function each playing his own part to maintain its smooth operation. The staff must have faith in their principals and confidence to their right of appeal in the event of adverse conditions being encountered, either in their work or at home.

Co-operation between the representatives of International Financing Agencies and the contractor is also accordingly desired. There will be a great many problems unless the specifications, contracts and drawings are satisfactorily and precisely drawn up in the final instance. Given this, solution to many problems which do arise is the fundamental one of human relationship.

* * *

9. CONSTRUCTION CONTRACTS AND LAW

By S. M. RIZWAN ABIDI

While there are associations of Consulting Engineers and those of Contractors in Great Britain and the United States since 1910, it is a great pity that this profession has been completely neglected in our country. In fact, the engineer in Pakistan is the worst hit professional.

Although construction has not yet been accepted by the Government of Pakistan as an 'industry' in the country but by international standards it has come to be acknowledged as such. With the advent of Indus Basin Projects it has become the largest industry in the country today with the largest single civil engineering contract in the world, pertaining to Mangla Dam Project being awarded in Pakistan. Contract laws vary from country to country. We in this country have inherited the British system as far as the contract laws are concerned. Under the present law a Contract should satisfy certain conditions as given in the paper. Details of the law when the contracts become void and the types of contracts are also mentioned in the paper. The author has discussed the advantages of competitive bid contracts. Competitive Bid Contracts are either Lump Sum or Item rate contract. The author then discusses the various types of contract such as Lump Sum, Item Rate and of combination of both these. It is necessary for obtaining competitive bid, contract documents are made available to the bidder. The practice adopted by WAPDA in such cases is discussed. In this paper details of the general condition of contracts or construction for construction projects are put forth. These are the various items which are usually operative on the various Indus Basin Project and has been evolved with the efforts of some of the best international engineering brains in the field of engineering.

* * *

10. CONTRACTING PRACTICES IN PAKISTAN

By MANGLA DAM CONTRACTORS

The authors have divided their contributions into three sections. The first deals with contracting practices in Pakistan as an Industry and they have discussed the present problem in the development of contracting practices in Pakistan and the part to be played by the Government and the others to develop the contracting practices in this country.

Pakistan is a developing young state. The process of industrialization has just begun. The problems of development of a contracting industry in Pakistan are ones which are typical of an under-developed economy. The basic problems may be summarized as under—

(*i*) Sources of Capital,

(*ii*) Training and Procurement of Technical

Personnel.

(*iii*) Nature of Incorporation.

The need for capital in any industrial enterprise is fundamental. Ways must be found to provide capital to contractors. Another way to meet the deficiency of capital is to invite foreign investment. There may be other means for capital development; our purpose here is simply to emphasize the need for it.

The contractor in Pakistan faces a very serious problem when he seeks enough trained men who can correctly design and efficiently execute complicated construction projects. The problem of finding skilled craftsmen in Pakistan though not as great as the recruitment of qualified engineers, is particularly troublesome on project as enormous as that of Mangla Dam. The method of in-service programme adopted by Mangla has produced excellent results. Within the past $2\frac{1}{2}$ years more than 5000 workmen have been trained and are now performing to the entire satisfaction of their supervisors.

In the present day world corporations are regarded as essential for the conduct of sizeable economic activities. A corporation needs a maximum measure of autonomy if it is to flourish.

PART II—VARIOUS FORMS OF CONTRACTS AND THEIR SUITABILITY IN PARTICULAR CIRCUMSTANCES

In this head the Mangla Dam Contractors particularly discuss Single Large Contracts *Versus* Multiple Small Contracts.

The author has discussed the various points of contract such as competitive contracts, negotiated contracts. Competitive contracts are further sub-divided into unit price contracts, lump sum contracts and combined unit price and lump sum contracts. Similarly the negotiated contracts are discussed under 5 different heads dealing with cost plus percentage of costs contracts, fixed fee contract, fixed fee profit with profit sharing, with a sliding scale of fee and with a guaranteed ceiling price.

Talking about large contract the author has stated that the general contractors may have experience of only a few of the many construction speciality so he has to depend on sub-contractor. That is called expansion.

The awarding of single large contracts, spread into multiple small contracts depend upon the unique situation, the economy of the country, area or corporation involved and the type of project.

PART III—ADMINISTRATION OF LARGE CONTRACTS

This is the last item discussed by Mangla Dam Contractors. The management of a large constructional contract involves organization, control, direction and coordination. After their consideration two charts as are putforth depicting how the organization is set up with Project Manager as the head of the Organization. In one case, there are immediately three sections under Project Manager. These constitute administration control, field construction, engineering and design. In the other case six divisions are shown under the Project Manager.

Communication channels are discussed to a great extent. Communication can be classified in a number of ways, direct and indirect, upward and downward or horizontal verbal or written. Within each of these there are hosts of variations. Some of these are discussed in the paper.

11. CONSULTING AND CONTRACTING PRACTICES IN PAKISTAN

By AHMAD KHALEELI

Heavy contracting industry subsists, as is well known, on modern equipment such as bulldozers, scrapers, graders, cranes, draglines, weigh batchers, concrete mixers etc., etc. These are required for the efficient and speedy execution of projects. Such essential equipment is not only very expensive but is also in short supply in our country.

Neither finance nor other facilities for importing such equipment are readily available today. Banks and other financing agencies are not favourably inclined to assist the building industry for they, generally speaking, consider a contractor somewhat of a security risk. This attitude has discouraged people with enterprise but limited means from entering this field, nor does this attitude permit the industry as a whole to develop and expand in the manner it should to meet the ever-increasing demand on it.

The practice of contracting depends on steady financial returns from projects after an initial investment of capital. In fact, however, running bills are often delayed on some pretext or other, landing the contractors in serious financial difficulties and thus slowing down operation very considerably. Even an established contractor cannot be expected in the conditions of today to prefinance several major projects at one time. Deductions from contractors bills in the form of security deposits, earnest money, guarantees, insurance cover etc., etc. are heavy and mean a substantial reduction in the availability of funds. The contractor is almost invariably faced with shortage of funds.

The author next compared the working of P. W. D. departments with WAPDA and then put forth suggestions which can encourage the private consulting and contracting practices in Pakistan.

The author suggests that in the next 5 years plan the country must take up to the new system of Industrialised building which economise on time and on labour with simplification of the design.

The instance of England plant hiring companies is given which can be helpful if adopted in this country also. Here there are many difficulties for a contracting organization but with cooperation and encouragement of Government and Public, a contractor can expect to overcome these handicaps and to face the construction era of the future with hope and confidence.

Pakistan Science Conference

GENERAL REPORT

The 17th Annual All-Pakistan Science Conference was held at Karachi University from 12th to 17th February 1965. The Conference was well attended. Nearly 500 delegates took part in this deliberations. A large contingent of foreign scientists was seen attending the various sections. In the Engineering Section, the representatives of Netherland, Turkey, China, Russia, West Germany America took very active part. This year's meeting had the largest contributions of original papers, about 36 of them. The deliberations throughout the Session were well attended. The Engineers and Scientists from Pakistan who took part in the proceedings include Khan Mohammad Azam, ex-Chairman East Pakistan Wapda, Kawaja Azim-ud-din, Chief of A. C. E. Karachi, Dr. A. G. Asghar, Vice-Chancellor, Eng. Un., Lahore, Mr. Mohammad Saeed, Chief Engineer, Quetta, Mian Afzal Hussain, Chairman Agricultural Research Council and several others well known scientists. In this brief report we have noted brief excerpts from the addresses of presidents of various sections which can interest the Engineering Profession. The complete address of Syed Munawar Ali Shah, the President of the Engineering Section is reproduced as such. Only headings of papers read in the Sessions are mentioned for lack of space.

Conference is Declared Open

The All-Pakistan Science Conference met for the first time in the New Campus of Karachi University. It was inaugurated in a big pandal accommodating more than three thousand audiences. The proceedings started at 10.30 a.m. with the recitation from the Holy Quran and assumption of presidentship for the year by Dr. S. D. Chaudhry. The address of welcome was read by I. H. Qureshy, Vice-Chancellor, Karachi University, followed by inauguration of the Conference by Prof. Mian Afzal Hussain. Dr. Chaudhry addressed the scientists and Dr. Niaz Ahmad, the General Secretary introduced the foreign delegates and read the Goodwill messages. In the afternoon Session a General Symposium on "Man Made Fibres" was held followed by a Popular Lecture on Physics of Elementary Particles by Professor Abdus Salam. The Proceedings in various sections started from 13th February and continued to 16th . The Presidential Address in Engineering Section was delivered by Syed Munawar Ali on Monday the 15th February 1965 at 11 A.M.

EXCERPTS FROM THE ADDRESS OF GENERAL PRESIDENT

Dr. S. D. Chaudhry, General President of the Conference surveyed the progress of the

Science from the Laboratory into the arena of everyday life. Science can now be directed to specific chosen aims by man to alter his material world. The man has now means to conquer hunger and diseases. Science offers a challenge to the society to use it for its welfare. It shapes the lives and thought of men and destiny of nations, scientific research and knowledge are essential elements of modern life. No nation can afford any longer to disdain the advice and collective foresight of its leading scientists and engineers. After these few remarks the President outlined his views on different development sectors of the country.

Industries

Speaking on the Industries the President said that no country can advance industrially unless its industrial activities are based on scientific research and technology. Many of our industries are running inefficiently because they have failed to utilise modern techniques of production and to utilise industrial wastes. The importance of technical manpower in the operation of industrial units cannot be over-emphasised. So long the industrialists do not operate their units with the best available technical and skilled manpower, they are bound to run inefficiently. Speaking of Housing and Communication, the speaker said that our housing problems does not seem to be attracting as urgent attention as it deserves from our talented engineers. We have not yet evolved technologically acceptable cheap house nor have we made any research on rural housing, based upon available resources of raw materials such as bamboo, local wood, cane, etc. Our research on roads suffers equally badly. In East Pakistan where land is scarce, valuable earth is taken haphazardly for making roads. Our inland water ways system is sadly neglected. Our talented engineers waste their time on jobs that are the function of technicians. Very few work on designing, planning or research.

Speaking of health service the speaker said that mere professional and scientific journals are not enough to keep them up to date. Reduction by way of in-service training is a must for all doctors if they are to be preserved from obsolescence.

Waterlogging and Salinity

The Agricultural sector in Pakistan offers a challenge to our scientists and technologists unparalleled anywhere else in the world. Thanks to the personal interest of our President, comprehensive measures are being taken by WAPDA to combat the menace of salinity and water-logging. This is not merely an engineering problem; it needs the combine efforts of scientists, technologists and engineers of different disciplines, botanists, soil scientists, physicists, foresters and others. In no sphere of developmental activity team work will pay more dividend. New mulching methods are likely to reduce evaporation, better agricultural practices similarly would lower percolation in the field. Breeding will provide more efficient crop plants that will have less transpiration need. Similarly growing of salt resistant plant could reduce the amount of irrigation water. With regard to East Pakistan which is a humid tropic region dominated by monsoon, East Pakistan Wapda has drawn up a Master Plan for flood control, drainage and irrigation.

Before closing his address the President dealt with the University Education and the part they can play in the development of the country.

creasingly important role. It is in this respect, I feel, that engineers generally fail. The "I-can-do-it-better-myself" attitude is far too common and in most cases it usually takes the form of "no-one-can-do-it-better-than-me". However, it should not be difficult to get rid of this fallacy. Even a modest estimate of the growth of technical knowledge indicates that such knowledge doubles in every fifteen years and there are now more than fifty thousand technical journals published every year. It is impossible for any individual to ride the spiral of technical knowledge alone for very long. It is high time those of our engineers, who occupy administrative and higher executive positions, try to appreciate the changing responsibilities of leadership. They should learn to trust their subordinates, and while keeping themselves abreast of the technical advancements, take advantage of the specialised knowledge of others. They should try to break the habit of personal involvement in trivial details and learn to manage the FLOW OF WORK rather than each item of work itself. They must adjust to these hard realities of administrative functions. If they are unable to assume successfully the functions of good management, and keep up the flow of work, the vacuum they will leave will have to be filled by others. You know it very well that it has happened all too often. Are we ready to meet this challenge?

I have said earlier that engineers feel that they are not getting due recognition. Here I pause to question myself. Are we really honest in making such a complaint? Are we not tilting at windmills when we place the responsibility for our present lack of status on any one else but ourselves? If we are not getting any recognition, may be a critical self-appraisal is in order.

To my mind the very first thing that we need look into is our own attitude towards profession. Till recently engineering services in Pakistan were completely monopolized by Government. The pace of development was also slow and sporadic. The principal duties of engineering services were the operation and maintenance of existing engineering works mainly in the field of irrigation, communication and public buildings. An engineering degree from a college was perhaps the ultimate in engineering education and provided enough of a guarantee for an assured job in the exalted position of Sub-Divisional Officer. In the department one took his position in the queue. Promotion was governed mostly by seniority. Merit was but of little consequence. Very rarely this ritual was disrupted. However, to add some spice to this dull dreary life, our alien government did introduce a novel form of aparthied by creating different classes in the services. This device had the advantage of creating jealousies, sowing the seeds of discord and extinguishing the simmering sparks of initiative and drive if any was still left. All this is too well known to you and I need not go into all these sordid details, but that is precisely what we received in legacy.

Working Engineer, an Architect of Future Progress

Things have not changed much as yet. Policy of class segregation and aparthied is bearing fruits inasmuch as engineers now form a house divided against itself. A degree in engineering, a secure job, preferably in a Government department and routine duties still remain our cherished goal. Average young engineer graduate still craves for the artificial aura of a Sub-Divisional Office and abhors the idea of sitting over a desk and pondering over elementary principles of

engineering design. Even if, through exigencies of circumstances or lack of openings in his desired fields, he condescends to adorn the design desk, he likes to tackle big problems from the very first day. The drudgery of solving simple mathematical equations, or compiling and sifting basic data does not interest him at all. The fabled stories of an S.D.O.'s grandeur still colours his vision and he is not yet mentally prepared to accept the position of, what I may call, a working engineer—an architect of future progress and prosperity. At the higher echelons the position is none the better. At higher levels the bureaucracy and officialism is steeped even deeper.

However, this situation cannot last for long. The domain of engineering is fast expanding the frontiers of P.W.Ds. and Government departments. In almost every phase of national development, private enterprise is now coming forward to commandeer the engineering talent at an ever-increasing rate. Even in the public sector, the volume and the magnitude of work, and rate of development, is growing so fast that Government is obliged to evolve a new machinery in the shape of corporate bodies. Although these autonomous bodies are still very much cribbed and confined in the mire of departmental procedure and bureaucratic supremacy, they do provide a comparatively freer atmosphere for engineers.

The age-old monopoly of Government is now breaking. In not too distant a future the number of engineers employed by, or engaged in, private enterprise would become equal, or even exceed, those serving with the Government. This should bring about a reorientation in our attitude towards engineering and all that it stands for. Instead of begging for recognition of our services and asking for a few crumbs of favour from Government, we should learn to stand on our own feet and make engineering a profession in the true sense. The very word profession has a religious, almost reverent connotation. It must reflect our faith in whatever we profess. Like religion "professionalism is a way of thinking and living rather than accumulation of knowledge and power. Knowledge and power are exceedingly important but professionalism has to do with their use rather than to be identified with them."

Engineers benefit communities

The nature of professional service also differ widely in various professions. For instance, in medicine and law the services are more personal. To one who has an infected appendix or an aching molar, or is trying to recover damages in a law suit, the doctor, the dentist or the lawyer, who successfully relieves him, is a very real benefactor, not to be forgotten very soon. This forms a relationship based on a service for which the recipient is personally very grateful.

In contrast-engineers' services are of general nature and are much less readily recognized. An engineer is engaged in development that serve the needs of many people. More often than not, his works benefit the whole communities, the nations and, in aggregate, affect the entire course of civilization, all without much realization of the services rendered on the part of those served. His achievements and his failures do not affect him so much personally as they reflect on the capability of the profession as a whole. The very nature of his services, therefore, demand a deeper sense of dedication and

higher order of discipline.

Engineering has been defined as "the profession in which the knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgement to develop ways to utilize economically, the materials and forces of nature for the progressive well-being of mankind". When we build a bridge, design a dam, stretch a power line or build an industrial unit we play a significant role in moulding the human destiny. Progress and prosperity through employment of science and technology is the gift of engineering to mankind. Let not the value of this gift be diminished or detracted by any act of ours who constitute the profession. We owe everything that we have to give in honest and sincere efforts towards enhancing the value of this gift. Dishonesty in any form is inconceivable in even the smallest detail of a professional mission. Love for sensationalism in human nature is too willing to magnify the dishonesty, irresponsibility and abuse of the public trust that may be occasionally manifested by a few engineers and subordinate technical personnel. Let us not give any chance for this sensationalism. Let each of us watch our steps. The integrity of the profession is the sum total of the integrity of all of its members—nothing more, nothing less.

