70 miles.

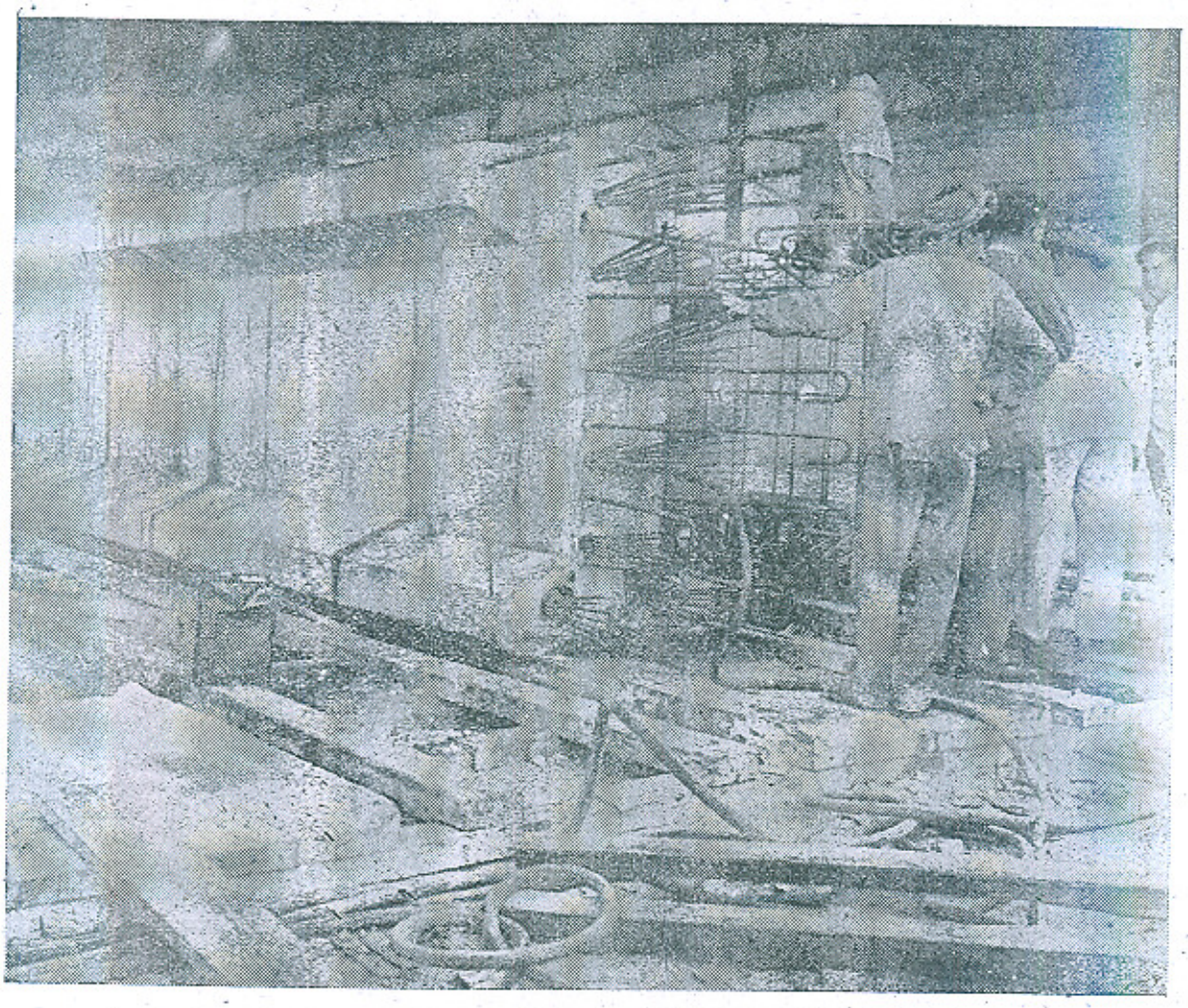
A light on Oyster Rocks is also erected to warn the in-coming vessels. It flashes at an interval of five seconds. Then a 20″ Sperry Projector has also been installed on a 100-ft : high tower at Manora to signal the vessels which accidentally enter the danger zone marked by the light on Oyster Rock (Bara Andai). The projector is expected to function very shortly.

EAST WHARVES

(A Note on essential features of the East Wharves reconstruction scheme.)

(1) For the information of the general public, press notice have been issued from time to time by the Administration outlining the broad features of the East Wharves reconstruction scheme. It must be pointed out, however, that the details of the scheme cannot be forecast accurately as they will have to be revised constantly, as the scheme progresses, in the light of new developments and changing conditions . They may even have to be altered right upto the time of implementation.

(2) BERTHS :—This scheme is for the reconstruction of 13 berths at the East Wharves extending from berth No. 5 at the south-end to berth No. 17 at the north-end.



Prestressed concrete girders, showing the prestressed steel wires in position.

The present berths are not of uniform length, ranging from 400 to 555 ft. In the new scheme, it is proposed to have berths of two standard lengths only. The five berths with proposed transit sheds, viz., berths Nos. 6, 8, 11, 13 & 16 will be 550 ft. long each, while the remaining 8 berths will be 484 ft. long each. The existing berths have from 26 ft. to 29 ft. deep water available alongside. In the new scheme it is proposed to have a uniform depth of 34 ft. of water available alongside at all the berths.

The existing berths consist of open type jetty construction with 5" & 6" dia screw piles with rolled steel joists frame-work and timber decking. The quay will of new berth will be of solid re-inforced concrete and pre-stressed concrete construction with suitable filling behind it, while the surface of the berths will be paved with cement concrete and will be strong enough to support the loaded railway trains and locomotives resulting in quicker shunting and placing of wagons for loading and unloading and a quicker turn-round of cargo ships.

The existing out-moded hydraulic cranes of 1.$\frac{3}{4}$-ton capacity will be replaced with 3-ton electric level Luffing cranes at all the 13 berths at the rate of four cranes per berth.

RAILWAY TRACKS.

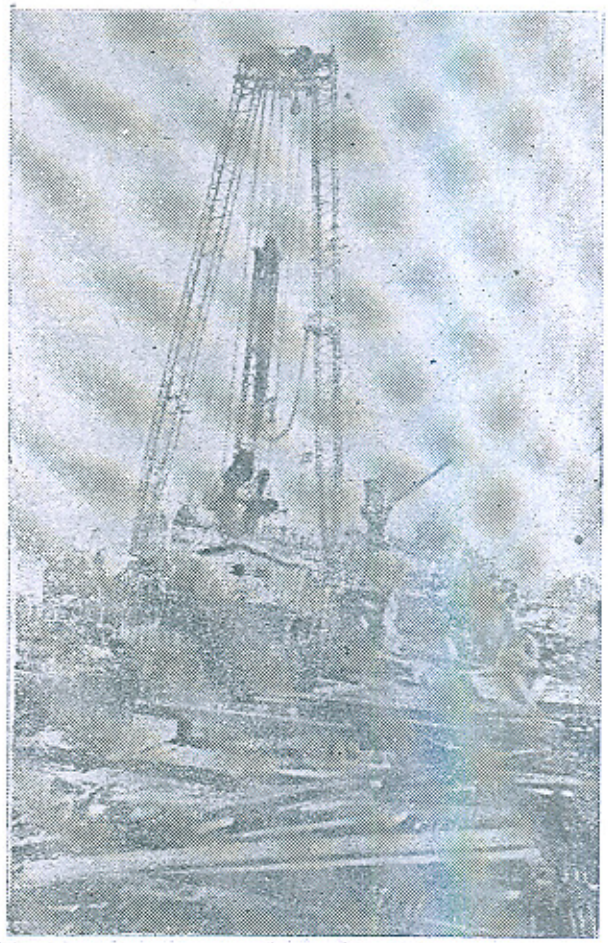
Three railway tracks will be laid along the Wharf face in addition to the travelling crane track. Space has also been provided provisionally for a fourth rail track, should this be required in future. Marshalling yard will be laid out in accordance with modern railway practice to afford minimum of delays in making of trains and placing of wagons. The transit sheds and plinths will be provided and served by two rail tracks on the land side, while space will be provided for a third rail track to be laid if required in future.

Two fuel oil pipelines for bunkering and discharging will be provided on all the berths. One fresh water main will also be provided for servicing all the berths. At berth No. 17, special arrangements shall be made for the receipt and discharge of coal.

As stated above, berths Nos. 6, 8, 11, 13 and 16 will each have a single storeyed transit shed of modern design with a 10′ wide loading platform on the land side. The Shed's floor will slope from quay level on the harbour side to platform level on the other side enabling mobile trucks and cranes to be used for movement of cargo into and out of the sheds. Each shed will also have roofed leantos at either ends for the storage of special cargo, and will be 500′ long by 191′-6″ wide in dimensions.

(7) TRANSIT PLINTHS:—

The remaining 8 Berths will have open transit plinths with paved re-inforced con-



Prestressed concrete girder layer at East Wharf, Karachi Port.

crete surface to enable mobile cranes to operate over the plinth area for storage and quick movement of cargo. Each of these plinths will be 434' long by 201'—6" wide.

(8) ROADS AND OVER-BRIDGES:—

The transit sheds and transit plinths will be served by a through road immediately adjacent to the rail tracks. This road will be approachable from the gate lodges at Berth No. 2 at the south end and from the N.M.B. Wharf Gate lodges near the Chinna Creek Bridge at the North-end. The road will also be connected to the Napier Mole Road by means of two road overbridges, one at Berth No. 11 and the other at some distance to the north of Berth No. 17. The main through road will be 92 ft. wide consisting of 62 ft. wide carriageway for vehicular traffic and 30 ft. wide parking space for trucks and camel carts along the fringe of the over-flow plinths to allow for end loading and unloading of cargo. The 2 road overbridges across the railway Marshalling Yards will quicken the movement and clearance of cargo by increasing the number of approaches from two to four. The bridges at berth No. 11 and berth No. 17 will have only single approach ramps at each end and will be in the shape of an "S". The approach ramps will have easy gradients of 1 in 35 to enable cargo loaded vehicles and camel carts to climb conveniently.

(9) OVER-FLOW PLINTHS:—

In addition to the transit plinths, it is proposed to construct overflow plinths on the Yard side of the main through roadway to accommodate cargo which otherwise would have to be sent to M.I. Yard. These over-flow plinths would be constructed at berths Nos. 9 to 17 only.

(10) STORAGE PLINTHS:—

The scheme also provides for the construction of storage plinths for export cargo between the Railway Marshalling Yard and the boundary wall along Napier Mole Road. These plinths will extend from Berth No. 5 to Berth No. 17 and will be rail and road served.

