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NEWS

QUARTERLY JOURNAL OF THE W. PAKISTAN ENGINEERING CONGRESS

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THIRTEENTH YEAR OF PUBLICATION

ENGINEERING NEWS

Quarterly Journal of the West Pakistan Engineering Congress

Vol. XIII MARCH-JUNE 1968 Nos. 1 & 2

In this issue

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Appreciation Improves Performance

This year at the annual gathering of the West Pakistan Engineering Congress, Engineers once again heard the appreciation of their achievements from Mr. Mohammad Musa, the Governor of West Pakistan. He paid a glowing tribute to their skill, and said that their untiring efforts are bringing prosperity to the country. The Engineers have met the challenge of the day and are completing big Projects one after another, with great efficiency and speed. They have contributed greatly to national achievement for the final goal.

Five years earlier, at the centenary celebrations in 1963, Engineers for the first time heard the appreciation of their work from the President of Pakistan. Since then, on many occasions, practically at the completion of every public utility Project, the work of Engineers received appreciation from the Head of the State.

A word of praise and appreciation is always a great reward for the hard labour of an Engineer, who has often to work under the most tiring circumstances. The public who sees the net result, can little realise the difficulties and problems which an Engineer has to tackle before attaining his objectives.

Engineers are the builders of the nation. Their actions and achievements add prosperity to the country. It is their sweat and labour which brings progress, happiness and prosperity to a nation. Think of the gigantic irrigation work, great hydel and thermal generating stations, chain of factories, innumerable highways and roads linking far off places, bridges over mighty rivers, railways and towering buildings, all of which add to the comfort and convenience of the inhabitants, and raise the prestige of the country. Have not the Wapda House and Alflah added a sense of greatness and prosperity to the onlookers ? The towering electrical transmission lines, the grand Mangla and Warsak Dams, scores of mighty barrages, give a sense of pride and prosperity. All these are the result of hard work and labour of Engineers.

In the present five years plan, out of the total outlay of Rs. 31,000 million, the Engineering Works accounts for Rs. 2256.8 million, nearly 70 per cent of the total development expenditure. This small group of Society, a fraction of the population, is to add 70% prosperity to the nation. Rightly, the Engineers deserve the praise and those who know the value of appreciation have lost no occasion to communicate and express their feelings.

A few simple words of appreciation infuse a new urge, a fresh resolve, and strenuous eagerness to achieve the goal and to fulfil the trust imposed upon oneself. This is in fact one out of the many virtues of the present regime who know the value of appreciation which can convert an impossibility into a possibility. It is encouragement which inculcates new eagerness and resolve to work and not rebukes and fault-finding.

The Engineers of the country now feel that their hard labour has not been in vain. They have their share of appreciation from the Head of the Province. It is now for them to continue striving and working harder, and fulfilling the trust placed in them.

West Pakistan Engineering Congress 50th Annual Session 1968

The Annual Session of the Congress was held from 23rd February to 2nd March 1968—at the Panjab University Hall. Mr. Mohammad Musa, the Governor of West Pakistan, inaugurated the Session. Mr. M. A. Waheed, President West Pakistan Engineering Congress, briefly described the activities of the Congress. The Governor in reply besides his written statement appreciated the services of the Engineers to the Nation in such terms which have not been heard for several years.

He traced the history of Engineering and told the audience that they had inherited a glorious past which they must strive to keep up. He expressed his gratification at the manner in which the engineers had met the challenge so far. He named the big projects and said that they had been completed with great efficiency.

He paid tributes to the professional skill of the country's engineers and their contributions to national development. He advised the Engineers, especially the younger ones among them, to be particular about their image in public.

If the common citizen did not prosper, a part of the blame would have to be shared by the engineers. This should be clearly understood by them. How they had to discharge this responsibility was for them to decide. All that they had to bear in mind was that they had to play a great role within the limited resources of the country.

Mr. Mohammad Musa said that the programme to attain self-sufficiency in food envisaged a lot of hard work, most of which had to be done by Engineers. More land had to be brought under the plough, irrigation works had to be constructed, fallow and salt-affected lands had to be reclaimed, barren areas had to be made fertile and communications had to be improved. All this requires zealous and selfless efforts on the part of Engineers.

Pakistan had developed enormously since the time President Mohammad Ayub assumed power, and foreign experts and economists had nothing but praise for it. The Governor said, Pakistan was respected by the big Powers and admired for her success in development Programmes by the smaller nations. A tribute to Pakistan's prestige abroad was her unanimous election to the Security Council recently.

Addressing a huge gathering at the 50th Annual Session of West Pakistan Engineering Congress, the **Governor of West Pakistan** said, "It gives me great pleasure to be here today for the inauguration of the 50th Session of the West Pakistan Engineering Congress.

In this large assembly, I understand, are gathered together engineers from diverse professional disciplines. This is certainly a good occasion for them to meet and to exchange knowledge and ideas and the experience gained during the past year. It is an opportunity for the more senior members of the profession to pass on some of their experience to the younger men who may have joined the fraternity recently and, in return, to acquaint themselves with the bright new ideas which younger people everywhere love to put forth. This annual gathering should also help to create an atmosphere of friendliness and mutual goodwill among the engineers from various fields who have become members of the Congress.

No Barriers

It is encouraging to note that the Congress, which has been in existence for the last 56 years, has registered a steady increase in its membership and has succeeded in bringing within its folds the various fraternities in the engineering professions. In this age of rapid development, geographical frontiers are no barriers in the process of dissemination of knowledge. Discoveries and achievements made in any part of the world spread quickly to other areas. It is heartening to note that some of the past deliberations of the Congress have won international recognition in the field of engineering.

Engineering is a branch of human activity which has been pursued from the earliest times, when man began to adopt his environment to his needs. Even the earliest human inhabitants of this planet had, out of necessity, managed a combination of the needed skills, however insufficient or incomplete. They had to acquire engineering skill of the crudest and most rudimentary type, and were able to make instruments for hunting, for domestication of animals and for building shelter for their living. All progress is but a continuation of history. Along the path of history exist great eras of human attainment when great engineering wonders were accomplished.

Engineering Monuments

The surviving monuments continue to symbolise the glory and the ingenuity of their great builders. It is a tribute to the imagination, skill and ability of some of our ancestors that even the people of our present day highly advanced world, are spell-bound in admiration on seeing some of their feats. Such works fulfilled the aspirations of those people and have been a source of inspiration for the succeeding generations. Those were the master-builders who conceived engineering feats which are gigantic even by present-day standards. The Egyptians, Assyrians, Babylonians, Romans, Greeks and, to top them all, the Muslims have contributed so much towards the advancement of engineering that their surviving works are a living testimony to the grand scale on which they conceived their works.

Our own land has given birth to many civilisations. Our history is replete with high standards of professional attainments. Even when the contemporary Western civilisations were at the peak of their glory, they had not yet conceived of the underground sewerage systems, the pucca brick paved streets, the huge granaries, the colossal swimming tanks and other like structures which formed a part of the Indus Valley civilisation. In the more recent past, the ascendancy of the Moghals in this sub-continent saw the attainment of new heights in the fields of engineering and architecture. We can justly be proud of that era and feel a sense of personal participation in those masterpieces of engineering design which are standing monuments of our past glory.

Engineering Onus

This glorious past endows upon the engineers of this country an added responsibility for the continuation of the same enthusiasm, high professional skill, vigour and integrity which distinguished their forefathers for years. They should try to exploit the unexplored domains and broaden the horizons of their knowledge and skill. Upon them has devolved the great task of developing their country. We are now well ahead on the path of economic development and a decade of reforms has been completed this year under the inspiring leadership of President Ayub. The pace and tempo of our development has not only to continue unabated but must accelerate, thus putting an increasing demand on the ability and energy of engineers.

The engineering field is growing fast with new and modern techniques being developed every day. It should be the duty of all engineers, young or old, to keep abreast with the advances made elsewhere and to apply this new knowledge to improve the quality of their own work. The age-old traditionalism has to be shed wherever and whenever necessary, to make room for new methods and ideas aimed at improving technical proficiency and the resultant products. The science of engineering is getting more and more complex every day, and it is only through continuous refreshing of one's knowledge that a high degree of proficiency can be maintained.

Better Life Aim

All of us feel gratified to contemplate that our engineers have so far met the challenges faced by them quite successfully. Their contribution in achieving the goal of a better life for the people of this country is worthy of commendation.

Gigantic engineering projects have been accomplished with efficiency. The Indus Basin projects have been executed by the engineers in a very proficient manner. The completion of the Mangla Dam ahead of schedule is a landmark in the history of the nation, and our engineers can be rightfully proud of this. The country looks up to them not only for the completion of other ambitious projects but also for the construction of much-needed schools, colleges, hospitals, storage bins, roads, canals and other works for improving the lot of the common man.

This is a cause so much cherished by our President, who is devoting all his time and energies to building up Pakistan as a truly welfare State. Investment in this great crusade definitely requires the contribution of engineers for its implementation. I am confident that this trust will be appropriately discharged.

Mr. President: I shall now say something about the points made by you in your very illuminating address.

Your description of the achievements of the various branches of engineering during the past year is very encouraging and highly gratifying. We all hope that the coming years will see a still better performance in all the relevant spheres, both individually and collectively.

It is true that the personal efficiency of any individual depends to a considerable extent on the environment made available to him. To attain the best in performance, in research, in planning and in designing, the engineers engaged therein need to be free from worries so that they can work devotedly. The present regime is for ever engaged in improving the lot of Government servants. Engineers are no exception, and their future and service conditions will always receive our due attention.

An Academy for Engineers should certainly help to improve the efficiency of the departments. My Government will give due consideration to a well-drawn up scheme commensurate with our resources, if it is prepared and submitted by your organization.

Pivotal Role

It is satisfactory to note that a large number of temporary engineers are being absorbed in permanent cadres. It is hoped that future recruitment will be restricted to cadre vacancies and these will be temporarily expanded as and when necessary and as enjoined by rules.

The institution of private consulting engineers has been developing for some time past within this Province, and with the passage of time it is expected to grow further. All of us interested in the improvement of engineering services look upon this development with great satisfaction. Consulting engineers have already started playing a significant role in the private sector and, I am sure, their impact will soon be felt in all fields of engineering activity.

Let me say in conclusion that we have to meet the challenge to be self-sufficient in food by 1970. This requires bringing more land under the plough and improving the existing farming methods. To attain these objectives, we have to construct irrigation works, reclaim fallow and salt-affected lands and level up barren areas. The role of engineers is pivotal in facing this challenge and in attaining the target. I sincerely hope that they will acquit themselves creditably and earn the lasting gratitude of the nation. With this confidence in our engineers, I declare the 50th session of the West Pakistan Engineering Congress open and wish you all Godspeed.

Abridge Address of the President of Congress

Mr. M. A. Waheed, President of West Pakistan Engineering Congress, addressed the Governor, Distinguished Guests and Members of the Engineering Congress :

It is a matter of great privilege for me to welcome on behalf of the West Pakistan Engineering Congress, the Governor of West Pakistan on this auspicious occasion. Sir, we are extremely conscious that your presence in our midst today is symbolic of your great interest in the development of Engineering profession and the welfare of Engineering services. We are indeed grateful that in spite of many important calls on every minute of your most valuable time you acceded to our request to inaugurate this session. We feel it most inspiring and encouraging.

West Pakistan Engineering Congress is the oldest and most representative body of Engineers in West Pakistan. It has had the honour of having on its roll eminent Engineers who dedicated their entire lives to the cause of the profession. The present membership of the Congress is well over 1200. During the last 55 years this organization has served as a platform for exchange of technical knowledge and venue for creating close personal relations amongst the members of the profession. The original contribution made by the Engineers through this Congress has been recognized in the international sphere and has resulted in considerable advances in Engineering science as adapted to the conditions of our country. The Congress proceedings are a source of valuable information to Engineers both young and old who occasionally fall back to these proceedings for reference whenever in difficulties.

Discussing other problems of the Engineers, Mr. Waheed said that there is lack of research in Engineering particularly on the Buildings, Highways, Public Health and Electrical sides. Coupled with the general standard of technical education, there is an ever-increasing gap between the available knowledge and its application to our needs. Whatever has been done in these fields of research here is insufficient and comparatively in an embryonic stage.

He then described the activities of the various Engineering departments during the year. The Irrigation department is helping to achieve self-sufficiency in food latest in 1970. The department planned to develop ground-water resources as much as possible and has been installing large number of tubewells in various areas.

The Pakistan Western Railway is finalising the construction of Kot Addu Barrage broad gauge rail link. The electrification of Khanewal-Lahore Section is progressing. Signalling has been improved together with the length of new heavy rail with welded joints to attain higher speeds with less noise.