Code of Ethics for Engineering Profession

As I said earlier the Engineering Profession is now coming out of the precincts of Public Works Departments and entering into every field of public and private life. It is, therefore, high time that the engineering societies of the country such as the Pakistan Institute of Engineers and the West Pakistan Engineering Congress, not only adopt a formal code of ethics for their members but should also devise ways and means of enforcing these codes forcefully and effectively. The historian, Arnold Toynbee, has recently stated "A civilization never collapses because of outside attacks but through spiritual failure within". This statement, or rather this axiom, would apply equally forcefully to every society and every profession. A code of ethics, backed by a call of conscience, provides that spiritual fibre which sustains every profession.

To my mind the most fundamental article of this code must be to uphold the dignity and the honour of the profession. Borrowing some ideas from the Code of Ethics prescribed by the American Society of Civil Engineers, I may suggest that our engineering societies should declare it unprofessional an inconsistent with honourable and dignified bearing for any member of the profession to attempt to injure falsely or maliciously, directly or indirectly the professional reputation, prospects or business of another engineer. The human nature as it is, finds it very satisfying to carp and cavil, to condemn and criticise. Proverbially one is apt to see a beam in one's own eyes but would not miss to note a mote in others.

Very often this tendency is confused with genuine difference of opinion, which in fact has been largely responsible for evolution of science and engineering. However there is a thin line of demarcation between the two. In our enthusiasm, and often out of ignorance, we are liable to cross this line into, what I would call, the realm of over-criticism bordering outright condemnation. That is which must be avoided. I am sure you will agree with me that nothing has disfigured the public image of engineer more than unbridled and unguarded criticism especially in the

presence of non-engineers who are not familiar with all the technicalities of the problems and are therefore likely to misinterpret and carry entirely wrong impressions.

Engineering Societies can educate an Engineer

While talking of engineering profession, one can hardly ignore engineering education which is the starting point and therefore warrants careful reappraisal and review. This in itself is such a vast and involved subject that a brief discussion would do no justice and a detailed discourse is hardly possible. Suffice it to say that to a very large extent our ability to shoulder the responsibilities of tomorrow would depend on our attitude and approach to the engineering education to-day. I would invite practising engineers and engineering societies to give some thought to the problem of education which is not confined to the colleges and universities alone. The responsibility of advancing the frontiers of knowledge is shared jointly by the world of learning and the world of practice.

In ultimate analysis the future of the profession largely depends on the engineers themselves. It is up to each one of us to prove our credentials through our own ability, integrity and conscientious application to duty. One just cannot wish oneself up the ladder to success or depend on someone else to push or pull him up. It was perhaps Confucius who said that "success comes not from asserting authority which few of us will ever have, but from asserting competence which is available to all". My friends, in this world of struggle, THERE IS NO SUBSTITUTE FOR COMPETENCE.

Proceedings of the Engineering Section

(17th All-Pakistan Science Conference)

This year the Engineering Section of the Pakistan Science Conference was very active. Delegates from five different countries delivered lectures and took part in the discussion of the Proceedings.

Similarly out of the nine presidential addresses, five were of interest to Engineers. Three addresses directly related to the Engineering subject.

The Presidents and their addresses

The following were this year presidential adresses.

Dr. S. D. CHOUDHARI, General President of All, Pakistan Science Conference.

S. MONAWAR ALI SHAH, President of Engineering, Irrigation, Hydel Power, Hydraulics Communication, Electricity, Public Health Section.
"Engineering Profession in Pakistan."

Dr. A. K. QURESHI, President of Chemistry and Applied Chemistry Section.
"Some Current Trends in Chemical Engineering".

Dr. MISS M. K. ELAHI, President of Geology, Geography and Anthropology Section.
"Efficiency of Agriculture in West Pakistan".

Mr. SULTAN ALI CHOUDHARI, President of Agriculture, Animal Husbandry and Forestry Section.
"Presticials, their Past, Present and Future."

Dr. S. M. A. HAQUE, President of Physics, Mathematics, Statistics, Astronomy and Meteorology Section.
"Some aspects of Convection in the Atmosphere".

Prof. NAJIB KHAN, President of Medicine, Pharmacy, Veterinary Sciences Section.
"Man-power in the Health Programme of Pakistan".

Mr. FERDOUSE KHAN, President of Education and Social Sciences Section.
"Some urgent problems in education".

Dr. M. RAHIM ULLAH QURESHI, President of Biology, Zoology, Botany and Entomology Section.
"Marine Fisheries of Pakistan Development and Research".

Proceedings of Engineering Section

This year 41 papers were presented: 20 on the subject of Irrigation, Hydraulics and Hydraulic Structure, 5 on Building Construction and Soil Mechanics, 4 on Roads, 4 on Electrical Power Production and Transmission, one on Water Supply and 2 were of a general nature.

The foreign delegates contributed six papers, two were from Peoples Republic of China, and one each by USSR, Turkey, Netherland and West Germany.

Prof. WU CHEN-CHIEH and Dr. L. C. CHU presented papers on "Study of Seepage Flow by Means of Three Dimensional Electric Analogy" and "On the Effects of Raising Green Manure Crops on the Amelioration and Utilization of saline soils in the People's Republic of China".

Prof. ABDUL ZAHDOV of Central Asian Soviet Republic of Kazakh SSR spoke on Water Constructional Works and experience in Reclaiming vast area of lands in Central Asia.

Prof. TH. THISSJE of Netherlands, ex-Secretary-General of International Hydraulic Structural Research spoke on Flood Control with special reference to East Pakistan.

Dr. CAMAL BIRON, Head of Mining Department, Faculty of Mining, Technical University, Istambul delivered an illustrated lecture on Coal mines and mining of Coal.

Dr. I. H. FLATE of Hanover lectured with the help of slides on Modern Methods of Groundwater Development.

Representative from U.S. included.

Dr. ALVIN AYERS, Soil Science and Fertility.

Dr. STEFARS S. KRASHEVSKI, Soil Classification and fertility.

Dr. D. P. SCHLICK, Coal Specialist.

Below is given the authors and the subjects of 41 papers presented to the Conference.

PART 1

Irrigation Hydraulics and Hydraulic Structures

1. Abdur Rehman and Mushtaq Ahmad.
   Irrigation Research Institute, Lahore.
   "Similarity Laws for fluvial Hydraulic Models."
2. Dr. Nazir Ahmad, Sarfraz Ahmad and Mohammad Akram.
   "Estimating evaporation from free water surface."
3. G. F. Zaffar and Irshad Ahmad,
   Irrigation Research Institute, Lahore.
   "Estimate of Soil Moisture with Calcium Carbide."
4. H. J. Asar.
   C. E. Remodelling, Lahore.
   "Hydrology of West Pakistan."
5. Jamil A. Pervez,
   Director Planning, WAPDA, Lahore.
   "Use of Electronic Computor for Indus Basin, Irrigation Power System Operation Studies."
6. Ch. Mohammad Umar,
   S. E., Surface Water Circle, Lahore.
   "Characteristics of the Waters of the Indus System."
7. Sh. Ahmad Hassan and M. A. Hafiz.
   A.D.C., Lahore.
   "Problem of Irrigation in the Indus Basin (II) Volumetric versus Crop Rate Basis of charge for Irrigation Water."
8. M. A. Hafiz,
   O.S.D., A.D.C., Lahore.
   "Drainable surplus in the Gaja Drainage and Reclamation Project of Ghulam Mohammad Barrage."

9. H. S. Zaidi, Nur Din and M. A. Qayyum.
Soil Land Classification Circle, Lahore.
"Relation of Saturation Percentage to some soils properties."

10. H. S. Zaidi, M. Iqbal Ahmad and M. A. Qayyum.
"Infiltration Studies on Soil of Upper Rechna Doab."

11. M. I. Choudhry,
Dacca, East Pakistan.
"Coastal Embankment (Polders) in East Pakistan."

12. M. I. Choudhry,
Dacca East Pakistan.
"Karnafully Dam and its effects on Kassalong river of Chittagong Hill Tracts."

13. M. Ikram Ullah,
Engg. University, Lahore.
"Variation of Critical Reynolds number with cross section in open channels."

14. Pir Mohammad Ibrahim,
C. E. Consultant, A.D.C., Lahore.
"Controlled Fall."

15. A. Hamid and A. Ghaffar,
Water and Soils Investigation Circle, Lahore.
"Salinity and Alkalinity Hazard in Salinity Control and Reclamation Project 1 Rechna Doab."

16. A. Hamid and H. A. Shah,
Water and Soils Investigation Circle, Lahore.
"Calcium Carbonate Saturation in Tube-well Water of Scarp No. 1 and its relation with the development of incrustation problem."

17. Zia-ul-Haq and S. D. Pervez,
Irrigation Research Institute, Lahore.
"Efficiency of Silt Ejector in Kurrum Garhi Canal.

18. K. Azim-ud-Din,
Associated Consulting Engg., Karachi.
"Gumti river and its Problems."

19. Shaukat Ali,
Master Planning Division, WAPDA.
"Investigation Procedure in Groundwater Development Area and theory of pumping or acquifer tests for analysis of test data and use of the test results in actual Project Planning."

20. M. A. Hafeez,
A.D.C., Lahore.
'Irrigation and Drainage Problem in Project Area of the West Pakistan A.D.C."

21. Dr. Milton Foreman and Anwar-ul-Haque.
"Effect of Irrigation Waters on Soils—A Progress Report."

22. Rashid A. Malik.
"Irrigation Development and Settlement Pattern in the Upper Indus Basin."

23. Ch. Mohd Ali, C. V. Beasten and Mushtaq Ahmad.
"Hydraulic Model Studies on some design problems on Mangla Dam Project."

24. Ch. Mohammad Hussain.
"Influence of Capillary Moisture on the Irrigation Needs of Crops."

PART 2

Building Construction and Soil Mechanics

25. G. F. Zaffar, Kazim Hussain.
Irrigation Research, Lahore.
"Determination of Hardness of Earth."

26. G. F. Zaffar, I. H. Hamdani and Irshad Ahmad, Irrigation Research Institute, Lahore.
"Use of burnt clay as Pozzolanic Material."

27. G. F. Zaffar, Irshad Ahmad, Mohammad Shafiq, Irrigation Research Institute, Lahore.
"Potassium Permangnate Method for Estimation of cement in mortar and concrete."

28. S. Faiz Umar,
Tech. Officer, B & R, Lahore.
"Construction of Lahore Stadium."

29. Mohd Hafiz, A. Hafiz Ullah and M. Hanif Ullah.
"Use of Z-tile as first floor."

30. Mohammad Taslim,
Hyd. Res. Lab., EPWAPDA, Tejgaon, Dacca.
"Compressibility Characteristics of Typical East Pakistan Soils."

31. Mohammad Aftab-ud-Din,
Hyd. Res. Lab., Dacca.
"A General Study of Soil Classification using Hydrometer and Plasticity Index Tests."

32. Mohammad Seraj-ud-Din.
Hyd. Res. Lab., Dacca.
"A Comparative Study of Casagrande and by Schmerlamann Methods of Estimating true pre-consolidation for East Pakistan Foundation Soils."

PART 3

Roads

33. Mazhar-ul-Haq, Saeed Ahmad and Muzaffar Iqbal,
Road Research Lab., Lahore.
"Roads in Water-logged Areas."

34. Mazhar-ul-Haq, Saeed Ahmad and Jalil-ur-Rahman,
Road Research Lab., Lahore.
"Use of Bricks in Base Course."

35. S. Mazhar-ul-Haq, Saeed Ahmad and Muzaffar Iqbal,
"Low Cost Road Construction."

36. Abdul Hayee Choudhry,
West Pakistan Comm. & Works Department, Lahore.
"Study of Fayadiya Land Slide."

PART 4

Water Supply

37. Nazir Ahmad Jiabaji,
Director, Water Supply Public Health Engg., Lahore.
"Modern trends in the design of Rural Water Supply Scheme in West Pakistan."

PART 5

Electricity and Hydro-electricity

38. Jamil A. Pervez and Iqtidar Ahmad.
Planning and Investigation, WAPDA, Lahore.
"Planning of Small Hydel Scheme in Northern Area."

39. S. H. Durani,
Engg. University, Lahore.
"Communication between East and West Pakistan."

40. S. M. Haque,
Engg. University, Lahore.
"Electro-negative Gases for Power Transformers."

41. Dr. M. Saeed Zahid,
Engg. University, Lahore.
"Studies in ionising relation produced reactions in light and heavy waters."

FAO Regional Seminar on Water-logging and Salinity of W. Pakistan

[*Contd. from Vol.* 9, *No.* 4]

FARM DRAINAGE AND SALINITY CONTROL AT CHAKANWALI

By **Ch. Mohammad Hussain**

In order to carry out the investigations into the causes of infertility of water-logged lands, permanent changes in chemical and mechanical composition of soils and the methods by which these lands could be restored to normal fertility and for this purpose Chakanwali Reclamation Experimental farm was opened in 1926.

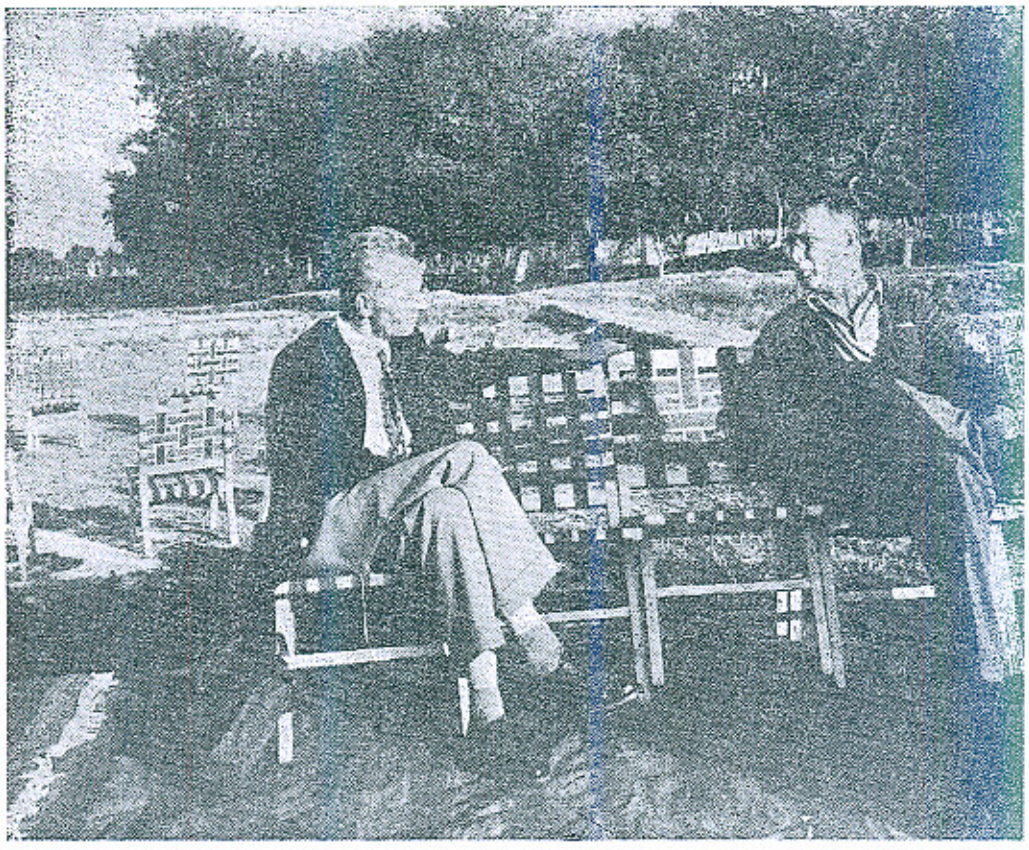
In respect of the conditions which existed at the time of start of experiments it may be stated that out of the total area of 3645 acres, the area under Sem (Water-logged land) was 700 acres, Thur and Rakkar (Sodium and Saline soils) 2260 acres, and the culturable land only fit for rice cultivation was 685 acres.

