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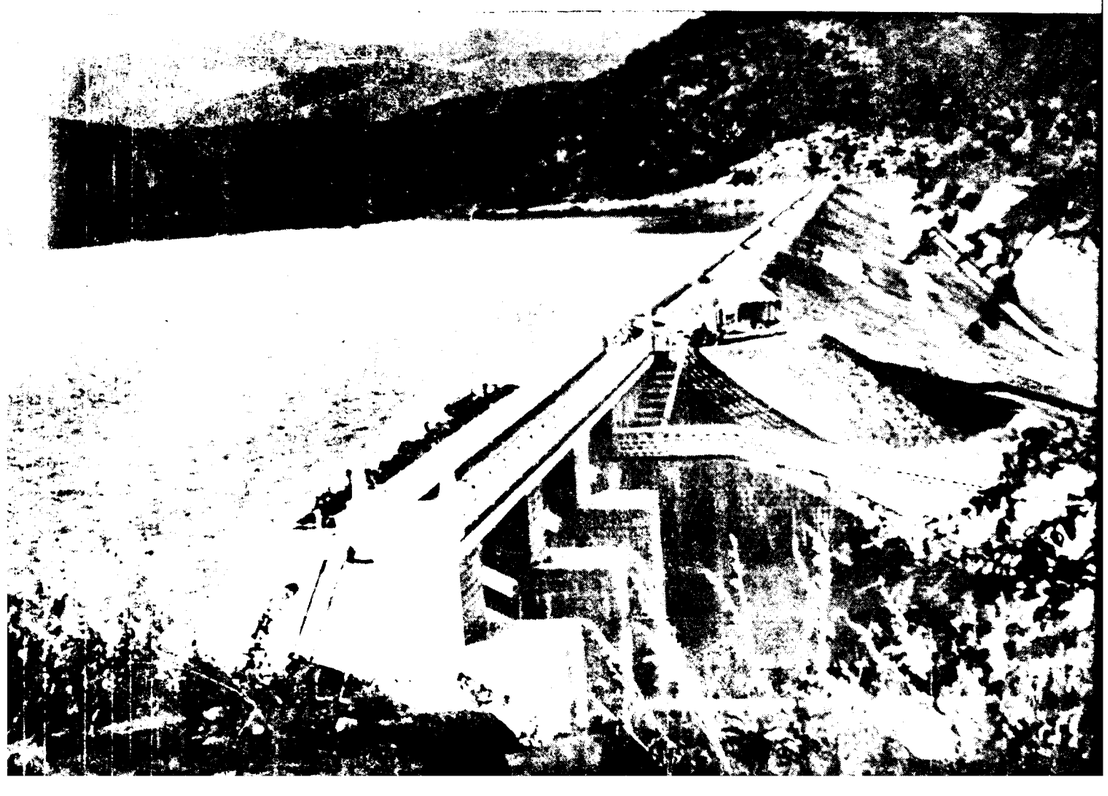
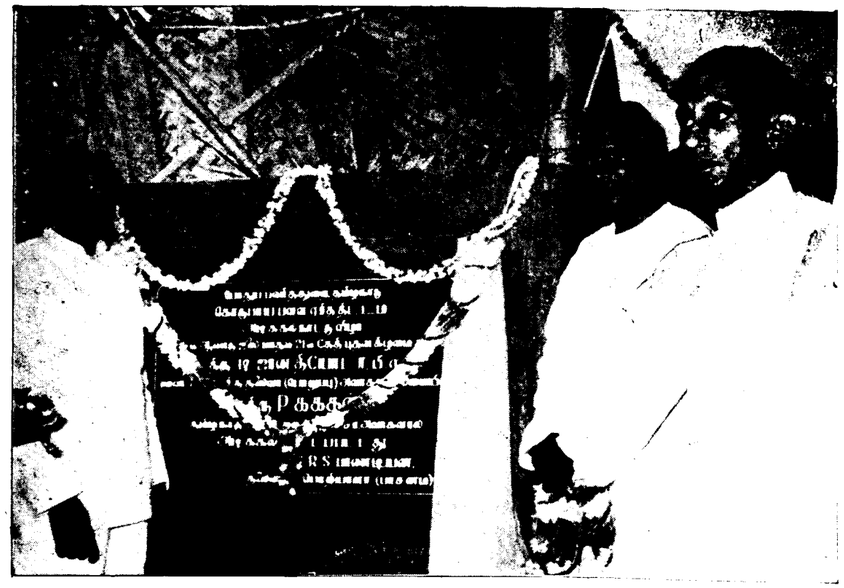
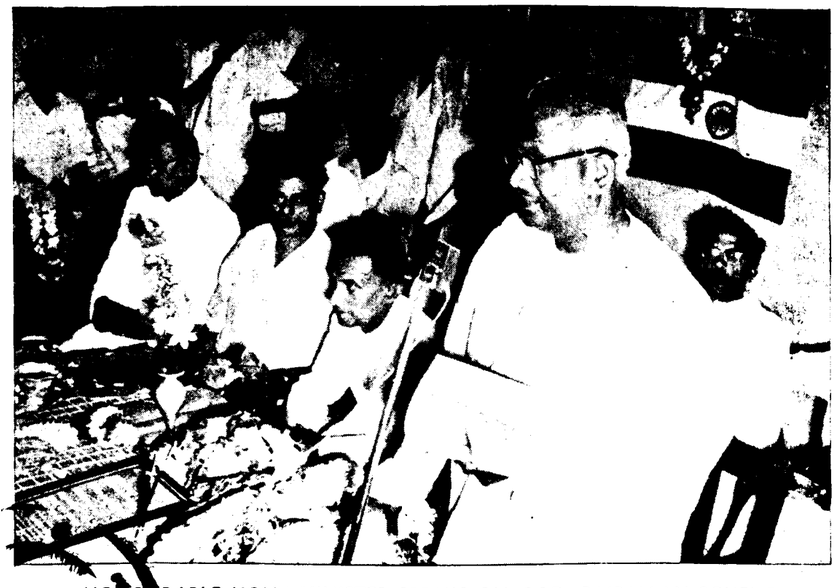
SATHIAR ODAI RESERVOIR





FOUNDATION TABLET FOR GODUBAIPALLAM SCHEME LAID ON 21ST JULY 1966.



HONOURABLE HOME MINISTER SPEAKS ON GODUBAIPALLAM SCHEME.

THE NEW IRRIGATION ERA

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ZONING OF MASONRY

BY

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1. *Introduction.*—Most of the low dams constructed in our State have been constructed by using 1 : 5 mix. for the top 50′ and below that 1 : 4 mix. has been adopted. But such a procedure cannot be followed in the case of high dams without sacrificing economy. In case of high dam, the most sceintific method of approach has to be undertaken in this regard. This article deals with such a method known as " Zoning of masonry for dam construction ".

2.0. The basic concept of the theory is enunciated below :—

The body of any dam is subjected to stresses of varied magnitude, depending upon the design conditions and height of the dam structure. This variance in stresses throughout the cross section of the dam is analysed for all the design conditions assumed, and zones of low and high stresses are located in the section and for these zones of specified stresses, masonry with specified mortar strengths or mixes are recommended based on the test results.

3.0. The main aim of the zoning of masonry is the most economical allocation of masonry of varied strength to different regions in the section of a dam, demarcated on the basis of maximum stress occuring, ensuring simultaneously the safety of the structure by adopting suitable factors of safety.

4.0. *Procedure.*—The procedure consists of the following steps :—

(*a*) The analysis of the stress at salient points in the section of the dam, for all the design conditions and maximum of these stresses for each point noted.

(*b*) After noting the maximum stresses in all the points, contours of stresses for 4 T/sq. ft. 5 T/sq. ft., etc., are drawn by method of interpolation in the section of the dam, drawn to scale.

(*c*) Demarcation of zones on the basis of stress, varying between a maximum and minimum stress.

(*d*) Recommending for each zone, masonry with specified mortar strength or specified mix, based on test results, adopting suitable factors of safety.

5.0. *Model calculation.*—Design zoning proposal for a non-spill way section, the profile of which is given in figure 1. Assume unit weight of masonry as 145 lb./cft. unit weight of water as 62·5 lb./cft. and unit weight of silt as 56 lb./cft. Angle of internal friction for silt may be assumed as 30°.

The other hydraulic data are as per Fig. 1.

5.1. *Analysis of principal stresses.*—The maxil mum section of the dam is analysed for principal stresses. The points at which the stresses have been analysed, are the junctions of the horizontal and vertical planes, chosen conveniently to cover almost the entire section of the dam.

The horizontal planes chosen are roughly at 40′ intervals and are at the following elevations +325, +285, +245, +205, +165, +125, +85, +60 (vide figure 1). The vertical planes are 1, 2, 3, etc., upto 13 spaced at 20′ intervals from the axis of the dam.

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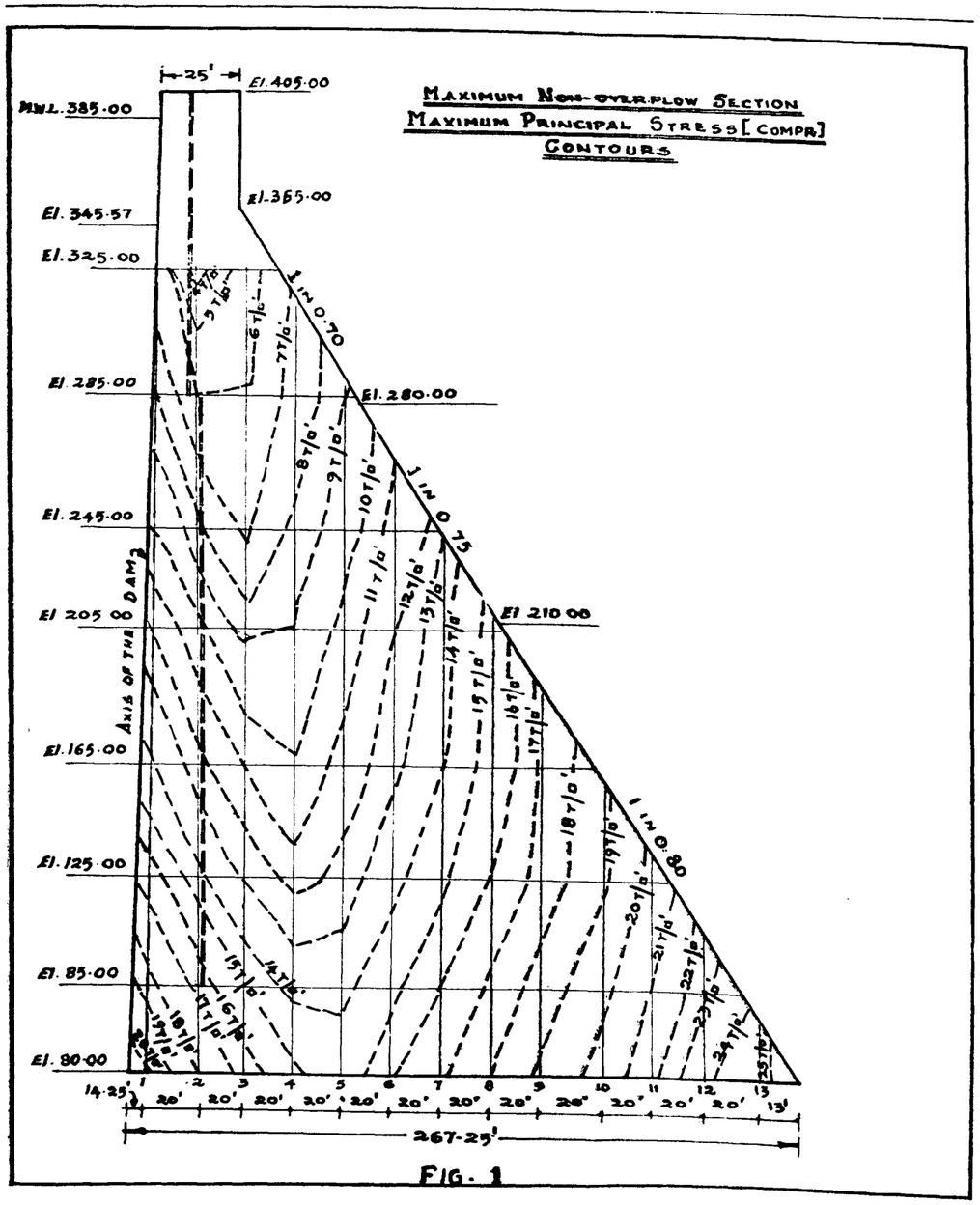

FIG. 1

5.2. The stresses are analysed at each point, for the three conditions, namely :—

(1) Reservoir empty.

(2) Reservoir full without uplift pressure.

(3) Reservoir full with uplift pressure.

The principal stresses, at a point, along any horizontal plane, are calculated by employing the formula given in page 21, chapter 9 of U.S.B.R., based on the theory of elasticity. The components due to seismic forces have been deleted in as much as this area is not subject to seismic.

(i) *Normal stress on horizontal plane* σ_z

$\sigma_z = a + $ by where

$$a = \sigma_z \quad D = \frac{\Sigma W}{T} - \frac{6 \Sigma M}{T^2}$$

$$b = \frac{12 \Sigma M}{T^3}$$

(ii) *Shear stress on horizontal or vertical plane* $Tzy = Tyz$.

$Tzy = Tyz = a_1 + b_1\, y + c_1\, y^2$ where

$a_1 = T_{zyd} = (\sigma_z\, \overline{D} - P^1) \tan \phi\, D$

$$b_1 = \frac{-1}{T}\left(\frac{7 \Sigma V}{T} + 2\, T_{zyv} + 4\, T_{zy}\, D\right)$$

(iii) *Normal stress on vertical plane* σ_y

$\sigma_y = a_2 + b_2 + c_2\, y^2 + d_2\, y^3$

Where $a_2 = \sigma_y D = a_1 \tan \phi\, D + P_1$

$b_2 = b_1 \tan \phi\, D = \frac{\partial a_1}{\partial z_2}$

$C_2 = c_1 \tan \phi\, D + \frac{1}{2} \frac{\partial b_1}{\partial z_2}$ and

$d_2 = \frac{1}{3} \frac{\partial c_1}{\partial z}$

(iv) *Magnitude of principal stresses* σp_1 *and* σp_2

$$\sigma p_1 = \frac{\sigma_z + \sigma_y}{2} \pm \sqrt{\frac{(\sigma_z - \sigma_y)^2}{2} + (T_{zy})^2}$$

If $(\sigma_z - \sigma_y) > 0$ use $+$
If $(\sigma_z - \sigma_y) < 0$ use $-$
} Alternative sign gives σp_2 which is $\perp$ to σp_1

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Maximum principal stress in T/D' and condition of occurrence.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
+ 325·00	6·304	6·329	3·852	5·462											6·439
Condition	RE	RE	RF-UL	RF-UL											RF+UL
+ 285·00	8·335	8·0·5	5·933	6·063	7·398										8·818
Condition	RE	RE	RE	RF-UL	RF-UL										RF+UL
+ 245·00	10·31	9·854	8·005	6·817	8·213	9·623	11·21								11·89
Condition	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF+UL								RF+UL
+ 205·00	12·51	11·90	10·18	8·474	9·061	10·42	11·93	13·60							15·43
Condition	RE	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF+UL							RF+UL
+ 165·00	14·69	13·96	12·93	10·71	10·02	11·29	12·61	13·93	15·38	17·20					18·08
Condition	RE	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF+UL					RF+UL
+ 125·00	16·8	16·05	14·5	12·90	11·4	12·4	13·65	14·90	16·05	17·5	18·90	20·4			20·6
Condition	RE	RE	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF-UL	RF+UL	RF+UL	RF+UL			RF+UL
+ 85·00	19·19	18·20	16·67	15·16	13·63	13·70	14·88	16·07	17·28	18·51	19·75	21·09	22·74		23·05
Condition	RE	RE	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF+UL	RF+UL		RF+UL
+ 60·00	20·60	19·55	18·05	16·60	15·10	14·50	15·66	16·83	18 03	19 23	20 44	21·66	23·90	24 20	25·75
Condition	RE	RE	RE	RE	RE	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF-UL	RF+UL	RF+UL

Condition RE = Reservoir empty, RF— UL = Reservoir full without uplift. RF + UL = Reservoir full with uplift.

5.3. The principal stresses are calculated at each point for all the three conditions and the maximum stress, occurring under any of those conditions, is chosen for each point and tabulated (*vide* table attached). It can be seen from the table, that the maximum stress near the heel portion occurs under the reservoir empty condition, in the middle portion under the reservoir full without uplift condition and in the toe portion under the reservoir full with uplift condition. So the maximum stress in the section of the dam occurs in the pattern as described above.

6.0. *Stress contours.*—The maximum stress, so found for each selected point which is the junction of the assumed vertical and horizontal planes, is noted for all the points in the maximum section of the dam, drawn to scale. The assuming linear variation, the points under which a particular stress (say 4 T/sq. ft.) occurs are located by interpolation and they are joined and this line will be the stress contour for 4 T/sq. ft. The procedure is repeated for 5 T/sq. ft. 6 T/sq. ft. up to 25 T/sq.ft. and the corresponding stress contours will indicate the pattern of distribution of the worst stress occurring under all the design conditions in the section of the dam and figure 1 shows the stress contours for the dam in question.

7.0. *Zoning.*—The zones are, then demarcated on the basis of stress, with the help of the stress contours. The range of stress, selected for each zone depends upon the required mortar strength and the factor of safety adopted. In case of Nagarjunasagar Dam, there are two zones namely A and B where the stresses in zone A, range between 15 to 20 T/sq. ft. and in zone B, the stresses are less than 15 T/sq. ft. Adopting a factor of safety of 8 for both the required average compressive strength of zones, mortar at one year are given as 160 T/sq. ft. for zone A and 120 T/sq, ft. for zone B, for Nagarjunasagar Dam.

7.1. In the case of dam in question, the following zones are demarcated on the basis of given range of stresses (Ref. Fig. 2) :—

Zone B=Stress below 13 T/sq. ft.

Zone A=Stress between 13 T/sq.ft. and 17·75 T/sq. ft.

Zone A_1=Stresses between 17·75 T/sq. ft. and 25·75 T/sq.ft.

7.2. Based on the test results, the following three months strengths are specified for the zone :—

Zone B—120 T/sq. ft.

Zone A—160 T/sq. ft.

Zone A_1—206 T/sq. ft.

Relevant tests are to be carried out in order to determine the exact proportions of sand cement and additive, if any, like fly-ash and surki, for the mortars and the mixes with the corresponding compressive strengths are recommended, based on the test results.

A 9′ thick layer of zone A, is provided in the upstream side of the dam, from the hydraulic considerations, in order to provide impervious cover to the upstream face of the dam.

The coming proposal is shown in figure. 2.

Bibliography—

(1) Zoning of Masonry Dry form Nagarjunasagar specification and Drawing.

(2) U.S.B.R. chapter 9—Gravity Dams.