(11) SCHEDULED PROGRAMME:—

The contract for the construction of the Quay Wall has already been awarded to a dutch firm—N.V. Volker Anneming Maatschappij Ltd. Contract for the purchase of electric cranes has been awarded to M/s. Krupp Ardelt of Germany. Preliminary work on the scheme began in January. 1955 and the whole work is scheduled to be completed by the year 1961 at a total estimated cost of Rs. 1151.45 lakhs.

CLIPPINGS

(1) The Glen Shira Hydro-Electric Project By John Paton, M.I.C.E. (Institution of Civil Engineers, April 17, 1956.)

The Paper describes the development, lay out and design of the Glen Shira project of the North of Scotland Hydro-Electric Board. These works, which are at an advanced stage of construction and partially commissioned, are designed to produce 80 million units annually at 20 per cent load factor.

(2) Pumping Problems: Present and Future, By Herbert Addison, O.B.E., M.Sc. (Hydraulics Division Meeting, Institution of Civil Engineers, May, 1, 1956.)

When moving large volumes of water, it seems likely that the engineer may find to an increasing extent that purely gravitational schemes will no longer suffice. But in many instances he will have to depend more and more on pumps. One aim of the paper is to examine this trend, taking as examples the application of pumps in pressure-boosting installations, in hydro-electric works, and in land reclamation.

A SHORT NOTE ON MOHENJO-DARO*

Mohenjo-Daro, the "mound of the dead", lies 7 miles from Dokri Railway Station on the Kotri-Larkana Branch Line of the North Western Railway. A few years ago this site was no more than a group of mounds of light red tint, contrasting pleasantly with the blue of the sky and yellow grey of the surrounding plain, covered over with thorny shurbs. Upon the highest of these mounds was perched the ruins of a Buddhist Stupa and it was not until the year 1942, when the Archaeological Department started excavations there that the prehistoric character of its remains was revealed.

It is not definitely known who were the people who built Mohenjo-Daro or when it was built. Most historians believe that this city was established in the pre-historic age during the time of pre-Aryans, dating back to 2500 BC. The inhabitants seem to have led more or less a peaceful life, except on one occasion, when they were attacked by the invaders from Baluchistan. In addition to these enemies Mohenjo-Daro had to contend with a more serious foe, the river Indus, now flowing close to the deserted city. The subsidence of walls and well-lining at two distinct levels of the city show that floods took place about five times and on each occasion the city was deserted and re-occupied after the danger was over.

It is also not known what finally forced the inhabitants to leave Mohenjo-Daro; whatever may be the cause the city ceased to exist after 1500 B.C. and lay in ruins until the second century A.D. when a small part it was temporarily occupied by Buddhist monks.

ARCHITECTURE AND MASONRY

The city, as unearthed presents a picturesque scene. The houses are made of burnt bricks, well baked to a light red colour. Stone does not appear to have been used; large stone rings threaded on poles to form columns have, however, been found.

There seems to exist a definite scheme of town planning. Streets run in straight lines and are crossed by others at right angles with alignments from east to west or from north to south. The main streets present an orderly appearance, for not only are windows non-existent but wherever possible, the entrances to houses are all through narrow by-ways.

SANITATION

The system of sanitation which the Mohenjo-Darians adopted, was of a very superior order. The houses in the city were built to admit light and air through doorways. The streets were so designed that the winds swept down a main broad thoroughfare, and sucked the stagnant air out of the adjacent small streets. The method of drainage is well preserved and is the most complete ancient system yet discovered anywhere in the Indo-Pakistan subcontinent. From every street ran a brick-lined channel, which was connected by smaller tributary drains from buildings on either side. Every house had a cess-pit. To prevent water from escaping into the soil, a little brick-lined pit was provided at each junction where one drain entered another from a higher level. The bricks were so carefully rubbed down and fitted together

* Presented by A. G. Shaikh, Additional Chief Engineer, **Buildings & Roads, Southern Zone**. to the Members of West Pakistan Engineering Congress on occasion of their visit to Mohenjo-Daro on 17*th February*, 1957.

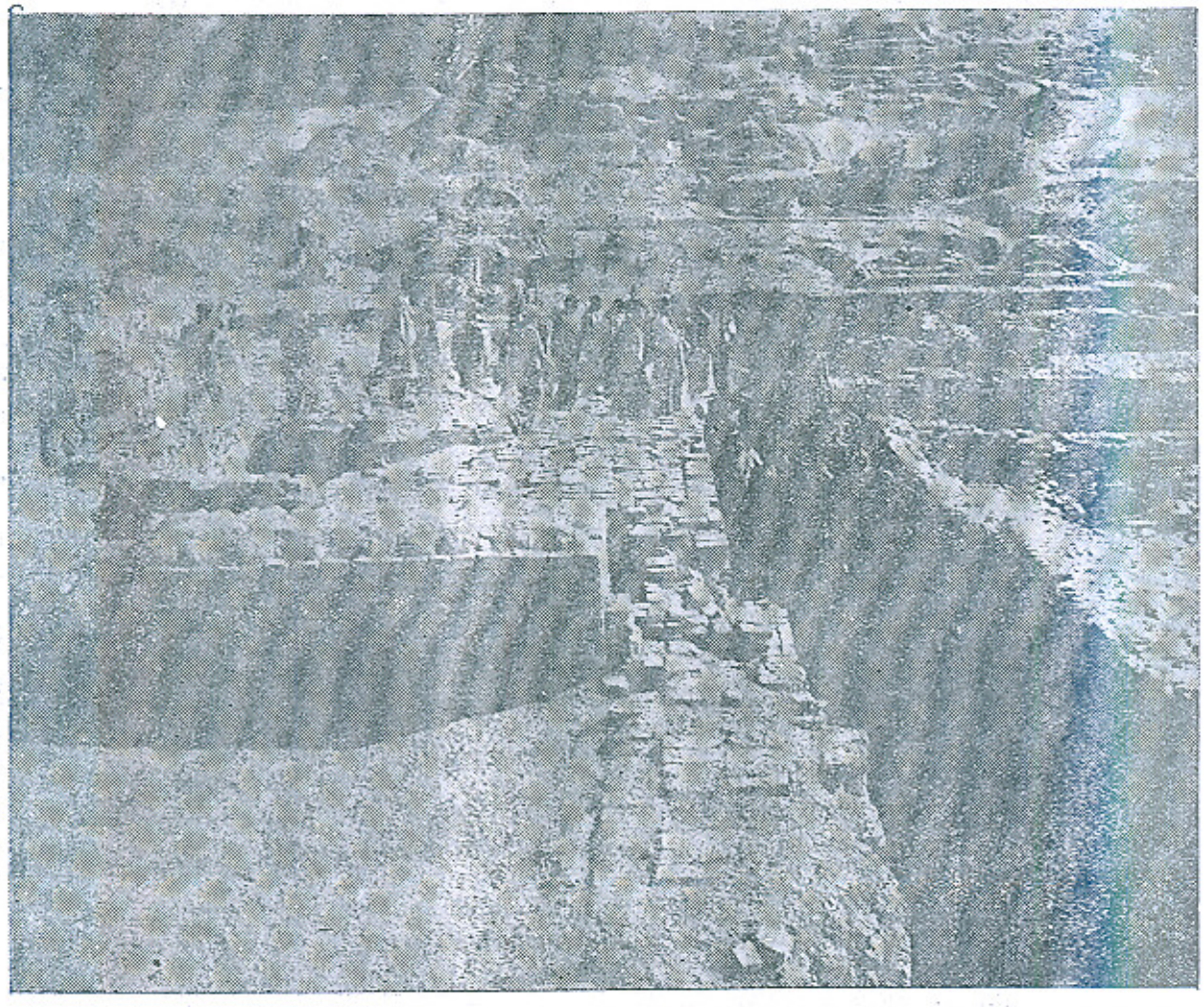
that the joints are even now hardly visible. The masonry at certain points projected slightly to provide decorative features in an other blank wall. Bath rooms were built in each house on the street side for convenient disposal of water. Where bath-rooms and latrines were on the top floors, brick channels in the thickness of the wall were constructed for water and refuse to flow off.

IMPORTANT BUILDINGS EXCAVATED

(Use of Bitumen.)

Some important buildings that have been unearthed are a "Sacred Bath" a place and an Assembly Hall. The Sacred Bath which is situated to the west of the Stupa is 35'-3" long and 25'-2" wide and is surrounded by a cloistered walk with two entrances on either side. The bricks in the inner wall of the great Bath were laid in gypsum mortar The outer face of this wall was covered with bitumen so that every step was taken to make the bath water- tight. It is here that Mohenjo-Darians performed their ritual and had a dip in the water on ceremonial occasions.

The Palace is a large straggling building of excellent masonry, arranged round two spacious courtyards wth servants' quarters and a number of store-rooms. It is 225' long and 150' wide, having walls 5' thick.



Congress members through the bazar of Mohenjo-Daro.

It appears to have been the residence of the Governor with Administrative offices of the city.

The Assembly Hall is a spacious building with a roof supported by 20 rectangular brick *piers* set in four rows of five each. It is believed to have been used for religious assemblies in the days of the Buddhists and as a marketing *hall prior* to that.

COMMERCE

This city once enjoyed a reputation in commerce as has been established from the antiques unearthed. Mesopotamians, Egyptians and Arabs often visited this place and exchanged various commodities with Mohenjo-Darians. Recovery of a broad even, similar to those found in Mesopotiamia, seals and sealings having the "Sacred Knot" well known from the prehistoric culture of Aegean Island and Egypt depicted on them support these facts. Several portions of the legend of Gilgamaesh killing loins have also been found inscribed on several seals. These subject survived in ancient Greece in the legend of Hercules.

RELIGION

The interesting feature of the excavation so far conducted is the absence of any temple in the city. There is no documentary evidence to show what religion the Mohenjo-Darians followed, No stone image was found except one in a dilapidated state which is clothed in a robe carried over to the left shoulder and under the right arm. It has a short beard and shaven lips, resembling figures of gods worshipped by the people in ancient Sumer. Figures of Lord Shiva, pottery figurine representing a female deity as Shiva's wife, Byzantine cross and Swastika (religious symbols in the Neolithic Age, 4000 to 5000 B.C.) recovered from debris, show that Mohenjo-Darians worshipped various gods.

