TABLE 5

COST OF VARIOUS MORTARS PER 100 CFT

Mix (Vol)			Quantities (cft)			Cost
C	L	S	C	L	S	(Rs)
0	1	2	-	43	86	551
0	1	3	-	31	93	425
1	1	6	15	15	90	906
1	1	7	13.1	13.1	92	794
1	1	8	11.5	11.5	92	716
1	2	8	11.25	22.5	90	824
1	2	9	10	20	90	741
1	2	10	9.4	18.8	94	704
1	2	12	7.83	15.66	94	600
1	3	12	7.67	23	92	672
1	3	14	6.7	20.1	94	700
1	3	16	5.9	17.7	94	539
1	¼	3	28.3	7	85	1399
1	0	2	41	-	82	1878
1	0	3	28.3	-	85	1322
1	0	4	22.5	-	90	1071
1	0	5	18	-	90	873
1	0	6	16.67	-	100	823
1	0	7	14.3	-	100	719
1	0	8	12.5	-	100	640

The cost of various mortars given in Table 5 is based on above quantities of sand from which volume of cementing material is calculated on the ratio specified.

Tbe basic price of ingredients upto site of work has been taken as follows in determining costs given in Table 5:-

Cement	=Rs.55/- per bag or Rs.44/- per cft. =Rs.26/- per 40 kgs.
Lime Yield of putty	=2.6 cft. per 40 kgs.
Putty	=Rs.11/- per cft.
Sand	=Rs.90/- per 100 kgs.

It will be seen that lime mortars are cheapest while cement mortars adopted in buildings, are more expensive than almost all cement-lime mortars (expect 1:1:6) and both the lime mortars. If lime mortar (1:2) is used instead of cement mortar (1:6) in masonry walls, the saving in 100 cft. mortar will be about Rs.272 i.e. Rs.0.75 per cft of masonry work. In other workds, it will mean a saving of about Rs. 2.0 per sft. of plinth area. On the other hand, if lime mortar (1:3) is used, as will be required in buildings such as Basic Health Units, primary and middle schools and residential buildings, the saving in terms of money will be significant when compared to cement (1:6) mortar. It will be possible to save Rs.4.0 per cft. of mortar which when transformed into masonry, will yield a saving of over Rs.3.0 per sft of plinth area.

PLASTERS

Cement mortars are the only plasters used in buildings in Pakistan. The usual mix adopted is 1:5, while some authorities indulge in prescribing richer mixes more out of lack of confidence than requirements of a particular situation. The basic qualities required of a plaster are that it should have high surface hardness, good workability under trowel, low shrinkage and good bond with the surface on which it is applied. Lime plasters possess almost all these qualities but these have slowly gone out of use due to our lethargy and lack of knowledge. The BRS Lahore had experimented

with different plasters in 1965 and found that even the lean cement or cement-lime mixes were pretty durable under exposed tests. But lime mortar (1:2) mixed with 1 lb. of chopped hessian per cft of lime, gave a very workable mortar which was liked by the masons immensely. This mortar was used in internal plasters of experimental rooms and gave satisfactory results. The addition of hessian provides an extra safety reinforcement to arrest any cracking tendency. Hessian rope or bag is chopped into small pieces and softened in water for a day before mixing in lime putty for maturing. Assuming the present day rates of hessian as Rs.2 per lb., an additional expense of Rs.86 per 100 cft of lime mortar will be involved. The cost of 100 cft of such a plaster on the analysis given in Table 5 comes to Rs.637 as compared to Rs.873 for 1:5 cement mortar. If this mortar is used in place of usual 1:5 cement-sand mortars, a saving of Rs. 2.36 per cft. of mortar will be available which when transformed to plinth area rate, will give a saving of over Rs.0.30 per sft. The saving may appear to be insignificant but the real point is that if the same purpose is served by an economical technique, it must be adopted as cumulative effect of wasteful practices in a building has a large financial impact on national scale because of repetitive nature of building practices. The only drawback in lime sand hessian mortar is that it takes long to dry but then it does not need water curing. A better alternative may be to use 1:2:9 cement lime sand plaster.

FOUNDATION CONCRETE

The conventional specification of the PWD requires foundation bed to be laid in 1:6:12 lean cement concrete. The real purpose of the concrete bed is to disperse the footing load over larger area which purpose could be served equally well by compacted dry ballast or ballast mixed with sand as is done for the road pavements. But if bed concrete is to be used, it will be better to use 1:2:4 lime-sand-ballast mix as recommended by Indian Research. The cost of such a lime concrete works out to Rs.458 per 100 cft as compared to Rs.612 for 1 : 6 : 12 cement

concrete, assuming cost of ballast as Rs.2 per cft and other materials as given at page 16. The switch over to lime concrete would mean a saving of about Rs. 1.50 per sft. plinth area. It may be noted that 1:2:4 lime sand ballast concrete will be stronger than 1:6:12 cement concrete because the former contains more cementing material enough to coat coarse aggregates for adequate bond. The only snag is that lime concrete cannot be used under damp conditions. However, for such situation 1:1:6:12 cement lime sand ballast is suggested instead of 1 : 4 : 8 cement concrete because the former is estimated to cost Rs. 1.30 per cft less than the latter.

POINTING

The pointing of masonry is important as it prevents disintegration of masonry mortar due to atmospheric effects. For this reason, strong mortars are usually used in pointing but the current practice of using 1 : 2 cement sand mortars is perhaps wasteful. The BRS London vide its Digest No.72 recommends adoption 1 : 2 : 7 cement lime sand mortar for most of the works. For severe exposures, the mortar recommended for pointing is 1:1:5. The use of strong mortar with weak bricks, such as we have in Pakistan, invites a risk of salts (in bricks) crystallising under the surface of bricks rather than on mortar joints and thus causing spalling of bricks.

PRACTICAL HINTS

i) Lime putty can be used for a week or two if it is prevented from drying;

ii) Longer the curing time of putty in the tank, the better its quality;

iii) The overburnt and underburnt lime slakes rather slowly and if allowed to remain in putty, will expand after setting, causing popping or pitting in plasters and cracks in masonry. These injurious constituents are reduced by extensive maturing of putty and removed by screening;

iv) Damp sand facilitates thorough mixing with lime putty and prevents formation of nodules if dry sand is mixed with putty;

v) Whereas cement masonry gives higher strength when damp bricks are used and masonry is cured afterwards, the masonry in lime mortar does not have either to be laid with very damp bricks or cured so thoroughly;

vi) Lime mortar may be avoided in masonry below dpc where cement lime (1:2:9) mortar is recommended. This will reduce the cement demand by about 33% from masonry in F&P;

vii) Use of lime, either as mortar or plaster, is to be avoided during frosty winters or in areas subjected to frosts.

viii) If dry hydrate is used in mortars instead of putty, the volume of hydrate must be increased upto 1½ times that of putty.