(3) Design calculations for Lower Bhavani Project.

(4) Design calculation for Sholiar Dam.

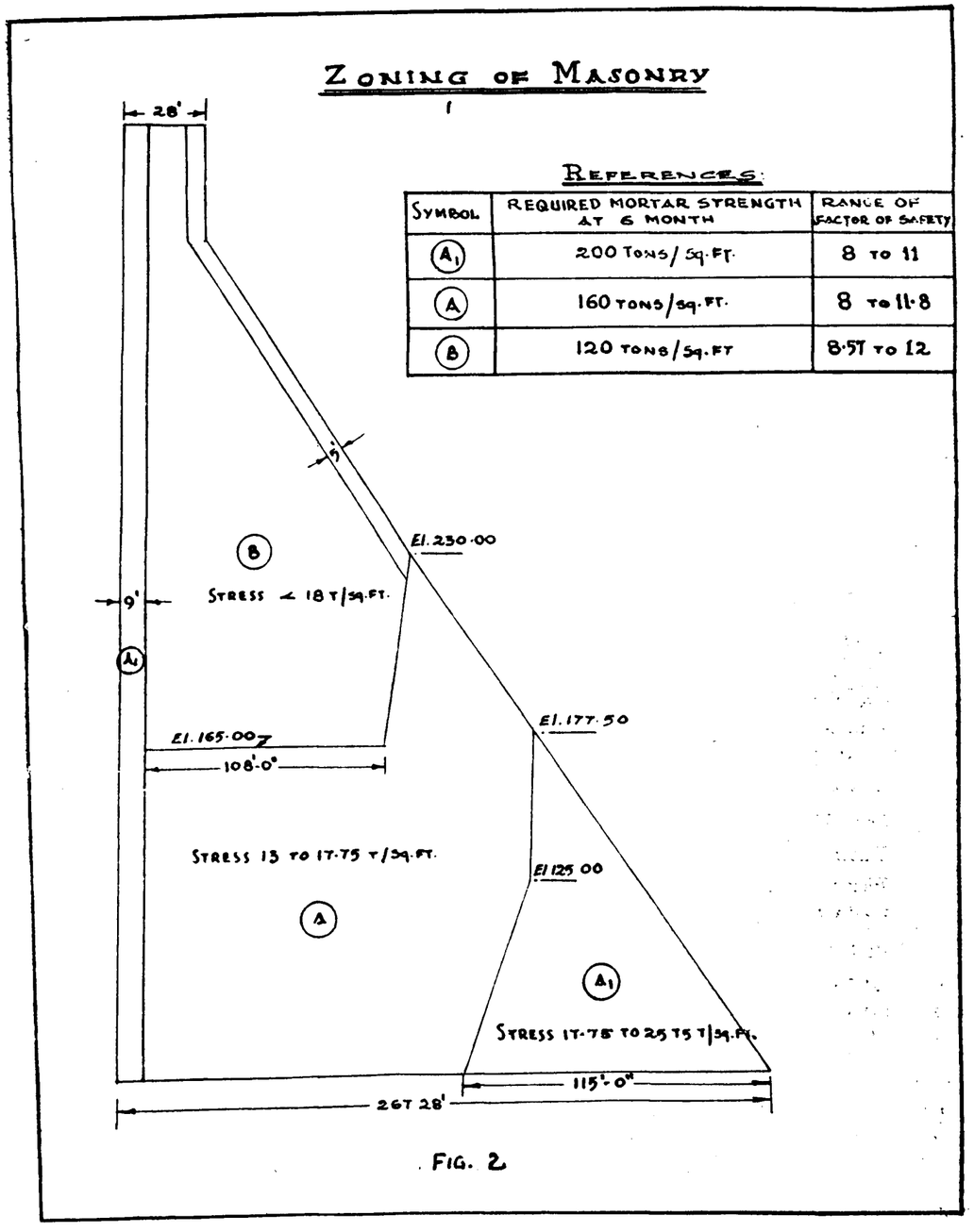

FIG. 2

STUDY OF JOINT MOVEMENTS IN A MASONRY DAM

BY

SRI W. S. WINNFREAD, B.E.

Introduction

As a corollary to the intensified efforts to utilise the water resources in the country for agricultural and industrial development a number of dams are being constructed. It is necessary to ensure that the design of such costly structures is based on consideration of structural safety and economy in cost. For this purpose it is essential that the performance and behaviour of the structures are regularly observed by embedding suitable instruments during their construction. This necessity is now universally accepted for the advancement of knowledge and to assist in research and design criteria to be assumed for future constructions.

This practice of installing instruments has been adopted by the Madras State in the case of a few masonry-*cum*-earth dams, for instance Lower Bhavani Project, Manimuthar and Vaigai Reservoir Projects. Instruments that are usually installed in irrigation structures comprise of the following :—

(*a*) Strain Meters.

(*b*) Stress Meters.

(*c*) Joint Meters.

(*d*) Thermometers.

(*e*) Piezometers.

(*f*) Uplift Meters.

(*g*) Settlement Apparatus.

The first four are usually installed in concrete or masonry dams while the remaining three are fixed in earth dams. These instruments are installed at suitable places during the construction of the structures.

The purpose of this paper is only to give a brief account of the installation and analysis of the Joint Meters data in the case of the Masonry dam of the Vaigai Reservoir Project.

Description of Joint Meters

The joint meters usually employed are of the Carlson's type (Fig. 1).

Inside the brass case (Fig. 1) a steel frame work supports Ceramic pulleys and Long single loops of steel wire forming contraction and expansion coils are wound round these and held in tension by small springs. The greater part of the displacement the motor undergoes in use is taken up by the spring which provide for movements in the standard meter of about 0·20.

A hub is provided on one end of the meter to fit a tapped socket. In practice the socket is embedded in the concrete of a high block to form the anchorage on one side of the construction joint to be observed. The flange on the meter engaged and held by the embedding concrete in the following (low) block on the opposite side of the joint.

Since there may be considerable shearing movement in contraction joints, the joint meter is designed to withstand a shearing movement of 0·10 inch by reducing the frame section at the ends to serve as elastic hinges. A flexible bellows forms the centre section of the joint meter to take the longitudinal and shearing motions of the case, without undue straining.

Field Measurements

Readings are taken on joint meters with a Carlson testing set which is a special form of the wheatstone bridge. The resistance ratio is measured with the *White-Green-Black* conductors in that order, for determining joint opening or closing. The resistance is measured with the *White and Black* conductors for

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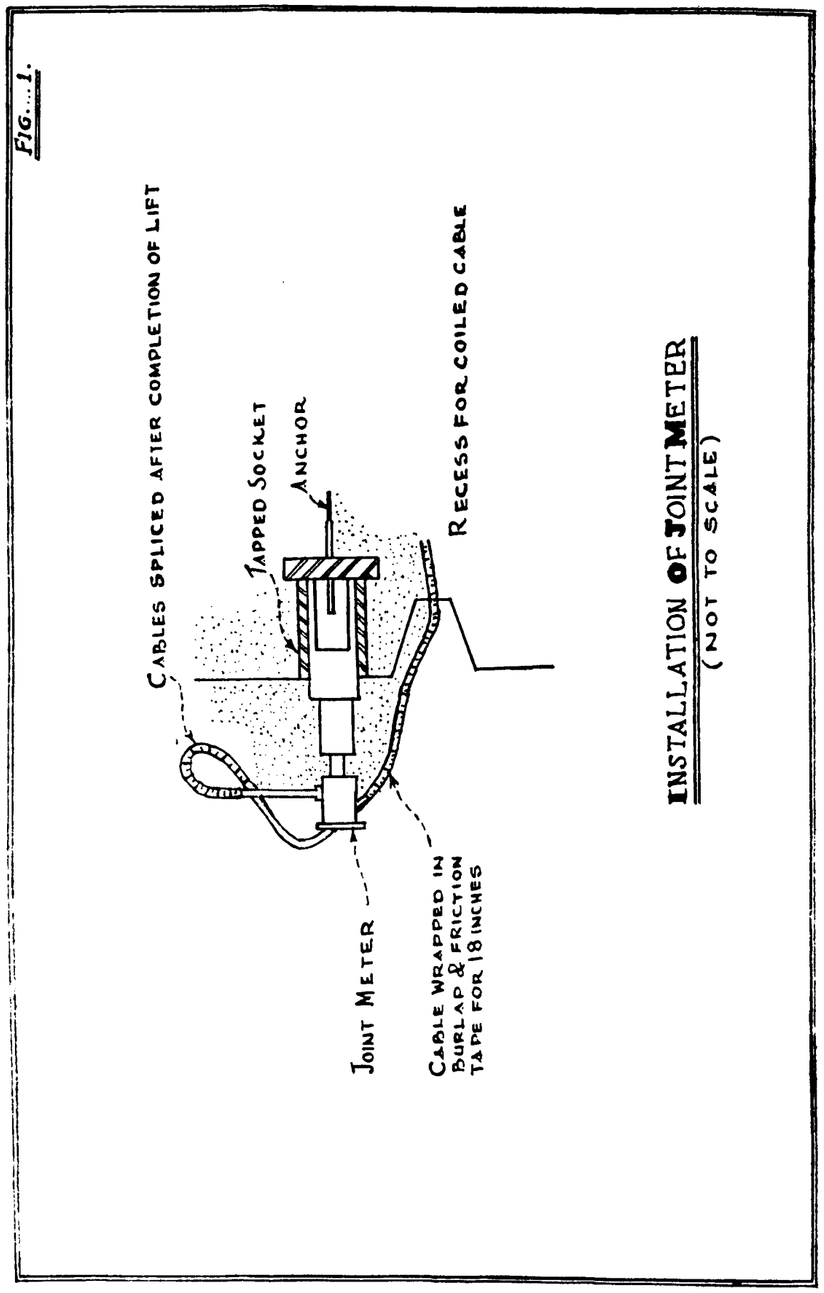
FIG. 1.



INSTALLATION OF JOINT METER (NOT TO SCALE)

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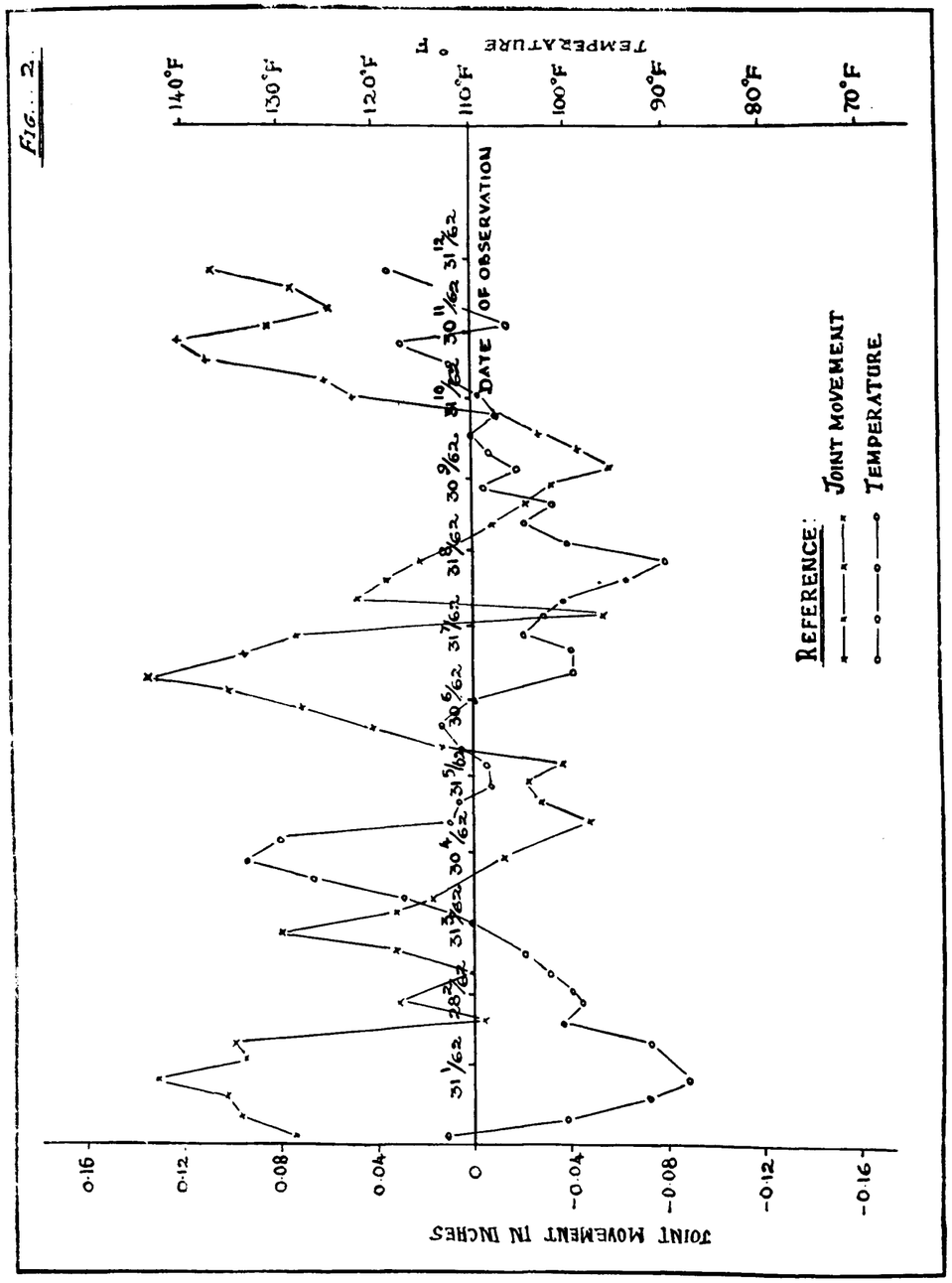
FIG. 2.



determining temperatures, where 4–conductor cable is not used. Where 4–conductor cable is available, directions are supplied with the testing set for making the connections.

Joint Meters in the Vaigai Masonry Dam

Six joint meters have been installed in the masonry dam of the Vaigai Reservoir Project. They are located between blocks 9 and 10, and blocks 10 and 11 at elevation 862·00 and 882·00 respectively. For convenience and brevity, these six meters are referred to as J1, J2, J3, J4, J5 and J6. Of these, the meter J2 has completely failed in its performance.

Observations have been made on these meters periodically and the data processed. As a typical case, data sheet for the meter J1 alone for the year 1962 is presented in this paper (Table 1 and Fig. 2).

Computation of Joint Movement

The procedure for computing the joint movement is shown in the table appended. A perusal of this table will show that each meter has been provided with a few calibration constants. The meter resistance at 0°F with the cables, change in temperatures per ohm change in resistance and the calibration constant for the joint movement are furnished by the manufactures for each meters. Only the resistance ratio and meter resistance are measured in the field. The value 'Ratio closed' refers to the time when the joint is known to be closed. Normally it refers to a time few hours after the meter has been covered with concrete. In this example this ratio is 97·10 per cent.

Analysis and Results.

As already stated, observations have been made on all the joint meters installed in the Vaigai Dam since their installation. These data have been processed and the opening or closing of the joints computed along with the corresponding temperatures. The relationship between joint movements and temperatures have been plotted graphically along with the time of observations. Only one table showing a typical calculation and the corresponding graphical representation of the relationship between joint movements and temperature have been included in this report.

It might be observed from Fig. 2 that temperature and joint movements are not keeping pace with each other. This apparent anomaly may be attributed to the fact that the low diffusivity of the masonry structure does not enable it to respond quickly to the fluctuations of ambient temperatures. This phenomenon should present itself on a time lag existing between the curves of temperatures *vs.* time and that of joint movements *vs.* time respectively. The plots do indicate some positive trend for certain periods. Moreover, the absorved movements barring stray cases, are within the permissible range. From the results of the analysis, it may generally be concluded that as might be anticipated for masonry dams the joint movements are of low order and do not warrant any remedial measures such as grouting.

JOINT MFTER DATA SHEET.

TABLE I.

Joint meter No. 1

Project —Vaigai Dam.

Calibration.—(1) Meter Resistance with cables .. .. 52·72 ohms. at O°F.

(2) Change in temperature per ohm Change in resistance .. 10·73°F

(3) Calibration constant .. .. 0·80044" per 0·01% ratio change.

(4) Ratio closed .. .. 97·1 per cent,

Date.	*Meter resistance. ohms.*	*Temperature F.*	*Resistance ratio.*	*Change in ratio.*	*Indicated movement.*	*Remarks.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			PER CENT.	PER CENT.	INCHES.	
3— 1—62	63·27	113·2	98·80	1·70	0·0748	Joint open.
10— 1—62	62·12	100·9	99·32	2·22	0·0977	"

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Date.	*Meter resistance. ohms.*	*Temperature F.*	*Resistance ratio.*	*Change in ratio.*	*Indicated movement.*	*Remarks.*
(1)	(2)	(3)	(4) PER CENT.	(5) PER CENT.	(6) INCHES.	(7)
18— 1—62	61·28	91·9	99·44	2·34	0·1030	Joint open.
26— 1—62	60·90	87·8	100·12	3·02	0·1329	,,
3— 2—62	61·13	90·3	99·26	2·16	0·0950	,,
10— 2—62	61·29	92·0	98·36	2·26	0·0994	,,
18— 2—62	62·12	100·9	97·00	0·10	(—) 0·0044	Joint closed.
26— 2—62	61·91	98·6	97·84	0·74	0·0326	Joint open.
3— 3—62	62·02	99·8	97·50	0·40	0·0176	,,
10— 3—62	62·22	101·9	97·14	0·04	0·0018	,,
18— 3—62	62·47	104·6	97·80	0·70	0·0308	,,
26— 3—62	62·99	110·2	98·94	1·84	0·0810	,,
3— 4—62	63·16	112·0	97·82	0·72	0·0317	,,
10— 4—62	63·62	116·9	97·40	0·30	0·0132	,,
18— 4—62	64·50	126·4	97·08	(—) 0·02	(—) 0·0009	,,
26— 4—62	65·18	133·7	96·80	(—) 0·30	(—) 0·0132	Joint closed.
3— 5—62	64·84	129·9	96·40	(—) 0·70	(—) 0·0308	,,
10— 5—62	63·19	112·3	96·00	(—) 1·10	(—) 0·0482	,,
18— 5—62	63·00	111·4	96·46	(—) 0·64	(—) 0·0282	,,
26— 5—62	62·80	108·1	96·60	(—) 0·50	(—) 0·0220	,,
3— 6—62	62·84	108·6	96·24	(—) 0·86	(—) 0·0378	,,
10— 6—62	63·08	111·2	97·40	0·30	0·0132	,,
18— 8—62	61·52	94·3	97·90	0·80	0·0352	Joint open.
26— 8—62	61·12	90·2	97·60	0·50	0·0220	,,
3— 9—62	62·06	100·3	97·20	0·10	0·0044	,,
10— 9—62	62·50	104·9	96·90	(—) 0·20	(—) 0·0088	,,
18— 9—62	62·20	101·7	96·60	(—) 0·50	(—) 0·0220	Joint closed.
26— 9—62	62·90	109·2	96·36	(—) 0·79	(—) 0·0328	,,
3—10—62	62·50	104·9	95·82	(—) 1·28	(—) 0·0563	,,
10—10—62	62·81	108·2	96·20	(—) 0·98	(—) 0·0431	,,
18—10—62	62·98	110·1	96·49	(—) 0·61	(—) 0·0268	,,
26—10—62	62·70	107·1	96·80	(—) 0·30	(—) 0·0132	,,
26— 9—62	63·77	135·5	97·27	(—) 1·25	(—) 0·0662	,,
3—10—62	63·30	130·4	96·90	1·60	0·0720	,,
10—10—62	63·41	131·6	97·10	1·40	0·0630	Joint open.
18—10—62	63·40	131·5	97·44	1·06	0·0477	,,
26—10—62	63·36	131·1	97·60	0·90	0·0405	,,
3—11—62	63·30	130·4	98·44	0·60	0·0027	,,
10—11—62	63·41	131·6	98·60	0·10	0·0045	,,
26—11—62	63·52	132·7	99·20	0·70	0 0315	,,
3—12—62	62·08	117·0	98·70	0·20	0·0090	,,
10—12—62	62·20	118·3	98·66	0·16	0·0072	,,
18—12—62	62·71	123·8	98·60	0·40	0·0180	,,
26—12—62	63·25	129·8	99·77	1·27	0·0572	,,

CONVERSION TABLES

(Issued by the Central Water and Power Commission.)

