MINOR IRRPGATION PROJECT (NEW TANK PROJECT)

RESERVOIR

- It is artificial lake or impoundment from a dam is used to store water.

- It may be created by construction of dam or bund across the river .

Design Of Tank Bund Includes…

- Fixing of centre line of bund
- Profile of the canal
- Canal alignment
- Reservoir capacity
- Design of Sluice
- Design of Weir
- Computation of earthwork
- Stability analysis

SELECTION OF SITE FOR BUND….

- Water storage should be largest for minimum possible height and length.
- Good foundation should be available at the site.
- Materials of construction should be available at the site or near to it.
- It should be accessible in all seasons.
- The overall cost of construction and maintenance should be taken into consideration.

SURVEY WORKS

- The survey work was conducted for knowing the reservoir capacity and to design the earthen bund.
- Capacity contours are drawn to know the capacity of reservoir.
- Contours obtained by both plane table method and block contour method at equal heights.
- Area is computed directly by AutoCAD to know the capacity of reservoir.
- The alignment (center line) of the bund line has established by use of Theodolite at equal chainage intervals. The levels were then noted down using Dumpy Level and leveling staff.

BUND :-

BUND IS A SOLID BARRIER CONSTRUCTED AT A SUITABLE LOCATION ACROSS A RIVER VALLEY TO STORE WATER.

OBJECTIVE OF CONSTRUCTION:-

1. IRRIGATION.
2. DOMESTIC PURPOSE.
3. DROUGHT AND FLOOD CONTROL.

TYPES :

- GRAVITY BUND

- EARTHEN BUND

We have provided Earthen Bund for Minor Irrigation Tank

EARTHEN BUND :-

- EARTHEN BUND IS MADE UP OF SOIL WHICH IS EASILY AVAILABLE IN THE DAM SITE. EARTHEN BUND IS GENERALLY PREPARED WHERE THE FOUNDATION IS NOT STRONG ENOUGH TO BEAR THE SELF WEIGHT OF CONCRETE DAM.

DESIGN CALCULATION:-

RAIN FALL DATA:-

SI.NO	YEAR	ANNUAL RAINFALL IN MM
1	1996	1123.6
2	1997	1164.4
3	1998	961.9
4	1999	1589.7
5	2000	1214.0
6	2001	705.2
7	2002	699.4
8	2003	875.8
9	2004	938.4
10	2005	1362.7
11	2006	1255.6
12	2007	1334.1
13	2008	1218.0
14	2009	1418.0
15	2010	1327.6
16	2011	1336.2
17	2012	899.3

DEPENDABLE RAINFALL:-

SI.NO	YEAR	ANNUAL RAINFALL IN MM
1	2002	699.4
2	2001	705.2
3	2003	857.8
4	2012	899.3
5	2004	938.4
6	1998	961.9
7	1996	1123.6
8	1997	1164.4
9	2000	1214.0
10	2008	1218.0
11	2006	1255.6
12	2010	1327.6
13	2007	1334.1
14	2011	1336.2
15	2005	1362.7
16	2009	1478.0
17	1999	1589.7

The order number **m,** given by equation

$$\mathbf{m} = N * \frac{p}{100}$$

Where **m**= order number

N= number of years i.e. **17**years

p= Dependability percentage i.e.**60%**

considering the tank of 10 we take the annual rainfall is1218.0mm

By Strange's graph of yearly runoff for 1218.0mm rainfall is 26cm

Catchment area = 4.97 sq.km

COMPUTATION OF THE YIELD OR RUN-OFF:-

Referring to strangers table,

The annual runoff due to total monsoon rainfall (considering good catchment) is
Annual Rainfall=catchment area* rain fall = 122900m^3

CAPACITYCONTOURS:

Area of contour 93.3= 41288.718m^2
Area of Contour 93.5=47489.583m^2
Area of contour 94.0=55673.712m^2
Area of contour 94.5=62492.153m^2
Area of contour 95.0=69715.700m^2
Area of contour 95.5=73019.973m^2
Area of contour 96.0=84785.069m^2
Area of contour 96.5=100388.575m^2
Area of contour 97.0=109975.162m^2
Area of contour 97.5=124980.804m^2
Area of contour 98.0=153120.483m^2