CONCLUSIONS

The overall effect of using lime in masonry mortars, internal plasters and foundation concrete in financial terms, would give a saving of about Rs. 4.80 per sft. of plinth area. But the real saving will be in terms of cement which presently is a scarce commodity in the country. It is estimated that if cement is eliminated (or reduced) from some elements of building such as foundation concrete, masonry above dpc internal plasters and pointing etc. the demand of cement will reduce by at least 25% from the building activity and that too without any loss of efficiency. The economy and saving in cement is well worth exploiting in construction of all public buildings to set a healthy example for the Private sector fo follow. Needless to add that whatever has been suggested above, is being used successfully in other countries for the last many decades and no risk, whatsoever is involved.

ACKNOWLEDGEMENT

The writer acknowledges his gratitude to the BRS Lahore for permitting to guide the testing work and to use the results in compilation of this paper. Special thanks are due to Ch. Ali Muhammad, Senior Research Officer of the Building Research Station, Lahore, for his unstinted support, help and cooperation throughout this work.

BIBLIOGRAPHY

1. Emley W.E. "Tests of Limes" National Lime Association Proceedings (1912-13).

2. Emley W.E. and Young S.E. "The Crushing Strength of Lime Mortar" National Lime Association Proceeding (1913).

3. Kirkpatrick F.A. & Orange W.B. "Compressive Strength of Cement Lime Mortars"J.A. Cerm. Soc. (January 1919).

4. BRS London Digest No.75 "Strength and Stability of Walls" (1955).

5. Voss C., Walter "Exterior Masonry Construction" Nat Lime Association Bulletin 324 Washington (1956).

6. BRS London Building Note No.47 (August 1957).

7. Symposium on Manufacture & Use of Building Lime in India (1958).

8. BRS London Digest No.2 (Second Series) 1960.

9. Mathur G.C. "Building Lime" Lime Manufacturers Association India 1961.

10. Indian Standard C. P. 1625 on "Preparation and Use of Lime Mortars in Buildings" (1962).

11. SCAFE Seminar U.N. Document No.1&NR/BM/23 on "Building Lime" (January 1968).

12. B.S. Code of Practice No.111 "Structural Recommendations for Load-bearing Brick Walls" (1971).

NEED FOR NUCLEAR POWER AND THE ROLE OF ENGINEERS

Address delivered by Dr. Munir Ahmad Khan Chairman Pakistan Atomic Energy Commission at the Mid term session of Pakistan Engineering Congress, Lahore on 5. 9. 1979.

INTRODUCTION.

It is indeed a very great honour for me to have been invited to this Congress which, as the Secretary has pointed out is the oldest and highly respected Engineering Society in the country. You know better than any one else what is the justification and rationale for Pakistan's nuclear power programme and why Pakistan is pursuing it despite opposition from several quarters.

At the very outset I would like to emphasis that Pakistan's nuclear power programme has been stepped up and is being vigorously pursued not because of prestige or domestic political reasons. The programme has been devised only and largely by keeping the over all national requirements of development in view. It is not a short term programme but represents a long term commitment to meet our energy and fuel needs for the next few decades.

IMPORTANCE OF ENERGY.

For the development of a country it is essential to provide inputs of energy, capital, management know-how and skills.

It is now an established fact that the percapita consumption of electricity in any country is one of the reliable indices of growth and development in the country. To illustrate this one may make a comparison between the advanced countries and the developing nations with regard to energy consumption. In USA, an average citizen consumes about 10, 000 units of electricity per year. In the other advanced countries of West Europe, this consumption is between 6000-9000 Kwh/capita.The world average is about 1600 units per capita per year and even in the poorer nations of Asia the average is more than 300 units per year. This is in sharp contrast with regard to Pakistan where the average consumption of electricity has risen only recently to barely 160 units per person from a mere 10 Kwh/capita/year at the time of independence in 1947.

Not only that,but even our known fossil fuel reserves are also extremely limited and inadequate to meet our demands. Despite latest discoveries of oil and gas at Dhodak and Pir Koh (in Baluchistan) our total known fossil fuel reserves of coal, oil and gas are so limited that they correspond to about 1/40th of the world average per head and are equivalent to only 15 tons of coal per head. How meagre this amount is can be judged from the fact that

it corresponds to average consumption per capita in the United States in just over one year. This means that our nation has a total reserve per citizen which would suffice for only one year for an average American.

Our planners have estimated that the per capita consumption of energy in Pakistan will increase four fold by the end of this century. Over the same period our electricity consumption would grow even faster, from the present 160 Kwh/capita to 700 Kwh/capita. It may be noted that during this period the everage world consumption will increase to well over 3500 Kwh/capita

How to meet our growing demands? of course we have to exploit to the maximum our hydro potential, coal, oil and gas and in fact whatever energy source we can harness expeditiously.

CONVENTIONAL ENERGY RESOURCES.

a) Hydro.

Our conventional energy resources are however, very limited. Hydro power is our major resource at the moment but it has constraints both due to the total amounts available and the rate and location at which it can be exploited. Most of the hydro resources are concentrated in the north and require high transmission costs to utilize the power generated at the load centres. As the most favourable sites have been exploited the cost of constructing dams at new locations, most of which are in seismic region, is becoming very high. Neverthe-

less from technological and economic points of view we can exploit only about 50% of 20, 000 MW (theoretical potential) by the end of this century. We are likely to exploit only about 3200 MW by the end of 1980 while 6800 MW of the remaining economic potential is not yet exploited. Thus hydro can provide about 30% of the installed capacity requirement.

b) Coal, Gas, Oil.

The coal in Pakistan is not only limited in quantity but most of it is lignite and thus poor in quality and difficult to use for power production. Our total coal deposits (proven and probable) amount to 483 million tons which when reduced to good quality coal correspond to only 173 million tons. This may be compared with 81 billion tons of coal reserves in India.

