2007-08

Field Training Report

Report submitted to-

Superintending Engineer,
Earthen Dam Circle,
Central Design Organization , Nashik
(19/06/2008-22/06/2008)

अधिक्षक अभियंता,
मातीचे धरण मंडळ, नाशिक

Superintending Engineer,
Earth Dam Circle, CDO, Nashik

कार्यकारी अभियंता,
मातीचे धरण विभाग क्र.२

Executive Engineer,
Earth Dam Division-II, 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: १९ ते २२ जुन २००८

Duration:19 to 22 June 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. M.S. Bendre Saheb**, Earth Dam Circle, Central Design Organization, Nashik.

The training program was scheduled for six working days, started on 16th June 2008 and we were directed to study about Design of earthen dam and its components under the guidance ot Executive Engineer- **Shri. P.N.Narkhede saheb**. I had undertaken a case study of design and completed it successfully.

This report includes the day-to-day details of training program at Earthen Dam Division No-2, Earth Dam Circle, Central Design Organization, Nashik. It also contains the study and observations performed by me. I learned valuable information regarding Design Procedure or earthen dam through guidance by officers as well as publications like- Design Process Manual, IS Codes, Central Design Organization, Nashik Standards etc. I had collected reference materials and Technical Notes from the office.

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. M.S. Bendre Saheb, Superintending Engineer,** Earth Dam 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. **P.N. Narkhede** Saheb, Executive Engineer (Earthen Dam Division-II) 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 **Shri. T.K. Gaikwade,** saheb**,** Sub-Divisional Engineer and **Shri. G.D. Rahabe** saheb, Assistant Engineer-II 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)

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Chapter 1. About Central Design Organization, Nashik

WATER RESOURCES DEPARTMENT GOVERNMENT OF MAHARASHTRA, INDIA

CENTRAL DESIGNS ORGANISATION, 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

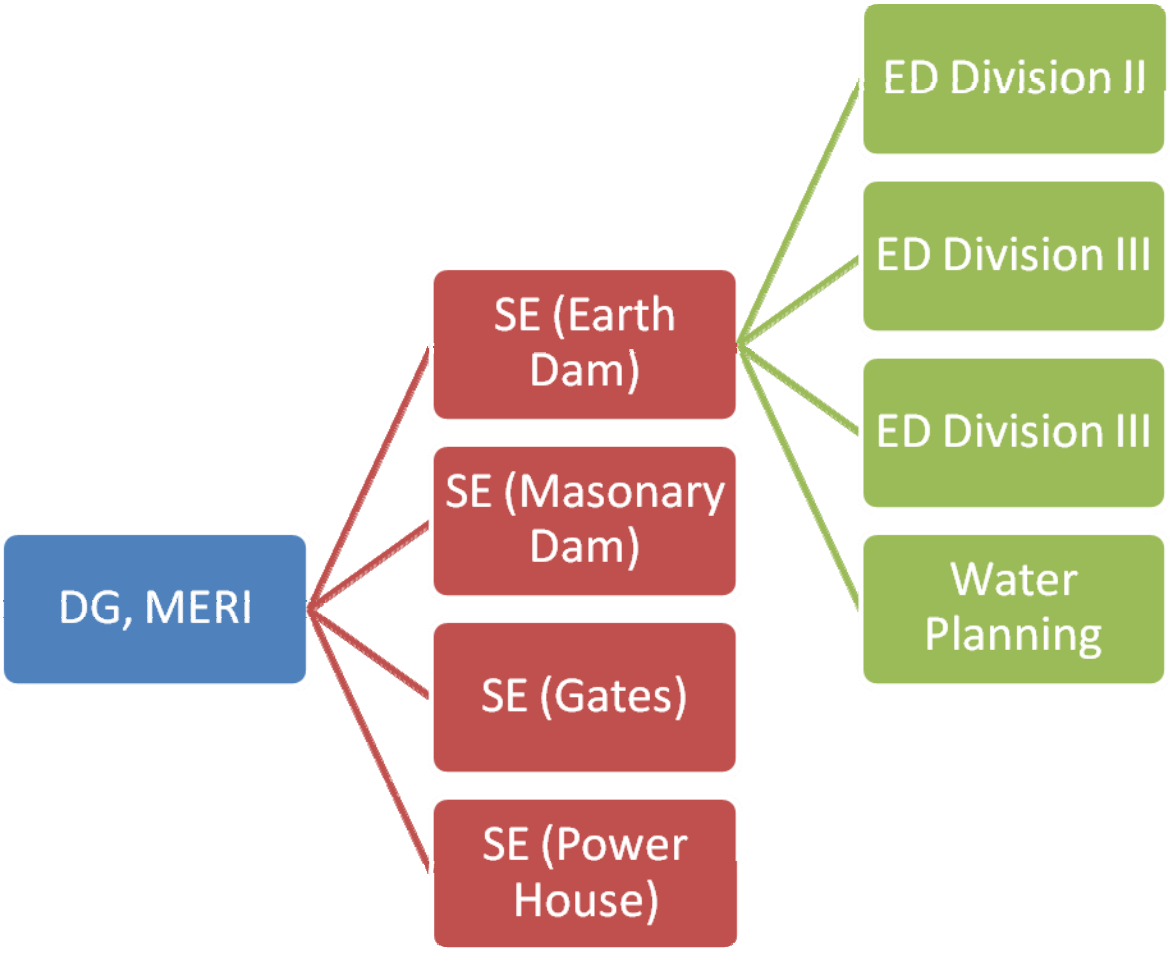
- Design of irrigation project /Design of Hydro Electric Project / Design of Lift Irrigation Scheme.
- Hydrology, Yield, Flood, Simulation studies and Flood routing.
- Detailed design of Earth dam, Gravity dam and its junctions.
- Design of different types of spillways / Energy dissipation arrangements.
- 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.

