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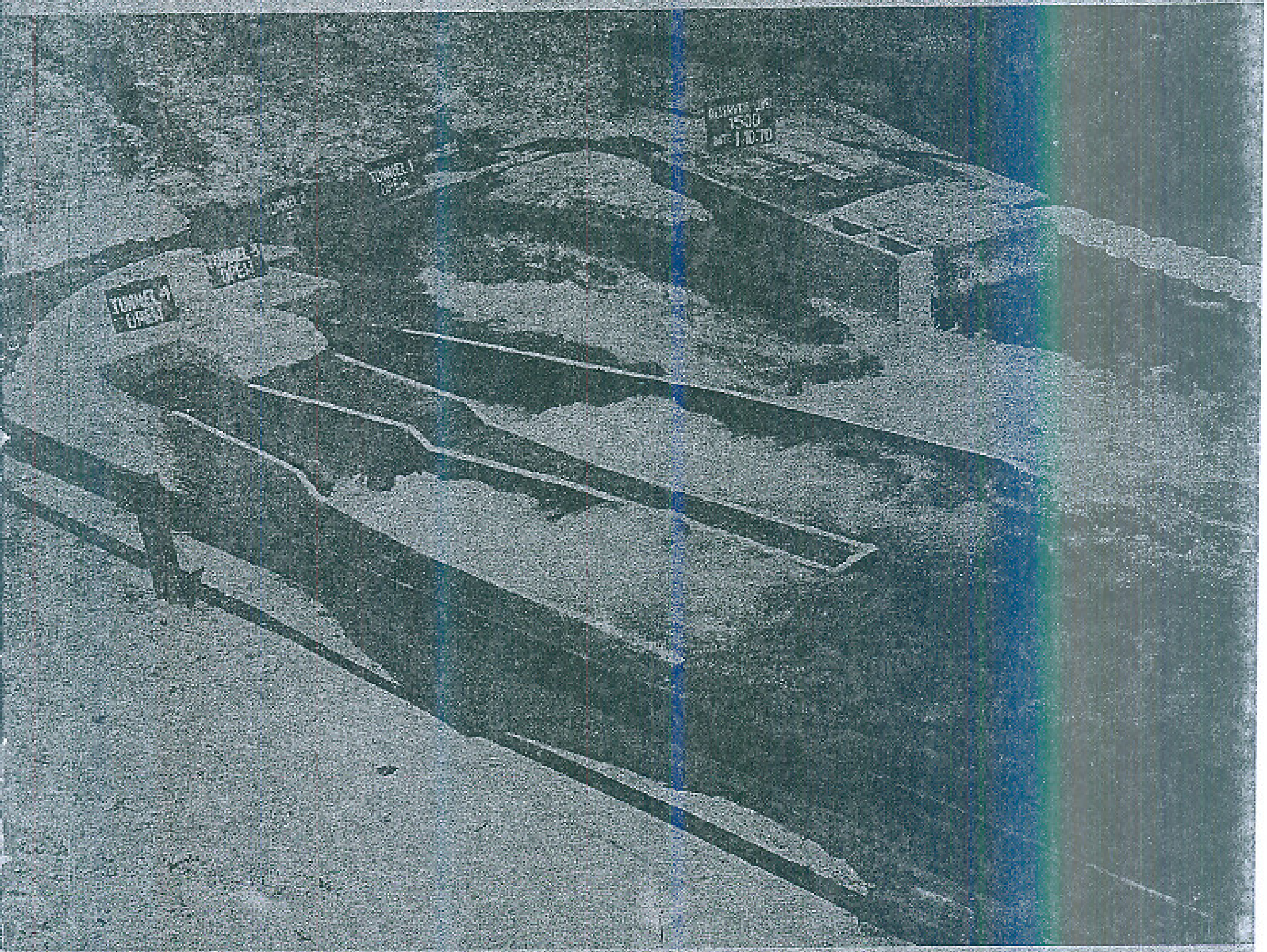

QUARTERLY JOURNAL OF THE
WEST PAKISTAN ENGINEERING CONGRESS, LAHORE

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SIXTEENTH YEAR OF PUBLICATION

ENGINEERING NEWS

Quarterly Journal of the West Pakistan Engineering Congress

Vol. XVI JUNE, 1971 No. 2

In this issue

TITLE COVER

A view of the Model for outlet of Tunnels 1—4 of Tarbela Dam being studied at Hydraulic Research Station, Nandipur.

Printed by Mirza Muhammad Sadiq at Ripon Printing Press Ltd., Bull Road, Lahore.

March Towards Self-Reliance

Nothing corrodes the essentials of the sovereignty of a nation more than its dependence on foreign powers for its economic sustenance. Freedom is the essence of life and it cannot be bartered away for any material gains. No subjugated country has ever been seen to remain content with the chains of slavery, just because that might be holding a vague promise of one more crumb of bread. The nations have swam through the rivers of fire and blood just to hold their heads high as free and independent nations. To attain the independence is paramount and so is the necessity to retain it eternally. Exernal vigilance is the price of freedom and no dignified nation ever shuns it.

Pakistan is passing through the most critical period of her life. The very existence has been conspired against by its enemies. Subterfuge, treachery, subversion, armed attack direct and indirect: which weapon is not being tried against it. The latest additions to this has been the leverage of foreign assistance which some countries have deployed to ask us to surrender our independence, sovereignty and solidarity. The Consortium countries have underrated our love for independence and definitely have misunderstood the character of this nation. No nation ever barters its independence for the promise of good plums in the cake.

What is the foreign assistance? It is nothing more than the moral repayment of the debt that these erstwhile colonial powers owed to the recently freed nations, whom they exploited, plundered and impoverished during long periods of their occupation. The nations like our's were not left behind for some natural phenomenon, but because of the fact that when the human knowledge was ripe for the technological advancements, we were already reduced to the position of 'hewers of wood' and 'drawers of water'. When after a few centuries we re-emerged on the stage of nations to play our role, there was a yawning gap of resources and technology between our erstwhile masters, now masquerading as friends. It should have been the approach that knowledge and resources are the common gifts of Allah to all the humanity and whosoever is blessed abundantly must return a part of it to those who happen to be less fortunate. But alas! the higher values of humanity count the least. Some of the nations exploited their superiority in technology and resources to enslave the others and when the march of history blocked their way to such physical enslavement, they just changed their tactics and resorted to economic colonization. This was the worst form as in case of physical occupation the burning flame of freedom would melt the shackles of slavery, but in the new form the opium of 'assistance to develop' was a lull to sleep.

Pakistan was very craftily addicted to this opium and has now lived on it for the last 20 years. What have we gained from it? Nothing except the capital intensive consumer goods industry. Nothing except that we did not develop the indigenous resources. Nothing except that we forgot that labour is the real wealth. Where have we landed ourselves? The doling nations have the audacity to suggest a typical solution of their own for the purely internal situation of the country. This is a challenging situation. But we know the capability of this nation to face the crisis. It has always flourished through the crises and has moved from one height of glory to another through the crises.

تندئی باد مخالف سے نہ گھبرا اے عقاب
یہ تو چلتی ہے تجھے اونچا اڑانے کے لیے

It is reassuring that the nation has boldly expressed its determination to meet the challenge and has refused to be browbeaten. Of course this determination is most welcome but unless it is simultaneously matched by practical steps, we cannot ward off the evil for the future. The answer to the challenge the motto of 'self reliance'. For this the whole nation need be mobilized. Let the nation pledge that it will not consume anything which it does not produce from its own resources and through its own manpower. Let the nation pledge that it will avail of the modern technology only through the labour of its own nationals. Let the nation pledge that it will shed off the purposely ingrained inferiority complex that it lacks resources. Nothing is more untrue than this. How can a nation lack resources which has vast tracts of fertile soil, abundance of sunshine, hospitable climate, the brimful of flowing rivers and above all and the most important of a vast multitude of studious and hardworking patriots, imbibing the ingenuity of the skilled craftsmen. Once the nation does so, it is bound to be invincible and immune to such arm twisting.

The engineers of this nation have a special role to play in this situation. The nation is suffering from the twin disease of low productivity and under utilization of manpower potential. The low productivity is typical of the capital intensive industries when they are entirely dependent on imported machinery, its spare parts and to some extent on imported raw material. This was the logical conclusion of addiction to foreign assistance where the beggars are not the choosers. While we expectantly look towards foreign assistance to keep the wheels moving, our own excellent manpower remains unutilized. These are the two fields where the engineers are to come to nation's rescue. It is a big challenge, let us see how the engineers through their ingenuity, dedication and patriotism meet this challenge.

Governor Inaugurates 52nd Session of West Pakistan Engineering Congress

The Governor of the Punjab Lt.-General Attiqur-Rahman, H.Q.A., S.Pk., M.C, graced the occasion to inaugurate the 52nd Annual Session of West Pakistan Engineering Congress on 8th April, 1971.

Speaking before a big gathering of engineers of all walks of life from West Pakistan, the Governor called for self appraisal and casting away parochial feelings. This he said was the only way to meet internal and external dangers. He urged the people to dedicate themselves whole-heartedly to the service of nation for the solidarity and glory of the country for happier and peaceful future.

The following is the full text of his speech :

Mr. President and Gentlemen,

It is a matter of great pleasure for me to speak to this gathering of engineering talent drawn from almost all walks of the profession and gathered from all provinces of West Pakistan.

Right from the beginning of history the ingenuity of man has exploited the gifts of a resourceful nature by devising one method or another. The primitive man, as he fashioned the bow or carved his dwelling in the cave, reflected a stage in the course of man's engineering skill. Now the old times have given way to sophisticated techniques of the present age which require an almost continuous appraisal of the place of engineering in our lives. We have reached that point in human history where engineering and scientific knowledge have become the keynote of all progress, the basis of all prosperity, the byword for all that is good and relevant; indeed for very existence itself. There is no doubt now that the state of development or backwardness of a nation is measured by the range and sweep of its technical and scientific development.

If we have to survive in this technology-oriented world we have to intensify our efforts not only to draw upon the store-house of knowledge built by other nations but also to develop it further and adapt it to suit the needs of our own situation. We have to make our own contributions if we want ourselves to be respected and if we want to avoid the degrading label of a regular "hanger-on". I am afraid if we do not change our ways radically we shall soon find ourselves deserted by those who are now helping us; for in this fast moving world no one can afford to have a permanent dependent. In fact we have to change our whole attitude towards engineering and technology if we want to make full use of them.

Only some time back, while addressing another engineering body, I stressed the importance of working with one's own hands to achieve maximum possible results and deplored the tendency of fighting shy of it. To me the word engineering automatically brings to mind the image of field work. Unfortunately, it is true that no class of people deserves greater criticism in this respect than the higher echelons of the engineering profession. Ordinarily an engineer would, in course of time, develop greater love and passion for field work; for it is only in the field, in the actual execution of work that he can achieve personal fulfilment and prove his real worth.

In the coming days there will be greater evidence of democratic practices in our country and of accountability to the people. There will be a gradual levelling of economic extremes in society and consequently there will be a change in concepts as to what constitutes true public service. We must all be prepared for that period when the talent and energies of everyone will have to be turned to the public good. The engineer, in particular, must start learning from now that the objective of all that he undertakes is the good of the people and that there is a purpose in everything that he does.

Another crying need of the time is that we should not solely rely upon engineering designs and ideas imported from other lands. Our works should reflect our own traditions and culture, our own climatic conditions and our own economic circumstances. This is the only way in which we can contribute something original and beautiful to the world of engineering and technology. We must do our utmost to exploit our own resources, and we must encourage the establishment of industries which can make use of local talent and local raw material and at the same time meet our engineering requirements. This would also help save much needed foreign exchange and build up the quality of self-reliance which is so necessary for advancement in this field.

For this purpose we have to undertake extensive research and study, and the Engineering Congress is a good forum for that sort of thing. I have a feeling, however, that there are too many engineering associations working towards the same and allied objectives. Perhaps it would be better if their efforts should be combined. Instead of several bodies chasing the same goals, co-ordinated action may bring forth some positive results.

Mr. President, you have referred to foreign consultation, and, as you have rightly said, in certain cases it was inevitable. The Government would, on its part, extend all possible assistance in encouraging local consultation. I think however that the initiative rests with the engineering community itself. Retired engineers, professionally well-known, should team up their talent and set up consultation services manned by the more imaginative and energetic among them, and I am sure they would soon start replacing foreign personnel. In this way money spent on foreign consultation could be saved and the trend of unemployment reduced to some extent.

We must take stock of the situation and examine why technology is rated low in our country, as you have just stated. You will find on analysis that people's sentiments generally represent an aspect of their experience. I am not trying to put you in the dock; considering the available resources you have worked wonders and the nation feels grateful to you for that; but there are questions one must ask oneself as an engineer.

Have you genuinely striven to raise the prestige of the engineering profession in the eyes of the people? Have you worked really hard to improve yourselves and the quality of your product? Are you willing to submit yourselves to a difficult life in order to improve the image of your profession? Have you always worked honestly and have your eyes always been on technical excellence and not on undeserved personal benefits? I admit that every individual in this nation must ask himself these questions, but being highly educated and enlightened people and literally the builders of the country, you must do so more than anybody else. This self-analysis becomes all the more necessary for you because of the unfortunate associations which the engineering profession has come to acquire in the public mind. You have to realise that respect and regard are earned by selfless service only. I admit that sometimes good work goes unrecognized by the public if conducted in a publicity vacuum. Facts and figures about engineering achievements must be placed before the people, for in this age of mass communication it becomes almost a duty that what is done for the people must be adequately told to the people.

Gentlemen, we are meeting today at a very critical period of our national history and it is only through a process of honest self-appraisal that we can remove our shortcomings; no outsider can point them out to us effectively. The people of one region have to understand and appreciate the problems and difficulties of the people of other regions. We cannot afford to be stubborn and dogmatic about our beliefs and our points of view. People who want to live together must consciously make an effort to live together. We must put aside personal, petty and parochial feelings and dedicate ourselves whole-heartedly to the service of the nation. That is the only way to meet internal and as well as external dangers. We must cease to think in terms of Punjabi, Bengali, Sindhi, Baluchi or Pathan. We must divert all our attention and energies towards the solidarity and glory of our country with the ultimate objective of achieving a happier, peaceful world where barriers of region, race and creed are blown to smithereens in the face of a passionate love for Pakistan.

Mr. President, thank you for inviting me to this important assembly. I hope your Congress continues to flourish, and I wish you all success.

Lt. General Attiqur-Rehman, Governor of the Punjab, is being introduced to the Executive Council of West Pakistan Engineering Congress, Lahore.

Delegates to the Annual Session of West Pakistan Engineering Congress during the break after inauguration.

Abridged Version of the Presidential Address April 8, 1971

Mian Alim-ud-Din, *S.K, S.Q.A.* P.S.E.I., the President of West Pakistan Engineering Congress for 1970-71, in his address of welcome outlined the activities of the Engineers in the

field of Irrigation and Power, Communication and Works, Railways and other allied branches of Engineering profession. He highlighted the work done by the Engineers after emergence of Pakistan. The replacement plan under the Indus water treaty with India under the auspices of the World Bank is a big Engineering feat, which challenged the Engineers of West Pakistan and the Engineering Community accepted it with grace.

The West Pakistan Railways converted coal fired steam Engines into oil fired locomotives, this work was done so fast that now coal fired Engines could hardly be seen on the railway tracks. The Electrical Engineers accepted a similar challenge when India cut off power supplies and gigantic programme of power production and transmission was their responsibility, which they are doing against a heavy demand load. The power production increased from 28 Megawatts in 1947-48 to 1281 Megawatts in 1970-71 including part generation of Mangla Power House. Mian Alim-ud-Din, President of the Congress, called for a total ban on the employment of foreign consultants and contractors except under very special circumstances. He also suggested that foreign General Consulting firms should Pakistanise themselves as soon as possible as it was in their own interest because it would give them longer life in developing Pakistan.

