SEPTEMBER 1991

Engineering News

A QUARTERLY JOURNAL OF THE PAKISTAN ENGINEERING CONGRESS



ON ROAD TO NATIONAL SELF RELIANCE

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THIRTY FIFTH YEAR OF PUBLICATION
ENGINEERING NEWS
Quarterly Journal of the Pakistan Engineering Congress
Vol. XXXV September 1991 No. 1 , 2 & 3

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NATIONAL SELF-RELIANCE

The present Government has met national aspirations by adopting the course of national self-reliance in economic policies. This was a long over-due need in line with the principles adopted by the Father of the nation while founding the country. Unfortunately, the policies followed by our planners in the past have left us far behind other nations which have progressed much more than us in a smaller span of time. China, South Korea are notable examples. Major factors responsible for this situation can be summed up in the following;

Scientific & technological base in the country was not allowed to develop under a colonially inherited generalist bureaucracy. No R&D was institutionalised. Scientific & Engineering manpower was not allowed to play its role.

Wrong economic priorities were drawn allowing only turnkey transfer of technology in areas of consumer goods. Heavy engineering industry was hardly allowed to develop.

Emphasis has been on indiscriminate foreign loans.

Local industrial potential was not fully developed.

The newly announced resolve of self-reliance can succeed if the following is effectively organised:-

a) The administrative structure responsible for implementing the new package must be professionalised so as to be capable to achieve the desired results.

b) Till the system is reorganised, policies implementation should not be left to the old steriotyped administrative set up not designed to handle new ideas.

We hope that Mr. Muhammad Nawaz Sharif, the Prime Minister with new ideas and energy, would be able to really achieve the national goals of self reliance in some meaningful measure.

Estimation of SCS Curve numbers and Rational method coefficients for Urban drainage

*Mahmood Hussain Raja.

INTRODUCTION.

Historically, the rational formula has been the most widely Used U.S. method for estimating the peak discharges for inlet and storm drainage design on small watersheds. The basic input requirements include the drainage area, a rainfall intensity for the design return period and runoff coefficient, (C). As it is usually applied, the rainfall intessity is for a storm duration equal to the time of concentration, which is dependent on a number of factors including the land use, the watershed slope, and the hydraulic length to inlet.

The runoff coefficient is typically obtained from a table as function of land use, with the table providing a range of values for each land use. While not widely used, tables of recommended C values exist that allow for variation in C with respect to soil type, rainfall intensity, slope design frequency, and amount of surface runoff. When a range of values is given for a particular land use. It is assumed the larger values of the runoff coefficient should be used for the larger events (i.e., return periods greater than 25 years) and steeper slopes. however, the tables often lack sufficient detail on exactly what value should be used in any given case.

For design applications where a complete runoff hydrograph must be developed, U.S. Soil conservation Service (SCS) methods have often been used as an alternative to the rational method.

The typical SCS approach requires the estimation of excess precipitation, using the curve number (CN) method, and the application of a unit hydrograph to convert the excess precipitation into a direct runoff hydrograph.

For this procedure, input includes the drainage area, precipitation depth for the design return period, the runoff curve number, and the time of concentration. The runoff curve number is an index of runoff potential and is a function of the soil type and land use, the soil cover complex and condition, and the antecedent soil moisture is usually assumed to represent "average" conditions (neither excessively wet nor dry).

In general it is evident that the two methods, the rational formula and the SCS procedures, are based on the same input data: drainage area, precipitation, the time of concentration, and a runoff index. However, the literature contains little guidance for relating the two approaches in manner that would yield consistent results when comparing the peak discharges calculated by each method.

UNIT HYDROGRAPH

The unit hydrograph method is a "black box" technique which does not directly depend upon physical laws but rather on an observed response function (i.e, unit hydrograph). For locations with guaged rainfall and runoff data unit hydrograph of direct runoff by simply adjusting the ordinates proportionaley so that the volume of direct runoff represents one basin inch of excess rainfall. Unfortunately, a unit hydrograph that is derived from another storm may not be the same as that derived from another storm. So a number of uit hydrographs with similar storm durations are derived and averaged, with the result assumed to be the representative basin unit hydrograph for that duration. Two separate approaches are

* Deputy Director Engineering, Lahore Development Authority

sicussed in this study. These are based on the assumption of a linear runoff response to a uniformly distributed rainfall (Consistent with the underlying rational method assumptions).

TRIANGULAR RUNOFF HYDROGRAPHS

The excess precipitation, Q, (4) can be expressed as:

$$Q = \frac{(P-Ia)^2}{(P-Ia)} + S \quad \text{for} \quad P > Ia \qquad (1)$$

The potential maximum retention, S, depends upon the soil type, the cover and cultivation practice, and upon the anticedent moisture conditions.

The initial abstraction (2, 3,) can be determined by the following equation:

$$Ia = 0.2S \qquad (2)$$

Based on the rational method assumptions (1) the direct runoff hydrograp resulting from uniform storm with a duration equal to the time of concentration, can be assumed to be triangular in shape. The linear rising limb reaches a peak flow at t_c, and the flow rate then recedes linearly to zero at some later time.

The resulting volume of runoff represented by this hydrograph can therefore be shown to be functionally related to the storm rainfall, p; the runoff coefficient, c; and the assumed time base of the runoff hydrograph.

Since the volumes of runoff and excess precipitation are equivalent, equations (1) and (2), which define excess precipitation as a function of curve number and P, can then be used to relate values of C and CN. This approach is illustrated below for two different assumptions of hydrograph time base: a recession limb equal to the rising limb, and a recession limb greater than the rising limb.

METHOD ONE: SYMMETRIC TRANGULAR HYDROGRAPH

ASSUMPTIONS

1. A storm with uniform intensity and a duration equal to the time of concentration, which produces a symmetric runoff hydrograph as shown in Figure 1.
2. Rising limb = recession limb = t_c.
3. Peak flow occurs at t_c.

The volume of runoff for this hydrograph may be determined from the following equation:

$$V = \frac{1}{2}\left(2t^c\right) q_p = t_c\, q_p \qquad (3)$$

The value of q (peak runoff per unit area) is defined as:

$$q_p = ci \qquad (4)$$

and the total depth of precipitation, P, for this storm is given by:

$$P = i\, t_c \qquad (5)$$

Therefore, by substitution, the volume of runoff can be related to P and c by:

$$V_R = PC \qquad (6)$$

Since this volume is equivalent to - excess precipitation, equation (1) yields:

$$\frac{(P-.2S)^2}{(P+.8S)} = PC, \quad \text{or}$$

$$C = \frac{(P-.2S)^2}{P(P+.8S)} \quad \text{for} \quad P \geq .2S \qquad (7)$$

With S related to CN by Equation (2), the above equation can be used to destermine values of C, for a specific CN value and a range of P values. These results are presented graphically in the subsequent sections.

2. METHOD TWO: ASYMMETRIC TRAIANGULAR HYDROGRAPH

ASSUMPTIONS

1. A storm with uniform intensity, with a duration equal to time of concentration.
2. A recession limb equal to W times the rising limb, which produces an

asymmetric triangular hydrograph as shown in Figure 2.

3. Peak flow occurs at t_c.

With these assumptions, the volume of runoff can now be defined as;

$$V = \tfrac{1}{2} q_p (1 + w) t_c \qquad (8)$$

By using equations (4) and (5) as before, the runoff volume is:

$$V = \frac{(1+w)\, CP}{2} \qquad (9)$$

and, with equation (1):

$$C = \frac{2\,(P-.2S)^2}{(1+w)\,P\,(P+.8S)} \quad \text{for} \quad P \geqslant .2S \qquad (10)$$

Since a typically used value for the time base of the hydrograph is in the order of 2.5 times the rising limb duration, W then equals 1.5, and:

$$C = \frac{(P-.2S)^2}{1.25\,P\,(P+.8S)} \quad \text{for} \quad P \geqslant .2S \qquad (11)$$

Again, the results of this equation used in conjunction with Equation (2) are presented in the following sections.

RESULTS AND DISCUSSION

Using equations (7) and (11), coupled with Equation 2, tables were prepared showing the variation in C-values as a function of selected values of curve numbers and storm precipitation depth. Table 1 and 2, respectively, show these results for the symmetric and asymmetric triangular hydrographs, with figures 3 and 4 presenting the corresponding graphs of the tabular values.

Functionally, both methods depict similar relationships among values of C, CN, and precipitation. Where total depth of precipitation, P, is less than 0.2 S, there is no runoff and hence the value of c is zero. As the value of CN approaches 100, the resulting C-values increase and approach a maximum value of 1.0 for the symmetric hydrograph, and 0.80 for the asymmetric hydrograph.

As a common design practice, the maximum value of the curve number that is used for completely impervious areas is 98, to permit minor losses due to either interception or depression storage. With CN = 98, the figures indicate that the C-values for both methods are reasobable to the typical values that would probably be used for small impervious watersheds. With a total storm depth of 2 inches, the maximum value of C is 0.89 for the symmetric hydrograph, and 0.71 for the asymmetric hydrograph. For depth of 0.50 inches, these values drop to 0.64 and 0.51 respectively.

Therefore, with th simplistic approach assumed triangular runo hydrographs, it appears th peak flows from the triangul hydrograph method, especial for high curve numbers an rainfall depths can b estimated easily.

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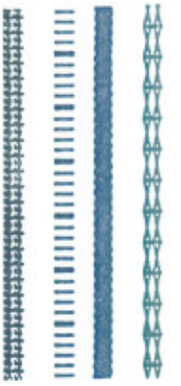


Table 1 Run off Coefficients for Triangular Hydrograph, with Recession Limb = Rising Limb

CN	100	98	95	90	85	80	75	70
Precip. (inches)					Runoff Coefficient			
0.166	1	0.291	0.038	0.000	0.000	0.000	0.000	0.000
0.250	1	0.427	0.125	0.004	0.000	0.000	0.000	0.000
0.330	1	0.515	0.204	0.029	0.000	0.000	0.000	0.000
0.375	1	0.554	0.244	0.049	0.001	0.000	0.000	0.000
0.400	1	0.573	0.265	0.061	0.003	0.000	0.000	0.000
0.420	1	0.586	0.280	0.071	0.006	0.000	0.000	0.000
0.500	1	0.636	0.338	0.111	0.023	0.000	0.000	0.000
0.600	1	0.683	0.400	0.16	0.051	0.006	0.000	0.000
0.750	1	0.734	0.473	0.227	0.097	0.030	0.003	0.000
0.800	1	0.784	0.494	0.247	0.113	0.040	0.006	0.000
0.875	1	0.767	0.522	0.276	0.136	0.056	0.014	0.000
1.000	1	0.791	0.563	0.320	0.174	0.083	0.030	0.005
1.200	1	0.821	0.616	0.381	0.229	0.128	0.061	0.021
1.250	1	0.828	0.627	0.395	0.242	0.138	0.070	0.026
1.400	1	0.844	0.658	0.433	0.279	0.170	0.094	0.044
1.500	1	0.854	0.675	0.456	0.301	0.190	0.111	0.056
1.600	1	0.862	0.691	0.477	0.323	0.210	0.128	0.069
2.000	1	0.887	0.741	0.547	0.398	0.281	0.191	0.120
S*	0	0.204	0.526	1.111	1.765	2.500	3.330	4.286

* S is potential maximum retention

Table 2 Run off Coefficients for Triangular Hydrograph, with Recession Limb = 1.5 X Rising Limb

CN	100	98	95	90	85	80	75	70
Precip. (inches)					Runoff Coefficient			
0.166	0.8	0.229	0.030	0.000	0.000	0.000	0.000	0.000
0.250	0.8	0.339	0.100	0.002	0.000	0.000	0.000	0.000
0.330	0.8	0.441	0.163	0.023	0.000	0.000	0.000	0.000
0.375	0.8	0.443	0.195	0.039	0.001	0.000	0.000	0.000
0.400	0.8	0.458	0.212	0.049	0.002	0.000	0.000	0.000
0.420	0.8	0.470	0.225	0.057	0.005	0.000	0.000	0.000
0.500	0.8	0.509	0.271	0.089	0.018	0.000	0.000	0.000
0.600	0.8	0.546	0.320	0.128	0.040	0.005	0.000	0.000
0.750	0.8	0.587	0.379	0.181	0.078	0.024	0.002	0.000
0.800	0.8	0.598	0.395	0.198	0.090	0.032	0.005	0.000
0.875	0.8	0.613	0.418	0.221	0.110	0.045	0.011	0.000
1.000	0.8	0.633	0.451	0.256	0.139	0.067	0.024	0.004
1.200	0.8	0.657	0.493	0.306	0.183	0.102	0.049	0.017
1.250	0.8	0.662	0.502	0.316	0.193	0.111	0.056	0.021
1.400	0.8	0 675	0.526	0.346	0.223	0.136	0.076	0.035
1.500	0.8	0.683	0.540	0.365	0.241	0.152	0.089	0.045
1.600	0.8	0.689	0.553	0.381	0.258	0.168	0.102	0.055
2.000	0.8	0.710	0.593	0.438	0.318	0.225	0.152	0.096
S*	0.0	0.204	0.526	1.111	1.765	2.500	3.330	4.286