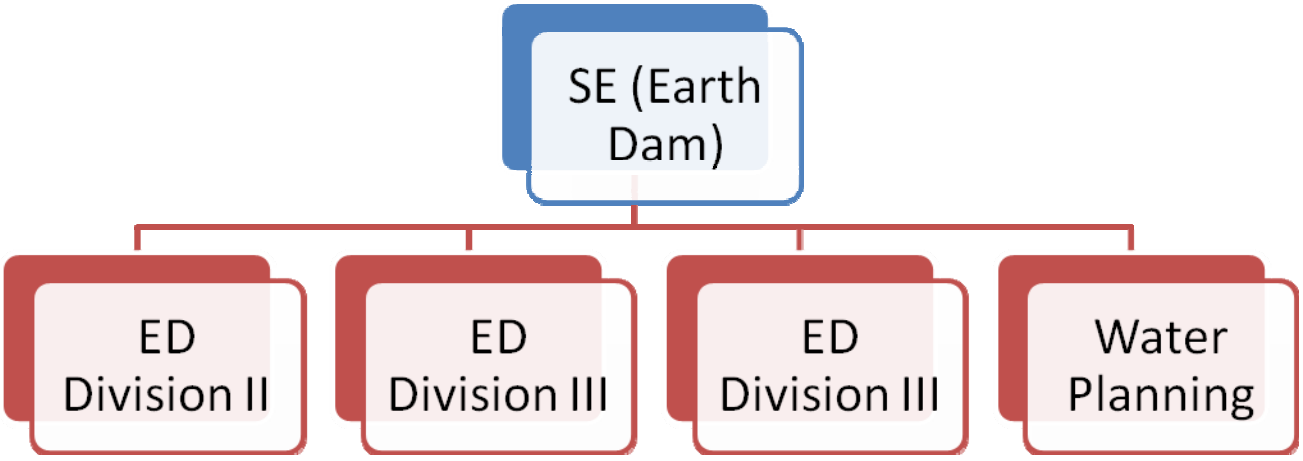
CDO was formed in the year 1957. It has four design circles headed by Superintending Engineer. Design units in each circle are headed by Executive Engineers which are assisted by Deputy Engineers and Assistant Engineers.