He made these suggestions to meet the unemployment problem of engineers. He said that Government departments had limited absorption capacity while the production of engineers and technicians from universities, colleges, and institutes was much more than the requirement of the Government and semi-Government agencies. The backlog of qualified engineers was growing. Unless some new avenues were in sight and doors of the industries were opened up, the problem could not be solved adequately. In this connection he urged the Government to set up a commission to go into the question of unemployed qualified engineers. Emphasis should be on the new industries with engineers-intensive bias.

He said that the Tarbela Dam was employing 350 Engineers and about 1,000 Technicians. They have no prospects on completion of the Tarbela Dam unless more dams of the sizes of the Mangla and the Tarbela were planned. The planners should have a close look at this matter and prepare plans to keep the trained personnel from Tarbela occupied after 1973-74 which otherwise would add heavily to the problem of unemployment of engineers.

He regretted that opportunity of planning, designing and execution of the schemes of the magnitude of the Indus Basin works was not fully made available to Pakistani Engineers, though a large number of them remained employed with the project. The reason was that most of the major designing and planning along with the review work was done at London, New York, Chicago where association of adequate number of Pakistani engineers was not possible. Leadership in every little department of construction was with the foreigners. Pakistanis could only play secondary or more inferior roles. This was the field where the nation had lost and the loss could not be determined in terms of figures. If Pakistani engineers could avail of the opportunity the country would have been in a position to provide specialised leadership in large number of engineering field in Pakistan and elsewhere.

Concluding his address Mian Sahib appreciated the announcement of the Government granting Class I status to the graduate Engineers, and advised the young Engineers that public should be provided with much better dispensation of service than it has been receiving so far and the ethics of working among the Engineers should have a marked change for the better.

Abstracts of the Proceedings of the West Pakistan Engineering Congress, 1971

The 52nd annual session of the West Pakistan Engineering Congress was held at Irrigation and Power, Communication Works Secretariat Premises from 8th to 11th April, 1971. The sittings of the session on 8th to 9th comprised paper readings on various intricate and complex engineering problems of the day. In this session which was attended by a large gathering of engineers from all parts of West Pakistan, 7 papers, three on uplift pressure under hydraulic structures on river beds, one on design of irrigation tunnel, one on 500 K.V. super grid, one on Power distribution system, protection and safety and one on surveying and mapping for road, were presented.

All these papers being of applied nature are obviously of vital importance for the National Development and are the gist of lifelong experience of the engineers of our country. In order to introduce the readers to the most valuable material contained in these papers, their abstracts are detailed in the pages to follow.

1. Rasul Barrage—Rana Mohammad Aslam Chohan

The new Rasul Barrage was constructed from 31st March, 1965 to 22nd December 1967. The ponding to feed the canals was started on 8th January 1966. With the establishment of the requirements of irrigation system by early February when the flow downstream was practically nil, patches of silty circles 4-9 ft. in diameter with bubbling activity of gas or air in different periods were observed. This phenomenon was repeated several times during barrage operation. With this strange phenomenon, certain quarters had the feeling that this vital structure may not be able to give its due performance in accordance with the designed structure as envisaged in replacement works. To evaluate the causes and assess remedial measures model investigations were carried out on uplift pressure. These investigations were supplemented with exploration of sub-soil geological formation, its physical and chemical characteristics including permeability, well tests, and dye tests for sub-soil water flow velocities etc. The investigations in which Electric Analog was also utilised, pointed out certain remedial measures of which the most vital is provision of gravity relief wells. With the introduction of properly placed well of a proper design, it was proved that the structure is reasonably safe for normal operation and maintenance. No untoward limitations were required to be imposed except the constant watch on the deposition of silt on the downstream side in relation to the uplift pressure which may warrant adjustment in the regulation of pattern at site.

2. **Marala Barrage: Investigation for high uplift pressure under the downstream floor-Ramiz Ahmad Malik, T.Q.A.**

Marala Barrage was designed for the following effective heads of water against uplift pressure:

Undersluices	..	U/s W.L.	812.0	Normal pond level
		D/s W.L.	787.0	Top of D/s rubble apron.
		Head	25.00 ft.	
Normal opening	..	U/s W.L.	812.0	Normal pond level.
		D/s W.L.	790.5	Top of lip wall at D/s end of floor.
		Head	21.5 ft.	

During normal building of pond level it was observed that at a critical point φ value ranged between 23.0—40.0 against the designed value of 21.0 at pier no 35. This showed that the uplift pressure on d/s floor against the aforesaid pier was high as compared to that for which barrage was designed. It was thus proposed that the barrage be operated at a maximum head across 13.0 ft. by releasing some of the water downstream. This procedure was likely to result in short supplies in Upper Chenab Canal during the period of low supplies in the river. In order to ascertain the cause of high uplift pressure, drilling through the d/s concrete floor was carried out. This was a difficult job requiring skilful handling as there were possibilities of sand blowing out if drilling was made under normal ponding conditions. Hence the drilling was made with special measures and cares. From the drilling it was pointed out that:

1. Areas of high uplift pressures lies between pier No. 31 and 40.
2. The high uplift pressure is due to the pressure of higher elevation of clay lense and low order of permeability of the zone. It was due to this that very little space was left for seepage water to flow between the toe of sheet piles and improvable clay crust.

Various remedial measures were assessed as a measure to lower down the uplift pressure, the remedial measures finally approved constituted of construction of the ten dummy piers, raising of lip wall, installation of relief wells and extension of the stone apron.

3. **Model Test for assessing the causes of excess uplift pressure under downstream Floor of Bays No. 31-40 of Marala Barrage and Remedial measures—S. M. Ayoob and Ch. Mohammad Ali, T.K.**

Hydraulic Model Studies were taken up for assessing the causes and remedial measures for excessive uplift pressures under the downstream floor of bays of Marala Barrage.

The stratification determined with the help of drilling process was represented in the model with clay and downstream end of sheet pile was imbedded in it. The model reproduced almost the prototype results. The following remedial measures for lowering φ values on downstream floor were recommended as a result of model test.

1. Providing impervious floor of appropriate dimension on the upstream of the barrage.
2. Stoppage of drainage through seepage gap between sheet pile F_2 and clay layer.
3. Providing relief wells in loose apron and drainage wells in the downstream floor.
4. Weep holes in downstream end in sheet pile to restore drainage.
5. Weighting of downstream floor either by laying mass concrete over it or construcing dummy piers.

A combination of relief wells and dummy piers has been accepted as the final solution of the problem.

4. Design of a two miles long Irrigation Tunnal for Khanpur Dam Project—S. Khalid Asmi and A. Aziz

This paper describes the design procedure of horse-shoe tunnel of Khanpur Irrigation System and of R.C.C. lining for this tunnel. The purpose of structure, limitation of design, limitation of equipments, time limit, economic and construction problems were specially kept in view while designing. The findings of geological explorations at diffrent locations which formed the basis of designs were also critically examined. The design of R.C.C. lining for the tunnel was done by Elastic Centre Method which is the standard method for such designs. Beside this the design of temporary steel ribs and circular steel ribs used as permanent lining for that portion of tunnel which runs into soft ground are also detailed in this paper.

5. West Pakistan 500 K.V. Super Grid—Mahmood Ahmad Cheema

For the proper scientific planning of the future transmission system, load flow and stability requirements of Extra High Voltage transmission system, keeping in view load growth, generation source, existing transmission voltage and their economies etc. is necessary. In this paper the pattern of development of the generation for the year, 1969, 1975, 80 and 85 are calculated. This estimate of growth of load is further divided into basic loads and tubewell loads. According to the author the major generating facilities in West Pakistan planned to meet the system power demand up to and including the year 1985 are Hydro-Power at Mangla as 800 MWs. at Tarbela, 2100 MWs, and at Guddu 1000 MWs. Besides this there are small generating stations at Karachi, Hyderabad, Sukkur and Warsak. While assessing the power requirements and its distribution in the light of abovementioned facts and figures, the author is of the view that it will be essential to divert surplus power from Northern areas to Southern areas during summer months and from Southern areas to Northern areas in winter. This distribution will, however, be influenced by new advances in Nucleur power, cost of Nucleur power, discovery in future of new gas and oil fields and coal deposits.

6. Distribution System Protection and Safety—Javid Akhtar

The author in this paper has expressed his deep concern over the increasing number of accidents on distribution system which are mainly due to the gross overloading of lines, long distribution lines and faults in consumers' installations. The types of failures generally are breakage of conductors and energisation of metal parts which are normally at earth potential. The author is of the view that for earth leakage circuit breakers and fuses be used for the protection against faults. It should also be kept in view that the earthing system should provide very low earth resistance. Similarly in fusing system the fuses should blow up in case of faults from line to line and line to neutral.

7. Surveying and Mapping for Roads—Saleem Akhtar Bhalli

Planning and designing of improved road system to meet the requirement of increased volume and intensities of traffic depends upon surveying and mapping which should be conducted to conform desired standards. In this paper the author has categorically detailed the basic requirements of surveying and mapping work for road construction. It has been stressed that frequent checks to the survey work carried out by private or Government agencies be made. Besides this, collection of accurate engineering data for design purposes and maintenance of record are essential items in survey work. The author is of the view that staking out be taken up by the department concerned keeping in view the basic characteristics of data collected during survey works.

Symposium on Problems of Engineering Profession in Pakistan

On Saturday the 10th of April, 1971, a symposium on "Problems of Engineering Profession in Pakistan" was held. In all, there were eight printed papers, while six papers were ~~presented~~ for discussion. The Symposium was presided by Mr. M. S. Minhas, Vice-President of the Congress and the Chief Engineering Adviser to Agricultural Development Corporation.

In his paper on "The Participation of Engineers in National Development," Mr. Imtiaz Ali Qizilbash, Director, Telecommunication, WAPDA, said that Pakistan could not progress unless the whole nation was allowed to participate in the development campaign. The general elections had been successfully conducted as promised by the President and what was now required was to make the services efficient and professionalised. The President's awareness of this issue was demonstrated in the setting up of the Services Reorganisation Committee. The national interest now demanded that the exclusion of engineers from decision-making institutions must come to an end.

Mr. Qizilbash said that the figure of unemployed engineers in Pakistan was between 1,500 and 2,000 and that brought into focus the fact that Pakistan was under-utilising its precious technical manpower resources. In Pakistan today, he observed 12,000 engineers in a population of 130 million: less than one engineer for over 10,800 people. As compared to that, a small but developed country like Denmark with a population of 4.5 million had about 10,000 engineers which came to one engineer for 450 people. In Turkey the ratio was 1 : 2,200. These figures clearly show that Pakistan does not possess the number of engineers required. Yet, he said, the country was confronted with a situation where there were hundreds of engineers unutilised. The Development objectives had obviously not been clear and for a developing country, this was alarming. A paper "of Engineers and Accounts" was presented by Riaz H. Bokhari, Financial Adviser and Chief Accounts Officer (Modernization) P.W.R. Mr. Bokhari is a graduate engineer and he joined Pakistan Railway accounts service in 1950. His observations are of an Engineer-*cum*-Accountant. The author feels that inefficiency in government accounting arises mainly from an arrangement under which respective accounting reconciliations, transfers, adjustments and documentations are mistakenly regarded as substitutes for an adequate system to ensure accountability. According to the author, the Engineers have, by and large, remained disinterested spectators so far. It is necessary that they should take cognizance of the developments and provide motivations, strong pressures and directions, where necessary. The advent of computor should provide an occasion for Engineers and Accountants to get together and to explore ways and means of introducing a total management information system serving both of them from the same data base. In these days of surplus engineers, it can be seriously considered whether after departmentalisation of accounts, members of this profession (Engineering) should provide the personnel for the accounting function also.

Papers were also contributed by Mr. Mohammad Umar, Mr. I. A. Zaffar, Mr. S. M. Rafi Ahmad and Sh. Nisar-ul-Haq in his paper "An Engineer in search of an image" has laid down steps for alleviating the conditions of employed and unemployed engineers.

Participating in the Symposium, Dr. Mobashar Hassan, M.N.A., the Engineer-Politician, expressed the view that the engineers had genuine problems, but these could not be solved by a mere change in service rules or structure. He was referring to the various suggestions made in the papers read at the Symposium. Referring to the position of the local Engineering talent *vis-a-vis* foreign consultants, Dr. Mobashar pointed out that it will be futile to oppose foreign capital by changing Civil Service rules. This would be possible if a sound, stable and workable Socio-Politico-Economic base was established. Mr. A. B. Akhond, Chairman, West Pakistan Railway Board, who also participated in the discussion, urged the implementation of the recommendations of the high-powered Committee on Engineering problems. He emphasised the need for harnessing the indigenous resources and for setting up much needed steel mill in the country.

Engineer's Tour

DELEGATES TO THE 52nd SESSION OF WEST PAKISTAN ENGINEERING CONGRESS VISIT SITES

A special train carrying about 70 delegates was run from Lahore to Daharki, Karachi, Hyderabad and back to Lahore.

The delegates visited the following Projects of Engineeing interest:

(*a*) *Guddu Barrage:*

Estimated cost Rs. 65 crore; for the project, is designed for a maximum discharging capacity of 1.2 million cusecs. This project which commands 29 lac acres was completed by Pakistan Engineers

(*b*) *Guddu Thermal Power Project:*

First phase having two 110 Megawatt Units have been supplied and erected by Skoda of Czechoslovakia. One 110 MW Unit in the second phase from Russia and two similar units are planned for the third phase.

(*c*) *ESSO Fertilizer Factory:*

This factory is the biggest urea manufacturing plant from Natural Gas so far in West Pakistan. This Engineering complex is running in full swing at Daharki. This enterprise is a great boon for agricultural development.

(*d*) *Valika Chemical Industries and Cement Factory Karachi:*

Polythene, a common and very important product being utilized in the present-day industry, is being manufactured in this factory. Molasses are converted into alcohol, cleaned and concentrated up to 96.7 per cent and finally is further concerted into granules of polythene.

(*e*) *Pakistan Refinery Ltd. Karachi:*

This is one of the first and initial Petro-Chemical enterprises in Pakistan. The Project was started in November, 1959 and it started functioning in October, 1962 with a capacity of 1.5 million tons. Expansion was completed in 1964 raising the capacity to 2.5 million tons. The Refinery is designed for treating light Iranian crude oil by "fractional distillation" process. In this process crude oil is separated into a number of fractions containing a narrow range of Hydro carbons. Output comprises of big gasolane, solvent, high octane petrol, blending component,

[*Continued on page* 20

New Council of West Pakistan Engineering Congress for 1971

The members of the Engineering Congress met on Sunday *i.e.* 11th April, 1971 for business session and elected unanimously Mr. I. A. S. Bokhari, Managing Director (Power) WAPDA, Wapda House, Lahore, as the new President of the Congress. Five Vice-Presidents were also elected from various Departments. The general body also elected three office-bearers and twenty members of the Council.

The new Council constituted as under:

President:

Mr. I. A. S. Bokhari, P.S.E.I.,
Managing Director, (Power) WAPDA,
Wapda House, Lahore.

Vice-President:

1. Mr. M. S. Khan, General Manager, Brush Rahman Limited, G. T. Road, Lahore.
2. Mr. M. S. Minhas, P.S.E.I., Chief Engineer, A.D.C., Lytton Road, Lahore.
3. Mr. S. I. A. Shah, P.S.E.I., Chief Engineer Building Department, Bahawalpur.
4. Mr. Iqbal Ahmad Shahab, Director Projects Wapda, Wapda House, Lahore.
5. Mian Mazhar-ul-Haq, General Manager, Greater Lahore Project. 4-A Gulberg, Lahore.