VOLUME CALCULATION:-

1. TRAPEZOIDAL METHOD :-

$$\mathbf{V} = h\left\{\left(\frac{A1 + An}{2}\right) + A2 + A3 + \cdots + An - 1\right\}$$

VOLUME =412860 m^3

2. PRISMOIDAL METHOD :-

$$\mathbf{V} = \frac{h}{3}\{(\mathbf{A1} + \mathbf{A2}) + 4(A2 + A4 + \cdots + An - 1) + 2(A3 + A5 + \cdots + An - 2)\}$$

VOLUME=411362m^3

TOTAL STORAGE CAPACITY = **412860** m^3

ATER REQURIMENT OF CROPS:-

1. **Depth of water required for the various crops in the cultivated in command area as follows** :-

SL. NO.	CROP	DELTA (cm)
1	Rice	120
2	Sugarcane	120
3	Cotton	50
4	Pulses & Grams	30
5	Vegetables	45
6	Maize	450

2. **Standard value for the duty for various crops in the cultivated in command area as follows** :-

SL. NO	CROPS	DUTY IN HECTARES/CUMEC
1	SUGARCANE	730
2	RICE	775
3	KHARIF	1500
4	RABI	1800
5	PERENNIALS	1100
6	HOT FODDER	2000

WATER REQUIREMENT FOR IRRIGATION

CROP	RICE (ha)	SUGARCANE (ha)	COTTON (ha)	PULSES &GRAMS (ha)	VEGETABLES (ha)
LBC AREA (m^2)	10.96	10.96	26.304	43.84	29.22
RBC AREA (m^2)	16.44	16.44	39.456	65.76	43.84
TOTAL AREA (m^2)	27.4	27.4	65.76	109.6	73.06
VOL =Δ*AREA (m^3)	3288	3288	3288	4384	2191.8

SELECTION OF SUITABLE PRELIMINARY DIMENSION OF EARTH DAM (Strange's Recommendations)

Height Of Dam In Meters	*Maximum Freeboard In Meter*	*Top Width In Meters*	*U/S Slope (H:V)*	*D/S Slope (H:V)*
Up to 4.5	1.2 to 1.5	1.85	2:1	1.5:1
4.5 to 7.5	1.5 to 1.8	1.85	2.5:1	1.75:1
7.5 to 15	1.85	2.5	3:1	2:1
15 to 22.5	2.1	3.0	3:1	2:1

1.8.2DESIGN OF EARTH DAM

- By the economical point of view, depending upon the water requirement the height of the dam is fixed.
- Full reservoir level (FRL) = +98.00m
- Maximum water level (MWL) = FRL+ 0.5 = +98.00m
- Top bund level (TBL) = MWL+ free board = +100.00m
- Top width of dam = 2.5m
- Dead storage level (DSL) = +93.50m
- Free board = 2m
-
- As the dam height is more than we have considered providing zoned type of earth dam.
- Considering dam into two zones
- Shell (sand level)
- Hearting zone (silty clay)

- **EARTH WORK CALCULATION FOR DAM**
- CENTRAL IMPERVIOUS CORE : (HEARTING ZONE)
  - Materials used = silty clay
  - Top level of central impervious core (MWL+ 0.5) = +99.00m
  - Ground level of bund a = +92.00m
  - Top width of impervious core h = 2.5m
  - Slope (both side) =1:1
- 2. OUTER SHELL
- (a) Materials used = sand gravel
- (b) Top level of dam = +100.00m
- (c) Lowest level of dam = 92.00m
- (d) Slope:
- (i) Upstream side = 2:1
- (ii) Downstream side = 1.5:1
  - Top width = 2.5m

DESIGN OF EARTH DAM:-

By the economical point of view, depending upon the water requirement the height of the dam is fixed.

1. Full reservoir level (FRL) =**835.065**m
2. Maximum water level(MWL) =FRL+0.5 =**835.565**m
3. Top bund level (TBL)=MWL+free board =**836.565**m
4. Top width of dam = **9** m
5. Dead storage level (DSL) = **820.045**m
6. Free Board =**1.5**m

As the dam height is more than **10**m we have consider providing zoned type of earth dam.

