Engineering News

A QUARTERLY JOURNAL OF PAKISTAN ENGINEERING CONGRESS

Vol. XXVI No. 2 JUNE 1981

CODE OF ETHICS

PAKISTAN ENGINEERING CONGRESS

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

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

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

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

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

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

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

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 mischief". xi : 85

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

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

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

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

۴۔ اَوْفُوْا بِالْعُقُوْدِ ۭ ○

"Fulfil the obligations". v : 1

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

TWENTY SIXTH YEAR OF PUBLICATION

ENGINEERING NEWS

Quarterly Journal of the Pakistan Engineering Congress

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.

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laws of probability and the random character of the streamflow is, therefore, most important. In Hydrology, practically speaking, most processes are random and the respective variables are equally random. Since in this study extreme floods are our primary concern only the highest discharge from each year has been used to formulate the series of the events. Such a series ignores the second highest event in any year, which in many cases exceeds some annual maxima. The objection can be overcome by partial series which are formed by the floods above a selected base. The base is commonly taken to be the lowest flood. In the partial series the choice of the base is subjective and the events may not completely satisfy the requirements of independence.

TABLE - I

S. No.	Name of Discharge site.	Period of record.
1.	Indus at Kalabagh.	1928-79
2.	Indus at Chashma.	1971-79
3.	Indus at Taunsa.	1958-79
4.	Jhelum at Mangla (Pre Dam).	1928-66
5.	Jhelum at Mangla (Post Dam).	1967-79
6.	Jhelum at Rasul (Pre Dam).	1922-66
7.	Jhelum at Rasul. (Post Dam).	1967-79
8.	Jhelum at Railway Bridge.	1967-79
9.	Chenab at Marala.	1922-79
10.	Chenab at Khanki.	1925-79
11.	Chenab at Qadirabad.	1970-79
12.	Chenab at Trimmu.	1928-79
13.	Chenab at Panjnad.	1928-79
14.	Ravi at Jassar.	1948-79
15.	Ravi at Shahdara.	1925-79
16.	Ravi at Balloki.	1925-79
17.	Ravi at Sidhnai.	1925-79
18.	Sutlej at Suleimanki (Pre Dam).	1926-57
19.	Sutlej at Suleimanki (Post Dam).	1958-79
20.	Sutlej at Islam (Pre Dam).	1925-57
21.	Sutlej at Islam (Post Dam).	1958-79
22.	Sutlej at Adamwahan.	1954-79

-o-o-o-o-o-

The annual series formulated by the annual floods (maximum discharge each year) have been used for the analysis. As the time unit in these series is a water year, the mutual independence of consecutive observations is more likely. The events belonging to Pre Dam and Post Dam periods on River Jhelum and Sutlej do not come from the same population and have, therefore, been regarded separately.

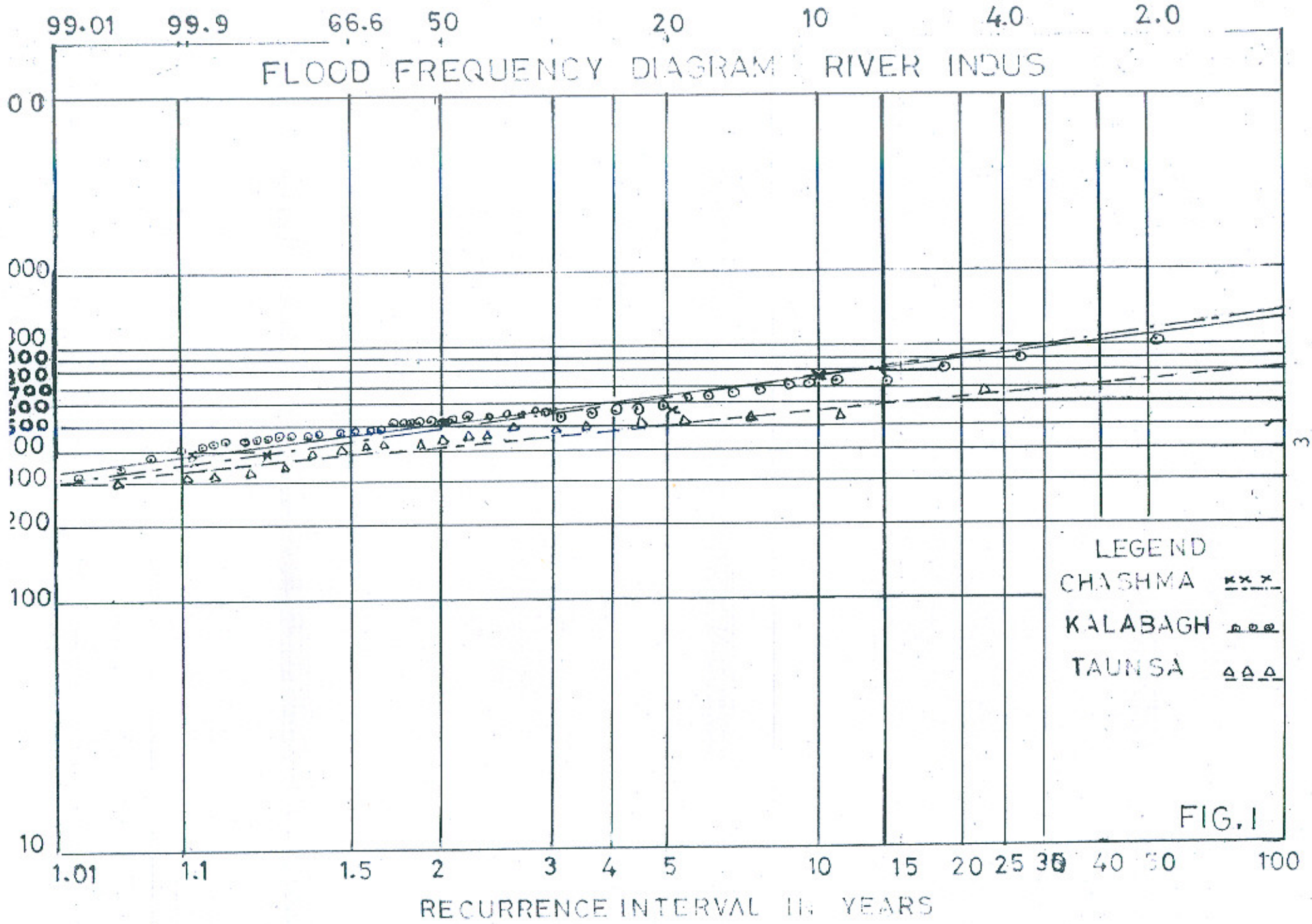
2.3 PLOTTING POSITIONS.

It is extremely important to identify the exact nature of the statistical distribution to which the annual series of data correspond. Following three distributions which are more suited to the streamflow data were used for the frequency curve fitting exercise.

i) Weibul.
ii) Gumbel.
iii) Pearson Type-III.

2.31 WEIBUL PLOTTING POSITION.

If the peak floods forming the annual series are arranged and ranked in descending order of magnitude then according to Weibul formula:-


99.01
99.9
66.6
50
20
10
4.0
2.0
FLOOD FREQUENCY DIAGRAM : RIVER INDUS
000
00
100
200
100
10
LEGEND
CHASHMA
KALABAGH
TAUNSA
FIG. I
1.01
1.1
1.5
2
3
4
5
10
15
20
25
40
100
RECURRENCE INTERVAL IN YEARS

S

TITLE

LDA fourteen storey building under Construction on Egerton Road, Lahore. Photo: Courtesy LDA.

FLOOD PREDICTION AT BARRAGES/HEADWORKS OF PUNJAB RIVERS

By

*MUZAFFAR HUSSAIN. **MUHAMMAD SARFRAZ.

1-INTRODUCTION

No structure of importance, either in or adjacent to a river should be planned or built without due consideration to the damage it may cause or the damage to which it may be subjected in a time of flood. Therefore, determination of floods of rare magnitude which the flood works and other structures may be required to with-stand has received much attention of the water resources planners and designers.

The hydrologic events are surprisingly found to follow one or the other statistical distribution and depending on the accuracy and independence of historic record the frequency analysis yields meaningful results and forms one of the major phases in hydrologic design. The application of statistical approach in flood prediction enables planning, design and economic appraisal of the flood management works with reference to a flood of specified magnitude.

Fortunately, the Discharge Division, Punjab, Irrigation Department maintains a long and continuous gauge and discharge record of all the rivers in Punjab which provided the vital information for the flood frequency analysis presented in this paper. Assuming the annual peak discharges as random and independent the series of events were formulated and curve fitting exercise was performed using Weibul, Gumbel & Pearson Type III distributions to identify the distribution which provided best fit for the data. For most of the sites Weibul distribution gives better results and is eventually recommended for flood prediction at these points.

The results of this analysis should find application in flood prediction and choice of design floods for flood protection works. Extrapolation beyond the period of record may however be done objectively and in full recognition of the conditions of a particular case.

2 - FLOOD FREQUENCY ANALYSIS

2.1 BASIC DATA.

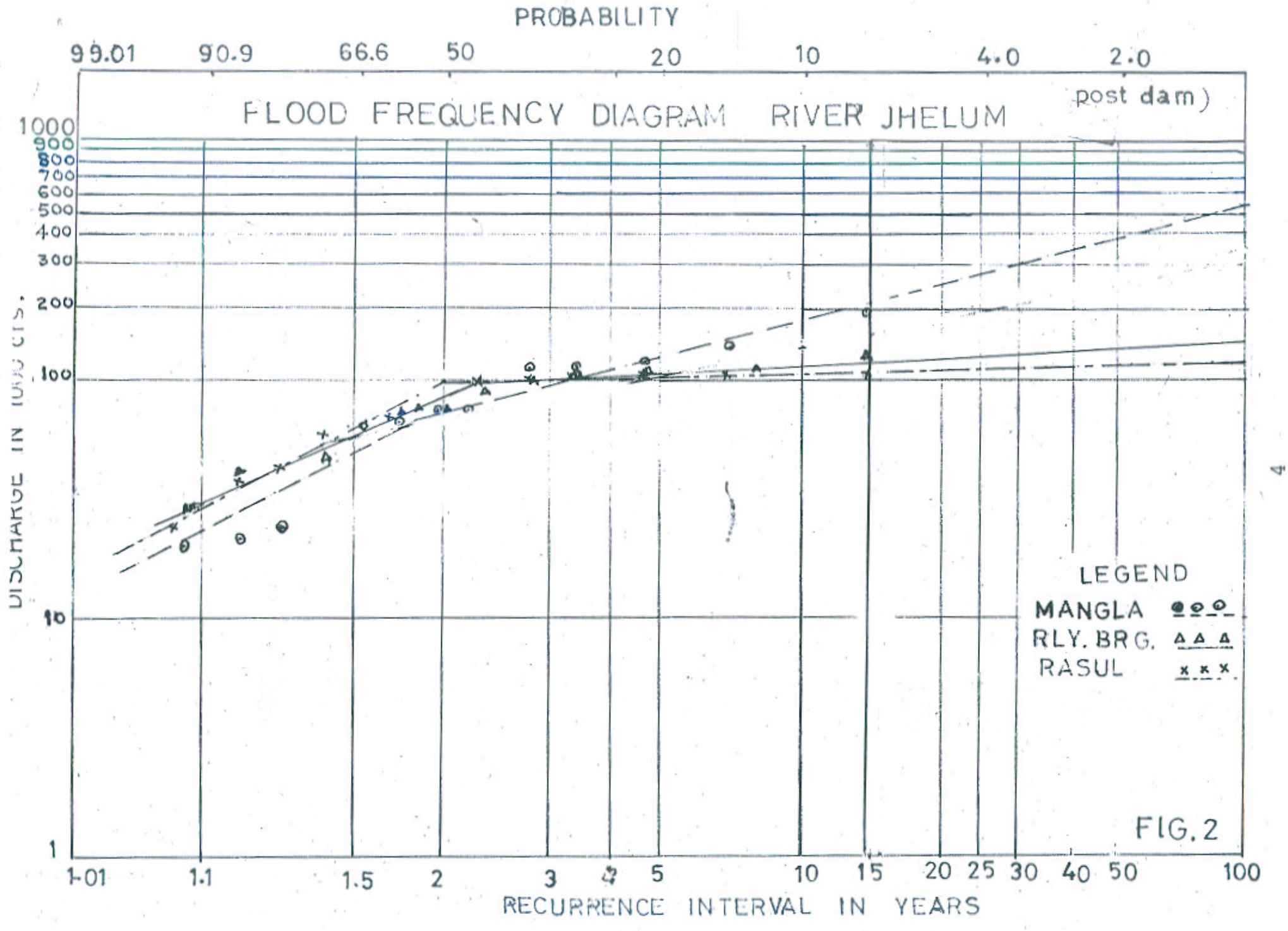
The basic data for a frequency analysis are the recorded observations of flows at the points of interest. With the advent of Irrigation System in the Punjab Plain the Irrigation Department started observation of stage and discharges at all the Headworks/Barrages and important Bridge sites and a record thereof was maintained in the Discharge Division specially instituted for the purpose. A large mass of required data is therefore available. The Table-I gives the names of sites analysed and the period of record.

