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ENGINEERING NEWS

Quarterly Journal of the West Pakistan Engineering Congress

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TITLE COVER

A view of Memorial of Pakistan Resolution (1940) – *a symbol of Pakistan Idealogy*

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THE DIALOGUE STARTS

President Zulfiqar Ali Bhutto addressed some three hundred Engineers from all over West Pakistan on 13th February, 1972* in the Darbar Hall of Governor's House at Lahore. It definitely represents the beginning of a new chapter of harmonious relationship between the Government of the day on one hand and the Engineering Community on the other. The President was candid and forthright in his speech. He spoke of pleasant things and also of unpleasant. He spotlighted the importance of Engineers in the execution of development plans and expressed his Government's determination to embark upon a huge Public Works Development programme wherein the engineers will be called up to play their full role. This was most heartening and welcome. The importance of the function did not lie in what had been specifically said or was intentionally left unsaid, but in the very fact that a dialogue has been started by the top man of the State with the Engineering Community which have grievances of maltreatment at the hands of vested overlords and is an exploited class inasmuch as it had never been allowed to play its full role in the reconstruction of society. To that extent there is a kinship between the engineers and the new masters of nation's destiny who are the champions of the cause of oppressed and exploited.

The President reminded the engineers of their position of responsibility and of his expectations from them in respect of conducting themselves as a disciplined group; never resorting to such agitational tactics as may be common to labour class. It is so kind of the President to have assigned in his thinking a position of respectability to the engineers. The engineers themselves are deeply conscious of this exacting demand on their conduct. In spite of this if they had to resort to such measures as 'unworthy' of an educated and disciplined group, there must be certain compelling reasons for that. The breaking point on their patience would not have come but for unbearable frustration. They could not have treaded the path of 'lawlessness', if not driven in desparation to that : who does not know how their hearts were bleeding and how painful was the journey from the Irrigation Secretariat to Assembly Chambers exactly three years ago on the same 13th February as the President was graciously addressing them in 1972? Were the engineers only worthy of marching in protest on the roads? Has the decadence of this society

*Due to uncertain conditions in the country Dec. 1971 issue of the Journal could not be published in time. The delay is regretted.—*Editor*.

gone to that limit that it has nothing better to offer to the builders of nation except to be exposed to ridicule and humiliation. No one knows better than the President himself as to how agonizing it is to feel one's creative ability not being allowed to play its full role when it is desperately needed to save a worsening situation. He himself has lived with such situations and therefore none else is better placed to appreciate the agony and the suffering in the mind of engineers who watch helplessly the path of the Pakistan's progress being blocked because the groups of creative ability with engineers in the vanguard are not freed from the overlordship of vested class and not allowed to play their full role.

The President talked of corruption amongst engineers and also of internal bickerings and rivalries of the serving engineers. Corruption is a malady which is eating the very vitals of our society. Every one of us must hang down his head in shame that in some way or other it is putting up with a corrupt system. But according to the President's own manifesto it is the present socio-economic system which is breeding corruption. The thread of corruption is running throughout the fabric of society. The engineers are not more corrupt than the society at large. Does this constitute sufficient reason to deny the engineers the rightful role in the reconstruction of society? The President knows fully well that the vested interest class in order to sustain its overlordship deploys such diversionary tactics. Was it not the lot of a despised dictator of our country to have banned all the political activity because he charged the politicians to be corrupt? Some of the politicians did indulge in corrupt practices, but did the nation and the President himself accepted the philosophy of denying the politicians their rightful role? The President owes his present position in having defied this obnoxious logic of a dictator. He launched a heroic struggle to let the politicians come to full play. We are certain that the President will soon see through the hollowness of this argument. No group can be condemned as a whole for the failure of some individuals. The rightful role of each group must be restored to them and the corruption is to be ruthlessly curbed by changing the present system which is breeding pathological, love for money and worldly belongings and permits of unethical measures to plunder and appropriate the fruit of somebody else's labour.

The engineers do not want to deceive themselves into an attitude of self-righteousness. The corruption is enemy number one and must be eliminated. Mutual Conflicts and rivalries are there and have to be transformed into mutual cooperation and democratism. That is why the engineers demand a self-correcting institutional arrangement in the form of Engineering Council. The engineers will definitely have exercise in self-criticism but the present overlords of service hierarchy must know that they are not more pious than the engineers. They are definitely no less sinners and therefore have earned no right to throw the first stone on the engineers.

The nation is passing through the most perilous crisis of its existence. Its very existence is at stake. The need of the hour is to let the forces of construction emerge at the top and given full opportunity to rebuild the damaged fibre of the nation. The engineers, the scientists, the technologists, the professionals are the hope of future. They are to build and let them build the new system.

West Pakistan Engineering Congress Council, 1971-72

In the last issue of this journal, the biographic sketches of the President, Secretary and two of the Vice-Presidents were published. Some of the remaining office-bearers are introduced in this issue.

VICE-PRESIDENTS

BIODATA OF ENGR. M. S. KHAN, *Vice-President, West Pakistan Engineering Congress, Lahore.*

Engr. Khan acquired his degree in Electrical & Mechanical Engineering in 1957 from the Karachi University. He was awarded University Gold Medal by President Field Marshal Ayub Khan for standing first class first throughout the four engineering examinations. He did his Bachelor of Science in 1954.

He underwent his graduate apprenticeship in fabrication of ships and heavy steel structures and in the manufacture of Diesel Engines at the Karachi Shipyard and Engineering Works Ltd., for two years and worked as Assistant Mechanical Engineer, in charge of Engine Manufacture for another year.

Engr. Khan was selected by the Ministry of Education, Government of Pakistan for Hawker Siddeley Industries Scholarship in 1960 for training in England. He underwent industrial training in the manufacture of Diesel Engines at the works of Mirrlees Nationals Ltd., U.K. for one year and at Brush Electrical Engineering Co. Ltd., of Loughborough, England for another year in the manufacture of electric motors, generators, transformers and switch-gear.

On return from England, Engr. Khan joined as Production Manager of M/s. Brush-Rahman Ltd. in which capacity he planned, constructed and commissioned their electric motor manufacturing factory at Lahore. In 1965 he was promoted as General Manager of the Company in which capacity he is working to date.

Mr. Khan is the President of the Pakistan Association of Electrical and Mechanical Engineers who have been the torch-bearers

of the engineers' struggle for professional management. He is also the Secretary of the Federation of Engineering Associations which represents more than 12 engineering associations of the country.

Mr. ISMAIL ALI SHAH

Born at Lahore on the 15th May, 1919. Was selected on the basis of All India Written Competitive Examination for Admission (15 seats) to the Punjab College of Engineering and Technology (Elect. & Mech.) in 1937. Proceeded to England and obtained B.Sc. in Civil Engineering from Bristol University in 1941. Passed the A.M.I.C.E. (London) Examination in 1953 and later was elected Member of the Institution of Civil Engineering in 1960. Became fellow F.I.C.E. since 1969. Did Post-Graduate course in Building material, Techniques and Research (Manchester University). Post-Graduate Course in Building site management and Control (Manchester University) under Colombo Plan in 1966/67. Post-graduate course in Planning for Development from the Institute of Economic Development Karachi. Advanced Course in Administration at the Pakistan Administration Staff College, Lahore 19th Session (1969).

PROFESSIONAL CAREER :

Assistant Engineer with M/s Perkins & Sons of Bristol. On return to India joined Punjab Public Works Department in 1942 as an Assistant Engineer : After that he was appointed Lecturer in Civil Engineering and in charge of Special R. C. Construction, including Bow String Girders of 76′ span tackled for the first time at the Rasul School of Engineering. Promoted Executive Engineer in February 1948. Planned, surveyed, and prepared the Scheme of the Thal Roads consisting of 650 miles at a cost of 2½ crores Project—for the Rehabilitation of Refugees; work of tremendous responsibility in most trying conditions immediately on Independence, in addition to 600 miles of other Roads in the Province costing Rs. 2 crores. As Executive Engineer Planning and Design P.W.D. (B & R) Secretariat, he worked for some time as Assistant Professor at the Punjab College of Engineering and Technology, Lahore. At Lyallpur as Executive Engineer he got constructed 3000 tons food storage Bins and Godowns in a record time. Then became Under Secretary Roads and later Establishment, in the Punjab (B & R) Deptt. In West Pakistan worked as Design Officer, Technical Officer and Acting Consulting Architect in Central zone, Lahore. Promoted Superintending Engineer in 1957, and posted at Hyderabad where the scheme of 2 crores Liaquat Medical College and Hospital Project, Jamshoro along with 15 lacs one Unit offices were tackled.

Thereafter appointed Director Works Research and Co-ordination in Chief Engineer, West Pakistan office in 1958 as a Principal Staff Officer, 105 crores 2nd five year Road Development Plan of B & R. Department was proposed. Scrutiny for Technical sanction to crores worth of schemes of both Building and Roads Budget was his responsibility. As Chief Engineer, Lahore Municipal, Corporation in 1960 prepared 15 crores Master Plan for Water Supply, Severage and Roads for the Metropolitan city of Lahore. On return to Parent Department

in 1962, was appointed Director Education Buildings Design Centre where standardised Plans for Primary, Middle and High Schools were prepared for the five regions of West Pakistan according to geographical, climatical and topographical conditions in cooperation with the U.S. Aid, an International venture. Appointed Project Director, Health and Agriculture Departments in 1963, where Projects of Hospitals in District Headquarters were dealt with along with the works at the Ayub Agriculture Research Institute (through Consultants). Appointed Chief of Housing and Transport in the P & D in 1966.

Appointed Director-General West Pakistan Housing and Settlement Agency in March 1967 dealing with schemes of all Satelite Towns in West Pakistan and the Township scheme of Lahore.

Promoted Chief Engineer Buildings central zone in October 1967. Huge programme of District Headquarters Hospital, Food Storage Godowns, Schools and Colleges etc. was successfully carried out. Transferred as Chief Engineer Buildings, Bahawalpur in April, 1970. There in addition to the normal Projects, the project of Quaid-e-Azam Medical College at Bahawalpur was tackled at the Highest Priority. Starting from scratch the scheme was prepared within a period of two months, got cleared from P.D.W.P and C.D.W.P. and also made temporary arrangements to start the classes within a period of two months as directed by the Governor. The Project is now going on in full swing at an Estimated Cost of 4.25 crores. He has earned public appreciations of his work at every stage of his service including that of the Government. Now transferred and posted as Chief Engineer Punjab Buildings Department at Lahore from 17-12-71.

HONORARY BUSINESS MANAGER

ASHFAQ AHMAD QURESHI

Born in East Punjab on 10th May, 1933 and got Engineering Degree from Karachi University in 1956. Joined B & R Department, West Pakistan in 1957. From the beginning remained posted on Major Construction works and contributed towards the completion of Lahore Stadium where he worked as a Sub-Divisional Officer for about two years and then as Executive Engineer for another two years. After promotion in 1963 he completed numerous major building projects of importance and lately, the Liaquat Memorial Hall at Rawalpindi. The President of Pakistan has greatly admired the work done while performing the opening ceremony. During 1965 War Mr. Qureshi rendered most valuable services while posted at Lahore and his name was recommended for Civil Award.

HONORARY PUBLICITY SECRETARY

SH. NISAR-UL-HAQUE

Sh. Nisar-ul-Haque Director, Machinery Pool Organization, Wapda, was elected Honorary Publicity Secretary.

Graduate of Mechanical Engineering from Punjab, College of Engineering and Technology,

Lahore (1947-50), Mr. Nisar-ul-Haque did his Intermediate and Final Certificate in Industrial Administration from College of Technology, Manchestor, U.K. in 1951-54.

He joined as Assistant Shop Manager, Pakistan Ordnance Factory, Wah Cantt in 1956, till 1958 from where he joined Water and Power Development authority. In 1960 he was made workshop officer M. P. O., Lyallpur, where all types of heavy machinery for field works are maintained, there he was also responsible for organising the workshop with the Consultants M/s Morrison Knudson Ltd., of U.S.A. On promotion from workshop officer, in 1961 to area Superintendent M. P. O., Lyallpur, he was made incharge of whole zone. In 1962 he was selected as Assistant General Manager M.P.O. Wapda, where he was having administrative control of the Warehouses, and assisted General Manager in Engineering and Technical matters. In 1965 Mr. Shaikh was assigned the post of Manager, Warehouses till 1968, when he was appointed Director M.P.O. Wapda, Lahore. Mr. Nisar-ul-Haque has a very brilliant academic career and has a lot of distinctions and awards at his credit. During his active service, he has written and published papers on his concerned profession.

He is a council member of Institute of Engineers, Pakistan, and remained Vice-President of Wapda Engineers Association from 1964-68 and President from 1968-71.

Now he is serving the cause of West Pakistan Engineering Congress as Publicity Secretary.

HONORARY AUDITOR

MR. ANWAR H. REHMAN

Mr. Anwar H. Rehman graduated from the University of Panjab in 1939 and from the Institute of Engineers (India) in 1943. Joined Bahawalpur Irrigation Department in September 1943 as Assistant Engineer and moved over to Punjab Irrigation Department in December 1945. His first assignment in Punjab was as Sub-Divisional Officer Sidhnai H/Works Sub Division of Haveli Canal Circle. Later he was in charge of Construction of Thal Canal (main line lower). In early 1951 he was promoted as Executive Engineer and worked on various assignments. In 1960, he worked as Assistant, Director, Drainage and Planning in the office of W. Pakistan Chief Engineer. In 1962 he was deputed on training in Public Administration, (NIPA Lahore).

In 1964, he was promoted as Superintending Engineer Kalat Circle and was responsible for the Planning and Construction of various Irrigation Schemes in Baluchistan area. In 1966 he took over Upper Chenab Canal Circle and in 1967 was posted as Deputy Secretary (Technical) in the Office of Secretary Irrigation and Power.

In 1968 he went to U.S.A. on U.N. Fellowship Scholarship in Hydrology and was attached to Bureau of Reclamation, Denver Colorado for training. During his stay with the Bureau of Reclamation he specialised in Flood Hydrology and Sedimentation and later attended a course on Hydrology arranged by the U.S. Geological Survey Department at the University of Arizana Tucson. During his stay in U.S.A., he visited a large number of Irrigation Works constructed by the Bureau of Reclamation, such as Boulder Dam, Imperial Valley Dam, Grand Coulie Dam and many small Dams and Irrigation systems.

On return from abroad he took over Depalpur Canal Circle at Lahore. In early 1971 he joined Governor's Complaint Cell as Deputy Secretary Technical, from where he was posted as S. E. Upper Jhelum Canal.

Seminar on "Engineers and Solution of Economic Problems of Pakistan"

OCTOBER, 18-20, 1971

PRESIDENTIAL ADDRESS

By **MR. I. A. S. BOKHARI**

Member (Power) WAPDA and President, West Pakistan Engineering Congress

A mid-session Seminar was organized by the West Pakistan Engineering Congress, Lahore in the Hotel Intercontinental from 18—20 *Oct.*, 1971. *The Session was inaugurated by Sh. Ahmad Hasan, Vice-Chancellor, University of Engineering and Technology, Lahore on* 18 *Oct.*, 1971. *The proceedings of the Seminar are covered in this issue of Engineering News for the benefit of readers and fellow Engineers.*

Mr. Ahmad Hassan, distinguished Guests and Members of the West Pakistan Engineering Congress—

The presence of an eminent engineer of the calibre of Mr. Ahmad Hassan would be an honour for any professional gathering and this one is no exception. His being here today as our Chief Guest is an indication not only of our profound regard for his eminence but also of his continued interest in the national professional problems. It is my privilege today to welcome him along with other distinguished guests, on behalf of the Congress and on my own behalf.

