

Water and Development

Part 4b: Dams and Weirs

Milind Sohoni

`www.cse.iitb.ac.in/~sohoni`

email: `sohoni@cse.iitb.ac.in`

Dams and Weirs-The Kolhapur Type Bandhara



source: <http://www.maharashtra.gov.in/english/gazetteer/Nanded/images/kholhapur-dam.jpg>

The principle



पारनेर तालुकातील राळेगावसिद्धी बंधारा

- Concrete structure within the river bed.
- Gates open in monsoons and shut *just after*.
- Creates a storage used for agriculture/DW.
- The storage is largely confined to the river bed.
No land need be acquired.
- Used by upstream people!
- Appear in a sequence
- Fairly cheap and useful.
Very popular in India.

source:

http://ahmednagar.nic.in/html_docs/images/Ralegan.png

A typical calculation

- Height and length of KT weir: $30m \times 3m$.
- Length: 1000m and therefore volume: 100,000 cubic meter, i.e., 0.1MCM.
- At 10cm watering, we get 100 hectares of irrigation.
- About 30-40km of river gives us 4MCM per discharge.
- Dimbhe Storage is 375MCM.
- About 20-30 weeks of discharge gives about 100MCM through KT weir.

Reservoir+Earthen Dam

Objectives

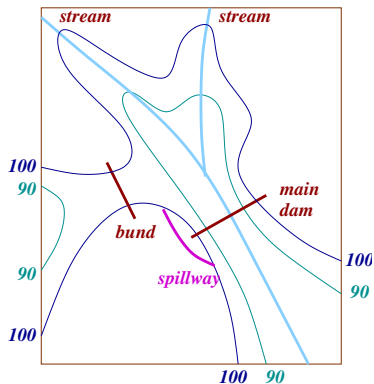
- Increase surface storage in system. Increase recharge and total GW stored. Improve surface water flows.
- Improve drinking water security and allow for livelihood water.



Costs

- Land acquisition, submergence. Considerable amount of earth.
- Sophisticated engineering design. Labour and fuel costs.

A Small Dam



- The **FSL** (full storage level) of the dam is the height at which water is stored, in this case, 100.
- The dam and the bund are higher. The bund was needed to achieve an FSL of 100.
- The **storage** is the modified contour at 100.
- The **spillway** is at 100 and cuts into the old contour at 100. Excess water overflows from here.
- The **Key-wall** protects the dam from the spillway.

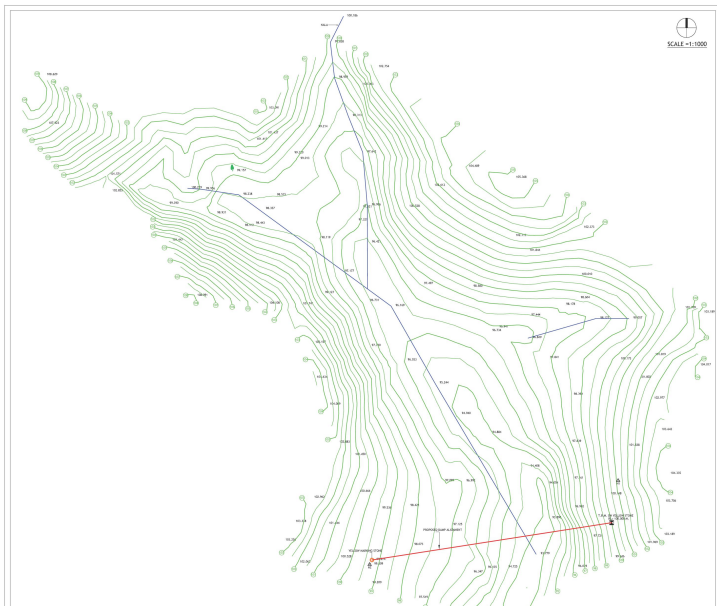
Life-Cycle

- **Expression of Interest**-GP, panchayat samiti
- **Need Assessment**-drinking water stress, livelihood needs, domestic needs, irrigation potential created.