The present area under different categories is:

	acres
(*i*) Total area of Farm ..	3645
(*ii*) Culturable area ..	2788
(*iii*) Area actually put under crops ..	2688
(*iv*) Area uncommanded ..	243
(*v*) Area under villages and residences ..	103
(*vi*) Area under roads, drains and water courses ..	511

Specifications Laid for the Drainage of Water-logged Lands

Under the prevailing situation in the area which confronted the drainage problems the provision of open field and collector drains was considered the first step and these were laid down as early as 1930. The use of the tile drain, moledrains and drainage wells was also made in the early stages of development. It was found that the use of open deep field drains with free outfall is quite beneficial and economical. With the gain of the experience and knowledge, in the Blocks close to the Lower Chenab Canal, the direction of the field drains had also been altered. In order that these should act as intercepter drains, these have been laid down now across the direction of the flow of seepage water.



Drs. Van den Berg and V. Kovda discussing at Chakanwali Farm

With this change the drainage has been improved and now better control is exercised when these drains are used for sub-irrigation. Successful rice crop is raised without surface canal irrigation in some part of farm area.

The distance between the field drains is 110 feet in case of heavy soils (with Kankar layer at some depth) and 220′ in case of light soils, and the depth is about 3 feet. The drainage system had worked very well and the results are very encouraging. The steps are being now taken to test the existing drainage system in accordance with the latest technique developed in other countries.

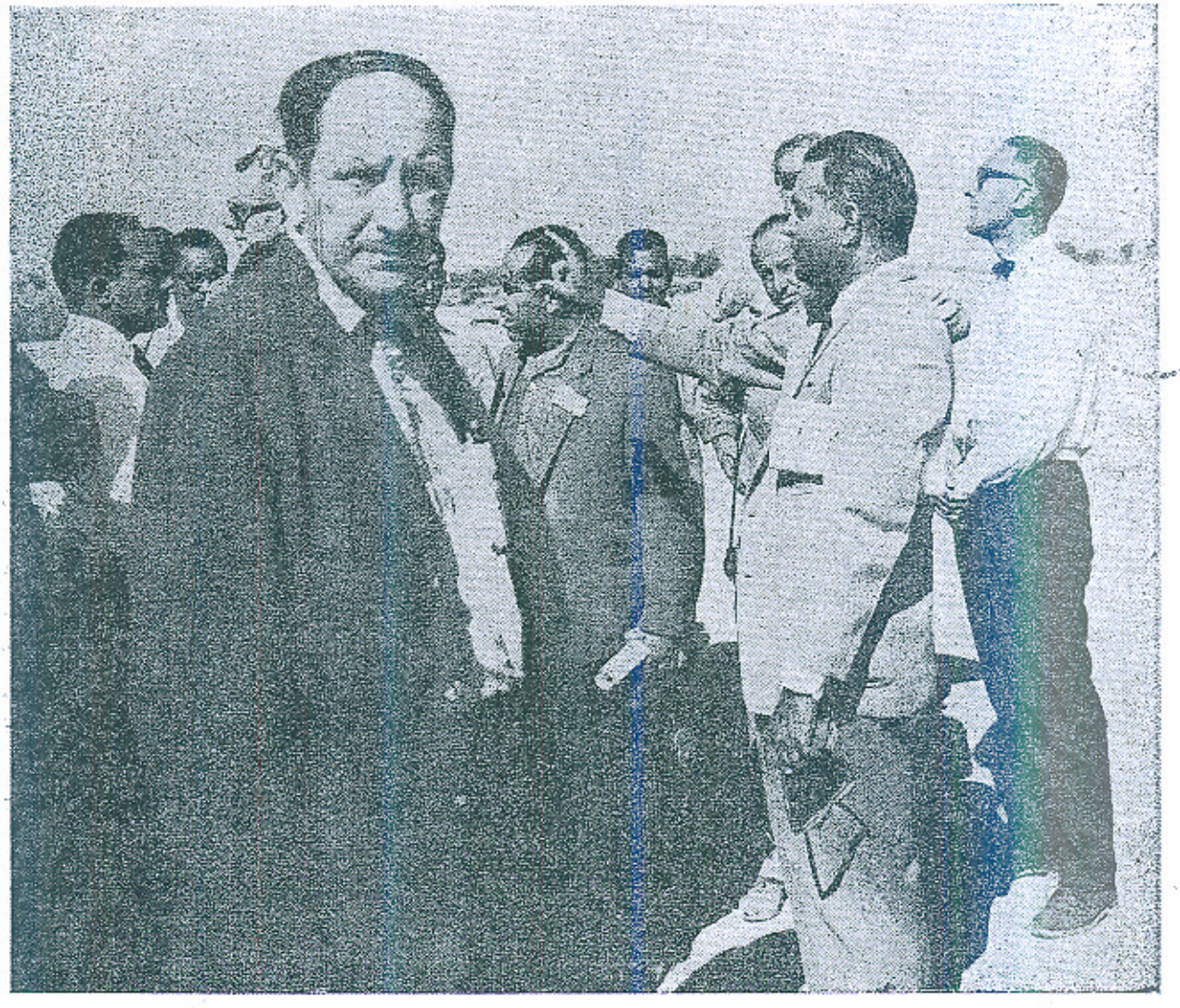
Expenditure and Income of Chakanwali Reclamation Farm

In the initial stages of land development the first few years are the expenditure years. In this case too as seen from Figure No. 4 it is seen that year 1926-34 were all expenditure years. During the year 1935-38 the land was given on lease and department control was taken off. Years 1939 to 1958-59 are more of income than expenditure years. The maximum annual profit during the year 1963-64 was Rs. 252,000.

POTENTIAL FERTILITY OF SODIUM SOIL IN GANJI BAR

By Ch. Mohammad Hussain

The Lower Bari Doab Canal at head has a full supply discharge of 7,000 cusecs, having commanded area of 1,460,659 acres. The area covered by the canal is known as Ganji Bar (containing patches of land devoid of vegetation). There are fairly large patches of fertile soils, but in between exist big pockets of stiff clay soils, with high exchangeable sodium percentage. In spite of all efforts of cultivators and the Government, about 50,000 acres were of such type, that even single blade of grass could not be grown. Such lands are called in the local language as Bara lands (sodium soils) which are highly arid, very closely packed and intractable. The profile is deep, soil crust thick ESP is generally high and the salt content is sometimes high and sometimes even lower than the normal limit of 0.2%. Bara land usually cracks to hexagonal shaped clode, and gives a metallic sould while riding across it. In sunshine from a distance these



Ch. Mohammad Hussain explains the Reclamation of Alkaline Soils of Montgomery area. Dr. Bower of U. S. Salinity Laboratory was a keen observer

lands present a scene of mirage. The surface is generally covered with a 'papri' a thin cake-like material which contains about 80% clay and is impervious to water.

Government decided to allot blocks of Government waste lands varying in size from 25 to 250 acres to the cultivators under specific soil reclamation conditions which authorised the land reclamation staff for control and to guide the operations in accordance with the methods developed at Bhallewala. The water duty for this area was fixed as one cusec for 45 acres at half divisional rates for the first two years and at full rates in the following four years.

From the investigation carried out at Bhallewala farm, it was inferred, that the reclamation of the soil did not depend on the use of amendments but the material like gypsum simply speeded up the process. The use of copious amounts of water for leaching, and growing of crops like rice and Jantar (Sesbania Aculeata) equally brings about the improvement by lowering the salt content, and the replacement of exchangeable sodium as a consequence of the release of calcium from soil CaCO3. The experimental work at Bhallewala Station also indicated that the amount of $CaCO_3$ in soil decreases in the first year followed by an other decrease in the second year of reclamation there by reducing the kanker percentage in the soil. In the second year of reclamation in sodium soils Janter (Sesbania Aculeata) leguminous summer crop is better reclaiming agent than rice. After two years leaching in summer and growth of leguminous crops in winter and these fields were directly put under cotton (19 acres) and sugarcane (5 acres). As by and by the salinity and alkalinity came down to normal limits, the area gradually increased under crops like Cotton, Sugarcane, Wheat, Maize and other Fodder crops. Now out of the total culturable land of 291.95 acres, the area fit for normal cropping is 275 acres.

The area so far reclaimed since 1944 is 11,899 acres and we would have reclaimed by now the whole area of 50,000 acres, if the additional water supply for reclamation would not have been a bottleneck.

ROLE OF JANTAR IN LAND RECLAMATION

By **Ch. Mohammad Hussain**

Like other members of leguminosae plants Jantar is capable of fixing nitrogen in the soil from the atmosphere. The plant is rich in root nodules and these nodules are caused by bacteria harbouring on the roots, as beneficent parasites. When squeezed they throw out a viscous fluid, which contains innumerable bacteria which can be readily recognised under a powerful microscope. The bacteria which form these nodules are able to derive their sustenance from the air, which higher vegetation is unable to do. The larger the quantity of root-nodules, the greater the amount of nourishment derived from the air and stored in the soil.

From experiments in the laboratory and the field it is noticed that:—

(*a*) Considerable quantities of gases are evolved. Of these carbon dioxide is one. This helps in

reducing soil alkalinity and soil toxicity.

(*b*) Under certain conditions evidence of generation of sulphuretted hydrogen (H_2S) is obtained. Sulphuretted hydrogen is a strong agent for developing an acid medium which again is helpful in bringing the alkaline soil to more congenial conditions for plant growth.

(*c*) Water extracts of Jantar leaves taken after varying periods of disintegration have indicated an acid solution of the strength of as much as N/50. This gives an assurance of restoring the pH values of the soil to that considered normal.

(*d*) The decaying organic matter add plants food in the soil; the large quantity of humus added improves its structure and its water-holding capacity.

Method of green-manuring and seed production

Jantar sown in the month of March will be approximately 4½ feet high by the beginning of June. At this stage the top 3 feet of Jantar should be cut and buried as a green manure in an adjoining fields where rice is to be transplanted. After burying in jantar heavy irrigation should be given and rice seedlings transplanted without waiting for the proper decay of the green matter. Cut plants of jantar in jantar field will sprout again and grow to a height of 4½ feet by about the middle of August. Another cutting like the first should be taken and utilised as green-manure in another field where wheat is to be sown. For this purpose cut jantar plants should be placed in furrows left by the plough and afterwards covered by running sohaga over the field. If there is no rain after burying in jantar an irrigation should be given. This helps in the decay of the green material. Complete decay of buried plants is essential to obtain satisfactory yields of crops.

DELEGATES VISIT TO FIELD SITES

A BRIEF NOTE ON SCARP-I

By Mr. F. K. BANDYAL

From 20 to 24 of November the participants of the Seminar visited SCARP I area and other sites of soil reclamation. Mr. Bandyal Project Director Scarp-I and Ch. Mohammed Hussain gave notes for information of the participants. In this Section we have briefly reproduced extracts from these notes.

Introduction

Salinity Control and Reclamation Project No. 1 stands for the control and elimination of the twin menace of salinity and water-logging that had come to assume an alarming proportion in the Project area known as Central Rechna Doab. In the Project Area embracing 12 lakh acres no less than 4.25 lakh acres had already wholly or partially been affected by Salinity and Water-logging.

It was against this background that Project-1 comprising a battery of a little

Mr. F. K. Bandial, Project Director, SCARP No. 1, and Sayyed Hamid, Chief Engineer, Salinity Control Wapda, explaining salient features of SCARP No. 1 Scheme.

over 2000 tubewells was launched with a view not only to reclaim the damaged area and save the healthy area from damage but also to step up agricultural productivity through increased irrigation supplies derived from the combination of groundwater and surface flows and reclamation of land.

Organisation

On the 1st of July 1964 the Government of West Pakistan brought into being a semi-autonomous body by the name of "Land and Water Development Board" under an act of the Legislature. The Board is headed by the Chief Secretary to Government of West Pakistan. SCARP-1 is the pilot project under the Board and comprises three principal wings, namely:—

1. Engineering Wing.
2. Agricultural Wing.
3. Co-operation Wing.

This set-up is further strengthened by a team of U.S. experts acting as advisers to the Directorate in all the three spheres mentioned above

Purpose and Scope of the Project

Briefly speaking, the target in SCARP-I

is to attain Irrigation intensity of one cusec for 150 acres and cropping intensity of 140 per cent. Before the launching of the Project one cusec of canal flow was being delivered to about 350 acres at an intensity of 75% while the cropping intensity did not exceed 80%. The ultimate object is to increase agricultural productivity by 100% in a period of 5 years.

Operation of Tubewells

SCARP-I embraces an area of 12 lakh acres. There are twelve individual schemes comprising of 2043 tubewells. The tubewell in individual schemes were: Harse Sheikh 44, Beranwala 126, Pindi Bhattian 21, Hafizabad 318, Khanqah Dogran 209, Sangla Hill 233, Shahkot 384, Chuharkana 24, Shadman 91, Shadman II 58, Chichoki-mallian 12, Zafarwal 390, Jaranwala 133.

Capital Cost of the Project

A. Drilling of 2043 tubewells including installation of equipment etc. =Rs. 102.6 Million

B. Cost of electric trans-mission lines =Rs. 71.0 Million.

Total =Rs. 173.6 Million.

Operational Cost

Yearly operational cost of the entire project for the last three years is as below:—

September 1961 to September 1962. =Rs. 75,00,000

October 1962 to September 1963. =Rs. 1,49,73,000

October 1963 to September 1964. =Rs. 2,49,29,000

Pumpage

Yearly pumpage figures in million acre feet along with the percentage utilization of the installed capacity by the tubewells in the entire Project area for the last three years.

Year.	Pumpage in million acre feet.	Percentage utilization.
1961-62		
Rabi ..	0.65	52.50
Kharif ..	1.07	72.70
Total ..	1.73	62.60% (Average)
1962-63		
Rabi ..	1.20	65.40
Kharif ..	1.40	72.90
Total ..	2.60	69.15% (Average)
1963-64		
Rabi ..	1.11	57.52
Kharif ..	1.37	63.12
Total ..	2.48	60.32% (Average)

Water Delta Achieved

Period	By T/well	By Canal	Total
1961-62 ..	2.37	1.0	3.37
1962-63 ..	2.44	1.0	3.44
1963-64 ..	2.04	1.0	3.04

Water-Table Behaviour

The behaviour of ground watertable in the Project area was closely watched by observing regularly the static water level of selected tubewells. The lowering of water-table during the last three years *i.e.* since the operation of tubewells is as under:—

1961-62	5'-9"	Decline of watertable is as compared to initial tested static water level.
1962-63	6'-9"	
1963-64	7'-8"	

Cropped Area

During the three years of the operation of tubewells in SCARP-I, the area cropped and

increase in various cropping seasons is as under:—

Year	Area cropped	Increase in cropped area
1961-62		
Rabi	.. 325603 acres	31749 acres
Kharif	.. 436079 acres	19313 acres
Total	.. 761682 acres	51062 acres
	(Average percentage of increase=12.2%)	
1962-63		
Rabi	.. 621736 acres	177742 acres
Kharif	.. 508128 acres	76237 acres
Total	.. 1129864 acres	25297 acres
	(Average percentage of increase=30.4%)	
1963-64		
Rabi	.. 629432 acres.	182089 acres.
Kharif	.. 600401 acres.	158195 acres.
Total	.. 1229833 acres.	340284 acres.
	(Average percentage of increase=38.5%)	

Cropping Intensity Achieved

Period	Intensity achieved
1961-62	89.00%
1962-63	100.80%
1963-64	103.26%

Pre-Project intensity was 77%

Rain Fall

Period	Average Rainfall in inches
1961-62	15.28
1962-63	16.86
1963-64	23.04

Reclamied Area

1. Total area of SCARP-I =12 lakh acres.
2. Area affected by Salinity and Water-logging. =4.25 lakh acres.
3. Area reclaimed up to the end of Sept. 1964 =2.27 lakh acres. Percentage of area reclaimed=57%.

Publicity

The agricultural wing distributed 40,000 posters and paddy cultivations and arranged for 7545 maunds of improved seeds, 67864 bags of fertilizer treated 106951 acres with insecticide and maintained 457 Nos. of Model farms and 228 Nos. of Reclamation farms. The Co-operation Wing advanced 37.19 lakh as loan and recovered 32.57 lakh.

F.A.O. Seminar on Water-logging and Salinity Concludes

For the next 6 days from 19 to 24 November, 1964, the members of the Symposium visited the research institutions and the field sites.

The laboratories of Wasid, Land Reclamation and Irrigation Research Institute were seen on Nov. 19. The next day Scarp No. 1 area was visited together with the Agricultural University at Lyallpur. The alkaline areas of Montgomery were seen on 21st.

