2007-08

Field Training Report

Report submitted to-

Superintending Engineer,

Gates Circle, CDO, Nashik

(30/06/2008-06/07/2008)

अधिक्षक अभियंता,

दरवाजे मंडळ, मध्यवर्ती संकल्पचित्र संघटना, नाशिक

Superintending Engineer,

Gates Circle, CDO, Nashik

कार्यकारी अभियंता,

दरवाजे व विमोचक विभाग क्र. १

Executive Engineer,

Gates & Outlet Division-1 , CDO, Nashik

सरळ सेवा भरतीने नियुक्ती दिलेल्या सहाय्यक कार्यकारी अभियंता श्रेणी–१ अधिकाऱ्यांसाठी क्षेत्रीय प्रशिक्षण कार्यक्रम, जलसंपदा विभाग

Field Training for Direct Recruits - Assistant Executive Engineer (Grade 1) of Water Resource Department.

कालावधी: ३० जुन ते ०६ जुलै २००८

Duration: 30 June to 06 July 2008

"क्षेत्रीय प्रशिक्षण अहवाल"

"FIELD TRAINING REPORT"

सादरकर्ता–

प्रविण कोल्हे, बी.ई.(सिव्हिल), एम.टेक. (आय. आय. टी.– कानपूर)

(सहाय्यक कार्यकारी अभियंता)

Submitted by-

Pravin Kolhe, BE (Civil), MTech (IIT-Kanpur)

(Assistant Executive Engineer)

Executive Summary

Maharashtra Engineering Training Academy (META), Nashik organized training program for direct recruits - Assistant Executive Engineer & Assistant Engineer (Class I) of Water Resource Department (WRD), in accordance with Maharashtra Engineering Service Examination-2004. As per schedule of training program, we were directed to undergo training under the guidance of Superintending Engineer- **Shri. Rajendra Jaltare,** Gates Circle, Central Design Organization, Nashik.

The training program was scheduled for one week and started on 30th June 2008 and we were directed to study about design of gates, outlets and their component parts under the guidance of Executive Engineer (A.C.) **Shri. V.V. Vaze.** We interacted with him and he guided us on subjects such as-General layout of spillway gates (radial and vertical type), structural and hydraulic design of gates and their component parts (skin plate, vertical stiffener, horizontal girder, end arms, trunnion hub, trunnion bushing, trunnion pins, trunnion brackets, anchor girders, anchorages, trunnion beam/tie, thrust block, seals, seals seat/wall plate, guide rollers, anchor bolts, lifting bracket, seal beam, lifting arrangement, hoist and so on) and Excel Sheet for design of these components. I also visited other divisions under this circle office and learned valuable knowledge regarding canal structures and vertical gates.

This report includes the day-to-day details of training program at Gates Circle, Central Design Organization, Nashik. While writing this report, I had gone through various design standards like Design Process Manual, IS Codes, Central Design Organization, Nashik Standards, CWC Standards etc and I had given these references in the appropriate locations. The report also contains the study and observations performed by me. I learned valuable knowledge regarding Design Procedure of Gates and Outlets through guidance by officers as well as reference material.

Acknowledgement

I take this opportunity to express my gratitude to those whose active help and support make this report possible in the present form.

First of all, I express my sincere gratitude to **Shri. Rajendra Jaltare, Superintending Engineer,** Gates Circle, Central Design Organization, Nashik for insisting in me the drive to work hard and for inculcating in me the discipline to think clearly.

It is the endless guidance and constant encouragement of Er. **V.V. Vaze**, Executive Engineer (A.C.) of Gates and Outlets Division-1 and I would like to express my heartfelt gratitude to him and his staff for providing me necessary technical information. He shared his valuable experiences with us and it was the most enjoyable part of training.

My special thanks to deputy engineer's- **Shri. D.N. Dhande,** and **Shri. S.S. Deshmukh** for their active help and valuable guidance. All the reports and reference materials were available for my study purpose.

Definitely the knowledge, I received during this training session was a lifetime experience and it will serve as a foundation for my career in Water Resources Department.

Last, but not least, I wish to express my gratitude towards my parents- Shivaji and Rohini, my grandparents- Rangnath and Sitabai, my uncle Raosaheb and aunty Radhika who sacrificed a lot to give me a good education.

- Pravin Kolhe BE (Civil), MTech (IITK)
(Assistant Executive Engineer)

Table of Content

Chapter 1. About Central Design Organization, Nashik

1.1 Establishment of Central Design Organization, Nashik

Development programme to harness the available irrigation potential and also to increase the power resources were undertaken by the state of Maharashtra, India on a larger scale after independence by construction of dams and hydro power projects. To cope up with the need of providing designs of earth and gravity dams. Central Designs Organization (C.D.O) was established in 1957 by the Government of Maharashtra.

The CDO at that time had to start from scratch, but because of continuing efforts of the Engineers working in the CDO, the Organization is now recognized nationwide as a pioneer Design Organization in the field of Dam Design. Organization was strengthened for undertaking design of Hydro Electric Projects. It has now established its own design practices from the experience gained from the designs prepared and executed for last 51 years which has stood the test of the time and which are commensurate with the relevant BIS Code and USBR provisions.