* S is potential maximum retention

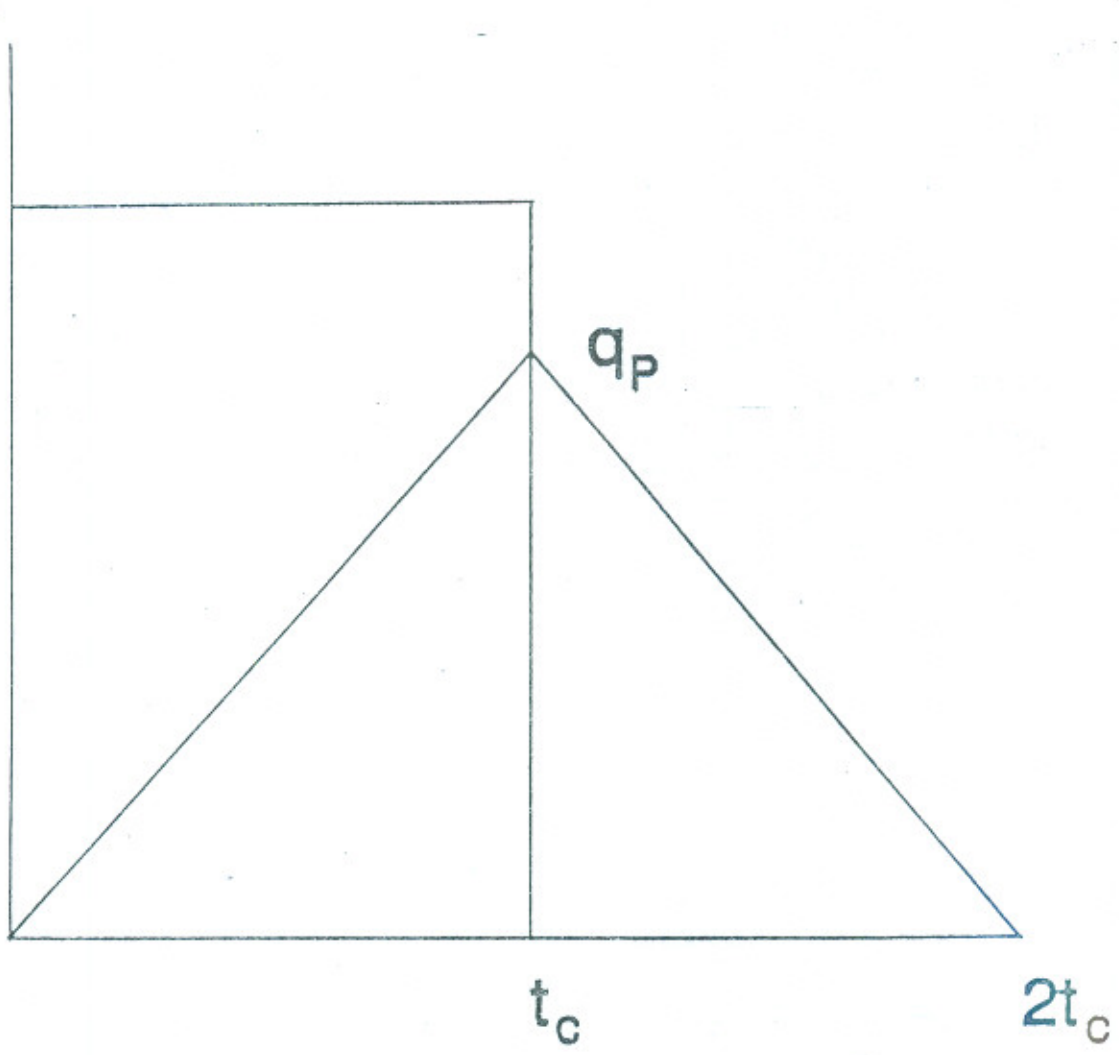


FIGURE 1 STORM WITH UNIFORM INTENSITY LASTING FOR t_c TO PRODUCE A SYMMETRIC TRIANGULAR DIRECT RUNOFF HYDROGRAPH

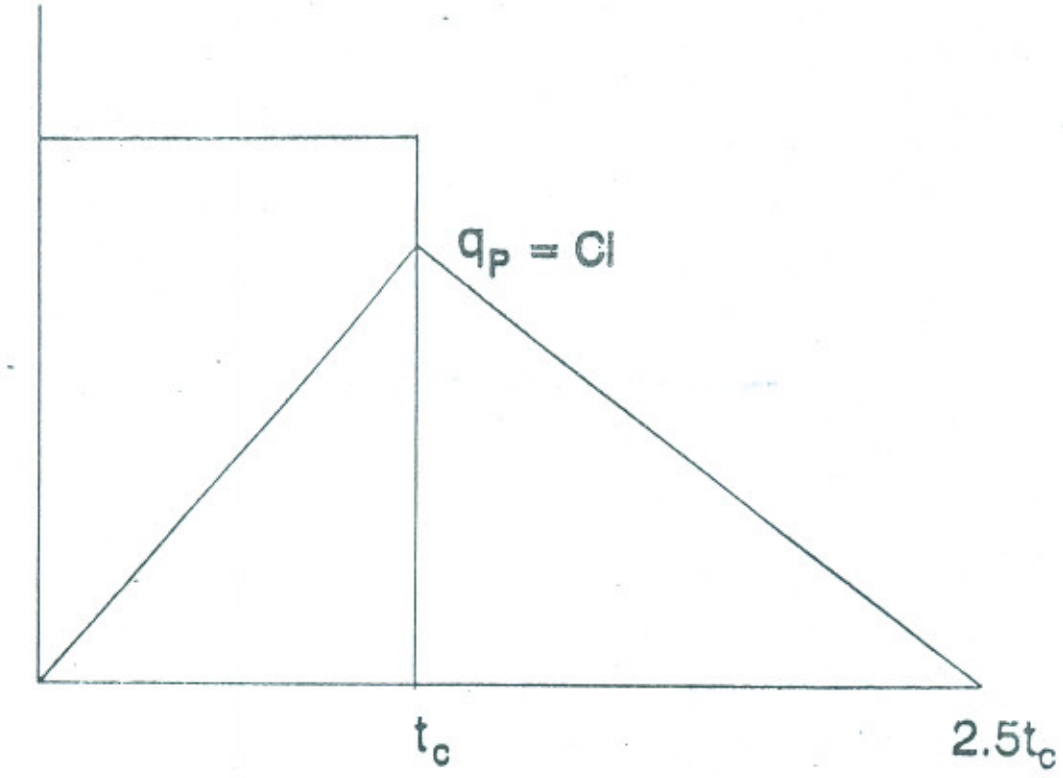


FIGURE 2 ASYMMETRIC TRIANGULAR DIRECT RUNOFF HYDROGRAPH

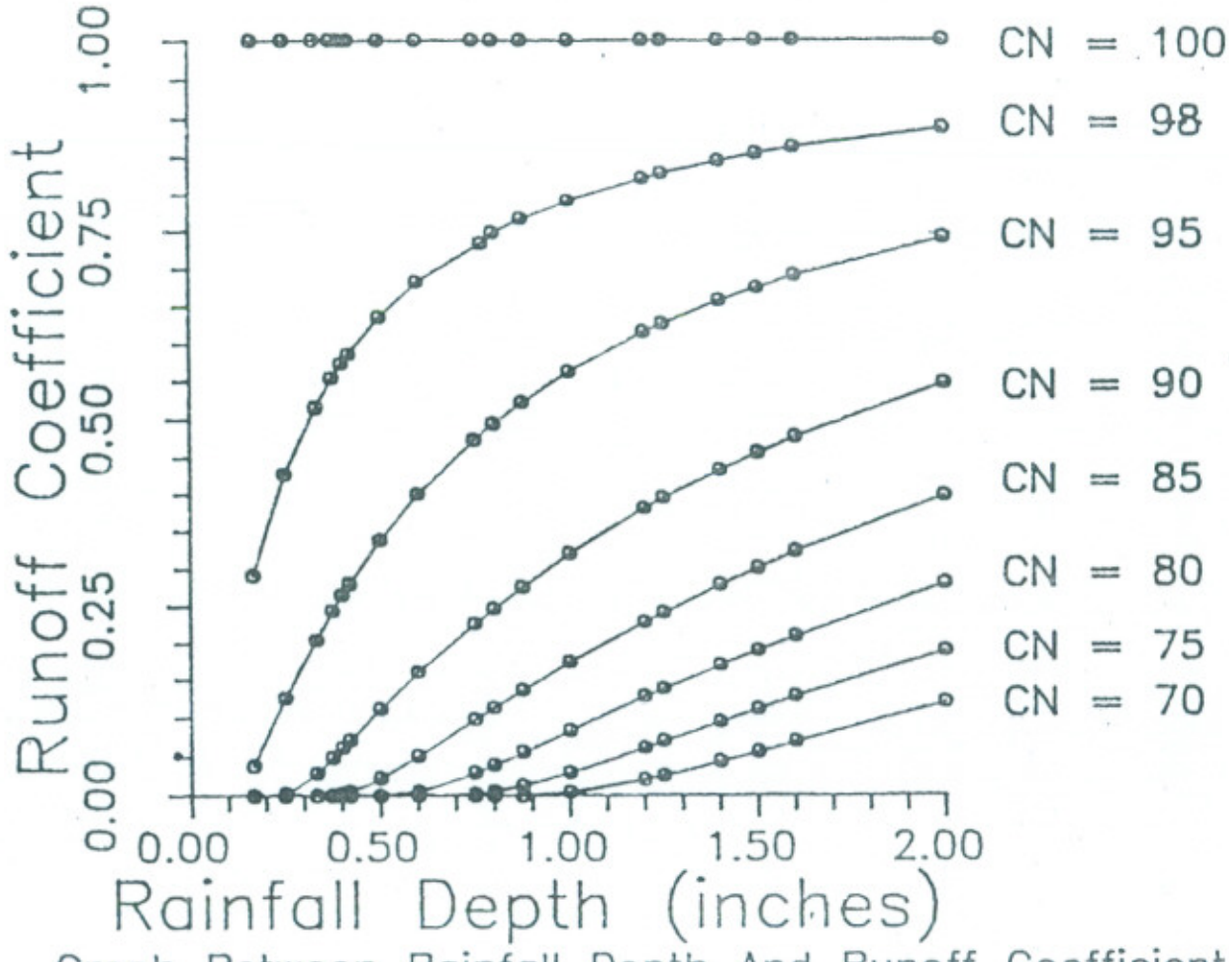


Figure 3 Graph Between Rainfall Depth And Runoff Coefficient When Rising Limb = Recession limb

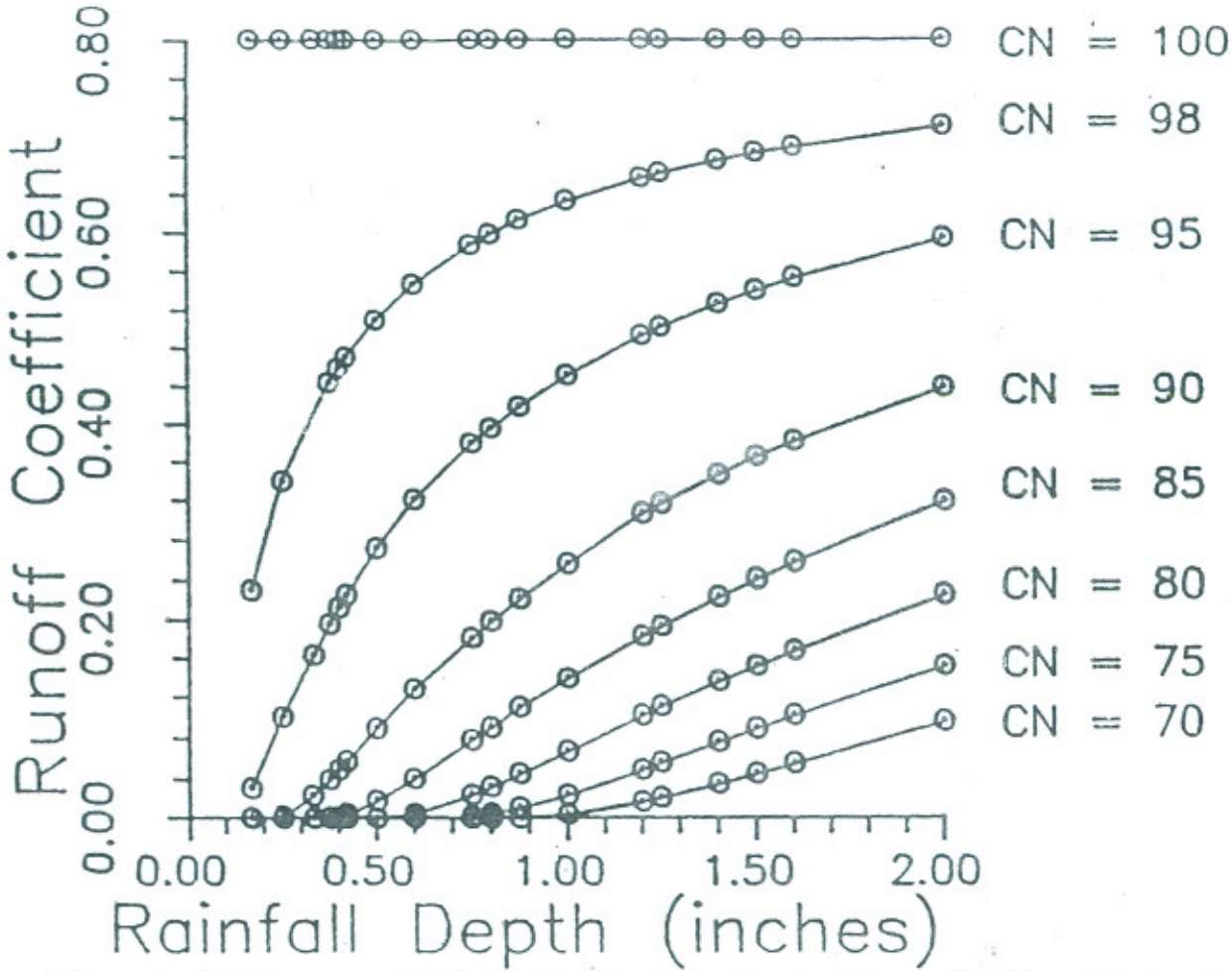


Figure 4 Graph Between Rainfall Depth And Runoff Coefficient When Recession Limb = 1.5 x Rising Limb

EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENTS OF SUNFLOWER UNDER DIFFERENT WATER TABLE CONDITIONS

By Ch. Talib Ai & Zia-ul-Haque

INTRODUCTION

Water is an essential resource in supporting our food and fibre and its demands for Agricultural Production, are rapidly increasing. On the other hand water resources are limited in terms of quantity, quality and occurrence. Water resources management is therefore, the need of the hour for intensive utilization of relatively fixed water supplies.

Many factors influence the amount of water consumed by Plants. The more important natural influences are climate, water supplier, soil and topography. The climatic factors believed to have the greatest effect on consumptive use on which data are generally available are temperature, precipitation, humidity, wind movement and growing season. Irrigation practices as well as kind of crops grown, their stage of growth and species, also influence the amount of water consumed.

Agriculture is the largest and most important single sector of Pakistan's economy. It currently accounts for about 31 percent of the gross domestic product (GDP). Agricultural exports generate about 70 percent of the total foreign exchange earnings and some 72 percent of the total population (60 million people) is rural. Due to the arid conditions Agricultural production in Pakistan is mainly dependent on irrigation with the irrigated area accounting for 90 percent of the total agricultural production.

In view of the importance of the irrigated agriculture in the economy of Pakistan the available water resources have to be employed for irrigation. Other uses of water represent an insignificant demand. Apart from the development of the water resources for irrigation use its management is also important in view of the wide extent of the waterlogging and salinity in the irrigated areas and due to the demaging effects of floods in the rivers.

Precise knowledge about evapotranspiration and irrigation requirements of different crops in a certain area with respect to water tabel condition, is vital for efficient utilization of available surface and ground water resources. The area having shallow water table depth i.e less than 3m are under a constant threat of developing waterlogging and salinity and special remedial measures are needed to keep them fit for sustained crop production. Scientific Information about the hehavior of soil moisture movement between soil surface and Water Table is thus easential to suggest precautionary measures to overcome most of the problems associated with shallow Water Table environments.

Shallow water table influences surface irrigation requirement of a crop considerably due to water consumption from the water table by the crop. The knowledge about ground water contribution and irrigation requirements of different crops with respect to different water table depths is important for vigilant and efficient utilization of available surface and ground water resources.

In Pakistan availability of water for irrigation at the right time and in adequate quantity is the principal constraints, Surface water sources have almost been harnessed totally and still the optimum water requirements of the present area under cultivation were not

being met frequently. Since surface sources could not be expanded, only two avenues of effort were open (i) To stretch out available supplies by exercising maximum economy in the use of water without effecting adversaly the crop yields and (ii) To learn the techniques of using marginal and even saline waters from ground water sources and to develop salt resistant crops. In both areas a great deal of research was needed which could neither be neglected nor postponed. Research was required in controlled conditions in which each in-put could be regulated and the results monitored and interpreted. The Lysimeter was the best Laboratory in which such research could be carried out.

In this paper, the results of a study on Sunflower crop have been presented which was conducted in Lysimeters of PCRWR. The main objectives of this study were to determine:-

(i) Irrigation requirements and evapotranspiration losses of Sunflower with respect to different water table depths ranging from 0.3 to 3.0m with 0.3m interval.

(ii) Moisture up take by sunflower from-Various static water tables as mentioned above.

(iii) Effect of different water table depths on redistribution of salts.

(iv) Effect of different water table depths on growth and Yield parameters of the crop.

It may however be mentioned that the data provided by the Lysimeteric studies formed the basis for th construction of SCARP projects, constructed at a very heavy cost throughout Pakistan. Secondily it had greatly helped the planners for calculating water requirements of various crops in various regions with different water table depths. In short, these studies had been of great help for planning of various projects pertaining to irrigated agriculture in the country providing data on irrigation scheduling, ground water contribution and the deep percolation losses under varying conditions of soil and water table depth.

MATERIALS AND METHODS

The experiment was conducted during March-June 1986 in Lysimeters of PCRWR situated in the Directorate of Land Reclamation Punjab, Lahore. These Lysimeters are of the size 3.05 x 3.05 m^2 at the surface and 6.1 m deep, which were equipped with well tested tensiosmeters for in situ measurement of soil moisture tension at desired depth. Soil sampling was avoided as far as possible to keep the soil profile undisturbed.

Watertables in these Lysimeters were maintained from 0.3 meter to 3.0 meter with 0.3 meter interval during the growth period of the crop.

Ground water contribution was estimated through measurement of in take of water by the Lysimeter to keep its watertable at static level. For this purpose one calibrated mariotte bottle was attached to each Lysimeter as shown in Fig. 1. Daily losses from these bottles were recorded which were finally used for the computation of periodic sub-irrigation.

Deep percolation losses under each water table condition were measured with the help of a simple automatic arrangement fitted with each Lysimeter as shown in Fig.1. The same amount of water as deep percolation discharged out through the provided opening to keep the water table at static level. the water thus running out was collected in a drum attached to each Lysimeter from where it was measured.

The crop in each Lysimeter was generally

irrigated as and when the soil moisture tension in the root zone approached 60-65 cb. However, in the initial stages of crop growth, one irrigation was given irrespective of the soil moisture tension for the application of second doze of urea fertilizer.

The effect of different water tables on re-distribution of salts was studied by taking soil samples form various depths before sowing and after harvesting the crop. These samples were analyzed in the laboratory to compare salt contents before sowing and and after harvesting the crop. These data finally helped to determine the influence of each water table on salt redistribution in the root zone.

The metrological data were regularly collected at the site using standard instruments. These data included maximum and minmum temperature, relative humidity (%), wind speed, pan ovaporation and rain fall etc.

A pre-irrigation of 7.62 cm depth was applied on February 28, 1986 in all the Lysimeters. After attaining field capacity the seed bed was prepared by ploughing and alternate planking. chemical fertilizers in the form of Urea, DAP, and Potassium @90,84 and 65 kg/ha (NPK) respectively were spplied at the sowing time. These fertilizers were broadcasted and thoroughly mixed in the soil. The second doze of urea fertilizer was applied along with first irrigation @ 56 kg/ha of N.

Sunflower (Cargil-204 Variety) was sown in lines 75 cm apart on March 3, 1986 at the rate of 3 seeds per hill. Plant to plant distance in each row was 25 cm.

The plants started emerging out after about seven days. Thining was done before first irrigation. Plant population in this experiment was 65 plants per Lysimeters (50000 plants/ha).

There were two big hives of honey bees in the experimental area which facilitated the cross pollination. Therefore artifical cross pollination was not needed. Necessary agronomic data including plant height, leaf area, size of flower (diameter) etc. were regularly collected during crop growth period. The crop was finally harvested on 26th June 1986. The flowers after picking were hung in the sun to get them completely dried. Later on the seed was seperated & yields were carefully determined for each Lysimeter.

Evapotranspiration of the crop under each water table conditions was determined using water balance equation:

$$ET = I + S + R - D \neq \Delta SM$$

Where ET represents evapotranspirations and I, S, R, D and Δ SM denote irrigation, rainfall, drainage surplus and change in soil moistur storage respectively. Crop co-afficients have also been worked out using Blaney-Criddle and Pan Δ methods.

Surface Irrigation Requirements with Respect to Different Water Table Depths

Surface irrigation requirements of the Sunflower crop with respect to different water table depths have been shown in table 2. It is obvious from this table that the corp requred only 7.62 cm of surface irrigation under water table depths at 0.3 and 0.6 m. This irrigation was needed only for the application of second dose of urea fertilizer. It is evident from the table that with the deepening of water table, surface irrigation requirements gradually increase and attain the highest value of 53.96 cm at 3.05 m water table depth. This progressive increase in surface irrigation requirements of the crop with the deepening of water table can be explained on the basis of the fact that under shallow water table

conditions, ground water contribution to evapotranspiration demands of the crop is higher which consequently reduces the surface irrigation requirements of the crop.

Evapotranspiration

Various hydrologic parameters observed for the computation of evapotranspiration of Sunflower are given in table 2. The data reveal that evapotranspiration losses were the highest at 0.6, meter water table depth. ET slightly decresses with the deepening of water table and attain a minimum value at 1.83 m water table depth. With further lowering of water table there is again an incressing trend. This obervation can be explained on the basis of the fact that in case of shallower water table depth, the water contents in the top layers of the soil remain higher due to capillary activities causing higher evaporation and transpiration losses; whereas, in case of deeper water table, capillary action does not extend upto the soil surface restricting evaporation from the soil surface.