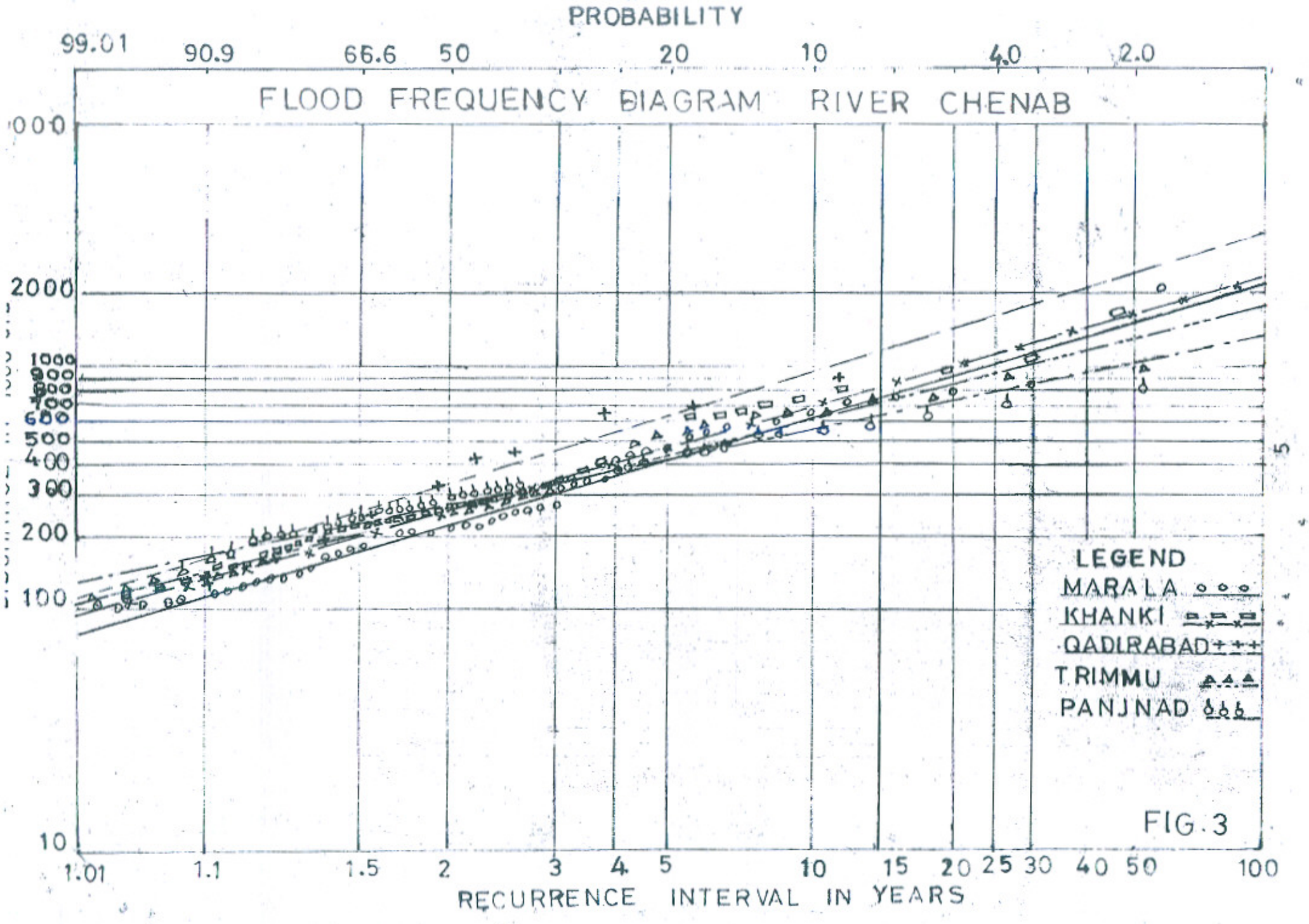
2.2 ANNUAL SERIES.

The frequency study is an appreciation of

* Deputy Director, Flood Cell, Punjab, I & P Department.

** Research Officer, Hydrology Directorate, I & P Department.


PROBABILITY
99.01
90.9
66.6
50
20
10
4.0
2.0
FLOOD FREQUENCY DIAGRAM RIVER JHELUM
post dam)
1000
900
800
700
600
500
400
300
200
100
10
1
DISCHARGE IN 1000 CFS.
LEGEND
MANGLA
RLY. BRG.
RASUL
FIG. 2
1.01
1.1
1.5
2
3
4
5
10
15
20
25
30
40
50
100
RECURRENCE INTERVAL IN YEARS


PROBABILITY
99.01
90.9
66.6
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4.0
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FLOOD FREQUENCY DIAGRAM RIVER CHENAB
000
2000
1000
900
800
700
600
500
400
300
200
100
10
LEGEND
MARALA
KHANKI
QADIRABAD
TRIMMU
PANJNAD
FIG. 3
1.01
1.1
1.5
2
3
4
5
10
15
20
25
30
40
50
100
RECURRENCE INTERVAL IN YEARS

$$P = \frac{m}{N+1}$$

$$\text{and } T = \frac{N+1}{m}$$

Where

P = The exceedance probability of the event.

m= Serial number when data is arranged in descending order.

N = Number of items in the series.

T = Return period.

The percentage probability is obtained by multiplying P by 100.

2.32 GUMBEL DISTRIBUTION

In 1941 Gumbel developed the extreme value distribution. His fundamental Theorem states that if X_1, X_2, X_3 ..... Xn are independent extreme values observed in 'n' samples of equal size N, and if X is an unlimited exponentially distributed variable, then, as n and N approach infinity, the cumulative probability $\acute{P}$ that any of the extreme will be less than a given value of X, is given by

$$\acute{P} = e^{-e^{-y}} \quad \ldots\ldots(1)$$

Here $\acute{P}$ represents probability of being less than or equal to a given event.

Y = reduced variate, for an infinitely large sample. Following relation between X and Y has been obtained.

$$X = \bar{X} + (0.7797\ Y - 0.4500)S \quad \ldots\ldots(2)$$

Now $P = 1 - \acute{P}$

$$\text{Also } P = \frac{1}{T}$$

$$\text{Therefore, } \acute{P} = 1 - \frac{1}{T} \quad \ldots\ldots\ldots\ldots(3)$$

Incorporating Gumbel's correction c, T is obtained by,

$$T = \frac{N}{m+c-1} \quad \ldots\ldots(4)$$

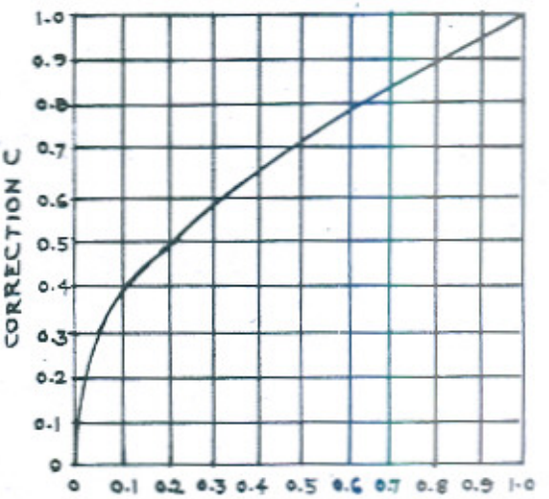


FIG: C - RELATIVE SERIAL NUMBER m/N

Figure C gives values of Gumbel correction against any relative serial number $\acute{m}/N$ ($\acute{m}$ is serial number when data is arranged in ascending order).

Equations (1), (2), (3) and (4) are used for the analysis of peak discharge data by this

