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ENGINEERING NEWS

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In this Issue

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Editorial

Quaid's Vision

A grateful nation celebrates the centenary of the Father of the Nation trying to relearn the spirit of his message. A full cycle of twelve months—the whole of one year—enough time span to re-dedicate and to be involved in the accomplishment of unfinished task. The task that never gets finished. It is the never ending pursuit for the realization of a vision that symbolizes life. When Allah chooses someone for the endowment of a vision, it is HIS limitless bounty. What a tremendous loss for those who, when bestowed with a vision, chose to be ungrateful by not sweating in the eternal pursuit of love and beauty ; not keeping kindled the flame of passion in their hearts and minds.

Quaid was a visionary. He saw a vision as to how his nation should look like ; united, strong, vigorous, dynamic, progressive, based on the sure foundations of social justice, equality and fraternity. He saw vision of a nation having discovered its comprehensive identity, having shaken off the crippling feeling of being left behind. He saw the vision of the nation standing on its own feet—not only in the physical sense, but also in ideological sense. The burdening shackles of slavery were to be cut off not merely by physical withdrawal of imperialistic powers but also by overthrowing the slavery of borrowed ideas. He saw the vision of an emancipated nation, practicing a system of its own, free of all oppressions and tyrannies.

What a plaything the celebrations would be if not for re-living the vision of society that he saw. We were scattered, he gave us unity. We were weak, he gave us strength through organization and faith. Our efforts were directionless, he gave us direction. He lead us from the despondancy of a "minority" to the bubbling confidence of a nation. He laid the foundation for us being worthy of living in a modern technological era. Quaid was every inch a man of Twentieth Century. He had fully imbibed the spirit of scientific investigation and was

aware of the potential of technological advancements. He was modern and not a traditionalist. He was socialistic and not feudalistic. All what he stood for and the methodology that he adopted was that of scientific era.

Looking at the Quaid's traits as that of a sponsor of modern progressive society, we, the engineers of the country of his creation, owe a large debt to be discharged in this year of Centenary celebration, and foreever afterwards. We are charged with the responsibility of introducing technology in the society. Technology gives the means to improve production methods and leads to better and higher production, new avenues of exploiting the natural resources. Technology when applied to serve humanity adds to the quantum of resources needed to meet human needs and thus ensures happiness and satisfaction. Linked to the concept of applying technology for incressing the production is the concept of equitable distribution of the fruits of new productive forces. Technology is a very powerful instument in the hands of those owning the means of production. If the use of technoloy is delinked from the concept of equitable distribution, it helps concentration of wealth in the hands of fewer people much faster than it could be done in a traditional feudal society. We are not to let the technology be used as an instrument of oppression to accentuate the inequalities. That is what Quaid meant when he expressed his desire to build the society on sure foundation of social justice and equality. It is an erronous concept to let the full dose of technology be given to society without resolving its conflict with the principles of social justice. Corrective measures can not be applied at the end. Technology and social justice are not mutually exclusive. They go hand in hand if we can just comprehend and imbibe the spirit of scientific era as the Quaid could do in contradistinction to the approach of obscurantists.

We the engineers of Pakistan rededicate ourselves, in this vear of Quaid's centenary, to work in the fulfilment of Quaid's vision to imbibe spirit of scientific investigation and to apply technology for better and quicker results to build Pakistan on the sure foundation of the principles of equality and social justice.

Public Health Engineering

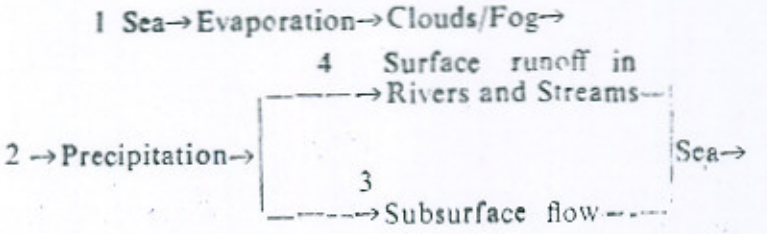
Ground Water Quality Management for Public Water Supplies

A. N. Cheema Chief Water Supply Division National Engineering Services (Pak) Lahore, Pakistan

Introduction

Of the estimated 324 million cubic miles of water present on this planet[1], 97·2% is brackish water in the World's great oceans and seas, while 2·8% is available in the form of non-brackish, water, sometimes termed also as "fresh" or "Sweet" Water, from where, uptill now, we had to meet all our requirements of Water Supplies whether these were for human beings, their livestocks and their Crops or for the life, as a whole on the surface of the earth, which is "sustained by water." No doubt efforts are now being made to reclaim the brackish water in order to meet the evergrowing demand for "fresh" water, which is feared to fall short of requirements, if the demand continues to increase, but it is likely to take considerable time before the process comes in the economical range of mankind, in general.[2]

The two "bodies" of water (97·2% & 2·8%) are linked through a continuous state of motion forming a cycle usually known as "The Hydrologic Cycle."



The foregoing, is the simplified form of Hydrological Cycle for which it is also estimated about two third of the precipitation that reaches the ground surface from atmosphere (Stage 2 of the Cycle), is returned to atmosphere by evaporation from water surfaces, soils and vegetation and through transpiration by plants. The remainder one-third returns ultimately to sea through the surface and underground flows as stage (4) in the cycle.

As described earlier, the most economical water resources for any particular region on the face of the earth, are to tap the stage (4) of the cycle namely (*i*) Surface flow.....Rivers, Streams etc, or (*ii*) Subsurface or underground flows.

For any specific use of water, Engineers are therefore confronted, with the propositions for the purpose of quality and quantity, of these two sources generally available in any particular region of the earth, to decide for a suitable alternative on the basis of merits and economy.

A Water Supply Engineer has to be extremely analytical to consider these two sources of water for short term as well as long term planning.

From history, we find, civilization developing in river valleys mainly due to the availability of water. In the absence of knowledge about the adequate treatment of surface water, people preferred settling at places where the ground water

table was shallow so that they could extract water from the ground easily and the open wells, no doubt very much prone to contamination, were considered to be safest source of drinking water.

Quality Management of Ground Water :

Engineers of our age, are also quite attracted to use the ground water, as the source, for the public water supply systems, because in majority of the cases, the ground water due to the natural filtration during the process of percolation from the land surfaces, does not need the "clarification process" which invariably has to be applied to the majority of surface waters generally, needing the following treatment steps : —

STEP I. Solid Liquid Separation :

Due to the suspension in raw surface water, a lot of colour and turbidity is present, which is separated by the process known ss "Coagulation and Flocculation." This is essentially a chemical process in which coagulants like alum (at a pH of 6·0 to 6·5 of the flocculated water defined by the author for tropical countries)[5] react with the natural akalinity to produce SETTLEABLE FLOCS, when mixing is done in accordance with certain specified principles[4]. To make the flocs tougher and heavier some poly-electrolytes[4] are used sometimes, depending upon the quantities of encountered sludge. Lime is added along with the primary coagulant to maintain the pH of flocculated water in the specified range. The process results in the "solid liquid separation."

STEP II. Removal of Solids :

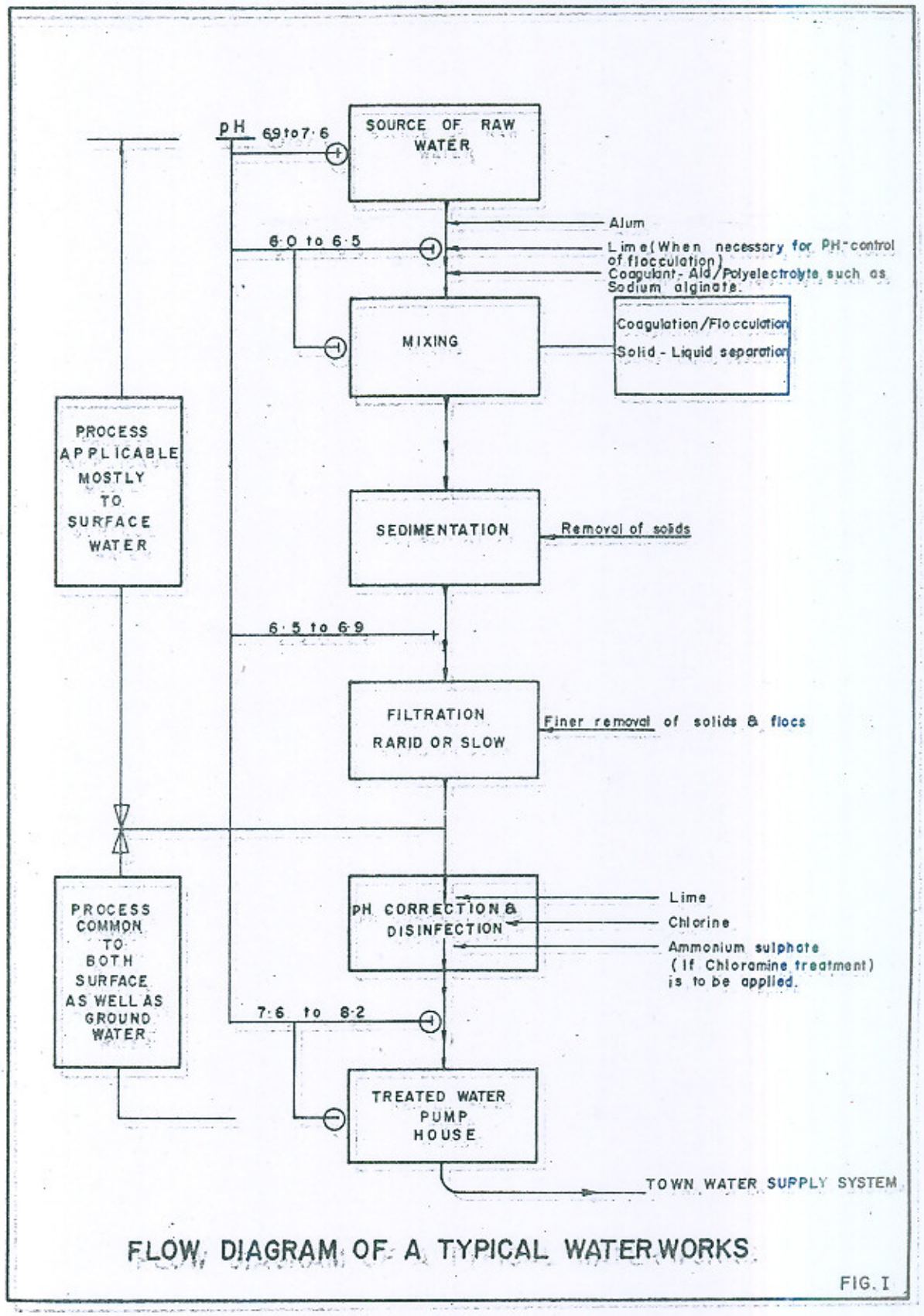
After the separation as mentioned in step I, the solids in the form of sludge are to be physically removed in specially shaped and designed engineering structure usually named as "Settling", "Sedimentation" "Clarifiers", and Sed-Clarifiers" Tanks etc. During the past two decades lot of research work has been done on such tanks, but any particular shape and "removal efficiency" are dependent upon the local conditions. For instance, the author determined in a Tropical African Country that vertical sedimentation tank, no doubt considered to be very suitable as "sludge-blanket clarifiers' in Europe requiring much less space, are very badly affected by the varying day-temparature[5] and after lot of experimentation circular eccentri-flow type of tanks turned out to be extremely useful for tropical climates etc. in which sludge is Mechanical. Recent research is concentrating on the efforts to reduce the time that the flocs formed normally take for safe removal. Tube settlers are now under experimentation in some countries.

STEP III. Finer Removal of Solids :

The effluent from the settling tank may still contain some solids or residual flocs which can be removed by passing the settled water through specially prepared filter beds of graded sand and gravel which cause the finer removal of suspension and partial elimination of bacteria count as well.

STEP IV. pH Correction :

pH of filtrate, is generally low in the range of 6·5 to 6·8 because of coagulation of raw water with alum and as such an alkali like Soda Ash or Lime is added to bring the pH in the range of 7·6 to 8·2, generally considered by the Water Engineers to be the best to meet various requirements of the consumers as well as the conveying pipe work and fittings



FLOW DIAGRAM OF A TYPICAL WATER WORKS

FIG. I

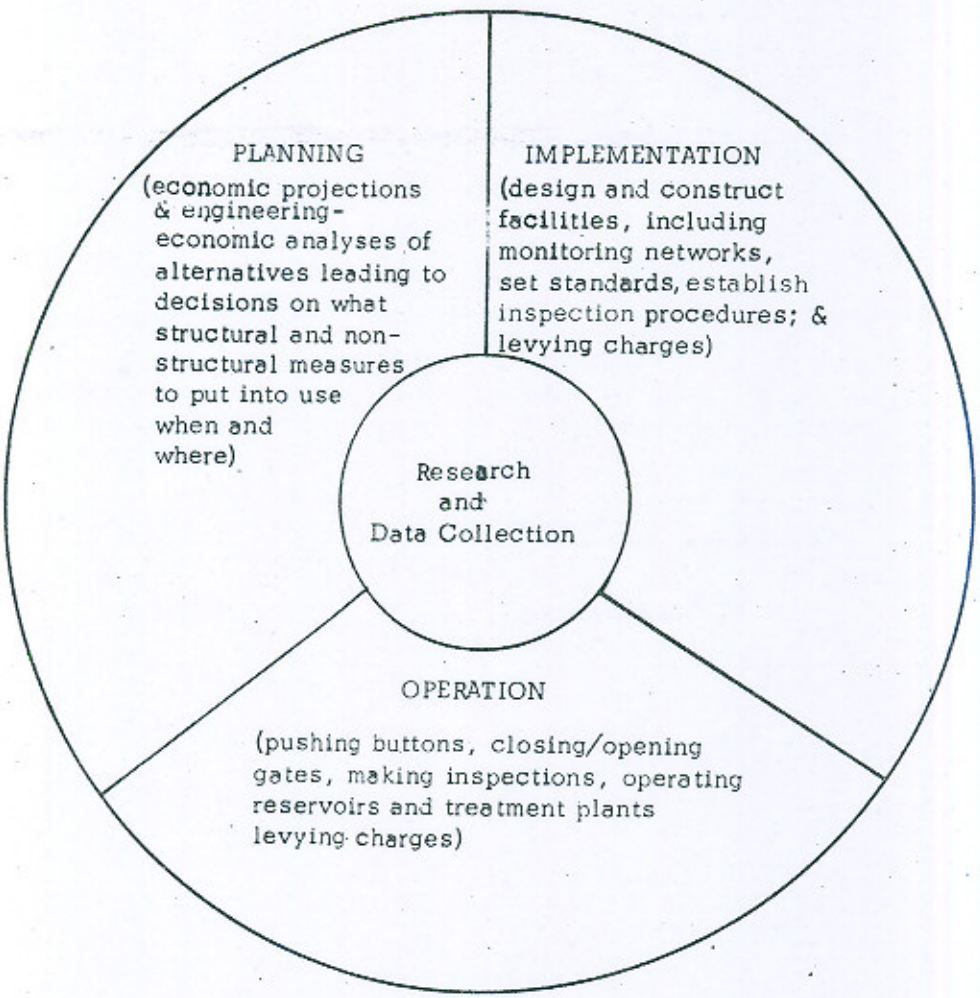


Fig. 2 - Range of Activities in Water Quality Management

STEP V. Disinfection :

The raw waters, whether these are from surface or underground, in majority of the cases, are known to be containing some pathogenic bacteria which can live in water for 2 years or more without destruction and as such disinfection of these waters, is absolutely necessary. Most commonly used dis-infectant is chlorine, which, as an oxidising agent, has disastrous effect on most forms of low organic life. Slow acting disinfectant like chloromines (produced as a result of combination of chlorine and Ammonia), which are stabler than chlorine but weaker in effect, have been found useful in cases where water contains phenols and addition of chlorine alone is likely to produce tastes. Also, it has been experienced that, where water is likely to pick up heavy contamination from Distribution System because of various reasons, the disinfecting qualities of chloramine for longer period, and distances is extremely useful. The author was able to maintain 0·2 to 0·3 P.P.M. chlorine residue in the remote end of distribution system running in hundreds of miles through African localities. Other disinfectants like OZONE are also now in use at various places and further research in this field is now going on to examine the toxic effects of chlorine.

VI. Removal of Taste and Odour :

Tastes and odours are caused by the following :—

(*i*) Dissolved gases such as Hydrogen Sulphide.

(*ii*) Living organic materials such as algae.

(*iii*) Decaying organic materials, such as grass, leaves and trash etc.

(*iv*) Industrial water either falling in a stream or percolating into the ground with shallow water table.

(*v*) Chlorine either as excess residue combining with phenols or decomposing organic matter.

VII. Water Softening :

The hard water is not essentially softened for potability for human consumption but mainly for the reduction of soap consumption and maintaining low costs for plumbing fittings. In fact, it has been reported in England[7] that the areas supplied with hard water reported less cases of cardio vescular diseases, when compared with the areas where extremely soft water was supplied. This fact, as yet is to be fully established. The need for softening water is therefore to be established first, before embarking on this process.

VIII. Removal of excess of Salts and Metals :

This process is absolutely necessary if excess of salts and metals is detected in the raw water and then subsequently in filtered water.

A flow diagram for a typical water treatment plant is shown in Figure 1 which indicates also the processes which can be common to both surface as well as ground sources.

There is generally a belief, which in majority of the cases turns out to be false, that ground water is safe and good enough without any need for treatment. In fact, in some regions of the World, the ground water, even though available in abundance, has been discarded for the reasons that the treatment was too complicated and too expensive.

