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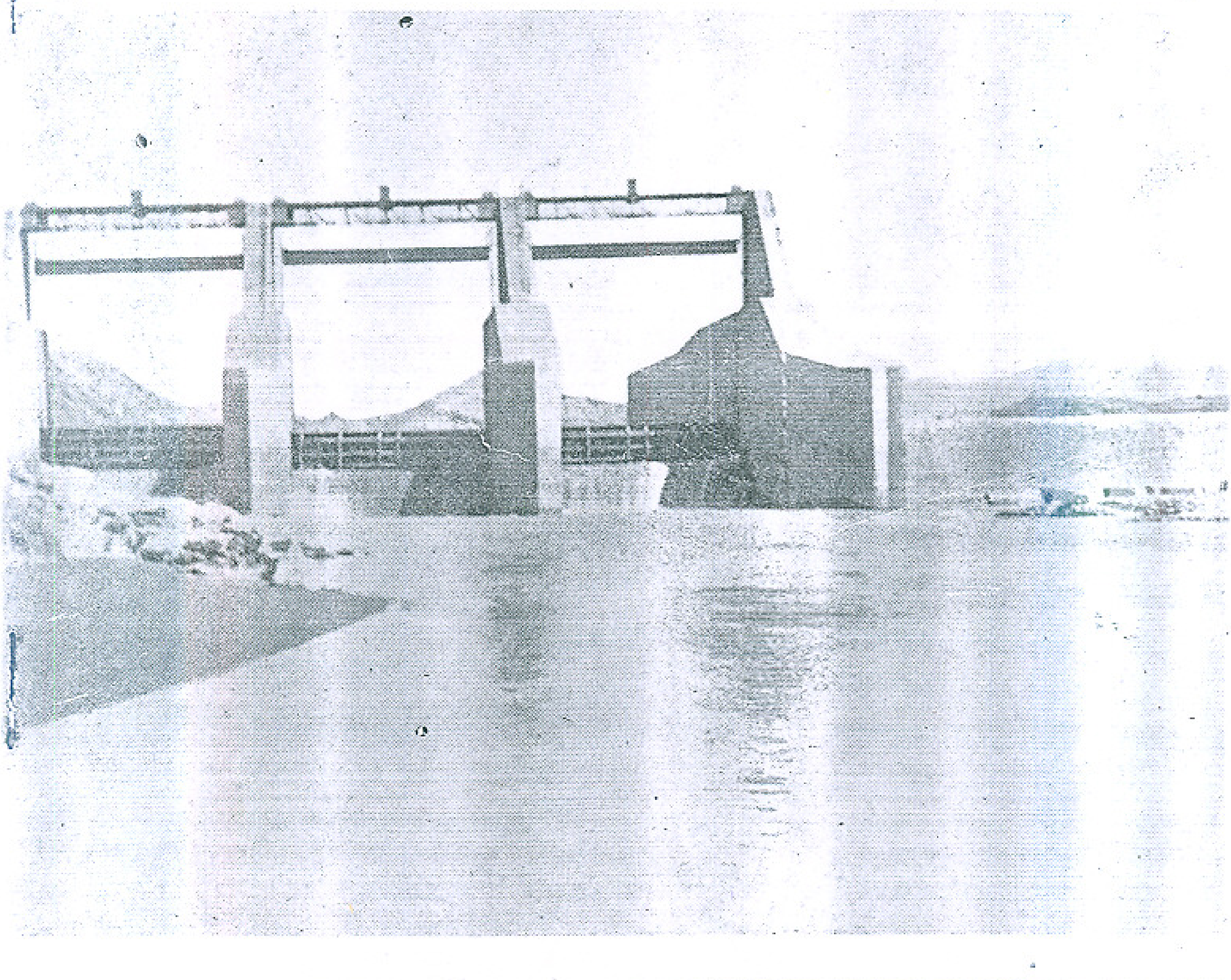

WEIR ON KURRUM RIVER
(See page 5)

ENGINEERING NEWS

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Contents

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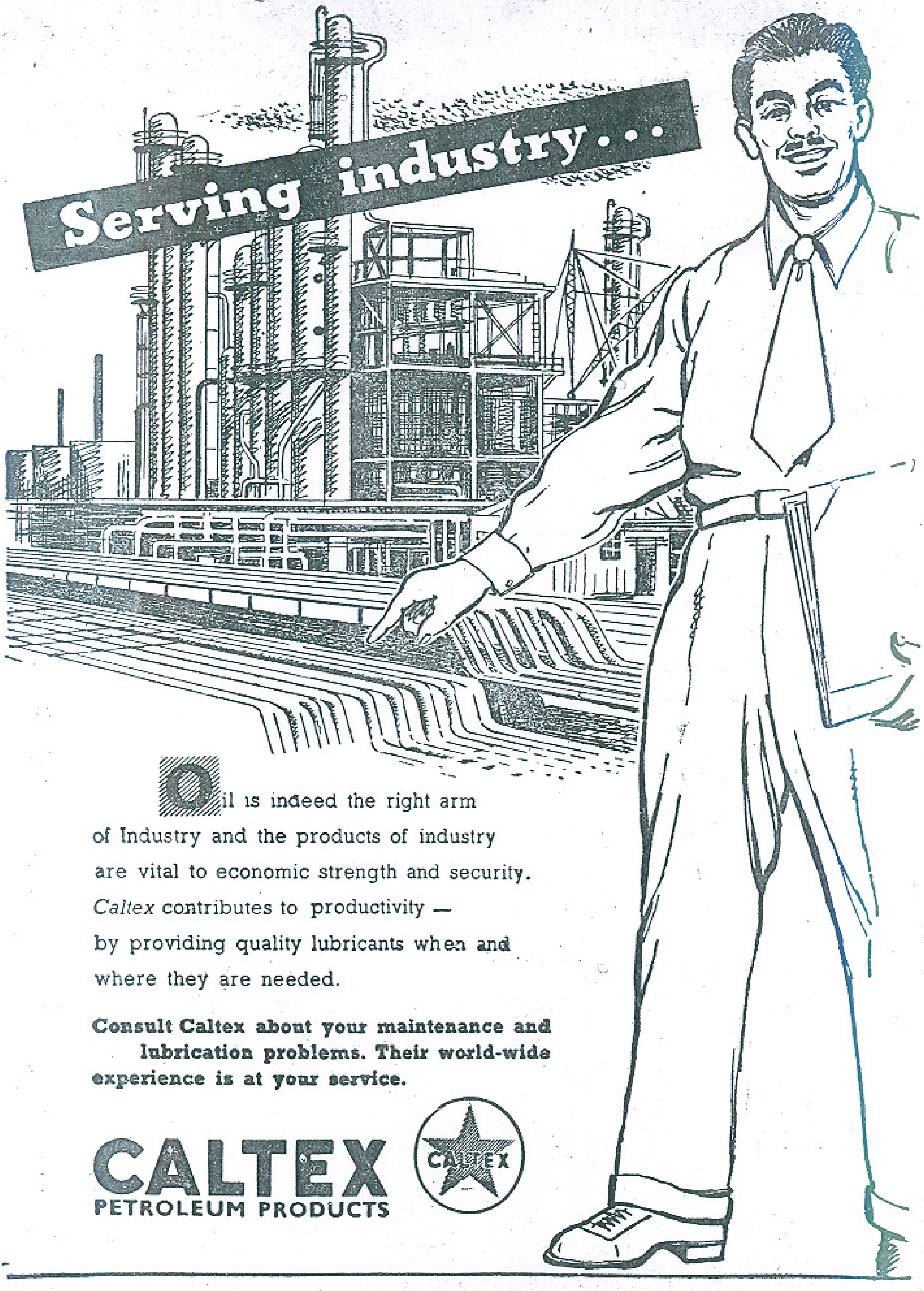
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About Ourselves

While we do not want to conceal our satisfaction that during its brief career this journal has put itself well on the way to fulfilling the purposes for which it had been launched, we owe it to ourselves to explain some of the difficulties with which we have invariably found our path to have been somewhat unreasonably strewn.

Publication of a journal is never a very sure pre-planned process. We cannot plot a course, take our ease, and move blithely along, believing that there is nothing we have ignored and that we need never reckon with unanticipated obstacles. Even our brief experience in this field has amply taught us that an optimism of this kind is largely indefensible: right from the point of trying to persuade some good writers to the struggle within the four walls of the printing press, the publishers are confronted by a host of problems incapable of solution by their effort alone, and not infrequently compelling a revision of what was a most cherished decision a few days ago.

The most outstanding of these problems is the non-availability of articles in sufficient number. We have yet to be allowed a reasonable choice in improving the quality of the reading material as most of the persons on whom we depend for contributions are either shy, evasive or preoccupied with professional pursuits. We had thought that the publication of a couple of issues will stimulate a willingness among the members of the profession to keep our hands full with articles, but unfortunately this hope has not been fulfilled.

We are pained that even comments from readers, to which every publication is entitled, have not been made available to us this time. No goals, however, humble, can actualize if those entrusted with their initiation and direction are forced to feel that their efforts are not being watched with a reasonable measure of interest even by the persons whom they are directed to serve. We do not mind criticism; on the contrary, we welcome criticism if it is calculated to help us in conceiving of the lines along which any improvements can possibly be brought about. But the non-chalance of readers, reflected in their not writing to us at all, is bound to arrest the progress of our efforts in the direction we have in mind.

No less baffling has been the problem of securing paper. Despite our having applied to the authorities well in time for allocation of eight reams of art paper, what we have been permitted at this late hour actually to purchase is a bare two reams which is as good as no allocation at all, because neither can we reduce the circulation of the journal, nor its volume. We have, therefore, again unwillingly to fall back on the use of the inferior mechanical quality which also is available with some difficulty in the market.

We do, however, hope that these difficulties will not beset us in future; and it will be possible further to improve the publication.

Kurrum Garhi Multipurposes Scheme

*By Sarwar Jan Khan**

OF ALL irrigation schemes under construction in West Pakistan, the Kurrum Garhi multipurpose project is most outstanding. It will go into operation within two years and will help fertilise the land lying on the western side of Indus and within the boundaries of Bannu District.

Before undertaking this scheme, about 100,000 acres of land in Bannu District were irrigated by constructing Kucha Brush Wood Boulder Bunds across the river. This method often resulted in washing away of the bunds, and blocking of the canals, depriving the land of irrigation, rendering waste the immense labour devoted to their construction, and making it necessary to engage fresh labour for their reconstruction.

PRESENT SCHEME

The present scheme consists of controlling the Kurrum river by means of a weir and diverting its water into irrigation channels. The Kurrum river, although a small torrent rising from Safed Koh and draining 4,215 square miles, has a perennial flow of average discharge equal to 560 cusecs, and sometimes floods up to 1.5 lakh cusecs.

The weir across the Kurrum river, consisting of three bays of 40 feet width, including undersluice, and founded on rocks, has been completed (front page photograph). The canal head regulator consisting of six bays of 20 feet each will discharge water into a tunnel, 450 feet in length and having a discharging capacity of more than 3,000 cusecs through a lined main line canal, which splits up into three channels, one of which feeds the reservoir of the Baran Dam and has a capacity of 1,600 cusecs, while the main line lower carries 1,400 cusecs. A silt excluder is to be constructed at this site and more discharge will be let into the main line upper corresponding to the discharge passing through the excluder bays. In plan I is given the details of the layout of the scheme.

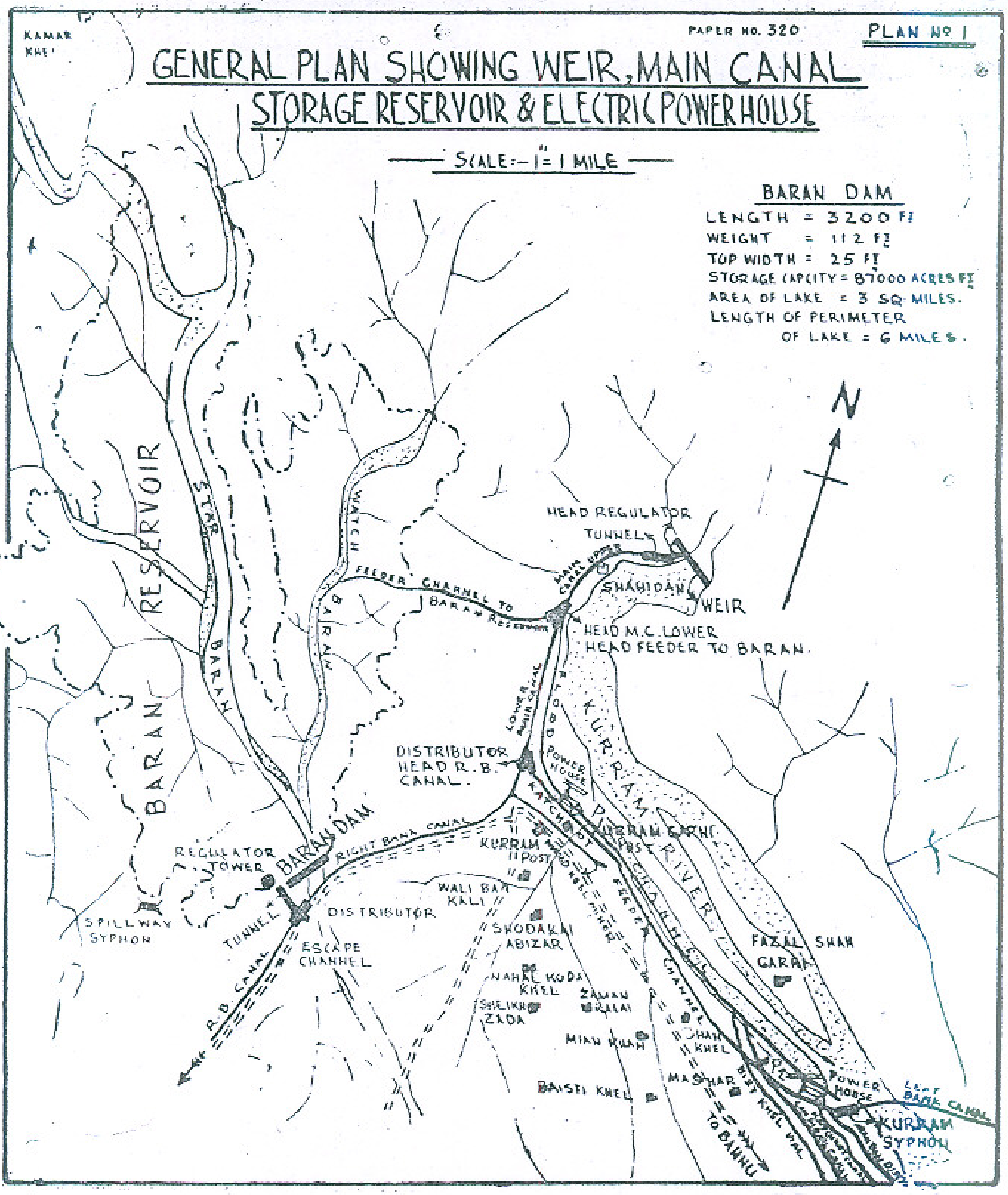
The most important item of this scheme is the creation of a reservoir in the Baran Nullah, which flows close to the Kurram river and the daming of which will create a reservoir of 87,000 cubic feet capacity. The Baran river is a small nullah with 154 square miles of catchment area and with the maximum recorded flood of 40,000 cusecs. This reservoir is to be created by constructing a 112 feet high and 3,200 feet long dam, with a spillway. It will be fed through the Baran Dam feeder channel with the water of the Kurram river.

The dam will be filled twice a year, once during monsoon, and the second time in spring, thus making possible to draw 800 cusecs for 55 days.

The construction of the dam is in full swing and round-the-clock work is in progress—excavating materials, bringing it to the dam site, and compacting it to the desired compaction by sheep foot roller.

An important item of construction of the dam as to grout the pervious bed-

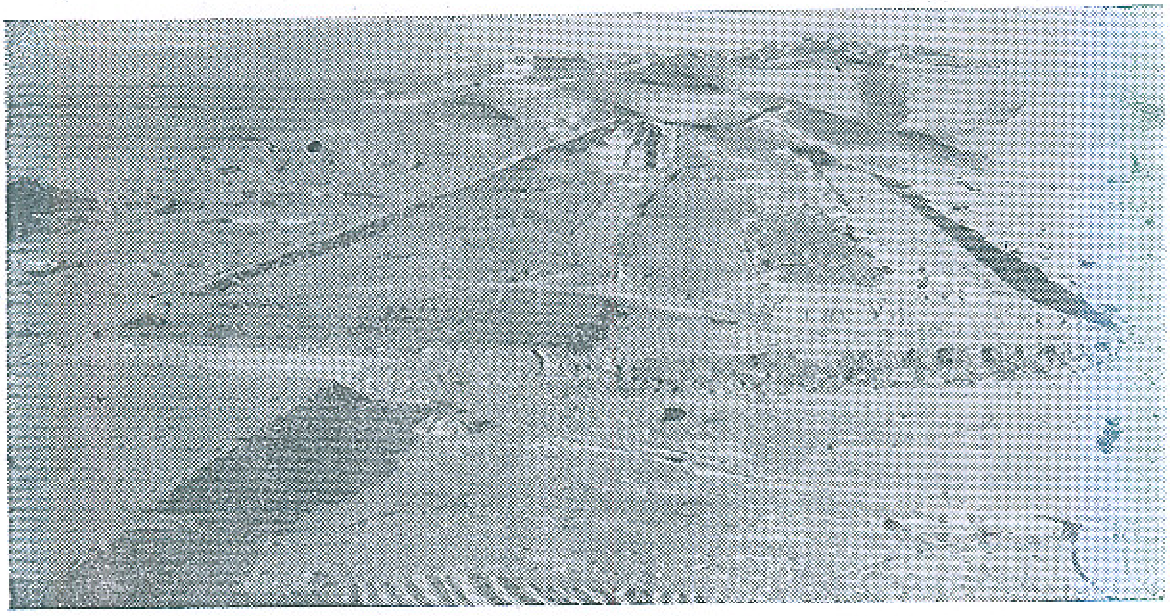
**Deputy Chief Engineer, Peshawar Region, Peshawar.*


PAPER NO. 320
PLAN No 1
GENERAL PLAN SHOWING WEIR, MAIN CANAL
STORAGE RESERVOIR & ELECTRIC POWERHOUSE
SCALE:- 1" = 1 MILE
BARAN DAM
LENGTH = 3200 FT
WEIGHT = 112 FT
TOP WIDTH = 25 FT
STORAGE CAPCITY = 87000 ACRES FT
AREA OF LAKE = 3 SQ MILES.
LENGTH OF PERIMETER OF LAKE = 6 MILES.
N
KAMAR KHEL
RESERVOIR
BARAN
HEAD REGULATOR
TUNNEL
SHAHIDAN
WEIR
FEEDER CHANNEL TO BARAN RESERVOIR
HEAD M.C. LOWER HEAD FEEDER TO BARAN.
KURRAM RIVER
DISTRIBUTOR HEAD R.B. CANAL.
POWER HOUSE
BARAN DAM
REGULATOR TOWER
RIGHT BANK CANAL
KURRAM POST
SPILLWAY SYPHON
TUNNEL
DISTRIBUTOR
ESCAPE CHANNEL
R.B. CANAL
WALI BAN KALI
SHODAKAI ABIZAR
NAHAL KODA KHEL
ZAMAN KALAI
SHEIKH ZADA
MIAN KHAN
FAZAL SHAH GARAI
BAISTI KHEL
MASHAR
TO BANNU
POWER HOUSE
LEFT BANK CANAL
KURRAM SYPHON

rock, which consisted of conglomerates, sand and silt stones etc., through which a considerable loss was expected. The grouted zone is illustrated in plan 2.

The earth dam being constructed at the site has three zones, one of impervious clay, and the two outer shells of semi-pervious and pervious regions. The spillway for this reservoir is still to be constructed.

area of land which includes existing irrigation of 112,000 acres with more reliance, safety, security and without loss of useful irrigation days and employment of free labour. The saving in free labour alone will amount to 60,000 men days. At present about 1,50,000 acres of 'banjar' land will get permanent irrigation water.



Baran Dam Under Construction.

Other important works which are complete include:—

(1) 300 feet of tunnels carrying the lined feeder channel.