Ground Water Contribution

Ground water contributions in terms of % of total ET of the crop with respect to different water table conditions have been presented in table 3.

The data reveal that about 83% of the total water use is met with from ground water at 0.3 meter water table depths. Ground water contribution gradually decreased as water table is lowered. At 3.05 meter the ground contribution drops down to about 8% of total water requirements of the crop.

Monthly Et and Blancy Criddle Crop Water use Co-officients

Monthly Et of the crop with respect to different water table conditions has been presented in table 4. It is obvious from this table that in general Et was the lowest in March for each water table condition which continued increasing in April and May with the crop growth. In June Et value dropped down by about 60% because of maturity of the crop.

Monthly Blaney Criddle crop co-efficiente for Sunflower have been computed and presented in table 5. Monthly crop co-efficient was 0.48 in the month of March. It increased in the months of April and may attainings peak value of 1.55 in May. In June its value declined to 0.79.

Consumptive use Pan Evaporation Ratio

Monthly as well as seasonal consumptive use-pan evaporation ratios have been worked out & presented in table 6. The results indicate that the ratio ET/E was 0.83 in March. It increased to 1.10 and 1.51 in the month of April and May respectively whereas in June, it dropped down to 0.72. The seasonal ratio comes out to be 0.98 for this crop.

Salt Re-Distribution

The reults of re-distribution of salts have been displayed in fig. 2. It is evident from this figure that under higher water table conditions, there is more salt accumulation in the top layers. This is mainly due to upward movement of salts with upward flux of water. This situation can be controlled by flushing down the salts during some part of the year when surface water is abundantly available.

Crop Yield

The account of yield and yield contributing components of the crop have been embodied in tables 7 and 9. The yield measured about 23, 35 and 41 quintals/ha for water tables 0.30, o.60 and 0.91 meter respectively. For deep water table it gradually increased and attained the highest value being 50.54 quintals/ha at 2.13 meters. Beyond this depth yield was

stagnant without any further increase in the yield. This indicates that optimum water table depth for this crop is about 2 meters.

Effect of Water Table Depth on Quality of Sunflower.

To observe the effect of different water tables on quality of seed, seed samples collected from each Lysimeter were sent to PCSIR Laboratory for analysis. The results are presented in table 9. It is obvious from this table that the lowest oil % was about 30% at 0.3 meter water table depth whereas the highest value of about 45% was obtained at 0.91 meter water table depth. Rest of the values fluctuated between these two limits. Protein contents of the oil ranged between 17.4 to 28.5 without any specific trend.

RECOMMENDATIONS AND CONCLUSIONS

1. Sunflower can be grown successfully even under very shallow water table conditons i.e. less than 1 m if soil and water are of good quality.

2. Optimum water table depth for this crop is about 2m.

3. Accumulation of salts in the top layers occur under shallow water table conditions. Periodic flushing of salts is necessary to keep the land fit for sustained crop production.

Table - 1 Meteorological Data Observed During Crop Growth Period

Period	Air Temperature C° Max.	Min.	Mean	Relative Humidity (%)	Rain (cm)	Class A Pan Evaporation (cm)
1986						
March						
1-10	27.50	14.30	20.90	57.83	0,00	3.50
11-20	23.88	12.00	17.94	56.44	1.84	3.61
21-31	25.88	13.25	19.57	51.75	0.18	4.84
March	25.75	13.18	19.47	55.34	2.02	11.95
April						
1-10	29.88	17.73	22.33	45.11	0.00	5.18
11-20	32.88	18.75	25.82	44.00	0.03	6.54
21-30	33.33	19.67	26.50	45.78	1.26	6.332
April	32.03	17.73	24.88	44.96	1.29	18.04
May						
1-10	35.57	20.0	27.79	44.57	0.59	5.83
11-20	34.22	21.0	27.61	42.78	0.18	6.69
21-31	32.78	19.33	26.06	42.00	0.62	7.78
May	34.19	20.11	27.15	43.12	1.39	20.20
June						
1-10	33.67	21.0	27.34	388.83	0.47	7.23
11-20	42.38	27.75	35.07	47.88	0.00	8.99
21-30	38.44	26.44	32.44	69.00	5.50	7.13
June	38.16	25.06	31.61	51.57	5.97	23.35

Table - 2

HYDROLOGIC PARAMETERS OBSERVED
DURING CROP GROWTH PERIOD

Water Table Depth Ft.	M.	Irrigation (cm)	Sub-Irrigation (cm)	Rain Fall (cm)	SM (cm)	Drainage (cm)	E.T. (cm)
1.	0.3	7.62	69.05	10.67	1.63	5.73	83.24
2.	0.6	7.62	68.27	10.67	2.15	4.33	84.38
3.	0.91	12.70	57.86	10.67	2.85	4.54	79.54
4.	1.21	22.86	40.85	10.67	5.65	3.85	76.18
5.	1.52	22.86	36.84	10.67	7.22	3.23	74.36
6.	1.83	30.48	24.06	10.67	8.25	1.70	71.76
7.	2.13	38.10	19.02	10.67	7.17	1.06	73.90
8.	2.44	38.10	16.57	10.67	8.63	0.93	73.04
9.	2.74	45.72	8.41	10.67	8.25	0.69	72.36
10.	3.05	51.96	5.93	10.67	7.19	0.55	77.20

Table - 3
GROUND WATER CONTRIBUTION WITH RESPECT
TO DIFFERENT WATER TABLE DEPTHS

Water Table Depth Ft.	(m)	Et (cm)	Ground Water Contribution (cm)	% Ground Water Contribution
1.	0.3	83.24	69.05	82.95
2.	0.6	84.38	68.27	80.90
3.	0.91	79.54	57.86	72.74
4.	1.21	76.18	40.85	53.62
5.	1.52	74.36	36.84	49.54
6.	1.83	71.36	24.06	33.71
7.	2.13	73.90	19.02	25.74
8.	2.44	73.04	16.57	22.68
9.	2.74	72.36	8.41	11.62
10.	3.05	77.20	5.93	7.68

Table - 4

Monthly ET of Sunflower (cm)

Period			Water	Table	Depth		(F	E	E	T)
Month	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
March	7.35	6.19	5.03	4.91	4.62	4.62	4.62	4.62	4.62	4.62
April	22.87	22.67	22.36	21.07	20.31	19.16	19.90	20.17	19.86	21.62
May	31.89	33.89	32.76	31.61	30.51	29.37	31.07	30.23	30.65	32.24
June	21.13	22.63	19.39	18.59	18.92	18.61	18.31	18.02	17.23	18.69
	83.24	84.38	79.54	76.18	74.36	71.76	73.98	73.04	72.36	77.20

Table - 5

MONTHLY CONSUMPTIVE USE CO-EFFECIENTS FOR SUNFLOWER WITH BLANCY GRIDDLE METHOD.

Months	Mean Monthly Temperature F°	Sun shine (%)	Consumptive use Factor (inches)	Consumptive use (inches)	Corp Co-effi (K)
March	67.05	5.67	3.80	1.82	0.48
April	76.78	8.75	6.71	7.82	1.16
May	80.87	9.60	7.76	12.06	1.55
June	88.90	9.57	8.50	6.78	0.79

Table - 6

CONSUMPTIVE USE PAN EVAPORATION RATIO

Month	Monthly ET (cm)	Monthly (Pan Evaporation)E (cm)	ET/E
March	4.62	11.95	0.38
April	19.86	18.04	1.10
May	30.65	20.20	1.51
June	17.23	23.35	0.72
Seasonal	72.36	73.54	0.98

Table - 7

YIELD OF SUNFLOWER UNDER DIFFERENT WATER TABLE DEPTHS

Water Table Depth		Grain Yield	
(ft)	(m)	Per Lysimeter	Quaintal/ha
		3.05 x 3.05 m2	
1.	0.3	2.15	23.12
2.	0.6	3.30	35.48
3.	0.91	3.80	40.86
4.	1.21	4.20	45.16
5.	1.52	4.20	45.16
6.	1.83	4.40	47.31
7.	2.13	4.70	50.54
8.	2.44	4.70	50.54
9.	2.74	4.70	50.54
10	3.05	4.50	45.39

Table - 8

Seed Index of Sunflower
(Av. Weight of 100 seeds in gms)

Water Table Depth		
(ft)	(m)	Seed Index
1.	0.3	4.31
2.	0.6	4.10
3.	0.91	4.26
4.	1.21	3.90
5.	1.83	4.21
6.	1.83	4.19
7.	2.13	4.40
8.	2.44	4.39
9.	2.74	4.30
10.	3.05	4.10

Table - 9

QUALITY OF SEED UNDER DIFFERENT WATER TABLE CONDITIONS

Water Table Depth			
(ft)	(m)	% age of oil	Protein value %
1.	0.3	30.39	20.06
2.	0.6	41.73	28.44
3.	0.91	44.40	17.39
4.	1.21	41.37	19.22
5.	1.52	42.19	21.42
6.	1.83	40.62	20.56
7.	2.13	38.59	10.93
8.	2.44	40.94	28.52
9.	2.74	38.77	25.97
10.	3.05	37.45	24.85

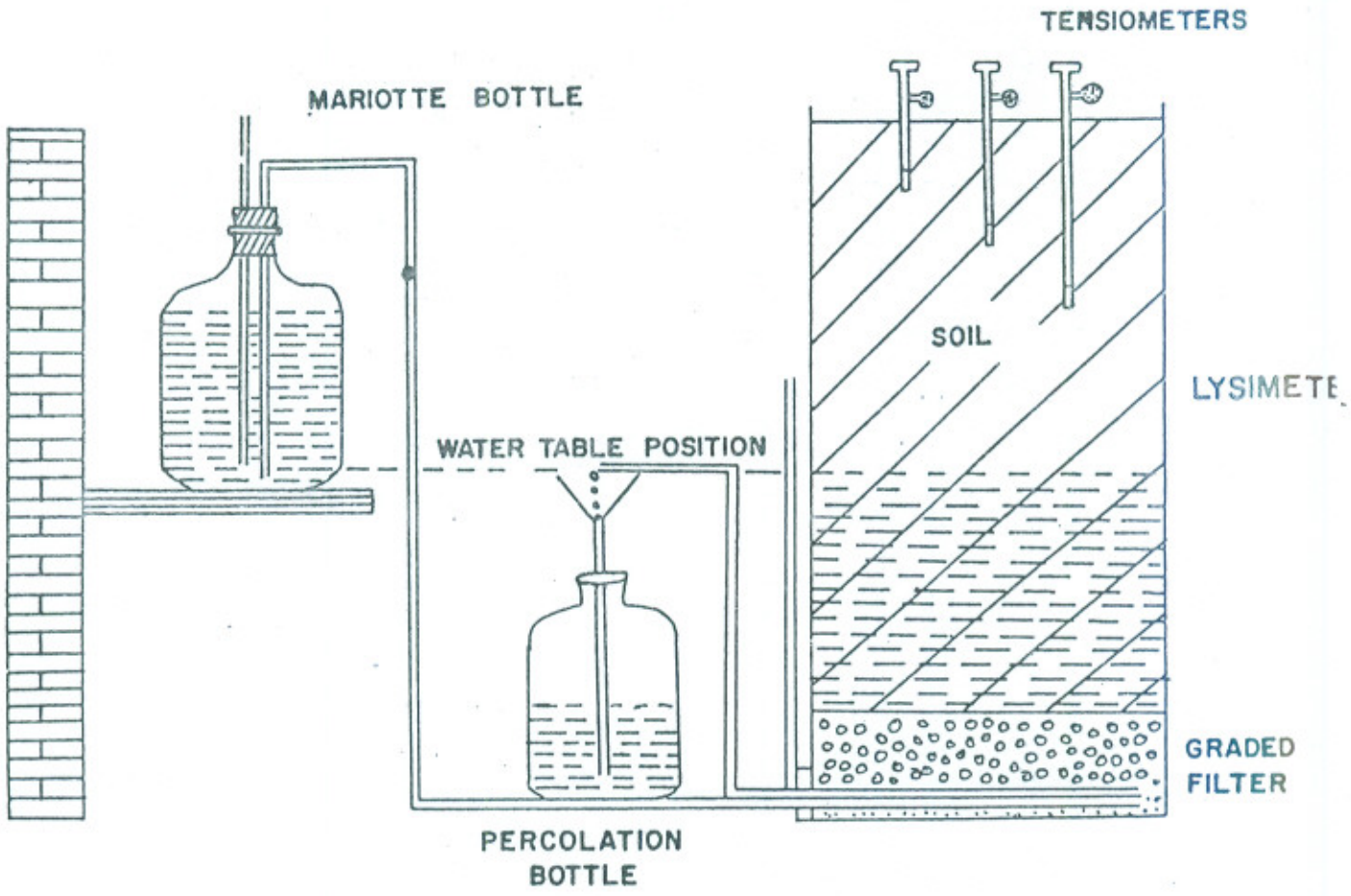


Fig.1 APPARATUS FOR THE MEASUREMENT OF SUB-IRRIGATION AND DRAINAGE SURPLUS.

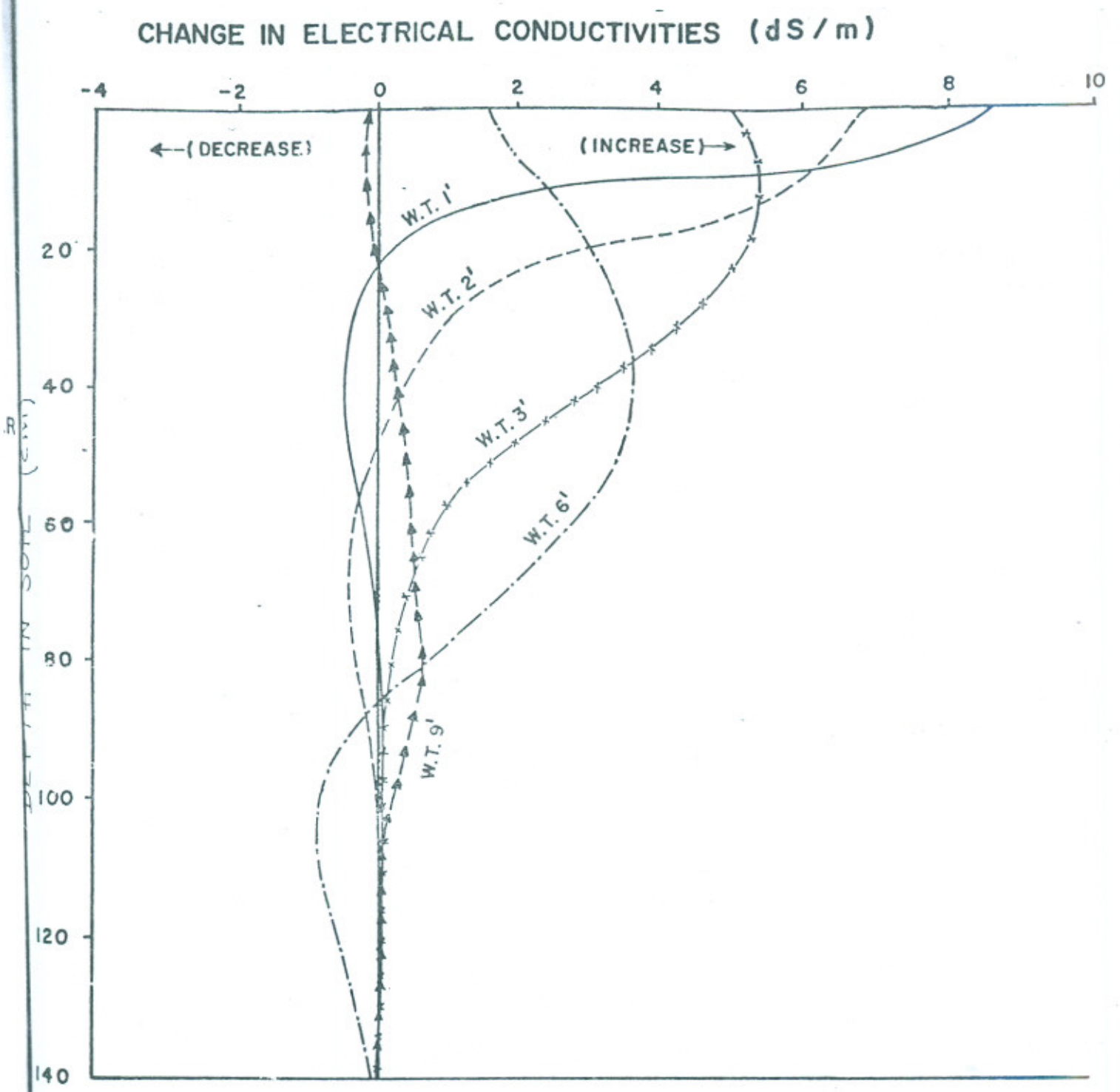


Fig. 2 SALT REDISTRIBUTION UNDER DIFFERENT WATER TABL CONDITIONS.

USE OF SALINE WATER FOR IRRIGATION

By
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And
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The canal supply in the country is limited and is insufficient to meet the requirements of crops, whereas the crop intensity is on the increase, because of increase in population and the simultaneous increase in pressure on agricultural lands. Ground water though available in ample quantity, is so often unfit for raising crops. Efforts are being made to supplement the canal supply with the use of poor quality ground water which is mixed with canal water in such a way that its hazardous effects are mostly eliminated. In case, the canal supply is meagre or not available, the application of poor quality water for crop production remains the only alternative to make use of and it is bound to have hazardous effect on soil conditions, which are harmful for raising crops.

Crop yields are reduced with the use of saline, water, because of increase in osmatic pressure of the soil solution, disturbance of ratio of different cations and anions in it and in plant tissues.

To prevent the accumulation of salts, the soil profile is leached periodically with some water in excess of that used for evapotranspiration. It is known as th leaching fraction.

The leaching fraction increases with the increase in salt contents of the irrigation water and it involves high cost of crop production. Here the conjuctive use of saline water with canal water may prove useful.