For the sake of convenience and economy the people always found it better to live at places where, by digging into the ground they could find enough water. This resulted in introduction of pollutants to water at the ground surface before it could percolate into the ground and where the natural filtration turned out to be inadequate the ground water got very badly polluted. The percloation media also added a number of salts and minerals which affected the pH as well as salt-content of ground waters.

While this process was continuing for ages, the modern man found it more convenient to enlarge the old centre of habitation into big cities and built underground net works of sewers, which in many cases were laid below ground water table, thus providing a perpetual potential source of contamination. Natural filtration was thus short circuited as the leaking sewers could deliver contamination directly without any filtration effect. As the demand of water on the land surface increased, it lowered the water-table but that was no consolation either, because that resulted in the increased volume of the polluted water going through the underground sewers where it had lesser thickness of the media to pass through, to reach the water table particularly during the breakage or leakage of the sewer pipes.

Greater care and cautions are therefore necessary for ground water management, from quality point of view in order to reduce the chances of contamination which affect the suitability of ground water for potability.

Protection Zones for Ground Water

In case all other considerations go in favour of "ground water supply, there is always a need to create protective zones around the points from where the water is to be extracted. General contaminants of organic or inorganic origin for water are as follows :

(*i*) Poisons such as compounds of flourides, chromium, arsenic, lead and some insecticides.

(*ii*) Colouring, odouring. and tasting, matter such as commercial colouring matters, Hydrogen-Sulphide and Phenol etc.

(*iii*) Sewerage, industrial waste and effluents, fuels, oils, greasses, waste materials, fertilisers and decayed animal bodies.

The "Protection Zones" are of the three categories which, for the sake of convenience Water Supply Engineers have defined as follows :—

Zone I.

This is the immediate vicinity of a bore hole or tubewell which is protected against both pollution as well as damage and is normally to be secured by means of fences etc.

Zone II.

The zone extends upto the area that the extraction point is at least at a distance of 50-days travel time of ground water from the extremity of the area. In this area Agriculture, without the use of excess of fertiliser, is allowed.

Zone III.

This zone extends from the point of extraction to a radius of ten times the radius of Zone II. The area covered by this zone should be protected against (*i*) Entry of

sewage in sub-surface (*ii*) Establishment of any settlement (*iii*) Storage of fuels, oils, chemicals and insecticides (*iv*) Cattle watering places.

The above mentioned zones, as mentioned earlier, are the protective zones, if the ground water is to be protected against external pollution. In case other considerations do not make it possible to have these zones, then ground water must be treated for all chemical and biochemical defficiences.

Table 'A' indicates the standard laid down by World Health Organisation for potable water which acts as a guideline, for all Water Supply Operators.

TABLE 'A'

STANDARD FOR DRINKING WATER
AS LAID DOWN BY W.H.O.

Substance	*Recommended Permissible Contents*	*Units*	*Remarks by Author*
1. pH	7·0 to 8·5		(For practical purpose 7·6 to 8·2 is considered to be the most appropriate range).
2. Total Solids	750/100	mg/l	
3. Colour	5	Units	
4. Turbidity	5	Units	
5. Taste	Acceptable		
6. Smell	Acceptable		
7. Iron (Fe)	0·3	mg/l	
8. Manganese (Mn)	0·1	mg/l	
9. Copper (Cu)	1·0	mg/l	
10. Zinc (Zn)	5·0	mg/l	
11. Calcium (Ca)	75·0	mg/l	
12. Magnesium (Mg)	50·0	mg/l	
13. Sulphates (SO^4)	200·0	mg/l	
14. Chlorides (Cl)	200·0	mg/l	
15. Sulphates of Mg+ Sulphates of Na	500·0	mg/l	
16. Phenolic acid	0·001	mg/l	

TABLE A (contd.)

Sabstance	*Recommendea Permissible Contents*	*Units*	*Remarks by Author*
17. Chlorofermical extract of Carbon	0·2	mg/l	
18. Alkylbenzoin Sulphate	0·5	mg/l	For infants this figure needs to be reduced de-
19. Flouridc	1·0	mg/l	pending upon other
20. Nitrate (NO_3)	trace	mg/l	local facilities.
21. Lead (Pb)	0·05	mg/l	

In case there is a large potentiality of ground water, and it is possible either to create the protective zones against pollutions or the water can be treated to attain the requisite W.H.O. Standards, then the choice would definitely go in favour of ground water taking into account, of course, other factors which may affect the economy of the source as a whole.

Quantitative Consideration of Ground Water, as a Source for Public Water Supply System :

Before finally relying on the ground water, as an adequate source, for the planning horizon quantitatively, lot of data and investigations are absolutely necessary.

(*i*) Population—present and ultimate for planning horizon with the rate of growth, etc.

(*ii*) Demands—seasonal, monthly, weekly and hourly fluctuations.

These are very vital factors, as figures cannot be borrowed from any other country, town or environment. Following Peak factors,[10] as determined for a city belonging to the third world, located in tropics would indicate, that ignorance about such factors could lead to inadqeuacies in source, treatment, pumping, storage and distribution systems.

Monthly Peak C_m		=	1·25
Weekly Peak C_w		=	1·12
Daily Peak C_d		=	$C_m \times C_w = 1{\cdot}40$
Hourly Peak C_h		=	1·9
If the average daily demand is taken as Q			
then Peak monthly demand =	Q_m	=	$Q \times C_m = 1{\cdot}25Q$
Peak daily demand =	Q_d	=	$Q \times C_m \times C_w = 1{\cdot}4Q$
Peak hourly demand =	Q_h	=	$Q \times C_d \times C_h = 2{\cdot}66Q$

In the personal opinion of the author, which is based on extensive experience and information gathered from various systems both in the developing as well as the developed world, only system with following design criteria were found to be satisfactory even when there were doubts expressed, due to lack of basic data, at the design stage.

(*i*) Source to be constantly checked for its potentiality and in case of anticipated short-fall alternatives worked out. This involves lot of collection and generation of data.

(*ii*) Treatment plant, if any, to be designed for peak daily demand Qd towards the end of the design period or the phase of development.

(*iii*) pumps and pumping mains for town supply designed for Q_d with storage facilities to cater for the Peak hourly demands. In actual practice, the storage required for this purpose may not exceed 25% to 30% of the Peak daily Demand *i.e.* 0·25 Q_d to 0·3 Q_d which means reserve storage equivalent only to 6-8 hours of the average demand.

In developing countries, where chances of power failures are not remote ; where extended mechanical failures cannot be ruled out and where pipe breakages of pumping mains (specially if surgesupression is not available) could rampage the system, reserve storage of higher magnitudes are recommended.

For example reserve storage whether on gronnd or in air of the order of one day's demand has to be provided in a number of African Towns in order to ensure the continuous supply of water for domestic and industrial purposes. The reserve storage capacities can be reduced by improving on the design and operation methods and by providing the stand-by Power Generators

However, the concept, which has been very common in some places, that if you use the ground water, you need less or no storage and you can pump directly into the system with mini-balancing tanks, provided in different areas, has not been found, working satisfactory anywhere.

"Storage" in ground as ground water source is no better than the water available from a river or a lake which has to be treated, pumped and distributed. The ground water in majority of the cases, would undoubtedly, need less treatment but rest of the process should be the same.

Balancing tanks, if not designed for any reserve storage, would only equalise the pressure on the pumps while pumping, independant of the demand variation of the Distribution system, but the moment there is a power failure, the minibalancing tank would go dry in a matter of minutes.

Some operating Authorities,[11] have switched on to 50% stand-by power requirements and half day's storage but this is all flexible according to the conditions prevailing in a particular system.

(iv) Distribution System :

The distribution network to be designed in accordance with the Peak hourly demand Q_h with minimum size of the main not less than 3". The staging of the pipe work is to be decided according to the demand and later based economy of laying the pipes "now" or on annuity value and capital investments.

No good distribution system could be developed unless the town planning aspects

are fully defined by the Town Planning Authority. In fact at the planning stage, the two should go hand in hand.

Secondly, from socio-economic point of view, data need to be collected as to how many people would actually be able to get the private water connections in their premisis and how many of them shall have to rely on the "Public Stand Pipes". Consumptions of the people having private connection and of those who have to fetch water from a stand pipe have to be worked out separately in order to plan a proper distri bution. While stand pipes are used by public mostly during the day and there are physical restrictions for a person to fetch water from a distance, the private connection would have more evened out peak demands because of the availability of water round the clock. A survey carried out under the author's supervision in a relatively poor area of a West African Town indicated per/capita demand for a private water connection 2·5 to 3·0 times the demand per capita for the people drawing water from the stand-pipes.[12]

Health Hazards :

1. Constant drinking of low pH water creates all sort of stomach troubles.
2. All water-borne diseases such as cholera, typhoid, dysentry result from pathogenic bacteria.
3. Infant mortality is always higher where water contains excess of iron and nitrates.
4. Water contaminated with sewage would contain E. Coli bacteria which inhabit the intestine of warm-blooded animals.

Conclusions :

(*i*) Choice of particular source for Public Water Supplies when both "Surface and Underground" are available, can be made only after the collection and analysis of lot of data on quantity, quality and economics of the project.

(*ii*) Management of any system of water supply could be effective only when operations incorporate the collection and analysis of data on day to day basis. The general principle of water quality management can be well concluded as in Fig. 2.

(*iii*) Philosophy, that clean water available from ground is always good enough for use should always be carefully studied before acknowledging it, as at times ground water is more difficult than surface water for treatment to bring it at par with W.H.O. Standards.

(*iv*) In developing countries, where power supplies are not adequately assured, reserve storages and stand-by power generation are absolutely necessary for continuance of supply during emergencies.

The capacity of the storage/balancing tank is not necessarily determined to meet the fluctuations in demand only but also for reserve storages.

(*v*) Unless a legislation is enforced, for the Protection Zone around an extraction point upto the radius as specified, it would not be possible to protect the ground water source against pollution; and once the ground water is polluted it must be fully treated before supplying to the people.

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Environmental Geomorphology of Lahore

By

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Introduction

The activities of man in changing the face of Lahore are of great concern to us. Many of us, teachers, planners, architects and engineers have been associated over the past several years with a concerted effort to focus attention on the problems of the city of Lahore, its changing environments and increasing pollution. We have organized and attended meetings, conferences, we have formed committees and sub-committees, we have opened Public Health Laboratories, Students Training Programmes and a large number of other activities. These activities are certainly praise-worthy as they have stimulated interest and knowledge of changing environment of our city, but the total problem of the environmental pollution has hardly been understood. Many of these problems are of such anature that need wider inter-disciplinary approach.

The subject itself is so vast and changes are so fast that any number of studies would hardly do any justice. Urgently needed now is a systematic study of the existing environment of the city. Researches and field observations would improve our understanding of the environment, its pollution and the inter-relationship between the man and the city.

In the following article an attempt has been made to describe some of the basic geomorphological parameters that govern the human environment in the city of Lahore and an understanding of these may be helpful to our planners and the citizens in keeping the environment of our city free of pollution.

Geology :

Nearly all the deposits underlying the city of Lahore and surrounding area are the products of geological events during Pleistocene and recent geological times. On these deposits soils have developed on which the city and its highways are located. The deposits also have influence on the drainage and recharge of the groundwater reservoir. From these deposits the supplies of groundwater are obtained for the entire city. The alluvial complex of Lahore consists principally of fine medium sand, silt and clay, associated with the fine grained strata and concertionary zones or nodules of Kankar. Drilling data obtained for several deep wells shows the absence of thick horizons of clay within the alluvium. Clay lenses occur only locally and have little vertical or horizontal continuity. The alluvium underlying Lahore is hetrogeneous in character and forms a unified highly transmissive aquifer in which ground water occurs under water table conditions. The yield of tubewells ranges from 2 to 4 cubic feet per second. Most of the water comes from the upper most 300 feet of the aquifer.

A cursory look shows that the entire city and the surrounding area is composed

of alluvial plain. However, detailed examination of the landscape reveals that different parts of the city have a variety of landforms which were formed at different times and through varying mode of alluvial depositions. Different areas having different modes of formations and geological characteristics have been mapped and designated as landform untits :—

1. Active flood plain.
2. Recent meander flood plain.
3. Subrecent cover flood plain.
4. Old level terrace.
5. Old basin and channel fills.
6. Severely eroded land.

Active Flood Plain

This landform is located in the Western and S. Eastern parts of the city and occurs along the Ravi. In recent years it has been bounded by flood protection embankments on both sides of the river. It is inundated almost every year in summer flood season.

Its surface is nearly level to gently undulating surface. The soils are young and are subject to continual deposition of new sediment practically every year. The soil material is generally silt loam, fine sandy loam and sandy loam.

Recent Meander flood plain

Recent meander flood plain is located in the N. Eastern section of the city and is slightly above the seasonal flood level and does not receive fresh sediments. Former river patterns in the area can still be picked up on aerial photographs. The soils are lex, silt loams, very fine sandy loams or sandy loams are common.

Sub-recent cover flood plain

This land form occurs in the south west of the city. This plain has long been abandoned by the river, and the riverine features such as oxbows, meander scrolls levees have long been obliterated, This plain generally lies at the same level as the meander flood plain. Soil cover is clayey.

Old Level terrace

Most of the eastern part of the city has old level terrace. In the south west of the city along Multan Road the old terrace is bounded by river cut scarp 20 to 30 ft high. The soils are calcareous, fine textured, alluvial in origin and contain calcium carbonate nodules. The surface is almost flat and devoid of relief. The average slope is north-east to south-west with an approximate gradient of one foot per mile.

Severely Eroded Land

At the point of confluence of old level terrace and active flood plain a zone of severely eroded land has developed where the original surface has been completely obliterated.

Old Basins & Channel Fills

The terrace land of Lahore which occupies large acres in the West is composed of basins and channels which are broad elongated depressions. Because of their low position these depressions collect runoff.

Hydrology

The city of Lahore is drained by the river Ravi which flow from north-east to south-west. Its discharges are subject to extreme variations of flow from a period of maximum summer discharge to a minimum

winter discharge. The summer discharge gradually rises from the middle of March and reaches peak in the monsoon season. The winter discharge is mainly derived from the ground water seepage.

The periphery of Lahore has been flooded repeatedly throughout history. It was only in 1950 and subsequent years that the Government undertook steps to control the floods in the city.

For centuries the people living in the city have received their water supply from underground water through wells, pumps and tubewells. The ground water of the area was examined by WASID in 1955-58. According to their report and other supplementary data it appears that the quality of water varies from place to place and in depth. The distribution of water quality of deep and shallow ground water is shown on map Nos. 2 & 3. The areas adjoining Ravi have less than 500 ppm salt in deep ground water whereas in large parts of eastern Lahore the salt content ranges from 500 to 1000 ppm. Only a small pocket of land in the south of the city has salts 1000-2000 ppm.

Shallow groundwater in the western half of Lahore shows salts less than 500 ppm. Most of the eastern Lahore has 500-1000 ppm of salts in shallow groundwater.

Urban Hydrology

Hardly any problems pertaining to urban hydrology are being discussed. Not much work has been done on the Hydrology of urban areas.

Savini & Kammerer are of the view that the continuing growth and concentration of population and industry in urban and suburban areas in recent decades has caused a complex merging of social, economic and physical problems. The interrelationship of man and his use and development of the land and water resources is a particularly significant aspect of urbanization, but there has been relatively little study to date of the effect of urban man upon natural hydrological conditions. Not much has been done in this field systematically for the city of Lahore.

A picture of the existing urban hydrological conditions is somewhat depicted in the Master Plan for greater Lahore as below :—

1. "Areas which have well planned drainage systems are not functioning properly because the drains have lost their original capacities due to siltage or blocking. This condition is found throughout the Mian Mir drainage system.
2. Low lying pockets within the city which are too low to drain freely into the New Mozange or the Civil Lines drainage systems. These are the Sabzi Mandi, areas south of the Shahalmi and Mochi gate and the Mohammad Nagar areas east of Railway Headquarter offices.
3. Low-lying areas to the west of the city which are lower than normal level of the city. They have no well developed surface drains and they are subject to frequent flooding. These are Sant Nagar, Krishin Nagar and Rajgarh.
4. Areas flooded because of inadequte storm drainage channels. An example of this condition is the out-

fall channel of the Mian Mir Drain. The section from Multan Road to the Bund is not sufficient to carry the discharge. In consequence strom water backs up in the channel and the upper reaches cannot discharge freely.

5. The Chhota Ravi drainage area lying to the south of the bund and north of G. T. Road and the Railway. The drainage system in this area has never been properly developed. The channel of Chhota Ravi itself is blocked in many places by cultivators and the outfall channel to the bund is inadequate.
6. Newly developed residential area to the south of Mian Mir drain such as Samanabad, Ichhra, Rehmanpura, Shah Jamal and Wahdat Colony. No drainage system has been built for these areas and the natural drainage is poorly developed. Rain water stands in local depressions until absorbed by the ground or evaporated by sun.
7. Finally a broad area south of the city extending towards Hudiara Drain towards which Greater Lahore in expanding only natural drainage exists as yet in this area.

Lahore waste water is drained by several Nullahs, sewers & drains into the river Ravi. In many localities within the city, sewage water is intercepted by the farmers to irrigate the urban agricultural land. Many city areas do not have any underground sewerage and the refuse water is allowed to collect in the nearby poorly drained areas.

It must be pointed out here that domestic sewage before it is treated usually contains the complete range of pathogenic micro organism found in the community producing the sewage. Some studies have indicated that the sewage water of various localities of Lahor contains a species of pathogenic organism such as agents causing typhoid fever, bacillary dysentery, amoebic dysentery, ascariasis and other protozoan and helminthic disease.

Not all the waste water of the city finds its way to treatment plants.

Solid waste

It has been estimated that about 2000 tons of solid waste accumulates in the city every day. The data on the type of reference collected and disposed does not exist. It is believed that major component of the solid waste is human excreta waste paper, polythene bags, rags, waste food and vegetables, etc. A major portion of this solid waste is irregularly lifted by Zamindars who use it as manure in the adjoining urban agricultural land. A large portion of filth and refuse often lies scattered and rotating in various localities.