The Communications and Works Department has been bifurcated into Highways and Building departments. Largest activities have been towards the construction of Bridges over Ravi at Lahore and Chichawatni. Jehangira Bridge on Kabul, Jhelum bridge on Jhelum river and a bridge on Sutlej near Bahawalpur. Three important highway constructions Lahore-Sheikhupura-Lyallpur, Sheikhupura-Sargodha-Khushab and Lahore-Multan are in advance stage of building.

Twenty-four major building projects have been completed at a cost of Rs. 306 lacs. Educational Institutions and Hospitals are under construction at an estimated cost of Rs. 3,868 lacs. Work on the Lahore Township Scheme is also in progress.

The Public Health Engineering Department is undertaking improvement of water supply and Sewerage in several cities including Lahore and Rawalpindi. The Water and Power Development Authority has been engaged on the completion of Indus Basin Project and many link canals and barrages have been constructed earlier than schedule. The salinity control and reclamation programme of WAPDA is progressing in Northern and Southern Zones. The Electricity Department has increased its energy generation from 2900 million Kwhs to 30 million Kwhs. There has been considerable expansion in the distribution of power supply.

West Pakistan Agricultural Development Corporation is preparing scheme for intercepting the rise of water in Guddu Barrage area and has increased the cultivation from 5 to 15 lacs in Ghulam Mohammad Barrage and similarly in case of Taunsa Barrage from 7 lacs to 10 lacs. The Land and Water Development Board has continued improvement of the area damaged by thur and sem.

Continuing the President said, "The ever-expanding development programme has created a great demand for Engineers and technicians. To meet the need, intake of Engineering College and the Engineering University has been increased. The number of polytechics has gone up to 14 from 4 and ten more will be added by 1970 bringing the total intake to 20,000 yearly. Evening programme have also been started at almost all technical institutes."

Concluding his address, Mr. Waheed remarked, "Sir, I conclude by praying to Allah for the continued prosperity of Pakistan, for continuation of able leadership offered by President Field-Marshal Muhammad Ayub Khan and his devoted team including yourself, the soldier of war and the crusader of peace. I am indeed grateful to you, Sir, for the singular honour you have done to me, the Engineering profession and the Engineering Congress in accepting our invitation to inaugurate the Session. I am also indebted to the honourable Guests for having graced the occasion. My thanks are also due to members of the Engineering Congress to elect me the President for the year and to the members of the Council for their whole-hearted co-operation and assistance to carry out functions during the year.

I now request you to inaugurate the 50th Session of the Engineering Congress.

ACTIVITIES OF THE LAST ENGINEERING CONGRESS ENDING DECEMBER, 1967

The last Council for the Session 1966-67 was elected on 20th October 1966. The Office bearers and the Council members were :—

President

Mr. M. A. Waheed, P.S.E.I.,
Director-General, Buildings Department, West Pakistan, Lahore.

Vice-Presidents

(*i*) Sh. Ahmad Hassan, P.S.E.I.,
Secretary to Government of West Pakistan, Irrigation and Power Department, Lahore.

(*ii*) Mian Alim-ud-Din, *S.Q.A.*, P.S.E.I.,
Chief Engineer, Irrigation, Lahore Region, Lahore.

(*iii*) Sardar Allah Bakhsh, P.S.E.,
Chief Engineer, SCARPS, WAPDA, Lahore.

(*iv*) Mr. C. A. Vali, P.R.S.,
Divisional Superintendent, P.W.R., Rawalpindi

(*v*) Dr. Mubashir Hassan,
Consulting Engineer, P. O. Box No. 730, Lahore.

Honorary Auditor

Mian Mazhar-ul-Haq, S. E., Public Health Engineering Circle, Peshawar.

Honorary Treasurer

Mirza Abdul Latif, P.S.E.I.,
Secretary, Land and Water Development Board, Lahore.

Honorary Business Manager

Syed Nazir Ahmad Shah,
Director, Greater Lahore Water Supply and Sewerage Scheme, Lahore, Improvement Trust, Lahore.

Council Members

1. Mr. A. M. Akhoond, *S.K.*, P.R.S.,
Chief Engineer, P.W.R., Lahore.
2. Mr. Ashfaq Ahmad Qureshi,
Project Engineer, Industrial Estate, Directorate of Industry, 100-Upper Mall, Lahore.
3. Mr. Zubair, P.S.E.I.,
Vice-Chancellor, Engineering University, Lahore.
4. Syed Faiz Omer,
Executive Engineer, Highways Project Division, Sialkot.
5. Mr. Haroon Rashid Toosy,
Executive Engineer, Qadirabad Barrage, WAPDA, P.O. Akalgarh, District Gujranwala.
6. Mr. Iqbal Ahmad Sabir,
Executive Engineer, Public Health Engg. Division, Lytton Road, Lahore.
7. Mr. Khushal Khan, P.S.E.I.,
Superintending Engineer, Northern Irrigation Circle, Mardan.
8. Mr. Khalid Mahmud, P.S.E.I.,
Executive Engineer, Trimmu Division, Trimmu.
9. Sh. Muhammad Akram, *S.K.*, P.S.E.I.
Consulting Engineer, Lahore.
10. Mr. M. H. Tirmazi, P.S.E.I.,
Deputy Secretary, Irrigation and Power Department, Lahore.
11. Sh. Mukhtar Ahmad, P.S.E.I.,
Director (Administration), Public Health Engg. Department, Lahore.

12. Ch. Muhammad Hussain,
Director, Land Reclamation, West Pakistan, Lahore.

13. Mr. Muhammad Afzal Cheema,
Executive Engineer, Balloki Division, Balloki.

14. Mr. Muhammad Khalil, P.S.E.I.,
Chief Engineer, Buildings Department, Hyderabad.

15. Mr. Muhammad Tayyab Sheikh,
S. E. Public Health Engg. Circle, Quetta.

16. Malik Nisar Ahmad, W.P.S.E.,
Executive Engineer, Montgomery Division, Sahiwal.

17. Mr. Nasir M. Khan,
Superintending Engineer, Public Health Engineering Circle, Lahore.

18. Mian Saeed Ahmad, *T.Pk.*, P.S.E.I.,
Director-General, Highways Department, W. Pakistan, Lahore.

19. Mr. Shafiq Ahmad Khan,
Deputy Director, G. A. S. for P.H.E.D., Lahore.

20. Mr. Sarwar Jan Khan, P.S.E.I.,
Chief Engineer, Irrigation Peshawar Region, Peshawar.

21. Mr. Sarfraz Khan Malik, P.S.E.I.,
O.S.D., Irrigation and Power Department, Lahore.

The Council held its first meeting on November 3, 1966 and elected the following Office-bearers:

(*i*) *Honorary Secretary*
Mr. Fayyaz Ali Shah, P.S.E.I.,
Deputy Chief Engineer, Highways Department, Bahawalpur.

(*ii*) *Honorary Joint Secretary*
Mr. Iqbal Ahmad Shahab,
Director Wapda, Lahore.

(*iii*) *Honorary Publicity Secretary*
Ch. Mazhar Ali, P.S.E.I.,
S. E., Irrigation, Sukkur Region, Sukkur.

(*iv*) (*a*) *Honorary Editor "Engineering News"*
Dr. Nazir Ahmad,
Irrigation Research Institute, Lahore.

(*iv*) (*b*) *Panel of Editors for the Journal*
(1) Mr. Khalid Mahmud, P.S.E.I.
(2) Mr. Ashfaq Hassan, P.S.E.I.
(3) Mr. Muhammad Afzal Zafar.

Rana Allah Dad Khan was also co-opted as Member of the Council.

The Council at Work

Activities of the Council included 19 monthly meetings in which several items were discussed and action taken.

(*a*) A Sub-Committee was formed to go into the question of pursuing with the Secretary to Department concerned and the Public Service Commission.

It was envisaged that cases of 260 temporary engineers in C & W Department and 120 temporary engineers in Irrigation and Power Department were under active disposal of the Public Service Commission. More than 150 vacancies will be further created in Class II when the case of filling of the existing vacancies in Class I in C & W Department and Irrigation and Power will be decided. About 30 Temporary Engineers in the Irrigation and Power have already been absorbed in permanent cadre and notified in the Gazette.

Arrears of Annual Subscription

This point remained on the agenda of all the meetings of the Executive Council during the year and ways and means were devised to recover as much arrears as possible from the members.

Permanent Headquarters for the Congress

A plot for the construction of permanent Headquarters of the Congress had been purchased at a cost of Rs. 79,368.00.

A Sub-Committee consisting of Dr. Mubashir Hasan and Rana Allah Dad Khan was formed to get the planning and designing expedited. This sub-committee was also charged with the task of collecting funds for the building.

Engineering News

The Journal continued in its thirteenth year of publication in spite of the difficulty of publishing material and finances.

Membership

On December 31, 1965 the membership stood at 1064 which increased to 1159 by December 31, 1967. It included 436 members from the Irrigation and 308 from the Building and Road Departments. Members of the other Departments included Electricity 86, Pakistan Western Railway 39, M.E.S., 32 WAPDA and Miscellaneous 258.

Finances

The closing balance with the Congress on December 31, 1967 was Rs. 12,757.82.

Election of New Council for the year 1968

The members of the Congress met on Monday the 26th February 1968 to elect the new President and his Council. Sheikh Ahmad Hassan, Secretary, Irrigation and Power Department, Lahore, was elected as the President of the Congress.

The Vice Presidents, Office-bearers and other members of the new Council :

PRESIDENT

1. Sh. Ahmad Hassan, S.Q.A., P.S.E.I.
   Secretary to Govt. of West Pakistan,
   Irrigation and Power Department,
   Lahore.

VICE PRESIDENTS

1. Sh. Muhammad Akram, S. K., P.S.E.I.
   Retired Chief Engineer, 17 Jail Road,
   Lahore.
2. Muhammad Anwar Qureshi, P.S.E.I.
   Chief Engineer Electricity, Wapda,
   Peshawar.
3. Mazhar-ud-Din, P.R.S.
   Divisional Engineer, P.W.R., Lahore.
4. Sayyid Hamid, P.S.E.I.
   Chief Engineer, Wapda, Lahore.
5. Mian Saeed Ahmad, T. Pk., P.S.E.I.
   Director General Highways, West Pakistan,
   Lahore.

HONORARY SECRETARY

1. Mr. Sarfraz Khan Malik, P.S.E.I.,
   Director Remodelling Works (O.S.D.),
   Irrigation and Power, Lahore.

OFFICE-BEARERS

1. Mian Mazhar-ul-Haq,
   S. E. Public Health Engineering Circle,
   Peshawar. (*Hon. Auditor*).
2. Mirza Abdul Latif, P.S.E.I.,
   Secretary Land and Water Development
   Board, Lahore. (*Hon. Treasurer*).
3. Sayed Nazir Ahmad Shah, P.S.E.I.,
   Director L.I.T. 87 Shadman Colony,
   Lahore. (*Hon. Business Manager*).

4. Ch. Mazhar Ali, P.S.E.I.
   Director Review Cell, Lahore.
   (*Hon-Publicity Secretary*).

5. Dr. Nazir Ahmad,
   Principal Research Officer, I.R.I. Lahore.
   (*Hon. Editor, Engineering News*).

6. Mr. Ashfaq Ahmad Qureshi
   Executive Engineer 5th Provincial
   Building Division, Lahore.
   (*Hon. Joint Secretary*).