Office-Bearers:

1. Mr. Faiz Omer, Executive Engineer, 11-K, Gulberg, Lahore, (Honorary Treasurer).
2. Mian Anwar H. Rahman, Deputy Secretary Complaint Cell, S. & G. A. D., Lahore, (Honorary Auditor).
3. Mr. Ashfaq Ahmad Qureshi, Executive Engineer, Provincial Building Division, Rawalpindi, (Honorary Business Manager).

Members:

1. Mr. S. M. Rafi Ahmad, P.S.E.I., Secretary to Government of Sind, Communications and Works Department, Karachi.

2. Mr. Sultan Hamid,
Deputy Secretary,
Communications and Works Department, Quetta.

3. Mian Mohammad Shafi,
Deputy Chief Engineer,
Highway Department,
Bahawalpur.

4. Mr. Abdul Latif Mirza,
Deputy Secretary (opt.)
Irrigation and Power, Lahore.

5. Mr. Sayyid Hamid,
Director-General,
Water Apportionment Cell,
Irrigation and Power Department,
Lahore.

6. Mr. Iqbal Ahmad Beg,
Chief Engineer, Lahore
Municipal Corporation,
Lahore.

7. Sh. Mohammad Akram, S.K.,
Retired Chief Engineer,
I-E-III, Gulberg-3, Lahore.

8. Mr. Mohammad Rafiq Bangish,
Executive Engineer,
Provincial Building Division,
Abbotabad.

9. Mr. A. H. Zaidi,
Executive Engineer,
Shujabad Division,
Multan.

10. Mr. Mohammad Rafiq Shad,
Assistant Director,
Public Health Engineering Department, 11-Lytton Road, Lahore.

11. Mr. Haroon Rashid Toosi,
Executive Engineer,
Sheikhupura Division,
Sheikhupura.

12. Mr. Mohammad Khurshid,
Executive Engineer,
2nd Provincial Buildings Division,
McLeod Road, Lahore.

13. Mr. Sardar Ghulam Jaffar,
Estate Officer, Civil Secretariat,
Lahore.

14. Mr. M. M. Khan,
Executive Engineer,
Moghalpura, Irrigation Workshop Division, Canal Bank, Lahore.

15. Mr. Iftikhar-ud-Din,
Planning Officer (Highway),
Planning and Development,
Lahore.

16. Mr. G. M. Qazi,
Research Officer (Roads),
Research Campus, P.O. New University Campus, Lahore.

17. Mr. Abdul Latif Bhatti,
Executive Engineer,
1st Provincial Building Division,
Rifle Range, Lahore.

18. Mr. Javed Ahmad Malik,
Assistant Engineer,
Survey Planning and Design Directorate P.H.E.D.,
11-A Lytton Road, Lahore.

19. Mr. Azhar Arshad,
Sub-Divisional Officer,
Provincial Buildings Sub-Division,
McLeod Road, Lahore.

20. Rana Mohammad Saeed,
Executive Engineer,
Lahore Improvement Trust,
Construction Division,
47-C-Model Town, Lahore.

21. Mian Alim-ud-Din S.Q.A., S.K.,
Secretary, Irrigation and Power,
Government of Punjab, Lahore.

At the 1st meeting of the New Executive Council of West Pakistan Engineering Congress elected the following Honorary Office-Bearers.

(*i*) *Honorary Secretary:*
Malik Mohammad Ashraf,
Director, Grid System Construction,
Power, Wapda, Lahore.

(*ii*) *Honorary Joint Secretary:*
Mr. Zafar Ullah Khan,
Section Officer, Highways,
C & W Department, Lahore.

(*iii*) *Honorary Publicity Secretary:*
Sh. Nisar-ul-Haq,
Director M.P.O. Wapda, Lahore.

(*iv*) *Honorary Editor Engineering News:*
S. M. Ayoob, P.S.E.I.,
Director, Irrigation Research Institute,
Lahore.

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motor gasoline, aviation turbine fuel, kerosine, diesel and fuel oil.

(*f*) In Hyderabad the Engineers visited water treatment plant, Zeal Pak Cement Factory and Wazir Ali Industries. Wazir Ali Industries produce Tallo Vanaspati, Soap and Treet Blades. These consumable goods being manufactured in the factory are a real fruit of Engineering technology in the service of common man.

Irrigation
and
Power

Evaluation of SCARPS Deep vs. Shallow Tubewells

S. M. H. BOKHARI,* PSE-I.
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Deep *Vs.* Shallow Tubewells

Technically speaking there is no such term as shallow or deep tubewells. This terminology got the currency with the introduction of mining concept and use of deep setting turbine pumps on a large scale in the SCARP areas. In more practical terms the usual small capacity tubewells installed by Irrigation and Agriculture Departments as well as private owners are classed as shallow wells which range in depths from less than 100 ft. to about 200 ft. and are fitted with centrifugal pumps generally. Against this, tubewells installed by WAPDA in Scarps having a depth of 250 to 350 ft. and fitted with deep turbine pumps are termed as deep wells.

The controversy over the shallow *vs.* deep tubewells is as old in this sub-continent as the introduction of SCARP'S. According to a majority of local engineers deep tubewells were neither technically nor financially viable for conditions prevalent in Indus Valley but according to the foreign Consultants deep tubewells were not only cheaper as compared to the shallow tubewells but technically more efficient and, therefore, deep tubewells have been installed indiscriminately in all the SCARPS executed so far.

The advocates for deep tubewells have not weighed following important factors while making their recommendations based on theoretical economic considerations and assumptions having no bearing on the socio-economic set-up in the country.

1. Deep tubewells are necessarily big capacity tubewells ranging from 4 to 5 cusecs and consequently one tubewell is required for an area of 600 to 700 acres. Under the existing irrigation system, for such a big area usually there are 2 to 3 watercourses having a capacity of 1 to 1.5 cusecs each. It, therefore, follows that these big tubewells can serve the area only when the link water courses connecting the tubewells to the existing watercourses are there. The spacing of the watercourses depends upon the general configuration of the area which can be commended and at places it is in thousands of feet. In such cases the length of link water courses may be over 3 thousands ft. Tubewell No. 434-Alipur Unit of SCARP III can be cited as an example where the length of

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link watercourse is over 3,000 ft. and the whole of it runs against the natural contours *i.e.* from south to the north to feed the existing water courses. Thus while preparing the economies of shallow *vs.* deep tubewells the cost of link watercourses including land lost through then shall have to be kept in view, together with the recurring loss of agricultural produce from the lost areas and the innumerable management problems listed hereunder.

2. Although the agriculture is as old as the Indus Valley in this part of the world, the irrigated agriculture through a permanent canal system was introduced in the beginning of the current century in the Punjab. The colonisation has followed a set pattern and various irrigation chaks have emerged as a by-product. Each chak usually comprises 300 to 400 acres of land served by one outlet and a deep study of various socio-economic factors such as improvement of land, development of irrigation and formulation of a homogeneous community would reveal that each chak has its own peculiar characteristics and exists almost as a distinct entity. Under the existing conditions of little technical know-how and low income from the small farms the management capacity of the farmers in these chaks is inadequate to undertake rehabilitation of the existing watercourses to carry the additional water being pushed into their watercourse, let alone construction and maintenance of link watercourses. Even in SCARP I where a lot of money has been spent under PL 480 to construct link watercourses and rehabilitate the existing watercourses, the contribution of the farmer in this field was almost negligible. This has obviously resulted in a poor efficiency of water utilization which can be seen from the poor results of SCARP I, despite maximum technical and financial help from U.S. Aid and other foreign agencies during its operation and maintenance.

3. In all the completed SCARP'S only those link watercourses are operating to some degree of satisfaction which were lined or pucca and were constructed by the Government. As far as the earthen link watercourses are concerned they are a source of recurring problems both for the farmer and the Government because the tubewell operation has to be interrupted again and again due to breaches in these link channels or even if the tubewell is not stopped the wastage of water due to leakage here and there is colossal. The operation and maintenance of these lengthy link watercourses is very expensive beside being cumbersome and therefore it was decided by the Government to leave it to the farmer to look after. With the passage of time it has been established that such a decision has no moral or technical justification and if the pumped water supply has to be put to any projected use, these link channels and link watercourses shall have to be maintained by the operating agency rather than irrigators.

4. According to the existing practices for normal cropping pattern the discharge in a private watercourse never exceeds 3 cusecs. Against this there are innumerable cases where the discharge in the link watercourses as well as in the watercourses will range between 5 to 15 cusecs in SCARPS II and III. These link watercourses and the watercourses carrying discharges beyond 3 cusecs cannot be maintained by the farmer and consequently the benefits derived from the pumped supplies are disproportionate to the recorded operational efficiency of these tubewells.

5. According to the existing policy of the Government the land required for the construction of the link watercourses is not to be

acquired and compensated for. Instead the land is to be offered by the owners, free of charge. Also, the link watercourses constructed by the Government would be maintained by the private owners. Both these things are unrealistic due to the following reasons:—

(*i*) In some cases a big deep tubewell is located far away from the chak it is going to serve. Therefore, the link watercourses required for connecting the tubewell to the existing watercourse passes through the land which is not going to benefit from the watercourse which this link is going to serve. In such cases it is greatly unjustified to force the poor land owners to surrender their lands permanently for a facility which is not going to benefit them but is going to result in a recurring loss to them in multiple ways such a reduction in culturable area and fragmentation of small holdings.

(*ii*) These long links have to run straight because the working head is limited and in this process they bifurcate the small landholding into bits and pieces and in some cases the area on one side becomes so small that due to lack of financial justification the irrigation facilities to these areas are cut and consequently it proves the last straw on the camel's back.

(*iii*) While locating the big tubewells in some cases no consideration could be given to the route of the link watercourses and the only consideration was non-interference. There it becomes practically impossible to connect this tubewell with the watercourse to be served by it because in the intervening block either there was an abadi or an orchard or a road or something which could not permit the construction of any connecting channel. Such instances can be found in SCARPS II and III. Burried pipe link water courses are being recommended for such wells by the consultants but how these long buried pipe links can be maintained by the illiterate irrigators is a subject matter which could not be debated too far, for obvious reasons.

(*iv*) It is beyond the physical as well as the financial resources of the poor irrigators to look after the link watercourse when its discharge is beyond three cusecs. Also, because a large number of irrigators from more than one outlet are required to maintain it in a reach which does not belong to them, at places due to the social customs and prevalent prejudices it is physically inconceivable for the shareholders to co-operate in this activity. Most often such gatherings of shareholders breed new animosities and multiply the rates of murder.

A complete survey through the existing SCARPS would reveal that a good deal of link watercourses cannot be constructed due to the above reasons and those which were constructed were not being maintained up to the desired level. The cumulative results become obvious in the form of lower efficiency of water utilization and consequently widening of the gap between the projected targets and the physical achievements. This has been amply demonstrated in SCARPS-I, II and III. Apparently there is no cutthroat solutions to these complicated water distribution problems associated with the big capacity deep tubewells.

6. When a deep tubewell goes out of action either due to electrical, mechanical, bore hole, distribution work or link water-course defiles a vast area of 600 to 700 acres and in cases more than even 1,000 acres is affected. Despite maximum efforts both on the part of local engineers and foreign consultants, efficiency of tubewell operation could not be stretched beyond 65 per cent in SCARP I, if we take into account the number of working hours as recorded by the Tubewell Operators. Therefore, if the number of big capacity tubewells in a project is higher, more area would be affected by the failure of tubewells which could be due to one of the many possible reasons. Again even if the recorded working efficiency of a project is 60 per cent the actual farm efficiency may be less than even 30 per cent because all the water being pumped by the big tubewells would not be reaching the watercourses and consequently the farms, due to losses in the defective link watercourses and spilling watercourses. It has also been noticed that in case of big tubewells requiring link watercourses both on the upstream and downstream side usually, links are constructed on one side only, by the bigger and richer land owners if on that side the length of the link is shorter. In such cases the real efficiency of a tubewell is extremely poor although according to existing criterion of recording the working statistics the operating efficiency of such wells may be very high because it may be running long hours to benefit only one side. The working hours statistics of these deep tubewells is thus not a correct index of their real efficiency. This has been the main factor in keeping the cropping intensity so low in SCARP I as compared to the projected intensity of 150 per cent. There are innumerable examples in SCARP II, SCARPS II and IV where only one out of 2 or 3 watercourses are connected to the tubewell and it is almost impossible to construct link watercourses on the other sides due to the many reasons listed earlier.

7. It has been amply demonstrated in the operating SCARPS that incidence of tubewell failures is much higher in case of big capacity deep tubewells as compared to small capacity shallow tubewells. The troubles like vibration of the column pipes, settlements due to sand blowing etc. was found to be much higher in 4 and 5 cusecs tubewells than 2 and 3 cusecs wells. There are innumerable examples which can be quoted from all the SCARPS but due to limited space operating statistics of SCARP III are reported in Appendix I.

8. If small capacity shallow tubewells are installed at the head of each watercourse or to serve two watercourses on a minor or distributary taking off from its opposite banks almost at the same point, all distribution problems discussed so far would be non-existent, link watercourses will not be needed and no land will be fragmented or lost on permanent basis. Under the present arrangements, however, the equitable distribution of pumped water is almost unimaginable.

9. It is a universal truth in Indus Valley that as we go deeper, the quality of water deproves. During an investigation in Khadir Unit of SCARP II it was noticed that salinity at 450 ft. was over 10 times higher than salinity at 150 ft. Deep tubewells in various completed SCARPS are, therefore, importing the saline ground water of much inferior quality and are deproving the soil characteristics quickly. The upper sweet acquifer is also being contaminated by the intermixing, which is made possible by long screens of deep tubewells.

10. For a given discharge in case of deep wells which are big capacity wells the head against which the water is being pumped is much bigger than small shallow wells pumping the same discharge. This obviously requires more electrical energy per cusec of pumped water from the deep and bigger wells as compared to shallow small capacity wells. Consequently the cost of O & M, a major portion of which is contributed by electric charges, goes up, in case of deep tubewells.

11. Due to anistropic conditions and clay lenses spread all over the Province the draw-down in case of deep tubewells is much quicker and consequently the water table drops below 10-15 ft. in a couple of years after commissioning. Besides cost element, the lowering of water to such depth is not desirable from any considerations. This view has been endorsed by the World Bank Report, as well as many Pakistani and foreign experts on the subject.

12. In the already completed projects, at least theoretically, only good water area has been exploited and the drainage tubewells meant to lower the water table in the saline areas have not been installed. A big chunk of 1,65,000 acres has been left out in SCARP-III where 100 saline tubewells meant purely for drainage purposes were to be installed as per approved P.C-I. There are similar left out areas in other SCARP'S as well. The continued functioning of these big capacity deep tubewells around these saline areas is resulting in salt instrusion into the sweet water areas. The area of influence of these big deep tubewells is quite big and it goes on extending till steady state conditions have developed. As the horizontal permeability is reported to be ranging between 50 to 100 times that of vertical permeability, these big tubewells are causing deterioration of water quality in the marginal as well as sweet water zones, faster than anticipated by planners. In SCARP-I, out of 12 schemes, the water quality of six has already deproved.