ABSTRACT.

APPENDIX II.

TABLE 1.

Values of prefixes of sub-multiples and multiples of metric unit.

Prefix.	*Numerical value.*		*Prefix.*	*Numerical value.*	
Micromicro or Pico (my or p)	0·000000000001	10^{-12}	Deca .. .. (da)	10	10
Millimicro or Nano (my or n)	0·000000001	10^{-9}	Hento .. .. (h)	100	10^2
Micro .. .. (y)	0·000001	10^{-6}	Kilo .. .. (k)	1000	10^3
Milli .. .. (m)	0·001	10^{-3}	Mega .. .. (m)	1000000	10^6
Centi .. .. (c)	0·01	10^{-2}	Kilomega or Giga (KM or G)	1000000000	10^9
Deci .. .. (d)	0·1	10^{-1}	Megamega or Tera (MM or T)	1000000000000	10^{12}

TABLE 2.

Conversion factors.

Length :

British to metric.

1 inch	=	25·4000 mm.	
1 foot	=	0·3048 m.	
1 yard	=	0·9144 m.	
1 rod	=	5·0292 m.	
1 chain	=	20·1168 m.	
1 furlong	=	0·2012 m.	
1 mile	=	1·609 km.	
	=	0·8690	Nautical mile International (n mile).

Metric to British.

1 mm.	=	0·0394 inch.
1 cm.	=	0·3937 inch.
	=	0·0328 ft.
1 metre	=	3·2808 ft.
	=	1·0936 yard.
	=	0·1988 rod.
	=	0·0497 chain.
1 kilometre	=	1093·6110 yards.
	=	49·7095 chains.
	=	0·6214 mile.
1 Nautical mile (International)	=	1·1508 mile.
	=	0·9994 Nautical mile (U.K.)

TABLE 3.

Conversion factors.

Area :

British to metric.

1 square inch	=	645·1630 square mm.
	=	6·4516 square c.m.
1 square ft.	=	0·0929 square m.
1 square yard	=	0·8361 square m.
1 square chain	=	404·6860 square m.
	=	0·0405 hectare (ha.).
1 acre	=	0·4047 hectare (ha.).
1 squre mile	=	259·0000 hectare (ha.).
	=	2·5900 square km.

Metric to British.

1 square c. m.	=	0·1550 square inch.
1 square m	=	10.7639 square ft.
	=	1·1960 square yards.
1 hectare	=	24·7100 square chains.
	=	2.4710 acres.
1 sq. km.	=	247·1045 acres.
	=	0·3861 square mile.

TABLE 4.

Volume and capacity.

The conversion factors given in Table 4 are based on—

1 inch = 25·4 millimetres.

1 gallon (U.K.) = 277·420 cubic inches = 4·54596 litres.

1 gallon (U.S.) = 231·001 cubic inches = 3·78533 litres.

1 litre = 1000·028 cubic centimetres.

1 bushel (U.S.) = 2150·42 cubic inches (U.S.) for measurement of dry goods.

British to metric.

1 cu. in.	=	16·3871 cu. cm.
1 cu. ft.	=	28·3161 litres.
	=	0·0283 cu. m.

Metric to British.

1 cu. cm:	=	0·0610 cu. inch.
	=	0·0352 fluid oz (U.K.).
	=	0·0338 fluid oz (U.S.).

TABLE 4—*cont.*

Volume and capacity—cont.

British to metric.

1 cu. yard	=	7·6453 hl.
	=	0·7645 cu. metres.
1 acre feet	=	0·1233 ha. metres.
1 bushel (dry) (U.S.)	=	0·3524 hl.
	=	0·0352 cu. metres.
1 bushel (U.K.)	=	0·3637 hl.
	=	0·0364 cu. metres.
1 U.S. barrel (liquid).	=	0·1590 cu. metres.
	=	1·5898 hl.
1 U.S. gallon	=	3·7853 litres.
	=	3·7854 cu. dm.
1 U.K. gallon	=	4·5460 litres.
	=	4·5461 cu. dm.
1 U.K. quart	=	1·1365 litres.
	=	1·1365 cu. dm.
1 U.S. quart	=	0·9463 litre.
	=	0·9464 cu. dm.
1 U.K. pint	=	0·5682 litres.
1 U.S. pint (liquid)	=	0·4732 litre.
	=	0·4732 cu. dm.
1 U.K. gill	=	0·1421 litre.
	=	0·1421 cu. dm.
1 U.S. gill	=	0·1183 litre.
	=	0·1183 cu. dm.
1 fluid oz. (U.S.)	=	29·5737 cu. dm.
	=	29·5729 ml.
1 fluid oz (U.K.)	=	28·4130 cu. cm.
	=	28·4123 ml.

Metric to British.

1 cu. dm.	=	0·0353 cu. feet.
	=	0·2200 U.K. gallon.
	=	0·2642 U.S. gallon.
1 cu. metre	=	35·314 cu. feet.
	=	1·3080 cu. yard.
	=	27·4962 U.K. Bushel.
	=	28·3774 U.S. Bushel (dry).
	=	6·2898 U.S. Barrel (liquid).
1 hectare metre	=	8·1071 acres.
1 litre	=	0·2200 U.K. Gallon.
	=	0·2642 U.S. Gallon.
	=	61·0250 U.S. cu. inch.
	=	0·0353 cu. feet.
	=	7·0392 U.K. Gill.
	=	8·4537 U.S. Gill.
	=	1·7598 U.K. Pint.
	=	2·1134 U.S. Pint (liquid).
	=	0·8700 U.K. Quart.
1 kilo litre	=	35·3157 Cu. feet.
	=	1·3080 Cu. yard.
	=	27·4969 U.K. Bushel.
	=	28·3782 U.S. Bushel (dry).
	=	6·2899 U.S. Barrel (liquid).

TABLE 5.

Ready reckoner for capacity units.

British to metric.

Fluid ounce (U.K.). (1)	*Millilitre (ml.) (to nearest ml.)* (2)	*Gills (U.K.).* (1)	*Millilitre (ml.) (to nearest ml.).* (2)
1	28	1	142
2	57	2	284
3	85	3	426
4	114	4 (= 1 pint) U.K.	568
5 (= 1 gill) U.K.	142		

TABLE 5—*cont.*

Ready reckoner for capacity units—cont.

Metric to British.

Millilitres.	*Fluid ounce (U.K.) (to nearest ¼ fl. oz.).*	*Millilitres.*	*Fluid ounce (U.K.) (to nearest ¼ fl. oz.).*
(1)	(2)	(1)	(2)
10	¼	60	2
20	¾	70	2½
30	1	80	2¾
40	1½	90	3¼
50	1¾	100	3½

British to metric.

Pints (U.K.).	*Litres.*	(1) *Millilitres (to nearest ml.).*	*Quarts.*	*Litres*	*Millilitres (to nearest ml.).*
(1)	(2)	(3)	(1)	(2)	(3)
1	..	568	1	1	136
2 (= 1 Quart) *U.K.*	1	136	2	2	273
			3	3	409
			4 (= 1 gallon) U.K.	4	546

TABLE 6.

Linear—Velocity.

British to metric.

1 feet per second	=	0·3048 m/s.
	=	1·0973 km/s.
1 Mile per hour	=	0·4470 m/s.
	=	1·6093 km/hr.
	=	0.8690 Nautical mile (International) per hour or km.
1 Nautical mile (U.K.) per hour.	=	1.0006 Nautical mile (International) per hour or km.

Metric to British.

1 metre per second	=	3.2808 ft/s.
	=	2.2369 mph.
1 kilometre per hour	=	0.9113 ft/s.
	=	·6214 mph.
	=	·5396 Nautical mile (U.K.) per hour or kn. (U.K.).
=1 Nautical mile (International) per hour	=	0.9994 Nautical mile (U.K.) per hour or kn (U.K.)
	=	1.1508 mph.

NOTES.—(1) Nautical mile (International) per hour is also called as International knot and is abbreviated as "Kn".
(2) Nautical mile (U.K.) per hour is also called U.K. knot is abbreviated as "kn (U.K.)".

Metric to British.

Millilitres.	*Pints (U.K.)*	*Gills (U.K.)*	*Fluid ounce (U.K. to nearest ⅔ fluid oz.).*
200	..	1	2
300	..	2	½
400	..	2	4
500	..	3	2½
600	1	0	1
700	1	0	4½
800	1	1	3
900	1	2	1½
1000 (=1 litre)	1	3	..

British to metric.

Gallons (U.K.)	*Litres.*	*Millilitres (to nearest 10 ml.).*
1	4	550
2	9	90
3	13	640
4	18	180
5	22	730
6	27	280
7	31	820
8	36	370
9	40	910
10	45	460

TABLE 6—*cont.*

Metric to British.

Litres.	*Gallons [U.K].*	*Quarts [U.K.].*	*Pints [U.K].*	*Gills (to nearest U.K. Gill).*	*Liters.*	*Gallons [U.K.].*	*Quarts [U.K.].*	*Pints [U.K.].*	*Gills (to nearest U.K. Gill).*
1	..	..	1	3	6	1	1	..	2
2	..	1	1	2	7	1	2	..	1
3	..	2¼	1	1	8	1	3	..	..
4	..	3	1	..	9	1	3	1	3
5	1	..	..	3	10	2	0	1	2

TABLE 7.

Weight or mass.

British to metric.

1 grain	=	0·0648 g
1 oz (tr)	=	31·1035 g
1 oz (Av)	=	28·3495 g
1 pound (tr)	=	0·3732 kg
1 pound (Av)	=	0·4536 kg
1 cwt.	=	50·8020 kg
	=	0·5080 quintal
1 short ton	=	0·9072 metric tonne.
1 long ton	=	1·0161 metric tonne.

Metric to British.

1 milligram	=	0·0154 grains.
1 metric carat	=	3·0865 grains.
1 gram	=	15·4324 grains.
	=	0·0322 oz (tr)
	=	0·0353 oz (Av)
1 kg.	=	2·6792 lb. (tr)
	=	2·2046 lb. (Av)
1 quintal	=	1·9684
1 metric tonne	=	1·1023 short ton.
	=	0·9842 long ton.

TABLE 8.

Density (mass length).

British to metric.

1 lb. per in	=	17·8580 kg/m.
1 lb. per ft	=	1·4882 kg/m.
1 lb. per yd.	=	0·4961 kg/m.

Metric to British.

1 kg. per m.	=	0·0550 lb/in
	=	0·6720 lb/ft.
	=	2·0159 lb/yd.

TABLE 9.

Density (mass/volume).

British to metric.

1 lb. per cu. in.	=	27·6799 gm/cu. cm.
1 lb. per cu. ft.	=	16·0185 Kg/cu. m.
1 ton per cu. yd.	=	1·3289 metric tonne/cu. m.
1 lb. per gallon (U.K.)	=	0·0998 g/ml.

Metric to British.

1 gram per cu. cm.	=	0·0361 lb/cu. in.
1 kilogram per cu. m.	=	0·0624 lb/cu. ft.
1 metric tonne per	=	0·7525 ton/cu. yd.
1 gram per ml.	=	10·0221 lb/gal (U.K.).

TABLE 10.

Moment of inertia (dynamic).

British to metric.

1 pound foot squared	=	0·0421 kg. m^2
1 pound inch squared	=	0·000292 kg. m^2

metric to British.

1 kilogram metre squared.	=	23·7304 lb. ft^2
	=	3417·1700 lb. in^2

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TABLE 11.

Moment of inertia (geometrical).

British to metric.		*Metric to British.*	
1 inch^4	= 41·6231 Cm.^{4}	1 Cm.^{4}	= 0·0240 in.^{4}
1 foot^4	= 0·0086 m.^{4}	1 m.^{4}	= 115·8629 ft.^{4}

TABLE 12.

Section modulus.

British to metric.		*Metric to British.*	
1 inch^3	= 16·3871 cm^3.	1 cm.^{3}	= 0·0610 in.^{3}
1 foot^3	= 0·0283 m.^{3}	1 m.^{3}	= 35·3147 ft.^{3}

TABLE 13.

Force.

British to metric.		*Metric to British.*	
1 poundal	= 13·825 dynes (dyn.) = 0·014 kg. f.	1 dyne	= 7·2330 × 10^{-5} pdl. = 2·2481 × 10^{-6} lb. f.
1 pound force	= 0·444822 × 10^6 dynes (dyn.). = 0·4536 kg. f.	1 kilogram force	= 2·2046 lb. f. = 70·9320 pdl.

TABLE 14.

Bending moment.

British to metric.		*Metric to British.*	
1 ft. lb.	= 0·1383 kg. m. = 13·8255 kg. Cm.	1 kg. m. 1 kg. cm.	= 7·2330 ft. lb. = 0·0723 ft. lb.
1 in. lb.	= 1·1521 kg. Cm.		= 0·8680 in. lb.

TABLE 15.

Work and energy.

British to metric.		*Metric to British.*	
1 ft. lb.	= 0·1383 kg. m. = 1·3558 joule (J).	1 kg. m.	= 7·2330 ft. lb.
1 horse power hour (hp. -h)	= 273·745 kg. m. = 0·7457 kwh.	1 kwh. 1 joule	= 1·3410 hp-h. = 0·7376 ft. lb.
1 ft. poundal (ft. pdl.)	= 0·0421 joule (J).		

TABLE 16.

Stress and pressure.

British to metric.		*Metric to British.*	
1 lb. per sq.in.	= 0·0703 kg/sq.cm. = 0·7031 metric tonne/sq.m.	1 kg. per sq.cm.	= 14·2233 lb./sq. in. = 0·9144 ton/sq. ft.
1 lb. per sq.ft.	= 4·8824 kg/sq. m.	1 kg. per sq.m.	= 0·2048 lb./sq. ft.
1 ton per sq.ft.	= 1·0937 kg/sq. cm. = 10·9366 metric tonne/sq. m.	1 metric tonne per sq.m.	= 0·0914 ton/s.q. ft.
		1 kg. per sq.mm.	= 0·6350 ton/sq. in.
1 ton per sq. in.	= 1·5749 kg./sq. mm.		

NOTE.—(1) On atmosphere as the unit of pressure is the pressure of 760 mm. of mercury at a temperature of 0°C.

1 atmosphere	= 14·6960 lb/sq. in = 1·0332 kg/sq. cm. = 1·01325 bar.	(2) 1 bar	= 14·5038 lb./sq.in. = 1·0197 kg./sq. cm. = 0·9869 atmosphere.

TABLE 17.

Power.

British to metric.		*Metric to British.*	
1 ft. lb. per second	= 0·1383 kg. m/s.	1 kg. m. per second	= 7·2330 ft. lb./s. = 0·0132 hp.
1 horse-power	= 76·0400 kg. m/s. = 1·0139 C.V. (metric horse-power). = 0·7457 kw.	1 kw.	= 737·5600 ft. lb./s. = 1·3410 hp.
		1 C.V. (metric horse-power).	= 542·4800 ft. lb./s. = 0·9863 hp.

TABLE 18.

Consumption (volume/length).

British to metric.	*Metric to British.*
1 U.K. gallon/mile = 2·8247 litre/km.	1 litre/km. = 0·3540 U.K. gallon/mile.

TABLE 19.

Consumption (length/volume).

British to metric.	*Metric to British.*
1 mile/U.K. gallon = 0·3540 km./litre.	1 km./litre = 2·8247 mile./U.K. gallon.

TABLE 20.

Quantity of heat.

British to metric.	*Metric to British.*
1 BThu = 252·0000 calories	1 calorie = 0·00397 BThu

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TABLE 21.

Density of heat flow rate.

British to metric.	*Metric to British.*
1 BThu/sq. ft. hr. =0·000075 cal/sq.cms.	1 cal/sq.cms = 13272·0 BThu/sq.ft. hr.
=2·7125 k cal/sqm.hr.	1 K cal/sqm. hr.= 0·3687 BThu/sq. ft. hr.

TABLE 22.

Thermal conductivity.

British to metric.		*Metric to British.*	
1 BThus/sq. ft. hr. (deg. F/ft.)	= 4·1338 × 10—³ cal/sq. cm. s (deg C/cm).	1 cal/sq. cm. s (deg C/cm.)	= 241·9090 BThu/sq. ft. hr. (deg F/ft).
	= 1·4882 K cal/sqm. hr. (deg C/m)		= 2902·9100 BThu/sq. ft. hr. (deg F/in.)
1 BThu/sq. ft. hr. (deg F/in.)	= 0·3445 × 10—³ cal/sq. cm. s (deg C/cm.)	1 K cal/sqm. hr. (deg C/m.)	= 0.6720 BThu/sq. ft. hr. (deg F/ft.)
	= 0·1240 K cal/sqm. hr. (deg C/cm.)		= 8·0636 BThu/sq. ft. hr. (deg F/in.)

TABLE 23.

Thermal conductance.

British to metric.		*Metric to British.*	
1 BThu/sq. ft. hr. deg F	= 0·000136 cal/sq. cm. s deg C.	1 cal/sq. cm s deg C	= 7373·4 BThu/sq. ft. hr. deg. F.
	= 4·8824 k cal/Sq. m. hr. deg C.	1 cal/sq. m. hr/deg C	= 0·2048 BThu/sq. ft. hr. deg. G.

TABLE 24.

Illumination.

British to metric.	*Metric to British.*
1 Foot candle = 10·7639 lux (lx)	1 lux = 0·0929 foot candle.
= 0-001076 phot	1 phot = 929·0300 foot candle.