- Masonry dam circle - 4 Design units and one geological unit headed by senior geologist.
- Earthen dam circle - 3 Design units and a Water planning unit.
- Gates circle - 4 Design units.
- Power House circle - 4 Design units.
- 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.



Chapter 2 Earth Dam Circle

2.1 Organizational Setup of Earth Dam Circle



2.2 Role of Earth Dam Circle

1) Preparation of General Layouts of main dam of Major/Medium Irrigation projects (Marathwada & Konkan region)
    a. Selection of type of dam
    b. Fixing the control levels.
    c. Finalization of spillway location
    d. Layout of tail & approach channel.
2) Design of Under Seepage Control Measures.
3) Design of Earth/Rock fill Dam for Major, Medium & Minor Irrigation Project. The stability of earth dam is checked for the following conditions.
    a. Upstream slope reservoir full with earthquake condition.
    b. Upstream slope for sudden drawn-down condition.
    c. Downstream slope for steady seepage with earthquake condition.
    d. Downstream slope for steady seepage without earthquake condition.
    e. Downstream slope for sustained rainfall condition.
4) For design of earth dam section, computer program is developed by this circle. This program is built in `Fortran Language' which covers maximum trials to give accurate results.
5) Design of junction between Masonry & Earth dam.
6) Provision of various types of instrumentation in earth dam.
7) Review Of Old Dams

8) Review of old dams. For taking review of old dams, Government of Maharashtra has prescribed a checklist. Accordingly the required data for the project is collected from field officers and study all the aspects, which are required for review & suggest the remedial measures if required. For review of project Hydrological study & structural stability is mainly checked.

9) To increase the existing capacity of the reservoir, the height of earth dam has to raise. The design for such raised earth dam section is also done by this circle.
10) Suggestions to the problems raised during construction/ after construction on field.
11) Hydrology studies (Water Planning
    a. Water availability (yield) studies.
    b. Flood study of major & medium projects for finalization of spillway capacity as well as C.W.C clearance.
    c. Simulation studies to check the performance of the project.
12) Design of canal structures: As per the government norms the design canals structures costing more than 2.5 crores is done by this circle.
13) Checking of the project report posed to Central Water Commission for clearance from Konkan & Nagpur Region.
14) Consultancy services for semi government/Private sectors for construction/ designs of earth dams.

15) Vetting of the designs & drawings for Irrigation Projects prepared by private consultant.

Since 1959, the work of design of earth dam is being done by this circle. Vast experience from last 49 years is available. Based on the practical experience gained C.D.O Code of practice for design of Earth dam is prepared. This circle have design more than 500 numbers of earthen dam in all regions of Maharashtra. This includes longest dams as well as high dams. Prominent among these are Warna dam in Kolhapur district having height 78m and Tillari in Ratnagiri district having height 75m are designed by this circle.

2.3 Data Required for Design of Earth Dam

For design of earth dam Foundation investigation and Borrow area investigation is necessary.

[1.] For Foundation investigation following data is required:

i) Bore hole data and open trial pits marked on 'L' Section showing detailed stratification.
ii) Undisturbed samples collected from the foundation at every 1.5m depth or change of strata.

[2.] For Borrow area investigation following data is required:

i) Borrow area Plan.
ii) For major and medium projects one sample per 30,000 m3 and for minor irrigation projects one sample 15,000 m3 of estimated quantity of earth work and at least 5 samples from each quarry shall be tested for each zone of the embankment.
iii) 20% samples should be tested exclusive from MERI , Nashik for confirmatory test.
iv) Annual rainfall for checking stability of dam for rainfall condition.
v) Location of stone quarries and filter material along with availability.

2.4 Data Required for Flood Studies

1) Catchment area plan up to the site in question for which flood studies are to be done to a scale of 1:50,000 or 1:2,50,000 depending on the size.
2) Hourly gauge data for 8 to 10 severe flood events for the flood period prefixing & suffixing 48 hours, for the river gauge site or dam site located near the point for which flood studies are to be done.
3) Stage Vs. Discharge data for the years for which severe flood events as stated (2) above are selected.