ANTIQUITIES

In the local museum near the site, which is in the charge of a curator are deposited the typical antiquities discovered during excavations. They include hundreds of pottery vessels of every shape and size from large-sized storage jars to beautiful miniature vases a few millimetres in diameter, pottery painted on various designs, model and top animals in clay, beads and ornaments with which the womenfolk loved to bedeck their bodies, artistic seals and sealings with inscriptions in a forgotten pictographic script which has baffled all attempts to decipher it and with beautiful designs of animals such as bull, rhino, elephant, tiger, buffalo, etc., copper and stone statuettes, stone weights, shell and ivory objects, copper utensils and objects of everyday household use are amongst the innumerable objects discovered at Mohenjo-Daro.

INCREASING ACID RESISTANCE IN CONCRETE

'Furacrete' a low viscosity, partially condensed resin syrup of the furnace type, is claimed to improve the resistance of concrete to corrosion by mild acids and other *reagents* that attack the cement. Developed by the laboratories of Semtex Ltd., a Dunlop subsidiary, 'Furacrete' replaces part of the guaging water during the mixing of concrete. When the cement is hydrated in the normal manner, the resin remains distributed until such time as acid solutions come into contact with the concrete. These acids harden the resin into a corrosion resistant mass, and dilute acids cannot damage the cement.

ESSENTIALS OF DAM SITE INVESTIGATIONS

By Malik Ramiz Ahmad.

IN THIS BRIEF ARTICLE THE AUTHOR HAS EXPLAINED THE ESSENTIAL REQUISITES FOR INVESTIGATING A SITE FOR DAM CONSTRUCTION. THE AUTHOR HAS BEEN CONNECTED WITH SEVERAL RECENT INVESTIGATIONS AND THIS ARTICLE CAN BE A SOURCE OF INTEREST TO MANY READERS.

INVESTIGATIONS for a dam site consists of three stages, RECONNAISSANCE, PRELIMINARY and FINAL.

Reconnaissance stage commences with the study of a scheme from maps, a quick field visit to determine elevations of specific points, nature of rock foundation and collection of some hydrological data. In the preliminary stage studies are undertaken for selection of a suitable site, geology of the dam site, type of dam suitable for that site, location of spillway, power tunnel, diversion tunnels, power house, camp area, and location of material of construction. The first two stages of investigation precede the authorised construction.

In the final stage when a project has been authorised on the basis of preliminary investigations, detailed investigations are carried out for selection of the type of dam, surveys are conducted both for site and materials, extensive foundation studies are conducted and hydrological data is analysed.

SELECTION OF THE TYPE OF DAM

The foremost consideration in the selection of any type of dam is the safety of the structure, commensurate with economy. The factors which determine the type of a dam are topography, foundation, constructional materials, diversion and care of the river during construction, spillway and outlet works.

The usual and widely selected type of dams are the straight and arched gravity, arch dams, rock-fill and earth-fill dams. The suitability of each type depending upon a particular condition is discussed below.

GRAVITY DAM.—These dam are generally made of mass concrete or stone masonry. They depend on cantilever action to carry the water load into the foundations which should be stable enough to withstand the maximum pressure coming over them. Then pressure is maximum at the heel when the reservoir is empty and at the toe when reservoir is full. Such dams are adaptable to all types of localities but its height is determined by the strength of foundation. On earth foundations it is limited to about 65 feet. One important factor in the consideration of gravity dam is the availability of suitable and sufficient quantities of concrete aggregate either in natural form or crushed rock.

The advantages of a gravitydam are that diversion can be built in stages. During working season dam can be built as high as possible and the river can be allowed to flow over it during floods. Even a portion of the dam can be used as spill

* Executive Engineer, Jhelum Dams Division, Jhelum.

way, thus reducing the cost of the project. Outlet works and sometimes power house structure can be accommodated in the body of the dam.

ARCH DAM :

This type is adopted when the length is small in proportion to the height and the sides of the valley are made of good rock that can resist end thrusts. Usually the length of the dam should not be more than two and a half times the height.

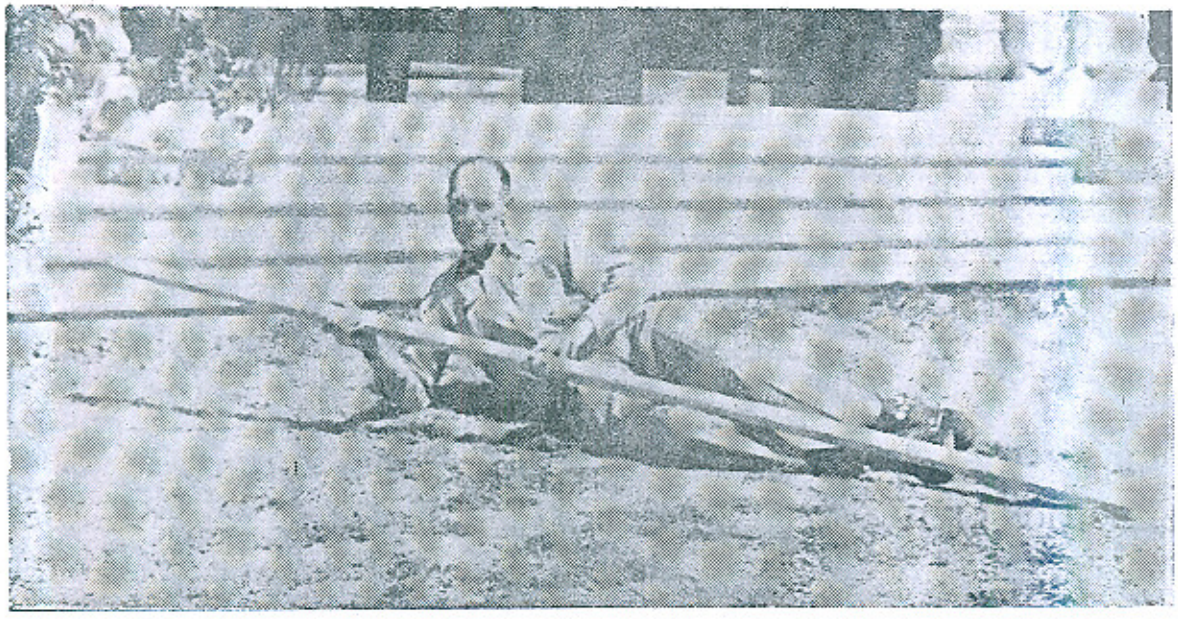
EARTH DAM :

For weaker foundations which cannot take the load of gravity dam, earth dam is generally prescribed. This type of dam has the longest base in proportion to height and, therefore, pressure intensity is less on the foundations as compared to other types of dams. Besides, since the quantity of seepage through pervious materials is inversely proportional to the distance the water has to travel, it is suitable for pervious foundations. As a large quantity of both pervious and impervious materials are required, it is very essential that sufficient materials should be available within economic distance of haulage. Stream diversion of this type of dam is accomplished by use of coffer dams and tunnels.

SURVEYS :

Thorough survey of the site must precede any dam construction. After connecting the site to any G.T.S. Bench Mark by precision levelling, observation for X-sections of the river, one mile upstream and ½ mile downstream at 1,000 feet intervals about the proposed dam site are carried out. Important population centres and existing communication to be affected by a reservoir are marked out. Usually G.T.S. maps 1.0"1= mile, serve the purpose but sometime maps to a scale of 1"=500 ft. with contour interval at 5 ft. are prepared.

It is essential to prepare detailed maps of the area containing the dam site, spillway, diversion and outlet works. The map should extend on either side of the river



Mr. Royer Rhodes, an eminent American Geologist, with a drill core.

upto the highest ridges which are to form the abutments The scale of these maps depends upon the topography of the site. Usually 1″=200 ft. contour intervals 10 ft. will do, but if the contour falls upon each other the scale is increased to 1″=50 ft. contour intervals remaining the same.

This is a specialised job and our own field staff i.e. overseers and surveyors cannot do this work accurately unless specially trained for it. It is always advisable to get the work done by the Survey Department. Their charges depend upon the scale of the map. For mapping of area on a scale 1″=200 ft. contour intervals 10 feet, their usual charges are about Rs. 15,000 per sq. mile. These maps are used for the lay out of various structures after getting geology marked on it from some experienced geologist.

Preparation of a reservoir map to work out the capacity of a dam is equally important The usual scale of these maps is 1″=2000 ft. contour interval 25 feet. But if the contours seem to be congested, the scale may be doubled. Instead of plane tabling the work can be done more quickly and accurately by aerial photography. The cost of such maps is approximately Rs. 1,000 per sq. mile. From the aerial photographs with 60% overlap maps upto a scale of 4″ equal to 1 mile contour intervals 25 feet can be correctly prepared.

MATERIAL INVESTIGATIONS

Cement, coarse and fine aggregate are required in large quantities for the construction of gravity dam. For rubble masonry stones are needed. Cement can either be manufactured if the raw materials are available quite close to the site or brought from the nearest factory, whichever is economical. Search should be made in the flood places of the river for any deposits of water-borne aggregates. A few open pits can provide clue.

If water-borne materials are not available, search should be made for a rock



J. M. Master, Geologist getting into a 200 ft. deep excavated vertical pit for inspection.

that can provide aggregate on crushing. Limestone , quartz or hard sand-stone can give suitable aggregate. A geologist can help a lot in locating suitable band close to the site. A map showing bands of various available rocks is prepared and rock shown on it.

Suitability of aggragate and their haulage considerations will determine the ultimate choice. In mountainous regions fine aggregates are seldom available close to the dam site. This is, therefore, either obtained by crushing or brought from some other place. The stone usually used should be from a hard rock, free from mica and not brittle.

MATERIAL FOR EARTH DAM : For earth dams, materials are required to form pervious, impervious and rip-rap zones of a dam. Soils are classified as pervious and impervious according to their coefficient of permeability. The latter is defined as the rate of flow of water through a unit section of soil under a unit head at a temperature of 60 degree F.

A few open pits are made in the area from which materials are to be obtained. These pits will indicate the nature and quantity of the available materials. Large blocks of rocks are required to protect the upstream face of the dam against rapid draw downs

and wave action. Hard lime stone is considered to be the best.

FOUNDATION INVESTIGATION

For study of foundation, geological and sub-surface explorations are very essential. For any dam site investigations, services of an experienced geologist are very essential to study the geology of the dam site area. He can identify and correlate the geologic features and thus judge their possible effect on the construction of a dam. Dip and strike of the rock at the dam site can be easily determined by him. Rocks dipping U/S add to the safety of the structure. Strike directions can help in aligning the tunnels. Some rocks do not stand firmly by arc actions if the direction of the tunnel is along the bedding plans particularly if the dip is vertical. Geologic section of the river at the dam site should be prepared by a geologist. These sections facilitate greatly the study of foundations condition.

