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GOVERNMENT OF MADHYA PRADESH

IRRIGATION DEPARTMENT

TECHNICAL CIRCULARS

Vol I-B

OFFICE OF THE ENGINEER-IN-CHIEF
IRRIGATION DEPARTMENT
MADHYA PRADESH
BHOPAL

1973

TECHNICAL CIRCULARS VOLUME I-B

C O N T E N T S

1	2	3	4
21	49-L/W (I)	3-7-58	Madian tank in Durg district (Maha-koshal region)-Appr ved Head sluice drawing 56
22	370/W (I) 58	2-8-58	Seetion of an earth dam-toe wall below the pitching 57
23	24-G/F/58	9-9-58	Setting up of new sediment sites and laboratories 58
24	18-D-1/58	6-12-58	Boulder toe of earthen dams 67
25	328/W (I)	7-1-59	Construction of and repairs to small village tanks (specifications) 68
26	94/W (i) 59	19-2-59	Top width of bund 71
27	9-D / T - 59	17-3-59	Karrie grooves in front of sluice gates of tank (depth of water upto 40') 72
28	21-J/I/W (I) 59	16-7-59	Control of weeds in irrigation channels 73
29	265/W-I	24-8-59	Note on alternative design of waste-weir for minor irrigation tanks 78
30	—	9-9-59	Preparation of irrigation projects 81
31	—	—	Note on puddle trench 89
32	—	—	Note on a type of adjustable pipe outlet 90

OFFICE OF THE CHIEF ENGINEER P, W. D.
Irrigation Branch Madhya Prabesh

No. 304-V/W(1)-56 Nagpur Dated the.10th Dec. 56

All Superintending Engineers(Irrigation)Mahakoshal Region
All Superintendent of Works.
Officer on Special Duty, Bhilai Project Circle, Dnrg

Sub: Top width of Bund.

Ref; This offce No. 304-L/W(I) 56 dt 12.9 56.

In supersession of this office reference quoted above the following minimum top width of bund should be provided.

	Maximum height. of dam in feet.	Minimum top width. of dam in feet.	Remarks
a.	0–16	6	
b.	16–30	12	
c.	30–100	16	
d.	over 100	20	

Note:- Top widths mentioned in col. 2 are to be adopted uniformly through out the length of the dam.

Sd/– V. P. Sethi
Superintending. Engineer (Designs)
for Chief Engineer,
P,W.D.Irrigation. Br.

No. 304-W/W (I) 56 Nagpur Dated the 10th Decr, 1956

Copy forwarded to:—

1. Additional Chief Engineer, P.W. D., (B&R) Gwalior, M. P.
2. Principal Engineering Officer, P.W.D Rewa, M. P.
3. Superintending Engineer, P.W.D. Bhopal Circle. Bhopal M. P.
   for information and guidance.

Sd/–V,P. Sethi
Superintending Engineer (Designs)
for Chief Engineer,
P.W. D.Irrigation Branch.

SUPERSEDED ON 19. 2. 59'

OFFICE OF THE CHIEF ENGINEER P.W.D.,
Irrigation Branch, Madhya Pradesh

No.6-T/DI-55

Raipur Dated 29th January 1957

All Superintending Engineers.
All Superintendent of Works.
Officer on Special Duty, Bhilai Project Circle, Durg.

Sub:- Drainage of D/S slope of earth dams.

Kindly refer to the typical sections of the main earth dam and Dykes of Hirakund sent under this office No. 6-Q/DI-55 dated 9-7-1956.

Your attention is specially drawn to the elevation of the D/S slope and related sections indicated on drawing No. 100-H-64. Drainage system indicated there should be followed in case of high dams say above 70' height. This practice may be followed for dams on lower height when special circumstances demand.

In any case this system is to be followed in case of Dudhawa and Saroda anms. Respective Superintendent of Works may kindly note.

Sd/—
Superintending Engineer (D)
for Chief Engineer, P. W. D.
Irrigation M. P. Raipur

OFFICE OF THE CHIEF ENGINEER,
P. W. D. Madhya Pradesh,

No. 304–M-I/W(I) 56 Dated 20.2 1957.

All Superintending Engineers
Superintendents of Works etc.

Sub:- Submission of designs and drawings

It is observed that designs and drawings are being sent to this office for approval in an incomplete state. In this connection following instructions are issued for compliance in future.

(i) Full data and relevant leading details should be given clearly on the drawing itself.
(ii) Calculations may also be given systematically on the drawing itself, if possible or on separate sheets if they are lengthy.

(iii) A design should be complete in all respects of data, calculations, drawings, references to previous approval if any, to the part features of the designs should clearly be indicated to quote few examples.

(iv) Some times only calculations for waste weir are sent for approval. In fact waste weir and spill channel system should be sent as a whole wtih details plan, 'L' section Cross sections T. P. Sections of approach channel and spill channels, and necessary calculations for length of waste weir, other falls and channel dimensions.

(a) Individual design of waste weir or a fall on a spill channel must be accompained by 'L' Section, and cross section of approach channel, spill channel, especially when they have not already been sent previously to this office or returned in original.

(b) Insufficient of T. P. sections lack of information, H.F.L. etc. are some of the common defects observed.

Kindly ensure the proper submission of design cases in all respects in future.

Sd/- V. P. Sethi
Superintending Engineer (D)
for Chief Engineer
P.W.D, Irrigation Branch

Endt No. 1357/W Dt. 16.3.57

To all Executive Engineers

OFFICE OF THE CHIEF ENGINFER P.W.D.;
Irrigation Branch, Madhya-Pradesh.

No. 304-B-2/W(1)56

Raipur, dated the 13th April 1957

The Officer on Special Duty
Bhilai Project Circle, Durg.
All Superintending Engineers.
All Superintendents of Works.

Sub:— Fixing of sluice gates

Ref:— This office No. 304-P-/W(I) 56 dated. the 28th July 56.

It is found that the installation of sluice gate and its fittings do not receive the due care it deserves.

2. In this connection necessary instructions have been issued vide reference quoted adove. These should be strictly followed.

3. In future, Sub-Divisional Officers in charge of civil works, S. D. O. Elect. and Mech. and Executive Engineer (E&M) should examine the gate and its accessories and see that there is no defect or damage in the gate and parts received. They should ensure the correct installation of the gate and its fittings and sign a certificate on the completion plan to the effect that:—

" I have personally checked up the installtion of the gate and its fitting and I have satisfied myself that these are in perfect order and lifting gear is working satisfactorily.

These certificate together with the report after the rains of the first year of operation should be sent to this office for scrutiny.

4. Necessary instructions should be given to all S. D. Os, and subordinates concerned that while closing the gate no attempt should be made to over press the same on the sill otherwise the gate or the lifting road are likely to be bent.

5. Provision of iron-grill (or trash racks) in front of the gate should not be omitted. This is very important for the first few years of the tank's operation as the trouble of drifting brushwood and logs is more during that period.

Provision of gauge should also not be over looked.

Sd/-
Superintendtng Engineer,
for Chief Engineer Irri. Branch
Madnya Pradesh.

CRITERIA FOR PUTTING IN SLUICE GATES FOR SMALL VILLAGE TANKS

1. Sluice gates may be provided by the Collector for tanks less then 100 acres and maintained by the Village Panchayats.

2. The sluice gates with locking arrangements will be provided in Nistar-cum Irrign, tanks at a level that will have adequate reserve storage for Nistar and evaporation in non-monsoon month. Capacity in million cft:-water spread area in acres X max. depth in ft. XI/35.

3, The area for irrigation may be roughly taken as 30 acres per million cft.

4. The area that can be irrigated may be approximately taken as equal to the catchment area, if it is purely an Irrigation Tank, The catchment area is the total drainage area from which rain water comes and collects in the tanks.

5. The sluice may be located in cutting at the commencement and commands the area to be irrigated,

6. There are number of designs for a simple. sluice, These designs of sluice gates for varying depths of water in the tank are enclosed. Generally putting in sluice gates involves Head wall to receive the frame and a tunnel or pipe line to carry the water from the face of the bund. Head wall isrequired on the down-stream side also.

7. The minimum size of the gate may be kept 1"-0"X1"-0" with rod and capstan arrangement, with guide frame etc. The gate and the frame shall have gun metal strips affixed to rubbing surface as to ensure water-tightness. The rod will have guide blocks fixed to Head-work at intervals not more than 6 ft. so that the rod is not bent or twisted during operation.

8. The gate should be fixed vertically so that the rod is plumb and central

9. It could be desirable to keep the sill slightly higher than the approach channel level so that the silt does not settle on the sill.

10. The gates should be maintained well painted and greased or oiled.

11. The pipe line may be of 1'-0" dia. Hume pipe laid 1'-0" of morrum and the collars well-set in cement mortar.

12. The top of the pipe is to be covered properly by puddle for 1'-0" depth for a length from the face wall so that no leakage can take place.

13. Masonry cut-off around the pipe may be provided at each junction as shown in the sketch. This is with a view to prevent seepage. The cut-off will be founded on concrete.

14. Where hume pipe is not available, a masonry barrel with 1'x1' with side walls 1'-6" thick and R. C. C. slab 4 1/2" thick with full bearing over side walls and foundations with concrete 1:5:8 resting on hard murum.

15. [a] The base width of the headwall and wing walls for various heights will be as follows :—

Height	Base width
Upto 3'-0"	1'-0"
Upto 6'-0"	3'-0"
Upto 12'-0"	6'-0"
Upto 15'-0"	7'-6"
Upto 20'-0"	10'-0"

15 [b] No wing walls are necessary on the downstream side and only pitching is enough. On the upstream side, wing walls with 45° splay may be adopted or slope pitched well after ensuring that the head wall is keyed well into the old bund.

15. [c] The top of the head wall must be at least 1 ft. above the maximum water level.

16. The present practice in many small tanks has been to cut the bund and use the water for irrigation. These cuts serve as flood escape, with the putting in of a sluice gate it is absclutely essential to provide for suitable flood escape or bywash, which will not end anger the safety of the bund.

it might be desireable to provide a stone-pitched flush escape at full tank level.

17. Near the head constructed sluice all passible precautions to be taken to ensure proper bond between the old and the new earth work. Sliptongues and goggles inclined up to the face of the slope to allow the new enbankment to settle tightly on the old one are to be provided.

18. (a) For very low heads of water with depth of water up to 5' only single wooden plug type sluice costing approximately Rs. 400/- may be adopted.

(b) For head of water 8' to 10' multiple wooden plug type sluice costing approximately 2340 may be used.

(c) Alternatively 12" Hume pipe sluice or masonry barrel type sluice and gate with Capstan arrangement costing approximately Rs. 2160 is recommended.

19. Any modifications and improvements or economy may be made only after inspection by a responsible officer of the Irrigation Department.

OFFICE OF THE CHIEF ENGINEER,P.W.D.
Irrigation Branch, M.P. Raipur.

No. 304-I-2/WI of 56 Dated the 24th April 1957.

All Superintending Engineers.
All Superintendent of Works.
Officer on Special Duty, Bhilai Project Circle, Durg.

Sub:- Design load for Road Bridges on Canals.

1. In future following loading should be adopted for road bridges on all types of canals.

i)	Road Bridges on National Highway.	I. R. C. Class "A" Double Lane of Traffic
ii)	Road Bridges on Provincial High way	I. R. C. Class "A" Double Lane of Traffic
iii)	Village road bridge	I. R. C. Class 'A" Single Lane of Traffic

2. (a) However, it is not proposed to remodel the existing bridges to suit the loading as proposed in para 1 above. But the instructions should be followed for all future constructions.

(b) Where a bridge is to be remodelled for reasons other than the inadequecy of the design loads now proposed, the loadings prescribed in para I above should be adopted.

Sd/- (V.P. Sethi)
for Chief Engineer, P. W. D.
Irrigation M. P. Raipur

Copy of memo No. 304/4-2/W(I) 56 Raipur, dated the 24th May 1957 from the Chief Engineer, P.W.D. Irrigation Branch, Madhya Pradesh, to All Superintending Engineers

Subject:— Type Design of Fall

Ref:— This Office No.304-A/W(I) 56 Dated 28-7-56

Kindly refer to the calculations given on the drawing of the above type design.

Following corrections may kindly be carried out in the same.

Length of Cistern.

(i) Instead of " $L_g = 5 (H_L + D)^{1/2}$ "

read " $L_g = 5 (H_L \times D)^{1/2}$ "

Depth of Cistern,

(ii) Instead of " $1/6 (H_L + D)^{2/3}$ "

read " $1/6(H_L \times D)^{2/3}$ "

Sd/-
Superintending Engineer (D),
for Chief Engineer, P.W.D.
Irrigation Branch, Madhya Pradesh, Raipur.

Note:- The original circular No. 304-A/W(I) 56 Nagpur dated the 28th July 1956 has been corrected as per this circular"

Instructions for operation of Face and Roller gates of Sluice for more than 40 ft. head.

Roller Gate to be used for regulation only;

Face Gate to be used for closing the culvert completely and should be stored above ater level.

Do not lift or lower face gate unless roller gate is elosed completely.

Do not lift face gate unless space between gates has been completely filled by valve being opened by one man winding until gear feels stiff. Then wait until gate can be lifted easily by two men.

Do not allow more than two men to work handles at one time.
(Copied from instructions engraved on gates supplied by Ransom and Napier Ltd.)

Sd/- (V. P. Sethi)
Superintending Engineer (D)
for Chief Engineer, P. W. D.
Irrigation Branch, M. P.

Office of the Chief Engineer, P. W. D.
Irrigation Branch, Madhya Pradesh

Endt. No. 598/W (II) 57 Raipur dated the 8th July 1957

Copy to all Superintending Engineer / Superintendents of Works/ Executive Engineers for information and guidance.

Superintending Engineer (D)
for Chief Engiueer, P. W. D.
Irrigation Branch, M. P.

Yadava Mohan, ISE.,
Chief, Natural Resources

GOVERNMENT OF INDIA
PLANNING COMMISSION
New Delhi, the 16th July 1957

D. O. No. NR-4 (5)/57

My dear Sood

Sub : Irrigation and Power schemes in the second Plan-Submission of technical details and project report.

While formulating the Second Five Year Plan, the Planning Commission had circulated to the State Governments and individually to all the Chief Engineers the procedure to be adopted in regard to the submission of the Project Reports for Irrigation and Power Schemes to the Planning Commission, the Central Water and Power Commission and the Advisory Committee on Irrigation and Power. These Circulars detailed the essential data which the project report should contain.

Some of the reports received recently indicate that the suggestions and requests made in earlier circulars of the Planning Commission are sometimes not being given effect to. For the convenience of your organisation and for your ready reference, I enclose copies of two important letters dated 13-5-54 and 31-5-54 on this subject. I shall be grateful if you will kindly recirculate them amongst the officers under your control who are connected with the planning and preparation of projects, and ensure that the broad suggestions of the Planning Commission in this regard are kept in mind.

Your's sincerely.
Sd/- Yadava Mohan

Shri M. L. Sood
Chief Engineer for Irrigation,
Government of Madhya Pradesh,
Raipur.

Office of the Chief Engineer, P. W. D.
Irrigation Branch, Madhya Pradesh

Endt. No 693/B/W (I) 56 Raipur dated the 4th September 1957

Copy with a copy of the enclosures is forwarded to All Superintending Engineers for information and guidance.

Please see that the suggestions detailed in enclosed circulars of Planning Commission are kept in view while preparing project reports of schemes included in the 2nd Five Year Plan of your region.

4 spare copies are also enclosed for distribution amongst the Executive Engineers.

Encl.: As above

Deputy Chief Engineer, (South)
For Chief Engineer, P. W. D.
Irrigation Branch, M. P.
Raipur

GOVERNMENT OF INDIA
PLANNING COMMISSION

No. PC (V)/1 (3) (A) /5A

New Delhi, 31st May, 1954

From,

Shri Yadava Mohan, ISE,
To Chief Engineer,
Irrigation/Electricity,
All State Government.

Sub : Irrigation and Power Projects for the Second Five Year Plan

The Central Water and Power Commission are presently engaged in writing up an Irrigation and Power Manual, a section of which will be devoted to the preparation of Project Reports and Estimates. As the publication of this manual is likely to take sometime, a list has been compiled to include all items which should be dealt with in Project Reports. It is requested that reports on schemes that are sent to the Planning Commission for inclusion in the next Plan are completed with reference to the items shown in the enclosed list.

2. It will be seen that this list is distinct from the form sent with my letter No. PC (V)1(3) (A) 54 dt. 13-5-54, both in contents and in aims. Whereas the latter has been designed to spotlight the various aspects of the Project technical, financial, regional etc., and is to form an adjunct to the project report, the reference list now enclosed has been prepared with a view to assist the Engineering Departments in ensuring that the Project reports are complete in all respects. As such this reference list is to be incorporated in the project report itself and would form an integral part thereof.

3. It may be found that a number of items are not applicable, in some cases, particularly for comparatively smaller projects. Although information would have to be omitted for items as may be inapplicable, it is requested that maximum number of items may be covered in each case. For large river valley projects, information may invariably be given on all the items shown in the reference list.

4. I shall be grateful if the roject Reports sent to the Advisory Committee are checked up with the enclosed list before being finalised. The co-operation of the Engineering Organisations in this respect will eliminate delays in examination of the scheme, and will be gratefully appreciated. The list is being sent to the Press. The number of copies required by you may please be communicated.

Yours faithfully
Sd/- (Yadava Mohan)
Chief, Natural Resources Division

Copy forwarded for information and necessary action to :—
1. The Secretaries (All State Governments),
2. Minister of Irrigation & Power
3. Central Water & Power Commission

Sd/- (Yadava Mohan)
Chief, Natural Resources Division

(Enclosure)

IRRIGATION AND POWER PROJECTS

List of Items and References

State ... .

Name of Project.....

Category of Project.....

Estimated Cost.....

Multi purpose
Irrigation.
Power.
Flood Relief.

Reference to page/to report or number of Drawing.

I. HYDROLOGICAL AND GENERAL

1. Have the following hydrological and meteriological data been collected showing the following information.

   (a) A map showing sub-divisions of catchment by tributaries, water sheds, rain gauge and temperature recording stations, gauge and discharge sites, contours and isohyetals.
   (b) Monthly and Annual rainfall and tempreature data for the catchment.
   (c) Average, maximum and minimum rainfall and temperatures.
   (d) Gauge and discharge data of tributaries and the main river.
   (e) Hydrographs of the river.
   (f) Maximum historical flood with hydrograph, and designed maximum flood and its frequency.
   (g) Maximum, minimum and average annual run-off,
   (h) Suitability of water for irrigation, drinking etc. and treatment contemplated, where required.
   (i) Silt data showing maximum, minimum and average silt intensities.
   (j) Erosion data and soil conservation measures, if any.
   (k) Sub-soil water data in the commanded area showing depth of water table and its seasonal variations,
   (l) Seismic data.

2. Has basin-wise development of the river been considered and the following information furnished ?

   (a) A map showing the overall proposals for valley development.
   (b) Alternative proposals, discussing their merits and demerits.
   (c) Extent to which any existing projects will be assisted or affected.

3. Has reservoir data been collected completely and following information furnished ?

   (a) Reservoir topography, area and capacity curves.
   (b) Probable rate of silting in the reservoir, and the life of reservior, comparison with silting of existing reservoirs.
   (c) Live storage, the number of years in which the reservior completely falls, average annual utilisation, evaporation losses, extra storage provided for carry over from year to year, if any.

(d) Working tables for the reservoir.
(e) Flood absorption and flood routing.
(f) Back water and tail water curves with bank levels.
(g) Fetch of reservoir, direction and velocity of winds and free board.
(h) Malaria control of reservoir.
(i) Area to be submerged and its classification, acquisition and compensation for land and properties.
(j) Programme of resettlement of population displaced from the reservoir area.

II. HEAD WORKS (Dam or Weir)

1. Have the following aspects been discussed and shown on a map.

(a) Dam site and considerations leading to its preference over other sites,
(b) borrow areas and quarries.
(c) Roads and Railways, existing and proposed.
(d) Colonies, Work shops and Offices.

2 Has a detailed survey map of the dam site been prepared (Scale 50 to 100 feet) showing the following ?

(a) All the natural features e.g., out-crops of rocks, springs etc.
(b) Dam and appurtenant works.
(c) Site for construction plant e.g., crushing and concreting plant, construction power plant, compressed air station etc.

3. Have geological investigations been made and a report showing the following submitted?

(a) A brief account of regional geology, major rock types, effects of faulting etc., description of other structural features and their relation to possible leakage, grouting proposals.
(b) Laboratory tests of samples of foundation material and their interpretation.
(c) Levels of ground water table and direction of flow and discussion of percolation tests.
(d) Reference to any special condition affecting the preliminary designs.

4. Have the following maps beed included ?

(a) Combined topographical and geological map.
(b) Map showing bed rock, contours.
(c) Logs of drill holes, test pits, exploratory tunnels etc.
(d) Maps, profiles and sections showing results of geophysical work or any other special method.
(e) Ground and Aerial photographs. if avaliable

5. Have investigations of construction materials been made and report showing the following attached ?

(a) Various types of embankment materials e g., pervious, semi-previous, and impervious, with quantities in various borrow areas.
(b) Stone for rip-rap and rock-fill.
(c) Materials for stone masonry and concrete comprising rubble, fine and coarse aggregates, with quantities and physical properties.
(d) Source of supply of cement.
(e) Laboratory tests performed on items (a) to (d)
(f) Haul roads for transport of construction materials.

(g) Plans of borrow area and quarries bore or trial pit data.

6, Have the main structure and appurtenant works e. g, dam, spill-way, power dam outlets, coffer dam etc. been designed and the following appended ?

() General plan, up–stream and down-stream elevations showing natural ground level final excavation levels.

(b) Foundation treatment and drainage.

(e) Spillway and outlets with energy dissipation arrangements.

(d) Maximum sections of overflow, non–overflow and earth dams.

(e) Retaining and training walls.

(f) Galleries and other openings.

(g) Gates, hoists and other control equipment.

(h) Diversion works during construction etc.

(i) Design calculations with list of assumptions made and factors of safety adopted together with justification for the types of structnres adopted.

III. IRRIGATION

Have the following investigations been made and report prepared ?

(a) (i) Existing irrigation facilities indicating gross area, cultureable commanded area irrigated area and extent of water utilised.

(ii) Proposed facilities indicating gross area, cultureable commanded area and area proposed for irrigation.

(b) Soil survey and pattern of crops indicating existing and proposed areas under various crops.

(c) Existing and proposed duties, deltas and intensity of irrigation.

(d) Monthly water requirements of crops based upon the proposed crop pattern.

(e) Existing and proposed water rates and land revenue rates.

(f) Losses due to evaporation, absorption and transmission from the canal system.

(g) Period of development of irrigation and its stages, if any.

(h) Direct benefits in foodgrains and other crops.

(i) Proposed Betterment levy with reasons,

(j) Water supply to towns and villages, if any provided'

(k) Possibility of water logging.

2. Have the alignments of main canals and branches and the following indicated in the report and drawings ?

(a) Contour map showing existing and additional irrigation canals, principal towns, rail, roads and highways.

(b) Alternative alignment of canals,

(c) Final alignment of main canals and branches.

(d) Trial pits or boring data for canal excavation and foundations of structures.

(e) Investigations for construction materials.

(f) Land acquisition and compensation for properties.

(g) Malaria control and health service.

3. Have the canals, branches and structures on them been designed and report and drawing, prepared for the following ?

(a) Remodelling the existing irrigation system, if any.

(b) Capacity factor, free board and other assumptions.

(c) Inspection and cross sections of the canals and branches.

(d) Cross drainage works bridges, regulators etc. (L-sections and cross sections of main structures and typical drawings for others.)

(e) Method of calculation of discharge of cross drainage works.

(f) Distribuation system including minors and outlets.

(g) Field channels and agency for their excavation.

(h) Regulation arrangement of off-taking channels.

IV. POWER DEVELOPMENT

1. Have investigations been made and the following details furnished ?

(a) Present position of power supply in the region system loads, system loads factor etc.

(b) Extent of firm power available from the scheme (working tables and the basis of estimation of firm power should be supplied, and extent of secondary power, if any.

(c) Load survey future peak and energy demands, anticipated system load factor.

(d) The function which the proposed scheme, would perform in relation to the other stations of the existing grid, if any and details indicating how the scheme has been designed to fit into the existing grid.

(e) Proposed initial and ultimate installed capacities, number and size of units, power factor, efficiency etc.

(f) The ap showing the general layout of the schemes including the dam, water conducter system' power house, step-up sub-stations and out going transmission lines.

(g) General map showing the transmission system and the location of the present and future loads.

(h) A note on the development of power in stages, if any.

(i) Present and proposed tariff rates, comparison of similar rates in other States and reasons for difference,

(j) Proposed source of coal, fuel etc,

(k) Proposed source of cooling water.

(l) Investigation of construction materials.

OTHER BENEFITS

1. Has the flood control aspect been investigated and drawing prepared and the following particulars indicated ?

(a) Pack flood, moderoted flood and optimum safe discharge in the flood plain.

(b) Area affected by floods at present and area which will get protected giving location and quantum.

(c) Special structure required for flood moderation e. g.

(d) Flood embankments.

[ii] Regulation by barrage in to various channels, old and new.

(d) Betterment levy, if any, for the area protected from floods.

2. Has navigation been provided and the following indicated ?

[a] Navigation reaches of river and canals with depth of drafts clearance under structures.

(q) Location and design of locks with data of foundations and construction materials.

(c) Existing and proposed navigation traffic, both passenger and goods.

(d) Existing and proposed tollage rate or registration fees of navigation craft.

3. Has fish culture, recreation etc. been considered and if so, have following details been given ?

Present facilities and scope of the scheme.

(b) Structures required e. g. fish ladders, gardens, health and pleasure resorts.