TABLE 25.

Brightness.

British to metric.	*Metric to British.*
1 candle/sq.in = 0·4870 lambert = 0·1550 stilb (sb).	1 lambert = 2·0536 candle /sq. in. = 929·0340 foot lambert
1 foot lambert = 0·001076 lambert = 0·000343 stilb (sb).	1 stilb (sb) = 2918·6500. foot lambert = 6·4516 Cd./ sq. in.

TABLE 26.

Constants for R.C.C. Design—Properties of reinforcing round bars.

Diameter. (1) *mm.*	*Sectional area.* (2) *sq. cm.*	*Perimeter.* (3) *cm.*	*Weight per metre length.* (4) *kg.*	*Diameter.* (1) *mm.*	*Sectional area.* (2) *sq. cm.*	*Perimeter.* (3) *cm.*	*Weight per metre length.* (4) *kg.*
5·0	0·20	1·57	0·15	25·0	4·91	7·85	3·85
6·0	0·28	1·88	0·22	28·0	6·16	8·80	4·83
8·0	0·50	2·51	0.39	32·0	8·04	10·05	6·31
10·0	0·79	3·14	0·62	36·0	10·18	11·31	7·99
12·0	1·13	3·77	0·89	40·0	12·57	12·57	9·89
16·0	2·01	5·03	1·58	45·0	15·90	14·14	12·49
20·0	3·14	6·28	2·47	50·0	19·64	15·71	15·41

TABLE 27.

Design constants for various concrete mixes and the usual permissible stress in reinforcement for balanced design.

Mix.	f_c KG./ SQ. CM.	t KG./ SQ. CM.	m	n	j	q
1 : 1 : 2	80	1400	11·7	0·400	0.867	13·9
1 : 1½ : 3	65	1400	14·4	0·400	0.867	11·3
1 : 2 : 4	50	1400	18·7	0·400	0.867	8·7

f_c = Permissible compressive stress in concrete in bending.

t = Permissible tensile stress in reinforcement.

m = Modular ratio = $\frac{2800}{3\ f_c}$

n = Neutral axis ratio.

j = Lever arm ratio.

q = $\frac{M}{bd^2}$

TABLE 28.

Principal conversion factors.

Serial number.	*Quantity.*	*British unit.*	*Equivalent metric unit.*	*Conversion factor.*	
				British to metric.	*Metric to British.*
(1)	(2)	(3)	(4)	(5)	(6)
1	Length	Inch (in)	Millimetre (mm)	25·400	0·0393701
		Inch (in)	Centimetre (cm)	2·540	0·393701
		Foot (ft)	Metre (m)	0·3048	3·28084
		Yard (yd)	Metre (m)	0·9144	1·09361
		Furlong	Kilometre (Km)	0·201168	4·97097
		Mile	Kilometre (Km)	1·609344	0·621371
		Nautical mile (U.K.)	International Nutical mile (n mile).	1·00064	0·999363
2	Area	Square inch (in^2)	Square centimetre (cm^2)	6·4516	0·155
		Square foot (ft^2)	Square metre (m^2)	0·092993	10·7639
		Squar yard (yd^2)	Square metre (m^2)	0·836127	1·19599
		Acre	Hectare (ha)	0·404686	2·47105
		Square mile (sq. mile)	Square kilo-metre (Km^2)	2·58999	0·316102
3	Volume	Cubic inch (in^3)	Cubic centimetre (cm^3)	16·3871	0·0610237
		Cubic foot (ft^3)	Cubic metre (m^3)	0·764555	1·30795
		Acre foot (acre ft)	Hectare metre (ham)	0·123348	8·1071
4	Capacity	Imperial gallon (gal)	Litre (l)	4·54596	0·219976
5	Mass	Pound (lb)	Kilogram (kg)	0·4535924	2·20462
		Hundred-weight (cwt)	Quintal (q)	0·50802	1·96841
		Ton	Metric tonne (t)	1·01605	0·98421
6	Linear density	lb/ft	Kg/m	1·48816	0·67197
7	Density $\frac{(Mass)}{(Volume)}$	lb/ft^3	Kg/m^3	16·0185	0·062428
		lb/in^3	G/cm^3	27·6799	0·0361273

Properties of round bars.

Diameter of bar. (*Inch.*)	*Diameter of bar.* (*mm.*)	*Sectional area.* (*Sq. cm.*)	*Perimeter.* (*cm.*)	*Weight per metre length.* (*kg.*)
(1)	(2)	(3)	(4)	(5)
3/16	5·0	0·20	1·57	0·15
7/32	5·5	0·24	1·73	0·19
1/ 4	6·0	0·28	1.88	0·22
19/64	7·0	0·38	2·20	0·30
5/16	8·0	0·50	2·51	0·39
23/64	9·0	0·64	2·83	0·50
3/ 8	10·0	0·79	3·14	0·62
7/16	11·0	0·95	3·46	0·75
1/ 2	12·0	1·13	3·77	0·89
35/64	14·0	1·54	4·40	1·21
5/ 8	16·0	2·01	5·03	1·58
45/16	18·0	2·54	5·65	2·00
3/ 4	20·0	3·14	6·28	2·47
7/ 8	22·0	3·80	6·91	2·98
1	25·0	4·91	7·85	3·85
1– 1/ 8	28·0	6·16	8·80	4·83
1– 1/ 4	32·0	8·04	10·05	6·31
1–27/64	36·0	10·18	11·31	7·99
1– 1/ 2	40·0	12·57	12·57	9·86
1–49/64	45·0	15·90	14·14	12·49
1–31/32	50·0	19·64	15·71	15·41
2–13/64	56·0	24·63	17·59	19·34
2–51/64	63·0	39·59	22·31	31·08
2–31/64	71·0	31·18	19·79	24·47
3–5/32	80·0	50·27	25·13	39·46
3–35/64	90·0	63·62	28·27	49·94
3–15/16	100·0	78·54	31·42	61·76
4–21/64	110·0	95·03	34·56	74·60
4–59/64	125·0	122·72	39·27	96·34
5–33/64	140·0	153·94	43·98	120·84
6–19/64	160·0	201·06	50·27	157·84
7– 3/32	180·0	254·47	56·55	199·76
7– 7/ 8	200·0	314·16	62·83	246·62

CONVERSION FACTORS-BRITISH TO METRIC UNITS OF MEASUREMENT.

Multiply.	*By.*		*To obtain.*
	LENGTH		
Mil	25·4	(exactly)	Micron.
Inches	25·4	(exactly)	Millimetres.
	2·54	(exactly)	Centimetres.
Feet	30·48	(exactly)	Centimetres.
	0·3048	(exactly)	Metres.
	0·0003048	(exactly)	Kilometres.
Yards	0·9144	(exactly)	Metres.
Miles (Status)	1609·344	(exactly)	Metres.
	1·609344	(exactly)	Kilometres.
	AREA.		
Square inches	6·4516	(exactly)	Square centimetres.
Square feet	929·03	(exactly)	Square centimetres.
	0·092903	(exactly)	Square metres.
Square yards	0·836127		Square metres.
Acres	0·40469		Hectares.
	4046·9		Square metres.
	0·0040469		Square kilometres.
Square miles	2·58999		Square kilometres.
	VOLUME.		
Cubic inches	16·3871		Cubic centimetres.
Cubic feet	0·0283168		Cubic metres.
Cubic yards	0·764555		Cubic metres.
	CAPACITY.		
Fluid ounces (U.S.)	29·5737		Cubic centimetres.
Liquid pints	29·5729		Milli litres.
Liquid pints (U.S.)	0·473179		Cubic decimetres.
	0·473166		Litres.
Quarts (U.S.)	9,463·58		Cubic centimetres.
	0·946358		Litres.
Gallons (U.S.)	3,785·43		Cubic centimetres.
	3·78543		Cubic decimetres.
	3·78533		Litres.
	0·00378543		Cubic metres.
Gallons (U.K.)	4·54609		Cubic decimetres.
	4·54596		Litres.
Cubic feet	28·3160		Litres.
Cubic yards	764·55		Litres.
Acre feet	1,233·500		Cubic metres litres.

Multiply.	*By.*	*To obtain.*
	FORCE/AREA.	
Pounds per square inch	0·070307	Kilograms per square centimetre.
	0·689476	Newtons per square centimetre.
Pounds per square foot	4·88243	Kilograms per square metre.
	47·8803	Newtons per square metre.
	MASS/VOLUME DENSITY.	
Ounces per cubic inch	1·72999	Grams per cubic centimetre.
Pounds per cubic foot	16·0185	Kilograms per cubic metre.
	0·0160185	Grams per cubic centimetre.
Tons (lons) per cubic yards.	1·32894	Grams per cubic centimetre.
	MASS/CAPACITY.	
Ounces per gallon (U.S.)	7·4893	Grams per litre.
Ounces per gallon (U.K.)	6·2362	Grams per litre.
Pounds per gallon (U.S.)		Grams per litre.
Pounds per gallon (U.K.)	99·779	Grams per litre.
	BENDING MOMENT OR TORQUE.	
Inches pounds	0·011521	Metric kilograms.
	$1·12985 \times 10^6$	Centimetre dynes.
Foot pounds	0·138255	Metre kilograms.
	$1·355282 \times 10^7$	Centimetre dynes.
Foot pounds per inch	5·4431	Centimetre kilograms per centimetre.
Ounces inches	72·008	Gram centimetres.
	VELOCITY.	
Feet per second	30·48 (exactly)	Centimetres per second.
	0·3048 (exactly)	Metres per second.
Feet per year	$0·965873 \times 10^{-6}$	Centimetres per second.
Miles per hour	1·609344 (exactly)	Kilometres per hour.
	0·47704 (exactly)	Metres per second.
	ACCELERATION.	
Feet per second^2	0·3048	Metres per second^2
	FLOW.	
Cubic feet per second feet	0·028317	Cubic metres per second.
Cubic feet per minute	0·4719	Litres per second.
Gallons (U.S.) per minute	0·06309	Litres per second.

467-7—4

Multiply.	*By.*	*To obtain.*
	FORCE.	
Pounds	0·453592	Kilograms.
	4·4482	Newtons.
	$4{\cdot}4482 \times 10^5$	Dynes.
	POWER.	
Horse power	745·700	Watts.
B. Th. U per Hour	0·293071	Watts.
Foot Pounds per second	1·35582	Watts.
	MASS.	
Ounces (A.V.D.P.)	28·3495	Grams.
Pounds (A.V.D.P.)	4·45359237 (Exactly)	Kilograms.
Short tons (2,000 lb.)	907·185	Kilograms.
	0·907185	Metric tons.
Long tons (2,240 lb.)	1016·05	Kilograms.

LABOUR LAW REPORTS

[Reported in the Labour Law Journal.]

(Letters Patent Appeal No. 141 of 1958, dated 26th May 1960).

Pages 494 to 498 of Labour Law Journal, April 1961—Punjab High Court Judgment.

Workmen's Compensation Act Section 30—Letters Patent (Punjab), Clause 10—Appeal—A party lesser of the factory against whom the relief under the Act was claimed, not appearing before the Commissioner for Workmen's Compensation, nor producing the lease deed in the proceedings—The lessees also not producing the lessee deed in such proceedings—Such party also not explaining the non-production of the lease deed—Without considering this aspect of the question and without considering the other material oral evidence on record, the claim for compensation against the lessor negatived on ground of probability only—Appeal against such Judgment under Clause 10 of the Letters Patent—Interference with such Judgment, if could be refused on ground that in a Letters Patent appeal finding of fact though erroneous could not be reversed—Appeal under Section 30 of the Act against such decision of the Commissioner, if competent:

A workman claimed compensation under the provisions of Workmen's Compensation Act impleading in the action the lessor of the factory on ground that under the terms of the lease deed the lessor was also liable as the employer along with the lessees. The lessor did not examine himself in the proceedings nor did he produce the lease deed. The lessees also did not produce the lease deed. There was oral evidence let in on the side of the workman regarding the existence of such term in the lease deed (the evidence of the scribe of the lease deed). The non-production of the lease deed was not explained by the lessor or the lessees. Without considering all these facts the claim against the lessor was negatived on ground of non-probability of such term in the lease deed. The appeal under section 30 of the Act against the decision of the Commissioner for Workmen's Compensation was dismissed.

Allowing the Letters Patent Appeal, held: The negation of the relief against the lessor was not justified. As the lessor failed to examine himself and also to produce the lease deed and to explain the non-production of the lease deed, inference adverse to this defence ought to have been raised. Failure to draw such adverse inference and to consider the other material oral evidence on this point must be held to have vitiated the conclusion in this respect. It could not be contended that in an appeal under Clause 10 of the Letters Patent a finding of fact could not be interfered with. Clause 10 of the Letters Patent is wieldly worded and it provides an appeal from a judgment of a Single Judge of this Court to a Bench of two Judges without any limitation or restrictions as is found in Section 100, Code of Civil Procedure. It is sure that as a matter of practice the finding on a question of fact given by a learned Single Judge of this court is usually treated with respect and is not likely interfered with but there is no legal impediment in the way of Letters Patent Bench reversing the find on a question of fact by the learned Single Judge if the same is considered to be erroneous. Any limitation, on the right of appeal which is not included in it by the Legislature, could not be read in Clause 10 of the Letters Patent. Further, in the circumstance of the case, it could not be contended that the appeal by the workman under Section 30 of the Act was not competent on it did not involve any substantial question of law. The expression "substantial question of law" as contemplated by Section 30 of the Act must be given a wide construction so as to cover even a case in which the Commissioner has clearly misdirected himself on a question of law. Failure to consider the material evidence on

record and to draw adverse inference from the unexplained non-production of the lease deed would make the appeal competent under Section 30 of the Act :

Pages 565 to 569 of Labour Law Journal, May 1961—Andhra Pradesh High Court Judgment.

Workmen's Compensation Act, Sections 17 and 28—compromise by the concerned workman to relinquish a portion of his claim for the personal injuries sustained by him as a result of accident arising out of and in the course of his employment, if could be pleased as a bar of his claiming the compensation due to him under the Act—Question based on acts, if could be raised for the first time in an appeal under Section 30 of the Act :

The plain wording of the Section 27 of the Workmen's Compensation Act leaves no room for doubt that any arrangement reached between the workmen and the employer would have no legal effect. The reason is obvious. The employee, who had been involved in an accident, would, during the period of his recovery from the accident, be out of employment and consequently deprived of his daily wages. The position of the workman and the employer is such that the employer is invariably in a position of authority and controls the situation and could dictate terms, the employee being the person looking to yield to the influence of the employer. It is for this reason that any agreement has the effect on the workmen of relinquishing his legitimate rights, is viewed with disfavour by the legislature and consequently, any such contract or agreement is regarded as null and void.

It is common knowledge that unless an objection is taken before the Commissioner and he has an opportunity of considering the same, the parties would not be allowed to raise the same at the later stages of the litigation, particularly, objections which are dependent on findings :

Pages 85 to 592—Labour Law Journal—Gujarat High Court Judgment.

Workmen's Compensation Act, A.3—Accident arising out of and in the course of employment—meaning of—Workmen suffering from a heart disease—Such workmen getting a heart attack before the start of his shift and removed to the hospital for treatment—After discharge from the hospital, the workman proceeding to a place for rest—Such workman subsequently succumbing—to the heart disease—No evidence to show that the employment of the workman accelerated his death-claim for compensation by the heirs of the deceased workman, in the circumstances, negatived :

Though the word "accident" occurring in Section 3 of the Workmen's Compensation Act is not defined in the Act, the word has been a subject-matter of a number of decisions as a result of which it has come to acquire a settled meaning. The word "Accident" generally means some unexpected event happening without design even though there may be negligence on the part of the workman. It is used in the popular and ordinary sense and means a mishap or an untoward event not expected or designed. What the Act really intends to convey is what might be expressed as an accidental injury. It includes not only much occurrences, such as collisions tripping over poor obstacles falls of roof, but also less obvious ones causing injury, e.g., strain which causes rupture, exposure to a draught causing chill, exertion in a stockhold causing apoplexy, and shock causing neurasthenias. But the common factor in all these cases is some concrete happening at a definite point of time and incapacity resulting from the happening. Since Section 3 provides that the accident must arise out of and in the course of the workman's employment, the accident in order to give rise to a claim for compensation must have some casual relation to the workman's employment and must be due to a risk incidental to that employment. But though an accident must be a particular occurrence which happens at a particular time, in order that it may constitute an accident within the meaning of Section 3, it is not necessary that the workman should be able to locate it in order to succeed in his claim. There would be cases where a series of tiny accidents, each producing some unidentifiable result and operating cumulatively to produce the final condition of injury, would constitute

together an accident within the meaning of this section. Thus where the duties of a workman's employment were such that his eyes were exposed to the glare of a furnace and the successive assaults on his eyes by the highlights of the furnace and the absorption on each occasion of ultra-violet rays slowly impaired his eyesight till a crisis came with the effect of completely blinding him. The workman was held to have suffered personal injury, namely, the affliction of his eyes caused to him by an accident. Thus, the case of man who with a history of previous heart attack, knowing that he has a bad heart, continued to work in an employment, which by the very nature of work he had to perform might cause further strain on his heart and might thereby suffer a further heart attack, would be included within the ambit of section 3. The fact that the workman continued in his employment knowing that he had a bad heart against the advice of a doctor and also knowing that his work would cause strain on his heart and precipitate another attack is irrelevant. Once it is found that the work which he has been doing is to be within his employment, the question of negligence, great or small on his part, is irrelevant. Once it is established that workman is doing an act which is within the scope of his employment though in a way which is negligent in any degree and is injured by risk incurred only by that way of doing it, he is entitled to compensation per Lord Atkin in Haris *vs.* Associated Portland Cement Manufacturers, Ltd. (1989 A C. 71). The determinate factor is whether the personal injury suffered by the workman arose out of and in the course of employment.

A case where a workman is suffering from disease and succumbed to the disease, the Commissioner has to consider as to whether the workman died from the disease alone or from the disease and employment taken together looking at it broadly. If it was the latter, then the workman would be entitled to compensation. The relevant factor to be ascertained in each case therefore would be ; did the workman suffer from injury or. did he die because the work that he was doing contributed to the injury or accelerated his death ? The fact that the workman was not actually working at the time of the personal injury would also not be relevant. In some cases it may be that by reason of his working in the employment his condition might due to continuous work, be worsening until the crisis comes, though when it does occur, he may not actually be working. That would not mean that the injury was not caused by an accident arising out of and in the course of his employment.

The principles which emerge from decided cases in this point are—

(1) There must be a casual connexion between the injury and the accident at the work done in the course of employment.

(2) The onus is upon the applicant to show that it was the work and the resulting strain which contributed to or aggravated the injury.

(3) It is not necessary that the workman must be actually working at the time of his death or that death must occur while he is working or had just ceased work.

(4) Where the evidence is balanced if the evidence shows a greater probability which satisfies a reasonable man that the work contributed to the causing of the personal injury it would be enough for the workman to succeed.