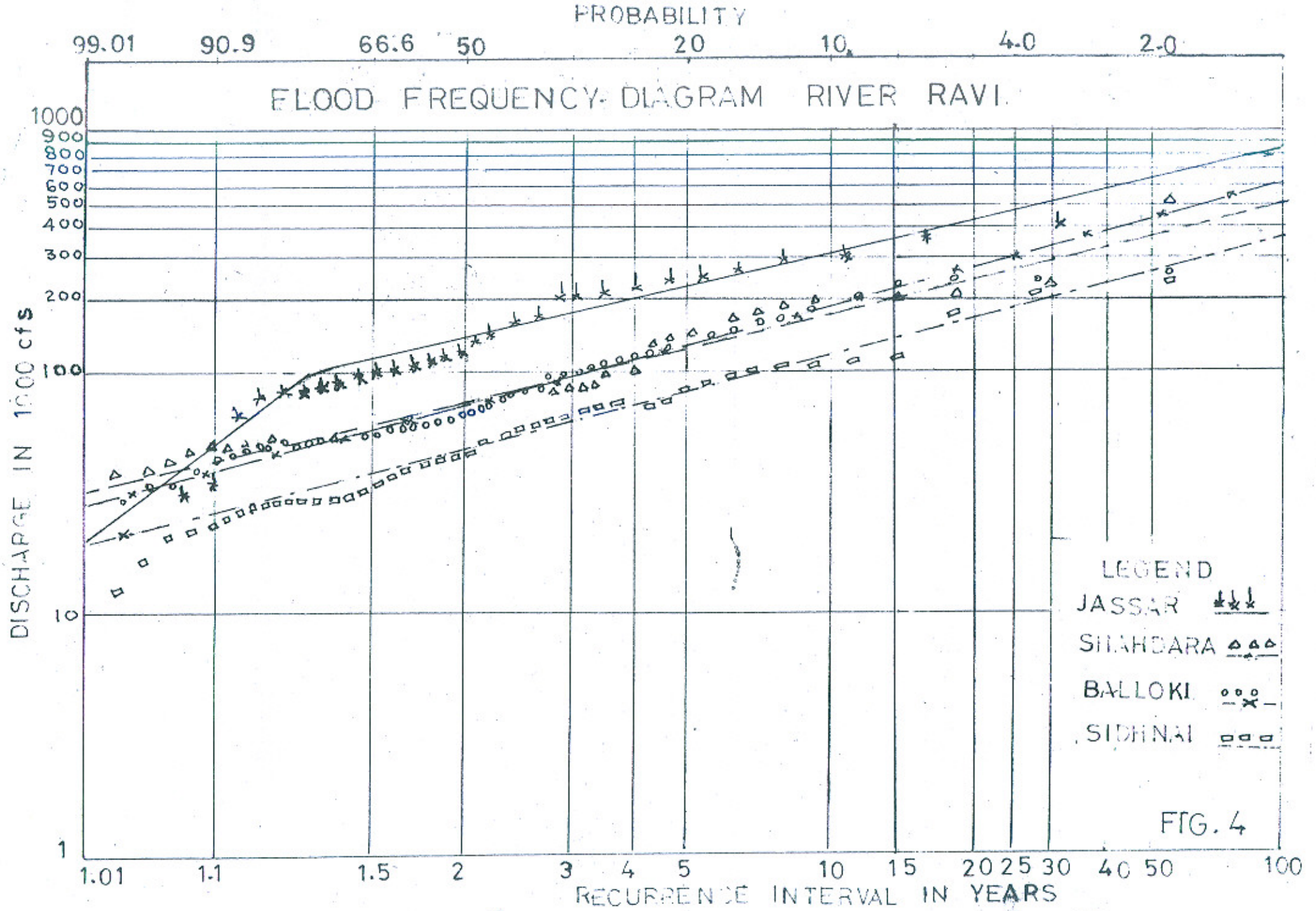
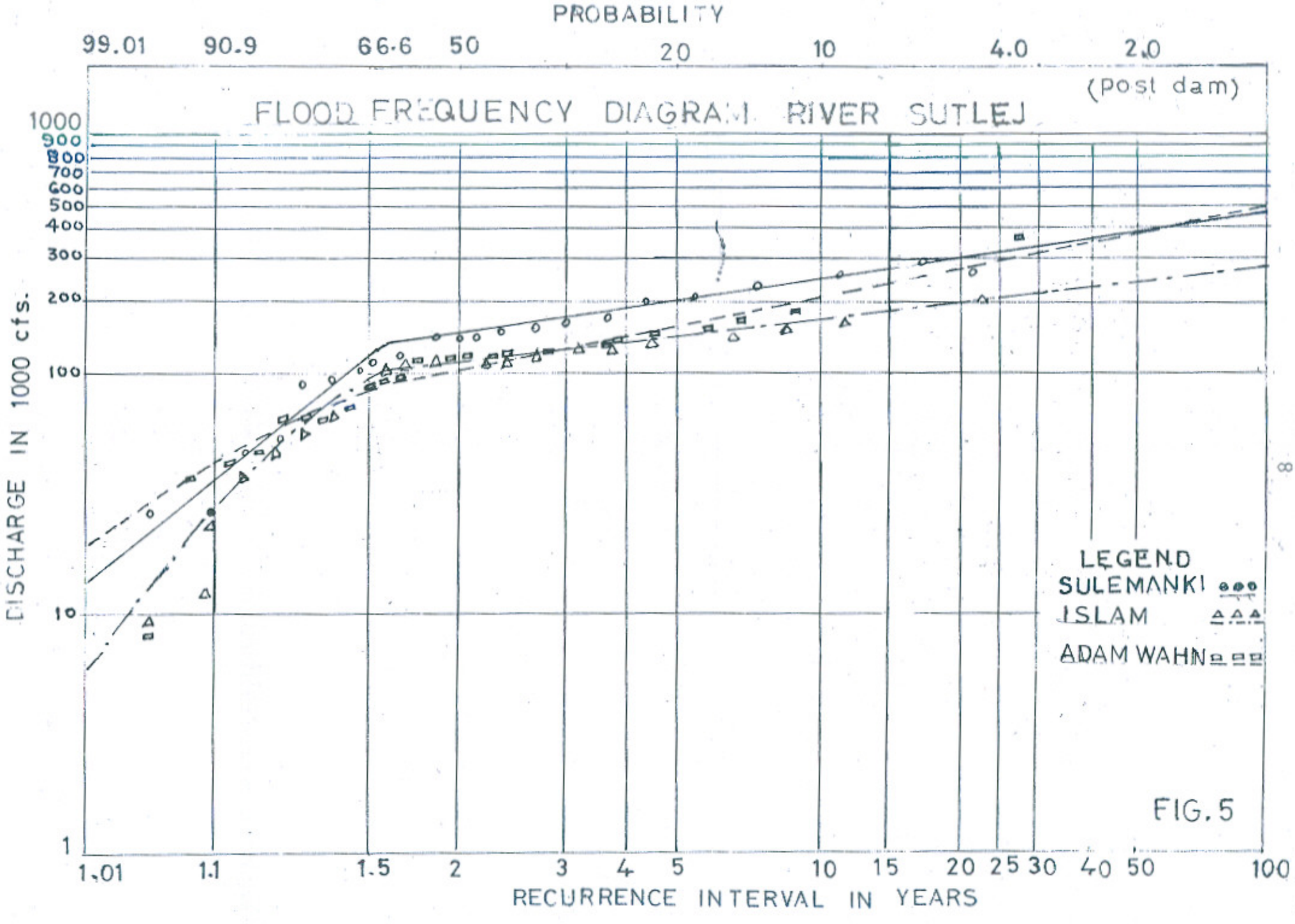

PROBABILITY
99.01
90.9
66.6
50
20
10
4.0
2.0
FLOOD FREQUENCY DIAGRAM RIVER RAVI
1000
900
800
700
600
500
400
300
200
100
10
1
DISCHARGE IN 1000 cfs
1.01
1.1
1.5
2
3
4
5
10
15
20
25
30
40
50
100
RECURRENCE INTERVAL IN YEARS
LEGEND
JASSAR
SHAHDARA
BALLOKI
SIDHNAI

FIG. 4


PROBABILITY
99.01
90.9
66.6
50
20
10
4.0
2.0
(Post dam)
FLOOD FREQUENCY DIAGRAM RIVER SUTLEJ
1000
900
800
700
600
500
400
300
200
100
10
1
DISCHARGE IN 1000 cfs.
LEGEND
SULEMANKI
ISLAM
ADAM WAHN
1.01
1.1
1.5
2
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10
15
20
25
30
40
50
100
RECURRENCE INTERVAL IN YEARS

FIG. 5

method.

The annual peak discharges are arranged in descending order and values of the reduced variate corresponding to each event are worked out by using (1), (3) and (4). The values of $\bar{X}$ and S are computed for sample data and corresponding values of X are determined using equation (2).

The computations for the annual series at all the Headworks/Barrages were made using formulae of Weibul and Gumbel plotting positions and the results were plotted taking discharge (in 1000 Cs.) versus the recurrence interval on a log probability paper and Gumbel paper respectively. Mean lines interpolated on the plotted points represented the likely position of all possible floods on the structure analysed. As observed visually and verified by the Chi Square test, the flood frequency diagrams obtained by Weibul plotting position better fitted in the observed data. These diagrams are attached as Annexure 1–5 and recommended for use in flood prediction for the respective Barrages/ Bridges sites.

2.33 PEARSON TYPE - III DISTRIBUTION:

The peak flood discharges of the Rivers Chenab at Khanki, Jhelum at Rasul and Ravi at Shahdara were analysed and fitted to Pearson Type III distribution. The scatter of points corresponding to the observed discharges about the line drawn through the points computed by the relations and tables of Pearson Type III distribution showed a poor quality of fit. Therefore, the analysis by this method was not done for other sites.

3- TEST FOR GOODNESS OF FIT

Chi Square Test at 5% significance level has been used to test the goodness of fit of the frequency distribution used in the analysis of the data.

The statistic X^2 is calculated by the relation

$$X^2 = \Sigma \frac{(O-E)^2}{E}$$

O = Observed value.
E = Expected value.

The computed values of X^2 are compared with the tabular values corresponding to 5% level of significance and (N-1) degrees of freedom. Annexure - 6 shows the computed/tabular values of $X^2_{.05}$ at all the sites analysed, both for Gumbel and Weibul distributions. It is observed that Weibul distribution yields much better fit and the hypothesis that the frequency distribution of the annual peak discharges coincides with Weibul distribution at 5% level of significance cannot be rejected. Further comparison of calculated values with $X^2_{.1}$ shows that the hypothesis also holds at 10% level of significance and exhibits even better quality of fitness. The same however, cannot be said for Gumbel distribution for which many of the computed values of X^2 exceed corresponding values of $X^2_{.05}$. Therefore, on the basis of the above test, flood frequency curves obtained by Weibul distribution are found statistically more sound for flood prediction at the sites considered.

4- APPLICATION OF FREQUENCY CURVES.

The flood frequency curves can be used to determine the magnitude of the flood of selected return periods.

The analysis can be further extended to determine the probability of risk, R, that a flood of equal or greater magnitude than a selected flood will occur at least once during the

ANNEXTURE – 6

CHI – SQUARE TEST FOR GOODNESS OF FIT

Name of Site.	Total Number of Year N	$\sum \frac{(O-E)^2}{E}$ 10^4 CS WEIBUL.	$\sum \frac{(O-E)^2}{E}$ 10^4 CS GUMBEL	X^2 .05	X^2 0.1
RIVER INDUS					
Kalabagh.	52	4.513	9.727	68.66	64.29
Chashma.	9	1.078	2.979	15.51	13.36
Taunsa.	21	0.654	2.376	31.41	28.41
RIVER JHELUM					
Mangla (Pre Dam)	39	11.292	133.88	53.36	49.54
Mangla (Post Dam)	13	1.687	3.023	21.03	18.55
Rasul. (Pre Dam)	45	48.203	176.489	60.36	56.36
Rasul. (Post Dam)	13	1.109	3.311	21.03	18.55
Jhelum Railway Brdg. (Post Dam)	13	3.201	1.707	21.03	18.55
RIVER CHENAB					
Marala.	58	19.808	147.718	75.61	71.03
Khanki.	55	13.923	152.030	72.13	67.66
Qadirabad.	10	7.117	9.021	16.92	14.68
Trimmu.	52	6.210	78.490	68.66	64.29
Panjnad.	52	10.908	6.228	68.66	
RIVER RAVI.					
Jassar.	31	6.835	4.295	43.77	40.26
Shahdara.	55	10.852	93.870	72.13	67.66
Balloki.	55	10.351	34.530	72.13	67.66
Sidhnai.	55	2.634	5.460	72.13	67.66
RIVER SUTLEJ					
Suleimanki (Pre Dam)	33	5.640	8.798	56.93	52.95
Suleimanki (Post Dam)	21	2.643	6.039	31.41	28.41
Islam (Pre Dam)	33	2.830	10.940	56.93	52.95
Islam (Post Dam)	21	8.663	5.966	31.41	28.41
Adamwahan	26	4.234	4.112	38.89	34.38

life time r of the structure. The life time is chosen considering the economic and service lives of the structures as defined below:-

ECONOMIC LIFE.

Economic life is the life for which the benefits from the structure are economically viable. This in turn depends on the economic situation in the country and the accounting rate of return. The life is taken as 50 years, since with discounting procedure the benefits after 50 years, however large, have little value.

SERVICE LIFE.

Service life of a structure is the life for which it remains serviceable. This depends upon the repairs and maintenance, occurrence of natural calamities like earth quakes and floods, etc.