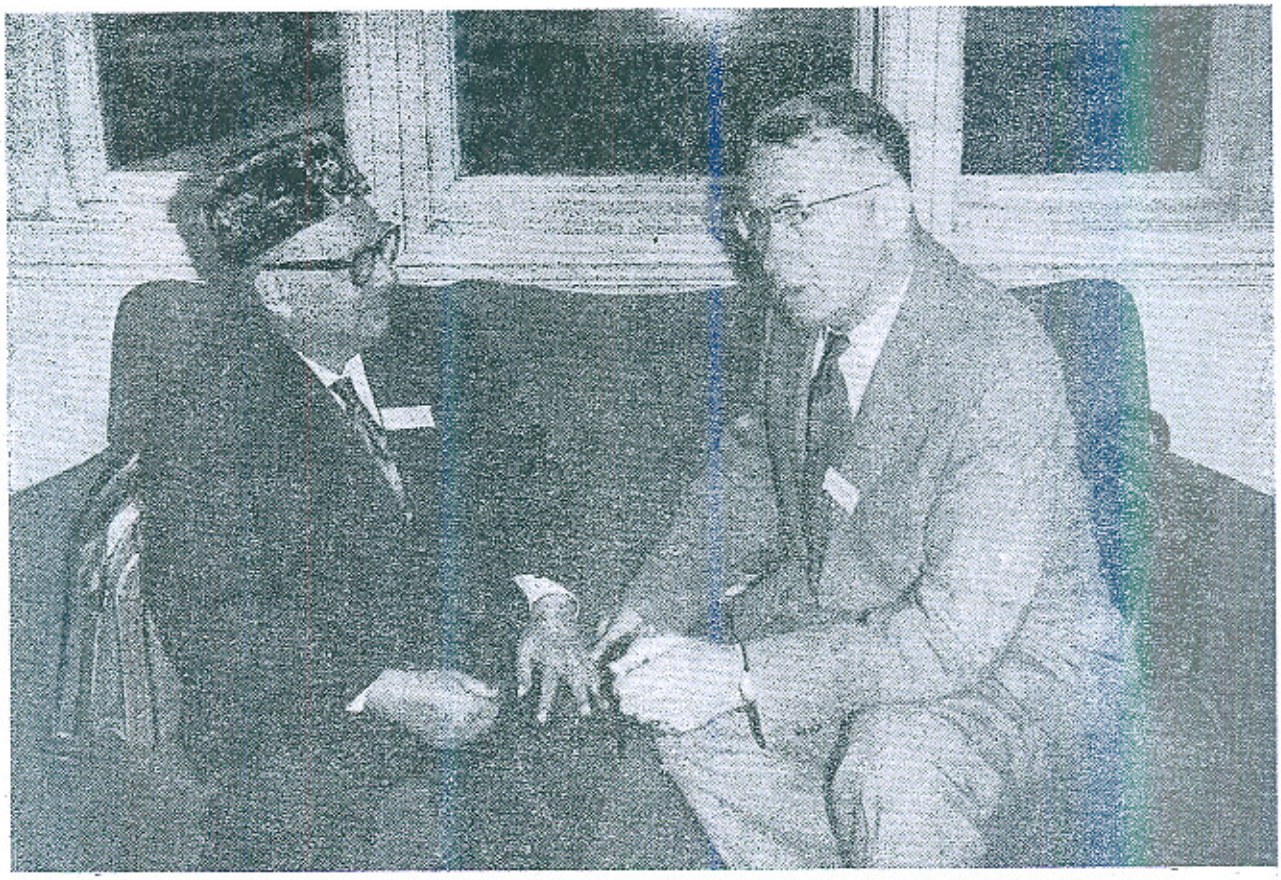
During the field trip Ch. Mohammad Hussain, Director, Land Reclamation issued several notes, the important one of which pertained to 'Potential fertility of sodium soil in Ganji Bar; Role of the Jantar in Land Reclamation, Farm Drainage Salinity Control in Chakanwali and Orchard Plantation under Irrigation and fluctuations high water-table conditions. Brief extracts from these contributions are recorded in this journal. For two days the Ghulam Mohammad Barrage area was inspected before reassembling for continuation of the Symposium on 15 November, 1964.

Mr. J. de Menedeau, Chief Water Resources of Irrigation Branch, F.A.O. outlined the subjects to facilitate further discussions. He suggested five subjects for discussions :—

1. Water requirement of crops.
2. Salt balance.
3. Optimum level of the watertable.
4. Irrigation methods.
5. Drainage methods.

It was planned that each subject will be introduced by a moderator followed by discussion on the same. Dr. Fireman was the moderator for the water requirements of crops. He introduced the subject. Professor Hagen, Mohammad Shafi Gill, Thomas Inge were the subsequent speakers.

The subject of salt balance was presented by Dr. C. A. Bower. He showed many slides and clearly explained the conception of drainage surplus. Dr. Kovda discussed the optimum level of watertable. Dr. Nazir Ahmad gave data collected in Pakistan on the same subject.



Prof. V. Kovda of Unesco and Dr. Nazir Ahmad discussing the Salinity and Waterlogging problem during F. A. O. Seminar, Lahore.

Dr. Hagen presented Irrigation methods. The last subject of drainage method was presented by Van den Berg. In this small volume it is not possible to put down the remarks of all the participants. Out of 78 participants of the Seminar, majority of the persons recorded their views.

We have reproduced briefly remarks of Van den Berg, Dr. Kovda and Dr. Nazir Ahmad only.

GENERAL CONSIDERATION OF DRAINAGE PROBLEMS

By C. VAN DEN BERG

Director, Institute of Land and Water Management, Netherlands

Van den Berg gave a discourse on 25 November on the subject of drainage and formation of saline lands. In the beginning he stated that due to shortage of time he has not been able to prepare a paper. He, however, wanted to point out at the outset that he has been discussing the problem with many of the participants and he has come to the conclusions that the problem is known to all Pakistanis and so is its solution, and in fact there was no need for his lecture.

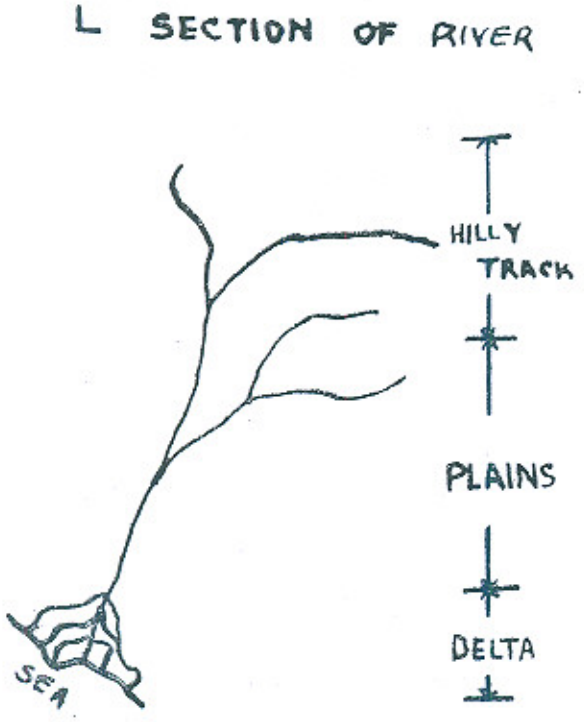


Fig. 1

He, however, would like to review the existing information about the land and hydrological conditions existing in many countries which have a problem similar to West Pakistan. The author drew an L-Section of a river system and the cross section of the Valley as shown in Figure no. 1 He stated that close to the foot-hill the slope is steep, watertable is deep, soil moisture is low and the soil is generally fine textured. Below the steep slope starts the valley, which has a moderate slope. The soil gets finer, its permeability changes from high to low and the ground watertable is usually high. The third region is the Delta where the ground-water is very often saline, soil is very fine and salinity exist.

Movement of ground-water

The author next explained the movement of ground-water. He stated that in the mountainous regions due to steep slope of land ground water flows either in to the river or along with the slope of the country. The river is usually the drainage line.

The land is well drained and there is no problem of water-logging. In the Valley lower down, the river at a high stage charges the land and it works as a drain at low stage. The land is very often water-logged. In the Delta area, river is the main

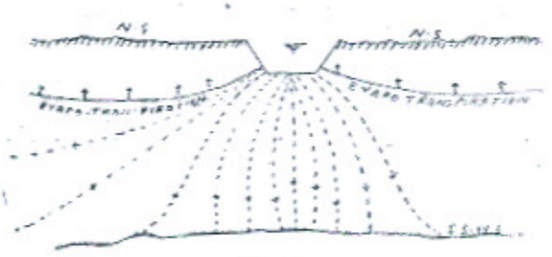


Fig. 2

source feeding the formation. The level of river is generally high and the seepage water continues moving towards the land (Fig. 2).

Salinity of groundwater

Explaining the salt contents of the groundwater in the three zones, the speaker referred to the work of Dr. Kovda. He explained that in the region of steep slope the groundwater possesses an excesses of carbonates. In the valley sulphates predominate and in Delta the excess salts are of chlorides (*see* Fig. 3).

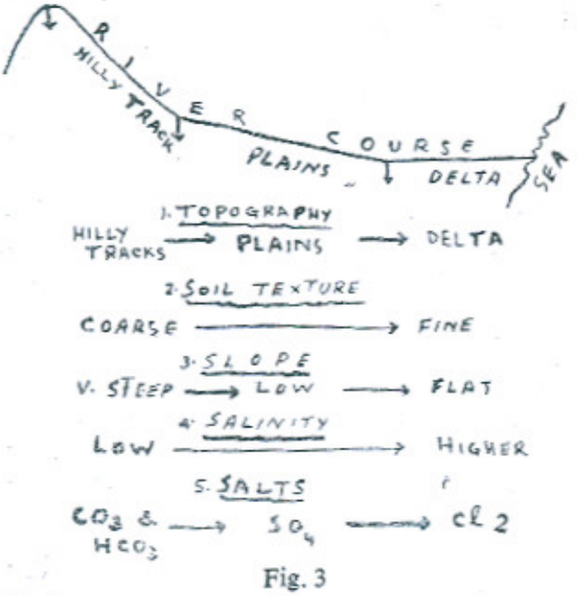


Fig. 3

Drainage

The drainage for the Upper Region is no problem. Here sustained agriculture can be had with or without Irrigation. In the valley, Irrigation canals are often the source of addition to sub-soil water.

The groundwater rises and the evaporation and evapo-transpiration brings the salts up close to the root zone. He then gave complete information to reclaim and keep a permanent condition for production. In order to keep a good equilibrium of water, soil and salts, drains are necessary on both sides of a canal. The distance and depth of drains can be worked out by Honghondt formula of the type $L = \frac{8KDm}{S}$ in which L is the distance between the drains, K is the hydraulic conductivity of the soil.

D is the soil layer in which the flow takes place and m is the Hydraulic head.

S is the amount of water to be discharged. The symbols of the above formula are explained in Fig. 4.

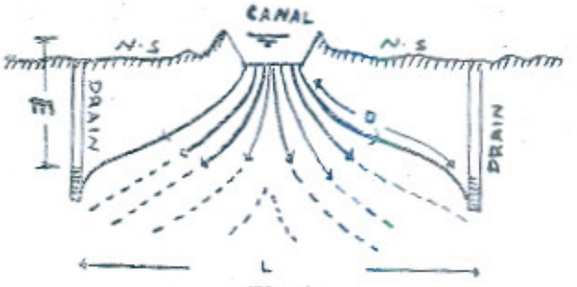


Fig. 4

During Irrigation there is no danger of salinization. Ground-watertable maintained at a depth of one meter is sufficient for good production. He actually worked an example by assuming the hydraulic parameter and the distance between the two drains. He stated that the distance between the two drains can be increased at the cost of depth of drains. The speaker worked out an example in which the depth of drains was kept at 3 meter. Hydraulic head was 1 meter and the distance between the drains worked out to be 200 meters. The author stated that if we make a drain 25 meter deep, this will create a very big hydraulic head, so that the distance between the drain can be considerably increased.

A Drain *versus* a tube well

The author explained the difference of the working of a tubewell and a drain. A tube-well does not remove the extracted salts. It lowers the groundwater below the direct intake of a plant as a results of capillary rise. Horizontal drain, however, has advantage both with regard to removal of salts and the sub-irrigation. With the increase in hydraulic head, the seepage is increased. This is not the case in a horizontal drain. For drainage of the land it is thus preferable to put in horizontal drains which can be installed with the surplus labour which is available in the country. This system will remove the salts of the formation and increase the agricultural output.

REVIEW OF PRINCIPLES OF SALINIZATION AND RECLAMATION OF IRRIGATED SOILS

By PROF. V. KOVDA **of Unesco Natural Science**

The author reviewed the soil salinization of irrigated soils at a great length. He said that he had the same conceptions as Dr. Van den Berg. West Pakistan is like a university to him from where he has learned many things. He put his subject into three parts :—

1. That dealing with the theoretical analysis.
2. Reclamation of saline soil mostly for cotton.
3. Amelioration of conditions similar to those existing in Indus Plain.

Much of his statements were based upon his theoretical and experimental conceptions which he has already put forth at the time of the Symposium on Sodic Soil in Hungary and which we have partly reproduced in the previous volume of the Journal. In the beginning he explained the relations between the evaporation and the conception of salts with respect to depth of groundwater. He explained by a diagram (Fig. 1) that there existed a critical depth usually 2 to 3 meters when the excessive salts do not accumulate at the surface. He said that the soil salinity was subjected to evaporation from the ground-water.

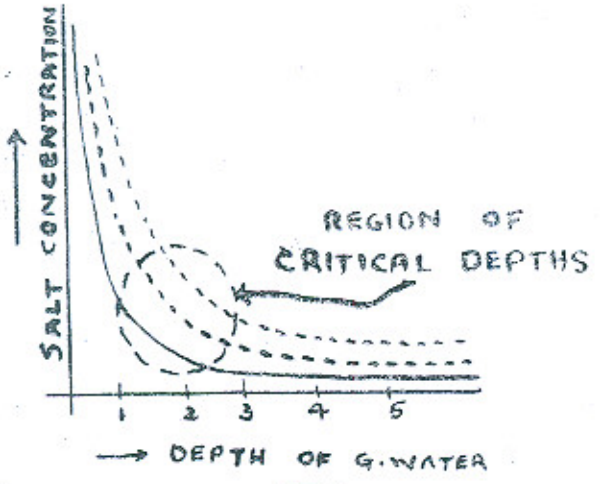


Fig. 1

He put forth his own ideas about the concentration of salts in different regions of the country. He pointed out that the analysis has been carried out by him for conditions existing in the whole world and which has been found to hold true in West Pakistan also. Invariably in ground-water of low conductivity, the existence of carbonates and bi-carbonates is high and it causes hydromorphic sodic saline soils. He showed a graph which he has prepared on the basis of data he collected from West Pakistan and

it represented that with depth of watertable at 1 or 2 meter, bi-carbonates and carbonates predominated. A small percentage of these salts is very harmful for the crops and this results in a serious condition of the appearance of Soda. Next to these are the sulphates which of course occur even with deeper ground-water. He put forth that lowering of ground-water level was not at all a solution for reclamation of land. He showed many diagrams which he plotted, explaining the concentration of salts and their effects on the land. He laid great stress on drainage as a means of reclamation in which the watertable was not to be taken to the deeper level to lose the advantage of sub-irrigation. He proposed a certain critical level for maintaining the watertable which will not cause any salinization of the land. In fact his discourse was very extensive and it contained a lot of information and the readers will await anxiously the issue of the report of F.A.O. which will have the details of his lecture.

EVAPO-TRANSPIRATION AS A FUNCTION OF DEPTH TO WATERTABLE AND SOILS

By NAZIR AHMAD AND MOHAMMAD AKRAM

During the Proceedings of F.A.O. Seminar at Lahore, discussion was held on the optimum depth of watertable. The senior author of this note submitted results of his recent experiments on some common crops wherein an estimate of sub-irrigation and the total consumption of water was made with watertable maintained at different depths in clay and silty soils. The data put forth was of great importance for conserving the water resources of West Pakistan. This note gives all the information which was presented in the discussion.

Wasteful Loss of Water

Recently an estimate of water lost from water surface in West Pakistan was carried out. It was determined that the annual loss of water from any free water surface in the Indus Plains varies between 60 to 108 inches. In terms of cusecs per sq. mile of free water surface, it represented a loss of 4 to 7 cubic feet per second. Kalari lake for instance with a surface area of 50 sq. miles is losing about 340 cusecs. Mangla and Tarbela Dams when completed will lose 587 and 642 cusecs of water respectively.

Water is also lost from bare soil. Recent observations indicated that the water lost is 50% of the free water surface with watertable at 2.5 to 3.0 ft. and with watertable at 6-7 ft. and at 10 ft. the water lost is 20% and 5% of the free water surface.

