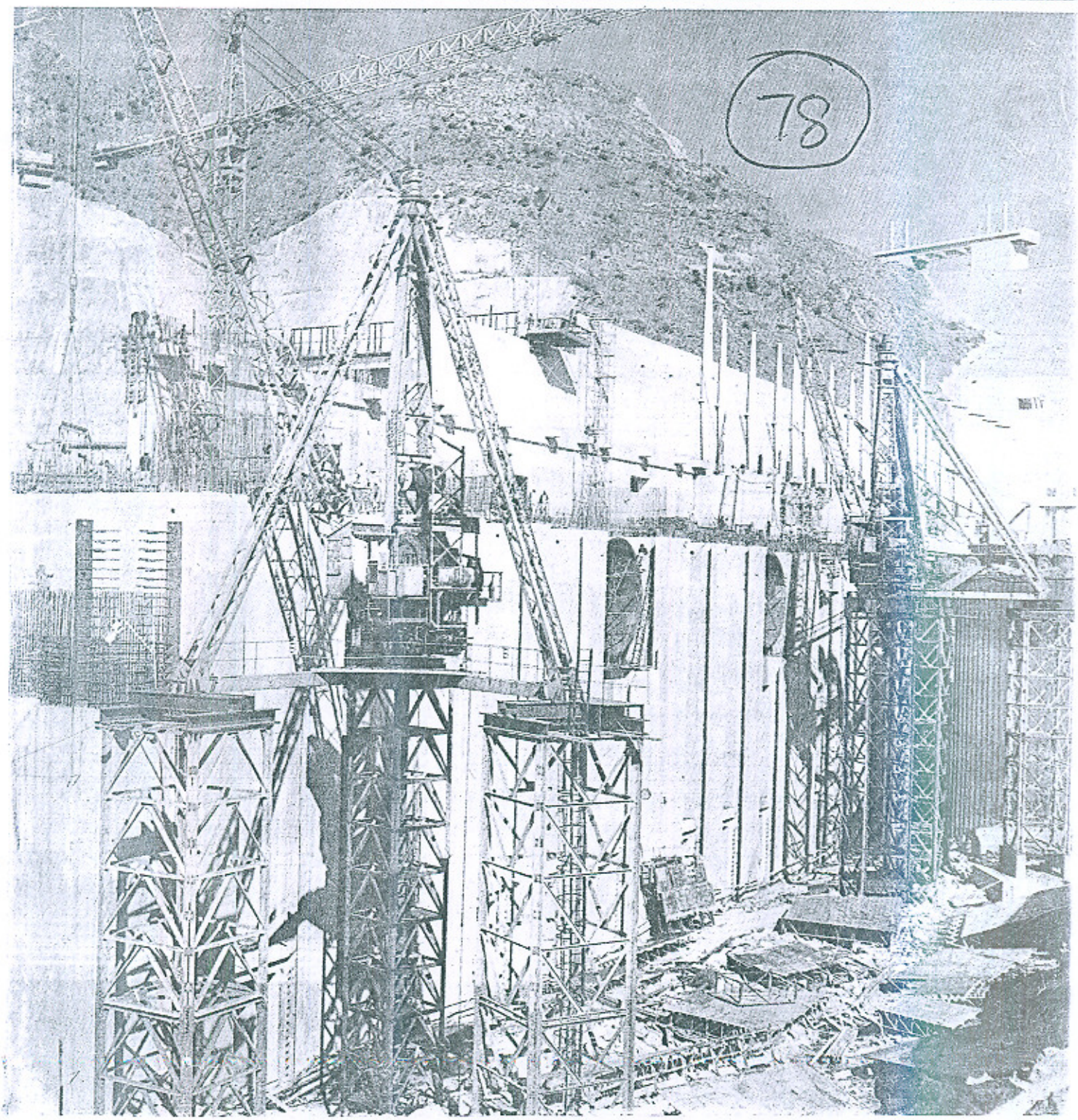
Engineering News

A QUARTERLY JOURNAL OF PAKISTAN ENGINEERING CONGRES

Vol. XXVII No. 1&2 March - June 198



CODE OF ETHICS

PAKISTAN ENGINEERING CONGRESS

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

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

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

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

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

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

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

۱۔ اِنَّ اللّٰهَ يَاْمُرُكُمْ اَنْ تُؤَدُّوا الْاَمٰنٰتِ
اِلٰٓى اَهْلِهَا ۙ وَاِذَا حَكَمْتُمْ بَيْنَ النَّاسِ
اَنْ تَحْكُمُوْا بِالْعَدْلِ ۭ اِنَّ اللّٰهَ نِعِمَّا
يَعِظُكُمْ بِهٖ ۭ

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

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

۲۔ اَوْفُوا الْكَيْلَ وَالْمِيْزَانَ بِالْقِسْطِ وَلَا تَبْخَسُوا
النَّاسَ اَشْيَاۗءَهُمْ وَلَا تَعْثَوْا فِي الْاَرْضِ
مُفْسِدِيْنَ ○

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

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

۳۔ وَلَا يَجْرِمَنَّكُمْ شَنَاٰنُ قَوْمٍ عَلٰٓى اَلَّا تَعْدِلُوْا ۭ
اِعْدِلُوْا ۣ هُوَ اَقْرَبُ لِلتَّقْوٰى ۣ

"And let not hatred of a people in you not to act equitably. Be just ; tha nearer to observance of duty". v

3. You shall not injure maliciously, dir ly or indirectly, the reputation or empl ment of another Engineer, nor shall you to act equitably while performing pro sional duty.

۴۔ اَوْفُوْا بِالْعُقُوْدِ ۭ ○

"Fulfil the obligations". v

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

ENGINEERING NEWS

Quarterly Journal of the Pakistan Engineering Congress

Vol. XXVII No.1 & 2 March-June 1982

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

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

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

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

o Advertisement rates: by arrangement with the Editor.

Page

Effect of fallowing and Cropping on Soil Salinization
... Ch. Muhammad Altaf Hussain & Muhammad Sadiq. 3

Organization Theories
Abdur Rahim Mian 18

Preventive maintenance and Replacement Stratagies – Application of Renewal Theory
... Dr. Amjad Parvez Sheikh 21

Seminar on Irrigation Water Management. 27

For members only

BOARD OF EDITORS

Editor

M. Afzal Zaffar

Associate Editors

Khalid Faruq

S. Nazar Hussain Mashhadi

Staff Editor

Sh. Muhammad Sadiq

TITLE

Extension Works in Progress of Tarbela Power House

EFFECT OF FALLOWING AND CROPPING ON SOIL SALINIZATION

By

*Ch. Muhammad Altaf Hussain**

*Muhammad Sadiq***

Soils are in equilibrium with the environmental conditions of the region in which they are present. In humid climate there is always plenty of moistrure and its movement is downward. The soils are almost free from salts and acidic in nature. In arid regions the situation is different. The rainfall is low and the soils are deficient in moisture. The trend of soil moisture movement is generally upward. It comes up from lower depths of the soil and evaporates leaving the salts in its upper parts. In bare lands the process continues indefinitely and the presence of saline soils is a common characteristic of the lands present in these regions.

The presence of salts in these lands is further affected with the depth of watertable and the amount of salts the ground water contains. More salts are added when the watertable is shallow and the ground water has higher amount of salts as compared to a situation where the watertable is deep and the ground water is of less salt contents. In semi – arid regions the conditions are almost the same as they are in the arid regions.

In these regions the barani agriculture is not possible. Irrigated agriculture is the only solution to develop agriculture there for which the supply of adequate amount of water of reasonable quality is a pre-requisite. The soils are to be reclaimed and maintained in salt free condition to ensure the continuity of growing good crops. For this purpose excessive amount of water should be given to leach the salts, and in reclaimed lands the trend of moisture movement should be kept downward. Thus addition of water in the ground water is inevitable. Consequently the watertable rises. To check its rise beyond a specific depth the drainage is to be provided. Thus irrigation and drainage should go side by side by side if successful agriculture is to be maintained.

In reclaimed lands the croppong pattern fallowed also plays vital role to effect the soil salinization. In case a land is kept fallow for some period, the salts should show the trend of upward movement. If fallowing is in Summer, it would behave differently, when compared with fallowing in Winter, because of variation in temperature. In summer the land dries up to a considerable depth and the water moves in the form of vapours from the lower parts of the soil which does not carry salts with it, but in Winter it rises to the top of the soil surface in the form of liquid, where it evaporates leaving the salts there. If the land is kept under cropping throughout the year and the drainage is effectively controlled, the salinization of soil would be checked upto a great extent. Thus in reclaimed lands the conditions which effect soil salinization need careful study. Keeping this in view the research work was under taken and the results of the experiment conducted are given and discussed here.