A large population of the city living in poor housing does not have flush system of disposal of night soil. The night soil is collected daily by sweepers. The method of night soil is primitive. It is collected in baskets and buckets and is carried on head for dumping either in filth depot or open dumping grounds. The entire operation is conducted carelessly ; there are no aesthetic considerations at all. Usually the night soil is spilled all the way from homes to the dumping places.

For the disposal of solid waste large binds and dumps are provided throughout

the city where residents may dispose garbage. The filth is removed intermittently by sweepers and the garbage is usually sent to the outskirts of Lahore five to seven miles away for dumping. The removal of solid waste is supposed to be independent of night-soil collection. However, in paractic, a considerable amount gets into the dust bins.

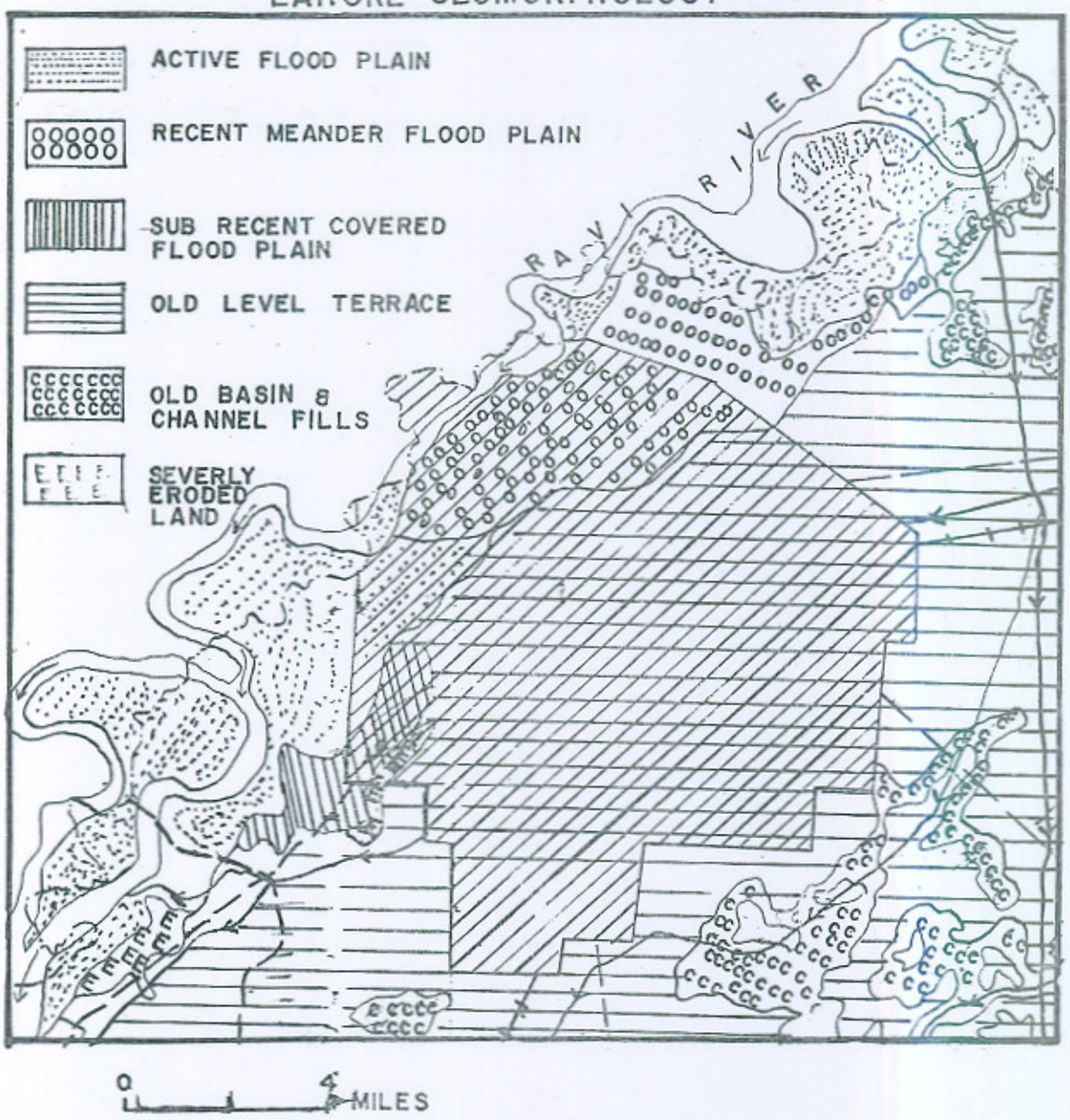
Out of the four dumping grounds for solid waste, at only two of them the filth is disposed off properly in trenches. One of these located at Mile 7 Multan Road operates about 100 trenches of 40 feet by 8 ft. in plan and about 3 feet deep. Solid waste and night-soil are dumped in the trenches until filled. The entire operation is carelessly carried out and is very insanitary. All the solid waste reaching the dump is not properly placed in trenches. Thousands of tons of garbage are also dumped on the ground. Similarly some compositing is done on smaller scale on the Bund Road dumping ground. It is estimated that some 25 trenches are working, like Multan Road dumping ground the entire operation is unsatisfactory and acres of rubbish surround the compositing area. In one of the WHO reports it is stated "Another problem, of increasing importance, is that of the collection and disposal of solid wastes, including refuse from municipalities and solids resulting from the treatment of sewage and industrial wastes. Failure to deal satisfactorily with the never ending flow of solid wastes constitutes a clear threat to public health and contributes to air, water and soil pollution as well as to the propagation of flies, rodents and other vectors of disease. In spite of this danger, however, achievements in the management of solid wastes are small when contrasted with the advances made in the treatment of waste water"

Viewing the position of the city of Lahore, the filth instead of being disposed is distributed to farmers, for use as a manure who spread it in their field not very far off from the city, and still a large proportion of it often lies scattered and rotting in various localities This certainly produces pollution of land, air, soil surface and ground water. In many parts of the city garbage is dumped into open drains and low-lying depressions of poorly drained areas, thereby creating not only a serious pollution problem but also providing breeding place for disease carrying insects.

Water Supply

With the rise in standard of living, increase in total use and per-capita use of water has taken place. Today, it has been estimated that percapita consumption of water is 30-35 gallons per day whereas it is likely to grow to 45 gallons per-capita by 1980. This has resulted in declining water level pressure on ground water reservoirs. Since there are large number of sanitary drains and poorly drained areas containing sewerage water, leakage from them has resulted in pollution of shallow ground water in many parts of the city. The areas of polluted ground water are generally located around the open sewerages and poorly drained areas. According to a rough estimate still twenty five percent of the people residing within the Municipal areas have to rely on water from hand pumps drawing water from shallow groundwater sources. Handpump water samples from many localities like Ichhra, Sant Nagar, Misri Shah and in villages located in the

LAHORE GEOMORPHOLOGY (FIG-I)



urban orbit of Lahore were examined, most of them give a distinct odour and tase. An extensive research is required to study the groundwater pollution in the city of Lahore. So far, no consistent effort has been made in this direction.

The problem of groundwater pollution is likely to become more acute as the sewerage service does not exist for all the settled areas. The present system of sewerage disposal is inadequate and insanitary. Large part of the city's untreated sewerage is diverted by farmers in the active flood plain areas for growing vegetables which are sold in the city. Vegetables from these fields are badly polluted.

Surface runoff from the urban agricultural lands receiving raw manure, leakage from overloaded sewers, drains and sanitary soakage pits have resulted in contamination of nearely all wells and pumps.

Almost untreated or inadequately treated sewage discharged into Ravi River has resulted in the pollution of river and the wells in the surrounding areas. Ravi River during winter at the junction of sewerage inlets, appears so abnoxious that it is almost impossible to stay near it for seconds. The excessive pollution of river Ravi would result in loss of aquatic life. The water of the river downstream is also becoming unfit for human consumption or recreational uses.

A journey through the city of Lahore shows that large part of it has grown in a piecemeal fashion. Large areas have been independently conceived with little or no coordination. Haphazard growth of the city has resulted in innumerable problems and hazards. Today the most fundamental problem facing the Lahorite is the preservation of environment in which he lives. The problem is important today when the size of the city and its population have increased and are exerting ever greater pressure on the environment, threatening it with irreparable damage.

A subject of highest priority in the study of the city of Lahore should be the mechanics and process in the constantly deteriorating environment wherein the natural changes resulting from urban growth, expansion of industries, are now being confused with inadequate planning and with the changes caused by man's activities.

FIG-III

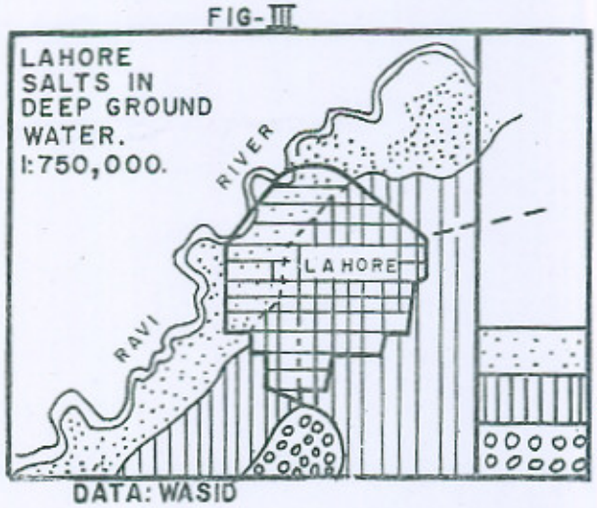
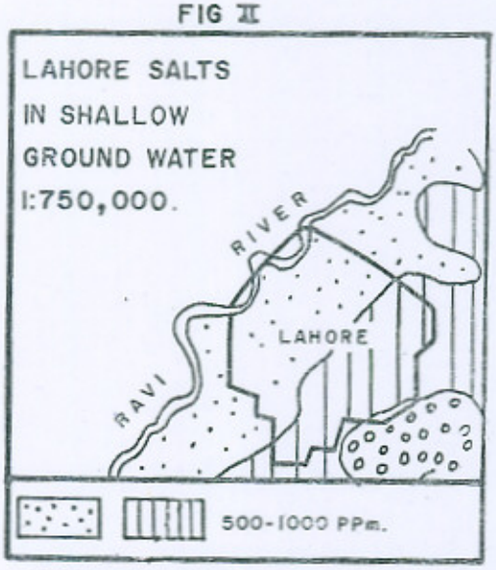


FIG II



Highways

Controlled Blasting in Road Construction

By

Lowari Tunnel Organisation

Introduction :

1. Presently it is costing Rs. 12, in the cost of explosive, to excavate one cubic yard of rock on road construction projects. This cost can be reduced to Rs 3 per cubic yard if we follow the commercial blasting techniques, instead of the military demolition techniques. The methods explained in this article are now being followed on Chakdara-Chitral road. In the past only wabox has been used for blasting. This is the most expensive explosive @ Rs 4·50 per lb. Judicious use of of wabofite @ Rs. 3 per lb and wabonite @ Rs. 2 per lb has been evolved which does the same job with considerable savings in explosive costs. Apart from economy the resulting rock slope is far more stable, uniform, neat and safe This method suffers from one major drawback, the inertia. Our troops just refuse to be convinced without the painful and prolonged indoctrination through lectures, demonstrations and practice. The object of this paper is to discuss :

(*a*) Preshearing and Smooth blasting.
(*b*) Production blasting
(*c*) Boulder blasting
(*d*) Cautious blasting

BLASTING TECHNIQUES

Preshearing or Presplitting :

3. When delay detonators are not available then drilling and blasting is carried out in two stages to achieve smooth cut. In the first stage a line of closely spaced holes is drilled and blasted, along the desired line of cut, to develop a line of shear, figure 1. This is called 'preshearing'. In the second stage, production blasting is undertaken to remove the bulk of the rock. Shock waves produced in this second stage do not travel beyond the shear-line. This results in a smooth cut slope. Since blasting is done in two stages it involves a little bit extra time—compared to the technique when delay detonators are available and both the preshearing and production blasting are done at the same time.

3. Amount of explosive required to create a line of shear, per sequare foot of rock, between two adjacent holes is called shear-factor. Shear factor ranges from 0·04 to 0·15 lbs per square foot, which depends on rock characteristics as given in table-1.. Following procedure is adopted for calculation and distribution of explosive in the holes ;—

(*a*) If the hole diameter is 1·5 inches then the hole spacing should be 1·5 feet to 2·0 feet. If the hole diameter is 2 inches then the hole spacing should be 2·0 feet to 2·5 feet. Hole spacing is decided on the basis of rock hardness, harder the rock closer the spacing.

(*b*) Area between two holes is calculated by multiplying hole spacing with hole depth. If hole spacing

TABLE 1

Rock Type	Rock Description	Rock Names	Rock actor bs/cu yd	Shear factor lb/sq ft
A	Massive, moderately blocky, unweatherd, very hard, high crushing strength with tight interlocking joints with 6" to 4 0' spacing.	Granites Dolerites, Diorites and gneissic granites and Amphibolites	0.7 to 1.0	0.08 to 0.15
B	Blocky and seamy, hard, slightly to moderately weathered, joints and fractures spaced between 1" to 2' and are imperfectly interlocked.	Granites, Diorites Dolerite, gneissic Schist, Amphibolites, Lime stones etc.	0.5 to 0.70	0.05 to 0 08
C	Crushed and weathered rock nearly cohesionless from sand to gravel size, highly fractured.	Crushed and weathered rocks.	0.3 to 0 5	0.04 to 0.05

is 2 feet and the hole, depth is 6 feet, then the area per hole, for preshearing is 12 square feet.

(*c*) Area multiplied with shear factor gives the amount of explosive required per hole.

(*d*) 15 to 20 per cent of this explosive is placed at the bottom of the hole and is called the bottom charge. Length equal to the diameter of hole in feet at the top is without any charge, and is called collar. Rest of the explosive is distributed evenly to achieve the required shear-factor. Wabox (80%) cartridge is cut and stuck to Wabocord with solution tape for even distribution along the entire length of the hole. For details of calculation and distribution of explosive, Fig-2.

Smooth Blasting

4. When delay detonators are available then smooth-blasting technique is followed. In this method both the smooth-blasting and the production blasting holes are fired simultaneously. Hole spacing, calculation of charge and its distribution along the hole is similar to that of preshearing except that slightly higher shear factor than preshearing is taken. This is necessary since smooth-blasting holes also remove burden infront of them. However the burden is kept between 2.5 feet to 3 feet.

FIG 2- PRESHEAR SMOOTH BLASTING

EXPLOSIVE DISTRIBUTION

EXAMPLE

HOLE DIA = 1·5 inch

HOLE SPACING = 20ft.

HOLE DEPTH = 10. 0ft.

AREA TO BE SHEARED PER HOLE = 10.0x2=20 sqft.

ROCK TYPE A –TABLE I

SHEAR FACTOR = ·08 lbs/ sqft.

EXPLOSIVE PER HOLE = 20x·08 =1.60 lbs –WABOX

BOTTOM CHARGE 20% = $\frac{1.60}{5}$ 0.32lbs SAY 6" OF CARTRIDGE

COLUMN CHARGE = 1.60–0.32 - 1.28 lbs is 3 CARTRIDGES.

COLLAR = 1. 5ft.

REMAINING HOLE LENGTH FOR EXPLOSIVE DISTRIBUTION 10.0–2.0 =8.0 ft=96 inches

24" EXPLOSIVE (3 CARTRIDGES) TO BE DISTRIBUTED IN 96 INCHES

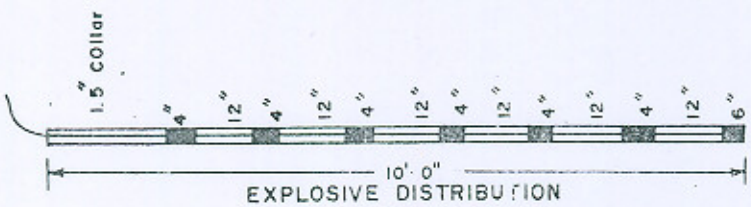
6 PIECES OF 4" CARTRIDGE EACH AT A DISTANCE OF 12 INCHES

CHECK FOR SHEAR FACTOR

WEIGHT OF 4" CARTRIDGE = $\frac{4}{8}$ x 0·45 lbs = 0·225 lbs

SHEARED AREA PER 4" CARTRIDGE = $\frac{16}{12}$ x 2' = 2·7 sq ft

SHEAR FACTOR = $\frac{0.225}{2.7}$ = 0·083 lbs/sqft O.K.



Production blasting

5. Blasting to remove bulk of the rock is called production blasiting or bulk blasting. When no delay-detonators are available then production blasting is done subsequent to pre-shearing. When delay-detonators are available then production-blasting and smooth blasting is done simultaneously. Following procedure is adopted for calculations :—

(*a*) *Burden and spacing*.—Burden is the distance between two consecutive row of holes and spacing is the distance between two adjacent holes in a row figure-3. For hole depths 4 feet to 10 feet table 2 gives recommended values of burden and spacing.

TABLE 2

Hole Depth A	Hole Diam 1·5" (38mm)		Hole diam 1·75 (45mm)	
	Burden V. ft	Spacing E. ft	Burden V. ft	Spacing E. ft
4·0	3·5	4·0	3·5	4·0
5·0	4·0	5·0	4·0	5·0
6·0	4·0	5·0	4·5	6·0
7·0	4·0	5·0	5·0	6·0
8·0	4·5	5·5	5·0	6·0
9·0	5·0	6·0	5.5	6·5
10·0	5·0	6·0	6·0	7·0

(*b*) *Powder factor*.—Powder factor is the amount of explosive in lbs per cubic yard required to blast a particular rock as given in table-1. It depends on the rock characteristics such as its hardness, weathering intensity and degree of jointing, fractures and interlocking.