High engineering appointments in the country have been held by Mr. Ahmad Hassan. Introducing a Chief Guest of such national fame is no more than a mere formality. The great majority of us who have gathered here today know that he has devoted his entire life in ennobling the engineering profession. His selfless devotion and zeal finally resulted in his well deserved elevation to the post of Secretary, Irrigation and Power, Government of West Pakistan. His present service to the Nation is in the capacity of Vice-Chancellor of West Pakistan University of Engineering & Technology where his maturity and experience provides the necessary invigorating influence on the creation of new generation of engineers.

As you are aware, the Engineering Congress, which was established nearly 60 years ago in 1912, has all through its existence been effective and versatile forum, dedicated to the promotion of science, profession and practice of engineering. It has always attracted eminent engineers of different specialities to read papers on chosen professional problems and exchange of technical views. This method of dissemination of knowledge has served the engineering profession very effectively during the past half a century. With the responsibility of National development, which the engineer of today is required to shoulder, a more frequent exchange of views has become necessary.

Heretofore the holding of such seminars was an annual feature and that too at the time of annual meetings. The rapidity with which the technological values are changing coupled with the ever-increasing responsibility of the engineer to discharge his nation-building role in keeping with economic

justification warrant that the seminars be held more frequently so that latest technical know-how becomes available to the practising engineers. These considerations have largely been instrumental in organizing this mid-session seminar and I hope the practice would continue.

The complexities of engineering problems with the stress on specialisation in different fields are ever on the increase and the problems being tackled and solved by engineers of the country remain in polarised isolation on account of geographical and departmental boundaries. The mid-session seminar is intended to provide an opportunity for highlighting the national problems and the technologists' approach for their solution.

Ever since its creation in 1947, Pakistan has been beset by many an economic problem and its arch enemy India and their friends hopefully thought that our existence as a free Nation would be shortlived. That Pakistan has come to stay and is growing stronger year by year is in no small measure attributable to the untiring efforts of the engineers who worked against many formidable odds.

In the face of renewed naked hostilities by India and the backing of its nefarious activities by some other countries, our duty today is no less onerous than what it was 24 years ago. Notwithstanding the number of achievements to our credit during this period, our nation-building role has barely begun to be recognised and greater contribution is now expected of us. Our approach has to be more sophisticated, our dedication has to be greater and above all, our knowledge must be such that economic development can proceed unhampered despite the limitations imposed by our resources.

It was with this object in view that we chose "Engineers and the Solution of Economic Problems of Pakistan" as the theme of this Seminar. The papers that are going to be presented are:—

(*a*) "Economic Problems & Pakistan". *By* Mr. M. S. Khan, General Manager, Brush Rehman, Ltd.

(*b*) "Consulting & Contracting Practices in Pakistan." *By* Mr. Monawar Ali Shah, General Manager, Computer Centre, Wapda.

(*c*) "Management of Public Enterprises." *By* Mr. Irshad Ahmad, General Manager, Planning, Development & Design, Wapda.

(*d*) "Training & Utilization of Manpower." *By* Mr. M. P. Murad, Manager, Guest Keen, Nattlefolds Ltd., Karachi.

(*e*) "Management of Private Enterprise." *By* Mr. Masud Hassan, Director, United Consultants, Ltd.

(*f*) "Engineers & Industrial Productivity." *By* Mr. Nisar-ul-Haq, Director, M. P. O., Wapda.

The first paper on "Economic Problems of Pakistan" introduces the problems currently confronting our economy, the study of which would enable the engineering community to apply itself to their solution and that is why this paper is the first to be read.

The second paper deals with the subject of "Consulting and Contracting Practices." In the course of completion of several small and big projects during the last 24 years we have accumulated a wealth of knowledge and are now in a position to improve the role played by the Consulting & Contracting agencies by a proper analysis of the practices evolved during this period with the hope that soon we shall be completely independent of foreign consulting and contracting services

thus saving a sizeable expenditure of foreign exchange.

The third paper relates to "Management of Public Enterprises." Some years ago, it was realised that public corporations would be an efficient instrument for development projects. As we all know, public corporations have now functioned in the country for more than a decade. It is now time to assess the performance of these corporations and take steps to improve them. Heretofore these corporations have been basing heavily on foreign assistance, a time has now come that we make maximum use of our own resources both in men and material. In this only the Engineers can guide the Nation and I feel sure that our engineers will live up to the Nation's expectations in this regard.

The fourth paper highlights the necessity of training and proper utilization of manpower. All organizations have to endeavour to train their employees so as to gear their performance more effectively to their requirements. The production of any enterprise and its level of efficiency are the direct attributes of properly trained personnel and nowhere is the need for this more acute than in the technological field. Unfortunately training of men has not been given the importance that it deserves. The rapid expansion in industry has necessitated inductance of a large number of fresh recruits and training has therefore assumed still greater importance. We will all agree that poor workmanship has been the biggest cause of the low standard of production. It is the duty of engineers to develop a scientific approach to this important problem.

The fifth paper brings into focus "Management of Private Enterprises." Although a lot has been done and is being done in the Public Sector, Private Sector is of greater economic importance. It, therefore, plays a pivotal role in the economic growth of the country. The expansion of private sector is dependent on capital formation which in turn depends on the efficiency of private enterprises, and this cannot be achieved unless we have sound scientific management. In the development of scientific management in this country, Engineer's contribution is of vital importance and, therefore, direct involvement of Engineers in Management of Private Enterprises is very essential.

The sixth paper to be presented in this Seminar is on "Engineers and Industrial Productivity." Adequate industrial productivity has several essential prerequisites and most of them are within the control of the engineers and we cannot be absolved of the responsibility of making a concerted effort to improve the productivity so that it can bear some semblance to the productivity level of other countries. We expect that our industrialists would recognise the vital part that the engineers can play in improvement of productivity and would not deny the engineers their rightful place in the management of industry so as to make him most effective in the overall interest of the local industry.

I hope that the papers that are being presented will be of great interest to you and the deliberations of this seminar will achieve the object of focusing the attention of engineers on matters of vital national importance.

Before I conclude, I would like to thank all those who have contributed papers for this Seminar and also those members of the Congress who have helped us in organizing this function.

I would now request Mr. Ahmad Hassan to deliver his inaugural address.

Inaugural Address

By **MR. AHMAD HASSAN, S.Q.A.,**
at West Pakistan Engineering Congress Seminar
on 18*th Oct.*, 1971

Mr. President, Fellow Engineers and Distinguished Guests—

I am grateful to Mr. Bokhari for the many kind words he has said about me. I am equally appreciative of the West Pakistan Engineering Congress, with which I have been associated for more than 40 years, for inviting me to inaugurate this Seminar. It is all the more an honour since this Seminar is dedicated to the important question of co-ordinating the role of the engineering profession with the national needs of our time.

The timing of this Seminar could not have been more appropriate and the importance of its theme can hardly be exaggerated. That our country today faces the greatest challenges is generally accepted? But where do we go from here? What is the role that we, as engineers, can play in the monumental task of national reconstruction? These are some of the questions that we should be addressing ourselves to these days. The deep concern of the West Pakistan Engineering Congress for ameliorating the economic lot of the country through greater intensification of engineering efforts is apparent from the choice of national problems which are proposed to be covered in this Seminar. All the subjects are thought-provoking and it is hoped that the eminent speakers who are participating in this Seminar would remove the veil of ambiguity from these formidable problems and present them in a vivid perspective for suitable action.

I have had the pleasure of knowing Mr. Bokhari for a long time and feel that his choice for appointment as Managing Director of Power Wing of Wapda and the President of the Engineering Congress at a time when the country is passing through the most crucial period of its history is most fortunate. With his selfless devotion to the profession he has already enhanced its prestige and in spite of the demands of the Power Wing, which take a heavy toll of his time, he has not been unmindful of the various pressing problems that pose a challenge to our continued development. His idea to have these discussed in this august body is commendable. At the cost of over-simplification, I would like to point out that our present national problems are either political or economic in nature. Although most political issues

have economic overtones and *vice versa*, the two can largely be separated. And it is, in the economic field particularly that we, the engineers, should be playing our due role.

The magnitude of the economic crisis we are currently experiencing is too well known but a brief reference to its impact on the national economy and on the average man will highlight the need for immediate remedial action.

The state of our national economy is alarming. Twenty-four years after the dream of millions of Muslims in the sub-continent came true, most of our countrymen still live in an unenviable condition. The basic necessities of life like food, housing and medicines are outside the reach of a preponderant majority of our people. The problem of unemployment has assumed frightening dimensions.

In a country of 12 crores, it is estimated that, on an average, one Pakistani works and is responsible for feeding about 10 mouths. Add to this the chronic inflation and your picture of the plight of an average Pakistani is complete. Whatever he is able to earn is offset by the continual decrease in his purchasing power occasioned by skyrocket increases in the prices of necessary and basic consumer goods.

In an age when other nations have used education to banish ignorance and illiteracy and to modernize its masses, to most of us in Pakistan, even a primary school cannot be taken for granted.

In an age when other nations are building super highways and running trains at 200 M.P.H., we continue to show our dependence on and loyalty to the bullock cart. In an age when other nations have harnessed science and technology and have elevated their scientists and engineers to a status of eminence commensurate with their contributions, the scientific and engineering know-how of this country has yet to secure its due recognition.

On the International plane, we present the same crippled picture. Our foreign exchange earnings are not sufficient to meet our needs for industrial raw materials, spare parts and the defence effort. We are experiencing great difficulties in servicing our foreign debts. Our international credit worthiness is at an all time low. But what has brought this state of affairs about? Was this the national visualized by the millions of Muslims who helped a dream come true? Is this the just and egalitarian system we all expected? In short, is this the promised land—the land of hopes and aspirations, of dreams and struggles?

There can be only one answer to the questions I have raised. But who has failed us? And where? More importantly, and that is what I think we are all gathered here for, what part can we, the engineers, now play to redeem the situation?

A national development effort must take into account the existing national wealth and heritage. There should be a realistic economic planning on the whole and manpower planning in particular on the basis of sound mathematical data.

In Pakistan, we are gifted with a rich alluvial soil, abundance of gas and minerals and abundance of manpower. Much of the manpower may be unskilled but it still could be effectively mobilized. And the skilled manpower we have, is second to none in the world. You may recall a recent press statement in which the foreign partners

incharge of the technical installation of the gigantic fertilizer plant near Lahore stated that most of the engineers who worked on the plant were Pakistanis and perhaps they were the "best in the world". To similar effect is the experience of the Indus Basin Foreign Consultants and Contractors. Coming from people with extensive world-wide experience, the statement should justifiably leave us with a sense of pride in our manpower resources.

A factor to some extent responsible for slowing down our present economic development is the recent withdrawal of foreign aid. A time comes in the history of all nations when they have to be on their own and we need not be unduly concerned with this situation but should welcome this opportunity of doing the best we can within our own resources. The burden of this re-adjustment quite naturally falls on the shoulders of the engineers and we must, therefore, endeavour to tackle the resultant problems in an organized and systematic manner so as to reduce to the minimum the effects of the withdrawal of aid, and no forum could be better qualified for initiating these than the West Pakistan Engineering Congress.

While several other factors have undeniably led to our current economic plight, it is my opinion that its magnitude could perhaps have been averted by the realization, at the national level, of the basic principle of modern life that Engineering is an economic activity and that an engineer occupies a pivotal position in the economic growth of a modern society. Supplemental to this principle is that a right man be appointed for the right job.

An Engineer is concerned with every aspect of the wealth process-manufacturing, distribution, conservation servicing and consumption. To quote a few, we construct, maintain and operate all means of communications on land, air and sea. We cater for electric power generation, transmission and distribution so vital for running the wheels of industry and other services. We have built for our country the world's most intricate irrigation system.

Considering the relationship between the engineering profession and national development, one would have thought that, as in other advanced countries, our society would have long ago well recognized the role that the engineers are destined to play in the development of Pakistan. But this, unfortunately, was not so, and our fraternity suffered colossal neglect in the overall policy-making processes. Various efforts made by us to secure due recognition are too well known to require repetition. As a former President of the Institute of Engineers, Pakistan and of this Congress, I drew the attention of President Yahya Khan and Governor Atiq-ur-Rehman to the problems and the crisis of confidence that exists amongst the country's engineers. With Mr. Bokhari, I was also on the Committee appointed by the President of Pakistan to specifically deal with the problems of the Engineers. It is unfortunate that the unanimous recommendations of this Committee have not been implemented. But the cause of the engineers is, I feel, too just to be successfully blocked by the vested interests for long. To say that "Experts should be kept on tap, not on top" has to be revised to add "but the tap must never be turned off".

As pointed out earlier, many of the problems facing us are economic problems. These can best be solved with the whole-hearted

(*Contd. on page* 22)

Proceedings of the Seminar Engineers and the Solution of Economic Problems of Pakistan

1st Day's Proceedings:

Mr. M. S. Khan read his paper "Economic Problems of Pakistan." Mr. Mohsin Ali, retired Chairman Central Engineering Authority and perhaps the seniormost Engineer in the country, presided. Discussion on the paper was initiated by Mr. Mazhar Ali. Mr. Ali related from his experience as a planner and explained in details how the plans are prepared in Pakistan. He said the plans were investment oriented. First of all big investment targets were fixed. Then on the basis of these targets, resources were allocated. However, when the time of actual financing came, usually these resources were not available and ad hoc cuts were imposed by the Finance Department. The plan was included in the budget, but at the time of release of funds full allocation was not made. Naturally the targets were not achieved.

Mr. Mazhar also drew the attention of the house to the strategy now adopted by the vested interests in keeping away engineers from the position of policy-makers. He said the under-impact of engineers pressure, some executive positions were given to the engineer but the policy was still laid down by the generalist. Thus all the responsibility was put on the shoulders of engineers whenever anything went wrong and the policy-makers got away without any criticism. Mr. Mazhar Ali suggested that such bodies like Engineering Congress and Institute of Engineers should set up their own planning cells, which should evaluate the plans already produced and tell the nation what was wrong and how these plans could be improved. He said that the various elements of plan like production targets, allocation of resources and regional distribution of this resource could be done by the Engineers.

He also gave the example of Engineering Industry, Gujranwala-Sialkot area which was running at 20% of the capacity on account of shortage of raw materials.

Speaking next Mr. Sayyed Hamid said that it was true that the capital investment industries were required for the development of the nation but he suggested the cottage and small industries should be paid greater attention. He referred to the vast disparities in income and suggested that engineers should suggest ways and means to employ

agriculture raw materials for development of small industries etc. He endorsed Mr. Mazhar Ali's proposal that Engineering Congress/Institute of Engineers should set up a cell to plan for nation's prosperity.

Mr. Khalid Butt of Pakistan Ordnance Factory, Wah said that Mr. Salim Khan's paper dealt with two aspects of our economic problems:—

(1) Low productivity and under-utilization of our industrial capacity.

(2) Better utilization of our manpower.

He said that under utilization of our installed capacity was on account of market conditions. Our industrialists wanted to keep low production in order to keep themselves in a sellers' market. If the production increased, then he will have to sell in a buyers' market which means more effort.

Another reason for under utilization of installed capacity was the shortage of raw materials and lack of maintenance spares. But the principal reason was that over 50% of our production capacity was geared to defence needs. With better co-ordination we could switch over idle capacity in defence products to civilian use. He gave the example of cartridge production, where the same plant could be used for production of lipstick containers. He however warned that such switch-over should be fully explained to the people otherwise it may lead to unnecessary rumours and criticism.

Regarding better utilization of manpower, he suggested that engineers should try to use unemployed manpower for the building of roads/dams and irrigation channels. This was done by Hitler in Germany in the thirties and by the Moghal Kings nearly 4 centuries ago.

Mr. Iftikharuddin said that what Mr. Khan had said was now no longer disputed. Even the Governor of State Bank had said in his Annual General Meeting that Pakistan was stuck up with capital-intensive, consumer oriented industrial complex. Mr. Iftikharuddin suggested that the 4th plan should be abandoned and if we get the maximum out of our existing resources we would be able to achieve what was set forth in the 4th plan without additional investment. He said that our present crisis was the result of planning by non-professional and nation was being made to pay for ignoring the engineers and technologists. He gave statistics from the Punjab Board of Economic Enquiry indicating that capital goods industry was being under utilized. He said that unless services were professionalised, no improvement could be achieved.