4) The hourly rainfall data of all the Self Recording Rain Gauge[1] stations located in the Catchment area in question, for the flood period as stated in point (2) above.
5) 5. Daily rainfall data of all ordinary rain gauge stations located in the Catchment area in question, for the period as stated in point (1) above .
6) Plan showing the locations of river gauge stations/ Tank and S.R.R.G. & O.R.G stations.
7) If medium or major projects are located in its Catchment area upstream, their salient features. In case, this upstream project contributes to a large extent to the downstream flood at the point in question, moreover moderate to the flood to a great extent, then data as mentioned in 1 to 6 above would be required for this upstream project. In addition Area-Capacity table & spillway details such as number and size of gates etc. would also be required for this upstream project.

2.5 Data Required for Yield Studies

1) Catchment area plan showing the location of the site for which yield studies are to be done.
2) Monthly runoff data observed at dam site or site maintained by either state or CWC[2] from the commencement of the station to this date.
3) Monthly rainfall data of all the stations located in the catchment area for 40 continuous years. This 40 years includes the years for which run off data is available.
4) Plan showing the locations of rain gauge stations & River gauge stations.
5) Monthly upstream utilization data of existing projects located in its Catchment area.

2.6 Data Required for Simulation Study

1. 40 years monthly runoff series at the site at which the simulation studies are to be done. The data required for yield studies are separately given.
2. Monthly evaporation depth at the project site.
3. Demands expected from the project
    a. Domestic water supply requirement
    b. Industrial water supply requirement
    c. Crop water requirement as per Modified Penman's method
4. Monthly upstream utilization data planned in its catchment area
5. Silt rate observed at the gauging site in vicinity
6. Original area-capacity table showing survey contours

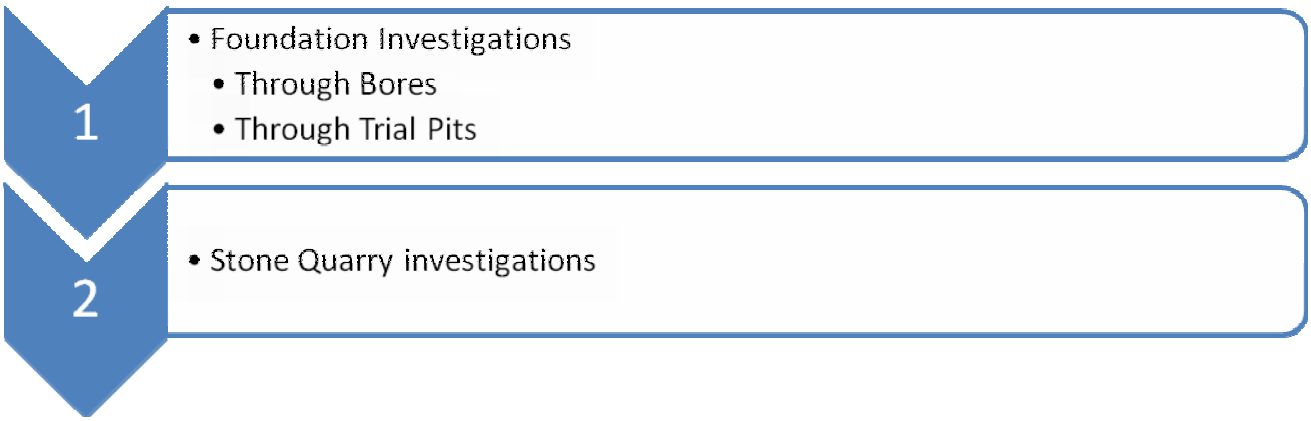
[1] SRRG: Self Regulating Rain Gauge
[2] Central Water Commission

Chapter 3 Design of Earthen Dam

3.1 General Principles of Investigations

Investigations are conducted in the office, field and/or in the laboratory. It generally follow the principle "Learn as you go" in which characteristic of the sub-surface topography and other relevant conditions are developed in progressively greater details as the exploratory work procedure