(*c*) *Under Drilling*.—Holes should be drilled below the desired bottom line or road level as shown in figure-3.

(*d*) *Calculations*.—If the area to be blasted is a level surface then the following procedure is adopted :—

(1) Calculate the volume of rock to be blasted by multiplying the area with uniform drilled depth in cubic yards.

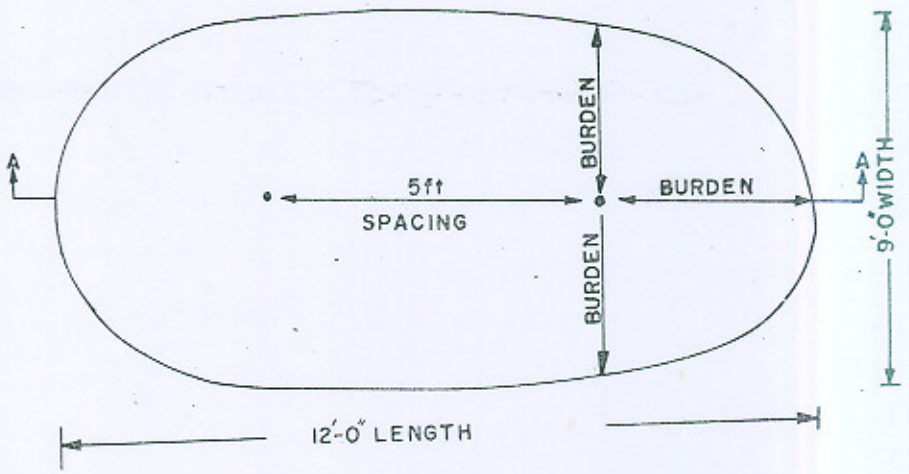
(2) Select the rock constant from table-1 and multiply it with volume of rock. This will give the quantity of explosive, in lbs.

(3) Depending on the hole diameter determine hole spacing and burden from table 2. This will give the total number of holes required to be drilled.

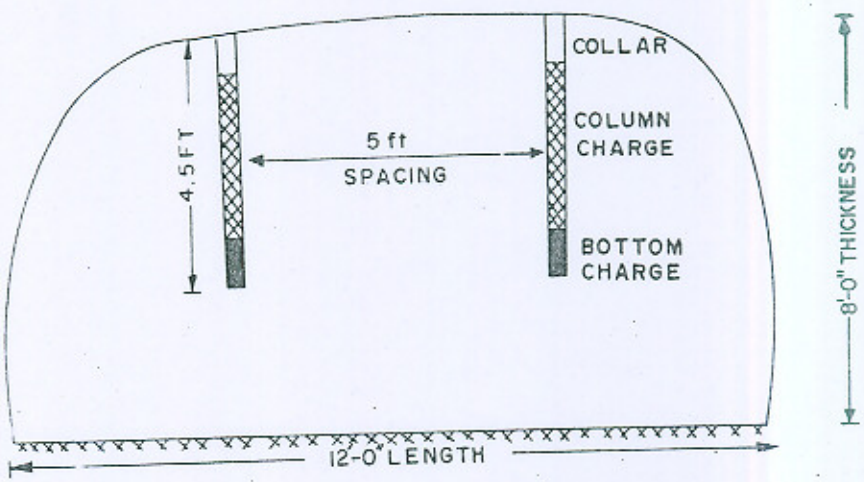
(4) Determine the explosive per hole by dividing the total explosive by number of holes.

(5) Only 20 percent of the calculated explosive per hole should be wabox. used as concentrated-

FIG 5 - BOULDER BLASTING



PLAN



SECTION A-A

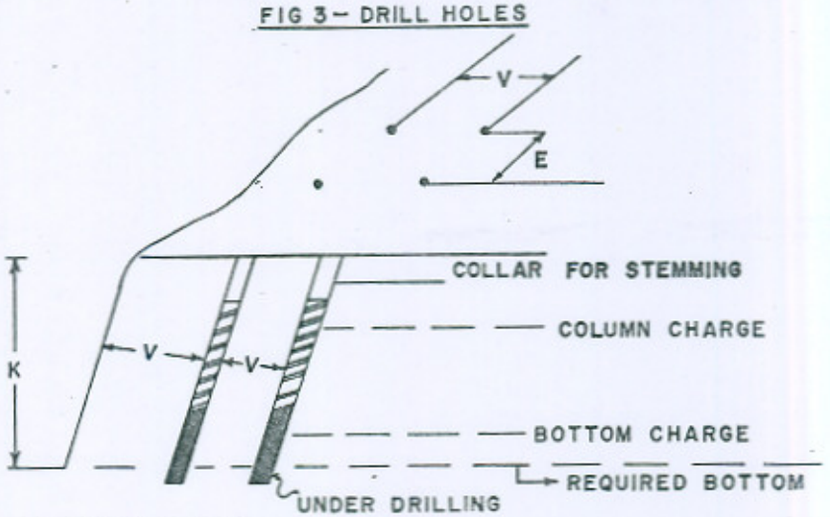
bottom charge. 30 percent of the explosive is to be wabofite which is filled on top of wabox. This is followed by 50 percent i.e. the balance of explosive, wabonite, figure-4. A wabox cartridge ($1\frac{1}{4}'' \times 8''$) weighs 0.45 lb and a wabofite cartrige weighs 0.25 lb.

Example : Calculations for a round (a round is the area to be blasted once) :

Length of cut		60 feet
Width of cut		30 feet
Depth of cut		10 feet
Hole diameter		1.50 feet
Calculated burden		5.0 feet
Calculated hole spacing		6.0 feet
No. of rows in the round		6
No. of holes in a row		10+1 = 11
Total No. of holes		11 × 6 = 66
Area of round 60×30	=	1800 square feet
Volume of round		1800×10 = 18,000 cubic feet = 667 cubic yards
Quantity of explosive = 667 x0.70 (with 0.70 lbs rock constant)		467 lbs
Quantity of explosive per hole		467 ÷ 66 = 7 lbs
Bottom charge @ 20%		1.40 lbs.
No of cartridges of wabox 80% ($1\frac{1}{4}'' \times 8''$)		1.40 ÷ 0.45 = 3.1 say 3
Column charge = 7.0 − 1.40	=	5.60
Column charge @ 30% wabofite 70% ($1\frac{1}{4}'' \times 8''$)		2.1 lbs.
No of wabofite cartridge		2.1 ÷ 0.25 = 8.4 say $8\frac{1}{2}$
Column charge @ 50% wabonite		3.50 lbs

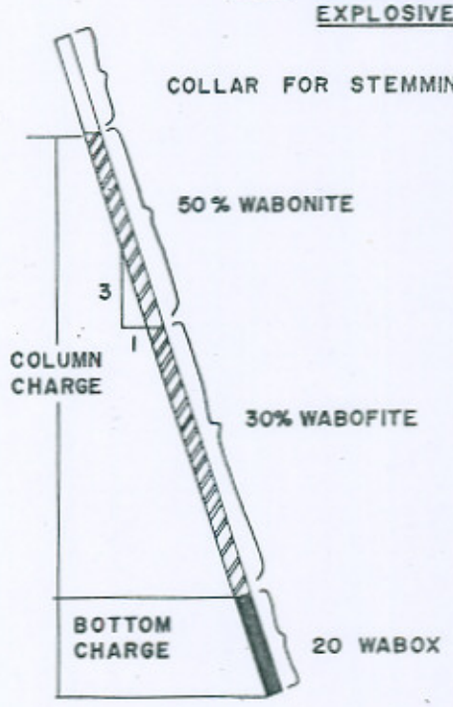
(*e*) If the area to be blasted is not level but instead it is sloping then the depth of holes will vary from row to row, figure 1. If the depth of cut is not more than 10 feet then road level can be achieved in one blast. However, if the depth of cut, is more than 10 feet (which is our maximum capability to drill at the moment) then blasting is done more than once. In the first blast the aim is to get a platform which facilitates subsequent blasting. In the following example it is assumed that the rock is sloping steeply. The depth of holes will vary from 4 feet to a maximum of 10 feet. Calculations will be carried out for each row separately for different depths. In this example, calculations have been shown only for 6 feet depth. The

FIG 3 – DRILL HOLES



K = BENCH HEIGHT
V = PRACTICAL BURDEN
E = HOLE SPACING
U = UNDER DRILLING 0.3. OF V

FIG.4. PRODUCTION BLASTING
EXPLOSIVE DISTRIBUTION



firing procedure for the entire round will depend on the availability or non-availability of delay detonators.

EXAMPLE

Length of round		60 feet
Burden for the row (only area in front is considered)		4 feet
Depth of round		6 feet
Hole diam		1.5 Inch
Hole spacing		5 feet
Area of the row		60 × 4 = 240 sequare feet
Volume of rock	=	240 × 6 = 1440 cu. ft. 53 cubic yards
No of holes in this row 60 ÷ 5		= 12 + 1 = 13
Rock constant		0.7
Quantity of explosive 53 × 0.7		= 37.1 lbs
Quantity of explesive per hole 37 ÷ 13		= 2.80 lbs
Bottom charge @ 20%		= 0. 56 lbs.
No. of catridges of wabox 80% (1¼" × 8")		= 0.56 ÷ 0.45 = 1.29 say 1¼
Column charge @ 30% Wabofite 70%		= 0.84 lbs
No of Wabofite cartridges		= 0.84 ÷ 0.25 = 3.36 say 3¼
Column charge @ 50% wabonite		= 1.50 lbs

Cushion Blasting :

6. Cushion blasting can be defined as a process in which final line of excavation is blasted after the removal of the main bulk material. When the depth of the cut is more than 20 feet it involves repeated drilling and blasting, resulting in very slow progress. In such cases it is recommended that rock should initially be tackled from the front with horizontal and inclined holes till the remaining burden is 5 to 6 feet. This burden can then be removed by cushion blasting. Following procedure is recommended :

(*a*) Remove the rock from toe by row of horizontal holes 8 to 10 feet, deep, using rock drill on air-leg. These holes should be at a height of 4 feet above the desired road level. The spacing between holes should be 5 to6 feet. When charging the hole outer one foot length of the hole should be left uncharged as collar, 30 percent of the remaining length of the hole should first be filled with well tamped wabox 80% and the remaining 70 percent with wabofite 70 percent.

(*b*) After blasting, all the loose rock must be carefully removed by scaling before drilling for the next round is resumed. This process is repeated till excavation is carried

out to within 6 to 6 feet of the final line of excavation.

(*c*) Presplit holes are now drilled from top as explained in Paras 2 to 3. However, for calculation of explosive shear factor should be taken as 0·1 to 0·15 lbs per square feet.

(*d*) These holes are fired by instantaneous detonator which will remove remaining 5 to 6 feet burden resulting in a comparatively smooth and stable rock surface.

Drilling and Blasting Procedure :

7. In order to follow the methods explained above it is necessary that detailed geological survey of the road section is carried out to ascertain the type of rock, as given in table-1.

8. Final excavation line should be marked on the ground keeping in view the required road width and the slope of drill holes, For stability of rock last row of holes is drilled at a slope of 4 on 1 (*i.e.* 4 vertical and 1 horizontal).

9. If there is overburden of talus and weathered rock it should first be removed manually or by dozer otherwise the drill rods get stuck and the bits get lost. This should be followed by a preliminary round of 2 to 3 feet deep holes so as to get to the competent rock before deeper holes are drilled for the main round.

10. Preshearing or smooth-blasting holes are drilled at a slope of 4 on 1 whereas bulk of the production blast holes are drilled at a slope of 3 on 1. Transition of slope between 3 on 1 and 4 on 1 is achieved in two or three rows.

11. If delay detonators are not available then the row of holes on preshear lines is blasted first by using a single instantaneous detonator. Production blast holes are then drilled, changed and blasted with a single instantaneous detonator in one go, Fig-1

12. If millisecond or half-second delay detonators are available then the smooth and production blast holes are drilled and charged together. Each row of holes is joined with the detonating cord independently. One delay detonator per row is placed such that delay increases from face towards the final line of excavation. The entire circuit is fired together, electrically, Figure-1.

Boulder Blasting :

13. During road construction large boulders are frequently encountered which occur either naturally or as a result of primary blasting. Sappers usually blast them with pressure charge which is wasteful in explosive and causes an extensive throw. The most economical method of blasting them is with drill holes as explained below and in figure 5.

(*a*) Calculate the boulder volume in cubic yards.

(*b*) Burden is assumed to be one half of the boulder thickness.

(*c*) Hole spacing should be 1·25 of assumed burden.

(*d*) Holes are drilled vertically to a depth of 1·1 of assumed burden.

(*e*) Powder factor is 0·15 lbs per cubic yard

(*f*) Explosive is distributed equally in all holes.

(*g*) Fifty percent of the explosive in each hole is to be wabox 80 % to be placed at bottom charge. The remaining fifty per cent is to be wabofite 70%. Holes should be well tamped with dry soil.

EXAMPLE

Boulder length	12 feet
Boulder width	9 feet
Boulder thickness	8 feet
Volume	$\frac{12 \times 9 \times 8}{27}$ = 32 cubic yards
Burden, 1/2 × thickness	4 feet
Spacing, 1.25 × burden	5 feet, only two holes required.
Hole depth, 1.1. × burden	4.4 feet say 4.5
Powder factor	0.15
Total charge, 32 × 0.15	4.8 lbs
Explosive per hole	2.4 lbs
Wabox 80% (1¼" × 8")	1.2 lbs i.e. 2.75 cartridges.
Wabofite 70% (1¼" × 8")	1.2 lbs i.e. 5 cartridges.

Cautious Blasting :

14. Cautious blasting is required to be undertaken in road construction in the vicinity of built up areas, irrigation system or fruit orchards so as to minimize or eliminate any possibility of damage. Damage is caused by excessive vibrations and flying rock which result from excessive explosive charge in a hole, incorrect firing sequence, inadequate burden in front of the first row of holes and overlooking the cracks and joints existing in the rock being blasted. Two of these factors namely, explosive charge per hole and firing sequence are the most critical considerations in cautious blasting.

15. The calculations are no different from what has been discussed earlier in preshear and production blasting except for the following ;

(*a*) When working out the quantity of explosive the rock factor should be taken as 0·2 lbs per cubic yard.

(*c*) Twenty percent of this explosive should be used as concentrated bottom charge, wabox 80%. Thirty percent of the explosive should be wabofite 70% and the remaining fifty percent should be wabonite, used as column charge.

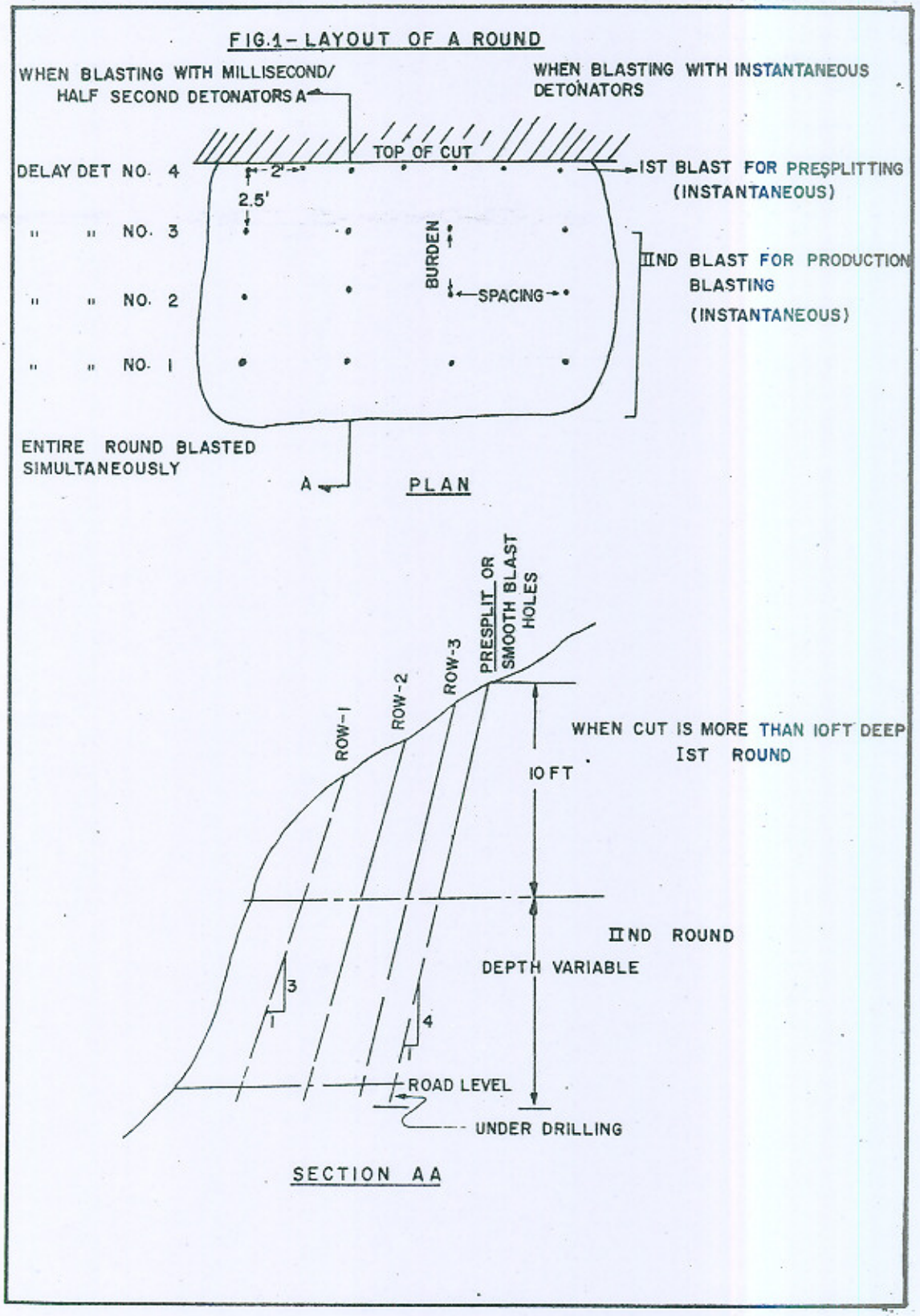
(*c*) *No tamping need be done* since tamping increases throw.