Mian Alimud Din, Secretary Irrigation and Power, emphasized the need for giving engineers Authority commensurate with Responsibility. He said that as Managing Director in Wapda although he could suspend a Chief Engineer but he could not appoint a peon. He suggested that the professional bodies should set up study groups to find out why engineers in responsible position failed to deliver the goods and could not meet the demands of the profession.

Closing the discussion Mr. Mohsin Ali said that he was fascinated by the way Mr. M. S. Khan marshalled his facts and figures. He said that our planning should be labour intensive and production oriented, we should make all out effort to fully utilise installed capacities and that the engineers should set up their own cells to formulate and evaluate plans prepared by the Government. He said that engineering platforms

should get stronger and stronger so that the country could be put on the road to prosperity.

PROCEEDINGS OF THE 2ND DAY

First Session:

Mr. Munawar Ali read his paper Development of Engineering Consultancy and Contracting Business in Pakistan. Prof. Ishfaq Ahmed was in the chair. Mr. Iftikharud Din introduced the speaker and the Chairman.

Opening the discussion, Mr. Altaf Hussain, C. E. Replacement Plan, while complementing Mr. Munawar Ali on his paper called for heart searching on the part of Engineers. He was of the view that Engineers in their own way could do a lot for Contractors and Consultants, without looking for any help from the Government. He said that if Pakistani Engineers could not benefit from the Foreign Consultants it was on account of their own shortcomings.

About contracting Mr. Altaf Hussain suggested that we should give status and respect to the Contractors in our society unless we did that, educated person will not take up this business as a career.

He agreed with Mr. Munawar Ali that opportunity existed for Pakistani Contractors/ Consultants in Foreign countries, particularly in RCD/Middle East countries. But success would depend on the image we have at home and the price we charge abroad.

He also referred to Bureau of Design and regretted that main opposition to it came from among the Engineers. He hoped that the Government will set up the Bureau soon. He thanked the Congress for the opportunity to speak at the Seminar.

Speaking next Mr. B. A. Malik, said that it was true that we could reform ourselves, but an Army in disarray could not be organised without the help of those in Authority. It is, therefore, necessary that the Government should help in organizations of consultancy and contracting business in Pakistan. He thought the Bureau of Design could play the same role as P.I.D.C. viz. supplementing the private sector. He also related the difficulties experienced by Engineers in presenting their works at International Congresses and Symposia and the way Foreign Consultant treated Pakistani Engineer on assignment with them. Foreign Consultants were reluctant to have clients' representatives with them. He thought Indus Basin Project offered a great opportunity for developing our consultancy and contracting business but the opportunity was missed on account of wrong planning by those at the helm of affairs.

Mr. Sayyed Hamid stressed the need for change in the thinking of departments who felt that they were in competition with contractors and consultants. He said department should be organized only to carry out operation and maintenance function, designing and construction be left to consultants and contractors.

Mr. Lewis Hussain spoke of his personal experience as a Consultant and related experience which he thought even the imagination of Mr. Munawar Ali could not conjure up. He said the Government Departments treated even consultants as contractors. He also stressed the need for Government encouragement.

Replying to the observations on his paper Mr. Munawar Ali referred to the fallacy that Pakistani Engineers were not willing to work with their own hands. He said that it would be waste of talents if the engineers were to do draughtsman's job as

was required by the foreign consultants. Apart from other considerations, it would not be economical. He said that I. B. was managed in such a way that only time-schedule was important and training of engineers was not given due recognition. Thus a great opportunity was lost.

In his Presidential address, Prof. Ishfaq Ali stated that as a teacher with 40 years' experience he could say that his best students went to the profession, particularly engineering. He said it was very heartening to note that now specialists like engineers were coming out to express themselves on the wider issue of the nation. At the time, when he raised his loud voice against the bureaucracy and other problems, he was asked to confine himself to education which was his field. He was indeed happy that the things had changed now.

He was indeed amazed that professional bodies like the Engineering Congress were coming out and suggesting solution to the nation's problems. He hoped that other professionals like Doctor, Teacher, will follow the example of Engineers and the day would come when these bodies will substitute what he called the "lone voice of the officials in the Secretariat".

He said that professional men made better managers, and the concept of "generalism" is nothing but a legacy of the colonial past. He said only a few "Aflatoons" had monopolised all the wisdom of the nation and disinherited the ability of the nation. This must be set right if nation has to flourish.

He said the allegations like corruption was just a trap to divert attention from the real issues. He congratulated the Congress for organizing the Seminar.

Second Session:

The second session was presided over by Mr. Hassan Habib. Mr Irshad Ahmed, General Manager, Planning & Design, Wapda, read his paper on "Management in Public Enterprise". Mr. Fazal Ahmad introduced the speaker and the Chairman to the audience.

Speaking on the paper Prof. Ishfaq Ali stated that the Management of Public Enterprise/Corporation is like management of a state. He said only professional men could do justice to such high offices. He said in the citadel of power, only privileged could get an entry. But these days the privilege came with knowledge. He said the Engineers who dealt with human beings and elements of nature like air and fire were best suited to be among those privileged to manage the offices of big corporations. He said the responsibility of ills of the nation was never accepted by the few who claimed to have all the wisdom of the nation. He referred to the happenings in East Pakistan which was unprecedented in the history of mankind, as nearly 1/2 of the nation was educated out of the Country and Islam. But he said no generalist was punished for that although they held the post of Education Secretaries and Information Secretaries.

He said that a brilliant man was instrument of destiny and all brilliant Engineers were to play a vital role in the destiny of the nation. He was definite that such brilliant persons could not be kept out of position of policy-making for long.

Mr. M. H. Bokhari referred to the Management of scarp projects and the difficulties being experienced in running the tubewells efficiently in Scarp-I Area. He regretted

the failure of institution like Wapda in not developing its own managers for top position. He also referred to the proposal for setting up Engineering Academy, which was required to train Engineers for managerial responsibilities. He gave the example of planning in Poland, where only profession could lead a team of planners.

Mr. Nisarul Haque congratulated Mr. Irshad Ahmad on his brilliant paper. He referred to the problems of public corporation particularly Wapda and mentioned the efforts made to improve the working of the organization. He said that Wapda had become synonymous with inefficiency. "Why this happened", he asked, "that a perfectly good and healthy institution like Public Corporation when transplantation in Pakistan became completely inefficient?"

Mr. Hassan Habib in his Presidential address paid rich tribute to Engineers and said that his experience in Pakistan Administrative Staff College showed the Engineers fared much better than non-engineers in the course he conducted at the College. He said that the myth of "Generalist" supremacy was exploded by Fulton Report. Findings of Fulton Committee was that higher managerial positions required those persons who started their careers as specialists and later on got experience in other disciplines. A generalist was only fit to undertake common services like that of a peon or stenographer. He said that in all societies today the main problem was modernization which had become imperative on account of technological revolution. The key people to undertake this were Engineers, Accountants & Economists. Only those persons could provide top leadership in our public enterprises. He was quite hopeful that in not very distant future, profession also will attain the rightful place. He asked the professionals to look beyond their specialities and look at overall framework of the society. He said that the professional should not be deterred by accusation of corruption, inefficiency which were levied against profession, as these deficiencies are the result of a mailise of the body policies and not confined to one particular section of the society. The fingers that were being pointed at the professionals were only to divert the attention for the real struggle. He was quite hopeful that the struggle for professional management for professionals will succeed in not too distant future.

Third Session:

Mr. P. Murad's paper on "Employment and Training of Manpower" was read by Mr. Iftikharud Din. Mr. I. A. S. Bokhari presided.

In his Presidential address, Mr. Bokhari referred to the crucial role the trained manpower played in the development of the country and how it was neglected by the vested interests which ruled the country. He referred to the training of Engineers and stressed the need for setting up an Engineering Academy. He also exhorted the Engineers to inculcate discipline among themselves as without discipline they could not become strong enough to assert their right and achieve their objectives.

PROCEEDINGS OF THIRD DAY

2nd Session:

Second Session of third day began at 11 a.m. Mr. A. K. Akhoond, Chairman, Railway Board, presided.

Mr. Rashid Ahmed, P.R.S., introduced the speaker and the Chief Guest:

Mr. Nisarul Haque, Director, MPO presented his paper: "Role of Technology in

increasing National Productivity."

Opening discussion on the paper, Mr. Rashid Ahmed said that it was very essential that we should know why productivity should be increased. He said most of the decisions which were economic or technological were being made either by bureaucrats or politicians who had no knowledge of technology. This must change if Pakistan is to prosper.

Mr. Masud Hassan said that Foreign Aid/ Loans were a sort of International Bank overdraft. He said there was no such thing as technological gap, there was only a management gap. Technology could be bought if we managed our resources well. As an example he cited the case of tax collection in Pakistan, which could yield much larger revenue if tax collecting machinery was properly managed. He said that Engineers were denied the right of decision-making at higher level in the country on such flimsy excuses as the engineers did not agree among themselves.

Mr. Azhar Irshad asked why Engineers were protesting now against bad planning, why could not they protest earlier? He said the Engineers must set their house in order. He mentioned the problems of fresh graduates who were not being given the opportunities for training.

Mr. Javaid Akhtar congratulated Mr. Nisarul Haque on his paper which dealt with fundamentals and framework. He said that it was on account of advance in technology that economic development was possible. He said that technological gap was there and it could be bridged if we followed the example of Japan, where they started new industries with technologies a little ahead of the Western countries. He said that whether we wanted capital intensive or labour intensive means of production, depended on the size of the market. If we need 10 yards of cloth a day a handloom would do, if 10,000 probably most sophisticated textile mills were required. He said Research & Development was required to adopt Western technology to our needs and not to carry on fundamental research.

Mr. Iqbal Ashraf said that we have failed in our moral fibre and therefore we had landed in difficulties. The production of wealth should be for higher purposes than mere consumption. We should develop spirited value so that we may lead the world and not be camp followers of others.

Dr. Mubashar Hassan congratulated the author on his paper. He said he had hit the problems on the head. He said technological explosion not only increased productivity but also led to social, economic and political problems. The change in technology, change the structure of the society, that is why that society in Pakistan was crumbling as a result of industrialization. He said it was a good sign that Engineers were looking beyond the drawing boards and discussing wider issues. He said that ordinary people appreciate those who served them and Engineers should acquaint themselves with the problems of the people and serve them. He said participation of people was most essential for the development of the countries and engineers as intellectuals must give the people a lead.

Speaking next Mr. Fazal Ahmed said that Engineer could make great contribution to National Productivity and economic progress. He said that we should adopt technology to our needs and should not import sophisticated technologies which were expensive

and also lead to waste of national resources. He suggested that all labour-saving devices should be reviewed, we should use earth-moving machinery sparingly and use our labour more as it was cheap and abundant. He said that the Congress should set up its own study group to produce feasibility report for more steel mills. He also suggested that Engineers should be given loans to set up industries based on new technology.

Mr. Mazhar-ud-Din stated that all planning was in fact allocation of resources and fixing an order of priority. He said yardstick to measure economic growth should be "happiness of our people and stability of our society".

He disagreed with the author that mass literacy was required to achieve economic development: what was required was exposure of the people to technological tools. He suggested that we should prepare plan of skills. He also disagreed with the author that we should export our Engineers and other professionals to earn foreign exchange. He said our best brains were outside the country. We should try to get them back. He said that the suggestion that we should invest in the technologies of tomorrow, rather than of yesterday, was worth consideration.

He said that the overhaul of our administrative machinery is long overdue. He, however, said that revolution of rising expectations should not be allowed to overstrip the capacity of the country.

Delivering his Presidential address, Mr. M. A. Akhoond, Chairman, West Pakistan Railway Board said that he always wondered why Muslims who had a great code of life, a great Prophet to follow, were now the most backward people in the world. The root cause for this, in his view, was neglect of steel industry, although according to the Quran steel was an important material. Muslims did nothing to acquire a steel industry. He said that we must remedy the situation if we were to live as a nation.

He also referred to the capabilities of Pakistani Engineers in the field of Irrigation Engineering & Design and regretted that this was not utilized fully in construction of Indus Basin Works. In this connection, he mentioned the disbandment of Central Design/Research Office under Secretary, Irrigation & Power, West Pakistan, as a result of which know-how and technology was lost. He said at one time West Pakistan was exporting wheat to other countries whereas now we had become importer of wheat. Thus the country was getting poorer and poorer in all aspects of our economic life. He threw a challenge and said that the country should be handed once to the professionals from next decade and if the things did not improve they should be thrown to the sea. He said Engineers were much better in planning, organizing and executing works and should be given their due share in policy-making.

He congratulated the organisers of the Seminar and the participants for the high level of papers and discussion. It was a sign of maturity. He also congratulated the President of the Engineering Congress for organising a mid-session Seminar.

He congratulated the author of the paper on what he said was one of the best papers of the Seminar. He supported the suggestion of the author that bureaucratic structure must be organised to make it more responsive to our present-day needs. In this connection, he mentioned the Cornelius Report and appealed to the Government to implement it at the earliest.

He also referred to the Engineers' Problems Committee Report and requested the Government to implement its recommendations which were unanimous. He said as Engineers we could not tolerate any further deterioration of our country and suggested that a delegation of Engineering Congress, Institute of Engineers and other bodies should wait on President of Pakistan and appraise him of the problem and request him for early implementation of solution offered by the Engineers for improving the profession and the country.

He also referred to the lack of communication among Engineers and suggested that Engineering Centre, which was jointly proposed by Institute of Engineers and Engineering Congress, must be set up soon. He offered his services for completing this project.

Mr. Saleem Khan read out the final recommendation of the Seminar after which the session was declared closed by the Chairman.

(*Contd. from page* 14)

and enthusiastic support of engineers. Engineers and technologists have led the development efforts in other lands. I am confident that you also with your professional training, sincerity and devotion, will be able to transform Pakistan into an economically sound and technologically modern society. Let us all here rededicate ourselves to the noble ideals on which our Nation was founded. Let us commit ourselves to a massive effort to better ourselves. For, when posterity records history, let it be said that the engineers played their due role and built a proud and prosperous Pakistan.—

Thanking you.

Pakistan Paindabad!

Recommendations of the Seminar

1st Day: 1st Session.

Paper: Economic Problems of Pakistan by M. S. Khan.

Chairman: Mr. Mohsin Ali, Chairman Central Engineering Authority.

Panel of Speakers: Mr. Mazhar Ali PSE I
Mian Alimud Din.
Mr. Sayyed Hamid.
Mr. Iftikharud Din.

Recommendations

Planning machinery should be overhauled to include technical expertise.

Council of National productivity be set up, manned by Engineers & Technical Experts. The Council should study the various sectors of Economy and devise steps to increase productivity.

2nd Day: 1st Session

Paper: Development of Engineering, Consultancy and Contracting Business in Pakistan by Mr. Munnawar Ali, PSE I, S.K.

Chairman: Prof. Ishfaq Ali Khan.

Panel of Speakers: Mr. Altaf Hussain, C.E. Replacement Plan.
Mr. B. A. Malik PSE I.
Mr. Sayyid Hamid.
Mr. Lewis Hussain.

Recommendations

Council of Engineering Profession should be set up as already demanded by the Engineers of the country (Draft enclosed).

The Central Bureau of Designs be set up at the earliest, as already agreed by the Government.

2nd Day: 2nd Session

Paper: Management of Public Enterprise by Mr. Irshad Ahmed.

Chairman: Mr. Hassan Habib.

Panel of Speakers: Prof. Ishfaq Ali Khan.
Mr. M. H. Bokhari
Mr. Nisarul Haque.