The service life of a structure is controlled and limited by its utility and compatibility with the technological advancements of the age coupled with other socio economic and political changes in the region.

Now, if T is the return period, then P (probability of equal to or exceedence of the corresponding flood) is given by $\frac{1}{T}$, r being life time of the structure, the probability of no occurrence of the above flood in r years, P (0), is $P(0) = (1-P)^r$. Then probability of occurrence of the T year flood at least once in r years i.e. risk

$$= 1-P(0)$$
$$= 1-(1-P)^r \qquad 1$$
$$= 1- \left(1 - \frac{1}{T}\right)^r$$

This expression is extremely useful in the risk analysis of the structures required to withstand floods of known return period during their life time.

A reference to the graphs at Annexure 1 to 5 will show that design flood return periods for Punjab Headworks and Barrages vary from 15 to 30 years. It is interesting to note the structures are exposed to a certain risk (99.6% to 99.9 %) of occurence of the design floods or more during their service life.

-o-o-o-o-o-

5- CONCLUSIONS

1. There are numerous frequency distributions which may describe and be used to represent the population of hydrologic data, however, care should be taken in the selection of a particular curve so that, where possible, its selection is based on physical reasoning. The population of data used should be homogenous and correspond to the same physical process.

2. Chi Square test for goodness of fit has shown that Weibul distribution better represents the annual peak discharges of Punjab rivers at the sites considered in the study and the corresponding flood frequency curves may be used for flood prediction.

3. The flood frequency curves provide a basis for risk analysis of the structures which are designed to withstand the floods of selected return period in their life time.

....

HYDRAULIC MODEL INVESTIGATIONS FOR SITING OF D.G.KHAN BRIDGE, U/S AND D/S TRAINING WORKS FOR PROTECTION OF D.G. KHAN LINK CANAL NO. I (RIVER INDUS)

By
Abdul Khaliq*

D.G. Khan, an important town, located on the western (right) bank of river Indus is not directly connected with the left bank and the nearest link of communication with the left bank is Taunsa barrage 45 miles north of the proposed bridge. Nearest permanent crossing downstream, 195 miles to the South, is Guddu barrage. The closest road terminal near D.G. Khan on the left (eastern) bank of river is Ghazi Ghat. A bridge Fig. I was proposed for construction to link D.G. Khan and Ghazi Ghat. This paper deals with the model studies for suitable location and orientation of the proposed bridge and also to recommend essential training works higher up to guide and funnel the river flow through the bridge. River Indus has been posing threat to D.G. Khan link canal No. I due to progressive shifting of the main river towards west. Protection measures of permanent and long nature for D.G. Khan link No. I were investigated and comprised in this paper.

River Indus below Kalabagh is a braided river flowing in a number of channels and the bed material at the site of proposed bridge is fine or medium sand. The average slope of the river between Kalabagh and Chashma, between Chashma and Taunsa and between Taunsa and Ghazi Ghat is 1.37, 1.31 and 0.77 feet per mile respectively (Hand book on Punjab Barrages I & P Department Pb., April 1978). The discharge in 1929 at Ghazi was estimated at 8,00,000 cusecs. Due to commissioning of Tarbela Dam, the pattern of river discharges will be different as the river will be regulated closely and frequency of high flood will be reduced. It is estimated on the basis of observed data that maximum flood above 5 lakh cusecs will be rare on the assumption that reservoir filling will start on 26th June and filled upto R.L. 1530 on 10th August. The discharges contributed by tributories below Tarbela rarely exceeds 2.5 lakh cusecs. The peaks in Swan, vihova and Sangar can syncronise with peak floods in Indus.

The main requirements of a bridge site in a briaded alluvial river are:-

a) It should suit the pattern of river channel at the time of construction of bridge, preferably spanning the main channel in order to pass the flow through the bridge with minimum training works.

b) It should be sited at a stable point on the channel where thereas is least chance of the river to change its course.

c) The bridge should preferably be located as near the khadir axis as possible and bridge line normal to khadir axis as it will be best suited to the long term future river course.

d) It should be sited where it will benefit from local features such as existing training works and resistant banks so that new training works will be reduced to a minimum and also where it will suit the requirements of Highway alignment.

* Hydraulic Officer, Hydraulic Research Station, Nandipur.

It is apparent, therefore, that there is no single site which will satisfy all the requirements. The best way is to conduct model experiments to select a site which satisfies most of these requirements.

Purpose of Model Study:

a) To select the most suitable location for the bridge between D.G. Khan and Ghazi What which includes as many of above features as possible.
b) To determine the most appropriate alignment of training works U/S of the bridge to attain nearly uniform flow distribution at the bridge for all angles of river approaches.
c) To check the flow conditions at different river discharges in the bridge area during first and second stages of bridge construction.

Model:

The study was carried out on a model, constructed to scales 1:400 (Horizontal) and 1:50 (Vertical) respectively incorporated river Khadir 18 miles U/S and 5 miles d/s of Ghazi Ghat. Horizontal scale was selected on the basis of space available for accomodating the model. The corresponding vertical scale was computed by Lacey's relation which ensures best reproduction.

$$V = 16\, R^{2/3}\, S^{1/3}$$

$$\frac{VP}{Vm} = \left(\frac{Rp}{Rm}\right)^{2/3} \left(\frac{Sp}{Sm}\right)^{1/3}$$

$$\sqrt{hr} = hr^{2/3} \qquad \left(\frac{hr}{Lr}\right)^{1/3}$$

$$hr = Lr^{2/3} = 400^{2/3} = 54.3$$

So the vertical scales was fixed as 1:50.

The model bed was moulded in sand (d50 = 0.13 m.m.) in accordance with 1974 river survey and cross sections (Fig. 1). The bridge waterway on model studies was computed for a maximum river discharge of 10,00,000 cusecs due to unavailability of drawing at the time of model construction.

According to Lacey, $W\ P = 2.67\ Q^{1/2} = 2670$ feet.

According to IRI the maximum waterway determined is 1.2 times Wp (Lacey width) which is equivalent to 3204 feet.

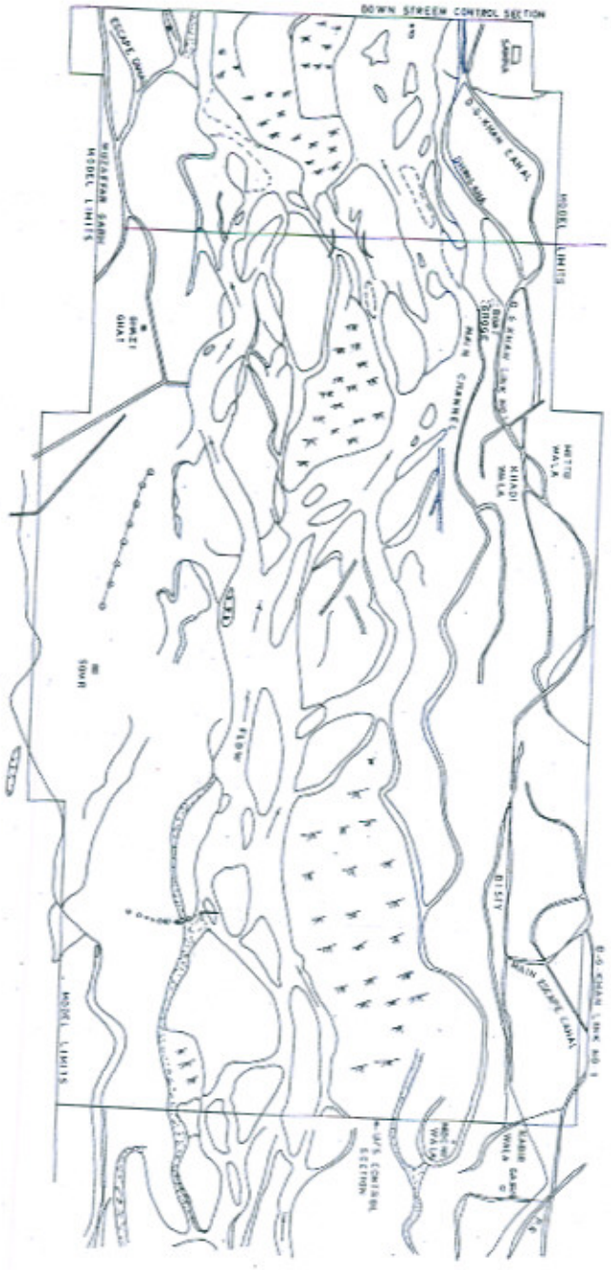
The bridge width between abutment to abutment was kept as 3400 ft divided into 17 bays each 200 feet span from cantre to centre of piers.

Tests:

Base Test: (Original Condition)

This test was conducted on initial moulding according to 1974 survey and cross sections by imposing a selected 1960 hydrograph with superposed peak flood of 10,00,000 cusecs to reproduce water slopes and water levels at known gauge sites, unfortunately the prototype information was not supplied by the sponsoring agency so the test was started without proving the model. This does not invalidate the model tests which are qualitative, relative and comparable and unnecessarily quantitative. The results indicated development of main channel bifurcated into two channels 5 miles U/S of Ghazi Ghat.

1. With discharge distribution in right and left channels at 1,00,000 cusecs as 70% and 30% respectively.
2. The flow in confined in the extreme right