REVIEW OF LITERATURE

Nazir reported that in case of bare lands when the watertable is maintained below 10' from surface in sandy, silty and in clay soils, the water lost by evaporation is 2 to 4% of the evaporation from free surface. With watertable

* Physical Chemist, Directorate of Land Reclamation, Punjab, Lahore.

** Research Assistant, D.L.R. Office, Lahore.

maintained at 0.9, 1.2 and 2.0 feet depths, in these very soils, it is 50% of that of free water surface. In case of the water saturated soils, evaporation causes a brisk fall of watertable within the range of capillary height after which the rate of fall slowly decreases.

Asgher et al showed that from 10.5 feet deep watertable 1.5 inches water is lost during the whole year.

MATERIALS AND METHODS

The work was carried out from 1972 to 1977 in the iron lysimeters which are 15' high and are of 36" diameter. These are 20 in number. They contain fine sandy loam type of soil in them. The soil was analysed before starting the experiment and after completing it. The soil samples were taken from 0–6", 6"–1' and 1'–2', depths of the soil in each case.

The arrangements exist in the lysimeters to maintain the watertables at the desired depths. The watertables were kept at 13.5, 10'.0 and 5'.0 depths. The electrical conductivities of the ground waters ware maintained at 5000 and 10000 micromhos/cm. Salts: Sodium choloride and Sodium Sulphate were used in equal quantities to make the above salt concerntrations of ground waters.

THE FOLLOWING SETS OF TREATMENTS WERE KEPT UNDER OBSERVATION

i Fallow throughout the year
ii Fallow in summer and cropping in winter
iii Cropping throughout the year
iv Cropping in summer and fallow in winter.

The crops grown were wheat and cotton. The wheat varieties were: Lyallpur 73 and Punjab 76 and that of cotton were: B557 and C 134

The agricultural practices recommended by the Agricultural Department were followed. The crops were irrigated whenever they visually needed watering. Each irrigation was of 3" depth. Tubewell water, the analysis results of which are given below, was used for irrigation.

Table–1 showing the analysis results of the tubewell water used for irrigation.

$EC \times 10^{6}$	pH	Millequivalents per litre							Total cations.	T.S. by evaporation.	RSC	SAR
		Ca	Mg	Na	CO_3^2	HCO_3	Cl	SO_4				
960	8.38	1.70	2.50	5.40		6.9	1.9	0.80	9'6	543	2.70	3.72

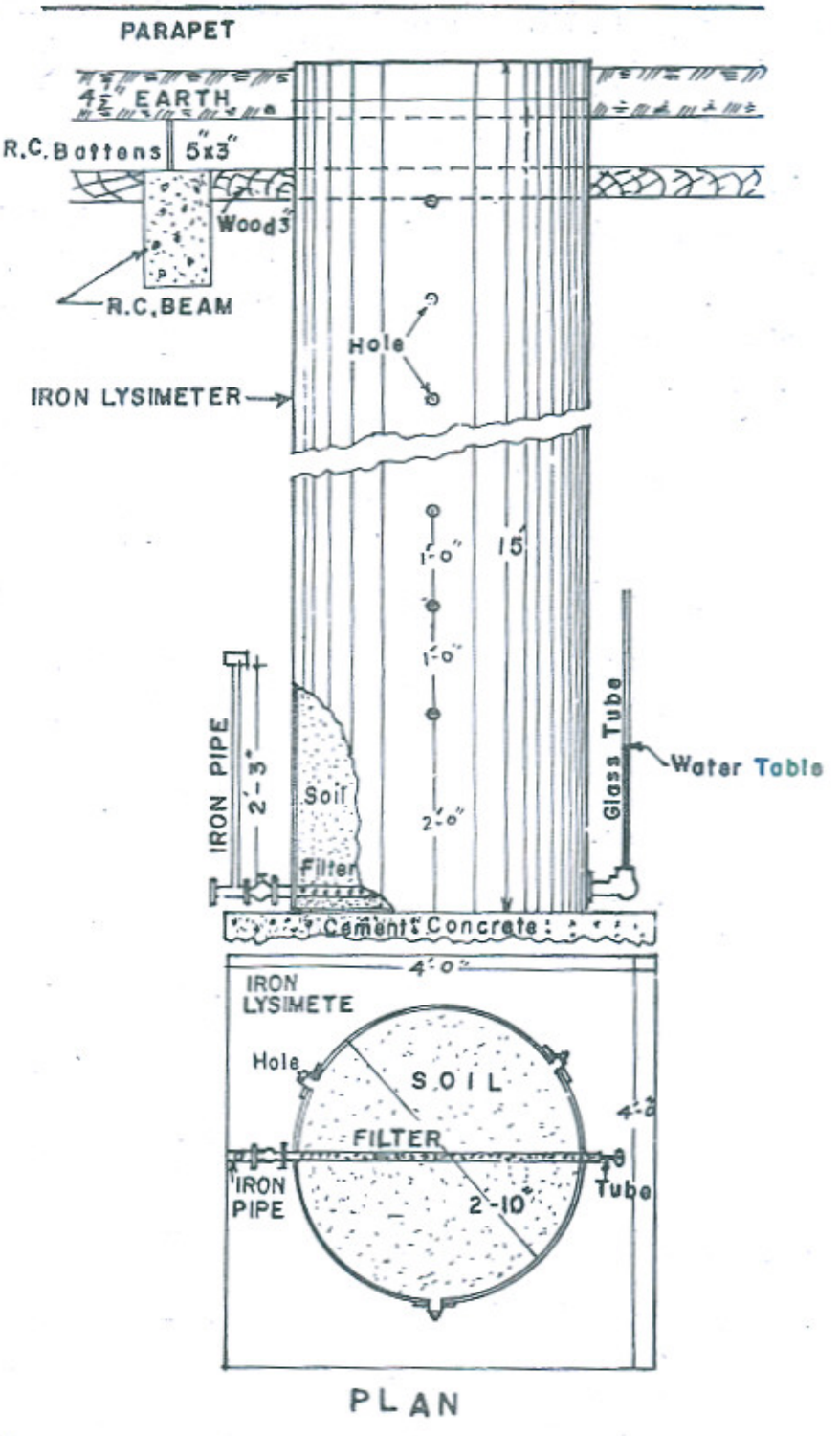
Complete record of the irrigations applied, the rainfalls received, the accretion and depletion in ground water and the crop yields was maintained.

RESULTS AND DISCUSSION

The analysis results of the soil in different lysimeters, before starting the experiment and after completing it, are given in table 2 and 2a respectively. They show that in the begining the salt percentage in the soil in all the cases was less than .2 and the pH was less than 8.5. Thus the soil was non-saline and non-alkali, but after five years, when the experiment was concluded the position of salts in different sets was different.

In Set–I which remained fallow throughout the year salinity developed in all the cases. With 13.5' and 10' deep water tables, the accretion in watertable was only in the monsoon season when the heavy rains were received. In dry season, most of the moisture retained by the soil evaporated leaving the salts in the upper part of it. In the beginning the salt level in the upper 6" of the soil was .14 percent in each case, but at the end it was .3 percent and .26 percent respectively. In case of 5' deep