Recommendations

The principle of Professional Management by the professionals be adopted and all those posts which have professional bias should be held by professionals.

The recommendation of the Engineers' Problems Committee in the region be adopted immediately.

2nd Day: 3rd Session

Paper: "Training and Utilization of Manpower" by M. Parvez Murad.

Chairman: Mr. I. A. S. Bokhari.

Recommendation

Engineering Academy for in-service training of Engineers be set up at the earliest, as already agreed by the Govt. (P. C. I. proforma attached).

3rd Day: 1st Session

Paper: "The Private Sector, The Engineer & his Profession' by Masood Hassan.

Chairman : Vice Admiral H. M. S. Chaudhry (Retd.).

Panel of Speakers: Mr. M. S. Khan.
Mr. R. N. Batra.

Recommendation

Govt. should lay down that Engineers should be appointed in sufficient numbers in Private Industries (draft Ordinance enclosed).

Paper: "Role of Technology in Increasing National Productivity" by S. Nisarul Haque.

Chairman: Mr. M. A. Akhoond.

Panel of Speakers: Mr. Rashid Ahmad.
Mr. Masood Hassan.
Mr. Izhar Irshad.
Mr. Javed Akhtar.
Mr. Iqbal Ashraf.
Dr. Mubashar Hassan.
Mr. Fazal Ahmed.
Mr. Mazharud Din.

Recommendation

Services should be reorganized in the light of recommendations of various committees/commissions on the subject.

Irrigation and Power Section

Cunette as a Device for Excavation of Link Canals Through Flow of Water

By **MOHAMMAD ALI KHAN, B. E. (OSM), M. I. E. (PAK)**
Deputy Project Director, Taunsa Panjnad Link Circle (WAPDA).

Although the subject under discussion is very unconventional, yet the strong conviction, developed due to my association with some of the link canals of Indus Basin Replacement plan has enabled me to venture to put forth the idea in the following lines.

Cunette as a means of developing excavation to the required section in respect of major link canals depends upon their nature, location and priorities fixed in the overall planning. The idea is purely based on economic considerations. It required two phases for its implementation. Instead of discussing the problem in general terms, I would prefer to argue with specific reference to a link canal which already physically exists. This is Taunsa-Panjnad Link Canal which in my opinion fulfils the requirements.

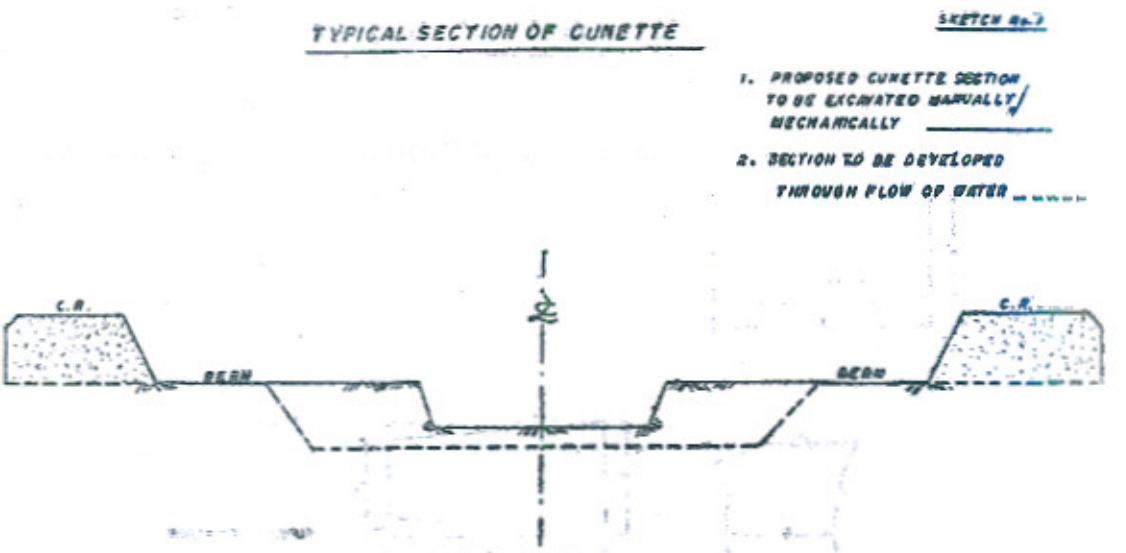
In this conception all the structures shall have to be constructed as per the design requirements. All the crests of the Control Structures where these are provided except the Head Regulator could be set low, with future provisions for raising these to the required levels, to cater for the unobstructed movement of the water charged with heavy sediment picked up from the erosion of the canal itself. Now a cunette with parameters shown in Sketch No. 1 could be constructed throughout the length of the link except at certain critical and unavoidable locations. For example, at the Head Regulator full excavation will have to be done covering the entire length of the stone pitching after which with smooth transition the excavation could be restricted to the section as shown in Sketch No. 1. This treatment will have to be adopted where such a situation warrants at the structures etc.

Now the nature of the soil within the prism throughout the length of the link is easily erodable at velocities which could conveniently be generated by the permissible steep slopes to be provided in the cunette section. When the stage is set for inletting water into the canals, there appears to be no need to follow the conventional regulation rules. To the extent the safety of the downstream pacca and semi-pacca works are involved, water could be released through the Head Regulator with higher discharges than are normally allowed so as to create high scouring velocities at the constricted

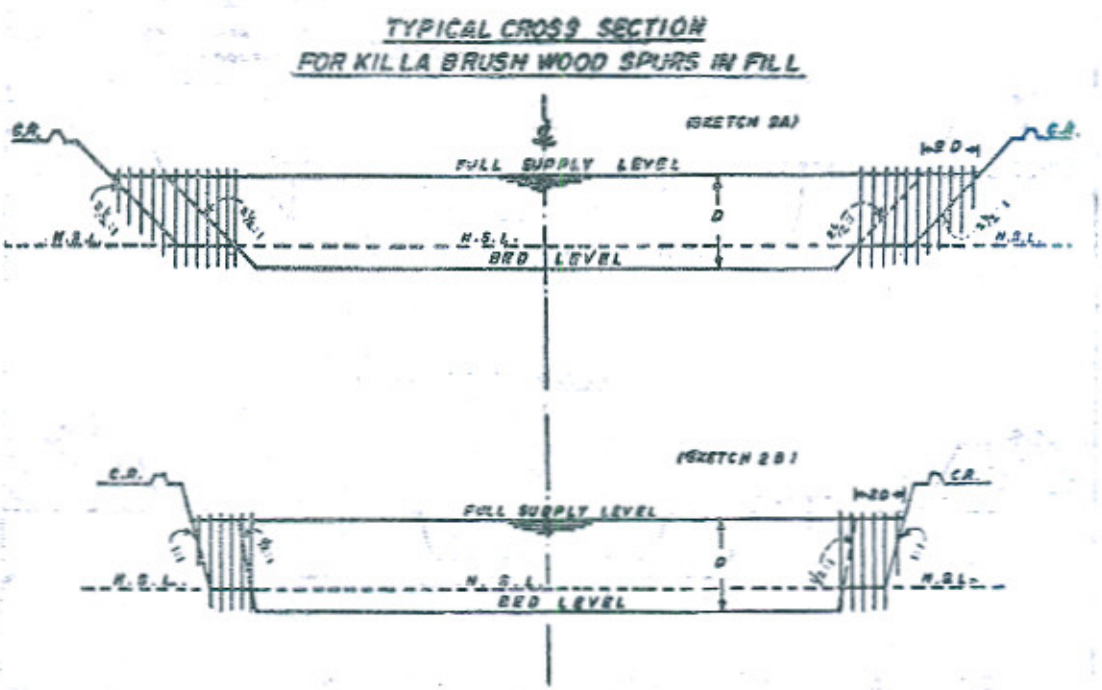
section from where the cunette starts. A close watch should be kept and it should be particularly seen that so long as satisfactory development takes place even at medium discharge, it should be allowed to be continued, to avoid abrupt changes in the course of the water. Increments to the discharges should be applied keeping in view the development of the section. During this process, if, at certain locations, erosion is likely to start at the end of the specified width of the berm, simultaneous protective measures through cross, longitudinal or hanging spurs as the case may be shall have to be resorted to. It should be borne in mind that the ultimately developed section of the channel would, naturally, not conform to the theoretical lines and grades of the design section. Therefore the left over protrusions and other unsightly features shall ultimately have to be removed, but in my opinion there does not appear to be any justification technically or aesthetically to dress the side slopes of the prism to the required grade because no earthen channel in its substantial length retains its original shape after its actual operation.

In reaches where cutting is involved the berms to be delineated in advance on the natural surface will have to be unloaded to required levels with the manual or mechanical operations preceded by water operation in the canal prism. As already stated above, all the structures including other masonry features shall have to be completed to the functional extent. In addition to this the reaches completely or predominantly in fill shall have to be constructed to cater for the full design discharge as per Sketch No. 2. Sketch 2-A shows the current practice followed in WAPDA for almost all the link canals, whereas Sketch 2-B depicts the practice followed elsewhere. In Sketch 2-A the banks have been set back to allow for formation of wide silt berms which ultimately increase safety of the banks of such critical reaches as those in fill. Therefore section indicated in Sketch 2-A is recommended because this not only increases the safety of the banks but also consumes greater quantity of silt (which will be available in good quantity with the water), than that indicated in section of Sketch 2-B. This will also, as in the case of structures, form part of the programme to be accomplished during pre-commissioning period. As these reaches are vulnerable to the attack of flowing water, these need special treatment. Before the link is run cross spurs with more liberal specifications both in their individual design and mutual spacing than are normally adopted should be constructed so as to induce quick and effective formation of silt berms. This will be quite possible because the flowing water under the above-mentioned conditions will be already heavily charged with sediment and therefore will easily unload sufficient quantity of its burden within the influence of the spurs. This condition of silt borne water will always be available if these happen to be lower reaches, because even if this preliminary running of the link is done during the winter season during which period water is generally silt free, the upper reaches (cunette sections) are providing ample opportunities for the water to pick up heavy silt which is produced during the process of development of the cunnette.

Similarly particular attention shall have to be paid for curved reaches. Every Irrigation Engineer associated with the running of earthen canals is well conversant with the phenomenon that generally erosion



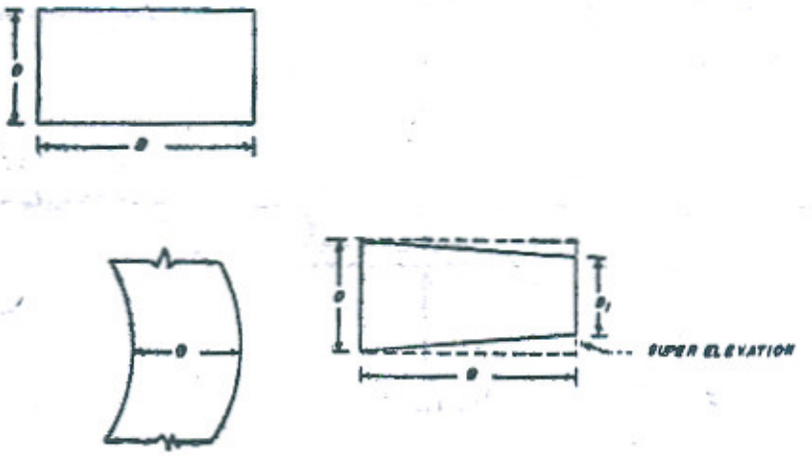
Sketch 1



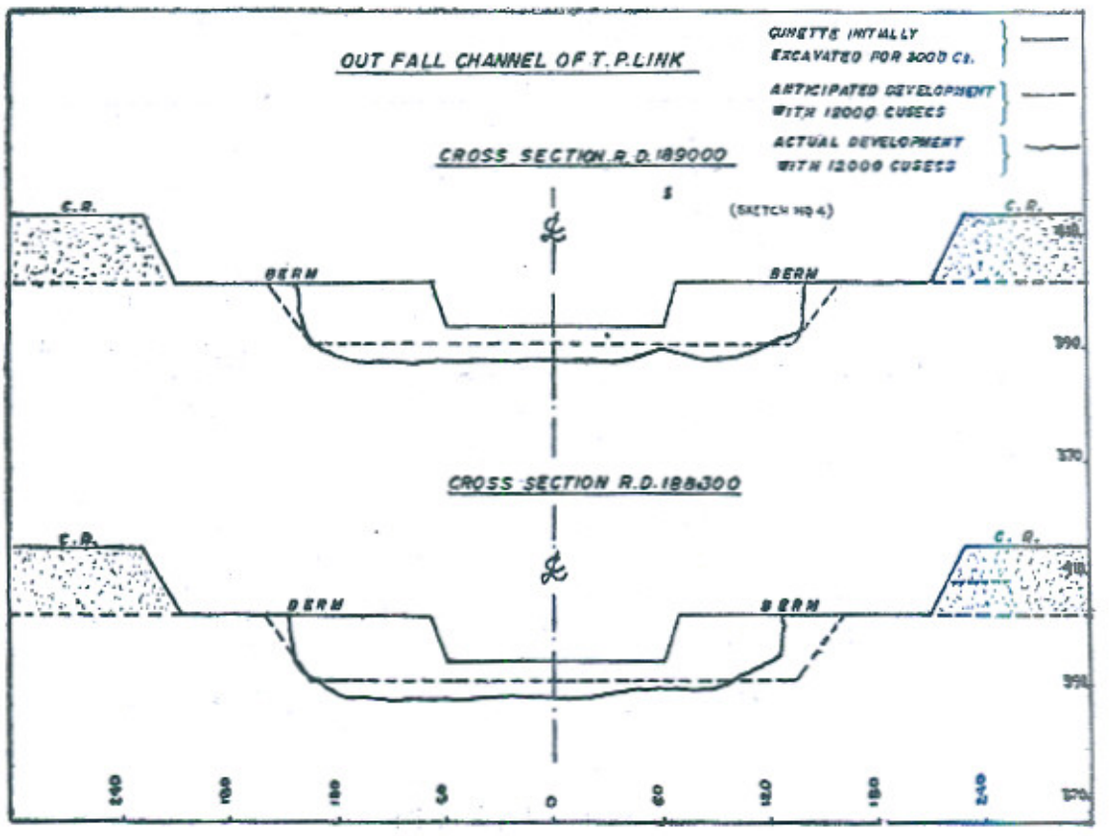
Sketch 2 (A & B)

SKETCH No 3

SUPER ELEVATION IN CURVE



Sketch 3



Sketch 4

takes place on the outside of a curve (concave side) whereas silt gets deposited on the inner side of the curve (convex side). To check the above behaviour of flowing water under the action of centrifugal force and to maintain equilibrium, provision of super elevation on outside of the curves is very much desirable. Now in our case here, super elevation in the curves shall have to be provided so that the development of the cunette in curved reaches is not out of proportion to that in the straight reaches. This is illustrated in Sketch No. 3.

Apart from certain limitations mentioned above for undertaking this venture, the one relating to the structures needs to be clearly enunciated. It is a must that the road bridges and the aqueducts are founded on deep piles as has been the practice in most of the link canals constructed under Indus Basin Replacement Plan, specially when no bed protection is provided because even in case of abnormal behaviours with deep scour the safety of these bridges is well ensured.

Every engineering proposition is supposed to be based on, *inter alia*, structural soundness and economical requirements. Its physical implementation is achieved only after the blueprints with the required details are in possession of those responsible for the execution. This is done either through manual labour or equipment or both. Even in cases of tapping natural resources, as the one under discussion, implementation is done as mentioned above. The beneficial use of the natural resource like water in the link canal is made after it is tamed and brought under control and regulation. In this article it appears paradoxical that attempt has been made to include the participation of this water, monster (which is so when under not fully controlled conditions) along with the human labour and equipment in the construction of the link canal project, which ultimately, after the completion, gets trapped itself for the service of mankind.