VI. CONSTRUCTION PROGRAMME EQUIPMENT & MAN-POWER

1. Has a construction programme been drawn up for the execution of the various components in the projects with the following details ?

(a) Machinery and equipment available together with the proposed requirements.

(b) The quantities of materials involved together with the daily out-turn proposed for major items like masonry, concrete, earth works.

(c) Justification of the construction programme adopted .

(d) Yearly requirements of Cement, Steel, Coal and other essential materials.

2. Have charts been furnished showing the construction programme and target diagrammatically for the various components of the projects ?

VII. ESTIMATE AND ANALYSIS OF RATES.

1. Have project estimates together with abstracts of quantities and costs for various components of the project been made and following details furnished ?

(a) Estimated cost of the various stages of the project.

(b) The year to which rates in the estimate pertain.

(c) Allocated costs of irrigation, power, flood control, navigation and other heads of the project.

2. Have analysis of rates been made and following details furnished ?

(a) Labour out-turns for various items.

(b) Materials required for unit quantities of items of works.

(c) The current schedule of rates in the area and rates proposed, Comparison with rates obtained on analogous work.

3. II. FINANCIAL RETURNS AND BENEFITS

1. Has the financial aspect of the project been discussed and the following details furnished ?

(a) The programme of expenditure on the various units of the project in foreign exchange and in rupees.

(b) The programe of development of irrigation, power, navigation etc.

(c) Gross revenue statements from the different functions of the project together with sehedule of water rates, betterment fees, irrigation cess, power rates and flood levies.

(d) Statement showing maintenance and establishment costs and net revenue available.

(e) A note on the productiveness of the project, stating percentage return, capital cost of irrigation per acre and of power per kilowatt.

((f) Financial resources available for construction of the project e. g. contribution by public, loan from centre etc.

2. Have total direct and indirect benefits of the project been stated in respect of the following ?

(a) Irrigation
(b) Power
(c) Food control
(d) Navigation
(e) Employment
(f) Other facilities

Place..... .....

Date..... .....Engineer

GOVERNMENT OF INDIA
PLANNING COMMISSION

No. PC (V)/1/3(A)/54 New Delhi dated May 13, 1954.

From :

Shri Yadava Mohan, I. S. E.,
Chief of Natural Resources Division and
Secretary, Advisory Committee on Irrigation
and Power Project.

To :

The Development Commissiners
All State Governments.

Sub : Irrigation and Power Projects for Second Five Year Plan.

Sir,

In my letter No. PC (V)/IV (5)/54 dated 23rd March 1954, the State Government have been requested to furnish short notes on the Irrigation and Power Projects that they propose to recommend for inclusion in the Second Five Year Plan.

2. Detailed project reports for most of these schemes would probably be under preparation with the State Governments now. The examination of these schemes would be expedited, if all particulars required by the Advisory Committee are furnished along with the project reports.

3. I enclose a form showing the various aspects which the Committee would consider in relation to the Irrigation and Power Projects for the next plan period. It is hoped that this form will assist the State Government in furnishing full information and data required by the Committee.

4. To complete the technical examination of the projects in a reasonable time, it would be desireable that the various parts of the project e. g. hydrology, power, designs, estimates, etc. are examined in the different Directorates of the Central Water and Power Commission simultaneously. The Commission would therefore, need four copies of the project reports. It is requested that six copies of the project report may be sent in the first instance; two of which may please be sent to me and the other four to Shri B. S. Nag. Director, Technical Examination and Resources, Central Water and Power Commission, who is the Additional Secretary of the Advisory Committee.

5. In addition to the six copies of the project report, 10 copies of the enclosed form may kindly be filled in and sent to me for distribution to the Members of the Advisory Committee for study.

6. Your co-operation in the matter will be appreciated.

7. 100/50 copies of the form are being enclosed with this letter for your use. Additional copies may be called for, if required.

8. These forms may also kindly be completed for the schemes you have already submitted for inclusion in the Plan.

Yours faithfully
Yadava Mohan
Secretary, Advisory Committee

Copy with a copy of the form forwarded to :

1. The Secretary (All State Governments)

2. The Chief Engineer Irrigation / Electricity (All State Governments)

Copy forwarded to :—

1. The Ministry of Irrigation and Power (Shri A. R. Khanna) (with three spare copies).

2. The Central Water and Power Commission (Shri B.S. Nag) (with 20 spare copies) for information and necessary action.

Yadava Mohan
Secretary, Advisory Committee
Irrigation and Power Projects

OFFICE OF THE CHIEF ENGINEER P. W. D.
Irrigation Branch, Madhya Pradesh

No. 304-C-3/W(1) 56 Raipur, dated the 2th Sept. 1957

All Superintending Engineers
All Superintendents of Works

Sub: Precautions to be taken when a completed tank fills for the first time.

Ref: Correspondence resting with this office memo No. 113-Q-9/W(I) dated 11. 5. 56

Kindly see that the instructions issued vide this office memo above are brought to the notice of all concerned.

2. New tanks should not be allowed to be fillled up as far as possible upto the F.T.L. in the very first year. Water should be escaped through the canal so that it fills up about 1/2 to 2/3rd in the Ist year, 2/3rd to 3/4th in the 2nd year and than full in the 3rd year.

3. Copy of the above noted letter has been sent to them vide this office memo No. 304 Z-2/W(I) 56 dated 22. 7. 1957 and may please be referred to.

Para 3 for S. Es. of M. B. Region and S. E. Tawa

Sd/-
Deputy Chief Engineer, (South)
for Chief Engineer, P. W. D.
Irrigation Branch, M. P. Raipur

OFFICE OF THE CHIEF ENGINEER P. W. D.
Irrigation Branch, Madhya Pradesh

No. 738-D/W(I) 56 Raipur, dated the 9th November 1957

All Superintending Engineers,
All Executive Engineers

Sub : Drainage culverts

It is noticed that the uplifts and damage to the drainage culverts is on the increase. The main reason is that no attention is paid to the cleaning of the outfall vents and approaches of the drainage works with the result that there is considerable heading up and the discharges through the vents have to be forced. It is, therefore, desired that the Sub-Divisional Officers and Executive Engineers should please note on this aspect, while inspecting the canals for Annual inspection reports and take timely action.

Encl : Nil

Sd/-
Deputy Chief Engineer (S)
for Chief Engineer, P. W. D.
Irrigation Branch M. P., Raipur

OFFICE OF THE CHIEF ENGINEER P. W. D.
Irrigation Branch, Madhya Pradesh,

Memo No. 836/W (i)56 dated 5-12-1957

All Superintending Engineers
All Superintendent of Works

Sub : Works Maintenance, inspections of Canals and Head Works

It was accepted in the Superintending Engineers conference, held recently at Raipur that present rules about inspections of Canals and Head works of Irrigation tanks applicable to the old M.P. are suitable and may be adopted in the entire new M.P. State.

Extract of Paras 134 and 134-A of the 'Printed diary of Returns' and a sample copy of proforma of register in which such inspection reports should be recorded are enclosed herewith in this connection for information and necessary action.

Longitudinal section and cross sections of the Dam showing levels of top of Dam and side slopes after each monsoon and the expenditure incurred every year should also be indicated in the register at the end of the each report.

Kindly see that the inspections are carried out on due dates by the Officers concerned according to the rules and the inspection reports recorded in the Registers meant for this purpose.

Encl: Two

Deputy Chief Engineer (N)
for Chief Engineer P. W. D.
Irrigation Branch, Raipur.

Name of Return	Date on which due in the Office of the			Remarks
	E. E.	S. E.	C. F.	
134. Report on the complete inspection of head woks of Irrigation works by Sub-Divisional Officer.	Between Ist Nov and Ist March as soon as the inspection has taken place:	The report on head work will be forwarded by the E. E. to S E. as soon as possible after they have been received from the S. D. O. The report for large channel carrying 100 cusecs and more at head will be forwar ded by the E. E. to S. E. as soon as possible after they have been received from the S. D. Os. Report on the smaller channels carrying less than 100 cusecs will be dealt with by the E. E.		E. Es. are required to inspect annually (i) All head works costing Rs. 2 lacs or more and 25 % of all other head works. All head works costing less than Rs. 2 lacs should be inspected by the E. E. at least once in 4 years. ii. E Es are required to inspect annual 10 % of all chnnels having head dis charge of 100 cusecs of more. 2. S. D. Os. are required to inspect annually :— 1. All Channels carrying more than 10 cusecs discharge at head. 2. All damaged masonry works. 3. Only 25% of all channels carrying 10 cusecs or less head. All such channels should be inspected by the S. D. O. once in 4 years. 3. All channels carrying 10 cusces or less at head should be inspected by the section subordina te annually and a report submitted to S. D. O. These report will be dealt with by the S. D. O. and not forwarded to the Executive Engineer. 4. S. D. O. should submit their reports on each work or in the case of large works on each channels as soon as they have inspected it after the rains. The report should be submitted any time between 1st Nov. and Ist June but as much as possible should be submitted to the E. E. before the Ist March.
134 (A) Report on the complete inspection of Irrigation Channel by S. D. Os.	Between Ist Nov. and Ist June.			

ANNUAL INSPECTION REGISTER

S. No.	Name of work	Date of inspection and remarks by the S. D. O.	Date of inspection and remarks by the E. E.	Remarks by the Superintending Engineer
	Head works :—			
1.	**Main and subsidiary bund**			
2.	**Sluice**			
3.	**West Weir**			
4.	**Masonry works on spill channel**			
5.	**Other items**			
	Canals :—			
1.	**Main Canals**			
2.	**Distributories**			
3.	**Masonry works**			

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh, Raipur.

No .304-0-3W(I) 56 Raipur dated the 12-12-1957

All Superintending Engineers
Superintendent of Works

The following Extracts from the Concrete Association of India Publications as noted against each are sent herewith for your information and guidance.

1.	(a) Precautions in design of pipe line (Para 8 Chapter 1)	Concrete Association of India Publication titled Concrete pipes for irrigation
	(b) Laying concrete pipes (Chapter 3 Full)	
2.	Summary and other precautions for water-tight concrete (Pages 10-12)	Concrete Association of India publication titled Water tight concrete.

Encl : As above

Sd/-
Dy. Chief Engineer,
for Chief Engineer, P.W.D.
Irrigation Branch, M. P.

Precautions in design of pipeline.

In the design of lengths of pressure pipe lines under several feet head of water, the following precautions should be observed.

(i) Prevent the building up of excessive pressure in pipe by water-hammer or trapped air. For trapped air provide vents or relief valves at summits of gradients as at C in Fig. 1. For water hammer at outlet gates pipe structures, e. g. pump stands, surge chambers, etc. extending at least 2 ft. above the hydraulic gradient line.

(ii) Design the system and layout to keep the working head as low as practicable. This will ensure minimum pumping costs, least trouble with the pipe line, and low maintenance.

(iii) Test some of the pipe by using test pressure equal to twice the working head.

(iv) Build pipelines which are straight and on uniform gradients. This will minimise water hammer.

(v) Close outlet gates and valve gently and gradually. A sudden shutting out may below the pipeline.

CHAPTER -3

LAYING CONCRETE PIPE

Hand made-socketted pipes—

Pipes are generally laid with their sockets facing upstream. Pits are dug for the sockets so that the pipe throughout its length rests on the hard ground at the bottom of the trench. Jute or hemp dipped in neat cement paste is wrapped round the plain end of the each pipe, it should be just thick enough to be inserted into the socket of the pipe already in position. Before the pipe inserted in the socket, mortar made of I part cement and 2 parts sand is applied to a thinkness of about 3/8 inch. over the spigot end of the pipe andal.o inside the socket. Care must be taken to see that the pipe is placed well in to the socket and that the packing is not pressed through into the pipe. Steel tools are used to ram the hemp tight when the pipes are in position. The remaining space in the socket is then filled with 1 : 2 mortar and finished off with a bead on the outside. The work of the hemp jointing should be kept about 20 ft. ahead of the mortar filling to ensure ease of working aad regular progress. A bag full of straw should be put inside the pipe and drawn forward by means of a rope as laying of the pipeline proceeds, this will ensure that no obstruction is left in the pipes. The joints in the pipe line should be kept wet for 24 hours by a covering of wet gunny bags. Trench filling should be done in 6 inches layers. The trench should not be flooded before the pipes have been filled with water else the pipes will tend to float and cracks will develop. The pipe line can be' tested 8 hours after completion of the last section.

(i) Cost : The following is an approximate cost of laying 12 inches dia. hand made concrete pipes at present day rates.

(a) Labour for laying 300 ft. pipe length per day.

10 Mazdoors	@ Rs. 2.00	20.00
3 Masons	@ Rs. 5.00	15.00
1 Bhistie	@ Rs. 3.00	3.00
1 Mistry	@ Rs. 5.00	5.00
		Rs. 43.00
		Say Rs. 15.00 per 100 ft.

(b) Materials per 100 ft.

Jute or hemp 2 lb. @ 4 Annas per lb.	Rs. 0.50
Sand 5 cft. @ Rs. 40 per 100 cft.	Rs. 2.00
Cement 1 1/2 bags @ Rs. 5 per bag	Rs 7.00
Total exclusive of earth work a+b	Rs. 10.00
Earth work @ 10 cft. per rft,	Rs. 25.00
1000 cft. @ Rs. 40 per 1000 cft.	Rs. 40.00
Total : Rs. 65 00	
per 100 rft. of pipe line.	

Laying of spun concrete pipes-

(i) Spun concrete pipes with loose collars - If spun on concrete pipes are used the method of laying is as follows--

Pipes are lowered into the trench with care to avoid damage. They should be laid to orrect line and level with the help of sight boards. Men with experience are necessary for succh pipes laying. As each pipe is laid and aligned, loose collet should be slipped on befoe

laying the next pipe. The recess at the end of pipe (see Fig 22) should be filled with jute

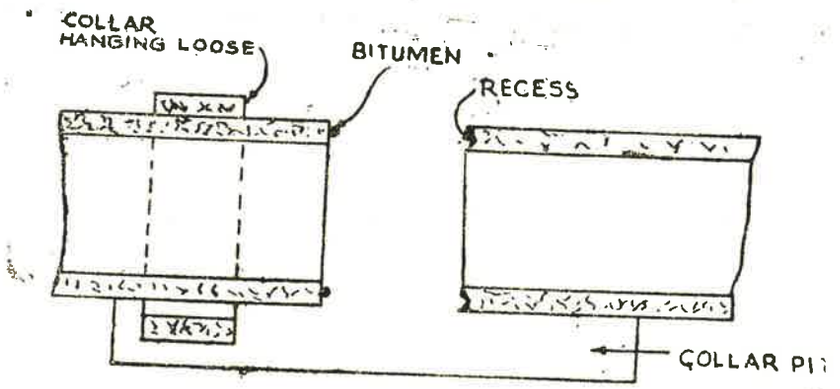


FIG 22 Section on centre line of pipe in trench

brading dipped in hot bitumen. The next pipe should then be brought forward until the plastic ring in the recess of the first pipe sets in to the recess of the second pipe. For smaller diameter pipes this operation should be repeatd for about six times and the whol length should then be jacked together as shown in Fig 23. The object of the jacking is to thoroughly

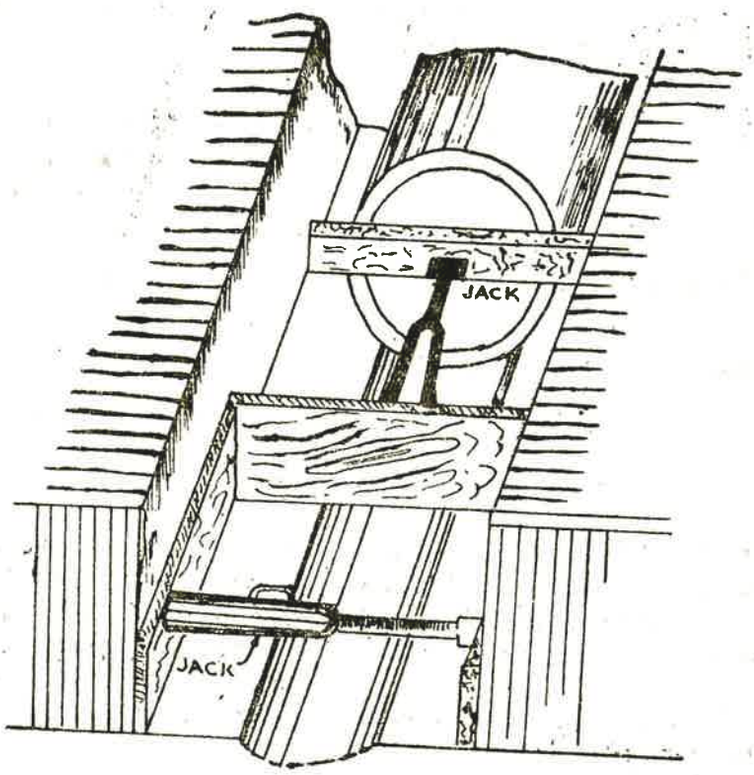


Fig 23 Jacking the pipes together

compress the bitumen, quantity of which should be just enough to fill the recess when pressed hard by jacking. Case should be taken to see that pipes do not move out of alignment while jacking. Before and after jacking it is desirable to ensure that there is no offset at the joint. If there is no offset on the outside it is unlikely that there will coller hanging loose be one on the inside where it is undesirable The loose coller should then be set up with the help of wedges as shown in Fig. 24 taking care to have an even caulking space all round. Into this caulking space is rammed a and $\frac{1}{2}$" mixture of cement and sand just sufficiently moistened to hold together in the form of clod when compressed in hand. The caulking should be done from one side of the coller and to stop mortar from escaping at the

other end, a removable clamp made up of angle irons should be fixed at the back of the collar (Fig 24). The caulking should be so firm that it would be difficult to drive the point

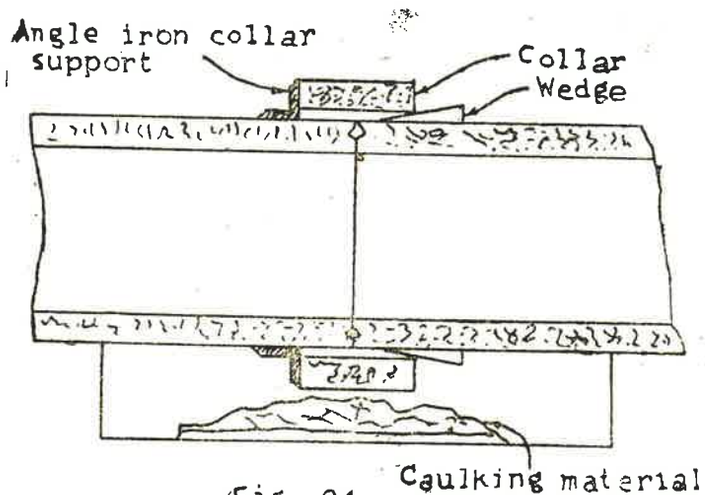


Fig. 24.

of a penknife with well rammed earth to prevent all chances of subsequent movement when a further length is jacked. Curing of the joint is of great importance. As soon as the joint is sufficiently set the trench should be filled and the soil around the joint kept thoroughly wet for 10 days atleast. The finished joint is shown in Fig. 25.

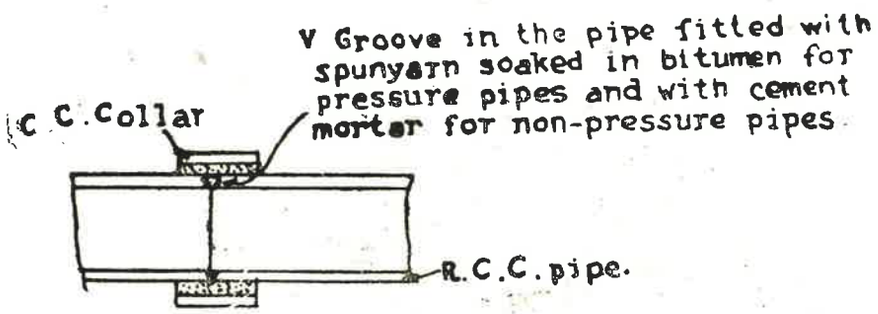


Fig. 25

(a) Expansion joints : Inthe case of buried pipe lines, expansion joints sh uld be provided at intervals of a maximum of 500 ft. but for exposed pipes the joints should bc at 50 to 75 ft. Expansion joints are made with cast iron or steel collars with lead caulking to place of the the usual r inforced concrete collars and cement mortar caulking

(b) Refilling : Refilling of trench should be done in layers of 6 inch deep, properly watered and consolidated by ramming.

(c) Cost of laying spun concrete pipes with collars—

An analysis of the cost of laying 400 rft. of 12 inch dia spun concrete pipe. is given below.

(a) Labour

Mazdoors 14 @ Rs. 2 each	Rs. 28.00
Masons 2 @ Rs. 5 each	Rs. 10.00
	Rs. 38.00

(b) Materials

Cement 4 bags @ Rs. 5 per bag	Rs. 20.00	
Sand 20 cft. @ Rs. 40 per 100 cft.	Rs. 8.00	
As halt 1/13 drum @ Rs. 195 per drum	Rs. 15.00	
Jute 10 lb. @ Rs. I per lb	Rs. 10.00	
Coal for hearting asphalt	Rs. 2.00	
	Rs. 55.00	Rs. 93.00
Total cost laying 400 rft. exclusive of earth-work, say		Rs. 100.00
Cost per 100 Rft.		Rs. 25.00

OTHER PRECAUTIONS

If proper attention is paid to the above precautions ordinary concrete 5 inches or more in thickness should be quite water tight and its watertight qualities should improve with age.

If additional precautions are considered necessary, one of the following expedients may be adopted:

(a) Instead of the ordinary Portland cement some special form of cement may be used, such as special water repellent cement or cement to which a waterproofing admixture has been added at the works.

(b) There are in the market many integral waterproofers which can be added to the ingredients of the concrete during mixing as means of increasing the factor of safety against permeability, but poor concrete with the addition of a water proofing material will not be waterproof concrete. When waterproofing admixtures are used, the maker's instructions should be closely followed.

(c) If the exterior of the structure which is to be made waterproof is accessible and an additional safeguard is required, an obvious solution is to apply an external waterproof surface treatment.

(d) If for some reason it is found that the concrete is not watertight, a waterproof rendering inside the structure may be adopted, it is most important in this case to 'key' the rendering to the concrete surface to prevent the rendering from blistering and cracking. In such cases the advice of the makers of the waterproofing medium should be obtained in advance.

SOUND STRUCTURAL DESIGN

It is evident that a concrete structure which is to be watertight must be properly designed so that no cracks will occur due to settlement, earth pressure, etc. since such cracks may allow water to pass, however good the quality of the concrete may be.

SUMMARY

To ensure concrete being watertight the utmost attention must be paid to:—

i) the materials to be used.

ii) the grading of the aggregate, and the proportions of the concrete mix.

iii) the minimum amount of water which will give a workable mix.

iv) the workmanship in mixing and placing.

v) the bonding of the concrete surfaces at joints.

vi) the curing of the concrete.

vii) care in design of the structure to minimize the risk of settlement cracks etc.

viii) care in removing falsework or shuttering.

If this is done, the result should be a good, waterproof concrete. For additional safeguards see paragraphs (a), (b), (c) and (d) above.

MADHYA PRADESH
Salient Data.

I. GENERAL DATA. ——————PROJECT

1. District.
2. Tehsil.
3. River or nallah.
4. Location of dam.
5. Name of River Basin.
6. Longitude and Latitude (Dam site)... (Topo sheet No.)
7. (a) Year of start.
   (b) Year of completion.

II. HYDROLOGICAL DATA.

1. Mean Rainfall (over.....years)
   (a) Annual
   (b) Mansoon.
2. Mean Monsoon Run-off.

   (Calculated by.....) Percent.

   (Formula to be entered here)

   Inches. M. cft./Sq. mile.

3. A. Average.
   B. Maximum
   C. Minimum

FLOOD.

(a) Maximum observed. Cusecs.

(b) Maximum adopted Cusecs.
(Formula to be given)

III. RESERVOIR DATA.

1. Catchment area Sq. miles.
2. Mean Monsoon Yield. M. cft.
3. Gross storage capacity. M. cft.
4. Dead storage capacity. M. cft.
5. Live storage capacity. M. cft.
6. Percentage of gross storage to normal monsoon yield. %
7. Percentage of dead storage to gross capacity. %

8. Full tank level i. e. F. T. L. R.L.

9. Maximum water level i e. M. W. L. R.L.

10. Top of bank level i. e. T. B· L. R.L.

11. Lowest sill level i. e. L. S. L. R.L.

12. Water spread area at F. T. L. Sq. mile / acres

—do— at. M.W.L. Sq. miles / acres.

IV. (a) Pick-up weir/Anicut

To be filled in where required.

1- Independent catchment area Sq. miles

2- Designed discharge

3- Lowest sill level R.L.

4- Crest of weir level R.L.

5- Maximum water level R.L.

6- T.B,L. of Afflux bunds

7- Number, size and sill levels of head sluices.

8- No. size and levels of under sluice.

V. DAM DATA.

	Main dam	Subsidiary dam, I	II	III

1- LENGTH OF DAM

(i) Earth
(ii) Masonry

2. MAXIMUM HEIGHT OF DAM.

(i) Earth
(ii) Masonry

3, QUANTITY OF WORK IN DAM

(i) Masonry
(ii)Earth work

4. (a)Length of waste weir Rft.
(b) Maximum discharge of waste weir. Cusecs

VI. CANALS

a- [i] Length of main canal. miles
[ii] Length of branch canals. miles
[iii] Length of distribuiory and minors, miles
b. Head Discharge Cusecs

e. Duty adopted.