GHAZI GHAT ROAD BRIDGE

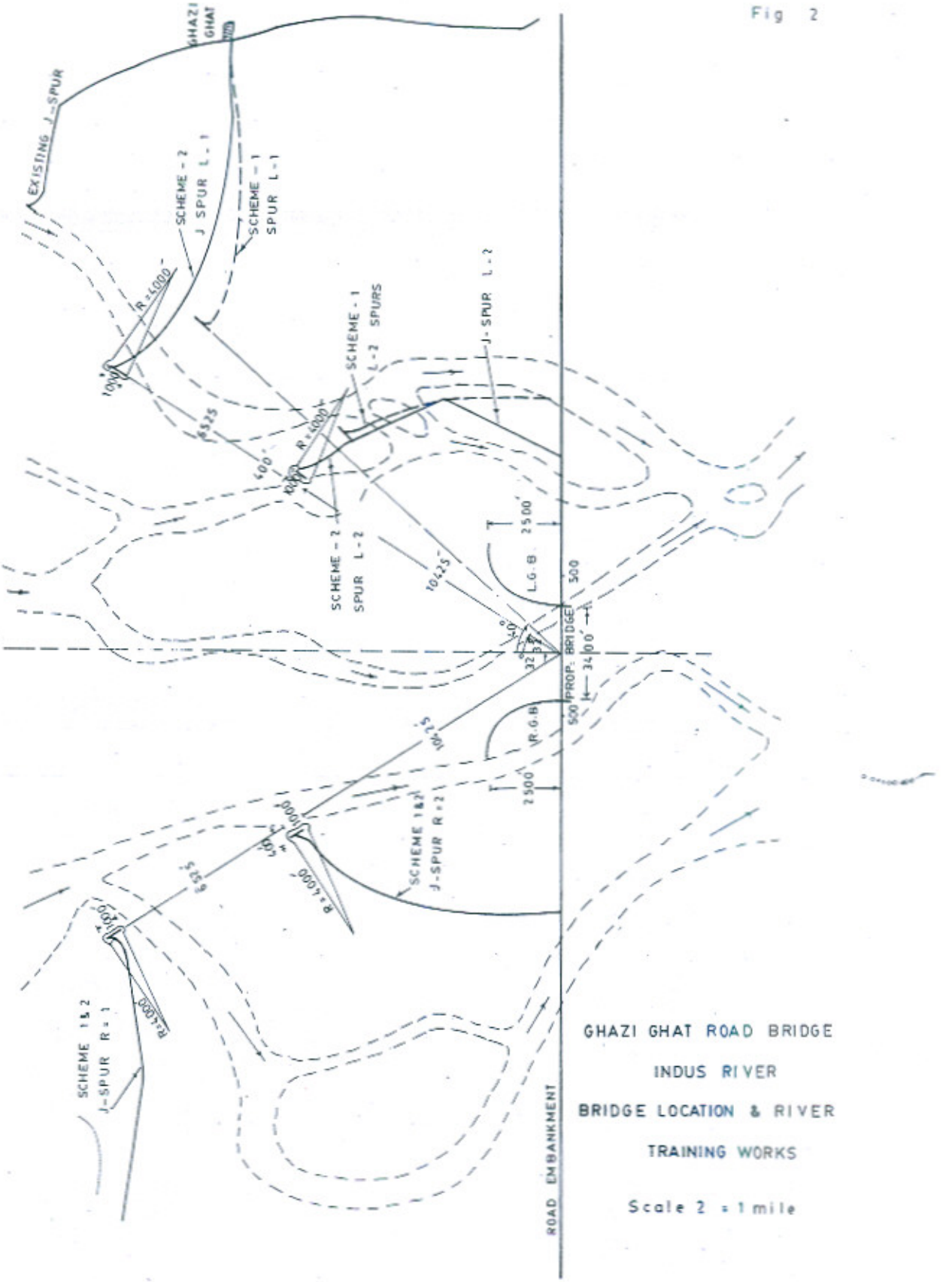
INDUS RIVER

SURVEY 1974

Scale 1" = 7000'

Fig 1

Fig 2


GHAZI GHAT
EXISTING J-SPUR
SCHEME - 2 J SPUR L-1
SCHEME - 1 SPUR L-1
R=4000'
SCHEME - 1 L-2 SPURS
J-SPUR L-2
SCHEME - 2 SPUR L-2
L.G.B.
R.G.B.
PROP. BRIDGE
SCHEME 1&2 J-SPUR R=2
SCHEME 1&2 J-SPUR R=1
ROAD EMBANKMENT
GHAZI GHAT ROAD BRIDGE
INDUS RIVER
BRIDGE LOCATION & RIVER TRAINING WORKS
Scale 2 = 1 mile

and left channels upto 200,000 cusecs at which all the creeks are active. The flow starts spilling the banks at about 250,000 cusecs which increases till the flow spreads out in a sheet at 400,000 cusecs with the exception of some dry and high grounds.

The study for the bridge and upstream training works was conducted in two schemes as below:

Scheme - I: (Assymmetrical spurs system on two flanks of the bridge).

Scheme - II: (Symmetrical system of spurs on two flanks).

The two schemes were tested with bridge at cross section - 16 and its axis nearly parallel and coincident with river khadir axis. Symmetrical guide banks evolved best from model studies in the last two decades were constructed. Tests with assymmetrical and symmetrical placement of right and left flank spurs in Fig. 2 were completed. The results showed that spurs in scheme - I developed deepest scour pits 80 feet and 16 feet on the right and left sides respectively at the bridge. Scheme - II deal with symmetrically aligned spurs on two flanks showed better approach conditions and discharge distribution through the bridge.

After finalising the alignment of training works in scheme II above the tests were carried out with right and left handed worst dominant river approaches forming deep embayment at spurs L1 and R1 (Fig. 3). The results of bed tests showed that with right handed approach discharge distribution in bridge bays improved with scour in middle bays and high bed levels along abutments. Velocities along spur R1 shank U/S face increased which necessitated construction of a mole spur at some later date. In test with left handed river approach the flow remained along left guide bank. The deepest scour holes in the bridge was at R.L. 433 on left against 436 on the right with right handed approach. The scour at spurs L1 and L2 is almost indentical indicating that the existing Ghazi Ghat spur is effective in controlling the scour at left bank spurs.

Recommendations:

I.R.I. on the basis of analysis of model results recommended that:-

1. Bridge be located at cross section - 16 with its axis nearly coincident with khadir axis.
2. Guide banks of length 2500 feet on bridge axis with straight length 400 feet, curved length 1050 feet at divergence 15° on a radius$^{2.5}$ times bridge width (R = 8510 feet) head length 1050 feet on a radius 0.5 time bridge width (R = 1700 feet).
3. J-spur L1 and L2 and R1 and R2, 6525 feet apart as in scheme II symmetrically located on lines 32° with bridge axis (Fig. 2,4). Experiments were also conducted for different phases of construction schedule.

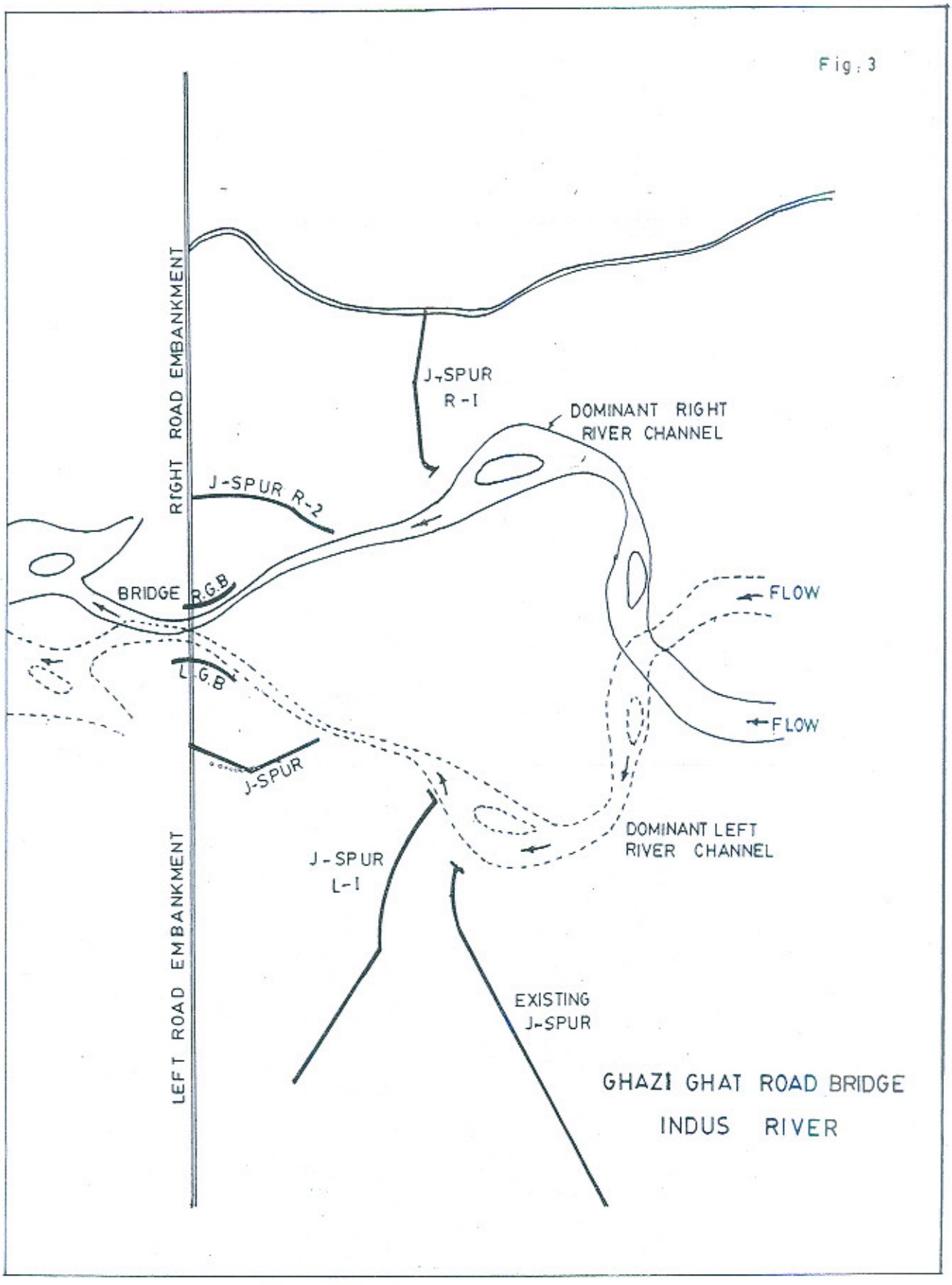
Schedule of bridge construction:

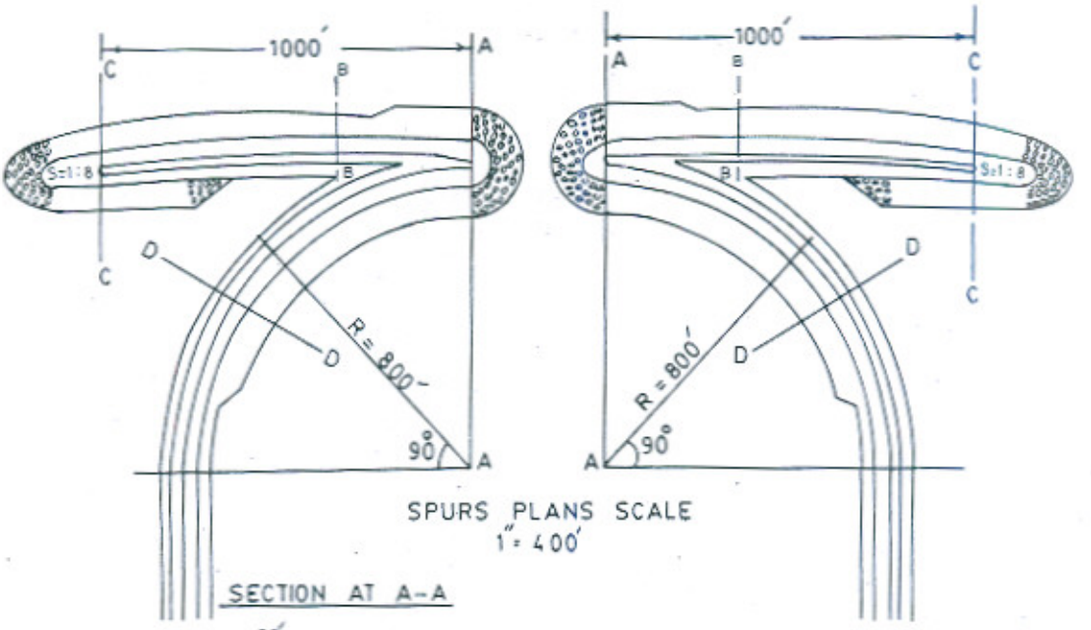
Punjab Highway Department estimated the construction of bridge, proposed training works and approach roads within khadir to be completed in 3 years and two flood seasons will be passed during construction period. (Director bridges letter No. 19-B(W)/65/1270/bridges dated 13-8-78). The construction schedule proposed by I.R.I. and agreed by Highway Department is as follows.