MEMBERS

1. M. A. Waheed, P.S.E.I.
   Director-General Buildings,
   West Pakistan, Lahore.

2. Mian Alim-ud-Din, S.Q.A., S.K. P.S.E.I.
   Chief Engineer of Irrigation, Lahore
   Region, Lahore.

3. A. R. Qureshi, S.K., P.S.E.I.
   Chief Engineer Public Health
   Engineering Department, Lahore.

4. Sarwar Jan Khan, S.Q.A., P.S.E.I.
   Chief Engineer Irrigation and
   Power, Peshawar Region, Peshawar.

5. A. W. F. Sheikh, P. S. E. I.
   Chief Engineer Irrigation,
   Quetta Zone, Quetta.

6. Rana Allah Dad Khan, Rana Motors,
   The Mall, Lahore.

7. S. I. A. Shah, P.S.E.I.
   Chief Engineer Buildings, Central Region,
   Lahore.

8. Sayed Fayyaz Ali Shah, P.S.E.I.
   Deputy Chief Engineer, Highways
   Department, Lahore.

9. Mian Mohd Shafi, P.S.E.I., S.E.
   2nd Provincial Buildings Circle, Lahore.

10. A. A. Siddiqi, P.S.E.I., S.E.
    Bahawalnagar Circle, Bahawalnagar.

11. Manzur Abbas Akbar, P.S.E.I., S.E.
    Provincial Building Circle, Bahawalpur.

12. M. R. Vehra, P.S.E.I., S.E.
    Provincial Buildings Circle, Sukkur.

13. Mian Anwar H. Rehman, P.S.E.I.
    Deputy Secretary (G) Irrigation and
    Power Department, Lahore.

14. I. A. Shahab Director (Works)
    WAPDA, Sunny View, Lahore.

15. Jamil Asghar Khan, P.S.E.I.
    Director Designs, Wapda, Sunny View,
    Lahore.

16. M. R. Goheer, P.S.E.I.
    Superintending Engineer Highways
    Circle, Lahore.

17. Sardar Allah Baksh Khan , P.S.E.I.
    Chief Engineer SCARPS, West Pakistan,
    Sunny View, Lahore.

18. Ch. Muhammad Hussain, Director
    Land Reclamation, Canal Bank, Lahore.

19. Dr. Mubashir Hassan, Consulting
    Engineer, P.O. Box 730, Lahore.

20. Ch. Muhammad Khurshid, Executive
    Engineer, 2nd Provincial Buildings
    Division, Lahore.

21. Qazi Ghulam Mustafa, Estate Officer,
    Civil Sectt., Lahore.

22. Manzoor Hussain Bukhari, P.S.E.I.
    Section Officer (Tubewells) I & P
    Department, Lahore.

23. Haroon Rashid Toosy, Executive
    Engineer, Qadirabad Barrage, Wapda
    P.O. Akalgarh, District Gujranwala.

24. Muhammad Akbar, Executive Engineer,
    Provincial Buildings Division, opposite
    Frere Hall, Karachi.

INTRODUCING

MR. AHMAD HASSAN

The President of the Congress 1968-69

Mr. Ahmad Hassan was elected President of the West Pakistan Congress for the year 1968-69. He was born in Bahawalpur and educated at Aligarh and Durham University of England where he graduated in Civil Engineering.

He joined the Bahawalpur P.W.D. in 1930, was promoted Executive Engineer in 1937-38 and Superintending Engineer in January, 1948.

He officiated as Chief Engineer, Bahawalpur, in 1952, and then in 1954, and was substantively appointed as Chief Engineer and Secretary to the Government of Bahawalpur in Public Works and Development Department in 1955.

As Executive Engineer he was on deputation with the Government of India in 1942 in connection with the construction of Bahawalpur Section of the National Highway.

He initiated, planned and constructed the Abbasia Canal Project in 1945-47 which helped to settle lakhs of refugees.

He was responsible for the town planning of the Model Towns and the New Mandi Towns in Bahawalpur State.

He planned and constructed the Amir of Bahawalpur Mosque at Bahawalpur.

He was the architect for all the important public buildings in the state of Bahawalpur such as the Sadiq Public School, the Stadium, a 250-bed Hospital, Jamia Abbasia College, now Jamia Islamia Degree College and a large number of hospitals, colleges, high schools and dispensaries scattered all over the Bahawalpur State.

The electricity department under his charge expanded and seven new cities were electrified.

He established the Abbasia Forest Plantation in 1949 and greately extended the Lal-Sohara Forest.

The Government of Bahawalpur lent his services to the Government of Pakistan in 1952 in connection with the Water Dispute with India. He was selected in 1953 to go to Denver to assist the Consulting Engineers in the preparation of the Water Dispute case and was later a Member of the Water Delegation in Washington in 1953-54.

The Government of Pakistan, on the unanimous recommendations of Chief Engineers of all the Provinces, had taken a decision in 1953, to construct Guddu Barrage near Mithankot. Mr. Ahmad Hassan, then a Superintending Engineer in Bahawalpur, submitted at length his views on the subject. Ministry of Industries decided to convene another meeting of Chief Engineers of all the Provinces who after consideration of his views in detail, agreed to modify their previous recommendations. The Government of Pakistan, therefore, decided to shift the Barrage back to Kashmore. The Pat Feeder of Guddu Barrage as now constructed was a part of his recommendations of 1953.

When in April 1957, Tando Masti Khan Fall of Rohri Canal collapsed, his proposal of creating a big diversion lake nearly two miles long, one mile wide, to dissipate the energy of eleven feet fall in a canal of over 10,000 cs. saved an area of over 25 lakhs from a major catastrophe.

After integration, he was responsible for important and emergent repairs to Panjnad Headworks. The Minister appreciating the progress, stated on the floor of West Pakistan Assembly that the work was being completed with unprecedented speed and efficiency and that it was an achievement which the Government and its Engineering staff could well boast of.

In October 1957, Mr. Hassan was appointed as Additional Chief Engineer, Operation, West Pakistan, and later officiated as Chief Engineer, West Pakistan in 1959 and 1960. His services were placed at the disposal of the Government of Pakistan in 1959 and he was responsible for finalizing the system of Link Canals of the Replacement Plan, their alignments and designs.

On Reorganization of the Irrigation Department in April, 1962, he went on deputation to the Agricultural Development Corporation as its Chief Engineer and Adviser. To the Corporation was thereafter transferred one by one the control of Irrigation Systems of the G. M. Barrage, Guddu Barrage, Taunsa Barrage and the Thal Canal, thus completing the transfer to the Corporation of all the major developing irrigation systems of West Pakistan.

During this period one of his major achievements was the change in the alignment which had been adopted by the consultants for the Chashma-Jhelum Link Canal. The revised alignment besides being very much cheaper to construct and maintain will provide opportunity for the development of the Greater Thal area.

He envisaged a large channel for the Kalri lake to convey the silty waters to the irrigated lands which would also help to increase the life of the lake.

He was appointed as the Secretary in the Irrigation and Power Department, in 1966. As head of the Irrigation Department, his actions have resulted in achieving self-sufficiency in food grains in West Pakistan much earlier than anticipated. With proper control and regulation of river supplies and carefully planned use of Mangla water, the agricultural produce in the country has exceeded the targets.

He was elected as President of the Lahore Centre of the Institute of Engineers (Pakistan) for the year 1967-68.

He was elected President of the Engineering Congress for 1968-69. He is an example of a man who has devoted 38 years of strenuous life to the service of his country. It is a model which many young engineers would wish to follow. The 'Engineering News' management welcomes most cordially Mr. Ahmad Hassan as the new President.

Plastic Theory of Design

B. A. CHOWDHRY*

In this article Mr. Chowdhry has discussed at length, the Plastic Theory for the Design of cement concrete structures. The article contains a history of the development of this subject with innumerable references to various authorities, instrumental in its development. A design of beam on the basis of ultimate load theory has also been worked out. The paper is of considerable information for all those who are charged with the responsibilities of designing R.C.C. Structures.

At the beginning of the century the R.C.C. design was still in its infancy; the designers did not have any design theories and were mostly guided by test specimens. They had a better concept of the behaviour of different materials used in R.C.C. than many engineers of today. The early designs of reinforced concrete structures were usually all carried out on the basis of ultimate strength of the members, but later on when straightline theory was discovered, many designers favoured this theoretical method of design rather than basing their design on the actual ultimate strength of the member. In this practice many advantages were lost as in most cases the elastic theory under-valuated the strength of the member. The elastic theory also predicts incorrect factor of safety because the materials must be stressed beyond their elastic limit before the failure takes place.

In many of the earlier design theories such as presented by Thullie in 1897, Ritter in 1899, Talbot in 1904, Whitney in 1907 and Mensch in 1914, the calculated values were well related to test results and were all ultimate strength theories. Most of the structures in that period were designed on the basis of plastic action *i.e.* the ultimate strength theory. In fact, the concrete design started with ultimate strength concept. Galilei's work of 1638 regarding flexure strength of beams was exclusively based on ultimate strength. Hook's law was discovered in about 1678 and it was after about 143 years that theory of elasticity was developed by Navier in 1821, which forms the basis for working stress method of design.

Koenen was first to publish his ultimate

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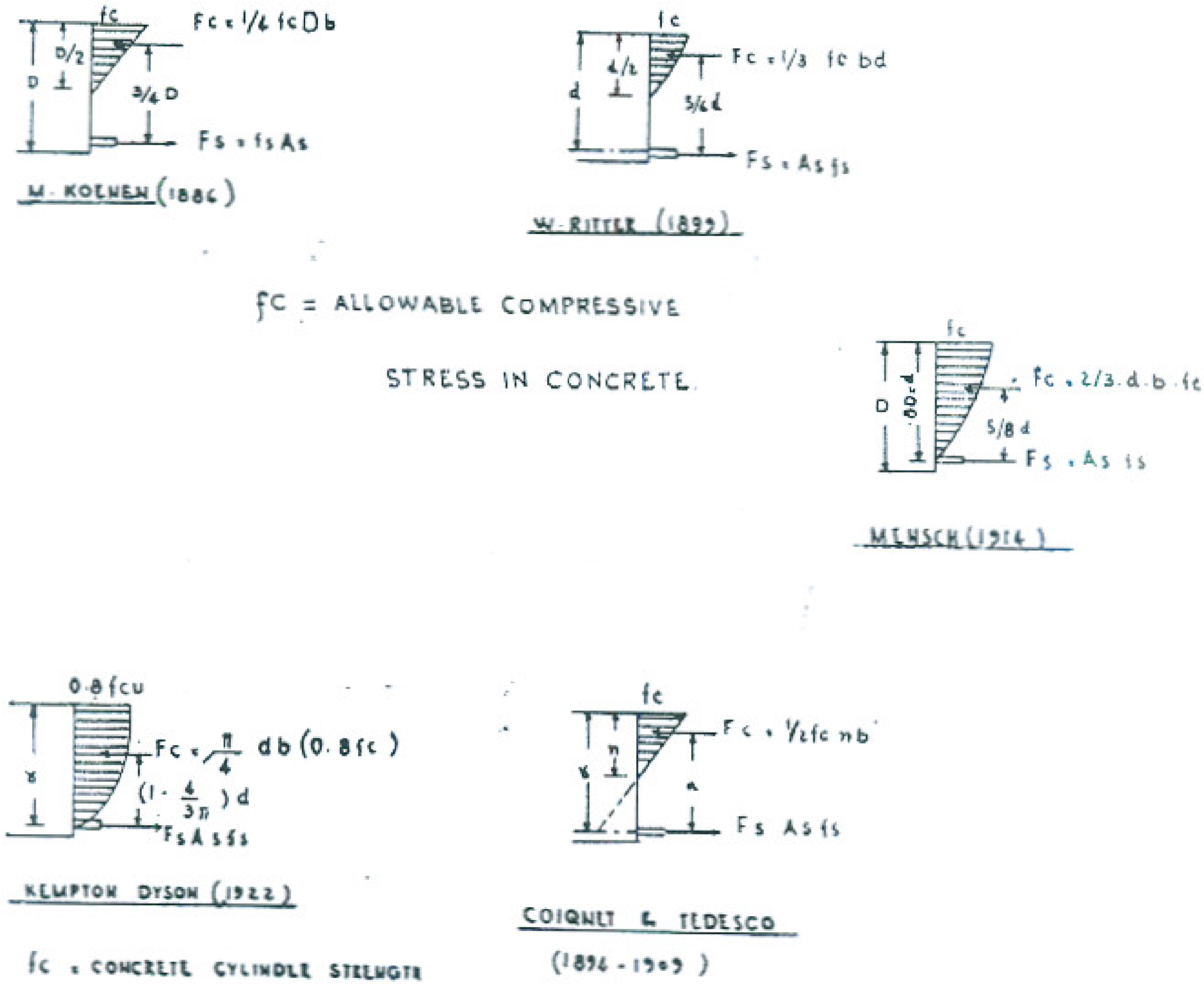
load theory in 1886. He assumed a straight-line distribution of concrete stress and neutral axis at the centre. Ritter and Talbot assumed concrete stress distribution as parabolical while Mensch assumed it to be a cubic parabola and assumed neutral axis at 0.8 of the depth.

In England, Kempton-Dyson was the first to present ultimate load theory in 1922. He assumed concrete stress distribution as 1/4 of an ellipse and neutral axis at the level of steel in case of compression failures. Since then many other engineers have published their own theories and so far about 30 theories have been published.

It was about 1909 when straightline theory of Coignet and Tedesco was accepted. The main reason of its acceptance was its simplicity. The design by straightline theory became quite common and normal understanding was that when beams were designed with a working stress in concrete as 0.33 of the ultimate concrete test cylinders strength, the safety factor of concrete was 3. In 1920, however, Lyse, Slater, and Zipprodt pointed out by actual beam tests, that this was not so and the safety factor was rather high which showed the inelastic behaviour of concrete.