(i)	At canal out let	acres/Cusecs.
(ii)	Tank duty [In case of Kharif Irrigation	acres/m. oft.
(iii(	Delta [at the field]	
	a. Rice	inches
	b. Wheat	inches.
	c. Cotton	inches.
	d. Sugarcane	Inches.
	e. Other Crops (by name)	inches.

d. Area Commanded (Agricultural Statistics)

a.	Number of villages to be served.	
b.	Total area commanded.	
c.	Total culturable area.	
d.	Total area unber caltivation (existing)	
i)	Kharif	acres.
ii)	Rabi	acres.
iii)	Sugarcane	acres.
iv)	Vegetable	acres.
v)	Other crops (By name)	acaes.
	Total :	acres.
	Double cropped area	acres.

f. Net cropped area acres.

g Irrigated area (existing) acres.

Designed Irrigable acrea :

1. Rice	acres.
2. Wheat	acres.
3. Cotton	acrea.
4. Jawar	acres.
5. Other Kharif	acres.
6. Rabi	acres.

7. Garden Crops acres.

Total —

Not Items not required may be deleted.

VII. Financial

1. Estimated cost (including over-head charges)

2. Unit-I-Headworks Rs.....

Unit II Canals and Distributories Rs.....

3. Cost per acre Irrigated.

4. Percentage Return (at the end of 20th year after completion of the project)

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh, Raipur.

No. 227-/W(I) 58 Raipur dated the 23rd March 1958

All Superintending Engineers
All Superintendent of Works

Sub:— Steel.

Kindly note that wherever in the design, the working stress in the steel is considered as 18,000 lbs /Sq. inch, the steel to be used should be of tested quality. If the untested quality is used the working stress should be reduced to 16.000 lb/Sq. inch.

For Hydraulic structures, likely to remain under water for long period, the allowable stress in the steel may be reduced to 12.000 lb/Sq. inch.

Sd/- V. P. Sethi
Deputy Chief Engineer, (S)
for Chief Engineer P.W.D
Irrigation Brauch M. P.

OFFICE OF THE CHIEF ENGINEER, P. W. D
Irrigation Branch, Madhya Pradesh

No. 741/W 3-B

Nagpur, dated the 25th April 1958

All Superintending Engineers

Subj:— Construction of Minor Irrigation Tank and Village Project tank.

The instructions already issued for the construction and repaired small village tanks vide this office No. 346/Ka. 54. dated 9th March. 1954. Copy sent vide this office memo No. 741/4-2/BI. bated 21/24 th April 1956 will alsohold good for nistar tanks as well as for famine reilef tanks.

No reduction should however be made in the design of waste-weir and spill width. Full width as required by a proper design should be allowed even for village and nister tanks.

Sd/—
Superintending Engineer,
for Chief Engineer, Irrigation Branch,
Madhya Pradesh

OFFICE OF THE CHIEF ENGINEER P. W. D.
Irrigation Department M. P.

No. 292/W(I) of 58 Raipur Dated the 15 May 58

All Superintending Engineers,
All Superintendent of Works

Sub;- Approach road to tanks.
Ref:- This Office memo No. 304/WI-56 dt. .7.56

In supersession of the orders contained in above letter the following modified instructions are issued for guidance and necessary action.

(i) Generally where the main canal cuts an important road, it is advisable that approach road to Headworks be made along the canal on service bank, rather than on any alignment, unless there is some direct cart track whichm is uch shorter than the canal.

Even though the approach road to the tank may not be direct, but it will provide additional advantage of affording facilities for inspection of canal in that reach.

(ii) Until the canal bank service road is ready, surface dressed approach road as suitable may be constructed for carriage of machinery etc. It may be noted that heavy earth moving equipment can be transferred easily on surface dressed roads rather than on metalled roads.

(iii) No boulder soling or metalling on these approach roads is necessary and roads would be of morum specification as usual bans, expect in case of direct approach roads, where in bad patches, neeessary soling and metalling may be provided in restricted lengths.

(iv) Boulder soling or metalling shall not be provided without prior specific approval of this office.

(v) Provision in the estimates will also be made on the above lines.

Sd/-
Dy. Chief Engineer,
for Chief Engineer, P. W. D.
Irrigation Branch, M. P.

Copy of No. 318/W[I] 58 dtd· 3rd June 1958, from Chief Engineer, Irrigation Branch, Raipur to the Superintending Engineer, Mahanadi Circle, Raipur.

Sub;- Preparation of estimates.

From the secrutiny of estimates recently received in this office, it is noticed that uniform procedure is not being adopted by all and estimates are prepared and submitted with too many unauthorised provisions. The following are specifically brought to the notice of all concerned:

1. All materials excavated from puddle trench, spill channel and approach channels, etc. must be deducted for re-use which can possibly be re-used. In case the materials are not used, the Engineer-in-charge will have to explain this as an item of excess. In case the quantity of materials excavated are more than the quantity that can be reused, only the materials that cae be reused should be adjusted.

Normally all such materials are fit for reuse either in casing, hearting, pitching, chipping, toe walls or filter and clay blankets, etc. The services of Executive Engineer (Soils) and his staff are now available and may be availed of in case of doubts in deciding upon the suitability of each materials. So for the tendency is just to scrap every thing excavated even the Hard-rock, on one or other pretext. Proper organisation of the work is of course also a pre-requisite for this.

2. Rates should be normal rates as per schedule of rates. In case the rates have to be increased analysis and reasons for extra higher percentages should be explained. So far the practice noticed is to provide enormously high increased rates, even though the works are being carried out at schedule rates. Normally Supdt. Engineers are only empowered to sanction such higher rates, but instances are not rare where no such sanction was obtained by Executive Engineer/Sub-divisional Officers, This is also a bad and seriously objectionable practice and need to be discouraged by all concerned.

3. For calculating the quantities of earth work of canals and dams, only the sections as per drawing are to be taken. In case the Engineer-in-charge has increased or decreased the quantities he will explain it in the completion reports about the excess. The estimate must show the picture as it should have been, if the work would be done according to the drawing. plans profiles and grades shown therein.

Items like approach and haul roads to quarries, construction and removal of ramps, shrinkage allowance and removal of overburden from quarries etc., being contingent on the item of earth works are included in the rates stipulated in S. S. R. and para 7 below andr no increase in quantities on this account need be made as hither to being done by some Circles.

Any deviations from these should be explained with proper explanation in the completion report with proper authoriti .

4. Due care is not being given to the preparation of covering and enclosing other technical data with stage-II estimates presumbly under the impression that technical aspects of the scheme have already been approved in the stageII-estimate and there is therefore, no necessity to report the same. This is not correct. In fact estimates have been received in this Office without these reports. It is the covering reports which indi- cate thevarious aspects of the project in consolidated form and its necessity cannot be

overemphasized. Everything written in the report of Stage-I estimates is to be fully brought out in the covering report together with deviations made either during inspection or whiie preparing stage-II estimate.

5. Cases are not rare where the catchment areas, capacities of the tanks and the areas available for irrigation in the command are not found to be as stated in the stage-I estimate. It is the duty of Engineer-in-charge to see that while starting new construction, he should first satisfy in respect of these items and recover a clear certificate in this stage-II estimates to this effect. Cases have been reported, where channels have been constructed for designed areas, but either the capacity is now reported to be less or the full area is not available in the command for irrigation and thus the channels are in excess of requirements. This reflects badly on the efficiency of the department and need to be avoided at all levels.

6. In numerous cases the explanation for excess is given as not provided in the stage-I estimate without dealing with the necessity of its actual provision. Here the question arises whether this was a genuine omission in the stage-I estimate and what action, if any has been taken by the Engineer-in charge to bring the same to the notice of his higher officers in terms of paras 424 and 428 of P. W. D. Manual vol. I. In fact in not a single case, the above requirement has been fulfilled, and works are being carried out with complete disregard to the provisions of stage-I estimate (huge construction of building structures and wells etc. costing twice and even thrice the provision made in the stage-I estimates and without making a single reference to the Chief Engineer's office is a glaring instance of this praetice) with the pious hope that work as executed shall have to de provided and accepted in the stage-II estimate, This is not only unsatisfactory but seriously objectionable from the audit point of view and need to be avoided by all concerned.

7. Rates for earth work with earth moving machines and manual labour

From the number of projects, so far completed the following rates have been found suitable;-

1. For low bunds say upto 35.40 ft. height, an overall rate Rs. 55/- per % O. C. ft. complete with carriage rolling and watering etc. is sufficient.

2. For low bunds say upto 35.40 ft. height, the rates vary from Rs. 65/- to Rs. 75/- % cft. depending upon the distance of quarries including remming, rolling and watering. Forquarries within one mile, rate of Rs. 65/-%O is enought with other increase of one mile in distance the rate is Rs. 70/- per % O.C.ft. including watering and rolling. Expendi'ure on construetion. and removal of ramps, approach road to quarries, clearing over burden quarries and electrifi catio of dam sites wherever necessary to facilitate night working is all including in these rates and no extra provision on these accounts need be made.

All provisions in excess of the above features will hence- forth be deleted in this office without making any references to the Superintending Engineer, Executive Engineer, conce-

ned and excesses if any on this account will go to prove bad organised and uneconomical working and will have to be explained fully by the Engineer–in–Charge in the completion reports. Savings on these rates will of course in the same way earn commandations for the Officers in charge of the work and I shall be eager to know all such cases.

Superintending Engineers, Executive Engineers will kindly see that before forwarding estimates to this office all these points are looked into by them and estimates modified accordingly.

Sd/-

Endt. No, 318–A/W(I) 58 Raipur Dated the 3rd June 1958

Copy forwarded to the Secretary to Government, M. P. P. W. D. Bhopal, for favour of information.

Sd/—

Note— The rates shown in para 7 of circular are cut dated cannot be adopted for estimation now.

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, M. P. Raipur.

No, 328 W(I) Raipur, Dated the 13th June 58.

All Superintending Engineers.

A copy of article contributed by Shri G. S. Madan on " Treatment of Dam foundations by Pressure Grouting published in the issue of Indian Concrete Journal of October 57, is enclosed herewith for information and guidance.

Ens: One Article Sd/-

TREATMENT OF DAM FOUNDATION BY PRESSURE GROUTING

by G. S. Madan, B. Sc. Hons (Lond.) M. I. C. E. M. I. E. (Ind.)

Faults, fissures, decay, permeable strata and rock formations in the body of the foundation of dams may often result in seepage of water through them resulting in-

(a) Loss of water stored in the reservoir dammed,

(b) erosion of soft material in the strata or rock formation, thus further widening faults, fissures, etc. with consequent increas^ in loss of water stored,

(c) upward lift due to the presence of water under hydrostatic pressure, thus resulting in reduction of load carrying capacity.

It is obvious from the above general remarks that suitable treatment must be carried out to seal faults and fissures, strengthen the decayed material and reduce the porosity of the permeable strata or rock in order to prevent wastage of water and ensure the safety of the structure.

PRESSURE GROUTING.

Treatment by pressure grouting comprises of injecting cement and/or chemicals into the faults, fissures etc. under suitable pressure, so as to seal them. To do this, holes at suitable intervals are drilled to various depths in the body of the rock to intercept the faults. These holes are not generally subject to prior water tests as a start is always made with very thin grout(or even water). When drilling water is lost, the holes should be injected at that depth rather than continued for the whole stage. Very thin grout or water is used at the commencement of injections and gradually the water content of the grout is carried out in accordance with specified pressure as per Table 1. In exceptionally fine fissures or porous rocks, the use of chemicals as prior lubricants to cement injection is necessary, whilst in some grounds chemicals alone must be used.

Water pressure tests are carried out after injection either with an air pump or with a small hand pump (Boiler testing type), the use of the injection pump is not recommended. The pressure to be used is generally specified by the Engineer and will depend on the type of rock and the head on the reservoir when full. Some Engineers specify higher testing than injection pressures, which is absurd. The criterion is generally about 1 ft. of water loss in a 1 $\frac{1}{2}$ in. hole in ten minutes—although, at all but the final stage, this might be relaxed to say 2 $\frac{1}{2}$ ft.

The above water tests are of use in controlling the conduct of the work, but are of little or no intrinsic value when applied to a grouted hole after cleaning out. The critical test is the one carried out on intermediate holes and the final treatment holes without any grouting having taken place through the former.

A typical specification for hard rock testing pressure is given in Table-1.

Table-1. Testing pressures in hard rock

Depth of stage to be treated (measured from the top of concrete face or rock as the case may be)	Maxm. water test pressure (Measured at the top of the hole) psi.	Maxm. grouting pressure (measured at the top of the hole) psi.
1.	2.	3.
to 10 ft.	10	20

1	2	3
10 to 20 ft	30	40
20 to 30 ft.	50	60
30 to 40 ft.	70	80
40 o 50 .	90	100
50 to 60 ft.	110	120
60 to 80 ft.	140	150
80 ft. and over	180	180

PLANT REQUIRED

Usually two percussion drilling rings are required to, one injection pump, with necessary compressors, drill rods, jack bits, nipples, mixing tanks, flexibles, and necessary pipes. Depending on this size of the job and availability of the site, it is usual to estimate for drilling and injection at the rate of 50ft. per drill per shift.

MODUS OPERANDI

(a) For concrete dams:— At the time of concreting the cut-off trench, steel or asbestos pipes usually 2 in i/d for Ingersoll Rand drills and 1 1/2 in i/d for Atlas drils are placed vertically along the centre line of the trench about 15 ft. on centres if the underlying rock is suitable and 7 ft. 6 in. on centres in other cases, to enable the drilling of the rock underneath to be carried out without having to drill through the concrete.

It is preferable to screw suitable lengths of pipes as concreting proceeds. Sometimes, short length of pipes originally placed are kept free and withdrawn for further use for the purpose of economy. This generally leads to irregular holes and bits and pieces of concrete, aggregate, and rubbish fall down the hole making drilling difficult and often leading to abandonment of the hole or necessitating grouting the hole with cement, leaving it for, say a week, and then drilling. It is, however, considered best to drill through the concrete as required and not to use the pipes as sleeves. The size of the holes is determined according to the natnre of the rock to be drilled and the depth to which drilling is required. Some consulting Engineers specify 4 in. dia. holes but usually 2 in. or 1 1/2 in. dia. holes amply meet the purpose and are much cheaper andquicker to drill. Cementation work is undertaken preferably after a length of the cut-off trench has been concreted and not before. This minimises any risks of uplift of the strata, enables contact blanket grouting being carried out between the rock surface and the overlaid concrete and enables grouting being carried out at higher pressures.

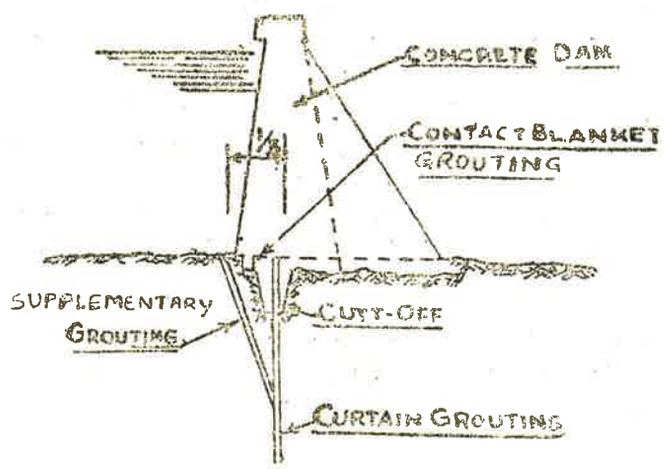


FIG. 1

FIG.2

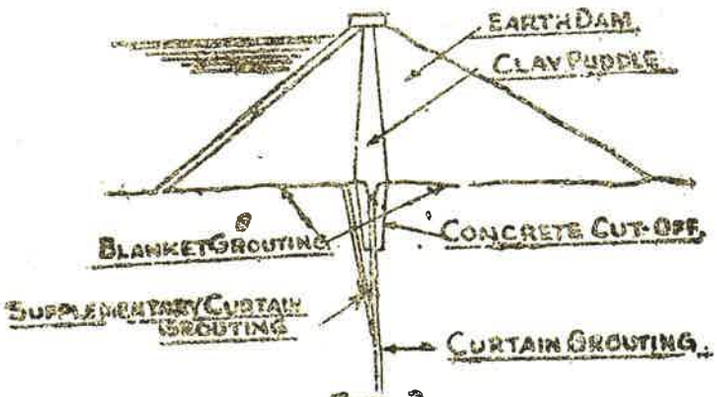


FIG.3

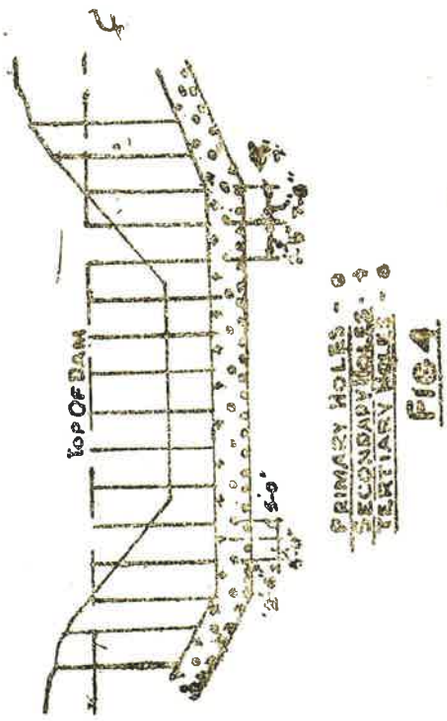


FIG 4

If pipes are not provided, 3 inch holes are drilled about 3 ft. deep at the required spots and filled to half the depth with neat cement mortar. Pipes 2 in or1. 1/2 inch i/d, the lowerand of which are blocked with paper and the upper end gathreaded, are than inserted and pushed home, the mortar rising along the sides. The pipes are then wedged hard and the holes completely filled with mortar, living the pipes about one foot clear of the surface. At least 24 hours are allowed for the mortar to set before drilling is undertaken. As soon as these pipes set hard, holes are drilled to the underside of the concrete. An injection is then made to seal the contact zone. Twelve hours after, the hole is flushed out by drilling out the cement and throughly cleaned. The water test is carried out and, if successful, drilling and grouting proceeds usually in 10 ft. stages, generally with the water test, after injecting each stage. If at any stage the water test falls, the whole is re-injected and again tested. The work is first carried out in primary holes, spaced at about 15 ft. on centres. The drilling and treatment in the secondary holes spaced intermediate to these may follow one or two stages behind the primary holes. The behaviour of the seeondary holes and of test holes put down intermediate to these will determine the necessity of any further series of intermediate holes. Generally, primary and secondary holes only are necessary (the primary, and secondary a nd tertiary holes are shown in plan in Fig. 2). It is preferable to drill the above in one line, say along the centre or sides depending on how the strata is dipping.

In the case of very hard rock, the top 2 to 3 ft. of the foundation under the concrete is usually badly shattered. Also in some cases, the surface rock may be badly decayed. Two lines of holes, drilled 2 to 3 ft. deep and 15 ft. on centres staggered in plan, are grouted to form a contact blanket as shown in Fig. 1. If, as a result of curtain grouting using tertiary holes it is found that a considerable quantity of grout has been used or that the tests have been just satisfactory or some holes cannot be tightened up, it may be decided to have supp-lementary curtain grouting as shown in Fig. 1. For this purpose holes are drilled usually at 15 ft. on centres at the upstream face as shown, at an angle, so as to meet the original line of the vertical hole about 40 to 50 ft. below the rock face. These holes are grouted as described before. This work can be undertaken during or after construction is completed.

The depth to which the curtain grouting treatment should extend depends upon a numbers of factors, but for dams upto 40 metres in height treatment should extent to a depth equal the height of the dam, of the depth of treatment may be worked out from the following formul;

$d = 1/3\,h + c$

d = depth of treatment in feet.

h = height of dam in feet

c = varies between 25 ft. and 75 ft.

On the wings of the dam curtain grouting may have to be extended beyond the concrete depending on the nature of rock or strata.

(b) For Earth dams : In most instances the holes are drilled at 7 ft. 6. in intervals along the line of the cut-off trench and treated in a manner similar for concrete dams. It is, however, comman practice to under take blanket grouting (Fig. 3) before proceeding with curtain grouting. Also, at the heel of the trench, the holes are usually spaced closer apart, say 5 ft. or even 2 ft. 6 in. on centres and staggered as shown in Fig. 4.

In most cases the wing walls require careful treatment to form an, impervious curtain. Holes are drilled usually extending well beyond the end of the concrete core wall in one, two or three lines as the case may be at 15 ft. intervals and staggered in plan. In some cases, after the construction is completed, some leaks may be noticed as storage commences. These can be seeted by supplementary curtain grouting as in the case of concrete dams.

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh

No. 329 W(I) 58 Raipur dated the 13th June 1958.

All Superintending Engineers
All Superintendent of Works

A copy of article contributed by the late Shri J. S. Narasimhan, on "Remodelling of old tanks published in the issue of the journals of institution of Engineers (India) for September 1957, is enclosed herewith for information and guidance.

Ens:— One article

Deputy Chief Engineer,
for Chief Engineer, Irrigation Branch,
Madhya Pradesh

REMODELLING OF OLD TANK BUNDS.

The Late
J. S. Narasimhan
Associate Member

SUMMARY.

The problems of strengthening and modernising a large number of ancient tank bunds with a view to increase their storage capacity are of great technical and economic importance to irrigation Engineers. The paper describes various field and laboratory tests necessary to collect data regarding the strength characteristics of old bunds, and gives design criteria to suit specific problems. The various causes of failure of bunds and methods of improving their slopes, stability and foundations are also dealt with. Design features based on test data for fllling breaches in bunds are also given.

1. INTRODUCTION :

One of the significant contributions of soil mechanics during the last 20 years has been the development of techniques for accurately describing the essential characterircs of soils and their selection for use in construction of earth dams. Certain field tests enable determination of the characteristics of foundation soils and their behaviour with regard to settlement. Thus the design and construction of high earth dam according to controlled conditions have been, no doubt scientifically rationalised, but no attention has ever been paid to evolve scientific and rational methods to remodeland renovate the large number of old dams constructed in India many centuries ago. Some of them are still in good condition while some which have breached continue to be in dilapidated state. While earth dams of over 100 ft. height were not constructed in the past, medium sized earth dams upto 50 ft height were common. There is, how ever, no record of the designs or techniques adopted by Engineer in constructing them and hence their collection opens a new field for research. While the design and construction of new earth dams conforming to modern techniques are not fraught with serious risks, the design and remodelling of old dams present several difficult problems. Data regarding soil types used in the old dams and their strength cnaracteristics are not available. In the absence of such information, proposals to remodel them for increased storage capacity require very careful consideration specially when the foundation soils are weak. It is not economical to completely demolish existing dams and construct new ones. With the new types of sampling equipment and soil testing methods now available, it is possible to ascertain the strength characteristics of foundation soils on a more rational basis. Some of the techniques adopted by the author in solving proplems relating to remodelling of several old dams of heights not exceeding 50 ft. and certain field and laboratory tests are discussed below.

2. FIELD INVESTIGATIONS :

Strength characteristics of existing embankments.

Remodelling of an old tank bund requires determination of (a) stabtlity of the exis-

ting bund, and (b) stability of its foundation. If remodelling includes raising the, bund the stability of the bund and its foundation have to be examind for the increased section Stability de ends on the strength characteristics of the soil used. If deep sampling equipment is available, undisiturbed core samples may be taken from different sections of the bund at various depths below the M. W. L. along (a) the central axis of the bund, (b) the mid-centr of its downstream slope and (c) on its upstream slope if the water level in the reservoir permits. If sampling equipment is not available, it is necessary to excavate trial pits. This is rather expensive and time consumping, and in case samples are to be obtained from great depths, the size of trial pits will have to be very large. The author has adopted this procedure, limiting the depth of trial pits to about 15 ft. below M. W. L. in case of bunds with 30 ft. depth of water in the reservoir. The soil profile in the trial pit has to be carefully examined and recorded. The undisturbed core samples are subjected to unconfined compression strength tests. In case of soil having gravel fraction it will be necessary to conduct 'triaxial' tests on undisturbed samples to determine the cohesion and the angle of internal friction of the soils in the bund. In-situ densities and moisture contents of samples at various depths must also determined. The field tests result should be recorded as shown in table -1.

TABLE I

Field test results on soil samples.

1. Details of trial pit with reference to chainage.
2. Reduced level at which core sample is taken.
3. In-situ density of soil in lb. per cft.
4. In-situ density expressed as percentage of Proctor density
5. Natural moisture content.
   a. Percentage dry weight of soil.
   b. Percentage saturation at in-situ density.
6. Unconfined compression strength of soil in lb. per sq. in.
7. Triaxial (quick) test on undisturbed sample.
   (a) For cohesion C
   (d) For angle of of internal friction. (/)
8. Box shear (quick) test on remoulded sample for field
   (a) For cohesion C.
   (b) For angle of intrrnal friction (/)
9. Soil Characteristics.

Seepage characteristics and determination of phreatic line in embankment.