In West Pakistan about 2.0 m. acres have watertable within 5 ft., 1.2 m. acres within 10 ft. and 7.7 m. acres within 15 ft. The loss of water from soils with high watertable is thus excessive. About 72 inches is the average annual loss in the Indus plains from free water surface, 2.0 m. acres with watertable at 3 to 5 ft. may lose about 4 to 6 m. acres ft. of water and 1.2 m. acres another 1.8 m. acres of water. This is the loss if the land is kept fallow. A consider-

able area of the land is however, always under crops. These cause a modification in the loss of water. It is both as a result of evaporation and transpiration. In this note an estimate of water transpired over and above the actual requirement of a crop is given under different positions of watertable and the nature of soils. Detailed information for only cotton and sugarcane crops is recorded although some data for wheat, barley, gram and lentils is also included. In-addition an estimate of the amount of water drawn from underground as sub-irrigation is also recorded. Some idea can be had about the optimum depth of watertable so that the crop may draw its maximum requirement from sub-irrigation and at the same time may not waste any amount of water.

Experimental Set-up

The experiments, results of which are given in the note, were carried out in Lysimeters installed at Niazbeg. There were nine Lysimeters of cement concrete with 25 sq. ft. surface area. Their depths varied from 5 to 15 ft. Sugarcane crops were grown in these.

Another 14 Lysimeters of 3.0 ft. diameter (7 sq. ft. surface area) were of hume pipe of 8 or 10 ft. in depth. Studies with cotton crop were carried out in these. Before the cotton crops some results with wheat, gram, lentil and barley were also collected in these. Only two types of soils were experimented upon. One had more clay and the other more silt. Their mechanical analysis was as given in the Table below.

The soil had been carefully packed with special precautions and conditions, details of which is not given in the note. The soil in nine lysimeters of 25 sq. ft. surface area had been in position for the last 5 years where as in 3.0 ft. diameter hume pipe it was recently filled either in 1961 or in 1963. The 8 ft. deep pipe were freshly filled with soil. Those studies were possible only after the perfection of a double acting valve which allowed the flow from a reservoir of water when the crop needed sub-irrigation. After an irrigation the drainage caused the valve from the reservoir to close and allowed the surplus water to be passed out into a container. It also kept the watertable at a fixed level.

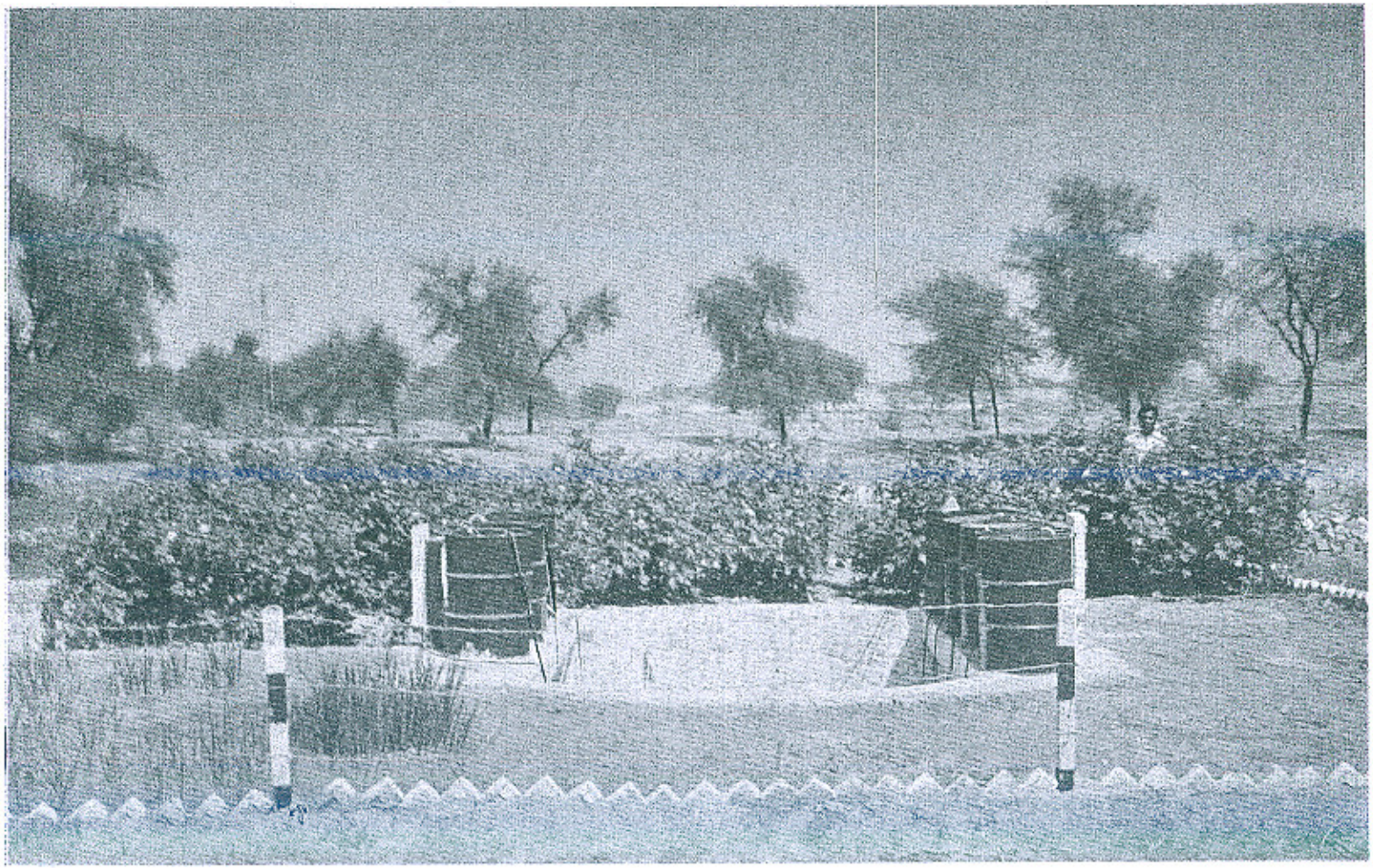
THE RESULTS

(a) Cotton Crop

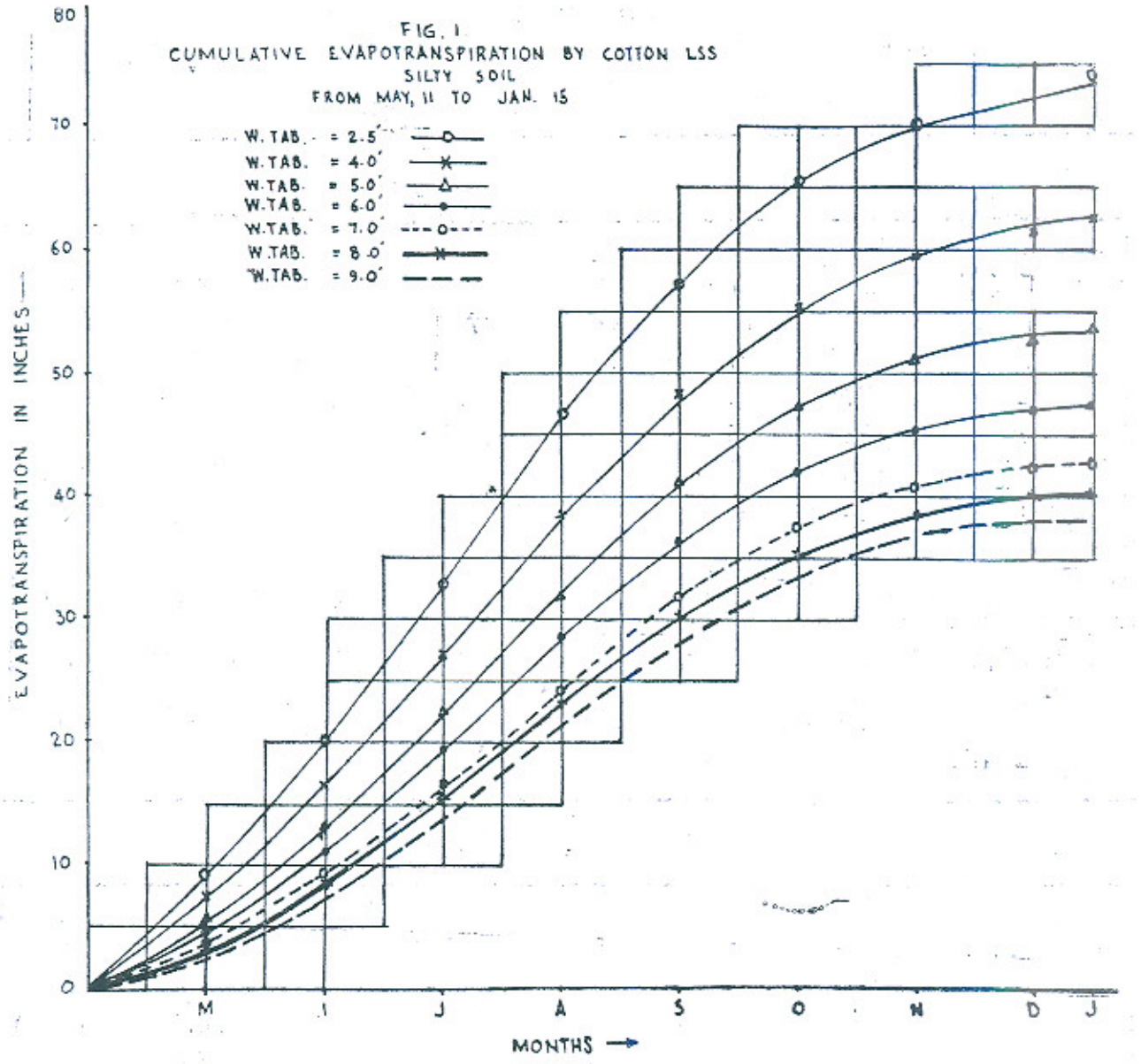
Cotton L.S.S. variety was sown in 14 lysimeters, half of which had silty soil and the

Mechanical Analysis of the Soil

TS %	pH	Percentage Sand			Percentage Silt		% Clay	Remarks
		Coarse above 0.6 mm.	Medium 0.6 to 0.149	Fine 0.149 0.074	Coarse 0.074 to 0.02	Fine 0.02 to 0.002	Above 0.002 mm.	
0-.14	8.2	1.0	7.0	13.0	34.4	30.1	14.5	Clayey soil.
0-.07	7.8	1.0	17.5	27.0	35.7	10.6	8.2	Silty soil.



Evapotranspiration Experiments on Cotton



rst clayey soil. Watertable was maintained at depths varying from 2.5 to 9 ft. The data collected from 11 May 1964 to 15 January 1965 is given in Table No. 1 which gives the surface irrigation, rainfall, rainfall run off, percolation or drainage surplus, sub-irrigation and evapo-transpiration. Monthly evapo-transpiration for both the soils is plotted in Figs. 1 and 2 for all the 7 depths of watertable.

In Table No. 1 the ratio of evapotranspiration with respect to evaporation from free water surface is worked out. The ratio of sub-irrigation is also compared to the same factor. These results are plotted in Fig. 3.

The total requirement of crop has been assumed equal to 32.0 inches and on this basis the excess water transpired and the percentage of sub-irrigation has also been worked out and plotted in Figure 4.

Conclusions for Cotton Crop

The results of observations are:—

(*i*) Cotton crop consumes much more water as compared to that from a free water surface. The ratio of the

TABLE NO. 1

Seasonal Evapotranspiration data of cotton L.S.S. from May 11, 1964 to January 15, 1965

All units are in inches where not stated.

Soil	Silty Soil						
Tank No.	1/2	2/2	5/2	6/2	9/2	4/1	5/1
Watertable (ft.)	2.5	4.0	5.0	6.0	7.0	8.0	9.0
Surface Irrigation	12	12	12	12	12	12	12
Rainfall	27.894	27.894	27.894	27.894	27.894	27.894	27.894
Surface run off	5.25	5.68	9.30	6.0	5.00	6.00	6.5
Percolation	7.06	5.20	9.07	9.97	9.829	7.79	9.27
Sub-irrigation	46.316	33.486	32.076	23.376	17.635	14.096	14.076
Total Evapo-transpiration	73.90	62.50	53.60	47.30	42.70	40.20	38.20
Percentage Excess Evapotranspiration*	131.0	96.6	67.5	48.0	34.0	25.0	20.0
Ratio of ET/EV **	2.19	1.856	1.592	1.410	1.268	1.194	1.135
Ratio of Sub-Irrigation with Evap., ST/EV.	1.375	.995	.953	.695	.524	.418	.408

Soil	Clayey Soil						
Tank No.	3/2	4/2	7/2	8/2	10/2	6/1	7/1
Watertable (ft.)	2.5	4.0	5.0	6.0	7.0	8.0	9.0
Surface Irrigation	12	12	12	12	12	12	12
Rainfall	27.894	27.894	27.894	27.894	27.894	27.894	27.894
Surface run off	3.39	5.60	5.50	5.50	7.0	7.0	7.0
Percolation	3.74	1.73	3.02	4.12	6.16	7.04	5.16
Sub-Irrigation	31.736	23.536	17.526	14.526	15.266	14.046	11.066
Total Evapo-transpiration.	64.50	56.10	48.90	44.80	42.00	39.9	38.80
Percentage Excess Evapo-transpira-tion. *	101.6	75.5	52.8	40.0	31.3	24.7	21.2
Ratio of ET/EV **	1.916	1.666	1.453	1.331	1.247	1.185	1.153
Ratio of Sub-Irrigation with Evap. ST/EV.	.943	.699	.521	.432	.454	.417	.329

*Lowest value of ET with watertable at 20 ft. is taken equal to 32 inches.
**Lake Evaporation = 33.66".

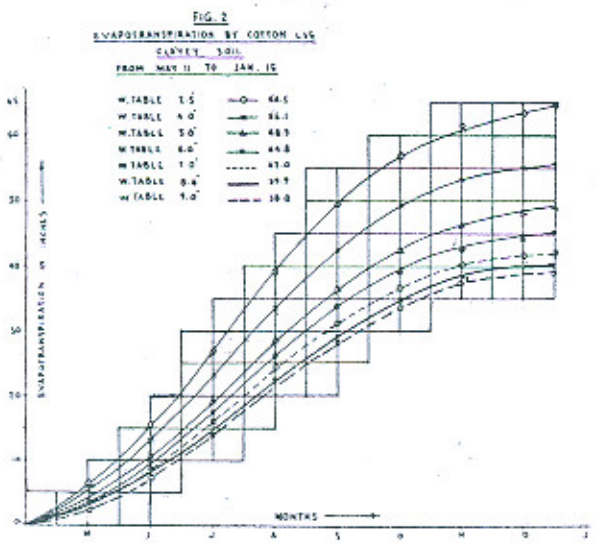
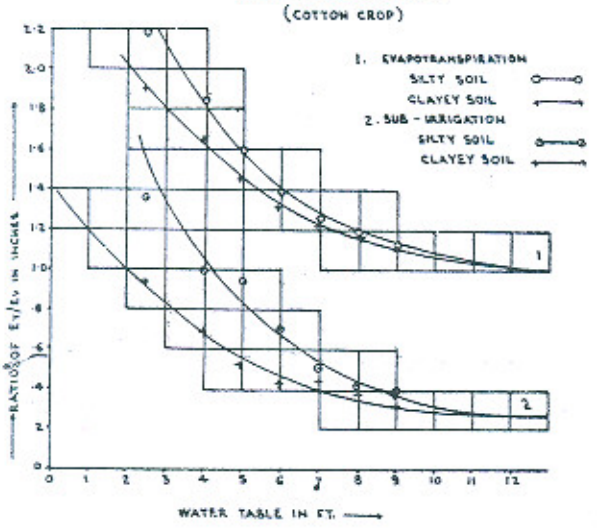


FIG 3
RATIO OF EVAPOTRANSPIRATION & SUB IRRIGATION WITH LAKE EVAPORATION W.R.T. W.TABLE DEPTH (COTTON CROP)



factor ET/EV with watertable at 9 ft. is 1.135 and at 2.5 ft. is 2.19 so that excess water transpired in both cases is 113 and 219 per cent respectively.

(*ii*) The higher the watertable, the more is the wasteful loss of water. This crop with watertable at 9 ft. also wastes a lot of water. A suitable depth of watertable for the crop seems to be beyond 15 ft.