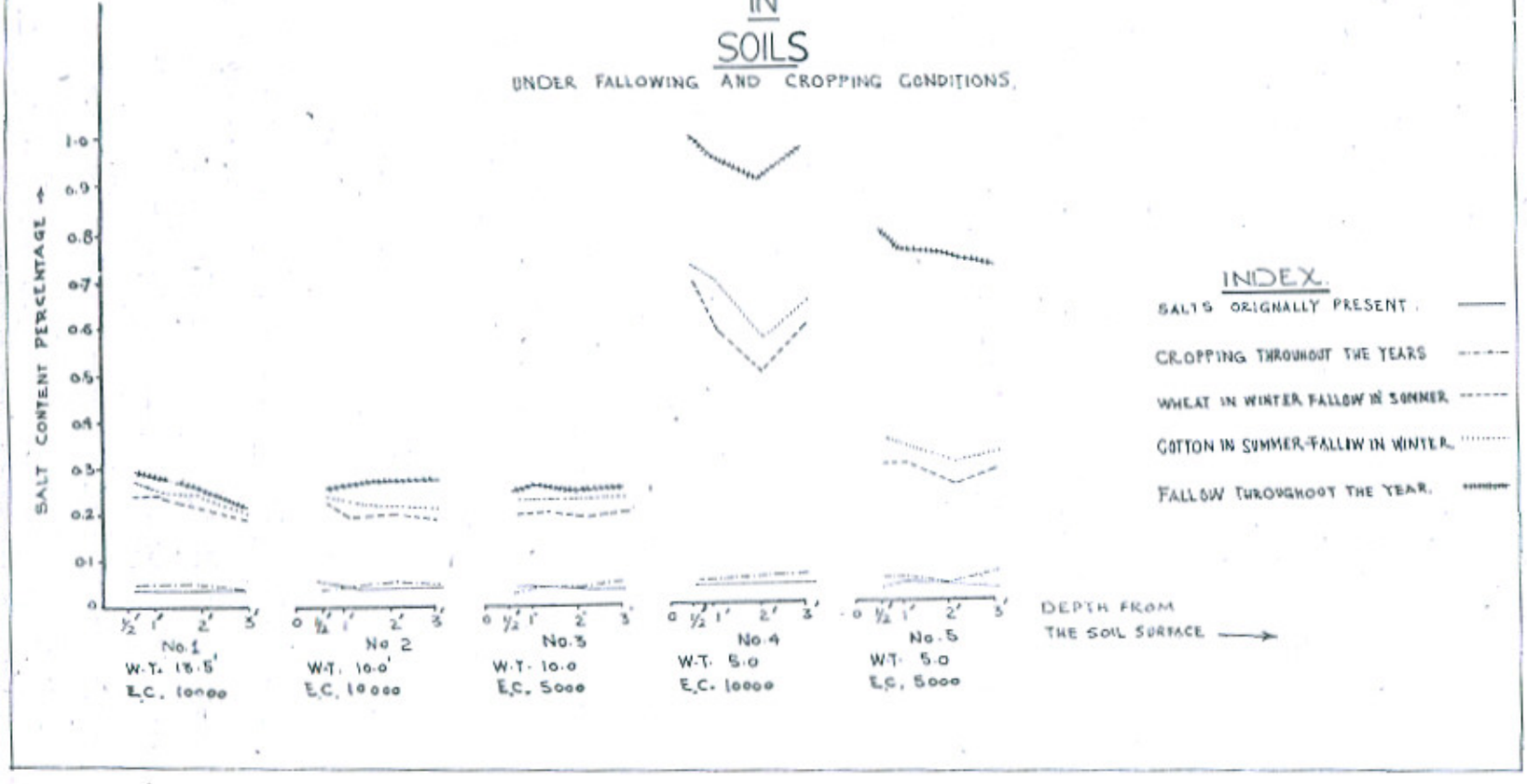
DETAIL OF IRON LYSIMETER



D. BY: A. GHAFFAR

MOVEMENT OF SALTS IN SOILS

UNDER FALLOWING AND CROPPING CONDITIONS.



watertable the position was different. Some accretion in the watertable took place in the rainy season, but during the remaining period of the year the water losses from the ground water were very high (table 3 & 3-a). The rain water retained by the soil and the sub-soil water both contributed to the accumulation of salts in the upper part of the soil, The salt percentage of the soil with 5' deep watertable, where the E.C. of the Ground water was 10000 micromhos/cm was more when compared with the same depth of watertable where the E.C. of ground water was 5000 micromhos/cm the salts originally present within the 6" depth of the upper soil were about .14 percent while at the end they were observed to be 1.0 and .80 percent respectively.

In Set–II wheat crop was sown in winter and the land was kept fallow in summer. Here the accumulation of salts was comparatively less as compared to the cases when the land was kept fallow in winter. In the beginning they were about .14 percent and at the end they were .25 percent at 13.5'.deep water table and .23 percent with 10' deep watertable. In case of 5' watertables their amounts were .3 percent and 0.7 percent with the EC of ground water being 5000 and 10000 micromhos/cm respectively. In Set–III where the soil remained under cropping throughout the year, there was no effect on the salt content of the soil. They were about .14 percent in each case both in the beginning and at the end. It shows that in case of irrigated lands if the crop cover is given to the soil throughout the year and the drainage is effectively controlled the chances of soil salinization are mostly eliminated.

In Set–IV the cotton crop was sown in summer and the land was kept fallow in winter. It was observed here that the accumulation of salts was more at the top of the soil. Originally they were about .14 percent but at the end with 13.5' and 10' deep watertables they were .28 and .24 percent respectively. With 5' deep watertables they were found to be .35 percent and .73 percent when the ground water had EC 5000 and 10000 micromhose/cm respectively. Thus fallowing in winter is more harmful than one in summer.

EFFECT ON THE GROWTH OF CROPS

The results of crop yields are given in Table 3. In Set–II wheat was grown in winter and the soil remined fallow in summer. The highest yield of the crops were obtained with 13.5' and 10' deep watertables. With 5' deep watertables the yields were generally low. It might be due to the excessive amount of moisture present in the root zone, because equal irrigations were applied in all the cases. Moreover, here the salts also accumulated in the root zone. They would have put in stress on the crop roots due to high osmotic pressure which develops in the soil solution with the increasing amount of salts.

Set–III was kept under cropping throughout the year. The crop rotation followed was wheat–Cotton. Here too the highest yield was obtained with 13.5' and 10' deep watertables. There was no accumulation of salts in the root zone of the crops even with 5' deep watertables. The fall in yield might be attributed to the excess of moisture, because equal irrigations were applied in all the cases. In case of cotton the crop being deep rooted, its roots would have passed into the saline zone and they would have been under stress due to the high osmotic pressure of the saline water which had EC 5000 micromhose/cm.

In Set–IV, where cotton was grown in summer and the land remained fallow in winter, the fall in yield of the crop with 5' deep watertables would have been due to the presence of excess of salts and the crop roots being have passed in the saline water zone.

SUMMARY AND CONCLUSION

In arid regions the bare land are generally saline. The agricultural lands are affected with the cropping pattern followed on them. In winter, the temperature being low, the soil moisture moves to its top in the form of liquid and carries salts with it, where it evaporates leaving the salts there. In summer, the temperature being high, the soil dries up to its lower depths and the soil moisture is lost from there in the form of water vapours which do not take salts

with it. Thus fallowing in winter is more harmful than fallowing in summer.

When a soil is kept under cropping throughout the year, the crop water requirements are provided by the surface irrigation application and the drainage is maintained properly. The chances of its salinization are mostly eliminated.

If the ground water is brakish, the higher yields of crops are obtained with deep water tables when compered with shallow ones.

REFERENCE.

1. Irrigation, Drainage and salinity. ** An International Source Book FAO/-UNESCO, 1973.

2. Baver L.D. ** Soil Physics Third Edition, 1961.

3. Ahmad Nazir Dr. ** Special Report No. 235--PH/Soil PHY--161 Studies on Soil Evaporation with whatertable at different depths in different kinds of soils.

4. Asghar A.G.
Rehman A. and
Zaidi H.S. ** Studies in Lysimeters
Part--IV, Crop Planning
For Salinity Control, 1962.

TABLE (2) SHOWING THE ANALYSIS RESULTS OF THE SOIL BEFORE STARTING THE EXPERIMENT

SALTS ORIGINALLY PRESENT 1972.