Earthwork in the lower depths, especially when sub-soil water level is higher than the bed level, causes extra efforts and difficulties resulting in higher costs. Almost all the earthwork in cunette could be done as dry excavation and balance underneath wet excavation could be completed through the flowing water. Hence by this natural process of excavation through water as described above substantial quantitative and qualitative saving in earthwork can be achieved.

Where deep cutting is involved, huge spoil-banks requiring extra land can be minimised thus effecting saving in the cost of the land as well. This reduction in magnitude and height of spoil banks will also result in substantial elimination of the adverse effects of slipping of the sides of the banks, that is likely to take place due to heavy surcharge.

The slow and gradual "staunching operation" of every newly constructed canal are automatically merged into the quick and almost sudden "launching, operations" as is evident from the details explained above, thus effecting economy both in time and money.

The ideal conditions for such a venture would be where the full supply level of the link throughout is lower than the natural surface level, alignment almost to be straight and easily erodable soil which is of course the predominant characterstic of the soil, where the canal system is spread out in the

Indus Basin.

The whole above-mentioned process is actually 'channel training' like ' river training,' arresting the extraordinary trend of erosion and inducing erosion where required for balancing. All this calls for round the clock vigilance and judicious planning and execution. According to the current practice, killa bushing is done prior to the inletting of water into the canal both as a protective measure in cutting reaches and berm formation device in total or partial fill reaches. This indiscriminate practice, in my opinion, of constructing spurs throughout the length does not appear to be quite necessary. For example, inner curves in cutting can safely be avoided. It has also been noticed that straight reaches with homogeneous characterstics and reasonably good soil could also behave satisfactorily without killa bushing. Under the circumstances explained above, during the process of development of cunette, it could easily be seen the location where killa bushing is needed. This will be rational and hence result in the optimum use of spurs.

By what has been explained above, tremendous economy can be effected in the overall cost of the Project retaining all design features including the target dates of completion. If the whole length of the link is in cutting, it can be proved that a saving of about 69% can be attained in the earth. Where certain fill reaches are involved, proportionate deduction will have to be applied from the above percentage to arrive at the correct saving. If compared with a project like T. P. Link canal, the figure would work out to Rs. 15.00 millions, as is evident from the following calculations worked out by taking the Outfall Channel of T. P. Link as an example:—

Reference Sketch No. 1

Excavation actually done in cunette through labour/mechanical means for a discharge of 3,000 cusecs —

Average depth = 8.5 ft.

Cross Section = (120+8.5)×8.5
= 1092.25 or say 1092 sft.

Excavation involved in full section to cater for a discharge of 12,000 cusecs:—

Average depth =12.00 ft.

Cross Section =(266+30)×12=3552.00 sft.

Therefore excavation *i.e.*, erosion in this case achieved through flow of water for the development of the cunette =3552—1092.00
=2460.00 sft.

Percentage of saving in Earthwork=69.2 or say 69%

Total earthwork involved =22.5 million cu. yds.

Assume that 1/3 of this quantity will have to be done during precommissioning period =1/3×22.5=7.5 m. cyds.

Balance quantity =22.5—7.5=15.00 m. cyds.

Hence the quantity that could be excavated (*i.e.*, eroded) through flowing water

$$=\frac{69\times 15}{100}=10.35 \text{ m. cyds.}$$

A through rate (unclassified) of Rs. 1.42 per cu. yd was allowed on this Project.

Total amount involved=10.35×1.42 million rupees=14.70 million rupees. Add 0.3 million rupees towards saving in the cost of land.

Total saving=15.00 million rupees.

The additional expenditure that is likely to be incurred for trimming and removal of unsightly features is not taken into account because it is presumed that this could be

offset by the saving in the costly wet excavation below sub-soil water-level.

The concept of cunette is not new. This has been sufficiently utilized for other purposes on various other projects. Now its application for the link canal connecting one river with the other, although adventurous in conception, is not utopian in implementation. In our own case on Taunsa Panjnad Link this has been put to use for the Outfall Channel in a length of about 1.6 miles. Its proposed cross section along with the one developed after the operation have been shown in Sketch No. 4, which is self explanatory and also proximity of the developed section to the design one is worth noting. It will be of interest to mention here that no regular and special efforts were made to train this Outfall Channel in its full length. Only in locations where abnormality in erosion was noticed, protective measures, mostly through Brush Wood and hanging spurs were adopted. Therefore if steps could be taken throughout the length, it is quite possible that the desired results could be achieved very closely. From the examination of the Cross Section of the Outfall Channel (Sketch No. 4), it will be observed that during the first season of the running of the Canal the bed got eroded giving the desired results. After running of the canal during subsequent season some siltation took place due to back-water flow, as a result of rise in flood waters in the river Chenab. When the flow of water will be low in Chenab and the link is run as usual, the bed may again get eroded. This appears to be a cycle of operation to be continued for some years until the beds of the Outfall Channel and the river Chenab adjust between themselves to suit the natural requirements of normal flows. However a watch will have to be kept on the behaviour of this Outfall Channel and corrective measures adopted in case any abnormality is noticed. My main point, actually, in describing the behaviour of the Outfall Channel is that it responded very well to the conceived plans. In fact the good behaviour of this outfall channel prompted me to write this article and therefore became a source of inspiration for me.

The whole process could be compared with a contract between "flowing water" and the "human owner" on Work Order basis, without prejudice to the cause of either of the parties. In the Work Order system, either the Contractor or the Department could terminate the unfulfilled contract, if the circumstances so warrant, without imposing penalty to the Contractor or claim from the Department. A parallelism between modus operandi in treatment of this article and the actual Work Order system has been drawn, primarily to bring home my conclusion that nothing will be lost on this undertaking. A trial should be given to this venture which if it subsequently proves to be unpracticable for which chances are very remote, could be given up and conventional means be adopted to complete the work. This is not going to have marked effects either in the cost or in the overall planning of the project.

What has been discussed in the preceding paragraphs is the outcome of the confidence gained and the practical experience attained during my close association with the operation and maintenance of link canals immediately after their construction. The results of such a venture as described above should conform to the broad outlines of the generally accepted empirical concepts. In fact civil engineering in general is an abstract science which is somewhat true for Hydraulics applied to Irrigation Engineering, particularly in respect of flow

in open alluvial channels. There had been many mental exercises by quite a few eminent hydraulic engineers for the last several decades either based on a mass of data collected from available sources of the world or on their own field experience corroborated with laboratory tests. The present Regime Concept is the result of evolutionary process undergone through trial and error methods, as is evident from subsequent adoption of the early rejected ideas, recognising these to be nearer truth. Although Engineering hydraulics, as applied to the flow of water in stable alluvial channels, appears to be well established, yet it has culminated only into empiricism based on experience and laboratory testing, which is, therefore, still a challenge for a hydraulic engineer who should struggle for achieving the analytical insight of the problem, which would go a long way, effecting economy not only in money but also in time, as this would greatly do away with costly model tests. I am confident that the present tempo of continuously broadening empirical knowledge will one day lead to the desired objective. Although in spite of the above I will be unduly over-stepping my competence, if the useful results and the immense advancement attained which give reasonable practical guidance to the Engineer are not recognised.

My dwelling at length above, on the aspect that the Engineering hydraulics as referred to above is not an exact science is actually to bring home the advocacy of the subject under discussion. Further elaborating this, launching of this proposition into practical reality will not depart us from any known applicable analytical principles. Before actual finalization of any scheme relating to hydraulic structures etc., every important work is first put to model test with the help of empirical formula that could be confidently applied. Therefore, the final blueprints are actually the blending of empirical concepts and the practical behaviour in the laboratory. In this article I consider the Outfall Channel of Taunsa Panjnad Link as a model test conducted in the field. In fact it is a full-size model test coupled with achievement of the object desired.

Water Resources Development and Integration of Water Resources Plans with the National Five Year Plans for Economic Development

By **SARFRAZ KHAN MALIK, PSE I**

Chief, Water Resources, Planning Commission, Govt. of Pakistan, Islamabad.

Perhaps after human resources, water is the most important natural resource of a country. Therefore, if water resources of a nation can be developed to human advantage, they can directly result in the flow of economic and social prosperity to its people through increased agricultural and industrial production. Water Resources Projects serve one or more of the following purposes:—

1. Domestic supply
2. Industrial supply
3. Irrigation
4. Electric power
5. Flood control
6. Navigation
7. Recreation.

Water Development thus provides the physical infra-structure through which most of the basic human needs can be provided to achieve an affluent society. With this objective in view, Pakistan has throughout accorded a very high priority to the Water sector in its Five Year Plans.

Since the development of Water resources in the country is brought about through the implementation of specific water resource projects, I consider it worth-while to briefly mention the stages through which a Water Project passes from the time of its conception to the time of full realisation of its benefits.

These stages in the appropriate order are:

(1) Conception of the Project.
(2) Reconnaisance.
(3) Surveys and Investigations.
(4) Feasibility Studies.
(5) Planning & Design including preparation of detailed estimates and project preparation;
(6) Approval of the project;
(7) Mode of financing of the project;
(8) Execution of the project;
(9) Completion of the project;
(10) Transition from construction to the operation and maintenance;
(11) Efficient management and operation and maintenance of the project over its expected life period.

The object of reconnaisance is to define the scope of investigation, to limit it to more promising lines of development and to their crucial elements. The investigations examine the hydrologic, topographic, geologic and economic features of the project. Subsequent planning and design further

elaborates on the physical details of the proposed project and provides a basis for financial planning taking into consideration prospective costs and benefits and the means by which the project can be financed and costs repaid. Execution calls for management skill of the highest order in mobilising and deploying large quantities of equipment, material and labour and to ensure that the project is completed to the exacting standards of the designers and according to a carefully prepared construction schedule. However, despite its paramount importance, financial planning has not always been given the meticulous attention of design and execution with the result that the projects have sometime failed to realise their anticipated benefits. Costs are often under-estimated and revenues over-estimated.

The transition from construction to operation and maintenance of a project is one of the more critical periods of project development. There are two actions involving personnel which materially assist in the smooth transfer of projects from construction to operation. The first is to establish the management operation and maintenance organisation and assign key staff members to it well before the construction is completed. The second is to transfer some of the construction staff to the operating organisation. The first action permits close liaison between constructional and operational staffs and allows a gradual assignment of duties by the latter. The second action assures the retention of staff members acquainted with construction activities and later with operation of the facilities.

For subsequent efficient operation and maintenance of Water Resources Projects, and adequate cost and funding programme, a well established standard operating procedure and a comprehensive record-keeping and reporting procedure are essential requirements.

However, a Water Planner in a National Planning Organisation is more concerned with the following aspects of Water Resources Planning:

(1) Methods and policies for financing economically and technically viable water projects with a look on the repayment of cost.

(2) Inclusion of such a project in the overall Water Resources Plan.

(3) Integration of the Water Resources Plan with the National Five Year Plan for economic development.

1. Financing of Water Resources Projects

It is inevitable that development projects involving large capital outlay should be subject to close scrutiny before they are committed. An investment once made is largely irreversible, and to avoid losses it is necessary to be reasonably certain of the outcome of the investment. The object of technical and economic feasibility studies leading up to the commitment of a large project is to present the facts of the proposal and to assess its physical, economic and financial results.

After technical feasibility is determined, economic analysis is undertaken to make certain that in the long run the benefits of the scheme will exceed the costs entailed in construction and operation. The financial analysis determines whether an enterprise is financially sound and how much and how soon will the direct monetary returns be derived from the capital investments made in a project.

The difference between the financial and economic analysis is that the latter takes

into consideration all benefits, tangible and intangible, primary and secondary, and all costs including induced and associated costs as well as construction and O & M costs. The former includes only the direct monetary returns which are normally less than the overall benefits; induced and associated/indirect costs are excluded.

Water Resources Projects, like most large development projects, involve considerable expenditure in foreign exchange. The financial analysis must therefore take into account the local and foreign exchange component of costs. The terms of procuring the local and foreign capital, interest rates, grace period and maturities among other factors have to be examined with a good deal of care in relation to their effects on project cost and profitability. The capital is most effectively used when the user is conscious of the burden of repayment; when he is not conscious of it there is a tendency for subsidies to be perpetuated, whether they are needed or not, with consequent ill-effects on the economy.

2. Preparation of Overall Water Resources Plan

With each of the major projects having been subjected to an examination of the type described earlier, a list of water projects is prepared and *inter se* priority of projects is determined keeping in view economics, social. regional and political considerations. However, with the break-up of the One Unit, this task has been made more difficult for our water resource projects in the Fourth Five-Year Plan.

3. Integration of the Water Resources Plan with the National Plan for Economic Development

The Water Resources Master Plan so prepared is then finally integrated with the National Five Year Plan. This exercise is subjected to many stresses and strains within the national planning organization. After the emergence of an overall picture of resource mobilization, an exercise of fixing inter-sectoral priorities and determining sectoral allocations begins. This is the time when some of the finest speeches and dialogues are heard within the Planning Commission; various alternatives are worked out, the importance of investment in one sector in preference to the other and vice versa is emphasizingly argued and finally the exercise of fixing physical targets and financial allocations for each secter of economy is completed.

The first important step planners should take in integrating Water Resources and Economic Development Plans is to make the national objectives, policy goals and strategy of development planning clear to the national agencies incharge of Water Resources Development. They should spell out in considerable detail the desired aggregate and annual growth rate of economy in indicating national targets by sectors and areas of emphasis and priority.

The integration of Water Resources Projects with the Development Plans is facilitated to a considerable extent by taking the following steps in respect of the planning of Water Resources Projects;

(*i*) Select soundly conceived projects with a potentially good demand for their products and services;

(*ii*) rank them in the order of this contribution to economic and human resource development, which are among the major objectives of development planning.

(*iii*) work out the scope of each project, its structural interdependence and the extent to which it could induce production in other sectors;

(*iv*) estimate the national currency and foreign exchange requirements with sufficient degree of accuracy;

(*v*) lay down a realistic time schedule for the execution of each project;

(*vi*) make available the administrative capacity and the political will to take these essential steps; and finally

(*vii*) carry out the projects in accordance with carefully developed programmes of action.

However, some important practical questions that arise from an attempt on integrating Water Resources Projects into the Development Plan are these:

(*i*) What additional capital costs are likely to be incurred by cultivators in bringing water to their lands and in bringing new land under cultivation, as induced by the availability of water?

(*ii*) What additional cost will be incurred by the state in promoting the development of irrigation, in erecting bridges, providing ferries, canals and so on?

(*iii*) What will be the attitude of farmers in response to the conversion of dry lands into wet lands?

(*iv*) What changes are likely to take place in the cropping pattern and land utilization consequent on irrigation and the availability of power?

(*v*) What rates should be charged for water and power and what is the economic justification for imposing additional tax burdens on land?

(*vi*) What is the prospective additional demand for trade and transport facilities, taking into account the likely changes in the crop pattern and expansion of agricultural production?

(*vii*) What new opportunities will arise for the development of agro-industries and other industries?

(*viii*) What will be the employment prospects of the project during construction and operation?

(*ix*) What measures should the Government take regarding provision of other facilities such as credit, better seeds, and fertilizers, in addition to the provision of water?

(*x*) What will be the overall effect on the incomes and living standards of the people in the region where the project is to be located.

Satisfactory answers cannot be given to these questions without adequate knowledge of the existing social and economic conditions of the country and of how they are likely to change in the course of the development of the project. To obtain this knowledge, it may be necessary to initiate socio-economic surveys and studies covering the region repeating some of these surveys and studies later on to measure the impact of project development.

In the great majority of cases, Water Resources Projects are capital intensive. Their capital requirements are concentrated in a short period of time. They sometimes have long gestation periods and usually long lives. In consequence though they may be amenable to co-ordination with the other elements of comprehensive Economic

Development Plans in the long run, they may be so only to a limited extent in the short run. Since our operational development plans have a time horizon of five years, actual co-ordination cannot usually be achieved between Water Development Projects during the programme period with the other elements of the same Plan. For practical purposes, therefore, co-ordination with these elements will have to be effected with the Water Resources Development Projects initiated during an earlier Plan but expected to become operational during the period of the current Plan.