Sodium Chloride and Sodium Sulphate constitute main salinity. They are highly soluble in water. When they accumulate in the rootzone of crops, they are expected to be in soil solution. When the land has moisture of field capacity level, they may mostly be eliminated with the application of a canal irrigation at this time.

The hypothesis has been tried experimently at the laboratory level and the results achieved therefrom are presented here in this presentation.

REVIEW OF LITERATURE

Ayers et al (1952) reported that emergence of wheat and barley seedlings was delayed for 2 - 3 days, when irrigation water contained 500 ppm of salts and there was an additional delay of 1 - 2 days when irrigation water of 10,000 ppm salts was used.

Lunin et al (1960) found that the yield of plants decreased almost linearly with increasing salinity of irrigation water.

Chang (1961) observed that irrigation water containing 3000 ppm salts did not depress alfalfa yield unless the sodium contents of soil or of irrigation water was high.

Kelly (1963) observed that natural precipitation might leach salts that accumulate as a result of applying a saline water. if the amount of precipitation is sufficient to penetrate the soils to depth below the rootzone, the accumulation of salts might be largely prevented thereby. With waters relatively high in sodium percentage the periodic application of gypsum is advisible. The similar observations have been reported in a report from Tunisia.

Kaddah and Ghowall (1964) revealed that grain yield of corn was greatly reduced by irrigation with water having 1500, 3000, 6000 and 9000 ppm

salts.

Muhammad (1967) observed that yield of both maize and sorghum decreased almost linearly with increase in salinity and Sodium Adsorption Ratio of irrigation waters. Higher salinity and Sodium Adsorption Ratio affected severally the yield of maize and sorghum crops which was only 20% of that obtained at lower salinity and Sodium Adsorption Ratio levels.

Hussain (1968) observed that the water with high residual sodium carbonate and low concentration of salts had injurious effect on soil conditions. The adverse effect was faster when both the components: the salt concentration and the Residual Sodium Carbonate were high. The deterioration period could be prolonged with increase in depth of irrigation applications The hazardous effects were more pronounced, when a water of poor quality was used on normal soils.

Khan and Rana (1969) pointed out that the waters having T.D.S. from 1616 to 1832. Sodium Carbonate from 9.39 to 11.12 were not at all safe for use for irrigation.

Hussain et al (1973) found that in a period of nine years the salinity level of soils was reduced considerably or it remained unchanged with the application of a group of waters having Electrical conductivities varying from 750 to 2000 mmohs/cm. It, hwever, increased appreciably in other two cases, where the Electrical conductivities of the waters used were 2000 to 3000 mmohs/cm. They observed further that in case of marginal or poor quality waters, the growing of sensitive crops were eliminated in a period of 9 years from the areas where they were used. The yields of the tolerant crops were also adversely affected.

Haider and Farooqi (1975) reported the deterioration in the soils, where water having T.D.S. more than 750 ppm was used. The extent and degree of degradation of the soil was professively more under the increasingly poor quality of the water applied.

Mahmood at al (1979) submitted that in areas,where the heavy rainfalls are received during a part of the year, the salts added in the soil with the use of poor quality waters are mostly eliminated from the rootzone of the crops by leaching.

Chaudhry et al (1983) reported that wheat yield was affected more adversely in fine textured soils by water salinity as compared with coarse texture soils.They further reported that water having salinity of 2039 ppm increase the soils salinity significantly i fine textured soils as compare with coarse textured soils.

Altaf (1982.83) ha shown that the infiltration rate c a poor land is increasec signigicantly with the applicatior of sulphate ion in the soil.

Chaudhry et al (1984) reported that use of saline wate upto 200 ppm T.D.S. on a medium textured soil did not deteriorate the soil properties and did not cause reduction in yield of wheat and rice crops as Sodium Adsorption Ratio and Residual Sodium Carbonate were very low. They further reported that infiltration rate of the soil increased at all water salinity levels.

Altaf et al (1985) made successful use of saline/sodic waters having ECx106, 860, 2500 and 3000 to grow maize,berseem, cotton and sorghm.

MATERIAL AND METHOD

The experiment was conducted in specially designed plot 3' x 3' and 5' deep, the side walls of which were made of pacca bricks and were plastered with cement on which a covering of bitumine was given further to avoid any side leakage of moisture. They contained fine sandy loam soil in them whcih had direct contact with the earth at the

bottom to allow free upward and downward movement of moisture. The soil was anaylsed, before starting the experiment and after completing the same. The crop rotations followed in the experiment were:-

1) Maize - Berseem - Cotton - Sorghum - Toria.

2) Maize - Senji - Sugracane - Guara - Wheat.

The waters used for irrigation had electrical conductivities: 1000, 2000, 2500, 3000, 3500 and 4000 micromohs/cm. Their analysis results are given in Table - 1.

These waters prepared by mixing commercial salts in the local tubewll water which had elctrical conductivity 1000 micromohs/cm. Sodium Chloride and Sodium Sulphate were mixed in the ratio of 1:1 on the basis of their equivalent weights and were dissolved in water to buld up the desired level of electrical conductivity.

Irrigations were given to crops, whenever they needed watering. Each irrigaton was of 10.16 cm depth. 3 irrigations of this water were applied and after every 3rd irrigation a canal water irrigation was given within 48 to 72 hours of its application. The general agricultural practrices followed in the field were kept in view to grow the crops.

RESULTS AND DISCUSSION

The analysis results of the waters indicate (Table -1) that water no. 1 was useable for irrigation no.2 was saline water and the others were saline sodic waters.

The irrigation delta applied in crop rotation No.1 was 465.29 cm in depth. It included 233.68 cm saline water, 91.46 cm canal water and 140.25 cm rainfall. In rotation no.II it was 585.93 cms. In this case saline water was 314.92 cms canal water was 132.08 cms and the natural precipitation was 138.93 cms.

The analysis results of the soil before and after the crop rotation (Table 3A, 3B, 4A and 4B) indicate that there had not been any significant change in the salt content of the soil in the rootzone of different crops.

The yield results of various crops indicate (Tabel 5A and 5B) that the performances of all the crops in the two rotations remained uneffected and it corresponded to the normal conditions of the soil.

From this it is concluded that under Lahore conditions the hypothesis of making use of poor quality water, where 3 irrigations of poor quality water are applied with one irrigation of canal water, has worked successfully.

The crop wise situation indicates (Table - %A and 5B) that maize is sensitive to salinity, but it grows mostly in the moonsoon season. The conjuncitive use of saline water with canal water and the occasional rainfalls which were received in this part of the year kept the soil salinity level in favour of the crop.

The cotton crop is sensitive to salinity at the germination stage. It is sown in the months of May - June and it grows mostly in the moonsoon season. Its behaviour was similar to that of maize and the same was the case of sorghum.

Berseem and Toria are winter crops. Both are tolerant to salinity. The rainfall being scanty in this season, the application of one canal watering after each third irrigation of saline water kept the soil conditions favourabhle for the growth of these crops.

Sugarcane is a salinity sensitive crop. In the months of March to June, the practice to apply a canal irrigation after every third irrigation of poor quality water, saved the crop from injury by the ground water salinity. From August to September the crop had the additionai advantage of moonsoon rains to maintain its flourishing growth.

CONCLUSIONS

From the discussion given above it appears that under Lahore conditions, waters having effective electrical conductivity as high as 3400 to 3500 micromohs/ cm, (Tabel 7A and 7B) may be used to raise almost all the agricultural crops advantageously. The study has opened a new field for research for making use of poor quality waters, when they are free from Residual Sodium Carbonate.

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TABLE - 1

ANALYSIS RESULTS OF WATER USED FOR IRRIGATION

S. No.	pH	EC x 10^6 at 25C°	Ca + Mg	Na	CO_3	HCO_3	C_1	SO_4	RSC	SAR
1.	7.5	1000	4.5	5.5	-	5.0	2.5	2.5	0.5	3.66
2.	7.6	2000	4.5	15.0	-	5.5	5.5	8.5	1.0	9.99
3.	7.8	2500	6.0	19.8	-	6.0	7.5	12.3	-	11.42
4.	7.8	3000	7.0	26.0	-	5.5	8.5	19.0	-	13.90
5.	7.8	3500	7.0	32.0	-	5.5	10.5	23.0	-	17.10
6.	7.9	4000	8.0	36.5	-	5.5	13.0	26.0	-	18.30

TABLE - 2

IRRIGATION DELTA APPLIED TO EACH CROP IN A CROP ROTATION (Cms)

ROTATION - I

Water Quality	Maize	Berseem	Cotton	Sorghum	Toria	Total
Saline Water.	30.48	71.12	50.80	50.80	30.48	233.68
Canal Water.	20.32	30.48	10.16	20.32	10.16	91.46
Rainfall.	33.58	9.27	69.06	21.18	7.16	140.25
Total:-	84.38	110.87	130.02	92.30	47.80	465.37

ROTATION - II	Maize	Senji	Sugarcane	Guara	Wheat	Total
Saline Water.	30.48	40.60	142.24	50.80	50.80	314.92
Canal Water.	20.32	20.32	50.80	20.32	20.32	132.08
Rainfall.	33.58	5.41	70.38	20.90	8.66	138.93
Total:-	84.38	66.33	263.42	92.02	79.78	585.93

TABLE - 3A

ANALYSIS RESULTS OF THE SOIL BEFORE INITIATING THE CROP ROTATION-I

	0 - 15 Cm.		15 - 30 Cm.		30 - 60 Cm.		60 - 90 Cm.	
860	1.18	4.74	1.02	3.69	0.95	2.06	1.15	2.03
2000	1.13	1.25	2.12	6.50	2.97	5.40	2.62	4.34
2500	2.73	1.40	2.40	3.84	3.40	5.80	4.00	7.80
3000	1.13	1.80	1.50	2.81	0.95	4.13	1.04	2.82
3500	2.43	4.19	2.28	2.31	1.99	4.34	1.61	4.25
4000	1.07	1.49	4.10	2.65	3.52	1.57	4.15	2.77

TABLE - 3B

ANALYSIS RESULTS OF THE SOIL AFTER COMPLETING THE CROP ROTATION-I*

860	1.10	2.80	1.63	3.80	0.90	2.96	1.15	5.20
2000	1.65	3.56	1.43	2.99	1.38	4.45	1.33	2.82
2500	1.80	3.90	1.10	3.16	1.35	2.89	1.43	3.19
3000	1.60	3.40	1.83	3.70	1.53	5.02	1.50	6.50
3500	1.90	4.10	2.10	3.90	1.75	3.30	1.70	4.90
4000	1.58	4.02	1.80	3.95	1.65	4.39	1.38	4.06

* The values are average of 4 replications.
The pH of the soil saturation extract varied from 8.3 to 8.0

TABLE - 4A

ANALYSIS RESULTS OF THE SOIL BEFORE INITIATING THE CROP ROTATION-II

	0 - 15 Cms.		15 - 30 Cms.		30 - 60 Cms.		60 - 90 Cms.	
	Av. E.C	Av. SAR.	Av. E.C.	Av. SAR.	Av. E.C.	Av. SAR.	Av. E.C.	Av. SAR.
860	1.30	4.85	1.05	3.68	0.98	3.13	0.85	2.75
2000	2.70	12.10	2.30	9.40	2.20	7.20	2.20	6.40
2500	1.85	8.50	1.60	7.93	1.43	2.78	1.40	6.90
3000	2.47	10.24	1.74	5.60	1.10	2.97	1.07	3.79
3500	2.30	7.74	2.09	6.39	1.51	5.43	1.50	8.03
4000	2.98	10.97	2.30	8.95	1.85	8.20	2.63	10.14

TABLE - 4B

ANALYSIS RESULTS OF THE SOIL AFTER COMPLETING THE CROP ROTATION-II*

860	1.73	3.83	1.83	3.45	1.53	2.70	1.80	4.30
2000	2.24	4.50	2.30	4.24	1.84	2.57	1.70	5.00
2500	2.23	4.53	2.08	4.50	2.68	4.40	1.93	6.13
3000	2.60	6.04	2.17	7.10	2.34	4.97	2.50	6.24
3500	2.27	5.44	2.24	6.90	2.80	5.77	2.54	5.27
4000	2.34	7.97	1.90	6.44	2.60	7.40	2.50	7.80

Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.

__ Samuel Johnson, Baswell's Life or Johnson

TABLE - 5A

YIELD RESULTS OF CROPS IN KG/PLOT

ROTATION-I

Crop	1000	2000	2500	3000	3500	4000
Maize.	1.83	1.63	1.87	1.65	1.82	1.28
Berseem.	8.52	8.09	8.47	7.38	8.29	8.39
Cotton.*	161.25	263.00	216.00	229.25	291.25	141.25
Chari.	15.87	17.00	18.00	17.00	17.50	15.37
Toria.*	34.25	35.12	15.25	21.50	19.37	43.50

TABLE - 5B

YIELD RESULTS OF CROPS IN KG/PLOT

ROTATION-II

Maize.	1.27	1.41	1.36	1.38	10.60	1.20
Senji.	4.44	3.96	4.58	3.91	4.23	4.18
Sugarcane.	19.00	17.62	18.25	15.75	19.87	13.12
Guara.	9.26	8.16	7.98	8.22	8.43	8.09
Wheat.	0.80	0.58	0.63	0.61	0.66	0.53

* Gram / Wheat.

Men are four:
He who knows not and knows not he knows not, he is a fool-shun him;
He who knows not and knows he knows not, he is simple-teach him;
He who knows and knows not be knows, he is wise-follow him!

__ Arabic Apothegm

TABLE - 6

PERIODS OF MAJOR RAINFALL

Date	Maize	Date	Cotton	Date	Sugarcane.
04.08.1983	3.55 Cm.	19.06.1984	2.87 Cm.	6/1984	2.87 Cm.
19.08.1983	10.66 Cm.	07/1984	22.68 Cm.	7/1984	22.68 Cm.
29.08.1983	3.09 Cm.	08/1984	24.86 Cm.	8/1984	24.86 Cm.
		09/1984	17.80 Cm.	9/1984	17.82 Cm.

TABLE - 7A

EFFECTIVE SALINITY OF IRRIGATION WATERS IN CASE OF DIFFERENT CROPS

ROTATION - I

	Maize	Berseem	Cotton	Sorghum	Total
EC X 10^6					
	25.07.83 - 20.10.83	26.10.83 - 23.04.84	15.05.84 - 12.01.85	13.11.85 - 18.03.86	
860	518.24	788.09	403.21	662.65	731.17
2000	1205.20	1832.77	937.70	1541.06	1700.41
2500	1506.52	2290.97	1172.12	1926.32	2125.52
3000	1807.82	2749.16	1406.55	2311.59	2550.62
3500	2109.13	3207.35	1640.97	2696.85	2975.73
4000	2410.43	3665.55	1875.40	3082.12	3400.83

TABLE - 7B

EFFECTIVE SALINITY OF IRRIGATION WATERS IN CASE OF DIFFERENT CROPS

ROTATION - II

	Maize	Senji	Sugarcane	Guara	Wheat
EC X 10^6	25.07.83 - 20.10.83	27.10.83 -	10.03.84 - 14.02.85	23.5.85 - 25.08.85	20.11.85 - 27.04.86
860	518.24	789.38	630.22	664.67	766.64
2000	1205.20	1835.76	1465.64	1545.75	1782.90
2500	1506.52	2291.71	1832.05	1932.18	2228.62
3000	1807.82	2753.65	2198.46	2318.62	2674.35
3500	2109.13	3212.59	2564.87	2705.06	3120.08
4000	2410.43	3671.53	2931.28	3091.50	3565.80

CONSTRUCTION QUALITY IMPROVEMENT IN IRRIGATION AND DRAINAGE PROJECTS

by

Harald D. Frederiksen

(This useful paper, though addresses Irrigations Projects yet the contents are equally applicable to other areas as well - ENJ)

ntroduction:

(Comment under para 1 below has been communicated to the President, Pakistan Engineering Congress, Engr. Shams-ul-Mulk in connection with the International Confrences on Quality Assurance in Eng. Projects organised by the Congress. ENJ)

I want to express my ongratulations for calling a onference on this important ssue how to attain onstruction quality. It is a ressing matter, yet skirted by everal countries because of s many difficulties. Further, I m most pleased that you have rought together not only the overnment Engineers from roughout Pakistan, but that ou have also included ontractors and consultants in ese deliberations, because, it only through an industry de effort that solutions can e found and implemented.

Today, a majority of ountries have large programs nderway classified as habilitation, upgrading or odernization of irrigation and ainage projects. Indeed, in many countries these efforts now constitute the dominant expenditure in design and in construction. As available water and land resources become essentialy fully developed, a reduction in new design and construction work is natural, but unfortunately, there hasn't been a parallel reduction in the total funds needed. The explanation inevitably cited for this situation that calls for increasing rehabilitation funds is poor O&M.

3. Concerns arise, however, when these programs and the individual works are examined more closely. The amount of funds committed and planned are huge. This is not a minor activity for a few staff, but a continuing major undertaking. The list of facilities to be treated touches almost every system in the country. And most telling, five, ten and fifteen year old facilities seem to dominate the effort while features that are fifty to one-hundred fifty years old are found for the most part to be satisfactory, even when they are located within the same scheme, indeed, about the same structure and have received perhaps even less maintenance.

4. Tragically the vast majority of what we see is reconstruction of inferior, failed construction. And the continuing illusion, whether intended or not, that these expenditures in the billions of dollars is caused by lack of O&M or simply a need to modify systems recently built for some good, though vague reason, will prevent the recognition and resolution of the true problem in most cases. The cost of this poor quality of recent design and construction dictates that effective action be taken where it will remedy the situation. And that point is not in O&M. It is in design and construction (D&C).

5. An effort has been initiated in the Asia Region of the Bank to address this matter in its constituent countries with urgency. This will entail a close cooperation between borrowers and the Bank. In parallel, the International Commission on Irrigation and Drainage (ICID), Working Group on Construction is instituting a program to help its member countries attain this

same goal. And there is no doubt that major changes can be made if everyone focuses on bringing project quality up to standards already established by the responsible entities. No country can afford nor is it believed that knowingly any wishes to do otherwise.