Contrary to the general belief Gas reserves in Pakistan are not very large and it will continue to be used for other valuable purposes. Gas is a very important raw material and we need to utilize it in the manufacture of fertilizers, petrochemicals and domestic use and cannot afford to burn it merely for power production. In fact the optimal economic use of gas particularly when it is not available in large quantities does not permit its use for power production. Our reserves of 26.4 million million cubic feet correspond to 724 million tons of coal and unless new discoveries are made our gas will be fully committed by 1988.

Last year Pakistan spent over 500 million dollars on the import of oil to meet its domestic requirements of industry and transportation. This year the oil import bill would be $ 935 million which represents 43% of our foreign exchange earnings. Even after the recent discoveries of oil at Dhodak, we will continue to import over 85% of our total needs. Oil import bill accounts for more than one third of our foreign exchange earning and keeping in view the trend of increase in oil prices and the growing demand, this bill will go much higher. Obviously it will be an unbearable strain on our economy to further increase the cost of importation of oil by using it for power generation on a large scale. Besides, oil has several other important uses and it is not optimally economical to burn it for power production. That is why even those countries which have surplus oil reserves are turning to nuclear energy to meet their rising energy demands. The growing consumption of oil and its increasing prices demand that even if we succeed in striking indigenous reserves of oil we will have to depend upon other more economical sources of power generation.

Inspite of these limitations of conventional resources of energy our planners have earmarked a considerable portion of them for power generation. Our estimates show that even after allocating a significant portion of the available gas and coal for power production, our hydro and other conventional resources can

not give us more than 11,000 MW installed capacity by the end of this century as against our demand of 27,000 MW by that time.

Keeping in view this energy resource picture, Pakistan has no choice but to look forward to harnessing nuclear energy for meeting its power demands. For it offers the only economical and practical answer to our problem of energy shortage. The Nuclear power plants are more expensive than conventional oil fired plants in capital cost to start with, but the running (fuel) cost of the former is much less than the latter. Our analysis has proved that on the average a Kw of electricity generated by oil fired plants (including running) costs about Rs. 42/- per unit as against Rs. 25/- required for power generated through Nuclear plants.

NUCLEAR POWER.

The Pakistan Atomic Energy Commission has prepared itself for the role it has to play in meeting energy requirements. A 137/MW nuclear power plant is already functioning at Karachi. The plant run and maintained entirely by Pakistan engineers has offered us most valuable experience. The Canadian embargo on the supply of nuclear fuel and spare parts in Dec'76 started the beginning of a self reliant programme in Pakistan which will reduce our dependence upon others. The fact that Kanupp has been run and maintained satisfactorily by our engineers since 1976 despite Canadian embargo is a testimony to our determination to be on our own.

Following KANUPP another nuclear power plant is planned to be set up at Chashma in Mianwali District in the Punjab. Necessary preliminaries for this 600 MW power plant have been completed and the actual construction will begin as soon as the difficult financial position becomes easy. The multi million project has been approved by the Executive Committee of the National Economic Council. Following Chashnupp, the Commission plan to set up more nuclear power plants at a much faster rate.

FUEL CYCLE & REPROCESSING PLANT.

Now I turn to one of the crucial aspects for Pakistan's nuclear power programme. Why do we need it and why have we been singled-out for criticism from among a large number of countries in this regard. The central role of a reprocessing plant can be understood from the following facts. A power reactor normally burns 1-3% of uranium after which because of fission products produced in the fuel, the reactor loses its ability to sustain chain reaction. The burnt fuel is, therefore discharged and fresh fuel added. We can reuse this discharged fuel provided we remove the poisonous fission products and clean up the uranium and separate plutonium which is produced in the reactor. A reprocessing plant is used to perform this operation. Its advantages are:-

i) It enables one to recover unburnt uranium which can be re-used in new power reactors.

ii) It yeilds plutonium

which is known appropriate fuel for breeder reactor.

Without plutonium there can be no efficient breeder reactor and without breeders the full potential of nuclear power can not be realised.

The critics of our reprocessing plant want us to depend upon them for the critical supplies of the reactor fuel. This, however, is not acceptable to us. We have had a bitter experience with Karachi Nuclear Power Plant when Canada unilaterally withdrew from its contractual obligation and stopped supplying fuel for the plant. In fact the history of Pakistan is replete with instances of broken pledges and unfulfilled promises. A power reactor is almost a billion dollar project and cannot be left at the mercy of others, who may stop fuel supplies any time without any notice and thereby jeopardize a country's entire economic development programme.

It is because of this crucial role of the reprocessing plant that Pakistan is determined to go ahead with this project. As the President of Pakistan stated recently, Pakistan is proceeding with its peaceful nuclear power programme and we will be able to complete our reprocessing plant even without outside assistance.

ROLE OF ENGINEERS.

Now I wish to turn briefly to the role of engineers in the development of nuclear power in Pakistan. Unfortunately, the impres-

sion in the world is that access to nuclear technology is synonymous with nuclear weapons and developing country seeking nuclear technology is after proliferation. This, however, is not so and the misconception in this regard must be corrected. Development of nuclear power has nothing or very little to do with nuclear weapons.

In the early 1940s and 50s the role of nuclear physicists was very important to discover and understand the phenomenon of fission. After the basic scientific knowledge have been attained the role of technologists and engineers in the nuclear field became more predominant. In fact it were the engineers who translated the discovery of fission into practical nuclear power. Nuclear technology is truly inter-disciplinary because it covers a large spectrum of disciplines such as physics, chemistry, electronics, electrical, mechanical, chemical, mining, civil and even geology and seismology. It requires mastery over diverse specializations in apparently such remotely connected fields as underground water technology so as to understand how nuclear waste products can migrate and meteorology to see how these fission products will disperse. All major branches of engineering have a very important role in nuclear power. In fact if there is any one sector where we have a meeting ground of all disciplines and which offers a tremendous opportunity for collaboration it is the field of nuclear technology. I therefore, request the Pakistan Engineering Congress

not to abandon the field of nuclear power to physicits alone but to prepare its members to play a leading part in bringing nuclear power to Pakistan. The nuclear power offers tremendous opportunities and challenge to the engineers of Pakistan.