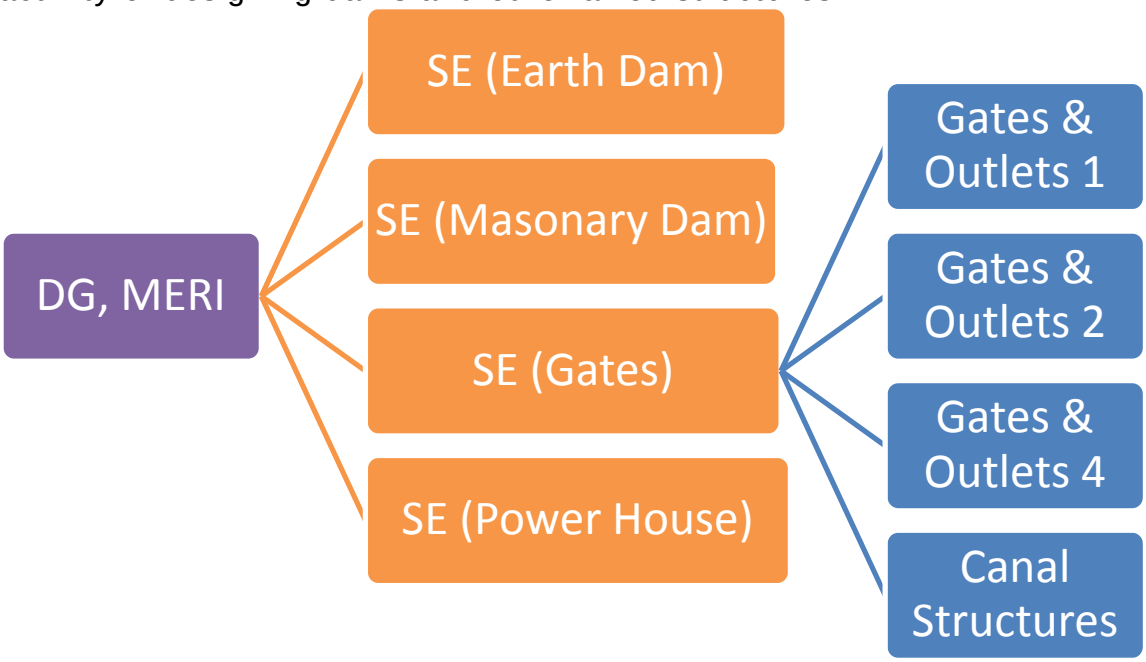
CDO is located at Nashik a central place connected with rail and road. It has its own building and residential quarters for the staff. The pioneer research institute of the state, Maharashtra Engineering Research Institute (MERI) is located in the same premises, which is complementary for the Design.

1.2 Activities of CDO

- Design of irrigation project /Design of Hydro Electric Project / Design of Lift Irrigation Scheme.
- Hydrology, Yield, Flood, Simulation studies and Flood routing.
- Detailed design of Earth dam, Gravity dam and its junctions.
- Design of different types of spillways / Energy dissipation arrangements.
- Instrumentation.
- Design of various types of Outlets.
- Design of all types of Gates.
- Design of various types of Major Canal Structures.
- Design of Hydro Electric Projects.
- Design of lift Irrigation Schemes.
- Review of old dams and suggesting remedial measures, if required.
- Scrutiny of Project Report for C.W.C. Clearance.
- Working on different Committees of BIS for preparation of various standards.
- Consultancy services for Semi Government / Private Sectors.

1.3 Organizational Structure

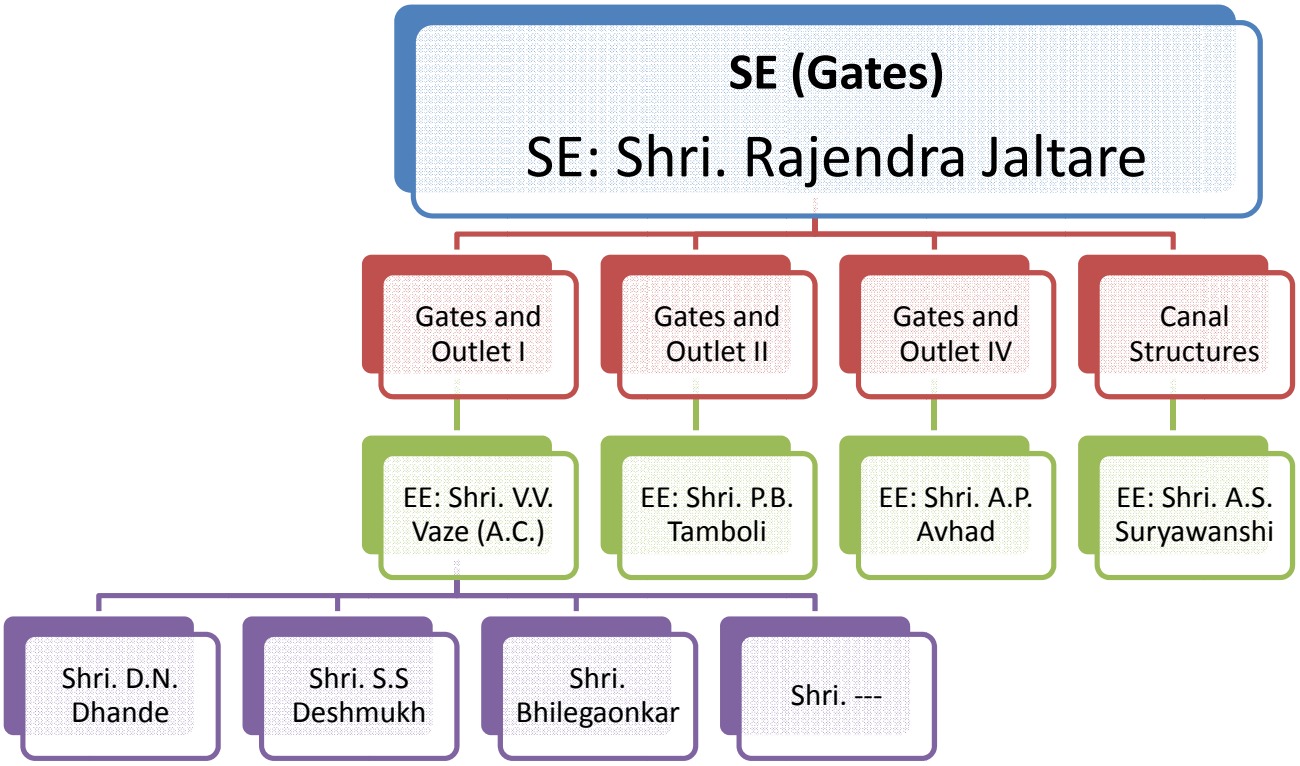
Maharashtra State is one of the developed states in India in agriculture sector. The policy makers have given due importance for the creation of irrigation potential for which construction of Major, Medium and Minor projects is taken up on a large scale. There are 1427 large completed dams in the state and many more are coming up. Central Designs Organization (CDO) is the state owned Organization under the Irrigation Department of the state entrusted with the activity of designing dams and other allied structures.