3.2 Types of Investigations



3.3 Design of Earthen Dam

Design of earthen dam includes the design of

1. Under seepage Control measures
2. Structural Stability Analysis

3.3.1 Under Seepage Control Measures

Aspects of under seepage control measures are covered in the following Indian Standards-

IS:8414-1977	**General Principles for Design of Under Seepage Control Measures**
IS:4999-1968	Recommendations for Grouting of Pervious Soils
IS:5050-1968	Design, Construction & Maintenance of Relief Wall
IS:6066-1971	Recommendation or Pressure Grouting of Rock Foundation

3.3.1 Stability Analysis of Earth Dam

General Principle: Whenever difference of levels exists within a continuous soil mass, gravitational forces tend to cause the movement from the higher elevation to the lower one. Another force which tends to cause this movement is the force due to seepage. Earthquake also generates forces which tend to cause movement. All these forces cause shearing stress throughout the soil and mass movement occurs unless the resisting force on every possible surface, plane or curved are more than the actuating forces.

The shear strength at failure on any surface within an earth dam is direct related to the normal stress on that surface and has the relationship expressed by Coulomb's Equation-

$S = C' + N' \tan(ø')$

$S = C' + (N-U)\tan(ø')$

Where,

S = Shear Strength of the failure surface.

C' = Cohesion intercept in terms of effective stress.

N = Total Normal Stress acting on failure surface

U = Pore Water Pressure acting on failure surface

N' = N – U = Effective Normal Stress and

ø' = Angle of Shearing Resistance in Terms of Effective Stress

3.4 Design Conditions and Pore-Pressure Allowance

An earth dam shall be safe and stable during all phases of construction and operation of the reservoir. Hence the analysis shall be done for the most critical combination of external forces which are likely to occur in practice. The following conditions are usually critical for the stability of earth dam-

Case I	**Construction condition with or without partial pool (for u/s and d/s slopes)**
Case II	Reservoir Partial Pool (for u/s slope)
Case III	Sudden Drawdown (for u/s) slope
Case IV	Steady Seepage (fro d/s slope)
Case V	Steady Seepage with sustained rainfall (for d/s slope, where annual rainfall is 200cm or more)
Case VI	Earth Quake Condition (for u/s and d/s slope)

For Earthquake condition, stability analysis is done by using Response Spectrum Method.

Chapter 4. Standard Dimensions of Earthen Dam

4.1 Top Width

For Major and Medium projects the top width of dam is as follows-

Dam having height up to 15 m	**3.0 m**
Dam having height from 15 to 30 m	4.5 m
Dam having height more than 30 m	6.5 m
For Gated Spillway	6.5 m

For Minor Irrigation Projects the top width of dam shall be as follows-

Dam having height up to 20 m	**3.0 m**
Dam having height from 20 to 45 m	4.5 m
Dam having height more than 45 m	6.5 m
For Gated Spillway	6.5 m

4.2 Guard Stones

On both the edges of dam top, guard stones of size 200 x 200 x 750 mm in precast cement concrete blocks 1:3:6 shall be provided at a spacing of 3 m centre to centre.

4.3 Kerbing Stone

Where the d/s slope is not pitched, the d/s edge of dam top road shall have kerbing stones of size 300 mm x 150 mm x 300 mm.

4.4 Berms

The berm width and their vertical interval shall depend on the stability requirements. However, the berm width should not be less than 3.0 and vertical interval should not exceed 12 m.

4.5 Free Board

Normal FB should not be less than 2 m above FRL and minimum FB should not be less than 1.5 m above MWL.

Upstream Slope : Minimum of 2.5 H:1V
Downstream Slope:

4. 6 Stripping of Dam

The dam seat shall be stripped off to remove all the decomposed material highly organic soils, bushes, roots of trees. The minimum depth of stripping shall be 05 m.

4.7 Cut-Off Trench

The entre line of COT shall be fixed at the point of intersection of sloping line starting from centre of top of hearting having a u/s slope of 1V:0.25H and the stripped ground level.