(*d*) If millisecond delay detonators of less than 100 millisecond are available then they should be used as explained earlier in para 12. In boulder blasting where there are no rows but only a few holes then the individual holes should be initiated with one detonator per hole.

(*e*) If no delay detonators are available then the holes should be fired individually or upto a maximum of four holes at a time. In such cases explosive should be calculated with powder of 0·1 lb per cubic yard of rock instead of 0·2 lbs as given in para 15a.

16. It has been noticed during trials that excessive throw is caused mainly by

FIG.1 - LAYOUT OF A ROUND



the first row of holes when the burden in-front of the row is judged wrongly and consequently there is more charge than required It is therefore essential that the first row of the holes should be placed properly in relation to the burden. If these instructions are followed then the rock mass will be fragmented such that it can be removed manually.

Conclusion

17. Large number of our engineer troops are employed on road construction projects in mountainous regions. In rock blasting they follow military demolition techniques which are far more expensive than the commercial techniques. Considerable economy can be brought about by correct spacing of holes and by use of cheaper explosive. So far our powder factor has been 2.5 lbs of explosive per cubic yard of rock but by adopting commercial techniques it has been brought down to 0.8 lbs per cubic yard. Economy is further ensured by using wabofite and wabonite instead of wabox, which is the most expensive explosive.

18. Most of our accidents on road construction are caused by rockfalls from unstable rock slopes. Accidents can be prevented by preshearing and smooth blasting at the correct slope. The resulting slope is stable, neat and uniform apart from being pleasing to the eye.

19. We have been paying exhorbitant property compensation to the owners when we have caused damage due to our uncontrolled blasting techniques. The rock throw has been as much as 300 yards. It is now possible to save most of this compensation money by cautious blasting. There are some excellent examples of cautious blasting on Chakdara-Chitral road where the verandah has been demolished but the house is standing safe and the people still living in it or one house in a village has been demolished and the rest are standing without a single crack.

20. Here a word of advice is essential. Our troops do not give up their old methods easily. It has taken six months to break the officers and men in the new techniques. Without strict supervision they still revert to their old habits. The effort required in introducting new techniques is well worth the trouble in terms of economy and safety of man.

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Industrial Section

Pakistan's First Automatic Plastic Injection Moulding Machine

By

AJMAL HUSSAIN —*Managing Director, Sayyed Eng., Ltd. 65, The Mall, Lahore.*

INTRODUCTION

Plastics have many advantages over the conventional materials such as wood, natural fibres, steel and non-ferrous metals; they do not corrode, they are lighter and much cheaper. Therefore, it is not surprising that plastics have found a place in every home and in every branch of engineering. Their products range in size from bottle tops to yachts ; they are used in making precision gears which are noiseless, self-lubricating and have almost endless life; they are even used for girders for buildings. The applications are so many that we cannot give even a general list here. There are hundreds of varieties in the plastics family, each with different characteristics to suit different groups of applications.

It should be mentioned here that this unique material has one serious drawback: it is indestructible. Unlike natural materials, it is not broken down into elements when it is returned to earth. Thus, disposable items made of plastics pollute the environment. They cannot be burnt because of the lethal gases they produce. For this reason research is being done to develop plastics that are "biodegradable", that is, they are broken into their basic elements by natural processes. Some success has been reported in this, but biodegradable plastics will take a long time to replace the present non-degradable plastics in all the fields. Until this happens the world will accept plastics as a necessary evil.

Injection moulding machines

The most common process of converting plastics into finished products is called "injection moulding". In an injection moulding machine the plastic (usually from the polystyrene or the polypropylene families) is heated in a cylinder to a semi-fluid state; this process is called "plasticization". It is then injected into a mould, whose two halves are clamped shut in the machine. After injection the mould is allowed to cool and the plastic solidifies to take the shape of the cavities into which it is injected. The two halves of the mould then open and the finished product is ejected. Usually for small components multi-cavity moulds are employed which produce a number of components in each injection cycle.

General specifications

The most important specification of an injection moulding machine is its "shot weight", that is, the maximum weight of plastic that can be injected into the mould. The bore of the plasticising cylinder and the stroke of the injection plunger determine the volume of the material that can be displaced, and hence the shot weight. The pressure inside the plasticizing cylinder has

to be high (in the range of 7 tons/in^2 and 10 tons in/^{2}) so that the mould cavities can be filled quickly. If injection takes long, the material solidifies in the injection channels, called "runners", before the cavities are filled. The "gates" through which the the material enters the cavities are kept very narrow: down to 0.004 inch bore. This "pinpoint" injection technique produces components without visible pip marks which would otherwise need a grinding operation. These narrow gates make high injection pressure essential.

The second important specification of the injection moulding machine is the "clamp force", that is, the force with which the two halves of the mould are pressed together. If an injection pressure of 7 tons/in^2 is used for a mould whose cavities have a projected area of 5 in^2, the force which tries to open the mould will be 26.25 tons, calculated as follows :

mould opening force =

(injection pressure) $\times$ (projected area of cavities and runners) $\times \frac{75}{100}$

This formula assumes that 75% of the pressure inside the plasticizing cylinder is communicated to the mould cavities. To ensure that the mould stays shut during injection, mould clamp force must be in excess of the mould opening force. For a machine with a shot weight of 4 oz, a clamp force of 45 tons should be adequate for most types of moulds.

The clamp force determines the size of mould clamping hydraulic cylinder, the hydraulic oil pressure, the size of the tie bars which provide the reaction to the compressive force--in fact the design of the whole machine depends almost entirely on the clamp force requirement. To give you an idea, a machine with shot weight of 6 lb should have a clamp force around 1,000 tons. Machines with clamp force of 5,000 tons though not common, are in use. They are almost as big as houses.

In addition to the basic specifications of shot weight and clamp force, one considers features such as "mould closing stroke", which is the maximum distance travelled by the "moving platen", on which half of the mould is mounted. Another important specification is the size of platen, which determines the maximum physical size of mould that can be mounted on the machine.

Sequence of operations

The sequence of operations in an injection moulding machine is as follows :—

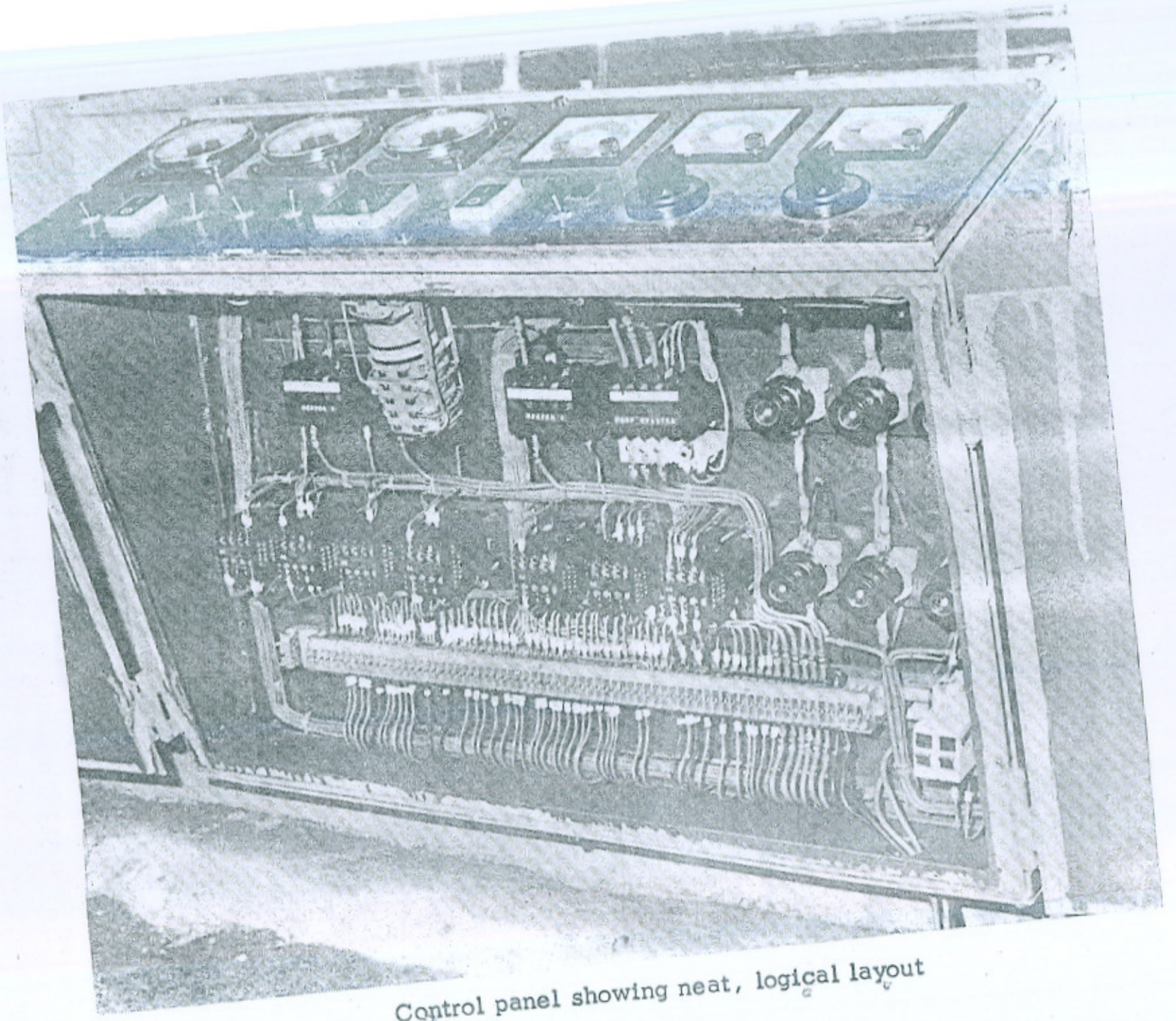
(*a*) Moving platen carrying half the mould moves forward at high speed.

(*b*) As the two halves of the mould come close to each other, the moving platen slows down to ensure smooth mould closing.

(*c*) The mould closes and the clamping force is built on the two halves.

(*d*) Injection takes place (the required quantity of material is already fed into the plasticizing cylinder and plasticized at this stage).

(*e*) Injection plunger (or screw) returns, separating the injection nozzle from the mould and at the same time feeding a measured volume



Control panel showing neat, logical layout

of material into the plastizicing cylinder.

(*f*) Mould cools.

(*g*) Moving platen moves back, opening the mould and also ejecting the mouldings.

(*h*) Moving platen pauses at the end of its stroke before starting the next cycle.

The sequences mentioned above are all automatically performed in modern injecting moulding machines. Electrical or electronic timers control the duration of pause, mould cooling and injection. Electronic temperature controllers maintain the temperatures of the various zones in the plasticizing cylinder within pre-set limits. Mould closing speed, clamp force, injection pressure, and injection speed are all set by adjusting various hydraulic valves; the hydraulic circuit then repeats these speeds and pressures automatically in each cycle. This repeatability of the cycle ensures that the mouldings maintain dimensional accuracy and constant physical properties.

Safety Features

All modern injection moulding machines have safety circuits to protect the operator, the mould, and the machine itself. Here are some of the essential safety systems:

(*a*) Until full clamp force is built, injection should not take place.

(*b*) If during mould closing the guard door is opened, the moving platen should return and stop in fully open position.

(*c*) Once the mould is closed and injection starts, the mould should not open until after the injection operation is completed and cooling period is over. During this time the opening of guard door or switching the mould opening control should be disregarded by the machine.

(*d*) If any plastic material is left in the mould from the previous cycle, the mould clamp force should not be produced and the mould should open.

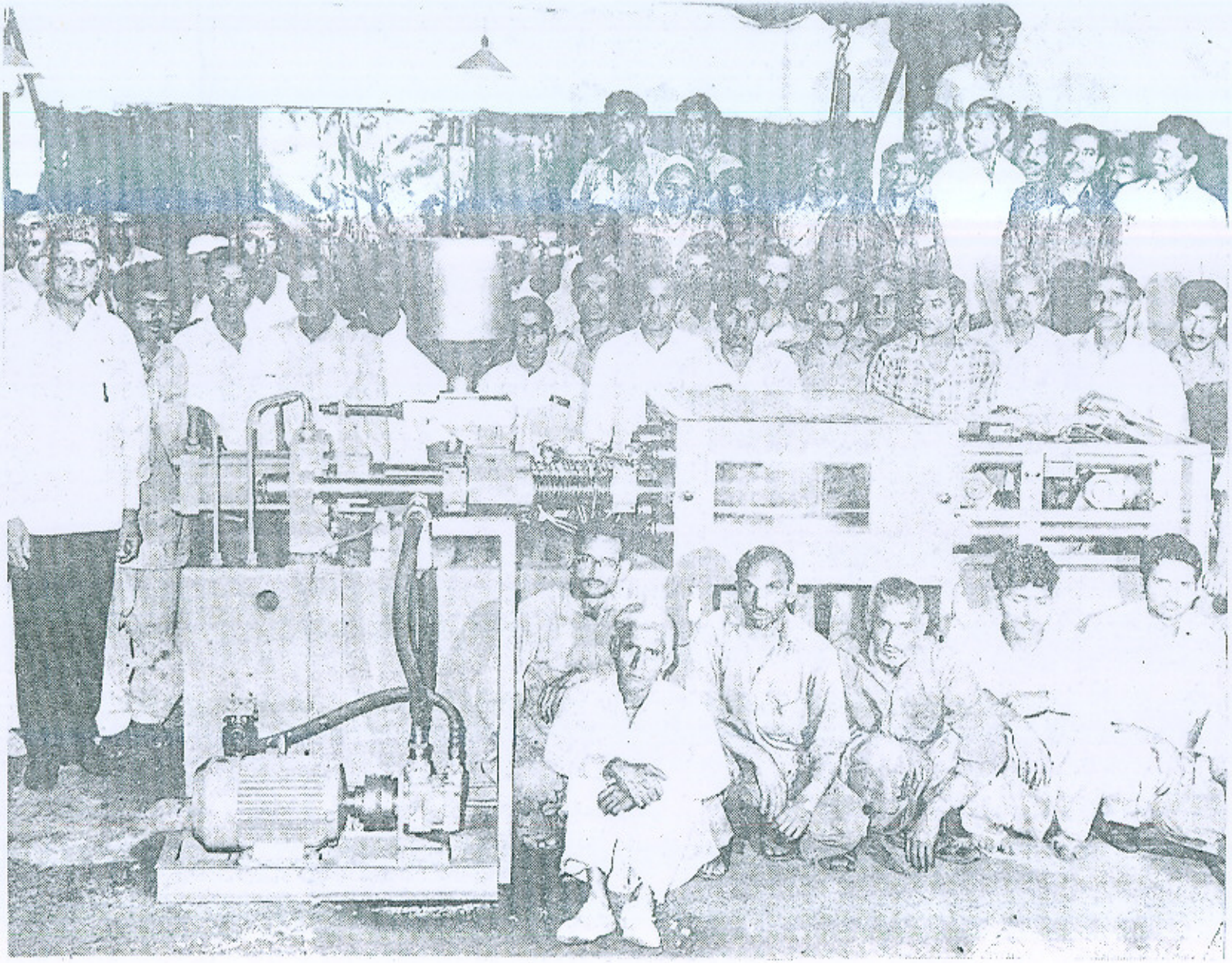
Design of Pakistan's First Machine

Almost all industrially developed countries design and make their own injection moulding machines. The functions and safety systems are almost all the same, but the electrical, hydraulic and mechanical design differs from maker to maker. When we designed the MKIII, Pakistan's first automatic plastic moulding machine, we made an original design. Of course we were familiar with the systems of all the well-known European and Japanese machines, but we did not consciously copy any.

Our machine was designed by the writer and built by PECO under the writer's personal supervision. The areas in which PECO had no experience (such as hydaulic systems and advanced electrical circuits) were handled by the writer.

Special features

The MKIII contains all the automatic systems and safety devices we have mentioned. Also, it has the following outsanding features, which are the result of good electrical and hydraulic circuitry:



Workers of the Slow Speed Diesel Shop in PECO who helped in Assembling the machine and in making many of the parts

(*a*) Smooth, noiseless and vibration-free operation.

(*b*) Fool-proof lubrication of all moving parts.

(*c*) Continuous filtration of the hydraulic oil with a warning system to indicate clogging of filter.

(*d*) Hydraulic and electrical circuits have been laid for quick and easy maintenance.

(*e*) The hydraulic pump unloads automatically when pressure is not needed. In this condition it discharges to the tank at zero pressure, cooling the oil, conserving power and increasing its own life.

Fabrication

We did not attempt to make the individual hydraulic and electrical components such as pumps, directional valves, flow controllers, pressure switches, relays, etc. Just as the European manufacturers of machines buy these components from specialist manufacturers, we also bought them. In fact the European manufacturers buy most of their fabrications, sub-assemblies and control panels as well, but we made them ourselves.