CDO was formed in the year 1957. It has four design circles headed by Superintending Engineer. Design units in each circle are headed by Executive Engineers which are assisted by Deputy Engineers and Assistant Engineers.

- All the staff is quite experienced and attained certain degree of expertise.
- All the key software's are indigenously developed to suit the needs of the design.
- Nearly 200 trained Engineers are working in this organization.
- It has its own building.
- The reputed Maharashtra Engineering Research Institute (MERI) is also located in the same premises. The model studies and other material testing work are carried out in the Institute which timely corroborates/supplements design needs.
- The organization has enormous amount of collection of various technical literature and fulfills needs of the time by adding on the latest.
- The organization has published number of papers in various1 national and international seminars.

1.4 Organizational Setup of Gates Circle



1.5 Role of Gates Circle

The activities involved are as below.

[1.] Designs of spillway Gates
[2.] Designs of Outlet Gates.
[3.] Preparation of General layout of:
  a. Irrigation outlets, (I.O.)
  b. Power outlets. (P.O.).
  c. Irrigation Cum Power Outlets (I.C.P.O),
  d. River outlets(R.O.)
[4.] Design of Appurtenant works (R.C.C. component etc.) for Outlets.
[5.] Design of Trash rack Panel & Intake gate for L.I.Scheme.
[6.] Design of major canal structures.
[7.] Preparation of General layout of Head Works of all major projects in Vidarbha Region.
[8.] Necessary assistance to field officers in getting clearance of projects from Central Water Commission, New Delhi.

Chapter 2. General Layout of Spillway Gates

2.1 Introduction

The number and size of gates is decided after considering the maximum project floods to be passed and the economic spillway length. This study is done at Water Planning Division of Central Design Organization, Nashik. Following data is required for deciding general layout of spillway gats-

1. The layout of overflow portion, the number and size of gates.
2. Final OF[1] and NOF[2] section
3. Type of spillway bridge (precast, prestressed or cast-in-situ R.C.C)
4. Ogee and upper nappe water profile at MWL coordinates
5. No. of days in which the WL is below crest level.

2.2 Method of finalizing the General Layout

1. One of the standard prestressed precast RCC bridge is adopted, depending on the size of Standard Gate as given below-

Sr. No.	Vertical lift Gate size	Range of design head in m.
1	0.9m. x 0.9m.	7m.-20m.
2	1.2m. x 1.2m.	15m-50m.
3	1.2m. x 1.8m.	15m.-30m.
4	1.5m. x 2.4m.	

2. Necessity of minimum clearance of hoist wire rope, at road bridge girder and near parapet 300mm and at hoist bridge girders as 150mm, should be maintained.
3. Minimum clearance of 1500 mm (IS 4623-2000) is to be ensured, between upper nappe profile (at MWL) and the gate bottom, in gate fully opened position, and the trunnion. The clearance can be reduced to 1000 mm if standardized gate dimensions are otherwise required to be modified.
4. Profile of NOF section and earth dam section, existing at the junction with spillway should be shown in dotted lines, duly superimposed in the spillway layout.
5. For approaching the trunnion girder platform (for routine repair and maintenance) a permanent access either from a horizontal girder bridge of from ladder provided along downstream face of each pier, is to be indicated on the drawing without giving dimensions.

[1] Over Flow
[2] Non Over Flow

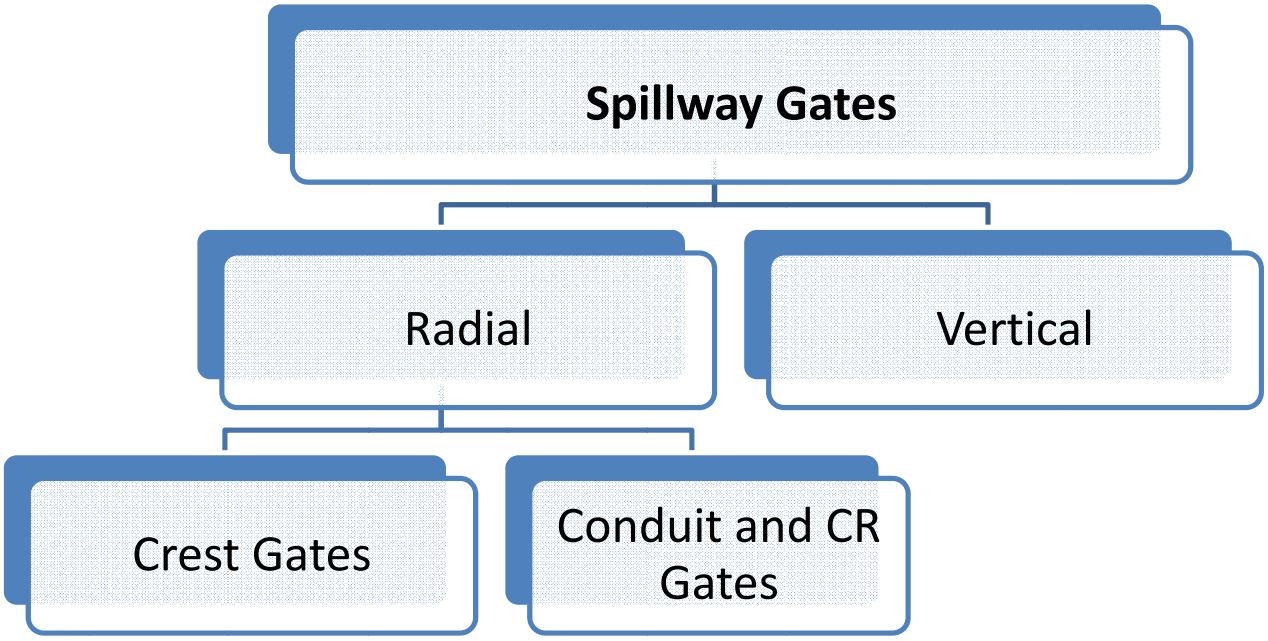
6. Check whether all intermediate piers are of same width as standardized for the three gates. If any of them is different (owing to location of outlet/river sluice etc.) make necessary alterations in trunnion girder for that pier and mention such alterations in the notes.
7. In the gate fully opened position, it should be checked that, at least two guide rollers on each side, do not leave the track plate.
8. Details of Hoist Bridge and hoisting arrangement which are relevant to the gate layout are taken from the standard layout at end.