13. The theory of deep tubewells as well as the cost economics is closely linked with the concept of mining advocated by the Panel of Scientific Experts headed by Dr. Revelle. It was suggested by the Panel that within the life span of a tubewell project which was put at 40 years, the water table should be dropped down to about 75 to 100 ft. *i.e.* to pre-irrigation level. This concept is no more valid and now in certain areas like Khairpur Project for instance, the water table is recommended to be stabilised at 7 ft. from the ground surface in order to save the date-palm trees from drying up. It is possible that these date-palm trees may not die even if the water table goes up to 15 ft. if surface irrigation was applied but this surface irrigation can be applied only in a limited area and those date-palms which are outside the existing irrigation boundaries and are located at places where the artificial irrigation is also not possible the hazard still persists. As a matter of fact all that is required to be achieved, is the dewatering of the root zone to restore continuous aeration which is pre-requisite to optimum crop production. Both the technical and financial aspects of the studies help to make a decision in favour of stabilising the water table at a depth of 10 ft. throughout Punjab. In doing so the cost of pumping would be maintained at a very low level and the desired objective of eliminating the menace of water-logging and salinity could be also achieved, provided more surface supplies were diverted to the area, to make up for the shortage of irrigation applications and provide leaching requirements. This would also help in eliminating all possible chances of lateral salt movements which are

becoming apparent in areas where deep tubewells are operating on the boundaries of marginal and poor water quality zones.

14. The installation of deep tubewells has forced us to rely on almost 100 per cent imported material starting from the strainers up to the mechanical and electrical equipment. Even for those equipments which are manufactured in Pakistan (such as KSB pumps and Siemens motors and control panels) foreign exchange is demanded on the pretext that the imported raw material for such equipments is not available in Pakistan. This compulsion to import foreign equipment and material results in a huge foreign exchange requirement for which foreign aid and loans had to be applied for. All of these aids and loans included the employment of Foreign Consultants a precondition to their sanction. This has resulted in the following problems:—

(*a*) A huge foreign exchange investment on supervisory staff; and

(*b*) Employment of Foreign Contractors for the installation of these tubewells as well as ancillary works. These ancillary works are usually done by Pakistani contractors and yet a part of payment has to be made in foreign exchange.

Consequently despite such a huge investment both in the local and foreign currency, the participation and training of the local skilled and unskilled manpower, contracting agencies and manufacturing concerns has been much less than desired. This can be seen from the fact that a contract for installation of only 250 tubewells in SCARP 2-B could not be finalized for years because no Pakistani contractor could prequalify to bid according to the conditions laid by U.S. Aid for this work. In the same country over 90,000 shallow tubewells could be sunk contemporarily without any technical or financial aid from abroad, with almost 90 per cent local material and 100 per cent local skill and technical knowhow. The problems of over-capitalization and huge unutilized investment does not end up with the erection of these deep imported tubewells because our consulting engineers for planning, design and construction as well as the Aid-giving agencies feel strongly that unless more foreign loans are applied for the arrangement of spare parts and equipment from abroad and technical assistance in the form of O&M consultants, these projects cannot be operated at the designed level of efficiency. An O&M loan of $3.3 million recently offered by a friendly country could not be utilized as it involved a perpetual reliance on the foreign assistance for the routine operation. It also meant additional financial burden on the highly subsidized projects.

15. As the things stand today a comparison between the deep and shallow tubewells has become meaningless, because almost throughout the Province of Punjab shallow private tubewells have been installed most of which have centrifugal pumps and would go out of action if the water table is lowered beyond 10-15 feet. It must be remembered that rate of private tubewell installation averages about 10,000 tubewells per year which means an annual investment of about Rs. 10 crores in the private sector. Most of this capital flows out from private sources and but for this investment would have remained unused although A.D.B.P. is also supporting this activity through loans and credits. Thus Government can ill afford to put this most valuable investment in private sector to naught by launching deep tubewell projects in the Public Sector which would result in rapid drying up of these shallow wells.

From the gradually increasing number of private wells it has been established that the concept of public tubewells resubstituting the private tubewells from 1970 onward advocated by some was an under-estimation of the efforts in the private sector. There is no case on technical, financial or moral grounds to suppress such a healthy investment trend in the private sector.

16. The advocates of deep tubewells base their case on the following types of arguments:

(a) *The operation of a project to maintain water table at a level of 10-15 feet across the project area is technically infeasible.*

It would be adequate to mention that Hunting Technical Services (Sir MacDonald & Partners) recommended that in Khairpur Project the water table should be maintained at a depth of 7 ft. Although this decision is being reviewed, but even the new depth would be between 10-15 ft. Dr. Peter Lieftinck also advocates in his reports that water table should be maintained at 10-15 in the Indus Valley. This was again confirmed by Review Mission, in June 1970.

(b) *The amount of water obtained from pumpage under conditions would be such that the obtainable levels of agriculture across the area would be at great variance.*

How unrealistic this hypothesis is, can be seen from a comparison of agricultural development in the areas served by deep tubewell in SCARP-I (Appendix II) and adjoining areas served by shallow tubewells. Similarly areas in Bari Doab served by private tubewells can also be quoted.

(c) *The cost of the project would increase by at least 20 per cent or so.*

While working out the cost of shallow tubewells, Consultants must have assumed that they would design, plan and supervise the construction of these wells on the pattern of deep well and the contractor would be also a foreigner. But for shallow tubewells all the equipment such as pumps, motors and strainers could be very conveniently local made requiring comparatively much less foreign exchange and local contractors and local engineers could design, supervise and instal these tubewells. Thus instead of 20 per cent excess, there would be reasonable saving both in the foreign exchange and the rupee compnent. According to the advocates of deep tubewells themselves the cost of power, which is the major component of O&M cost, would decrease in case of shallow wells because of the decreased lift. As reported earlier, the incidence of failure due to sinking, vibration, crooked shaft etc. would be non-existent or less in shallow small capacity wells and, therefore, the annual/unit of pumped water would be correspondingly lower in case of properly designed shallow wells.

(d) *The cost and difficulty of electrification of project with shallow tubewells would be more than that with deep tubewells:*

This apprehension is more psychological than real. All the tubewells shallow or deep have to be along the minor distributaries and at the head of the watercourses or close by. Therefore, there could be hardly any difference up to 11 K.V. lines. The only possible difference would be in the number of Transformers, which will go up in case of shallow tubewells but excess in the cost on this account would be offset by the reduced cost/per unit of smaller Transformers and other equipment required in this case. Similarly the electrification would be equally or less difficult in case of shallow wells.

(*e*) *The benefits to be derived from simplified distribution of water made possible through shallow tubewells would be negligible:*

In case of shallow small capacity tubewells, the entire discharge of the tubewells can be conveyed to the farms through the existing watercourses. In case of deep tubewells unless the complicated link watercourses and other distribution works are completed and also maintained properly, the tubewells either remains idle or if it runs, the water pumped goes to waste. In SCARP I, all the link water courses and distribution works could not be completed in full even seven years after its commissioning. Similarly in SCARP 2-A which is in operation since 1963-64, all the link watercourses have not been constructed as yet and those constructed are not being maintained by zamindars properly especially in case of deep tubewells with marginal and poor water quality.

Even in Mona Experimental Project where just to maintain 138 tubewells there is one Project Director of the rank of Superintending Engineer, one XEN and one SDO and the Project is being maintained by WAPDA as a Model Project, the latest position of link watercourses is as poor as shown in the statement at Appendix III. According to a report about 30 per cent of the tubewells are not operating in Scarp II-A due to similar reasons. Thus these wells are highly inefficient when their installed capacity is compared to the actual farm applications in a given time counted from the date of their commissioning. Against this shallow small capacity tubewell located almost at the head of a water course would not remain idle even for a day after it is commissioned and its entire discharge could be usefully employed.

Thus there is no comparison between the efficiencies of the two types. Even the revised Government decision that link watercourses should be constructed as a part of the project is not a complete solution because in at least 15 to 20 per cent cases the link watercourses pass through the lands of those who are not benefited from the tubewells for which these links are required. These landowners do not offer the land required for the construction of these link watercourses free of charge and, therefore, it becomes impossible to construct the link watercourses in such cases. Such deep tubewells (at least 15 to 20 per cent of those in any project) would, therefore, remain unutilized for indefinite period or misused by unauthorized persons.

It is thus a case of comparison between a poorly utilized investment in deep tubewells which cannot operate for lack of link watercourses and the optimum use of investment in case of shallow small capacity tubewells. Therefore, it would be futile to argue that benefits derived from simplified distribution of water in case of shallow tubewells were marginal as compared to the complicated water distribution system in case of deep tubewells.

(*f*) *The distribution of water in the area where only ground-water could be used, would be considerably more complicated in case of shallow wells as compared to deep wells:*

In uncommanded areas both the shallow and deep tubewells would require a new water distribution system and problems or benefits in both the cases will be identical with only exception that in case of deep well normally a higher discharge shall have to be handled by the farmer and his limited management capacity may create innumerable problems especially in cases of unrectangulated smaller landholdings. Again, if a deep big capacity tubewell goes out of action for one of the many possible reasons, a much bigger area would face utter disaster, both due to lack of irrigation supplies and rise of water table and consequently salination and water-logging. Thus it is incorrect to say that distribution of water in the area where only ground-water could be used would be more complicated in case of shallow small capacity tubewells.

(g) *The benefits of the project would decrease markedly if shallow tubewells are installed instead of deep tubewells:*

Such a statement can be made by the Project Planners married to the concept of deep tubewells on considerations other than technical or financial. The project benefits depend on the irrigated area or cropping intensity, cropping pattern, productivity index of the soil being exploited and the agricultural marketing practices. The tubewells have to serve the dual purpose of lowering the water table below the root zone and to supplement the irrigation supplies for increasing the delta of crops sufficient to account for leaching in addition to consumptive use requirements. So long as these two objectives are achieved at a minimum cost the purpose is served and it is immaterial whether it is served through deep or shallow tubewells.

In a conventional SCARP planning, hardly 40 to 60 per cent of the installed capacity is proposed to be pumped during a year. This design is based on the theoretical peak requirement of a particular cropping pattern on full development of the project when 150 per cent irrigation intensity has been achieved. Therefore, before fuller development has taken place the annual utilization has to be proportionately less to remain with economical operating expenses, especially so when we find that root zones get dewatered during a couple of seasons and thereafter the pumping is mainly meant to meet irrigation requirements. Thus economical utilization of these wells should restrict their use to about 40 to 60 per cent working no fuller development corresponding to 150 per cent intensity and about 27 to 40 per cent on 100 per cent and about 32 to 48 per cent at 120 per cent cropping intensity. Therefore, the remaining unutilized capacity is an index of over-capitalization. This undue overburdening of the project cost can be relieved considerably if the installed capacity of the tubewells is kept at 60 per cent of the present value for the same area and raises the annual utilization rate from the present low to about 80 per cent progressively. And as the development proceeds more tubewells can be added if at any stage it is discovered that water requirements are not being met. This is quite possible because all breakdown due to link water-courses and even most of the problems due to leaky and spilling water courses would vanish if shallow small capacity tubewells are installed, improving thereby the overall efficiency of the tubewell deliveries between the discharge box and the farms. The unutilized blocked investment would be reduced to a bare minimum and there would be no reduction in the quantum of water supplied at a particular time especially during the first 7 to 8 years. The rate of area development would be faster because there will be no constraint on account of missing link water-courses and every drop of the installed capacity could be put to use.

At present the high capacity deep wells are sunk, which remain unutilized for years at a stretch firstly due to the lag between their installation and energization and then due to incomplete or improper link watercourses and when all these bottlenecks are almost removed, fuller utilization of most of these tubewells becomes impossible either due to reduction of discharge and deterioration of water quality or due to bore hole defect, whereby the tubewells have to be abandoned. Thus projected economic and financial returns based on highly idealized assumptions of fuller utilization of the installed capacity for a long period of 40 years (economic life of the tubewell assumed in the early projects by foreign consultants) and increase of cropping intensity to 150 per cent of the culturable area during 8 to 10 years, could not be achieved within the life span of Scarp I which was administered for the first about 10 years strictly according to the area development approach advocated by Dr. Revelle of U.S.A. It is disappointing to note that during an appraisal of SCARP-I by I.A.C.A. in 1964-65, a formula for growth rate of cropping intensities in areas of different classification was developed. To prove that the behaviour of SCARP I was strictly according to this criterion and it would be possible to attain a max of 150 per cent cropping intensity in 10 to 15 years, the values of intensities achieved were reported to be 111 per cent and 114 per cent during the years 1963-64 and 1964-65 against the actual low values of 98 per cent and 101 per cent respectively. Thus it is clear from Appendix IV that in an over optimum to justify the approach advocated by consultants to have deep wells, unrealistic projections of 150 per cent cropping intensity have been considered reasonable by the I.A.C.A. and World Bank Group. Therefore, it is incorrect to conclude that a change over from deep tubewells to shallow tubewells would decrease markedly the benefits of a project. On the contrary the cost benefit ratios would improve by a direct as well as indirect reduction in the capital and annual cost without affecting the accumulative benefits.

Some model studies have been carried out on an electrical Analogue to predict the ultimate system behaviour under steady state conditions. Regardless of actual field conditions inputs have been seemingly designed to arrive at pre-supposed water table behaviour after a certain length of time. No sane hydrologist would agree with the assumption that rivers are a source of constant head in the Indus Valley throughout the period of study on the electrical model. The rivers induce seepage during summer but act as drainage channel during winter. The hydrological pattern is going to be further upset by stoppage of three eastern rivers by India and damming up of the remaining ones. The rate of possible recharge into an isolated strip aquifer (complete Doab or a part thereof) has been pitched high to justify high capacity deep tubewells. It is objectionable to consider non-perennial and fluctuating irrigation canals as source of constant head. Similarly no corrections have been made for the possible break-downs due to various avoidable and unavoidable circumstances and mutual interference between various wells when the water-table drops to levels where the areas of influence of various tubewells overlap.

Based on this purely hypothetical study which stands on idealized and over-simplified version of transmissibility and storage coefficient, it has been concluded that steady slate conditions are likely to develop and corresponding to this situation water table behaviour has been plotted. According to these results in SCARP III the projected decline in the water table has been shown to range between 5 to 10 ft. even after 20 years of continuous operation, in the areas adjoining rivers as well as Irrigation Channels. In the left out saline area a rise of +10 ft. over the pre-project levels is shown to take place during the first ten years of operation. If these results are taken as correct the following conclusions emerge:—

(1) 1,65,000 acres of land overlying saline ground water would be drowned and turned into deep pond in 10-20 years. The position would show up more precarious if in this electrical model the effects of T.P. link are also stimulated. For similar reasons the saline areas left out in all the completed SCARP would be completely waterlogged and lateral movement of salt would be imminent.

(2) There will be a sharp gradient between this left out ponded area and adjoining project area where the water table would have dropped to over 10 ft. (total head 20 ft. during the same period). This would naturally induce lateral movement of saline groundwater and vast tracts of sweet zone around this poor quality zone would go bad. The problems need to be tackled in the real earnest right now. Saline drainage wells with complimentary surface drains should be constructed together with the anti-waterlogging measures along the T.P. link without any further delay, otherwise a major portion of investment in Kot Adu unit and a part of Rangpur Unit will go waste.

(3) In areas where even deep tubewells cannot lower the water table beyond 5 to 10 ft. despite continuous operation for 10 years (full economical life of the project tubewells according to the present analysis), there is no technical or financial justification to instal deep wells and waste long strainers and high-capacity expensive turbine pumps and motors. Closely spaced shallow wells fitted with locally manufactured centrifugal pumps, motors and strainers, would perhaps be the best choice from any consideration.

To sum up, it can be said that under the present system of land tenure and inheritance law the water distribution problems associated with the deep tubewells are almost insurmountable and all the estimates of cost and economic returns given in the feasibility report published by consultants so far, are just theoretical, by no means possible to accomplish. Huge losses are involved in the non-utilization of these very expensive installations when immediately after their commissioning a large number of them have to be closed down or their use restricted due to salinity Alkalinity hazard associated with their pumped waters. The project objectives are not fulfilled, the operation and maintenance charges go much higher than projected and financial returns drop to deck. These installations are foreign in all respects such as material, workmanship and their optimum O & M also requires foreign consultants and foreign funds for the spare parts and equipments. Such an enterprise cannot be encouraged for all times to come specially when despite huge cost, the life of these tubewells is hardly 10 to 12 years.