The next important field test is to determine the seepage characteristics of the embankment. The line of saturation in the existing bund under M. W. L. conditions is ascertained. The records of seepage flow in the existing bund, usually maintained by P. W. D. authorities can be relied upon. If such record is not maintained, it will be necessary to determine the seepage line from observations of water level in the trial pits. Most of the old bunds are made of homogeneous sections, and contain usually clayey and gravelly soils, In some cases, district

layers of clayee soils followed by pervious soils are also prevalent. In such cases the rate of speeage will be more. If the bunds are constructed on impervious foundation the rate of seepage and the velocity of flow in the embankment will differ from the rate and velocity through the foundation because of the difference in properties of the materials used for them. It is therefore necessary to determine not only the 'phreatic' line in the embankment but also the permeability characteristics of the soil in it as well as in the foundation. The permeability test can be conducted in the laboratory. It is however difficult to ascertain exactly the seepage characteristics of the foundation and to extract undisturbed core samples from the foundation to conduct permeability test on foundation soil samples taken adjacent to the downstream toe of the bund. The in-situ density of foundation soil under the embankment would be more than that in the rear of the downstream toe. But it would be reasonably correct to assume the permeability co-efficient of the foundation soil as equal to that of the core samples at the downstream toe, its value being determined under a normal weight equal to the weight of the embankment. The author had to adopt this procedure in several cases to determine the seepage characteristics. The saturation line in a porous embankment will be appreciably flat and the sections of most of the old tank bunds are homogeneous. The average hydraulic gradient for a bund can be easily determined by noting the observed seepage levels on its downstream slopes at each chainage, but it would be better to determine the saturation line in the bund under M. W. L. conditions by noting the water levels in one or two trial pits excavated in its deeper sections. Data regarding piping or boiling conditions and any other phenominal changes in ground contours adjacent to the downstream toes should also be recorded. These field notes should be reported in the form shown in table 2.

TABLE 2

Seepage characteristics of embankment and foundation soils

1. Chainage at which tests are conducted.
2. Reduced level at which seepage is noticed on downstream slope.
3. Water level in reservoir on date of tests.
4. Average hydraulic gradient.
5. Permeability co-efficient of embankment soil, i. e. ft. per year (by laboratory tests)
6. Permeability co-efficient of foundation soil (by laboratory tests) on core samples taken from foundation adjacent to downstream toe.
7. Details of piping or boiling or any phenomalen change in ground contour adjacent to downstream toe.

Field data for designing filling of breaches

In addition to emodelling, certain field tests have to be conducted for recommending proposals for breach filling of existing bunds.

The index properties of foundations soil below the foundation bed should be determined as in table 3.

TABLE 3

Typical index properties of clay deposits in foundation.

1. Characteristics of deposit.
2. Unconfined compressive strength, Q in tons per sq. ft.
3. Sensitivity, St.
4. Natural moisture content, W.
5. Liquid limit, Lw.
6. Plastic limit, Pw.
7. Compressive index, Cc.
8. Preconsolidation pressure in excess of present oberburden pressure.
9. Blow : per ft. in standard penetration test, N.

In some cases, the bed is underlain at shallow depths by rock formation, e. g. of sand stone and shale. It may be filled with deposits of clay or silty clay overlain by sand. Careful studies of formation profiles in trial pits should be conducted. Tube samples 2 in. long of the deposit should be tested for unconfined compressive strength. There has been a case where the profile indicated the existence of soft sandstone having a laminated stratum, and the bund had breached repeatedly at the same location due to this. Clay shale bed rock was also noticed in the foundation in breached portions. The breaches were obviously caused from poor foundation soil. The physical properties of clay-shale bed rock are not clearly understood, and at one time it was classed as 'bed rock' and some times as 'hard-clay'. In the undisturbed state, it is dense, homogeneous and impervious, and appears to possess sufficient strength to support a dam above. But it is proved that it swells and softens when subjected to weathering. When it is present under the foundation a flat slope will be necessary for the foundation sections. Location of ground water level in the foundation and its pressure gradient should also be determined

The strength characteristics of the soil adjacent to the breached portions should also be ascertained. Suitable borrow pits should be selected for use in breach filling. Design features of effectively keying the breached sections into the existing bund on either flank should also be studied.

Slips in embankment

There are cases where slips have occured in the embankment portion without causing a complete breach. The detail of such slip which occured in the Malkapur Tank bun (Fig. 1) is given below.

In this case, a slice of soil had sunk to about 3 to 4 ft. below T. B. L. before it moved bodily forward by about 5 ft. In such a case, the field investigations should be first directed to determine the cause of slip. The curvature of the slice and the strength characteristics and natural moisture content of the soil in the sloped portion should be found. Sometimes slips in the upper portions of downstream slopes are caused from loss in shear strength of the soil

in the lower strata due to super-saturation of the soil from ineffective drainage of seepage flow. Construction of a masonry wall in the core of the embankment also contributes to the loss in shear strength of the soil adjacent to the wall. The slip in the Veerasamudram Tank bund (Fig. 2) is an instance of such a failure. Hence careful investigations should be conducted before remodelling old tank bunds where masonry core walls are constructed. The natural moisture content and void ratio of soil samples taken on the upstream side of the core walls will give an indication whether shear strength is in the fill near them. If the strength is inadequate remodelling will be necessary to avert possible failure of the bund.

3. Laboratory Tests

The tests usually conducted in the laboratory for proposed remodelling of old tank bunds include the following ;—

1. Indentification tests on the soil used in the bund construction.
2. Determination of strength characteristics of remoulded samples compacted to field in density and field moisture content.
3. Determination of permeability of the soil compacted to field in-situ density.
4. The stability of the existing bund with the existing slope has to be examined. This analysis is usually conducted by the draw-down condition for the upstream slope and under full reservoir condition for the downstream slope. The average strength characteristics of the soil are taken into consideration.

4. Design criteria for remodelling old bunds.

Proposals for remodelling an existing bund for increased storage capacity have to be finalised after evaluating its strength and slope stability. The following features of bund design, which commonly include considerations of seepage loss, point of interaction of line of saturation with the downstream side of the bund, steepness and stability of bund slope, and improvement by placing a blanket of pervious material, are to be checked. It will therefore be necessary to determine the position of the phreatic line for the section. The phreatic line for most of the old bunds are basic parabolas and not straight lines with the slope 4 horizontal to 1 vertical as assumed in the P. W. D., and is determined by analytical methods. Prof. Pavlovsky's theory on flow of water thr ugh homogeneous earth dams (theory of slope stability) for determining the seepage line in a dam is a simple and valuable aid to design engineers. The theory is based on consideration of forces exerted by seepage water. The seepage water through the dam meets resistance and for its flow some energy has to be spent. This condition exists in the dam where the line of saturation intersects the downstream slope and the unused kinetic energy exerts hydraulic pressure on the soil particles. This hydraulic pressure has an effect on the stability of the slope and has to be taken into consideration. The seepage pressure is localised in a definite region below the intersection of the line of saturation with the slope, and this, according to Pavlovsky, is followed by the sliding of a mass of earth above that region. Besides the 'slip circle' method, avlovsky's theory can also be used for design purposes. It is however found that the line of s turation as determined by Pavlovsky's method is at a lower level in the bund section than that determined by the basic parabola.

Several cases of remodelling of bunds increasing the storage capacity of reservoirs have been successfully solved by the author. These are mentioned in table 4.

TABLE --4

Remodelling of old tands bunds

Name of tank bund and location.	Object of remodelling	Remarks.
Malkapur, Sangareddy Taluq.	Strengthening for additional factor of safety.	Slip occured downstream
Veerasamudram, Vanaparty Taluq.	Strengthening for additional factor of fsaety.	Slip occured downstream slope.
Bhosaga, Gulbarga	For increased storage capacity	
Yellamma, Hosangabad,	For breach filling.	
Chintalacheru.	Strengthening for additional factor of safety, for breach filling, and for increased storage capacity.	

For tanks with water depth of 30 ft. and above under M. W. L. conditions, the average strength characteristics of the soil sample at the depth of 15 ft. should conform to the following specification.

Cohesion.	6 to 8 lb. per sq. in.
Angle of internal friction.	10 to 15 degrees
In-situ density	100 to 105 lb. per c. ft. (95 % of Proctor density)
Average permeability co-efficient in compacted state to field density	6 to 10 ft. per year

If the strength characteristics do not satisfy the above, the section is unsafe and remodelling will be necessary. In some cases, the author had to recommend the removal of 12 to 15 ft. of the existing old bund as it contained very poor quality soil with low degree of compaction. The remodelling of the Bhosga Tank bund, (Fig. 3) and the Chintalacheru Tank bund (Fig. 4) are examples of this. The section of the bund above this level is designed as a zonal section using impervious soil in the hearting, semi-pervious soil on the upstream and pervious soil on the downstream side. The design criteria recommended by the author for zonal sections are given in table 5.

The superimposed zonal section designed to the remodelled requirements has to be constructed under controlled conditions. The impervious soil is not available within economical lead, the width of the impervious core should be limited to 8 to 10 ft. as shown in (Fig. 2.)

If the remodelling proposals do not require raising of the bund but concern only improvement of its slope stability or reduction of seepage, then the following procedure is

recommended by the author.

The top width of the bund should not be less than 8 ft. If the seepage through the old bund is very heavy due to the presence of sandy soil, suitable filters should be provided at its downstream toe and the downstream slope flattened to at least 2 : 1 with a berm 5 ft. wide at the midpoint of the slope. In cases where reduction of seepage is of primary consideration, pumping bentonite clay under pressure into the core section should be considered. By this method, the voids in the previous material may be filled up and excessive seepage controlled. The method was thought of for strengthening the Baithpally Tank bund, but it was felt that it would result in the development of quicksand condltions in its lower strata which contained of the author is for grouting bv cement slurry of known consistency into the porous material. In one case where impervious soil was not available, soil stablised cement has been used to arrest heavy seepage in the bund and it has given the desired effect. This method should be tried often for remodelling.

In cases of breach filling the design of bund foundation is of importace . Usually breaches take place in narrow portions. There are many cases where breach took place at the same place over again. This may be due to two reasons (1) the soil selected for breach filling may not be satisfactory, (2) the fonndation soil may be of poor quality containing soft calcareous soil. A careful study of the soil profile in the foundation at least up to one-half the depth of water is very essential. If the breached sectlon has a water depth of more than 30 ft. under M. W. L. conditions, its design should be invariably of the zonal type. For lesser storage depths, homogeneous section may be adopted, depending on the availability of suitable soil with in economical lead. Fig. 5 shows proposed cross-section of Yallamma Tank for breach filiing.

Foundation design in breach filling shou d always be entrusted to the soils Engineer. Techniques for datermining strength characteristic of foundation soil are still in a research stage. The stresses developed in foundations under embankments are determined at present by certain mathematical formula based on elastic theory. But there are limitations in the adoption of these methods. At present the strength of soils at depths where large stresses are developed in the foundation are determined by laboratory tests and the factor of safety for foundation stability is caleulated from the results. In case the foundation consists of sheet rock, the morden practice is to cut trenches in it and paint it with bitumen or mud slurry. The old practiee of constructing masonry core walls is no longer adopted.

There are instances where the foundation in breached portions contains sand extending to depths of more than 25 ft below the bed. In such cases the relative density of sand and its void ratio at different depths should be determined. Where it is not economical to remove the entire sand stratum, a part of it may be removed, and two cut-off trenches, one in the centre and another at the upstream to of the bund, should be provided. These trenches should be filled with impervious soil. The depth of sand to be removed is fixed by conducting experiments for submerged density and quicksand conditions on the sand in the foundation. The author recommended this design in the breach filling of Yellamma Tank (Fig. 5) where the design of sand exceeded 20 ft. below the bed.

5. Joining breached section with old bund :—

Proposals for breach filling should also take into consideration keying of the breach filled portion into the old bund on both flanks. These joints always constitute weak spots unless precaution is taken in the design There are several instances of failure due to faulty joints. In cases where the breach abuts hill slopes, provision should be made for taking the impervious core at least 10 ft. into the cut in the hill slope. The old practice was to construct masonry core walls but this can not be recommended as the plane of contact between the soil and the wall allows passage surface and heavy seepage pressures would be developed at the down stream end of the section and lead to the failure of the bund.

6. General Consideration :

The growth of trees on the downstream slope of bunds is not desireable as roots of dead trees eventually decay and form seepage ducts. In remodelling old buna containing big-trees, careful consideration should be given whether or not to distroy such trees whose roots pierce the the lower section of the bund.

Seepage from embankments and foundations is usaually allowed to drain into borrow pits located within a few yards of the downstream toe. This is bad practice. An accumulation of seepage at the toe saturates the foundation soil and weakens the bund and its founda-tion. The seepage water should be drained away to the nearest valley and all the existing old borrow pits filled up.

Repairs to old bunds including remodelling are usually carried out by contractors. Where remodelling involves the use of road rollers, the desireable degree of compaction is usually obtained. But in all other cases, compaction is done by hand tamping. Even here mechanical compaction should always be insisted upon. The use of frog rammers, sheepfoot tampers, etc, should be stressed in remodelling even small tank bunds for increased stability.

TABLE 5

Design criteria for zonal sections of eart . dams.

Soil Characteristics for zonal sections.	Design Values.	Remarks.
1. For impervious zones		Tests for 1 (a) to (e) and 2 (a) to (d) conducted on soil passing 4 mesh.
(a) Cohesive strength.	Above 10 lb. per sq in.	
(b) Angle of internal friction.	Less than 5 degrees	
(c) Permeability at Proctor compacted state	Below 1 ft. per year.	
(d) Optimum dry density (Proctor compaction)	Between 90 to 95 lb. per cft.	
(e) Atterburg test.		
(i) L. L. of soil	Between 40 to 65	
(ii) P. L. of soil.	Between 25 to 40	
2. For semi-pervious zones.		
(a) Cohesive strength.	Between to 10 lb. per sq. in	
(b) Angle of internal friction.	Between 5 to 15 degrees	
(c) Permeability at Proctor compacted state.	1 to 6 ft. per year.	
(d) Optimum dry density (Proctor compaction)	Between 100 to 110 lb. per cft.	
(e) Atterburg test		
(i) L. L. of soil.	Between 30 to 40	Tests conducted on soils passing 40 mesh.
(ii) P. L. of soil	Between 20 to 30	
3. For pervious zones.		
(a) Cohesive strength	Below 5 lb. per sq. in.	Tests conducted on soils passing 4 mesh.
(b) Angle of internal friction.	Not less than 30 degrees	
(c) Permeability at Proctor compacted state.	More than 6 ft. per year.	

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh,

No. 49-L/W (I) Dated 3rd July, 58

All Superintending Engineers
Madhya Pradesh

Subject :- Madian Tank Project in Durg Distt. (Mahakoshal Region)
Approved Head sluice Drawing.

The approved head sluice drawing of Madian Tank Project is enclosed herewith for reference.

Sd/
Chief Engineer,
Irrigation Branch M. P. P. W. D.,
Raipur

SECTION ON C.D.E.

HALF TOP & HALF BOTTOM PLAN.

Top of The Bund. RL. 1206·00

Dry Stone Pitching 1'Thick over 6" Chips.

Grouted pitching

Barrel 4x5'

Weepholes 6' Apart Above F.S Level.

Puddle Filling

12" R.C.C. Slab

6" C.C. Cap.

Temporal Joint.

Cement Concrete 1:5:10.

6" C.C. Flooring 1:2:4.

SECTION ON XX.

Distribution Bars ¾ ϕ @ 9¾" c/c.

DETAIL OF R.C.C. SLAB ON BARREL.

SCALE 1" = 1'-0"

C.C. Coping 3 Thick

C.C.C. 1:2:4 Flooring.

CROSS SECTION ON A-A.

T.P SECTION.

RL. 1183·75

RL. 1182·75 Kankar Soil

Hard Moorum

RL. 1175·00 Soft Rock

Certified that the T.P Section is as shown above.
sd., K. Harry Reginald.
S.D.O Khairagarh

Grouted stone Pitching 12" Thick

Bed of Approach RL. 1175·00

Suitable Wing leading to the Bridge to be provided.

HEARTING

CASING

Puddle Filling

Cement Concrete Lining.

NOTE:- ROAD BRIDGE HAS BEEN PROVIDED FOR THE PURPOSE OF INSPECTION AS PER THE INSTRUCTIONS CONTAINED IN C.E.'S MEMO. NO. 122-M/W 11/56 DATED. 4-2-1957.

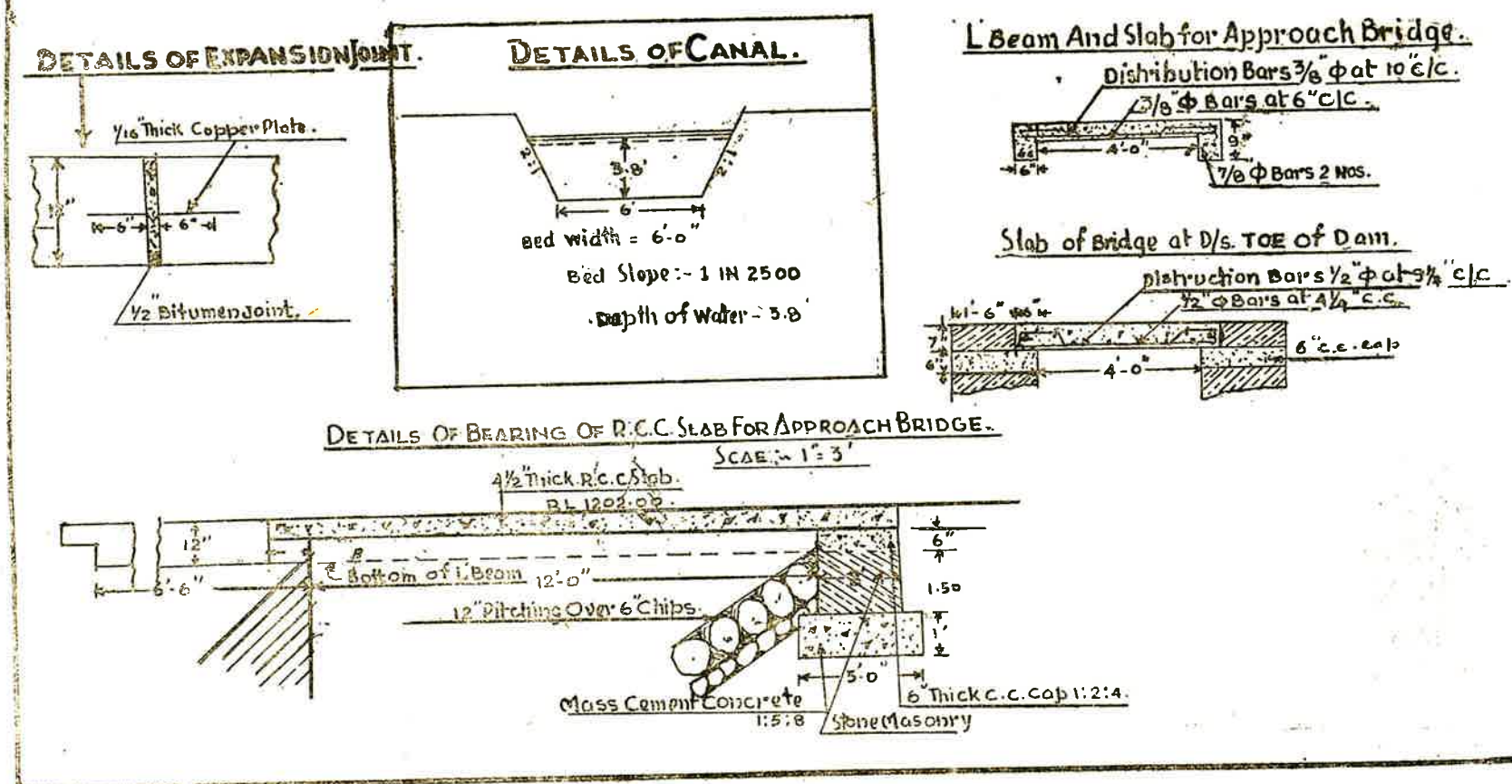
LONGITUDINAL SECTION.

DATUM - 1160.00

TOTAL DISTANCE

REDUCED LEVEL

To Dy. Rf. Nagpur.



CALCULATIONS

DATA

L. S. L.	1175.00	F. T. L.	1197.00
H. F. L.	1200.00	T. B. L.	1206.00
Area to be Irrigated			64.00 Acres
Duty of Cusec			80 Acres
Discharge required			6400/80 = 80 cusecs
Add 5% for losses			20 Cusecs
		Total	100
Add 15% for Future Expansion			15 Cusecs
		Total	115 Cusecs
The Sluice Gate should be able to discharge			115 Cusecs
Minimum Head Allowed			2'-0"
Velocity Caused	$= C\sqrt{2gh}$		7.92/Sec.
Area of Sluice Gate	$= 115/7.92$		14.5 sq. ft.

Provided a Gate of 4'×4' size since Tung abhadra Workshop have 4'×4' Gates ready and will be in a position to supply early.

Barrel provided 14.5+20% $= 14.5+2.9 = 17.4$

So 4'×5' section has been provided.

SLAB OVER BARREL

R. C. C. CALCULATION—The Slab is to be designed to resist the Column of Earth above (Saturated)

Slab thickness = 12"

Weight of Earth over the barrel = R.L. (1206–1181)

Weight of Earth per R.F.T. = 25×130=3230 Lbs. =25ft.

Self wt. of Slab $12/12\times150 = \frac{150 \text{ lbs.}}{3400 \text{ Lbs.}}$

Span = 4 Ft. Effective Span = 5 ft.

Max B.M. $\frac{3400\times5\times5\times12}{8} = 127500$ in Lbs.

Values for FC = 600 Lbs./ Sq. in

FS = 12000 Lbs./Sq. in.

M = 15

Effective depth $D = \frac{\sqrt{M}}{110\times12} = \frac{\sqrt{127500}}{110\times12} = 9.85"$

Over all depth = 9.85+1.5=11.35"

Provided = 12"

AREA OF STEEL

in) As $\frac{1.07\times12\times9.85}{100} = 1.26$ Sq. inches

Provided 3/4 dia M. S. bars @ 4.2 Say 4.25 Crs.

Distribution Steel @ 20% Main reinforcement

$= 1.26\times\frac{20}{100} = 0.252$ Sq. in.

Provided 3/8" bars @ 5¼" Crs.

DESIGN OF SLAB BELOW TOWER

Assuming Slab Thickness 15"

Height of Masonry over the Slab = R. L. 1202.00—1181.25=20.75 Ft.

Weight of Masonry per R Ft. = 150×20.75 = 3113 Lbs.

Self-wt. of Slab per rft. $= \frac{15}{12}\times150 = 188$

Total Load :—3301 lbs. Say—3300 lbs.

Span = 4ft. Effective Span = 5 Ft.

Max B. M. $= \frac{W\,l^2}{8} = \frac{3300\times5\times5\times12}{8} = 12.3750$ ft. lbs.

Effective Depth $D = \frac{\sqrt{M}}{110\times12} = \frac{\sqrt{123750}}{110\times12} = 9.68"$

Add for cover 1.5" Total Depth=9.68+1.5=11.18" say 12"

But Provided 24" (This is to keep in line with barrel Slab)

Area of Steel (Main) $As\frac{1.07}{100}\times12\times9.68 = 1.24$ Sq. inch "Provided 3/4" O bars @

Provide ; 3/8" dia bars. @ 5.32" Crs.

NOTE—But for convenience and as the extra cost is not much same Reinfo per Slab Over Barrel is provided as per order of C.E.

i.e., (i) Main Reinforcement 3/4" dia 4.25" Crs. (ii) Distribution bars 3/ 8"

CHECK FOR BEARING PRESSURE UNDER

Total Weight coming on the whole Slab and beam are

1] Self weight	530×12	= 6360 Lbs.
2] Live Load at 100 Lbs/Sq. Ft.	100×12×5	= 6000 Lbs.
3] Wt of Railing at 20 lbs/Rft.		= 480 Lbs.
4] Pin Point Load 1 Ton		= 2240 Lbs.
TOTAL		15080 Lbs.

Total Load coming on each support $\frac{15080}{2}$ 7,540 Lbs.

Wt. of Concrete in Founds	6×3×1×120	=2160 Lbs.
Wt of Masonry	5×2×1½×150	=2250 Lbs.
Wt. of Concrete Cap	5×2×1/2×120	= 600 Lbs.

Total=12550 lbs or 5.6 tons

This is distributed over Area of 3×6=18 Sq. ft.

∴ Load per Sq. ft. = 5.6/18 = 0.31 Ton which is safe.

DESIGN OF APPROACH FOOT BRIDGE

I (A) DESIGN OF SLAB – Assuming Slab Thickness as 6″

(1) Self Weight of Slab = 1/2 × 150 = 75 Lbs.
(2) Live Load at 100 Lbs 100 Lbs

Total 175 Lbs.

Clear span is 4′-0″ and effective span is 5′-0″

$$\text{B. M.} = \frac{175 \times 55 \times 12}{8} = 6562 \text{ inches lbs. Say } 6570 \text{ inches Lbs.}$$

$$f_c = 750,\ f_s = 18000,\ Q = 126$$

$$d = \sqrt{\frac{M}{Qb}} = \sqrt{\frac{6570}{126 \times 12}} = 21''$$

Taking Cover of 1.5″ Depth of Slab will be 3.6″

But provide over all thickness of 4 1/2″

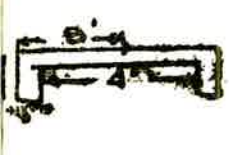
$$\text{Area of Steel } A_s = \frac{6570}{18000 \times 0.87 \times 2.1} = 0.134 \text{ Sq. inch}$$

Adopt 3/8″ dia. @ 5″ c/c as spacing should not exceed
This gives an area of 0 265 sq, inch,
Distribution Reinforcement is 20% of the above = 0.026 Sq. inch
Adopt 1/4″ dia at 10″ c/c.

[B] DESIGN OF 'L' BEAM

(i) Load from Slab 175 × 5 × 1/2 = 437 1/2 lbs.
(ii) Wt. of rib say 6″ × 12″ = 72 lbs.
(iii) Wt. of railing 20 lbs/rft = 20 lbs.

Total 529 1/2 lbs say 530 lbs.