(2) The lined main line lower which bifurcates into the right bank canal and the Katchkot canal, on which lie two 60 feet falls at sites P1 and P2 marked on the plan. The construction of penstock and foundation for turbine is complete, and the work is in full swing so as to complete the job according to the schedule.

BENEFITS OF THE SCHEME

(i) This multipurpose scheme, on its completion, will irrigate 262,000

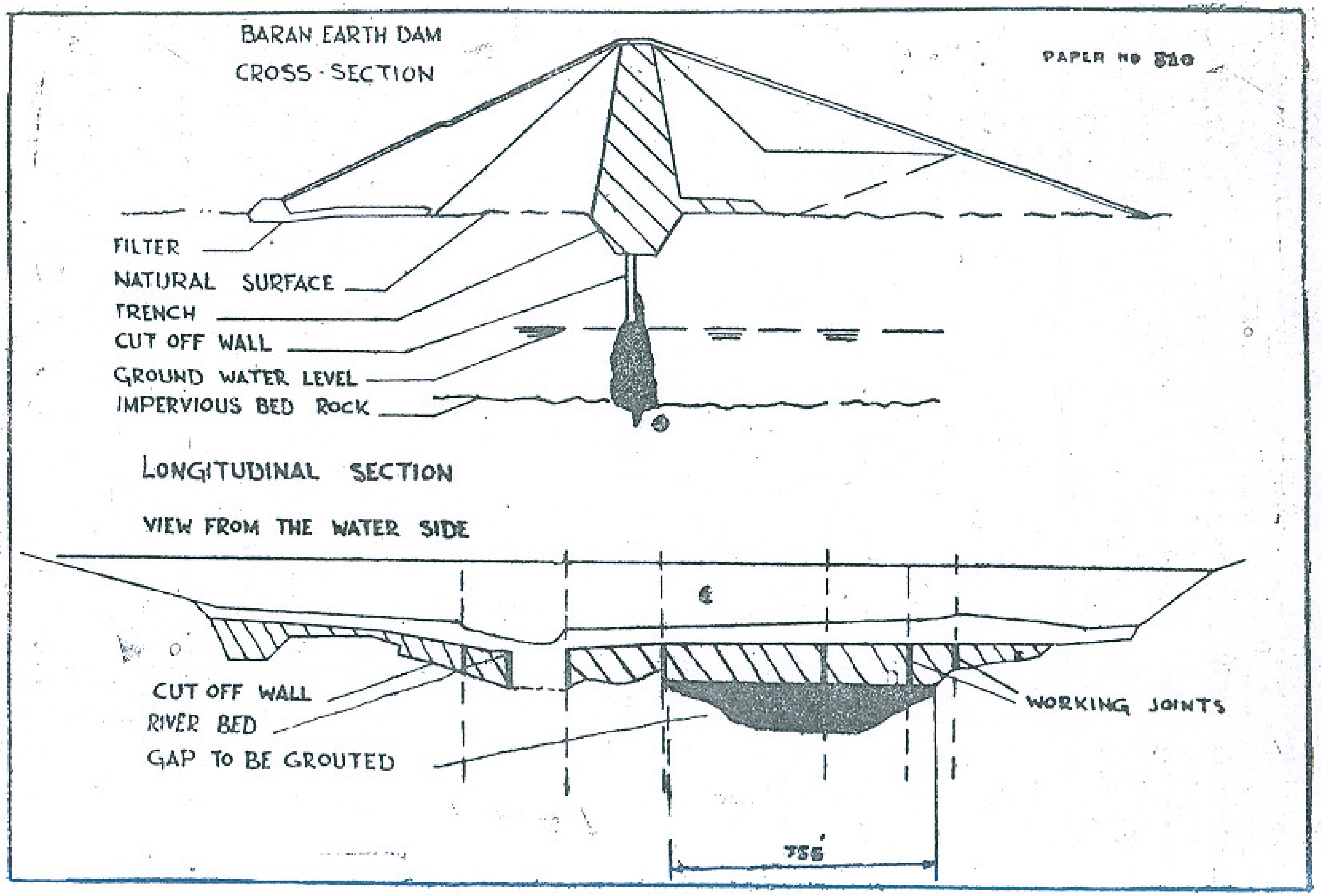
(ii) At the two 60-foot falls on the Kachkot canal, which carries a discharge of 558 to 400 cusecs, cheap hydel power of the order of 4,000 K.W. can be produced which further adds to the development of Bannu District.

(iii) Afforestation and reclamation of about 20,000 acres of unculturable area will be possible.

The bed of the Baran Nullah, canals and distributaries can be planted with trees.

(iv) This area has quite a big problem of drinking water. At places water is 200 feet below the ground level. This scheme will give permanent relief to the area.

Plan 2


BARAN EARTH DAM
CROSS - SECTION
PAPER NO 820
FILTER
NATURAL SURFACE
TRENCH
CUT OFF WALL
GROUND WATER LEVEL
IMPERVIOUS BED ROCK
LONGITUDINAL SECTION
VIEW FROM THE WATER SIDE
CUT OFF WALL
RIVER BED
GAP TO BE GROUTED
WORKING JOINTS
755'

METHODS AND TECHNIQUES OF GROUND WATER INVESTIGATIONS

*By M. S. Minhas**

THE cheapest source of water is a river. This source has been tapped in the Punjab as well as in other parts of the country by building diversion dams. The second in the order of importance from financial and economic standpoints is the water released from storage dams, where multi-purpose projects may be built.

In tapping ground water, great risk is involved not only in respect of the quality of water but also with regard to the quantity and the type of the land where the water is to be utilised. If the soil is of a poor quality, the crops and their out-turn may not sustain the expensive development of ground water supplies. On the other hand, if the quality of water turns out to be poor, the entire expenditure on the installation of wells will be wasted. These are some of the major factors which have to be considered before launching a ground water development project.

In many countries the development of ground water on an intensive scale led to such a heavy draught that the existing pumping machinery had to be discarded and a more expensive equipment capable of lifting water from greater depths had to be introduced. Outstanding examples of this phenomenon were provided by the Joaquin Valley of California and the Salt River Valley of Arizona. Besides the cost of the new machinery, an increase in the pumping lift entails a greater consumption of power and, therefore, an increase in the recurring cost too. Obviously, therefore, in these areas it was never possible to assess the safe yield of ground water.

THE SAFE YIELD

The maximum rate at which water can be artificially withdrawn from an aquifer without depleting the supply or altering the chemical character of the water until the time the withdrawal is no longer economically feasible, is termed the safe yield. It varies with economic conditions as well with factors like recharge, natural discharge, pumping head etc.

One of the difficulties in assessing the economic yield is proper appraisal of the economic and physical factors which are likely to change from time to time. The economical pumping level may change considerably over a period of time; an increase in the cost of power or in the available resources of water may decrease the economical pumping lift; and in some cases the amount of water in the storage may be so large that withdrawals in excess of the recharge, as stated above, be the only possibility for a long time to come.

*Ground-water Engineer, Ground-water Development Organisation, Lahore.

BASIC INVESTIGATIONS

In view of the progress in ground water research abroad and the serious ground water problems at home, a correct appraisal of the ground water supply must be made, and for that some basic investigations are necessary. These investigations cannot be confined to the development of ground water; sometimes their scope has to be considerably extended in order to determine the necessity of draining an area, and drainage covers not only the process of dewatering but also that of removal of salinity and alkalinity. In West Pakistan the problem is not so much of dewatering the waterlogged area, as of reclaiming saline and alkaline lands. The only method for reclaiming saline lands is leaching the affected fields—a process involving application of water, and thus creating the same problem which it is designed to combat, that is drainage of excessive water. Hence the principal lines along which ground water investigations may be carried out are as below:—

(1) Studies for planning ground water irrigation projects on the basis of region, major basin or sub-basin.

(2) Studies of geological and ground water conditions, of corrective drainage works on an existing irrigation system, as well as those related to potential drainage problems on lands to be irrigated.

(3) Studies to collect ground water data required for design and construction system, as well as those related to potential drainage problems on lands to be irrigated.

Some basic data are necessary for the solution of area-wise problems of ground water. A number of general procedures are laid down for obtaining such data. Let us consider in brief these general methods as well as the data obtainable from them.

GROUND WATER INVENTORY

The amount of ground water available to a given area depends on a number of factors—the amount of distribution of precipitation and surface flow, the type of soil, the topography of land, the extent of intake and catchment areas, the amount and type of vegetation cover during different seasons, the previous conditions of saturation, the depth to the water-table and the permeability of aquifers. Since ground water supplies are derived ultimately from precipitation, it is necessary to make an estimate of the potential recharge from precipitation on catchment and intake areas. Where surface irrigation is done, a certain percentage of the applied water contributes to the ground water reservoir, thus the effective precipitation occurring from rainfall and the irrigation water applied.

The general ground water inventory factors of increment and decrement are as folows:—

INCREMENT

(a) Rainfall percolating to the water table;

(b) influent seepage from rivers, canals and other sources; and

(c) inflow from outside the area being investigated.

DECREMENT

(a) Effluent seepage into rivers and drains;

(b) evaporation and transportation;

(c) artificial discharge by pumping; and

(d) sub-surface discharge from the area under investigation to adjoining areas.

These factors have to be determined over a period of years depending upon the continuity of the available record.

In making a ground water inventory, special care should be taken in demarcating the boundaries of the area to which a particular method is applied. As far as possible, this area should consist of a hydrologic and geologic unit, and contain a water body, the sources and losses of which can be segregated. The main problem besetting our investigations in the Punjab has been that the alluvial field being traversed by five streams without any apparent subsurface divide, it is not possible to reconstitute it into specific units by defining their boundaries. It is only surface features which enable a division of an area into suitable units and, therefore, in our case the Doabs are the major hydrologic units, the sub-units being divided by the drainage divide of a canal system.

The methods of making a ground water inventory have not as yet acquired the accuracy necessary to make them universally acceptable. They often require investigations so extensive and prolonged that they cannot be applied except to studies of importance. Meinzer has developed certain methods, a summary and general discussion of which is given in the "Outline of Methods for Estimating Ground-water Supplies".*

The making of a ground water inventory obviously involves various methods of hydrologic research. It is in the pursuit of these methods that various items of works have been adopted for field studies during the course of our investigations on ground water, and I shall cover these one by one.

WELL INVENTORY

An inventory of existing wells and springs contains much information that is useful in various phases of a ground water investigation. Its preparation, therefore, be regarded as a priority matter. From the inventory of wells the total pumpage in an area can be worked out.

DETERMINATION OF FLUCTUATION

The behaviour of the subsoil water-table may be affected by the peculiar geologic conditions of the substrata, the intensity of irrigation, the rainfall of the area and the intensity of pumpage by wells. The changes of barometric pressure, earthquakes and even running trains may influence the water level in wells under certain geologic conditions, while seasonal and monthly observations will reflect the effect of rainfall, inflow or seepage from canals. These changes are noted by making regular and periodic observations of water levels in observation wells and hydrographs of fluctuations in water levels in a set of wells. These studies have to be both short-range and long-range to enable us to arrive at accurate results.

The studies relating to well observations in the Punjab have been neither extensive nor intensive in the past. However, under the new setup of the Ground Water Development Organisation these observations are scheduled to be more frequent in areas having specific problems, such as waterlogging and salinity. Use has been made of existing masonry wells for observing water levels. Though economical this setup is rather crude and does not yield correct results. For this purpose it is proposed to replace the existing wells with pipe wells. It may also be mentioned that another phase of ground water investigations is to study the hydrologic conditions of the ground water reservoir below acquicludes, which may be rather extensive and fairly thick. The aim of this study is to observe the levels and

**U.S. Geological Survey Water Paper 636-C.*

hydrostatic pressure at depths ranging from 200 to 700 feet.

A continuous recording of fluctuations of water-table will require some pipe observation wells, with automatic water depth-recorders showing the immediate effect of rainfall, irrigation, barometric pressure changes etc. Piezometers (small pipe observation wells) also are used in evaluating effects of irrigation and canal seepage, and are installed along the existing canals, drains or deep wells. Piezometers of different depths indicate the hydrostatic pressure of underground water only at the bottom of the device. The movement of water and the gradient can thus be determined from the hydrostatic pressures indicated by piezometers. The source of seepage thus determined, the location of interception drain is facilitated. Piezometers may be installed in single, double or triple units in a grid. For a 100-acre area, a spacing of 300 feet to 400 feet, and for an extensive study, a spacing of one-quarter to half a mile is sufficient. The depth of a piezometer is governed by the expected depth of a water-table at the lowest level of the yearly cycle and by any usual soil stratification.

RAINFALL STUDIES

The objective of rainfall studies is to obtain data fairly representative of an area, with one rain gauge station serving at east 40 square miles. The existing rain gauges were found to be adequate except in the Thal area, where it was considered necessary to set up more rain gauge stations. These have since been installed. For evaporation studies, evaporation tanks of the kind used by the Bureau of Plant Industry of the U.S.A. have been set up. The studies on evaporation will be further supplemented by Lysimeters, which will provide data on

(1) Consumptive uses of crops;

(2) effect of the varying depths of water-table on salinity and crop production;

(3) accretion of irrigation water and rainfall to the water-table.

These studies will provide the data necessary to determine the varoius factors of the ground water inventory.

DISCHARGE MEASUREMENTS

The influent seepage from and the effluent seepage to rivers has to be determined by setting up discharge measurement stations on rivers in such a way that the intervel between the two stations does not exceed 50 miles. The methods of discharge observation at these sites also have to be improved, and for attaining completeness of record and measurement of discharge in high floods, heavy weights up to 300 lbs., mechanical or electric hoisting arrangements, and automatic depth-recorders are being set up on rivers at important sites. The losses and gains in different reaches of rivers will be worked out from the data thus obtained in the field. That will determine the influent seepage from and the effluent seepage to rivers. In the same way, seepage losses from canals are to be determined by selecting suitable reaches of different canals and branches. The flow of drains, especially seepage drains, also, is corelated and fitted into the general equation of ground water inventory.

The general equation for the portion of hydrologic cycle considered is:—

1. NEGATIVE OR INFLOW ITEMS:

   (a) Inflow at the Base Upstream Station.

   (b) Precipitation on the free water surface.

   (c) Bank ground water storage (for declining river stage).

   (d) Tributary inflow.

(e) Channel storage (declining river stage).

2. POSITIVE OR OUTFLOW ITEMS
   (a) Outflow at the Base Downstream Station.
   (b) Evaporation from the free water surface.
   (c) Bank Ground water storage (rising river stage).
   (d) Diversion.
   (e) Channel storage (rising river stage).

The difference equals the direct ground water inflow to the stream. But it does not equal the total excess ground water in the area.

GEOLOGICAL STUDIES

Principally, the Darcy law is used in calculating the yield of water moving under a hydraulic gradient. Darcy's equation is $Q = PIA$ where:—

- Q is the quantity of water discharge per unit time;
- P is the permeability of the formation through which water is moving;
- I is the hydraulic gradient; and
- A is the area of formation across which water is moving.

To arrive at A and to determine the general sub-surface conditions of the flow of water, the geology and characteristics of the formations should be known. The geology of an area is rarely known beforehand in sufficient detail with the help of which to define the boundaries and composition of aquifers. The existing deep wells and their logs help a geologist in preparing a programme for test drilling and geophysical work. Drilling being an expensive operation great care has to be taken in formulating as well as carrying out a programme. It is not always possible to set up a complete programme at the start. Often, the results of the first holes are to determine the location of the later ones, making a competent field supervision absolutely necessary. Availability of competent drillers and adequate technical supervisors is, therefore, vital to the success of this work.

In order to determine the thickness of aquifers the occurrences of acquicludes, the aerial extent of aquifers, and the hydraulic characteristics of aquifer materials, the following work has been understaken in the Punjab.

TEST DRILLING

Test drilling is being done by a straight rotary method. The strata chart of the hole drilled is obtained by the driller in collaboration with an experienced geologist. The pattern of test wells is that holes are located on test well lines at three-mile intervals, the distance between test well lines being 15 to 20 miles. The details of subsurface geology between two test well lines are determined by geophysical work. Mainly, it is the electric resistivity method that has been adopted for corelating the occurrences of aquifers.

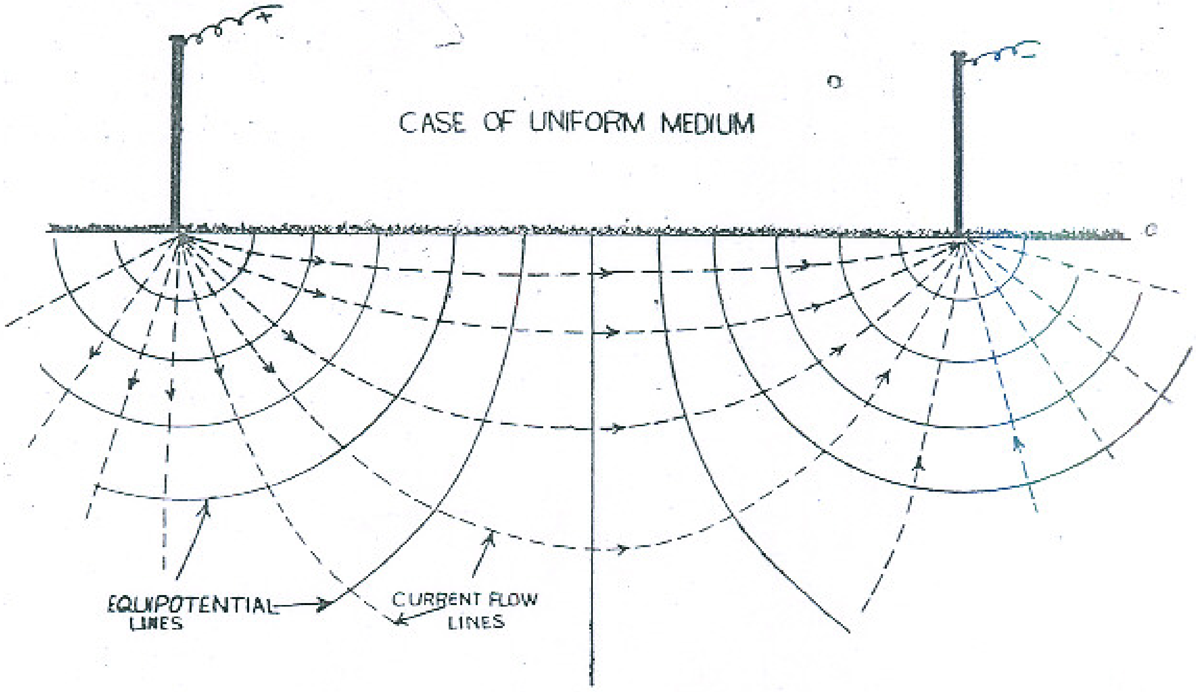
In the Punjab, the existence and the depth of the rock ridge known as Shahpur-Delhi is to be determined. Some investigators have envisaged the possibility of these rock ridges acting as a barrier to the flow of underground water, thus contributing to the rise of the water-table. It is in this connection, though not primarily for that reason, that the depth of test holes is of the order of 300 feet to 600 feet and 1500 feet. The formations drilled in a test hole, also, are compared by conducting an electric-logging test within the hole itself. The test holes are converted into observation wells where it is necessary to do so for drainage studies. They also help in planning location of test wells, and sometimes a test hole can be converted into a test well with advantage.

The principal use of geophysical methods appears to be along the line of prospecting—in extending the information derived from test drilling and in making the drilling more effective.

Geophysical methods of exploration also furnish direct or indirect information regarding the occurrence and composition of ground water. The location of water-table is most economically determined by geophysical methods in areas where drilling to greater depths would be expensive. The thickness of previous formations and water-bearing mediums is also determined in the same way, and it requires proper interpretation of the results by the ground water geologist.

The electric resistivity method, which involves interpretation of the conductivity data, takes into account the vertical and lateral sub-surface distribution of ground water and its variation in chemical content. The underlying principle is to measure the resistivity of the formation by introducing electric current at two points on the surface and measuring the potential development in the sub-surface at any other two points not far from the electric current. Saline water will have low resistance and an estimate of the degree of salinity can be based on the degree of the decrease in resistance. Saline water and saturated clay behave similarly, and in electric resistivity studies they are likely to be confused with one another.