Mr. President, we also face some limitation and constraints in the spreading development of nuclear technology in Pakistan. One of the most serious problem is the growing deterioration of our educational standards and the politicizing of our academic institutions. As someone said we are becoming a nation of educated"illiterates" who can brandish all sorts of degrees and diplomas without the requisite knowledge to back them up. This is very dangerous trend and givesus false illusions. It is said that the quantum of world's knowledge has doubled in the past 25 years and will double again in the next 10 years. Since we graduated the world knowledge has increased by more than twice. Our recent graduates, therefore, need to know much more than their predecessors. Unfortunately, however, our younger graduates learn much less and are not equipped to compete against the rapidly rising standards of technical education in the rest of the world.

We also have the problem of quantity of our technical manpower. Our engineering base is very limited. A great contribution of this Congress would be to help reform the educational system of engineering institutions in Pakistan so that we can produce a much larger number of

high quality graduates. I believe they can do this because members of this Congress are all in responsible positions and the authorities will listen to them. Let us emphasize upon all concerned that the educational institutions are not edequately equipped to meet the challenge, and this downward slide in their standard must be checked if we are to develop our country and match the others.

Nuclear energy also requires a great deal of self discipline and control to be handled very carefully from purely safety, maintenance and engineering points of view not to speak of political and emotional handling. We must have a certain measure of self restraint and control which we unfortunately lack.

Looking into the next decade there is bound to be yet another revolution in technology. The next decade will be the decade of lasers, computers, electronics and other sofisticated devices which will help do things in a fraction of time as compared to the present. For instance, the basic resource evaluation of a country will be done with the help of satellites scanning in just a few years rather than decades as at present. Lasers will help in nuclear energy (ooth fission and fusion) communications industry, defence and in so many other areas. All these subjects need to be introduced in Pakistan. Our younger generation must be clearly told that if we do not catch up with other countries we might soon lose communication with the rest of the world because we will not understand their language.

We take great pride in receiving generous foreign remittance and are happy that a large portion of our foreign exchange earning come from these remittances. We however, don't realise that for every one dollar that we get through foreign remittance we lose several times, more in terms of technical brain-drain and loss of production at home. If we are to help friendly countries and participate in their development and growth we shall do it not just through export of skilled and un-skilled manpower but through export of plant and technology. Among the Muslim countries we have relatively more advanced technology. Our engineers must come forward and seize this historical opportunity of providing technological support to the Muslim and the Third World countries. Missing this chance might mean putting our brotherly countries at the mercy of others.

Pakistan also faces the problem of transfer of advanced technology and our engineers must wake up to this problem. The Pakistan Engineering Congress should emphasis upon the engineers of Pakistan to stop dreaming that they will be offered technology through the benevolence of advanced countries without any struggle on their own part. We must recognise the political price attached to such gifts and pause and reflect whether we can pay this price. We engineers must, therefore, shed our illusions and resolve to be on our own feet and start a vigorous programme for acquiring and

developing technology in Pakistan by building up necessary institutions, educational and industrial infrastructure for this purpose.

I also take this opportunity to point out yet another very disturbing factor affecting the growth of technology in the country. It is that we lack dedication and our work ethics have degenerated. We must arrest this trend. To survive and progress as a nation we, as the educated class, must develop moral integrity, national pride and selfless dedication to the moderanization of Pakistan.

I thank you.

THE YELLOW DWARF

By

Khalid Faruq

The SUN, our unfailing daily visitor who brings light into darkness every morning and and blazes its trail across the skies till it sets in the West plunging the world again into darkness, has been doing so almost with the same regularity for the last about 5000 million years - millions of years before this self conceited bi-ped, classified as a Homo Sapien made its honourable appearance on the surface of the planet & had the affront to put his head up and give it a searching look. By far the largest and most brilliant object in the skies, it has always had such a profound and dominating influence on the life on this planet in all its meanings that through the ages it has been held in awe, revered, deified and worshipped. With the advancement of knowledge science has recognised this celestial over lord as an average middle aged star of the category Yellow Dwarf - a huge ball of fire with truly staggering immensity of physical dimensions - so immense that human mind is humbled in its failure to fully comprehend the real meaning of their magnitude. The mere appearance of a few blisters on the face of the Sun (Sun Spots) spewing out torrents of high speed particles, produces violent electromagnetic storms 93 million miles away on the earth (when magnetic compasses go awry) affecting weather and radio communications (sometimes totally blacking out the latter) and occasionally producing

a fantasy of colours at the poles (Aurora). The Sun spots may appear to be mere pock marks but in actual size may be large enough to easily engulf a handfull of earths. A periodicity of about 11 years in Sun spot activity has been identified & people have also attempted to co-relate the occurence of social revolutions, wars and other upheavels on the surface of this planet with the maxima of the periodicity.

Out of the tremendous amount of energy being poured out in all directions, the tiny earth (diameter less than one hundredth of the Sun) situated at a distance of no less than 9, 29, 00, 000 miles receives an energy equivalent of 4.69×10^6 Horse Power per square mile of its area. The entire generation capacity of Electricity in Pakistan is about 3000 M. W (although max: generation already touched is much less) which is equivalent of 4.02×10^6 Horse Power i.e. slightly less than the Sun's energy received on just one square mile of the area. At the surface the Sun has a temperature of above $5000^{\circ}C$ (a temperature at which almost every thing on this earth would melt or boil) producing an overall luminosity of 3×10^{27} candle power with an intensity of illumination of 1.5 million candles/square inch. This seemingly interminable energy which the Sun is pouring out for the last 5000 million years is the product of a thermo nuclear process taking place in the inferno deep in the bowels of the star where the temperature and pressure are an inconceivable $20,000,000^{\circ}K$ and 500,000,000

tons per square inch converting 4 million tons of Hydrogen into Helium every second. At this tremendous pressure and temperature the process of conversion of hydrogen into helium takes 5 million years to complete. Even at this tremendous rate of self -consumption there is no fear on the human scale of the sun exhausting its energy and being extinguished. With its mean diameter of 8, 64, 940 miles containing about 335,000 Billion Cubic miles of hot gases in its mass of 1.958×10^{27} tons (about 2000 quadrillion tons), it is estimated to blaze its trail for another 5000 million years before entering its destined cycle of extinction marked by first swelling to a Red Giant stage(when Mercury will be baked, Venus fried and Earth boiled) In about further 2000 million years,it will start shrinking again and ultimately after going through the ordained death-throes over a period of about 50, 000 million years it will have lost all its glaze, blaze and glory and become a black and intensely cold lump, joining the galaxy of a multitude of other dead heroes scattered through out the immensity of the space. But that is not all. The Sun is yet on another journey,the end of which is not known. In addition to its rotation about its axis in about 17 days, it is revolving along with rest of the stars of the Milky Way, round the centre of the galaxy(which is about 27 to 30 thousand light years away) at an orbital speed of 4, 81,000 mph completing its one revolution in 225 million years. It is also hurtling

through the space along with the entire Milky Way at a reckless speed of 1. 35 million miles per hour possibly in an extremely large circular or near circular orbit. September is not known what fate awaits the Sun, its faithful family of satellites (which will not abandon it even in its death) and the entire Milky Way at the end of this mad journey.