Clear Span is 12′-0″ and effective Span is 13′-0″

$$\text{Max. B. M.} = \frac{530 \times 13 \times 13 \times 12}{8} = 1,34,355 \text{ inch lbs.}$$

Breadth of Flange 1/6 × 12 × 12 – 26″ (1/6 Effective Span "L" Beam)
,, 6″ × 24″ = 30″ – (Breadth of rib + clear distance between ribs)

HENCE ADOPT WIDTH OF FLANGE — 24″

Effective Depth = 9″
The neutral axis falls within Slab. The Design is, therefore, just like that of ordinary Rectangular Beam.

$$\text{Lever Arm } jd = d\left(1 - \frac{n}{3}\right) = 9\left(\frac{1-0.385}{3}\right) = 7.648$$

$$\text{Resisting Moment} = 126\ bd^2 = 126 \times 24 \times 9 \times 9 = 2,44,944.$$

This is more than the B. M. 1,34,355 Inch lbs.
Hence Section adopted is Safe

$$\text{Area of Steel} = \frac{\text{B. M.}}{f_s . Id} = \frac{1,34,355}{18000 \times 0.87 \times 9} = 0.96 \text{ Sq. Inch}$$

Provide 1/8 Bars 2 Nos. Giving 1.263 Sq. Inch.

$$\text{Shear} = \frac{530 \times 6.5}{6 \times 0.87 X 9} = 73.5 \text{ Lbs./Sq. Inches which is safe.}$$

As per Notings on 1/N to 3/N of file No. 68/SE (D) 66 "Received the drawings from S. E. (D) Raipur."

II ALTERNATIVELY R. S. JOISTS CAN BE USED.

Ft. (Tension or Compression) = Tons/Sq. in
Ft. (Shear intensity.) = 3 Tons/ Sq. in
Ft. = 7 × 2240 = 15,680 Inch lbs.

B. M. = MR X Ft.

$$\text{M. R.} = \frac{1,34,355}{15,680} = 8.5\text{§}.$$

Refering to the properties of R. S. Jois's Section (P. 45 of hand Book by P. N. Khanna)

5″X4/12″ is suitable. This gives 18 lbs./Rft. & gives a Modulas of 9.1

BRIDGE SLAB ON D/S TOE OF DAM

Adopt Class Up Loading.

For 4″ Clear Span over all Depth 1″ Effective Depth 20 Ft.
Main Reinforcement 1/2″ dia Bars at 4/4″ c/c
Distribution Reinforcement 1/2″ dia bars at 9 3/4″ c/c.
Wheel Guards to be Provided.

NOTE :–

(i) Wheel Guards to be provided for the Bridge at D/S Toe of Dam.
(ii) Suitable Steps Leading to Bridge to be provided on D/S Face of Dam.
(iii) The U/S Slope under Tower is changed to 1.1/2 :1 to reduce the Span.

GOVERNMENT OF MADHYA PRADESH IRRIGATION BRANC

HEAD SLUICE

MADIYAN TANK PROJECT IN DURG DIST. MAHAKOSHAL

Drawn By Sd. K. Hanry Reginold [B. E.] S. D. O. Khairagarh	Submitted By :- Sd. R. N. Pathak Ex. Engineer Juhri
Traced By :- G. N. Biturwar Dt. 4—8—58	Recommended By:- Sd. S. G. Inamdar S. E. Tandula Ci
Checked By :- Sd. B S. Suba Rao (A. E)	Approved By :- C. E. Memo No. 49-L Dated 3rd July 19
Scale :- 1″ INCH = 5′ FEET	Approved by :- Sd. M. L. Sood Chief Engineer; Irrigation BR
Retraced By :- R. MAHAWADI. Tracer, Designs, C. E. Irri. Dept. RAIPUR M. P.	

OFFICE OF THE CHIEF ENGINEER
P. W. D. Irrigation Branch M. P. Raipur

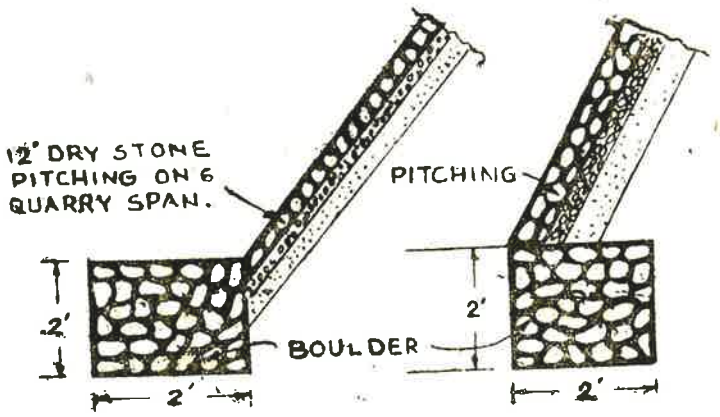
No. 370 / w(I) 58. Dated 2nd August 58.

All Superintending Engineers
All Executive Engineers

Sub :— Section of an earth dam-toe wall below the pitching.

It is observed that the junction of toe wall and stone pitching is not properly indicated on drawings.

The correct junction is as indicated below :—



CORRECT POSITION INCORRECT POSITION

Officer on Special duty (D)
for Chief Engineer, P. W. D.
Irrigation Branch M. P.

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh

No. 24-G/F/58

Dated, Raipur, the 9th Sept. 58
18 Bhadra, 1880.

The Chief Engineer, Flood (P&D).
Central Water & Power Commission,
Flood Wing,
New-Delhi.

Sub :- Setting up of new Sediment sites and Laboratories.

Ref :- Your letter No 12.4.56 Sf.c. M3572 dt. 5.3.57 and SCM 11.9.58-508 dated 9th March, 1958.

It is proposed to establish about 17 silt observation stations in the Madhya Pradesh State in the comming years in view of the several projects to be taken up.

2 The names of the proposed stations as well as the existing ones are shown in the list enclosed herewith.

3. The stations at Kasayari, Pararah, and Unchera, which are shown as existing ones in your list, have been omitted as this office has no information about their functioning. Superintending Engineer concerned have been requested to report the position and his report is awaited. However these stations have been included in the list of names proposed ones.

4. In the list sent by you, a site has been proposed near 'Sakalda' dam site on Narmada river. The location of this site may please be indicated. Probably it is 'Chikalda' and not Sakalda. Instead a silt odservation site at on Narbada which is some distance above the 'Chikaldali', site is proposed.

5. A silt observation station at Bamori Dam site has been shown on Sind river. This may please be corrected as Bamori Dam site is on 'Suket Nadi' which is a tributary of Parbati river. On Sind river a silt observation site is proposed near Karera in Shivpuri District.

The silt observation station at Barakachhar was closed and shifted to Dudhawa site on Mahanadi river which is under operation since 1955.

Similarly site below confluenee of Denwa and Tawa also may be treated as existing against Bagra Tawa station.

Requisition for the loan assistance would be made in due course when final estimates are prepared.

Copy of each of the sample estimate is also sent for information.

Yours faithfully,

Sd/-
Secretary,
Technical Advisory Committee
to State Flood Control Board,
Madhya Pradesh, Raipur.

Encl : One statemen
& estimate.

Endt. No. 24 –H/F/58 Dated, Raipur, the 9th Sept. 1958, 18 Bhadra, 1880.

Copy forwarded to : —

1. All Superintending Engineers.
2. All Superintendents of Works.

For information and necessary action. Necessary estimate may kindly be submitted early, with a site plan, showing the location of the station and its Latitude and Longitude. A sample estimate for Gauge, Gauge and Discharge and Silt observation stations is enclosed herewith for your guidance which may be modified where called for. The enclosed statement may also kindly be perused and corrections and modifications, if any, may be indicated.

Yours faithfully,

Encl :– 1 Statement
1 Estimate

Sd/–
Technical Advisory Committee
to State Flood Control Board,
Madhya Pradesh, Raipur
For Chief Engineer, Irrigation.

ABSTRACT

ESTIMATE FOR SETTING UP OF SILT OBSERVATION STATION ONLY

Quantity & Sub-head	Rate Rs.	Per	Amount Rs.	Total Rs
I. Installation of Equipment:				
1) Special silt equipment as per details			1000/-	
2) Ordinary silt equipment as per details			815/-	
			1815/-	
Add for fluctuation of market Rates 20%			364/-	
			2179/-	
			Total say Rs.	2180/-
II. Maintenance and Operation				
1 year Silt Analyst	160/-	P. M.	1920/-	
L. S. Repairs to sampler etc.	L. S.		50/-	
			Total 1970/-	
Add contingency 3% on Rs. 1970/-			59/-	
			2029/-	
		or say Rs.		2030/-
Total I 2180 and II 2030			= 4210/-	

Note—Provision of boat and crew is not included in this as it is presumed that wherever there is silt observation stations, there will be discharge station also.

ABSTRAC

Sample estimate for setting up of Discharge & Silt Observation Station

Quantity	Sub-head	Rate Rs	Per	Amount Rs.	Total Rs.	
1.	Installation & Equipment.					
L. S. 1	Cable, Anchorage, Chains etc including fixing		L. S.	500/-		
L. S. 2	Cost of a boat for observing discharges.		L. S.	1000/-		
L. S, 3	Making Approach roads etc.		L. S.	800/-		
L. S. 4	Construction of temporary quarter and storage godown etc.		L, S.	900/-		
					3200/-	
L S. 5	Mathematical Instruments					
1	(a) Levelling instruments	1000	per one	1000-		Rates as per estimate submitted by S. E. Rewa in connection with Bichi gauge station.
2	(b) Levelling staff 14' long	75	do	150/-		
1	(c) Current meter	1000	do	1000/-		
1	(d) Measuring tape 100'	50	do	50/-		
1	(e) Stop watch	75	do	75/-		
1	(f) Refill.	30	do	30/-		
1	(g) Chain with arrows 100'	30	do	30/-		
1	(h) Prismatic compass	250	do	250/-		
1	(i) Ranging rod 8' long 10 Nos.	7/8/-	do	75/-		
1 set	(i) setsquare	5.00				
1 No.	(ii) Parallel roller	30.00				
1 No.	(iii) Triangular scale with bar	15.00				
		50.00		50/-		
6	Silt equipment					
(a)	Special Silt equipment as per list			1000/-		
(b)	Ordinary silt equipment as per details			815/-		
			Total	4525/-		
	Add 20% on fluctuation of market rates of equipment on Rs. 45.25 × 20 = 905.00			905/-	5566/-	
	Add 3% contingency on Rs 4525/-			136/-		
				5566/-		
					8766/-	

Say Rs. 8770/-

ABSTRACT

Estimate for setting up of river or stream gauge station

Quantity	Sub-head	Rate Rs.	Per	Amount Rs.	Total Rs.
RIVER OR STREAM GAUGE					
1	Installation and eqiupments 30 R ft. Length of gauge 30'	5/-	R. ft.	150/-	150/-
P.	Maintenance & Operation				
L. S.	Maintenance of gauges	L. S.		10/-	
6 months	Part time gauge reader or 1 No. per site for 6 month.	30/-	per month	180/-	
	Contingency 3%			6/-	
			Total	196/-	
			Say Rs—	200/-	

ABSTRACT

Quantity	Sub-head	Rate. Rs.	Per.	Amount. Rs.	Total Rs.
	II. Maintenance and Operation				
L. S.	1) Rating for current Meter for one year		L.S.	30/-	
208	2) Skilled Khalasis for dis--charge observations 4nos. per day per week 4x52 at Rs. 2.50 per day.	2.50	day	520/-	
60 gallons.	3) Kerosine Oil for super--visors, gauge readers etc. 5 gallons, per site per month for year 1x12x5=60 gallons.	1.5	gallon	90/-	
L. S.	4) Miscellaneous including stores, cotton, ropes etc; including spares.	L. S.		100/-	
L. S.	5) T. A. for work charge establishment	L. S.		200/-	
	6) Repairs to silt Sam--plers etc.	L. S.		50/-	
	Establishment :-				
1 year	7) Supervisor, one on	158/-	P. M.	1896/-	
1 year	8) One silt Analyst.	160/-	P. M.	1920/-	
1 year	Post and Telegraph Stationary at Rs. 15/- P. M.	15/-	P. M.	180/-	
	Add for Contingency 3% on item 2,3,7 and8			132/-	
				5118/-	5118/-
			Say Rs.....	...5120/-	

Total 1 and II
8770+5120 = 13,890/-

Note:--- (1) The rates are mostly based on the ones provided by the C. W. &. P. C. for similar estimates. They may be modified where required.

(2) The provision of the Ma thematical Instruments may be deleted or modified according to the requirements.

STATEMENT SHOWING THE SPECIFIED EQIUPMENT FOR A SEDIMENT OBSERVATION LABORATORY

S No.	Name of article	Lowest Rate Rs.	Qty. Reqd.	Amount
1	2	3	4	5
1	Tongs brass for dishes test tubes, flask length 9''	1/4 each	3 nos	Rs. 3/12/-
2	Stop watch swiss made.	35 "	1 no	Rs. 35/-
3	Hot air oven metallic with iron stand I'×I'×I'.	45 "	1 no	Rs 45/—
4	Chemical balance (sensitivity 001gm) in a case	135 "	1 no	Rs. 135/—
5	Weight box 1–100 gms. with wts.	28 "	1 no	Rs 28/—
6	Trough or basin enamelled rectangular or circular	1/8 "	1 no	Rs. 1/8/—
7	Enamelled buckets with lids size $1\frac{1}{2}$" dia.	8/8 "	6 nos	Rs. 51/—
8	Enamelled plates 9" dia.	-/12 "	6 nos	Rs. 4/8/—
9	Enamelled jug–4pints copacity	4/8 "	1 no	Rs. 4/8/—
10	Enamelled bowls (cup) 1 pint. cap.	1 "	2 nos	Rs. 2/—
11	Enamelled funnel 6" dia.	1/12 "	2 nos	Rs. 3/8/—
12	Enamelled funnel 9" dia.	3/4 "	2 nos	Rs 6/8/—
13	Funnel stand teak wood	1/6 "	2 nos	Rs. 2/12/—
14	Funnel stand wooden double, teak wood	1/8 "	1 no.	Rs. 1/8/—
15	Stand for silt measuring tubes 20 holes	2/4 "	2 nos	Rs. 4/8/—
16	Stove Primus (kerosene oil)	41/8 "	1 no	Rs. 41/8/ –
17	Tripod stand	-/12 "	1 no	Rs.-/12/-
18	Flexible wire 3/16" dia.	8/- lb.	50 ft	Rs. 50/-
19	1 Bucket 12"	2/8 ,,	1 no	Rs. 2/8/-
20	Plier 8" long	4/8 ,,	1 no	Rs. 4/8/-
21	Pipe wrengh 14 "	18 ,,	1 no.	Rs. 18/-
22	Physical balance in a glass case sensitivity 1 mgm.	60 ,,	1 ,,	Rs. 60/-
23	Weight box for above with 1.50 gm. & mgms. weights.	7/8 ,,	1 no	Rs. 7/8/.
24	Pipettee stand wooden	4/4 ,,	1 ,,	Rs. 4/ 4/-
25	Tringular file 6"	1/-,,	1 ,,	Rs. 1/-
26	Brush for cleaning cylinders	1/4 doz	3 nos	Rs. -/5/3
27	Brush for cleaning test tubes	-/10/- ,,	3 ,,	Rs. -/2/6
28	Wire gauge with asbestos	1/7/9 ,,	5 ,,	Rs. /12/-
29	Pipe clay triangles	-/12/- ,,	2 ,,	Rs. -/2/-
30	Rubber cork for silt sampler	1/8 ,,	2 doz	Rs.3/-
31	Cork borer set	2/8 Set	1 no.	Rs. 2/8/-
32	Beakers tall 500 cc. glass	48 doz	1 doz	Rs. 48/-
33	Measuring cylinders 1000 cc.	45 ,,	2 nos	Rs. 90/-
34	Measuring cylinders 500 cc.	27 ,,	2 nos	Rs. 54/-

1	2	3	4	5
35	Desicator 9″ dia.	29/8 „	1 no.	Rs. 29/8/-
36	Flask F. B. Glass 1000 cc. cap.	3/- each	3 nos	Rs. 9/-
37	Funnel glass 4″ dia	9/- doz	3 nos	Rs. 4\8\-
38	Pipette glass 100 cc.	1/12/ each	1 no	Rs. 1/12/-
39	„ „ 25 cc,	-/8/8/- „	2 nos	Rs. 1/6/6/-
40	Porcelain basin 3.5″ to 4.0 dia glazed inside and out side	25/8/- doz	6 nos	Rs. 12/12/-
41	Thermometer 50°C 1/10 (English and German)	11/8 each	2 nos	Rs. 23/-
42	Thermometer 111°C (English)	3/12 „	2 „	Rs. 7/8/-
43	Rubber pade 6″ dia	/8/- „	2 „	Rs. 1/—
44	Bottles glass ordinary I ib, cap.	2/12 doz	1 doz	Rs. 2/12
45	Filter paper circular whatmen No. 2,15 cm dia	3/14 pkt·	2 pkts,	Rs. 7/12
46	Glass tubing assorted.	1/- per lb.	2 lbs.	Rs. 2/—
47	Presure rubber tubing 5/16″ bore	-/7/- erft.	30 ft.	Rs. 1/32/—
48	Filter paper sheet whatman No. 2	110/- ream	1/2 ream	Rs. 55/—
49	Glass marking pencils	3/- per doz	6 Nos.	Rs. 1/8/—
50	Calcium chloride fused	1/- lb	1 lb	Rs, 1/—
51	Sodium hydroxide	3/- lb	1 lb	Rs. 3/—
52	Glass rod assorted	1/4 lb	2 lbs	Rs. 2/8/—
53	Sodium carbonate	1/8 lb	1 lb	Rs. 1/8/—
54	Watch glass 4″ dia.	1/12 doz	6 nos	Rs. -/14/—
55	Spirit Lamp glass 4 ounce cap.	10/8 doz	I doz	Rs. 10/8/-
56	Test tube holders	1/2 each	2 nos	Rs. 2/4/—
57	Pinch corks	-/8/- doz	6 nos	Rs. 0/4/-
58	Meter Rod	1/- each	1 no	Rs. I/—
59	Burette stand wooden double	4/- „	I no	Rs. 4/—
60	Bucket stand wooden with hooks	30/- „	1 no	Rs. 30/-
			TOTAL	Rs. 815/—

Statement showing the specified equipment for a Sediment Observation Laboratory

S. No.	Name of Article	Lowest Rate Rs.	Qty. Reqd.	Amount.
1	Bottle type silt samplers 18' long	67/15 each	1	Rs. 67/15/–
2	do 10' long	63/15 ,,	1	Rs. 63/15/–
3	Double jacket cylinder	37/15 ,,	1	Rs. 37/15/–
4	Puri	61/15 ,,	1	Rs. 61/15/–
5	Apparatus.	36/15 ,,	1	Rs. 36/15/–
6	Bed silt sampler	69/15 ,,	1	Rs. 69/15/-
7	Metallic one litre bottle	7/8 ,,	2	Rs. 15/ –
8	Sieve brass 4 in. dia height 3 in with 100 sieve cloth	12/- ,,	1	Rs. 12/—
9	New of sieves with mesh 4,3,5,3,2.5,2,1.5 1.0 and 0.6 mm.each sieve of dia 4" height3'	95/– ,,	1 set	Rs. 95/–
10	Puri's Siltometer with accessories	415/– ,,	1 set	Rs. 415/–
11	Silt measuring tubes glass capacity 2 ml.	1/8/- ,,	2 doz	Rs. 36/–
12	do cap. ml. 5	2/– ,,	2 nos	Rs 4/-
13	Conical flask (cap. 1000 ml.) made of brass.	7/8/- ,,	2 nos	Rs. 15/-
14	Beakers 500 ml. capacity tall type without spout made of brass.	53/- doz	1 doz	Rs. 53/–
			Total	Rs. 984/—
			Say	Rs. 1000/—

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh

No. 18/D-1/58 Raipur, dated the 6th December 58

All Superintending Engineers

Sub.—Boulder Toes of Earthen Dams

Following instructions regarding boulder-toes are issued for your guidance :—

(i) Ordinary Boulder Toe should be provided on the down-stream throughout the length of earthen dam excepting the portions of embankment which do not hold any water up to H. F. L.

(ii) The height of the toe should ordinarily be kept at one sixth the height of the embankment.

(iii) Variations can be made in the above specifications for reasons of cost, nature of foundation, topography, etc., if required, with the permission of Superintending Engineer.

Sd/-
Deputy Chief Engineer
for Chief Engineer, P. W. D.
Irrigation Branch, Madhya Pradesh

Note—For modified instructions refer T. C. 16/W (M) 61 dated 30-11-61, T. C. No. 38/W (M) 63 dated 23-3-63 and T. C. 40/W (M) 63 dated 18-5-63

OFFICE OF THE CHIEF ENGINEER, P. W D
Irrigation Branch, Madhya Pradesh.

No. 328/W (1) Raipur, dated the 7th January, 59

All Superintending Engineers,
All Superintendent of Works
All Executive Engineers

Sub:—Construction of and repairs to small village tanks (specifications)

Copy of this office memo No. 346/W of 54 dated 9-3-1954 together with the copy of this office memo No. 741-W-3/B. dated 25-4--1958 in supersession of para 2 of the above memo is enclosed.

These specifications will particularly apply to the minor irrigation works executed under the community Development programme.

Encl :—As above

Sd/—
Superintending Engineer,
Minor Irrigation P. W. D.

OFFICE OF THE CHIEF ENGINEER, P.W. D.
Madhya Pradesh

Memorandum

No. 346/W

Nagpur, dated the 9th March 1954

To

All Superintending Engineers
All Executive Engineers
Madhya Pradesh

Sub:—Construction of and repairs to small village tank

Certain instructions were issued in this office memo No. 595-A/W dated 15-11-49 and this office memo No. 601/F/W dated 9/1/1951 to adopt cheaper specifications for such tanks than ordinarily adopted for irrigation tanks. It is, however under stood that most of the P. W. D. officials, working in Community Projects and in National Extension Service Blocks are either unawre of these instructions or are not giving effect to them. It is, therefore, considered desireable to draw special attention to these instructions which are reproduced below :—

(1) Ordinarily, no puddle trench is necessary except in the nala portion or where heavy leakage is anticipated due to soil being very porous.

(2) Ordinarily, no pitching is necessary.

(3) Free board, flood lift, top width and slopes of bund can be kept as below:

Ht. of bund from G. L. to H. F. L. (Feet)	Free Board (Feet)	Width of top (Feet)	Slope of bund	Flood lift (Feet)
Upto 11	3	4	2:1	1
above 11	4	6	2:1	2

(4) Sluice should be of Hume pipe barrel type with locally prepared hand operated wooden shutter.

(5) Irrigation can be done from open cut but whenever possible sand/cement oultet pipes should be provided.

(6) Irrigation channels should be of water course specification with bank top widthof $1\frac{1}{2}$ free board 1' bed width 1' to 2' land side slope $1\frac{1}{2}$:1 Bridges should be of pipe crossings either without face walls or of dry stone/brick masonary.

2 No instructions have so for been issued about the design of waste weir and spill channel. Ordinarily irrigation tanks are about 60% tanks but village tanks generally are over 80% tanks As such the width of waste weir and spill channel can be substantively reduced. Ordinarily half of the normal widths can be kept but where soil is not bad further substantial reduction can be made. The main thing is to reduce cost to the maximum. Of course some risk is necessarily involved in this, but it is adviseable tb run such risk to reduce initial cost. After. all steps can be taken in due time to prevent damage to an undesireable extent.

Sd/—
Chief Engineer P. W. D.
Madhya Pradesh

No. 346-Ka/Ka-54 Nagpur dated the 9th March 1954

Copy is forwarded to :-

All Dy. Commissioners, Madhya Pradesh
All District Development Officer, Community Projects.

for information. It is requested that the instructions may please be brought to the notice of all P. W. D Officials working with you.

Sd/-
Chief Engineer
P. W. D. Madhya Pradesh

Office of the Chief Engineer, P. W. D.

Irrigation Branch, Madhya Pradesh

No. 741-W-3/B Nagpur, Dated 25th April 1956

All Superintending Engineers (Irrigation)

Sub:—Construction of Minor Irrigation Tank and Village Project Tank.

The instructions already issued for the construction and repair to small village tanks vide this office No. 346/Ka 54 dated 9th March, 54, copy sent with this office memo No. 741. 4-2/BI dated 21st/24th April will also hold good for nistar tanks as well as for famine relief tank

No reduction should however be made in the design of waste weir and spill width. Full width as required by a proper design should be followed even for village and nistar tanks.

Sd/—
Superintending Engineer
for Chief Engineer, P. W. D.
Irrigation Branch, M. P. Raipur

OFFICE OF THE CHIEF ENGINEER, P.W. D.
Irrigation Branch, Madhya Pradesh

No. 94/W (i)--59 Raipur, dated the 19th Febry 1959.

All Superintending Engineer

All Superintendent of Works

Sub :— Top width of bund.

Ref :— This office No 304-V.-W/I-56, dated 10-12-56

On reconsideration it is found that the top width of 16' for the heights of dam say 30' to 60' is rather on a high side. It should be reduced to 12'.

In view of this the circular under reference may kindly be amended as below :—

Maximum height of dam in feet	As now proposed to be amended.
As in T. O. No. 304 V /W /I-56 dated 10-12-56	
,, (b) 16'--30'	(b) 16'-60'
,, (c) 30'-100'	(c) 60'-160'

Sd/--
Superintending Engineer (D)
for Chief Engineer P. W. D.
Irrigation Branch Madhya Pradesh

OFFICE OF THE CHIEF ENGINEER, P. W. D.