SUB-SURFACE EXPLORATIONS: Sub-surface explorations are essential for determining the depth of overburden in the river channel, at the spillway crest and over the abutments if the rock is not exposed, the nature of materials in the overburden, the nature of bed rock under the foundations and the depth to which the rock is weathered. The methods used for such explorations are open test pits, adits, geophysical and drilling. These are described as below:

OPEN TEST PITS: Open test pits are usually limited to examination of depth of overburden. These reveal completely the nature, structure, and composition of overburden.

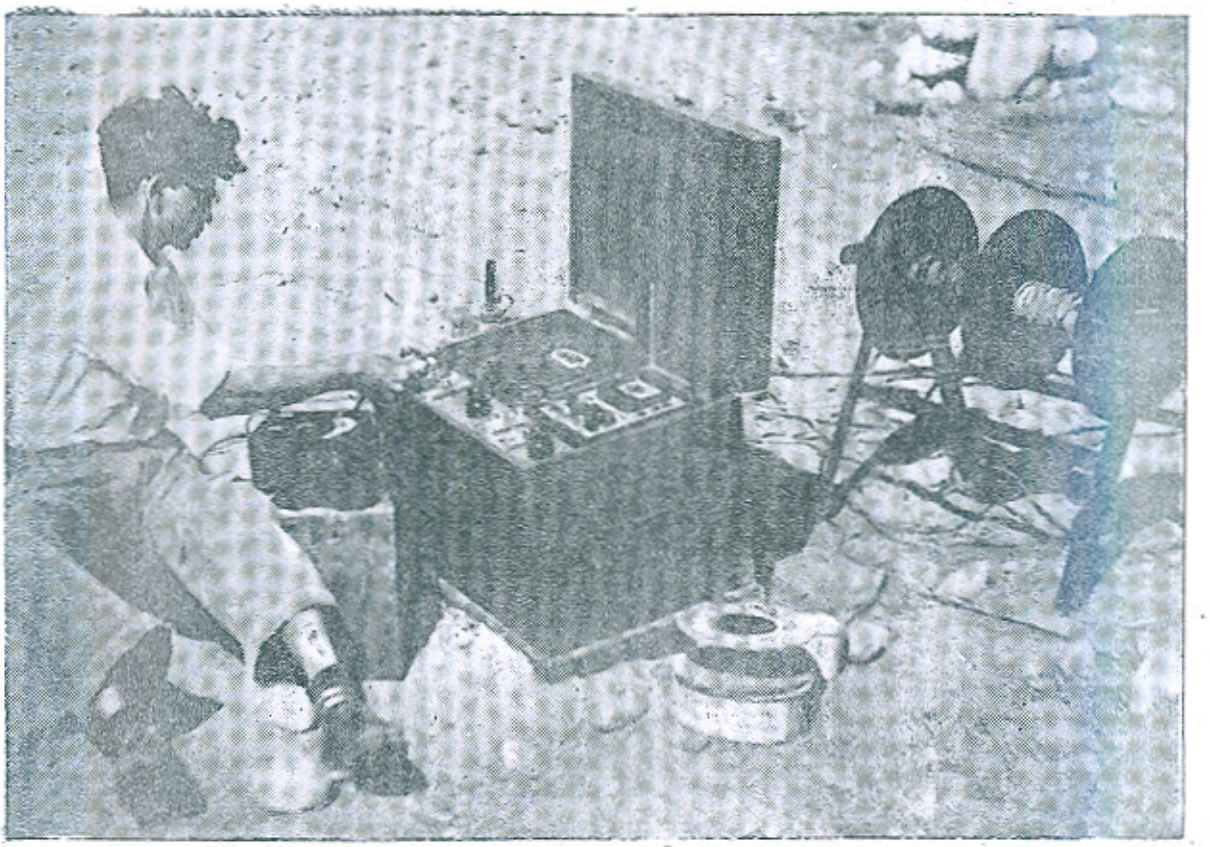
ADITS: These are shafts excavated horizontally at suitable points on the axis



Local Method of Pit Excavation

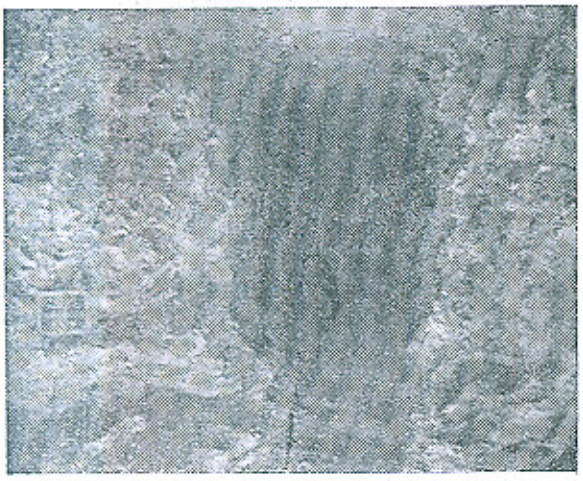
line. The convenient size for working is 8′ x 6′. In the case of foundation containing alternate layers of shales and sand stones, it is best to locate the adit at the junction of the two so that the nature of jointings are also known. In the Dams Investigation Circle adits have been excavated in sand stone, shales, granite, slate and compact sand stone.

In all the cases cribbling was not required. The excavation was very easy in compact sand and a little difficult (although done with manual labour working with jumpers and hammer) in the case of sand stones. It is very tough in the case of granite and slates whose rocks had to be blasted. Holes were made with a petrol driver warsop drill and 80% gelatine cartridges were used for blast-



Mr. Irshad uses his Electrical Resistivity Set.

ing. The excavation rates in these rocks ranges for Rs. 1/- to 1/8/- per cft.



Excavated Adit, size 8 ft. × 6 ft.

GEOPHYSICAL EXPLORATIONS

Of the several methods of geophysical prospecting the most widely used are electrical resistivity and seismic refraction. The underlying principles of electrical resistivity are measurement of potential drainage between two parts when current is induced in the medimum. This method is suitable for classification of materials, determination of the depth of overburden and indication of sheared or decomposed bedrock.

Seismic refraction is another method commonly used for sub-surface exploration in which the measurement of the rates of propagation of waves caused by explosions is carried out.

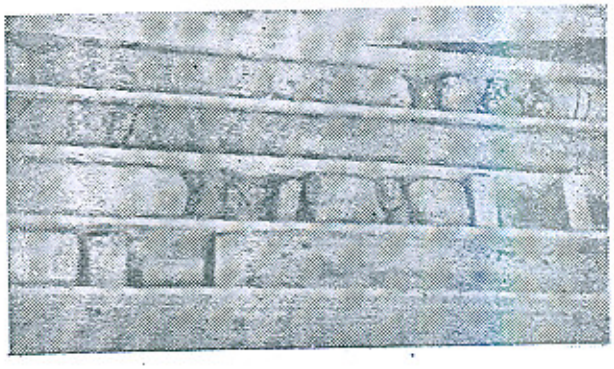
This depends upon the difference in the elastic properties of the huge rock and overburden. This method has been found more useful and dependable in determination of depth of bedrock than the electrical resistivity method.

DRILLING: One of the most reliable methods of sub-surface explorations is rotary core drilling. The machine consists of a cutting edge mounted at the end of a hollow barrel called core barrel to which are connected a series of steel drilling rods. Rotary motion is imparted to the drilling rods through a prime mover. The cutting edge may be made of carbide steel or be set with small diamond bits. Two types of drilling machines are being used in the Dams Investigation Circle. One is Craelius make and the other Longyear one. The rate of drilling per foot obtained in the Dams Investigation Circle varies from Rs. 24/-to Rs. 36/- depending upon the nature of rock.

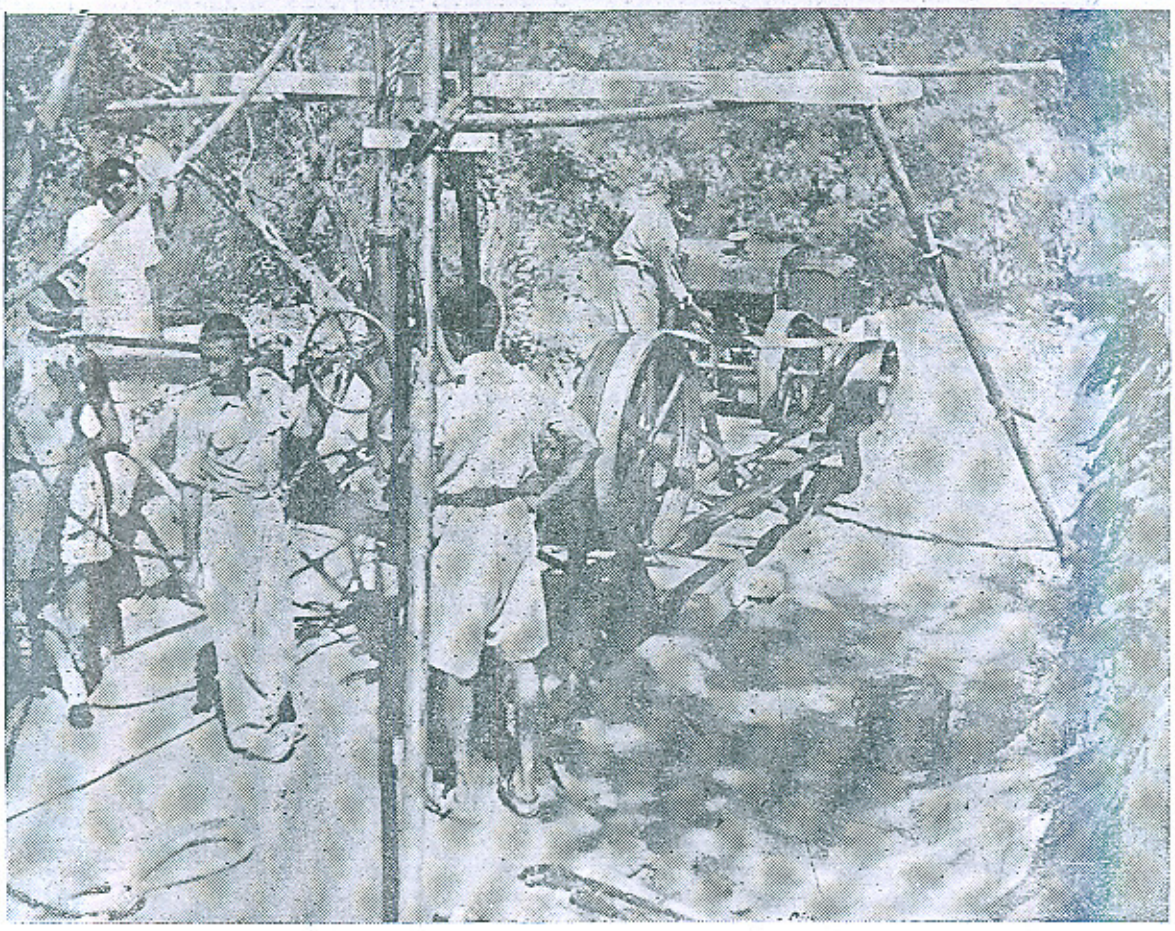
The cores obtained from drilling should be carefully preserved. These may be placed in woodden case boxes 5'x1' in size, divided into troughs just wide enough to take the core. Cores obtained from shales strata slake on exposure to air. These should, therefore, be immediately coated with wax and preserved in core box.