(English and Indian case—law considered.)

In the instant case the workman who had a previous heart attack and who was suffering from a heart disease went to the mills to attend to his work. His shift was to commence at 3-30 p.m. At 3-20 when he was sitting in another department where he had gone to see his friend he got a heart attack and was removed to the hospital for treatment. He was discharged from the hospital after about a month and a half. He went to the village of relative for rest where he died after about six months. His death was due to heart attack which he must have got after he was discharged from the hospital. There was no evidence whatsoever to show that the work he had been doing until he suffered the attack in the mill premises had contributed to the causing of his death. There was no evidence also to show as to what was

the condition of the deceased during the period while he was taking rest at his relative's house. Something might have happened during his stay there to cause strain to his heart and that must have contributed to the collapsing of his heart. The burden was upon the heirs of the deceased workman who claimed compensation to establish that the heart of the workman which was already in a diseased condition after the first attack had, by the strain of the work he was doing, become weaker and which ultimately collapsed causing his death.

In the circumstances, the claim for compensation must be held to have been rightly rejected by the Commissioner.

Pages 260 to 265—Labour Law Journal, September 1961, Andhra Pradesh High Court Judgment.

Workmen's Compensation Act, sections 2 (*n*), 3, 12 and 30—Workman—A workman employed in a rice and flour mill for carrying paddy bags, weighing them at the weighing balance and stacking the rice bags—Such person engaged by and working under a maistry—Water required for washing purposes and for drinking by the labourers working in the factory, taking from a bore-well situated in the factory premises. The engine-driver of the factory calling the workman to help him in cleaning the borewell pipe by removing it—The workman dying as a result of electrocution while engaged in the work of cleaning bore-well pipe—No evidence to show that the engine-driver was not authorized or instructed to carry out the reparis in the bore-well pipe—Such a person, if workman within the meaning of section 2 (*n*) of the Act—The workman, if could be said to have died as a result of accident arising out of and in the course of employment within the meaning of section 3 of Act.

A person was employed in a rice and flour mill for carrying paddy bags, weighing them at the weighing balance and stacking rice bags. He was engaged and was working under a maistry. Water required for washing purposes and for drinking by the labourers working in the factory was taken from a bore-well situated in the factory premises. The engine-driver of the factory called the workman to help him in cleaning the bore-well pipe to ensure the supply of water. While engaged in such work, the worker died as a result of electrocution. His widow filed an application for compensation against the management of the factory under the provisions of the Workman's Compensation Act, which was allowed. There was no evidence on record to show that the engine-driver was not authorized to carry out repairs in the bore-well pipe.

In the appeal under section 30 of the Act it was contended on behalf of the appellant, the factory management, that the deceased was not a "Workman" qua the factory—owner within the meaning of section 2 (*n*) of the Act and that the accident could not be considered to have arisen out of and in the course of his employment as cleaning of the bore-well pipe was not part of the duties of the deceased person.

Negativing the said contention, held, that the mere fact that the deceased was one of the four or five coolies constituting a Muttah in charge of the maistry by itself could not have the effect of the deceased not being a workman within the meaning of the Act. Following the decision in A.I.R. 1949 Mad. 46 and 1954-II L.L.J. 426 the deceased was a "workman" qua the factory management within the meaning of section 2 (*n*) of the Act.

There was evidence to show that the engine-driver was not entrusted with the work of repairing the pipe or was not instructed or ordered to take the services of other coolies. In the circumstances of the case it could be reasonably presumed that the engine-driver must have been detailed to attend to the stoppage of water, and it was obvious that he would not be in a position to attend to the same without any assistance. Hence there was a casual connexion between the new work entrusted to the deceased and his normal employment. The accident occurred in the premises. It occurred during the working hours at a time when the deceased was at work and from the mere fact that it occurred at a time when he was doing some other work at the instance of the engine-driver, who has obviously working for and on

behalf of the management, it could not be said that the deceased ceased to be in employment at the time of the accident. The expression "employment" in section 3 of the Workmen's Compensation Act is wider than the actual work or duty which the workman had to do. It is enough if at the time of the accident the workman was in actual employment although he might not be actually turning out the work which it was his duty to carry out. It is for this reason that even when a workman is resting, or having his food, or taking his tea, or coffee (in the factory premises) or proceeding from the place of employment to his residence and an accident occurs, the accident is regarded as arising out of and in the course of the employment.

(Case-law referred.)

Pages 467 to 478—Labour Law Journal, October 1961, Calcutta High Court Judgment.

Workmen's Compensation Act, section 3 (1) and proviso (*b*) (ii) thereto accident arising out of and in the course of employment—A railway employee working in the workshop meeting with an accident while crossing the railway lines for reporting to work after finishing his tiffin. The railway employee not using the level-crossing situated at a distance of 40 feet on one side and at a distance of 400 feet on the other side. No evidence to prove the existence of a footpath or track at the point where he crossed the railway lines. No evidence to prove that the use of such route was usual or recognised or impliedly permitted by the railway authorities—Claim for compensation by the railway employee, in the circumstances, rejected.

A railway employee working in the railway workshop met with an accident while crossing the railway lines when he was going back to the workshop after finishing his tiffin. He did not make use of a level crossing situated at a distance of 400 feet on the other side. He preferred a claim for compensation under the Workmen's Compensation Act. It was not proved at the enquiry that the route used by the workman was the usual or recognised one or the use of which was impliedly permitted by the railway authorities for going to and coming out of the workshop.

In the circumstances of the case and in view of the existence of two level-crossings and the absence of any evidence to prove that the route used by the workmen was the usual or recognised route used by the workmen in the workshop for going to or coming out of the workshop, the accident resulting in injuries to the workman could not be considered as one arising out of and in the course of employment.

The absence of any order or prohibitory notification by the Railway Administration under proviso (*b*) (ii) of section 3 (1) of the Act warning the workmen from against crossing the railway lines for the purpose of coming to the factory does not absolve the claimant from providing that the accident arose out of and in the course of employment.

(A.I.R. 1954, All 132....Distinguished on facts.)

(Pages 542 to 546.—Labour Law Journal, November 1961, Andhra Pradesh High Court Judgment.)

Employees' State Insurance Act, sections 2 (8) and 66 (1) —Workmen's Compensation Act, section 3 (1)—Factories Act, section 24 (1) (*a*)—Employment injury—Accident arising out of and in the course of employment—An unskilled worker employed in oil mills to feed the crushing machine worked by a belt mounted on a pulley fixed to a power-driven shaft—Stock of groundnut supplied to the concerned works exhausted—In order to avoid the machine getting damaged, the worker trying to shift the belt off the moving pulley by giving a kick to the belt—while doing so the workman getting caught between the pulley and the belt— The accident resulting in the death of the concerned workman—The duty of fixing and removing the belt, done by the mechanic and fitter—Mechanic and fitter not available at the relevant time to stop the machine—No arrangement as contemplated by section 24 of the Factories Act, made in the factory for such purposes—The claim for contribution under section 66 of the Employees' State Insurance Act, if could be negatived in the circumstances on ground

that the workmen did something voluntarily without being asked to do so and which was not part of his duty.

The facts of the instant case are as follows :—

An unskilled workman was employed in an oil mill to feed the crushing machine which was worked by a belt mounted on a pulley fixed in a power-driven shaft. A mechanic and fitter was employed in the factory *inter alia* to fix and shift off the belt. No safety arrangement as contemplated by section 24 (1) (*a*) of the Factories Act was made in the factory for such purposes, viz., for moving belts to and from fast and loose pulleys.

On the day in question the supply of groundnut given to the worker got exhausted. The mechanic and fitter was not available at that time. In order to prevent the machine from getting damaged (by running empty with any groundnut) the workman tried to shift the belt off the moving pulley by giving a kick to the belt. While doing so his leg got caught between the pulley and the belt and he was pulled up to a height of six feet from where he fell down and died instantaneously.

It was contended on behalf of the employer-appellant that the claim of the Corporation for contribution under section 66 of the Employees' State Insurance Act was not sustainable as the workman exposed himself to a peril which was on account of his own action un-connected with his employment, as it was not part of his duty to attend to the shifting of the belt from the moving pulley and that he acted on his own responsibility and without any direction or order from the employer.

Negativing the said contention on the facts of the case, held that there was intimate and casual connexion between the accident, the act which resulted in the death of the concerned workman and his employment. At the time the accident occurred the deceased was in fact employed on the duty of his employment which was at and in connexion with the crushing machine. The accident occurred in the premises of the mill and close to the place where he was normally employed. Although the immediate act which led to the accident was no doubt foolish and a risky one, it cannot be said that, that act was so remote from the sphere of his duties as to be regarded something entirely unconnected with his employment. It might be true that it was not part of the duties of the deceased to kick the belt from the moving pulley which normally forms part of the duties of the mechanic and fitter. But obviously, the deceased was interested in the course of his employment to see that the crushing machine did not keep in working when there was no groundnut to feed it. Apart from the fact that it involved waste of power, there was apparently the added risk of the machine getting damaged. So, whatever the deceased did, must be regarded as having been done by him in the best interest of his employer, and in order to prevent the machine from getting damaged, thereby resulting in loss to the employment.

(1960—I.L.L.J. 434—Applied.)
[A.I.R. (1933) Cal. 220—Distinguished on facts.]

SIXTH CONGRESS ON IRRIGATION AND DRAINAGE

BY

SRI S. SHANMUGAM, B.E., M.SC.*

The sixth conference of the International Commission on Irrigation and Drainage was held in New Delhi between 4th and 15th January 1966. Inaugurating the conference Dr. Radhakrishnan, President of India, expressed that the conference would help the country to find out what to do and how to develop its agriculture. He stressed that the knowledge with regard to the new technique should reach the farmer. Welcoming the delegates Dr. K. L. Rao urged further international co-operation in the fields of irrigation, flood control and drainage. Of the 59 countries in the Commission, 18 countries have an irrigated area of more than a million hectares, accounting for more than 90 per cent of irrigated area in the world. Regarding Irrigation in India he said that inspite of the phenominal rate of development of irrigation in India, the area irrigated is only 1/5th of the cultivated area. Dr. Rao added that irrigation and drainage are complementary in assuring the basic requirements for plant growth. An efficient drainge system helps to counteract the effect of salinity or alkalinity. The control of floods will also lead to increased food production. As examples he quoted Japan and Assam where flood control measures have yielded increased crop. He concluded that irrigation, drainage and flood control were therefore vital in stabilising the agricultural economy of several countries.

Dr. T. Ippan, who presided, expressed that irrigation is a complex science. Much remains to be done to improve irrigation and drainage practices. He pointed out that about 2/3rd of irrigated area of the world was located in arid or semi-arid regions of Asia. Although Asia had about one half of the population of the world, yet it produced only 1/6th of world's food. If good irrigated agriculture is practiced, the food supply could be increased two to five times without any increase in acreage, he added.

The discussions were started on 7th January on the following four questions out of which the papers on questions 20 and 22 will be more useful for the officers of this department :—

Question No. 19.—Reclamation of saline lands under irrigation.

Question No. 20.—Sediment in irrigation and drainage channels.

Question No. 21.—Development of deltaic areas.

Question No. 22.—Integrated operation of reservoirs for irrigation, flood control and other purposes.

In this paper some of the interesting points discussed in the conference under each question will be touched upon.

Q. 19. *Reclamation of saline lands under irrigation.*—Twenty-five reports from eleven countries were submitted on the different aspects of reclamation of saline land. A few reports deal with the investigation regarding reclamation approach and soil salinity appraisal. Dr. Hoon has stressed the need for much investigations and has brought out the role of Government organisation in such regional investigation. To determine soil salinity, Myers has evolved a novel technique based on photogrammetry and temperature sensing. Mr. Yasuji Matsumura, described electrical conductivity determinations for quick estimation of soil salinity. Mr. Shigoo Youeda has established a method by the use of hydrogen peroxide. Different methods of controlling soil salination and reclamation measures for

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saline, saline-alkali, alkali and acid sulphate soils were discussed. Mr. Talsma has assigned that for control of soil salinisation, the critical water table depth must be that at which evaporation rate is 0·1 cu. metre/day. Leaching is a common method of reclaiming saline lands. Based on field results, Mr. Talsma has indicated that an equation can be derived for the quantity of leaching water in terms of salt concentration. But the utility of leaching curves is restricted to specific conditions since it depends to a large extent on the water application. Leaching can be better achieved under unsaturated soil conditions. For reclamation of alkali soils, Messrs. R. C. Reeve and E. J. Doering have advocated the use of high salt water distribution method. This method can be adopted if suitable water is available for successive dilusions. For reclamation of acid sulphate soils sea water with saline mud has been successfully used in British Guiana.

Drainage planning has been reported by many authors. Mr. R. A. Milne and Mr. N. Rapp have indicated the effects of ground water pumping and the utility of pumped water for irrigation and leaching. Horizontal drainage, open and tile drains have been mentioned for effective leaching operation. For alkali soils chemical amendments such as lignite, gypsum, industrial wastes, kankarlime, etc., are recommended. During the discussions, the delegates from Russia outlined the drainage practices obtaining in their country and expressed that vertical drainage with improved irrigation methods reduces secondary salinisation. Chemical amendments are to be resorted to if the salts present in the soil are not easily soluble. It was desired that standards regarding the point at which reclamation works should start and the safe limit of salt content and ground water depth should be fixed for uniform practices. Summing up the discussion Dr. Hoon said that using saline water for reclamation should be tried on a large scale.

More works have yet to be done to evolve laws governing the spread of salinised soils in irrigated areas.

Q. 20. *Sediment in irrigation and drainage channels.*—Twenty-two reports from ten countries were discussed on this subject, from which only the important points will be brought out in this paper. More details on this subject will be dealt with in the next issue.

It is well known that large number of rivers carry heavy sediment load during floods and their regime changes at narrow and wide section where degradation, aggradation and meandering continue to occur. It is necessary to know the total sediment transport and the silt distribution of the suspended and bed loads at specific locations in a river to plan Irrigation Projects.

Silting in irrigation and drainage channels necessitates precise measurements of sediment carried by streams and channels with a view to ensure judicious distribution of silt at control structures. Instrumentation in use for measurement of silt load is as yet in evolution stage and needs considerable research to perfect it. Based on the experience in gauging the Ganga and Yamuna rivers, Handa has expressed that Bottle sampler is the more versatile suspended sediment sampler, easy to operate with little cost requiring no elaborate mechanism. It was stressed that the fertilising value of the silt transported in irrigation channels should be correctly assessed. Bradford and Tarecki have described the effectiveness of water borne sediments in sealing the canals and reducing seepage losses. On the basis of prototype data of table channels, Lacey has presented definite relationships between various parametres for design of regime channel. Chitale, Lippi and Shegal have studied the behaviour of a number of regime channels in Punjab, U.P., etc., and have critically examined the applicability of Lacey's regime equation.

Simmons and Millers have presented a graphical relation to predict the form of bed roughness which relates to stream power, median fall diameter of bed material and forms of bed roughness. More papers were presented on the diversion structures for excluding sediment at off-takes. Walter, Shunmugam and Raj (Madras) have presented a new type of device called flume type excluders which is claimed to effect 80 per cent reduction in silt entry canals. Various other types of devices such as undersluices, guide vanes, vortex tubes, drop inlets,

settling basins and tunnel type excluders were also discussed. Settling basins are in use in Japan and Russia. But its use is restricted because of enormous space and machinery, etc., required Tunnel type extractors were used successfully in Sarda canal with about 63 per cent sediment ejection efficiency and the prototype performance observed was in close conformity with the model results. During discussion Dr. Joglekar stressed that proper rigime sites should be chosen, channel silting and scouring should be studied and the upper limit of silt charge in channels should be fixed. Mr. Framji expressed that where a Lacey's f is a dependent variable XVS consists of Independent variables and thus all analysis should be based on XVS. Mr. Gole said that design of channel should be related to silt distribution at head works. Summing up Mr. Gupta said that accurate collection of field data is necessary for study of (1) Movement of bed, suspended materials, (2) Sediment concentration, (3) bed form and rugosity co-efficient and (4) aggredation and degradation.

He also said that improved instrumentation is necessary for measurement of velocities and sediment load and the economics of the various devices for sediment exclusion should be studied in the field.

Q. 21. *Development of deltaic areas.*—In the development of deltaic areas different aspects of tidal, coastal reclamation and agricultural Engineering aspects have to be considered together. There is an abundance of water in the areas. But Irrigation and drainage heads are so small that there is danger of flood from the river and the sea. The land thus requires protection from inundation. Salt water intrusion is another obstacle to be overcome. Due to complete utilisation of river water upstream, and consequent low periodical flows and also due to deepening of the navigation channels, there is pronounced salt water intrusion in this area. If it is possible to regulate a sustained flow in the river, a hydraulic barrier could be built to check salt water intrusion. Tidal regulators near the mouth of river form physical barriers against salt water intrusion. Where salt water intrusion cannot be prevented, irrigation water has to be supplied from other sources.

In California, construction of Levees and channels led to the reclamation of 100 islands at the confluence of major rivers. There is a high rate of erosion and subsidence of islands. The problems facing the area are water quality control, maintenance of Levees on suitable foundations, etc. A new problem is the transfer of a flow of water of more than 50 cubic meters/sec. through the delta from North to South without contamination with the brackish water in the western port. A peripheral canal was found to be the best taking into consideration water quality and transfer, local water supply, flood control, seepage and drainage control, drainage, etc. In Korea, reclamation of tidal lands were effected by the closure of three estuaries and irrigation of the area by pumping and drainage by gravity. Salt water intrusion has been stopped and salt intrusion from internal sources controlled by flushing. In the reclamation of the deltaic area of river Po, the principle of separate drainage for the high and low lands has been adopted. After reclamation, land subsidence between 1·5 to 2 metres in 100 years is predicted. The important object of the scheme is the colonisation of the delta. Model studies conducted for locating a salt water barrier at Thannermukkam in Kerala indicated a regulator with suitable sill designed such that the navigation interest of Cochin Harbour is kept unaffected while helping to raise 2 crops in the Kuttanad area. In Japan, a tidal weir is under construction at the estuary of river tone to control the influence of sea water in the backwaters, stabilise and increase the agricultural production in the area. The paper gives a regulation chart for the weir gates in order that the control of down flow is restricted to the minimum ranges required for purposes of water use.

During discussion it was stressed that due consideration should be given to reuse of return flow in deltaic area. It was also stressed that there should be sustained release from the upstream reservoirs to develop hydraulic barrier

with deltaic areas. Mr. Volker said that Deltas should be included in the planning of over all river basins and there should be proper collaboration with the meterological agents for storm and surge signals. More prototype data on the hydraulic structures in deltaic areas and mechanics of salt water intrusion are needed. Studies should be encouraged on the effective methods of drainage and irrigation, economic utilisation of return flow and land subsidence problems in the delta.

Q. 22. *Integrated operation of reservoirs for irrigation, flood control and other purposes.*— The topics discussed under this head includes the operation of the following four types of reservoirs :—

(1) Single purpose reservoirs, (including those only for irrigation or flood control use.)