(F g. I)

In 1931 Emperger strongly criticised the straightline theory and this initiated a lot of interest in the study of ultimate load design.

A reinforced concrete structure is primarily to carry load and any structure which can carry load satisfactorily is considered a good one. This was the philosophy of the pioneers of reinforced concrete designs. At that time no attention was paid to the conditions at working load. This concept was, however, reversed with the passage of time and designers started designing structures by the application of elastic theory by considering conditions at working load completely forgetting the ultimate conditions. Since then many assumptions have been made, some of which are totally incorrect and our designs are unrelated to actuality.

In our conventional methods of design, the safe stresses have been written down in codes and the designer has just to do a numerical exercise to prepare a design without any regard to the type of the building and this in certain cases results in uneconomical designs.

In elastic theory the stresses in the material are fixed keeping in view their quality etc. During the past, as our method of manufacture of concrete and steel improved, the design stresses were also increased. However, the basic method of design remained the same.

The past history of concrete shows that structures designed according to elastic theory, could stand very well even if the working load exceeds the designed load. In fact, the structures could take up a lot of extra load and hardly any structure failed because of overload. This gave some dissatisfaction to the designers who very much wanted to find some economical but not illogical, safe method of design. Hence the revival of plastic theory.

The basic difference in the designs according to plastic theory is that while in designs according to elastic theory, the internal stresses based on a linear stress strain relation are equated to allowable stresses, in ultimate load design the strength of a section is equated to the stresses produced by ultimate load. The design according to ultimate theory thus predicts the actual factor of safety of the structure.

Normally an overall load factor or factor of safety of 1.6 to 2.2 is allowed depending on the ratio of dead load and live load and the type of structure. In some countries where this method has been used for the design of structures a saving of 30 to 40 per cent in steel has been obtained.

No appreciable progress, however, was made in the ultimate load design till 1930 when more attention was devoted towards research in this field and Emperger presented his paper in 1931 followed by Stüssi in 1932. Both these papers had certain important features. Stüssi stated in his paper that ultimate strain in concrete is an important factor affecting the strength of a beam failing in compression. Stüssi had based his ultimate strain on results obtained in axially loaded cylinders. However, Baumann in 1934 and Bradtzaeg in 1935 showed that much higher fibre strains could be developed in members subjected to flexural compression than in cylinder tests. Thenceforth greater emphasis was laid on the necessity of considering the characteristics of the concrete stress block as determined from test of beams rather than from test cylinders. The theories developed by Bradtzaeg in 1935, Jensen in 1943 and Chambaud in 1949 all followed this line of action. However, even up till now we do not know exactly the action of stress block in a beam.

The ultimate load theory must tell us whether a particular member is going to fail in tension or compression and must predict its strength.

If members are designed according to plastic theory, they will be of more uniform strength and savings are effected by reduction in sections. In some cases beam sections are reduced which also affect the shuttering cost, height of the building including the foundations.

Ultimate strength design is already in practice in Brazil, Poland, Austria, Czechoslovakia, U.S.S.R. and is also favourably considered in America and England.

In designing according to straightline theory there is a lot of inconsistency. For example, when the load is purely axial the design is made according to ultimate strength method and when there is direct load and flexure straightline method is used and there is a mixture of methods when member contains compressive reinforcement. In ultimate strength design method there is one common design procedure whether the load is axial or is combined with flexure etc. etc. In ultimate strength theory each member is designed for some multiple of service load called ultimate load which is in excess to the maximum load to which there is any reasonable possibility of the structure to be subjected to, giving due regard to the flexural action of the material composing the member while determining the carrying capacity. The load factor covers all defects in material and workmanship.

For all big structures the question of overload factor is of great significance as it affects the economy of construction to a large extent. We have to decide how much we are prepared to spend for a possible but unrealistic load condition. A large group of structures and continuous beams, girders, frames etc. have a lot of reserve strength due to phenomenon of redistribution of stresses. Advantage of this property is not taken in the ordinary design except when we design according to ultimate strength theory.

Design According to Ultimate Strength Theory

Basically the procedure in the design is the calculations of the dead and live loads, calculating the ultimate design loads by multiplying the dead and live loads by different load factors and then caculating the moment, shear etc. and finally designing the section.

Normally it is easy to assume a dead load for a certain member of the structure from approximate formula, and as regards live load it will depend upon the type of the building, its exposure to overload etc. etc. The dead load is multiplied by an overload factor and live load by another which is normally higher than for dead load. There are two schools of thought regarding deciding this overload factor. Before we consider them it is worth mentioning that there are two modes of failure of a particular member of a structure in R.C.C. There may be tension failure in which case when the steel reaches yield point there will be cracking of the concrete, large increase in deflection and all this will give sufficient warning and necessary repairs can be carried out and building saved from complete destruction while the second case is of compression failure of concrete which will be sudden and without any warning. In first case the example may be of R.C.C. beam failing in tension of steel or failing in shear of a beam having web reinforcement. So certain modes of failures are more undesirable than others. In multi-storeyed buildings having flat slabs the roof may have sudden failure due to overload by punching around the columns without giving any warning and as its load falls on the next floor it may also fall around the columns and thus whole of the building may collapse while on the other hand if the roof fails due to over-stressing of steel, ample warning is given and building can be saved from complete collapse. So it is clear that certain modes of failure are more undesirable than others and according to one school of thought such mode of failures should have a greater factor of safety than others while according to second school of thought the building is designed not to fail and all modes of failure should be guarded against equally.

Load factors are selected on the clear presumption that an ultimate 28 days' compressive strength of a concrete cylinder is in no case less than the assumed ultimate strength. It is, therefore, recommended that during actual design of conrete mix a higher strength of concrete than assumed ultimate strength should be aimed at to account for any lapses in control which are normal. The writer would suggest an average strength between 15 to 20 per cent higher than the designed strength.

The American practice is to have same load factor for steel tension and concrete crushing failure while according to British practice the load factor for steel is smaller than concrete evidently to avoid compression failures which are much more disastrous than tension failures. The writer recommends the British practice.

DESIGN OF BEAMS:

Ultimate Load Design Equations

American Concrete Institute and American Society of Civil Engineers Joint Committee have recommended the following formula for calculating the ultimate resisting moment of the beams in flexure.

$$\frac{Mu}{bd^2} = Pfy\left(1 - \frac{Pm}{2}\right) \qquad .. \quad (1)$$

Where Mu = Ultimate Moment.

P = Percentage of steel $\frac{As}{bd}$

fy = Yield point stress in steel but not greater than 60,000 lbs/sq. in. for design purposes.

b = Breadth of the beam

d = Effective depth.

$m = \frac{fy}{0.85\ fc}$.

fc' = 28 days' concrete cylinder strength

Alfred Zwieg has given a simplified method for the design of rectangular section in flexure. According to him the rectangular section is assumed and for an ultimate moment Mu the area of steel is found as under:

$$\bar{A}s = \frac{Mu}{ad} \qquad .. \quad (2)$$

Where a = 0.9 fy and for fy = 60,000

a = 4.5 if Mu is in ft. kips

The actual steel required is

$$As = K\ \bar{A}s \qquad .. \quad (3)$$

Where $K = 1 + \bar{P}c + 2(\bar{P}c)^2 + 5\ (\bar{P}c)^3$

in which $\bar{P} = \frac{\bar{A}s}{bd}$ and

$$C = 0.59\ \frac{fy}{fc'}$$

Zwieg has worked out tables for the value of K for various values of p and thus the whole process becomes very simple and can be covered in 3 steps. This process has certain limitations and for further study the readers may refer to his paper published in ACI Journal of May—1967 which also contains the tables for K.

Compression Failure

In compression failure the stresses in concrete at the compression edge go so high as to crush the concrete and thus cause failure while tension stresses are within the safe limit, that is, below the yield point. In compression failure the equation developed by C. S. Whitney is so far the simplest although its applicability to low strength concretes (below 3000 lbs. per sq. inch) is considered to be conservant. His equation is:

$$\frac{Mu}{bd^2\, fc'}=1/3 \qquad .. \quad (4)$$

On account of abrupt compression failure and also considering uncertainties of concrete strength Whitney equation may be modified as under:

$$\frac{Mu}{bd^2\, fc'}=1/4 \qquad .. \quad (5)$$

This equation can well be used for all cases of balanced reinforcement to get average maximum value of Mu/bd^2. To safeguard against sudden compression failure the ACI code, however, requires that in flexure members the ratio of tension reinforcement shall not be greater than

$$P = 0.4\,\frac{fc'}{fy}$$

The applicability of Whitney's equation No. 5 in practical design is as under:

Since we are now designing by ultimate load, the live load is multiplied by a factor 2.4 and dead load by 1.2. Bending moments are obtained in the usual manner.

If a concrete of fc'=3000 lbs. per sq. inch is used the Whitney's equation No. 5 can then be reduced as under:

$$Mu = 750\ bd^2 \qquad .. \quad (6)$$

The total bending moments both for the live and dead loads is then equated to Mu in equation No. 6 and the design of the section is found out in the usual manner. The area of steel is then worked out by Zwieg formula as per equation No. 3.

Columns

Reinforced concrete columns are of two types, Tied Columns and Spiral Columns. The ultimate load for a tied column can be calculated simply by adding the ultimate strengths of longitudinal reinforcement and concrete in the column. This was stated by Considēre in his book translated into English in 1903. He also considered the effect of Spiral on ultimate strength but studies made by Richart, Brandtzaeg and Brown in 1928-29 are far more important and give an exact idea regarding effect of spiral on ultimate strength of columns. Most extensive research, however, on axially loaded columns was done by ACI in 1930's. They tested 582 columns. In their investigations the concrete strength was varied from 2000 to 8000 lbs. per sq. inch, both dry and moist conditions were included and percentage of reinforcement was varied from 0—6 per cent, steels of structural, intermediate and rail grade were used. The percentage of spiral reinforcement varied from 0—2 per cent. After these studies, the ultimate strength of a spiral column was recommended as the sum of (1) Compression resistance of the concrete core (2) compression resistance of the longitudinal bare stressed to their elastic limit and (3) compression resistance which would be produced by the imaginary longitudinals of the spirals multiplied by 2.

There is one important point which must be kept in mind while designing a column. All members subjected to an axial loading definitely have some accidental eccentricity which may be due to end conditions, inaccuracy in casting and lapses in site control. This accidental eccentricity should be taken into account while designing a column. As per standard practice of ACI, eccentricity for spirally reinforced columns is taken as 0.05 times the total dia. of the column. For tied columns it is taken as 0.10 times the least dimension of the section.

Shear of Beam

Rognestad in his research note titled "What do we know about diagonal tension and web reinforcement in concrete" published by University of Illinois Engineering Experiment Station Bulletin, while reviewing the shear strength of reinforced concrete beams has discussed about 170 documents on the subject published between 1897-1951. In these documents it is shown that a stress in stirrups only accounts for about 30 to 60 per cent of the total shear resistance of the beam. The British Standard Code of practice, however, demands that when the shear stress exceeds the allowable limit of concrete shear stress, whole of the stress should be taken up by the shear reinforcement. This was done because all the design formulae put forward were imperical and had a limited range of validity.

The formation of cracks completely changes the status of stress in the uncracked zone and it is suggested by Laupa, Siess, Newmark and Zwoyer that in the majority of shear failures it is actually shear compression failure. The compression zone of the concrete in such a case is reduced due to diagonal cracking instead of tensile cracking as in case of flexural failure. Till the formation of diagonal tension cracks the stresses in tension steel and concrete are approximately proportionate to the external moment at a particular section. With the formation of diagonal cracks this relationship changes and a redistribution of internal stresses takes place. This redistribution may cause immediate failure or lead to stable conditions permitting further increase in load. It may, however, be noted that shear failures always reduce the carrying capacity of the beam in flexure. The extent of reduction depends on the reinforcement index *i.e.* ratio of actual amount of tensile steel to the one required for balanced design and value of bending moment, shearing force and depth of the beam at the section concerned.

The shear failure is usually sudden although in some cases the development of diagonal cracks give some warning. This failure is, therefore, rather undesirable.

A test programme to determine the shear strength of beams was carried out at the University of Illinois under Talbot and reported by Richart and Larson in 1927-28. Another test programme was carried out for Emergency Fleet Corporation and was reported by Slater, Lord and Zipprodt in 1926. Almost all the tests were made on thin web L-shaped beam with relatively large amount of web reinforcement. The Illinois test included variety of bent up bars and their combination with various spacings etc. etc. The Emergency Fleet Corporation tests mostly dealt with stirrups bent to various shapes such as vertical and inclined. In both these investigations great emphasis was placed on streass in the web reinforcement. After these studies the following expression was finally recommended for ultimate strength in shear.

$$v = 0.005\ fu + rfu$$

where $v = \frac{V}{bjd}$, r is the percentage of web reinforcement and fu is the stress in web reinforcement (yield point).