The cost economics of deep tubewell would have been different if like U.S.A. the normal size of the dry farms ranged between 600 to 700 acres and agriculture was highly mechanized. Therefore, in Pakistan the planning and design of tubewell projects in the public sector must be tailored according to the prevalent socio-economic pattern of life, so that rapid development was possible without generating complicated financial and managerial problems like the one created by link watercourses etc. in all the Salinity Control and Reclamation Projects completed to date.

APPENDIX I

VIBRATION OF PUMPING SETS IN ALIPUR UNIT

Extent of the Problem

Out of 1935 tubewells of SCARP-III, only 72 were commissioned in February, 1969. Within six months (July, 1969) well No. 415 having a discharge capacity of 5 cusecs started vibrating. It had run for 3553 hours before it was stopped for pulling out. Since then 17, out of 72 wells (all having 5 cusecs capacity) went out of commission due to the same reason. All these wells have been recommissioned either by replacements of the damaged components or by changing the pump settings depth.

Causes for Vibration

According to the (K.S.B.) Manufacturers, instructions at page 10 of the Booklet on Deep Turbine Pumps, vibrations may possible be caused by either of the following factors:—

1. Misalignment;
2. Foundation not rigid;
3. Impeller partially clogged causing unbalance;
4. Shaft bends;
5. Rotating element bind;
6. Worn bearings;
7. Air or vapour entering pump on suction side.

None of the 17 pumps pulled out so far vibrated due to the causes listed above. Instead the vibrations were caused by a totally different reason—"loose joints between the column pipes and sockets due to damaged threads of both the sockets and the column pipe and bronze spider being out of centre."

Cause for Anxiety

The very fact that this cause of vibration was not even anticipated by the manufacturer and yet it has already affected over 25 per cent the tubewells within a period of less than a year after their commissioning, is a source of great concern. Unless effective remedial measures are adopted after understanding the root cause of these bad threads, it is probable that not only the remaining wells fall prey to the same trouble of vibration but even the repaired wells are damaged again and again. The situation, therefore, calls for an immediate attention.

Pointer towards the Problem

Since 22-7-1969, when the first well started vibrating, the emphasis of the O & M Agency has been to recommission these tubewells as quickly as possible to restore water supply to needy crops and to understand the real causes for the bad threads simultaneously.

The details of pulling out as well as observation are given separately. Strangely enough, one well No. 424, which was operating all right and had no sign of vibration when pulled out, had a badly damaged column pipe and a socket. This makes a total of 18 damaged wells pulled out and recommissioned.

The issue was also discussed threadbare in the office of M/s T & K with Mr. Sandven and Mr. Ceiler of M/s K.S.B. by the writer during the last week of December, 1969. There was a difference of opinion and hence the need for a deeper look into the matter. Following is the summary of thoughts expressed by various persons consulted on the causes of damaged threads:—

1. Manufacturer's Defect:	Defective Material; bad worksmanship.
2. Glavanic Cell Action:	During the period the tubewells were idle after installation, under the influence of differential potential between the submerged column pipe threaded portion and bronze spider, transfer of metal from threaded portion might have caused the damage. The severity of this action is reduced during the operation period of the tubewell.
3. Bad handling of the column pipes and other accessories during carriage as well as installational site:	
4. Defective Design of the column pipe sockets and spider assembly:	(*i*) Metal combinations may not be proper. (*ii*) The thrust caused by the discharge may be more than maximum permissible for the design of the combination.
5. Some unearthed phenomenon:—	

Note: (*i*) Out of 72 tubewells of Alipur Sub-Unit 25 tubewells had a capacity of 5 cusecs. Out of these 18 have already been pulled out and recommissioned. It is quite probable that remaining 7 will also start vibrating very soon.

(*ii*) Partly to understand the causes of this wide-spread problem and partly to remove the defect, the foreign contractor agreed to pull out 139 wells in Alipur Unit. The problem however still persists which means it could not be diagnozed properly.

APPENDIX II

COMPARATIVE STATEMENT GIVING INTENSITIES OF CROPPING IN

(*a*) L.C.C. System—SCARP I.

(*b*) L.C.C. East Outside SCARP I.

(*c*) L.C.C. West Outside SCARP I.

Year	SCARP I	L.C.C. East	L.C.C. West
1	2	3	4
1960-61 ..	82%	107%	93%
1961-62 ..	84	109	106
1962-63 ..	92	111	108
1963-64 ..	99	111	108
1964-65 ..	101	114	110
1965-66 ..	107	112	108
1966-67 ..	101	116	111
1967-68 ..	98	121	116

(Shudkar Figures)

APPENDIX IV

UNREALISTIC BASIS OF FIXING PROJECT TARGETS

Abstracts from water and power resources of West Pakistan, a study in sector planning Volume II, page 56. The development of irrigation and agriculture.

"Report on experience with the SCARP I (Salinity Control and Reclamation Project) provides some check on the realism of the IACA Projections. SCARP I is situated in an area where salinity was quite severe, and not unlike the conditions postulated for Salinity Category III (about 45 per cent of the CCA requiring reclamation). In the first four years of operation in SCARP I, cropping intensity has increased from 89 per cent to 110 per cent. This compares with IACA's estimated increase, under Category III conditions, from 97 per cent to 114 per cent over a four year period. Table 2-18 illustrates this comparison. The close correspondence between the SCARP I experience and IACA's Category III projection tends to support the view that IACA's estimates represent feasibilities.

The IACA selection of an overall average of 150 per cent intensity at full delta as the ultimate objective was influenced by a desire to provide the means by which small farms could rise about the subsistence level and produce marketable surpluses. IACA concludes that if water supplies were made adequate for an ultimate intensity of only 130 per cent (at full delta irrigation), farmers would continue to underwater and expand their cropping to an operational limit of about 150 per cent. Because of IACA's conviction that underwatering must be stopped as rapidly as possible in the interest of eliminating salinity in the long run, it has recommended a programme which matches the farmers' desire to increase cropped acreage with a water supply which will enable them to preserve the productivity of their lands. The Study Group agrees that full delta irrigation is essential to West Pakistan's long-term agricultural development. It also recognizes, however, as noted earlier, that there are short run advantages to the farmers from under-irrigation at lower yield levels. The increase in intensity, but at less than full delta applications, may thus be more rapid than IACA has projected within the rigid set of assump-

TABLE No. 2-18

Cropping intensity increases in SCARP I compared with IACA projections:

Time period	SCARP I as shown by World Bank Report Vol. II, page 56	SCARP I* as actual reported by I & W.D.B.	Category III
Start of operation	78%	78%	80
1st year (1961-62)	89%	85%	97
2nd year (1962-63)	100%	91%	107
3rd year (1963-64)	108%	98%	111
4th year (1964-65)	110	101%	114

Note—*This column is not a part of Table 2-18 as given on page 56. This has been added here to give a comparison between the intensities reported by World Bank with the actuals. These figures have been taken from the annual printed reports of Land and Water Development Board.

tions it has used with respect to intensity growth.

TABLES NO. 2-16

Page 54 Vol. II Lieftinck Report

1. IACA Base for Projection of Growth in cropping Intensities—Time required to reach 150%.

Starting Intensity %	Salinity Category (*a*) I	II	III
		Years	
135	5	b	b
120	6	10	b
110	7	10	b
100	8	11	15
90	9	11	15
80	10	12	16
70	11	13	16
60	12	14	17

(*a*) Salinity Categories are defined as follows:—

I—15% of CCA requires reclamation;

II—30% of CCA requires reclamation;

III—45% of CCA requires reclamation.

(*b*) No cropping intensity is high in the salinity categories.

(Source IACA's Comprehensive Report, Vol. 7, page 215)."

These hypothetical Projections were checked by IACA against the intensities in SCARP I and found to be reasonable. *Unfortunately the intensities of cropping assumed to have reached in SCARP I, as reported by IACA and World Bank were too high as compared to actual. This can be seen from the comparison given under Table* 2-18. *The max intensity achieved in SCARP I was* 108-9 *during* 1968-69, *which dropped down to* 104.9 *during* 1969-70. *In* 1964-65, *it was only* 101 *against* 110 per cent *assumed by IACA.*

Therefore the rate of increase of cropping intensity Projected by IACA is too rapid and rather impracticable in Indus Valley. Similarly the economic and financial projections of the development plan dependent on deep imported tubewells are hard to achieve.

Hydraulic Model Studies of Tarbela Dam, Tunnel Outlet Structures

CH. MOHAMMAD ALI, T.K.*

Four ½ mile long tunnels through the right rock abutment of Tarbela dam will serve initially for river diversion during the last phase of construction of main embankment and then will be harnessed for power (tunnels No. 1 and 2, eventually No. 3) and for irrigation releases (tunnels 3 and 4 eventually only 4).

All tunnels from intake to the central gate chamber will be 45 feet in diameter with appropriate transitions for changes in shape. Downstream from the central gate chamber, Tunnels, 1, 2 and 3, which will eventually serve as power penstocks, will be fitted with steel liners having an inside diameter of 43.5 feet. Tunnel 4, which is strictly for irrigation releases, will be 36 feet in diameter. By means of a wye branch and appropriate transitions near the downstream end, Tunnels 3 and 4 will each terminate in two rectangular conduits 16 feet wide by 24 feet high. Each of the four rectangular conduits will be fitted with a radial gate for regulation of the discharge. Downstream from the radial gates stilling basins are provided, one for Tunnel 3 and one for Tunnel 4. Tunnels 1 and 2, on the other hand, will operate uncontrolled as piers and gates are not scheduled for installation in the central gate chambers until the tunnels are no longer needed for diversion.

During diversion stage each irrigation release tunnel will have a discharge capacity up to 1,00,000 cusecs and the discharge from each tunnel will pass through a stilling basin and return to the river. Each power tunnel during diversion stage will discharge up to 2,00,000 cusecs and the uncontrolled flow from tunnels 1 and 2 will be disposed of in between fixed boundaries: the powerhouse wall on the left and the left stilling basin wall of tunnel No. 3 on the right. The material of outlet area of tunnels No. 1 and 2 is bedded metamorphosed rock, principally up-ended, highly fractured, and of questionable quality. A diagonal draw containing loose material down to Elev 1020 crosses the outlet area. The problem is to convey the high velocity flow from tunnels 1 and 2 to the river, without flooding or exposing the powerhouse area to excessive splash or spray, without endangering the safety of powerhouse wall on the left or

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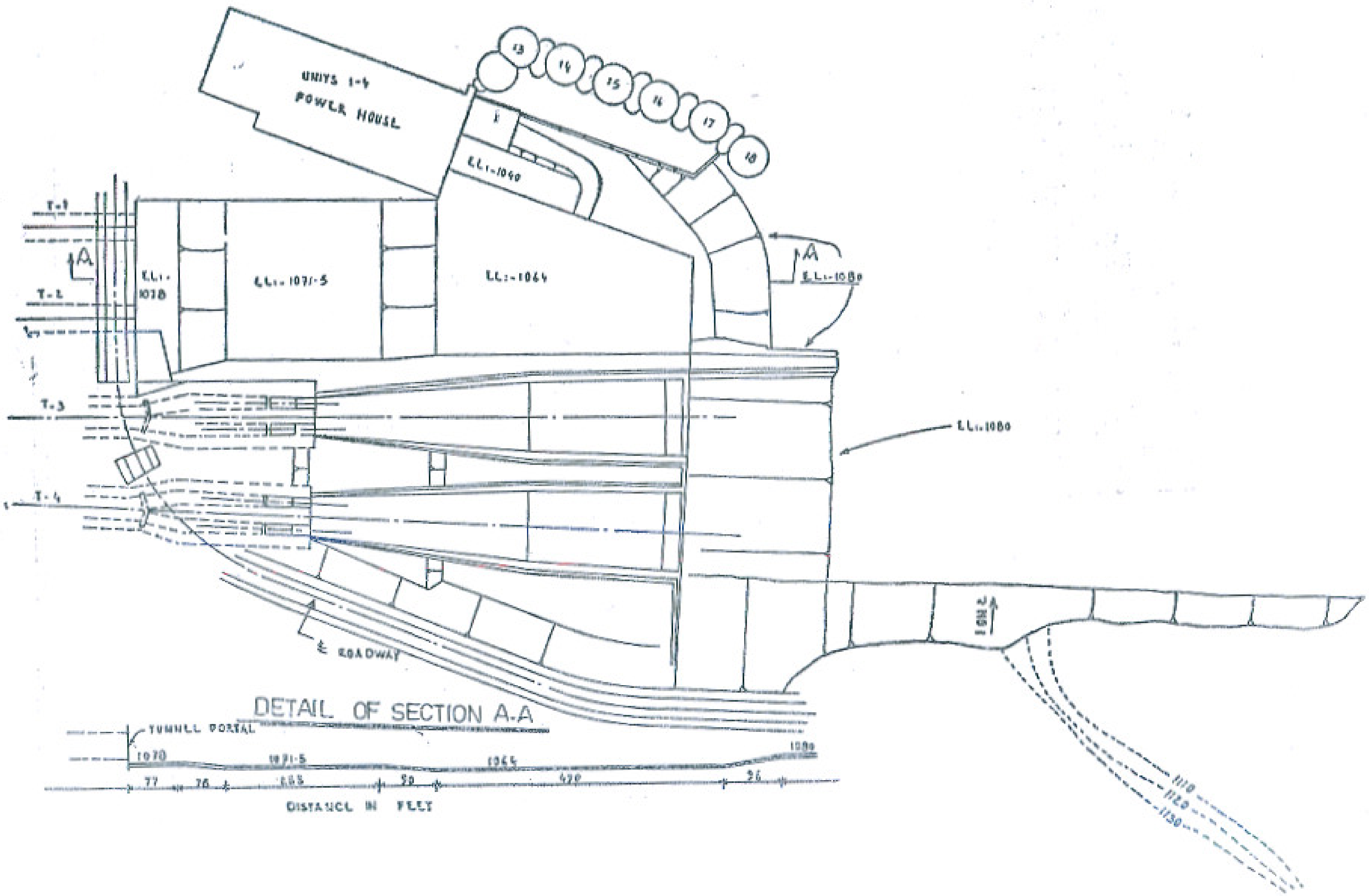
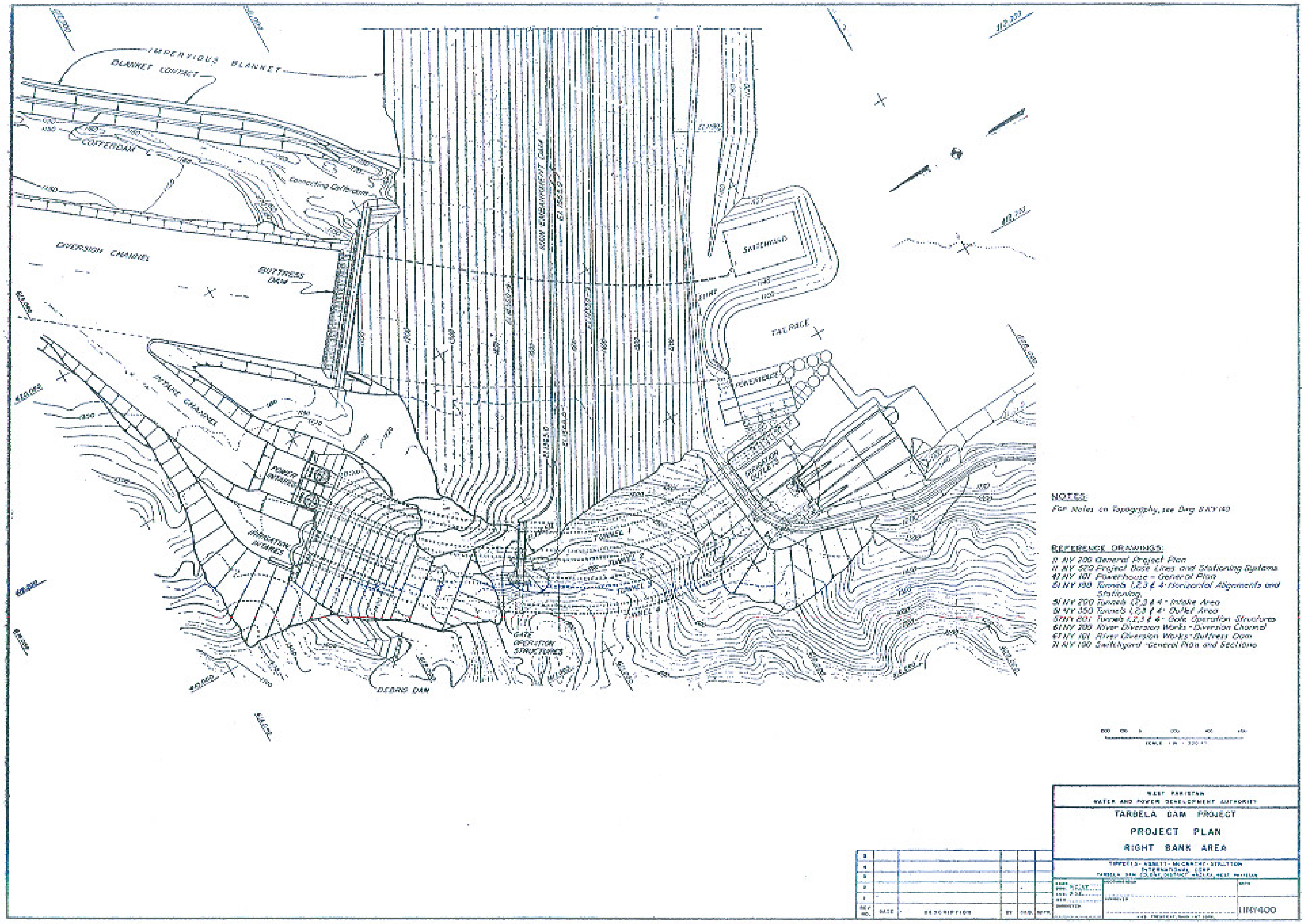