HYDROLOGICAL DATA

It is one of the most important data which effects design of all the structures connected with storage project. It consists of rain fall data of the drainage basin, run-off data of the river and estimation of the highest flood discharge. Rain fall data is collected from rain guage stations located in the catchment area of the river. It can be used for correlating rainfall and run off and for constructing unit hydrographies. The data collected in our country suffers from a serious draw back i.e. intensity of rain fall is never recorded. Rain gauge reading is



Core box with drilling core.



Craelius drilling machine.

taken once a day usually in the morning. This some times splits up the same storm on two days. In estimation of the highest floods, lack of intensity of rainfall is badly felt.

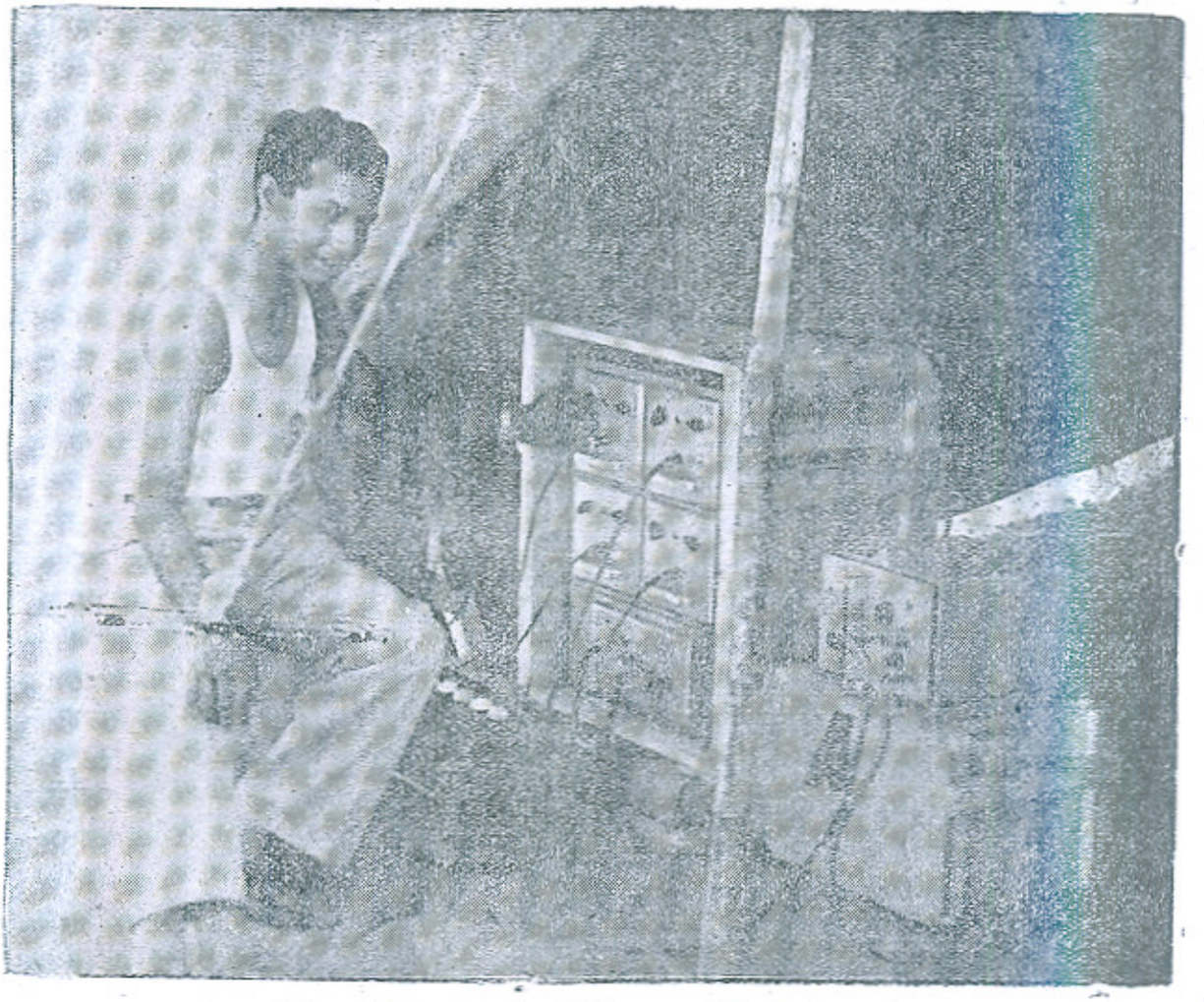
RUN OFF DATA: This is made from collection of daily discharge data of the stream over as many years as possible. From this data the annual run off of the river is calculated. In our country gauge are read in the morning as well as in the evening. Generally flood peaks are missed and therefore the data so collected gives run off on the conservative side. Estimation o the highest flood discharge is carried by the use of Empirical Formula, Unit hydrograph, highest flood marks or comparison with similar catchments. Empirical Formula generally gives exaggerated value. Unit hydrogrpah is applicable if rainfall's data extending over a number of years is available along with run off data for some of the years.

According to the highest flood marks method, flood marks are ascertained by local enquiry from the old people. These flood marks are picked up by levelling and water surface slope of the flood determined. Then by the Manning's formula velocity of flood flow and hence magnitude of flood is worked out. If the highest flood values of a catchment are known then maximum flood for a similar or a part of the catchment is determined by the formula $Q=C\sqrt{A}$

Where Q=Flood discharge
A=Area of catchment
C=A constant.

value of C is worked out for the catchment with known maximum flood and thus maximum flood for the other catchment.

SEDIMENT STUDIES: This is also one of the important data to be collected as determines the dead storage to be provided. Silt observations are carried out daily and sometimes twice a day if the discharge varies substantially. The samples are collected and analysed. The latter are best collected by a depth-integrating sampler that collects water in descending from and ascending to the water surface. The samples can be analysed in the field by setting up a small laboratory.



Mr. Mannan using Seisomagraphic Equipment.

HOUSING PROBLEM IN PAKISTAN

BY MAZHAR-UL-HAQ SAEED AHMAD*

Food, clothing and shelter are three basic needs of the man. These days the problem of shelter is indeed very pressing and also difficult of solution in our country. Any attempt to solve—this vast problem must be preceded by a systematic collection of statistics or extensive surveys to have a precise knowledge of the housing shortage that afflicts Pakistan.

ALTHOUGH the urban areas accommodate only 10% of the total population of our country, they are in need of immediate relief from congestion. The Planning Commission in India in the First Five-Year Plan has collected the following data, on their housing problem in urban areas which shows that the situation has gone worse for the last two decades:

Decade.	Increase in Urban Population.	Increase in number of occupied houses.
1921-31	.. 5.2 Million	1.1 Million
1931-41	.. 10.6 Million	1.8 Million
1941-51	.. 16.3 Million	1.7 Million

There is no such data available in Pakistan, but the general conditions prevailing in the country being similar to those in India, this data could be safely taken to depict the picture here.

The housing shortage as such is formidable, and it has been aggravated due to the continuous influx of refugees since independence, increase in population, movement of population to large cities and industrialisation. Our immediate task should, therefore be to go on building houses and making housing schemes according to current demands. This calls for a bold and an enlightened housing policy on a national level.

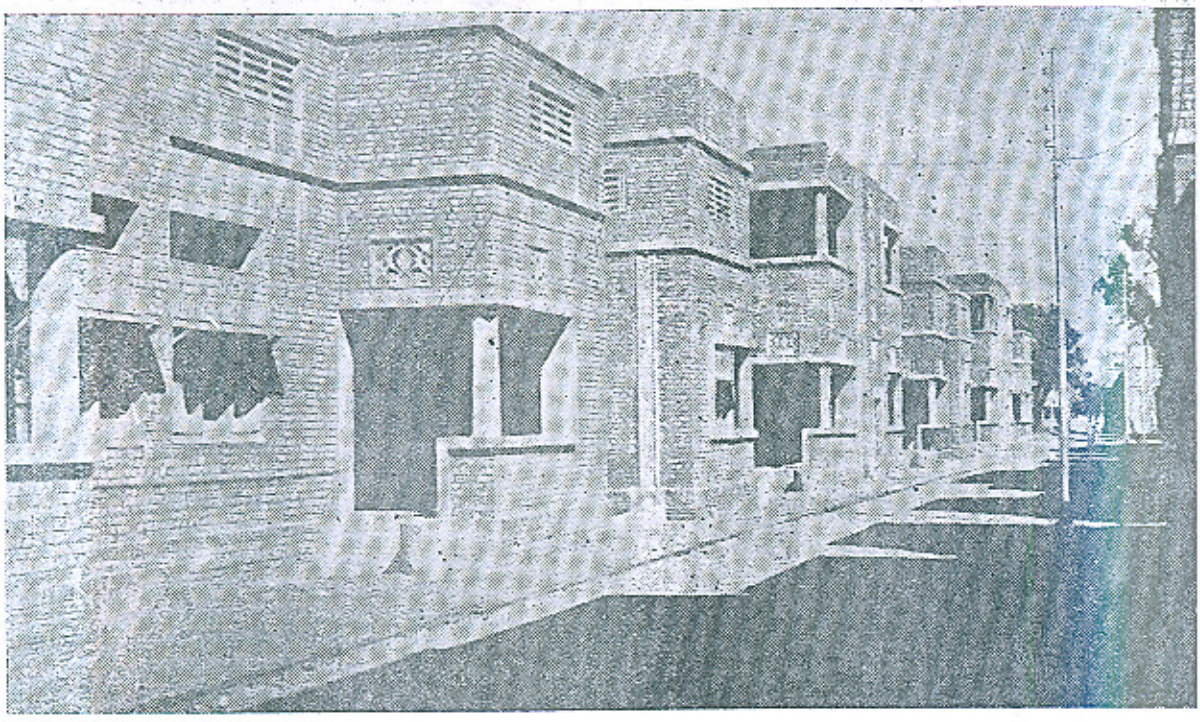
The Planning Board of Pakistan has estimated that with the yearly population increase of over one million we would need 200,000 (five persons per house) houses every year. The need for replacement may increase the figure to 300,000 or 4,00,000 a year. The Plan has a provision to spend Rs. 771.2 million (77.12 crore) from public exchequer alone by 1960, while private investment would be just as much. Out of this, a sum of Rs. 22.2 million (Rs. 2.22 crore) is set aside for survey of housing, housing conditions, country surveys, preparation of housing policy, designing of projects, experimentation, education programme, and building materials studies. The country thus needs intensive development of resources, building materials, and vast changes in our building techniques.