For 12 x 5 m	Use 20 T hoist
For 12 x 6.5 m	Use 40 T hoist
For 12 x 8 m	Use 42 T hoist

For 12x4 m and 8x4m Mechanical hoists are yet to be standardized.

9. The angle of rope with the radius at gate top in gate fully closed position should not be less than 90^0

2.3 Classification of gates

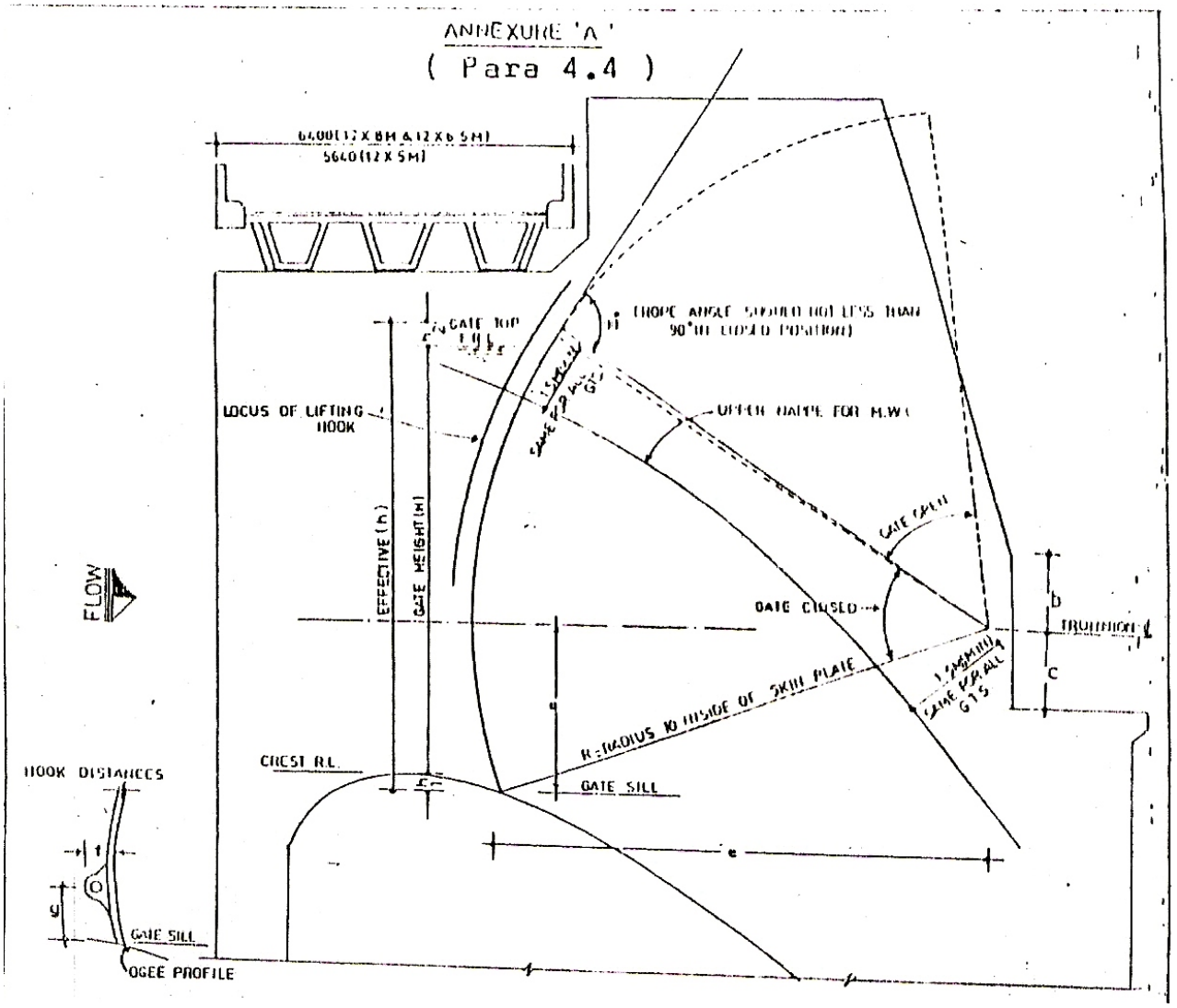


2.4 Data check list for Radial Gates Layout

1. The Layout of Overflow Portion,
2. The No. and size of gates.
3. Sanctioned overflow section.
4. Sanctioned non-overflow section.

5. Spillway road bridge details.
6. Ogee co-ordinates and equation.
7. Co-ordinates of water profiles of upper nappe at MWL (at the center of bay)
8. Total No. of days in year, in which the water levels is below the spillway crest level.
9. Total No. of days in year, in which water goes below a level corresponding to 40% of gate height.