4.8 Top width of Hearting

1	**Major irrigation projects**	**Minimum 4.5 m**
2	Medium Project	
	Height up to 30 m	3.0 m
	Height above 30 m	4.5 m
3	Minor Project	
	Height up to 45 m	3.0 m
	Height above 45 m	4.5 m

4.9 Random Zone

Top Width: 3 m
u/s and d/s slope: 0.5H:1V

4.10 Seepage Control Measures for Body of Dam

- Inclined/Vertical Filter
- Horizontal Filter
- Longitudinal Drains and Cross Drains

4.11 Protection of Slopes for Reservoir Embankment

Upstream Slope Protection

- Hand Placed Rip rap
- Dumped Riprap
- Filter Below Riprap

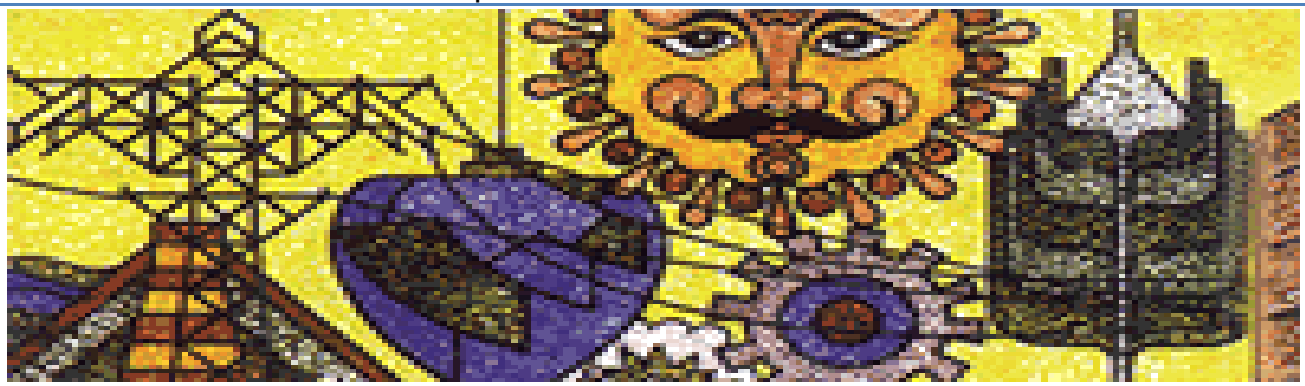
4.12 Junction of Earth Dam with Masonry Dam

The standard lays down guide lines for design of junctions of earth dam with NOF masonry dam on either sides of spillway and divide wall.
Following are the principles of design-

1. Good Bond between earthwork and masonry
2. Adequate Creep Length at the contact zone at different elevations.
3. Protection of Earth Dam Slopes against Scouring Action.

4.13 Types of Measurements in Dam

1. Pore **Pressure** Measurement.	Piezometers a) Stand Pipe b) Closed System Hydraulic c) Electric d) **Pneumatic** and Hydraulic
2. Movement	
3. Seepage	
4. Strains and Stress	
5. Dynamic Loads (Earth Quakes)	
6. **Reservoir** and TWL	
7. Wave Height	
8. Rainfall	Terminal Well
9. Data About Material Properties	



Chapter 6. Conclusion

The training session at Earthen Dam Division-2 of Earthen Dam Circle, Central Design Organization, Nashik, was the most enjoyable session for me. I joined Earthen Dam Division-2 on 19th June 2008 under the guidance of **Shri. P.N.Narkhede Saheb Executive Engineer** and interacted with him along with the staff of division. Training session ended on 22nd June 2008 and this report includes the summary of the training.

I learned the procedure of Design of Earthen Dam and its components.

It was nice experience for me since I could realize the importance of Earthen Dam Design Division.

At last, I am thankful to Superintending Engineer- **Shri. M.S. Bendre Saheb,** Executive Engineer- **Shri. P.N.Narkhede Shri. T.K. Gaikwade,** saheb**,** Sub-Divisional Engineer and **Shri. G.D. Rahabe** saheb, Assistant Engineer-II and all the staff of division for providing me an opportunity to enjoy the thrill of design and providing all the necessary documents and related procedure.

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Government of Maharashtra.