Considering dam in to two zones:-

a) Shell (sand gravel).
b) Hearting zone (Silty clay).

- **EARTH WAORK CALCULATION FOR DAM:-**
- **CENTAL IMPERVIOUS CORE:-(HEARTING ZONE)**
-
- Material used **=Silty clay**
- Top level of central impervious core(MWL+0.5) **=836.065**m
- Ground level of bund **=817.045**m
- Top width of impervious core **a =3**m
- Height of central impervious core **h =19.02**m
- Slope (both side) **=1:1**
-
- **OUTER SHELL:-**
-
- Material used **=sand gravel**
- Top level of dam **=836.565**m
- Lowest level of dam **=817.045**m
- Slope:
- Upstream side **=3:1**
- Downstream side **=2:1**
- Top width **=9**m

TYPES OF LEVELS:

- **MAXIMUM WATER LEVEL:(MWL)**

Maximum water level is the one at which water level is measured during highest floods.

- **FULL RESERVOIR LEVEL :(FRL)**

Full reservoir level refers to the max water level in reservoir up to crest of the spillway in normal operating condition of the reservoir

- **DEAD STORAGE LEVEL :(DSL)**

Dead storage level refers to the minimum water level to be maintained in the reservoir in normal operating conditions of the reservoir.

TYPES OF STORAGES:

- **USEFUL STORAGE:**

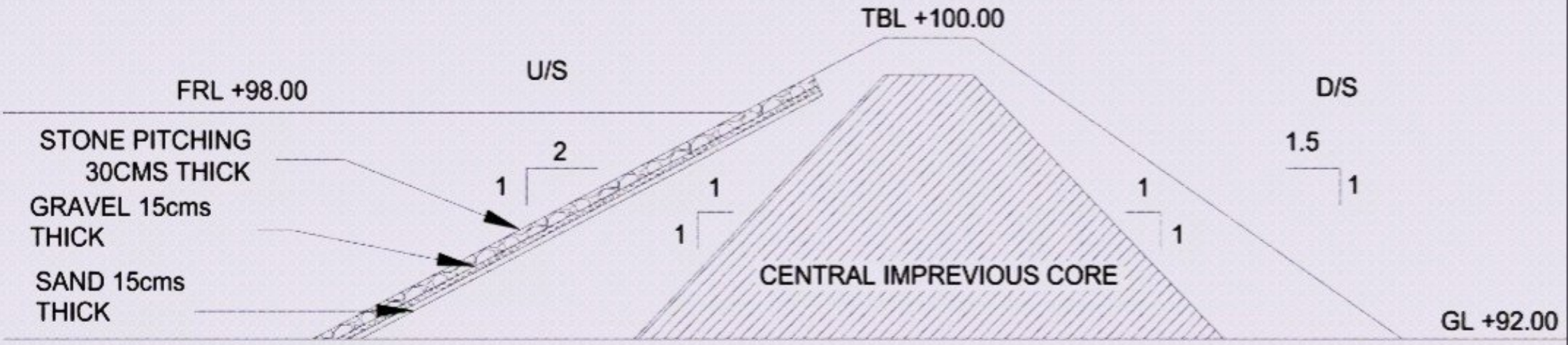
The quantity of water available between **FRL** and **DSL** is known as useful storage. It is the actual quantity of water which can be drawn from reservoir for the purpose for which water is stored.

- **DEAD STORAGE:**

The quantity of water available below **DSL** is known as dead storage. It is provided in reservoirs to accommodate sediments.

- **SURCHARGE STORAGE:**

Excess of water available above **FRL** up to the gate is known as surcharge storage.



EARTHEN BUND

CANAL DESIGN

CANAL

- A Canal is an artificial channel, generally trapezoidal in shape constructed on the ground to carry the water to the fields either from the river or from a tank or reservoir.

TYPES OF CANAL

- IRRIGATION CANAL
- CARRIER CANAL
- FEEDER CANAL
- NAVIGATION CANAL

1.11.7 DESIGN OF CANAL

The canal is designed for the maximum monthly withdrawal from the tank.