2.5 Layout of Radial Gates



2.6 Design of Radial Gates

Radial Gates are so named because they are made to the shape of a portion of a cylinder that rotates about its horizontal axis. Normal the convex faceoff the skin plate is the upstream face. The hydrostatic load on the skin plate is carried by system of primary and secondary beams which are in turn supported by end arms. The end arms are radial members emanating from the pin bearing located at the axis. These types of gates are used as spillway crest gates and canal regulating gates in India.
Central Design Organization, Nashik standardized following sizes of gates-

8 m span x 4 m height	Parallel End Arm
12 m span x 3 m height	Inclined End Arm
12 m span x 4 m height	Parallel End Arm
12 m span x 5 m height	Inclined End Arm
12 m span x 6 m height	Parallel End Arm
12 m span x 8 m height	Inclined End Arm

2.7 Component Parts of Radial gates

Gate Leaf including Skin Plate, vertical stiffeners, horizontal girders
End arms (Inclined and Straight or parallel arm)
Guide Rollers and seals with clamping plates
Trunnion hub, bushing, pin and bracket
Trunnion Girder and its anchorages (Bonded, Unbounded, Combined, Prestressed) or Yoke girder and anchor girder
Gate sill, wall plate and anchorages
Hoist and its anchorages
Thrust Block
Guide Rollers
Anchor Bolts and Anchor Plates
Trunnion Chairs
Lifting Bracket
Seal Beam
Lifting Arrangement- (u/s and d/s)

2.8 Design of Vertical Lift gates

Vertical lift gates are water retaining steel structures generally used for spillway, sluices and penstocks in dams and for barrage and canal regulators. Beside having structural stability they should be reasonable watertight, capacity of being raised or lowered by hoist at the specified speed, should have alterative arrangement for operation in case of power supply failure, and should operate

partially open condition and pass discharge without cavitations and vibration, if meant for regulation.

2.9 Component parts of Vertical gate

Skin Plate
Vertical and Horizontal stiffeners
Horizontal Girder
Wheel and Wheel track
Seals and accessories
Hoist Bridge Components and Pylons
Guide Rollers/Guide Shoes
Track Base
Guides
Seal Seat, Seal Base and Sill Beam
Anchorages

2.10 Provision of Stop Logs

Stop logs should be provided for routine maintenance of crest gates when the water level does not go below the crest for at least one month in a year. In some of the spillways where number of gates is large and the period left for annual repairs and maintenance is less (about a month or so), it is not possible to maintain 1/3 number of gates each year (It is a standard CDO practice to carry out gate maintenance at least once in 3 years), it may be necessary to provide stop log gates even though the criteria of water level going below crest for at least one month is fulfilled.

Chapter 3. Design of Outlets

3.1 Introduction

Irrigation outlets are the openings in dam provided with discharge controlling gates with d/s conduit i.e. water conductor system. The discharge as per requirement and at desired time/period can be regulated by operating the sluice gate in the intake well. The d/s side conduit is carrying free flow discharge. Being high velocity of this discharge, the air, d/s side of the gate is also sometimes carried away with flow outside the conduit. Hence there is possibility of negative pressure on d/s side of service gate. To avoid this effect air vent is provided.

3.2 Emergency Gate

As service gate is continuous in operation, timely repair and maintenance of these gates are required. Hence to take this gate out of the slot, to isolate this part from the reservoir an Emergency Gate is provided just u/s to the service gate. The service gate is stem operated, while emergency gate is occasionally used, and it is kept in hanging condition at top of dam/intake well and operated by wire rope.

The service gate and emergency gate, both are provided in side an intake well. It is either rectangular or circular in shape. Some cases the emergency gate is provided out side the well like in case of masonry dam.

Hoisting Arrangement:

Proper hoisting arrangement is provided atop the intake well with chequrred plate flooring both gates.

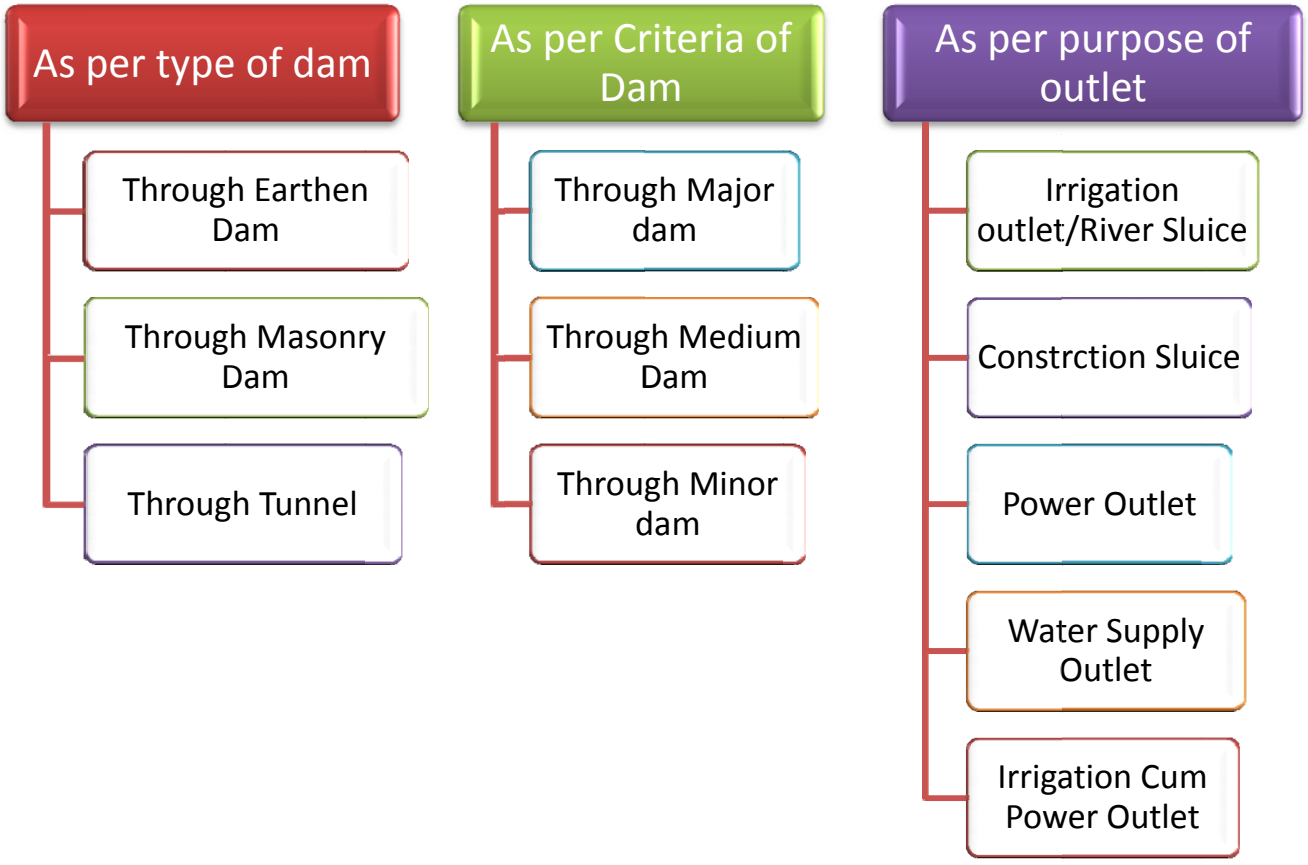
Bye-Pass Valve:

In order to reduce hoisting capacity bye pass valve arrangement is provided d/s of this gate in the well. By operating this valve hydrostatic balance condition can be created on both sides of the service gate and hence hoist capacity can be reduced.

Approach Bridge:

Approach Bridge in the form of structural steel is provided from dam top to intake well top to reach at hoisting platform.

3.3 Classification of Outlets



3.4 Structural Components of Outlet

1. Bell Mouth Portion
2. Approach Channel
3. Intake Structure/Bell Mouth
4. Approach Conduit
5. Intake well with E.G. and S.G. arrangement
6. RCC Box conduit
7. Hoisting arrangement
8. D/s conduit, tunnel etc.
9. Energy Dissipation Arrangement
10. Approach Bridge

3.5 Hydraulic Design of Outlet

Following parameters are decided in hydraulic design-

1. Deciding area of gate.
2. Number of opening and size of gate
3. Preliminary estimate for provision of driving head (Cut-off) for outlet design
4. Requirement of minimum driving head
5. Dimensions of gate slot and block outs.

3.6 Number of opening and size of gates

These are generally decided on the basis of similar outlets designed in the past or by trial method, assuming the number and size and working out the discharge capacity. The discharge through a gate is worked out after verifying whether the gate opening acts as a sluice or as an open crested weir. The coefficients of discharge to be adopted for different opening are given in the ISO Manual prepared by Central Design Organization, Nashik.

3.7 Classification of Irrigation Outlets

The irrigation outlets are classified according to the project as well as the section through which they pass. The general classification is given below-

3.7.1 Irrigation Outlet through Major Project

a. Through Earthen Dam
b. Through Masonry Dam
    i. Through NOF
    ii. Through Pier
    iii. Through Tunnel

3.7.2 Irrigation Outlet through Medium Project

c. Through Earthen Dam
d. Through Masonry Dam

3.7.3 Irrigation Outlet through Minor Project

e. Through Earthen Dam
f. Through Masonry Dam
g. Through Tunnel

3.8 Design of Service and Emergency Gate

Outlet is provided in dam to release controlled discharge. The requirement may be for irrigation, power generation; drinking water for downstream habitation etc. the required discharge can be released by provision of gates.

There are two types of gates, which are normally adopted wheel type gate and slide gate. The service gate and emergency gates are generally vertical lift type gates. The emergency gate is normally downstream sealing type gate and service gate is normally of upstream sealing type. However this depends on the layout of irrigation outlet.

3.9 Component of Service and Emergency Gate

Skin Plate	Horizontal Girder
Rollers	Vertical Stiffeners
End Verticals	Wheel Pin
Guide Bracket & lifting bracket	Track plate
Track girder	Sill Beam
Anchorages	Seals
Stem Rod	Hoist capacity of gate
Ballast	

3.10 Data required before outlet location is approximately decided.

- Project Report, Basin Survey Contour Plan. (Already prepared for area-capacity curves.)
- Detailed block levels (or contour plan)along Dam axis (already prepared for finalization of dam alignment)

3.10.1 Data required after outlet location (and type) is approximately decided.

1. Survey Data
2. Foundation data.
    a. Bore Data.
    b. Trial Pit Data.
3. Hydraulic Data.
4. Levels:-
    a. T.B.L
    b. H.F.L
    c. F.S.L
    d. Spillway crest level
    e. M.D.D.L.
    f. Sill level of outlet.

g. Silt level.

5. Area - Capacity Curve.
6. Water planning.

3.10.2 Additional Data Needed in Case of ICPO or PO

1. The M.D.D.L. for power generation.
2. The working tables for power house operation.
3. The location of power house.
4. Machine centre line R.L.
5. L-Section of water conductor system.
6. Approved copy of feasibility report.

3.10.3 Additional Data Needed in Case of Construction Sluices

1. Purpose of provision of the Sluice.
2. L-Section showing sequence of construction of dams and programme of construction marked thereon.
3. Method of diversion of river contemplated.
4. Amount of controlled discharge & corresponding level if such discharge is desired to be let out through the outlet.
5. Max. Discharge requirement at a specified minimum head.
6. Max. Static head to which the sluice is likely to be subjected.
7. Max. Operational head to which the sluice is likely to be subjected.
8. Max. No. of years for which the sluice is expected to function.
9. Whether the sluice will be permanently plugged after use or otherwise.

3.10.4 Additional Data Needed in Case on Water Supply Outlet

1. Whether the discharge is to be let out into the river or whether a pressure pipe line takes off directly from the storage.
2. Working tables for water-supply releases.

3.11 Structural Design of Bell Mouth

Design of bell mouth portion for outlet without approach conduit is discussed as below. The bell mouth portion is of varying thickness member. The bell mouth portion consists of top slab, two sides and bottom slab. The bell mouth portion is considered as closed box. The minimum thickness of member is considered for design purpose. For design of top bell mouth portion dead weight of member and load due differential water head as 2 t/m^2 is considered. For design of sides of bell mouth portion differential water head of 3 t/m^2 is considered.