Tarbela Dam Project—Model of Stilling Basin and Outlet Area
Scale = 1/60


IMPERVIOUS BLANKET
BLANKET CONTACT
COFFERDAM
Connecting Cofferdam
DIVERSION CHANNEL
BUTTRESS DAM
BYPASS CHANNEL
POWER INTAKES
IRRIGATION INTAKES
MAIN EMBANKMENT DAM
TUNNEL 1
TUNNEL 2
TUNNEL 3
TUNNEL 4
GATE OPERATION STRUCTURES
DEBRIS DAM
SWITCHYARD
TAILRACE
POWERHOUSE
IRRIGATION OUTLETS
NOTES:
For Notes on Topography, see Dwg
REFERENCE DRAWINGS:
General Project Plan
Project Base Lines and Stationing Systems
Powerhouse - General Plan
Tunnels 1,2,3 & 4 - Horizontal Alignments and Stationing
Tunnels 1,2,3 & 4 - Intake Area
Tunnels 1,2,3 & 4 - Outlet Area
Tunnels 1,2,3 & 4 - Gate Operation Structures
River Diversion Works - Diversion Channel
River Diversion Works - Buttress Dam
Switchyard - General Plan and Sections
WEST PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
TARBELA DAM PROJECT
PROJECT PLAN
RIGHT BANK AREA
TIPPETTS - ABBETT - McCARTHY - STRATTON
INTERNATIONAL CORP.
DATE
DESCRIPTION
BY
11NY400

the stilling basin wall on the right.

The work performed at Nandipur Hydraulic Research Station on stage III diversion involved investigation of the following features:—

(*a*) Determination of the optimum geometry and shape of stilling basin (including the divide walls and end cill) for tunnels 3 and 4. Static and transient pressures for the final design were observed on the Chute, into the stilling basin floor of the stilling basin and the side walls.

(*b*) Finding out a workable solution to the problem of conveying uncontrolled high velocity flow from tunnels 1 and 2 to the river downstream without entailing work stoppage or damage to the existing structures *i.e.* powerhouse wall on the left and left stilling basin wall of tunnel 3. The testing of tunnels 1 and 2 outlet area involved numerous schemes and modifications. The final arrangements tested for the outlet area is shown on figure attached. The bed of the area between powerhouse wall and left wall stilling basin for tunnel 3 was lowered to elevation 1071.5 to provide sufficient headroom for assembling penstock manifolds at a later date. The paving was extended to the end of stilling basin of tunnels 3 and 4 and natural table rock downstream was removed to Elev. 1080. A part of curved cellular coffer dam forming the right bank of diversion channel stage III was retained up to cell No. 18, and thus the back current (which unbalances the main flow) in the wake of 4 unit powerhouse was confined to minimum possible area.

(*c*) The flow emerging from tunnels 1 and 2 impinges at an angle to the left stilling basin wall of tunnel No. 3 resulting in overtopping of flow into the stilling basin of tunnels 3 and 4. The detailed fluctuating water levels were observed on the two sides of the left stilling basin wall of tunnel No. 3 for different reservoir levels and different combinations of flows from tunnels 1 to 4 to work out the probable maximum head across at different points along this wall. The average and surging pressures were observed at different points on the left face of left stilling basin wall of tunnel 3 along the powerhouse wall and bed of the outlet area of tunnels 1 and 2 with different operating conditions of reservoir and tunnels.

(*d*) The maximum head across the left wall of stilling basin for tunnel No. 3 as worked out from water levels was quite less than worked from transient pressures and observation led to significant reduction in section of the wall. The detailed velocities were observed along the bed of paved area below tunnels 1 and 2 to design the slab free of cavitation pressures.

Buildings and Highways

A Correlation between Atterberg's Limits and Optimum Moisture Content (Proctor's Test)

C H. MOHAMMAD TAHIR[1]
G. F. ZAFAR[2]
I. H. HAMDANI[3]

The authors have established three relationships between:

1. *Plasticity index and liquid limit,*
2. *Optimum moisture content and plastic limit:*
3. *Optimum moisture content and liquid limit:*

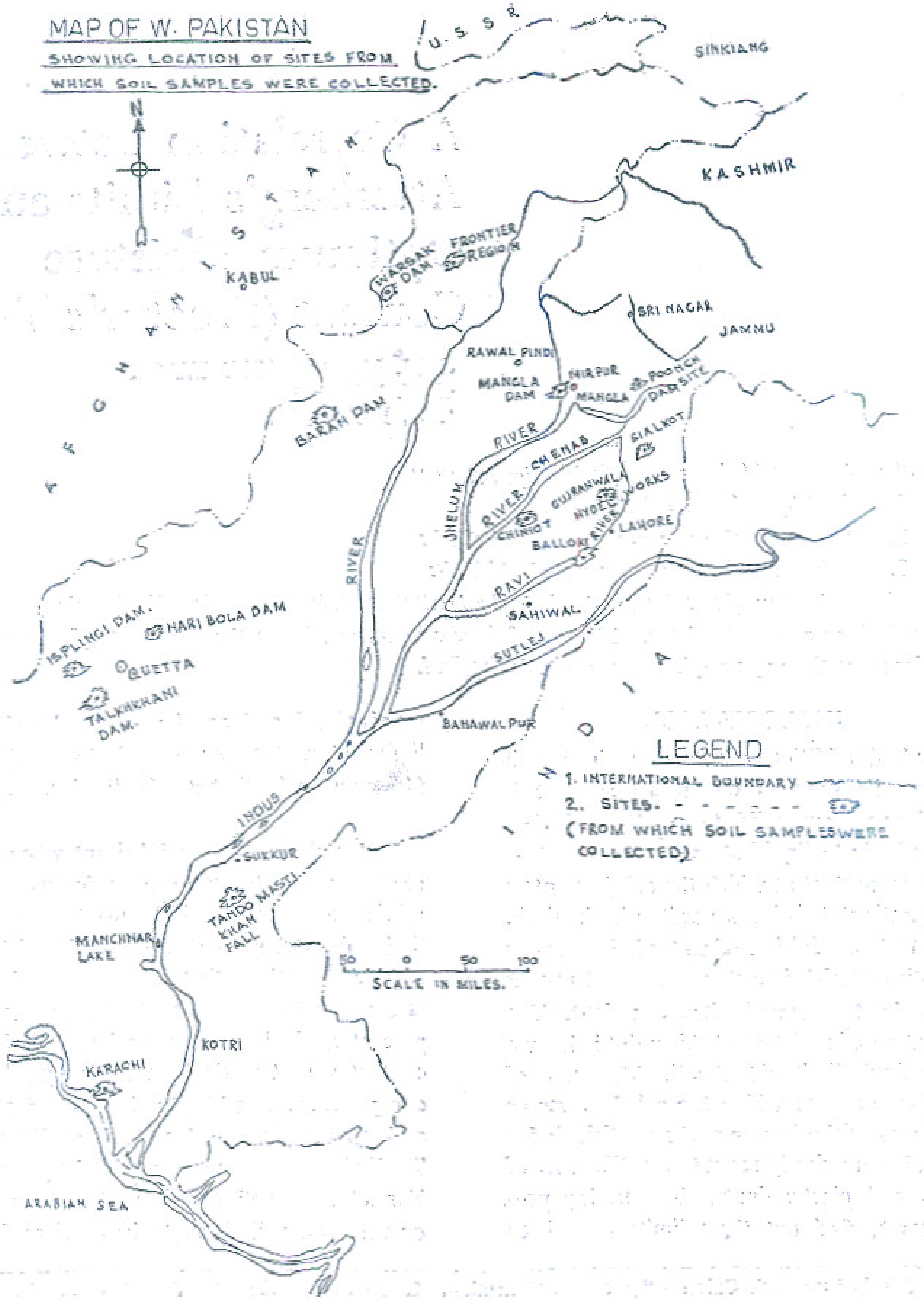
after a thorough study of test data available in the Institute pertaining to various Engineering projects scattered all over West Pakistan. The use of these equations will save time and cost of testing and will also serve the purpose of quality control in the field.

INTRODUCTION

Gradual addition of moisture in a soil changes its physical conditions so that it transforms from solid to plastic and then from plastic to liquid state. The percentage moisture content at which the soil just enters into plastic state is known as its plastic limit. With further addition of water it behaves as a plastic material till a stage is reached when it just begins to flow under its own weight. The percentage of moisture at this point is known as the liquid limit of that soil. The range of moisture between which the soil behaves as plastic material is known as the plasticity index which is numerically equal to the difference of liquid and plastic limits. The testing procedures to find out these limits have been standardized and are known as Atterberg's limits after the name of the Scientist (Atterberg) who first standardized them.

Water also acts as a lubricant when soils are compacted to attain more density. This lubrication acts effectively up to a certain limit of water percentage beyond which the same compactive effort decreases the density rather than to increase it. This limit of water percentage is known as optimum moisture content of that particular soil for a particular compactive effort which has been standardized and commonly called "Standard Proctor's Test" after the name of the Scientist (Proctor). For all construction projects based on soils or wherever soils have to be used as Engg.

1. Principal Research Officer (Phy. & Soil Mechanics). 2. Research Officer (H. & G. W). 3. Assistant Research Officer.


MAP OF W. PAKISTAN
SHOWING LOCATION OF SITES FROM WHICH SOIL SAMPLES WERE COLLECTED.
N
U. S. S. R
SINKIANG
KASHMIR
AFGHANISTAN
KABUL
WARSAK DAM
FRONTIER REGION
SRI NAGAR
JAMMU
RAWAL PINDI
MANGLA DAM
MIRPUR
MANGLA
POONCH DAM SITE
BARAH DAM
SIALKOT
RIVER CHENAB
JHELUM RIVER
GUJRANWALA
HYDEL WORKS
CHINIOT
BALLOKI
LAHORE
RAVI
SAHIWAL
SUTLEJ
RIVER
INDIA
ISPLINGI DAM
HARI BOLA DAM
QUETTA
TALKHKHANI DAM
BAHAWALPUR
LEGEND
1. INTERNATIONAL BOUNDARY
2. SITES. (FROM WHICH SOIL SAMPLES WERE COLLECTED)
INDUS
SUKKUR
TANDO MASTI KHAN FALL
MANCHHAR LAKE
50 0 50 100
SCALE IN MILES.
KOTRI
KARACHI
ARABIAN SEA

materials, the very first problem is to classify the soils involved. One of the methods to classify soils is the grain size analysis which gives us a picture whether the material in question is a sand, silt or clay for which arbitrary ranges of particular size have been fixed *viz.*

Sand : 2.0 to 0.6 mm
Silt : 0.06 to .002 mm
Clay : less than .002 mm

but experience has shown that the physical characteristics particularly "Plasticity" which has to play a major role in the future behaviour of the construction are not entirely dependent on the particle size only, instead the inherent nature and history of origin of the material is more important. Thus, besides grain size analysis, the classification should be based on the 'Atterberg's limit'.

All the testing procedures being lengthy, it was considered necessary to develop inter-relationships from an enormous amount of test data available in the Institute gathered from all over West Pakistan from various Engg. projects.

Work carried out

First of all an equation established by "A Casagrande" between paslticity index and liquid limit *viz.*

P. I. = 0.73 (L. L-20)

where P.I.=Plasticity Index
L.L.=Liquid limit
and LL > 20

was tried whether it held good in the results available with the authors on West Pakistan soils as mentioned above.

It was noticed that in most of the cases of our plastic soils, the very condition that liquid limit should be more than 20, did not hold good. Thus the above formula was considered inapplicable to West Pakistan alluvial soils.

The entire available data were analysed and plotted and it was found that the following equation should replace the Casagrande equation.

P.I. = 0.65 (L.L—14.0)............(1)
where L.L > 14.0

This straight line relationship has been derived by the least square method (Fig. 1). The straight line obtained from the Casagrande equation has also been drawn on the same figure (Fig. 1) in dark. It is clear that the Casagrande line falls away from all the points plotted from our data and is therefore not applicable to West Pakistan soils.

The second relationship was similarly established between O.M.C. (Optimum moisture content) and P.L. (Plastic limit) as shown in Fig. 2 *viz.*

O.M.C. = 0.83 (PL—1.90).........(2)

using the relation PI = LL—PL and solving (1) and (2) simultaneously we get the third relationship *viz.*

O.M.C. = 0.29 (LL+20.6).........(3)

All the abovementioned data is given in Table 1 and as already discussed, the straight lines obtained are the best fitting on the plots because all the points do not lie on the straight lines.

Counter check

Twenty-seven soil samples were collected from the field and the relevant tests were carried out afresh to ascertain the validity of equations 1, 2 and 3. These results are given in table 2. It was found that the equations hold good within a deviation of ± 13% in case of equation 2 and ± 15% in case of equation 3.