6. And the lending institutions are keen to halt these wasted efforts and to stop the subsequent disenchantment of those who were to have been served by properly funcitioning facilities. The rapid growth of unproductive debts by countries who can least afford them must be stemmed. And what does poor construction quality of the type found actually cost? The first reworking will cost perhaps 40 to over 100 percent more than if constructed to acceptable standards initially. Repeated reconstruction will continue to add still more to the excess.

7. This paper is intended to stimulate discussion of the subject with the objective of seeking practical, effective solutions followed by early implementation. Identified causes of poor quality are described first. This is followed by suggested actions required for improvement. Finally, the means for introducing change are proposed.

Causes for Poor Quality Construction.

8. Numerous causes for poor construction can be cited. Nine are offered as those that constitute the primary reasons encountered most commonly and are found to exist in many countries. The choices may differ because of one's perspective, but these noted are believed to dominate.

(a) Design precluding practical construction -- Too often designers have little,if any exposure to construction. Their designs are highly theoretical with a lack of knowledge of materials, of standard methods and of capability and limitations of laborers and equipment evident in key features. A few examples may be cited.

(i) Weather Cons-traints -- Concrete and masonry configuration, foundation and earthwork and the specified methods often are not reasonable for the temperature and rainfall conditions encountered during the sched-uled cons-truction season, the size of contract or the location. Conditions pre-clude acceptable results with the earthwork or concrete work methods inherent in the plans. Accommodation of cross drainage prior to and even after commencing operation is frequently not thought through during design.

(ii) Soils/geology constraint - Again foundation desig selection of lining configurat and type, means for deali with groundwater conditio during and after constructi and accommodation changing conditions within large project area are oft inappro-priately handled.

(iii) Equipment and ski constraints -- Designs are oft applied uniformly to all sizes work and all locatio throughout a count regardless of difference needs or of the capacity contractors to be involve Features with compl configurations or comspositi are designed that cannot constructed for lack equipment or materials key its success. Construction loa ings due to equipment ar common construc-ti practices go unrecognize And on small contracts, t skills of the contractor's for men and laborers assumed the adopted design will nev be found among those biddi such work. The use of sever different classes of concrete the same structure may see wise theoretically, but is guarantee to result in constru tion of deficient structures.

(iv) Faulty design Excessively stee embankments and the insi slope of the section in ear

canals are common, costly errors. Structures having complex configurations with varying sections and insufficient re-inforcement or other provisions are also common. Improper applications of water-stops-usually too many -and cons-truction joints and inadequate accommodation of differential move-ments are at the root of failures of many otherwise sound structures.

(b) Deficient contract documents -- Plans and specifications often rely on standards without sufficient specificity to meet the conditions at hand. Site conditions are not fully recognized. Indeed, often the bid documents present only general configurations. Two groups of deficiencies are common.

(i) Bid Drawing -- Often, the detailed construction draw-ings are only pursued once the contract is underway with all the usual surprises and costly changes or omissions. And inveitably, these drawings are prepared by engineers new to the project, several years after the original preliminary engineering was carried out. Thirty drawings for a 353 million dollar dam or sixty fives drawings for a 400 million dollar power plant are far from adequate. If all bidders don't clearly know what is to be done it becomes in part a guessing game - usually resulting in an inadequately priced contract. Later, the original designer's intent comes into question by the final designers and the field personnel in the course of detailing and inspecting the work. Contractor claims for delays and altered and new work is inversely propor-tional to the brevity of the bid documents.

(ii) Exculpatory language -- The cost of inadequate field information available to design is tremendous. Much of the time and cost overruns throwing projects into question are due to this. Insufficient or erroneous geological and hydrological data are particularly damaging. To make matters worse, agencies usually try to place the construction risks of this inadeaquate information on the contractor. This goes against sensible policies of gathering complete information on the situation for all contractors -- as well as the designers -- to use in preparing their approach to the work and estimating costs with confidence. The "cleverness" of placing the risk of unknowns on the contractor forces shortcuts to survive, accommodation by the agency to avoid delays and increased, unproducitive claims and litigation.

(c) Inappropriate cons-truction period or inapporpriate construction timing --

Inadequate or excessive time for construction or intentionally or unintentionally scheduling work for periods of excessive heat for acceptable concreting, high precipitation, uncertain power supply or locally unavailable water for soil compaction will affect quality unless documents provide unusually great detail and the price is paid. This is particularly cornmon when completing remedial work on systems already in service. On occasions, excessive periods are allowed. Agency staffing costs increase. But, quality can also suffer by the contractor not assigning a crew and equipment matching the minimum required for good work. Maintenance of partially completed work is inevitably inadequate. The most common example is where earthwork is let to one contractor and the concrete structure and lining are awarded to another after the first has been completed. The responsibilities and the cause of deteriorated work essential to that work which follows always leads to a reduced quality.

(d) Too small or inappropriate

contract packages -- Improper packaging is an often unrecognized constraint on securing acceptable construction quality. Short-term social and political objectives that are believed to call for this over-ride one of the essential conditions to obtaining quality, permanent structures.

(i) Too small packages -- Small contract packages prevent a contractor from justifying use of equipment that otherwise gives superior results. It causes use of unacceptable handmixing and headbasket placement of concrete in sturctures where strength or durability necessitate modern methods. Excavating and trimming equipment essential to quality earthwork in large canals connot be marshalled. Compaction to preclude settlement of earth structures is impossible without proper, costly equipment and appropriate procedures.

(ii) Segregating work -- Setting out work on one site or a reach of canal into several. different "specialty" contracts immediately assures disputes on items of work and responsibilites for inferior results on the site, particularly where the physical work joins or overlasps. The effects of time delays by such precedures was mentioned in item 4 above. Seque-ncing of activites, undisputed responsibility for results and compatibility of methods can only be assured with reason if all involved work is placed clearly with one party.

(e) Inadequate or superficial pre-bid conferences -- Pre-bid conferences are not only usual on work in the irrigation field, but attendance, together with a site visit, is a pre-requisite to acceptance of a bid in many countries. The primary purpose is to assure a more complete understanding of the work and permissible approaches. Not only does it promote exchanges and amplification of the documents, but also an opportunity for all contractors to hear the same exchange with the owner's staff clarifying questions prior to bidding.

(f) Incapable contractor -- Contractor capability is an absolute essential if quality is to be attained. Practices by governments and the industry often combine to preclude the establishment and survival of truely competent construction firms. The upgrading of contractor selection process requires that both the government and the construction industry support the establishment and firm enforcement of standards for good contractors.

(i) Inadequate equipment -- A bidder should not be considered for a job unless it has the type and number of pieces of equipment available for the contemplated work. once site work is to commence, all equipment, with backup and parts as necessary, should be on site and the contractor's proposed procedures proven out fully before work is to begin. Confirming the project engineer's intent to enforce such provisions at the pre-bid conference would help assure compliance.

(ii) Inexperienced foremen and crew -- Inexperienced crews cannot produce quality work. Training is necessary for new people. But it must be done before major operations are allowed to commence. And it is with crew training and in the planning and overseeing the workmen's tasks that the capability of the formen becomes essential. Too often contractors lack the means to attract or retain good, steady people. The size and age duration of the contract is the best indicator as to whether solid, capable contractors will bid.

(iii) Underfunded or over-extended -- new contractors or marginal contractors often

suffer from limited financing. Reputable contractors may become overextended, even through no fault of their own, indeed, sometimes due to the owner's delays in payments. Regardless, a contractor confronted with cash-flow problems or more seriously, financial constraints, inevitably will short work quality to reduce cash needs. This is the reason that the supporting data to tenders describing the firms financial strength must be examined very closely, even for long established contractors. And the situation must be reconfirmed for all subsequent tenders even though the contractor's other pre-qualifying information remains acceptable. Bonding is a prime step to minimize this problem, but in some countries the administration of this measure is ineffective.

(g) Short-comings in government-furnished materials and clearances -- Materials supply, clearances for purchases or import and sometimes equipment leasing by government are often involved in contract work. Even with the best of intentions and efforts, the government cannot always remove the complications and risks adversely affecting work quality.

(i) Materials supply -- The government inevitably supplies some of the materials used in constructing civil works. Aggregate and borrow materials are the most common. But cement, reinforcing steel and pipe are other examples. Deficiencies in the quality of any of these materials will directly reduce quality unless the government immediately corrects the situation without affecting the contractor's work or schedule. Variability of cement characteristics, particularly when from different sources, commonly forces adoption of the characteristics of that having the lowest quality for determining the mix. Unfortunately, agencies don't always move effectively to remedy the situation and instead insist on using the defective items in order to clear their stock, to remain on schedule or for some even less justifiable reasons.

(ii) Equipment leasing -- The extent to which governments furnish equipment to contractors, either as rentals or direct government operations has diminished. But this arrangement has been a cause of quality problems where utilized. Unacceptable equipment performance has been cited by contractors as causes for defects no matter what the actual cause be. And when equipment has truly not performed the agency has still insisted to continue its use for any of a number of reasons. Responsibilities for equipment maintenance is of course a related problem.

(iii) Clearances -- Delays in clearing the contractor's items for project use or for import or securing essential supplies have proportionately serious impacts on the conractor's program and, hence, forces it to seek whatever remedy is possible, typically reducing the quality of the work.

(h) Deficiencies in contract administration -- The principal area of activity where the government agency can influence project quality is in its handling of contract administration and construction monitoring, supervision and inspection. The latter actions will be discussed in the following section.

(i) Deficiencies in construction draw-ings and review of contractor submit-tals -- Incomplete drawings not only mislead or create a basis for work deficiencies, but also undermine or misinform the owner's own inspectors. And assigning the designers in place at the time work is actually under-taken to detail designs or interpret the intent

of the original designers who completed inadequate bid documents several years earlier only risks further errors. Importantly, the examination of contractor's submittals should be assigned to the most experienced engineers intimately familiar with the facility design and related criteria. These submittals are, after all, what the contractor is going to install and, hence, will bear directly on the final quality. To the contrary, agencies often assign their most junior engineers to this task. It is not a very glorious job, yet, few recognize or can properly address the questions posed.

(ii) Delays in processing change orders -- Delays in processing change orders have several adverse affects on quality. On complex projects, ignorance of recent actions among the owners own staff may cause improper decisions affecting quality. Frequently, it forces changes in the normal sequence of the contracor's work. And delayed resolution will make the contractor even more difficult to deal with in like situations in the future.

(iii) Delays in payment for satisfactory work -- As noted earlier, a contractor desperate for funds becomes very difficult to supervise and is soon crowded into shortening quality to save money. Timely payment of the work as performed in accordance with the contract provisions is an essential component of the owner's quality assurance efforts.

(iv) Inadequate communications between project management and the contractor -- Continuous, open communications between the project management and the contractor is essential for efficient operations. Questions by the contractor and clarification by the owner can only be resolved in a timely manner by direct exchanges. Free access among the top engineers and scheduled meetings on a frequent basis between the agency and the contractors are a key. Unfortunately, many sites have been visited where such links do not exist.

(v) Lack of effective project monitoring system -- Comprehensive, timely monitoring is rarely approached on many projects, even those that have to be classified as large or complex by any standards. Often brief, crude bar charts prepared for project authorization constitute the only semblance of schedules. And monitoring is limited to the original categories by the managers as time permits. Without detailed monitoring and results kept current in the offices of the project engineers and managers consistent with their needs, quality suffers. Appropriate staff assignments -- skills, levels and timing -- cannot be made, means and supplies to meet contractor needs will fall short, payments will slide and all the many other actions essential to facilitate quality will be missed or delayed. A comprehensive CPM type program with the independent monitoring and control staff to keep the system functioning as required is a must for today's projects.

(i) Deficiencies in construction supervision and inspections -- The inspection and construction supervision function is the project engineer's key link with the field work. It is without doubt the single most direct activity affecting the quality of construction. A well conceived program of inspection, sensibly instituted with firm prompt application of all contrac provisions is required and connot be compromised i quality is to be attained. Bu many conditions that inhib effective inspection and supervision are encountered.

(i) lack of project and agenc management oversight an support -- Without to

management knowledge of the work and its immediate unquestioned support sound, inspection is impossible. The details of work progress and quality must be documented and submitted to senior management promptly. (A key need for a comprehensive project monitoring system.) Staff's lack of experience, frequent turnover and excessive work are often found to limit management's effectiveness. lack of communication and transport may contribute. Improper attitude and dedication together with outside interference, direct or indirect are too frequently found. And it is the attitude of the owner's senior management that determines all else affecting quality - for better or for worse.

(ii) Weak enforcement policies and remedial actions -- How many times does one find rejected concrete or fabricated works disposed on a site? Or a record of stopwork orders? How often does one see recommendations to halt payments until quality provisions are met? How often are contractors disqualified from bidding because of previous poor or uncompleted work? Ask these questions in settigs where serious quality deficiencies are found on recent and current work and both the obvious answers and the inadequacy of enforcement of contract provisions in force will be confirmed. This situation is the result of intentional decisions by project management because the proper actions are spelled out in the legal documents. And anyone reaching a senior position on a project knows, without question, what is required for sound construction -- just meet acceptable standards in engineering.

(iii) Improper or omitted procedures -- Incorrectly conducted tests - field and laboratory - are obvious deficiencies to be guarded against. The more difficult area to ascertain and remedy is field inspection procedures. Ineffective timing of site visits, omitting follow-up on violations, inadequate records, not viewing key construction steps, allowing commencement of work without essential equipment or personnel on site and foregoing confirmation of questionable conditions by alternate, yet, reliable means, are examples of improper or omitted procedures. Unannounced spot checks by inspectors of the contractor's work and by senior management of the inspectors' activities are essential.

(iv) Lack of formal inspection records -- Comprehensive inspection records are vital to documenting construction quality and conditions of work. Critical steps such as foundation preparation, form work constructions, steel placement, installation of embedded metal, concreting equipment on site, curing methods in place and all related actions are rarely noted with each initialed by the responsible inspector. Then any later shortcomings can be pursued more effectively.

(v) Insufficient/delayed involvement of designers in construction issues -- Design of facilities common in water projects are based on a range of assumptions as to site materials and conditions. the actual are not learned until construction operations commence. Yet, the individuals on site and approving construction actions are usually unaware of the designer's understanding reflected in the design and the design's sensitivity to deviations from the assumed. In fact, often serious conditions are built into the facilities by virtue of not involving the designers in a timely manner,if at all.

(vi) Inadequately trained inspectors and supervising engineers -- Frequent staff

rotation - even within the construction units - is usual in many countries. Even more often inspectors examining work, deciding as to adequancy and confronting the contractor directly are the most junior and ill prepared staff members. Attitude may be a problem, but ignorance of what should be secured and, hence, what should be reported to higher supervisors when disputes arise is also encountered.

(vii) Inadequately trained laboratory technicians -- Laboratory technicians must know the testing routines. But to be effective they also must be trained in the purpose and importance of the tests assessing quality of the final facility. Gaps exist in the staff understanding the test details, but even more damaging, ignorance of the implications of individual and groups of tests and of other information that would further clarify a given quality questions.

(viii)Personnel shortages -- Numbers do not mean that staffing levels are adequate for construction supervision and inspection. The only measure of staffing levels is the number of appropriately experienced staff on the construction sites. Projects sites have been visited where there were far too many people -- one had twenty-two engineers plus support staff to oversee two earthwork sites on a moderate sized canal and one bridge under way. But when weighing their ability to carry out the duties called for by work in progress, however, there was a severe personnel shortage and construction quality was entirely dependent on the good will of the contractor.

(ix) Lack of equipment and transport -- Inspectors must have the means to visit sites and laboratories at the precise time required. Contractors cannot wait nor do they necessarily wish to. If delays are imposed, claims usually follow. And if work continues without timely inspection, quality is assured to suffer. The worst situation is when the inspectors must rely on the contractor for transport - and this is not uncommon.

(x) Inadequate construction plans -- The consequences of inadequate bid plans has been mentioned. Difficulties in completing satisfactory construction drawings was described. But even with these problems remedied, unavailability of drawings on site and the incomplete familiarity of field staff with the drawings is a common cause of construction not complying with the designer's intent or standards.

Primary Categories of Required Actions for Improvement

9. A number of actions are required if improvement in quality is to be realized. Certainly the specific measures and their relative importance will vary from situation to situation. But for ease in addressing the approaches and in ordering where and when steps should be taken, the more common actions are grouped by project phases.

(a) Agency policies and their application -- Agency policies, in wiriting, must provide unequivocal guidance and support for actions that will allow quality in the final product. These must guide creation of the essential staff capability and ennunciate management's intentions for agency and contractor performance.

(i) Personnel policies -- The government must provide an appealing efficient work environment. But it must, more than anything else, have the ingredients of a strong civil service framework in place. The organizational structure and personnel procedures and rules must provide incentives for specialization and assure promotion on merit. compensation and facilities must reflect the position -

managerial or technical. It is not for lack of people that agencies cannot produce, indeed, usually there is excess. It is poor motivation and work conditions that drive people out of a field or divert their attention and efforts to other matters, frequently in conflict with actions to secure quality.

(ii) Contractors selection policies -- Contractor selection policiies should yield procedures tailored to secure the contractor capability to do the work at hand, not to meet social or training objectives or to provide indirect income to local residents. The design /construction units should define the nature of the work, equipment and skills required detailing the size, experience and financing involved. And contractors who have failed to fully meet contract provisions in the past must be removed from all lists.

(iii) Contract enforcement policies -- Management, through their project engineers must convey their insistence on quality. Promptly halting contractor payments for inferior work, correcting faults by the contractor without cost to the government even if discovered later and taking strong disciplinary measures with lenient agency staff are example actions resulting from application of strong management policies. The most important action is an open, prompt backing of the inspection staff under the work situation.

(b) Project formulation -- The pre-construction activities that lead to its definition must, of course, be sound if the project is to be built and subsequently perform satisfactorily. This includes everything from engineering to formulating the construction program itself.