It may be added that according to these studies ultimate strength in shear depends upon the following factors:

1. The compression strength of concrete;
2. The percentage of longitudinal reinforcement;
3. The ratio of length to depth of a beam for a given type of loading.

It is assumed that there is full bond between web reinforcement and the concrete and as such concrete helps in resisting the shear stress. This equation was not, however, conducive as during the test only 1/3rd beams failed in actual shear and secondly those tests were primarily made to study the effects of several variables on the stress in the web reinforcement. Richart, therefore, suggested the following equation of shear failure,

$$v = C + fu$$

where C is a constant and its value varies from 90 to 200 p.s.i. depending upon the quality of concrete and percentage of web reinforcement.

Web reinforcement plays a very important role in the failure of beams in shear. The beams without web reinforcement usually fail in an undesirable manner than beams with web reinforcement. Their failure is usually sudden while failure of bems with web reinforcement is usually in a ductile manner.

Bond

First detailed study on bond stress was made by Abrams in 1913. This involved hundreds of specimens and is perhaps the biggest contribution on the subject. In fact after his tests no major contribution has been made except the work of Gilkey, Chamberlain and Beal in 1938 wherein they proved that bond stress developed was not in proportion to the compressive strength of concrete after a certain limit. Bond stress is calculated from the usual formula u=V/o.jD/. This is the average bond stress. No definite formula has so far been suggested for the ultimate bond stress.

Deformed bars were introduced in the beginning of 1940s and this required complete revolution of the valuable data on bond. Clarke's tests have provided sufficient information in this regard. Deformed bars reduce the width of tension cracks as long as longitudinal splitting of concrete is permitted. It is, therefore, necessary that lateral ties are provided to prevent this splitting.

Conc'usion

A question may be asked as to when the design by plastic theory is a logical one based on the actual working conditions of a structure, why there is hesitation in this change-over from elastic design to plastic theory of design. In this connection it may be mentioned that there is always hesitation to change from one set of method to another new, relatively untried one although well supported by logic and experience. The straightline method of analysis gives very wrong figure of the strength of a structure and the predicted strength may differ as much as 100% from the available strength.

Another reason why designers are reluctant to use ultimate design method for beams in bending etc. is, because of the procedure of design by working stress design method is much simplert han by ultimate design method. However, many attempts have been made to simplify this method and with the modified method it is now as easy and convenient to design a section in bending by ultimate design method as by working stress design method. By designing structures according to ultimate strength method the materials are much better utilised than if design is done according to working stress method and there is a good deal of saving in steel particularly. This saving in steel varies according to the strength of concrete used, steel stress and also on ratio of live to dead land. Smaller live/dead load ratio gives more savings than higher live/dead load ratios. These savings in steel may vary from 30 to 40 per cent depending upon the above-mentioned facts. It may also be mentioned that concrete resistance of a beam in compression when calculated by ultimate strength method is about 100 % more than obtained by working stress design method. The difference in the two methods of design is on account of the fact that the ratio "ultimate load/designed load" is not equal to the ratio "ultimate stress/designed stress" as computed by elastic theory. In case these ratios were the same there will be no difference in the two methods of design.

It must be understood that collapse load as calculated by ordinary plastic theory is not necessarily the ultimate load on which the design is based but other factors such as fatigue produced by repetitive loading and excessive deflection may be overriding factors. For tension failures the difference in the two methods of design is not very much. In compression failures, however, the two theories give very different results and this is on account of under-estimating the compressive capacity of concrete by elastic method of design. The plastic theory is now fully developed and it is hoped with its adoption sufficient economy may result particularly in these days of soaring cost of construction.

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Attention !

Members Please

The Executive Council of the Engineering Congress has decided in its meeting held on 4-5-68 to remove the defaulter members from the membership of the Congress. The names of the defaulter members have thus been deleted from the mailing list.

—*Editors*

Geology and Hydrology of the Indus Formations

By **NAZIR AHMAD**

Geology of Indo-Pakistan

Geologists state that the Indian peninsula was formed more than 250 million years ago during the palezoic period. Still later in the tertiary period, about 25 million years ago, when the Himalayas started erupting, the Indian peninsula[1] was already fully mature and stable. Enormous powerful eruptions caused the rise of the Himalaya Mountains into a chain of ranges, some of which rose more than 29,000 ft. above the level of the sea. The main Himalaya ranges bordering the Indian peninsula are about 1500 miles long. Those along West Pakistan from Indus to Sutlej are about 350 miles long, another 200 miles mountains exist from Sutlej to Kali. The Nepal Himalayas start from Kali and extend about 500 miles to Tista. The last portion consists of 450 miles of the mountains from Tista to Brahmaputra at the eastern end of Assam.

Between the Himalaya ranges and the Indian peninsula existed about 300,000 square miles of great depression which was filled with sea water. As shown in Fig. 1, this depression now constitutes the present plains of the Indus and the Ganges river systems.

The Siwaliks

At the foot of the mountains there exists a very long range of unconsolidated materials partly brought down from the Himalayas and left at the edge of the plains. These are the famous Siwalik hills between 2000 to 4000 ft. in height and extend from Assam to the north west portion of West Pakistan. These hills contain a large amount of water transported materials, shingles and boulders, attributed to be deposited by a geological river called the Siwalik which originated from Assam and flowing 1500 miles along the foot-hills discharged somewhere into the sea, most probably near the present Attock in West Pakistan.

Indo-Gangetic alluvial Plains

The Plains of the Indus and the Ganges River systems conceal great ruptures and fractures of the earth crust thousands of feet in depth. It was originally occupied by sea. During the past few million years, the depression has got filled up with the alluvium washed down from the mountains. It now forms about 3 lakh square miles of the most fertile land.

The area which now constitutes the West Pakistan was originally a sea bed. It had some extension of the Aravalli mountain ranges of the Northern India. These mountain ranges are now buried under alluvium with some hill tops still exposed as out crops in the vast flat plains of the Indus at sites like Shahkot, Sangla Hill, Chiniot and Kirana Hills near Sargodha.

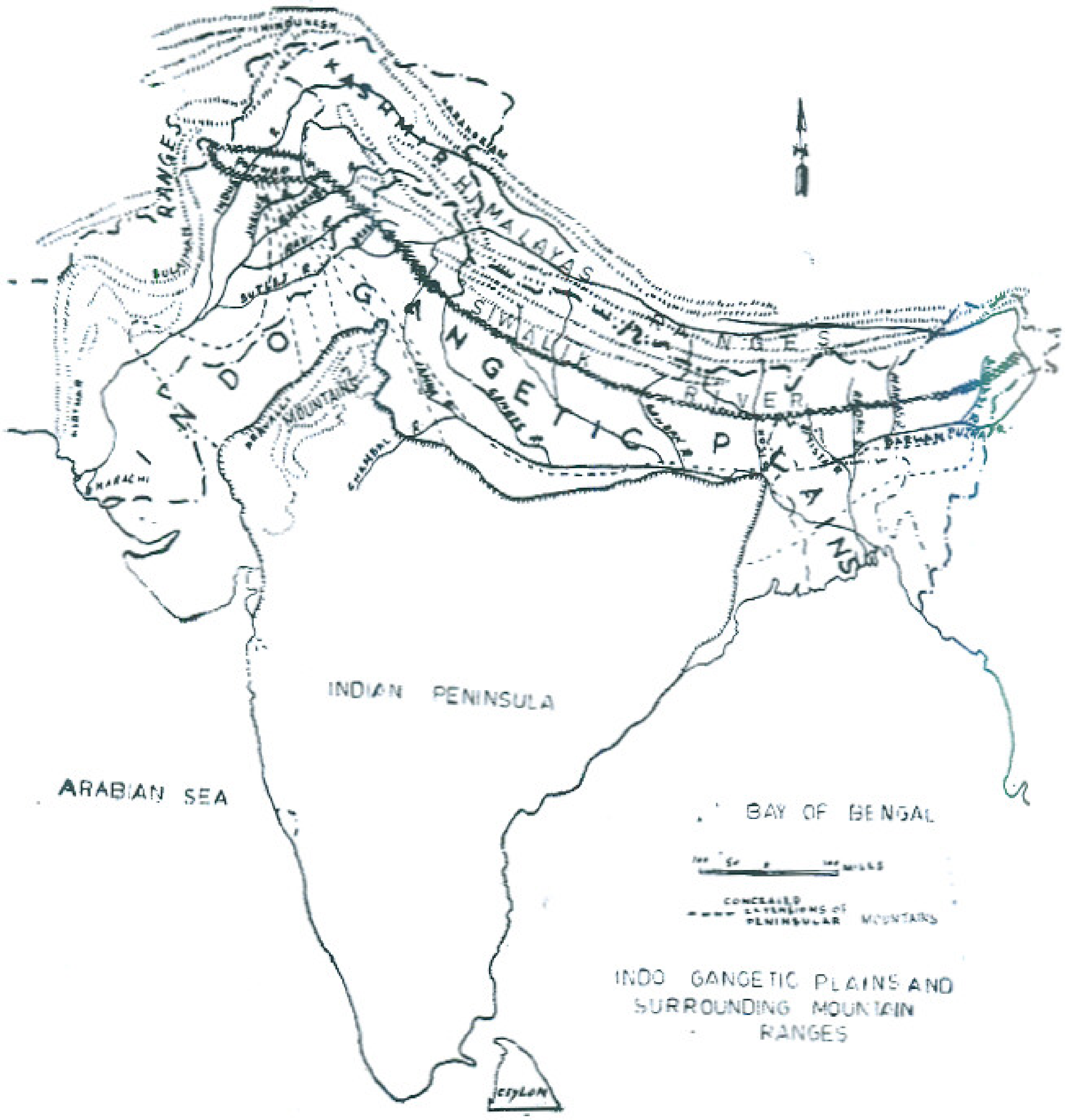


Fig. 1

The Siwalik Splits Up

Geological changes upset the flow of the Siwalik river. It was split up into many small streams, so that rivers like Indus, Ganges, Gandak, Kosi, Tista and Brahmaputra were born. Thousands of years ago the Ganges, Jumna, Sutlej and the Indus formed a combined lower valley and the water flowed through this valley into the Arabian Sea. A possible path of the flow of these rivers flanked by Aravalli mountains on the East and the Sulaiman ranges on the West was as exhibited in Fig. 2.

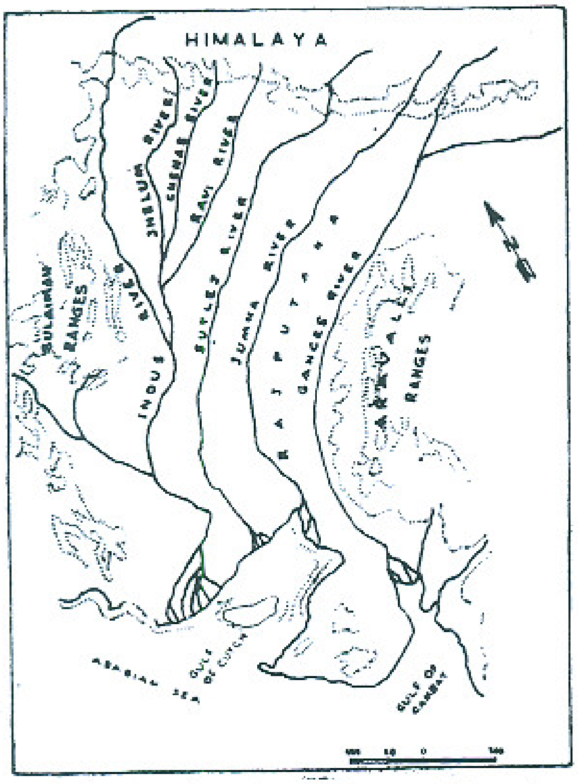


Fig. 2. Rivers Ganges, Jumna, Indus etc., flowed to the Arabian Sea.

It is sometimes believed that in the Geological past, the Brahmaputra and the Indus formed a single river flowing westward into the Arabian Sea. This presumption is on the basis of tremendous gorges which the Indus cuts through the Himalayas. Such gorges could only be formed by the flow of a much larger volume of water than that carried by the Indus.

The river divisions have been created, geologically speaking, a very short time ago when the last rise of the Himalayas took place.