Future possibilities

The successful construction of Pakistan's first automatic injection moulding machine is relevant not only to the plastics industry but also to industries engaged in die casting, die stamping, deep drawing etc. With some modifications the MKIII can be made into a press for industry or for agricultural produce. We now have the confidence for making automatic electro-hydraulic machines in Pakistan

General Section

International Conference
in
Mechanical Engineering
with main emphasis on
Energy

The six-day International Conference in Mechanical Engineering with main emphasis on Energy was held from 22nd to 27th March, 1976. The conference main was sponsored by the Department of Mechanical Engineering of the University of Engineering and Technology in collaboration with Pakistan Science Foundation, Defence Science Organization, University Grants Commission, Pakistan International Airlines and Pakistan Atomic Energy Commission.

The conference concluded with the following recommendations :—

1. **Assessment of Indigenous Resources and Energy Policy :**

A programme to assess the indigenous energy resources should be initiated forthwith and an energy policy formulateed to ensure the optimum use of the combined resources. Such assessments must be repeated regularly to enable the policy to be tuned to data on new discoveries, demand and technology.

2. **Hydro Energy Exploitation :**

A vigorous programme should be initiated to bring into service more hydro potential; both run-of-the-river and pumped-storage.

3. **Small Hydro Project :**

Many smalier hydro projects on streams aud canals can bring great benefits to remote regions unlikely to be reached by the main grid-system for many years in future. These can and should be speedily implemented.

4. **The Nuclear Power Programme :**

The nuclear power programme announced by the Government as a result of Joint I.A.E.A., P.A.E.C. Study has been noted with interest and it is hoped that concentrated efforts will now be applied to complete the leading power project of the series in the most economical manner.

5. **Alternative nergy Resources :**

An assessment of the potential for alternative renewable energy resources, *e.g.*,, geothermal, wind, tidal and solar power energy should be put in hand to evaluate both small and large-scale possibilities. The use of hydrogen as synthetic fuel may also be explored.

6. **Non-Commercial Energy Resources :**

Where the non-commercial energy resources can be improved upon, through

controlled community, re-afforestation or biochemical conversion of drug & farm wastes, this should be facilitated. Substitute energy forms such as bottled gas and small electric generators may have to be provided to ensure an effective transition.

7. **Energy Advisory Board :**

There is an increasing need in Pakistan to take a balanced and yet realistic view of complex energy development programmes. We strongly recommend, therefore, that a Government Advisory Board on Energy should be established. This Board would include senior people from Government, Industry, Commerce and the Universities. It would be able to call for assessment papers from the national energy organizations and consultants relating to possible energy projects. Its view would, in the first instance, be confidentially provided to Government though with proper authority from time to time they might be published openly with some backing analysis.

8. **Institute of Energy & Power :**

In order to produce enough manpower capable of local design and manufacture of different types of power plants using conventional fuels an Institute of Energy and Power be established immediately in the University of Engineering and Technology, Lahore. The Nucleus already exists in the Mechanical Engineering Department and establishment of the Institute to impart instruction and research mostly at the post graduate level is possible.

9. **Overseas Energy Research Links :**

The interchange of ideas between engineers and scientists in Pakistan and those overseas is becoming increasingly valuable and important. Means should be found where possible for finding joint research and development projects. It seems likely that organizations such as the Universities Grant Commission and the Pakistan Science Foundation might be favourably disposed towards this objective, especially if approached with a few firm energy project proposals indicating overseas collaboration prospects.

10. **Energy and Seminars for Liaison :**

Seminars or energy subjects can provide an invaluable link between engineers outside the University and those within. These should be arranged say for six occasions each year. On each occasion an alternative speaker from one of the energy industries should be invited to lead the discussion.

A session-wise list of papers presented at the conference is given below. These papers are available with the Uninersity of Engineering and technology at nominal cost—Ed.

Session-1, Thermal Energy
(22-3-1976)

1. Mr. W.G. Cartwright and Mr. M. J. Hill — Two dimensional compressible blades to blade flow in radial and mixed flow turbines.

2.	Khawaja Daood, Chief Engineer Thermal Power Stations, WAPDA.	Thermal energy and Pakistan
3.	Mr. Nazim Hussain Siddiqui Director Construction for Power Stations, WAPDA.	Exploitation of untapped poor quality fuel resources.
4.	Mr. Z. Nejat	Geothermal Energy
5.	Mr. B. Kaftanoglu and Mr. B. Kilkis	A computer aided design technique for heating system of Buildings to Achieve economy in Energy and Materials.
6.	Mohammad Zahir Shah Senior Engineer, Shahdara Power Station.	Problems of thermal power stations in Pakistan.
7.	Dr. Ghulam Sarwar Sheikh	Estimation of Fluid Energy from Model Test.

Session-2, Nuclear Energy
(23-3-76)

1.	Doc. Dr. Ing. Sumer, Sahin Ege Universitesi Muhendislik Bilimleri Fakultesi Bornoya/Izmir.	Neutron Physics analysis of thermonic reactors with U-233. As fuel and Beryllium as moderator.
2.	Mr. Muhammad Ahmad	Studies for a Dual Purpose Nuclear Plant in Pakistan.
3.	Dr. Javaid Yunas Uppal and Mr. Naeem-ur-Rehmad Durani and	Capabilities of Pakistani engineers for design of nuclear structures.
4.	Mr. Mohammad Ahmad	Siting considerations for a nuclear power station.
5.	Dr. S.M. Bhutta	Importance and Implementation of Quality Assurance Programme for Nuclear Power Plants
6.	Mr. Mohammad Ahmad	An Example of Optimisation Calculations of a Dual Purpose Nuclear Plant for Karachi Area.

Session-3, Hydel Energy (And General)
(24-3-76)

1.	Mr. Khalid Jahangir	Water Tunnel as a Hydraulic Research Tool.
2.	Mr. Imtiaz Ali Qizilbash	Rapid Development of Pakistan's Hydro-electric Resources for its Progress.
3.	Dr. A.A.N. Sayigh	The Energy Prospects in the Arab World.
4.	Dr. G.R. Rainbridge	Energy Development in Britain Relevant for Pakistan.
5.	Dr. M. Ikram Khan	Bulk Type Turbogenerator
6.	Dr. A.R. Siddiqi	An Economic Approach to Goods Inward Inspection.
7.	Dr. M. Ikram Khan	Banki Turbine.

Session 4, Solar Energy and Miscellaneous

(25-3-1976)

1.	Mr. S. Kakac and Mr. T.N. Veziroglu	Solar Production of Synthetic Fuels. As a Means of Strong Solar Energy.
2.	Mr. R.W.J. Cockram	Director - Research Development and Design.
3.	Mr. K.S. Ong and Mr. M.L. Koosinlin	Economic and Social Aspects of Solar Water Heaters in Malaysia.
4.	Dr. M. Ikram Khan	Solar Collectors
5.	Dr. M. Sultan Hussain	Role of Design Engineers in Technical Advancement of Pakistan.
6.	Dr. M. Ikram Khan	Alternative Engineers.

Session-5, Design and Producrion

(26-3-1976)

1.	Mr. W. G. Cartwright	A one Dimensional Procedure for Optimizing Centrifugal Compressor Geometry.
2.	Dr. G. B. Onipinola	Induction Ramining of I.C. Engines
3.	Mr. Mohammad A. Moustafa	Specified Surface Cams with Oscillating Followers.
4.	Mr. M. K. Agarwal and Mr. R. S. Agarwal	Thermodynamics of Vapour Compression System for Desalination of Sea Water.
5.	Dr. M. Sultan Hussain and Mr. M. Islamuddin Saleem	Size Effect of Contact Stresses on Gear Teeth.
6.	Mr. G. Kekata Rao	Stress Analysis of Grinding Wheels with Embedded Metal Plate and Ring Reinforcement by Finite Element Method.
7.	Dr. Altaf R. Siddiqi	An Economic Approach to Goods-Inward Inspection.
8.	Mr. Mohammad Ashraf Ch.	Electrodialysis, as a Water Desalination Process.
9.	Dr. Amjad Pervez Sheikh	Renewal Theory and Application in Preventive Maintenance and Replacement Strategies.
10.	Dr. Manzour Atta	New sources of Energy.
11.	Dr. A. R. Siddiqi	Restricted Bayesian Acceptance Sampling Plans.
12.	Mr. M. Islamuddin Saleem	Curriculum Design for Mechanical Engineering Education.
13.	Mr. M. H. Zuberi	Investigation of Pakistan Sands for Gray Iron Castings.
14.	Dr. M. Sultan Hussain and Mr. M. Islamuddin Saleem	Functional Learning in the Engineering Education.
15.	Dr. A. R. Siddiqi	A new Concept in Participative Management.

16.	Mr. M. Islamuddin Saleem	Heat Pipes.
17.	Dr. A. R. Siddiqi and Mr. M. H. Zuberi	Quality Control with Minimum Cost.
18.	Mian Fazal Ahmad	Planning to conserve Electrical Energy in Pakistan.
19.	Dr. Muhammad Din	Role of Chemical Engineers in Energy Conservation.

News and Notes

Unplanned Industrial Growth : Less Hospitals Traffic Hazards :

There are at present not less than 5000 industrial units in Lahore ranging from one-man workshops to large factories employing more than 1000 workers. Most of the small workshops are located in the older localities of the City. Unplanned and uncontrolled growth of small industries has created socio-economic problems. Noxious smoke that these workshops emit impairs the health of the people at large and provides food for thought for our health planners.

There were altogether 14 hospitals in 1954. Now we have less than 20. In actual fact there are only four or five properly equipped hospitals in the City. Mayo Hospital is the biggest of them. But this hospital does not cater for the needs of Lahore whereas forty percent of the patients come from all over the Punjab. The other big hospitals—UCH and General Hospital are located far away from the city. For T.B. patients there is just one proper hospital with limited accommodation.

Special arrangements are needed to control traffic in Lahore, particularly in view of the fact that the existing traffic control system is thoroughly inadequate. Lahore has its own problems. Our roads are narrow and width changes at short distances. Also our traffic is an inter-mixture of fast & slow-moving vehicles. There are no arrangements for parking. Our roundabouts have also been indifferently planned and ill-dimensioned. Lahore is growing rapidly and the traffic problems are mounting. The authorities should take cognizance of the mess and evolve a system that will work.

LDA Plan to Build 2·5 Lakh Quarters :

The Lahore Development Authority has drawn up a scheme to construct 2·5 Lakh quarters and flats at various places in the city to meet housing requirements of the citizens.

The scheme is proposed to be implemented in five years. Sites selected for the quarters and flats include, besides 1600-acre scheme area on Multan Road, Al-Faisal Town. Garden Town and Rakhchadra near Model Town.

The construction of multi-storied flats for the low-income people in Lahore will soon be in full swing with the funds being loaned out by the House Building Finance Corporation to the Lahore Development Authority.

Water-logging Photographic Survey by WAPDA Soon

The WAPDA is shortly under-taking the infra-red photography on a large scale for the first time in the history of Pakistan to determine the extent of damage caused by the twin-menace of waterlogging and salinity to the agricultural lands.

Efforts were made to get this work done locally through Pakistani agencies, but the facilities available with these agencies were inadequate and they were not fully equipped for undertaking this assignment, which involved most modern techniques and equip-

ment in such a short time, so this task was assigned to some French firm.

The survey will help in various water resources projects, like flood protection, irrigation, agricultural and land uses in the Indus Basin in addition to the eradication of waterlogging and salinity.

According to the contract, the French firm will train the Pakistani experts in aerial photography, laboratory processing of films and photo interpretation.

Waterlogging Menace :

Waterlogging is posing grave danger to land in the northern area since the construction of Qadirabad-Balloki Link Canal in 1966-67.

About 20,000 acres around a dozen villages have been rendered uncultivable. Framers could not prepare their lands for cultivation in the past few years on account of the rising water table. Scores of houses have actually collapsed in the area : some have been damaged. The worst-affected villages are : Chak Khard, Chak Ghazi, Kakanwala, Sooianwala, Nakki Chatha, Kotli and Kot Hara.

A proper plan needs to be prepared to tackle the waterlogging menace Some time back a scheme was prepared for the purpose but no step has yet been taken to give it a practical shape. The obvious need of the hour is that tubewells be sunk along the canal. If immediate steps are not taken, the woes of tillers would multiply.

Rs. 3·2 Crore for Tourism this Year

According to a press release of the Ministry of Tourism a sum of Rs. 3 2 crore was being spent on tourism development projects in the country during the current financial year.

Besides renovation of hotels, being supervised by the Tourism Department in some cities, 50-bed hotels would be built at Gilgit, Hunza and Chitral.

The PTDC would publish pamphlets containing information on tourism.

A proposal to set up tourist agencies in U.S.A., Japan and Europe to attract tourists was under active consideration of the Government.

Tarbela water to be available for Kharif :

All is set at Tarbela and additional irrigation water from the reservoir would be available for the Kharif Crops which shall prove very helpful in substantially increasing the cultivated areas under sugar-cane, maize and rice. Every drop of the water in addition to the normal flow of irrigated water is very precious and should be fully utilised by the farmers in increasing the area under the Kharif crops. Additional water would be available on April 5 from tunnels three and four and on April 7 from tunnel number five.

It is learnt that 1·6 million acre-feet of water from the Tarbela reservoir is being distributed amongst the provinces by the Federal Government on an ad-hoc basis, keeping in view their respective demands and requirements of the schedule of repairs of stilling basins of tunnels three and four and the safe operation of the spillway, but wirhout prejudice to their rights or claims. This is an interim arrangement till the question of apportionment of river waters is resolved.

Cement Gaps :

The Government has undertaken an ambitious programme to increase the

production of cement. It includes expansion of two existing units and establishment of three new factories. Work on all these projects is currently in progress. Besides, schemes for a few more cement plants are under active consideration. When completed in the next four years, these projects will between them be able to add 24 lakh tons to the existing production level of about 34 lakh tons. This would to a great extent ease the situation of chronic shortage of the commodity that the country has been faced with for quite some time.

Special Feature

Introducing Pakistani Consulting Engineers

5. Republic Engineering Corporation (Rec.) Ltd.

Consulting Engineers, Architects and Planners,
53-Main Gulberg, Lahore

History and Background

The Republic Engineering Corporation was established in 1951, as a Firm of Consulting Engineers, and Planners, with head office in Lahore. The firm provides comprehensive consulting services to both the public and private sectors in Pakistan and abroad. and through its professional excellence, has grown, over the past decade, from a relatively small organization to a highly diversified and specialized firm offering integrated professional services to its clients covering the fields of Water Resources, Buildings, Communications, Transport and Environmental Planning. The firm has already planned, designed and supervised a large number of important engineering projects costing over Rs 100 Crore while projects worth Rs 46 Crore are presently in hand. The Directors and Associates of the firm are themselves outstanding designers whose expertise is backed by a strong team of about 75 professionals which includes highly qualified and experienced Irrigation Engineers, Hydrogeologists, Agronomists, Bridge Engineers, Highways and Communication Engineers, Structural Engineers, Geotechnic Experts, Soil and Water Scientists, Water Supply and Sanitary Engineers, Municipal Engineering Experts, Economists, Architects and Planners, many of whom hold M. Sc. and Ph. D degrees and specialized experience from abroad. This blend of professional disciplines combining the technology of the engineer, the vision of the planner and the appraisal of the economists, provides a real integrated approach to find optimum and useful solutions to problems. Emphasis on efficient management of each project from planning through design, construction and start-up assures the client of satisfactory completion of the work on schedule and within budget. The firm aims at finding most economical solution through the use of latest and sophisticated design techniques and makes extensive use of computers for the optimisation of highway alignment designs, analysis of bridges, shells and other structures, preparation of bill of quantities, water supply net work and distribution analysis and analog model studies. Services of associates both foreign and local specializing in different fields of engineering are available for supplementing the firm's expertise on complex problems or special projects.

Composition.

The firm comprises the following Technical Divisions.

1. **Water Resources Division**

   The expertise offered by the Division includes :—

   (*i*) Exploitation and utilization of surface as well as groud water poten-

tial for agricultural use which covers all phases of work such as reconnaissance surveys surface water systems, the assessment of water storage and distribution techniques for surveying by sonar, gravity and resistively methods. etc.

(*ii*) Feasibility studies, desgin, construction, supervision of irrigation and drainage works, flood control works, storage dams, weirs and barrages ; appraisal of terrain stability.

2. **Buildings and Architecture Divis'on**

This Division offers integrated services covering architecture, structure, plumbing, water supply, electrification and air-conditioning. Multi-storey buildings and industrial buildings are a speciality of the Division, in which the firm has effected great saving for its clients. The firm has successfully handled major grain handling and storage projects including automatic conveying system and is presently handling auditoriums, cinemas, a chancery building and other building complexes.

3. **Environmental Planning Division**

The professional services offered by this Division includes :

(*i*) Pre-investment studies, planning, designing, detailed engineering and supervision of water supply treatment and distribution systems, storage reservoirs, etc.

(*ii*) Urban and regional planning, comprehensive development plans, land use and property development studies etc.

4. **Electrical and Mechanical Division**

The Electrical and Mechanical Division provides well coordinated service in the fields of :

(*i*) **Electrification**

- Multistoreyed Building.
- Township Distribution
- Illumination Design.
- Lifts and Escalators.

(*ii*) **Power Engineering**

- System Studies.
- Diesel and Gas Stations.
- Transmission Lines.
- Gridstations and substations
- Distribution Systems.

(*iii*) **Airconditioning**

- Airconditioning.
- Heating and Ventilation.
- Refrigeration Systems.
- Humidification designs.