SYMPOSIUM ON THE MECHANICS OF ALLUVIAL CHANNELS

(June 24,1979 to June 28,1979)

OBJECTIVES

By early 1979,the research under ACOP had been in progress for over five years out of its stipulated 7 years through 1980. During this period, ACOP had completed over 1400 equilibrium experiments covering the hydraulic, transport and morphological measurements on different canals. In addition, over 400 special experiments had been completed covering subject areas such as the velocity and sediment concentration distribution, dynamics of flow in alluvial channel bends, temporal and special variations of velocity and sediment concentration, sediment conduction by ejectors, error analysis of basic and derived quantities, etc.In addition, ACOP had developed instruments for field measurements of velocity pulsations, boundary shear stress, real time sediment concentration and three dimensional properties of bed forms. Some of these instruments had been successfully used in field research even under trying conditions.

These planning, field research, instrument development, and data analysis activities on ACOP provided an opportunity to share the experience with research groups and workers in this subject area and to evaluate the achievements of this Project. It was proposed to be achieved through holding of this Symposium in Lahore (Pakistan) during June,1979. The main Symposium objectives were to:-

i) Disseminate the canal data obtained by ACOP,

ii) Present the results of interim analysis, and

iii) Review the scope of research conducted thus far and

   a. Suggest additional experimentation, if warranted, to take the Project to satisfactory conclusion.

   b. Provide guidelines for the follow-up scientific activi-

September

ties to make use of data base provided by ACOP.

CONDUCTION

The total Symposium activity was extended over the period June 24 - July 1, 1979. This included pre-Symposium (June 24 and 25) registration, briefing and field trip to ACOP observations on QB Link near Chuharkana; technical proceedings (June 26 - 29) at Lahore; and post-Symposium field trip (June 30-July 1) to Mangla and Tarbela Dam Projects of WAPDA.

The Symposium was formally inaugrated on June 26 by Air Marshal Inam-ul-Haq Khan HJ, HI (M), Minister of Water and Power, Government of Pakistan. It was attended by 180 eminent engineers/professionals / scientists from Pakistan and abroad, its salient features are brought out in the following.

To set the stage for the Symposium, four Keynote addresses on the state of art' were presented by eminent scientists and engineers on the following topics:-

i) Role of Regime Concept in the Design of Alluvial Channels in the Indus Basin

ii) Measurement Techniques in Alluvial Channels

iii) Morphologic Processes in Alluvial Channels

iv) Stabilization of Alluvial Channels.

Eighteen papers dealing with data, evaluation results, instrumentation and methods of analysis were presented in the Symposium. These papers briefly summarized the interim research results obtained from ACOP and the associated work conducted at the collaborating agency (initially Colorado State University and now George Washington University). The presentations were made by Pakistan (ACOP) and US(GWU) groups who had actually conducted the research and covered:-

i) Behaviour of Alluvial Canals

ii) Water and Sediment Quality

iii) Measurement Procedures

iv) Research Planning and Instrumentation

v) Dynamics of Sand Bed Canals

vi) Resistance and Transport Functions in Sand Bed Channels

In between the technical sessions were held the panel discussions to consider the 'state-of-the-art' regarding the mechanics of alluvial channels, the contributions made by ACOP research, critique of the work already done and the direction of future research. There were five panel discussion sessions, in keeping with the framework of ACOP research, and covered:-

i) Overview of Regime Theory Concept

ii) Future needs, methodology and instrumentation in alluvial channels research

iii) Morphologic, hydraulic and sediment transport relations in alluvial channels

iv) Channel stability and stabilization of alluvial channels

v) ACOP - review and future direction

Copies of all addresses and technical papers were circulated amongst the participants, while the full panel and paper discussions recorded. After editing and incorporation of the relevant discussions, it was proposed to publish later on the complete Symposium proceedings.

OUTCOME

Symposium deliberations proceeded in accordance with its basic objectives and resulted in outcome as highlighted hereinafter.

ACOP DATA

It was recognised that ACOP data from selected sand bed canals of Pakistan - covering discharge range of 2,000 to 22,000 cfs - was unique. Its analysis/evaluation could significantly help in advancement of the scientific knowledge, for which purpose:-

i) ACOP data should be expeditiously documented and published (on yearly basis (if possible) and given wide circulation for dissemination by the national/international research groups and workers in the subject area.

ii) Further 3 - 5 year data collection might continue (though with curtailed scope) to provide base line information for about a decade; due to very complex process involved in river mechanics, creation of that much data base could help in better understanding of the basic phenomena.

b. Hydraulic geometry relations for 'At Station' and 'Downstream' locations derived from ACOP data are a significant step forward in rationalisation of the regime equations. In time to come, these might assume the form of 'ACOP Equations' for design of regime channels.