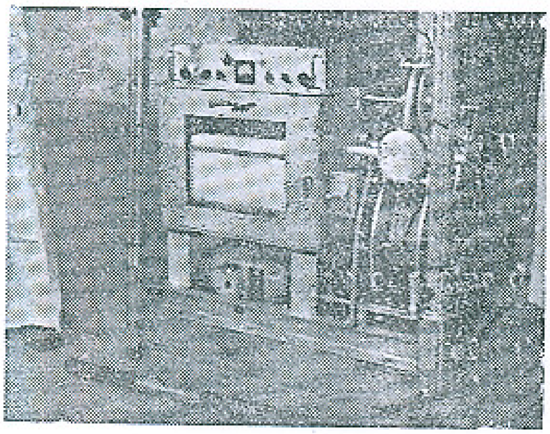
While exploring in an area, use is made of the information collected from test holes described above, and an intelligent study of the test drilling data helps in interpreting geophysical results. Gist sets are being used by the Ground Water Development Organisation for exploration by electric resistivity methods.



The electric well logging technique used by all engineers in the field is widely used for determining texture characteristics and prosity of formations. The electrode is lowered in a hole after drilling has been completed.

PUMPING TEST

For determining permeability (P in Darcy's equation) many methods are employed, but the most practicable and reliable results are obtained by pumping tests, known also as aquifer tests. For determining the hydraulic characteristics of aquifers, aquifer tests are performed on tube-wells, located at suitable intervals and spread almost in a grid system over an area under irrigation. However, a knowledge of the limits of the methods of pumping test* is necessary for achieving reliable results.



Wsdco XDM Electric Logging Set

Having information on the transmissibility co-efficient, the storage co-efficient, the storage capacity, and the drawdown of wells, the yield of a well field or a group of wells can be computed by the Theis Equilibrium formula. The permeability and the storage co-efficient thus obtained give a correct picture of the conditions of ground water, whether artesian or water-table or leaky artesian. Aquifer tests will supply data that will help determine the interference and spacing of wells as well as the future drawdown of wells.

INTERFERENCE OF WELLS

Interference occurs when two or more wells are so close that their cones of depression overlap one another during pumping. This results either in a greater drawdown in each well, or in a reduction of the discharge, or in both. The matter of spacing of wells becomes one of relationship between the advantages of reduction of interfernce and the advantages of closer spacing. In some cases it may be possible to lower pump bowls below the lowest expected water level although this will necessitate an increased pumping lift. To avoid interference, proper spacing should be determined at the beginning of a project. A testing of existing wells may provide data for designing and spacing of wells and for revision of the existing locations. Besides field tests, model studies in laboratory for application of electric analogy methods should facilitate solution of complicated problems of interference of wells as well as others related generally to ground water. Arrangements exist at the Lahore Irrigation Research Institute for such laboratory studies.

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*(*For details please refer to the paper " Methods for Determining the Permeability of Water-Bearing Materials " by L. K. Wenzal of the U.S. Geological Survey).*

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MODERN EARTHMOVING EQUIPMENT

*By Asrar Ahmad Qureshi**

THE term earthmoving is used generally for operations involving the moving of earth, rock, coal or ore. A civil engineer working on a major project like the construction of a dam, of an irrigation channel, of a railway embankment or of an airport, is confronted with the task of selecting the right type of machines, which requires a sound knowledge of the functions as well as the limitations of the machines.

There are two fundamental operations in earthmoving:

(1) **Productive soil manipulation**—as is done by bulldozers or angledozers, draglines, shovels, excavator loaders, etc.

(2) **Earthmoving proper**—as is done by Rear Dump trucks, Bottom Dump trucks, Conveyor Belts, Cableways, etc.

Both of these operations are combined by a machine called scraper, which loads itself and then carries the load to the place of dumping.

The machines most commonly in use are as follows:—

BULLDOZERS:

A bulldozer is a tractor (it may be a wheel type, or a track type, which is known usually as a crawler-tractor) fitted in the front with a strong steel blade for pushing or dozing earth. The blade is operated hydrualically; and it can be raised and lowered only in a vertical plane. An angledozer is similar to a bulldozer, the only difference being that in the former the blade can be tilted at an angle to the horizontal plane. Both of them can be used for moving earth within short distances. The action involves a back-and-forth movement of the tractor, every time bringing forward considerable amount of earth and depositing it at the desired place.

USES

Bulldozers are used for clearing jungles and bushes, for levelling uneven land, for pushing scrapers, for spreading the earth dumped by Bottom Dump and Rear Dump wagons, for felling trees by pushing them with the dozer blade, for making roads etc. A bulldozer is an indispensable piece of equipment for any earthmoving operation of a considerable size. Bulldozers range in horsepower from 50 to 400. In bigger ranges, each track is powered independently through a hydraulic torque convertor. A hydraulic torque convertor is a device which ensures maximum transmission of power to wheels or tracks at all times, through the medium of a fluid coupling, instead of the usual mechanical gears. This device eliminates shocks to the engine caused by an extra heavy resistance to the movement of the tractor, thereby ensuring a longer engine life and an efficient performance.

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*Asrar Ahmad Qureshi, B.Sc., (Engg.) M.Sc., (Iowa) ; A.M.I.E (Pak) ; J.M.A.S.C.E. (USE) ; Manager, Blackwood Hodge (P) Ltd.

EXCAVATORS

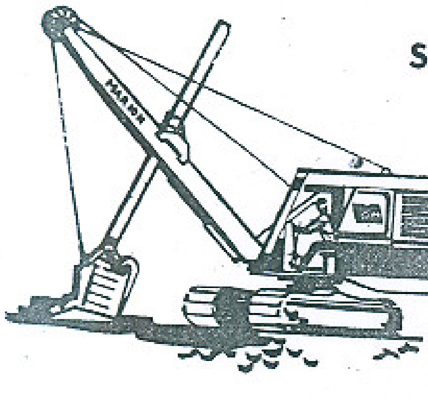
Excavators are machines serving as draglines, shovels, hoes, clamshells, cranes, and pile drivers. An excavator can be easily converted from one such machine to another by changing the front-end attachments.

What all these machines do is lifting something—earth or steel—and move it to a different location. To accomplish these functions they depend upon four basic operations, three of which are common to all machines and the fourth is essential to shovels only. These are (a) hoisting, to raise the load, (b) crowding (used only on shovels), to force the dipper into the material to be dug, (c) swinging, to move the load laterally to a new location, and (d) travelling, so that the entire unit can move to and about the job.

In all these machines, the revolving superstructure is placed on a mounting crawler or of the rubbertyre type. The or base, which may be either of the front-end operating equipment may consist of various booms and attachments, such as buckets, dipper sticks, hook blocks, etc., which determine the final type of operation of the unit—that is, as a shovel, as a crane, as a dragline, as a clamshell, as a hoe, or as a pile driver.

(i) THE SHOVEL

The shovel, probably, is the most popular and widely used type of power excavator. Its equipment consists of the shovel boom proper, the dipper stick, the dipper, and the dipper trip mechanism. In addition, it includes some mechanism on the revolving superstructure for crowding and retracting the dipper stick.



SHOVEL

The following operations are involved in a shovel dipper stick.

(1) The hoisting operation, by which the dipper is pulled through the material being dug.

(2) The crowding operation, by which the dipper is thrust or forced into the material being dug.

(3) The retracting operation, by which the dipper is withdrawn or pulled out of the material.

(4) Hoisting and crowding are usually employed simultaneously in the digging cycle—that is to thrust the dipper into material at the same time when it is being pulled through the material.

(ii) THE DRAGLINE

The dragline derives its name from the dragline bucket. The dragline bucket may be described as a scoop which is tossed away from the machine on to the material and is then dragged towards the machine, the bucket being filled with the material as it is dragged in and pulled through it. It is mostly used for underwater or dampy excavations. Some more uses of the dragline will be described later.

(iii) THE CLAMSHELL

This name is derived from the general shape and the operation of the clamshell bucket which is used on this machine. In general, a clamshell bucket consists of two halves or shells, hinged together at the top so that the bucket can be opened, or so that both the shells can be drawn together to form a sort of bowl-like arrangement. At the start of digging cycle the bucket rests on the material with shells open. On operation, the two halves or "clams" of the bucket come together, digging their way into the material and filling the bowl of the bucket as they come together. While the bucket is closing the weight of the bucket helps the bucket to bite into and penetrate the material being dug.

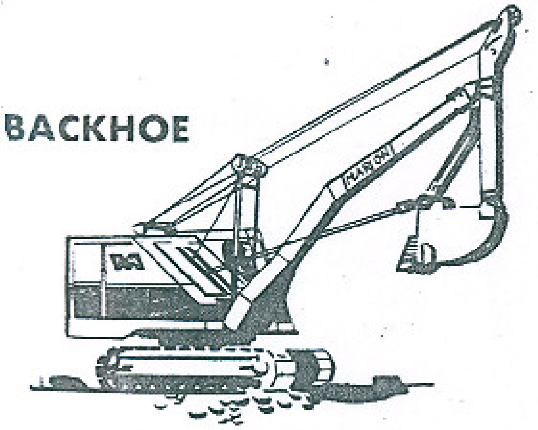
(IV) THE LIFTING CRANE

The Lifting Cranes primarily are units for lifting an object, transferring it to a new location by swinging of the superstructure or travelling of the entire unit, then lowering or replacing the object in its new position or location.

The basic lifting crane equipment consists of a common crane boom, hoist-drum laggings for the desired line speeds and pulls, and a hook block to provide the required parts of the line for the lifting service specified.

(V) THE HOE

The hoe is so named because its digging action resembles that of the garden hoe, in that the dipper is on an arm which is pulled towards the machine to dig. The hoe consists of a boom with a dipper stick pivoted at the



end of the boom, a dipper attached to the lower end of the dipper stick, proper drum laggings, and a mast or A-Frame at or near the boom hinges to provide proper hoist cable leads.

OPERATION:

(1) The boom, with the lower arm extended, is lowered into the excavation.

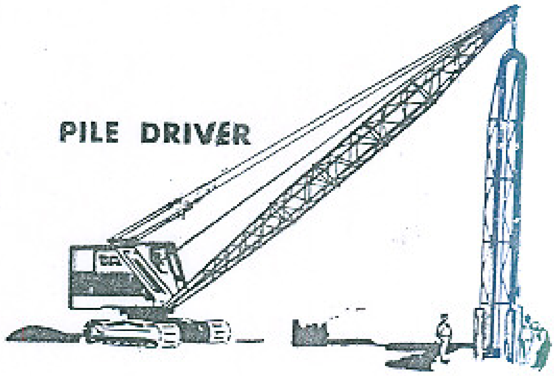
(2) The dipper is dragged or pulled towards the machine by means of the drag cable.

(3) When the dipper is filled, the entire boom assembly is raised by means of the hoist cable.

(4) The load is dumped by extending the dipper stick.

(VI) THE PILE DRIVER

Pile Drivers are machines for driving piles of various things—wood, con-



crete, pole type or steel sheet piling for foundations, sheathing or coffer dam work.

In general, a pile driver consists of the common crane boom equipment and hoist-drum laggings of a proper size, suitable cable, plus pile driving equipment.

WORK ZONE AND GENERAL CONDITIONS OF APPLICATION

(i) Shovel Work Zones: Digging a bank of rock or dirt, digging into a gravel bank or a clay pit, stripping overburden, digging cuts on a highway construction, or any job where there is a good bank or face for the shovel to work against. A shovel will also dig below grade or ground level for the construction of shallow ditches or roadside berms.

Other uses include to slope, trim and dress slopes on bank, dumping loads into hauling units at or above the ground level, dumping on to spoilbanks; dumping on hillside into valleys by side casting; dumping on to convey or belts.

GENERAL CONDITIONS OF SHOVEL APPLICATIONS:

A shovel should be used under the following general conditions:

(1) When the material to be dug is firm or hard.

(2) Where the excavation is large enough or sufficient space is available for the shovel to work and for the hauling equipment to have access to the shovel.

(3) Where disposal of material requires dumping of loads above or at the ground level.

(4) Where the nature of excavation provides for such depth or cut that the full productive ability of the shovel can be utilized.

(ii) Dragline Work Zones: A dragline is the most efficient unit when used

(1) to dig earth. slate, or wellshot rock, to strip overburden, to dig basements and to borrow pits;

(2) to dig trenches, and to dig and clean drainage ditches;

(3) to dispose of the excavated material by dumping it into hauling units; and

(4) to dispose of material by casting on to a spoilbank or built-on embankments.

GENERAL DRAGLINE CONDITIONS:

The dragline is used

(1) where it is necessary to dig at or well below the ground level;

(2) where the materials to be dug are soft to medium hard;

(3) where wet bottom job conditions exist, like the cleaning of ditches or the dredging of river sand and gravel; and

(4) where it is desired to cast or dump material as far from the unit as possible.

(iii) Hoe Work Zones: The hoe may be said to be a cross between a dragline and a shovel as it possesses some characteristics of each. It digs harder material than dragline or clamshell.

The hoe is used for

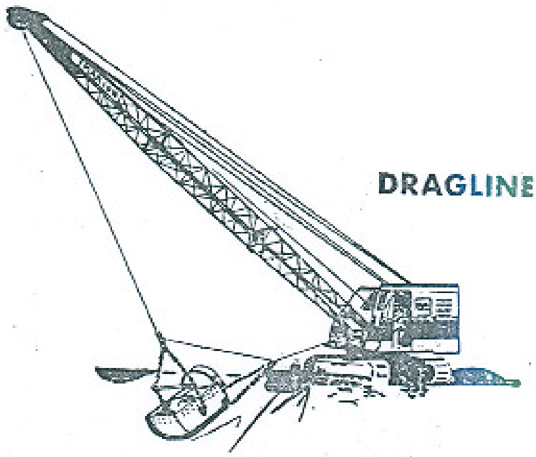
(1) digging channels and basements;

(2) digging trenches; and

(3) disposal of material by loading it into hauling units.

GENERAL CONDITIONS OF WORK:

(1) When the excavation is below the ground level;



(2) when the material to be dug is firm or hard;

(3) when the excavation must be trimmed closely; and

(4) when the disposal of the material is at a rather short range.

(iv) Clamshell Work Zone: It can dig or sport dump below, at or above the level of the machines.

(1) It is an ideal machine for handling or placing material at a higher or a lower level than would be possible with shovel or dragline.

(2) It is used to dig foundations, footings, pierholes, trenches, cellars, etc.

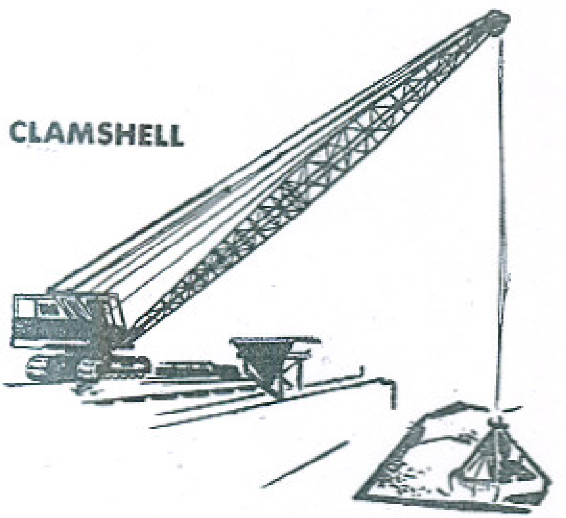
(3) It can be used for digging roadside ditches, and for building berms, trim banks and slopes. It can also be used for loading and unloading railroad cranes or hauling units. Another clamshell work is to build stockpiles, and to charge bins or dump materials about the ground level.

GENERAL CLAMSHELL CONDITIONS:

(1) It should be used where the materials to be handled are relatively soft or loose up to medium hard;

(2) where the digging or the handling of material is to be in the vertical range—below at or above the ground level;

CLAMSHELL



(3) where the digging is vertical and straight down as in the digging of piers, holes, shafts etc.;

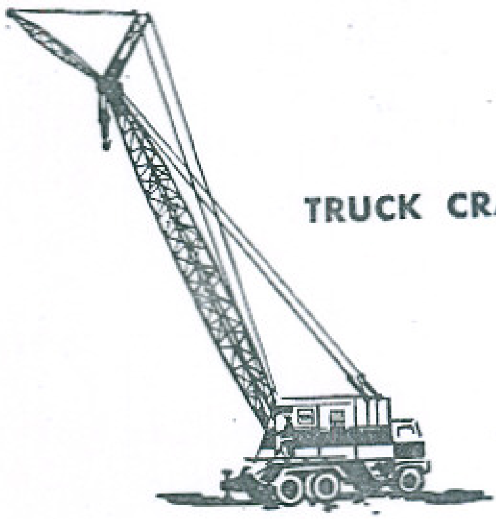
(4) where the dumping or disposal of material is required to be accurate;

(5) and for digging of sheathed trenches in which the vertical action of the bucket enables a clamshell to be worked through the cross bracing of the trench.

(v) Crane Work Zones: The primary purpose of the lifting crane is to lift load, to swing it or to make it travel to a new location, and to lower or to place it in a new location. The crane may be used, (a) to load and unload railroad cars and trucks, and (b) to lift and place loads anywhere in this work zone.

GENERAL CRANE CONDITIONS:

The crane may be used:



TRUCK CRANE

(1) where the load must be placed well above the ground level, e.g. erecting steel, stacks, bins and piling lumber;

(2) where extreme precision is required in placing load, as in erecting and straightening fabricated steel;

(3) where the load must be handled at the ground level, e.g. in unloading cars, storing material, etc., and

(4) where the load must be placed or lowered well below or well above the ground level, as in laying pipes and powering or lifting concrete buckets.

3. OFF-THE HIGHWAY TRUCKS

The three most important types are:

(1) Rear Dump Trucks.
(2) Bottom Dump Trucks.
(3) Scrapers.
(4) Side Dump Trucks, (this type being rarely used).

These trucks are available in the market in capacities varying from 6½ cubic yards or 10 tons, to 32 cubic yards or 50 tons.

(1) REAR DUMPS:

Off-The-Highway Rear Dump Trucks are not modified highway trucks. They are machines in which every part—the engine transmission, the differential, the steering, the suspension, the body tyres, in short, everything—has been designed for a dependable off-the-highway service. Rear dumps are loaded easily by shovels, draglines or transferbins. One end of the truck body is lifted up by hydraulic jacks and the load is dumped behind it.

(2) BOTTOM DUMPS:

A Bottom Dump consists of a four-wheeled tractor, pulling a Bottom Dump wagon, having doors in this bottom for discharging earth.

(a) Loading: A big open top area, a low loading height, and a large body capacity of a truck is an ideal combination for a fast and efficient loading. Bottom Dumps are loaded easily by loaders, shovels, draglines, or transferbins.

(b) High Production: Bottom Dumps are efficient units for relatively long and high speed hauls with large payloads. Their grade ability is somewhat less and their hauling capacity is somewhat larger than that of a rear dump of equal horsepower.

(c) Manoeuvrability: Exceedingly good manoeuvrability for working narrow cuts and fills, is a quality of Bottom Dumps. This is achieved by means of a short wheel base tractor joined to a semi-trailer.

(d) Dumping: Bottom Dumps shed their loads faster than other types of hauling units. Dumping on a fill is generally accomplished without a stop. The load is spread in windows, the length being controlled by the door opening's width and the travel speed. When dumping into drive-over hoppers, the load is delivered fast and clean because of the wedge shape of the body and big door-openings. The full-length-and-width doors are air controlled.

(3) SCRAPERS:

Scrapers are efficient earthmovers, combining the abilities to load, to haul, to dump and to spread. A scraper consists of a tractor pulling a scraper. Two types are built—a twin power scraper and a conventional scraper with a single engine. The twin power unit has separate engines driving the tractor and the rear wheels of the scraper. In both types, scraper operations are hydraulically controlled.

Fast acting and positive hydraulic control contribute to the outstanding performance of scrapers. All scraper operations are independent of each other. In addition to digging, loading and spreading fast, scrapers haul at travel speeds up to 31 m.p.h. when fully loaded.