NEWS

INTERNATIONAL ASSOCIATION OF HYDRAULIC RESEARCH SYMPOSIUM ON RIVER MECHANICS

An International Symposium on River Mechanics will be held in Bangkok, Thailand, from January 9th-12th, 1973, under the auspices of the International Association for Hydraulic Research.

Co-sponsors are the International Association of Hydrological Research, and the United Nations Education, Scientific and Cultural Organisation (UNESCO).

The Symposium is organised jointly by the Committee on Fluvial Hydraulics of IAHR, and the Asian Institute of Technology.

The official language of the Symposium will be English but contributions may be submitted either in English or French. The Symposium is open to anyone interested in River Mechanics.

The Symposium will be divided into three technical programs :

Flood Investigations.
Erosion and Sedimentation.
River and Estuary Model Analysis.

Each technical program will open with an address by a guest lecturer who will review the current state of research in that field.

There will be a program of visits and tours, and a program for ladies.

Papers are invited on the following topics:

Flood Investigation

(*i*) Flood Computations.
(*ii*) Flood Measurements.
(*iii*) Flood Damage.
(*iv*) Flood Warning.
(*v*) Channel Control and Stabilization Methods (including the selection of construction methods appropriate to the Asian Region).

Erosion and Sedimentation

(*i*) Sediment Transportation Mechanics.
(*ii*) Sediment Measurement Techniques.
(*iii*) Sediment Yield and Deposition.
(*iv*) Sediment Control Methods and Remedial Works (including the selection of construction methods appropriate to the Asian Region).

River and Estuary Model Analysis

General papers about techniques of physical and mathematical modelling of the hydraulics of rivers and estuaries are preferred, but accounts of specific studies of rivers and estuaries in the Asian Region are admissible.

Summaries of papers, of not more than 500 words, are required before March 1st, 1972.

Intending authors or participants are invited to contact the Symposium Secretary, Dr. Subin Pinkayan, Asian Institute of Technology, P.O. Box 2754, Bangkok, Thailand.

Building and Highways Section

A Study of the Solar Heat Absorbed by Various Colours

By MIAN M. HANIF*, M.Sc. ENGG. (Pb)

To find out whether colours contribute to the absorption of solar heat, a study was carried out at the Building Research Station, Lahore. Seven colours were studied and it was found that various colours do absorb different amounts of solar radiant heat depending upon their reflectivity.

INTRODUCTION

In tropical countries like Pakistan the main problem for the designer of a building is to keep the solar radiant heat out of the building as far as possible so as to promote a comfortable living. The solar heat enters the building from the roof, walls, windows etc., A little more than 50% of the heat enters the building through the roof and the remaining heat enters from the walls. The solar load on the walls depends upon their orientation.

The heat received both by the roof as well as by the wall is partly absorbed and partly reflected back depending upon the type of material, type of surface and also the colour of material. Usually the buildings in Pakistan are plastered from outside and are painted, distempered or colour-washed according to the colour scheme of the Architect. It has been felt that colours also play a significant part in absorbing or reflecting back solar radiant heat depending upon their quality and the type of surface on which they are applied.

Colour and its classification

Colour: Colour is that quality which enables one to distinguish between two objects which are otherwise identical in size, texture, shape and brightness. It is a visual sensation caused by the stimulus of light or the memory of such a sensation.

There are two systems of colour classification :

1. Classification given by B.S.S. 2660, and
2. Munsell system of classification.

1. *British Standard System* : The B. S. S. 2660 gives a system in which 101 colours have been categorized on 10 different cards numbering from 0 to 9. Generally the colours in each group are graded from light to dark from top to bottom of the cards. The

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strength of the colour is in descending order of the card number. Card number 0 represents the strongest colour whereas card number 9 contains the greys. The white and the black colours are also shown on card number 9. The intermediate cards show the light and strong colours in 8 hue groups given as follows:

Card No.	Colour
1	Red
2	Yellow-Red
3	Yellow-Red
4	Yellow
5	Green-Yellow
6	Green
7	Blue-Green and Blue
8	Purple-Blue & Red Purple

The British Standard further specifies the main types of finishes for which each of the above colours is suitable. In addition the British Standard also gives the approximate Munsell reference for each colour as proposed by Munsell Colour Company, U.S.A.

2. *Munsell System.* A Munsell reference amounts to a name for a colour, a name which has been defined subjectively by 3 dimensions of the colour in terms of Hue, Value and Chroma.

Hue. Hue distinguishes red from blue, green from yellow etc. and is denoted by letter (for example R for Red, BG for Blue-Green), with prefix numbers 2.5, 5, 7.5 or 10.

Value. Value is related to lightness or darkness of a colour and is quoted as ranging from 0 to 10; the low figures represent the darker colours and finally black (0), the high figures represent the lighter colours and finally white (10). From the value of the colour it is possible to calculate its approximate reflection factor or the percentage reflectivity. The reflection factor is the ratio of the percentage of light reflected from a surface to the total of incident white light. A theoretical ideal smooth pure white surface reflects 100%. A rough or perforated surface absorbs light and thus lowers the reflection factor.

Chroma. Chroma is strength of colour. A pigment of full chroma is strong and free of any degrading factor.

Thus according to the Munsell atlas a colour is identified by 3 pieces of information. The Munsell system is a means of classifying colour and colour difference by direct visual comparison. Superficially the introduction of Munsell references appears to be complicating matters but once one becomes accustomed to it, it is found to be very simple and conveying very precise and correct information and distinction between properties of colour which a designer must know.

To understand the evaluation of the colour according to the two systems, mentioned above, a simple example is explained to show the information which is immediately conveyed by reading the gradation given by each colour in the British Standard.

A colour is described as below:—

5—064
G (E)
SG
M
5GY 4/6

The serial No. 5—064 is the British Standard index for the colour showing that the colour belongs to Card No. 5 of the British Standard and that the colour belongs to the intermediate range and 64 is its serial number.

The letter G (Gloss), SG(Semi-Gloss) and

M (Mat) are a guide to the finishes to which this particular colour is normally suited. The letter E shows that in addition to internal use the paint is also suitable for exterior use in gloss finish.

The last term is approximate Munsell reference. 5GY indicates a strong green-yellow hue; figure 4 is the value and 6 is the chroma showing a high strength of the hue. As mentioned earlier, the approximate reflection factor of the paint from the value in the Munsell reference can also be calculated by the formula:

Reflection factor = V(V—1)

where V = value of the colour.

In this case the reflection factor or percentage reflectivity for V=4 comes out to be 12%. It may, therefore, be appreciated that a colour in this way has been completely identified.

For the benefit of the readers a table giving the exact percentage reflectance for the exact Munsell value is given in the Appendix.

Identification of colours used

While starting this study, the colours which were kept under observation in Building Research Station were not identified according to either British Standard or Munsell reference. Four colour plates were, however, available even at a later stage and they were compared with the colour-cards available in B. S. 2660 and their identification has been given in Table 1 along with the approximate identification of two other colours whose plates are not available. The grading of the colours according to locally manufactured distempers by M/s. Evershine Paints Ltd., Karachi, are also given in this table.

Work done at Building Research Station, Lahore.

This study was carried out by making wooden frames each with overall dimensions

TABLE 1

Identification of colours used

Description of colour	Classification according to B. S. 2660	Approximate Munsell ref. according to B. S. 2660	%age reflectivity	Evershine distemper grading	Remarks
Black	9-103	0			
Grey	9-097 G(E)	10 B 4/0.5	12.001	D-17 Dove Grey	
Green	6-072 G(E)	10 GY 6/4	30.05	DB-Middle Green	
Blue	7-084 G(E) SG	7.5 B 6/6	30.05	D-16 Middle Blue	Approximate
Cream	3-041 G(E) SG	10 YR 9/6	78.66	D-6 Cream	Do.
Pink	1-020 G SG M	7.5 R 8/4	59.10	D-9 Rose Pink	
White	9-102	0	100		

of 15″×15″ in plan. The frame was 1½″ wide and 1″ thick and it was wrapped all round with white muslin cloth. The empty space measuring 12″×12″×1″ between the frame was filled with cotton. All the 3 materials *i.e.*, muslin cloth, wood and cotton are bad conductors of heat. The thermal conductivity of cotton and wood being 0.25 and 0.4 BTU/hr/sft/$\overset{\circ}{F}$/in. respectively. On one end of the frame a hole was provided for the insertion of theremometer.

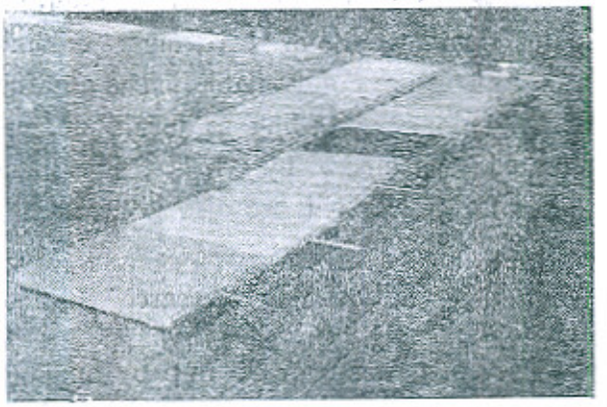

Photo showing the colour plates lying on platform.

The following distempers were applied in 3 coats on the two sides of the cloth:—

1. Black
2. Grey
3. Green
4. Blue
5. Cream
6. Pink
7. White

White surface was obtained by applying 3 coats of whitewash on the cloth. The black surface was obtained by mixing lamp suit in varnish and applied on the surface of the cloth. All the plates were redistempered after about 3 months when the earlier distemper started fading out.

A platform measuring 10′×10′ and 2′ high as shown in photograph was made in the back compound of old Building Research Station premises at 2-Lake Road, Lahore, and ordinary earth was filled in this platform. The finished surface of the platform was only earthen. The idea of having an earthen platform was to have an insulating environment around the colour plates so as to avoid all other possible sources of heat intrusion and interference. The coloured muslin plates were placed on the earthen platform in flat position exposing the 12″×12″ surface to the sun and termperature readings were taken with the help of mercury-in-glass thermometers, after every hour starting from 8 o'clock in the morning to 6 p.m. in the evening. The thermometer for recording the temperature was inserted in the plates up to a depth of about 3″ from the frame's outer end. The bulb of the thermometer was all the time embedded in cotton. Simultaneously, the temperature of the surrounding air was also noted. After the last reading of the day, the plates were removed from the open and placed inside. They were again placed on the platform in the morning.

When the study was initiated in 1963 the temperature was read with the help of mercury-in-glass thermometer but as these thermometers were frequently broken by the staff, they were replaced by the alcohol-in-glass thermometers. Readings were taken with the help of alcohol thermometers for about 4 months. It was, however, found that the readings being indicated by the alcohol-in-glass thermometers were not correct and the recording of temperature with the help of mercury-in-glass thermometers was again resorted. It is for this reason that readings taken during 1963 have been screened out being erratic and unreliable.

VARIATION OF AVERAGE MONTHLY MAX TEMP. WITH DIFFERENT COLOURS FROM APRIL 1964 TO MARCH 1955

FIG. 1.

Table 2 shows the figures of the monthly average of the highest temperature obtained in each individual colour starting from April 1964 to March 1965, *i.e.* for full one year.

Figure 1 shows the variation of the monthly average of maximum temperature during the year (4/64 to 3/65) for all the colours kept under study. The dotted line shows the variation for the ordinary air temperature.

Observations

1. Fig. 1 shows that various colours do absorb solar radiant heat differently.

2. The highest temperature obtained is naturally with the black as represented by the uppermost line.

3. The coolest colour is naturally the white.

4. The other colours studied can be arranged in order of coolness as follows:—

   (*a*) Grey
   (*b*) Green
   (*c*) Blue
   (*d*) Cream
   (*e*) Pink

Some measurements made at the United States National Bureau of Standards to determine the effect of colour and finish on the absorption of solar heat by surface show the following order of relative temperature rise when the inclination of panels with the horizontal was kept as 30°:

1. Blank (lamp black)
2. Medium green paint.
3. Pearl grey paint.
4. Canary yellow paint.
5. Flat white paint.
6. Glossy white paint.

TABLE 2

Showing the average max. temperature (°F) observed with different colours during the year.

Co our	April 1964	May 1964	June 1964	July 1964	Aug. 1964	Sept. 1964	Oct. 1964	Nov. 1964	Dec. 1964	Jan. 1965	Feb. 1965	March 1965
Black ..	152.2	159.5	161.4	143.6	147.3	139.1	142.4	118.8	103.3	110.0	120.9	136.1
Grey ..	123.9	123.2	136.9	130.4	131.6	128.5	121.7	98.6	83.1	90.6	90.2	108.7
Green ..	123.9	128.8	132.9	123.6	123.0	120.7	116.1	94.5	77.6	82.9	91.1	100.4
Blue ..	116.9	119.2	126.1	112.5	114.7	115.1	110.9	87.2	72.0	79.9	86.7	99.1
Cream ..	113.0	114.6	122.9	114.4	114.2	106.9	102.2	83.0	70.5	75.4	80.7	97.9
Pink ..	106.4 (23 days)	108.4	115.6	106.1 (18 days)	107.0	100.8 (25 days)	95.7	78.7	67.8	71.1	76.8	85.7
White ..	107.3 (23 days)	108.2	112.2	107.4 (18 days)	107.0	101.9 (24 days)	95.7	76.9	67.2	68.1	74.0 ..	85.7
Ord. Air ..	106.8	105.9	112.3	104.1	102.5	98.3	96.6	82.3	72.3	74.5		89.3

This also proves that different colours do absorb different amount of heat although it is influenced by the type and nature of colour as well as that of the surface. The above order also approximately confirms the sequence obtained in this Laboratory. The difference in sequence is due to the nature of colour and the reflectivity of the surface.

5. During the summer the highest temperature obtained with white is about the same as the ordinary air temperature.

6. In winter season from November to March, the cool colours give temperature slightly less than the ordinary temperature and will have cooling effect on the building although of insignificant nature.

7. The heat absorbed by various colours is inversely proportional to their reflectivity.

also held flat. This study was started in June 1964 and finished in March 1965. Table 3 shows the figures of monthly average of the highest temperature obtained in each colour.

Figures for the month of January 1965 to March 1965 are not given as the readings during these months ranged for 7 days to 19 days and are therefore not considered to be representative.

The order in which the solar radiant heat is absorbed by the colours on the mortar plate is the same as in case of coloured muslin plates. Figure 2 shows the comparison of maximum temperature variation observed in case of muslin plates and mortar plates. There is a difference between the maximum temperature obtained in each colour applied on two different surfaces. This is due to the materials and the nature

TABLE 3

Showing the monthly average of max. temp. °F obtained with different colours applied on 1 : 5 *cement-sand mortar plates.*

Colours		June. 64	July. 64	Aug. 64	Sept. 64	Oct. 64	Nov. 64	Dec. 64
Grey	..	127.2	123.3	123.3	118.1	119.0	98.0	81.0
Green	..	123.9	120.0	115.5	116.7	116.6	98.1	84.0
Blue	..	120.5	110.6	115.5	117.9	116.3	88.9	79.64
Cream	..	118.3	108.7	111.7	117.7	107.5	86.7	72.75
Pink	..	114.0	110.2	109.8	108.1	110.0	90.4	75.67
White	..	114.6	113.9	103.0	107.6	103.6	84.9	72.42

Later on it was thought that the study will be closer to the actual conditions if readings of the temperature are taken in mortar plates, coated with the same colours. As such mortar plates $\frac{1}{2}$" thick and 12" × 12" in plan were made with 1 : 5 cement-sand and painted with the same colours as mentioned above. A suitable hole was left on the side of the mortar plate to receive the thermometer into the plate. These plates were

of the surface of the two types of plates. In case of mortar plates, the surface was comparatively rougher and therefore less reflective. Except for grey which is one of the highly absorbing colour, the mortar plates generally show higher values of the average maximum temperature.