Canal bed slope = 1in 500

Maximum withdrawal of the tank = $0.29 m^3/sec$

Canal is designed for the most economical trapezoidal section.

Half of top width = sloping side

$(b+2nd)/2 = d (n^2+1)$

Side slope $n = 1/\sqrt{(3)}$ (Most economical slope)

$(b+2 * \{1/\sqrt{(3)}\} * d)/2 = d (\{1/\sqrt{(3)}\}^2+1)$

$b = 1.155d$

Area of trapezoidal section = $d (b+nd)$

$= d (1.155d + 0.577 * d) =$

$1.732 d^2$

Wetted perimeter = $p = b + 2d (n^2 +1)$

$= 1.155d + 2d \{1/\sqrt{(3)}\} = 2.31d$

Also hydraulic mean depth; $m = d/2 = 0.5d$

Discharge $Q = AC\,(mi)^{(1/2)}$

$Q = A\,(1/N)\,m^{(1/6)}\,(mi)^{(1/2)}$

$= 1.732d^2 * (1/N)\,m^{(2/3)}\,(i)^{(1/2)}$

Taking $N = 0.0225$ for unlimited channel

$i = 1$ in 500

$0.29 = 1.732d^2 * (1/0.0225) * (d/2)^{(2/3)} * (1/500)^{(1/2)}$

$d = 0.22$ provide $d = 0.25m$

$= (2 * 0.25)/\sqrt{(3)} = 0.288 = 0.3$ m

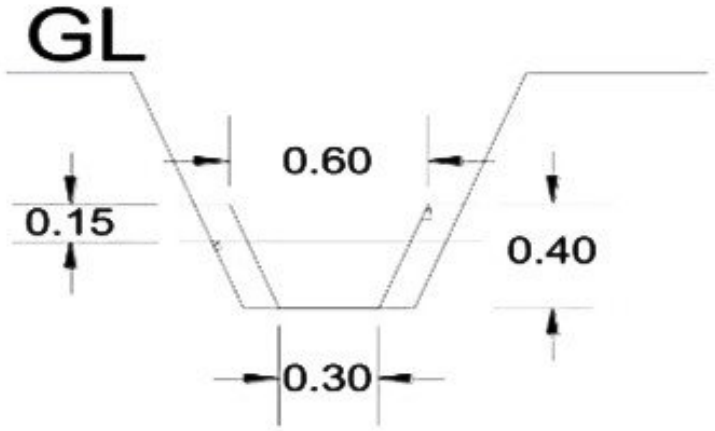
Providing free board of 0.15m

Total depth $= 0.25 + 0.15 =$ **0.4m**

Top width $= b + 2nd = 0.3 + 2(1/\sqrt{3})0.25$

$= 0.588$ **= 0.6m say**

CANAL CROSS SECTION



all dimensions in m

SLUICE DESIGN

- **1.11.6 DESIGN OF SLUICE**
- Discharge through sluice is given by $Q = C_d A^* \sqrt{(2gh)}$
- Where, h = head over sluice gate = 4.5m
- C_d = Co-efficient of discharge = 0.63
- A = Cross Section Area of Sluice
- $Q = C_d A^* \sqrt{(2gh)}$
- $0.253 = 0.63^* A^* \sqrt{(2^*9.81^*4.5)}$
- $A = 0.043 m^2$
- $A = \pi/4 d^2 = 0.043 m^2$
- d= 0.23m provide 0.25
- Adopt diameter of sluice as 0.25m
- By adopting diameter of sluice =25cm
- The maximum monthly discharge will be $=0.29 m^3/sec$

SURPLUS WEIR DESIGN

SURPLUS WEIR

- Weir is a overflow section from which water is discharged. Protective works in the form of aprons, etc are required to keep the bed from erosion. Where the foundation is hard rock no protective works are necessary.

- Diversion weirs are usually 3 to 10 meters high and their primary function is to raise the river level for diverting the water into the canal.