(2) Multipurpose Reservoirs (having, among others, either irrigation or flood control or both as their function).

(3) Reservoirs forming an integrated system in a river basin.

(4) Reservoirs for inter basin developments.

The various aspects of reservoir operation discussed during the conference are detailed below :—

(*a*) Method of operation which is adaptable to specific conditions where operational demands include different purposes.

(*b*) Design considerations—Synchronisation of water releases for hydropower generation to meet demands for power at different times of the year.

(*c*) Administration and co-ordinated operation of reservoir to meet the needs of all agencies connected with the use of water.

(*d*) Effect of requiring long sustained flows from the reservoirs in a high valley on the agricultural development and or floods in the lower valley including the effects of heavy rainfall in the upper and lower valley.

(*e*) Cost benefit considerations of storage capacity reserved for different uses.

Mr. Berg of U.S.A. while describing the integrated operation of 14 multipurpose reservoirs constructed in the Kansas River Basin presents an excellent description of operating procedure covering the agreements with the irrigation districts and the corps of Engineers the allowances for irrigation releases to reach the area of use, standing instructions to reservoir Superintendents, etc. In this, the system developed to meet flood emergencies caused by non-forecastable rainfall involves a wide spread net work of local residents reporting on stream flow and rainfall, radar stations for tracking storms, telemetering systems, radio communication to all key points, telephone facilities, etc. Mr. Berg mentioned the electric analogy model for routing flood flows. Once the hydrological data are programmed into the model, the rainfall excess from each sub-watershed is converted to discharge and routed down the river accumulating with initial hydrographs and reservoir out flows in proper sequences. The model is expected to be very effective in optimising reservoir releases directly affecting urban areas which suffered severe damage during the 1951 floods. The reservoir system in the Missouri River is an excellent example of a highly integrated multiple purpose operation, with six large storage reservoirs having principal functions in flood control, power generation, navigation, irrigation, recreation, etc. A co-ordinating committee represented by each connected district forms a unified plan of operation each year with a sincere desire to obtain the maximum in overall benefit from integrated operation of the main system. The paper "The reservoir operations in the Cauvery" presented by K.V. Ekambaram details the regulation practices adopted for the two large reservoirs of Cauvery under flood and non-flood conditions, and the procedures formulated for an integrated operation of the system for equitable distribution of water between the two states as per the agreement. This system is a fine example of a project serving more than one political sub-division and provides further evidence that a most essential element in a successful integrated river operation is a comprehensive agreement between affected interests to resolve their differences.

David, M. Rockwood and Mark L. Nelson (U.S.A.) have described the extremely complex and highly important problem of stream flow forecasting and reservoir regulation, not only in water resources planning and design studies but also in both routine and flood season operation of Columbia River Basin of Canada and the U.S. in North America. They have developed an electronic automatic data processing approach for the complex reservoir and river system operations and illustarted the method as they have used it in the Columbia River basin. Optimum regulation of the multipurpose reservoir system depends on the accuracy of the stream flow forecasting. This involves not only the forecasting of precipitation but also of temperature sequences, since much of the flow in Columbia river is derived from snow melt. The proper scheduling of releases and retentions of stream flow of maximum benefits require several types of stream flow forecasts such as long range volumetric forecasts for periods of mouths for flood seasons, medium range forecasts for periods of 5 to 30 days and short range forecasts for periods of one or up to perhaps 10 days. H. Oliver from England has discussed in his papera technique of flood control for concrete structures whereby the requirements for flood retention storage and downstream discharge requirements are co-ordinated for optimum results. In the method discussed for operating the spillway gates for attennuating large floods where an over flow and a gated spillway are used together, the operator will compute the rate of inflow into the reservoir by observing the rate of increase in storage and combining this with the discharge thro' spillway gates. By making repeated observations at uniform time intervals during the early stages of the flood and knowing beforehand the accepted time interval between the start of floods and peak of floods, he will be able to predict the peak flow of the flood and lapse of time until the peak shall occur. With these data he will select an outflow for gates and over flow spillway so that a constant flow will be maintained through the river channel downstream and the alteration of the flood will be accomplished. And, should the inflow design flood occur the resulting maximum reservoir water surface will not encroach upon the design free board of the dam. The regulation of the present Aswan Dam to supply the downstream requirements of discharges varying from 300 cumecs to 4,000 cumecs through 136 sluices located at different elevations at various upstream heads was discussed by M.A. El. Madany (U.A.R.). The calculations of required sluice openings to compensate for variable pool elevations were summarised graphically in the form of a nomograph. From an analysis of the nomograph, the author suggested connecting the control sluices to an electric motor which would be activated by a float thus permitting the control sluices to be opened or closed automatically throughout the day to maintain a uniform rate of release as the pool elevation varies.

In Soviet Union, efficient utilisation of the water resources has necessitated an artificial redistribution of river natural flow both in time and area by construction of multipurpose reservoirs. Many branches of the national economy such as power generation, water transportation, irrigation, industrial and domestic water-supply, fishing and flood control are affected and improved by regulation of rivers. Designing and constructing reservoirs for multiple purpose in Soviet Union have reduced capital investment per unit of power development, per unit of irrigated area and other benefits. Bhatnagar has described the present and proposed water resources development in the states of Punjab and Rajasthan in India. These developments include Bhakra Dam and other Dams on the Sutlej River and the proposed Beas Dam and related power plants, diversion Dams and canals. The reservoirs will be operated conjunctively to provide irrigation, power, flood control and other beneficial uses. For Bhakra Dam, in order to obtain the most interim operation, a reservoir factor chart was derived. Full irrigation demands would be met during the filling period after which this rule curve would be utilised to determine what portion of the demand should be met to the best utilisation of the available supply for irrigation and power purposes.

In the general discussion the following points were stressed :—

(1) All water resources should be developed with a multipurpose view.

(2) It is better to design the systems to maximise benefit aspects.

(3) River systems studies should be undertaken to improve flood forecasting methods.

(4) Studies on improving the weather forecasting techniques, minimising evaporation losses should be encouraged.

(5) Mathematical model studies and electrical anologue computor studies for flood routing should be widly practiced predicted.

(6) All problems on utilisation of water resources should be resolved where necessary on international basis.

(7) There should be more co-operative efforts on the maximum utilisation of International rivers.

Thus the operation of reservoirs has direct bearing on the important multiple purpose functions of a water resources development. The complexities of reservoir development and operation will be compounded in the years ahead as the demand increases for food and fiber for the world's rapidly expanding population. This demand will require not only the lands not now irrigated but susceptible of irrigation be developed but also that water-supplies be increased for lands now inadequately supplied. From a planning stand point, it is essential that we continue to improve our technology. For this we should maintain a high level of research and make use of the new tools that are being made available to us through developments in the other countries.

" Yo rigid ploughmen : Bear in mind
Your labour is for future hours.
Advance ! Spare not ! Nor Look behind !
Plough deep and straight with all your powers."

—*Richard Henry Horne.*

NEWS FROM ABROAD

River bridge trusses reset without dislocating traffic

The supporting pier of the old river bridge at Charleston in U.S.A. was slightly tipping over, threatening to drop both trusses into the river. The kink was noticeable in the road-way.

The trusses were each 270′6″×20′0″×40′0″×652 tons. They were about 100 feet above the river bed level. Their abutting ends have moved 19″ northwards at road level for the original position and 14″ at their bearings. The repair work, without interruption to about 12,000 vehicles using the bridge everyday was carried out with the help of false work tower foundations line of bearing piles on each of the four sides of the pier footing, cofferdam, etc.

A new type of plaster

A new type of plaster which is claimed to be useful in many ways has been developed by " The Rubber Producers Research Association ". This plaster will not crack, can be bent like a sheet of plastic and cannot be damaged by nails.

The brittleness and inflexibility are removed from gypsum which forms the plaster, by replacing a natural rubber latex in the place of water. The plaster must be stabilised and diluted before the latex is added. The know how is in using the right amount of rubber and suitable stabilisers. Plasters, by changing these components can be made to set quickly or to take longer setting time.

All plastic house for sale in Belgium

A new Belgium Company, Messrs. S.A. Sedibat is marketing a factory built house made almost entirely of inexpensive plastic. The life of the house is expected to be 50 years.

Both the design and the erection of the house are simple. Prefabricated wall panels in standard storey heights of 8 feet and lengths up to 6 feet are laminated at the Ghent plant. Outside surface of the 2 inches thick panels is polyvinyl chloride inside surface is polyster, a layer of insulation foam is sandwiched between doors and windows are factory installed in cut outs in the panels.

Belgian officials, have given the plastic houses the same fire ratings as conventional houses. Inside doors, door frames, kitchen cupboards and even the kitchen sink are all made of plastic.

Multi storied plastic buildings with built in garages are expected to come in the near future.

Malpasset acquittal

Court declares engineers not guilty in dam collapse.

For the second time, five French Engineers have been declared not guilty of homicide through negligence in connection with the collapse of Malpasset Dam in which 421 persons died.

The Court of appeals at fix-en-Province, in South East France, last week supported the verdicts of two orginal Court trials that five men involved in the design, construction and inspection of the 197 foot high thin-arch dam were innocent.

A year and a half after the collapse, the public prosecutor of Draguignan, a town near Frejus, the collapse site, charged Jacques Dargeou with homicide through negligence. Mr. Dargeou was Chief Engineer for the Ministry of Agriculture, which built the dam jointly with the department of Var. He was tried in 1964 and acquitted.

A year later, Mr. Frejus Victims Association relatives of persons who died in the collapse, brought original action on similar charges

against four other engineers connected with the dam.

The four men involved in a second trial of Draguignan were Jean Bellier, son-in-law and partner of the late Andre Coyne, designer of Malpasset, Raymond Martin, Manager of Societe-de-Tope-Photographic Company, hired to make periodic inspections of the dam, Jean Kauffuann, Mr. Martin's successor and Leon Nourrit, Mr. Dargeou's successor.

The second trial was brief and resulted in acquittal for the four Engineers. The Frejus Victims Association appealed both verdicts. After a month of deliberation, the fix-en-Province appeals court decided that none of the five engineers could be held responsible for the collapse.

Among the Court's conclusions : Jacques Dargeou's capacity as director of construction could not legally be established. Jean Bellier was "a cog in the machine" of the Coyne firm, and had no roll in the construction of the dam. No charge could be made against Leon Nourrit, Jean Kauffuann and Raymond Martin were completely out of the picture.

The Court ordered the Frejus Victims Association to pay trial cost. Legal battles generated by the failure of Malpasset are not over yet Civil Court, at Nice, is dealing with damage suits brought by the Frejus Victims Association and is expected to reach a verdict later this year.

Tokyo leaps over height limit

In Tokyo, a crowded, sprawling city of 11 million persons, where fear of earthquakes has kept building heights inefficiently low, a company that is breaking the height barrier with a 36-storey office tower has found new trouble radio waves.

Japan National Railways charges that the 100 million Kasumigaseki Koso Building by Mitsui Real Estate Company would block JNR's microwave communications line for the train operations. The solution is either to build a microwave relay atop the building or to raise the height of JNR's antennas, but the dispute is over who should foot the bill.

While the lawyers feud Mitsui has already begun foundation work for the 482 feet tower, which will be one of Asia's tallest when it is completed in 1967. Until 1963, Japanese law limited maximum building heights to only 102 feet, because of earthquakes. With the development of earthquakes safeguards however, the law has been changed to permit buildings with a total useable floor area up to 10 times larger than the site, area, thus removing all legal height limitations.

The Koso tower, one of the first high risers to take advantage of the new law, is designed to withstand earthquakes three times more intense than the great Kanto Earthquake of 1923, which destroyed most of Tokyo and Yokohama. According to the builders, the tower's strength will come from extensive use of steel.

By using steel beams with a span of 52 feet the engineers have eleminated all columns in the office space. Yield strength of the steel is 34,000 psi. All 70 building columns will be 27 × 40 inches in cross section. Exterior columns, in relief, emprasize the height of the building.

The steel framed structure will have a rectangular base measuring 41 feet by 274 feet and a rectangular service core, 36 feet by 189 feet housing elevators, escalators, air conditioning, ventilation ducts, and utilities.

Built on a nearly one-acre base, the Koso building will have a total floor space of 1·8 million square feet. The three level basements, 75 feet deep, will chiefly serve as a parking garage for 500 cars. About 73 per cent of the tower's 175,700 square feet site will have open gardens considered to be a great extravagance in crowded Tokyo.

The building was jointly designed by Mitsui Real Estate and Juro Yamashita a Japanse architect. Chief structural engineers is Dr. Kiyoshi Muto of Tokyo University. Kajima Construction Company, and Mitsui Construction Company will be joint contractors.

புதுயுகப் பாசனம்

" வரப்புயர நீருயரும், நீருயர நெல்லுயரும்
நெல்லுயர குடியுயரும், குடியுயரக் கோவுயரும் ".
— ஔவையார்.

தமிழகத்தில் நீர்ப்பாசனம்

* (ஓர் ஆய்வுரை.)

முன்னுரை.—இந்திய தீபகற்பத்தில், மேற்குத் தொடர்ச்சி மலைகள், கிழக்குத் தொடர்ச்சி மலைகள் ஆகிய இரு மலைத் தொடர் அமைப்புகள் குறிப்பிடத் தக்கவை. 2,400 மீட்டர் (8,000 அடி.) உயாமுள்ள மேற்கு மலைத் தொடர் ஒழுங்கற்ற தனது செங்குத்தான சிகரங்களோடு மேலைக்கடற்கரையை யொட்டி அரபிக் கடலிலிருந்து சுமார் 130 கிலோ மீட்டர் தூரத்தில் இருந்து 160 கிலோமீட்டர் வரை (80 மைலிலிருந்து 100 மைல் வரை) தொலைவில் செல்கிறது. சுமார் 610 மீட்டர் (2,000 அடி.) உயரமுள்ள கிழக்கு மலைத் தொடர் கிழைக் கடற்கரை ஓரமாக, ஆஞல் கடலிலிருந்து மிகத் தொலைவில் ஒரே தொடர்ச்சியாக இல்லாமல் செல்கிறது. இவை மிரண்டும் நீலகிரி மலைகள் எனப்படும் ஓர் மலைக் குவியலில் ஒன்று சேருகின்றன. இப்படியாகத் தீபகற்பத்தின் கிழக்குப் பகுதி சமவெளியாக வங்காள விரிகுடா வரை இலேசான சரிவுடன் உள்ளது.

பருவக்காற்றும் மழையும்.—எனவே தமிழகத்தில் எல்லா ஆறுகளும் அனேகமாக மேற்கிலிருந்து கிழக்காகவே ஒடுகின்றன. ஆயினும் குமரி மாவட்டத்திலுள்ள கோதையாறு நதி மட்டும் இவ்விதிக்கு விலக்காக கிழக்கிலிருந்து மேற்காகப் பாய்ந்து அரபிக்கடலில் கலக்கிறது. ஜூன் திங்களிலிருந்து செப்டம்பர் திங்கள் வரையுள்ள தென்மேற்குப் பருவக் காற்றுக் காலத்தின் மேகங்களே, நீண்டு உயர்ந்து நிற்கும் மேற்கு மலைத் தொடர் தடுத்து நிறுத்தும் அரணாக விளங்குகிறது. ஆஞல் அது காவிரி, வைகை, தாம்பிரபரணி, கோதையாறு ஆகிய நதிகளின் மேற்பகுதிகளுக்கு மட்டுமே நன்மை பயக்கும்படியாக உள்ளது. அக்டோபர் திங்களிலிருந்து டிசம்பர் திங்கள் வரையிலிலுள்ள வடகிழக்குப் பருவக் காற்றால் மட்டுமே நாட்டின் கிழக்குப் பகுதி பயன்பெறுகிறது. எனினும் இப்பருவக்காற்று தென் மேற்குப் பருவக்காற்றைப்போல் அவ்வளவு வலிவுள்ள தாகவும், நம்பற்குரியதாகவும் இல்லை. இம்மாநிலத்திலுள்ள நதிகள் (முன்பு குறிப்பிட்ட 4 நதிகளின் மேற்புருதிகளையும் சேர்த்து) யாவும் வடகிழக்குப் பருவக்காற்று வீசும் பகுதியிலேயே உள்ளன. இப் பருவக்காற்றின் குறைபாடுகள் நமது மாநிலத்திற்கு பெரும் பிரச்சினையாக உள்ளன. மாநில முழுமைக்கும் ஆண்டு சராசரி மழை 950 மி.மீ. தான் (38 அங்குலம்).

நீர்ப்பாசனம்.—நீரும், நீரைக் கட்டுப்படுத்தும் அமைப்புகளும் தென்னாட்டவருக்கு மிகவும் முக்கிய மானவையாகும். இம்மாநிலத்திலுள்ள 6¼ மிலியன் ஹெக்டர் (15 மிலியன் எக்கர்) விளை நிலத்தில் ஐந்தில் இரு பங்கிற்கும் அதிகமான பகுதி நிரந்தரமாக பாசன வசதியைப் பெற்றுள்ளது. சமீப காலத்தில் நடத்தி முடிக்கப்பட்ட திட்ட வேலைகளின் மூலம் நீர்ப்பாசனம் எவ்வளவு நன்முக வளர்ந்துள்ளது என்பதைக் கீழே உள்ள அட்டவணை மூலம் அறியலாம்.

[எண்ணிக்கை ஆயிரம் ஹெக்டாரில் (ஆயிரம் எக்கரில்.)]

ஆண்டு.		கால்வாய்கள்.	ஏரிகள்.	இணறுகள் மற்றும் பிற முறைகள்.	மொத்தம்.
1958–59	..	840 (2075)	840 (2076)	580 (1435)	2260 (5586)
1959–60	..	843 (2083)	833 (2058)	603 (1490)	2279 (5631)
1960–61	..	882 (2179)	936 (2314)	644 (1592)	2462 (6085)
1961–62	..	893 (2207)	939 (2320)	630 (1558)	2462 (6085)
1962–63	..	902 (2230)	957 (2364)	659 (1628)	2518 (6222)

இவ்வாறு 2½ மிலியன் ஹெக்டர் (6¼ மிலியன் எக்கர்) நிலம் பாசன வசதியுடன் பயிரிட்டாலும் இங்குள்ள மூன்றரை கோடி மக்களுக்கு இம்மாநிலம் உணவளிக்க முடியவில்லே. எனவே உணவு தானியங்கள் இறக்குமதி செய்ய வேண்டிய நீலே எற்பட்டுள்ளது.

மாநிலத்திலுள்ள ஆறுகள்.—காவிரி, வைகை, தாமிர பரணி, கோதையாறு ஆகியவைகள் முக்கிய பெரு நதிகள். பாலாறு, பொன்னையாறு, வெள்ளாறு, அரணியாறு, குசஸ்தலேயாறு முதலியவை நடுத்தர ஆறுகள். இவ்வாறுகள் எற்கனவே பெருமளவு பயன் படுத்தப்பட்டு வருகின்றன. மேலும் தேக்கங்களின்

* Translated from the article on " Irrigation in Madras State—A review " prepared by Sri T. V. Subramanian, Assistant Engineer Office of the Chief Engineer (Irrigation).