INTERIM ANALYSIS RESULTS

i) Canal behavioural evaluation results did reflect an improvement over the previously adopted approaches. For instance :-

a. Gross phenomenological behaviour of Pakistan Link canals has paved the way for improved operation and maintenance procedures. This is evident from ready acceptance of ACOP recommendations by the concerned operating agencies of Provincial Irrigation Departments. (with enlarged data base their efficacy might increase further).

ii) Tracer (nascent and fluorescent coated) laboratory studies on bed sediments of Pakistan canals have been interesting. These should be persued to determine the cumulative effect of the changes in the sediment properties due to dyeing on the transport rates so that tracers could be used as a reliable vehicle to represent the behaviour of natural sediment.

iii) Hydraulic and Sediment measurement procedures being followed in ACOP were compatible with those being followed internationally. In respect of lab quality control, the method of 'check samples' of

known concentration/ distribution could be introduced. USGS had recently started this procedure and check samples of sand / fine material could be made available to ACOP.

iv) Strategy adopted by ACOP on the design and data collection methodology through individual goal oriented experiments seemed reasonable. However, the goals initially set by ACOP were somewhat ambitious (which was not unusual in research efforts of this type and magnitude) without full cognizance of the complexity of processes involved in the alluvial river mechanics. As such, ACOP should try to wrap-up those special studies whose interim results have been presented in the Symposium. This should be accomplished through additional data collection / evaluation efforts within the remaining or extended (if feasible) Project duration. The other studies could be persued as a part of the proposed 'Prototype Research on Alluvial Rivers'.

v) In respect of instrument developments, ACOP Pumping Sampler and Bed Shear Plate were significant. Efforts should now be concentrated on improvisation / field testing of the proposed 'Multi-port ACOP Pumping Sampler'. In addition, the Density Cell unsatisfactory results for laboratory measurement of sediment concentration should not discourage ACOP in giving the instrument a field trial on Pakistan canals.

vi) ACOP's interim results regarding 'Prediction of Bed Forms and Frictor Factors' if supported by additional data could provide a useful method for relating the bed form dimensions to the form resistance. Further, to improve its utility, three-dimensions (instead of the two-dimensions used in most of the work in this subject area) would have to be considered before a realistic model for relating the form resistance to the form dimensions could be developed.

vii) Verification of various

alternative sediment transport functions from ACOP data indicated that Colby and Modified Colby methods were the most suited for computing bed material load for given discharges in the range of ACOP canals. It was however, to be recognised that probable error in sediment discharge calculations could be 50 - 100%, even under most favourable circumstances. Thus selection of a particular alternative be based on checking calculated sediment discharge against any observed values of the channel under consideration or on similar ones.

ACOP REVIEW & FUTURE DIRECTION

Review:

i) Good quality data have been collected, which are of universal interest. However, to make better use of this data base by another 3 - 5 years with the scope limited to the essential minimum.

ii) The data should be expeditiously documented/ published and given wide circulation amongst national/international research agencies in the subject area. For this purpose, the data management through computerisation was the right approach and should be stepped up to issue the related reports and make them available to US National Technical Information Service (NTIS) and other interested agencies for dissemination.

September

iii) ACOP has tried to strike a good balance between the basic research needs of the sponsor (US National Science Foundation) and applied research needs of Pakistan. This is manifest in significant ACOP's contributions, such as:-

a. Reducing the existing gap between flume(lab) and prototype data with the object of increasing the understanding of various process in alluvial river mechanics.

b. Improved instrumentation developments in respect of sediment

sampling, bed shear, water surface slope and three dimensional bed form measurements.

c. Effective technology transfer between US and Pakistan groups through periodic short term assignments to the other country of the professionals, research associates and graduate students.

d. Providing basis for phenomenological behavioural evaluation of Pakistan canals to improve the existing canal design, operation and maintenance procedures.

e. Providing an outfit to Pakistan with highly dedicated and trained manpower in the field of hydrologic data collection and evaluation using the latest techniques. This was a definite asset to Pakistan in future investigations on canal monitoring, navigational and flood control studies as well as other water resource planning, development and management activities.

f. Showing the way to a successful and effective cooperative research effort between two countries about 10,000 miles apart on the globe.

iv) There have been some apparent failures in the Project which should be avoided in future. For instance:-

a. Four valuable lives were lost during field observations in Pakistan (better provision of safety equipment and implementation of procedures warranted).

b. Organisational set-up in Pakistan to handle the initial assignment, was apparently being phased out. Care should be taken to keep it in tact through gainful employment including financial inducement commensurate with the opportunities for professional advancement including foreign education/training.

c. The organisational set up in US was under-estimated in keeping with somewhat ambitious programme objectives, the time limitation and extent of the Project. For future, more care-

ful planning and implementation in this respect would be necessary.

d. While some robust instruments were improvised/developed by ACOP for successful field use, a number of sophisticated electronic and other gadgets miserably failed. Probably, the main reason behind this was that these instruments had been manufactured for the ideal laboratory conditions without much regard to quite different field conditions (specially in Pakistan).

Future Direction :

i) To derive full benefit from the investment already made, ACOP should continue for another 2 - 3 years beyond its present terminal date of December 1980. The work scope should, however, be limited to:-

a. Reduced data collection from the under-study canals to establish the essential data base for a period of about 10 years.

b. Filling the data gaps to refine the interim research results presented in the Symposium including study of the 3-dimensional bed forms.

c. Trying out the 'Tracer Method' of sediment concentration measurements on some small sized canals.

d. Persuing refinement/field testing of the instruments not yet perfected, such as Multiport Pumping Sampler and Density Cell.

e. Having a feel of the rivers by initiating ACOP type observations on representative (straight, meandering, braided) reaches on Nara Canal, which is basically a river with controlled water-sediment inputs from Sukkur Barrage.

ii) A separate 3 - 5 year proposal be drawn up for 'Prototype Research on Alluvial Rivers'. This should very carefully consider the logistic, instrumentation and related environmental problems of extremely fluctuating and very wide Indus Basin rivers, which are quite different from ACOP Canals. With this caution the work scope could cover:-

September

a. Base Line (ACOP type data collection on selection on selected typical river reaches.

b. Monitoring of water-sediment inflows - outflows in selected river reaches between two control points.

c. Modelling including verification of water-sediment inflows-outflows from small, medium and large sized river storage reservoirs.

d. Design, and construction and monitoring of river channel stabilisation structures by using local materials to evolve standards for cheap and effective works.

The foregoing deliberations of the Symposium were duly considered during the subsequent Project review by GWU/ACOP including evolution of further short and long term research strategies.

LIST OF PAPERS PRESENTED

1. ROLE OF REGIME CONCEPT IN THE DESIGN OF ALLUVIAL CHANNELS IN THE INDUS BASIN.
   Abdul Wahab P.Sheikh, Additional Chief Secretary, Irrigation & Power, Government of Sind.