(a) SINGLE ENGINE SCRAPERS:

Loading: Single engine scrapers sometimes require assistance of a pusher tractor for loading. The average hauling cycle, however, usually permits the pusher to assist from two to five scrapers. Scrapers work efficiently either singly or in fleets and are not dependent on loading machines that cannot be readily moved.

Dumping: Fast and positive hydraulic dumping controls permit loads to be spread to any desired depth and over any length of a fill. The high apron lift and the positive roll-out ejector help in fast dumping.

(b) TWIN POWER SCRAPERS:

Self-Loading: The Twin Power unit self-loads all materials commonly referred to as "scraper dirt"—that is without the assistance of a pusher tractor—under almost any job conditions.

Performance: Two engines power tractor and scraper drive axles separately; large tyres provide unusual flotation and traction, not found in other scrapers. The no-spin differential is standard in the scraper axle and optional in the tractor axle.

Spreading of Loads: Independent controls permit even spreading of the load, using the same apron and ejector arrangement as single-engine scrapers. In scrapers the twin power is an advancement with significant advantages. It became practicable with the development of heavy-duty torque converter and semi-automatic transmission. These are some of the important features:

(1) Large-capacity units utilizing proved power and drive components.

(2) Easy operation, and elimination of engine synchronization problems through the use of torque converters.

(3) Power equal to, or greater than that provided by a single power plant.

(4) Improved traction in Scrapers and Bottom Dumps through the use of widely separated drive axles.

LOADERS:

The loader is designed for high-speed loading of Bottom Dumps. It is pulled by a crawler tractor and its conveyor belt is powered by a diesel engine at the rear of the loader. The puller tractor and the loader are controlled by one operator, hydraulic controls being conveniently located in the tractor.

The loader handles most types of earth free of large rock, at rates ranging up to 1200 yards per hour, a very fast performance. Under favourable conditions, a Loader-Bottom Dump team is the fastest as well as the most efficient method of off-the-highway material moving. This combination has become an accepted standard (under certain conditions on large-scale projects such as dams, airports, highways, plant sites, and numerous stripping operations where big yardage has to be moved.)

SPECIALITIES OF RUBBER TYRES EQUIPMENT:

Better Flotation and Excellent Traction: The problems besetting operations over soft, spongy surfaces, borrow pits, and fills in an average heavy construction job, are solved by the provision of maximum flotation and traction. The most satisfactory method of achieving this is the use of large traction tread tyres, which provide better flotation than multiple small tyres of equal load capacity. The combination of a large tyres area in contact with the ground, a large rolling radius, and traction tread tyres, provides the flotation and traction needed in adverse working conditions.

4. USES OF OFF-THE-HIGHWAY TRUCKS:

Rear Dumps are used:

(1) for hauling large rock, ore, shale and similar materials or a combination of free-flowing and bulky loads;

(2) when dumping into restricted hoppers or over edges of fills;

(3) when the unit is subject to severe pounding in loading; and

(4) for maximum flexibility covering a variety of materials jobs.

Bottom Dumps are used:

(1) when dumping into drive-over hoppers, or where the load is spread in windows;

(2) for hauling free-flowing materials; and

(3) when relatively level roads allow high speed.

Scrapers are used:

(1) when cuts of limited size in many locations are required;

(2) for controlled spread of materials;

(3) when no mixing of materials is required; and

(4) when efficient earth-moving with minimum investment is desired.

Twin-Power Scrapers are used:

(1) for maximum traction, such as in self-loading; and

(2) for maximum flotation over soft, spongy ground.

Loaders are used:

(1) when 5 to 10 loads of free-flowing materials can be obtained between loader turn-arounds;

(2) for relatively long and level cuts and borrow pits; and

(3) when the volume of the material to be moved permits use of a loader and Bottom Dump fleet.

5. MATCHING EARTHMOVING EQUIPMENT TO A SPECIFIC JOB:

In matching the equipment to a specific job, three important steps are necessary:

(1) a thorough analysis of the operation;

(2) selection of proper equipment; and

(3) determination of the number of machines required and of the cost per yard or per ton.

The analysis should include such factors as existing equipment, loading, hauling, and dumping conditions; the required daily or hourly production; future haulage requirements; and any other data having a bearing on the job.

The manufacturers provide detailed descriptions of individual models, including size, construction, horsepower, capacity and performance. They also provide an "Estimated Hourly Ownership Cost Form", and give advice on the best models of "Hauling Production and Cost Estimates."

With the help of this information an estimated total cost of the job can be worked out and the equipment selected.

—o:o—

Importance of Thermal Properties of Concrete

*By Nazir Ahmad**
and
Mohammad Saleem†

In this article the authors have stressed the importance of thermal properties of cement and its aggregates while making quality concrete. The co-efficient of expansion of aggregates and cement is helpful in selecting materials of the same thermal expansion and thus the possibility of cracks is reduced. The heat of hydration is a characteristic of the type of cement used. In the case of mass concrete where quick equalisation of temperature for the whole mass is essential, heat of hydration, heat conductivity of concrete mass, its specific heat and diffusivity acquire an important role and the knowledge of these physical variables help in the construction of quality concrete.

CONCRETE is made by mixing properly graded hard and innert type of rock fragments with graded fine aggregate and a cementing material. A common type of cement is called the portland cement which consists of:

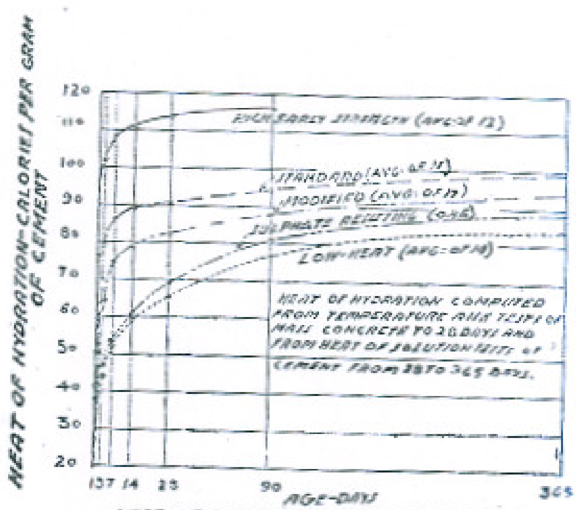
Lime or calcium oxide	60 to 65 per cent.
Silica	20 to 22 ,,
Iron Oxide	3.0 ,,
Alumina	5 to 6 ,,
Magnesium Oxide	2.5 ,,
Sulphate	2.0 ,,
Alkalies	0.2 to 0.5 ,,
Water	1 to 2 ,,

When water is added to cement or to its mixture with aggregates, hydration of cement starts and heat is produced which is called the heat of hydration of cement.

HEAT OF HYDRATION:—

There are several varieties of cement —each one used for a specific purpose. If a structure is liable to be attacked by salts, puzzolanic or high alumina cement is suitable. The latter variety of cement is quick setting and produces more heat on wetting than the former, which is slow setting and produces low heat. Thus, for a specific job a particular variety of cement is suitable.

While investigating heat qualities of cement, Sawage classified it into the following five varieties:



HEAT OF HYDRATION FOR VARIOUS TYPES OF CEMENT.

Fig. 1

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S. No.	Type of Cement	Average composition in percentage.							Lose on Ignition.
		1	2	3	4	5	6	7	
1.	High early strength	56	15	12	8	5.9	1.3	2.6	1.4
2.	Standard	43	31	12	8	2.8	0.8	9.4	1.2
3.	Modified	43	30	6	13	¢2.9	0.6	3.0	1.0
4.	Sulphate resiting	43	40	5	7	2.9	0.4	1 6	1.0
5.	Low heat	21	51	6	14	3.2	0.3	2.7	1.1

1. = Tricalcim silicate.
2. = Di-calcium silicate.
3. = Tri-calcium.
4. = Tetra-calcium alumino-ferrite.
5. = Sulphate.
6. = Free calcium oxide.
7. = Magnesium oxide.

These are complex compounds, which are formed in the [2]clinker when burnt at a high temperature. In fact, the composition of cement is the same as already given, only the proportion of the compounds differs.

The heat of hydration for these varieties of cements, as determined by Savage, is illustrated in Fig. 1. This figure shows that each type of cement produces a different order of heat on wetting.

Again, the common aggregates are the fragments of quartz, sand-stone, granite, basalt, lime-stone, shale etc. The fine aggregates are smaller pieces of the above stones, and, in addition,

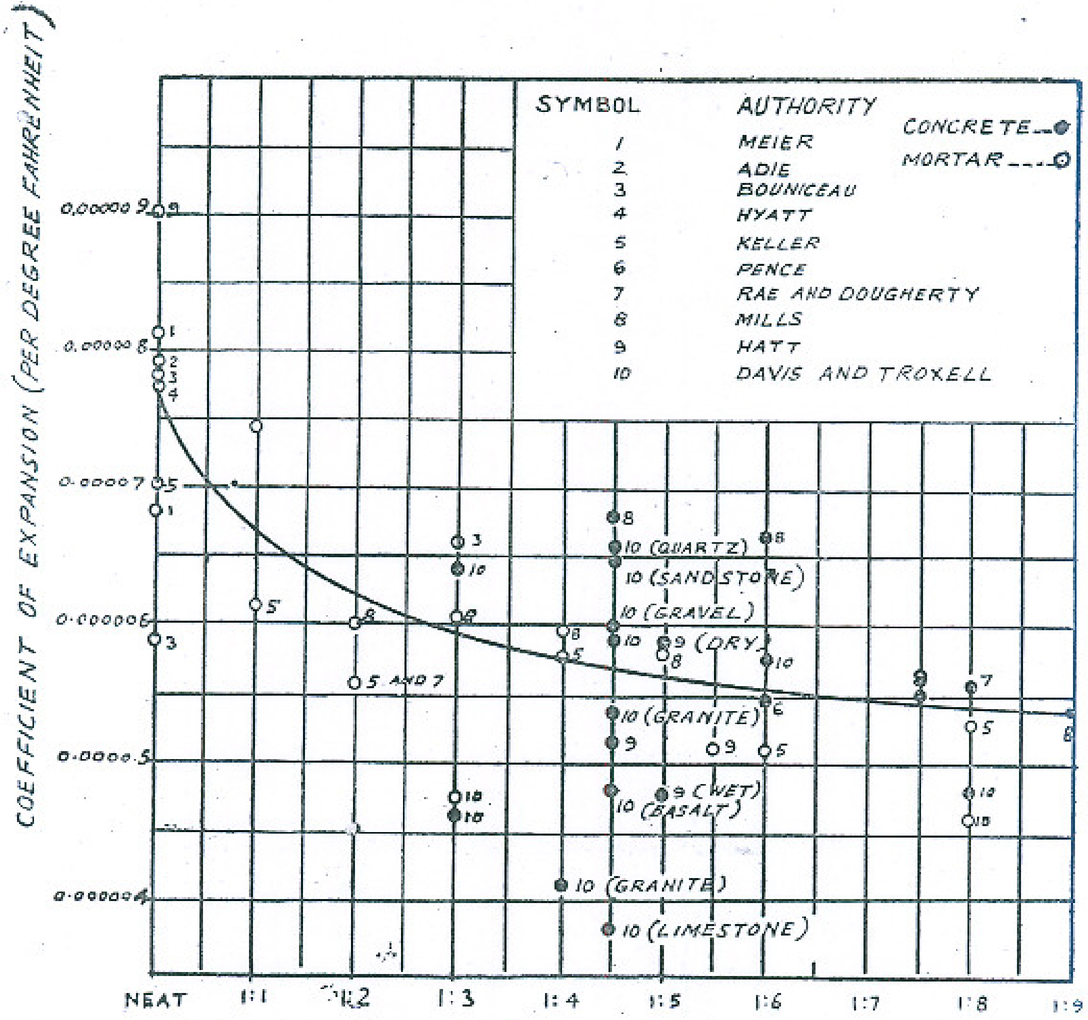

Fig. 2

they contain silica, mica and some other minerals. These substances, when mixed with cement and hydrated, show a rise of temperature and the mass behaves like other materials as regards thermal expansion, heat conduction, specific heat, heat diffusivity etc. We will discuss below each of these items briefly.

Name of Dam	Co-eff : of thermal expansion used.
Norris Dam	6.2+6,2×10 per unit length per degree
Fontania Dam	4.6×10-6 " "
Shasta Dam	7.6×10-6 " "
Ordinary average value for 1 : 2 : 4 or 1 : 3 : 6 concrete	5.5×10-6 " "

THERMAL EXPANSION:

Like all materials, cement concrete expands; and its expansion is governed by the composition of the concrete. It has been observed that co-efficient of expansion varies with each type of rock and its condition of compaction, age, etc. When mixed with cement in a different proportion, the co-efficient of expansion varies usually with the cement content and with the nature of aggregates. In fig. 2 is shown the result of thermal expansion obtained by various [3]authorities. Neat cement possesses the highest thermal expansion and it falls with the addition of sand. Similarly quartz when used as aggregate will give the highest expansion co-efficient and lime-stone will give the lowest. This figure also leads to an important deduction that if the aggregates are made of different types of rocks or the fine and coarse varieties the materials having different orders of thermal expansion will result in cracks. It is thus essential that as far as possible the same type of aggregates or those having the closest thermal co-efficients should be mixed together, before an aggregate is selected to be used, its thermal co-efficient should be determined for which there are innumerable methods known to the [4]physicist, the most convenient being to observe the expansion by fixed microscopes and by changing the temperature of the stuff. The most accurate method is that of Fizeau in which the expansion co-efficient of even a small piece can be determined by the principle of interference fringes. Examples of the thermal co-efficient for various materials used in American Dams are:

HEAT CONDUCTIVITY AND DIFFUSIVITY OF CONCRETE:

In the case of mass concrete, where it is to be laid in sufficient thickness, a knowledge of heat conductivity, specific heat and diffusivity is important, because on these factors will depend the equalisation of temperature in a concrete block. If concrete is poured in too thick a layer or is of a low conductivity, the difference between inside and outside temperatures of a block will be too great, and this can result in differential stresses and even in appearance of cracks. While constructing the Boulder Dam in America, it was estimated that the temperature of the concrete made with portland cement will rise to 45°F and by natural heat dissipation methods, it will take more than 100 years to equalize the inside and outside temperatures. Thus for deciding the thickness of placing of concrete, it is essential to know its time interval and means of heat dissipation, as well as its thermal properties. Given below is a brief information about the methods employed to determine these factors.

HEAT CONDUCTIVITY:

This is defined as the amount of heat Q, flowing in time t through a cube of surface area A, length x, maintained at two different temperatures equal to Q1 and Q2.

The heat is given by

$$Q = K \cdot A \cdot \frac{(Q_1 - Q_2}{X} \cdot t$$

K — thermal conductivity measured either in British Thermal Units (B.T.U.) or in C.G.S. System. Although there are several methods of determining this constant, but a modified arrangement set up in the Institute is shown in. (Fig. 3).

So far, the Research Institute has not been asked to evaluate this property of concrete but it is expected that sooner or later when the field engineers are actually faced with the problem during the construction of the Warsak or the

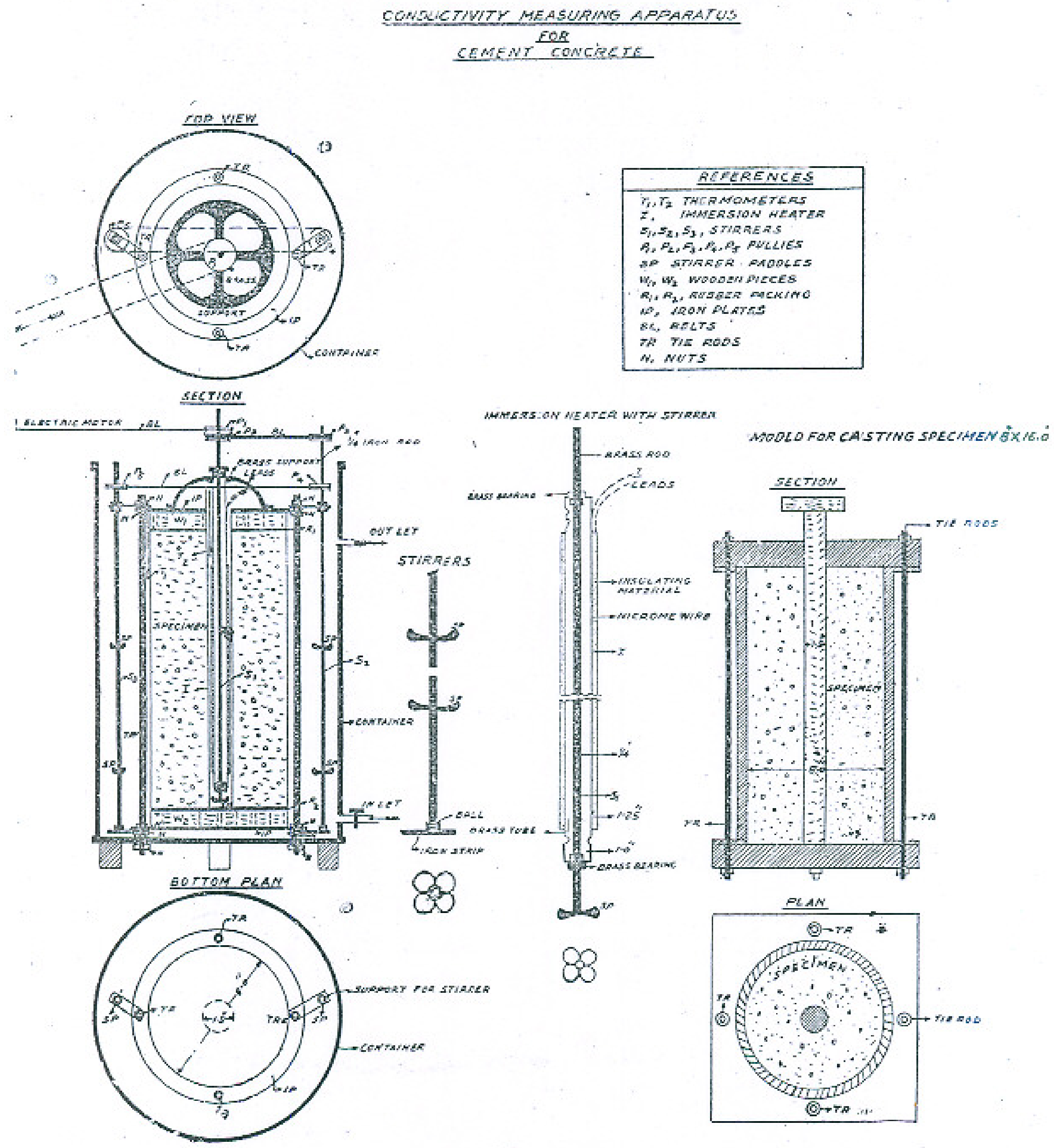

Fig. 3

Mangla Dam, they will look to the Institute for help and then we shall be in a position to give the order of conductivities of our own rocks. In the mean time, an example of various materials is put forth to illustrate the variation of this factor. (See Fig. 4).

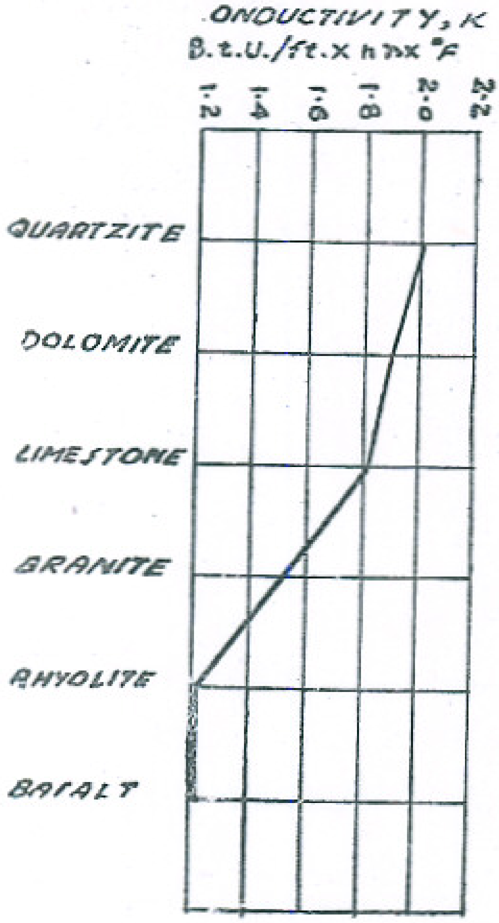

Fig. 4

SPECIFIC HEAT

This is defined as the quantity of heat required to raise the temperature of one gram of a substance through 1°C. In B.T.U. the specific heat is the quantity of heat needed to raise the temperature of one lb. of a substance through 1°F. The method of its determination is also very simple and is not given in this note. The order of this constant, determined for some common materials is given in Fig. 5.