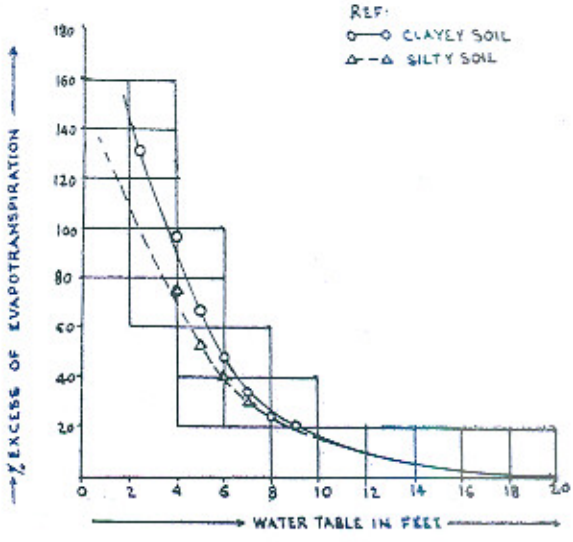
(*iii*) A silty soil wastes more water as compared to a clayey soil but with watertable beyond 10 ft., the effect of the nature of soil is eliminated.

(*iv*) Sub-irrigation has also a similar variation as evapo-transpiration. It increases considerably with the rise of watertable. The stable order of sub-irrigation seems to occur with watertable at 10 ft. or beyond. The difference of clayey and silty soil persists. Silty soil with high order of capilarity takes more water from sub-irrigation.

(*v*) Nine feet is not a proper depth of watertable for the crops as even at this depth, it wastefully transpires more water.

(*vi*) A similar study was carried out with L.S.S. variety of cotton during 1963 when the annual rainfall was only 8.17 inches and the crop was sown in silty soil with watertable maintained as 3, 5 and 9 ft. respectively. The evapo-transpiration, sub-irriga ion

FIG : 4
PERCENTAGE INCREASE IN EVAPOTRANSPIRATION DUE TO HIGH WATER TABLE BY COTTON CROP



then determined was as under:—

Depth to water-table in ft.	Total evapo-transpiration (inches)	Sub-Irrigation (inches)	Sub-Irrigation % of total.	Excess water transpired, % of assumed consumption equal to 33 inches.
3	84	61.49	73	154
5	72.3	49.3	69	119
9	40.3	16.89	42	22

(*b*) Sugar Cane

Sugar Cane variety L-54 was sown in eight lysimeters, six with clayey soil and two with silty soil. The watertable was maintained at 3.0 to 14 ft. Complete information for one season of crop, April to February* is given in Table No. 2. The monthly evapotranspiration is plotted in Fig. 5 for both types of soil.

The ra io of evapo-transpiration to sub-irriga ion and with free wa.er surface evaporation, is plotted in Fig. 6. The excess evapotranspiration above its actual requirements of water is plotted in Fig. 7.

FIG: 5

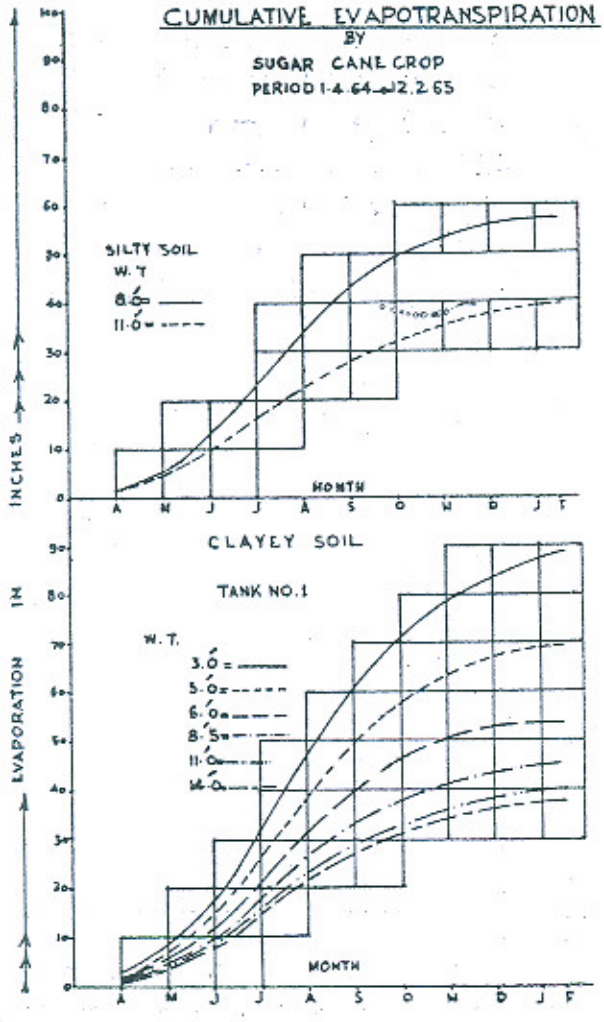


FIG.6
RATIO OF EVAPOTRANSPIRATION TO SUB IRRIGATION IN HIGH WATER TABLE CONDITION BY SUGARCANE CROP

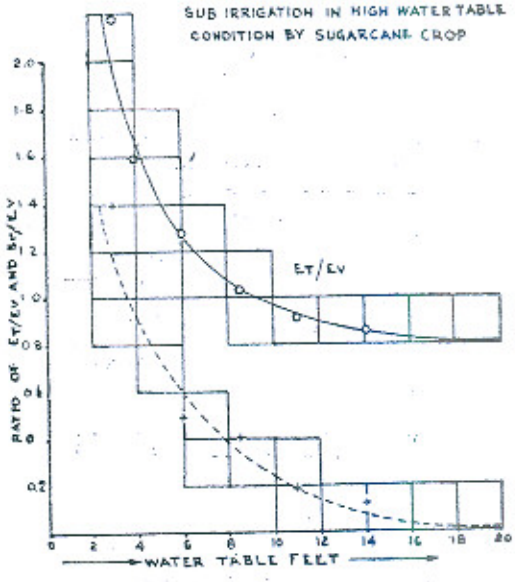
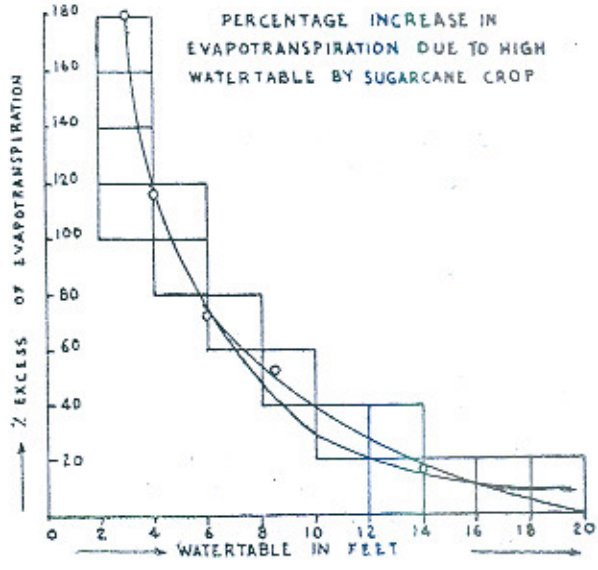
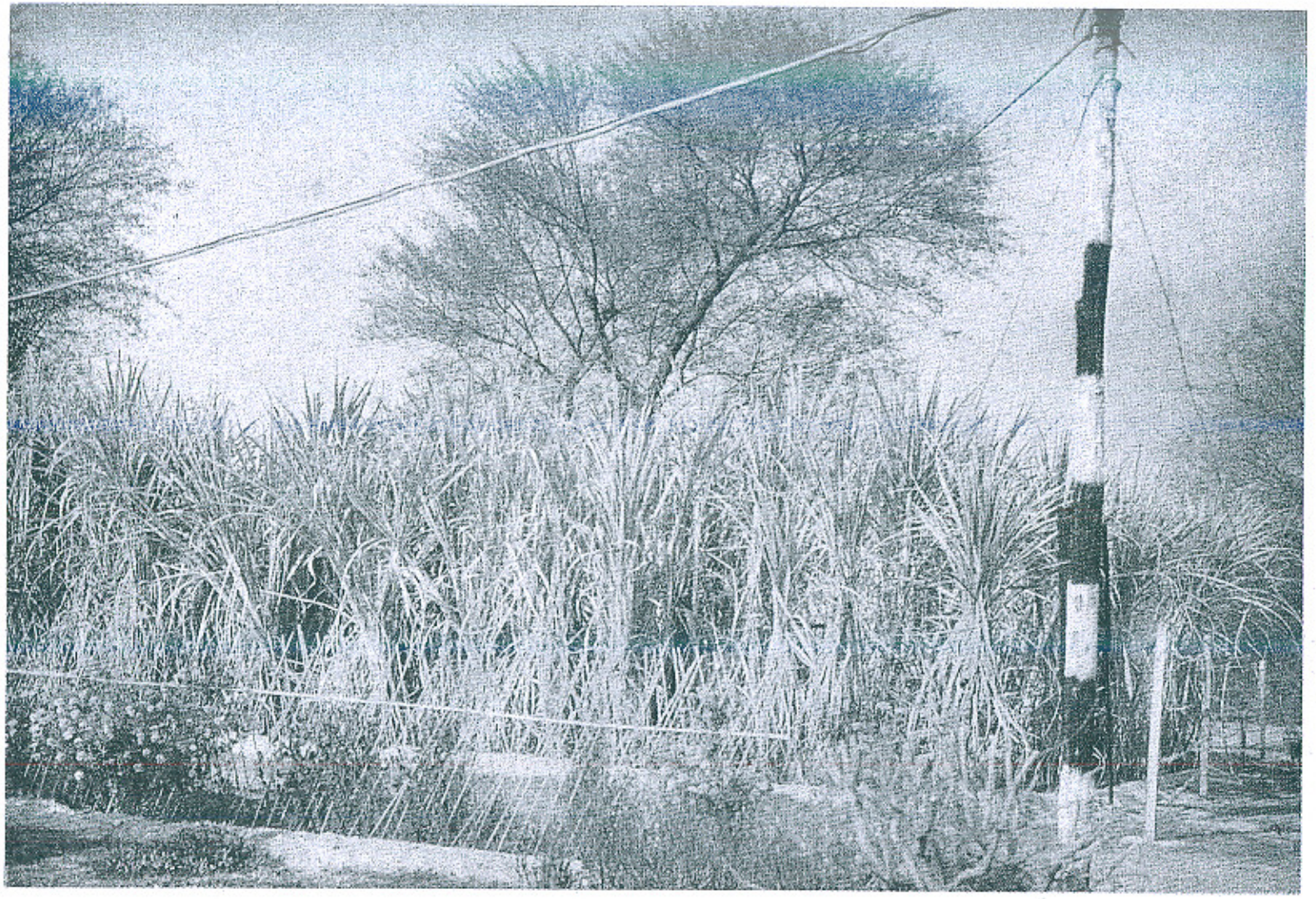


FIG. 7



* Due to dalay in the issue of the Journal, up to date deta has been utilized.



Evapotranspiration Experiments on Sugarcane

TABLE NO. 2

Seasonal Evapotranspiration Data by Sugar-cane L-54 from 1-4-64 *to* 12-2-65.

All units are in inches except when stated.

Soil		Clayey					Silty	
Tank No.	1	4	5	2	6	3	8	9
Watertable	3'-0"	4'-0"	6'-0"	8'-6"	11'-0"	14'-0"	8'-0"	11'-0"
Surface Irrig.	16.5	16.5	17.77	17.60	17.60	16.5	16.5	16.5
Rainfall	28.843	28.843	28.843	28.843	28.843	28.843	28.843	28.843
Run off	30.0	3.1	2.8	4.5	5.1	4.1	3.1	5.2
Percolation	7.9556	7.639	6.60	10.60	10.19	9.40	6.789	9.131
Sub-Irrigation	55.1625	34.456	16.557	13.507	7.937	5.007	21.542	8.488
Evapotranspiration Percentage Excess	89.52	69.06	54.97	44.91	39.15	36.85	57.00	39.50
Evapotranspiration*	179.8	115.8	71.8	40.34	22.34	15.15	48.1	23.5
Ratio of ET/EV**	2.09	1.61	1.28	1.044	.915	.857	1.420	.923
Ratio of Sub-Irrigation with Evap.*	1.38	.801	.485	.407	.185	.116	.501	.193

*Lowest value of ET at 20' W. T. Depth is 32" assumed for this season only.
*Observed Lake Evaporation=43.0"

It may be noted that the year of experiments (1964) was very humid with 28.8 inches of rainfall during the growth of crop. There was run off as well as percolation. Some of the plants also got lodged perhaps affecting the total evapotranspiration.

Conclusions on Sugar Cane

(*i*) The conclusion for this crop are that the crop consumes more water than lost from free water surface. With watertable at 3.0 and 14 ft. this loss (ratio of ET/Ev) was 209 per cent and 86 per cent respectively.

(*ii*) The higher the watertable, higher has been the evapo-transpiration and the sub-irrigation. (Figs. 6 and 7).

(*iii*) With certain depth of watertable (about 8 ft.) silty soil loses more than clayey soil but the difference is eliminated with depth of watertable equal to 11 ft.

(*iv*) A suitable depth of watertable for

sugar cane crop causing no additional loss of water than its actual requirement, appear to be beyond 15 ft. but for this crop 6-8 feet depth appear to be suitable as at this depth there is fairly low order of wasteful loss.

(v) A similar study was conducted on this crop last year in silty soil with watertable maintained at 3.0 ft. The year 1963 was very dry with annual rainfall of 8.17 inches only and during the experiment, the lysimeter crop was not protected by a crop all round.

The results recorded were as under:—

Depth to water table (ft.)	Total evapo-transpiration (inches)	Sub-Irrigation (inches)	Sub-Irrigation % of total	% excess water transpired when evapo-transpiration is assumed at 48".
3	185.5	135.32	73	285

Experiment with Winter Crops

During the year 1962-63, 3 ft. diameter hume pipe lysimeter were made use of to study the evapotranspiration and sub-irrigation from barley, wheat, gram and lintel. These results are recorded below in table 3. These studies also point out to the fact that a considerable amount of water is utilized by the crops from the underground formation.

TABLE No. 3

Total Evapo-transpiration, Sub-Irrigation in inches per different Crops.

Name of Crop.	Growth Period.	Soil.	Water table in ft.	Total Evapo-transpiration in inches.	Sub-Irrigation in inches.	Sub-Irrigation, percent of total	Excess Water Evapotranspired percent of assumed	Total assumed in inches.	Rainfall during crop period.
Wheat	Mid. Nov. 1962 to 1963	Clayey	7.5	13.35	9.32	69.3	0.350	13.0	0.99
,,	—	Silty	5.3	17.20	13.13	77.8	4.20	13.0	0.99
,,	1963 to 1964	Silty	6.0	22.62	10.02	45.9	9.62	13.0	1.29
,,	—	Clayey	5.0	29.25	12.159	41.8	16.25	13.0	1.29
,,	—	Silty	5.0	26.29	11.584	46.2	13.29	13.0	1.29
Gram	1962 to 1963	Silty	5.0	18.80	17.81	95.0	5.0	18.0	0.9
Barley	1962 to 1963	Silty	4.7	17.87	12.80	71.6	41.0	12.0	0.9
Lentil	1962 to 1963	Silty	6.0	13.36	9.31	70.0	11.33	12.0	0.9

Trimmu-Sidhnai Link Completed

By MIAN MASUD AHMAD

On 12th March, 1965 WAPDA completed the Trimmu Sidhnai Link, the first vital link in the Trimmu-Sidhnai-Mailsi-Bahawal Link Canal System. This is the first phase of the link canals of the Indus Basin Works completed one month earlier than the target date. It will transfer waters of Jhelum and Chenab rivers to the Sutlej Valley Canals. In this article some details of the link are given.

T. S. Link

The Trimmu-Sidhnai Link Canal is the first component of the three link canals forming the Trimmu-Sidhnai-Mailsi-Bahawal System which connects the three rivers—Chenab, Ravi and Sutlej. This system is designed to convey the waters of the Western Rivers, Indus, Jhelum and Chenab to the Sutlej river for replacing a major portion of the Sutlej Valley Canals presently served from the Islam Barrage.

The Trimmu - Sidhnai - Mailsi - Bahawal Link commands a considerable part of the Islam Canal System either directly or by exchange, and in spite of its many disadvantages in respect of limited command and the necessity of constructing costly new river structures across the Ravi and the Sutlej, it has the chief merit of utilizing the surplus flows of the Indus conveyed through the Chasma-Jhelum Link.