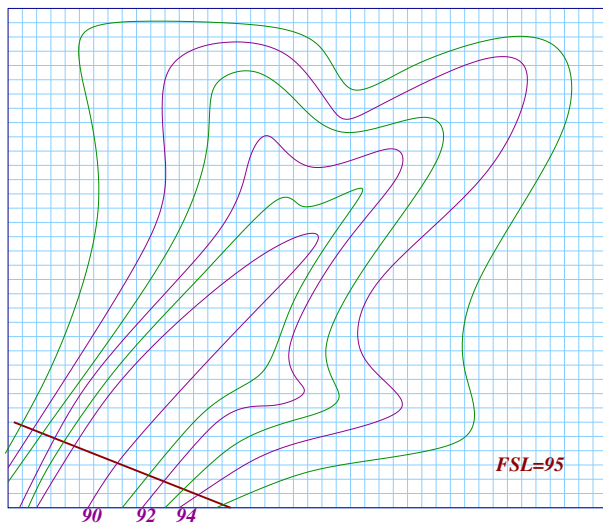
Drinking W.	35 HH	0.2 person-day	200 days	Rs.(L) 1.4
Buffalo	10	Rs. 500	200 days	Rs.(L) 1.0
Agri. land	3 acres	Rs. 10,000	1 season	Rs.(L) 0.3
Dom. Use	35 HH	0.2 person day	200 days	Rs(L) 1.4

- **Site selection.** Land acquisition, forest land. Storage created. Hydro-geological suitability.
- **Pre-feasibility Study.** Technical report. Cost-benefit analysis.
- **Community Approval.** Water Use agreement. Committee. hand-over details. Labour and community contributions. Soil and water use and other construction modalities.

Alignment



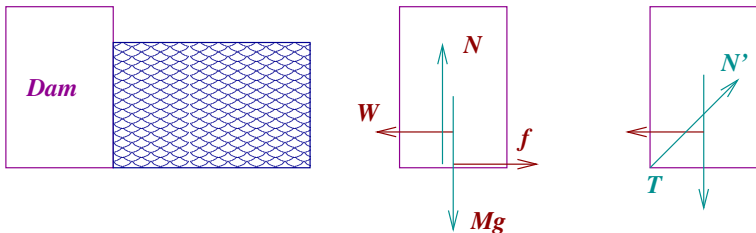
Storage Calculation



Storage = $A_{90} + \dots + A_{95}$. Height of dam = 6m + safety.
Thickness = 25m.

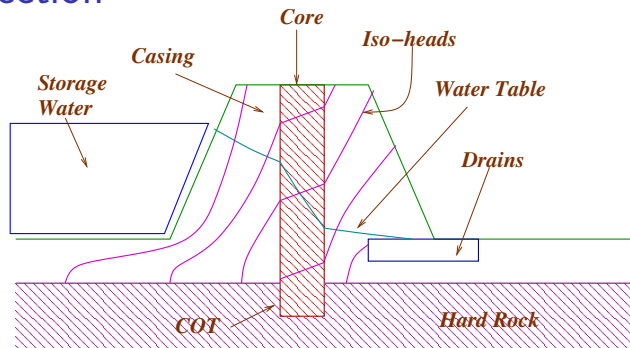
Design Principles

- **Structural Stability.** Sliding and Toppling. Tension and the role of rock-toe. The two free-body diagrams. **Safety and Risk-assessment.**



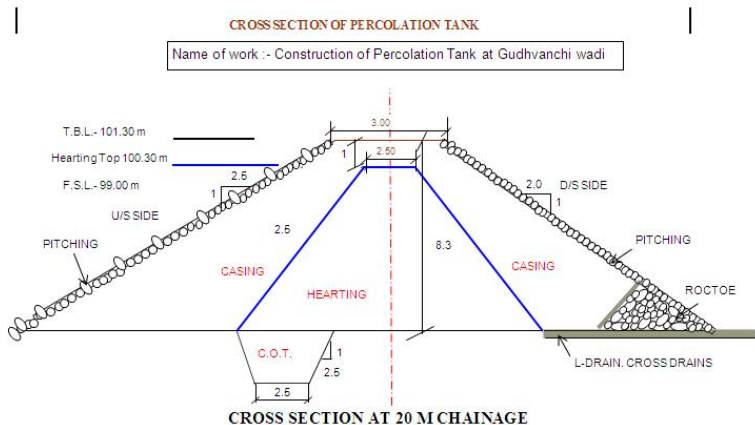
- **Hydro-geologic analysis.** Water within the dam. Drains. Groundwater recharge. Downstream effects.
- **Watershed analysis.** Peak rainfall. Height above FSL and key-wall.