HEAT DIFFUSIVITY

This factor has been devised to determine the dissipation of heat from a given mass and is expressed as:

$$D_f = \frac{K}{S e}$$

Where K = conductivity.
S = Specific heat.
C = Density of concrete.

If the density of concrete is known the heat diffusivity can be evaluated.

RECORDING OF TEMPERATURE IN CONCRETE.

A knowledge of thermal properties of cement and concrete is helpful in constructing a strong and durable structure, and once concrete has been laid at site, the recording of its temperature can give an insight into the internal conditions of concrete. In a dam, in which sometimes concrete is more than several hundred feet thick, recording of temperature inside concrete can give a useful picture of the internal conditions. A recording instrument to be put inside during the laying of concrete is thus necessary.[6] Naturally, no ordinary thermometer can be of any use. Recording instruments suitable for installation in concrete can be based either upon the thermo-electric function or on resistance changes. The former method, although very sensitive, is not suitable as the thermo-couple measures the potential difference which is developed due to difference in temperatures of the two junctions and the potential difference can be developed even in concrete without change in temperature, due to the presence of alkalies in cement. The only instrument suitable is that based upon resistance changes and those materials which have a big change in resistance with a change in temperature are more suitable; such materials

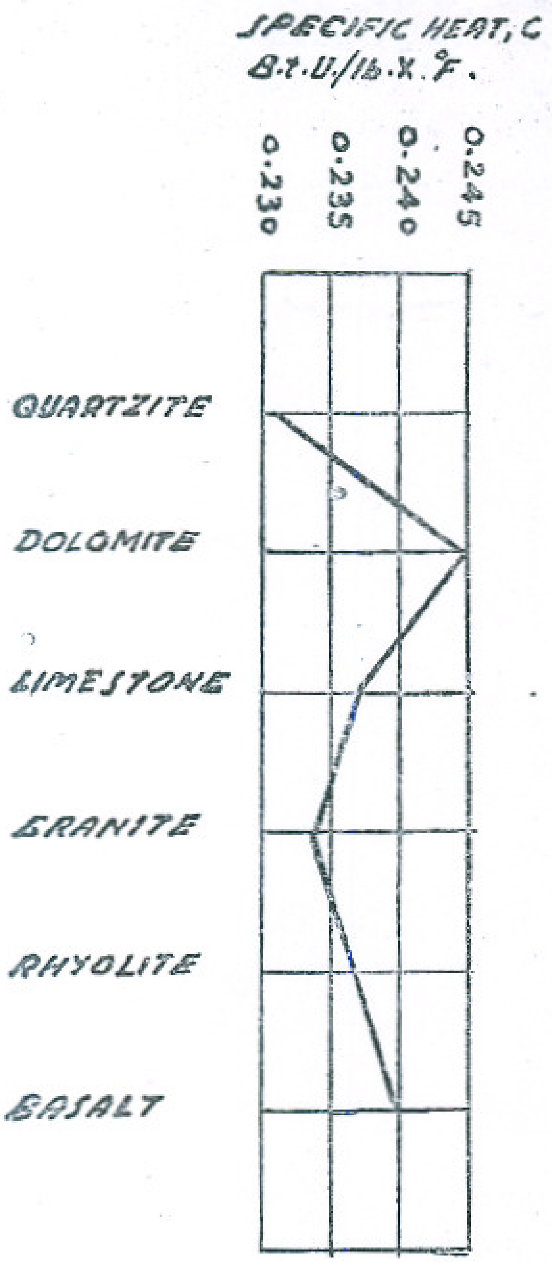

Fig. 5

are copper and silver. The instruments that have been developed in the Institute are based upon changes or resistance of a copper wire with changes in temperature of concrete. These have been made by using S.W.G. No. 47 copper wire wound on mica former and enclosed in a copper pipe. The leeds are soldered out and can be joined to other leeds through a pipe layed in concrete.

Normally, the resistance of copper varies linearly with a rise in temperature and the usual variation is 0.4 ohm for 100 ohm resistance per degree rise in temperature, but the latest instrument developed in the Institute has been calibrated into °F and it directly gives the temperature.

These thermometers have been installed in the concrete of raft of Chichoki Hydel Projects and although used very sparingly, they have been found to record the internal temperature quite satisfactorily.

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and

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FOR the raft foundation of the Chichoki Hydel Power House two classes of mix were designed—Class I, consisting of $1:1\frac{1}{2}:3$ mix having a 28-day strength of 3500 lbs|sq. inch; and Class II, consisting of $1:2:4$ mix with a 28 day strength of 3000 lbs|sq. inch.

Both sand and coarse aggregate had not only to be well graded to conform to the type grading curves, but continuous uniformity in the grade also had to be ensured for the production of a uniform high quality concrete.

The local sand with a F.M. of 0.77 having no particles coarser than 0.149 m.m. (100 mesh sieve) was rejected as being totally unsuitable even for mixing with coarser sands. The blending of Wazirabad sand (F.M. 1.55) and Campbellpur sand (F.M. 3.6) in the ratio $1:2$ was found most suitable with a grading curve within the B.S.S. limits. It was decided to use this blend in both the classes of concrete mix.

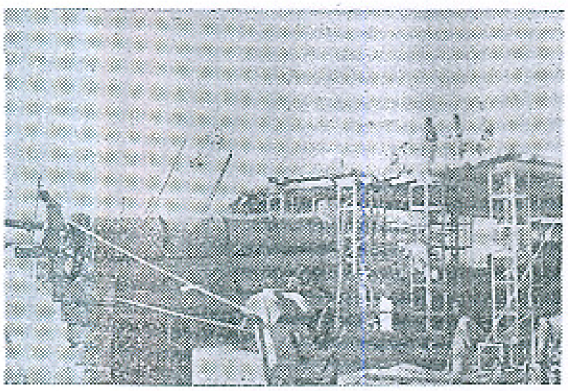

Fig. 1. Screener.

The coarse aggregate to be used was river shingle, uniformly graded upto $1\frac{1}{2}$" size. For the two classes of concrete, $1:1\frac{1}{2}:3$ and $1:2:4$ type gradings for mixed aggregates were prepared by the Research Institute.

Field tests proved that the shingle reaching the bins had no uniform grading, whatsoever, as transportation destroyed any natural grading it might possess. It, therefore, became necessary to divide the shingle into three graded fractions, viz $1\frac{1}{2}$" to 3|4", 3|4" to 3|8", 3|8" to 3|16" and to mix them in such proportions as to conform as much as possible to the type gradings. Results obtained are shown in Table 1. There is a very little difference between the type gradings and the results of the mixed fractions.

MECHANICAL SCREENING

Screening a proper size most effectively and economically, in the absence of a screening and batching plant, was a problem. Hand screening would be both laborious and expensive. Ultimately, it was decided to use a mechanically rotated screener of the type shown in Fig. 1).

The screener which is 20′ long and

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3' in diameter is rotated at a speed of 20 r.p.m. by an electric motor of 30 H.P. by belt drive. It is erected at an inclinaion, the upper or feeding end being $1\frac{1}{2}'$ higher than the lower or driven end.

WASHING

Prior to screening, the shingle is washed (as shown in Fig. 3). The tip wagons of shingle are passed under a

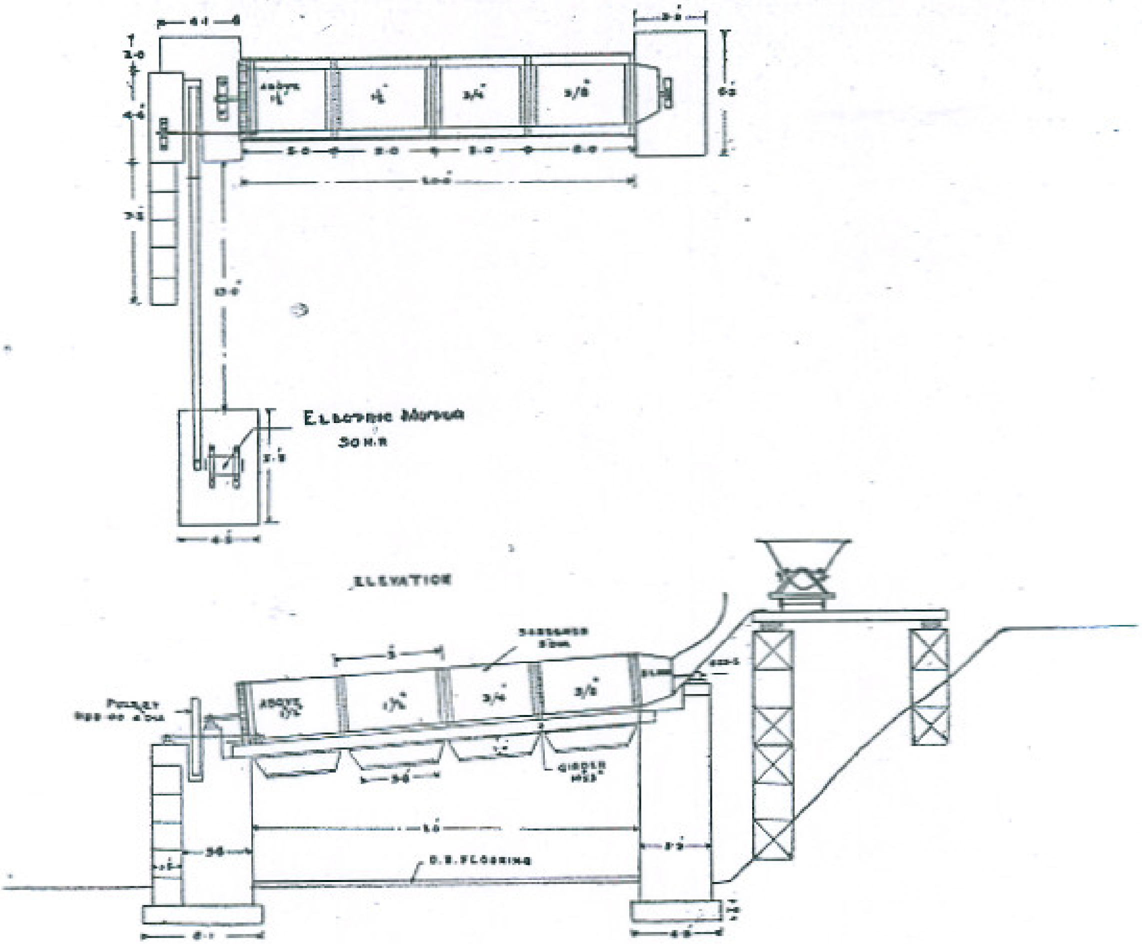

Fig. 2.

The shingle is fed through a chute and it passes, in turn, through four compartments of circular mesh—3|8", 3|4", $1\frac{1}{2}$" and $1\frac{1}{2}$" respectively. Under each compartment is a hopper which delivers each size fraction tȯ its particular bin. (Fig. 2).

Field tests proved that the over and under sizes in each fraction were more or less consistent and were allowed for in the proportioning of each fraction in the mix. (Fig. 1) gives a view of the screener).

strong jet of water delivered through a flexible hose, attached to the delivery pipe of one of the tube-wells, being used for dewatering the foundation pit.

After washing the tip wagons are pushed to the screener along the track erected on crib staging.

BATCHING

The sand for each mix is weighed in tip wagons by means of hand-operated weigh bridges (shown in Fig. 4) This operation has been simplified by having

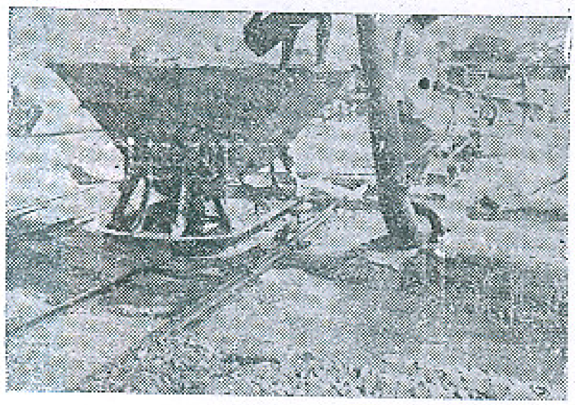

Fig. 3. Washing Shingle

all tip wagons used at the same tare. The shingle of each graded fraction is also taken by weight. This is done by fixing in the tip wagons marks corresponding to the weights required. The shingle for each mix is then loaded up to the respective mark.

From the weigh bridges the tip wagons are hand-pushed to the mixers, a pair of which are shown in Fig. 5.

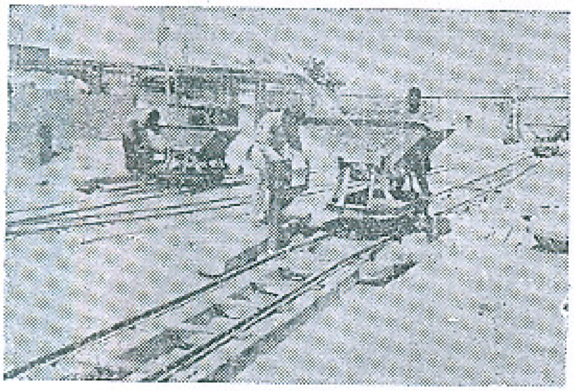

Fig. 4. Tip Wagon for Screener

WATER

The addition of water to each mix is strictly controlled. For Class I concrete (1: $1\frac{1}{2}$: 3) the water cement ratio is 0.46, while for Class II (1: 2: 4) it is 0.55. The slump attained is $1\frac{1}{2}$". Field tests are made twice or thrice a day to determine the moisture content of the aggregates, and allowance is given for evaporation on hot days.

Compaction of the placed concrete is done by pneumatic vibrators.

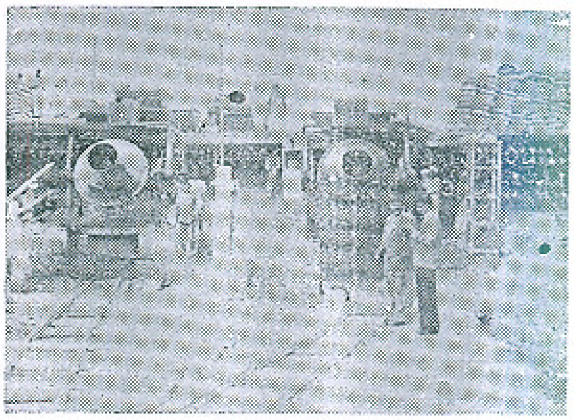

Fig. 5. View of the Miners

RESULTS

Eight concrete specimens are made daily from different batches of mixed concrete taken at random.

After standard curing the specimens are sent to the McLagan College of Engineering and Technology for test.

The results obtained so far in the field are beyond expectations. The crushing strengths are up to the specified limits and in many cases are higher, viz. 28 days' strength of 4,500 lbs|sq. inch for 1: 2: 4 concrete.

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TABLE No. 1.

COMBINED GRADINGS FOR COARSE AND FINE AGREGATES.

SIZES.	$1\frac{1}{2}$"	3/4"	3/8"	3/16"	7	14	25	52	100
Type grading for 1: $1\frac{1}{2}$: 3 mix.	100	63	43	31	23	16	11	5	0
Grading of mixed fractions in field for 1: $1\frac{1}{2}$: 3 mix.	97	60	40	31	21	14	10	6	1.5
Type grading for 1: 2: 4 mix.	100	67	48	35	26	20	15	8	0
Grading of mixed fractions in field for 1: 2: 4 mix.	96	65	44	32.5	25	18.5	13	7	1.5

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PERSONALIA

1. Mr. Nisar Ahmad, P.S.E.I. was relieved on March 22, 1956, to undertake a six-month study of concrete dam projects in the United States.

2. Mr. Mohiud-Din Khan P.S.E.I. also proceeded to the United States to study concrete dam projects for six months, and was relieved on April 24, 1956.

3. Mr. M. A. Ahad Khan, S.S.E. II returned from the United States in August this year after studying various problems and matters related to flood control and water resources.

4. Mr. Altaf Hussain, P.S.E. I., who was loaned out to the Central Government to work with the water dispute delegation in Washington, returned his department on July 7, 1956.

5. Mr. B. A. Malik, P.S.E., II., who was also working with the water dispute delegation in Washington, came back and is now working with the Central Government in the Dams Irrigation Department.

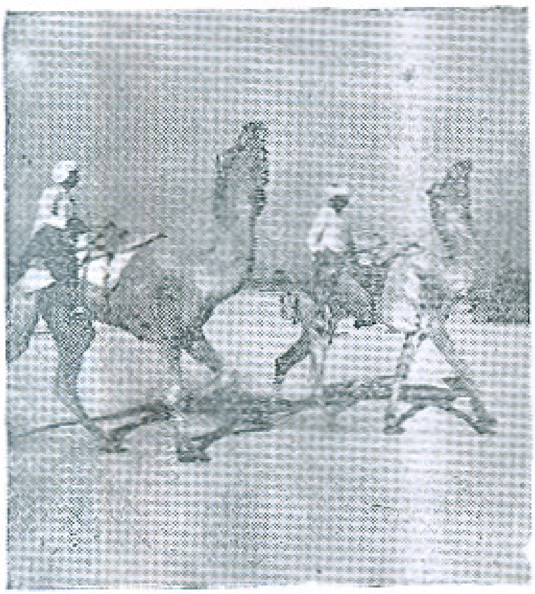
6. Mr. Shafqat Hussain Qureshi, Assistant Engineer, Buildings and Roads, was married to Dr. Shamim Qureshi. He is proceeding to the United Kingdom for a three-year course in town planning at Kings College, New Castle upon Tyne, Durham University, on September 1. His wife, who is accompanying him, will undertake higher studies in medicine.

The Financial Aspect of Reclamation of Bara Soil of Lower Bara Doab Colony

By Dr. A. G. Asghar and M.A. Hafeez Khan†*

BESIDES the normal deterioration of culturable land on the Indus Valley Canals, there exist in the Lower Bari Doab Canal Colony patches of extremely deteriorated soil varying in size from a few acres to a few hundred acres, and scattered between Montgomery Town and the tail reaches of the Canal. These patches are much older than the Lower Bari Doab Canal, and their soil is popularly termed as 'Bara'. The area classified as 'Bara' is about 40,000 acres, the whole of which is state-owned.

The 'Bara' lands were excluded from colonization as their soil was incapable of bearing any vegetative growth, irrigation water being unable to permeate it. Attempts at reclamation of this soil were made quite early in the course of colonization operations by the Department of Agriculture, but the science of soil deterioration and reclamation being yet in its infancy, these experiments did not produce any ecouraging results.



Bara Land Before Reclamation.

Describing briefly, 'Bara' soil is intractable, of very high alkalinity (with or without excess of salts), and devoid of vegetation. It is so hard that while riding across, it produces a metallic sound. In sunshine, it produces the view of a mirage. It breaks into hexagonal clods and after rain it is covered by a thin layer of very fine clay, generally known as 'Papri'.

RECLAMATION OF BARA LAND

In view of the progress made in the technique of land reclamation as well as of the shortage of food supplies created by World War II, it was decided in 1943 to reclaim this land. Blocks of 'Bara' land were offered on lease to enterprising cultivators on attractive terms. The main features of the lease were:

1. The lease will be for a period of twelve harvests.
2. The lessee will have to lay out, irrigate and cultivate the land

*Director Land Reclamation Lahore.

†Assistant Director Lahore.

strictly according to the instructions of the land Reclamation Department throughout the period of the lease, he will not be allowed to engage sub-tenants, and will have to reside at the site.