Deviations

1. When compared to pink colour, 25 %

COMPARISON OF AVERAGE MAXIMUM TEMPERATURES (°F) OF INDIVIDUAL COLOURS OBSERVED WITH MORTAR PLATES AND CLOTH PLATES

(JUNE 1964 TO DEC. 1964)

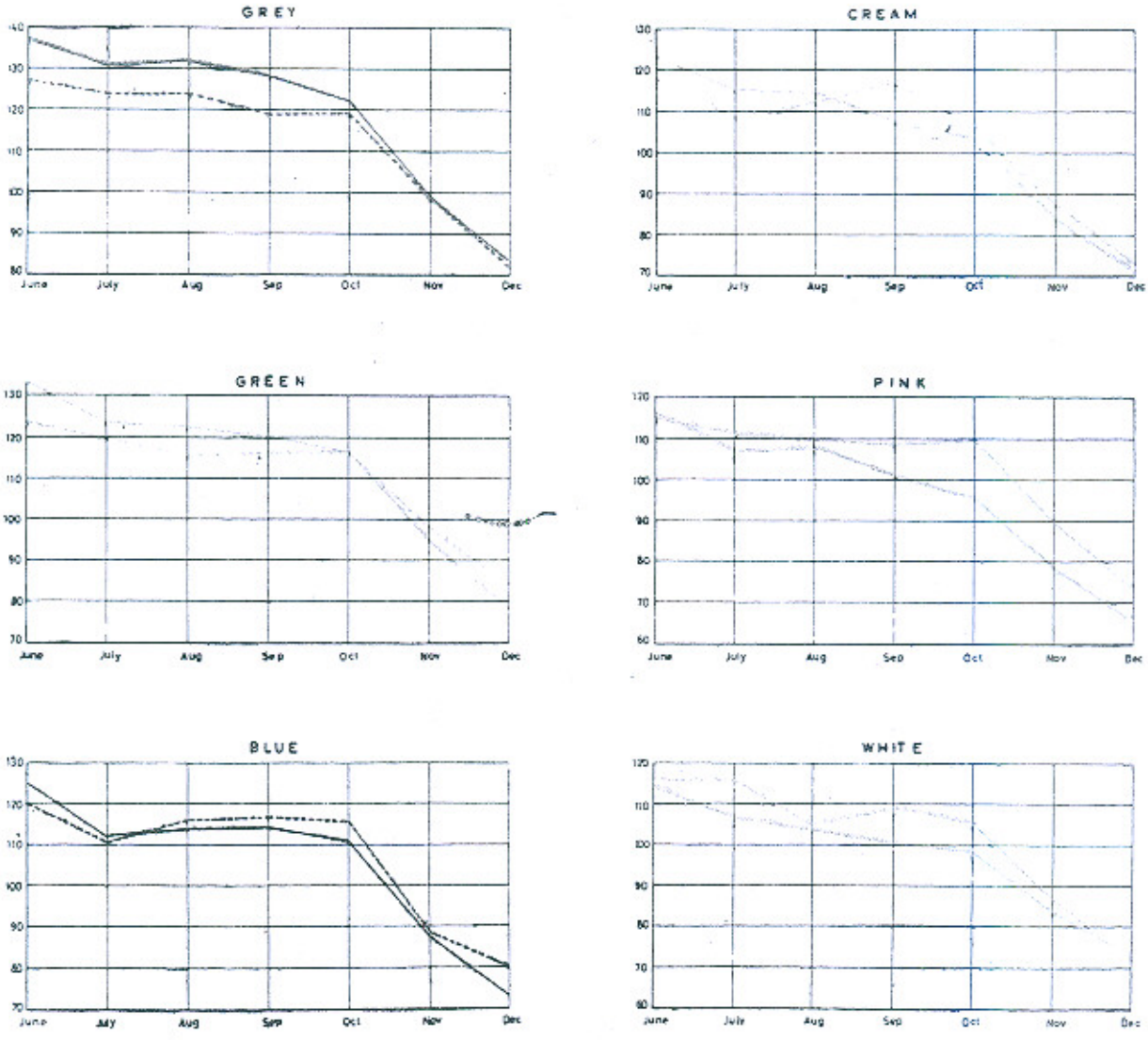

FIG: 2

CLOTH PLATE: ——

MORTAR PLATE ----------

readings of the white colour are erratic, but in view of its reflectivity, it has been graded at its proper place.

2. Since the pink colour under study is very close to the white colour in its reflection of heat, there is a likelihood of mixing up this colour with that of the burnt clay tiles or bricks. It may be mentioned that the reflectivity of the brick red colour is low and the brick or tile being less reflective absorbs more heat.

A study was carried out at Building Research Station, Lahore to find out the heat absorbed by an ordinary burnt clay tile and a whitewashed tile and a temperature difference of 20°F was observed. This difference of temperature is due to the reflective quality of the tile material and colour which is very different from the colour used in this study and that too on a muslin cloth.

Recommendations

From this study of seven colours it may be observed that colour can play part in reflecting back solar radiant heat and full exploitation should be made to achieve thermal comfort in buildings due to this factor also.

White colour can be used advantageously on roof tops through which the major portion of the heat comes from. It can also be used for walls but is likely to promote glare in the summer month. The doors and windows especially the steel ones if exposed to the sun, can be painted white to reflect back heat and light.

Curtain cloths for windows exposed directly to the sun should have colours which are less absorbant of heat.

The walls of buildings should be distempered in colours keeping in view their heat absorption properties.

A little thinking in the selection of colour can therefore improve the living in buildings.

ACKNOWLEDGMENT

The study was started at the initiative of Mr. Ashfaq Hasan, Director Building Research Station to whom the whole credit goes for guiding the work. The author is also thankful for his permission to publish this paper. The author is grateful to Mr. Yousuf Amin, Senior Research Assistant who has helped in compiling the relevant data.

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APPENDIX

Table of Reflection Factors for Munsell Values

Munsell Value	% Reflectance	Munsell Value	% Reflectance
0.0	.000	2.6	4.964
.1	.120	2.7	5.332
.2	.237	2.8	5.720
.3	.352	2.9	6.128
.4	.467	3.0	6.555
.5	.581		
.6	.699	3.1	7.002
.7	.819	3.2	7.471
.8	.943	3.3	7.960
.9	1.074	3.4	8.471
1.0	1.210	3.5	9.003
		3.6	9.557
1.1	1.353	3.7	10.134
1.2	1.505	3.8	10.734
1.3	1.667	3.9	11.355
1.4	1.838	4.0	12.001
1.5	2.021		
1.6	2.216	4.1	12.66
1.7	2.422	4.2	13.35
1.8	2.642	4.3	14.07
1.9	2.877	4.4	14.81
2.0	3.126	4.5	15.57
		4.6	16.37
2.1	3.391	4.7	17.18
2.2	3.671	4.8	18.02
2.3	3.968	4.9	18.88
2.4	4.282	5.0	19.77
2.5	4.614		
5.1	20.68	7.6	52.30
5.2	21.62	7.7	53.94
5.3	22.58	7.8	55.63
5.4	23.57	7.9	57.35
5.5	24.58	8.0	59.10
5.6	25.62		
5.7	26.69	8.1	60.88
5.8	27.78	8.2	62.71
5.9	28.90	8.3	64.57
6.0	30.05	8.4	66.46
		8.5	68.40
6.1	31.23	8.6	70.37
6.2	32.43	8.7	72.38
6.3	33.66	8.8	74.44
6.4	34.92	8.9	76.53
6.5	36.20	9.0	78.66
6.6	37.52		
6.7	38.86	9.1	80.84
6.8	40.23	9.2	83.07
6.9	41.63	9.3	85.33
7.0	43.06	9.4	87.65
		9.5	90.01
7.1	44.52	9.6	92.42
7.2	46.02	9.7	94.88
7.3	47.54	9.8	97.39
7.4	49.09	9.9	99.95
7.5	50.68	10.0	102.57

Reproduced from 'Colour and the Child' by R. Merle Frean and D. M. Calderwood; Technical Report No. 7 : 1959 of the National Building Research Institute, CSIRO, S. Africa, March 1946.

Co-efficient of Permeability of Cohesive Soils as Related to Plasticity Index and Mean Diameter

By C. M. TAHIR,[1] G. F. ZAFAR[2] AND I. H. HAMDANI[3]

This paper deals with the permeability of cohesive soils in the remoulded state as related to plasticity index and mean diameter. In the first phase the existing laboratory data on the testing of soils for permeability and other characteristics like compaction, atterberg's limits and grain size distribution were scrutinised to establish relationships. After a thorough study on the subject a log-log graph has been prepared with the coefficient of permeability in cms/sec. as ordinate and a variable η as the abscisin. The variable η is the ratio (between mean diameter (cms) of the soil and its plasticity index. The following empirical equation has been derived:

$$K = 1.57 \times 10^{-10} + 1.8 \times 10^{-4}\,\eta + .43\eta^2$$

where K = *Coefficient of permeability in cms/sec.*

$$\eta = \frac{\text{Mean diameter in cms}}{\text{Plasticity index}}$$

In the second phase some sixteen soil samples of different grades were collected and subjected to the relevant tests for a counter check and confirmation of the above equation.

INTRODUCTION

Permeability is the property of a soil which permits water to flow through its pores. Knowledge of soil permeability is very essential in many engineering problems, like those of earthern embankments etc. Permeability values must also be known for designing of drainage facilities to avoid earth slides and retaining structure failures and to determine the extent of pumping operations for excavation work.

The fundamental physical laws according to which all laminar flow takes place are the dynamical equations of motion, known as the Navier-Stokes equations. The pore channels of a soil mass are so narrow and tortous, so irregular in cross section, and so complex in their inter-connection and subdivision that an analysis of the flow through individual pores is not possible. However, in engineering problems involving seepage through soils it is not the flow through

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individual pores that is of interest. Instead the flow desired is the combined flow through all pores of an element of volume which is sufficiently large to give a typical representation of the soils mass as a whole. Investigations based on average conditions in representative samples are sometimes called micro-scopic studies.

The law for flow through soils is named after Darcy who demonstrated experimentally that the rate of flow is proportional to the gradient. Darcy's law is written :

$$Q = k\,i\,A \qquad ..(1)$$

The area 'A' in the above equation is the total cross sectional area of soil mass, across which rate of flow Q occurs, under a hydraulic gradient i. K is the coefficient of permeability.

Another expression for the rate of flow through irregular section or any comparable section may be written

$$Q=(Cs\frac{Vw}{\mu}\ R_H^{\ 2}\ n)\ i\ A \qquad ..(2)$$

where Q=rate of flow through a soil mass.
Cs=shape constant.
R_H=hydraulic radius.
n=number of pores (porosity)
A=area of pore.
i=gradients.

The concept of hydraulic radius in soil pores leads to an expression originally presented by Kozeny, for the effect of void ratio on the permeability.

The hydraulic radius may be expressed as

$$R_H=e\ .\ \frac{Vs}{As} \qquad ..(3)$$

The ratio $\frac{Vs}{As}$ is a constant for any given specimen of soils. Difficulties may be encountered in some soils if accurate evaluations of the ratio are attempted, because surface areas of irregular grains are not easily determined and large part of the total surface area may be contributed by a small fraction of very small grain (unpublished results of investigations by W. R. Hiltner in M. I. T. Soil Mechanics Laboratory). However, these difficulties can in no way reduce the significance of the fact that the ratio has a definite, constant value.

Let Ds be diameter of the spherical grain which has the same ratio of volume to surface area as holds collectively for all grains of a given soil. This ratio of volume to surface area may be expressed for the spherical grain as :

$$\frac{Vs.}{As}=\frac{1/6\ \pi\ Ds^3}{\pi\ Ds^2}=1/6\ Ds$$

$$\therefore\quad R_H=e\frac{Ds}{6} \qquad ..(4)$$

Substituting the value of R_H in (2) replacement of the porosity term by e/1+e, and introducing a composite shape factor C to include the factor Cs, the numerical constant, and all other shape effects, gives

$$Q=(Ds^2\frac{\gamma w}{\mu}\ \frac{e^3}{1+e}C)\ i\ A \qquad ..(5)$$

comparing (1) & (5) it follows :—

$$K=Ds^2\frac{\gamma w}{\mu}\ \frac{e^3}{1+e}\ C \qquad ..(6)$$

It is reasonable to expect that the seepage velocity through a given soil and the permeability of the soil are proportional to the square of the average pore dimensions. Since the item having the greatest effect on sizes of pores in a given soil is the grain size, it may be concluded that permeability varies approximately as the square of the grain size.

Allen Hazen found that the permeability of filtered sands could roughly be expressed by

$$K = 100 (D_{10})^2 \quad ..(7)$$

In this expression D_{10} is the 10 per cent size, which is known as Hazen's effective size and K is the coefficient of permeability.

Since it was determined for filtered sands, it may not give satisfactory results for soils of other types. In case of fine grained soils the effective size (D_{10}) is not easily determined therefore larger percentage size may be used for permeability computations.

Main Text of the Report

The coefficient of permeability in all the International units decreases with the increase of clay content in a soil specimen as shown in the Table below:

TABLE 1

K (cms/sec)	Drainage	Soil type
10^2	Good	Clean gravels
10^1	Good	Clean gravels
1.0	Good	Clean sands
10^{-1}	Good	
10^{-2}	Good	
10^{-3}	Good	Clean sand and
10^{-4}	Good	gravel mixture.
10^{-5}	Poor	Very fine, sands, organic and inorganic silts, mixture of
10^{-6}	Poor	sand silt and clays, glacial till, stratified clay deposits.
10^{-7}	Practically.	Homogeneous clays below zone of weathering.
10^{-8}		
10^{-9}	Impervious.	

After Casagrande and Fadum

The decrease in the porosity leads to a decrease in the permeability of a soil for two distinct reasons. First, it causes a decrease in the percentage of cross sectional area available against flow, second it causes a decrease in the dimensions of pores which decreases the average velocity.

As mentioned in foregoing pages, that in fine grained soils the higher percentages of grain size can be taken for the computation of the coefficient of permeability as such from the previous data of the Institute for this tests various dia sizes of particles *viz.* d_{20}, d_{30}, d_{40} and d_{50} were put to computations and it was found mean dia particle size was most fitting for fine grained soils free from gravel. A counterbalancing factor, plasticity index was used for calculating η by taking their ratio

$$i.e.\ \eta = \frac{\text{mean diameter in cms}}{\text{plasticity index}}$$

The assumptions for bringing this ratio into the computations was based on the equation (6). The permeability increases with soil grains sizes and it varies inversely with the decrease in the pores. The fine grained soils acquire plasticity which gives a reflection to the clay content in it and ultimately decrease the porosity.

The variable η was calculated for all types of soils tested in the Institute (typical data attached Table 2). The coefficient of permeability of fine grained soils determined at Proctor's maximum density were plotted as ordinate and the variable η as abscissa, on a log-log graph (Fig.). The cluster of points forms a parabolic shape. The mathematical equation was derived which is written as

$$K = 1.57 \times 10^{-10} + 1.8 \times 10^{-4}\eta + .43\eta^2$$

were K=coefficient of permeability in cms/sec.