3.12 Lifting Beam for Emergency Gate

The lifting beam is provided for emergency gate if number of gates provided is more than one. Hence lifting beam is required for taking out these gates, on by one, at hoisting platform level with the help of EOT crane. The lifting beam consists of standard or fabricated channels placed back to back and joined by batten plates. The lifting bema while in operation travels between the guides free along with trash rack panel. The beam section is designed as a compression member and the hook is designed as a tension member.

This also includes following designs-

1. Design of pin for wire rope.
2. Design of beam section.
3. Design of Hook.
4. Design of pin for supporting hook
5. Design of batten plate for lifting plate
6. Design of weld

3.13 Design of Irrigation-Cum-Power Outlet (ICPO)

Design of ICPO consist of design of following components-

1. Trash Rack Panel & embedment's
2. RCC portal for hoisting of trash racks
3. Lifting Beam for Trash Rack Panel
4. Service & Emergency Gate leaf and embedment
5. RCC Hoisting portal for emergency gate
6. RCC design of Bell Mouth Conduit through earth dam
7. RCC Design of trash rack structures
8. RCC design of intake well in tunnel
9. RCC design of intake well in earth dam
10. RCC design for downstream gated structure
11. Approach bridge
12. RCC portals for approach bridge
13. Design of Y-piece
14. Design of Anchor block
15. Design of bulk head
16. Design of manhole

Chapter 4. Design of Canal Structures

4.1 Introduction

The canal structures design division of Central Design Organization, Nashik deals with the design of CD[1] works like-

- Aqueduct
- Canal Siphons
- Cross Regulator cum Escape
- Culverts

4.2 Important Points to be Noted

1. Details of Canal Crossing
2. Details of Nalla Crossing
3. Structure proposed by field officer
4. List of following drawings and reports-
    a. Index map, L-section, Cross Section
    b. Copy of approved CBL and Cut-Off statement of Canal duly certified
    c. Alignment approval letter of competent authority
    d. Head loss available at proposed structure
    e. Trail pit and bore hole results duly certified by the competent authority
    f. Safe bearing capacity of foundation strata
    g. Depth of foundation
    h. Proposed location of structure/ seismic zone number
    i. Observed HFL if river/Nalla at proposed structure location
    j. Maximum water table at crossing

4.3 Data Needed for Design of CD Works

[Ref. Govt. Circular no MIP 2259/27908-J Dated-19-10-1959]

Sr. no.	CANAL DETAILS	
1	a) Full Supply Discharge b)Design discharge	Cumecs Cumecs
2 3 4	Canal Bed level Full Supply level Top of Bank level	m. m. m.

[1] Cross Drainage

5	Canal Bed-width	m.
6	Free board	m.
7	Service road top width	m.
8	I.P. top width	m.
9	Velocity of flow	m/sec.
10	Canal Bed Gradient 1 in	
11	Canal Lined/ unlined	
12	Value of 'n'	
13	Side slopes of Section (H:V) adjacent to aqueduct at u/s &d/s	
14	Head loss available For proposed structure	m.
15	Enclose copy of approved CBL , cut-off statement of canal	
16	Additional information	

4.4 Categories of CD works

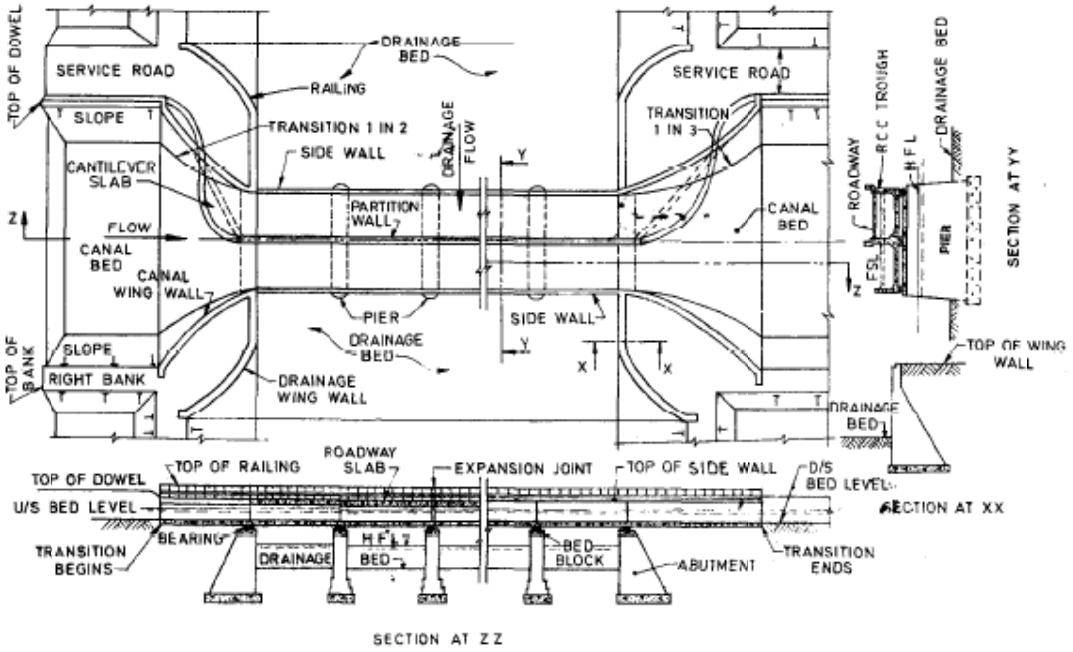
1. Structures for canal over natural drainage channel
    a. HP Drain/Sub drain
    b. Aqueduct
    c. Nalla Siphon
2. Structures for canal under natural drainage channel
    a. canal siphons
    b. super passages
3. Structures for canal protection and operation e.g. cross regulators cum escape, head regulators etc.