SET–1			DEPTH							
			0.6''		6''–1'		1'–2'		2'–3'	
W.T.	E.C.	LYS.NO.	pH	TS	pH	TS	pH	TS	pH	TS
13.5	10000	1	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	10000	2	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	5000	3	8.3	0.13	8.3	0.14	8.3	0.13	8.3	0.13
5.0	10000	4	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
5.0	5000	5	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
			SET–2							
13.5	10000	1	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	10000	2	8.3	0.13	8.3	0.14	8.3	0.14	8.3	0.14
10.0	5000	3	8.3	0.14	8.3	0.13	8.3	0.14	8.3	0.14
5.0	10000	4	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
5.0	5000	5	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
			SET–3							
13.5	10000	1	8.3	0.13	8.3	0.14	8.3	0.14	8.3	0.14
10.0	10000	2	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	5000	3	8.3	0.13	8.3	0.14	8.3	0.14	8.3	0.14
5.0	10000	4	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
5.0	5000	5	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.135
			SET–4							
13.5	10000	1	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	10000	2	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
10.0	5000	3	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
5.0	10000	4	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14
5.0	5000	5	8.3	0.14	8.3	0.14	8.3	0.14	8.3	0.14

TABLE-2(a) SHOWING ANALYSIS RESULTS OF SOIL AFTER COMPLETING THE EXPERIMENT

SET-1 FALLOW THROUGHOUT THE YEAR FROM 1972 TO 1977

W.T.	E.C x 10^6	LYS.NO.	DEPTH 0–6″ pH	0–6″ TS	6″–1′ pH	6″–1′ TS	1′–2′ pH	1′–2′ TS	2′–3′ pH	2′–3′ TS
13.5	10000	1	8.2	0.30	8.2	0.29	8.2	0.26	8.2	0.22
10.0	10000	2	8.2	0.26	8.2	0.27	8.2	0.27	8.2	0.27
10.0	5000	3	8.2	0.25	8.2	0.26	8.2	0.25	8.2	0.26
5.0	10000	4	8.1	1.0	8.1	0.85	8.1	0.80	8.1	0.87
5.0	5000	5	8.1	0.80	8.1	0.75	8.1	0.74	8.1	0.72
			SET-2 WHEAT IN WINTER AND FALLOW IN SUMMER							
13.5	10000	1	8.2	0.25	8.2	0.25	8.3	0.22	8.3	0.18
10.0	10000	2	8.3	0.23	8.2	0.20	8.3	0.20	8.3	0.12
10.0	5000	3	8.3	0.20	8.3	.20	8.3	0.19	8.3	0.20
5.0	10000	4	8.2	0.70	8.2	0.60	8.2	0.50	8.2	0.60
5.0	5000	5	8.3	0.30	8.3	0.30	8.2	0.25	8.4	0.28
			SET-3 CROPPING THROUGHOUT THE YEAR							
13.5	10000	1	8.2	0.15	8.2	0.15	8.2	0.15	8.2	0.14
10.0	10000	2	8.2	0.15	8.3	0.14	8.2	0.15	8.3	0.13
10.0	5000	3	8.3	0.14	8.3	0.14	8.3	0.15	8.2	0.16
5.0	10000	4	8.2	0.15	8.2	0.15	8.2	0.16	8.2	0.16
5.0	5000	5	8.2	0.15	8.2	0.15	8.3	0.14	8.2	0.16
			SET-4 COTTON IN SUMMER AND FALLOW IN WINTER							
13.5	10000	1	8.2	0.28	8.2	0.26	8.3	0.25	8.2	0.20
10.0	10000	2	8.2	0.24	8.2	0.23	8.3	0.22	8.3	0.21
10.0	5000	3	8.3	0.23	8.2	0.23	8.3	0.23	8.3	0.23
5.0	10000	4	8.1	0.73	8.1	0.70	8.2	0.57	8.1	0.65
5.0	5000	5	8.2	0.33	8.2	0.34	8.3	0.30	8.2	0.32

TABLE 3 SHOWING THE ACCRETION AND DEPLITION IN WATER TABLE AND WATER BALANCE IN DIFFERENT YEAR

SET 1. FALLOW THROUGHOUT THE YEAR

			1973			1974			1975			1976			1977		
E.C x 10^6	W.T.	LYS. NO.	R.F (")	ACC. or Dep (")	Water Balance (")	R.F. (")	Accretion or Deplition (")	Water Balance (")	R.F. (")	Accretion or Deplition (")	Water Balance (")	R.F. (")	Accretion or Deplition (")	Water Balance (")	R.F. (")	ACC. or Deplition (")	Water Balance (")
10000	13.5	1	29.62	3.41	26.21	18.18	6.06	12.12	24.75	- 4.12	20.63	39.09	- 5.68	33.41	19.22	- 2.66	16.56
10000	10.0	2	"	- 1.72	27.90	"	- 4.19	13.99	"	- 2.50	22.25	"	- 2.60	36.49	"	1.46	20.68
5000	10.0	3	"	- 1.23	28.39	"	- 3.04	14.14	"	- 1.88	22.87	"	- 2.29	36.80	"	.78	20.00
10000	5.0	4	"	2.75	32.37	"	2.12	20.30	"	- 6.36	31.31	"	- .82	38.27	"	4.80	24.02
5000	5.0	5	"	2.90	32.52	"	2.86	21.04	"	5.41	30.16	"	- 1.17	37.92	"	4.17	23.39

E.C. Electrical conductivity.
W.T. Water Table.
LYS. Lysimeter
NO. Number.
R.F. Rainfall
Acc. Accretion
Dep Deplition.

TABLE 3(a) SHOWING THE IRRIGATION DELTA APPLIED AND THE YIELD OF CROPS

SET-2 WHEAT IN WINTER FALLOW IN SUMMER

			WHEAT				FALLOW			WHEAT				FALLOW			WHEAT			
			19.11.72 to 18.4.73				19.4.73 to 21.10.73			22.10.73 to 19.4.74				20.4.74 to 11.11.74			12.11.74 to 27.4.75			
			IRRI: 12".0 R.F. 2".17							IRRI: 15".0 R.F. 2".59							IRRI: 15".0 R.F. 4".04			
ECx10^6	W.T.	LYS. NO.	IRR+RF. (")	Acc./ Dep. (")	Water (Cons.) "	Yield (Gms)	R.F.	Acc./ Dep. (")	Water Balance	IRR+RF. (")	Acc./ Dep. (")	Water (Cons.) "	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance	IRR+RF. (")	Acc./ Dep. (")	Water (Cons.) "	Yield (Gms)
10000	13.5	1	14.17	0.59	14.76	480	25.69	0.17	25.86	17.59	1.11	18.70	460	15.46	-4.62	10.84	19.04	-2.44	16.60	450
10000	10.0	2	"	1.56	15.73	450	"	0.54	26.23	"	2.34	19.89	420	"	-3.72	11.74	"	-0.48	19.52	400
5000	10.0	3	"	1.63	15.80	400	"	0.65	26.34	"	2.20	19.79	340	"	-3.73	11.73	"	0.87	19.91	350
10000	5.0	4	"	1.96	16.13	250	"	1.92	27.61	"	4.24	21.83	250	"	0.92	16.38	"	5.69	24.73	250
5000	5.0	5	"	2.02	16.19	300	"	1.61	27.30	"	4.89	22.48	280	"	0.47	15.93	"	5.10	24.14	300

Continued.....

FALLOW			WHEAT				FALLOW			WHEAT				FALLOW		
28.4.75 to 14.11.75			15.11.75 to 29.4.76				30.4.76 to 18.11.76			19.11.76 to 28.4.77				29.4.77 to 8.11.77		
			IRR: 12.0" R.F. 3.81"							IRR: 18.0" R.F. 2.54"						
R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+R.F. (")	Acc./ Dep. (")	Water Balance (")
20.71	-1.88	18.83	15.81	.01	15.82	450	35.58	-26.58	19.0	20.54	-1.69	18.85	420	16.07	0.54	16.61
"	-0.87	19.84	"	0.41	16.22	400	"	-15.48	20.10	"	-0.68	21.22	400	"	1.22	17.29
"	-0.07	20.64	"	0.82	16.63	350	"	-15.18	20.40	"	0.22	20.76	380	"	1.38	17.45
"	-3.11	23.82	"	1.37	17.18	200	"	-11.98	23.60	"	6.90	27.44	180	"	6.84	22.91
"	2.46	23.17	"	1.25	17.06	300	"	-11.48	24.10	"	6.34	26.87	300	"	6.54	22.61

TABLE-3(a) SHOWING THE IRRIGATION DELTA APPLIED AND THE YIELD OF CROPS

SET-3 CROPPING THROUGHOUT THE YEAR

			WHEAT				COTTON				WHEAT				COTTON				WHEAT			
			19.11.72 to 18.4.73				17.5.73 to 7.12.73				22.10.73 to 19.4.74				19.5.74 to 6.12.74				6.12.74 to 27.4.75			
			IRR: 12",0 R.F. 2.17"				IRR: 12",0 R.F. 25.1"				IRR: 15",0R.F. 2.38"				IRR: 12",0 R.F. 15.46"				IRR: 15.0" R.F. 4.04			
ECx10^6	W.T. (ft)	LYS. NO.	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)
10000	13.5	1	14.17	- 0.42	13.75	500	37.11	- 9.71	27.40	150	17.38	0.54	17.92	480	27.46	- 0.36	27.10	150	19.04	- 2.61	16.43	460
10000	10.0	2	"	0.01	14.18	450	"	- 8.61	28.50	140	"	1.38	18.76	440	"	10.44	27.90	130	"	0.57	19.51	420
5000	10.0	3	"	- 0.06	14.11	400	"	- 8.81	28.50	160	"	1.42	18.80	380	"	0.64	28.10	110	"	0.47	19.51	350
10000	5.0	4	"	3.37	17.54	230	"	- 7.91	29.20	100	"	4.50	21.88	250	"	1.84	29.30	90	"	3.52	22.56	250
5000	5.0	5	"	3.27	17.44	320	"	- 7.61	29.50	120	"	4.91	22.29	300	"	2.14	29.60	120	"	3.15	22.19	280

Continued.....