TABLE

Typical test data (previous) of soil samples

Report No.	Sites	Grain Size Analysis								
		% pass U.S.S.						Pipette Analysis		
		8	16	30	50	100	200	.02 mm	.005 mm	.002 mm
133	Nari Bolan Dam ...	...	100	99.9	99.6	99.0	98.0	61.9	33.9	21.1
211	Mangla Hydel Site ...	100	99.1	98.1	90.5	78.8	67.5	42.1	19.6	10.5
,,	,,	100	99.1	98.3	86.8	73.5	51.6	26.7	10.9	4.9
225	Frontier Region ...	67.1	52.7	38.2	27.9	22.7	19.6	14.6	7.6	3.4
239	Masan Dam Site ...	99.7	99.4	99.3	98.3	79.5	57.7	22.8	9.4	5.7
,,	,, ...	99.8	99.6	99.5	97.9	75.5	45.5	15.0	6.3	3.5
,,	,, ...	84.3	83.5	83.1	79.1	74.7	67.1	34.3	13.8	7.4
,,	,, ...	100	99.6	98.9	90.8	79.0	74.0	44.4	15.6	10.2
242	,, ...	100	99.7	99.5	97.9	91.2	79.6	30.3	13.8	9.2
,,	,, ...	100	99.1	98.8	91.0	61.7	50.0	25.7	10.2	6.1
,,	,, ...	100	99.8	99.7	99.5	97.3	96.0	84.4	65.4	38.2
,,	,, ...	98.4	95.1	92.6	86.5	56.1	24.3	7.4	3.3	1.9
349	Poonch Dam Site ...	99.7	99.1	98.6	88.0	58.7	41.0	21.9	13.9	8.6
,,	,, ...	99.3	98.2	97.0	84.3	54.0	33.6	20.7	9.8	6.0
388	Nari Bolan Site ...	...	...	...	...	100	99.7	60.6	30.2	21.0
,,	,, ...	99.9	99.8	99.5	87.3	59.4	48.5	34.2	20.3	13.9

2

collected from various sites.

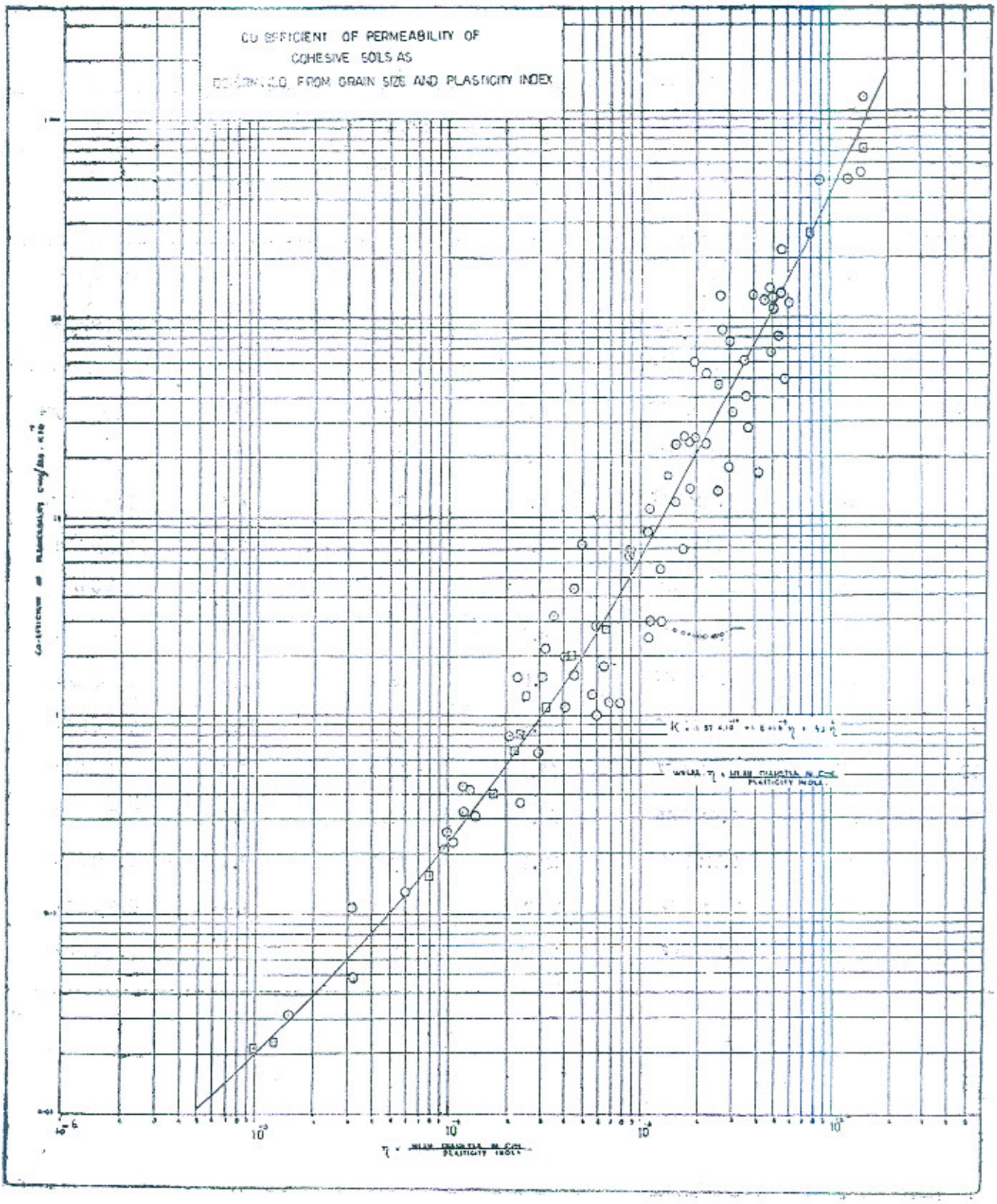
Report No.	Sites	Mean diameter (d50)mm	Coefficient of permeability K cms/sec (observed)	Atterberg's limits.			d50 (cms)
				Liquid limit	Plastic limit	Plasti-city index	PI =q
133	Nari Bolan Dam ...	.012	1.3×10^{-8}	43.6	24.6	18.4	6.0×10^{-5}
211	Mangla Hydel Site ...	.03	3.7×10^{-8}	29.1	16.8	12.3	2.4×10^{-4}
,,	,, ...	.073	1.1×10^{-6}	21.5	14.9	6.6	1.1×10^{-3}
225	Frontier Region ...	1.4	5.0×10^{-5}	27.0	16.8	10.2	1.4×10^{-2}
239	Masan Dam Site ...	0.6	1.33×10^{-5}	17.7	16.4	1.3	4.6×10^{-3}
,,	,, ...	.083	1.3×10^{-4}	20.0	19.4	.6	1.6×10^{-2}
,,	,, ...	.043	4.5×10^{-7}	24.9	18.9	6.0	7.1×10^{-4}
,,	,, ...	.025	6.6×10^{-8}	27.4	19.2	8.2	3.0×10^{-4}
242	,, ...	.039	1.8×10^{-7}	26.3	20.3	6.0	6.5×10^{-4}
,,	,, ...	.074	6.2×10^{-6}	16.5	14.3	2.2	3.4×10^{-3}
,,	,, ...	.003	3.2×10^{-9}	4.3.4	23.5	19.9	1.5×10^{-5}
,,	,, ...	.15	5.0×10^{-5}	25.5	23.8	1.7	8.8×10^{-3}
349	Poonch Dam Site ...	.11	4.0×10^{-6}	19.8	16.6	3.2	3.4×10^{-3}
,,	,, ..	.13	1.4×10^{-5}	20.4	17.8	2.6	5.0×10^{-3}
388	Nari Bolan Site ...	.015	2.3×10^{-8}	34.5	20.1	14.4	1.0×10^{-4}
,,	,, ...	.086	1.4×10^{-6}	20.3	15.5	4.8	1.8×10^{-3}

TABLE

Sample No.	Grain size Analysis								
	% pass U. S. S.						Pipette Analysis		
	8	16	30	50	100	200	.02	.005	.002
1	99.8	99.0	97.1	88.9	75.0	55.8	27.8	10.5	2.1
2	100	99.7	99.3	98.5	96.0	87.5	54.1	25.0	16.3
3	...	...	100	99.8	99.5	99.0	88.3	62.5	43.5
4	...	100	99.7	98.3	97.8	93.5	41.5	21.2	17.6
5	...	...	99.6	98.5	97.8	92.1	34.6	16.5	12.7
6	100	99.8	99.2	98.5	96.5	89.5	50.0	15.5	9.3
7	100	99.0	97.5	92.0	80.5	55.8	26.6	16.8	13.5
8	...	100	99.6	98.5	96.5	84.0	36.5	17.9	11.5
9	...	...	...	100	99.9	98.1	60.0	27.9	18.3
10	98.3	90.8	76.0	54.6	41.8	32.2	17.1	5.9	1.8
18	...	100	99.8	99.3	99.0	98.5	87.5	59.5	35.5
12	100	98.0	92.5	76.0	54.9	40.0	23.5	14.6	11.5
13	100	99.7	99.6	98.4	85.5	61.2	15.4	4.2	2.8
14	...	100	98.9	97.3	91.0	78.5	40.0	16.2	8.0
15	99.9	99.7	99.5	99.0	98.5	91.8	38.5	11.8	6.1
16	100	99.5	98.5	98.0	96.2	86.7	44.2	18.4	13.0

3

Sample No.	Mean diameter (d50) mm	Coefficient of permeability K cms/sec (observed)	Atterberg's limit			d50 (cm)
			Liquid limit	Plastic limit	Plasti-city index	PI
1	.064	2.6×10^{-5}	22.8	22.0	.8	8.0×10^{-3}
2	.018	0.8×10^{-7}	26.8	19.3	7.3	2.4×10^{-4}
3	.0023	2.1×10^{-9}	45.0	21.8	23.2	1.0×10^{-5}
4	.028	1.6×10^{-7}	29.1	20.0	9.1	3.07×10^{-4}
5	.035	2.0×10^{-7}	25.2	17.4	7.8	4.90×10^{-4}
6	.020	1.3×10^{-7}	26.0	20.0	6.5	3.33×10^{-4}
7	.065	4.4×10^{-6}	24.5	22.0	2.5	2.6×10^{-3}
8	.033	4.0×10^{-8}	27.4	18.2	9.2	3.6×10^{-4}
9	.013	1.7×10^{-8}	34.2	18.5	15.7	8.0×10^{-5}
10	.24	7.0×10^{-5}	20.0	18.4	1.6	1.5×10^{-2}
11	.0034	2.40×10^{-9}	48.4	25.5	23.1	1.3×10^{-5}
12	.13	6.0×10^{-7}	28.5	16.9	11.6	1.1×10^{-3}
13	.061	1.6×10^{-6}	20.2	16.6	3.6	1.7×10^{-3}
14	.03	6.7×10^{-8}	29.1	19.1	12.3	2.4×10^{-4}
15	.029	2.6×10^{-7}	22.2	17.8	4.4	6.6×10^{-4}
16	0.25	1.3×10^{7}	28.4	18.9	9.5	2.6×10^{-4}


COEFFICIENT OF PERMEABILITY OF
COHESIVE SOILS AS
DETERMINED FROM GRAIN SIZE AND PLASTICITY INDEX

On the basis of large observations the values of constants involved are :

1.57×10^{10} cms/sec.
1.8×10^{-4}/sec.
0.43/cms/sec.
and

$$\eta = \frac{\text{mean diameter in cms}}{\text{plasticity index}}$$

For a counter check of this equation thus derived, 16 soil samples, collected from different localities, were subjected to all the relevant tests. The data is included in Table 3.

CONCLUSION

The coefficient of permeability can be very nearly determined from the empirical relation :—

$$K = 1.57 \times 10^{-10} + .43\eta^2 + 1.8 \times 10\eta^{-4}$$

where K=coefficient of permeability cms/sec.

$$\eta = \frac{\text{mean dia in cms}}{\text{plasticity index}}$$

thus saving a lot of time involved in running the permeability test. This equation replaces the Allen Hazen equation, but is applicable to cohesive soils.

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NEWS AND NOTES

PAKISTAN INTERNATIONAL SYMPOSIUM ON ELECTRICAL ENGINEERING

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Head of Department and Chairman, Organizing Committee.

Attention : Members Please

PUBLICATION OF ENGINEERING NEWS

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

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

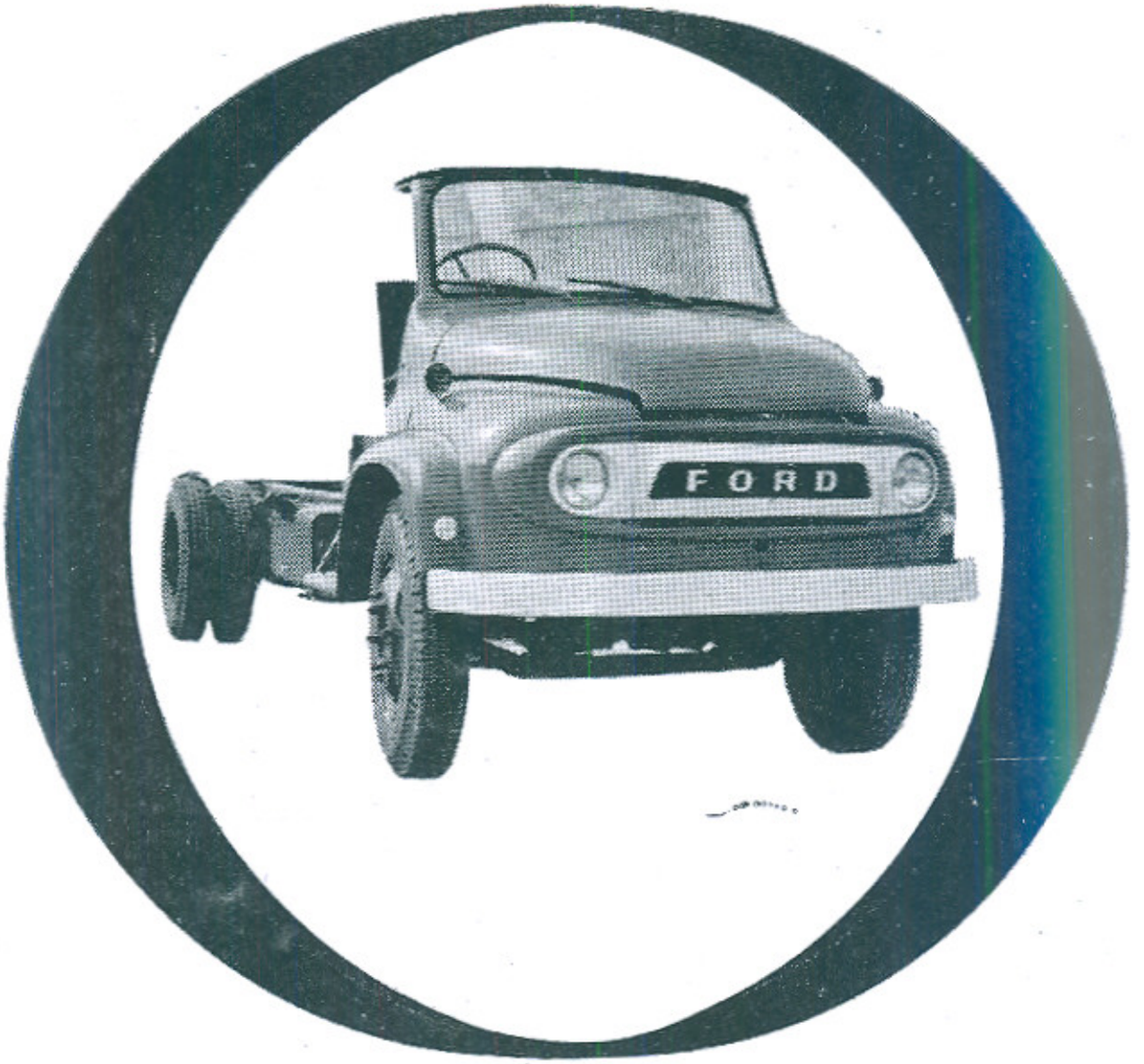
Other interesting features are news pertaining to Engineering Professions, abstract of papers and other relevant material.

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

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

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

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



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