Irrigation Branch, Madhya Pradesh

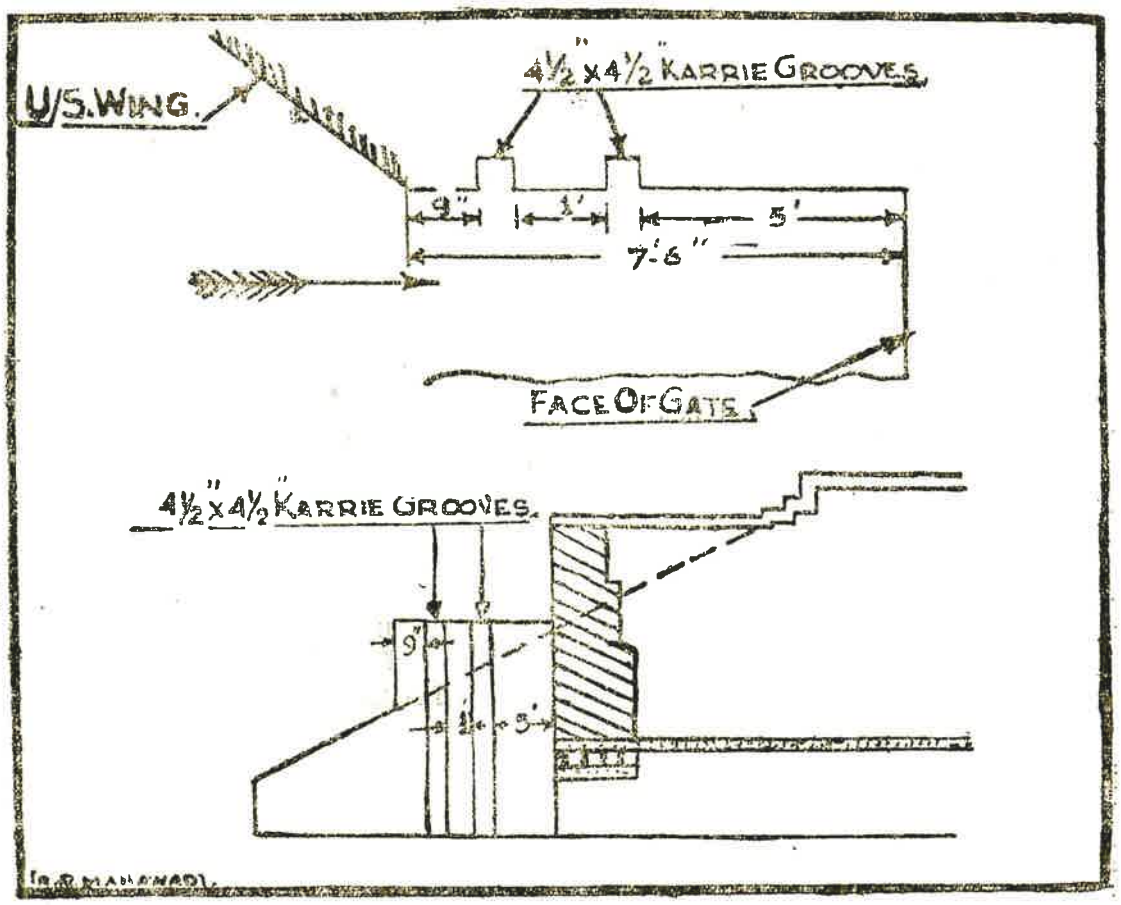
No. 9-D/-T 59 Raipur, dated the 17th March 1959.

All Superintending Engineers
All Superintendent of Works.

Sub :— Karrie Grooves in front of Sluice Gates of Tank (depth of water upto 40')

Ref :— This Office No. 13-K/D (I)–56 dtd. 6–11-59

According to the above circular, the space between the face of the gate and the first row of Karrie grooves is prescribed to be 2'. This is rather on the low side. It should be increased to 5'. Modified arrangement will be as below :—



Second question is about the height up to which the grooves should extend.

Ordinarily, these should be extended upto the top of wings as indicated in the above sketch. Variation may be made in individual cases where called for.

Sd/-
for Chief Engineer
P.W.D.Irrigation Branch M. P.

OFFICE OF THE CHIEF ENGINEER, P. W. D.

Irrigation Branch, Madhya Pradesh

No. 21-J./ I./W (I) 59 Raipur dated the 16th July 1959

To

All Superintending Engineers
All Superintendent of works

Sub:—Control of weeds in Irrigation Channels

A Note on the Eradication of weeds in canals is enclosed herewith for information and guidance.

Sd/-
Chief Engineer, P. W. D-
Irrigation Branch M. P.

NOTE ON ERADICTION OF WEEDS IN CANAL

Encl. No. 1 of
C. E. M. P. P. W. D. Irr.
Memo No. 21-W(i) of 59
Raipur the 1959

The Problem :—

From the time water was first diverted from rivers centuries ago to furnish supplemental moisture for growing crops. Weeds have created one of the major probiems in efficient operation and maintenance. The life giving water which makes deserts bloom also furnishes ideal conditions for the growth and propagation of undesireable vegetation on the banks and in the channels of irrigation systems.

Tall annual weeds and woody perennials growing on the banks catch floating debris which builds berms and desiment bars resulting in a reduction in carrying capacity of the channels. Noxious perennial weeds growing on canal rights of way are a constant source of intestation to adjust crop land by means of creeping roots or by seeds which may be carried by the wind and irrigation water. These type of weeds are classed as land or ditch-bank weeds.

Submersed and emergent water weeds growing in the channels create another group of problems. They reduce the capacity of canals making it difficult to supply sufficient water to the crops. The reduction of capacity also decreases velocity of flow resulting in deposition of sediment and costly cleaning operations. The reduction in capacity also necessitates raising the water level of the canal which causes increased seepage because of the greater wetted perimeter aggravated by the fact that the water above the normal flow line is in contact with less compacted soil.

Floating weeds have similar effects but are more troublesome in clogging structures.

Methods of control :—

1. Land or ditchbank weeds
   1) Cutting with
   (i) Scythes sickles etc.
   (ii) Movers-Power operated

   2) Burning with flame throwers spray burners etc.

   3) Grazing-cheepest and best method of controlling land weeds especially after establishment of desirable grasses.

) Chemical :— Three main classes.

   (i) Selective Herbicides (Hormone type)-Mainly effective on broadleaf varieties, Of these 2, 4-D (Dichlorphenoxyacetic acid) is the most effective, 2, 4, 5—T (Trichlorophenoxyacetic acid) is effective in some cases.

) form of salts or esters, they are usually sprayed, mixed with water or oil. Care must be taken to present the spreed, whilst spraying, to adjacent crops. This danger has led to the prohibition of the use of the velatile esters in many locations.

   (ii) Contact Herbicides:— Effective to varying degrees on most weeds : Diesel Distillate, Kerosene, Chlorates (Diluted). They are usually sprayed.

(Iii) Soil sterilants, used to remove weeds permanently around structures, etc. Chlorates, Borates, Borate Chlorate mix common use in U. S. A., Aresnicals, T. C. A. (Sodium Trichloracetate) is a useful temporary eterilant.

(Arsenicals are extremly poisonous and are not recommended for general use in irrigation systems). Sterilants should be applied on solid form or as sprays just prior to a rainy season as they must be carried into the root zone and come into contact with the root systems.

II Emergent Weeds.

(1) Hand and Mechanical

(i) Scythes, sickles etc. (ii) Weed rakes.

(i.i) Culters. drawn, propelled, launch mounted and with moving blades.

(iv) Excavators Dieglines and shovels with special buckets, bucket dredges, screw type dredges.

(2) Burning (with flame throwere etc.)

(3) Drying and frosting (where practicable).

(4) Grazing cattle will control some emergent weeds but frequently damage banks.

(5) Chemical

(i) Selective Herbicides (2,4-D and 2,4, 5-T)

(ii) Contact Herbicides Disel distillate Benoclor, Kerosene, Aromatic solvents (coal tar and petroleum derivatives)

As a genesal rule aromatic solvents which are mainly effective on submersed weeds, are injected in to low velocity flowing water and distribution is by the water bringing the chemical in to the contact with the plant life (from 5 to 8 gallons of solvent are introduced over a 30 minutes period for each cusec of flow)

III. Floating weeds :-

(1) Hand and mec weeds may be removed by hand with forks etc. or by screens but this method is slow and expensive.

(2) Chemical (i) Selective Herbicides (2,4.-D) (ii) Contact Herbicides-Disel distillate

Floating weeds are readily controllable by using the herbicides.

IV. Submerged weeds

(1) Hand and mechanical

(i) Flexible underwater saws

(ii) Chains

(iii) Scrapers used in mortar lined channels.

(iv) Cutters usually V shaped blades may be drawn propelled or launch mounted and have moving blades.

(2) **Chemical** :— Aromatic solvents are proving the most effective method of controlling submersed weeds. They are however, toxic to fish. To increase the concentration the water level should be lowered before applying the herbicides. This also has the advantage that the larger fish will migrate to deeper water.

U. S. control practices. :—

Ditchbank floating and emergent weeds :—Mechanical methods are still used on some projects but chemical treatmants have largely replaced them. The treated weeds however, are frequently burnt off later.

Grazing is regarded as the best method of control of ditchbank weeds.

Submerged weeds :— Clearing is the most popular method of mechanical control. Aromatic solvents are increasing in popularity and proving most effective.

French Control Practice. :—

Manual control is still widely used. Cutting barges, and a type of flexible saw consisting of a series of blades bolted together and weighted, are commonly used. Shovels, draglines, etc, are used at times but banks are often wooded to provide shading and have to be cleared with bulldozers etc, before mechanical plant can be used.

Contact herbicides are used on floating and emergent weeds but little use is made of the selective herbicides. Research, is however, proceeding.

Australian Control Practice :—

Most mechanical methods are practised to varying degrees in Australian Continental etc. have been killed by cutting two or three time in the appropriate season.

Chemicals are giving excellent results and should become with further research on the principal mathod of weed control.

Indian practice (Deccan Canals):—

The most successful method of eradicating the weeds so far found is the "Rush Rotation System" wherein the canal is closed for three to five days in every ten day rotation and the canal bed is kept dry and exposed to sun. The reasons why this system has been so remarkably successful in eradicating weeds are that it brings into operation a variety of factors all of which tend to check weed growth.

(i) The depth of canal water is greater as the irrigation programme is to be burried through and hence profuse light of sun rays is excluded.

(ii) During closures the bed and the sides are dry and exposed to scroching sun, Alternate drying and weeting has a very adverse effect on weed growth.

By following this Rush Rotation systems on the three major Deccan Canals, the weed trouble has been greatly reduced, though at places the weeds still persist, where those are removed periodically by manual labour. Mechanical means have not so far been tried on the Deccan canal for weed clearance not is chemical treatment of canal water tried as the latter entail danger ro human and animal life.

Sudan Practice :--

Control by use of chemicals i. e. cooper sulphates has been tried out to gain quantitative information on the best method of using cooper sulphates for weed control in the Gezera canals. The treatment is actuated at the canal head offtakes and the doses are applied with the discharges passed down the infested canals at a certain predetermined ratio. The results of the experiment were remarkable in the complete control of floating weeds with very little regrowth towards the end of the watering season. However, when compared with hand and mechanical methods, the cost of experiment was found very high. Efforts are still being made to continue with the experiment to reach an economic cost for its wide application in the Gezera canalised scheme, This has been done for acquatic weeds (30 P. P. M. parts per million of cuso 4 initials dose in July 2 P. P. M. doses) The cuso 4 treatment has additional advantage that it killed the snails which spread bithariza.

For bank weeds besides, hand cutting and grazing spoil from silt clearance of canals is used for building up or raising of the berms to reduce the width of weed growing on the bank and in the water.

Prevention : Some of the possible future weed problems may be alleviated when they are considered in the design and construction of irrigation systems. The elimination of unnecessary free board will reduce the area where weeds may grow. Adequate all weather distoh-bank roads should be provided to facilitate weed control operations as well as to allow proper inspection of the system and movement of maintenance equipment. Although pipe irrigation systems and concrete lined canals are not constructed primarily for reducing weed problems they do serve this purpose,

Best method of control, where possible is by the elimination of the source of infeastation and prevention of spread. This is assisted by the establishment of seed traps either single or multiple stage and the growth of more desireable plants such as grasses.

Ditchbank grazing may also reduce downstream infestation.

As most emergent weeds do not thrive in water in excess of 3 feet in depth it is often possible to design channels to contain this depth of water and so prevent the growth of those weeds.

OFFICE OF THE CHIEF ENGINEER; P.W. D.
Irrigation Branch, Madhya Pradesh

No. 265/W-I

Raipur, the 24th August, 1959

All Superintending Engineer,

Copy of a note on "ALTERNATIVE DESIGN OF WASTE WEIRS FOR MINOR IRRIGATION TANKS" by Shri D. S. Sinha, Superintending Engineer, Minor Irrigation is enclosed for information and guidance. The method suggested could be incorporated in some of the new schemes, especially in the Community Developement blocks where topographical conditions may favour its adoption. It will particularly be suitable for flat country where taking out of a diversion waste weir channel is possible without involving over flow of banks and cutting through valuable properties.

Encl :— One note.

Sd/-
Deputy Chief Engineer,
P. W. D. Irrigation Branch, M. P.
Raipur

No. 265 A/W–I/

dated the 24th August 1959

Copy is forwarded to all Executive Engineers / Sub-Divisional Officers, Minor Irrigation Sub-Divisions. for information and guidance.

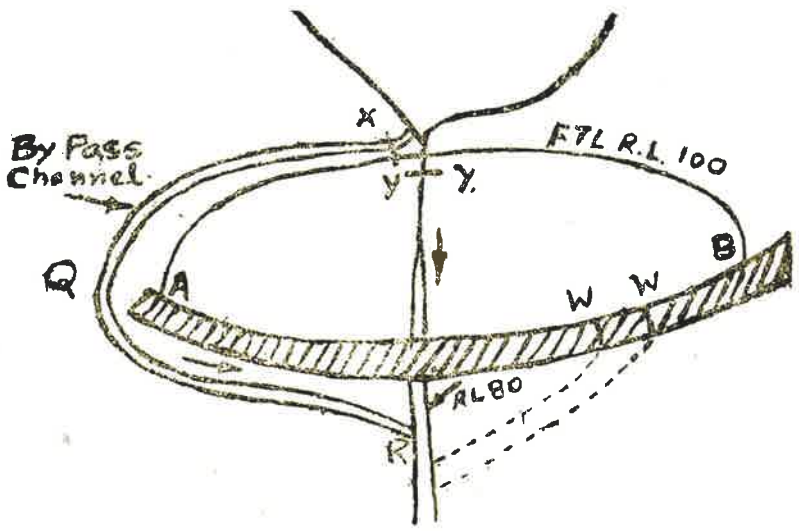
Encl :- One note

Sd/-
Deputy Chief Engineer
P. W. D. Irrigation Branch,
Madhya Pradesh

ALTERNATIVE DESIGN OF WASTE WLIR FOR MINOR IRRIGATION TANKS

The surplussing arrangement described below is commonly noticed in village irrigation tanks. Its technique is quite sound and the same is recommended for adoption in minor irrigation tanks of bigger catchments. The schemes will become much cheaper, as not a single brick or stone is used for constructing structures necessary for disposing off the surplus flood water. The method will have wide application particularly where the flanks are erodable with no hard soil or rock for locating the Waste Weir and the spill channel.

These tanks do not have any waste weir in the flank. The feeder nala is made to branch off at the point of entry into the tank, i. e where the F. T. L. contour crosses it. As soon as the the tank gets filled up, the water is allowed to flow in to bye pass channel which joins the parent stream lower down. The sketch below shows the arrangement :—



A. B. is the tank bund across the nala having its bed at R. L. 80. The F. T. L contour at R. L. 100 cuts the nala at the point P. From P a bye--pass channel PQR is dug joining the main nala at R. The point to be observed in this arrangement is that the bed slope in the bye pass channel PQR will usually be flatter than the bed slope in the direct course PQ of the stream because of the longer length of the former. If, therefore, the diversion of water can be effected at the point P no protection works will be needed for the bye pass channel PQR. What the cultivators do is to allow the feeder nala to flow into the tank in the early monsoons, the bye–pass channel being kept closed by a low earthen bund X-X. As soon as the tank filled they block the feeder nala at P by a cross bund Y—Y and allow the water to flow in to the bye-pass channel by breaching the bund XX. Quite often this arrangement is automatic and the cultivators have to make practically no effort for controlling the inflow at P.

In our normal design of Waste-Weir, the whole trouble originates from the fact that we attempt to negotiate the drop between the F. T. L. and the nalla bed (20' in this case) in a short distance by locating the W/W in the flank (W—W). This necessitates the presence of hard and unerodable soil in the spill channel construction of falls and regular W/Ws with drop walls, We have to reject many of our minor irrigation projects only because rock or hard ground is not available in the flank for locating the Waste Weir.

In the arrangement adopted by the cultivators there would never arise the question of retrogression in the bye-pass PQR on account of its bed gradient being flatter than that

of the parent channel. It is also not necessary to dig the bye pass in its full section. In the first instance it could be made of a small section. Before the very first rains, the main nalla could be blocked at the point P by a cross earthen bund and the floods allowed to enter the bye pass PQR. It will automatically carve out its full flood water-way if not in the first season certainly in the second season. Even if the bund is washed away it will not matter because in that case water will flow through both the parent stream and the bye pass channel. As pointed out earlier even if full floods pass through PQR, there will never be any danger of retrogression. The villagers control the flow at P by erecting cross earthen bund. This could be made more permanent by the construction of masonry bars with channel iron-verticals fitted with Kajri shutters..

The above arrangement will be particularly suitable for sites having flat tank basins. So also in a low percentage tank, there will be great saving in costs. In our normal design, the cost of surplussing arrangement is out of proportion to the cost of the project where the tank has to impound only a fraction of the inflow from the catchment and the balance is to be allowed to flow across the waste weir. The additional advantage is that the work at nala closure could proceed on without any fear or time limitations because water can always be diverted through the bye- pass channel. In fact, excavation of the pass channel will have to be the very first step in the construction of an irrigation tank, with the above surplussing arrangement. If the tank takes two seasons for completion the bye pass will have scoured out its full flood cross section.

Sd-/
(D. S. SINHA)
Superintending Engineer,
Minor Irrigation P. W. D.

ALTERNATIVE DESIGN OF WASTE WLIR FOR MINOR IRRIGATION TANKS

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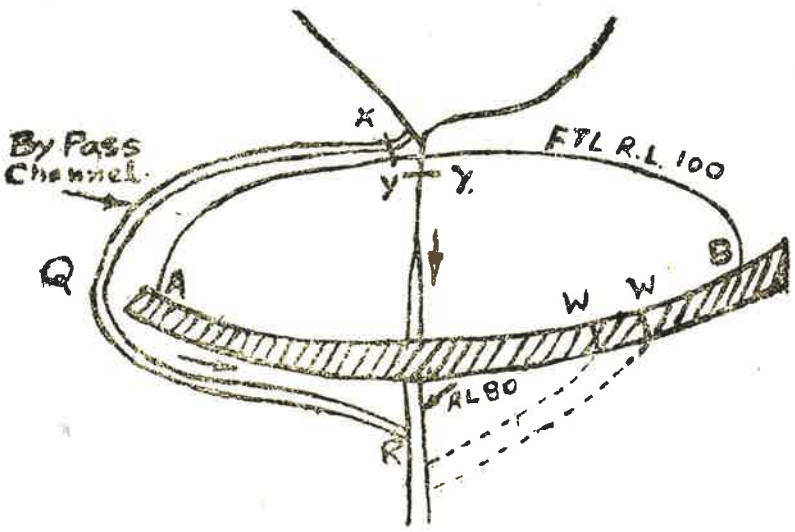
These tanks do not have any waste weir in the flank. The feeder nala is made to branch off at the point of entry into the tank, i. e where the F. T. L. contour crosses it. As soon as the the tank gets filled up, the water is allowed to flow in to bye pass channel which joins the parent stream lower down. The sketch below shows the arrangement :—



A. B. is the tank bund across the nala having its bed at R. L. 80. The F. T. L contour at R. L. 100 cuts the nala at the point P. From P a bye-pass channel PQR is dug joining the main nala at R. The point to be observed in this arrangement is that the bed slope in the bye pass channel PQR will usually be flatter than the bed slope in the direct course PQ of the stream because of the longer length of the former. If, therefore, the diversion of water can be effected at the point P no protection works will be needed for the bye pass channel PQR. What the cultivators do is to allow the feeder nala to flow into the tank in the early monsoons, the bye-pass channel being kept closed by a low earthen bund X-X. As soon as the tank filled they block the feeder nala at P by a cross bund Y—Y and allow the water to flow in to the bye-pass channel by breaching the bund XX. Quite often this arrangement is automatic and the cultivators have to make practically no effort for controlling the inflow at P.

In our normal design of Waste-Weir, the whole trouble originates from the fact that we attempt to negotiate the drop between the F. T. L. and the nalla bed (20' in this case) in a short distance by locating the W/W in the flank (W—W). This necessitates the presence of hard and unerodable soil in the spill channel construction of falls and regular W/Ws with drop walls, We have to reject many of our minor irrigation projects only because rock or hard ground is not available in the flank for locating the Waste Weir.

In the arrangement adopted by the cultivators there would never arise the question of retrogression in the bye-pass PQR on account of its bed gradient being flatter than that

of the parent channel. It is also not necessary to dig the bye pass in its full section. In the first instance it conld be made of a small section. Before the very first rains, the main nalla could be blocked at the point P by a cross earthen bund and the floods allowed to enter the bye pass PQR. It will automatically carve out its full flood water-way if not in the first season certainly in the second season. Even if the bund is washed away it will not matter because in that case water will flow through both the parent stream and the bye pass channel. As pointed out earlier even if full floods pass through PQR, there will never be any danger of retrogression. The villagers control the flow at P by erecting cross earthen bund. This could be made more permanent by the construction of masonry bars with channel iron- verticals fitted with Kanri shutters..

The above arrangement will be particularly suitable for sites having flat tank basins. So also in a low percentage tank, there will be great saving in costs. In our normal design, the cost of surplussing arrangement is out of proportion to the cost of the project where the tank has to impound only a fraction of the inflow from the catchment and the balance is to be allowed to flow across the waste weir. The additional advantage is that the work at nala closure could proceed on without any fear or time limitations because water can always be diverted through the bye- pass channel. In fact, excavation of the pass channel will have to be the very first step in the construction of an irrigation tank, with the above surplussing arrangement. If the tank takes two seasons for completion the bye pass will have scoured out its full flood cross section.

Sd-/
(D. S. SINHA)
Superintending Engineer,
Minor Irrigation P. W. D.

OFFICE OF THE CHIEF ENGINEER, P. W. D.
Irrigation Branch, Madhya Pradesh.

Raipur, dated the 9th September 19.9

A Superintending Engineers
All Superintendent of Works

Sub : – Preparation of Irrigation Projects.

The C. W. & P, C. of late have been objecting to the use of abstract proforma (herewith followed by this State) for calculating the financial results of Irrigation Projects A copy of the Financial result statement with covering note dealing with the Nagda Nallah Project in the forms approved by the C. W. & P. C, is sent herewith for your information. Kindly see that financial results of our schemes hereafter, are worked out on these lines except that :—

(1) Water rates to be adopted as sanctioned by State Government for newly constructed schemes in the regions concerned.
(2) Betterment levy to be provided as per laws enacted by the State Government for for the regions concerned.
(3) Cost of Maintenance will be assumed at a flat rate of Rs. 2/- per acre.
(4) In the enclosed statement, it has been assumed that Irrigation will commence on the 3rd year of the commencement of the construction and will fully develop by the 7th year. This however, will be changed keeping in view the local conditions and the programme of work already decided upon
(5) The interest rate will continue to be adopted at 4 $\frac{1}{2}$% per annum.

Sd/—
(C. H. Sanghvi)
Deputy Chief Engineer
for Chief Engineer P. W. D.
Irrigation Branch. M. P.

Encl :- Copy of Statement of Financial forecasts, benefits and recommendations Nagda Nala Project.

NAGDA NALA PROJECT

Financial Forecasts, Benefits and Recommendations.

11. 1 FINANCIAL FORECASTS.

The Nagda Nala Projeet is a single purpose scheme purely meant for irrigation. As such the entire cost is alloeated to irrigation for the purpose of Financial forecasts.

The receipts from betterment contribution are taken at Rs. 240.00 per acres, recoverable in yearly instalments of Rs. 12-00 for the first five instalments and Rs. 18-00 for the next ten years. These charges will be without interest. The betterment fee is levied one year after the commencement of irrigation

The working expenses of the canals have been taken at Rs. 1.00 per acre after the completion of the Project, whereas the working expenses of the dam and appurtenant works have been calculated at 1/2% of its cost.

While working out the financial returns, interest charges on the capital outlay have been taken at 4.5%.

The net revenue on full development works out to Rs. 56,300 per year excluding betterment charges [Statement XI/6].

The financial statement XI/1 to XI/3 are prepared and are attached at the end of this Chapter.

Statement XI/1 gives the yearly expenditure (Abstract) under units I and II.

Statemcnt XI/2 and XI/3 show the details of yearly expenditure under Unit I and II respectively.

Statement XI/4 shows the development of Irrigation. Irrigation will commence on the third year of the commencement of the construction and will fully develop by the 7th year.

Statement XI/5 gives the annual revenue from water rates. The annual revenue on full development will be Rs. 75,000.

Statement XI/6 shows the working expenses under Unit I and II and the net revenue from Irrigation. The net revenue on full development in 7th year will be Rs. 56,500.00

Statement XI/7 shows the recoveries from betterment contribution.

Statement XI/8 has been worked out for Financial forecast taking into account the betterment contribution and irrigation revenue.

The % return on the sum at charge at the end of the fifth year after the completion of the project when the full development of irrigatton is expected to take place, works out as under and increases progressively till it reaches the maximum at 20th year after completion:-

5 th year after completion	1.276.
10th year after completion	1.364
15th year after completion	1·614
20th year after oompletion	1.862

The percentage return again decreases after 20th year because the simple interest (Rs. 0.628 lakh) during the year on net cumulative capital outlay is more than revenue (Rs. 0. 5650) during the year.