3. The area on lease will be provided with normal water supply at the rate of one cusec for 300 acres throughout the year. In addition, the area under reclamation will provided with an extra supply for reclamation at the rate of 45 acres per cusec during the summer season.
4. The reclamation supply will be charged for on a volumetric basis at half the Divisional rate for the first four Kharif seasons, and at the full Divisional rate during the remaining two seasons. During the Rabi season the normal occupier's rates will be charged.
5. During the first four harvests no land revenue or 'Malikana' will be levied. Thereafter, the area will be assessed to land revenue and 'Malikana' at the rate of rupee one and annas eight, and annas twelve per acre, respectively.
6. On the expiry of the lease, if the land has been fully reclaimed to the satisfaction of the Land Reclamation Officer, the lessee shall have the option to acquire proprietary rights over one-half of the area at a concession rate of Rs. 150 per acre, the other half reverting to the Government for disposal at its discretion.

These conditions are generally known as "half resumable reclamation conditions".

INCOME AND EXPENDITURE

The financial aspect of the reclamation of 'Bara' land is the basic consideration on which depends the success of reclamation. Although the project has been in operation for about a dozen years, and the demand for 'Bara' land on the terms described above has in-

Bara Soil After Reclamation

creased tremendously, considerable ignorance prevails among persons desirous of allotment of land regarding the actual cost of reclamation and the income from land during the reclamation period. The actual expenditure and income of a representative block will, therefore, be of interest, and will lead to some reliable conclusions.

The lease under examination was granted to a retired officer of the Indian Army in 1947. The block had an area of 70.23 acres. The lease expired in 1953. The area was cultivated through directly engaged labour. The lessee invested his cash savings in this land. The whole of the area was declared reclaimed, and the lessee has acquired proprietary rights over half of the area. A complete account of expenditure and income was maintained by the lessee. The only item of expenditure and income excluded from this account is the fodder crops.

A summary of the expenditure and income of each year is given below:—

AREA 70.23 ACRE

	EXPENDITURE				INCOME			
First year – – – –	Rs.	7,146	1	9	Rs.	166	0	0
Second year – – – –	Rs.	5,024	3	0	Rs.	390	0	0
Third year – – – –	Rs.	3,584	14	0	Rs.	815	8	0
Fourth year – – – –	Rs.	4,533	11	0	Rs.	1,324	0	0
Fifth year – – – –	Rs.	4,719	8	0	Rs.	1,824	0	0
Sixth year – – – –	Rs.	5,768	0	0	Rs.	5.756	0	0
Total	Rs.	30,776	5	9	Rs.	10.275	8	0

Net Expenditure – – –	Rs.	20,500	13	9
That is about – – – –	Rs.	20,501	0	0
Add to this the purchase price of 35.12 acres Rs. 150 at the rate of per acre acuired by the lessee –	Rs.	5,268	0	0
Grand Total – – – –	Rs.	25,769	0	0
Cost per acre – – – –	Rs.	737	0	0
Cost Per square – – –	Rs.	18,425	0	0

An item-wise analysis of the expenditure would be a useful guide in planning reclamation of this type of soil and is given in Table 1.

The analysis shows that manual labour accounts for 50 per cent of the gross expenses, land revenue and cost of water for 15 per cent and seeds and manure for 13 per cent. It is obvious that a cultivator who supplies his own labour and does not hire labour will have to make cash investment of about half the amount incurred in this case.

CONCLUSIONS

From the data reproduced above the following inferences are drawn.

1. Taking the price of a square of canal-irrigated good land in the colony as something between Rs. 25,000 and Rs. 30,000 the land acquired by the lessee cost him something between two thirds and three-fifths of the purchase price of culturable land in the colony.
2. Although reclaimed 'Bara' land has been shown to cost less than the normal land, even if in exceptional cases its cost is equal to the price of good land, it is not reasonable to expect that the reclamation of highly deteriorated land would cost less than the purchase price of good normal land.
3. The lessee does not have to incur a lumpsum cost, and therefore, even a cultivator of humble means can afford to invest the required sum of money over a period of six years.
4. The cash investment of a lessee

who tills the land himself, and whose family labour is also engaged on it, will be considerably less.

5. It is important to observe that more than 33 per cent of the net cost of reclamation was incurred during the first year of the lease and about 60 per cent in the first two years. Failure to reclaim the whole land generally happens in the cases in which the lessee is unable to make sufficient investment in the initial stages, when a good deal of layout and levelling work is involved.

6. It is suggested that a higher income would have been realized by a lessee if he had been able to spend more on manuring of the land. Heavy manuring of the land under reclamation brings quicker returns.

TABLE I SHOWING AN ANALYSIS OF EXPENDITURE ON THE RECLAMATION OF A 70 ACRE PIECE OF 'BARA' LAND

Year	Purchase Live of stock	Implements	Labour	Levelling and Layout	Seed	Maintenance Live of stock	Land Revenue and contract of water supply	Manure	Temporary hut	Miscellaneous	TOTAL
1	2	3	4	5	6	7	8	9	10	11	12
1st	2,130-0-0	404-0-0	2,520-0-0	460-0-0	447- 8-0	400-0-0	594-13-9	x	x	189-12-0	7,140-1-9
2nd	475-0-0	x	2,650-0-0	200-0-0	419- 8-0	x	759-11-0	200-0-0	320-0-0	x	5,024-3-0
3rd	x	65-8-0	2,600-0-0	x	564- 6-0	150- 0-0	x	205-0-0	x	x	3,548-14-0
4th	250-0-0	x	2,580-0-0	x	443- 0-0	x	1,025-11-0	150-0-0	85-0-0	x	4,533-11-0
5th	725-0-0	x	2,520-0-0	x	436-12-0	x	852-12-0	185-0-0	x	x	4,719- 8-0
6th	x	x	2,502-0-0	x	702-12-0	150- 0-0	2,283-4-0	130-0-0	x	x	5,768- 0-0
	3.580-0-0	469-8-0	15,372-0-0	660-0-0	2,013-14-0	700-0-0	5,516-3-9	870-0-0	405-0-0	189-12-0	30,776-5-9

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Materials Used in Prestressed Concrete

*By B. A. Chowdhry,**
B.Sc., D.I.C., A.M.S.E. (London)

PRESTRESSED concrete is one of the most important 20th century discoveries in the field of concrete technology. Being a new technique it is not well developed and well understood in our country. To understand it fully we must study the different properties of the materials used in prestressed concrete and their effect on the prestressed design.

Unlike reinforced concrete, prestressed concrete is almost a homogeneous material. The steel used in prestressed concrete does not form an integral part of the structure, but is only used to introduce the necessary compressive stresses. In fact, if we can manage to introduce compressive stresses in concrete by some other means, such as jacks bearing against immovable abutments, the use of steel can be completely done away with. But, in practice, immovable abutments are rarely available, hence steel is invariably used for introducing compressive stresses.

There are many methods of introducing compressive stresses in concrete which are protected by various patents. These methods can be classified into the following two main heads—(a) pre-tensioning, and (b) post-tensioning.

Besides, there are two other methods which are sometimes used for introducing compressive stresses—(a) by external compression, and (b) by controlled expansion of cement.

As already mentioned, we can introduce compressive stresses with the help of jacks bearing against immovable abutments, but since immovable abutments are rarely available, this method can be seldom used. As regards introducing compressive stresses with the help of controlled expansion of cement, this method is as yet in an experimental stage.

In pre-tensioning wires are stressed, bearing against strong moulds, before concrete is placed into moulds. After the concrete has set and achieved the necessary strength, the wires are released. The stress is transferred from the wires to the concrete with the help of a bond. Since the wires are under tension, the concrete comes under compression.

POST-TENSIONING

In this case holes are left in concrete when it is cast. After the concrete has set and achieved proper strength, high tensile steel wire cables are passed through these holes, which are known as ducts, and are tensioned and kept in that position with the help of anchorages at the ends. This prestress is transferred to the concrete through bearing plates used along with the anchorages.

Let us now consider the different properties of the materials used in these processes.

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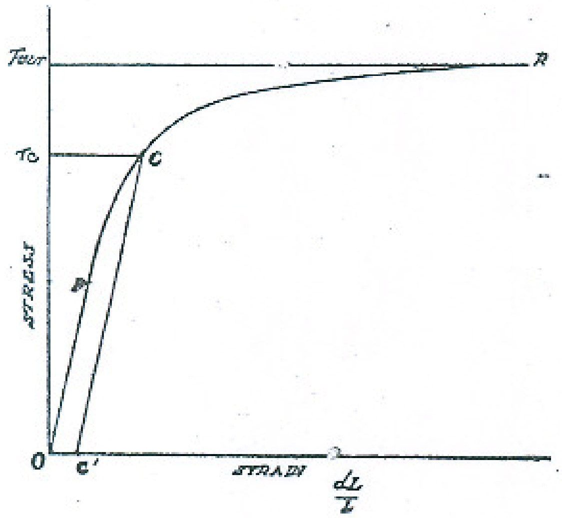
PROPERTIES OF STEEL

Many earlier experiments in prestressed concrete failed because the ordinary mild steel was used to introduce prestress. The maximum permissible stress in mild steel is limited to 27,000 lbs per square inch. The structures were alright just after their construction but in the course of time due to creep of steel and creep and shrinkage of concrete, the steel lost almost all the tension, and, as a result, the prestress introduced into the concrete was also lost. In fact, before the invention of prestressed concrete the necessity of producing high tensile steel was never felt as in the ordinary R.C.C., steel of high tensile strength cannot be used because of excessive cracks appearing in the tensile zone of the R.C.C. member due to excessive strain. In consideration of this fact the maximum permissible stress of steel in the ordinary R.C.C. was limited to 27,000 lbs. per square inch. Due to this limitation no attempts were made to produce steel of high tensile strength.



Stress-Strain Diagram

In 1920 Freyssinet pointed out that prestress was lost due to creep and shrinkage of concrete. He also suggested that this loss due to creep and shrinkage of concrete could be counterbalanced by using steel having a very high elastic limit. The steel having a very high yield point can be subjected to a very high stress and the loss due to creep and shrinkage would be only a small proportion of the actual prestress applied.

As already said, mild steel was used for introducing prestress before the invention of high tensile steel. The steel was usually stressed to 16,000 lbs per square inch producing a strain of approximately 0.0005. This was alright immediately after applying prestress, but after some time the strain due to creep and shrinkage of concrete almost counter-balanced the strain due to prestress, and thus all prestress was lost. However, if high tensile steel is used and stressed to 100,000 lbs. per square inch, it would produce a strain of 0.0034. Even if one-seventh of the strain is counter-balanced by creep, there would remain sufficient prestress in concrete.

In 1944 Magnel pointed out that creep takes place in steel too, and that losses due to creep of steel may be sometimes more than the losses due to creep of concrete.

The losses of prestress in concrete due to creep of steel and creep and shrinkage of concrete would range between 15 and 25 per cent.

However, high tensile steel was produced and this overcame all difficulties of prestressed concrete. So, the steel used in prestressed concrete should be of a very high tensile strength. The higher is the yield point of steel the better it is, as better qualities of concrete can be utilized in combination with steel of a high tensile strength and that would make the process more economical.

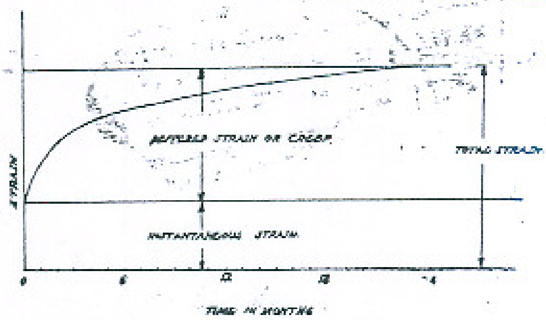
In fact, a specially high quality of steel and concrete can produce the most economical section in prestressed concrete. A poor quality of the material may lead to a complete failure of the structure. The effects of a poor quality of material are far more serious in prestressed concrete than in the ordinary reinforced concrete. High tensile steel must be used with good quality concrete. It is futile to use steel having a very high yield point with poor quality concrete. We cannot subject steel to very high stresses if the concrete is not capable of taking the resulting compressive stresses. The steel usually used in prestressed concrete is in the shape of hard-drawn wires with the ultimate tensile strength ranging between 100 to 150 tons per square inch, and the size ranging between 0.04 inch diameter to 0.02 inch diameter—the ultimate strength being smaller for large diameters. Where prestress is to be transferred with the help of a bond it is suggested that steel wires of the minimum diameter available be used. The transfer of prestress with the help of a bond is questionable for wires of more than 0.1 inch in diameter.

For high tensile steel there is no definite yield point stress. It has become a practice in the ordinary R.C.C. and steel works design to consider the yield point stress as the basis for deciding the permissible stress. Since high tensile steel has no definite yield point stress this method cannot be extended for deciding permissible stresses in prestressed concrete. So, in the case of high tensile steel without a definite yield point it has become a practice to adopt "proof stress"—using it the same way as the yield point stress. The "proof stress" is the stress at which the inelastic strain is 0.1 per cent or 0.2 per cent of the gauge length if load is maintained for 10 seconds. It is called 0.1 per cent or 0.2 per cent proof stress. The word "permanent" is sometimes used for "inelastic", and the difference in the assessment of proof stress is not very important. It is usually specified that the proof stress should be at least 70 per cent of the ultimate stress.

Small diameter wires are usually supplied in coils. These wires may need a straightening before being used. But as straightening affects the properties of the wire, the wire should be obtained in as large a coil as possible to minimise the necessity of straightening. Steel may be used either as a single wire or in the form of cables. When it is used in the form of cables, the ultimate strength of the cables, theoretically, is the same as the ultimate strength of the wires, but, in practice, it is generally 5 to 10 per cent less than that of the wires. This reduction is due to twisting and stretching during the manufacture.

CREEP OF STEEL

Steel, when subjected to a continuous and constant tensile stress, continues to elongate for a period of time. Immediately on the application of load, a strain is produced in steel known as instantaneous strain. If the load, that



Creep in Concrete or Steel

is, the tensile stress, is continued to be applied for some time the steel continues to elongate and this inelastic elongation of steel is called "creep". The rate of this creep depends upon the intensity of the stress, the temperature of the steel and the duration for which the steel is subjected to loading. This rate increases with an increase in stress and temperature, but it decreases with an increase in the duration of loading. The rate of creep is usually very high just after loading and then it begins to decrease. In fact, the most of the creep occurs within a few hours of loading.

It may be mentioned here that the creep in a wire rope is greater than that in single wires.

The creep in steel can be overcome by slightly overstressing the steel wire for a short period. Since most of the creep takes place just after loading, by slightly over-stressing steel the most of the losses can be accounted for, and the maximum loss due to creep of steel may then be taken as four per cent.

High tensile wires should be tested for creep before use. The creep limit is classified as "technical creep limit" and "physical creep limit".

The technical creep limit is the limit stress which causes an elongation of .008 per cent between the 60th minute and 100th hour after loading. This value, however, is applicable only if elongation between the 6th and the 60th minute after loading does not exceed 0.016 per cent.

The physical creep limit is the limit of stress up to which the deformation under load does not increase with the lapse of time. However, during loading, elastic deformation may be accompanied by plastic deformation.

Before use, the bars should be tested to ensure that they would not be damaged during transit. They should also be turned round to see if their surface would not crack.

The steel used for prestress must be of a very high ultimate strength. This, generally, is achieved by increasing the carbon content in steel. An increase in carbon content increases the strength and hardness of steel considerably, but it greatly reduces its ductility. Therefore, some other alloying elements are used to increase the ductility of high-strength or high-carbon steel. Thus, in the specifications for the steel used in prestressed concrete, provision is generally made for the cold bending test.

ELASTIC LIMIT OF PRESTRESS IN WIRES

The elastic limit of a prestress wire can be increased by subjecting it to tensioning before use. Thus, if we take a wire with an elastic limit of 75 tons per square inch, subject it to a stress of 80 tons per square inch, and then release the stress, the wire will acquire an elastic limit of 80 tons per square inch. The ultimate strength, however, will remain the same and the ultimate elongation will be smaller by the amount of permanent strain the wire has already undergone. But in prestressed concrete there is no necessity of tensioning the wire before use as this process automatically takes place when wires are stressed for prestressing.

The deferred strain or the creep takes place much more rapidly in steel than in concrete. In fact, the creep is almost complete after 15 to 20 days—two-thirds of this occurring at the end of the first 12 hours of tensioning.

USE OF FIBRE GLASS

Steel is an important building material but its shortage is felt all over the world. High tensile steel, which is of prime importance in prestressed concrete, is very costly and is not manufactured in most countries. Before prestressed concrete can be brought on a sound footing and made to compete with other types of construction, the availability of high tensile steel at much cheaper rates is essential. Attempts have been made in recent years to replace steel with such material as could be produced at a low cost all over the world. Fibre glass may be an answer—it may completely replace high tensile steel in no distant future.

Compared with high tensile steel, fibre glass has a very low modulous of elasticity. This is a great advantage in prestressed concrete. Losses in prestress due to creep and shrinkage of concrete, etc., are usually taken as 15 to 20 per cent if high tensile steel is used. Due to low modulous of elasticity of fibre glass, these losses would be reduced to a very small amount.

Fibre glass has got a very high strength, and the values of 3.4×10^6 lbs per square inch have been recorded. However, the values of 2.5×10^5 lbs per square inch can be easily achieved. The modulous of elasticity of fibre glass is approximately 10×10^6 lbs. per square inch.

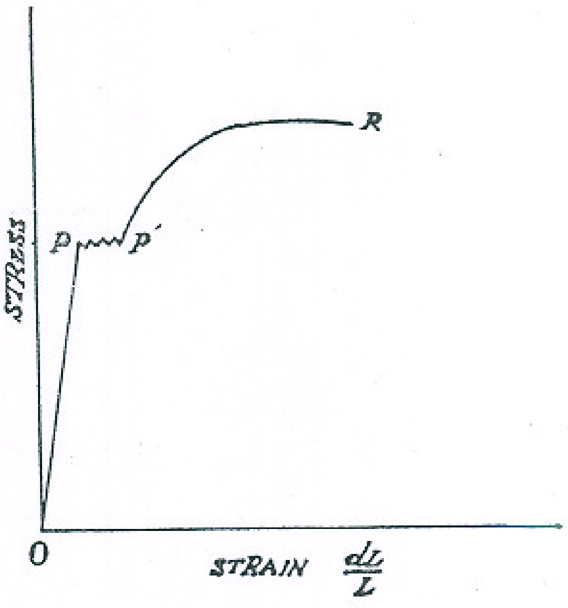
Moisture has a marked effect on the strength of fibre glass. The drier is the fibre glass, the stronger it is. Moreover, fibre glass is very brittle, so it is necessary to protect it.

End anchorages for fibre glass have to be specially designed as, being very brittle, there is a possibility of its ends being crushed in the grip itself. The strength of fibre glass depends upon the diameter and the length of the fibre. A decrease in diameter and length will increase strength.

Before fibre glass can be used in prestressed concrete, many difficulties have to be overcome. To maintain its strength, fibre glass must be protected from moisture. One way of achieving this is to cover fibre glass with some material to protect it from moisture during its manufacture.

Duration of loading also affects the strength of fibre glass and this effect is known as "static fatigue". A good deal of experimental work has yet to be done to establish its tensile strength and modulous of elasticity.

After an answer is found to all the above-mentioned difficulties, glass reinforcement will completely replace the high tensile steel in prestressed concrete. By using improved methods of manufacture, a strength of 1,000,000 lbs per square inch can be achieved in fibre glass, as against the maximum value of 3,60,000 lbs per square inch recorded for high tensile steel. When this time comes the amount of fibre glass to be used for prestressed concrete would be one-fourth by volume and one-thirteenth by weight to that of the high tensile steel. This will completely revolutionize our building economy and at that time prestressed concrete would be put on a really sound footing. Fibre glass reinforcement would be most suitable where there is humidity in atmosphere and salts in water, provided that it is protected from moisture.



Stress-strain curve for Steel wire yield point

Before steel is used for prestressing its properties must be tested. Stress strain diagrams should be drawn with the limit of proportionality and the yield point, etc., indicated thereon. Its ultimate elongation, contraction of areas and modulous of elasticity should be worked out. Since high tensile steel does not possess a definite yield point, the yield point should be worked out on the basis of proof stress, as already stated. From the stress-strain diagram can be calculated the necessary elonga-which should be given to the wires to get the end anchorage tension, specified in the design.

For steel ropes, where steel wires are twisted together, the governing strength of the rope is not that of individual wires but that of the rope as a whole. However, in the case of wire cables, where straight wires are bunched together, the properties of the cables are the same as those of the individual wires.