First stage construction:

a) It comprises completion of both guide

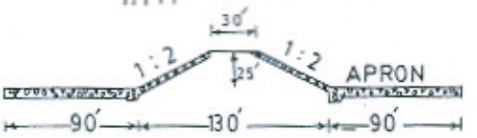
Fig. 3


RIGHT ROAD EMBANKMENT
J-SPUR R-1
DOMINANT RIGHT RIVER CHANNEL
J-SPUR R-2
BRIDGE
R.G.B
L.G.B
FLOW
FLOW
J-SPUR
DOMINANT LEFT RIVER CHANNEL
J-SPUR L-1
EXISTING J-SPUR
LEFT ROAD EMBANKMENT
GHAZI GHAT ROAD BRIDGE
INDUS RIVER

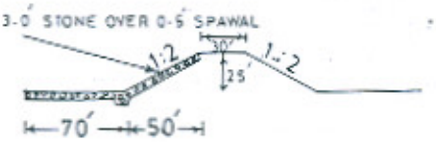


SPURS PLANS SCALE
1" = 400'

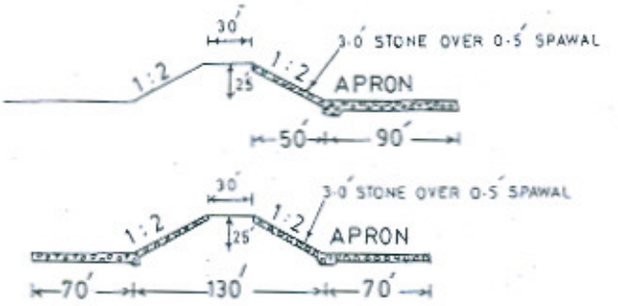
SECTION AT A-A



SECTION AT B-B'



SECTION AT D-D



SECTION AT C-C

SCALE - 1"=100'

banks, approach road on the left flank upto Ghazi Ghat, flood embankment 2000 feet road embankment on either side of bridge protected by mole head spurs and sinking of wells for bridge piers.

b) Second stage construction involves completion of left road embankment upto Ghazi Ghat and bridge foundation and piers.

c) Final stage of construction includes completion of right flank spurs R1 and R2, river diversion through the bridge, completion of road embankment on the right and super structure of the bridge.

The study was conducted in December 1978 on river survey 1974, as the new accurate survey was not available, to test the adequacy of the above stated stages of construction. On the basis of analysis of results of different tests, the first and second stage construction schedule were recommended in Fig. 5 for adoption at site vide I.R.I. No.422-G/GRB/237 dated 27-1-1979.

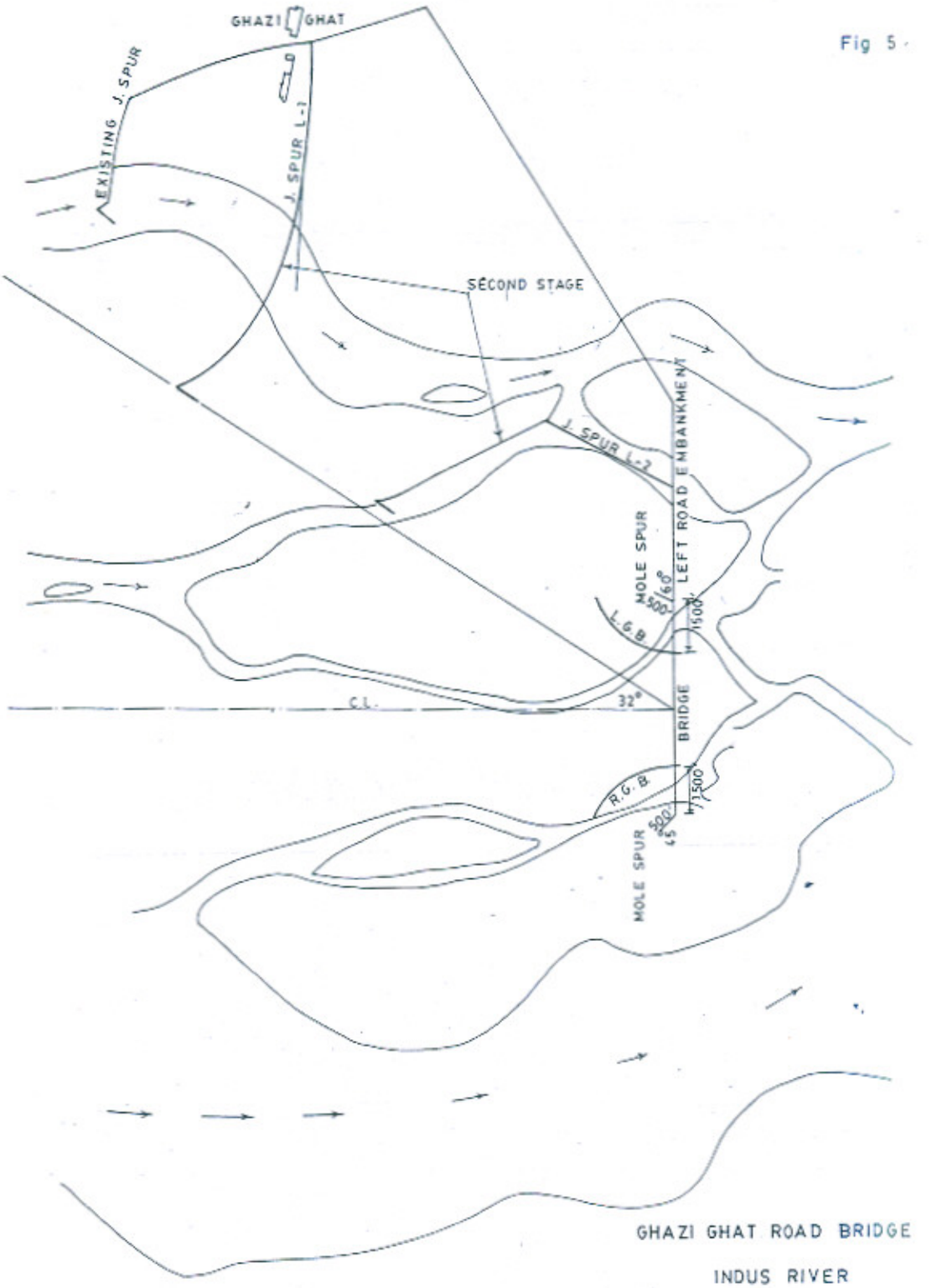
Measures for the protection D.G.Khan Canal Link No.I downstream of proposed bridge.

After the construction of Taunsa Barrage, the pattern of river Indus U/S and D/S of the barrage has changed drastically. Left bank of D.G. Khan Link No.1 has been subjected to severe erosion at its two bends due to progressive meandering of river bends towards western (Right) bank. The link No.I had been set back a number of times. The 15th diversion of link No.I between R.D. 154500 to 175000 was done in 1979. The last alignment of D.G. Khan Link No.I opposite R.D. 159500 was 44 feet from the main river bank which necessitated 16th diversion from R.D. 152000 to 174500. A new model on scales of 1:500 (Hor.) and 1:50 (Ver.) was constructed incorporating a river stretch 8 miles U/S and 22 miles D/S of the proposed bridge. The model was moulded in sand of d50=0.13 m.m. Proof run test was conducted with river survey and cross sections of 1979 to reproduce the water surface slopes and further erosion of the right bank. The setting back of link No.I is not a permanent solution, therefore, construction of spurs is imperative to keep the river at a safe distance from link No.I. Number of tests were performed with system of two and three spurs and following recommendations were made.

1. The optimum location and alignment of 3 spurs is shown in Fig. 6 and geometry of spur head with X-section in Fig. 7. Upper J-spur at R.D. 143 with curved head 900 feet is necessary to take care of the upstream embayment from a wide angle and to push the flow to the existing left side channels. The sloping part of the spur forbids any attack from the back side.
2. J-spur No.2 at R.D. 152 with head 750 feet crosses the main channel at cross over position of Thalweg line, checks regression of flow back in the existing active channel and helps in deflecting the main flow appreciably away from the existing course of the river.
3. J-spur No.3 with head 750 feet long stops any regression of the river back to the deep channel opposite R.D. 156000 to R.D. 175000 and keeps the flow currents towards left side.

The recommended system of 3 spurs are located on a large curve and so the embayment forming at spur heads (after bridge construction) will be instrumental in forming a counter meander downstream of the spurs with inner bend facing link No.I. The erosion of upper