Jumna and Ganges Change Flow Directions

As depicted in Fig. 2, the Ganges and the Jumna were independent rivers and carried their waters to the Arabian Sea.[2,3] After some geological change or as a result of deposition of the alluvium in the Punjab and Rajputana, the Ganges and the Jumna changed their courses and started to flow to the Bay of Bengal.

The severed and dismembered Siwalik river split up into Karnali, Gandak, Kosi etc.; all became tributaries of the modern Ganges.

The old course of the Jumna flowing through Eastern Punjab (India) and Rajputana is still in existence as an insignificant stream which loses itself in the sands of the Bikaner desert.

The Jumna is probably the sacred Saraswati of the Hindu Shastras in Vedic times when this river and the Sutlej flowed independently into the Rann of Cutch.

An old river bed exists between Ambala and Bathinda and then from Bikaner to Bahawalpur on to Sind nearly 600 miles in length. It may probably be the old bed of the Saraswati. It is now named as Hakra or Ghagger river.

Birth of Modern River System

The rise of Potwar into a plateau converted the North-West section of the main rivers into a separate independent drainage basin with the Sutlej forming the most

Easterly tributary. Hitherto the main river had travelled to its confluence with the Indus along a track which was a North-Western prolongation of the present course of the Jumna, thence via the present bed of the Soan to the Indus.

The Punjab portions of the present Jhelum, Chenab, Ravi, Beas and Sutlej rivers originated after the uplift of the topmost stage of the Siwalik system and subsequent to the severance of the Indus from the Ganges. The Potwar plateau building movements could not but have rejuvenated the small riverlets of the Southern Punjab, which until then were discharging into the lower Indus. The vigorous erosion resulting from this impetus enabled small streams to combine one after another and ultimately, the head waters joining together as important torrents descending from the mountains. These torrents grew in volume and formed the present five rivers of the province, having their sources in the snows of the Great Himalaya Ranges and deriving their waters from as far East as the Manasarowar lake on the Kailas Ranges. The Western portion of the broad but now deserted channel of the main river is occupied today by the small insignificant stream called the Soan. This river is quite out of proportion with its vast drainage area and the enormous extent of the alluvium deposited in its basin.

Recent shifting of the Punjab rivers

The great rivers of the Punjab have frequently shifted their channels. Very recently in the time of Akbar the Great, the Chenab and the Jhelum joined the Indus at Uch, instead of at Mithankot, which lies 60 miles downstream. In those days Multan was situated on the Ravi. It is now 36 miles from the confluence of that river with the Chenab. One hundred seventy-five years ago the Beas suddenly deserted its old bed and joined up with the Sutlej near Ferozepore several hundred miles upstream. One can still follow the flow path of the Beas between Sahiwal and Multan.

It is said that at the time of Alexander, the Indus flowed more than 80 miles to the East of its present course. It deserted its old bed which is now dry. It used to flow into the Rann of Cutch, which was then a gulf of the Arabian Sea. The Indus movement towards the West is much pronounced. Different causes have been attributed to it.

The present dry bed of a river to the East of Sind, known as the Eastern Nara, is either the old bed of the Indus, or most probably the channel of the Sind portion of the Sutlej after the river had deserted it.

The famous cities of Mohenjo Daro, situated on the Indus in Sind, and Harappa on one of its tributary in the Punjab, were probably abandoned at a much earlier date due to the vagaries of the shifting rivers and also due to their recurring flood deposits, which finally buried them.

Depth of the Alluvium

The depth of the bed rocks within the plains of the Indus or the Ganges has not been exactly mapped. At places it was considered to be as deep as 15,000 to 20,000 feet. In the Punjab, as already mentioned, out crops of rocks similar to those existing at Delhi and the Aravalli hills, are in existence. These are suddenly found rising up in the flat plains. In 1952 when the investigations into the causes of waterlogging in the Indus plains were being undertaken, some of the authorities attributed one of the causes of waterlogging to the existence of subterranean mountains.

An attempt was made by the Irrigation Research Institute, in 1928 to 1930, to map the depth of location of the subterranean rocks existing in the Punjab plains. In those days Etövös Balance (Fig. 3.) had

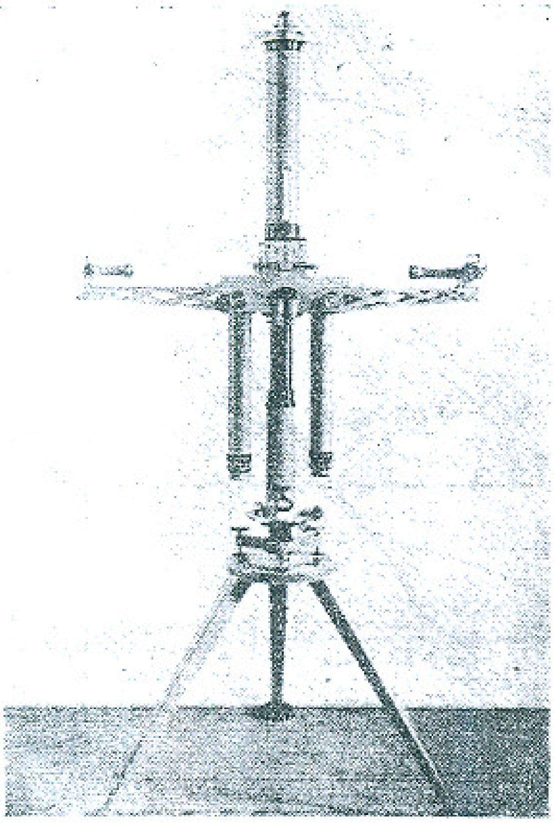


Fig. 3. Etövös Balance used by Bose of Gravity Survey

been developed which recorded changes in he gravity of underground formations and thus gave an idea of the depth of the subterranean rock. Dr. Bose[4] used this balance. He followed the paths as shown in Fig. 4. It was more or less along the line of out-crops. He observed several cross sections as marked in Fig. 4. Only three of these along AA,′ II′ and FF′ are plotted in Figs. 5, a, b & c, exhibiting the depth of the alluvium existing over the bed rocks which just at the point of the out-crops suddenly dips steeply to a great depth. At Chiniot where the Chenab flows through the two gorges, the bed rock in the wide gorge was found 300 to 400 feet below the surface.

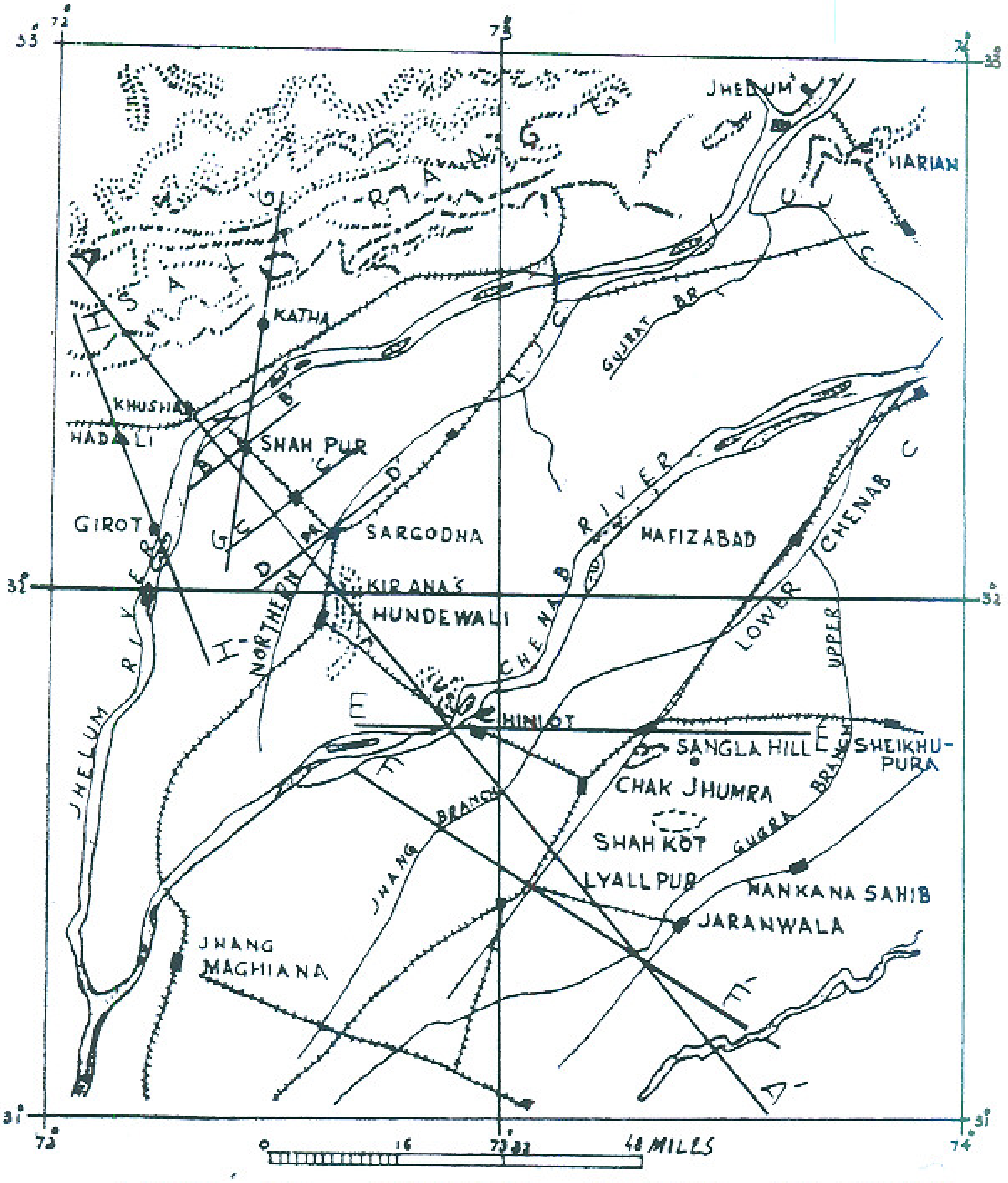
At many places over the so-called ridge of the buried mountain alluvium, deposit between 1000 to 2000 feet thick exists.

In the section II′ across the ridge, it dips fairly steep.

At that time no confirmation of the bed rock was carried out by actual borings. Only recently WAPDA[5] conducted boring tests to confirm the existence of the rock formation. The bores were carried down till the rock was struck. In Fig. 6 the depth contours of the bed rock are plotted after Kidwai.[5] The depth of bed rock along two cross sections is shown in Figs. 7 and 8.

A study of these figures shows that even adjacent to the out-crops, the rock has a steep dip. Across the ridge, the depth of rock is very much deeper.

These investigations have not only given an idea of the alluvium deposited in the Indus Plains but have also cleared the conception that the existence of subterranenan rocks was not a cause of waterlogging in West Pakistan. Previously it has been the conception of many geologists including Glenny,[6] Superintendent Geologist of Indo-Pakistan, that the ridge was one of the causes for the water-logging of the Indus Plains. Karpov in his recent paper[3] was of the same view, but the studies carried out in the Irrigation Research Institute[7] on the basis of rate of rise of watertable, nature of accumulation of water in the formation both upstream and down-stream of the ridge, etc., have not