2. BEHAVIOURAL EVALUATION OF SOME PAKISTAN CANALS.
   Riaz Nazir Tarar and Ahmad Masud Choudri.

3. HYDRAULIC GEOMETRY RELATIONS FOR SAND BED CANALS.
   Khalid Mahmood Ahmad Masud Choudhri and Rariq Masood.

4. REMODELLING OF ROHRI CANAL BASED ON ACOP DATA.
   B.A.Luna and S.N.H.Mashhadi.

5. WATER QUALITY IN SOME PAKISTAN CANALS.
   Maqbool Ahmed Malik and Haider Ali Shah.

6. PROPERTIES OF NASCENT AND FLUORESCENT COATED BED. SEDIMENTS FROM PAKISTAN CANALS.
   Sultan Ali Barque and Khalid Mahmood.

7. FLUVIAL SEDIMENT MEASUREMENT AND ANALYSIS PROCEDURES IN ALLUVIAL CHANNELS RESEARCH.
   Maqbool Ahmed Malik and Riaz Nazir Tarar.

8. PHYSICAL, CHEMICAL AND MINEROLOGICAL CHARACTERISTICS OF PAKISTAN CANALS.
   C.A. Majid and S.M.H.Zaidi.

9. MEASUREMENT TECHNIQUES IN ALLUVIAL CHANNELS.
   James K.Culbertson and Harold P.Guy.

10. HYDRAULIC MEASUREMENT PROCEDURES IN ALLUVIAL CHANNELS RESEARCH.

11. ERROR ANALYSIS OF ALLUVIAL CHANNEL MEASUREMENTS.
    Khalid Mahmood, M.M.Siddiqui and Tariq Masood

12. DATA MANAGEMENT IN ALLUVIAL CHANNELS OBSERVATION PROJECT.
    Tariq Masood and Maqbool Ahmed Malik.

13. DESIGN OF RESEARCH STRATEGY IN ACOP.
K.Mahmood and R.N.Tarar.

14. DEVELOPMENT OF INSTRUMENTS IN ACOP.
Ahmed Masud Choudri and Haibat Khan.

15. LOW FREQUENCY PULSATIONS IN CONCENTRATION AND VELOCITY MEASUREMENTS.
K.Mahmood, G.L.Eyster and T.M.Niaz.

16. STUDY OF A DENSITY CELL TO MEASURE SEDIMENT CONCENTRATION.
K.Mahmood and T.M.Niaz.

17. MORPHOLOGIC PROCESSES IN ALLUVIAL CHANNELS.
J.F.Kennedy.

18. MEANDERING THALWEGS IN STRAIGHT SAND BED CANALS.
K.Mahmood and S.A.Hassan.

19. DYNAMICS OF FLOW IN SAND BED CANAL BENDS.
S.L. Naas and K.Mahmood.

20. PREDICTION OF BED FORMS AND FRICTION FACTORS IN ACOP CANALS.
K.Mahmood, S.A.Hassan and P.H.Nasseri.

21. VERIFICATION OF SEDIMENT TRANSPORT FUNCTIONS ON ALLUVIAL CHANNEL DATA.
K.Mahmood, W.G.Dorough and R.N.Tarar.

22. STABLIZATION OF ALLUVIAL CHANNELS.
Howard E. Christian.

September

NEWS AND NOTES

Modular bricks for Govt.buildings in Lahore

The Government of Punjab through P&D Board has directed all Engineering Departments dealing with building construction to adopt Modular bricks in Lahore. The size was introduced by Building Research Station in 1962-63. The new bricks have an actual size of 7-5/8"x3-5/8x3-5/8 as against traditional bricks having size of 9"x4-3/8x2-11/16.

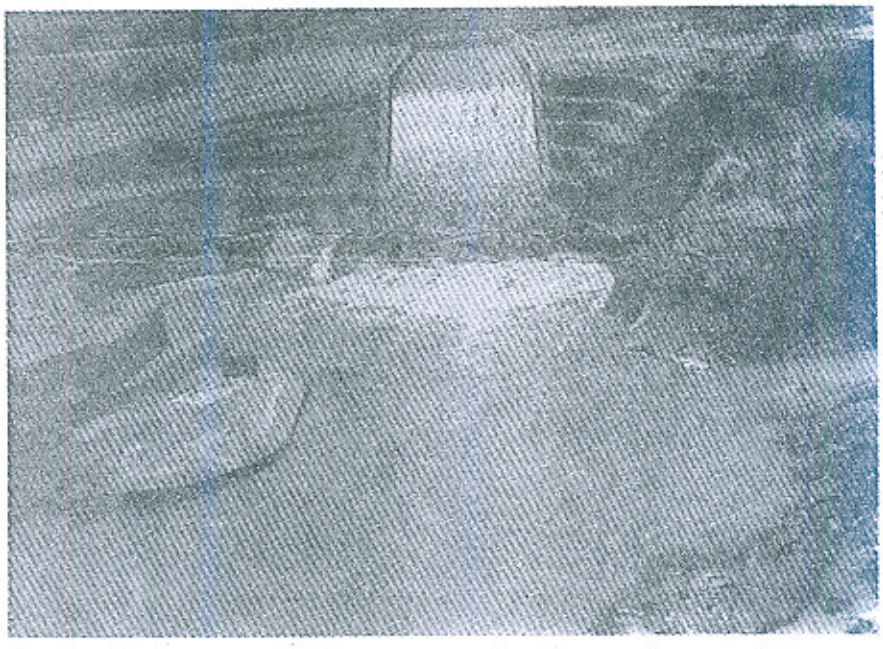
Particulars	Traditional bricks	Modular bricks	Advantages of new size.
. Actual size (ins)	$9 \times 4\frac{3}{8} \times 2\frac{11}{16}$	$7\frac{5}{8} \times 3\frac{5}{8} \times 3\frac{5}{8}$	Can be placed to face any side
. Nominal size with mortar joint (ins)	$9\frac{1}{4} \times 4\frac{5}{8} \times 3$	8 x 4 x 4	
. Volume(cu.in)	103	95	Lighter in weight.
. Courses per ft.height.	4	3	Less courses to reach a given height.
. Cu.ft.mortar per 100 sft.wall:			
-do- ½ brick	6.2	5.1)	Less mortar
-do-1 brick	14.6	13.1)	will be
-do-1½ brick	24.0	21.6)	required.
. Bricks per 100 cft.normal masonry	1387	1350	
. Bricks per 100 sft. wall:			
-do- ½ brick	520	459)	Less bricks
-do- 1 brick	1040	909)	will be
-do- 1½ brick	1560	1350)	required.