COTTON				WHEAT				COTTON				WHEAT				COTTON			
16.5.75 to 11.12.75				11.12.75 to 29.4.75				4.5.76 to 5.12.76				5.12.76 to 28.4.76				13.5.76 to 24.11.77			
IRR: 0.0" R.F. 20.71"				IRR: 12.0" R.F. 3.81"				IRR: 9.0" R.F. 35.58"				IRR: 18.0" R.F. 2.54"				IRR: 12.0" R.F. 16.07"			
IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)
20.71	- 2.40	27.31	130	15.81	0.06	15.87	430	44.58	- 17.38	27.20	120	20.54	0.30	20.84	400	28.07	- 0.86	27.21	130
"	- 1.71	28.0	130	"	.16	15.97	390	"	- 16.78	27.80	110	"	0.56	21.10	380	"	.08	28.15	110
"	- 1.61	28.10	120	"	.20	16.01	340	"	- 16.58	28.0	120	"	0.64	21.18	350	"	0.14	28.21	100
"	- 0.22	29.49	100	"	1.57	17.38	260	"	- 15.38	29.20	90	"	4.41	25.95	220	"	1.24	29.31	80
"	Nil	29.71	100	"	1.66	17.47	300	"	- 15.08	29.50	100	"	4.26	25.80	300	"	1.44	29.51	80

TABLE-3(a) SHOWING THE IRRIGATION DELTA APPLIED AND THE YIELD OF CROPS

SET-4 COTTON IN SUMMER FALLOW IN WINTER

			FALLOW			COTTON				FALLOW			COTTON				FALLOW		
			20.11.72 to 16.5.73			17.5.73 to 7.12.73				8.12.73 to 18.5.74			19.5.74 to 6.12.74				7.12.74 to 15.5.75		
			IRR: 12.0" R.F. 25.11"							IRR: 12.0 R.F. 15.46"									
Cx10^6 06x	W.T. (Ft.)	LYS. NO.	R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+ RF. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance (")
0000	10.0	1	2.97	- 0.44	2.53	37.11	- 9.71	27.40	150	2.38	0.98	3.36	27.46	- 0.26	27.20	160	4.04	- 1.85	2.19
0000	10.0	2	"	1.40	4.37	"	- 8.61	28.50	140	"	1.83	4.21	"	0.54	28.0	120	"	0.60	4.64
5000	10.0	3	"	1.33	4.30	"	- 8.91	28.20	130	"	1.80	4.18	"	0.64	28.10	100	"	0.97	5.01
0000	5.0	4	"	2.80	5.77	"	- 7.81	29.30	100	"	3.70	6.08	"	1.84	29.30	80	"	3.44	4.48
5000	5.0	5	"	0.11	3.08	"	- 7.71	29.40	90	"	3.74	6.12	"	2.04	29.50	100	"	3.03	7.07

COTTON				FALLOW			COTTON				FALLOW			COTTON			
16.5.75 to 11.12.75				12.12.75 to 3.5.76			9.5.76 to 5.12.76				6.12.76 to 12.5.77			13.5.76 to 24.11.77			
IRR: 9.0" R.F. 20.71"							IRR: 9.0 R.F. 35.58"							IRR: 12.0" R.F. 16.07"			
IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yield (Gms)	R.F. (")	Acc./ Dep. (")	Water Balance (")	IRR+ R.F. (")	Acc./ Dep. (")	Water (Cons.) (")	Yiel (Gm
29.71	2.41	27.30	120	3.81	0.14	3.95	44.58	- 17.18	27.40	120	2.54	0.18	2.72	28.07	- 0.94	27.13	100
"	- 1.81	27.90	110	"	0.74	4.55	"	- 16.58	28.00	100	"	0.61	3.15	"	0.05	28.12	80
"	- 1.50	28.21	100	"	0.74	4.55	"	- 16.36	28.22	110	"	0.60	3.14	"	0.15	28.22	80
"	- 0.19	29.52	90	"	4.14	7.95	"	- 15.05	29.53	90	"	1.86	4.40	"	1.32	29.39	60
"	.02	29.73	100	"	4.32	8.13	"	- 14.81	29.77	70	"	1.81	4.35	"	1.46	29.53	50

ORGANIZATIONAL THEORIES

BY

*Abdur Rahim Mian**

Summary:

Management usually attempts to organize an organization in a way that will facilitate the attainment of its goals. Since there are a vast number of structural variations possible, finding one that will be appropriate for a given organization is an exeptionally complexed problem.

in order to answer such structural design questions, a number of prescriptive organization theories have been formulated, including.

1. Classical or traditional organizational theories.
2. Humanistic organizational theories.
3. Contingency theories of organization design.

The most appropriate theories for engineering organization are the first two. I will confine myself to describe the main features of these two theories and their practical application.

Purpose:

The aim of this paper is to introduce the main features of classical traditional and humanistic theories with emphasis on its practical applicability.

Theory X : The Traditinal of classical theories

Behind every managerial decision or action are assumptions about human nature and human behaviour. A few of these are remarkably pervasive. They are implicit in most of the literature of organization and in much current managerial policy and practice.

The Main Assumptions

1. The average human being has an inherent dislike of work and will avoid it if he can.
2. Because of this human characteristic of dislike of work, most people must be coerced, controlled, directed, threatened with punishment to get them to put forth adequate effort toward the achievement of organizational objectives.
3. The average human being prefers to be directed, wishes to avoid responsibility, has relatively little ambition, wants security above all.

The ideal organization prescribed by the classical theories was quite bureaucratic with a high degree of role specialization.

The following individuals from different countries contributed to these theories.

Taylor – 1911.
Fayol – 1929.
Urwick – 1940.
Weber – 1947.

Theory : The Humanistic Theories

The main assumptions:

1. The expenditure of physical and mental efforts in work is as natural as play or rest. The human being does not inherently dislike work.
2. External control and the threat of punishment are not the only means for bringing about efforts towards organizational objectives. Man will exercise self direction

* Project Manager, Central Design Office, C&W Deptt: NWFP., Peshawar.

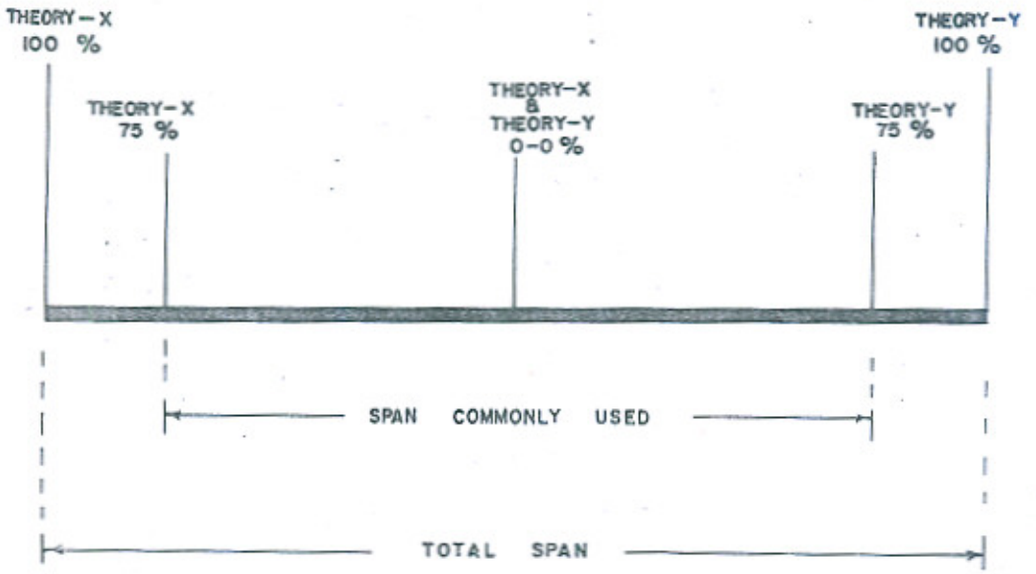


FIGURE I. THEORY – X AND THEORY – Y

(A PRACTICAL APPROACH)

a and self control in the service of objectives to which he is committed.