(i) Site investigations -- Foundation conditions and construction materials are two areas where care in the evaluation must be exercised by designers and the construction specialists or quality will be placed in jeopardy. Exploration should be planned and verified for meeting all needs while also providing the information on which the contractor can reasonably plan his approach and estimates.

(ii) Design constructability -- Constructability of designs should be reviewed by experienced construction specialists as a formal step with appropriate approvals just as is required for approvals of designs. Structure configurations to facilitate forming and placement of concrete is an example. Large undertakings may warrant discussions during the design phase with equipment manufacturers in the earthwork and concrete fields.

(iii) Plans and specifications -- Clarity and completeness of plans and specifications should be a prime objective of the agency. Again, reviews by experienced designers and construction engineers are essential in the formal processing of documents. And every agency must assure consistency on a project as well as among projects. Careful descriptions of conditions and tests for acceptability and measurement for payment are critical to orderly administration and to promote quality. Proven standards applied consistently also greatly facilitate the work of both the contractors and the field engineers.

(iv) Contract packaging -- Contracts should be packaged in a manner to best facilitate quality work. Overlap of responsibilities or geographic area among different contractors are to be avoided. Minimum size should provide a volume sufficient to justify the equipment and skilled cre that will produce the quality specified. Remember, contractors can sub-contract (as allowed by the contract) if it makes sense economically without appreciably increasing

the owners efforts.

(c) Project management -- The field of "project management" (PM), demands more recognition as a specialty than it typically receives. First of all, it must not be confused with construction inspection or supervision as those terms are usually understood and used. PM entails the planning, preparation and overseeing of the entire construction program. It includes many agency actions at every level needed to initialing and carrying out the undertaking in an efficient and timely manner. Staff of all key slots that perform this function must be experienced and on-the-job training to qualify shouldn't be considered, given the tremendous money and consequences for project quality involved. The background and skills must be held by the top people before they are given the responsibility and not learned by trial and error in the execution of the actual work.

(i) Project planning and monitoring -- Detailed project planning is the first formal step that should be completed before project execution is approved. This must not be left as an adhoc "happening". The interdependence of the project components, the scheduling to allow early generation of benefits, the weather impacts and the size and duration of suitable contracts are a few considerations that must be carefully assessed in preparing the program. No project should be assumed planned nor should work be allowed to commence before a detailed CPM type chart displaying the schedule, mutually agreed to by the contractor and the owner's engineers, is produced. In parallel, a program monitoring and reporting unit should be created. This parallel effort should install the mechanisms, including communications and computers that assures prompt complete reporting of project status and related information at the frequency to allow staff at every level to take sound, timely decisions.

(ii) Agency organization -- Office and field organization of staff should be geared to the project and to the agency's overall structure. Prompt response to construction conditions coupled with the application of experience and skills to the questions should dictate the organization, not past approaches nor left over arrangements from previous activities. Central construction and design office support should be reviewed in conjunction with formulatiog the field structure. And the structure must be evident to provide the over-sight and immediate actions to apply the quality assurance policies cited earlier.

(iii) Authority and responsibility -- The responsibility and authority necessary to effectively carry out the agency's, and each sub-unit's, role should be set-forth in concert with the project organization's structure and officially communicated to the contractor. A like designation by the contractor should be transmitted to the agency. Again, timely response and the accounting for quality necessitate that all know the assignments. And these unambiguous assignments should be made to sub-units and positions and then tested before major activities commence. Position statements and qualification requirements should be prepared and applied rigorously.

(iv) Coordination and communications -- Well thought-out procedures to implement the steps involved in meeting the assigned responsibilities should be introduced in conjunction with the assignment themselves. Software and equipment needs were implied in the earlier section on monitoring. In addition, a reliable

communication link is required between all of the responsible offices. And inspectors should have vehicular transport at a minimum.

d) Execution of the construction program -- Project construction execution is the final determinent of quality, assuming satisfactory design. It relies on fulfillment of the many actions preliminary to commencing the work. But they alone do not guarantee results.

i) Procedures -- Most agencies have procedures for field work. Nevertheless, the agency should examine its procedures specific to each project and view them in the light of the common shortcomings and actions noted in earlier sections. Typically, more attention is required in tracking materials, linking tests to facilities and documentation of remedial actions when deficiencies are found. Thoroughness in record keeping cannot be over-stressed. This constitutes the basis for identifying faults, evaluating staff and contractor response, holding people accountable for results and resolving disputes with the contractor.

j) Staffing -- Staff in charge of every significant activity must be experienced and well trained for his assignment. None should be placed in a position merely for the sake of promotion. Care must be exercised, if assignment is a means to gain experience under a rotation program, that the individual knows the construction field, that he is trained for the position and that this is fully consistent with the work required. And if people cannot be located that fully meet needs, outside recruitment or augmentation by consultants should be used.

(iii) Training -- Training should be carefully formulated on the basis of the actual staff capacity and the demands that will evolve as the work progresses. Inspectors and laboratory staff should have refresher courses on larger undertakings, particularly when new equipment and management procedures are to be introduced. Many comprehensive formal construction training programs are now available and a central "institute" headed by respected construction engineers-not professors nor 'institute'- can effectively serve as the mechanism for using these materials.

(iv) Equipment and facilities -- Again, computers and communications are an immense aid to project supervision - essential for large projects. These should be installed prior to commencing work and staff fully trained in their use before field activities begin. Transport is of course an obvious need, yet, instructions should be issued to preclude the diversion of vehicles or inadequate maintenance. Equipment reliability must be assured. Adequate office space, secure record files and support materials must be available at the primary sites.

(e) Internal 'Auditing' -- Just as inspectors serve as 'auditors' of the contractor's work quality so some agencies have found it effective to formalize their internal audit and over-sight program to assure their internal quality. This should be viewed as being parallel to financial accounting and should be open and apparent to all. It should not be seen or used as an internal policing program - this is essential for employee confidence and support. Selection of experienced, well respected individuals is critical to a smooth non-threatening application of this program.

(i) Project level -- The project engineer is the ultimate 'auditor' of the work. He should make the review of the detailed performance of his organization and the individuals his primary concern

and responsibility. This cannot be delegated. His top office engineering and field engineering heads share this task in addition to their more direct responsibilities. Parallel formal audit units, sometimes including even the materials laboratories, have been used by some agencies. But this should be discouraged as it often disrupts the effective, joint performance of the organization when work is performed under contract than by the agency's own forces. It also leaves responsibility and accountability for project results more nebulous.

(ii) Agency level -- The chief of the agency's central construction office has a responsibility similar to the project engineer. Some agencies have found it very useful to have a staff office responsible for reviewing all projects underway by the state's agency for quality during construction and also monitoring results, particularly, repairs and replacement after the facilities are placed in operation. As a minimum, a central agency unit should be established to formally examine all project reports, claims, payments and make regular field visits to the various projects to compare submittals with field results. The quality of the completed facilities and the quality inferred by staff actions - good and bad - should receive regular and thorough attention from this central agency high level team. This is, after all, the final measure of the office's effectiveness of meeting the agency's assignments.

Means for Introducing Change

10. The executing government agency bears the full responsibility for project quality. Neither contractors nor others outside the sector can rightfully be credited for the results, whatever they may be. Only it can set the tone of its approach and create the proper attitude and environment for its staff.

11. One might consider the actions required in an improvement program. A first step for agencies that actively want to upgrade their performance and the quality of their work would be to convince a small team of outside experts to examine the situation and submit a preliminary assessment. Facilities - new and old - should be inspected and possible primary and secondary causes described for any deficiencies identified. With that in hand, agency management can better appreciate the needs and proceed with formulating and implementing a program for detailing the problems and remedying the deficiencies. A combination of measures found effective include:

(a) Appoint an outside experienced group of individuals to conduct a peer review assessment of the agency. This group would examine the principle elements determining quality and effectiveness of the agency's work. Policies, organization, standards, rules and procedures, staff capability and support would be treated. The group should be asked to make specific recommendations for improvements in all areas of weakness.

(b) Management should issue a comprehensive statement setting forth its objective, the program for improvement, the schedule for implementation and concrete terms for measuring success in reaching short-term objectives. This will constitute the clear indication of management's intent concerning quality and exactly how it will be attained and will spell out exactly what is expected of every staff member. It will set the attitude for the whole effort.

(c) The agency must institute consistent, unequivocal policies together with effective

procedures to assure quality work by its staff. It means the rejection of all sub-standard work, materials or equipment (and no one can profess not to know what quality is called for nor can they say they are unaware of the specifics). This includes acknowledgement of superior performance by staff and units and the disciplining of individuals, including removal, for poor performance.

(d) Guides and reference materials should be prepared -- (utilizing the vast quantity already available) that would be used at the appropriate levels to effect the improvement. There should not be a large bundle of documents to clutter the shelves, but be carefully tailored to each need and the level of application. The means for implementation, the schedule for introduction and the method for monitoring results should be devised and presented with the material.

(e) Workshops should be held to initiate the quality improvement program -- and to facilitate the implementation of each separate action. But these should be carefully planned and the presentations must be made by senior, experienced and knowledgeable individuals so that the sessions are truly helpful and the participants realize that management means business.

(f) Focussed training is essential to improve staff capability -- or even for the 'experts' to remain current. (And it should be recognized that the latter does not necessarily entail formal course work.) But the training program must be carefully conceived and executed. Key to success here as elswhere is for the management to be involved in defining the needs, selecting the participants and setting the schedule. Large programs with fixed training sessions can often be counter-productive. Further, both the course content and the instructors must be of highest quality or this basic means to improve staff will be a waste.

(g) In-depth visits and "on the job training" (OJT), on properly functioning projects should be an established means for introducing the latest techniques -- and demonstrating the practical applications in the areas of construction and O&M to mid-management and technical specialists. However, the too frequently encountered junkets for people near retirement have no place. If arrangements to assure adequate time and in-depth examination of the subject areas are not possible, the visit should be cancelled by the agency (or the entity to be visited). Again management must spend the time to help set the OJT program and to verify its proper execution.

(h) Stronger enforcement of program procedures -- by the country financing and oversight agencies (and of project agreements by lending institutions where participating) will greatly aid the executing agencies. Strong, uncompromising actions by outside entities will send needed signals to all as to what is expected and what will be accepted and what will not be accepted. Any lack of attention, indeed, obvious 'blind eye' to results undercuts the responsible agency officials. And it is for the top agency professionals to secure such support if it is inadequate or not evident to all. These outside entities also have an unquestioned obligation that they must not skirt.

Responsibilities

12. The responsibilities for the improvement of agency performance and the attainment of high quality work lies entirely with the agency's top officials. They can initiate any inquiry deemed necessary, they can set out the policies and rules and they can institute the remedial programs and the measures for enforcement. They are the responsible

(Continued on page 64)

PRIME MINISTER FELICITATED

The Executive Council felicitated Mr. Mohammad Nawaz Sharif on his election as Prime minister of Pakistan and expressed hope that under his dynamic leadership the Nation would embark on a bright future of prosperity.

Engineering Congress submits recommendations to the National Pay Committee

The Executive Council of the Pakistan Engineering Congress held deliberations on the status of Engineers vis-a-vis their pay structure with a view to ameliorting their suffering and sense of deprivation. The Council formulated their viable pay structure and ancillary benefits and submitted to the National Pay Committee for their sympathetic and judicious consideration.

Engineering Congress submits recommendations to the Government on "Quality Assurance in Engineering Projects."

Recommendations as a result of deliberations on the International Seminar on Quality Assurance in Engineering Projects held at the Forum of Engineering Congress were formulated by the Executive Council of the Engineering Congress and submitted to the Government for its consideration.

Dr. Muhammad Shafi Chairman SUPARCO Addresses Engineering Congress

Dr. Muhammad Shafi, Chairman SUPARCO addressed a well attended gathering of the Engineering Congress elite at Avari (Hilton), Lahore on 10th September 1990. He very ably dwelled upon the "SPACE Research and Development in Pakistan" and answered interesting questions on the conclusion of the discourse.

WELCOME TO NEW ENGINEERING CONGRESS MEMBERS

The Engineering New Journal extends its hearties felicitations to the following on their being admitted to the Pakistan Engineering Congress fold as new members.

Engr. Anwar-ul-Haq Toor	B.Sc. Engg. (Civil) PHE Deptt.
Engr. Muhammad Waqar Akhtar	M.Sc. Engg. (Civil) Dy Director LDA
Engr. Bilal Ahmed	B.Sc. Engg. (Civil) Jr. Engr. NDC
Engr. Asad Iqbal Khokhar	B.Sc. Engg. (Mech) NESPAK
Engr. Tariq Nawaz	B.Sc. Engg. (Elect) NESPAK
Engr. Waseem Tariq	B.Sc. Engg. (Elect) NESPAK
Engr. Asghar Ali	M.Sc. Engg. (Civil) WAPDA
Engr. Muhammad Arif	B.Sc. Engg. (Civil) SDO P&P DEPTT.
Engr. Muhammad Ashraf Sheikh	B.Sc. Engg. (Civil) Chairman Rly Board

Engr. Mian Ashiq Hussain	B.Sc. Engg. (Civil) Chief Engineer Pak Rly
Engr. Mohammad Ilyas	B.Sc. Engg. (Elect Asstt. Engineer SST)
Engr. Umar Karim	B.Sc. Engg. (Civil)
Engr. Tahir Rashid	B.Sc. Engg. (Civil) SDO Bldgs.
Engr. Husnain Ahmad	B.Sc. Engg. (Civil) SDO Bldgs.
Engr. Jamil Ahmed Shamsi	B.Sc. Engg. (Mech) Dy Director WAPDA
Engr. Najib Ahmed	M.Sc. Engg. (Civil) Sr. Engineer NES-PAK
Engr. Shamim Anwar Khan	B.Sc. Engg. (Elect) WAPDA
Capt Engr. Mohammad Imran	B.Sc. Engg. (Civil) Army
Capt. Engr. Tipu Sultan Khan	B.Sc. Engg. (Civil) Army

WHAT HAS PAKISTAN ENGINEERING CONGRESS DONE FOR YOU DURING 64TH SESSION

(A circular of the Congress has communicated the following report on its performance during the 64th session of the Congress-ENJ.)

A. GENERAL:

* Recommended to the Govt. that extension beyond superannuation may not be granted.
* Submitted recommendations to the Services Reforms Commission about the Engineers for the grant of loans.
* A manhandling incidence of a senior railway officer by workers was taken prompt congnizance and suitable action was taken.
* Countered effectively efforts of Diploma holders aiming at encroaching on the priveleges of graduate engineers in respect of appointments and promotions.
* Set up a library containing useful technical literature in the Congress Head Office.
* Renovated basement of Congress Building and setup office of the Congress, and lecture/committee room.
* Contested Income Tax Department decision to levy tax on the income of the Congress Building successfully.
* Made arrangements for construction of 2nd floor of Pakistan Engineering Congress Building and work will be taken in hand sooner the funds are available.
* Sent recommendations to pay committee.

* Sent recommendations on Construction Industry to the Government.
* Sent recommendations on Quality Assurance to the Government.
* Enrolled new Members in the Congress fold.

B. PUBLICATIONS:

* A unique book on "DAMS AND BARRAGES" in Pakistan.
* A volume of summaries of 52 technical papers awarded Gold Medals by Pakistan Engineering Congress.
* Proceedings containing 13 papers on International Conference on "QUALITY ASSURANCE IN ENGINEERING PROJECTS", held for the first time in Pakistan.
* Proceedings containing six papers on Mid Term Seminar on Construction Industry.
* Annual Proceedings containing sixteen technical papers spread over 516 pages.
* Annual Symposium on "OPERATION AND MAINTENANCE OF COMPLETED PROJECTS" containing eight technical papers.
* Four issues of the Engineering News Journal.
* Members Directory updated.
* Executive Council Directory.
* Secretary's Annual Report.

C. VISITS TO ENGINEERING WORKS:

(i) Visited seven important factories for updating knowledge of members.

(ii) A trip will be taken to Southern Areas of the country on the conclusion of the session.

D. TALKS/LECTURES:

Sixteen guest speakers were invited to address at the Congress forum to speak on important topics.

STRESS - spice of life or kiss of death?

Stress on unavoidable consequence of life, is not necessarily harmful and the trick is to find the right degree of stress that has a positive effect, says

Dr. Paul Rosch

While stress is different for each of us, all of our laboratory and clinical research confirms that the sense or feeling of being out of control is uniformly distressful. As is not being able to express emotions.

Contrary to popular belief, however, one occupation is not necessarily more stressful than another. What is important is the person-environment fit. Some individuals thrive on life in the fast lane and hectic place that overwhelm others. That's because they have a great degree of control over their activities, a strong commitment to what they are doing and no problem getting things off their chests.

Conversely, these same people would find it stressful to be involved in dull, routine daily activities that others find rewarding because they present no challenge and require little responsibility and decision making.

Another erroneous assumption is that once you reach the top rung of the corporate lader your troubles are over. In an article on 'Stress and the CEO' several years ago, I reviewed several surveys that came to the opposite conclusion, especially, for those heads of relatively small companies who feel tremendous personal responsibility for the welfare of their employees.

There are a variety of approaches that may be useful in mitigating the effects of stress, incluing meditation, progressive muscular relaxation exercises, visual imagery biofeedback, jogging, yoga, etc. But, just each of us, no single technique will work for everyone.

What is more important is to recognise that is not the situation but how you perceive it that causes your stress, and that mastering congnitive restructuring techniques offers the greatest potential of reducing stress.

Hardly a new observation Marcuys Aurelius wrote 1,800 years ago, "If you are pained by any external thing, it is not the thing that disturbs you but your judgement about it. And it is in your power to wipe out this judgement now." And as Eleanor Roosevelt noted, "Now one can make you feel inferior without your consent."

Stress is an unavoidable consequence of life, and though some situations are unavoidable and beyond our control, there are others we can do something about. The secret is in being able to distinguish between them.