PERMISSIBLE STRESSES

It is normal to assume the working stresses due to bending in concrete as one-third of the strength of a six inch cube after 28 days of curing. The writer does not agree to this practice and suggests that working stresses in concrete be taken as one-fourth to one-third of the crushing strength of concrete cube 6" x 6" cast at the time the concrete is placed and tested when the structure is subjected to a full working load. This 28 days' period is a very ambiguous thing and it may lead to confusion in certain cases. It is not difficult ultimately to make concrete having a crushing strength of 6,000 lbs per square inch by selecting good aggregate; and with good construction practice, concrete having a crushing strength of 8,400 lbs per square inch is not difficult to obtain. So working stresses in concrete can be taken from 1,500 to 2,000 lbs per square inch, in the first case, and from 2,100 to 2,800 lbs per square inch, in the second case.

Prestress is applied to a structured member much earlier than the member is subjected to a full working load. So, at the time prestress is applied to a concrete member, the safe working stress in concrete can be taken as one-third of the crushing strength of the concrete at the time prestress is applied. Concrete with a crushing strength of 9,000 lbs per square inch at the time a full load is applied to it, may have a crushing strength of 6,000 lbs per square inch at the time prestress is applied to it. So, a working stress in concrete of 2,000 lbs per square inch may be taken at the time prestress is applied.

These suggested working stresses in concrete provide a good factor of safety and would account for any reasonable variation in the strength of concrete due to certain unexpected difficulties.

STRESSES IN WIRES

The stress in high tensile steel wire should not exceed 0.8 per cent of the 0.2 per cent proof stress or 0.6 per cent of the ultimate tensile strength of the wire, whichever is smaller. Steel is generally manufactured in a factory under strict supervision. Therefore, to have a lower factor of safety in the case of steel is not unreasonable. However, during prestressing every wire is subjected to a test and it is generally stressed to about 10 per cent more than the greatest working stress to account for the creep in steel and other losses due to creep and shrinkage of concrete. The wire will never be subjected to this stress again, and if wires can stand this stress at the time of prestress, the question of their failure at the time a structure is subjected to a full working load does not arise.

CORROSION AND ITS PREVENTION

*By Nasir Ahmad**

This article endeavours to explain the causes and methods of prevention of corrosion of non-ferrous metals which is one of the major problem confronting the engineers responsible for maintaining their structures in a good condition. The author has described three stages at which preventive measures become imperative.

BY corrosion is understood the slow destruction of metals by chemical or electro-chemical agencies. The commonest form of corrosion is the destruction of ferrous metals through oxidization, known as rusting.

Corrosion is of the following six kinds, determined according to the degree in which metal is affected:—

(i) Widespread corrosion: In this kind of corrosion the rust is distributed over the entire surface of the metal.

(ii) Localised corrosion: This is a kind of corrosion in which the rust occurs in patches.

(iii) Pitting: When as a result of the rust eating into a metal, pits begin to appear, the corrosion is termed 'pitting'. Such pits are considered negligible if their depth is less than 2 m.m. A pit deeper than 5 m.m. may be considered very deep. When pits begin at opposite points on both the faces of sheet metal, the hollows eventually meet, resulting in perforation.

(iv) Channelling: It is a kind of corrosion which follows the direction of the rolling of bar during manufacture.

(v) Graphitization: This kind of corrosion particularly affects cast iron.

(vi) Exfoliation: When corrosion occurs beneath a surface film or a coat and forces away the outer skin, it is called exfoliation.

PREVENTION OF CORROSION

Prevention of corrosion is possible at:

(a) the design stage,

(b) the production stage, and

(c) the service stage.

PREVENTION OF CORROSION AT THE DESIGN STAGE:

The choice of a non-corrodible metal is itself a kind of prevention of corrosion. Various kinds of stainless steel made by adding nickel chromium or copper to low carbon steel are the most valuable group of corrosion-resisting alloys available at present. There are also other non-ferrous metals the alloys of which are corrosion-resistant. Corrosion of steel bridges, columns and gates can be reduced further by careful designing. For instance, structural connections may be so arranged that drops of polluted water may not stick or accumulate anywhere.

Orientating the members to provide the maximum amount of drainage or provision of drainage and ventilation

**Assistant Design Mechanical Circle, Irrigation Department.*

holes in "boxed" members and the limitation of rivet pitches are very effective corrosion preventing devices. In the plate girder design, the inner flange plate should be continued to the end of the girders. If this is not done, the crevices along the girder between the flange angles and the web plate will be filled with polluted water, and the corrosion of the web plate at the section carying the maximum shear force will start.

AVOIDANCE OF HIGH STRESSES IN MEMBERS THAT ARE SUBJECTED TO VOBRATION:

It has been found that the effect of corrosion on a metal while it is under high stress is often much more severe than under ordinary conditions. It is, therefore, important that high stresses in the members that are liable to corrosion be avoided. Another essential precaution is to avoid contact of dissimilar metals, particularly association of metallic and non-metallic materials.

An additional factor of safety can be introduced at the designing stage when it is feared that the circumstances of the use of a structure would be extremely favourable to corrosion. For instance, while designing canal gates which would have to remain in constant contact with water and, thus, would be liable to be reduced in size as a result of corrosion, should be provided with an extra twenty per cent cross-section.

PREVENTION OF CORROSION AT THE PRODUCTION STAGE.

In the manufacture of steel structures it is essential tha? rivets, when driven, shall completely fill the holes and, if countersunk, the counter-sinking shall be completely filled by rivets as otherwise formation of polluted water will take place in the crevices and corrosion will start.

After the manufacture of a structure, oil, grease, and even rust, should be removed from all surfaces and either a primary coat of paint or a rust preventive treatment be given before moving the structure out of the workshop.

A permanent protective treatment can also be given to the structure. This treatment, calculated to remain intact throughout the life of the structure, includes electro-deposition of nickel, chromium, copper, lead, cadimum and zinc plating. Hot dipping in molten metal and flux or cementation or chemical processes and metal spraying may also be used.

The structure to be given such coat will be first thoroughly cleaned.

PREVENTION OF CORROSION AT THE SERVICE STAGE.

Temporary anti-corrosive treatments are offered in the cases in which permanent rust proofing would impair the efficiency of the structure, for instance, in the case of the structures exposed to the atmosphere after regular intervals.

The selection and application of a temporary preservative coating can be made by keeping in mind the composition of the part to be preserved, the nature and function of the parts, the type of exposure involved, the degree of preservation required, and the difficulties in the application of a coat, if any.

Several kinds of preservatives are available in the market, such as varnishes, enamels, lacquers, tarry, bituminous solutions and emulsions, oil paints, oils and mineral jelly. The selection of a preservative will depend largely on an assessment of the circumstances prompting its use.

WELCOME TO OUR NEW MEMBERS

The editorial board of the Engineering News felicitates the following members of the engineering profession on their joining the Engineering Congress, and it hopes that the Engineering News would be enriched by their contributions and suggestions.

1. Mazhar-ul-Haq, Director (Development) Electricity Department, Peshawar.
2. Mr. Abdur Rauf, S.D.O., P.W.D., Wana.
3. Mr. Sultan Mahmood Khan, Technical Officer to the Dy. Chief Engineer, Irrigation, Peshawar.
4. Mr. Muqarrab Khan, Director Operation, Electricity Branch, Peshawar.
5. Mr. Qazi Khan, XEN, Sulemanki Div., P.O. Sulemanki, P.W.D. Irrigation Branch, H|Works, Distt. Montgomery.
6. Mr. Ijaz Ahmad, S.D.O., 'E' Const. Sub-Divn., Lahore.
7. Mr. G. R. Khokhar, S.D.O., P.W.D., B. & R., Leiah.
8. Syed Ziaul Hasan, S.D.O., P.W.D., Public Health Branch, Lahore.
9. Malik Nazir Hussain, S.D.O., I.B. Kullur Kot.
10. Syed Manzoor Hussain Bokhari, Asstt., XEN., under training in Bhakkar Divn., I.B., Distt. Mianwali.
11. Mr. Muhammad Aslam, S.D.O., Gowalmandi Reh. Sub-Divn., Bank Square, Lahore.
12. Mr. M. Zahurul Haq, Asstt. Design Engineer, Addl. C.E.'s Office, Peshawar.
13. Rana Ghulam Shabbir, Asstt. Design Engineer, P.W.D., B. & R., Lahore.
14. Mr. Mohammad Siddique, S.D.O., Nishtar Hospital Sub-Divn., Multan.
15. Raja Saadat Mand Khan, XEN., Ahmedpur Divn., Bahawalpur Region.
16. Mr. Mohammad Tanwir Hussain, XEN., Provl. Divn., (B. & R.), Lahore.
17. Mr. Iqbal Ahmad Shahab, S.D.O., Provl. Sub-Divn., Lyallpur.
18. Mr. Zafar Iqbal Qureshi, S.D.O., Provl. Muzaffargarh.
19. Mr. Nisar Ahmed Khan, S.D.O., Satellite Town, B. & R., Montgomery.
20. Mr. Alim Ahmed Khan, Asstt. Engineer, E.|M., E.S.D., Lahore Cantt.
21. Mr. Abid Ali Khan Shirwany, S.D.O., L.I.T. City Construction Sub-Divn., Aggarwal Ashram, Lahore.
22. Sayyed Abdur Rehman Shah, Asstt. Design Engineer, Irrg. Deptt., Lahore.
23. Mr. Salimullah Khan, XEN., Projects & Designs, N.W.R., H.Q., Lahore.
24. Mr. Habibur Rehman Khan, S.D.O,. Rawalpindi, Provl. Sub-Divn., Rawalpindi.

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25. Mr. Saleem Akhtar, XEN., Mangla Dam Circle, Mangla Mechl. Divn., Mangla.

26. Mr. Muhammad Bilal, P.A. to Director, Irrigation Research Institute, Lahore.

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27. Mr. Abdul Majid Mohmand, A.E. & S.D.O., P.W.D., B. & R., Mar- [illegible]

28. Mr. Shafiq Ahmad Siddiqi, S.D.O., 2nd T.|L. Sub-Divn., Bharat Building, Lahore.

29. Mr. Abdul Khaliq Mian, XEN., P.A. to S.E. Link Circle, Lahore.

30. Mr. S. Nazir Ali, S.E., 1st Circle, P.W.D., Electricity Deptt., West Pak., Lahore.

31. Mr. B. N. M. Rojiani, XEN., Lower Sind Roads, Planning Divn., 6, Napier Road, Karachi.

32. Mr. M. I. Suleman, Abdul Majid Memon, XEN., Sukkur Roads Divn., Sukkur.

33. Sheikh Abdul Karim Hadi Bux, XEN., Water Supply Divn., Hyderabad.

34. [illegible] ed Agha, Asstt. Engi- [illegible] h Sub-Divn., Karachi.

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35. Khan Muhammad Hussain, Thatta.

36. Sayyed Mahmud Hasan Tirmazi, XEN., Lyallpur Divn., I.B., Lyallpur.

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37. Mr. Allauddin Khan, Dy. C.E., Irrigation, Lyallpur Region, Lyallpur.

38. Mr. Nazir Ahmad, XEN., G.E., C.A.D., Havalian, District Hazara.

39. Mr. Zafar-ud-Din Sheikh, 5-Bank Square, The Mall, Lahore.

40. Mirza Wahid Shah Beg, S.D.O., P.W.D. (B. & R.), Tank, District Dera Ismail Khan.

41. Khan Mohd. Iqbal Khan, A.E., P.A. to XEN., Baran Dam and Hydel Falls Construction Divn., I.B. Bannu.

42. Mr. Mohd. Zahir Sheikh, S.D.O., Kannya Sub-Divn., Sammundri, District Lyallpur.

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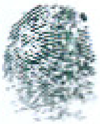

DEPARTMENTAL NEWS

1. IRRIGATION BRANCH

The Shadiwal Hydro-electric Power [illegible] Shadiwal, [illegible] District, on the Upper Jhelum Canal. It will have an installed capacity of 12,000 K.W.H. with an utilizable annual output of 82.85 million K.W.H. The power shall be used mainly for energizing the tube-wells installed in Chaj and Rachna Doabs and, as such, it will improve the agricultural resources of the country.

The work on this scheme was started in 1953 and by May, 1954, besides completing about 50 per cent of the excavation of the power house pit, considerable progress was made on the civil side of the Project.

The excavation of the pit was stopped on May, 14, 1954 at the suggestion of Mr. Ings, the Chief Engineer of Messrs Acres and Company who visited the site. Mr. Ings advised that further excavation be stopped pending a decision by the Canadian Government regarding the financing of the project and the arrival of equipments and drawings under such decisions.

The consent of the Canadian Government to finance the project partially was received in the middle of August, 1954 and Messrs Acres and Company were appointed the Consulting Engineers to the Project. According to the latest schedule supplied by Messrs. Acres and Company, the work on the proper construction of the power house building should start in August, 1956, and the installation of the first set be completed by February 29, 1958—the second and the final set being completed two months later.

As regards the other civil works, about 95 per cent of the head race excavation has been done and the lining will be started shortly. Fifty per cent of the tail race channel has been excavated and the rest will be done when the power house shall be nearing completion so that the earth work from the tail race may be utilized for refilling the pit. About 50 per cent of the colony buildings have already been constructed and the rest are expected to be completed by March, 1957.

2. P.W.D. BUILDING AND ROADS

On the integration of the West Pakistan provinces into a single unit, with Lahore as its capital, the new Government was immediately faced with the momentous task of providing accommodation to a very large number of Government servants, who were posted to the Civil Secretariat at Lahore. The housing problem in Lahore was already very acute, and when the new staff from other pre-integrating provinces arrived here, it was found extremely difficult to provide them with suitable accommodation from the existing Government estates. It was, therefore, planned to construct new colonies for the officers and the staff who had not been in Lahore before the merger of these provinces came into effect.

STAFF QUARTERS

It was decided to construct 1,000 quarters for assistants and clerks at an estimated cost of Rs. 84,09,000. This work, which was taken in hand straightway, is likely to be completed in a record time—that is by the end of September this year—although it will take some more time to complete the roads in the colony. This colony, which has been named Wahda Colony, will have two high schools, one each for girls and boys, four primary schools, a market, a post office, a dispensary, and a police post.

In addition to this, 234 staff quarters are being constructed in the Poonch House at an estimated cost of Rs. 23,58,000. These quarters also will be completed by the end of September this year, and the roads will be completed by the end of 1956.

In order to provide accommodation to low-paid Government servants, 500 "D" type quarters at Sodhiwal and 782 of them at Rehmanpura have been constructed and allotted to deserving persons. This work, again, has been accomplished in a record time despite heavy odds, for instance the scarcity of building materials, labour etc.

OFFICERS RESIDENCES

The West Pakistan Government has decided to construct 40 residences for senior officers and 83 for junior officers at an estimated cost of Rs. 41,89,200 and Rs. 42,93,994 respectively, at the following places in Lahore:

13 senior officers residences at Danepur Road.

27 senior and 27 junior officers residences at Bahawalpur House.

56 junior officers residences at Shah Jamal Road.

The work on 17 senior officers' and 12 junior officers' residences will be completed during the current financial year—that is by September, 1956. The work on the rest of the residences will be taken in hand during the current financial year and will be completed by December, 1957.

MINISTERS' RESIDENCES

Nine Ministers' residences—four at Patiala House, four in the G.O.R. Estate and one on the Canal Bank Road—will be constructed at an estimated cost of Rs. 16,67,100. These bungalows also will be completed by the end of 1957.

In order to remove congestion in Lahore, the Government has constructed 828 "D" type quarters at different places in Lahore to provide accommodation to squatters and other poor refugees who are living in improvised huts and howels.

The Government also have approved a scheme for a satellite town in Lahore at an estimated cost of Rs. 58,01,800. A sum of about Rs. 33,00,000 has been placed at the disposal of the P.W.D. for expenditure on this scheme during the current financial year. Planning is already under way, and arrangements for acquisition of land are being made by the Urban Development Department.

Two Unit civil hospitals, one for outdoor patients and the other for in-door patients, will be constructed at Rattan Bagh at estimated cost of Rs. 2,97,200 and Rs. 22,51,000 respectively.

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News and Notes

SOME ASPECTS OF FLOOD OF 1955 IN RIVER RAVI

MUHAMMAD NAZIR, Deputy Chief Engineer, while addressing the engineers of West Pakistan in Lahore under the auspices of the Institute of Engineers, Pakistan, stated that there are various estimates of the magnitude of the flood which passed at Shahdara in 1955. These estimates vary from 9,56,000 to 4,50,000 cusecs, while according to the speaker, the most probable figure was 354,000 cusecs.

This flood caused damage to the Ravi syphan mainly due to undermining of the foundation. It is very tempting to say that the work was never designed for this superflood. The stones needed on the flexible spron assuming a side slope of 3:1 works and at 360 cubic feet against those provided were equal to 120 cubic feet. The excessive score due to local concentration and insufficiency of stores might have been a cause of damage to the structure.

As for Mahmood Booti Bund, the design has two sand cores on the river side and a brickbats core wall. This design does not help in the least to lower the seepage line. The masonry core must have also cracked. It is a practice provide an earthen core in place of a masonry one in a dam.

(Extract from the address of the author).

ABBASIA CANAL EXTENSION PROJECT

To save the seepage losses of the Abbasia Canal and to make use of the water thus saved, the Extension Scheme was prepared. According to this scheme, the Canal will be lined and the water thus saved from absorption will be utilised in the extension of perennial irrigation to 2,74,000 acres of Crown waste land.

The extension of the Abbasia Canal is being done in two stages. The first stage consisted of the construction of the main canal and the feeders, including some distributaries, to provide irrigation to 1,30,000 acres of Crown waste land. This was completed during the period 1946 to 1951 at a cost of Rs. 37 lakhs.

In the second stage the main canal and the feeders are to be lined to save absorption losses. The cost of lining is Rs. three crores and that of construction of the distributaries to provide irrigation to the remaining 1,44,000 acres of Crown waste land will amount to Rs. 41.89 lakhs.

The work is proposed to be completed within four years.

The sale of 2,74,000 acres of Crown waste land is estimated to bring Rs. 531 lakhs.

The percentage return in the eighth year after the completion of the project will be 8.23. The project, therefore, is very productive.

(Extract from a report by A. Hassan, Deputy Chief Engineer, Bahawalpur Region).

REFRESHER COURSE IN NUCLEAR PHYSICS

A six-week refresher course in nuclear physics was organised by the Panjab University Physics Department. The course, which was sponsored by Dr. Nazir Ahmad, Chairman of the Atomic Energy Commission, attracted physics teachers from all corners of the country and was a great success. Nearly 125 discourses were held in which eminent atomic physicists, botanists and mathematicians took part. A major contribution to the success of this course came from Dr. Basir Pal and Qazi Abdur Rashid.

IRRIGATION RESEARCH INSTITUTE

By the end of the first quarter of the 20th century extensive perennial irrigation systems had been laid in this part of the country; and it was felt that the problems facing the engineers in the field were to be studied on scientific lines. Thus came into being the Irrigation Research Institute. Originally, this laboratory was housed in a small wing of the Panjab University laboratories and its activities were confined to the investigation of the factors causing the rise of water table. But soon its value in other fields of Engineering research was realised. The Institute was, therefore, reorganised and it comprised of Land Reclamation, Chemical, Mathematics, Statistics, Physics, and Hydraulics sections.

In 1936, foundation for the Hydraulic Field Research station was laid at Malikpur, a few miles downstream of Madhopur Headworks, and Soil Survey and Cement Testing Laboratories were added to it in 1943.

Known internationally for its capacity to handle the most intricate problems, the Institute made an important contribution to the design of weirs on sand foundation. Barrages in this part of the country are built on sand and the water percolating under the structure causes an uplift pressure which may blow up or undermine the foundation, thus causing the failure of the structure.

The subject was investigated in the Hydraulics and Physics sections of the Institute and it was discovered that the laws of flow of water in sand were identical with those governing the flow of electricity. This confirmation of the theoretical deductions placed a powerful tool in the hands of those investigating the subject and in collaboration with field engineers, complete rules governing the safe design of weirs on sand foundations were formulated.