TABLE No. 1

Technical laboratory data of typical alluvial soils in West Pakistan on optimum moisture content (Proctor) and Atterberg's limits

Project	Optimum Moisture content (%)	Atterberg's Limits: Liquid limit %	Plastic limit %	Plasticity index
Mangla Dam Project.	9.8	16.0	14.4	1.6
	14.9	29.1	20.2	8.9
	11.3	21.3	14.4	6.9
	12.9	27.5	15.7	11.8
	14.0	32.6	19.4	13.2
	16.5	37.8	21.7	16.1
	12.5	24.5	15.1	9.4
Sialkot, Murray College Site.	11.0	15.0	14.3	.7
	9.0	16.1	13.4	2.7
	12.5	29.0	18.7	10.3
Baran Dam Site	11.1	15.0	14.3	0.7
	9.5	16.0	14.8	1.2
Nari Bolan Project.	15.5	40.8	19.5	21.3
	13.0	30.1	15.7	14.4
	12.6	27.0	15.6	11.4
	14.5	35.2	17.2	18.0
	16.0	41.2	19.7	21.5
	13.8	34.6	17.2	17.4
Balloki Headworks	12.0	21.8	16.8	5.0
	13.5	25.5	19.5	6.0
	15.0	26.1	17.8	8.3
	11.0	20.1	14.6	5.5
Frontier Region	14.0	32.2	18.5	13.7
Chichoki Hydel Site.	10.5	21.0	15.2	5.8
	10.0	18.6	14.4	4.2
Isplingi Dam Site	12.8	26.3	18.8	7.5
	16.3	30.8	20.8	10.0
Poonch Dam Site	11.3	19.8	16.6	3.2
	15.0	29.5	21.1	8.4
	17.0	41.0	20.8	20.2
	11.0	20.8	15.4	5.4
Gujranwala Hydel Project.	17.5	39.5	20.5	19.5
	19.0	48.5	26.2	22.3
1	2	3	4	5

TABLE No. 2

Technical data of selected soils samples on optimum moisture content (Proctor) and Atterberg's limit

S. No.	Optimum moisture content %	Atterberg's limit: Liquid limit %	Plastic limit %	Plasticity Index
1	15.3	27.3	20.5	6.8
2	13.5	23.7	18.7	5.0
3	10.2	18.8	14.0	4.8
4	11.2	18.0	15.2	2.8
5	12.7	30.3	19.2	11.1
6	16.5	34.2	19.5	14.7
7	12.0	26.5	14.9	11.6
8	13.4	24.5	18.7	5.8
9	13.5	33.7	18.0	15.7
10	22.8	48.0	29.0	19.0
11	22.2	44.4	29.3	15.1
12	19.5	45.6	24.3	21.3
13	18.5	37.8	21.5	16.3
14	20.0	49.2	24.5	24.7
15	18.9	41.0	26.2	14.8
16	21.3	44.8	26.5	18.3
17	20.0	45.7	27.2	18.5
18	20.8	44.2	28.4	15.8
19	17.9	38.7	25.2	13.5
20	18.7	40.0	25.8	14.2
21	20.5	36.8	26.2	10.6
22	10.0	20.1	14.6	5.5
23	9.8	15.1	14.0	1.1
24	18.4	42.0	22.7	19.3
25	16.0	38.3	23.0	15.3
26	16.8	42.7	24.2	18.5
27	18.5	43.0	24.5	18.5

This deviation is not extraordinary in case of soils testing where besides personal errors the environmental effects are unavoidable and inherent complexities in different soils due to presence of organic matter and various types of salts etc. are also responsible for deviations from anticipated results.

Discussion of Results

The following three relationships have been established:—

$$PI = .65\,(LL - 14) \quad (1)$$
$$OMC = .83\,(PL - 1.9) \quad (2)$$
$$OMC = .29\,(LL + 20.6) \quad (3)$$

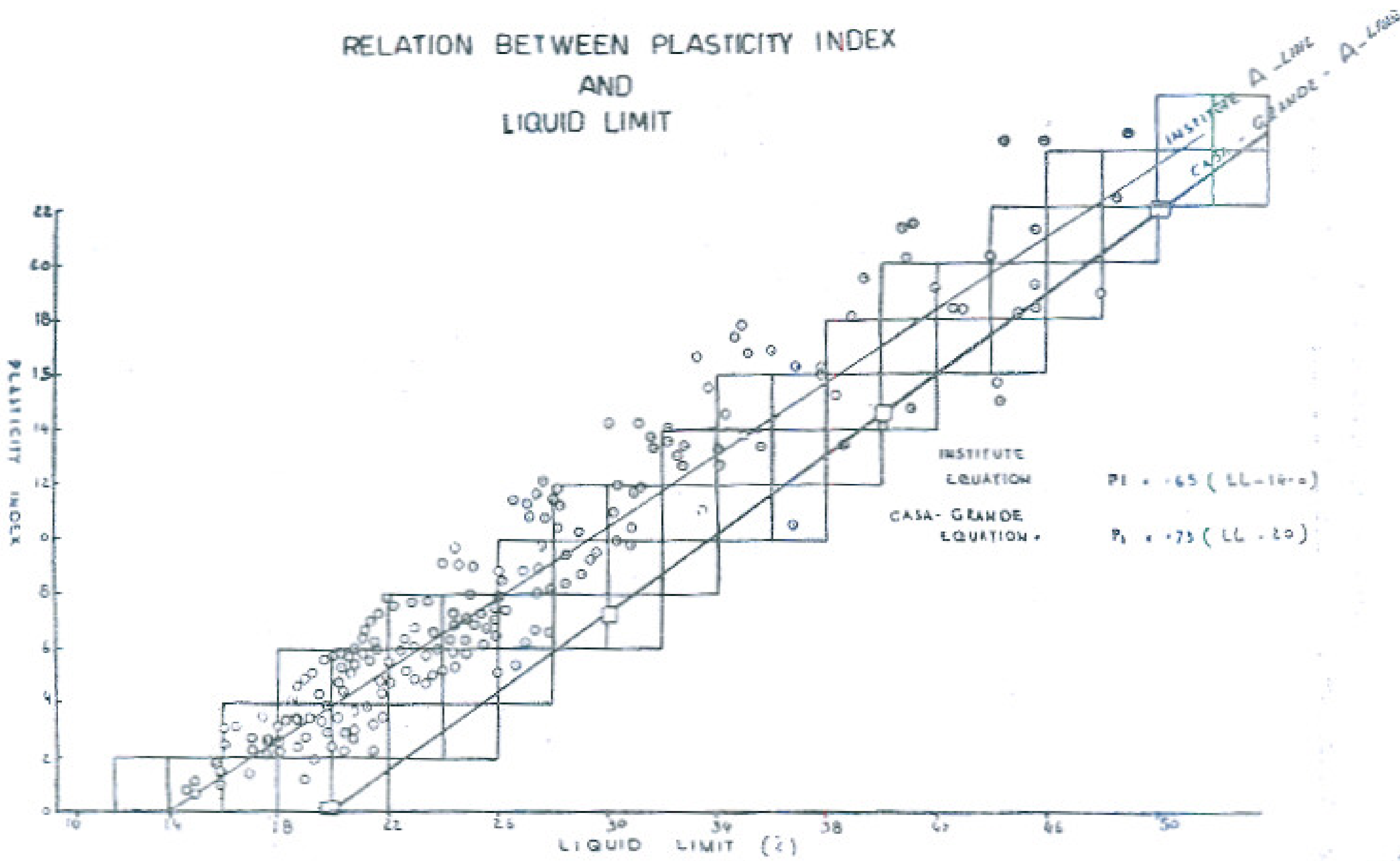

RELATION BETWEEN PLASTICITY INDEX
AND
LIQUID LIMIT
INSTITUTE A_LINE
CASA - GRANDE - A_LINE
PLASTICITY INDEX
INSTITUTE EQUATION
PI = ·65 (LL−16·0)
CASA- GRANDE EQUATION =
PI = ·73 (LL − 20)
LIQUID LIMIT (%)

Fig. 1

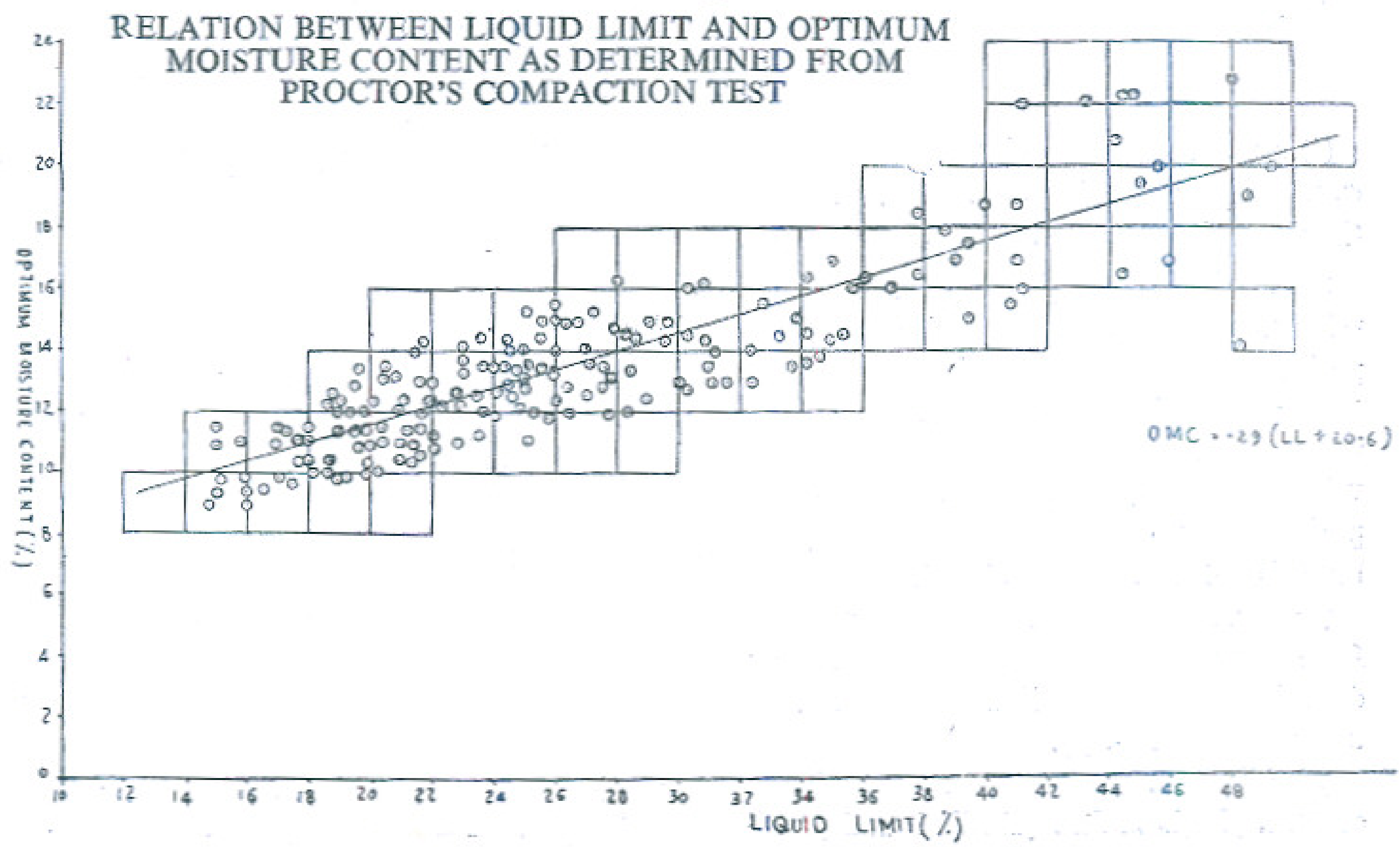

RELATION BETWEEN LIQUID LIMIT AND OPTIMUM
MOISTURE CONTENT AS DETERMINED FROM
PROCTOR'S COMPACTION TEST
OPTIMUM MOISTURE CONTENT (%)
OMC = ·29 (LL + 20·6)
LIQUID LIMIT (%)

Fig. 2

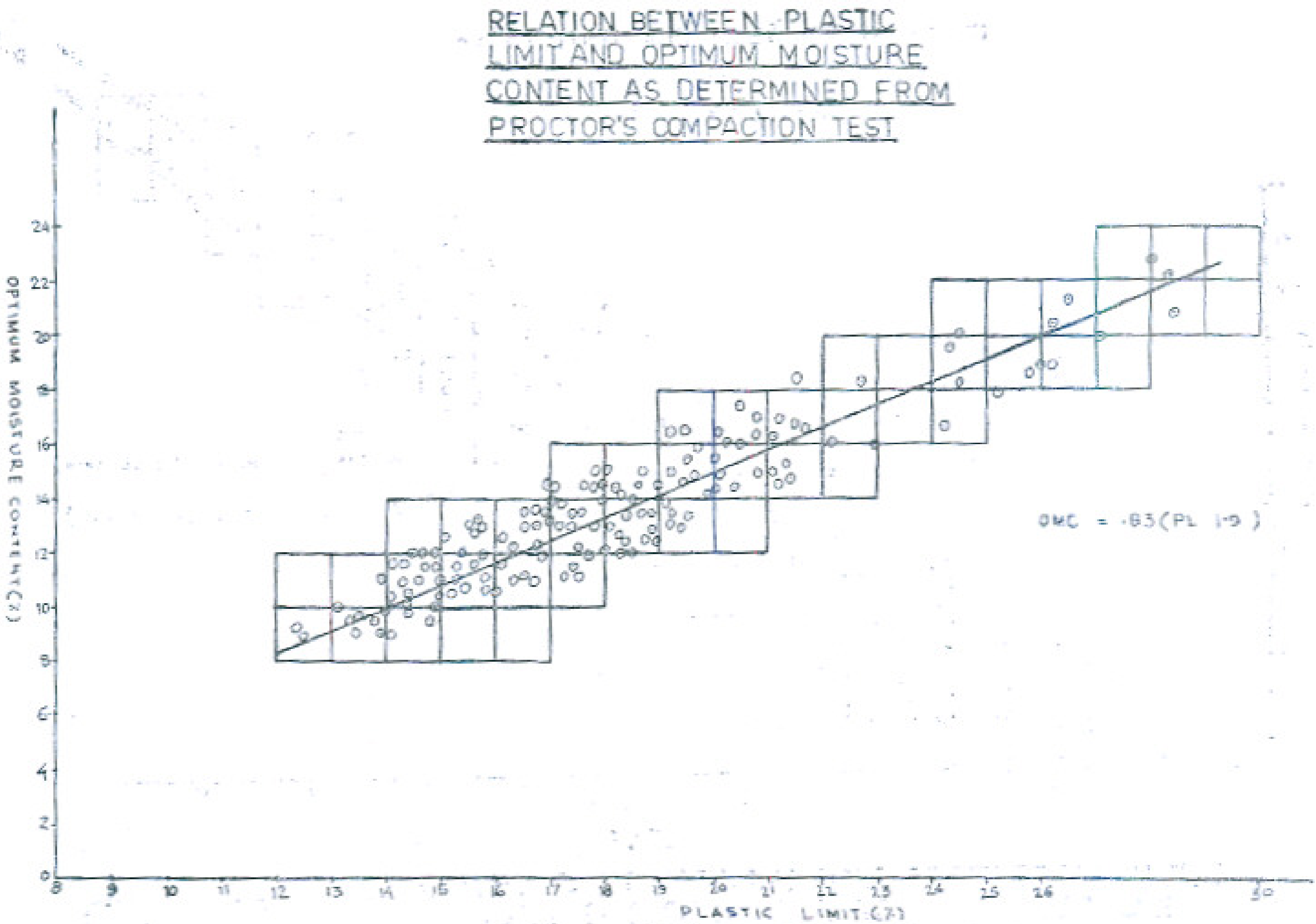


Fig. 3

(*i*) Equation (1) replaces Case-grande equation—for Pakistan alluvial soils due to the reasons given below:—

(*a*) The Plasticity Index which is actually a reflection of the clay content in a soil is a positive number only if LL > 20 (according to casa-grande) whereas the available data with the Institute (attached) shows that the value of Plasticity Index is not necessarily a positive number under the condition LL > 20 but it is a +ive even if LL > 14.