This articles is an attempt to deal with the prevailing high cost of houses in our country by devising ways and means to reduce their cost without going into the strictly engineering details.

Broadly speaking, a house can be split into two categories, *i.e.*, land and building. Each has been discussed separately as under:—

LAND:—Land takes away about one quarter of the total cost of a house. To create an incentive and encourage private enterprise in housing schemes, Government should provide land for housing units at cheap rates after developing the area. This is possible by utilising crown land or evacuee lands near the cities providing all amenities

*Research Officer, B and R Laboratories, Lahore.



Poonch Housing Scheme.

there and encouraging all classes of public to come forward and build houses. The incentive to the poor or the lower middle class can be given in the shape of free land and also making *nuclear* houses, giving it on a long lease ownership basis.

BUILDING : The cost of building is split up into labour charges, cost of material and miscellaneous expenses. Each has been separately discussed.

1. LABOUR CHARGES : At present, the high cost of housing construction is partly due to the high cost of labour which varies from 25 to 30% of the overall cost, with slight variations, depending upon the type of construction. Out of these, nearly 1/3rd goes to the unskilled labour, while the balance to the skilled one.

A considerable number of masons, carpenters in our country are unskilled. And there exist no working standards on which a non-technical builder can judge a worker's quality and quantity of daily output. This affects the quality and efficiency adversely, and increases the cost. There is a scheme of vocational training to produce skilled labour master masons, and technicians, etc., to overcome this difficulty. It may be hoped that these trained workers will in turn raise the general level of skill and help in reducing the cost. Another device that works well in villages is that of voluntary labour. A vast number of people both in rural and urban areas have no money to spend on houses. But they can, with a little training, contribute their own part, or full-time labour to it, thus reducing the cost of construction.

PREFABRICATED HOUSES

Prefabricated house too is an answer to the problem of high cost of labour and general construction. They are very common in Western countries, where component parts of a house are prefabricated in a control workshop, transported and assembled at site. But for our country a partial prefabrication system such as prefabrication of roof joints roof-

ing materials, windows and doors will be more suitable. The prefabricated building units should be small enough to be handled by hand or by single mechanical controvances. There is no need to have huge central factory for a vast region. Small factories spread all over the country serving smaller areas shall reduce transport charges considerably. The system of partial-prefabrication is already in vogue in Karachi where a large construction programme is going on since Independence. Some of the foreign and local firms are doing good prefabrication work there. The public has reacted not very badly to this type of construction. This could be extended to other important towns in Pakistan.

2. MATERIALS:—Materials form nearly 70-75% of the cost of the building. The supply of basic building material at cheap rates in adequate quantity is essential for the success of a housing programme without cheap material the progress of housing shall remain slow Certain suggestions given here aim at reducing cost of building material either through control or subsistence from Government.

Basic material for the construction of houses in West Pakistan are bricks, or concrete blocks, steel, cement, bajri, wood and other miscellaneous items such as electrical, and sanitary fittings or other small stores.

Each one has been separately taken up and ways for the reduction in cost of each have been discussed below.

BRICKS: The cost of bricks depends on the cost of labour, coal and land. So far, the labour and operational charges in a brick kiln mostly depend on the skill, technique and experience of the kiln owner and only a small saving can be affected on this item, unless substantial research is done in the brick burning techniques. Cost of land can be reduced if the government provides waste lands suitable for brick manufacture near the site of construction. This facility shall not only directly cut down the prices of burnt bricks, but also indirectly give an incentive to the prospective kiln owners.

Another important factor that affects the cost of bricks is coal. Slight rise in its cost, or the paucity at the mines is an enough excuse for the kiln owners to raise prices disproportionately. The rail freight of coal is approximately Rs. 20/- per ton from Quetta to Lahore and price at mines is Rs. 30/-per ton (Price July 56) that has since increased to Rs. 50/- per ton (January, 57). If the coal prices and eventually brick prices have to be brought down, freight charges should reduced to a minimum say Rs. 5/- per tons.

By improving the mining technique, it is also possible to cut down the price up to Rs. 20/- per ton at mine head. The cost of bricks can thus come down to say Rs. 25/- from the current Rs. 45/-/- per 1000.

STEEL:—(I) With increased house building in the Five-Year Plan, the cost of steel is bound to go up with the existing supplies. The production capacity of rolling mills in the country should be explored first. National requirements should be gauged as precisely as possible. Then arrangement be made for import of steel from abroad. A steady flow of steel in the market shall wipe out profiteering.

(II) Pre-stressed concrete is a cheaper material the use of which can cut down cost on steel. A bold and progressive policy is needed to interest our engineers in the use of pre-stressed concrete in place of steel as far as possible.

CEMENT: Cement is a major item in a house construction. Its prices can be reduced to say Rs. 4/- per bag (retail) without affecting the export position. It can be done by examining cost of production, controlling prices or promoting healthy competition between the manufacturers. Reduction in freight is again a factor that bump down the prices considerably. Out of a total retail price of Rs. 5/9/- per bag of cement at Lahore (Prices July, 1956), as freight is as much as Rs. 1/-/- per bag from the Wah Factory, while basic rate at the Factory is Rs. 3/13/-per bag, -/6/- as tax and -/6/- handling charges. Concession in freight is normally given on fresh fruits

to cut down prices. Similar concession for building materials is bound to boost up housing programme.

WOOD: Wood is another problem for our builders. We have very little forests in our country and whatever we have are being rapidly used up. The picture is indeed very dark in this respect. Some of the alternatives are:

(a) To use country wood such as shisham, keekar and others in 2nd class houses, and find ways and means to get a first class stuff out of them. In this way we can save deodar and other good quality wood for better purposes.

(b) To reduce the number of doors and windows, etc. in a house to the minimum possible.

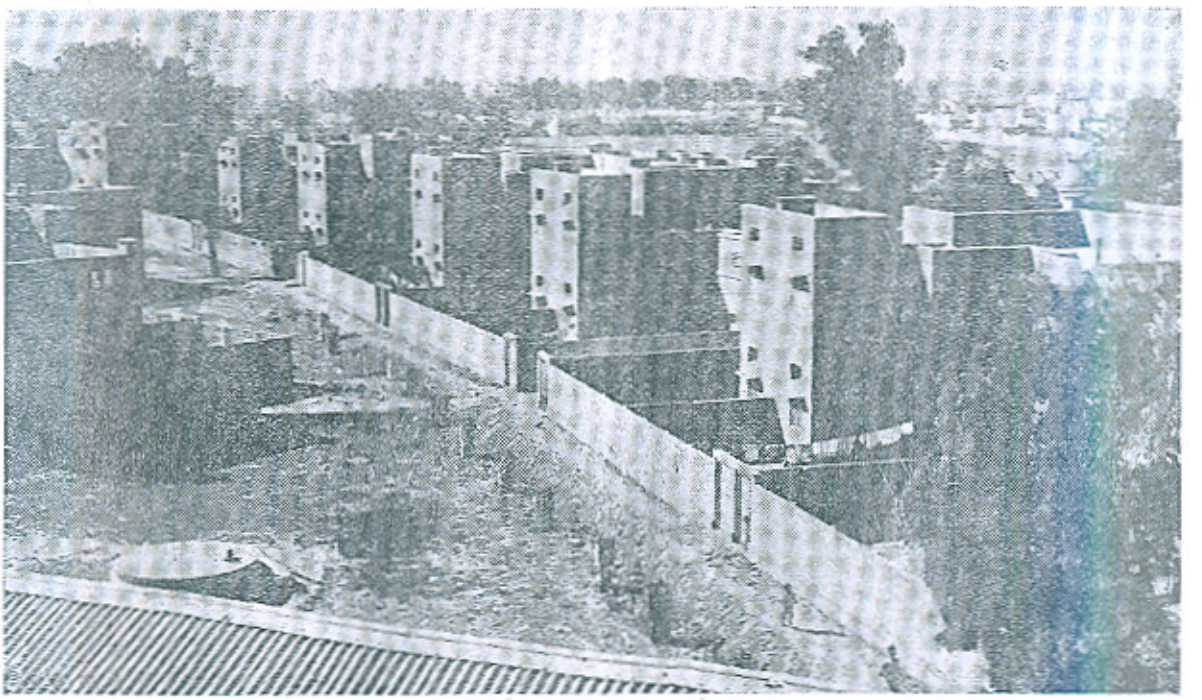
(c) To find out alternative materials, such as pressed cardboard, or other synthetic materials for making doors and windows and to use minimum of wood in them.

(d) To import wood from India if it can be procured on easy terms, preferably on barter system.

BAJRI: This material where locally available does not present any problem but rather simplifies construction, such as at Karachi or a part of Ex-Frontier. The prices of bajri at distant places range upto Rs. 120/- per % C.F.T. (such as at Multan) with the basic rate at origin as only Rs. 26/-/- per % C.F.T. Railway freight mainly contributes to the cost, which can be cut down to its minimum. Bajri is used in roofs, floors etc. But as it is a costly item, efforts should be made to find out alternative materials. Light roofs with prefabricated wood-sand cement sheets, or straw cement sheets could be used in place of bajri.

RESEARCH IN BUILDING MATERIALS AND TECHNIQUES

Research in the planning of low-cost houses, building techniques, and for cheap materials needs immediate attention. The shortage of housing has been a problem for all European countries after the war, and still continues in Far Eastern countries. The work done so far in these countries on new techniques in construction could be usefully



Quarters of Wahdat Colony.

employed subject to suitability for our conditions.

The following points will go a long way in meeting the shortage of housing material :—

(a) Boards comprising engineers, socio-economists and industrialists be constituted to collect statistics on housing needs, investigate the prices of materials and find out ways and means to bring down the prices. The Board should constantly keep a minimum ceiling price, by seeking help from the government or reduction in taxes, or by more liberal imports of the material that is not available locally in enough quantity.