LINE OF GRAVITY SURVEY FOLLOWED BY BOSE

Fig. 4
MAP OF RECHNA AND CHAJ DOABS

RECHNA — DOAB
SUB-TERRANEAN CROSS SECTION ALONG AA

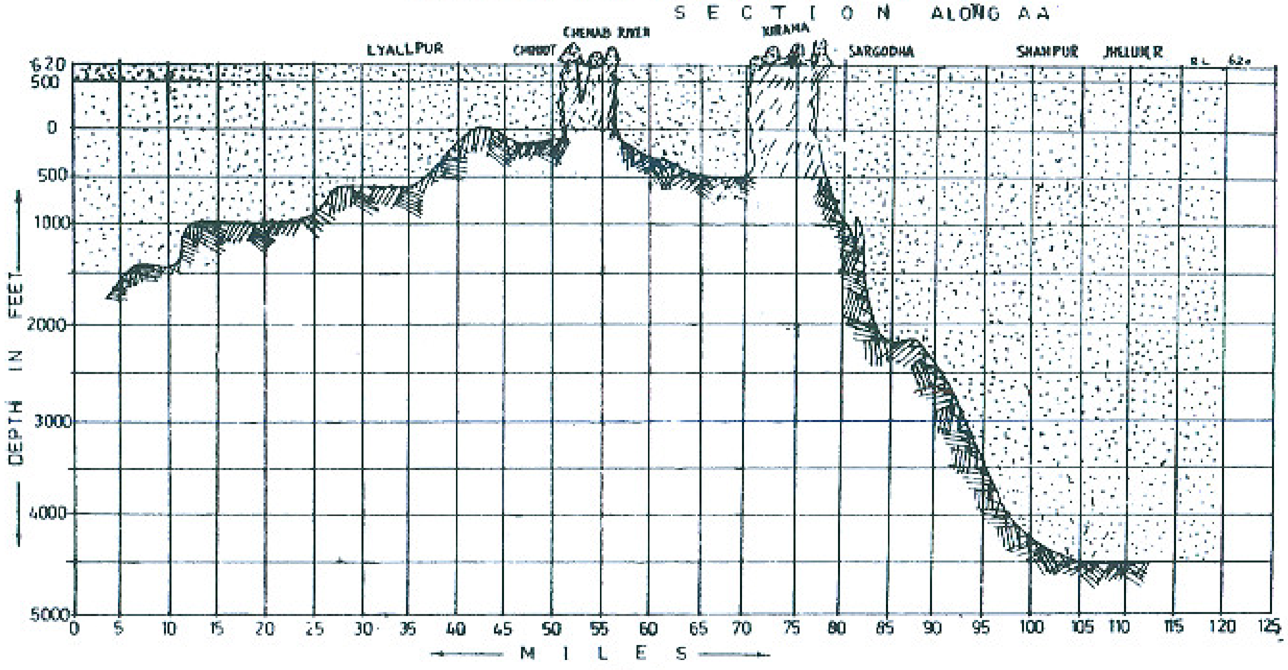


Fig. 5-a

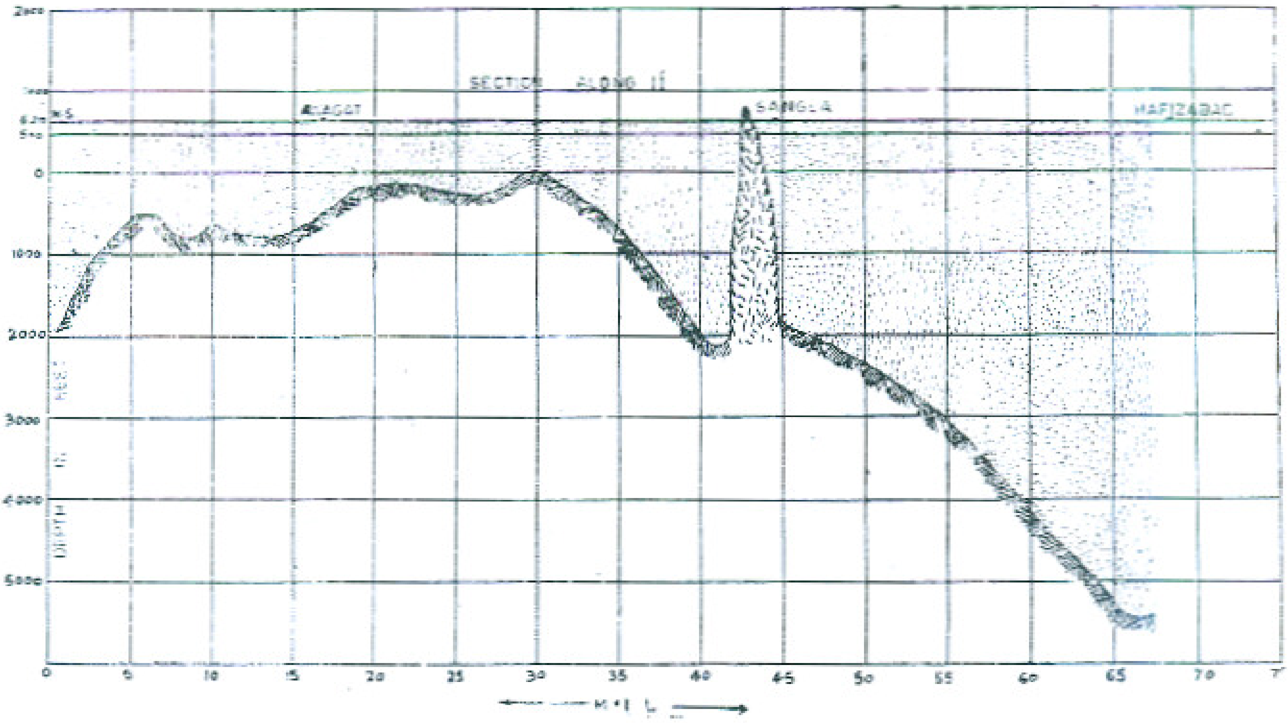

SECTION ALONG II'
SANGLA
HAFIZABAD
2000
0
1000
2000
3000
4000
5000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
MILES

Fig. 5-b

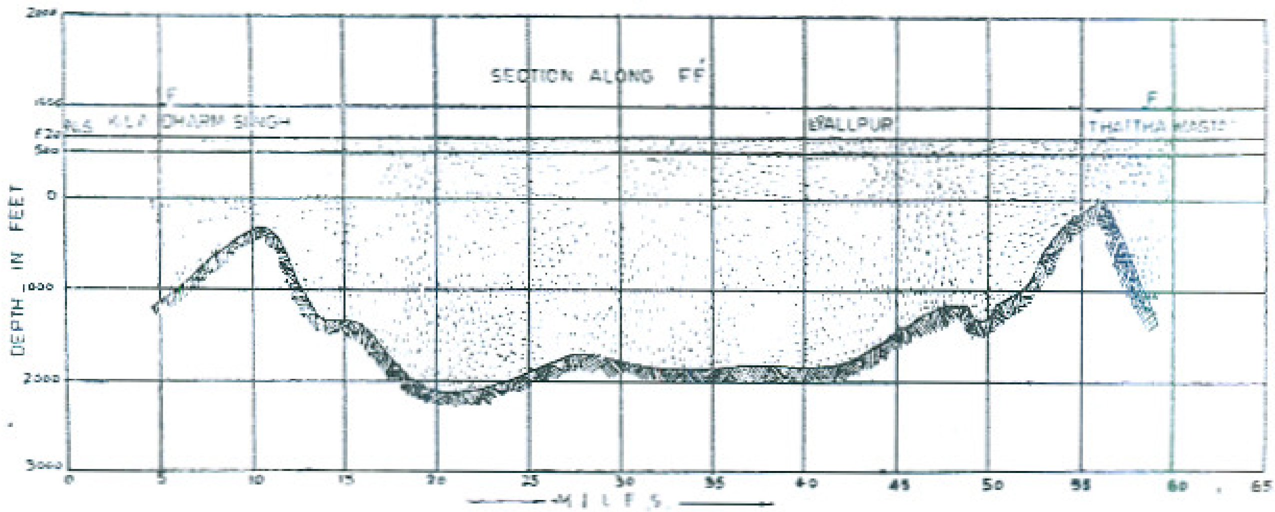
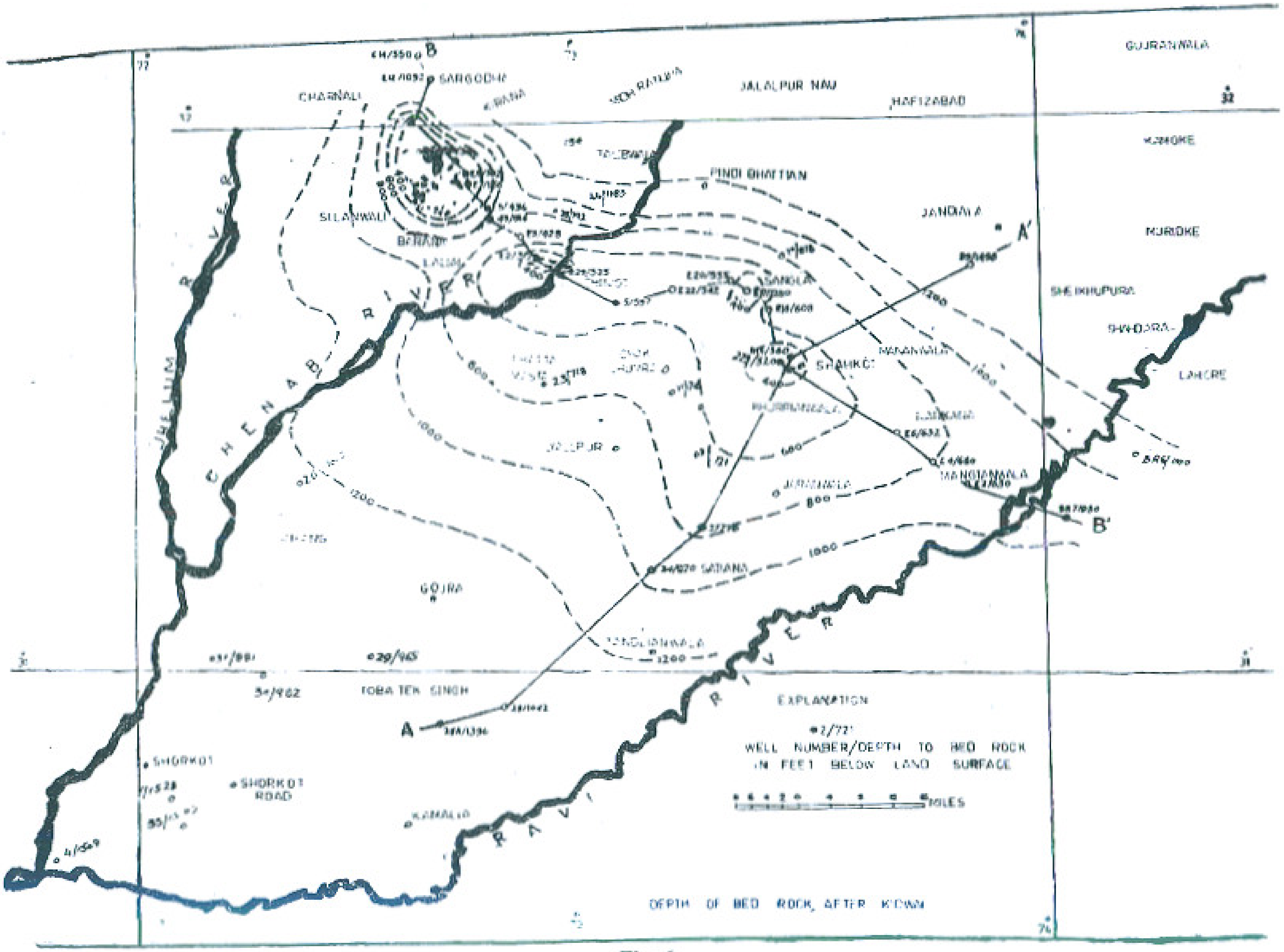

SECTION ALONG FF'
DHARM SINGH
THATTHA
F
F
DEPTH IN FEET
0
1000
2000
3000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
MILES

Fig. 5-c


GUJRANWALA
JALALPUR NAU
HAFIZABAD
SARGODHA
CHARNALI
SILANWALI
PINDI BHATTIAN
JANDIALA
A'
B
B'
A
KAMOKE
MURIDKE
SHEIKHUPURA
SHAHDARA
LAHORE
SHAHKOT
SANGLA
MANANWALA
MANGTANWALA
SATIANA
GOJRA
TOBA TEK SINGH
SHORKOT
SHORKOT ROAD
KAMALIA
CHENAB RIVER
JHELUM RIVER
RAVI RIVER
EXPLANATION
WELL NUMBER/DEPTH TO BED ROCK IN FEET BELOW LAND SURFACE
MILES
DEPTH OF BED ROCK, AFTER KIDWAI
Fig. 6