3. Commitment to objectives is a function of the rewards associated with their achievement.
4. The average human being learns, under proper conditions, not only to accept but to seek responsibility.
5. The capacity to exercise a relatively high degree of imagination, ingenuity, and creativity in the solution of organizational problems is widely, not narrowly, distributed in the population.
6. Under the conditions of modern industrial life, the intelectual potentialities of the average humanbeing are only partially utilized.

The central principle of organization which derives from theory X is that of direction and control through the exercise of authority - - - what has been called 'The Scalar Principle'.

The central principle which derives from theory Y is the integration - - - the creation of conditions such that the members of the organization can achieve their own goals best by directing their efforts towards the succes of the enterprise.

Someone once said that fish discover water last. The 'Psychological environment' of industrial management—like water for fish—is so much a part of organizational life that we are unaware of it.

Theory—Y is also known as MsGregor's theory Y, 1960.

The practical application of these theories

I present here the practical application of these theories.

The social scientists are talking about two extremities. What practically is happening in the world is mostly different than that of their exact concept. Both theories are contradicting each other.

It appears that no leadership theory can possibly explain all the problems of organization. The present world mostly thinks that it has attained a climax in education, values, civilization and knowledge, but it is imagination only. There are very few countries where theory Y is exercised to a great degree. Even in a country like U.S.A., a country with greatest human rights, only the highly educated and intellegencial will be found in favour of theory Y. How many such persons are there of the whole nation? In most of the rest of the world such people are negligible because in these countries, somehow, always a kind of chain of command exist — theory X.

The rapid, sophisticated, complexed and technological growth in engineering technology alongwith modern engineering management science have forced worldwide the urgency and need of knowing these theories.

A successful top executive must be well versed with the said theories and should have capability of using it judiciously either in pure form or in a combination of both.

Most common experiences show that a leader should move in combined span of both theory—X and Y as shown in figure No. 1.

The acceptance of social science will grow more as the world advances. In future, the tendency towards theory Y will increase further but the gap will remain the same between first, 2nd, 3rd and 4th world simply because of maintaining superiority of one over the other and as such equilibrium will not be obtained. This concept is based upon 'struggle for existance'. There will be a super theory—Y and today's theory—Y will be looked upon as old as today's theory—X.

References

1. McGregor Douglas, (1), The human side of enterprise, (1960).
2. Mian, A.R. (2), 'Term project CE. 532—Construction methods and management,' Winter, (1980), the University of Michigan Ann Arbor, U.S.A.

PREVENTIVE MAINTENANCE AND REPLACEMENT STRATEGIES — APPLICATION OF RENEWAL THEORY

By

*DR. AMJAD PARVEZ SHEIKH**

1. INTRODUCTION

This paper is second in the series of articles on the Preventive Maintenance and Replacement strategies. While the first article (19) gave a comprehensive survey of the work done in this area, this paper deals with the application of renewal theory in obtaining the operating characteristics of the periodic replacement policies and in analyzing the stochastic process thereby generated.

As mentioned elsewhere (4,18,19) items need to be replaced if they fail due to sudden stochastic failure. Representing the time to failure by a random variable and replacing each failed item with an item of similar type, a renewal process is developed. Thus, renewal theory not only helps in the study of behaviour and performance of industrial replacement policies but also such an approach can be put ot use in the fields of Reliability Engineering and other related fields.

2. OBTAINING THE OPERATING CHARACTERISTICS OF THE PERIODIC REPLACEMENT POLICIES USING RENEWAL THEORY:

An operating characteristic of a policy is a measure defined on the stochastic process induced when the policy is implemented.

Let,

$\Theta(\xi,\zeta)$ = Probability of a preventive replacement by time ξ, given that the equipment was new at ζ,

$\Xi(\xi,\zeta)$ = Probability that the equipment fails by ξ given that it was new at ζ.

Where ξ and ζ are both variables measurable from the time of the last preventive removal. Therefore,

$\Delta(\xi,\zeta)$ = Probability that the equipment is replaced by ξ given a renewal at ζ,

$= \Theta + \Xi$

Also, let,

$\Omega(\xi,\zeta)$ = the expected number of failures in the interval $\overline{o,y}$ prior to a preventive maintenance action, and

$\Lambda(\xi,\zeta)$ = the probability distribution of the time between successive preventive replacements.

If the most important characteristics of a preventive maintenance policy are denoted by,

$U_p(y)$ = the expected number of preventive replacements in the interval $\overline{o,y}$,.

$U_f(y)$ = the expected number of failures in the interval $\overline{o,y}$,.

then, from the laws of renewal theory, we can obtain the following renewal equations (5).

$$U_p(y) = \Lambda(y) + \int_o^y U_p(y-Y)\, d\Lambda(Y) \quad \ldots (1)$$

* BSc (Mech Engg.), MSc (Quality & Reliability Engg) UK, Ph.D (Engineering Production) U.K. Member IEP, Member, Pakistan Engineering Congress, Member, American Society for Quality Control, Registered Professional Engineer, Principal Engineer, National Engineering Services (Pakistan) Ltd., 417 WAPDA House, Lahore.

$$\ldots\ldots(2)$$

Where

$$\Omega(y) = \Xi(y,o) + \int_{o}^{y} \Xi(y,z)\, d\Omega(z) \quad \ldots\ldots(3)$$

and $$\Delta(y) = \Delta(y,o) + \int_{o}^{y} [1-\Delta(y,z)]\, d\Omega(z) \quad \ldots\ldots(4)$$

for the periodic preventive maintenance policy,

$$\Theta(\xi,\zeta) = \Theta(\xi,\zeta) = \begin{cases} 0 & \ldots, \xi-\zeta < N \\ 1-\Phi(N) \ldots, \xi-\zeta \geq N \end{cases} \quad \ldots\ldots(5)$$

$$\Xi(\xi,\zeta) = \Xi(\xi,\zeta) = \begin{cases} \Phi(\xi-\zeta), \ldots, \xi-\zeta < N \\ \Phi(N, \ldots \xi-\zeta \geq N \end{cases} \quad \ldots\ldots(6)$$

Let the asymptotoc characteristics λ_p and λ_p corresponding to $U_p(y)$ and $U_p(y)$ denote the expected rate of preventive replacement and expected rate of failure, respectively. Then from the renewal theoretic arguments, (5)

$$\lambda_p = \lim_{y\to\infty} \frac{U_p(y)}{y} = 1/\mu_1 \quad \ldots\ldots(7)$$

$$\lambda_f = \lim_{y\to\infty} \frac{U_f(y)}{y} = h/\mu \quad \ldots\ldots(8)$$

where μ_1 = mean of $\Delta(y)$

and $h = \Omega(\infty)$

In words the expected preventive replacement rate is simply the reciprocal of the mean time between preventive replacements, and the expected failure rate is the same reciprocal multiplied by the expected mumber of failures prior to preventive replacement.

3. USE OF RENEWAL THEORY IN ANALYSING THE STOCHASTIC PROCESS GENERATED BY RENEWAL THEORY:

Operating characteristics of many periodic preventive maintenance policies can be obtained by using the technique of renewal theory. The expected number of preventive number of failures in $\overline{o,y}$, the expected rate of preventive replacement, and the expected rate of failure, are the most important operating characteristics of the replacement policies. Flehinger (5) has studied them by postulating two models to predict the reliability of complex systems. In the first model, the system operates continuously except for interruptions that caused the failure is located and replaced by a new and statistically identical component. In the second model:

(a). Complete systems ckcck-outs are conducted at the ends of consecutive intervals of fixed length Y, and all failed components are located and replaced by new and statistically identical components;

(b). The system operates continually except for interruptions caused by system failure, at all other items. When the system failure occurs, the failed component that induced the failure is immediately replaced.

Renewal theory is used for the analysis of the two models; the two policies are compared and for the second model, the depenence of system reliability on the maintenance interval is determined.

In another reference, Flehinger (6) has postulated and analysed a general model for the reliability analysis of systems under various preventive maintenance policies. The integral equations that determine the expected number of failures, the expected number of preventive removals and the reliability function, are developed. In another Reference (7), a particular model of a system subject to marginal testing, is considered and explicit values of these performance measures are obtained. The system is maintained in operating condition by replacing all failed components as soon as they fail and at regular intervals, conducting a test to locate those components which are expected to fail in the near future. All components located by this test are replaced.