(b) Reserach board of engineers, with sound technical knowledge, be asked to work on "Low-Cost Houses" and find out most economical use of material available locally for large-scale construction. The Research Board shall also try to find out, alternative materials.

The Board may start government-sponsored pre-fabrication factories and give lead and to advice private factories. This board shall ultimately determine the shape of things to come and put a new life into the entire scheme of housings and settlements planned for the country. The resultant gains shall more than far balance the expenditure on this research. The Board can also profitably draw on the experiences of India and the Western countries to meet this problem.

(c) To train skilled labour and ensure a uniformity in construction programmes and output coupled with efficiency.

(d) To investigate the possibility of reduction in freight charges of building material for a period of five years initially.

STABILIZING SHOULDERS WITH EMULSIFIED ASPHALAT

To provide greater safety for the motoring public and to reduce maintenance costs, road shoulders (berms) can be stabilized with a mixing grade of emulsified asphalts, followed by an emulsion seal. The result is a satisfactory shoulder at lower cost. SS-I (Asphalt emulsion) can be safely used for this purpose.

Steps in the stabilizing procedure are adjusted to meet the varying conditions, but usually begin by sprinkling the shoulder with water to hold the *fines* in position. The next step is to grade the shoulder material away for the pavement to a depth of 1 in. The emulsified asphalt is then added in several shots sometimes diluted with about 50 percent of water. The addition of water helps the dispersal of emulsified asphalt through the shoulder material.

The application continues until about 0.6 to 0.8 gallons (American) per sq. yd. is in the material. It is aided in dispersal by occasional blading. The finishing grader is equipped with a layout "boot" to give a straight shoulder line to the surface. It makes the final layout pass, followed immediately by rolling with a steel-wheel roller. When rolling is complete, a final light shot of mixing grade emulsion is applied and the surface covered with coarse sand.

A curing period of 7 to 10 days is allowed before application of a final seal consisting of 0.25 gallons per sq. yd. at Rs. 2 quick-breaking emulsion covered with $\frac{1}{4}$ in. to No. 10 oil aggregate. This final seal is then drag-broomed.

After the procedure is standerdized, the maintenance crews are able to stabilize about $1\frac{3}{4}$ miles of 8-ft., shoulder per day.

In the dry regions of West Pakistan, dust is a constant source of nuisance for the road user. Serious accidents have taken place due to poor visibility on the road. These hazards can be avoided if the road shoulders are stabilized with emulsified asphalt which is cheaper and effective in results.

ABBASIA CANAL EXTENSION PROJECT

*BY A. HASSAN

From the Panjnad Headworks situated just below the confluence of the Sutlej and Chenab Rivers takes off the Panjnad Canal which was constructed as a part of the Sutlej Valley Project to provide non-perennial irrigation to 12½ lakh acres of land in the District of Rahimyarkhan in the former Bahawalpur State.

FROM the Panjnad Headworks situated just below the confluence of the Sutlej and Chenab Rivers takes off the Panjnad Canal which was constructed as a part of the Sutlej valley project to provide non-perennial irrigation to 12½ lakh acres of land in the District of Rahimyarkhan in the former Bahawalpur State.

The Abbasia Canal too was being constructed at the same time from the Panjnad Headworks at a cost of Rs. one crore to provide perennial irrigation to 2¾ lakh acres. But when it was nearing completion, it was decided to abandon it in view of the difficulties that were experienced in the slump period of early thirties in the colonisation of the State. It was then decided to divert the perennial share of the Abbasia Canal into Panjnad Canal to provide perennial irrigation to the areas lying to the south-west of the railway line from Khanpur to the western end of the former Bahawalpur State.

This area of nearly 3.5 lakh acres has brackish sub-soil water and the cultivators have to depend on the canal water for drinking and irrigation. The rest of the area along the Panjnad Canal lying between the river and Lahore-Karachi railway line has sweet sub-soil water and being served with non-perennial irrigation largely depends on wells in winter for wheat and other Rabi crops.

ECONOMIC DEPRESSION

As the world-wide economic depression was over in the late thirties and the prices of agricultural product went up the colony lands began to develop very rapidly. There followed a rush of colonists from the former Punjab. Colonisation got further impetous during the war when the prices of agricultural produce shot up and the demand for land greatly increased. On account of pressure of population on the land and increased demand of food-grain for war purposes, it was decided by the Bahawalpur Government to reconstruct the abandoned Abbasia Canal as a post war development project.



Shisham Plantation

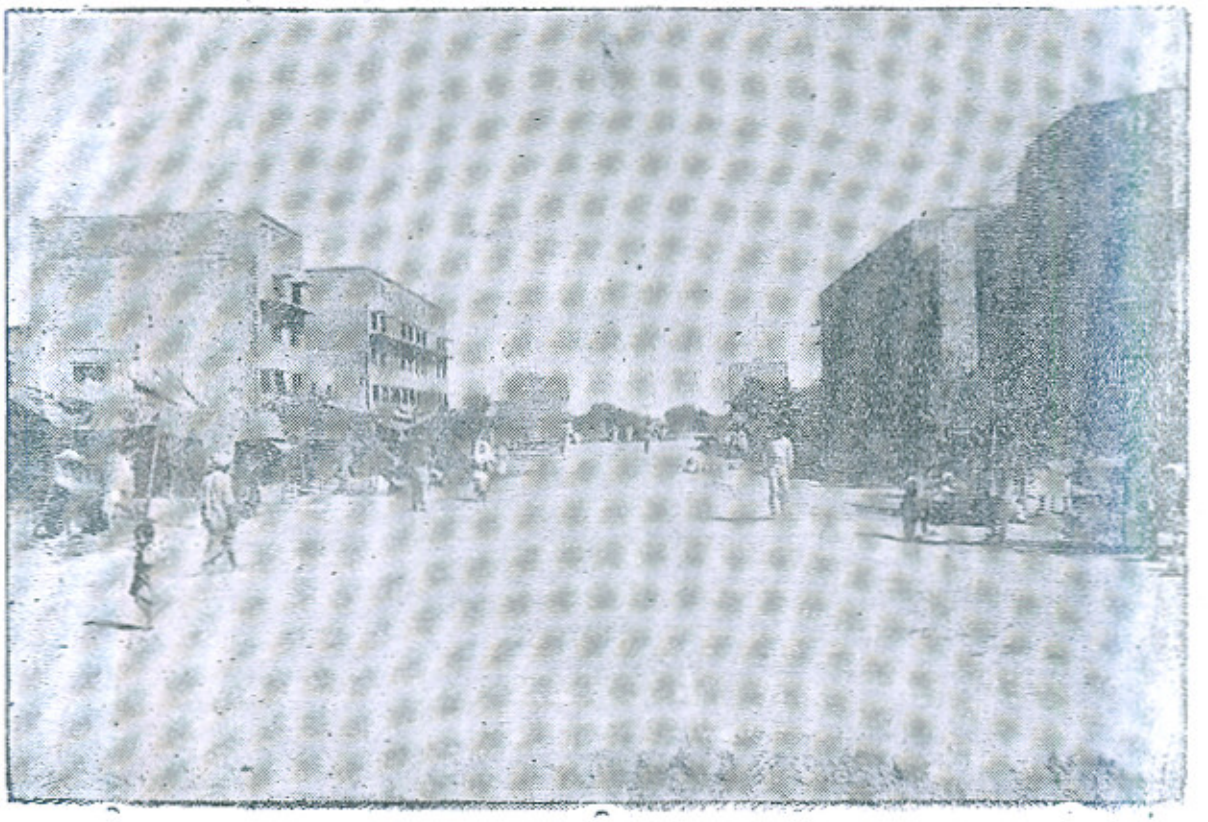
This raised the question of additional water required for the development of new areas. The Panjnad Canal was constructed

* Deputy Chief Engineer, Irrigation Branch, Bahawalpur.

in the S.V.P. with a capacity of 9,567 cusecs at the head. The maximum discharge of 1,500 cusecs flowed in the abandoned Abbasia Canal in winter to provide perennial irrigation to the areas towards its tail end. This results is exceptionally heavy losses through seepage not only in the main canal constructed with 6 times the capacity but also in the three big branches that run in winter with about $\frac{1}{3}$rd of their Kharif capacities. The seepage not only reduces supply of water to the Rabi crop, but also damages the land along the canal through water logging.

nad Canal to the Abbasia Canal. The heavy losses through seepage in the Panjnad Canal and its big branches will be avoided in this way. The water thus saved will meet the increasing need for irrigation of $2\frac{3}{4}$ lakh acres along the Abbasia Canal.

Through the north eastern part of this area, the whole of which is a crown waste land, passes the Lahore-Karachi main railway line and six railway stations situated between Dera Nawab Sahib and Khanpur lie within this area. A new Mandi town, Liaqatpur, has been built near one of these railway stations. Four



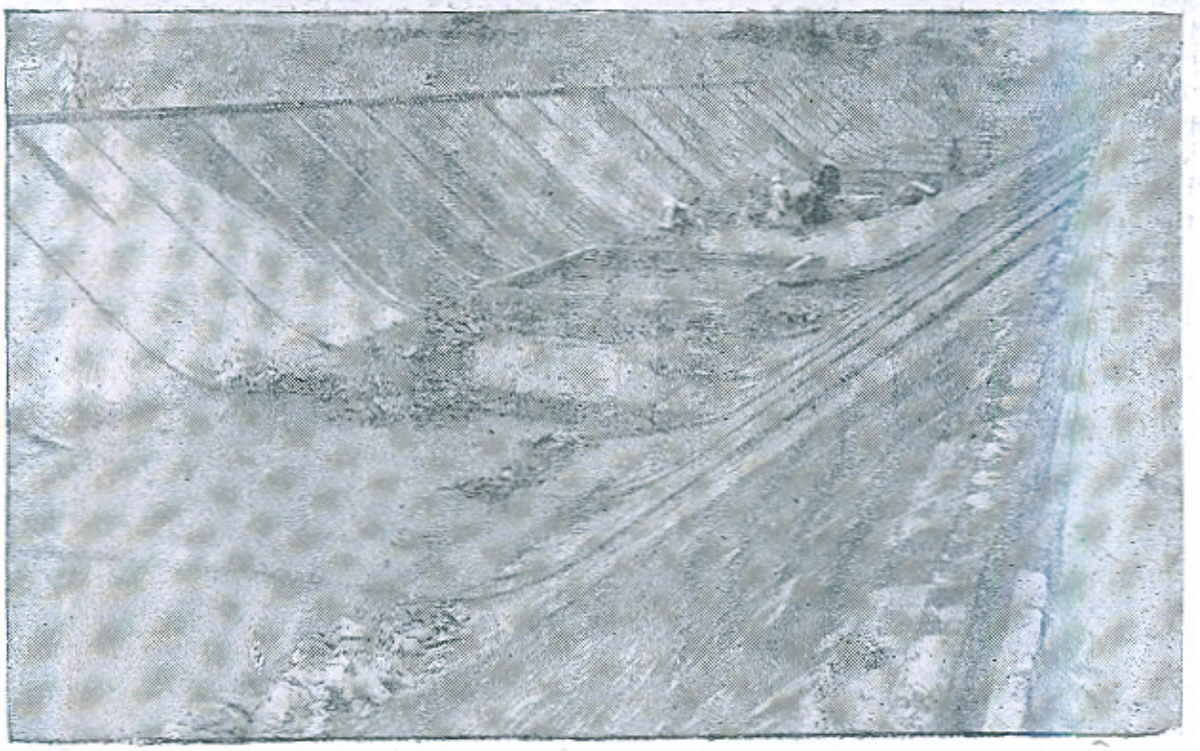
Mandi Town of Liaqatpur

EXTENSION PROJECT

The Abbasia Canal Extension Project envisages the lining of the Abbasia canal and connecting it through a feeder to the heads of all the perennial distributaries of the Panjnad Canal system. These distributaries will be transferred from the Panj-

cotton ginning mills and one steel rolling mill are already functioning in this new mandi town.