(*iv*) **Industrial Engineering**

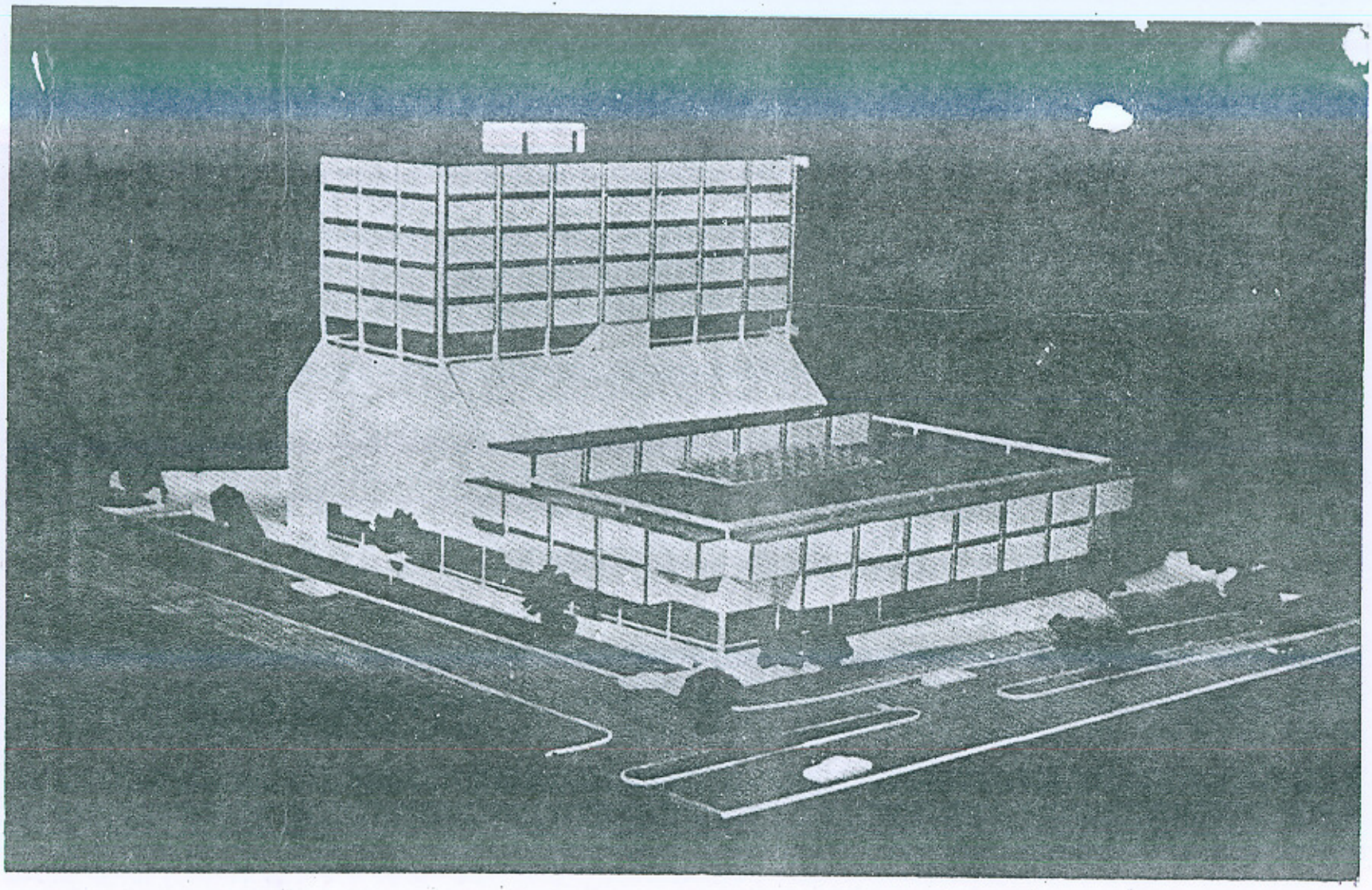
- Plant anp Process Design.
- Materials Handling.
- Producing Planning.

1. **Communication and Transport Division**

This Division is also equally competent in the whole spectrum of Transportation Engineering including establishment of Traffic patterns and demands, the determination of traffic and pedestrian flows and the design of various facilities and controls to cope with traffic demands, ports, harbours and airports.

Range of Services

The undernoted Services are rendered at the different stages of the Projects.



State Life Building, Peshawar

(i) Investigation and Planning

- Site Investigation and Surveys.
- Feasibility Studies.
- Master Planning.
- Economic Appraislas.
- Special Technical Studies.
- Programme Evaluation.
- Soil Investigation.
- Water Resources Investigation
- Water Quality Analysis.
- Land Scaping.

(ii) Detailed Design

- Structural Design and Architectural Drawings.
- Services Design and Drawings.
- Working Drawings.
- Cost Analysis.
- Cost Planning and Control.
- Specification.
- Coordination with Machinery Suppliers.
- Prequalifications of Bidder'.
- Tender Documents.
- Bill of Quantities.
- Bid Analysis and adjudication.
- Contract Documents.

(iii) Supervision of Construction

- Top Supervision.
- Detailed Supervision.
- Checking of Shop Drawings.
- Certification of Bills.
- Completion Drawings.

Principals

Ikramullah Niazi.
Director.
B.A. (Pb.), B.Sc. Engg.
D.I.C (London).
M.Sc. Engg. (London).
F. I. E. (Pakistan).

Has professional experience of over 30 years which includes last 14 years as a principal and Founder of Republic Engineering Corporotion and 16 years in the Communication and Works Department.

In the course of his involvement in the P.W.D. as Assistant Executive Engineer, Executive Engineer and subsequenetly as Superintending Engineer from where he sought retirement in 1959, he was engaged on designing, Planning and control of construction of a large number of highways, buildings. water sunply and drainage projects and was responsible for the reorganization of the Buildings and Road Research Laboratory at Lahore. His field of specialty has been Soil Mechanics and he has had extensive experience of highway design.

Ali Abbas Asghar.
Director.
M. Sc. Engg : (Toronto).
MI.C.E (London).
Advanced Course in.
Bridge Design (SloughEngland).

is a highly qualified Civil Engineer, and is registered as a Chartered Civil Engineer in U K. and as a Professional Engineer in the Province of Ontario, Canada.

Farid Ahsan-ud-Din

Director.

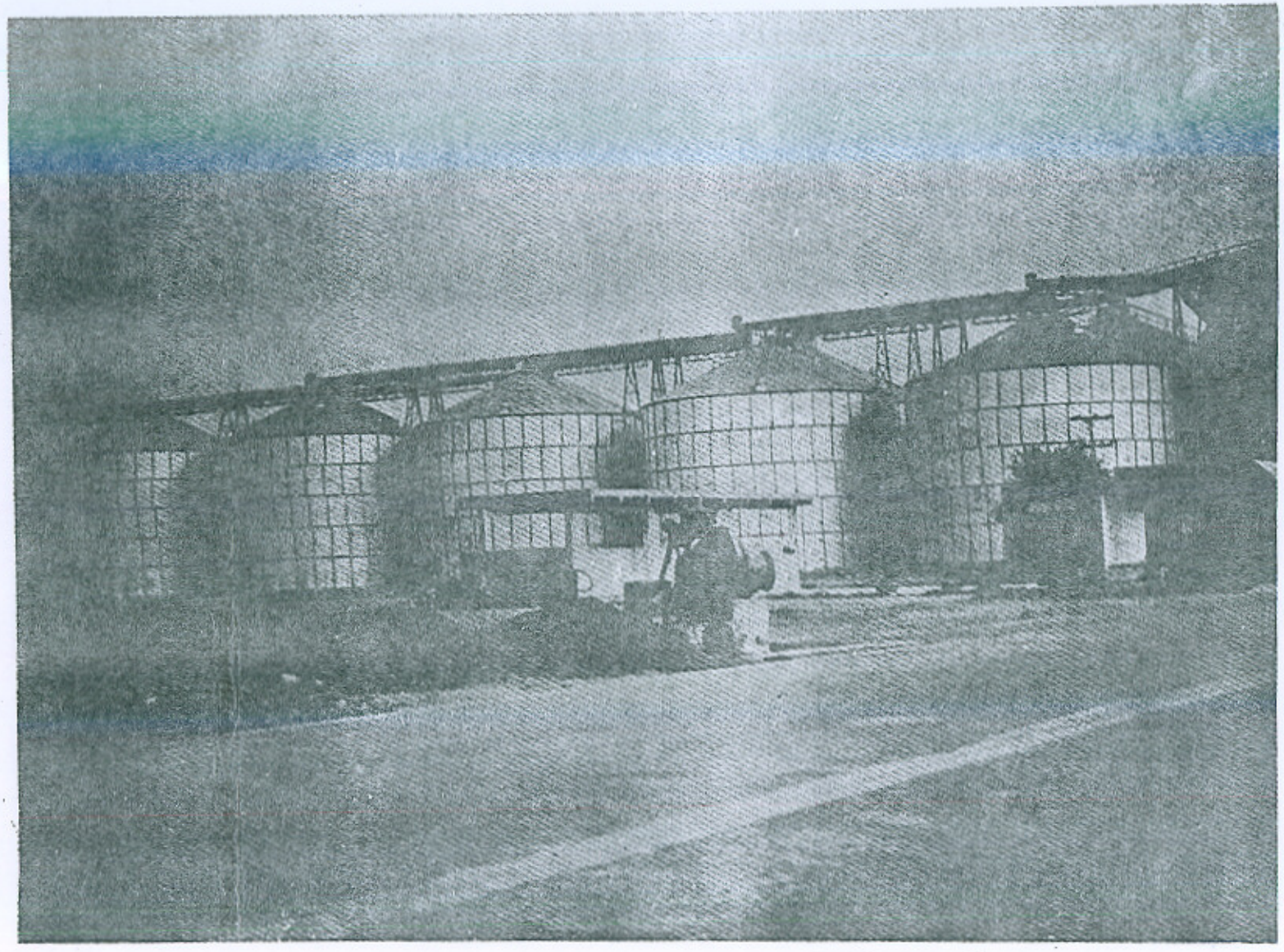
B.S. (Civil) with distinction.

Washington State University, USA.

M S. (Civil) University of Wisconsin, U.S.A.

Member, American Society of Civil Engineers, American Concrete Institute.

Graduated in Civil Engineering with distinction from the Washington State Uni-



42,000 Ton Automated Grain Silos For Agricultural Services Limited Multan

versity and obtained his Masters Degree in Structues from the University of Wisconsin, U. S. A, where he held the coveted Graduate School Fellowship. He then worked with a Consulting Engineering firm in America from 1965 to 1969.

Iqtidar Akmad Chaudhri
Director. B. Sc. (Civil Engg.)
M. Sc. (Hydraulic Engg.)
Advanced Courses in Soil Mechanics, Concrete.
Design, Computer.
Programming, Development Administration, Law and Development Economics,
Member, Institute of Engineers (Pak.).

Graduated in Civil Engineering from the Government College of Engineering and Technology, Lahore in 1961 and joined Republic Enginering Corporton which had then been created only recently.

Associate

Syed Iqbal Hamid
Associate. B. Sc. (Pb.)
Journalism Dip.
B. E. (Elec. and Mech.).
Fellow—Institute of Engineers, Pakistan.

In 1962, he joined the export department of M/s AEG, Frankfurt and subsequently M/s Brown Boveri et Cie, in Manheim and Baden on the planning, designing end erection of HV and EHV projects for power stations and transmission lines.

Sub-Offices

The firm has the followiug Sub-offices :

(*i*) Project Office :

(*ii*) Project Office :

(*iii*) Field Offices :
76/E-I Gulberg, Lahore.
42-C Block 6, PECHS, Karachi.

(*i*) 87-Harley Street, Rawalpindi.

(*ii*) Almansoor Bldg. Jampur Road, D.G. Khan.

(*iii*) Nizam Abad, Taunsa.

1. **Projects Completed**

(*i*) Shorkot Kamalia Unit SCARP-V

(*ii*) Dipalpur above B.S. Link SCARP-VII.

(*iii*) Shujaabad SCARP-VIII.
For WAPDA

The Services rendered were Project Planning and Preparation.
App. Cost was Rupess 500 Million.

2. **SCARP Mardan For WAPDA**

The Services included Project Planning Project Preparation for the Control of Salinity and Water Logging.

App. Cost was Rupees 100 Million.

3. **Rice Mills For Punjab Industrial Development Board**

The Services included Detailed Design and Supervisions of Construction.
App. Cost was Rupees 25 Million.
Extension of Factory Building and ancillary structures.

4. **For Pioneer Steel Mills, Ltd, Muridke**

The Services included Complete Design and Supervision of Construction.
Approximate Cost was Rupees 1.5 Million.

5. **Department of Electrical Engineering For Engineering University, Lahore**
Produced Detailed Structural Design.

Approximate Cost was Ruppes 1.2 Million.

6 **Surface Drainage of Islamabad**

Completed Feasibility Study of Surface Drainage of Islamabad.

App. Cost was Rupees 110 Million.

Water Supply and Sewerage Scheme.

7. **For Sind Trading Estate (S. I. T. E.) Karachi**

The Services included Detailed Planning, Designing of Storm Water Drains, Sewers and Water Supply Distribution Schemes covering 4000 Acres of Industrial Estate.

App. Cost was Rupees 10 Million.

8. **Grain Silo Project at Multan**

The Services included Detaied Design, Erection, Fabrication and commissioning of Silos including warehouse and office building, storage building etc., and Supervison of Construction.

App. Cost was Rupees 15 Million.

9. **English Electric Factory, Lahore**

The Services included Planning, Designing of Buildings and other facilities.

App. Cost was Rupees 15 Million.

10. **Sally Textile Mills Ltd , Jauharabad**

The Service included Complete Desigh and Supervision of Construction.

App. Cost was Rupees 5 Million.

11. **10: Storied Commercial Building, Queens Road, Lahore For West Pakistan Red Cross Society**

The Services included complete Architectural, Structural and Services Design.

App. Cost was Ruppes 11 Million.

12. **College of Agriculture, Tando Jam, West Pakistan**

The Services included Architectural and Structural Designing and Estimate of Costs.

App. Cost was Rupee 1.5 Million.

13. **Punjab University New Campus, Lahore**

The Services included Extension of IBR Chemistry, Chemical Technology Block-Detailed Design.

App. Cost was Rupees 25 Million.

14. **Agricultural University, Lyallpur**

Rendered Services for Detailed Design and Supervision of Rreproduction Block.

App. Cost was Rupees 1 Million.

15. **China Creek Napier Mole Bridge, Keamari, Karachi**

The Services included Economic and Engineering Feasibility Study.

App. Cost was Rupees 30 Million.

16. **9-Bridges on D. G. Khan Loralai Road For Pak PWO, Quetta.**

The Services included Detailed Structural Design.

App. Cost was Rupees 25 Million.

17. **Lahore-Lyallpur Highway (87 Miles) in collaboration with M/s. Louis Berger Inc (USA)**

The Services comprised Economic and Engineering Feasibility Study.

App. Cost was Rupees 100 Million.

18. **Lahore-Sargodha Khushab Highway (135 Miles) in collaboration with Louis Berger Inc (USA)**

The Services included Economic and Engineering Feasibility Study.

App. Cost was Rupees 150 Million.

19. **Roads (102 Miles) SCARP-I Area in association with M/s Incorporated Consulting Engineers, Lahore**

The Services included Economic and Engineering Feasibility Study.

App. Cost was Rupees 10 Million.

20. **Roads in West Pakistan and East Pakistan**

The Services included Economic and Engineering Feasibility Study.

App. Cost was Rupees 2 Million.

21. **Link Road at Steel Mills Site, Pipri, Karachi.**

The Services included Detailed Design.

App. Cost was Rupees 1 Million.

22. **Master Plan of Sukkur Town**

The Servises included Preparation of Development Plan for 20 years.

App. Cost was Rupees 10 Million.

23. **Civil Hospital at Gujranwals for 150 Beds.**

The Services included Architectural and Structural Designing with all other facilities.

App. Cost was Rupees 4 Million.

24. **Civil Hospital at Nawabshah for 125 Beds**

The Services included Architectural and Structural Designing with other facilities.

App. Cost was Rupees 2 Million.

25. **Fish Harbour on Makran Coast in association with M/s Incorporated Consulting Engineers and M/s. Sir William Halcrow and Partners.**

The Services included Economic and Engineering Feasibility Study.

App. Cost was Rupees 25 Million.

Projects in Hand

1. **Indus Super Highway (D. G. Khan-D. I. K. Section) For Indus Super Highway Board.**

The Services include Complete Design and Construction Supervision.

App. Cost will be Rupees 50 Million.

2. **Design of Township services For Pakistan Steel Mill Corporation Ltd.**

The Services include Complete Design and Documentation for 8000 acre township

App. Cost will he Rupees 500 Million.

3. **Repair of Workshops 706, Khuta For Special Works Organization, Rawalpindi Township**

The Services include Complete Design and Cocumentation.

App. Cost will be Rupee 80 Million.

4. **Multi-storied Building at Peshawar For State Life Insurance Corporation Ltd.,**

The Services include Tottal Architectural and Engineering Design.

App. Cost will be Rupees 40 Milion.

5. **Multi-storied Building at Lahore For Autonomous Enterprises Ltd.,**

The Services include Engineering Design and Documentation.