RAND Corporation has carried out a consideralbe amount of research on optimum replacement policies: McCall (16) has summarised this research work. These studies were initiated because it was apparent that better maintenance could result in worthwhile reduction in maintenance costs and weapon system downtime. Most of studies are centered upon the preparedness models. Other areas of interests are the demonstration of the optimality of policies possessing an opportunistic structure

(20), developing methods for computing policies (10-12, 14, 21) and applying these policies to Air Force maintenance problems (2, 11, 14). McCall (15) investigated the operating characteristics of the opportunistic replacement and inspection policies.

Another part of the paper investigates the operating characteristics for the general opportunistic replacement policy — the optimal policy for an uninspected part in the presence of a finite number of inspected parts.

Given a failure, McCall (14) presents a method for determining the replacement and repair actions which should constitute an overhaul. The ststem considered was composed of two-sub-systems, both inspected periodically: the first sub-system fails randomly; and the second fails according to an aging distribution (increasing conditional probability of failure). The system is automatically returned to the depot whenever a failure of either sub-system is detected.

A very detailed investigation concerning the optimal schedulug of replacement and inspection of equipment for which the preparedness model is appropriate was carried out by Jorgensen and McCall (10), an abbreviated form of which was published a year later. Another purpose of this study was to bring out a formal analogy between minimisation of cost and minimisation of the propotion of downtime used by Savage (21).

Another important use of the renewal theoretic approach was demonstrated by Soland (22). He determined the probability distribution of the demand for replacement parts in a specified future time interval. He discussed the ordinary, modified, and equilibrium renewal processes as models for physical processes in which parts are replaced as they fail. He used the renewal theory results to estimate the demand for replacement under a number of different conditions. At this stage, certain practical difficulties and methods of solving them were introduced, which have been further elaborated below:

(a). In case the probability distribution that governs some of the renewal processes is not the same as that governing the others, then this problem can be handled by creating each group of processes separately. In these groups, each process has the same failure-time probability distribution, using the appropriate density function in each case. We only need now to sum the means and variances of the number of renewals in all q processes.

As has been pointed out, the numerical calculation of the expected value and variance of number of renewals is possible only in certain cases. To this difficulty Soland suggested that in the general case the following identities can be used:

$$U_{(0)}(y) = \sum_{q=1}^{\infty} \varphi(y)$$

$$\varphi_{q\gamma\kappa}(y) = \int_0^y (y-z)\,\varphi(z)\,dz \qquad \ldots\ldots (9)$$

$$\varphi_{1\gamma\kappa}(y) = \varphi(y)$$

The above wquation follow the standard notations used in this paper.

(b). When the natural parameter of the renewal process is not time, then it also becomes difficult to apply renewal theory to the determination of demand for replacement parts (e.g., for parts on many vehicles, the natural parameters of the renewal process is distance travelled). If the conversion between time and the natural parameter of the process is deterministic no problem arises. Since, normally, the conversion is stochastic so that, one can only give a prbability distribution for the number of miles travelled in the given time period, then, the following relations can be used.

$$U_1(y) = \int_0^{\infty} U(z)\, g\,(z/y)\, dz \ldots (10)$$

$$Var_1(y) = \int_0^{\infty} \left[Var(z)\right] + \left[U(z)\right]^2 \cdot g(z/y)\, dz$$

$$-[U_1(y)] \quad \ldots\ldots(11)$$

where $g(z/y)$ = mortality of the number of miles, z, travelled in time interval $\overline{o, y}$

$U(z)$ = mean of the number of renewals in the mileage interval $\overline{o, z}$

$Var(z)$ = variance of the number of renewals in the mileage interval $\overline{o,z}$

$U_1(y)$ = mean of the number of renewals in $\overline{o,y}$

$Var_1(y)$ = variance of the number of renewals in $\overline{o,y}$

We can compute $U_1(y)$ and $Var_1(y)$ by approximating $g(z/y)$ by a discrete probability mass function. The assumption that the range over which z may vary during the time interval $\overline{o,y}$ is sufficiently small and it may be reasonable to assume that $U(z)$ and $Var(z)$ are linear functions of z over this range, can easily be checked by examining the curves of $U(z)$ and $Var(z)$. Thus, we can re-write the Equations (10) and (11) as

$$U_1(y) = U(\bar{z})$$
$$Var_1(y) = Var(z) + m\hat{z}$$

where

$\bar{z}$ = expected value of the number of miles travelled in $\overline{o,y}$

$\hat{z}$ = variance of the number of miles travelled in $\overline{o,y}$.

m = slope of $U(y)$ at the point $z = \bar{z}$, i.e., $m = u(\bar{z})$.

(c) Normally, it is assumed that the underlying mortality is known. In case it is not known, a great deal of data would be required to obtain it.

(d) The renewal theoretic approach for accumulating data, analysing it, and performing the computations could be very costly.

Bovaird (3) deals with those aspects of system maintenance which when combined together are termed as 'maintenance planning problem'. His approach utilises the economic theory and mathematics to obtain an optimal maintenance condition. A cost minimising maintenance model is obtained which considers deterioration and failure probabilities, man-hours for preventive repair, elapsed time for emergency diagnosis and repair, cost of setting up for periodic maintenance, cost of maintenance men, and cost of system downtime. A numerical example illustrates how the model can be used to obtain various quantities.

Barlow, Prochan and Hunter examined the operating characteristics of the maintenance policies in various studies (1,9) mostly by using renewal theory. Karlin and Scarf (13, Chapters 14-17) provided a general discussion of these operating characterisitics. In case the equipment is subject to scheduled maintenance (i.e., when a failure occurs) and during both of these operations it is considered non-repairable, Morse (17) has considered the case to optimise availability. Let preventive maintenance be applied after V_p hours of continuing operation without failure, then Truelove (23) considers the case to choose Y_p so as to optimise the stragetic reliability. He gives an approximate solution and shows that the optimum curve commonly drawn in Morse's case can also be used in his case approximately.

Certain probability functions, for use in reliability studies, of equipments which are maintained over a long period of time through replacement of components, expected number of replacements and renewal rate also fall into this category. Theoretical results of renewal theory are adapted to reliability studies of complex systems. Flehinger and Lewis (8) proposed three two-parameter models of distribution functions, with the properties: (a) initial lifetime mortality greater than zero; and (b) monotonically increasing hazard. The expected number of replacements were numerically calculated and plotted as a function of time for several different parameter values in each model.

BIBLIOGRAPHY

1. BARLOW, R.E., and PROSCHAN, F., 1964, 'Comparison of Replacement policies and Renewal Theory Implications', Ann. Math. Statist., V.35, pp.577-589.

2. BEAN, E., and McGLOTHLIN, W.H., 1959, 'An Analytical Model for Developing Optimal Ballistic Missile Maintenance Procedures', p-1696, the RAND Corp. May 13, 1959.

3. BOVAIRD, R.L., 1961, 'Characteristics of Optimal Maintenance Policies', Mgmt. Sci., V.7, pp.238-253.

4. COX, D.R., 1967 'Renewal Theory', Matheun's Monographs on Applied Probability & Statistics, John Wiley, N.Y.

5. FILEHINGER B.J., 1960, 'System Reliability as a Function of System Age; Effects of Intermittent Component Usage and Periodic Maintenance', O.R., V.8, pp.30-44.

6. FLEHINGER, B.J., 1962a, 'A General Model for the Reliability Analysis of Systems under Various Preventive Maintenance Policies', Ann. Math. Statist. V.33, N.1, pp.137-156.

7. FLEHINGER, B.J., 1962b, 'A Markovian Model for Analysis of the effects of marginal testing on System Reliability', Ann. Math. Statist, V.33, pp.754-766.

8. FLEHINGER, B.J., and LEWIS, P.A., 1959, 'Two-Parameter Lifetime Distributions for Reliability Studies of Renewal Procedures', IBM Jornal pp.58-73.

9. HUNTER, L.C., and PROSCHAN, F., 1961, 'Replacement when Constant Failure Rate Precedes Wearout', Nav. Res. Log. Quat., V.8, pp.127-136.

10. JORGENSON, D.W., and McCALL, J.J., 1962a, 'Optimal Scheduling of Replacement and Inspection', THE RAND Corp., Mem. No.RM-3098-PR (DDC No.AD-266-149), May 1962. (An abbreviated form published in 1963, O.R., V.II, N.5, pp.732-746).