The work on the canal was started after the war but to irrigate some of the area without waiting for the lining it was decided to split the Project into two stages.



Abbasia Canal Lining

The first stage comprised reconstruction of the Abbasia Canal and irrigation of about 60,000 acres of crown waste land. It was taken in hand in December, 1946. The lined canal was opened in 1948-49. It proved of such a great help in settling thousands of people uprooted from India after the independence that the Government of Bahawalpur decided to extend the first stage and uptil now irrigation facilities have been provided to about 1.3 lakh acres at a cost of about Rs. 37 lakh.

SECOND STAGE

Due to shortage of cement in the country the lining of the canal could not be undertaken in right earnest till 1955 when the Bahawalpur Government decided to go ahead with the work and sanctioned Rs. 346 lakhs for it.

This is the first project of its kind in as much as it aims at improving the existing irrigation system by preventing colossal waste of water. The project is very productive because every acre on it is crown waste land. If the whole area of $2\frac{3}{4}$ lakh acres is to be auctioned it will fetch over Rs. 10 crore. The Bahawalpur Government, however, in order to help the refugees and landless cultivators has decided to adopt the following scheme of colonisation:—

(1) 25% of area to be sold to the moneyed people and reserved for the Government farms.

(2) $37\frac{1}{2}$% of area to be allotted to the local landless peasants from congested areas of the State on cheap abadkhari rates on easy instalments.

The total cost of the Project including lining is estimated at Rs. 383 lakhs. The disposal of land is estimated to fetch over Rs. 532 lakhs inspite of the fact that $\frac{3}{4}$th of the land is proposed to be given away to the peasants in small lots at concession rates.

The progress of the Project has exceeded all expectations. A visitors joy knows no bound to see this desert bloom. The secret of the success is that there are no big absentee landlords in this area and that the land has been given to the tenants in small lots of 12½ acres each. This type of cultivator; knowing that the land belongs to him works on it day and night with his whole family and the charm of ownership is turning the sands into gold.

This colonist does not depend on bull dozers and tractors for breaking up sand dunes and levelling his land. Working day in and day out with determination he breaks up and levels down the sand dunes, 10 feet high or even more, with the help of his bullocks and camels. It is very gratifying to meet the once landless refugees who started the up hill task of breaking up the barren lands only 5 years ago but who is now a proud possesser of garden in its small holding of 12½ acres. Tied in his small house are two or three milch cattle that supplement substantially his monthly income. There is a smile on the face of the colonist, smile of satisfaction at the fruits of his hard labour.

FOREST PLANTATION

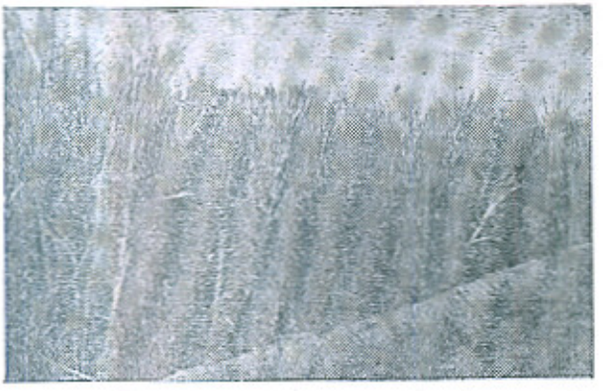
An area of 10,000 acres along the left bank of the canal has been reserved for forest plantation. Plantation was started in 1949 by the Irrigation Deapartment. The progress of plantation is exceedinlgy encouraging. Shisham nurseries were started on the berms of the canal. Maintenance cost of nurseries on the rich and moist soil of the berms was found to be almost nil. The Government supplies free stumps from its nurseries as a measure to encourage the colonists to plant shisham trees along their water courses.



Colonist's Bull Dozers

This experiment yielded excellent results. Going across the rapidly developing colony, a visitor sees tens of thousands of shisham trees in regular rows along the water-courses and clusters of trees around the busters. These serve as valuable wind breakers. There are more shisham trees per square mile in this young colony than in most of the older colonies in the country. This has completely changed the face of the area which only 5 years ago was a sandy waste.

A 5,000-acre plot of land near Khanpur is reserved for a sugar-cane farm for the proposed sugar factory at Khanpur. The land is very suitable for sugar-cane. The production of sugar-cane is double at this plot than the land along other canals.



Sugar-cane field in its first year of colonisation.

A plot of 1,000 acres adjacent to the sugar-cane farm has also been reserved for a Virginia Tobacco Farm

5,000 acres are reserved for settling cultivator from the Tribal area.

OTHER ADVANTAGES

Immediate relief to the refugees is not the only advantage gained by opening up of the unlined canal. Some important aspects of splitting the Project in two stages are the advantage gained from construction point of view.

By running of the Abbasia Canal and the feeder as Katcha channel under the first stage, great advantage has been gained in the staunching of canal banks and growing up compact silt berms with the runnnig of the channels during Kharif. Compaction of banks of a newly constructed earthen channel for the lining to rest on, is the most important, difficult and expensive. job. If this work is not satisfactorily carried out settlements and failures of lining occur. On the Abbasia Canal Project this difficulty has been overcome by running the channel as unlined to start with. The capacity of the unlined channel has been so adjusted that it gives a bed width suitable for lining for the final discharge. For example for a head reach final capacity of 2200 cusecs after lining, an unlined channel is constructed for 1,000 cusecs.

Another advantage of running the canal in its entire length under the first stage is that water is made available in the desert for the manufacture of brick tiles required for lining.

Lastly the running of the canal in Kharif season has helped to transport the river sand to the bed of the canal to be used for lining.

THIRD STAGE

There is also proposed a third stage of this Project. That comprises construction of a lift (24 feet) feeder from mile 7 (near Uch through which the Sui Gas pipe line passes on its way to Multan) of the Abbasia Canal to provide water to 2¾ lakh acres of crown waste land lying to the south of Dera Nawab Sahib towards the famous Derawar Fort.

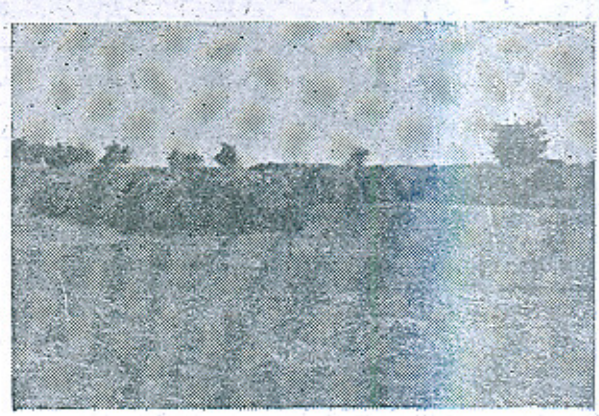
This area was originally to be irrigated by the Bahawalpur Canal, taking off from Islam Headworks, but was abandoned in 1932 due to the shortage of water in the Ghara Reach of the River Sutlej.

During Rabi when water in the Abbasia Canal is not enough for the additional requirements of the third stage, it will be obtained from tube-wells proposed

to be sunk in the head reach of the Abbasia Canal and the heavily water-logged areas in the head reach of the Panjnad Canal.

During the summer when water is available at Panjnad, the tube-wells can be stopped to reduce their working cost. Moreover during the monsoons when the supplies are available from the Islam Headwork even the pumps of the lift feeder can be stopped and water delivered to the area through the Bahawalpur Canal.

When completed, the Abbasia Canal Extension Project will provide perennial irrigation to nearly 5½ lakh acres of crown waste land and add very greatly to the production of food grain and cash crops.



Harvested wheat crop in the new land of the Colony

CHEMICALS DRY-UP PUMP PIT JOB

By C. MARTIN RIEDEL

Pit excavation in wet fine sand is being accomplished with the minimum of difficulty-after chemical soil solidification as Chicago's Department of Water and Sewers modernizes its old pumping stations.

Fine sand, largely water bearing, extends from ground level at El. 8 to El. 12. A stiff plastic clay extends from El.12 to rock at—35.7. Pit excavation has had to go to El. 27, and it has been a most tiring operation. The City Construction Division chose to use chemical soil solidification, a method employed successfully several years ago in the Chicago subway (Dearborn St. section) against a head of about 50ft.

According to the process based on the invention in 1925 of Hugo Joosten, Haarlem, Holland-two *carefully balanced* chemicals are *consecutively* pressure-injected into the loose soil to be treated permanently (no matter whether dry or wet): The first one, called Chem. I "joostenized" silicate of soda solution, is followed immediately by a strong calcium chloride solution. As both chemicals meet in the ground a rapidly-forming silicic gel of high surface tension converts the loose sand particles together into an insoluble, sand-stone-like mass of a hardness varying between 150 psi (about 11 tons per sq. ft) and 900 psi (about 65 tons per sq ft.), depending on the character of the loose material.

Properly solidified soil is watertight and withstands the attack of acids found in groundwater or saltwater along the shore. Hardness of the artificial sandstone increases with time. The *bond* to steel or iron is almost the same as that of concrete to steel. To obtain complete watertightness around the deep pit at this job, a 24-in. spacing of the injection was selected, which increased the structural strength of the treated area against the horizontal thrust of the hydraulic head, after excavation.