Particulars	Traditional bricks	Modular bricks	Advantages of new size.
8. Bricks per 100 sft. floor (on edge)	520	450	Less bricks required.
9. Bricks loaded in kiln section 27 ft.wide 54 ft. long and 7 ft. deep.	67068	76560	More bricks would mean less fuel for modular size.

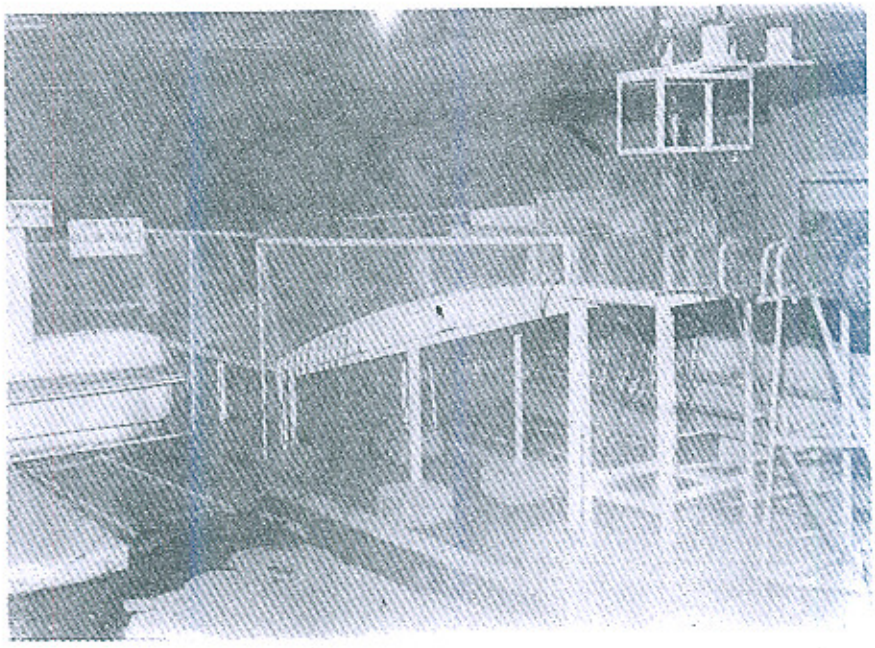
This size was supported by Royal Institute of British Architects, the International Modular Group and British Ceramic Society. The new size has tremendous advantages over the traditional size as per detailed comparison given above. The requirements of bricks and mortar will be reduced by the use of Modular bricks.

The study on the new size was carried out by Mr. Ashfaq Hasan during 1963-66 in his capacity as Director Building Research Station Lahore. The size was recommended by the International Seminar convened by United Nations (ECAFE) held in Bangkok in 1968 for adoption by all the developing countries.

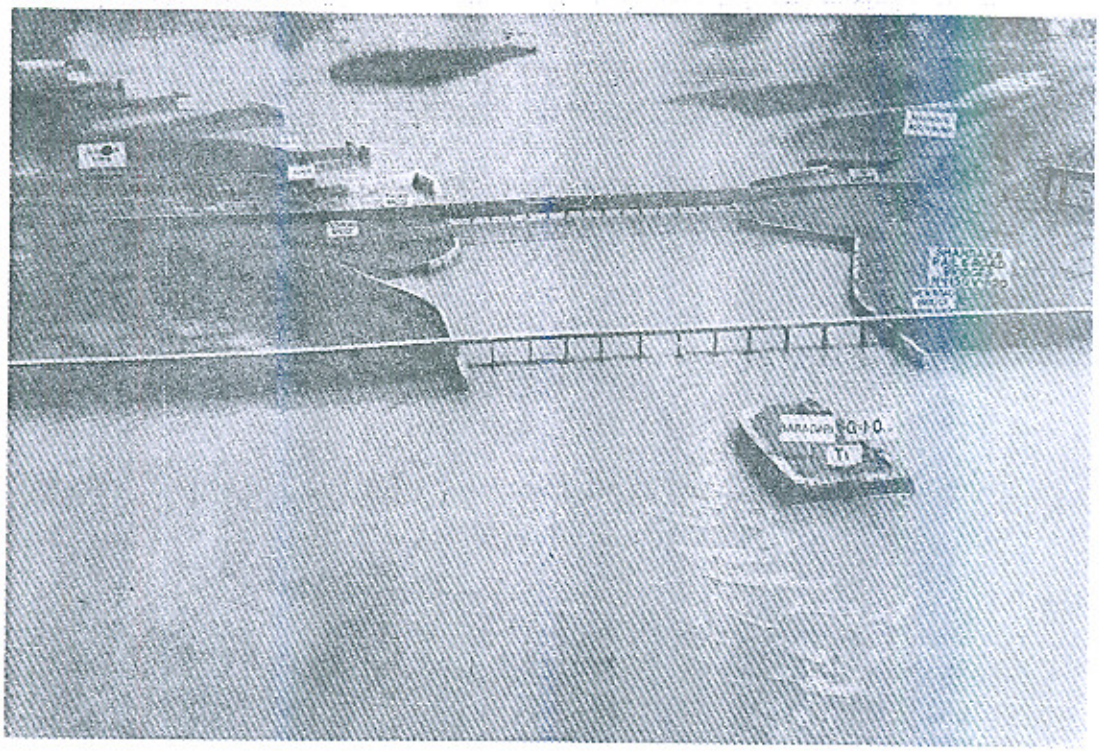
NEWS IN PICTURES



Tarbela Dam - Plunge Pool of Service Spillway Model as under experimentation at Hydraulics Research Station Nandipur - Showing IRI Proposed Spur on the Right Side of the Spillway.



Tarbela Dam - Tunnel-3 - The model as constructed in Lahore Hydraulic Laboratory - Showing Pressure Piezometers.



Shahdra Rail and Road Bridges - Ravi River -
Model Study at Hydraulics Research Station Nandipur
Showing the effect of 'Baradari' on the flow of river.

— All Communication should be addressed to the Chief Editor, Engineering News, P.W.D, Secretariate, Lahore, Pakistan.

— Contribution to this journal in the form of technical articles, news about engineers, engineering works research projects with photographs etc are cordially invited.

— When quoting from this journal, please specify volume number, date and author's name.

— Pakistan Engineering Congress is not responsible for any statements made or opinions expressed in this journal.

— Advertisement rates: by arrangement with the Editor.