Fig 5



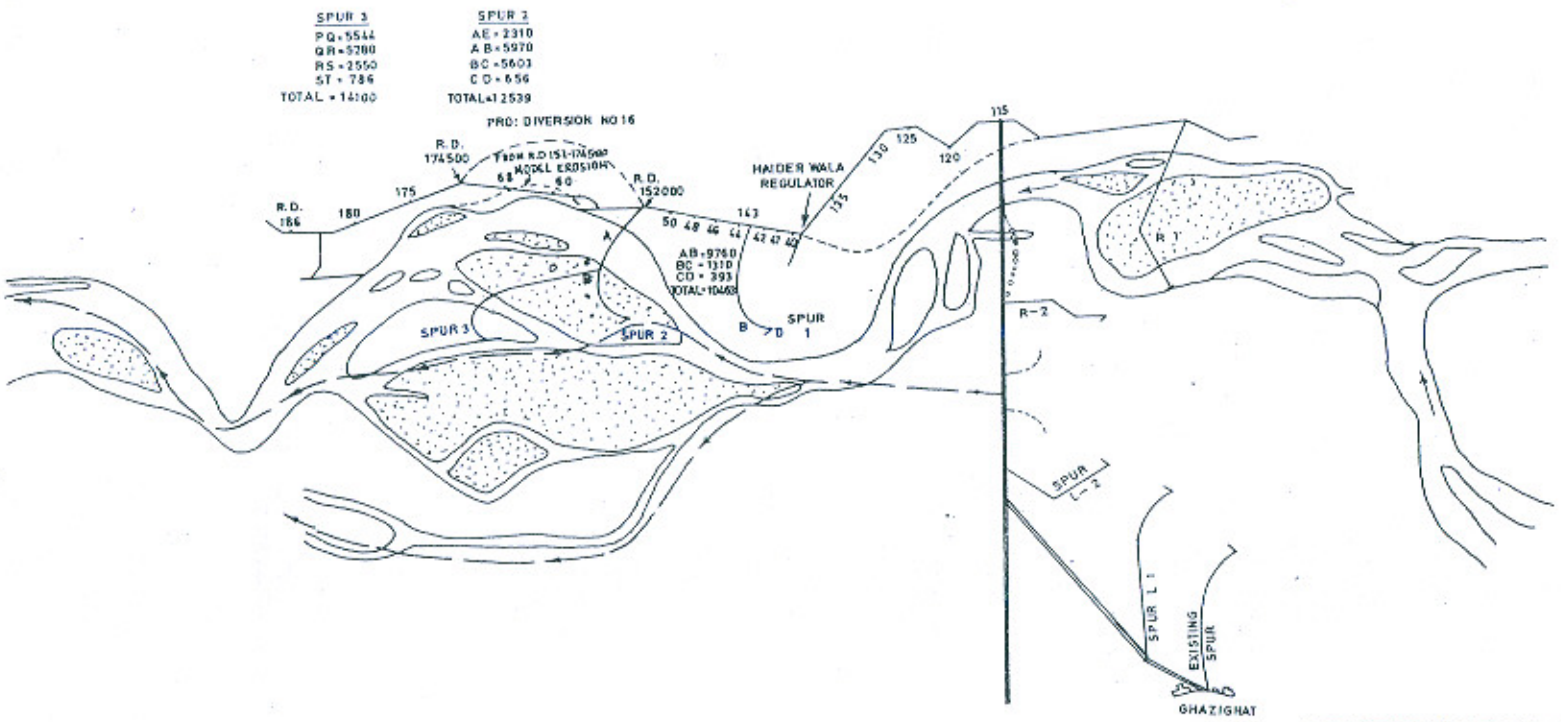
GHAZI GHAT ROAD BRIDGE

INDUS RIVER

2ND STAGE CONSTRUCTION

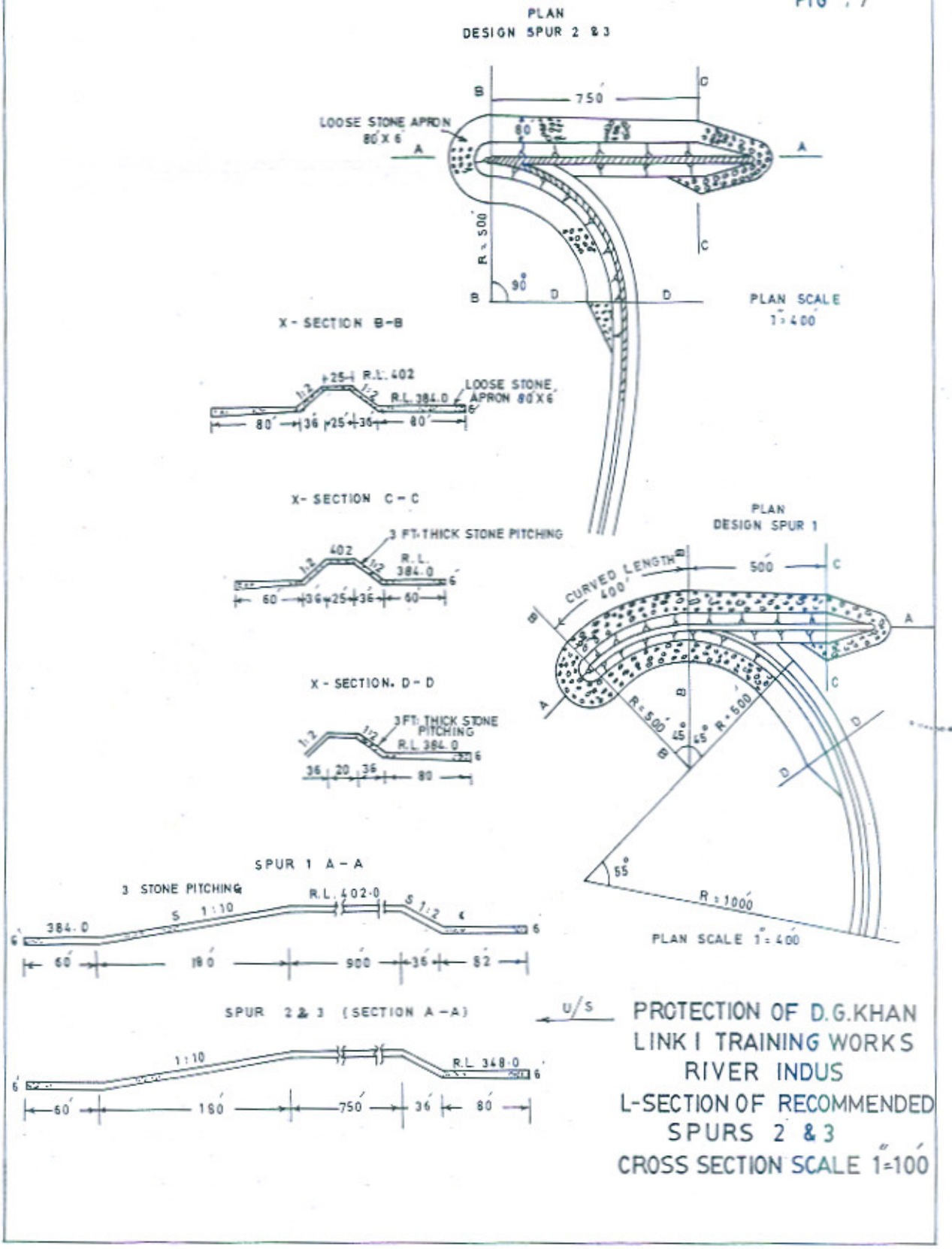
Scale 2" = 1 mile

FIG: 6



PROTECTION OF D.G. KHAN
TRAINING WORKS
INDUS RIVER
RECOMMENDED SPURS
SCALE 1" = 10,000'

FIG . 7



PROTECTION OF D.G.KHAN
LINK I TRAINING WORKS
RIVER INDUS
L-SECTION OF RECOMMENDED
SPURS 2 & 3
CROSS SECTION SCALE 1"=100'

bend of river opposite R.D. 92 to 97 of link No.I will be protected after construction of the bridge in presence of I.R.I. recommended up-stream spurs.

4. The apron level of the spurs should be as near the water table as possible.
5. The size of the stone (60-80 lb) should be 60-70%. The bigger size stone (80-120 lb) and smaller size stone (40 - 60 lb) should be 20 - 15%.

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CONTRACT SYSTEMS AND ADMINISTRATION

BY

*DR. AMJAD PARVEZ SHEIKH**

1. INTRODUCTION

Although there are no hard and fast rules which can be applied to any of the format of various contract systems, the conventional types in vogue can be categorized as, (1) lump-sum contracts, (2) scheduled or measurement contracts, and (3) cost plus contracts. Scheduled contracts include both percentage rate contracts (PRC) and item rate contracts (IRC). It is always essential to periodically review the conceptual aspects of these systems for performance improvement. Anything amiss thereby, may be located or gaps if any, may be closed. Each time a contract is to be awarded, the merits or demarits of these systems have to be evaluated such that a suitable choice is made under the given conditions. This is necessary because there use over the decades has created an apathy towards the selective use of each system.

This paper attempts to highlight the merits and demerits of various contract systems and the conditions in which these can be applied. Possibilities of malpractice while applying various systems of awarding contracts have also been touched upon.

2. CONVENTIAL CONTRACT SYSTEMS

A. LUMP SUM CONTRACT

Normally the remunerations in such contracts consists of a fixed lump sum which has been arrived at depending upon the situation in which such a contract agreement is drawn.

For the professional services provided by the Consulting Engineer, the lump sum fee is either determined by applying a percentage to the estimated construction cost, or by developing it on the basis of the man-month estimates for the engineering services required. Normally the latter approach is preferable depending upon the Client's desire. In such case, the lump sum consists of:

a) Estimated payroll or salary costs based on the estimated number of drawings, man-hours, salary rates, etc.
b) Estimated overhead costs.
c) Estimated direct cost including out-of-pocket expenses like travel and subsistence while away from home office, printing and reproduction expenses, telephone, telex, telegraph and postal expenses, etc.
d) A percentage surcharge on salary or payroll costs representing Fee for the Consultant for

* *Principal Engineer, NESPAK, 417-Wapda House, Lahore.*

availability of his Organization, a profit element etc.

Such agreements normally include:

i) Stated time limit for the performance of the services.
ii) A provision for additional compensation for time in excess of the stated time, and for changes required to be made after preliminary plans have been approved.
iii) An agreed upon detailed scope of work.
iv) A provision for equitable adjustment in compensation in case the original scope of work is expanded or reduced.

In case of construction projects if the LSC system is adopted, the Contractor agrees to complete work execution with all contingencies, in conformance to specifications and drawings for a fixed sum. Here, a rate schedule is specified in order to regulate the amount to be added to or deducted from the fixed sum on account of additions or alterations not already covered by the contract. No allusion is made in the contract to the departmental estimate of the work or the schedule of rates or quantities of work to be done. In such contracts, detailed measurements of work are not required except in cases of additions or alterations.

The plus points of the LSC system include the fact that the administration efforts for tender invitation and award of contract involve considerable lesser time. Interim and final payments are also faster as paper work of recording measurements and billings is less. Implementation planning and monitoring is easier and the Contractor can quote rates covering all risks without apprehensions of variations or deviations. Also a quick decision in awarding a contract enables an early start which coupled with quick payments can control the completion time effectively.

The LSC system is preferable for traditional and repetitive type of work especially for the building construction work.

A very important aspect of LSC system is that certain conditions have to be met prior to its application. These are:

a) Final and detailed designs and estimates should be ready in order to avoid variations and deviations which sometimes affect the completion cost and are the root cause of disputes in certain cases. The lump sum contracts cannot be used to the full advantage in case designs have not been finalized prior to tender invitation or need substantial modifications during construction.
b) There should be a full knowledge of commitments in advance.

B. SCHEDULED OR MEASUREMENT CONTRACTS

Both percentage rate contracts and item rate contracts fall in this category.

The Consultants' compensation for professional services rendered under this system, can be conveniently based on a percentage of the estimated or final total construction cost of work. In case the services cover only estimation and design, or in case the construction is deferred or cancelled, the compensation then is based on the estimated construction cost as determined by the Consultant. The final construction cost of work constitutes the actual total construction cost including costs of labour, materials and equipment and so on. This does not include however, the engineering and administrative costs of financing real estate, legal or other similar expenses.

In the percentage contract system, normally the owner supplies the bill of quantities and schedules of rates attached with tender indicat-

ing the anticipated value of work. The Contractor has just to indicate the percentage lower and above this anticipated value of work at which he is prepared to work. Such an arrangement exists in India for government departments jobs. In our country however, the bill of quantities is prepared by the owner or Consultants on their behalf along with schedules, but the rates are filled by the Contractors indicating the value of work suited to them. Such an arrangement reduces the administrative work related to tender computation thereby reducing the time for evaluation and also reduces the possibility of unbalanced bids. In the item rate contract system, the Contractor quotes his rates independently for every item. Contrary to PRC where reference rates have been provided, in IRC only quantities are specified and rate per unit is sought.

There are both advantages and disadvantages of scheduled contract system. Here, the complete finalization of design is not essential and the possibility of variation in the design exist. Originality in design can be allowed to be conceived in broader terms with allowance for modifications, once details of work are available. This aspect has its limitations also because such a latitude of permiting unavoidable changes in design sometimes lead to a liability of these systems. Loss of control occurs on the completion cost and time leading to possible disputes. The latter arise due to parties not agreeing to the rates of the changed quantities beyond permissible limits. Litigations or arbitrations also arise when changes in specifications occur.

The advantages of scheduled contract system include the reduction in the possibilities of overpayments in the running expenditures and final bills, because of the inbuilt existence of detailed computation of quantities of work items, their individual cost and summation. Also rigid control over consumption of materials is possible due to computation of quantities of every work and its exhibits in the schedule.

In the PRC & IRC systems, unbalanced tenders are sometimes generated. This situation arises if the rates for different items of work have not been offered on analytical basis. In such cases, the Contractors quote high the rates of items where quantities are likely to vary on the higher side and vice versa. The net total value of the tender is, however, worked out in such a manner that face value of the tender is low. This leads to the situation where the actual completion cost is much higher than the anticipated value due to the fact that the measurements of work are the basis of payments. A deterrent to the healthy competition arises when in extreme case the Contractors are lead to the situation where they have to carry out an item of work free of cost.

C. COST PLUS A FIXED FEE CONTRACT

Sometimes a situation arises when it is difficult to accurately estimate the cost of the project. In such a case, the Consultants are required to commence work immediately. This situation arises where speed of work is of prime consideration, or if, special studies, research work, alternate estimate preparation for the construction work, or experimental and model studies, are a pre-requisite to the initiation of the work. Here the cost plus a fixed fee agreement comes to the rescue. Such intermediary projects must however be specific regarding detailed terms of references or scope of work. Such an agreement is the proper way out for performing the services both in the field or at the Client's premises. In the cost plus a fixed fee agreement, the remunerations of the Consultants consist of all costs like salary costs, overhead and direct costs, to be reimbursed. Over and above, the Consultant is entitled to a fixed fee. This is based on a percentage of the agreed upon esti-

mate of construction cost which can vary as to the size, scope and complex nature of the project. The fee is enhanced if the scope of work of the project increases.