Alignment

The Trimmu-Sidhnai Link takes off from Chenab river at the existing Trimmu Barrage just below its confluence with Jhelum river and conveys the waters to Ravi river approximately 8 miles upstream of the existing Sidhnai Headworks. The Link follows an alignment parallel to and on the left side of the existing Haveli Canal in its entire length except in the last six miles tail reach where it runs straight towards the Ravi. It is designed to carry a full supply discharge of 11,000 cusecs. Its total length is 44 miles and it is unlined throughout. In the preliminary plans it was proposed to provide brick lining in 28 miles of the middle portion of the Link where the watertable was below the designed bed level. Subsequently this proposal was dropped as the incremental saving of the seepage losses was not commensurate with the additional

cost of lining. Besides the canal is in deep cutting in most of its length and an unlined section has the advantage of a drainage canal particularly during the winter months when it carries low supplies.

Earth Lining

The logs of exploratory holes bored along the centreline of the Link indicated that in most of the length the bed of the Link will be situated in clay and silty clays and fine sand. In those reaches where the canal passes through permeable sand strata a lining of compacted earth of selected impervious material obtained from the excavation of the Link is provided. The compacted earth lining is economical and is also effective in reducing the seepage losses. The earth lining is constructed by over-excavating the bed and banks to a depth of 4 feet. Selected earth from adjacent excavation is placed and compacted to a depth of 2 feet. The lining is protected by a 2 feet layer of un-compacted earth placed on its top.

Canal Sections

Early in the design stage, consideration was given to provide a common embankment between the Haveli Canal and the Link in order to save the cost of one embankment. Detailed studies, however, revealed that the excavation of the Link will provide adequate materials for the construction of both embankments without any additional cost and a separate bank will have the additional advantage of closing the Haveli Canal without the danger of damage to its lining at a time when the Link is operating. The side slopes adopted for the Link are 3 to 1 from the bed to one half the water depth and $1\frac{1}{2}$ to 1 from mid depth to the top of the bank. For large canals these slopes are more stable as revealed by the data of the existing canals of larger capacities. A minimum free board of 4 feet is provided.

Raising Pond Levels at Trimmu

The existing water levels at Trimmu and in Ravi river limit the available slope for the Trimmu-Sidhnai Link to 1 in 10,500 after allowing for minimum permissible working head at the head and tail regulators. Opinions differed on the adequacy of this slope and it was considered advisable to make provision in the design to permit a slope of 1 in 9,500 without significant alteration to the works. Accordingly all the structures on the Link are designed for the ultimate slope of 1 in 9,500 and the pond level at Trimmu is being raised 3 feet over the existing normal pond level and one foot above the existing emergency pond level to provide additional flexibility.

Silt Control

The limited scope for adjustment of the slopes and the restricted capability of the Link to transport silt under all conditions of flow, necessitated a detailed study of the sediment problem. Model experiments were carried out in the Fort Collins Research Station of the Colorado State University and in the Irrigation Research Institute, Lahore to determine the usefulness of extending the existing silt excluders at Trimmu and the extent to which silt ejecting devices should be provided to avoid the sedimentation problems. This was particularly important as any loss in the capacity of the Link due to silting would reduce the effectiveness of the entire system from Trimmu to Bahawal. Model studies revealed that the extension of the existing silt excluders was not particularly effective in reducing silt entry in the Link and that silt ejection devices would be more effective

Small Dams in West Pakistan

Small Dam Organization of Agricultural Development Corporation, West Pakistan has completed two more Dams in the districts of Rawalpindi and Campbellpur. Malik Amir Mohammad Khan, Governor, West Pakistan inaugurated on Tuesday, November 24, 1964 both these dams, as well as Kheri Murat Livestock Farm, which will utilize its water requirements for Tanaza Dam. The brief engineering features of the dams are mentioned here.

TANAZA DAM

Tanaza Dam is situated in Campbellpur District, nearly 45 miles from Rawalpindi. It is primarily designed to provide drinking water for human consumption and for the livestock of the Kheri Murat Farm for Dhanni Cattle and Hissar Dale sheep. It will also irrigate up to a maximum of 100 acres of the Farmland.

The Dam has a storage capacity of approximately 81 acre feet or 22 million gallons, out of which 22.5 acre feet have been provided for the release of surplus water.

The length of the pucca Dam is 395 feet and of the dike 390 feet. Its height is 32 feet. The total catchment area is 0.6 square miles. The Dam is of overflow type built of cement concrete with stone plums. Its life is estimated to be 125 years. The cost of the Dam is approximately Rs. 1,77,500. The Dam is set amidst picturesque surroundings which will make it naturally attractive for tourists and holiday-makers.

KHERI MURAT LIVESTOCK FARM

The Kheri Murat Livestock Farm for Dhanni Cattle and Hissar Dale sheep adjacent to the Tanaza Dam was entrusted to the ADC in January, 1962. A five-year scheme for the development of the Farm was immediately drawn up and the work on the ground was started on 1st July, 1962. During the short period of two years, a major portion of the scheme has been implemented; most of the essential buildings have been completed and a herd of 117 cattle of Dhanni breed and a flock of 150 Hissar Dale sheep have already been accommodated in the Farm.

Water supply for the Farm is provided by the Tanaza Dam which will also provide irrigation for the cultivation of fodder crops over about 100 acres.

It is proposed to add a Poultry Section of indigenous birds to the Kheri Murat Farm and a beginning will be made during the current year.

This composite Livestock Farm will adequately meet the needs of cattle breeders of the Dhanni tract. The lake formed by the Dam will prove an excellent breeding ground for fish and the surrounding area of the reserve forest is being developed as a game sanctuary. A nursery for various types of fruit trees and forest plants will also be developed.

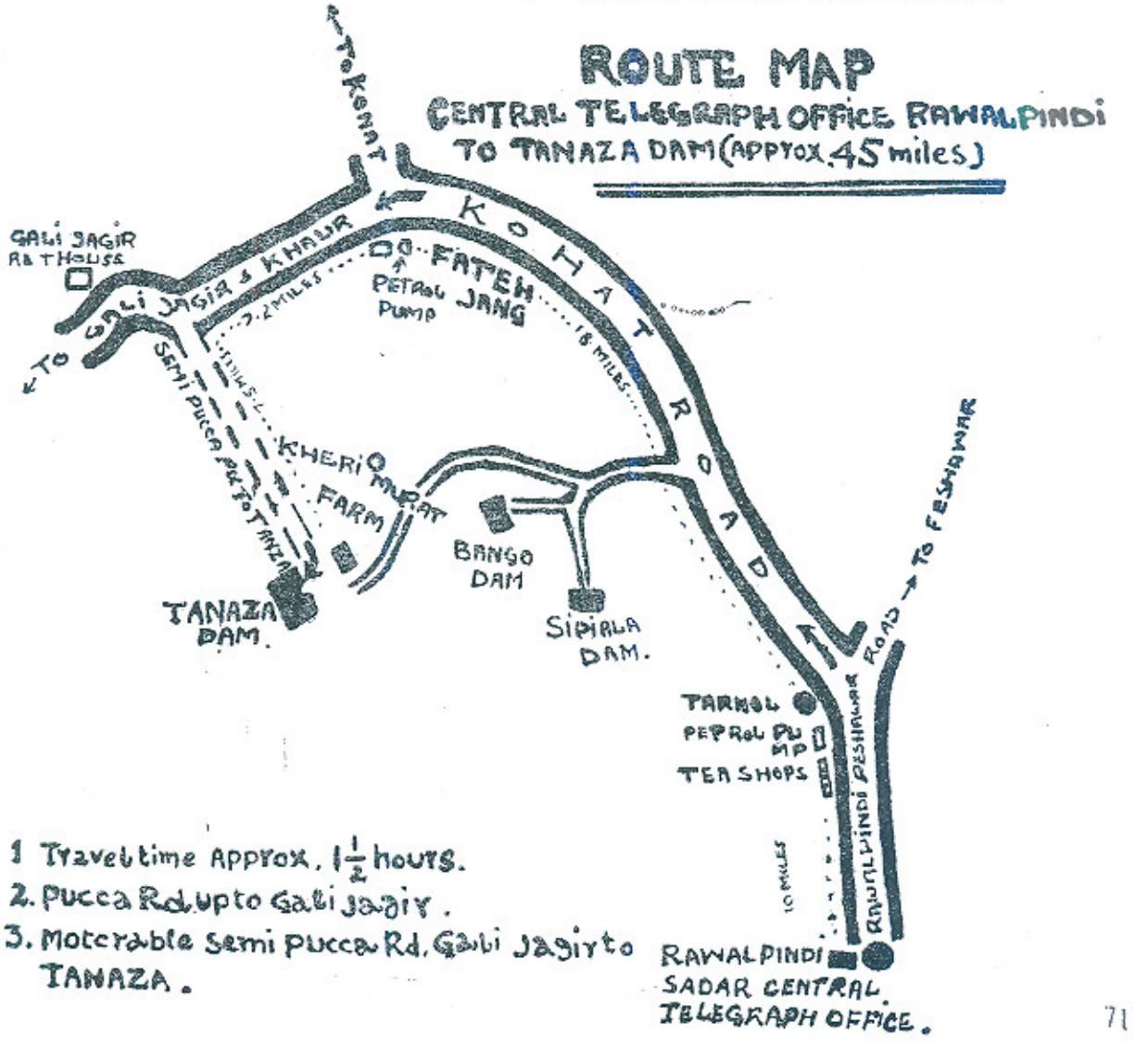
Utmost economy and simplicity have been maintained in the construction of the Farm buildings, cattle sheds, etc. Indigenous design and material have been employed for the purpose. The main objective of the Farm is to breed strong, useful animals and not just prize specimens. This will make the Farm a model for the average farmer of this region.

SIPIALA DAM

The Sipiala Dam, which is also being inaugurated by the Governor of West Pakistan, is situated in Tehsil Fateh Jang of Campbellpur District.

The Sipiala Dam has a catchment area of 4.02 square miles. Its height is 37.58 feet. It has been built in cement concrete with stone plums. The Dam has a full storage capacity of 568 acre feet and its average annual outflow will be 493 acre feet. The life of the Dam is calculated to be 125 years.

The Sipiala Dam will irrigate about 500 acres annually. The total cost of the scheme including the expenditure on the construction of the Dam and appurtenant works is Rs. 3,24,100. The lake of Sipiala will stock various varieties of fish. A demonstration farm for fruit and other trees will be developed in the command area of the dam.



Eseismic of the rock. Several reports described methods, apparatus and results, other insisted on possible correlation between the modulus, E*r* (of the rock) obtained by direct static tests on rock *in situ*, and the modulus Eseismic obtained by seismic tests.

3. Strains and natural prestressing in rock are being measured systematically in many countries. Interesting results of methods and apparatus are mentioned in several contributions. Importance of testing rock samples in the laboratories for strength and elasticity and other properties, in addition to the more expensive and spectacular tests *in situ* are put forth. Importance of small-scale model tests on dams, where the rock is correctly represented with its stratification, fissures, faults, and relative modules are discussed.

4. "Measurements of the deformability of a rock mass give no correct information on its strength". This was quoted by the General Report Failure proper under a load (hydraulic jack) is rarely observed during *in situ* tests. The most frequent type of failure occurs due to sliding. Measurement *in situ* of the shear strength becomes more and more a vital test, in many cases supplementing or even superseding the traxial tests.

Most of the tests were made by a combination of loads normal and parallel to the strata to be tested. The Japanese have described a pull out apparatus. A most interesting table is published by Rocha giving value of Cohesion, C, in kg/cm^2 [and the angle of internal friction values of C=1kg/cm] was to 7 kg/cm^2 are used.

A value of C=1kg/cm^2 to 7 kg/cm^2 was measured by a test on shales when stressed normal to the plane of rock. The angle of internal friction came out to be 45° to 60°.

Discussing physico-chemical and mechanical effect of water on Dam Abutments, it was desired that more research of this nature should be done in many laboratories, cocentraling on the behaviour of rocks which are subjected to constant or varying water pressures over long periods of times. There exists isolated information on bad experiences suffered with rock in permanent or non-permanent contact with water or with wet air.

Among the methods need for improving the quality of rock masses, grouting occupies the place of honour. Many authors emphasised the necessity and importance of 2 systems of drainage in the abutments. Many authors agree in considering drainage to be the necessary supplement to the well-designed grouting campaign.

On question No. 29, fifty papers from 23 countries were presented to the Conference. On this question the report prepared by Italian sub-committee on Dam measurement in Italy need special mention.

The latest, simple and most practical methods of measuring horizontal displacement in concrete dam is the pendulum.

Strains in concrete dams are generally measured by means of electrical resistance or vibratingwire strain gauges, and a growing technique is to precast the gauge into concrete cylinders or blocks which are subsequently embedded in the dam.

The Lisbon National Civil Engineering Laboratory developed two types of vibrating-wire strain gauge which have been placed at some points in Portuguese dams near Curlson meters for comparison purposes. One has a measuring length of 30 cm and a wire 15 cm. long. The other, has a base length of 60 cm. It has two wires, each 20 cm. long,

so mounted that when the length of one wire increases, that of the other decreases. Thus strains are measured by means of two independent variables and precision is much higher than in an instrument with a single wire as long as the gauge length.

Demountable surface gauges are cheaper than embedded gauges and can thus be used more extensively. They are flexible, since new gauge lengths can be added as required and rossetes can provide direct measurements of the angles and amplitudes of principal strains. There is no interference with the concrete even when long gauge lengths are used. On the other hand, bad weather may interfere with the taking of readings, and the measured strains are subject to transient effects.

Displacement Measurement

Displacements in fill-type dams are much larger than in concrete dams, and surveying methods based on the use of surface targets are the general rule. Crossarms are commonly used to detect internal settlement, but some particularly interesting devices have been developed in Sweden.

Porepressure measurements are naturally of great importance in fill-type dams, and there are differences of opinion as to the relative merits of hydraulic piezometers and of electrical gauges.

An essential difficulty was that large-scale tests were too expensive whereas small-scale tests gave too little information, nevertheless, the dam itself represented a full-scale test and its behaviour should therefore be studied and correlated with test results. R. W. Carlson (USA) said much the same thing and he pointed out that preconstruction investigations could not give full information and that these investigations should be followed up by observations on the dam in service.

Permeability tests on foundation figured prominently although without specific conclusion.

Temperature measurements

Temperature measurements in concrete dams, both during the hydraulic period and in normal service, are dealt with the several papers and emphasise the importance of temperature effects of dam behaviour and state of stress.

Gradients are regarded as basic consideration in the design and construction of concrete dams.

Correlation between model and prototypes behaviour

N. Schnitter carried out measurements on Zervrelia dam which was a large one and suffers dams which was medium size dams.

The observed radial deformations were compared with those computed by static analysis, and the most likely values were thereby determined of the moduli of elasticity of the concrete and the foundation rock; and of the coefficient of thermal expansion of the concrete. The values obtained corresponded fairly well with the test results, and an extension of the theoretical results backwards yielded the initial plastic deformation incurred by the dams and their foundations.

Earthquake Effects

Although papers from several countries include observations on earthquakes, the most important work on this subject would seem to be that in progress in Japan. A most informative contribution to the discussion was made by H. Kimishima, who described the studies undertaken by the Central Re-

(*Continued on Page* 17)

Abstracts of Papers

Turkish Hydro Projects.

(*Engineering News-Record, Vol.* 173, *No.* 2, 9 *July*, 1964, *p.* 43, 6 *pp.*, 2*ff*).

Among the projects included in a Turkish hydro-electric development programme are Keban and Circeroz. Keban dams situated on the Euphrates at the upstream end of Keban gorge, where the catchment area is 25,000 sq. miles and the average daily discharge is 22,400 cusecs ft. per sec. It will be a 16.8 million cubic yards rockfill structure rising 675 ft. above its foundations with the main section extending 200 ft. from the right abutment to the intake structure which will be a 330 ft., concrete gravity section abutting a concrete spillway, followed at the left abutment by a compacted earthfill-fuse plug. The six spillway openings with 49 ft. by 52 ft. 6 in. tainter gates will handle 420,000 cusecs and the fuse plug an additional 180,000 cusecs. The capacity of the reservoir will be 24.3 million acre ft. Keban power station will house seven 155MW sets and will have room for an eighth. Ciceroz dam will be a 505 ft. high, double curvature concrete arch on the Sakarya and will impound 746,000 acres ft. of water. Its overflow spillway will have three openings handing 127,000 cusecs and a compacted earthfill-fuse plug will handle an additional 57,000 cusecs. The power station will contain three 100MW sets which will feed into the 380KV transmission line that will run 400 miles from Keban to Ankara and 600 miles to Istanbul.

Hydraulic Jump in a Convergent Channel

(*G. A. Rubatta, Energia Elettrica, Vol.* 41, *No.* 5, *May* 1964, *p.* 329. 6*pp.*, 8 *ff.*)

The author considers the phenomenon of hydraulic jump in a horizontal convergent channel with vertical walls and uses dimensional analysis to determine the form of the functional relationships which gives the position of the end of the jump. The results of model tests are then used to develop non-dimensional equations for the abscissae of the end points of the jump. The equations are the same as those developed by the author for hydraulic jump in a divergent channel, but with the coefficients interchanged.