(*b*) Fig. 1 (dark line) which has been drawn from Casa-grande equation shows a clear deviation from the line drawn out of our data using equation No. (1).

(*ii*) All the values of optimum moisture content, plastic limit, liquid limit and plasticity index can be determined by knowing only one of them.

(*iii*) Optimum moisture content can empirically be controlled during the field compaction on the basis of plastic limit which is easier to determine and time-saving.

BIBLIOGRAPHY

(*i*) Technical data for twenty years on various projects in Irrigation Research Institute, Lahore.

(*ii*) "Soil Mechanics for Road Engineers" by Her Majesty's Publications.

(*iii*) "Military Engineering", Volume V, Part I, Roads and Airfields, 1957.

(*iv*) "Civil Engineering Hand Book" by Leonard Charlse Urquhart.

General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NEWS AND NOTES

ROAD RESEARCH PROGRAMME

Equipment worth $ 39,000 given to Provinces

The Ministry of Communications has supplied road research equipment worth 39,000 U.S. dollars to the Provincial Highway Departments to enable them to carry out their road research programme.

The equipment, supplied by the United Nations Development Programme, comprises four central testing units and seven field control units.

The East Pakistan Highway Directorate has received one central testing unit for its laboratory at Dacca and four field control units one each for its laboratories at Rajshahi, Jessore, Sylhet and Chittagong.

The Highway Department of the Punjab has been given one central testing unit and one field control unit, while the Highway Department of Sind has been given two field control units. The N.-W.F.P. and Baluchistan have also been provided with equipment.

The distribution of the road research equipment has been made on the recommendations of the Central Road Research Committee which has been set up by the Government to prepare and implement road research development programmes in the country.

The Ministry of Communications has already been supporting the road research efforts in the country through financial assistance to the Provincial Governments. A grant of Rs. 22.50 lakh has been made for organising a road research laboratory at Dacca. Similarly, Rs. 8.50 lakh have been given for the Road Research Laboratory, Lahore.

Besides, sizeable road research equipment has been obtained for East Pakistan under bilateral agreements and through other sources. The road research equipment procured for the coastal road project has been made available for use in Baluchistan. Similarly, road research equipment imported for the Karachi-Hyderabad Highway Project has been placed at the disposal of the Sind Highway Department.

PLEA TO SOLVE ENGINEERS PROBLEMS

The annual general meeting of the Punjab Gazetted Engineers Association in Lahore on Saturday *i.e.* April 10, 1971 called upon the Government to immediately implement the recommendations of the Engineers' Problems Committee.

The Association, in a statement, said that the Government, had recently accepted two recommendations of the Committee—Class I status to graduate engineers and elimination of unemployment. However, some of the recommendations such as professional management by professionals' and measures for the advancement of engineering science has been ignored. The statement called for the early implementation of all recommendations of the Committee.

The Association further called for the issuance of a notification accepting the engineers' demand for Class I status and framing of rules for their employment.

Following were elected office-bearers of the Association for the year 1971:—

President: Mr. S. M. Ayoob, Vice-Presidents: Mr. Akhtar Ali Chohan and Mr. Mazhar-ul-Haq, Secretary; Mian Iftikhar-ud-Din, Joint Secretary: Mr. Azhar Irshad Chaudhri, Financial Secretary: Mr. Javaid Ahmad Malik.

A 12-member Executive Committee was also elected.

MORE FACILITIES TO CULTIVATORS

The Punjab Irrigation and Power Department has allowed a number of irrigation facilities to the cultivators and zamindars for Kharif, 1971.

According to a directive issued by th Government in this connection, cultivator have been permitted inter-cropping of food grain crops like maize and bajra in garden and orchards throughout the zone comprising Lahore, Sargodha, Multan and Bahawalpu Divisions.

In addition, the cultivators have been allowed for Kharif 1971 to lift supplies of wate from drains and nullahs throughout Punjab at their own expense where local irrigation facilities do not exist.

Permission has also been given for drawing Kharif supplies on two-and-a-half month basis to the fallow lands.

TUNNELLING WITH MICROWAVES WATER

Japanese engineers are experimenting with revolutionary methods of tunnelling through mountains with microwaves.

They are also trying out high-pressure water-jets to crack rocks.

These new techniques of high-speed excavation, under development at the Railway Technical Research Institute Tokyo, are needed to build railways for Japan's 'bullet trains' which must run as straight as possible and, therefore, cut through mountains.

Railway officials said 53 per cent of the 398-kilometre (243-mile) new Sanyo-line now under construction between Okayama western Japan, and Hamta, on Japan's main southern-most island, will pass through tunnels.

Conventional methods of tunnelling with dynamite, or modern methods with the rotating metal blades of a boring machine are not satisfactory in Japan, because o rregular geological structures, the officials said.

The water method uses a "squirt gun," shooting water at 1,000-1,200 metres (3,280-3,936 feet) per second. The impulse from high-pressurised water will cause cracks in rocks which are enlarged by more water.

The Institute has already developed two jet pumps with a water-pressure of 2,500 and 5,000 atmospheres. It is now working on one with 10,000 atmospheres.

Officials said a rock breakage speed of one metre (3.28 feet) per second was practical, but there are still technical problems about how to keep the jet in operation for a prolonged period of time, how to devise a packing to withstand the tremendous pressure, and how to keep water from freezing under such pressure.

A practical prototype machine is expected to be completed in a few years.

The Microwave method of boring can 'cook' rock walls on the same principles as that of a microwave oven range.

Under microwave treatment, rock molecules or water particles in the rock collide, causing an increase of heat, which makes the rock swell and crack.

An experiment showed that a sample of rhyolite, a hard rock found in a tunnel on the new Sanyo line, was broken after irradiation of five minutes and 20 seconds from a distance of six centimetres (2.3 inches) with a power output of 20 kilowatts..

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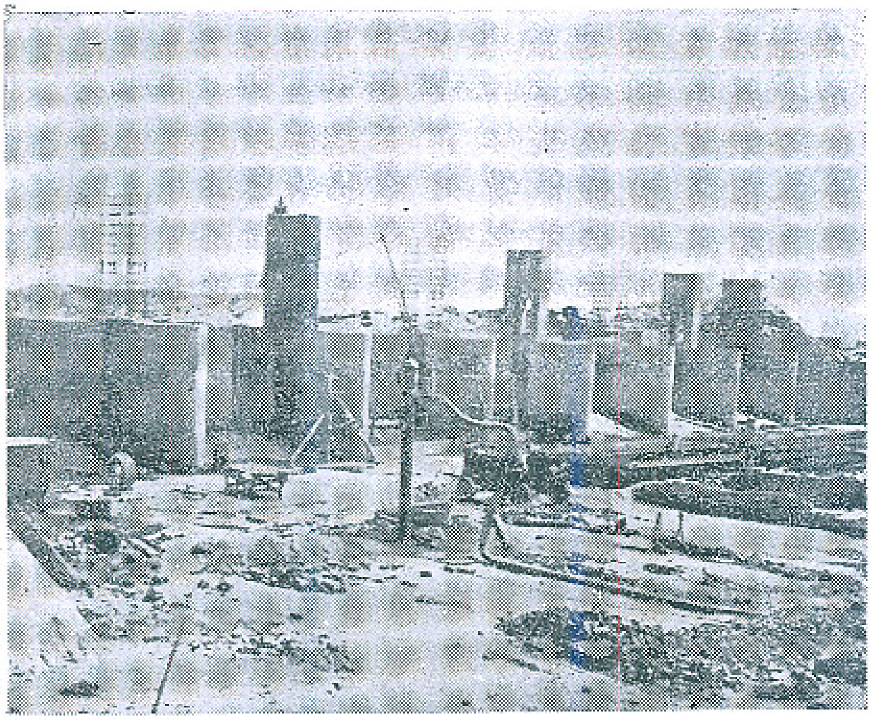

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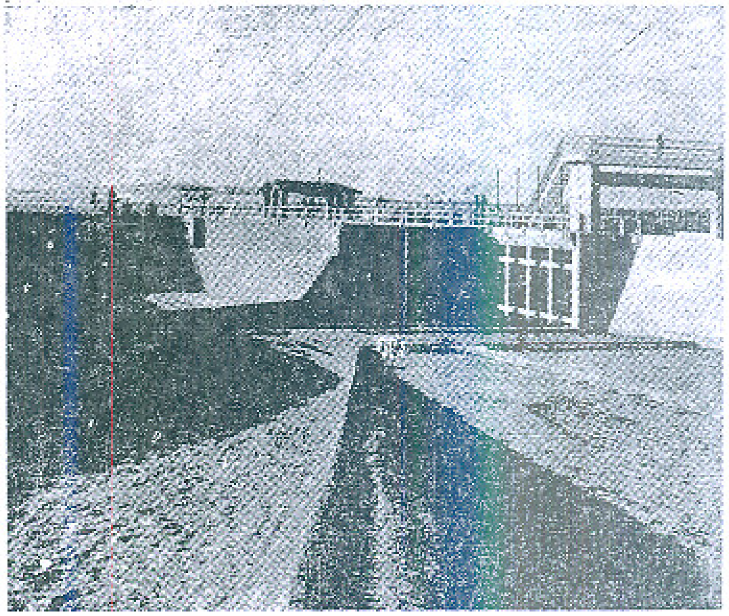

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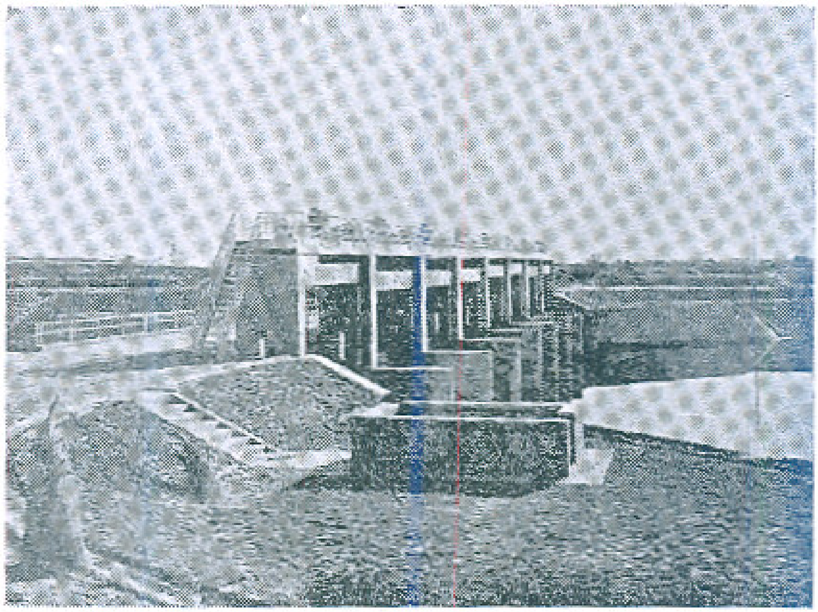

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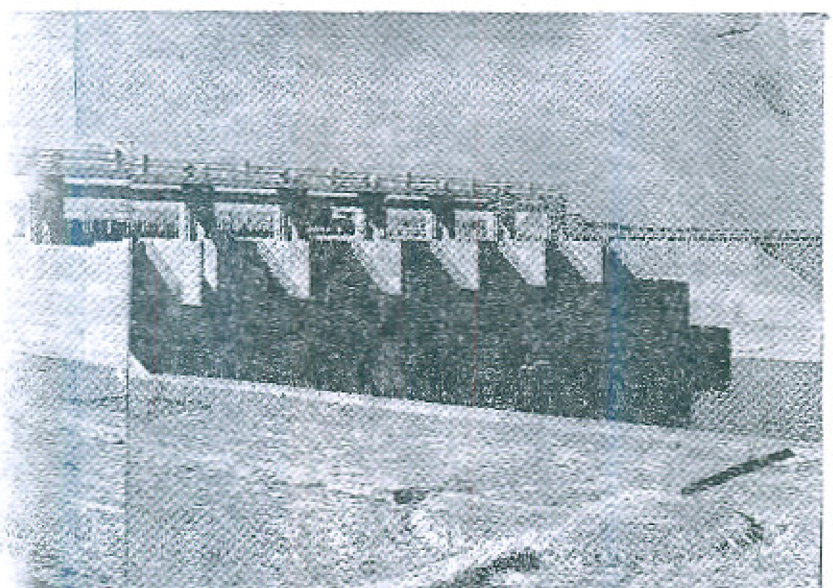

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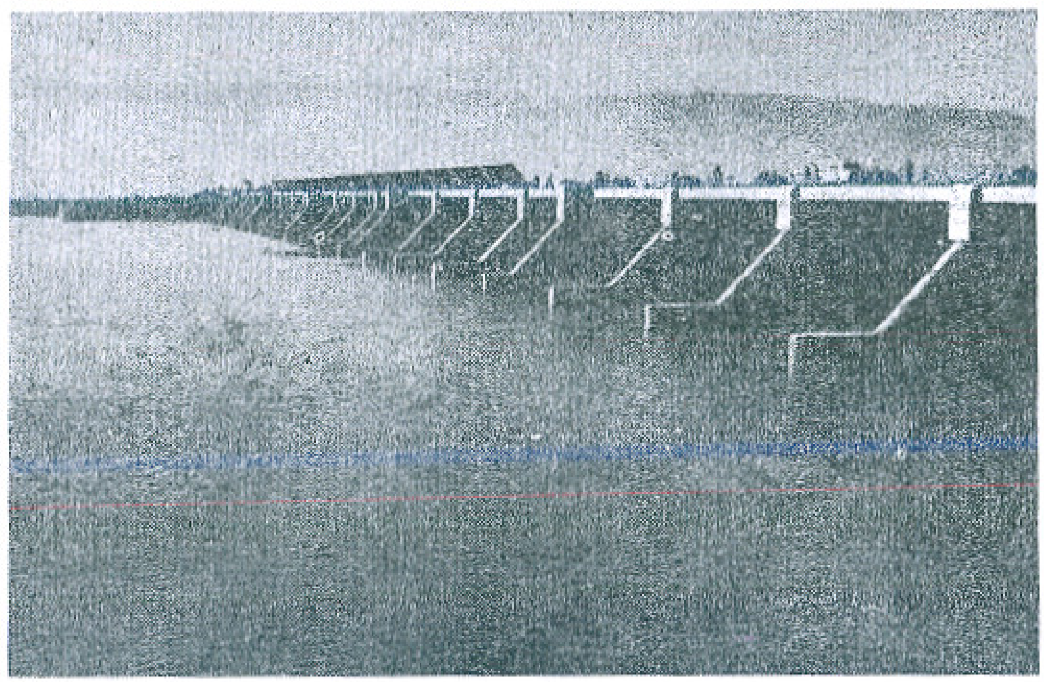

A view of the Chasma Barrage.

Attention : Members Please

PUBLICATION OF ENGINEERING NEWS

Members are requested to forward technical papers for publication in the Engineering News. There are five broad sections viz :

a. Irrigation and Power Section.
b. Buildings and Highways Section.
c. Industry Section.
d. Mechanical and Railways Section.
e. General Section.

Other interesting features are news pertaining to Engineering Professions, abstract of papers and other relevant material.

All papers submitted for publication must be forwarded to the Editor Engineering News two months ahead of the date of publication *i.e.* in January, April, July and October. Papers must be typewritten with double spacing on foolscap paper. Two copies of the paper are to be submitted.

All the relevant diagrams must be properly traced on transparent paper with Chinese Black Ink. Photographs should be on glossy paper. The diagrams and photographs must be properly labelled and numbered.

News in Pictures with brief introduction will be appreciated in every section of this publication.

Articles, news and notes and other suggestions are earnestly requested to make the Engineering News regular and useful for the profession.