11. KAMINS, M., 1960, 'Determining Checkout Intervals for Systems Subject to Random Failures', U.S. Air Force Project RAND No.RM-2578. The RAND Corp., June 15, 1960.

12. KAMINS, M., 1962, 'Rules for Planned Replacement of Aircraft and Missile Parts', U.S. Air Force Project RAND, Mem. No.RM-2810-PR, The RAND Corp., Santa Monica, Calif.

13. KARLIN, S., and SCARF, H., 1958, 'Studies in Mathematical Theory of Inventory and Production', K.J. Arrow, S. Karlin and H. Scarf (eds) Stanford Univ. Press, Stanford, Calif.

14. McCALL, J.J., 1962, 'Solution of a Simple Overhaul Model'. The RAND Corp. Mem. RM-2989-PR (DDC-AD-272-144), Feb. 1962.

15. McCALL, J.J., 1963, 'Operating Characteristics of Opportunistic Replacement and Inspection Policies', Mgmt. Sci., V-10, N.1, pp.85-97.

16. McCALL, J.J., 1965, 'Maintenance Policies for Stochastically Failing Equipment – A Survey', Mgmt. Sci. V.II, N.5, pp.493-524.

17. MORSE, P.C., 1958, 'Queues, Inventories, and Maintenance', Wiley, N.Y.

18. PARVEZ-SHEIKH, Dr. Amjad, 1973, 'Some Underlying Failure Distributions in Renewal Analysis', An Unpublished Ph.D. Thesis,Dept. of Eng. Prod., Univ. of Birmingham, U.K.

19. PARVEZ-SHEIKH, Dr. Amjad, 1981, 'Preventive Maintenance & Replacement Strategies – A Survey', Engineering News, A Quarterly Journal of Pakistan Engineering Congress, Sep-Dec., 1981.

20. RANDER, R., and JORGENSON, D.W., 1962, 'Optimal Replacement and Inspection of Stochastically Failing Equipment', Chapter 12 in K.J. Arrow, S. Karlin, and H. Scarf (eds) 'Studies in Applied Probability and Management Science', Stanford Univ. Press.

21. SAVAGE, I.R., 1956, 'Cycling', Nav. Res. Log. Quat. V.3. N.3.

22. SOLAND, R.M., 1968, 'A Renewal Theoretic Approach to the Estimation of Future Demand for Replacement Parts', O.R. V.16, pp.36-51.

23. TRUELOVE, A.J., 1961, 'Strategic Reliability and Preventive Maintenance', O.R. V.9, pp.22-29.

SEMINAR ON IRRIGATION WATER MANAGEMENT

A mid term seminar on Irrigation Water Management was held on 10th May, 1982 in the WAPDA Auditorium jointly sponsored by Pakistan Engineering Congress and Irrigation, Drainage & Flood Research Council, Government of Pakistan. Vice Admiral Mohammad Fazal Janjua, Minister for Food & Agriculture inaugarated the session.

The following papers were presented and discussed in detail by the participants of the Seminar.

1. Potential in watercourse/improvement.
   By Mohammad Ashraf & Mohammad Munir.

2. Crop Production as related to efficient use of water.
   By Bashir Ahmad & M.M. Iqbal.

3. Laser control system for Irrigation Water Management
   By Mushtaq Ahmad Gill, Mohammad Ashraf & M. Saleem.

4. Improvement of water Conveyance system and design of Irrigation Watercourses.
   By Mushtaq Ahmad Gill & Mohammad Ashraf.



Arrival of Chief Guest



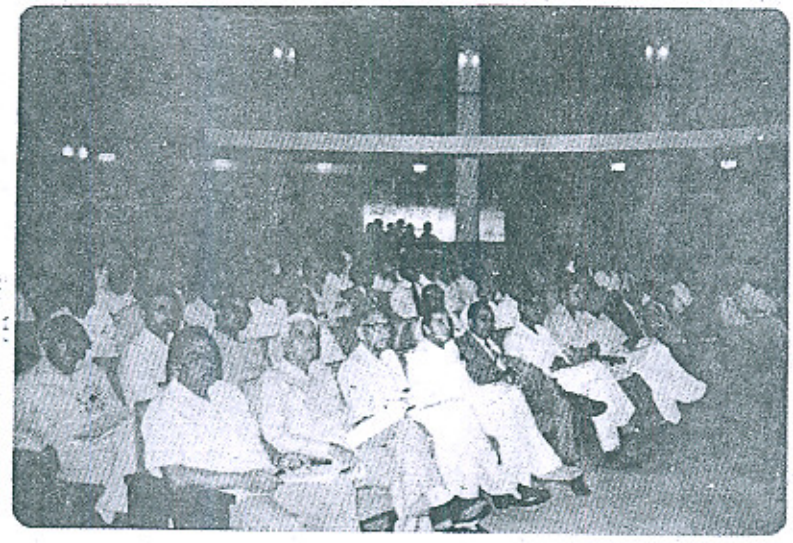
Introduction of Council Members



Adress by Mr. S.M. Ayoob
President, Pakistan Engineering Congress



Adress by Chief Guest
Vice Admiral M.F. Janjua



A view of audience

Conversion Factors

All authors of *Journal* papers are being asked to prepare their papers in this dual-unit format. To provide preliminary assistance to authors, the following list of conversion factors and guides are recommended by the ASCE Committee on Metrication.

To convert	To	Multiply by
inches (in.)	millimeters (mm)	25.4
feet (ft)	meters (m)	0.305
yards (yd)	meters (m)	0.914
miles (miles)	kilometers (km)	1.61
square inches (sq in.)	square millimeters (mm^2)	645
square feet (sq ft)	square meters (m^2)	0.093
square yards (sq yd)	square meters (m^2)	0.836
square miles (sq miles)	square kilometers (km^2)	2.59
acres (acre)	hectares (ha)	0.405
cubic inches (cu in.)	cubic millimeters (mm^3)	16,400
cubic feet (cu ft)	cubic meters (m^3)	0.028
cubic yards (cu yd)	cubic meters (m^3)	0.765
pounds (lb) mass	kilograms (kg)	0.453
tons (ton) mass	kilograms (kg)	907
pound force (lbf)	newtons (N)	4.45
kilogram force (kgf)	newtons (N)	9.81
pounds per square foot (psf)	pascals (Pa)	47.9
pounds per square inch (psi)	kilopascals (kPa)	6.89
U.S. gallons (gal)	liters (L)	3.79
acre-feet (acre-ft)	cubic meters (m^3)	1,233

٥- وَلَا تَأْكُلُوٓا أَمْوَالَكُم بَيْنَكُم بِالْبَاطِلِ وَتُدْلُوا بِهَا إِلَى الْحُكَّامِ لِتَأْكُلُوا فَرِيقًا مِّنْ أَمْوَالِ النَّاسِ بِالْإِثْمِ وَأَنتُمْ تَعْلَمُونَ ۝

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

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

٦- وَقُولُوا قَوْلًا سَدِيدًا ۝

"And speak straight words." xxxiii : 70

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

٧- اجْتَنِبُوا كَثِيرًا مِّنَ الظَّنِّ إِنَّ بَعْضَ الظَّنِّ إِثْمٌ وَلَا تَجَسَّسُوا وَلَا يَغْتَب بَّعْضُكُم بَعْضًا

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

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

٨- وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهِ عِلْمٌ إِنَّ السَّمْعَ وَالْبَصَرَ وَالْفُؤَادَ كُلُّ أُولَٰئِكَ كَانَ عَنْهُ مَسْئُولًا ۝

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

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

٩- وَتَعَاوَنُوا عَلَى الْبِرِّ وَالتَّقْوَىٰ ۖ وَلَا تَعَاوَنُوا عَلَى الْإِثْمِ وَالْعُدْوَانِ ۚ وَاتَّقُوا اللَّهَ

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

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

١٠- وَأَمْرُهُمْ شُورَىٰ بَيْنَهُمْ ۖ

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

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

١١- وَاعْتَصِمُوا بِحَبْلِ اللَّهِ جَمِيعًا وَلَا تَفَرَّقُوا

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

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

With

Best Compliments

from

M/s. HUSSAINY CONSTRUCTION COMPANY

LINK TRUST ROAD
RAHIMYAR KHAN
Phone : 2436

RAHUJA ROAD
SUKKUR
Phone : 2142