11 2 BENEFITS:-

The direct benefits from the Project will be an annual irrigation of 7500 acres on full development, out of a gross commanded area of 13,100 acres. The additional yield of crops, on account of this irrigation, will be 3000 tons of food grains. This will fetch an additional revenue of Rs. 12.00 lakhs besides making the area self sufficient and rich.

Other indirect benefits from the project will be general development of the area, increase in the purchasing power and wealth of the local people, increase in population is now expresely populated country and increase in the value of lands and other immovable property.

11. 3 RECOMMENDATIONS:-

Though the project does not satisfy the productivity test laid down by the Government of India, the project is recommended for approval and execution to develop the backward areas of Vindhya Pradesh. Providing irrigation to this area will go a long way in developing the local area in particular and increasing the wealth of the country in general.

NAGDA NALA PROJECT

FINANCIAL STATEMENT

Statement No. 1 showing the yearly Capital Outlay for Unit I and II

ABSTRACT

Sub-Head	(Amount in Lakhs of Rupees) Estimated Cost	First year	Second year
I Works	34.92	17.95	16.97
II Establishment	2.56	1.32	1.24
Leave and pensionary charges	0.27	0.13	0.14
III Tools and Plant	0.34	0.18	0.16
IV Suspense	...	...	...
Total	38.09	19.58	18.51
V Deduct Receipts and Recoveries	(—) 0.96	—	(—) 0.96
Total Direct Charges :—	37.13	19.58	17.55
Indirect charges :—			
(a) Capitalisation of abatement of land Revenue	0.48	—	0.48
(b) Audit charges	0 35	0.17	0,18
Total direct and indirect charges:-	37.96	19.75	18.21

NAGDA NALA PROJECT

FINANCIAL STATEMENT

Statement No. 2 Showing the Details of Yearly Expenditures on Unit-I Dam and Appurtenant Works.

Sub-head	(Amount in Lakhs of Rupees) Estimated Cost	First year	Second year
1	2	3	4
IWorks			
A] Preliminary.	0.60	0.60	—
B] Land	2.55	1.10	1.45
C] Works			
i] Earth Dam	18.45	10.06	8.39
iil Spiliway with draft channel and Head sluice for Right bank canal	1.77	0.50	1.27
iii] Head sluice for Left bank canal	0.22	0.06	0.14
K] Buildings	0.64	0.55	0.09
M] Plantation	0 02	0.01	0.01
O] Miscellaneous	0.45	0.18	0.27
R] Communications	0.15	0.12	0.03
P] Maintenance	0.22	0.12	0.10
Q] Special Tools and Plant	1.00	0.25	0.75
7 Losses on stock	0 02	—	0.02
8 Unforeseen items	0.05	0.02	0.03
Total I, Works	26.14	13.59	12.55
II. Establishment	1.89	1.00	0.89
Leave and pensionary charges	0.20	0.10	0.10
III. Tools and Plant	0.26	0.14	0.12
IV Suspense	—	—	—
Total —	28.49	14.83	13.66
V Deduct receipts and recoveries (—)	0.67	—	(—) 0.67
Total for direct charges	27.82	14.83	12.99
Indirect Charges :—			
a] Capitalisation of abatement of land Revenue.	0.40	—	0.40
b] Audit charges	0.26	0.13	0.13
Total Direct and Indirect charges	28.48	14.96	13.52

FINANCIAL STATEMENTS

Statement No. III. showing the Details of Yearly Expenditure on Unit II Canal System

Sub-Head	Amount in lakhs of Rupees		
	Estimated Cost	First year	Second year
1	2	3	4
1 Works			
A] Preliminary.	0.20	0.20	—
B] Land	0.41	0.30	0.11
D] Regulators	0.22	0.10	0.12
E] Falls	0 07	0.07	—
F] Cross drainage works	3.42	1.00	2.42
G] Bridges	0.15	0.05	0 10
H] Escape	—	—	—
K] Buildings	0 10	—	0 10
L] Earth work	3.04	2.00	1.04
M] Plantation	0.05	—	0.05
O] Miscellaneous	0.46	0.20	0.26
P] Maintenance	0.08	0.03	0.05
Water Courses	0.50	—	0.50
Special Tools and Plant	0 50	0 40	0 10
Losses on stock	0.01	—	0.01
Inforeseen	0.02	0.01	0.01
Total works	8 78	4.36	4.42
II Establishment	0.67	0.32	0 35
Leave and Pensionary Charges	0.07	0.03	0.04
III Tools and Plant	0.08	0.04	0.04
IV Suspense	—	—	—
Total	9.60	4.75	4.85
V Deduct receipts & Recoveries	(—) 0.29	—	(—) 0.29
Total Direct charges	9 31	4.75	4.56
Indirect Charges :—			
(a) Capitalisation of abatement of land revenue	0.08	—	0.08
(b) Audit Charges	0.09	0 04	0.05
Total Direct & Indirect charges	9.48	4.79	4.69

FINANCIAL STATEMENT

STATEMENT No 4 Showing the Development of Irrigation

Year from commencement of the Project	Percentage of Development	Area in Acres Kharif (Rice)	Rabi (Wheat)
3rd	20	200	1300
4th	40	400	2600
5th	60	600	3900
6th	80	800	5200
7th	100	1000	6500

STATEMENT No. 5 Showing Revenue From Water Rates

Year from commencement of Project	Rice			Wheat			Total Revenue
	Area in Acres	Rate per acre	Amount	Area in Acres	Rate Per acre	Amount	
3rd	200	10.00	2000	1300	10.00	13000	15000
4th	400	10.00	4000	2600	10.00	26000	30000
5th	600	10.00	6000	3900	10.00	39000	45000
6th	800	10.00	8000	5200	10.00	52000	60000
7th	1000	10.00	10000	6500	10.00	65000	75000

STATEMENT No 6 Showing working expenses and net revenue from Irrigation

Year from commencement of the Project	Revenue from water rates	Working Expenses			Net Revenue	Annual Irrigation
		Maintenance of system Rs 1,00 per acre Irrigated	Maintenance Unit I.	Total		
3rd	15000	1500	11000	12500	2500	1500
4th	30000	3000	11000	14000	16000	3000
5th	45000	4500	11000	15500	29500	4500
6th	60000	6000	10000	17000	43000	6000
7th	75000	7500	11000	18500	56500	7500

STATEMENT No. 7 Showing recovery from Betterment Fees

Year from commencement of Project	Irrigable Area Acres	Amount recovered	Cumulative Total
3rd	2000	—	—
4th	4000	24000	24000
5th	6000	48000	72000
6th	8000	72000	141000
7th	10000	96000	240000
8th	10000	120000	360000
9th	10000	132000	492000
10th	10000	144000	636000
11th	10000	156000	792000
12th	10000	168000	960000
13th	10000	180000	1140000
14th	10000	180000	1320000
15th	10000	180000	150000$_0$
16th	10000	180000	1680000
17th	10000	180000	1860000
18th	10000	180000	2040000
19th	10000	144000	2194000
20th	10000	108000	2292000
21st	10000	72000	2364000
22nd	10000	36000	2400000
23rd	10000	—	2400000

Note— Betterment charges will be made at the basis of Rs. 12.00 per acre per year for first five years and Rs. 18.00 per acre per year for the next ten years. The amount will be recovered in the following years after the land gets irrigation.

FINANCIAL STATEMENT

STATEMENT No. 8 SHOWING THE FINAL FORCAST

Year	Capital outlay Direct & Indirect during the year	Commulative capital outlay at the end of the year.	Commulative receipts from betterment fee	Net commulative capital outlay col. 3-4	Simple interest at 4.5% on net capital outlay during the year.	Commulative interest to the of the year	Net revenue during the year	Commulative net revenue at the end of the year	Net sum at charge at the end of the year col. 5+7—9	Percentage return on sum at charge col. 8 × 100 / Col. 10	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1st	19.75	19.75	...	19.75	0.444	0.444	...	...	20.194	...	
2nd	18.21	37.96	...	37.96	1.298	1.742	...	...	39.702	...	
3rd	...	37.96	...	37.96	1.708	3.450	0 0250	0.0250	41.385	0 060	
4th	...	37.96	0.24	37.72	1.703	5.153	0.1600	0.1850	42.688	0.374	
5th	...	,,	0.72	37.24	1.687	6.840	0.2950	0.4800	43.600	0.676	
6th	...	,,	1.44	36.52	1 660	8.500	0.4300	0·9100	44.110	0.974	
7th	...	,,	2.40	35.56	1.622	10,122	0 5650	1.4750	44.207	1.276	
8th	...	,,	3.60	34.36	1.573	11.695	0 5650	2.0400	44.015	1.282	
9th	...	,,	4.92	33.04	1.517	13.212	0.5650	2.6050	43 647	1,292	
10th	...	,,	6.36	31.60	1.454	14.666	0,5650	3.1700	43.096	1,310	
11th	...	,,	7.92	30.04	1.387	16.053	0,5650	3,7350	42,358	1.332	
12th	...	,,	9.60	28.36	1.314	17,367	0,5650	4.3000	41.427	1.364	
13th	...	,,	11.40	26.56	1.236	18,603	0,5650	4.8650	40,298	1,400	
14th	...	,,	13.20	24.76	1.155	19 758	0,5660	5,4300	39,088	1,443	
15th	...	37.96	15.00	22.96	1.074	20,832	0,5650	5,9950	37,797	1,493	
16th	...	,,	16.80	21.16	0.993	21,825	0,5650	6,5600	36.425	1,551	
17th	...	,,	18.60	19.36	0.912	22,737	0,5650	7.1250	34,972	1,614	
18th	...	,,	20.40	17.56	0.831	23.568	0,5650	7,6900	33.438	1,690	
19th	...	,,	21.84	16.12	0.758	24,326	0,5650	8,2550	32.191	1,752	
20th	...	,,	22.92	15.04	0.701	25,027	0.5650	8,8200	31,247	1,807	
21st	...	,,	23.64	14.32	0.661	25,688	0,5650	9,3850	30.623	1.845	
22nd	...	,,	24,00	13.96	0.636	26.324	0.5650	9.9500	30.334	1.862	
23rd	...	,,	24.00	13.96	0.628	26.954	0.5650	10.5150	30.399	1.860	

Normally the puddle trench should be taken to impervious strata. If this impervious strata is met with at a depth less than $\frac{\text{H. F. L. - G. L.}}{2}$ the puddle trench need only go about 2' inside the impervious strata. But, in no case the depth of pnddle trench be less than 6'.

The minimum width of the puddle trench at the base where the depth is less than $\frac{\text{H. F L. - G. L.}}{2}$ should be 6'.The width should be bigger where the height of the bund is high compared to the depth of the puddle trench A hard and fast rule cannot be laid down as each case will have to be decided on merit, considering the nature of the impervious strata, its depth, presence of natural impervious blanket etc.

(2) Where the impervious strata is at a great depth and it is extremely costly to take the puddle trench to the impervious strata, it will be permissible to take the puddle trench only upto $\frac{\text{H. F, L. - G. L.}}{2}$ provided the soil is good compact and not very permeable. Sand or loose sandy soil or highly stratified rock or very porous, moorum etc. cannot be considered as compact soil. Such cases will need special designs which may involve the use of sheet piles and/or clay blanket.

NOTE ON A TYPE OF ADJUSTABLE PIPE OUTLET

An attemyt has been made in the Lower Mahanadi Division to develop a type of outlet pipe which will be –

(a) Cheap
(b) Adjustable
(c) Removeable and yet resonably fool-proof when in position
(d) Capable of calibration in such a way that, when in action the discharge passing

can be determined with accuracy and ealse

2 The pipe outlet consists of (i) Cement-sand, hand moulded pipes, each of 2′ net length It is proposed to adopt 6" internal diameter pipes as standard The number of pipes required per outlet depends, of course, on the properties of the channel bank in which the outlet is placed. Each outlet has its pipes horizontal with invert level with the designed channel bed.

(ii) A hand moulded cement-sand reducing plug 2" thick to fit into the upsrteam socket of the upstream pipe of the outlet. In the centre of plug is a tapered hole of which minimum (down stream) dimeter is that calculated to pass the required discharge at the avilable head and of which maximum (upstream) diameter is 1" more. The sides of the hole are therefore at a slope of 1 to 4 ro the axis.

(iii) Wing-ends, made of cement, medium and coarse sand and bajri one type to fit to upstream socket of the outlet and the other to fit the downstream spigot in such a way that that the invert at each end is level with the flour. These wing-ends retain in ends of the outlet in position, prevent the wash away of the downstream bank, give the outlet a near appearance, allow of the easy measurement of the effective heads, prevent casual damage to the end of the outlet and generally give the effect of permanency in a temporary outlet [at a very small cost.] Paragraph 3 [iii]

The pipes are set in clay the wing ends carefully placed in position over their respective and pipes on earth foundations prepared to fit them and after the side earth has been tamped home, are held in positiyn by this earth and by the substantial heel and toe walls with which they are fitted, the reducing plug is fixed in the upstream socket in cement The effective diameter of the hole is engraved on the upstream face of plug.

Reduction in the effective size of a pipe can also be made by intryducting some form of baffle inside the outlet, say under the middle of the bank The advantage claimed for a hidden reducer of this nature is that one fitted it cannot be interfered with by the cultivator This advantage is more nominal than actual, the cultivator caa interfere with any type of out let if he wishes to end if he is permitted. Only by placing the reducer in visible position can interference be noticed readialy and action taken to reset the outlet and to punish the offender.

3. Manufacture of the outlets : (i) Pipes–The 6" diameter pipe are moulded in the specielly purchased "Pedershaab" steel moulds, Materials are in the proportion of 1 cement, 2 fine sand, 2 coarse sand. As similar pipe are being moulded in all division details are avoided in this note. Allowing 18 miles for lead on sand a cost of cement of Rs. 2.8.0 per cft, each Pipe at site of moulding cost of Rs. 0.7.1 excluding a proportion of the cost of the mould, or say Rs. 0. 7. 6. including a proportion.

(ii) Reducing plugs—The reducing plugs cost about Rs. 0 2 0 each on an average, including a proportion of the cheap mould.

(iii) Wing-ends (a) The wing ends are shown in details in Appendix–I and the drawing of the "from" used is given in Appendix-2. The drawing are self—explanatory. Other types of mould can be devised.

(b) The earlier wing-ends were made with their wings splayed at 30o to the axis Splayed wings have two disadvantage and no practical advantage they are more expensive than the straight type and are not so neat in apperance when two or more lines of pipe have to be placed s de by side The depths of the "heels" and "toes" can be reduced at will.

(c) Each mould has cost about Rs. 14 including all charges. On the assumption that 225 wing-ends will be moulded theirin the cost of mould per wing-end is one anna.

(c) A mixture of cement, fine sa· d and coarse sand, in the proportion of 1:11/2:3 is used Reinforcement has not been found to necessary.

(e) The setting up and oiling of the form work and preparation of the mixture follows the usual practice. The mould is opended about 12 hours after the concrete hae been placed, and the moulded article removed to the stacking grounn and covered with gunny bags which are kept wet for 10 days or so.

(f) As the labour was emyloyed on screening work, mixing and moulding for the pipes at the same time as for the win-ends, the accurate detailed costs for the wing-ends have been difficult to cstimate.

The following statoment gives a fair indication. It is based on the assumption that the labour is never sitting idle.

Details of cost of Manufacture of one upstreem wing-end.

(Straight type)

Total volume	..... 0.85 Cft.	
Proport on	..... 1:1 :3	
Quantity of cement	..... 0.28 cft.	
Sand	..... 0,42 cft.	
Screenings	..... 0,85 cft	Rs. a p.
Cost of 0.28 cft. cement at Re. 2.8.0 per cft		0. 11, 2
Lead of 1.27 cft and 18 miles at Rs. 11.80% cft		0. 2 4
Labour for 1.27 cft screening sand at Rs. 0,9.0% cft		0. 0 1
Cost of oil for mould		0. 0 3
Total cost of materials		0. 13 10
Cost of labour in mixing, placing, removing from mould, clearing mould and curing.		0: 4 2
Proportion of cost of mould [vide sub-paragraph (c) above]		0. 1 0
Total net cost of manufacture ...		1. 3 0

One of the downstream type of wing-ends will cost on a similar analysis Rs. 1.1.0 each.

(iv) The cost of a complete outlet fixed in position will depend on the distance of the site from the moulding yard and to a small extent, on the nature of the materials forming the channel bank at the site. Excluding carting and fixing charges, a 6" diameter adjustable pipe outlet of the form detailed in the note and say, 16' long, costs:

		Rs.	a.	p.
8	pipes at Rs. 0.7.6 each	3	14	0
1	plug at Rs. 0.3.0 each (including fixing)	0	3	0
1	up stream wing-end at Rs. 1.3.0	1	3	0
1	downstream wing end at Rs. 1.1.0	1	1	0
	Total	6.	5.	0

Note:- The actual length from toe to toe of bank will be about 18 ft. If wing-ends are not provided, 20' length of pipe line will be required to fit the bank. So the provision of wing-ends results in a saving of about Re. 0,15.0 on the pipes.

(v) Further adjustment is effected, when found necessary by raising the upstream wing-end, substituting another pipe fitted with the required size of reducing plug for the originally adjusted pipe and replacing the wing-end. As the pipe which is removed is usually of use else-where, the cost of further adjustment is limited to labour charges (two coolies for about two hours) plus Re. 0.3.0. for providing and fixing a new plug.

4. Experiments to determine co-efficients of discharge:- (i) It soon become evident that the introduction of plug with an area of hole say half that of the pipe into which it is fitted does not halve the discharge for the same effective head. The expansion taking place after the flow has passed the plug produces, in effect, an increased co-effecient. "In effect" is necessary as the real action is the production of an increase in the effective head due to the formation of space of low pressure at the head of the pipe proper. It is more convenient to treat this action as effecting the co-efficient rather than as affecting the head.

(ii) Two complete series of experiments were therefore carried out to determine the actual co-efficients–

(a) In a 6" pipe outlet 14' long with ordinary ends (socket end facing upstream) passing through an ordinary channel bank.

(b) In a 6" pipe outlet 14' long, with the upstream provided with a wing-end.

In actual practice outlets have downstream flow conditions varring from "free" to fully "submerged" so the experiments incorporate the various downstream conditions.

(iii) Four important results were arrived at :—

(a) That the preseance of the wing-end upstream increases the co-efficient in the cases where the diameter of the reduced hole is between 3 $\frac{1}{2}$" and 4". For lower diameters the effect is not very noticeable.

(b) That for either condition of upstream end of pipe the co-efficient increases rapidly as the size of opening is decreased from 6" to 4". Further decrease to 3" does not result in a definite change in the co-efficient. (The results do show minor changes, but only of 2 percent or so. The experiments themselves were hardly of that degree of accuracy).

(c) That the co-efficient does not vary with the effective head and (upstream heads of up to 2′ only were available).

(d) That, even when the downstream end of the pipe is discharging freely in to air, the back head downstream is not 'Nil' if the upstream head is measured above the centre of the pipe. There is always a minimum effective back-head. It varies from 0.15′ 0.25' for 6″ pipes fitted with plugs.

(iv) The detailed results of these experiments have been given in another note. They are summarized below, Those of series B are shown plotted in appendix 3.

Series A :- "Plain" ends upstream and downstream, the socket being upstream length 14'

Diameter of pipe	Diameter of plug	Ascertained co-efficient	Minimum effective head over centre of pi deownstream ft.
6″	...	0 67	0.20
6″	5 1/2″	0.725	0.25
6″	5″	0.83	0.25
6″	4 1/2″	0.90	0.20
6″	4″	1.05	0.15
6″	3 1/2″	1.06	0.15
6″	3″	0.99	0.15
Series B ;— As for series A but with a wing-end fitted upstream :			
6″	...	not obtained	not obtained
6″	5 1/2″	0.80	0.25
6″	5″	0.87	0.25
6″	4 1/2″	0.96	0.20
6″	4″	1.02	0.15
6″	3 1/2″	1.00	0.15
6″	3″	1.00	0.15

Note :— It has to be noted particularly that these results are for one type of reducing plug only. Differently shaped orifices will have different co-efficients.

(v) For practical purposes round figures co-efficients have been adopted. They are given on the Nomogram (Appendix 4).

(vi) Experiments to determine the co-efficients of discharge of pipe outlets of diameter other than 6″ have not been conducted in this division Mr. Agarwal, in the Kharung Division has experimented on 6″, 9″ and 12″ diameter pipes, 12″ and 24' long, with socket end upstream and with downstream ends discharging freely into air, under heads upto 5′.

Reducing plugs were not fitted. The results are under consideration.

(vii) The effect on the discharge co-efficients of variations in lenght of the pipss has not yet been determined. Mr. Agarwal's results indicate that the effect of increase of length is different for different heads and, as might be expected, for different diameters of pipe. Doubling the length of a 6″ pipe from 12' to 24″ decreased the co-efficient by 8 percent for a 1.5' head and by 9.8 percent for a 2′ head. On the other hand, the co-efficient of a 9″ pipe was increased by 7.8 percent for a 0.5′ head when the extra 12' length of pipe was added, decreased by only 1.6 percent for a 1.5″ head, and decreased by 5.9 per cent for a 2.0″ head.

It is evident that to obtain accuracy in ascertaining discharges of outlets on channels it is necessary to take cognizance of the length of the outles. But for outlets 11′ to 20′ long [corresponding to depths of water from 1′ to 3′ with 2 to 1 side slope of bank] the co-efficient for a 14′ long pipe will be sufficiently accurate for working purposes.

5. Practical working of the outlets:- This note will not be complete without a brief reference to the procedure adopted in 'Setting' the outlets before the commencement of the irrigation season and in checking the setting whilst irrigation is in progress.

(i) In a special form, prepared separately for each distributory, the chainages of the outlets, the area likely to be irrigated from each, the discharge required and the probable upstream head are noted. Unless it has actually been measured in the previous year the probable downstream head is not known especially when fields lying above the bed level contour have to be irrigated. In this, the first pear's working, a minimum downstrem depth of 0 7′ or of 0.3′ lower than the upstream depth, which ever is less, has been assumed for initial calculation purposes. The resulting probable available head is shown in the form and [by trial and error the required sizes of the orifices in the 6″ pipes calculated. Reducing plugs are fitted in accordance with these calculations.

(ii) The calculations are made easy by the use of the Nomogram (appendix 4) speci ılly prepared for this work. All subordinates should be fully conversant with its use before the rains.

(iii) As the co-efficient for each size of plug is known within all responsible practical limits, the discharge actually passing through any outlet can be determined readily in the following way. diameter of the plug is as noted in the register of outlets, the depths above invert (which is level with the floors of the wing ends) upstream and downstream can be measured simply by means of stick or a two-foot rule and the effective head ascertained. The relative co-efficient being used, the actual discharge can be determined from the Nomogram. After a little practice a subordinate can workout a dis-- charge and enter details .n his note-book in 2 minutes.

Note :— The working co-efficients contained in the table in the Nomogram give discharge resnlts that are slightly less than the actual for all normal lengths of outlet. For subordinates' purposes the precedure must be as simple as possible and it is advise-able to sacrifice a 5 % difference in accuracy to ensure simplicity. True accuracy can only be obtained if the co-efficient for any size of opening is varied according to the length of the outlet.

(iv) Each subordinate is provided with a steel V-notch graduated to read discharges up to 2 cusecs and by its use he checks the results obtained by the method mentioned in the paragraph when he has reason to doubt them and if a free overfall is obtainable in the water course leading from the outlets.

Outlets discharging more than two cusecs almost invariably consist of two or more "adjusted" or "unadjusted" 6″ diameter pipes. By closing the reminder, the discharge beiug passed by each pipe can be determined separately,

Substantial difference between V - notch result and the 'Nomogram' result for any outlet indicates (a) that the two ends of the outlet are not at the same level, or (b) that the reducing plug has been removed (this fact should be determined before any attempt is made to ascertain the discharge) or (c) that a mistake has been made in reading depths or (d) that all or any two of items (a), (b) and (c) may be concerned.

(v) If the discharge through the outlet is less than that provided and if none of the troubles (a) to (d) is present, it means that the effective head is less than that allowed for in the calculations. Sometimes the head can be increased sufficiently by clearing the water-course, or by removing obstructions from downstream of the outlet, in certain cases it may be necessary to control the depth in the channel. Very rarely is it necessary to alter the size of the plug. The subordinate is not permitted either to place temporary controls in the channels or to alter the sizes of the plugs until he has made a report to the Sub-Divisional Officer, on the special form (Appendix 5) provided for that purpose, and has received his instructions.

(vi) As details of the check of each outlet m,ade from time to time are entered by the sub-ordinate or inspecting officer in his note-book any peculier difficulties in regard to depth up-stream and downstream can be noticed and dealt with and the final results obtained this year used in rhe calculations for the resetting in the coming year.

G. A. D. COCHRANE
Offg. Executive Engineer,
Lower Mahandi Division.

APPENDIX—V

CONTROL OF IRRIGATION

Form of application for increasing the sizes of the openings of pipe outlets.

Report of Babu S. S. of Section, dated the,

1. Name of distributory-
2. Name of village
3. R. D. of outlet-
4. Agreement area cropped with rice under outlet-
5. Normal allowable discharge at 80 acres per cusec-
6. Diameter of pipe and of reducing socket-
7. (a) Depth in channel above centre of pipe on date of inspection
   (b) Depth in channel for which the outlet has been adjusted this year,
8. Depth in water course above centre of pipe on date of inspection-
9. Actual discharge passing–
10. Nature of complaint of cultivators–
11. Special difficulties of the chak or in distribution which justify giving an increased out-let discharge-
12. Recommendtaions of the subordinate

Signed.

No. dated

Forwarded to the Sub-Divisional officer.....
Sub-Division, for orders.

Signed.

No. dated.