After finalization of type of structure, the design and drawing is done for the general arrangement. Further this general arrangement report is send to respective competent authority for approval. After this approval the detailed design is done for various components of the structures.

4.5 Components of aqueduct

1. Abutment
2. Pier
3. Transitions-Entrance and exit
4. Cap-pier and abutment
5. Pedestals
6. Bearing
7. Anti-seismic arrangement
8. Box- trough/pipe
9. Approach Roadway
10. Wing Wall/Retaining Wall
11. Miscellaneous-pile and pile cap
12. Expansion joint
13. River training works

4.6 Typical Plan and Section of Aqueduct



4.7 Typical Layout of Level Crossing

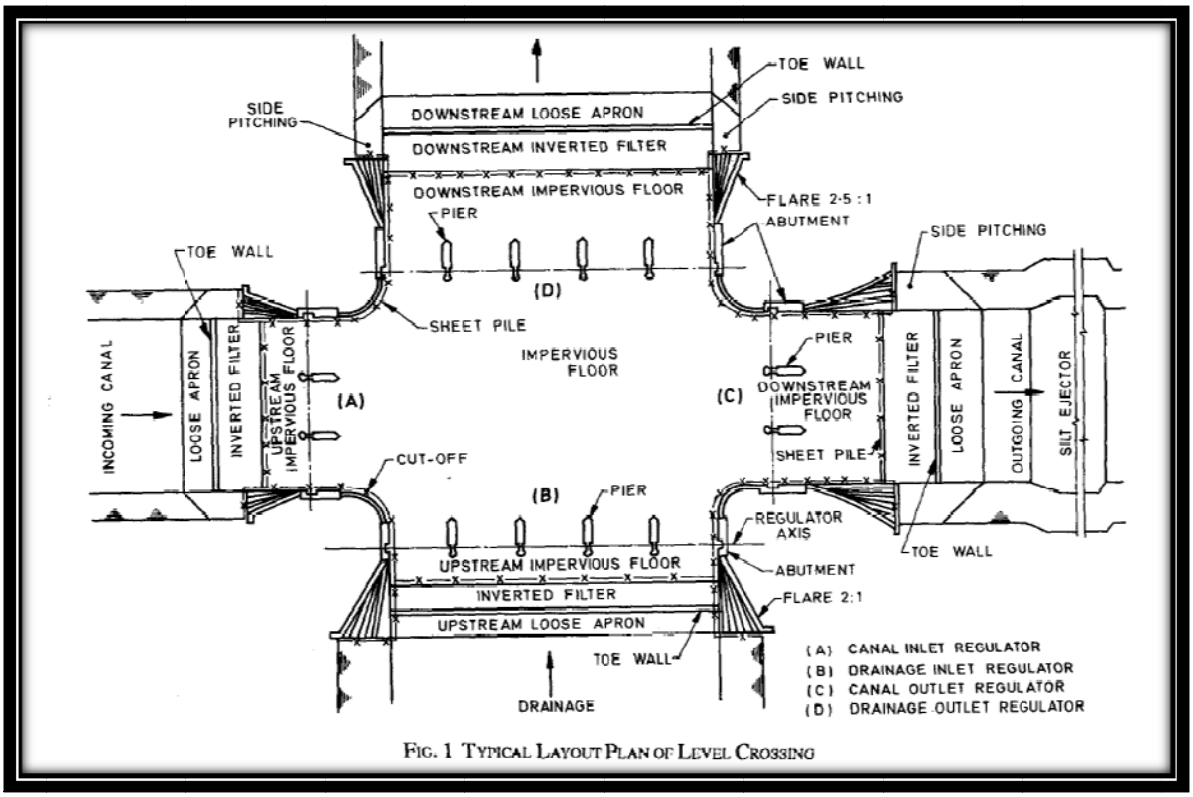


FIG. 1 TYPICAL LAYOUT PLAN OF LEVEL CROSSING

Chapter 5. References

[1.] Indian Standard Recommendations for Structural Design of Radial gates IS: 4623-2000.
[2.] Indian Standard Code of Practice for use for Structural Steel in General IS:800-1984
[3.] Hand Book of Hydro Electric Projects by P.S. Nigam.
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[7.] Sylven J.Skinner, paper on design of fixed wheel gate
[8.] US Army Crops of Engineers Manual No. 1110-2-1602 of 1963 entitled "Hydraulic Design of Reservoir Outlet Structures"
[9.] Mr. W.P. Simmons "Air Model Studies of Hydraulic Down pull" Journal of Hydraulic Division, January 1959, Practice of American Society of Civil Engineers
[10.] Handbook of Hydro-electric project by Nigam.
[11.] Central Design Organization, Nashik Code of Practice
[12.] ISO Manual of Central Design Organization, Nashik

Chapter 6. Conclusion

The training program at Gates Circle, Central Design Organization, Nashik was scheduled for one week and started on 30th June 2008 and I studied preliminary information about design of gates, outlets, canal structures and their component parts under the guidance of Executive Engineer (A.C.) **Shri. V.V. Vaze**. I interacted with him and he guided us on subjects such as-General layout of spillway gates (radial and vertical type), structural and hydraulic design of gates and their component parts (skin plate, vertical stiffener, horizontal girder, end arms, trunnion hub, trunnion bushing, trunnion pins, trunnion brackets, anchor girders, anchorages, trunnion beam/tie, thrust block, seals, seals seat/wall plate, guide rollers, anchor bolts, lifting bracket, seal beam, lifting arrangement, hoist and so on) and Excel Sheet for design of these components.

I also visited other divisions under this circle office and learned valuable knowledge regarding canal structures and vertical gates.

I express my sincere gratitude to **Shri. Rajendra Jaltare,** Superintending Engineer, Gates Circle, and Executive Engineer (A.C.) **Shri. V.V. Vaze**, Central Design Organization, Nashik for insisting in me the drive to work hard and for inculcating in me the discipline to think clearly.

I learned valuable knowledge regarding Design Procedure of Gates and Outlets through guidance by officers as well as reference material.

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