Cross-Section



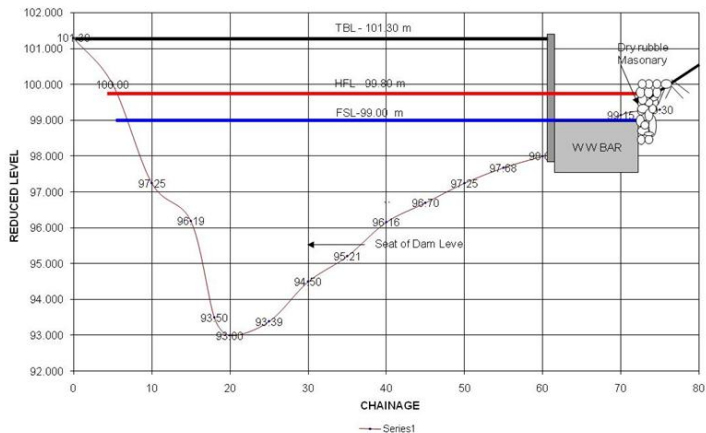
- **Core** : a wall of clay/low conductivity soil.
- **COT** : To insert into hard-rock.
- **Drains** : To keep the dam dry and prevent seepage flows.
- **Casing** : Muram like soil, supports the core.
- Note the water-table and the iso-head lines.
- Note the rapid drop in the water table in the core.

Section



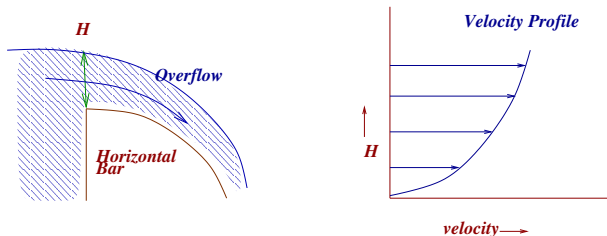
Section at alignment

CROSS SECTION OF PERCOLATION TANK AT GUDHVANCHI WADI



Overflow

- $H = HFL - FSL$ is the height or the *thickness of water* over the spillway bar.
- Estimate of flow in cu.m./sec is $Q = 1.6 * LH^{3/2}$, where L is the length of the bar.



For Gudwanwadi.

- Catchment was roughly 1.1 sq.km.
- A peak rainfall of 50mm/hour gives $Q = 15.3\text{cu.m./s.}$
- $H = 0.8$ and $L = 15\text{m}$ gives $Q = 17\text{cu.m./s.}$

Construction

- **Measurements and Marking.** Seat of the dam. Cleaning. Rock-toe. Drains.
- **Cut-Off trench.** Foundation. establishing cut-off. Inspection of strata. **Corrective Action** .
- **Filling and rolling.** Two types of soil. Watering and compaction. Checking soil conductivity.
- **Key Wall.** Masonry structure. Horizontal wall. Connection with earthen structure.
- **Pitching.** Lining, clean-up.

Project Management

- **Procurements.** Tanker, JCB, Dumpers. Soil and water. **Finance. Legal.**
- **Weekly targets.** Weekly bill payments-labour, machinery and fuel. Community and stakeholder meetings. Visit of experts.

Gudwanwadi Dam

- 85m long, 8m high, earthen.
- Storage 2 acres, 20K cu.m.
- **Cost:** 24 lakhs.
- Construction time: 6 mo.



- Note Spillway, and Key-wall.
- Note Pitching (stones) on the dam walls.

Nira-Deoghar-Earthen



source: <http://www.abilgroup.com/images/Nira-Deoghar.png>

The Earthen Bund at Khubi



source:

http://thdc.gov.in/Writereaddata/Projects/English/Images/PG_29

Salient Features

Exercise: Compute rainfall intensity. Estimate A_i for various i , average depth. Estimate irrigation efficiency.

1	Name of Project	: Musai M.I.Scheme	Dolkhamb M.I.Scheme.
2	Source	: Local Nalla	Local Nalla
	Location: State	: Maharashtra	Maharashtra
	District	: Thane	Thane
	Taluka	: Shahapur	Shahapur
3	Village	: Musai	Dolkhamb
4	Catchment Area	: 1.76 Sq.mile	3.68 Sq.miles
5	Average Annual Rainfall	: 107.7"	107.46"
6	75% dependable yield	: 244 Mcft.	-
7	Gross Storage	: 134.26 Mcft.	166.08 Mcft.
8	Dead Storage	: 5.75 Mcft.	9.32 Mcft.
9	Live Storage	: 128.51 Mcft.	156.76 Mcft.
10	Reservation for U/s	: -	-
11	Annual Gross Utilisation	: 134.26 Mcft.	166.08 Mcft.
12	Top of Dam Level	: 103.00 m.	134.00 m.
13	H.F.L.	: 101.50 m.	132.50 m.
14	F.R.L.	: 100.00 m.	131.00 m.
15	M.D.D.L.	: 89.00 m.	120.00 m.
16	Max. Height of Dam	: 89.00 m.	19.76 m.
17	Type of Dam	: 17.90 m.	Earthen Dam.
18	Length of Earthen Dam	: Earthen Dam.	213 m.
19	Length of Waste Weir	: 44 m.	60 m.
20	Max.Flood discharge	: 35.52 Cusecs	9284 Cusecs
21	Location of Waste Weir	: Left side	Right flank
	Submergence area	:	65.59 Hect.