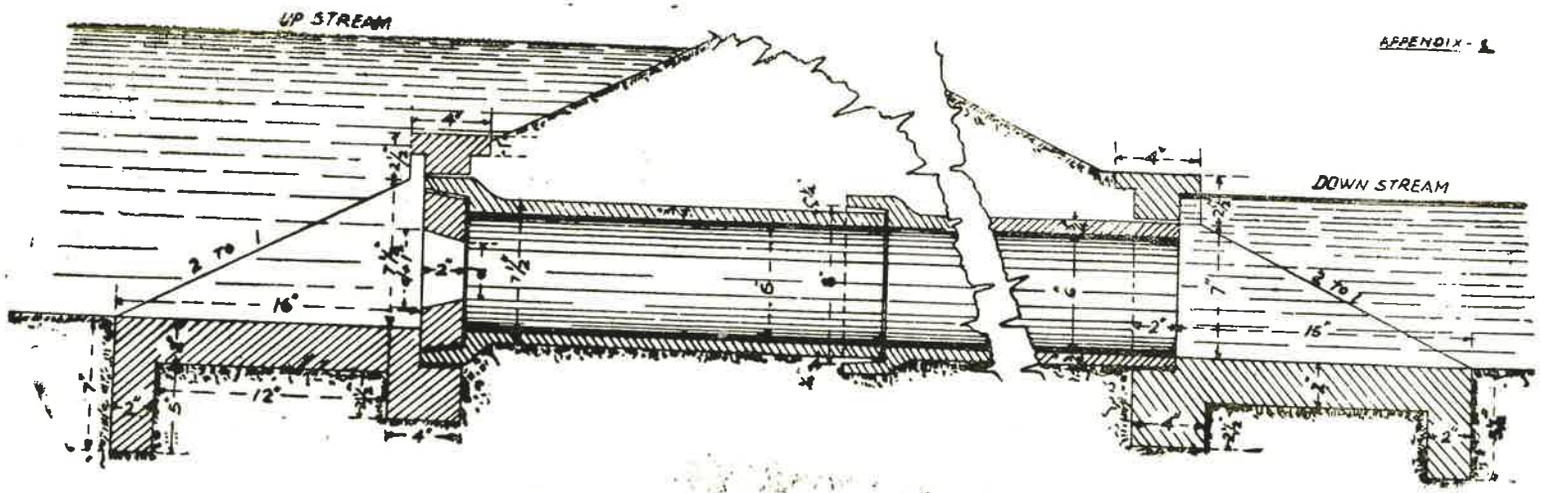
Returned to the Section subordinate with orders as below for early complaince.

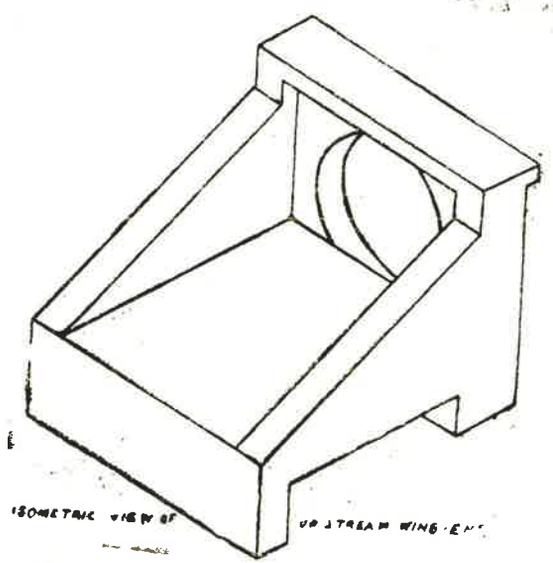
Sub-Divisional Officer,
Sub-Division,

The section subordinate should state what additional discharge he would like and whether the reducing socket should be changed or an additional pipe outlet provided.

Note:– The report should be submitted in duplicate, one copy being retained by the S D.O. Any changes made in the sizes or number of the outlets must be shown in the new outlet registers of both the Sub-Division and the Section.

APPENDIX - I





LOWER MAHANADI DIVISION

SKETCH SHOWING U/S AND D/S ENDS
OF
A CONTROLLED OUTLET

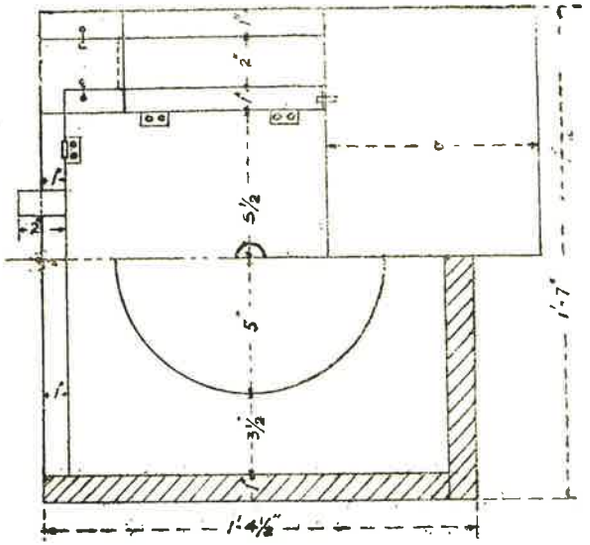
(S/d) G. A. D. Cochrone
Executive Engineer
Lower Mahanadi Division,
7-10-1932

APPENDIX 2

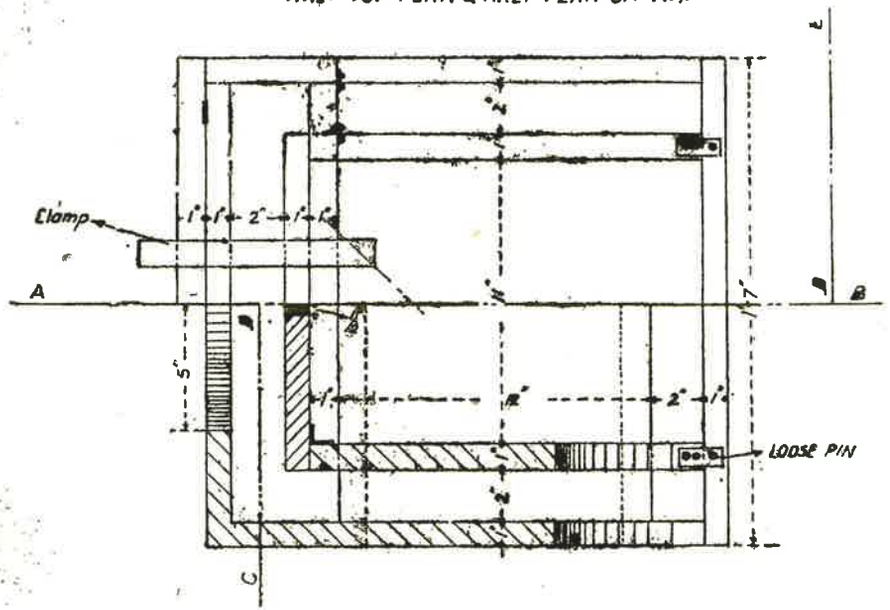
Lower Mahanadi Division

DRAWING OF WOODEN MOULD FOR UPSTREAM WING END

SCALE - 4" = 1'



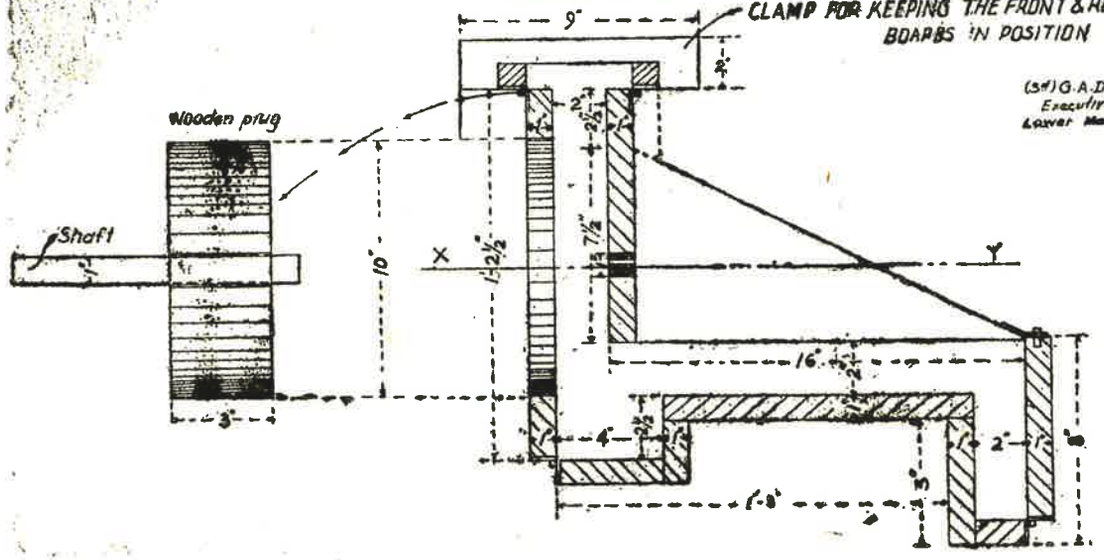
HALF TOP PLAN & HALF PLAN ON X.Y.



SECTION ON C.D.E

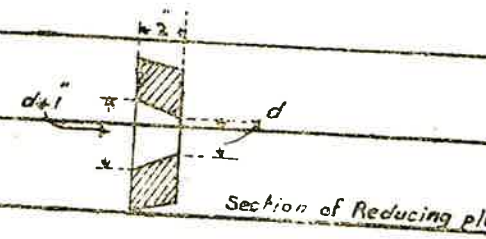
SECTION ON A.B.

CLAMP FOR KEEPING THE FRONT & REAR BOARDS IN POSITION

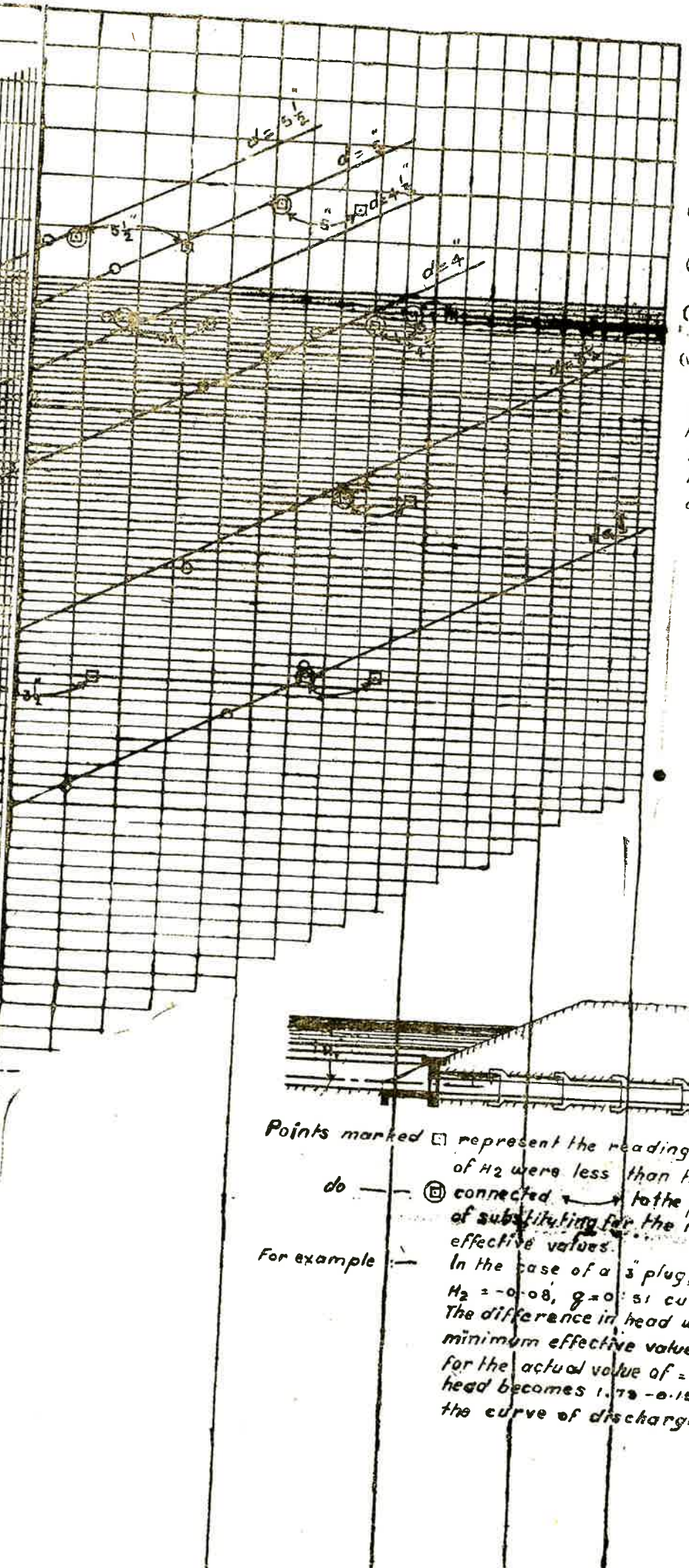


(Sd) G.A.D. Cochrane
Executive Engineer
Lower Mahanadi Division
D. 7-10-1932

CHART
SHOWING RESULTS OF
EXPERIMENTS FOR ASCERTAINING THE DISCHARGES
THROUGH A 6" DIA: CONCRETE PIPE 14 LONG
WITH THE SOCKET END UPSTREAM
FITTED WITH REDUCING PLUGS OF VARIOUS DIAMETERS OF OPENINGS (d)
BALODA TANK - MAY - JUNE - 1932



Section of Reducing plug



Appendix 3

The formulae of the lines shown are:

(I) $5\frac{1}{2}" \cdot q = 0.80\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.25$

(II) $5"\ q = 0.87\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.25$

(III) $4\frac{1}{2}"\ q = 0.96\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.20$

(IV) $4"\ q = 1.02\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.15$

(V) $3\frac{1}{2}"\ q = 1.00\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.15$

(VI) $3"\ q = 1.00\,A(2g)^{\frac{1}{2}}(H_1 - H_2)^{\frac{1}{2}}$
minimum value of $H_2 = 0.15$

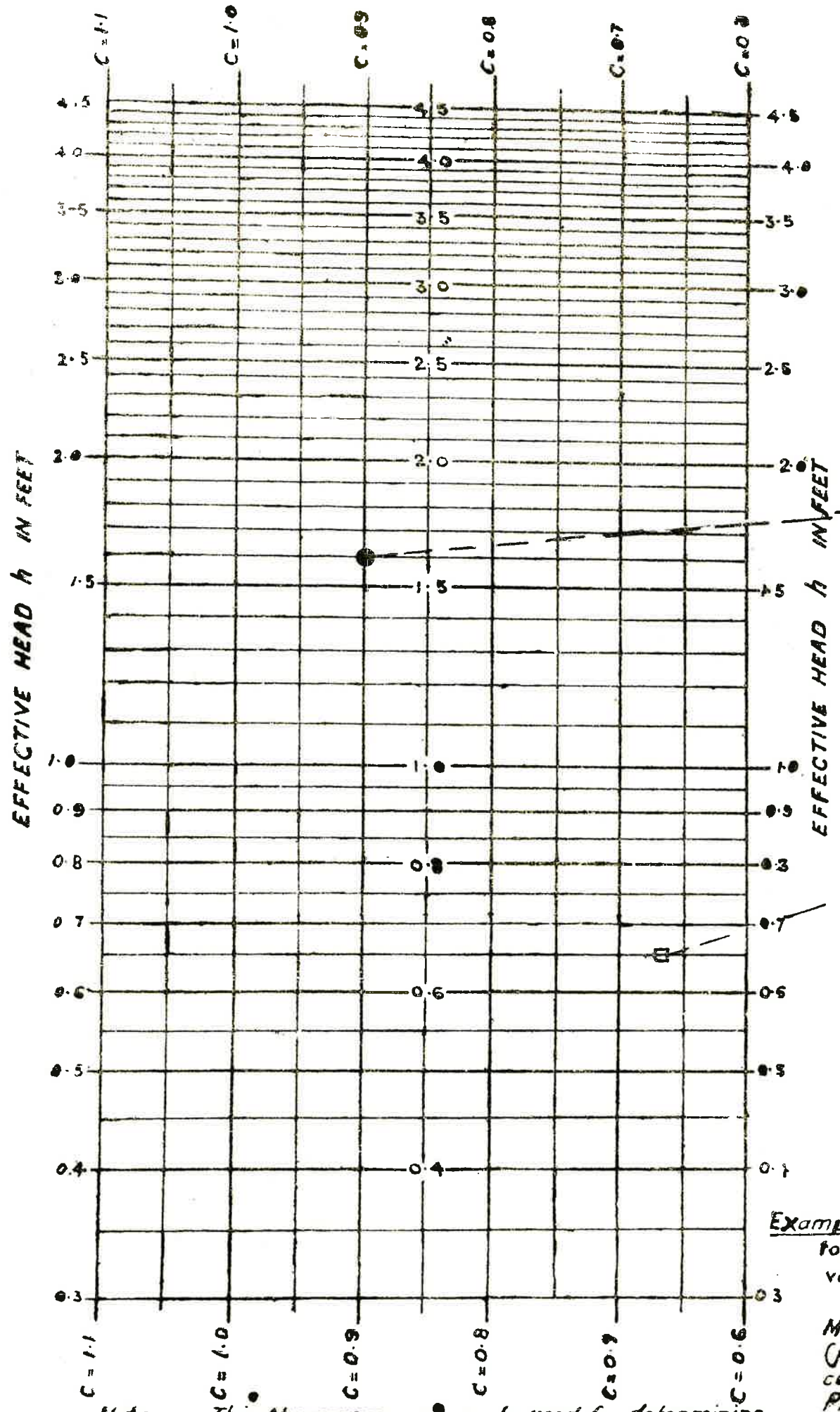
When wings are not fitted up stream, the coefficients of discharge are slightly lower, the difference being the smaller for the smaller diameters of plug:

Points marked □ represent the readings obtained when the values of H_2 were less than the minimum effective value

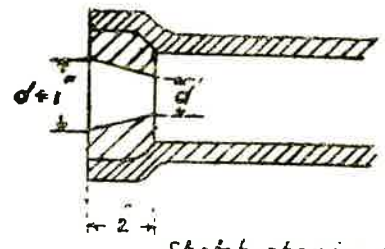
do —— ⓓ connected —— to the points □ represent the results of substituting for the read values of H_2 the minimum effective values.

For example :— In the case of a 3" plug, one result was $H_1 = 1.79$, $H_2 = -0.08$, $q = 0.81$ cusecs.
The difference in head was 1.87, but when the minimum effective value (0.15) for H_2 is substituted for the actual value of -0.08, the true effective head becomes $1.79 - 0.15 = 1.64$. This point lies on the curve of discharges.

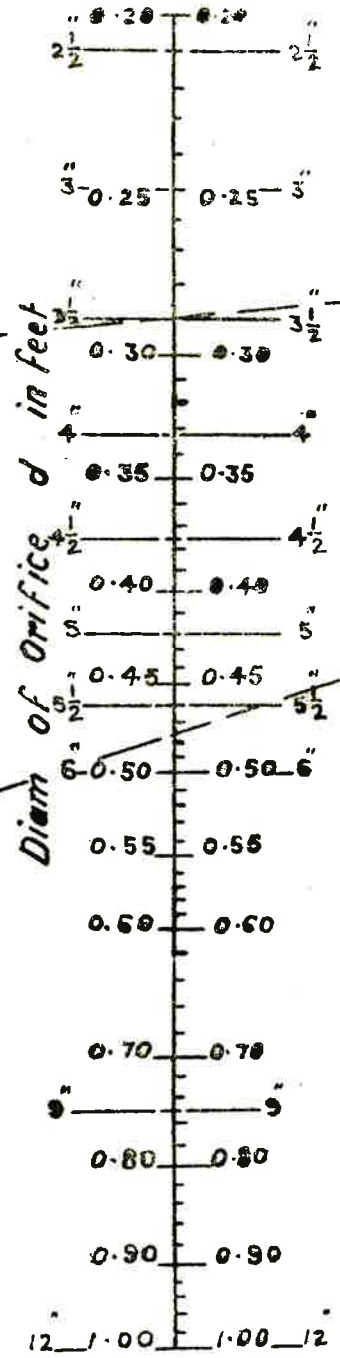
Scales of values of h in feet for Various coefficients



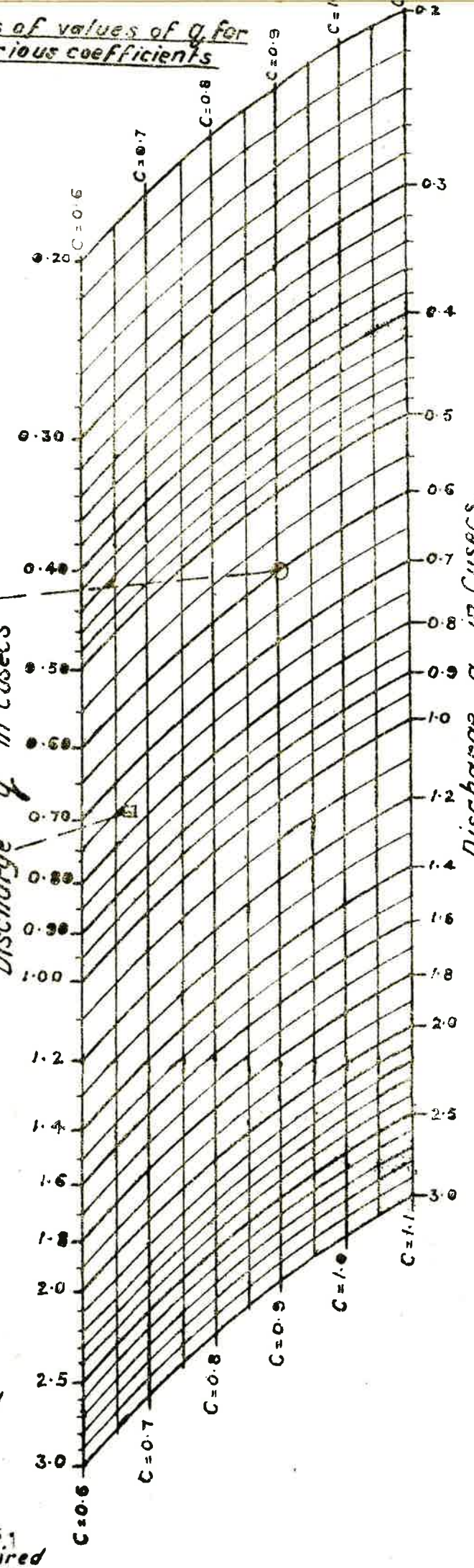
Note — This Nomogram can also be used for determining actual discharges of outlets, if H_1 & H_2 are measured



Sketch showing cross section of reducing plug



Scales of values of q for Various coefficients



Discharge q in Cusecs

See Next Page

Example :- Given a coefficient of 0.9, to find size of orifice to discharge 0.60 Cusecs at $H_1 = 2.3'$. Take $H_2 = 0.7$ (standard value if true value unknown),

Then $h = 2.3 - 0.7 = 1.6'$,

Mark h = 1.6 on the vertical scale of h below C = 0.9 (point is shown as o). On the vertical scale for q, corresponding to C = 0.9, mark the point o where q = 0.6, Place foot rule across these two points and read required diam of orifice (= 0.29) at cutting point on middle scale d is found to be 0.475

(See Nomogram on preepage)

APPENDIX-4

LOWER MAHANADI DIVISION

REVISED NOMOGRAM FOR USE IN CONNECTION WITH PIPE OUTLETS FITTED WITH REDUCING PLUGS

It has been determined by experiment that if a plug with orifice of dia.–d (say 0.25') is fitted in to the upstream socket of a pipe outlet of dia. D (say 0.5'), the expansion just D/S of the plug produces an appreciable increase in the co-efficient of discharge. Co-efficients as great as 1.2 have been obtained in certain cases. The coefficient depends on the dia. 'd' of the plug-hole, the dia. D of the pipe and the ratio of d to D. It also depends to a small extent on the effective head but for all practical purposes this last effect can be ignored if the formula given below is used.

$$q = C\ (2g)^{\frac{1}{2}}\ \frac{\pi}{4}\ d^{2}\ (H_1 - H_2)^{\frac{1}{2}}$$

$$= 6.28\ Cd^{2}\ (H_1 - H_2)^{\frac{1}{2}} = 6.28\ Cd^{2}\ h^{\frac{1}{2}}$$

Where C = approved co-efficient
d = effective diameter of orifice of plug
H_1 = U/S head over centre of pipe
H_2 = D/S head over centre of pipe
h = $H_1 - H_2$

(Note :— The pipe must be horizontal)

If the pipe at its D/S end is discharging freely in to air, a minimum value of H_2 must be taken

For the purpose of original adjustment, when the depth H_2 in the water course is unknown, a value of 0.7 may be assumed. Subsequent adjustments will be made on the actually ascertained values of H_2. If H_1 is less than 1', H_2 may be assumed as 0.3' less than H_1

Working coefficients for 6" pipe			Minimum values of H_2
6" Pipe, socket U/S	...	0.65	0.20
5.5" plug in 6" pipe	...	0.70	0 25
5" ,, ,, ,,	...	0.80	0 25
4.5" ,, ,, ,,	...	0.90	0.20
4" ,, ,, ,,	...	1.00	0.15
3.5" ,, ,, ,,	...	1 00	0.15
3" ,, ,, ,,	...	1.0)	0 15

Note :—The actual co-efficients are some what greater than these and vary slightly with the length of the pipe and the "Condition" of its U/S end

Date 9—6—1932

Sd/-
G. A. D. Cochrane
Executive Engineer
Lower Mahanadi Division
Ripur