App. Cost will be Rupees 60 Million

6. **Auditorium (for Arts Council, Lahore)**

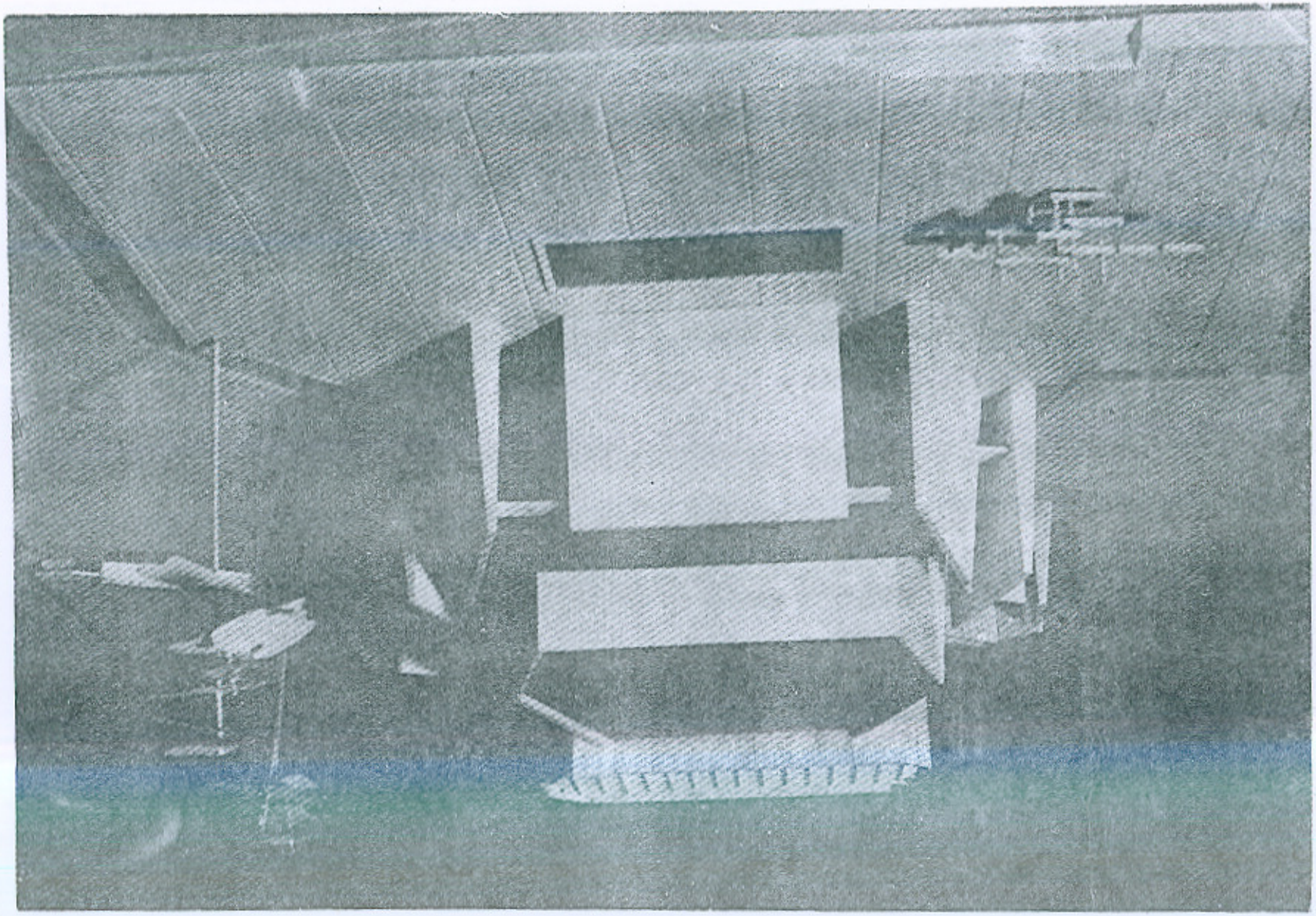
The Services include Complete Design and Supervision.

App. Cost will be Rupees 0.3 Million.

Key Personnel

1. Mr. M. M. Saleem.
Chief Engineer.
B. Sc., Engg : (Civil).

Pakistan Arts Council, Lahore



F. I. E (Pak.)
30-Years Experience.

2. Mr. Abdur Rashid.
Chief Irrigation Engineer.
B. Sc. (Hons) (Civil) Patna.
Specialization :
Study tour of Drainage and Folder.
Projects in Netherlands.
34-Years Experience.

3. Mr. Abdul Hamid Arif.
Chief Groundwater Hydrologist.
B. Sc. (Civil) Punjab.
M. S. (Hydrology).
University of Arizona, U. S. A.
22-Years Experience,
Member, American Society of.
Civil Engineers,
Member, American Geophysical.
Union, U. S. A.

4. Mr Z. A. Toor.
Senior Civil Engineer.
B. Sc. (Civil).
Post-graduate Dip. in.
Agri., Hydraulics and.
Experimental Hydraulics (France)
Post-Graduate Training.
Public Administration.
29-Years Experience.

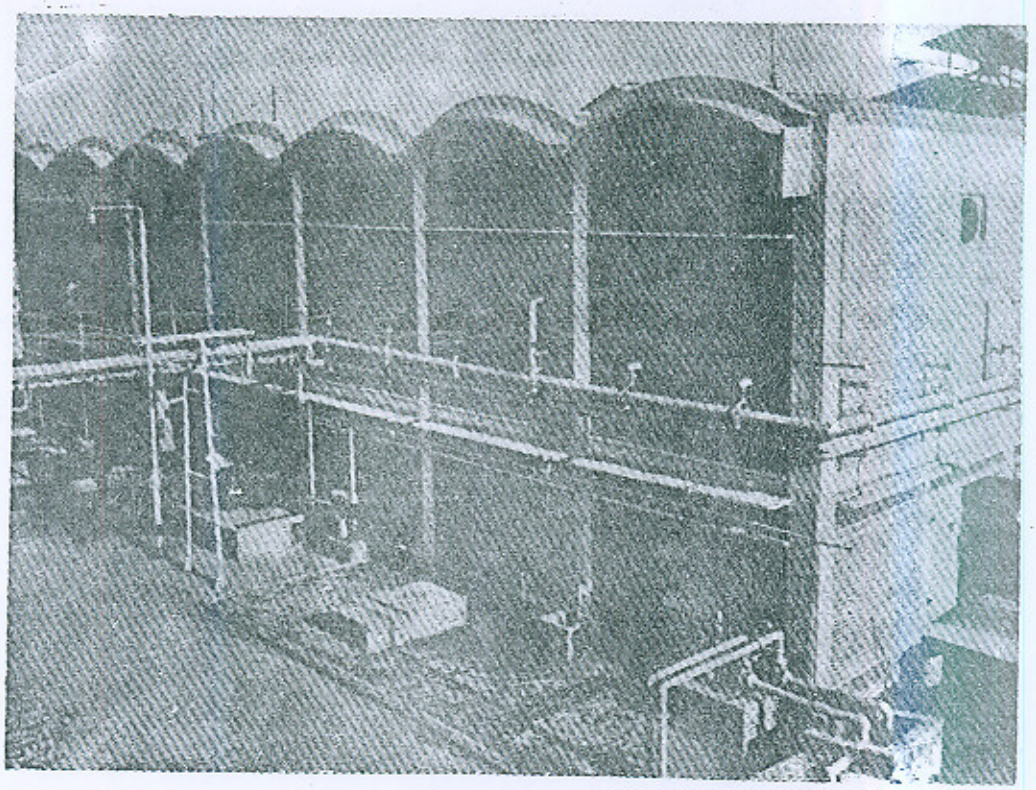
5. Mr. Tariq Saeed.
Senior Engineer.
B. E. (Civil).
M. Sc. (U.K.).
M. I. E. (Pak.).
8-Years Experience.

6. Mr. Syed Matloob Hussain.
Senior Engineer.
B. Sc. Civil Engg :
M. I. E. (Pak.)
Member, Pakistan Engineering.
Congress.
12-years Experince.

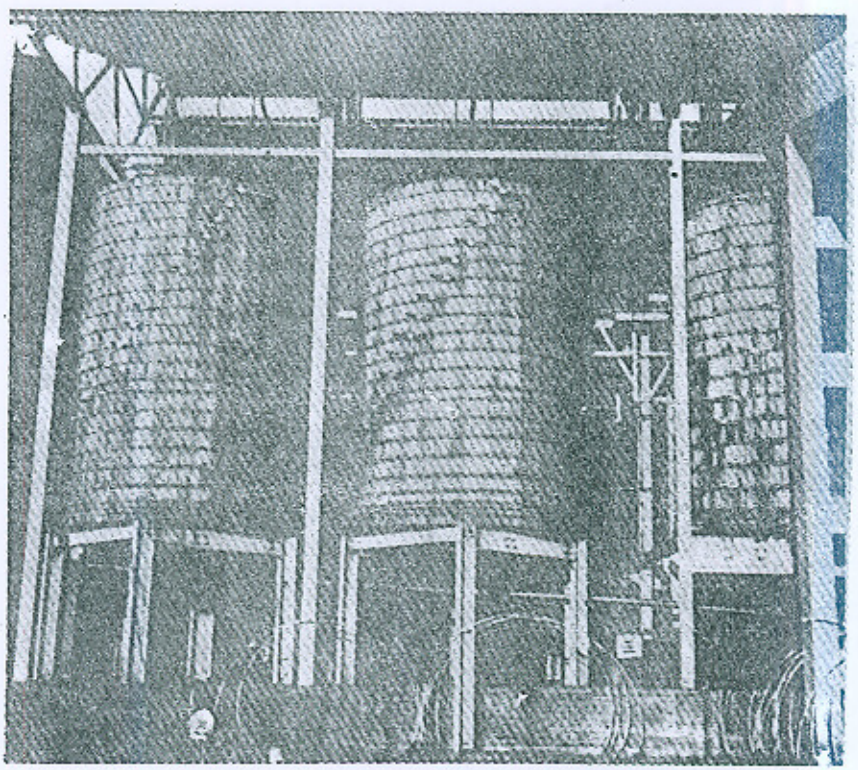
7. Mr. Ahmad Bhatti.
Senior Water Supply Engineer.
B. Sc. Engg : Bangkok.
10-Years Experience.

8. Mr. Khurshid Ahmad.
Senior Electrical Engineer.
B. Sc. Engg : (Elect).
8-Years Experience.

9. Mr. Ghulam Dastgir.
Chief Agronomist.
M. Sc. (Agri).



New Refinery Building at Glaxo Laboratories Factory
Ferozepure Road, Lahore



Glaxo Laboratories Factory, Ferozepure Road, Lahore

CODE OF ETHICS

PAKISTAN ENGINEERING CONGRESS

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

In the name of God, the Beneficent, the Merciful.

WHEREAS Allah enjoineth upon his men to faithfully observe their trusts and their covenants ;

that the practice and profession of engineering is a sacred trust entrusted to those whom Nature in its magnificent bounty has endowed with this skill and knowledge ;

that every member of the profession shall appreciate and shall have knowledge as to what constitutes this trust and covenant, and

that a set of dynamic principles derived from the Holy Quran shall guide his conduct in applying his knowledge for the benefit of society.

Now, therefore, the following Code of Ethics is promulgated. It shall be incumbent upon the members of the Pakistan Engineering Congress to subscribe to it individually and collectively to uphold the honour and dignity of the engineering profession :

١- إِنَّ اللّٰهَ يَأْمُرُكُمْ أَنْ تُؤَدُّوا الْأَمٰنٰتِ
إِلٰى أَهْلِهَا وَإِذَا حَكَمْتُمْ بَيْنَ النَّاسِ
أَنْ تَحْكُمُوا بِالْعَدْلِ إِنَّ اللّٰهَ نِعِمَّا
يَعِظُكُمْ بِهٖ

"Allah commands you to render back your trusts to those to whom they are due, and that when you judge between people, you judge with justice. Allah admonishes you with what is excellent". iv : 58

1. You shall be honest, faithful and just, and shall not act in any manner derogatory to the honour, integrity or dignity of the engineering profession.

٢- أَوْفُوا الْكَيْلَ وَالْمِيْزَانَ بِالْقِسْطِ وَلَا تَبْخَسُوا
النَّاسَ أَشْيَاءَهُمْ وَلَا تَعْثَوْا فِي الْأَرْضِ
مُفْسِدِيْنَ ○

"Give full measure and weight justly and defraud not men of their things, and act not corruptly in the land making mischief". xi : 85

2. You shall use your knowledge and skill of engineering for human welfare, and render professional service and advice which reflects your best professional judgment.

٣- وَلَا يَجْرِمَنَّكُمْ شَنَاٰنُ قَوْمٍ عَلٰى أَلَّا تَعْدِلُوْا
اِعْدِلُوْا هُوَ أَقْرَبُ لِلتَّقْوٰى

"And let not hatred of a people incite you not to act equitably. Be just ; that is nearer to observance of duty". v : 8

3. You shall not injure maliciously, directly or indirectly, the reputation or employment of another Engineer, nor shall you fail to act equitably while performing professional duty.

٤- أَوْفُوا بِالْعُقُوْدِ ○

"Fulfil the obligations". v : 1

4. You shall faithfully observe and fulfil all your obligations.

٥- وَلَا تَأْكُلُوْا أَمْوَالَكُمْ بَيْنَكُمْ بِالْبَاطِلِ وَتُدْلُوْا بِهَا
إِلَى الْحُكَّامِ لِتَأْكُلُوْا فَرِيْقًا مِّنْ أَمْوَالِ النَّاسِ
بِالْإِثْمِ وَأَنْتُمْ تَعْلَمُوْنَ ○

"And swallow not up your property among yourselves by false means, nor seek to gain access thereby to the judges, so that you may swallow up a part of the property of men wrongfully while you know". ii : 188

5. You shall not abuse your position or power, nor accept illegal gratification of any sort.

٦- وَقُوْلُوْا قَوْلًا سَدِيْدًا ○

"And speak straight words." xxxiii : 70

6. You shall express your opinion on engineering or other matters in a frank, open and straightforward manner.

٧- اِجْتَنِبُوْا كَثِيْرًا مِّنَ الظَّنِّ إِنَّ بَعْضَ الظَّنِّ إِثْمٌ
وَلَا تَجَسَّسُوْا وَلَا يَغْتَبْ بَّعْضُكُمْ بَعْضًا

"Avoid most of suspicion for surely suspicion in some cases is sin; and spy not nor let some of you backbite others". xlix : 12

7. You shall not criticise another engineer's work without his knowledge, nor malign, or injure his professional reputation.

٨- وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهٖ عِلْمٌ إِنَّ السَّمْعَ
وَالْبَصَرَ وَالْفُؤَادَ كُلُّ أُولٰئِكَ كَانَ عَنْهُ
مَسْئُوْلًا ○

"And follow not that of which thou hast no knowledge. Surely the hearing and the sight and the heart, of all these it will be asked." xvii : 36

8. Your professional advice shall be based on full knowledge of the facts and honest conviction, and you shall not write articles or advertise in self-laudatory language or in any manner derogatory to the dignity of the profession.

٩- وَتَعَاوَنُوْا عَلَى الْبِرِّ وَالتَّقْوٰى وَلَا تَعَاوَنُوْا
عَلَى الْإِثْمِ وَالْعُدْوَانِ وَاتَّقُوا اللّٰهَ

"And help one another in righteousness and piety, and help not one another in sin and aggression and keep your duty to God." v : 2

9. You shall help one another in upholding and doing what is right, and shall not associate with those who transgress and those who indulge in unethical practices.

١٠- وَأَمْرُهُمْ شُوْرٰى بَيْنَهُمْ

"And whose affairs are decided by counsel among themselves." xlii : 38

10. You shall decide matters of common professional interest by mutual consultation.

١١- وَاعْتَصِمُوْا بِحَبْلِ اللّٰهِ جَمِيْعًا وَّلَا تَفَرَّقُوْا

"And hold fast by the covenant of God all together and be not disunited." iii : 102

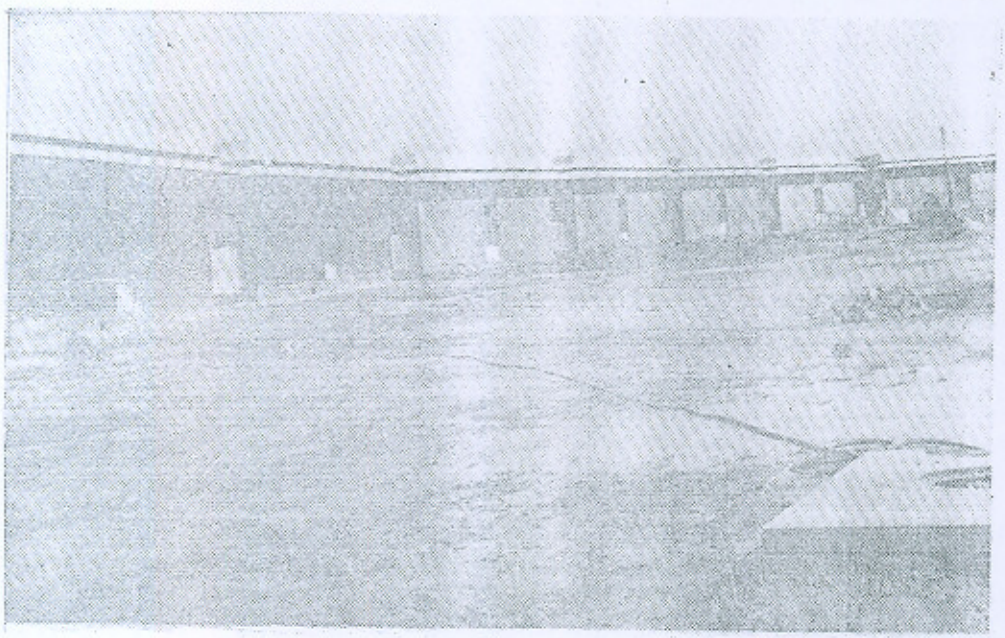
11. You shall strive individually and collectively to enhance the prestige of the engineering profession by ordering your conduct in accordance with this Code of Ethics, and shall not be disunited.

Zaman Engineering Corporation

Engineers – Contractors

13 - Beadon Road, LAHORE .

SPECIALIZING IN CONSTRUCTION
OF
CIVIL WORKS



A view of SOS Children Village (Pakistan) Lahore Under Construction by Zaman Engineering Corporaation

Under the sponsorship of SOS Kinderdorf International.

ALSO PRESENTLY WORKING ON THE CONSTRUCTION
OF
CIVIL WORKS & APPURTENANCE STRUCTURES
OF
"OSSEIN PLANT"
OF
MESSRS P. LEINER & SONS, TREFOREST
Glamorgan, U. S.