DR. B. K. PRASAD.

Underground Hydro-electric Stations.

(*Indian Journal of Power and River Valley Development, Vol. XII, No. 9, September* 1963, *p.* 3, 5 *pp.*).

This article constitutes a general survey of the factors intervening nowadays in the design and construction of underground hydro-electric power stations. There are now in service or under construction 300 such stations with an aggregate installed capacity of 31,000MW and about the same additional capacity under consideration. To mention only the countries with the greatest number of such plants, Italy is still in the lead with 60 installations in operation and eight in course of construction; Sweden and Norway follow with 20 and 26 plants respectively in operation, and with 18 and 12 under construction. This article briefly surveys the general characteristics of the two types generally adopted, *i.e.*, head developments and tail developments. In the former, pressure tunnels and shafts are short but tailrace may be long, while the latter type generally requires a long pressure tunnel and shaft, and a shorter tailrace. The various parts of the plants are briefly characterised and the survey is completed by an appendix giving details of 24 typical plants in service in various countries.

DEREK H. CORNFORTH, M.S., Ph.D.

Some Experiments on the Influence of Strain Conditions on the Strength of Sand.

Geotechnique, June 1964.

The paper describes briefly the plane strain apparatus developed at Imperial College, London, and the techniques employed to prepare and test specimens of sand. The characteristics of Brasted sand sheared under plane strain conditions are described and it is noted that the value of the intermediate principal stress in plane strain is considerably less than one-half the sum of the other two principal stresses.

The drained strengths of Brasted sand in plane strain compression tests are compared with strengths measured in triaxial tests at the same placement density. The strength density curves have the same general shape but the plane strain strengths are always higher, the differences in strength increasing progressively from about $\frac{1}{2}°$ in loose sand to more than 4° in the densest specimens tested. On the other hand, triaxial compression and extension tests agree approximately to a common strength density curve. The ultimate strengths measured in plane strain compression tests are constant, irrespective of placement density, and have approximately the same value as those measured in triaxial compression tests.

The development of strength in an intergranular structure is discussed and it is concluded that the strain condition is a major factor influencing the strength of sands.

T. S. NAGARAJ, M.E.

Soil Structure and Strength Characteristics of Compacted Clay.

Geotechnique, Vol. XIV, No. 2.

This Paper deals with the investigations on the shear strength characteristics of a high plastic clayey soil due to the change in electrolytic environment at a constant

water content and constant density. The influence of the aqueous phase composition and the type of exchangeable ions on the geometry of the clay particles has been studied. This investigation may find practical use in improving the bearing capacity of highly plastic clays and in the reduction of seepage losses through the cores of earth dams and clay blankets without appreciably affecting the shear strength of clays.

F. WILLIAM EVAN, M.I.C.E., M. I. STRUCT, E.

Earthquakes and Earthquake-Resistant Buildings in Japan.

Civil Engineering and Public Works Review, August 1964.

The articles discusses briefly the supposed causes of earthquakes and the scale used for earthquake measurement. The characteristics of earthquake motion are described, and the effects of varying distance and ground nature as shown in damage to Japanese buildings. The effects of earthquakes on rigid buildings are related to the generally accepted "rigid structure" concept, although the need for taller structures has led to a revaluation of "flexible structure" theories. Basic design philosophy is described in regard to both wooden and composite buildings. The wooden building is still of great importance in Japan and other Far East countries. The Japanese Regulations for Earthquake Resistant Construction are summarised, with information about seismic coefficients. Under the Section "Forms of Construction," Information is given about details adopted for wooden building, and, at more length, for composite construction, with the design reasons behind them. Perhaps the most interesting post-war structure from the earthquake resistant viewpoint is the atomic reactor at Tokai Mura. Some information is given about the design of this. In conclusion, the recent regulations permitting the erection of taller buildings are described, and an indication is given of their effects upon the thinking of Japanese architects and engineers. A brief account is appended of the Niigata earthquake of June 16, 1964. Some tentative opinions are expressed as to the causes of damage though any firm conclusions must obivously await the results of a detailed and expert survey.

F. SAWKO

Determination of influence lines and surfaces by electronic computer.

The Structural Engineer (London) Vol. 42, *No.* 8, 1964.

Describes computer programs for calculating influence line or influence surface ordinates for plane frames for the in-plane or transverse loading.

The importance of the use of influence surfaces for the analysis of bridge decks under abnormal vehicle loading is emphasized and several types of structures are solved as examples.

The analysis is based on the "unit displacement" method for influence lines and the matrix formulation of solution enables influence surfaces to be obtained by applying an equivalent loading to a structure; the deflected profile obtained from an elastic analysis provides the required influence line or surface ordinates.

P. I. DE

Soil-cement for the foundations of Buildings.

The Indian Concrete Journal (Bombay), Vol. 38, *No.* 3, *March* 1964, *pp.* 106-107.

Describes the use of soil-cement, in place of usual 1: 5: 10 concrete, in the foundations of an experimental school building at the Central Building Research Institute, Roorkee, India. Comparative local costs of lean concrete and soil-cement are indicated and it is contended that the latter is both cheaper and stronger. Soil-cement may also replace the brickwork of the wall below ground.

N. MOHAN RAO

The structural design of soil-cement pavements

The Indian Concrete Journal (Bombay), Vol. 38, *No.* 5, *May* 1964, *pp.* 167-171.

Discusses the design requirements for soil-cement courses in highway pavements in an attempt to present the problem in a proper perspective. While recommending the use of the unconfined compression test or triaxial test for evaluation of soil-cement in preference to the CBR test, a procedure has been suggested to relate these values with the overall CBR design by making use of the empirical relationship between CBR and the theoretical maximum shearing stress induced in the road crust. A design chart is presented for the ready application of this procedure.

SADHOO RAM

Graphical determination of concrete mix ratios

Cement and Concrete (New Delhi) Vol. 4, *No.* 4, *January-March* 1964, *pp.* 43-48.

Presents a chart for determining the proportions of a concrete mix. Includes a table for making approximate adjustments due to certain factors (*e.g.*, type of aggregate and air entrainment) in the chart. Illustrates use of chart with an example.

E. T. HANRAHAN, M.E., Ph.D., A.M.I.C.E.

A Road Failure on Peat.

Geotechnique, September 1964.

This Paper deals with the reconstruction of the Cush Road, Co. Offaly, which was undertaken in 1953-54. The scheme originally envisaged the application of an overload of 1½ ft. gravel, which it was intended subsequently to reduce after a consolidation period, thereby correcting surface deformations. Large and variable settlement occurred during construction as a consequence of what is now known to have been non-uniform and, in places, excessively thick applications of gravel. In three locations where the rate of deformation was such as to constitute virtual failure, corrective measures were adopted shortly after the first phase of construction comprising the excavation of the recently placed gravel and the substitution of bales of horticultural peat as a lightweight fill, surfaced with 18 inches gravel.

This expedient is seen to have arrested the settlement completely and the baled sections have successfully withstood the effects of traffic since 1954.

A laboratory analysis is included of the various types of deformation to which peat is subjected and a method is proposed for forecasting the magnitude of total settlement and the rate at which settlement occurs. The only test data required for making this estimate are the results

of a vane test, and a simplified (one-load increment) one-dimensional consolidation test. A discussion is included on the factors on which the forecast of settlement is based, including the effect of both load and dimensions on the magnitude and rate of consolidation settlement, elastic settlement, and "creep" *i.e.*, settlement not accompanied by volume changes. Good records have been kept of the settlements which have taken place in the road since construction and excellent agreement is seen between computed and observed values.

J. G. JAMES.

Epoxy resins binders for road and bridge surfacings.

Roads and Road Construction (*London*) *August* 1963

The toughness and good chemical resistance of epoxy resins, which were originally developed as adhesives and paints, have led to an examination of their possibilities as road-surfacing binders. Research has now been in progress for some years and several instances of the commercial use of resin-based surfacings are known in Great Britain. This article describes the range of uses on roads and bridges to which epoxy resins have been put and reviews the present state of research and experience. A section of the article is devoted to a detailed discussion of the types of resin and resin/aggregate mixtures used and to the techniques of mixing and laying. It is concluded that epoxy resins are promising materials for certain specialized applications, notably as adhesives for bonding nonskid aggregates to concrete, and as binders for thin surfacings on bridge decks, where lightness is important. It is emphasized, however, that experience is still limited, particularly on heavily trafficked roads and bridges.

(*Continued from Page* 69)

prequalified contractors were issued on June 23, 1961. Thirty five firms were selected out of 51 which applied for pre-qualification.

Only ten companies tendered, lowest bid being Rs. 120.125 m. from Kaiser Engineers and highest being Rs. 164.269 m. against the engineers estimate of Rs. 100.767 m.

Other special stepulations were:

Tender Bond Rs. 4,762,000 being 4% of contract price.

Insurance of all risks Rs. 141,670,000.

Performance Bond amounted to Rs. 23,810,000 being 20% of contract price. The firm was advanced 15 per cent of bid amount towards special plant and it was to be paid bonus equal to Rs. 10,000 per day for maximum of 180 days before 14 April 1965 and liquidated damage amount was Rs. 20,000 per day after 14 April, 1965.

NEW BOOKS

Proceedings of the International Conference on Soil Mechanics and Foundation Engineering, Budapast, 1963

Publisher Academy Press, Budapest, Pages 531.

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By B. SINGH & S. PARSHAD

Nem Chand & Brs. Roorkee, U. P., India Rs. 12.50

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By H. F. W. TAYLOR,

Academic Press, Inc., London and New York 1964, 442 pp. $ 15.00.

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The Effect of Curing Conditions on the Physical Properties of Concrete

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Magazine of Concrete Research (London), Vol. 16, No. 46, 1964, pp. 11-20.

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Optimum Management of Nile Discharge, Eighth edition

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Theory of Turbo Machines

By G. T. COSANADY

McGraw Hill Publishing Co., New York Toronto, London. 378 Page. £5.10*s*.

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Form Work for Concrete Structures

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McGraw Hill Book Co., New York Tronto, London. 330 Pp., $ 12.0.

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By SHERARD WOODWARD, GUZIENE-NOKI & CLEVENGER
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The Logic of Computer Arithmetic

By IVAN FLORES

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Published as AMA Management Report 76, by the American Management Association, Inc., 135 West 50th Street, New York, N. Y. 10020, 1963. 240 pp., bound $7.50.

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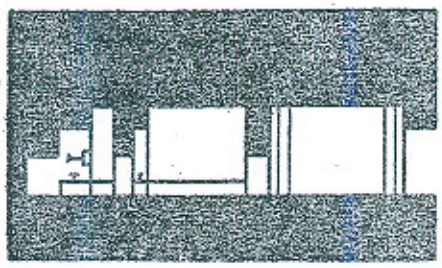

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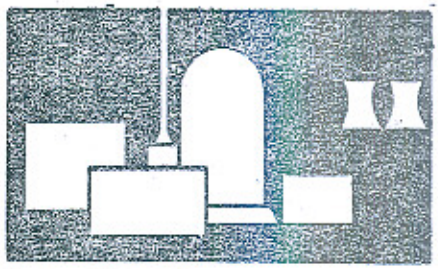

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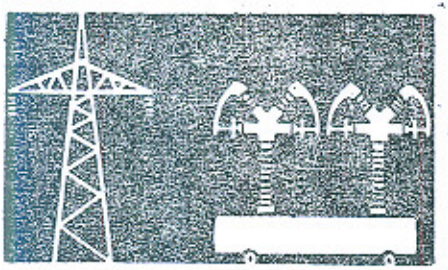

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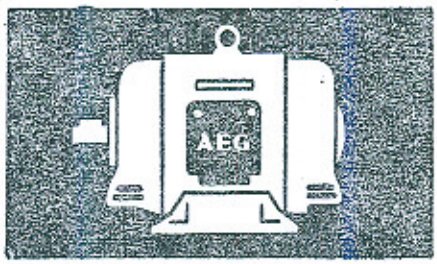

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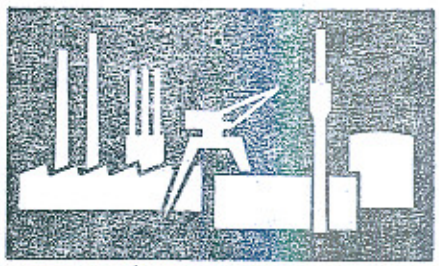

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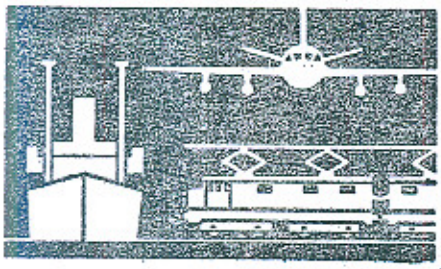

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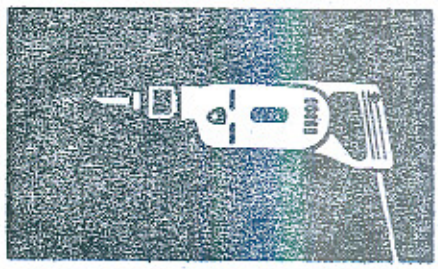

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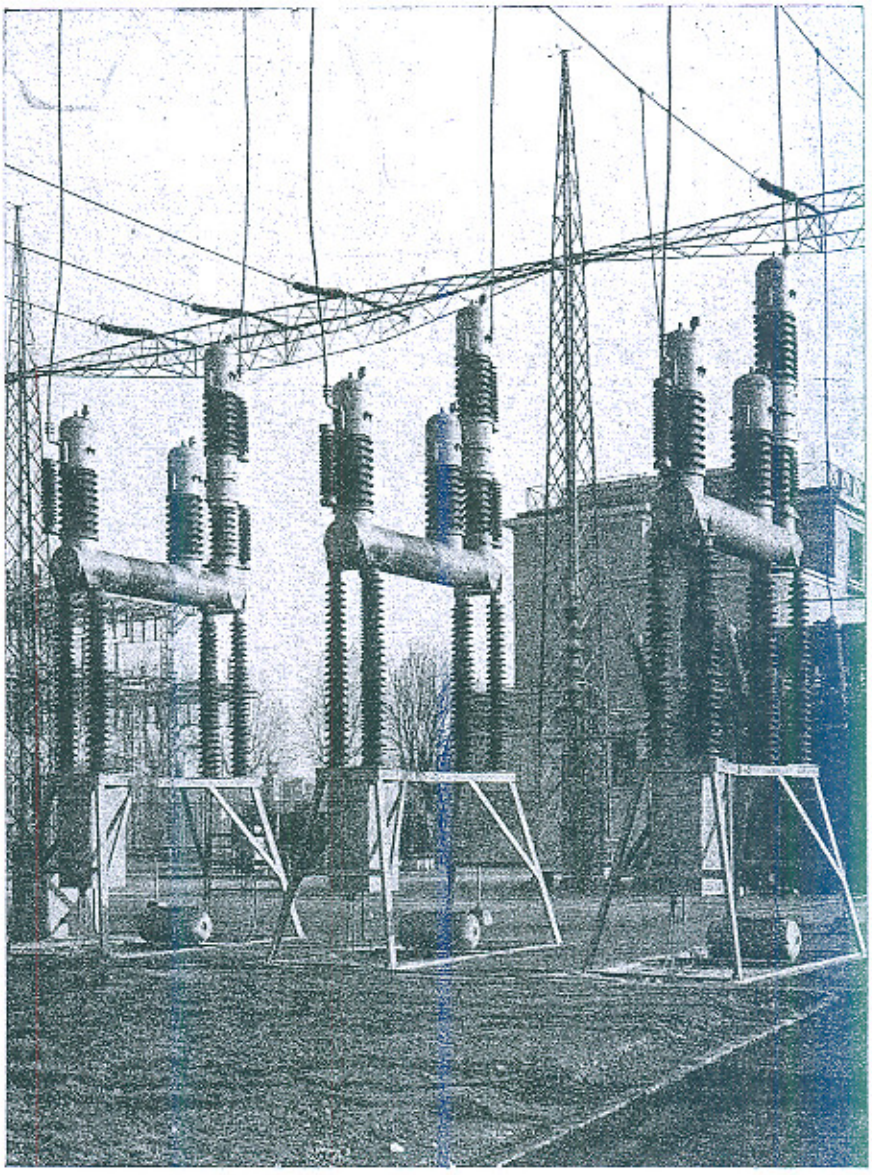

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