On Partition, the Hydraulic Research Station at Malikpur went to India. Most of the staff working in this Institute also opted for India. The Institute, however, was soon reorganised and its Land Reclamation and Chemical sections were amalgamated to form a separate Directorate to continue their fight against the deterioration of land due to rise of salts or of water-table. In the new set-up the Institute consisted of Hydraulics, Physics, Mathematical, Statistical, Soil Mechanic and Cement Testing Laboratories.

A new field station for hydraulic research was opened at Nandipur on the Upper Chenab Canal between Gujranwala and Sialkot. At this field station many more facilities than were available at its counterpart were laid.

Indus and its tributaries form one of the biggest irrigation systems in the world and the design and construction of its hydraulic structure present many difficult and complicated problems, some of them related to building of headworks on a permeable foundation. This Institute is guiding the engineers in the field in the design as well as in the construction of works.

The Institute also deals with problems like river training and control, canal falls and other structures, tube-wells and seepage; canal linings; flood control; sediment exclusion from canals, stability of works on sand foundations, stability of embankments, testing of materials, bearing pressure of soils and design of foundations. Besides, the Institute has the equipment to deal with stress analysis of structures and problems connected with dams.

Apart from the Irrigation Department, the Institute's help has been sought by the Port Commissioner, Chittagong, the North Western Railway, and the P.W.D. (Buildings and Roads). During the recent years, it tendered advice on (a) protection of Jehangir's Tomb from river action, (b) improving navigable depths near Chittagong Harbour, (c) training River Sutlej to protect the Adamwahn bridge of the North Western Railway, (d) the River Diversion Scheme of Indus at Kotri Barrage, (e) design of an automatic regulator for the Baran Dam and the Kurram Garhi Project, (f) syphon spillway and silt excluder design for the Dargai Hydro-electric Scheme, (g) twenty different investigations in connection with the design of the Taunsa Barrage, (h) silt investigation in connection with Mangla and Warsak Dams, and (i) design problems of Chichoki-malian, Shadiwal and Rasul Hydel Projects.

Recently, the Director of this Institute carried out an extensive survey of Saudi Arabia to tender advice on the development of that country's water resources.

(Extract from a radio talk by Mian Muzaffar Ahmad, Director Irrigation Research, Lahore).

ROADS IN PAKISTAN

The vast mileage of paved roads in Pakistan is a considerable achievement in view of the hand labour involved. Especially commendable is the self-help by the villagers under the Pakistan Village Aid Programme.

The three main problems are waterlogging, salt peter, and low cost roads. These and other problems are difficult to solve due to lack of equipment.

Some of the things that can be done now are:

1. Expansion of the excellent work on design of pavement thickness now being done by the Building and Roads Branch: When a person realizes that the pavement thickness may vary from 6" to 20" based on the ability of the subgrade to support loads, the importance of this design is realized.

2. **Compacting embarkments and subgrades better:** Placing a pavement on a subgrade, weak due to lack of compaction, can result in failure. This proper compaction is very difficult using hand labour.

3. **Making a wider use of local materials:** In the Central Punjab there is a serious shortage of construction materials and the solution of using brick for soling is excellent. Sand, where locally available, can be used as the lower layer of soling to reduce the thickness of more expensive materials. Voids in brick and stone courses should be filled with stone screenings or sand and never with silt or clay because silt and clay act as lubricant destroying the strength of the pavement in the presence of high moisture contents. Where gravel is cheaper than brick it should be used for soling and wearing course.

(Extract from the remarks of Mr. C. E. Larson at a meeting of the Engineering Congress.)

Clippings

(AMERICAN SOCIETY OF CIVIL ENGINEERS)

SYMPOSIUM ON ARCH DAMS

THE art of arch dam designing is becoming a science. The tedious work of analysis has been simplified by model study. Economy over the gravity type can be 30 per cent or more. Adaptation of long arches to wide valleys may dispel the idea that sites for arches are running out.

Statements like these augered wells for the future arch-dam construction both here and abroad as experts from Portugal, Italy, Japan, France and the U.S. joined in a symposium sponsored by the Power Division of A.S.C.E. at its Knoxville convention.

Mr. Andre Coyne of France in his paper "Arch Dams and their Philosophy" stated that there is no known failure of an arch dam. The difficulty would seem to be not to make it hold up, but to knock it down. Hyperstatic capacities enable them to compensate for unexpected foundation defects and for inadequate dimensions. Elasticity is the essential quality. Economy in volume is most certainly a paying proposition. Model Analysis has enabled us to go further and further in the use of wide valleys, even valleys wide at their base."

Of arch-dam analysis, Mr. Coyne wrote: "The best thing to do is to put up with simplified calculations giving results within two limits and to get from them courage for choosing a given design. This is then immediately elaborated on the model, retouching this model several times over so as to gain little by little on volumes and stresses. Today, over-exacting calculations are only undertaken as a final check, after all the dimensions have been established in the laboratory."

Mr. Julian Hinds, the famous U.S. dam designer who was among the developers of the trial load method of arch analysis, remarked in reply to Mr. Coyne that the work involved in the analysis is over-estimated.

Rocha Serafim and Da Silversia showed by a movie how they have analysed six out of the twelve arch dams built in Portugal since 1946, solely by models.

Carlo Semenza of Italy stated that 65 out of the 180 major dams in Italy were arch dams. He stated that Vafont Dam, 850 feet high, is also an arch dam.

R. W. Gunwaldsen of Japan stated that Japan first arch dam, 372 feet high, has been completed a year earlier than a gravity could have been finished. It has cost $5 million less than a gravity dam and 90,000 K.W. have been put on line one year earlier.

Members of the symposium were of opinion that without changing the quality of concrete, economical design will be made possible through increased knowledge of the behaviour of the structure and its foundation. Temperature can induce stresses of the same order as stresses due to loads.

A check-up on stresses by the trial load analysis method as well as by measurement of Ross Dam showed general agreement and if there was any difference it was due to temperature effect.

(From Engineering News Records June 14 1956).

POWER FROM THE TIDES

Generation of electricity from tides has formed a subject of studies of countless papers, but France is the first country who is spending $100 million to install the first tidal power project in Rance River to produce 342,000 K.W.

The work was started in 1954 and is scheduled for completion in 1963. The power generator unit will consist of 38 turbo-generators, each rate at 9,000 K.W. The machines will be set directly in the line of flow and completely submerged and will generate power with water flowing in either direction and, in addition, function as a pump as well as a turbine. Pumping can be utilised to raise or lower the levels of the reservoir beyond those attained normally, and thus to increase the available head for the turbines. This device will increase the available head from 15-20 to 18-25 ft.

The machines will be installed in the body of the dam and thus there will be no power house super structure.

The construction will, however, present many difficulties about construction of

Coffer Dam, but extensive model studies in the hydraulic laboratory which is located on the site is helping to determine the best type of Coffer Dam and most practical method of final closure

(From Engineering News Records, June 14 1956).

CHUHARKANA RECLAMATION PROJECT

The Soil Reclamation Board, with S. A. Majid, Chief Engineer, as Chairman, has issued a brief phamphlet giving the necessity, the urgency and the programme of reclamation at Chuharkana. In the 16 districts of the former Punjab of 63, 134 square miles and of a gross area of 37 million acres, the area under calibration is 20 million acres. Of this, 800,000 acres have gone completely out of cultivation and the rest is deteriorating at the rate of 40,000 acres per year. The water-logged land, although much less in proportion, is also a serious menace requiring immediate drainage.

Chuharkana is an experimental reclamation project which has been selected in consultation with officers of Central Government and after an advice by a team of experts of the F.A.O. of the United Nations.

The reclamation of 10,000 acres of this area is to be achieved with the help of tube-wells drainage and better farming methods.

The Government has sanctioned Rs. 35,00,000 for the operation of the scheme and the total income expected has been put at Rs. 4,000,000.

(From the Soil Reclamation Board Pamphlet).

THE BIG ONE GOES TO WORK

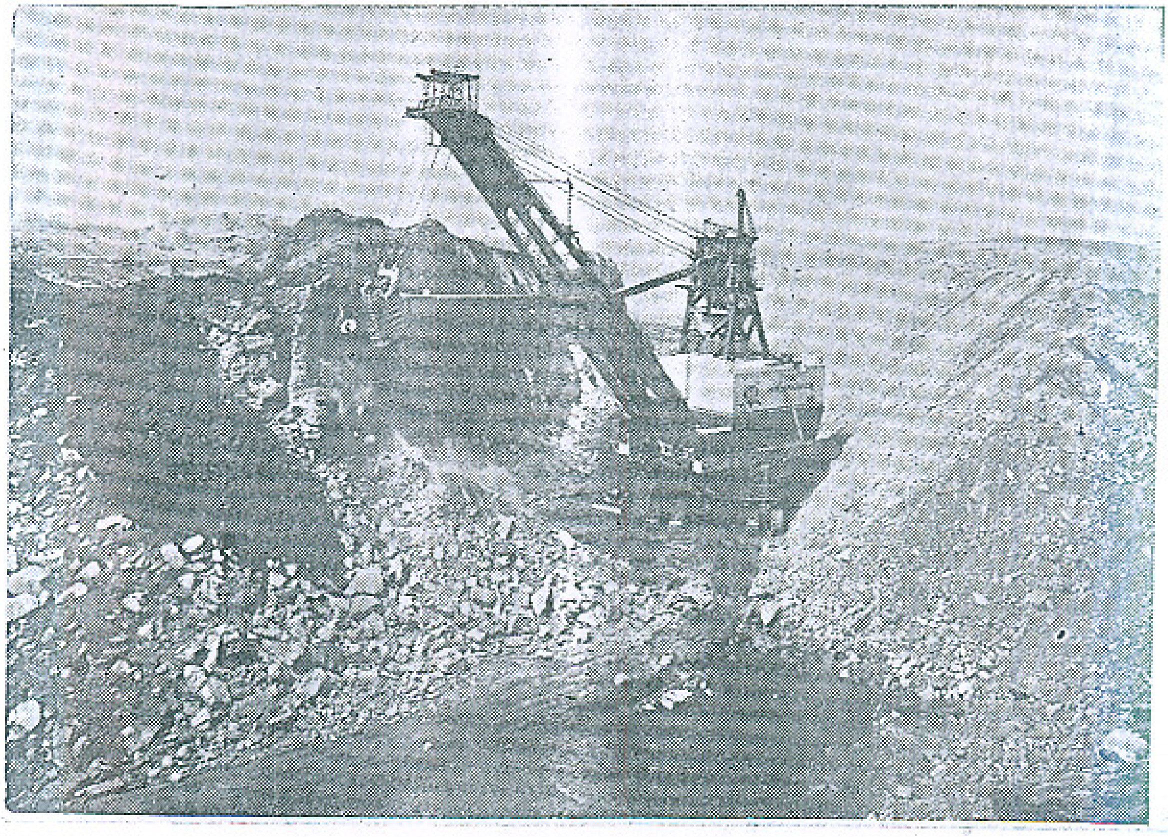
The world's largest power shovel has gone to work, stripping overburden in a Hanna Coal Company's Georgetown mine, south-east of Cadiz, Ohio. The five and a half million pound behemoth—the largest mobile land machine ever built in the United States —has been nick-named "The Mountaineer". Built at a cost of 2,600,000 dollars stands as high as a 16-storey building, can scoop up 60 cubic yards of dirt at a bite, and yet is controlled by just one man.

The big shovel is powered by 16 General Electric motors—and requires power at 7,200 volts. The main alternating current motors have a total rating of 4,650 horse-power—the total of all motors is 9,000 horse-power (equivalent to the horsepower rating of the latest ocean-going freighters). The total peak power demand of the shovel is 6,840 kilowatts—enough power to light 5,200 average homes.

The Mountaineer has a total lifting power of some 250 tons. It could lift 100 feet into the air a platform holding 166 automobiles, swing the platform through the air a distance almost the length of a football field, set it down on top of a ten-storey building and swing back for another load—all in 45 seconds.

The dipper of the machine has 60 cubic yards (90 tons) capacity. One dipperful of material would fill a room 10' x 20' x 8' in size. The machine can handle 14,400,000 pounds (about three times its weight) of material each hour. It is working three eight-hour shifts per day.

The Shovel has been manufactured by Marion and is distributed by Blackwood Hodge (Pak) Ltd.



BOOK REVIEW

The Engineering News reviews books of interest to its readers in every issue. As the magazine is circulated among all the members of the West Pakistan Engineering Congress, publishers of technical books should find it useful to get their publications reviewed by it. Publishers in Pakistan and abroad are requested to send publications to the Editor-in-Chief, Engineering News, Sir Ganga Ram Building, The Mall, Lahore.

The following books have been received:

I. "The ultimate Load Theory applied to the Design of Reinforced and Prestressed Concrete Frames". By Professor A. L. L. Baker, D.Sc. M.I.C.E. (Concrete Publications, Ltd., 14, Dartmouth Street, London, S.W.I., Price 18s.).

The design of reinforced and prestressed concrete structures by the Ultimate Load method has been in use in some Western countries for several years, and there is little doubt that this method will appear in the new codes of practice for concrete that are under preparation. The Ultimate Load method of design is based on the load causing failure of the whole structure, and not on the elastic theory that is used generally at present. This book is, probably, the first work published in the English language on design procedure according to the Ultimate Load method. It discusses the probability of failure and its effects, and describes how a suitable factor of safety can be decided upon. The conception of plastic hinges enables full use to be made of the economy that is possible by the Ultimate Load method of design, and this has been described in detail in this book.

It is hoped that the book will be of great interest to design engineers.

II. "An Introduction to the Theory of Structure" by W. Merchant, M.A., S.M., D.Sc., M.I. Struct. E., A.M.I.C.E., A.M.I. Mech.E., A.M. Am. Soc. C.E. and A. Bolton M.Sc. (Tech.) (published by Blackie and Sons Limited, 17 Stanhope Street, Glasgow, U.K. Price 30s.).

This book is based on lectures currently being given to under-graduates in the Department of Structural Engineering of the Manchester College of Technology. Although many books have been written on the subject, the author has given a fresh approach to an otherwise hackneyed subject. The book deals essentially with theory, but the practical aspects of various things as well as the limitations of the simple theory have not been excluded from consideration. This is particularly true of the theories of elasticity and of statics. The presentation of the theorem of three moments is not only completely new but also very simple—thus rendering the book particularly helpful to students.

The book is specially recommended for use in engineering colleges.

III. "Engineering Fluid Mechanics" by Charles Jaeger, D.Sc. Special Lecturer at the Imperial College of Science and Technology, and Consulting Engineer, English Electric Company Limited, translated from German by B. O. Wolf.

Blackie and Sons Limited, 17 Stanhope Street Glasgow, U.K., Price 60s.

Engineering Fluid Mechanics is a fast developing subject and considerable work has been done on it all over the world. Besides giving a historical background of the development of the basic hydraulic theory, Dr. Jaeger has dealt with the design and analysis of water power schemes. The book was first published in German in 1949 and was immediately recognised as a great work of reference for students of water power engineering. This translation in English will, therefore, fulfil a vital need of the hydraulic engineers in this country.

The author has presented some new material on discontinuous flow in open channels. He has not only dealt with the theory of water hammer but has also thrown light on some new and interesting facts. Part "D", dealing with the ground water flow will be found to be of special interest to engineers in Pakistan.

'DEFINITIONS AND FORMULAE' Metallurgy, compiled by E. R. Taylor, Published by Sir Isaac Pitman & Sons Ltd., London.

Putting together scattered information in such a way as to make it readily available for reference is an art by itself. The booklet speaks of the efforts of the compiler in this direction.

The book is divided into six sections, each containing useful information on chemical composition of the alloys besides, their definitions. The divisions into sections is based on a careful forethought of the requirements of the user.

For students, as the title signifies, the book will be of great use.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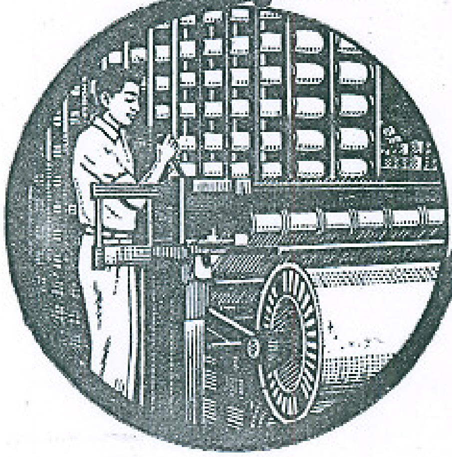

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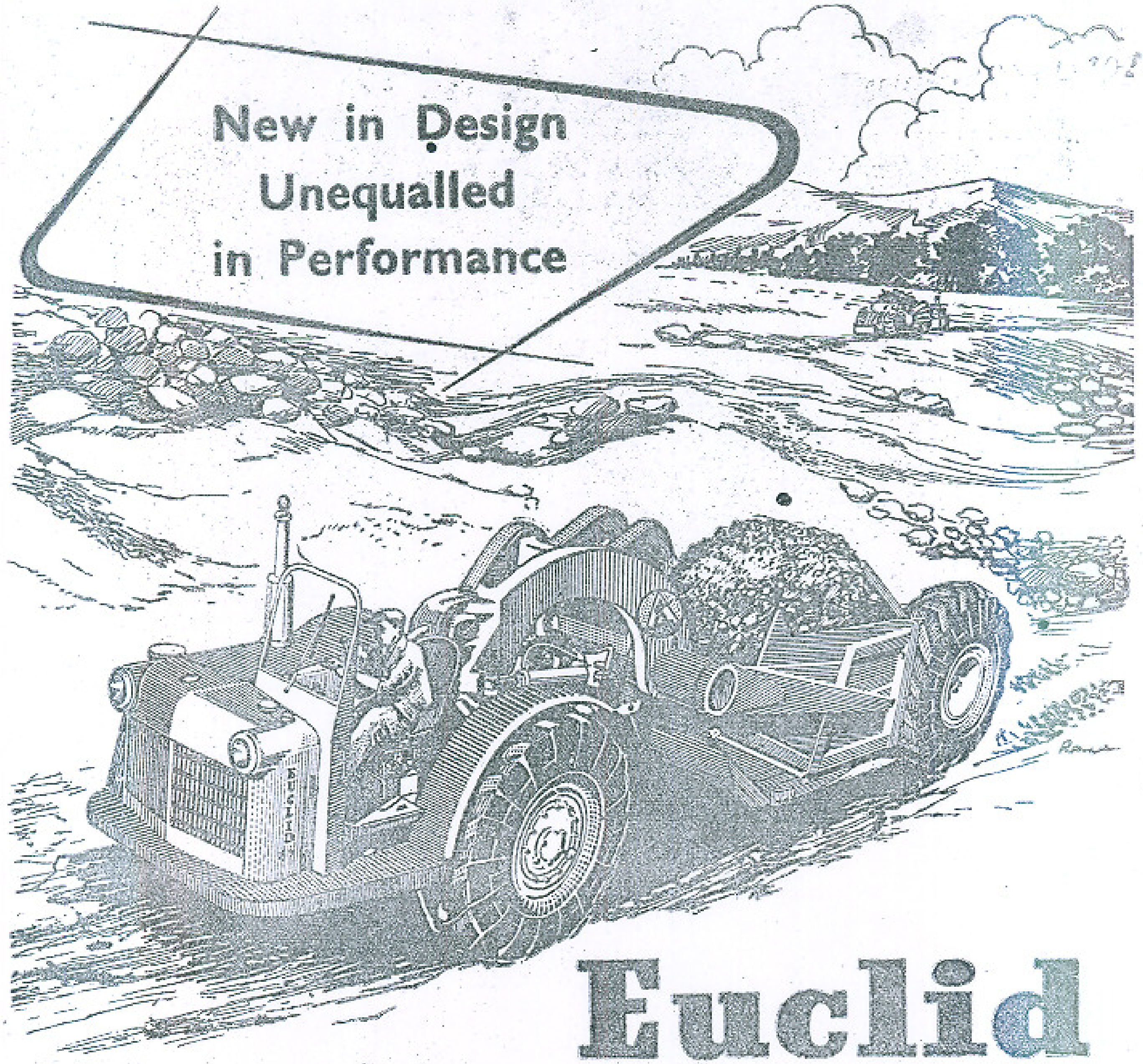

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