மூலமும் அவற்றின் ஆயக்கட்டுகள் விரிவுபடுத்தப்பட்டிருக்கின்றன. இவற்றின் தற்போதைய ஆயக் கட்டுகள் கீழேயுள்ள அட்டவணையில் தரப்பெற்றிருக்கின்றன :—

[எண்ணிக்கை ஆயிரம் ஹெக்டாரில் (ஆயிரம் ஏக்கரில்).]

காவிரி	612 (15,12)
வைகை, பெரியாறு	1,01 (2,50)
பாலாறு	70 (1,73)
தாமிரபரணி	47 (116)
வெள்ளாறு	43 (106)
பொன்னையாறு	30 (75)
கோதையாறு	24 (60)
குசஸ்தலையாறு	11 (26)
ஆரணியாறு	10 (24)
கூவம், அடையாறு	6 (14)
வராக நதி	3 (7)

மேற்கண்ட ஆற்றுப் பகுதிகளில் செயல்பட்டு வரும் நீர்ப்பாசன அமைப்புகளின் பட்டியல் பிற்சேர்க்கை 1-ல் தரப்பெற்றிருக்கிறது.

ஏரிகள்.—மழை குறைவான பகுதிகளில் ஏரிகள் மிக அதிகமாக இருப்பதால் அவை மேலும் முக்கியத்துவம் பெற்றுள்ளது. எல்லா இடங்களிலும் மிக அதிக அளவில் அவ்விடத்திற்குரிய நீரை **(local water)** பயன்படுத்தும் வகையில் அத்தகைய ஏரிகள் மிக்க கவனத்தோடு தக்க இடங்களில் அமைக்கப்பெற்றுள்ளன. அத்தகைய ஏறிகளில் செம்பரம்பாக்கம், காவேரிப்பாக்கம், மாமண்டூர், வீராணம் முதலிய ஏரிகள் பல நூற்றுண்டுகட்கும் முற்பட்டவை.

மாவட்டவாரியாக ஏரிகளின் மொத்த எண்ணிக்கை வருமாறு :—

மாவட்டங்கள்.	எண்ணிக்கை.
செங்கற்பட்டு	4,047
தென்னாற்காடு	2,605
வடாற்காடு	2,904
சேலம் (தர்மபுரி உள்பட)	2,459
கோயம்புத்தூர்	99
திருச்சிராப்பள்ளி	6,522
தஞ்சாவூர்	1,401
இராமநாதபுரம்	5,910
மதுரை	5,266
திருநெல்வேலி	2,667
கன்யாகுமரி	3,212
மொத்தம் ..	36,992

கிணறுகள்.—மற்றும் சுமார் 800,000 கிணறுகள் மொத்தத்தில் ஒரு கனிசமான பகுதிக்கு நீர்ப்பாசன வசதி அளிக்கின்றன. இக்கிணறுகளிலிருந்து 0·6 மிலியன் ஹெக்டார் (1·6 மிலியன் ஏக்கர்) நிலம் பாசன வசதியைப் பெறுகிறது. இப்பாசனம் முழுவதும் ஏற்றப் பாசனத் தாலேயே **(lift irrigation)** நடைபெறுகிறது. இடைக்கின்ற நீரையெல்லாம் முழு அளவில் பயன்படுத்தத் தென்னாட்டவர் எவ்வளவு ஆவலாய் உள்ளனர் என்பதற்கு இது ஒரு சான்று.

நீர்ப்பாசனம் (பழமையும், புதுமையும்)

பாசனம் தொன்மையானது.—இம்மாநிலத்தில் நீர்ப் பாசனம் ஆதிகாலந்தொட்டே வழக்கிலிருந்தது என்பதை நன்கறியலாம். கி.பி. இரண்டாம் நூற்றாண்டில் காவிரி டெல்டாவில் தற்போது கல்லணை உள்ள இடத்தில், முதன் முதலாக கரிகாற்சோழன் ஓர் அணையைக் கட்டுவித்தான். பாசன வசதிகளைச் செய்வதில் சோழ, பாண்டிய மன்னர்கள் ஒருவருடன் ஒருவர் போட்டியிட்டுக் கொண்டனர். அவர்கள் கட்டிய பல ஏரிகளும், நீரைத் திருப்பும் அமைப்புகளும் **(diversion structures)** காலத்தால் அழியாது இன்றும் நன்முறையில் பயன்பட்டு வருகின்றன.

பாசன வழி முறைகள்.—பழங்காலத்தில் மக்கள் தங்களின் பாசன முறைகளை ஆற்றின் நீரியல் **(hydrology)** தன்மைக்கேற்றவாறு மாற்றிக் கொண்டனர். ஆற்றுப் பெருக்கு குறைந்தவுடன் ஆற்றின் குறுக்காக மணல் திட்டு களை அமைத்து ஆற்று நீரைத் திருப்பி, முடியும் காலம் வரை பயன்படுத்தி வந்தனர். இவற்றிற்கும் பயன் படும்வகையில் கல்லால் கட்டிய சில அணைக்கட்டுகளையும் அமைத்தனர். கால்வாய்கள் அகலமாகவும், நிறைந்த தலைப்பையும் **(open head)** கொண்டனவாக இருந்தன. ஆற்றுப் பெருக்கின் காரணமாக வந்த மிகுதி நீரை பிற்கால உபயோகத்திற்குப் பயன்படுத்த ஏரிகள் தோற்றுவிக்கப்பட்டன. ஆற்றின் மேற்பகுதியில் நேர்முகக் கால்வாய்ப் பாசனமும் **(direct channel irrigation)** கீழ்ப் பகுதியில் நேரல்லாத ஏரிப் பாசனமும் **(indirect tank irrigation)** ஒன்றன்பின் ஒன்றுகத் தோன்றின. உதாரணமாகத் தாமிரபரணி ஆற்றைக் கூறலாம். இதில் முதலிலுள்ள 4 அல்லது 5 கால்வாய்கள் நேர்முகமாக ஆயக்கட்டுகளுக்கு பாசனமளிக்கின்றன. அப்பகுதியில் யாதொரு ஏரியும் கிடையாது. ஆனால் அவ்வாற்றின் கீழ்ப் பகுதியில் மருதூர், ஸ்ரீவைகுண்டம், ஆகிய அணைக்கட்டு களிலிருந்து பிரிந்து செல்லும் கால்வாய்கள் பல ஏரிகளை நிரப்புகின்றன. அப்பகுதியில் மேற்கண்ட ஏரிகளாலேயே பெரும்பாலும் பாசனம் நடைபெருகிறது. ஒரு சில கால் வாய்களால் மட்டுமே மிகச் சிறிய அளவில் நேர்முகக் கால்வாய்ப் பாசனம் நடைபெறுகிறது.

முன் காலத்தில் ஆற்றுப் போக்கை மாறுபடுத்த ஆற்றில் வெள்ளப் பெருக்கு குறைந்தவுடன் கொரம்பு எனப்படும் மணற் கரைகளை அமைத்து வந்தனர். இத்தகைய மணற் கரைகளுக்குப் பதிலாக வண்டல் போக்கிகளுடன் **(scour-vents)** கூடிய அணைக்கட்டுகளையும், கலிங்கல் களையும் **(weirs)** அமைக்க ஆங்கில அரசாங்கம் முதன் முதலாக முயற்சி எடுத்தது. பாசன முறைகள் வளர வளர ஆற்று வெள்ளப் பெருக்கையும் உபயோகப் படுத்தும் வண்ணம் தேக்கங்கள் அமைக்க வேண்டிய முறை அவசியப்பட்டது. அதன்படி பெரியார் நீர்த்தேக்கம் முதன் முதலில் ஏற்படுத்தப்பட்டது. அதற்குப் பின்னர் மேட்டூர் அணைக்கட்டுத் திட்டம் பூர்த்தியாக்கப்பட்டது. பற்பு ஐந்தாண்டுத் திட்டங்களின் மூலம் அநேக நீர்த்தேக்கங்கள் ஏற்படுத்தப்பட்டுள்ளன. இப்பொழுது இம்மாநிலத்திலுள்ள ஒவ்வொரு முக்கிய நதியிலும் குறைந்து ஒரு நீர்த் தேக்கமாவது உள்ளது. இத்தகைய நீர்த்தேக்கங்கள் மீன்சார உற்பத்திக்கும் பயன்படுகின்றன.

ஐந்தாண்டுத் திட்டங்கள்.—இரண்டாம் உலகப் போர் முடிவுற்றதும் வெளி நாடுகளிலிருந்து அதிகளவில் அரிசி இறக்குமதிசெய்ய முடியவில்லை. எனவே மூன்று ஐந்தாண்டுத் திட்டங்களின் மூலம் பல பெரிய பாசனத் திட்டங் களை ஏற்படுத்தி உணவு உற்பத்தியைப் பெருக்க ஏற்பாடு செய்யப்பட்டது. அத்தகைய பாசனத் திட்டங்களின் விவரங்கள் பிற்சேர்க்கை II-ல் தரப்பெற்றுள்ளது.

முதல் ஐந்தாண்டுத் திட்டம்.—இத்திட்டத்தில் ரூ. 297 மில்லியன் செலவில் பத்து பாசனத் திட்டங்கள் எடுத்துக் கொள்ளப்பட்டன. இவற்றுல் 141,000 ஹெக்டார் (349,000 ஏக்கர்) நிலத்திற்குப் புதிதாகப் பாசன வசதி ஏற்படவும், ஏற்கனவே பாசன வசதியுள்ள 50,000 ஹெக்டார் (124,000 ஏக்கர்) நிலத்திற்கு நிரந்தர விநியோகம் செய்யவும் வகை செய்யப்பட்டது. மொழிவாரி மாநிலங்கள் பிரிக்கப்பட்டதால் 1957-ல் கன்யா குமரி மாவட்டம் தமிழகத்தோடு இணைந்தது. இதனுல் பெருஞ்சாணி அணை தமிழகத்தோடு சேர்ந்தது. இந்த அணையால் 23,763 ஹெக்டார் (58,720 ஏக்கர்) இரு போக சாகுபடி நிலத்திற்குப் பாசன வசதி நிரந்தரமாக்கப் பட்டது. இதேபோல் ஆரணியாற்றுத் திட்டம் ஆந்திர மாநிலத் தோடு இணைக்கப்பட்டது. 1,012 ஹெக்டார் (2,500 ஏக்கர்) நிலத்திற்குப் புதிதாகப் பாசனவசதியளிக்கவும், 1,214 ஹெக்டார் (3,000 ஏக்கர்) நிலத்திற்கு நிரந்தரப் பாசன வசதியளிக்கவும் இத்திட்டம் ஏற்பட்டது.

முதல் ஐந்தாண்டுத் திட்டத்தில் இத்திட்டங்களுக்காக செல வழிக்கப்பட்டதொகை ரூ. 201 மில்லியன். முதல் ஐந்தாண்டுத் திட்ட காலத்தில் முடிக்கப்பட்ட மூன்று பாசனத் திட்டங்களைத் தவிர மற்ற எழுத் திட்டங்களும் இரண்டாவது ஐந்தாண்டுத் திட்டத்தில் சேர்க்கப்பட்டன. முடிக்கப் பெற்ற மூன்று பாசனத் திட்டங்களின் மூலம் 53,000 ஹெக்டார் (131,000 ஏக்கர்) நிலத்திற்குப் புதிதாகப் பாசன வசதியும் 50,000 ஹெக்டார் (123,000 ஏக்கர்) நிலத்திற்கு நிரந்தரப் பாசன வசதியும் அளிக்கப்பட்டன.

இரண்டாவது ஐந்தாண்டுத் திட்டம்.—இதில் முதல் ஐந்தாண்டுத் திட்டத்திலிருந்து வந்த ஏழு பாசனத் திட்டங் களுடன் மேலும் ஆறு புதிய திட்டங்கள் சேர்க்கப்பட்டன. பரம்பிக் குளம்-ஆளியாறு போன்ற மிகப் பெரிய பல்நோக்குத் திட்டங்களின் **(multipurpose projects)** பயனுக சுரங்கங்களின் **(tunnels)** மூலம் மேற்கு நோக்கிப் பாயும் நீர் கிழக்காகத் திருப்பி விடப்பட்டது. ரூ. 540 மில்லியன் மதிப்பீடுள்ள இந்த ஆறு திட்டங்களினுல் சுமார் 119,000 ஹெக்டார் (295,000 ஏக்கர்) நிலம் பயனுறும். இரண்டா வது திட்டத்தில் மொத்த பாசன வசதிக்காகும் செலவு ரூ. 144 மில்லியன் என்று மதிப்பிடப்பட்டது. முதலிரண்டு ஐந்தாண்டுத் திட்டங்களினுல் அமைக்கப்பெற்ற பாசனத் திட்டங்களின் மூலம் 138,000 ஹெக்டார் (342,000 ஏக்கர்) நிலம் புதிதாகப் பாசன வசதி பெறும். மேலும் 96,000 ஹெக்டார் (238,000 ஏக்கர்) நிலங்கட்கு நிரந்தரப் பாசன வசதி கிடைக்கும்.

மூன்றாவது ஐந்தாண்டுத் திட்டம்.—மூன்றாவது ஐந்தாண் டுத் திட்டத்தில் மேலும் நானகு புதிய பாசனத் திட்டங்கள் சேர்க்கப்பட்டன. இதில் பரம்பிக்குளம்-ஆளியாறு பல் நோக்குத் திட்டத்திற்கு அதிக நிதி ஒதுக்கப்பட்டது. இப் புதிய திட்டங்களின் மதிப்பீடு ரூ. 86·21 மில்லியன் ஆகும். இவற்றுல் 18,470 ஹெக்டார் (45,605 ஏக்கர்) நிலம் புதி தாகப் பாசன வசதி பெறும். மேலும் 5,945 ஹெக்டார் (14,680 ஏக்கர்) நிலத்திற்குப் பாசன வசதி நிரந்தரமாக்கப் படும்.

மூன்றாவது ஐந்தாண்டுத் திட்ட முடிவில் 279,271 ஹெக் டார் (689,559 ஏக்கர்) நிலத்திற்குப் புதிய பாசன வசதியும் 95,882 ஹெக்டார் (237,746 ஏக்கர்) நிலத்திற்கு நிரந்தரப் பாசன வசதியும் அளிக்க முடிந்தது.

திட்ட வேலைகளால் ஏற்பட்ட அனுபவங்கள்.—முன்பு கட்டப் பட்ட அணைகள் எல்லாம் திட ஈர்ப்புக் கட்டிட அணை **(solid gravity masonry dam)** வகையைச் சார்ந்தவை. ஆனுல் ஐந்தாண்டுத் திட்டக்காலங்களில் கட்டப் பட்டவை வேறு விதமானவை. இவைகளில் வழி நீர்ப் பாதையும் **(spillway)**, மதகுகளும் **(sluices)** உள்ள பகுதி கட்டிடத்தாலும், அவற்றின் இரு பக்கங்களும் மண்ணுலும் ஆனவை. மண்ணியலில் **(soil science)** சமீப காலத்தில் ஏற்பட்டுள்ள முன்னேற்றம் இதுபோன்ற அணைகள் கட்டுவதை சாத்தியமாக்கியுள்ளது. இம்மாநிலத் தில் கட்டப்பட்டுள்ள மண் அணைகளில் **(earthern dams)** மிக உயரமானது 35 மீ. (115 அடி.) உயரமுள்ளது.

இப்படி செயல்படுத்தப்பட்ட திட்டங்களின் மூலம் பிற்காலத் திற்கு உதவுகின்ற வகையில் நல்லதொரு அனுபவம் பெறலாம். இத்திட்டங்களில் எதுவும் முன் ஆயவின்றி துவங் கப்படவில்லை. மேலும் இத்திட்டங்களைச் செயல்படுத்தும் போது அவற்றின் அமைப்பு முறையிலும் நோக்கங்களிலும் எவ்வித பெரு மாற்றமும் நிகழவில்லை. நீர்த் தேக்கத் திலும் அதன் கால்வாய்களிலும் ஒரே சமயத்தில் வேலை துவக்குவது மிக எளிதாக உள்ளது. நீர்த் தேக்கம் அமைக் கும் வேலை முடிவுறும் முன்பே ஆற்றின் மேற்பகுதி பாசனத்திற்குப் பயன்படும்படி கால்வாய்கள் வெட்டப்பட்டன. இங்ஙனம் நீரை முதற்பகுதி சேமித்து வைக்கும்பொழுதே அதை உடனடியாக உபயோகப்படுத்தவும் முடிந்தது.

சிறிய அளவு குத்தகைகளின் **(small-scale contracts)** மூலம் வேலைகளை எளிதாகவும், விரைவாகவும் செய்வதோடு குத்தகையாளரின் லாபத்தை மிச்சப்படுத்த முடிகிறது. இயந்திரக் கருவிகளும் பெருமளவில் பயன்படுத்தப்படுகின் றன. ஆயின் அவை மனித உழைப்பையே முழுவதும் நிராகரிக்கும் அளவிற்கு உபயோகப்படவில்லை. நியாயமான முறையில் சிக்கனத்தை அடிப்படையாகக்கொண்டு மனித உழைப்பையும் இயந்திர உழைப்பையும் ஒன்று சேர்க்க முடி யும். சில திட்டங்கள் நிறைவேற்ற ஒப்புதல் கிடைத்தவுடன் அவற்றைச் சார்ந்த இடங்களில் புஞ்சைப் பயிர்களை விளைவிக்க ஏற்பாடு செய்யப்பட்டிருந்தது. ஆனுல் பிறகு அவற்றில் நன்செய் பயிர்களே பெருவாரியாக பயிரிடப்படுகின்றன. இது போன்ற சிறு மாறுதல்களை போகப் போக சரிக்கட்டி விட லாம். பரம்பிக்குளம்-ஆளியாறு திட்டம் புஞ்சைப் பாசனத் திற்காக ஏற்படுத்தப்பட்டமையால் அப்பகுதியிலுள்ள உழவர் கட்கு புஞ்சை சாகுபடியின் நன்மைகளை விளக்கி வருகிறார் கள்.

நீர் கிடைக்கும்பொழுது அதனை உடனே வயலுக்குப் பாய்ச் சுவதற்காக சிறு வாய்க்கால்களை **(field boothies)** நன்முறை யில் துரிதமாக வெட்டப்படவேண்டியது மிகவும் அவ சியம். இப்பணிக்கு உதவும் வகையில் சர்க்கார் துறையினர் விதிகள் **(departmental rules)** தளர்த்தப்பட்டுள்ளன. இதன்படி 50 ஏக்கர் பகுதி வரை சர்க்கார் துறையினரே கால்வாய்களை வெட்டி வருகின்றனர். இப் பகுதிகளுக் குள்ளும் கால்வாய்களை வெட்ட அரசாங்கத்தினர் புதிய சட்டங்களியற்றி வழி செய்துள்ளனர். இவ்வேற்பாட் டின்படி இப்பணிக்கு ஆகும் செலவை ஈடு கட்ட, கால்வாய் களை உபயோகிப்போரிடமிருந்து பின்னர், தகுந்த தொகை வசூலிக்கப்படும்.