1	Name of Project	: Musai M.I.Scheme	Dolkhamb M.I.Scheme.
	CANAL		
22	Canal length	: 3.00 Km.	7.17 Km.
23			
24	Canal Capacity	: 12.72 Cusecs	10.21 Cusecs, 4.875 Cusec
25	Area under command	: 600 Acres	196 Hect.
	(Irrigable)		
	i) Gross Command	: 1300 Acres	980 Acres
	ii) Cultural Command	: 1200 Acres	780 Acres
	iii) Irrigable Command	: 600 Acres	496 Acres
	Village benefitted	: 1) Musai, 2) Khaire,	1) Dolkhamb 2) Hedwali
	Village (Taluka wise)	-	3) Bandanpada 4) Sakurli
27	Total Cost of the Project	: Rs.11,110.00	Rs.17,03,275/-
28	B.C.Ratio	:	2.31

Budget

Annual Water Account for Minor Irrigation

Irrigation Year:- 2010-11

Name of Circle:- TIC Thar

Name of Division :- TMID Kalwa Thane

Project No.---->	26	27	28	29	30	31	32
	635	636	637	638	639	640	641
Name of Scheme	Advalli MI Thane Shahapur	Dolkhamb MI Thane Shahapur	Jambhe MI Thane Shahapur	Kharade MI Thane Shahapur	Musai MI Thane Shahapur	Veiholi MI Thane Shahapur	Hattipada MI Thane Vasai
Type viz. LMI, MI, LIS, ST etc.							
District							
Taluka							
Sub-basin No.	21	21	21	21	21	21	21
1. Designed Storage in Moum							
a. Gross	2.220	4.703	5.182	2.316	3.800	3.245	2.068
b. Live	2.030	4.439	4.842	2.054	3.640	2.997	1.823
2. Maximum live storage observed in the year	2.030	4.439	4.842	2.054	3.640	2.997	1.823
3. Projected water use in Moum for ----							
a. Kharif	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b. Rabi	2.030	4.439	4.842	2.054	3.640	2.997	1.823
c. Hot weather	0.000	0.000	0.000	0.000	0.000	0.000	0.000
d. Non irrigation	0.000	0.000	0.000	0.000	0.000	0.000	0.000
e.Total (3 a+3b+3c+3d)	2.030	4.439	4.842	2.054	3.640	2.997	1.823
4. Water drawn at canal head for irrigation							
a. Kharif	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b. Rabi	0.945	0.400	1.357	0.950	1.290	1.560	0.300
c. Hot weather	0.000	0.000	0.000	0.000	0.000	0.000	0.000
d. Total (4a+4b+4c)	0.95	0.00	1.36	0.95	1.29	1.56	0.30
5. Lifts From Tank							
a. Kharif	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b. Rabi	0.000	0.000	0.000	0.000	0.000	0.000	0.000
c. Hot weather	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6. Evaporation Losses	0.179	0.609	0.350	0.195	0.515	0.420	0.240
7. Leakages through dam	0.668	1.587	0.000	0.028	0.625	0.260	1.271
8. Total (4d+5+6+7)	1.792	2.496	1.707	1.173	2.430	2.240	1.611
9. Actual Area Irrigated by Canals							
a. Kharif							
i) Area							
ii) Irrigation System Performance (ha/M)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
b. Rabi							
i) Area	39.70	18.30	106.90	70.00	65.00	90.13	15.00
ii) Irrigation System Performance (ha/M)	42	46	79	74	50	58	50
c. Hot weather							
i) Area							
ii) Irrigation System Performance (ha/M)	0	0	0	0	0	0	0
10. Actual Area Irrigated by Tank lifts							
a. Kharif							
i) Area							
ii) Irrigation System Performance (ha/Moum)	0	0	0	0	0	0	0
b. Rabi							
i) Area							
ii) Irrigation System Performance (ha/Moum)	0	0	0	0	0	0	0
c. Hot weather							
i) Area							
ii) Irrigation System Performance (ha/Moum)	0	0	0	0	0	0	0
11. Non irrigation use	0.150	0.550	0.250	0.360	0.140	0.182	0.000
12. Live Storage on 30 th June	0.088	1.393	2.885	0.521	1.070	0.575	0.112
13. Replenishment in the month June							
14. Area Irrigated on wells/river/drain in	0	0	0	0	0	0	0

Bushy Dam-Masonry



source: <http://travel.sulekha.com/lovely-lovely-lonavala-maharashtra-travelogue-4508.htm>

Thanks