Yet, without stress there would be no life and, to a certain, extent, increased stress results in increased productivity.

It,s much like the tension required of a violin string. Too little produces a poor sound; too much causes it to snap. The trick is to find the right degree of stress that will enable you to make the best music.

Because we have learned that stress is not necessarily harmful, we have come to appreciate that, just as distress can cause illness, there are positive-pr, good' - stresses and emotions that have the opposite effect. Doing something you enjoy that benefits others, pride of accomplishment and an altruistic attitude all provide significant health rewards.

Symphony conductors (Boult, Muench), musical artists (Horowitx, Casals) and public entertainers (Buns, Hope) often live long and productive lives despite the tremendous stress imposed by

arduouspractice, hectic tavel schedules, dealing with temperamental artists, etc. But these appear to be more than offset by the positive 'vibes' they get via the approbation of their peers, the plaudits of the audience, pride of accomplishment and from doing something they enjoy that brings other pleasure.

Too many of us today, on the other hand, are simply little cogs in giant technocratic ventures, without the time to get jobs done to our satisfaction, or not being able to fuly utilise our talents and/or robbed of the opportunity to produce a personal, finished product we can take pride in.

A strong and stable social support system is also a powerful stress buffer. A major source of contemporary stress has been the abrupt disruption in social order and personal relationships, most evident in cultures wherein tradition and values that have endured for centuries are rapidly being shattered. In Japan, for example, the recent epidemic of heart attacks and sudden death in executives as a result of jon stress is so well-recognised it has its own name-karoshi.

Stress management training has therefore become a priority in employee assistance programs, as corporations increasingly recognise the resultant improvements in employee health, morale and productivity, which together with decreased medical and insurance expenses, produce significant profits.

Thus we need o develop more skills, not more pills, so that we can start to tap into the body's natural drugstore and its enormous potential for health enhancement and self-healing. In fact, the most important and ageing skill may be learning how to make stress work for you, so that you become productive rather than self-destructive. It will lead to better health and it will also add life to your years, rather than merely years to your life.

After all, everyone wants to live long, but nobody wants to grow old.

ENGR. S.M. AYOOB PASSES AWAY

Eminent Engineer S.M. Ayoob, who rose to the coveted position of Secretary Irrigation and Power Deptt. Government of the Punjab and thereafter served as Member (Water) WAPDA, passed away in August 1990. He was elected twice as President Pakistan Engineering Congress, besides being o the Executive Council for may years. A rich tribute was paid by the Executive Council to him for his service to the community in general and Engineering Congress in Particular. Fateha was also offered for his departed soul.

NEW RULES FOR ROAD PATCHING

Road reinstatement is big business - and frustrating for the motorist who endures traffic jam not of his making. In Britain moves are in hand to speed work and improve quality control

IN EUROPE an enormous amount of money is spent 'opening up' highways to lay pipelines, gas mains and telecommunication net works. In the UK a new report, the Horne Report, suggests a tighteining up on the so called 'openings industry', which spends in the region of $3.2 bn a year.

A requirement of first time reinstatement and a two year guarantee will make the electricty, gas and other utilities which between them, dig over 18,000 km of trenches for new and replacement mains and make over 1.25 million small openings each year, focus greater attention on cost effective methods of reinstatement.

The report proposes to improve the skills of the workforce and thereby to raise quality standards. This will, therefore, rquire training programmes so that in about five years time all operatives will be certificated.

But all this legislation will bring other aspects in its wake, and the one disturbing many people, connected with trench reinstatment work, is the fact that they will be criminally liable for the condition of the work carried out by contractors under their control.

This will, in turn, create a need for insurance for protection of the indivudual and to cover the cost of guarantee situations where a contractor may have gone into liquidation within the two years period.

The stakes are also high. a reduction of just 10% in the total cost would bring an industry wide saving of $320 m. For British Gas, which spends about $750 m, 10% represents a considerable amount of money - but this could be wiped out by increased insurance costs.

The development in recent years of long lengths of flexible piping has made some contribution to reduced costs by creating narrow trench technology where the minimum amount of earth is removed. Realising the potential of this market, some companies are developing a range of attachments, which could be used on equipment found on most roadworks - skidsteer loaders and backhoe loaders.

This range of attachments when teamed together will, it is claimed, not only produce a better trench reinstatement, but most of all cut reinstatment costs by over 30%.

More cost-efficient than the traditional method of opening up the road with jack hammers and compressor, the use of a planer head on the front of a skid steer loader, or the dipper of a backhoe loader, is clean, quick and simple one-man operation.

BEARING WEAR ELIMINATED

One of the biggest problems which has, in the past, bedevilled planners is bearing wear. Econ UK have been able to eliminate this by driving the cutter drum with hydraulic motor connected to the machine's hydraulics enabling the planer to be controlled from the cab.

With computer technology to design the fight pattern of the easily replaced carbide tungsten picks, we have been able to increase cutter performance with the minimum number of picks - therby controlling logn term maintenance costs.

Able to penetrate the hardest concrete or asphalt surface the planner can be set to remove the surface material ready for efficient clearing and will accurately plane up to man-holes, kerbs, walls and obstructions.

Econ's Henery Hobhouse says: "Fitted to the front of a skid steer loader, or in place of

the normal bucket on a telehandler or backhoe loader, our sweeper/collector bucket is environmentally clean and is ideal for in-town operation, due to its closed construction which reduces air-borne dust and dirt."

Maintaining an even pressure the automatic crowd control keeps the bucket at an even height just clear of the road surface.

Sweeping and collecting in one operation, the bucket has dual brush rotation to provide normal forward street sweeping action.

Doubling as a bucket with reinforced, bolt-on, wear lips and corners, the brush is hinged to the front of the bucket, so that it can be hydraulically raised to be emptied and to allow the bucket to be used for normal loading duties.

Eliminating trench subsidence problems and providing first time reinstatement, in line with the recommendations of the Horne report, independent trials have shown that Econ's pivot-steer vibratory wheel compactors can achieve a compaction force of 4,400 kg/m.

Full compaction must take place at the bottom of the trench reduce the possibility of subsidence.

In standard configuration the prvot-steer vibratory trench wheel compactors feature bolt on flanges to suit trenches from 100 to 150, 250, and 300 mm.

Providing compaction quicker and easier than any other method at present available the pivot steer action at the front of the vibratory wheel compactor enables it to follow the curve of the trench

OBITUARY

Dr. Mohammad Ikramullah, Ex-Vice Chancellor University of Engineering and Technology Lahore, and Ex-President Pakistan Engineering Congress passed away on January 20, 1991 due to sudden heart failure. Executive Council of Pakistan Engineering Congress extends its heartfelt condolence to the bereaved family and prays the Almighty Allah may rest the departed soul in eternal peace.

NEED FOR CHEMICAL DISARMAMENT

By

Jonathan Power

Every step of friendship, Presidents Bush and Gorbachev take towards each other, throws into relief the minefield which the 'cold war' years left behind.

Superpower rivalry lef to a fatal disregard for the trouble the two countries were storing up for themselves as they sold nearly every type of weapon all over the world, both for the cash it brought in and the fiendship it was supposed to fashion.

What wasn't sold with official approval was available on the black market courtesy of Western businessmen, in particular the West German but also British, Italians, Swedes and Swiss.

Iraq is merely the tip of it, in the past 10 years spending more than $80 billion on arms-more than Britain, France or West Germany spent on their own armouries. Every major power has been involved.

The Soviet Union has been the number-one seller of modern missiles; China has been the sole suplier of a long-range missile capable of carrying a nuclear weapon (the CSS-2); France has had a peculiar affinity for the most unstable and potentially dangerous buyers, such as Iraq; Britain openly made a cynical decision to take every opportunity to recycle the Middle East billions via arms sales; and the United States wantonly passed up the opportunity in 1978 to fashion a treaty to limit arms sales just at the moment the Soviet Union was really serious about it.

Last month Moscow resuscitated the proposal. This time the opportunity must be grabbed while it's there. The sale of ballistic missiles should be at top of the agenda, the hot item of the 1990s because of their ability to penetrate military defences.

Given the pace of development, it is likely that by the end of the century a sizeable number of Third World countries will own missiles with chemical and nuclear warheads and with a range long enough to threaten not only their neighbours but countries a continent away.

So far, the world has seen only three sizeable missile campaigns-the German use of around 5,000 V2s against the Allies in the closing stages of World Wat II; the Iran-Iraq missile exchange between 1980-88; and the use of about 1,000 Scud missiles by the Afganistan government against Mujahideen fighters.

On all three occasions, the missiles created tremendous fear among civilians, quite disproportionate to the damage they caused. Nevertheless, they were in no way militarily decisive. They were inaccurate and too feeble to do real harm.

This will change within the next few years once countries learn how to equip the missiles with chemical and nuclear warheads. This is the real danger. Chemical and nuclear missiles are a quantum leap in the mechanics of war. They become weapons of surprise attack than can in one blow alter the outcome of a conflict.

Because of this decisive ability, the pressure on a country at war to use them first will be formidable. Only if it has the means to retaliate after it had ben hit-the so-called second strike capability-would a pro-tagonist be deterred from trying first for a quick mortal blow. No Third World country, apart from perhaps China, is within sight of possessing such ability.

Feel frightened? One should be.

New nuclear and chemical powers, using misiles that can't be recalled once launched, will work on a hair-tigger. One breath of enmity from their

enemy and they will be tempted to strike before it is too late.

The 'cold war' was never this dangerous. Before the United States and the Soviet Union developed second-strike capability and thus acquired a stable deterrence, their nuclear force was essentially restricted to airplanes.

Those planes could always be recalled allowing precious time for a second thought and for an opponent to get his bombers in the air-another form of mutual deterrence.

Belatedly, three years ago; the big Western countries quietly negotiated the Missile Technology Control Regime in an attempt to put a lid on a situation that was too obviously out of control.

But it has been a weak instrument, seen as an exclusive, almost secretive, Nato operation (although it includes Japan). It did not include either the Soviet Union or other European missile sellers, in particular Austria and Switzerland, or the up-and-coming Third World sellers, China, Brazil,

Moreover, the United States, its lead member, is transparently compromised by its involvement with Israeli missile development.

Since last December there has been a substantial effort to broaden the regime's membership. Moscow has been wooed assiduously and, although still irked over the original blackballing, is now observing its principles to restricted selling.

This should be the age of the chemical and nuclear disarmament. No country needs these weapons of mass destruction now. The nations had better get on rapidly with this too-long ignored business, or see for sure a chemial or nuclear war some time in the next 10 year.

And the target, wherever you are in the world, could just as easily be you as me.

ENGINEERS IN THE FIELD

We are reserving some pages of the Engineering News Journal, from the next issue to cover the professional experiences of our engineers working in the field in different specialisations. Engineers are invited to write freely about their field observations with a view to suggesting improvements in materials, working methods, systems and procedures __ Engineering News Journal

ENVIRONMENTAL CHALLENGE

The greatest challenge facing the demolition industry in the 1990s is the expanding legislatio of environmental constraints for less noise and pollution. Quieter hammers and methods of non-explosive rock splitting are leading the way

THE GRADUAL trend towards controlled ldemolition and dismantling has brought about a singnificant change in the equipment selection process. Gone are the days when demolition ncessitated the use of a crawler crane and drop ball.

These days, the demolition site is largely the domain of the hydraulic excavator. Using a vast array of specialist attachments, the arrival and acceptance of the hydraulic excavator has served to make the demolition sector more efficient and productive than ever before.

The mounted breaker or hammer has possibly done more to promote the use of excavators in demolition than any other type of attachment. This has been due to a number or reasons.

Firstly, demolition using a hammer is selective, the machine operator being able to limit his assault on a structure to a particular area.

Secondly, operator safety is greatly enhanced. Using a hammer, the excavator and operator are generally kept well away from the dangers of falling debris and structural collapse.

It is then hardly surprising that the leading names of the mounted breaker sector should find themselves at the forefront of the demolition industry. In recent years, industry leaders like **Krupp, Rammer, Indeco** and **Montabert** have developed the traditional hydraulic piston design to an infinitely variable and adjustable unit.

'THINKING BREAKER'

Using a similar design, both indeco and Montabert have introduced a 'thinking breaker', an attachment which adjusts itself to optimise performance in any material. Judging the hardness of application by measuring the force deflected back into the hammer, the unit adjusts to harder, less frequent blows in hard applications or to softer, more frequent blows in softer, materials.

Introduced last year as part of the company's thinking series' **Indeco's** 621 breaker is already proving popular with users of excavtors in the 25 t to 27 t weight class. Meanwhile, **Montabert's** proven BRV range of variable breaker continues to grow, with the latest addition, the BRV32, already selling well worldwide.

While both Montabert and Indeco concentrate on the 'thinking' design, Rammer, a name almost anonymous with demolition breakers, has gradually developed a highly impressive machine range. From the S21 mini excavator/skid steer loader mounted unit, which at 2,200 blows per minute is claimed to be the fastest breaker in the world, to th huge 5.8 t operating weight rock breaking G120, the company has breaker to suit just about every carrier machine and application.

Clearly, this increase in breaker power could have caused an increase in the amount of vibration transmitted to the carrier machine. However, all of the leading marques have spent considerable time and effort on developing specialist mountings.

Integral design has also moved on with the likes of the UK's **Padley & Venables** concentrating on the use of high quality, heat treated steel to provide high wear resistance and hardness.

Following the machining operations, the tools are individually marked with identification 'symbol',

facilitating full manufacturings traceability. In conjunction with this the company operate an historical data based logging system enabling P&V to monitor every single tool by serial number and specific heat treatment process for indivdual furnace loads.

OTHER OPTIONS

But the breaker is no longer the only weapon in the demolition contractor's armoury. With the steady development of hydraulic pumps and the greater power that they now provide, the excavator boom has rapidly become an arm on which can be mounted any of a number of fingers or hands.

Concrete pulverisers, crushers and crunchers offer the user a number of benefits. Quieter, and more controllable than the standard concrete breaker, the crusher is also able to reduce concrete pieces to a manageable size, strip the concrete from the reinforcing steel bar to enable separation prior to crushing, and then

SOUNDPROOFED HAMMERS SOLVE A PROBLEM

Many of today's older hospitals no longer conform to modern requirements for the care and attention of patients. A recent example demonstrated how the demoliton and conversion work needed to bring these hospitals up to standard can be carried out without excessive noise levels.

In Berlin-Neukolln, Germany, a bunker was built between two hospital buildings during the 2nd World War to allow operations to be carried out during air raids. The walls of this bunker were up to 1.6 m thick and the ceiling 2 m thick.

After the war, advantage was taken of the thick concrete walls to provide protection against radiation from a 'Betatron', which produced the gamma rays used to treat tumours before the introduction of radioactive isotopes.

The bunker then fell into disuse and the decision was taken to have it demolished. Although the walls were not particularly heavily reinforced, the thick solid concrete could nonetheless only be tackled using hydraulic hammers. As it was important to keep noise levels down as far as possible for obvious reasons, Krupp hammers of type HM 902 and HM 710 were provided with soundproof casings.

However, this was not enough for the BerlineSenate's supervisory authority for town planning and the environment, so in addition to this, temporary noise-protection walls made of floorboards were set up on both open sides to a height of 8.5 m. The boards were fitted together with tongue-and-groove jointing in order to maximise noise reduction; if normal planking had been used, the efficiency of this sound insulation would have been spoiled by the 'window gap effect' (a window opened by even the smallest of gaps loses its noise-reduction capacity almost fully). These walls were then lined with 100mm thick strips of mineral wool which provied the actual sound-proofing.

Hans Pohl, junior boss of the Berlin demolition company of the same name, had the following to say about the extremely tight schedule which was imposed to keep inevitable disturbances - despite all the noise-reduction measures - to a minimum: "We had to complete the demolition work in 60 days, no easy task considering we had to get through about 1,600 mg of solid concrete.

In order to find out how effective these all-round sound insulation measures were, noise levels were measured in areas where one might expect to find patients, staff and visitors.

On the ramp of the main entrance to the new part of this huge hospital complex - around 70 m away - the enormal ambient noise level of 55 dB(A) was increased by only 2 to 3 dB(A), a barely perceptible difference.

At the side entrance, where there is a constant stream of people coming and going, levels of 60 to 65 dB(A) were measured. On the opposite side, the noise was clearly reflected by one of the older main buildings standing at right-angles, and the level in this areas rose to 68 dB(A), which is nonetheless relatively quiet.

Measurements were also taken on the first floor: the ambient noise level of approx. 60 dB(A) in rooms directly adjacent to the demolition site were avoided by clearing these rooms. Noise levels on the next floor up were avoided by clearing these rooms. Noise levels on the next floor up were already noticably lower.

rehandle both the concrete and the rebar into trucks or mobile rock crushers. Properly managed, the excavator fitted with a crusher attachment can carry out the works of three or four conventional machines.

One of the companies which has long been at the forefront of specialist excavator attachments is US based La Bounty. The company which is probably best known for its popular concrete pulverisers, has recently introduced a new MSD 11OR rotating mobile shear for use on carriers in the 12-13 t weight class.

With a shear jaw opening of some 440 mm, the MSD 11OR offers a cutting force at the throat of 400 t. A 360° continuous rotation allows penetration and precise cutting at virtually any angle.

This foray into shears will not, however, detract from the compnay's continuing development of its pulveriser range. Units are now available for carrier machines in the 3 t to 16 t operating weight class, making the mini to midi excavator an even more viable demolition proposition.

Ohio based Allied has also continued the development of the boom mounted concrete crusher. As local authorties have become more stringent and as the method of partial demolition/partial refurbishment grows in popularity, the jaw crusher or cruncher has found increasing uses.

The concrete Cruncher, a high speed demolition tool, is said to be capable of completing a demolition job in a fraction of the time required by conventional techniques. Opening and closing in three to five minutes, the unit is able to crush a wall with a rapid biting action.