3. POSSIBILITY OF MALPRACTICE WHILE APPLYING VARIOUS SYSTEMS IN PRACTICE.

As discussed above each system can be applied according to the situation it is most fit for. Each system has its plus and negative points. Each system cannot be complete so as to apply it to all situations. (5) The tendency amongst Contractors sometimes is to exploit the weaknesses of the system to their advantage. The result is in the shape of either unbalanced tenders, ring formation by Contractors or an unhealthy competition. If there is a lot of work and dearth of Contractors, they form a ring quoting enormous rates and share the booty. If there is less work, the situation is extreme with the Contractors leading to unrealistic quotes. They may go all out for the profitable portion of the work while using delaying tactics for the less profitable portion. Lack of honesty and dedication leads to the blind law giving opportunities to the Contractor with emphasis more on letter than on spirit. The offender can, in such cases, escape with impunity.

4. PROPER SELECTION OF A SYSTEM UNDER A PARTICULAR SITUATION.

An obvious problem is to apply an appropriate system to a particular situation. Generally speaking, whenever there is a standard type of work involving repetitive construction lump sum type of agreement is adopted. On the contrary, if the administrative efforts required especially in the invitation of bids and their evaluation are more, measurement contracts are preferable. For a combination of design comprising of both repetitive and modified work, it is preferable to adopt more than one or a combination of systems.

Since a project in such cases, is divided into parts, a healthy competition amongst Contractors arises which is a good omen. As each part of the project is now a small project on its own, even smaller firms can apply for the job. The resultant is keen competition and reduced completion costs, mainly because of administrative advantages. Here each Contractor can plan his part of the work properly with payments by the Client to each becoming less cumbersome and combined efforts of all Contractors ending up into reduced completion time, and finally needless to say gaining of advantages because of work provision to more firms. However, monitoring of all these agencies would need more attention by the Client.

5. VARIOUS SYSTEMS OF AWARDING CONTRACTS

The evaluation of bids and acceptance of the most suited offer is a challenging exercise which has attracted attention of both the Government and their agencies in the recent past all over the world (1,4,6). Lately, in order to find an appropriate method of suitable bid selection, many exercises were carried out by developing bidding models or strategies (2,7). All such efforts and experiences of experts in this field have unanimously confirmed the importance of using an appropriate procedure for the bid evaluation as to its reasonability and selection.

The conventional system consists of an open competition amongst bidders where from the lowest bid is accepted. This system has its limitations. On the other hand, at some places in the world like Australia, the Clients have gone in for negotiated tenders only, i.e. a single tender is invited and negotiated till a compromise

is reached amongst the Client and the bidder. The drawback of this system is that such procedure calls for unwanted dissatisfaction from the other suited bidders not allowed to bid for the same job. In India, government prefers open scheduled system wherein quotations are invited by fixing ceilings for different rates. The project is split up into various components with each portion of the project awarded to different Contractors. The major advantage claimed by those practising this method is that controlling of item rates directly effects the ultimate completion cost.

PACKAGE DEAL SYSTEMS

In a project involving the functions of planning, design and construction normally, these three functions are dealt with separately. All these different portions of work would include the conditions of contract, set of specifications and bill of quantities. If for example, the project consists of land development for houses for low income group, then following the precedence, a road contract would be awarded first in order to open up the work. Other services would follow. In this whole process, the Client would be craddling a fond hope that the work done by one Contractor is not undone by the other.

If time is to be saved, simultaneous action on all portins of work, as far as possible, must progress both laterally and vertically. Laterally means that work on the planning of services should go on simultaneously. Similarly, designing and eventually construction of all services should progress simulteneously. A step forward is vertical telescoping, meaning that while the work on a subsequent portion of design is being undertaken, construction of the designed portion is under execution. To be able to achieve the extent of time saving envisaged by the foreign aid giving agency, telescoping laterally as well as vertically would have to be adopted. So various experiments by the developed countries conclude that the time saving from inception to completion is attained by using package deal systems in many cases. This system, whereby one firm offers to be the designer-cum-contractor, affords substantial simplification in procedure and conduct as compared to the conventional system or the owner-contractor system. The prevailing name given to this system is 'Turn-key' contract. This arrangement reduces the possibility of disputes. This system has the added advantage that at times good Contractors have submitted alternate more economical proposals based on their design. Generally, Contractors because of their vocation, would while designing, be more conscious of construction cost. On the other hand, a Consultant in his loyalty to the Client, would prepare designs that most Contractors can undertake to ensure maximum competition. Similarly, a Contractor would diligently analyze the availability of materials, its costs, cost of transportation and so on, before incorporating it in the design. Therefore, in many cases, the 'Turn-key' contract system turns to be the most economical as well as technically feasible.

The disadvantage of the system is the likli-hood of nepotism seeping in and the resulting controversies. An unethical Contractor may also use substandard specifications who is given the complete responsibility of design and construction.

6. IMPROVEMENTS OVER CONVENTIONAL SYSTEMS

Since the mostly used system out of the prevailing systems is the competition amongst various bids and selecting the lowest one, some improvements have been suggested by the practitioners. The Danish system developed in Europe, consists of a formula:

$$NA = \frac{NL + 4A + NH}{6}$$

where;

NA = New Average.
NL = New Low
NH = New High
A = Average of all offers.

This formula is valid for offers which are a minimum of eight in number. For lesser numbers, Gore (3) suggests the formula:

$$AL = \frac{SAC - 2AT - AN}{3}$$

where;

AL = Acceptable Cost Level of Tender.
SAC = Sum of midrange cost of all Critical Activities:

$$SAC = \sum_{j=1}^{n} \tfrac{1}{2} (\max_i CC_{ij} + \min_i CC_{ij})$$

$$= \sum_{j=1}^{n} AC_j$$

AC is the midrange cost of each critical activity given by the formula.

$$AC = \tfrac{1}{2} (\max_i CC_{ij} + \min CC_{ij})$$

AN = Average Cost of the Normal Activities.

$$AN = \frac{1}{m} \sum_{i=1}^{m} CN_i$$

AT = Average Cost of Tender

$$AT = \frac{1}{m} \sum_{i=1}^{m} CT_i$$

Here CT_i = Cost of Tender i

i = 1,. . . . . ., m

CC_{ij} = Cost of each critical activity j in tender i.

j = 1,. . . . . ., n

CN_i = Sum of all Normal activities in tender i.

It is only the practice of these new improvements over the conventional system in particular situation which can authenticate as to their worth.

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INTERNATIONAL HONOUR FOR PAKISTANI ENGINEER

Dr. S.M.H. Bokhari led a Pakistani delegation to the 7th session of the U.N. Committee on Natural Resources held in New York during May, 1981. Pakistan is a member of this prestigeous body of the Economic and Social Council, which is responsible for the exploration, planning and management of mineral, energy and water resources.

By virtue of his long association with the United Nations and his outstanding contribution in the past, Dr. Bokhari is held in great international esteem. Therefore he was elected Vice Chairman of the Committee by acclamation, which is a matter of pride for the Engineering Profession as well as the whole nation. Dr. Bokhari chaired a crucial session of the Committee during which important issues, such as transfer of technology, effectiveness and limitation of Technical Assistance Programmes and role of U.N. System as a stimulant to the development strategies of the developing countries came under discussion.

Dr. Bokhari, moved six resolutions and co-sponsored two more with other member countries, which was the highest individual contribution compared to the collective contribution made by the remaining countries represented on the committee. His resolutions dealt with problems and potentials of resource management in the developing countries, present contribution made by the U.N. System, Wold Bank and other financing agencies and need to revise the rules and procedures for the grant of Technical Assistance to make the UNDP contribution more effective and meaningful. He laid great emphasis on the effective participation of local technical, managerial and material resources in the utilization of U.N.D.P. funds for Technical Assistance and Development and suggested that in the joint venture of local and foreign consultants and contractors, the lead role should be assigned to the major contributor, whether local or foreign, wherever it is found appropriate. His viewpoint was debated extensively and all the six resolutions tabled by him were adopted which is a unique honour for D. Bokhari, who deserves national felicitations and recognition of highest order. Dr. Bokhari visited Bait-ullah to perform his Umera, before returning to Pakistan. Dr. Bokhari is a life fellow of Institution of Engineers Pakistan and a chartered Engineer. Currently he is Joint Secretary in the Ministry of Water & Power, Govt. of Pakistan, Islamabad.

reviews

Examination of Water For Pollution Control
A handbook for Management and Analysis
Editor: M J Suess, World Health Organization, Copenhagen.
This three-volume work, prepared under the auspices of the WHO by 20 international experts, is said to comprehensively describe all aspects of the subject, from the design of measurement systems, through techniques for sampling, monitoring and analysis to data compilation and interpretation. Particular attention is given to statistical control, advanced instrument analysis, interpretation of biological indicators of water quality, and the design of an average laboratory.

Suggested readership is scientists, engineers and management in government, industry and universities concerned with public health, environmental science or pollution.
1500 pp approx
Price $A337.50
Available from Pergamon Press, P.O. Box 544, Potts Point, NSW 2011, AUSTRALIA.

Bioengineering for Land Reclamation and Conservation.
by Hugo Schiechtl
This book was originally published in Germany in 1973 and the German version reviewed by Dr N C Lambrechtsen in *Soil & Water* June 1974.

There is now a translation and revision funded by the Alberta Department of the Environment.

The stated purpose of the book is "to show how the products of scientific and technical research can be integrated with natural materials to obtain effective and economic methods of protecting, restoring and improving our environment."

The topics covered include:

1. Technical preparation for bioengineering works: support constructions using dead materials; drainage, gully, and bank protection construction for rock falls; wind protection systems; snow and avalanche protection; and contouring works;
2. Bioengineering methods for earthworks: soil stabilisation methods using live materials; methods combining dead and live materials; biotechnical drainage systems; surface protection methods; and supplementary building systems;
3. Waterway (hydro) bioengineering;
4. Plant materials used in bioengineering: selection of plant species according to plant sociological and ecological criteria; suitability of plants according to ease of propagation; and biotechnical suitability of plants;
5. Using bioengineering to its best advantage: the most frequent mistakes made in earthworks and hydro construction; choosing the right methods; and areas with special problems; and
6. The cost of bioengineering.

The hardback book costs $US30 and is published by the University of Alberta Press, Suite 450, Athabasca Hall, Edmonton Alberta, Canada T6G 2E8.

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

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

٦- وَقُولُوا قَوْلًا سَدِيدًا ۝

"And speak straight words." xxxiii : 70

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

٧- 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

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

٨- وَلَا تَقْفُ مَا لَيْسَ لَكَ 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.

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IRAN	230 K.V. 400 K.M. 63 K.V. 40 K.M.	400 K.V. 106 K.M.
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LIBYA	30 K.V. 496 K.M. 30/10.8 K.V. Sub Stations 3 Nos. Civil Works of Extension Plant of Zliten Desalination Power Project.	220 K.V. 300 K.M. 220 K.V. 30 K.V. 402 K.M. 66 K.V. 900 K.M. 66/10.8 K.V. 20 MVA Sub Stations 2 Nos. of Water Works Project.
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