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வரிகளும், தரு கால்வாய்களும் (supply channels) கிராமப் புறங்களில் வசிப்பவர்களுக்கு உதவியாக இருந்த போதிலும் அவற்றின் மிக அதிக எண்ணிக்கை ஒரு பார மாகவே இருக்கிறது. கிராம மக்கள் அவற்றை நன்கு பராமரிக்காததால் அவைகளில் வண்டல் மிக எளிதாகப் படிந்து விடுகிறது. அதிக வீணேச்சல் எதிர்பார்க்கும் தருணத்தில் உழவர்களின் பழைய முறையில் ஏற்பட்ட இடர்ப் பாடுகளையும், தோல்விகளையும் மறந்து, அரசினர் தங்கள் செலவிலேயே வரிகளிலும், கால்வாய்களிலும் உள்ள வண்டலை நீக்கி அவற்றைப் புதுப்பித்தார்கள். ஆனால் எதிர் காலத்திலும் இப்படி இல்லாமல் உழவர்களே குடிமராமத்து பணியில் பஞ்சாயத்து மூலம் அவற்றை நன்முறையில் பாதுகாக்கும் வகையில் அரசினர் விதிமுறைகளை ஏற்படுத்தி இருக்கிறார்கள்.

இத்துடன் நீரேற்று முறை (pumping), விசைப் பாசனத் திட்டம் (lift irrigation) ஆகிய முறைகளிலும் கிடைக்கும் நீரை முழு அளவில் பயன்படுத்தும் பணியில் அரசினர் மிக ஆவலுடன் ஈடுபட்டுள்ளனர். கிணறுகள் வெட்ட அளிக்கப்பெறும் உதவித் தொகை அதிக அளவு கிணறுகள் வெட்ட உபயோகப்படுகிறது. ஆற்றிலிருந்தும், கால்வாய்களிலிருந்தும் பம்புகள் மூலம் நீர் இறைக்க ஓர் திட்டம் ஆரம்பிக்கப்பட்டுள்ளது.

பூமிக்கடியில் உள்ள நீரின் அளவையும், அது எங்கே எத்தனை அடி ஆழத்தில் உள்ளது என்பதையும், ஆராய நில நீர்க் குழு (Ground Water Cell) ஒன்று அமைக்கப் பட்டுள்ளது. பூமிக்கடியிலுள்ள நீரைத் தனியாகவோ, மேல் நீருடன் (surface water) கலந்தோ எவ்வளவில் பயன்படுத்த முடியும் என்பதையும் இக்குழு ஆராயும்.

பிற்சேர்க்கை—I.

மாநிலத்திலுள்ள பெரும் பாசன அமைப்புகள்.

வரிசை எண். (1)	பாசனத் திட்டத்தின் பெயர். (2)	பயனளிக்கும் ஆறு. (3)	பயன்பெறும் மாவட்டங்கள். (4)	திட்டம் தூண்டு. (5)	செலவு (மில்லியன் தொகை ரூபாயில்). (6)	பாசனப்படுத்தப்பட்ட நிலம் 1964-65 ஹெக்./ஏக். முதல் போகம். (7)	இரண்டாம் போகம். (8)	குறிப்பு. (9)
1	காவிரி டெல்டா திட்டம்.	காவிரி.	தஞ்சாவூர்.	1889	10·33	358,458	86,597	
						896,542	191,558	
2	கட்டளைக் கால்வாய் திட்டம்.	காவிரி.	திருச்சி.	1926	4·88	24,278	16,514	
						63,262	39,299	
3	காவிரி மேட்டூர் திட்டம்.	காவிரி.	தஞ்சாவூர்.	1934	66·36	92,645	21,851	
						235,664	52,076	
4	நந்தியாறு வாய்க்கால் திட்டம்.	நந்தியாறு.	திருச்சி.	1899	0·07	3,210	1,037	
						9,676	1,536	
5	கீழ்கொள்ளிட அணைக்கட்டு திட்டம்.	கொள்ளிடம்.	தென்னற்காடு, தஞ்சாவூர்.	1903	3·43	44,260	12,492	
						112,195	24,062	
6	கொடிவேரி அணைக்கட்டு திட்டம்— (அ) அரக்கன் கோட்டை வாய்க்கால் திட்டம்.	பவானி.	கோயம்புத்தூர்.	1894	0·71	1,949	1,779	
						4,834	4,193	

பிற்சேர்க்கை I—தொடர்ச்சி.

மாநிலத்திலுள்ள பெரும் பாசன அமைப்புகள்—தொடர்ச்சி.

வரிசை எண். (1)	பாசனத் திட்டத்தின் பெயர். (2)	பயனளிக்கும் ஆறு. (3)	பயன் பெறும் மாவட்டங்கள். (4)	திட்டம் தூண்டு. (5)	செலவு (மில்லியன் தொகை ரூபாயில்). (6)	பாசனப்படுத்தப்பட்ட நிலம் 1964-65 ஹெக்./ஏக்கரில். முதல் போகம். (7)	இரண்டாம் போகம். (8)	குறிப்பு. (9)
						6,329	5,002	
	(ஆ) தடப்பள்ளி வாய்க்கால்.	பவானி.	கோயம்புத்தூர்.	1893	0·20	15,940	13,232	
						5,258	4,417	
7	கரிங்கராயன் வாய்க்கால்.	பவானி.	கோயம்புத்தூர்.	1893	0·18	12,837	8,479	
						41,737	18,972	
8	பெரியாற்றுத் திட்டம்.	பெரியாறு, வைகை.	மதுரை.	1897	10·84	1,11,701	48,646	
						7,046	5,834	
9	மருதூர் அணைக் கட்டுத் திட்டம்.	தாமிரபரணி.	திருநெல்வேலி.	1894	0·06	17,521	13,997	
						9,795	7,229	
10	ஸ்ரீவைகுண்டம் அணைக்கட்டுத் திட்டம்.	தாமிரபரணி.	திருநெல்வேலி.	1889	1·77	23,464	19,102	
						23,764	23,764	
11	கோதையாற்றுத் திட்டம்.	கோதையாறு.	கன்னியாகுமரி.	1906	16·11	58,720	58,720	
						5,044	5,758	
12	பேலாந்துறை அணைக்கட்டுத் திட்டம்.	வெள்ளாறு.	தென்னற்காடு.	1893	0·69	14,994	1,835	
						14,048	5,483	
13	சேத்தியாத் தோப்பு அணைக்கட்டுத் திட்டம்.	வெள்ளாறு.	தென்னற்காடு.	1895	1·19	34,953	15,589	
						7,379	3,140	
14	தொழுதூர் அணைக் கட்டுத் திட்டம்.	வெள்ளாறு.	தென்னற்காடு.	1925	2·62	21,187	3,881	
						1,919	327	
15	மேகமத்தூர் அணைக்கட்டுத் திட்டம்.	மணிமுத்தாறு.	தென்னற்காடு.	1891	0·09	5,226	1,049	
						3,557	238	
16	விருத்தாசலம் அணைக்கட்டுத் திட்டம்.	மணிமுத்தாறு.	தென்னற்காடு.	1893	0·24	10,577	715	
						2,145	1,423	
17	பரூர் எரித் திட்டம்:	பொன்னையாறு.	சேலம்.	1891	0·46	5,167	3,285	

பிற்சேர்க்கை I—தொடர்ச்சி.

மாநிலத்திலுள்ள பெரும் பாசன அமைப்புகள்—தொடர்ச்சி.

வரிசை எண்.	திட்டத்தின் பாசனத் பெயர்.	பயனளிக்கும் ஆறு.	பயன் பெறும் மாவட்டங்கள்.	திட்டம் முடிவுற்ற ஆண்டு.	செலவழிக்கப்பட்ட தொகை (மில்லியன் ரூபாயில்).	பாசனப்படுத்தப்பட்ட நிலம் 1964-65 ஹெக்டர்/ எக்கரில்.		குறிப்பு.
						முதல்போக	இரண்டாம் போகம்.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
18	திருக்கோவிலூர் அணைக்கட்டுத் திட்டம்.	பொன்னையாறு.	தென்னற்காடு.	1895	0·45	12,561 31,974	2,821 6,840	
19	பாலாறு அணைக் கட்டுத் திட்டம்.	பாலாறு.	செங்கற்பட்டு, வட ஆற்காடு.	1896	2·58	29,946 75,336	16,449 47,895	
20	செய்யாறு அணைக் கட்டுத் திட்டம்.	செய்யாறு.	செங்கற்பட்டு, வட ஆற்காடு.	1896	1·10	8,910 22,710	6,378 15,176	
21	பொன்னை அணைக் கட்டுத் திட்டம்.	பாய்னி.	வட ஆற்காடு, சித்தூர் (ஆந்திரம்).	1897	0·28	7,783 79,013	3,140 7,568	
22	செம்பரம்பாக்கம் ஏரித் திட்டம்.	கூவம்.	செங்கற்பட்டு.	1893	0·76	5,289 13,184	2,765 6,755	
23	சென்னை குடிநீர் பாசனத் திட்டம்.	குசஸ்தலை ஆறு.	செங்கற்பட்டு.	1893	1·87	2,345 5,571	118 194	
24	வல்லூர் அணைக் கட்டுத் திட்டம்.	குசஸ்தலை ஆறு.	செங்கற்பட்டு.	1893	0·08	1,113 2,641	..	

பிற்சேர்க்கை II.

ஐந்தாண்டுத் திட்டங்களில் சேர்க்கப்பட்ட பாசனத்திட்டங்கள்.

வரிசை எண்.	திட்டத்தின் பாசனத் பெயர்.	பயனளிக்கும் ஆறு.	பயன் பெறும் மாவட்டங்கள்.	திட்டம் முடிவுற்ற ஆண்டு.	செலவழிக்கப்பட்ட தொகை (1962-63 வரை) (மில்லியன் ரூபாயில்).	பாசனப் படுத்தப்பட்ட நிலம் ஹெக்டாரில்/ எக்கரில் 1962-63.		குறிப்பு.
						புதிய பாசனம்.	பழைய பாசனத்திற்கு உறுதி அளித்தது.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	முதல் ஐந்தாண்டுத் திட்டத்தில் சேர்த்துக்கொள்ளப்பட்ட பாசனத்திட்டங்கள்.							
1	கீழ் பவானித் திட்டம்.	பவானி.	கோயம்புத்தூர், திருச்சி.	1956	102·00	83,770 207,000		
2	பெருஞ்சாணி அணை (கோதையாற்று விரிவுத் திட்டம்).	கோதையாறு.	கனனியாகுமரி.	..	4·37	..	23,763 58,730	
3	காவிரி டெல்டா வடிகால் திட்டம்.	காவிரி டெல்டா.	தஞ்சாவூர்.	..	3·00	16,187 40,000	..	எக்கர் நிலம் தஞ்சையில் வெள்ள தால் மூழ்வ வதில் இ நிந்து காக படும்.
4	ஆரணியாற்றுத் திட்டம்.	ஆரணியாறு.	செங்கற்பட்டு, சித்தூர்.	1957	10·59	1,012 2,500	3,609 9,066	தலைப்பு வேலைகள் ஆந்திர மாநிலத்திற்கு மாற்றப்பட்டன.
5	மேட்டூர் கால் வாய்த் திட்டம்.	காவிரி.	கோயம்புத்தூர், சேலம்.	1957	19·29	18,211 45,000	..	
6	மணி முத்தாறு நீர்த் தேக்கத் திட்டம்.	மணிமுத்தாறு.	திருநெல்வேலி.	1958	50·50	8,094 20,000	33,589 83,000	
7	அமராவதி நீர்த் தேக்கத் திட்டம்.	அமராவதி.	கோயம்புத்தூர்.	1958	32·98	8,701 21,500	12,950 32,000	
8	வைகை நீர்த் தேக்கத் திட்டம்.	வைகை.	மதுரை, ராமநாதபுரம்.	1959	33·00	9,234 22,818	..	
9	திருஞ்ணகிரி நீர்த் தேக்கத் திட்டம்.	பொன்னையாறு.	சேலம்.	1958	20·24	3,642 9,000	..	
10	சாத்தனூர் நீர் தேக்கத் திட்டம்.	பெண்ணையாறு.	தென்னற்காடு, வட ஆற்காடு.	1958	25·80	8,498 21,000	..	

பிற்சேர்க்கை II—தொடர்ச்சி.

ஐந்தாண்டுத் திட்டங்களில் சேர்க்கப்பட்ட பாசனத்திட்டங்கள்—தொடர்ச்சி.

வரிசை எண்.	திட்டத்தின் பாசனத் பெயர்.	பயனளிக்கும் ஆறு.	பயன் பெறும் மாவட்டங்கள்.	முடிவுற்ற திட்டம் ஆண்டு.	செலவு (1962-63 வரை) வழிக்கப்பட்டதொகை (மில்லியன் ரூபாயில்).	பாசனப் படுத்தப்பட்ட நிலம் ஹெக்டாரில்/ ஏக்கரில் 1962-63. பாச	பாச	குறிப்பு.
						புதிய னம்.	மேம்பாடு அளித்தது.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	இரண்டாவது ஐந்தாண்டுத் திட்டத்தில் சேர்த்துக்கொள்ளப்பட்ட பாசனத்திட்டங்கள்.							
11	புதுக்கட்டளை உயர் மட்டக் கால்வாய்.	காவிரி.	திருச்சி, தஞ்சாவூர்.	1960	22·45	8,345 20,622	..	
12	புள்ளம்பாடிக் கால் வாய்த் திட்டம்.	காவிரி.	திருச்சி.	1960	20·61	8,949 22,114	..	
13	வீராணம் திட்டம்	வராகநதி.	தென்னற்காடு, பாண்டிச்சேரி.	1959	8·89	1,295 3,200	..	
14	நெய்யாற்றுத் திட்டம்.	நெய்யாறு.	கன்னியாகுமரி.	1963	9·03	3,723 9,200	..	
15	பரம்பிக் குளம் ஆளியாறு திட்டம்.	பரம்பிக் குளம் ஆளியாறு.	கோயம்புத்தூர்.	..	480·00	97,214 240,000	..	
16	கன்னியாகுமரி மாவட்டத்திலுள்ள நடுத்தர பாசனத் திட்டங்கள்.	கோதையாற்றுத் திட்டம்.	கன்னியாகுமரி.	1961	2·20	..	..	அதிக அளவு நிலத்திற்கு பயனளிக்கவும் புதுப்பிக்கவும் கால் வாய்களை மாற்றியமைக்கவும் இத் திட்டங்கள் உதவி புரிகின்றன.
	மூன்றாவது ஐந்தாண்டுத் திட்டத்தில் சேர்த்துக்கொள்ளப்பட்ட பாசனத்திட்டங்கள்.							
17	பாலாறு அணைக் கட்டு, கால்வாய்கள், முன்னேற்றத் திட்டம்.	பாலாறு.	வட ஆற்காடு, செங்கற்பட்டு.	1965	4·81	1,329 3,285	..	
18	சாத்தனூர் IIம் நிலை.	பொன்னையாறு.	தென்னற்காடு	1964	6·00	2,023 5,000	..	
19	கோமுகி திட்டம்.	கோமுகி.	தென்னற்காடு.	1966	8·70	2,023 5,000	..	
20	மஞ்சலாற்றுத் திட்டம்.	மஞ்சலாறு.	மதுரை.	1966	6·58	531 1,313	1,255 3,136	இது பிறகு திட்டத்திலிருந்து விலக்கப்பட்டது.
21	சித்தாறு பட்டணங் கால் திட்டம்.	கோதையாறு.	கன்னியா குமரி, திருநெல்வேலி.	1968	66·70	13,079 32,320	5,941 14,680	

OUR OWN FORUM

It is proposed to open a special feature " Our Own Forum " from the next issue of the journal in order to provide a forum to our departmental engineers to express their opinions on the various technical problems and other administrative and accounting problems allied to technical subjects which they may come across in the course of their duties or elsewhere.

The contributions to the forum are to be in the form of short and crisp letters addressed to the Editor, "The New Irrigation Era", Madras and sent to the Executive Engineer, Public Works Department, Gauging Division, Madras-5.

In this forum the readers of The New Irrigation Era also express (1) their opinion on the usefulness of the articles published in the journal, (2) their observations and comments in support of or contrary to the information or opinions expressed in the various articles, (3) their suggestions to improve the usefulness of the journal, or (4) any other topic which may be of general interest to the Engineers of the Public Works Department.

The readers are requested to co-operate to make this feature interesting and useful.

EDITOR,
The New Irrigation Era.

OCCASION OF INAUGURATION OF SUNDARAPANDIAN TANK SCHEME.

PRAYER—INAUGURATION OF TENKARAI TANK ON 23RD FEBRUARY 1966.

INVITATION TO READERS

Kind attention of the Engineers of the Madras Public Works Department and readers of the journal elsewhere is drawn to the meagre response to repeated requests for contribution of articles to the journal.

May we once again emphasise the two-fold objective of the journal, viz., to promote the interest of engineers and aiding their specialised work by placing before them the many problems of technical importance and ways and means of solving them, and secondly, opportunities being scarce for engineers to express their own experience in solving practical problems of design and execution, we wish to add that this journal has been the only medium of expression for those in the field. It is earnestly desired that the Engineering fraternity will come forward in large numbers to utilise this medium to its best advantage by offering their valuable contribution

The scope of the articles to the journal need not be rigorously confined to the subjects on irrigation alone. Articles which have a direct bearing on subjects given below are also welcome:—

(1) Technical aspects of foundation soils and foundation Engineering.

(2) Auxiliary works in the field of irrigation and other water-retaining structures and works.

(3) Practical solution to hydraulic problems in canals and distribution systems with reference to their maintenance.

(4) Problems of soil erosion and conservation and reclamation of land.

(5) Practical silt problems in rivers and reservoirs.

(6) Problems of sanitation and public health and possibilities of utilisation of sewage.

(7) Inland waterways and navigation, fishing schemes and protection of land against sea erosion, etc.

(8) Problems of drainage in deltaic tracts and entrance of rivers into the sea

(9) Run-off studies in catchments and evaporation studies in reservoirs.

(10) All allied subjects.

The Executive Engineers of the Madras Public Works Department are specially requested to encourage their Subordinate Officers to come forward with articles and enable the journal to flourish and serve the common cause of the Engineers of the State.

PRINTED BY THE DIRECTOR OF STATIONERY AND PRINTING, MADRAS
ON BEHALF OF THE GOVERNMENT OF MADRAS —1967

(1)	(2)	(1)	(2)