Another way of breaking up material is through non-explosive rock splitting. Darda's method operates on the wedge principle. Rocks, concrete or marble are not blasted but split. The method is simple. First, a hole with a prescribed diameter and depth is drilled into the material to be split. The wedge is then introduced into the hole while the wedge itself is still in a retracted position. Once in place a hydraulic pump unit is activated which causes the wedge to be pressed forward between the two counter-wedges separating them with great force and thus splitting

SPEEDY SAVING

The speed and versatility of Diamant Boart SA diamond wire sawing was demonstrated recently on a bridge demolition contract in West Germany. Highway B26, a two lane highway between Schwein-furt and Bamberg, was to be upgraded to a four lane dual carriageway, a job which involved the demolition of a bridge at Hallstadt.

Total demolition, using explosives, could not be contemplated as the railway line which ran over the bridge had to be retained. It was decided, therefore, to use diamond wire saws to cut longitudinally along the centreline of the structure and remove one half of the bridge deck at a time. This was then replaced with a temporary deck.

The existing 18 m long by 1.2 m deep prestressed concrete bridge contained 22 mm and 26mm dia steel reinforcing bars along with prestressing cables of 32 mm high tensile steel. The rails and ballast were removed and 200 mm diameter diamond core drills were used to drill vertically through the deck at 4.5 m intervals to enable the wires to be threaded.

Using a cable length of not more than 22 m, sawing began at around 18.00 pm on the Thursday and was completed towards midnight on the Friday. Alowing for delay when the wire came into contact with reinforcingbars of prestressing steel, actual sawing of them took no more than 24 hours.

In the meantime, pneumatic drills were used to free the deck from its abutments, and a Schmidbauer mobile crane lifted clear the 277 t section on the Saturday morning.

the material within 10-20 seconds.

SWISS APPLICATION

The splitter can also be used for underwater projects such as a recent application in Switzerland where concrete piles built for a temporary bridge across the end of Lake Zurich had to be disposed of using the company's C11Ssplitter. Experts feel this method will become increasingly acceptable as pressure for an environmental method grows.

But it is not just the specialist manufacturers which have been involved in the design and development of the demolition tool. Komatsu, the world's second largest construction equipment manufacturer, has recently introduced what it describes as 'the world's largest hydraulic crusher'.

Weighing in at 10 t, the unit features a jaw opening of 2.3 m and a full 360° rotation. Mounted on a hydraulic excavator carrier of 100 t capacity (like the company's owns PC650), the crusher produces a cylinder force of 250 t.

Developed with the co-operation of Komatsu equipment users, the unit recently proved its worth on a vast demolition contract near Osaka Station, Japan. site Komatsu's crusher is easily subs capable of handling 10 t pieces worl of concrete, quickly reducing it down to transportable sized chunks.

As the breaker and crusher have evolved, so a new sector of specialist equipment manufacturers have sprung up to take care of the less main stream jobs.

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CALL FOR PAPERS

5TH INTERNATIONAL DRAINAGE WORKSHOP (IDW5)

Pakistan Water & Power Development Authority (WAPDA) and International Commission on Irrigation and Drainage (ICID) will be holding the 5th International Drainage Workshop (IDW5) at Lahore, Pakistan on February 8-15, 1992.

Organisers have requested the prospective authors for submission of abstracts of papers for presentation in the Workshop to Mr. F.A. Zuberi Director General, IWASRI & Convenor Technical Sub-Committee (IDW5) 26/27 M, Model Town Lahore.

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NEW TRENDS IN SITE POWER ON CONSTRUCTION SITES

Generatring power on construction sites in neater, safer, quiter and more efficient then ever before, thanks to attentive manufacturers and effective legislation

MAJOR PLAYERS in the site power, market have seen substantial growth in demand world-wide in recent years.

The performance of French based mobile compressor manufacturer, **Maco Meudon** - reckoned to occupy the third position in terms of global market share - powers this point home. In the 1989 financial calendar year sales exceeded FFR 375 million, representing growth of 32% over 1988.

Also signalling the expanding international demand for portable site power is that Maco Meudon's exports sales exceeded French domestic business for the first time. The company also enjoyed market share growth in all products. Meudon's forecast for turnover this year FFR 500 million, reflects expectations of continuing growth.

Firm estimates of the total world market for site power system are harder to come by. One informed estimate offered to IC puts the annual sales of mobile compressors in major markets around 50,000 with Europe probably accounting for around 25,000 the Untied States a possible 15,000 with a similar figure for Japan.

Other date, from equipment analysis reports by construction plant markets specialist CIG, puts the market for mobile compressors in West Germany at around 5,000 pa, and 5,000 for production. In Italy, the market is estimated to be about 5,000 and production 3,000 while figure quoted is around 6,000 with production quoted a 4,000.

With prizes of that order in play, it is no surprise that there is intense international rivaly to meet this demand, with **Atlas Copco** and **Ingersoll-Rand** lvying with one another for the top position in portable compressor market share.

In the popular 35-65 1/s capacity range, Atlas Copco, earlier this year, stated confidently: "Between a quarter and a third of all compressors of this size sold throughout the world are of Atlas Copco manufacture."

Several of the leading manufacturers in this area of site power have evidently been doing well. At Ingersoll-Rand, John Stand, UK-based manager of marketing, whose responsibilities cover portable compressors in Europe, the Middle East and South Africa, says their has been "massive growth over the last three years.: While he commented that "the market is now at the top of the current cycle" and could be slightly reduced over the next year, he also sees it "staying buoyant."

In order to meet that level of sustained demand, on site innovation is a constant feature in site power equipment.

Maco Meudon, for example, had entered that large, on-site compressor market for the first time with three models designed and developed in cooperation with the company's US parent, Sullair.

One model is the MV201, a two-wheel, heavy duty portable compressor which produces 12m3/min (424 cfm) at 12 bar (175 psi) operating pressure. It is fitted with the new Caterpillar 3116T engine.

The MV291 also utilises the same engine to produce 17m3/min (600 cfm) at 7 bar (100 psi) operating pressure using different air end but otherwise common componentry to the MV201. The compressor is supplied as a trailer unit.

Largest in the new site compressor line-up is the MV3512. This four wheel model delivers 21m3/min (750 cfm) at 12 bar (175 psi) and is also fitted with a Cat engine,

the 3306T.

Maco's Peter Smith says the new ranges benefit from the ability to use existing 'know-how' and engineering facilities plus Maco's input in customising the machines for the European market where the company also adds its marketing and distribution strengths.

Europe, in the run-up to the free internal EC market post - 1992, is increasingly attractive to all types of construction equipment makers. Ingersoll-Rand's John Stang considers that an important factor in trends for the shape of portable compressor sector in the future will be "bringing down trade barriers within the EC."

In his view, this will favour the multi-nationals as some indigenous manufacturing companies have been protected in the past.

I-R, like other leading compressor manufactures, is active in other site power areas such as electric generators, not only in Europe but world-wide. For its part, Ingersoll-Rand has introduced three new, large portable air compressors featuring freater serviceability and a more compact and fuelefficient design. "We placed a premium on serviceability "says Dick Wennerberg, the US based marketing manager of Ingersoll-Rand's Portable Division. "To do that we flew more than a dozen service people from across the country to our Mocksville, NC, plant to act as consultants to our engineers."

The new units, models HP1300 WCU (1,300 cfm, 150 posig), XP1400 WCU (1,400 cfm, 125 psig), and the P1600 WCU (1,600 cfm, 100 psig), feature 435 - BHP Cummins engines with fuel efficiency ratings averaging 18.5gal/hr at 75% load.

I-R's Construction Equipment Group offers a line of portable, diesel-engined generator sets. The three models, 20,30 and 50 KW, are powered by conservatively rated, water-cooled, direct-injected diesel engines.

Atlas Copco also offers gensets in a range of eight models producing from 33-275kVA with a choice of voltages. The Atlas Copco generators are self-contained power packages in a compact, rigid housing, mounted on a heavy duty steel skid. Each unit had a weatherproof steel canopy for operation in all climatic conditions.

Other factors influencing the design of site power equipment in today's market place include demands for 'environment friendly' features. Another significant trend is the increase in the numbers of small, highly portable units.

In the genset market, dozens of specialist manu-facturers would-wide offer an extensive choice of machines tailored for general construction sites and, increasingly, for the plant hire or rental, sector.

I-R, in the UK, for instance, has an advance design P130 WD portable compressor aimed at plant hire customers. With the operator in mind, the design of the P120 WD had quiet and simple quick start and convenient controls. Other userfriendly features include automatic excess starting fuel and automatic bleeding of the fuel system in the Deutz F3L1011 diesel engine.

The new Deutz 1011 engine is gaining popularity with compressor companies and is being fitted to three models in Maco's MV renge. Maco also states that it will soon launch a new 'super compact' compressor, the Python. Weighing 100 Kg it is powered by a Yanmar diesel engine and develops 800 1/min (40 cfm) at 6bar (90 psi) operating pressure.

Atlas Copco also recently announced that, following two

years of extensive development, it has introduced a series of redesigned portable compressors in the capacity range 35-65 1/s. Designated XAS 35, 45, 55, and 65, the new models replace the previous XAS units. A customer marketing study showed that the key requirement from users was reliability and selected design features enhance reliability.

UK air compressor manufacturer, **Hydrovane,** this year added to the ranks of innovation by giving a first public showing of the HV4L portable air compressor powered by a Lister-Petter LPW3 Alpha Series engine, It is capable of delivering up to 85 cfm (401/sec) at 100 psi (7 bar) pressure.

FIERCE COMPETITION

Compention, if anything, is even fiercer in the genset sector than in air compressors. Innovations extend over the field from a similar trend to smaller, highly portable containerised power generation linked packages for use on lare constructions sites, and combinaton units.

US-based **Miller Electirc's** international Division, for instance, offers the three-in-one welder, power generator and air compressor, the Miller Air Pak. One engine provides all field welding, dutting and electrical generating tasks.

Multiprocess design performs ac, dc-ev welding for shielded metal are (stick) flux cored and gas metal are (MHG) welding, air carbor are cutting, plus TIG repair. Auxiliary power is 15 kW three-phase of 10 kW single-phase, while not welding, and 3 kW while welding.

The air compressor function provides 40 cfm of compressed air at 90 psi, generated by one engine combustion chamber, claimed as the 'Miller exclusive.' The unit has a 21 gal air storage tank, pressure regular and relief valves with automatic water drain.

UK-based **Compair-Holman** produces two units in its Zitair range of small portable compressors, the 85 and 100, both being available with a 2.5 KVA generator.

The operator simply switches over the generator when encessary and no second vehicle is needed to transport it. Ziaatair compressors are all fully silenced to EEC noise emission directives and have zinc coated bodies to resist rust. The machines feature flat body panels for simple repair work, easy access to the interior and the option of security embossing.

Features include ease of servicing a single-side, one locking door and Donaldson Cyclopak air cleaners. The equipment has full instrumentation, engine hour meter and a maintenance-free battery.

For large scale power requirements on site, British manufacturer **petbow** offers its Commnadenter system. This consists of 6m containers housing complete generating sets up to 1,000 kW in each, all mechanically and electrically linked together by a 12m control system and distribution switchboard container designed to control up to eight generating sets fully automatically.

Each 6m container, silenced to well below EC noise regulation requirements, houses not only the generating set but all the support systems necessary to make the unit a totally self-contained package with a fuel tank and top-up system, batteries and charging equipment, local controls and a fully lagged exhaust system.

The 'Portabe' can thus be used a as individual power package should this prove necessary or when the contract ends, Diesel engines employed can be chosen from leading makes such as Cummins, Perkins, MTU,

Dorman, Fiat, Volvo or Scania.

All alternators are of brushless design, fully tropicalised to withstand salt water atmospheres, dust, sand and high ambient temperature. The control system can be arranged to suit local site conditions and the degree of manual or automatic control required.

As a bonus, the system can be arranged to provide a construction camp with all its hot water requirements for kitchens, showers and central heating, via heat exchangers, which, at a small extra capital cost, can be incorporated in each engine's colling system.

Petbow says that its Command center system can provide power on site within 10-12 weeks. The company has a number of these systems currently in operation - on the Franco- British Channel Runnel project, in Antigua and in the Middle East.

Petbow's range of power generation extends from 5 kVA to 6,000 kVA.

In the fast-growing smaller end of the genset market construction managers have a very wide selection of equipment from which to provide portable site power. Japannese plant figures prominently in this crowded sector of the global market.

A major feature of **Caterpillar** gen sets is their single source design with engine, generator and switch-gear always performance matched.

Available for prime and standby power applications in ratings from 50 up to 6,560 kVA, they are all powered by Cat diesels and capable of running at 50 or 60 Hz. A signifiant development in Cat gen set technology is the introduction of the 3600 family of diesel engines. The 6, 8, 12 and 16 cylinder engines are used in gen sets with power ratings from 1,500 to 6,560 kVA.

Typical of the continuing extension of the choice available to end users or hire and rental companies are new diesel products lauched into the UK market by **Honda**. The new generators, adding a diesel option to the manufacturer's range of portable power, are the EX 10D and the EX 4D with rated outputs od 10 kVA, respectively, at 115/230V. Features on these generators include 'silent pack' design; key start stop; and engine protection systems.

The growing need to provide 'environment friendly' features is acknowledged in the design of these units. Both generators emit minimum operating noise due to their silencing systms, diffusing noise output to 65dB(A)/7m from the EX10D and 66dB(A)/7m from the Ex4D, well below EC regulation levels which are an increasingly important consideration in supplying the large European site power market.

Kubota had previously brought out its new breed of light weight, portable diesel generators, designated the 'Low Boy' range designed to operate well within the EC noise requirements.

The 'green' effect is also reflected in yet another new range of generators from **AEG**. Incorporating the latest technology in engine design, these 2 kVA, 3kVA and 5kVA units are designed specifically designed with the options to use lead-free petrol and for easy conversion to propane LP gas.

Designed for all singlephasé applications, the sets are said to be ideal for on-site use with electric power to tools, lighting and field communications equipment.

Scorpion Generators, based in the UK, has also introduced a new range of generators powered by Honda diesel engines. These are

based on the company's range of Lister-Petter and Lombardini machines. Using a tubular steel frame, powder coated for maximum durability, the engine and close coupled alternator are mounted on a steel base plate that is attached to this frame via-anti-tear, antivibration mounts.

Also produced are Honda petrolpowered sets from 1.5 kwW up to 5 kW: Scorpion's design team design and build genertos to individual order up to 1,000 kVA.

Lighting towers up to 18 m are also available to give a complete site electrical package from the company. The provision of site lighting is, of course, an important element in meeting on site power requirements. Apart from the lighting specialists and power 'package' supliers, genset producer frequently take the logical step and offer lighting equipment.

Ingersoll-Rand's Portable Division offers two portable light towers for use in low-light and night construction projects. The newest model, the 4060D, is powered by a genset-grade Kubota D950-BG diesel engine, which features a heavy duty flywheel to eliminate light fluctuation.

The three-section, telescoping tower of 4060D, is capable of mounting four floodlights from 12 to 30 ft. The unit provides 60 Hz. I-R's 5080D, portable light tower is powered by a Lister Diesel engine. The unit's generator provides 8 kW of output at a frequency of 60 Hz and is capable of powering six floodlights.

From the international electrical and lighting group **Philips Lighting** produces an extensive range of luminaires suitable for construction sites is available.

These units can be used with different types of high-intensity discharge lamps, ranging from 70,80,100,250, and 400 W lamps to the compact PLC 26 W lamp.

Philips Lighting underlines: "Whatever the specific nature of the construction site, certain basic requirement must be satisfied by the lighting. In the first place the lighting should, of course, ensure that people, machines and vehicles cn move about safely anywhere in the area and facilitate their performance of the various jobs and duties as required.

In order to withstand arduous onsite environments, the Philips range of floodlight luminaires has housing and gear compartment in injection-moulded and highly resistant polyamide (glass fiber reinforced nylon) of exceptional strength. In addition, there is a 5 mm-thick toughened glass plate which is attached to the housing by means of four clips made of stainless steel. The floodlight is also double insulated (Class II) and silicone gaskets between the front glass and the housing and between the lid and the connection box provide a jet and dust proof seal.

An important aspect of construction site lighting is the avoidance of glare and the creation of deep shadows which pose a safety hazard. Philips solves this problem by using asymmetric wide-beam light distribution where high-grade aluminium reflectors ensure not only the avoidance of glare but also a good lighting level and good beam control.

Auriga-Cooch, based in the UK, is a floodlighting specialist which offers a range of fast-tow, multi-role units. The cmpany makes the significant point that "The use of mobile floodlighting towers as an auxiliary power source in daylight hours when the lights are not required in an increasing practice in these days of tight margins." The company, which provides units to meet this trend, says that the extra utilisation of equipment brings significantly better

returns to operators such as plan hire (or rental) companies.

Plant hire is, of course, a major option to consider when planning to provide site power on site. Companies such as **Aggreko Generators,** which lays claim to operting the world's largest and most comprehensive power hire fleet, comprising generators, cable, load banks and transformers, can provide one answer.

An alternative to the process of a construction buyer or planner selecting every individual item require to set up a complex site power network, particularly on distant overseas sites, it to opt for the 'package' solution from a specialist supplier or contractor. **Tripower,** based in the UK, for instance, has supplied a major distribution system for the massive Cairo Waste water Scheme in Egypt.

Whatever the problem, the site power industry has the expertise, and the equipment, to ensure that ever site, no matter how remote, can plug into the power.

(Courtesy - International Construction)

(Continued from page 45)

people to explain the situation, the remedies and the costs of doing nothing to the politicians. This does not mean that it is an easy task. Indeed, in many situations it is difficult. But that still doesn't change the responsibilities or the required actions.

CONDOLENCE

The Executive Council of the Engineering Congress Condoled the sad demise of the following members who breathed their last in recent months.

The Council offered Fateha for their departed souls

1. Engr. Mohammad Akhtar Qureshi Chief Engineer (Retd.)
2. Engr. Siddique Ahmed Choudhry Superintending Engineer
3. Engr. Rana Ansar A. Imdad, Executive Engineer (Retd.)