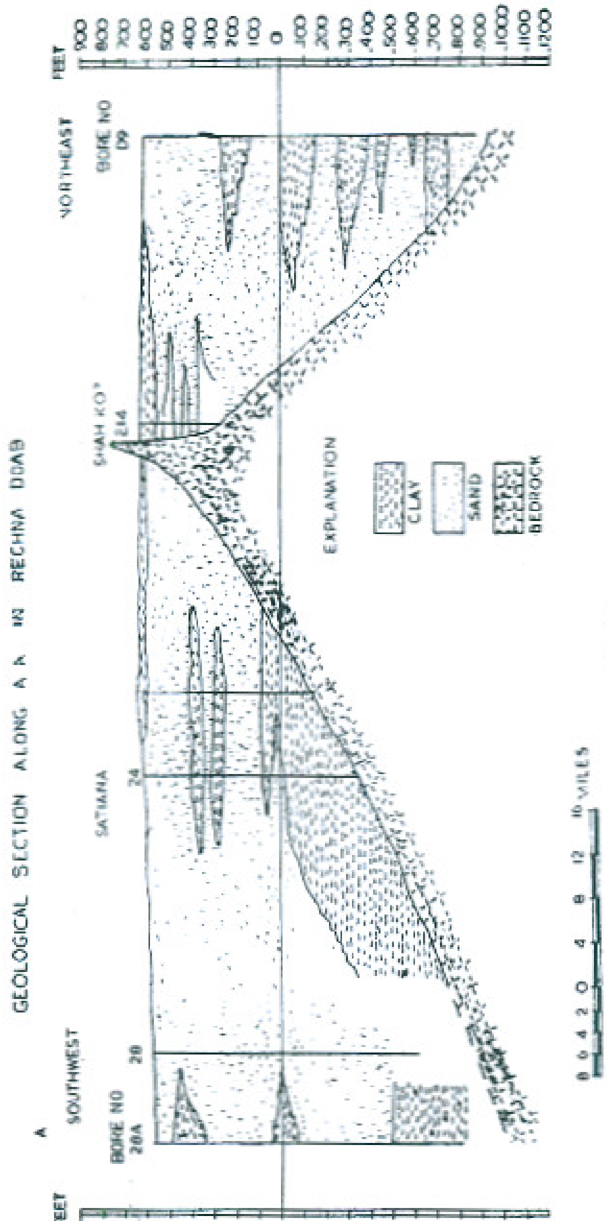


Fig. 7

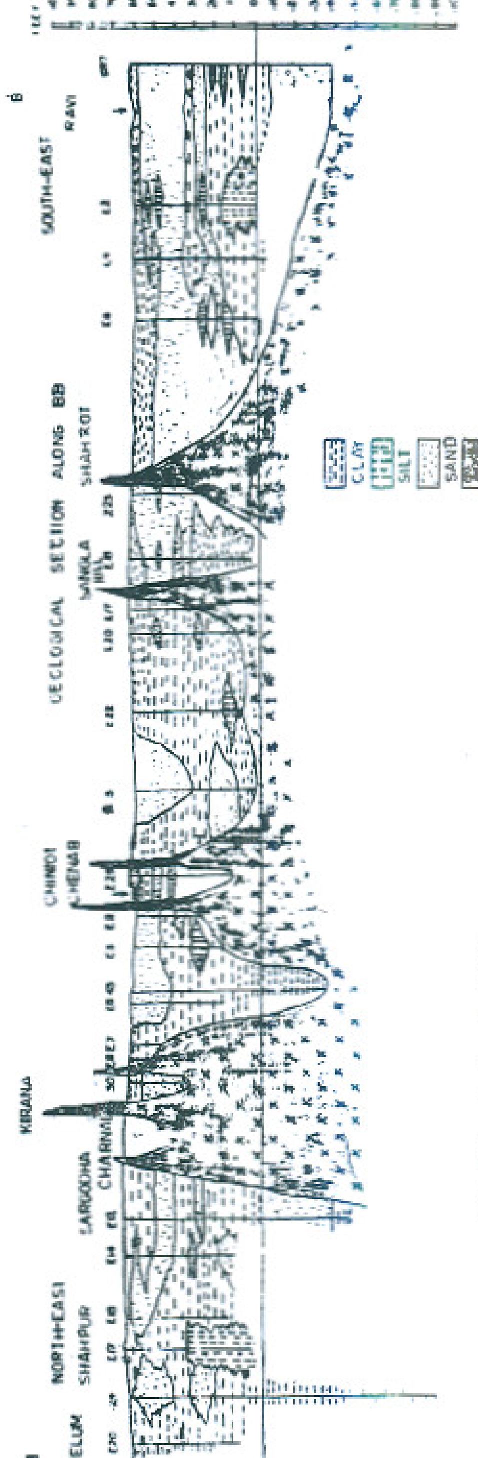


Fig. 8. Geological Section along B B !

supported the conception. In fact the existence of considerable deep alluvium in between the protuding rocks has a sufficient opening for the upper water to move into the lower regions. Kidwai[5] has also arrived at the same conclusions.

Groundwater Regions of West Pakistan

From the point of view of the availability of groundwater, West Pakistan can be divided into two main regions, the mountainous areas of the North, upstream of the Salt Range which includes the plateau of Potwar, mainly on the left side of the Indus and the sub-mountainous regions of the North-West Indus right up to its delta.

The Balucnistan which is nearly 1/3 of the West Pakistan, is quite distinct from these two zones, it has complicated geological formations and its groundwater resources are very meagre and uncertain.

The Potwar Plateau

One of the important portions of the Northern groundwater region of West Pakistan is the Potwar plateau. It lies between the Himalayan foot-hills in the North-West and is bounded by the Indus in the North-East and by the salt ranges

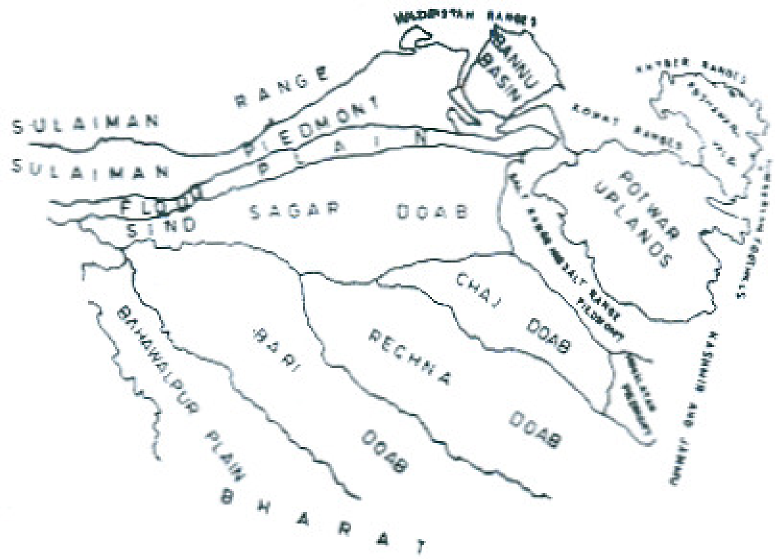


Fig. 9

at the foot of the Sulaiman ranges on the right of the Indus. These Northern areas are illustrated in Fig. 9.

The second region of West Pakistan from the point of view of groundwater lies below the salt range and includes the present irrigated flat alluvium plains of the on the South.

Just adjacent to the North of the salt range lies the Soan Valley followed by Rawalpindi plateau. North of Rawalpindi are the districts of Campbellpur and Haripur Hazara. In Fig. 10, the location of these areas is shown which possess complicated

POTWAR UPLANDS

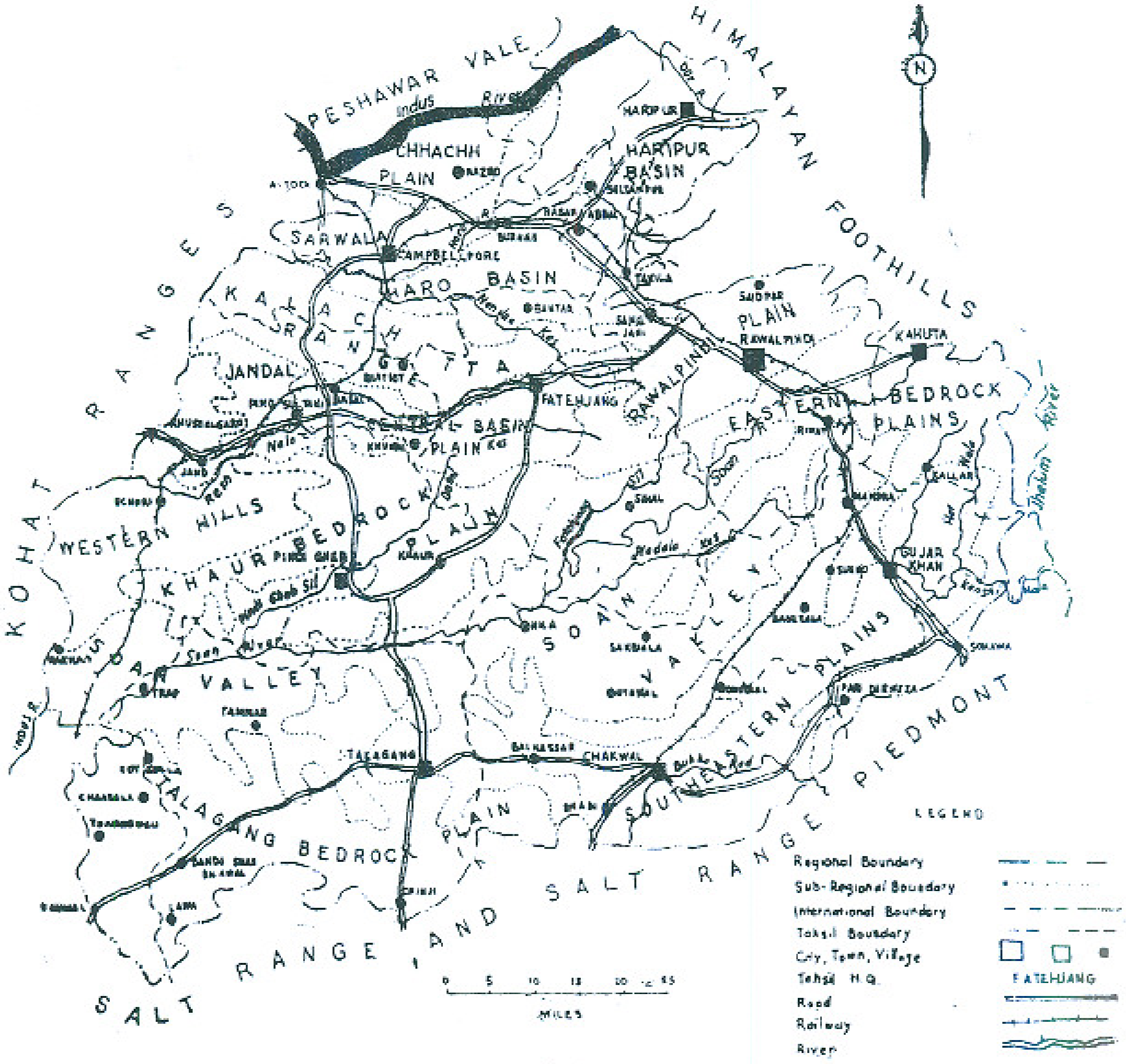


Fig. 10

geological formations with alluvial and loessial deposit, intermixed with stony and mountainous rocks. The land is most highly eroded and dissected, with small level alluvial plains and some sandy patches.

The Harrow is a small stream separated from the Soan Valley by small hilly ranges of Kalachitta which thrusts across the land towards Rawalpindi.

The underground formation of the Districts of Campbellpur and Haripur is highly complicated and is a remnant of alluvium which includes shingles and gravel beds transported by the geological rivers including the Siwalik. The shingles and stone beds are often covered by thick clay formations quite impervious to the infiltration of water. The top soil is highly eroded and is full of deep gullies which have been cut through by the rushing rain water. Out-crops of lime stones are found and so are the rocks of shale and sand stones. The slope of landscape is steep, so that the annual rain water, about 30 inches a year, runs through the gullies without infiltrating into the underground formation. The few small streams like Harrow, Siran, Daur and their tributaries have all shingle beds and at places overlying clay formations. The flow of these deep channels is insignificant except during summer rainfall periods. Some of the old shingle beds contain seeped water and is a source which can be exploited. These streams do not add much water to the adjoining lands. Whatever small quantity of water infiltrates during high stages, returns back into the deep streams at low stages of the rivers. The ground water often lies at deep depths. It has no regular addition of surface recharge. It is the seeped water which has accumulated in shingle & sand beds. At places the formations are found to be devoid of water. Probably the top clay layers are sufficiently thick and allow little seepage. The Indus although fairly big, is not a significant feeding source. The land along with its banks has steep gradients. The river flows at a deep level. The availability of ground water is thus low and at places doubtful. The water has to be lifted from great depths. The yield of tubewells is generally low. Small areas like Hazara are flat lands at the foot of low hills. These get discharge of rainfall and longer retention of surface water. Some sites even show a condition of water-logging. Large number of shallow open wells also exist in this area.

At some places it is expected that tube-wells will be successful. The area, however, needs detailed geological investigations before one can be sure about the availability of sufficient quantity of good quality water for irrigation by tubewells.

The Soan Valley

The valley has the largest areas of eroded lands. Innumerable riverlets, which are generally tributaries of the Soan, carry away the eroded soil with the rushing rain water. Insignificant valley storage also gets regenerated back into the riverlets. In the upper reaches the erosion has exposed the rock beds. In the lower portions of the Valley heavy thick clays are encountered which permit very little infiltration from the top. Some pockets of sand do exist which store small volume of seeped water sufficient to be lifted by a Persian wheel. This source is rather small for lift irrigation by tubewells.