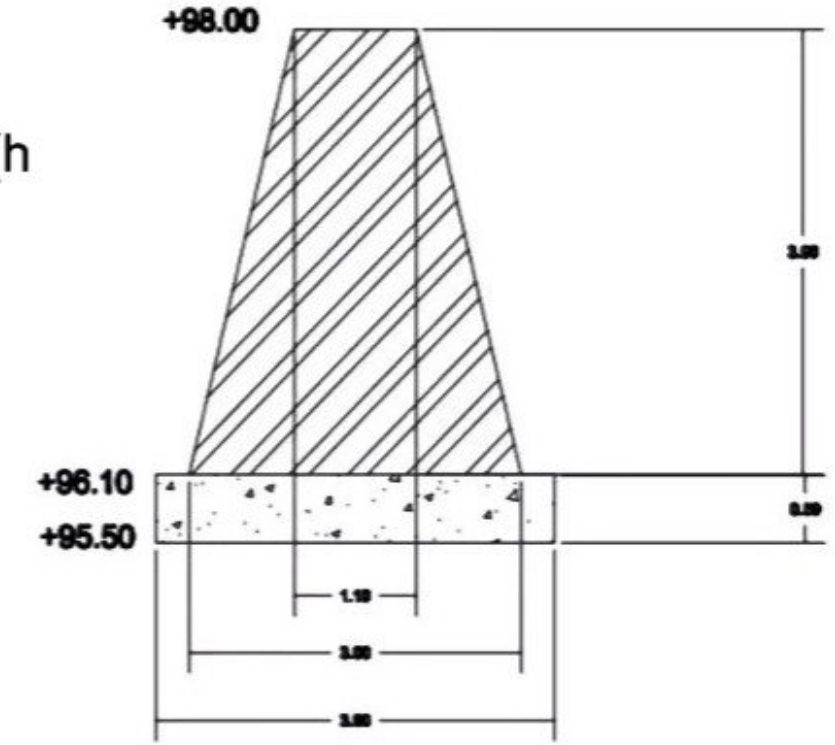
- A weir is generally placed at right angles to the direction of flow of the river. The required height of weir must be determined from the consideration of the stream flow during low flow period.

CONDITIONS FOR STABILITY OF WEIRS

- There must be no tension in the masonry or in the contact plane between the weir and the foundation.
- There must be no overturning.
- There must be no tendency to slide on the joint with the foundation or any horizontal plane above the base.
- The maximum toe and heel pressures on foundations should not exceed the prescribed safe limits

- **DESIGN OF SURPLUS WEIR**
- M.W.L=F.R.L= +98.00m
- Catchment area = 4.973Sq. Km
- Ground level at site = +97.50m
- Tank bund height = +99.00m
- Submersion of foreshore lands limited upto +98.80m
- **DESIGN:**
- **Estimation of flood discharge entering the tank**
- Discharge is given by
- $Q=CM^{(2/3)}$
- Where 'C' is Ryve's co-efficient varying from 6.8 to 15.
- Assuming 'C' to be 6.8
- Therefore $Q=6.8*(4.973)^{(2/3)}$
- Q=19.81cumec
- **LENGTH OF WEIR**
- Water is stoned upto level of +98.00m i.e. F.R.L and crest level has to be at +98.00m
- Submersion of foreshore lands is limited to +98.80m
- Therefore the head of discharge = +98.80-98.00
- h= 0.80m
- There is no arrangement is provided to store water during high floods.
- Assuming weir to be broad-crested weir , so the discharge per one meter length of the weir is given by
- $Q= (2/3)C_d *h* \sqrt{(2*g*h)}$
- Where $C_d=0.562$ & h=0.80m
- $Q= (2/3)*0.562*0.80* \sqrt{(2*9.81*0.80)}$

- Therefore length of surplus weir required = (19.81/1.18)
- = 16.78m Say 17m
- **WEIR**
- Crest level = +98.00m FRL
- Ground level =+97.50m
- Land where hard soil is met = +96.00m
- Taking foundation 50cm deeper into hard soil the foundation level is at +95.50m. The foundation level is 60cm thick.
- Therefore Top of foundation = +96.10m
- Height of weir above foundation = +98.00-96.10
- = +1.9m
- **CREST WIDTH**
- It is given by = 0.55 (√ (H)) + (√ (h
- = 0.55 (√ (1.9)) + (√ (0.3))
- = 1.06m
- Say 1.1m



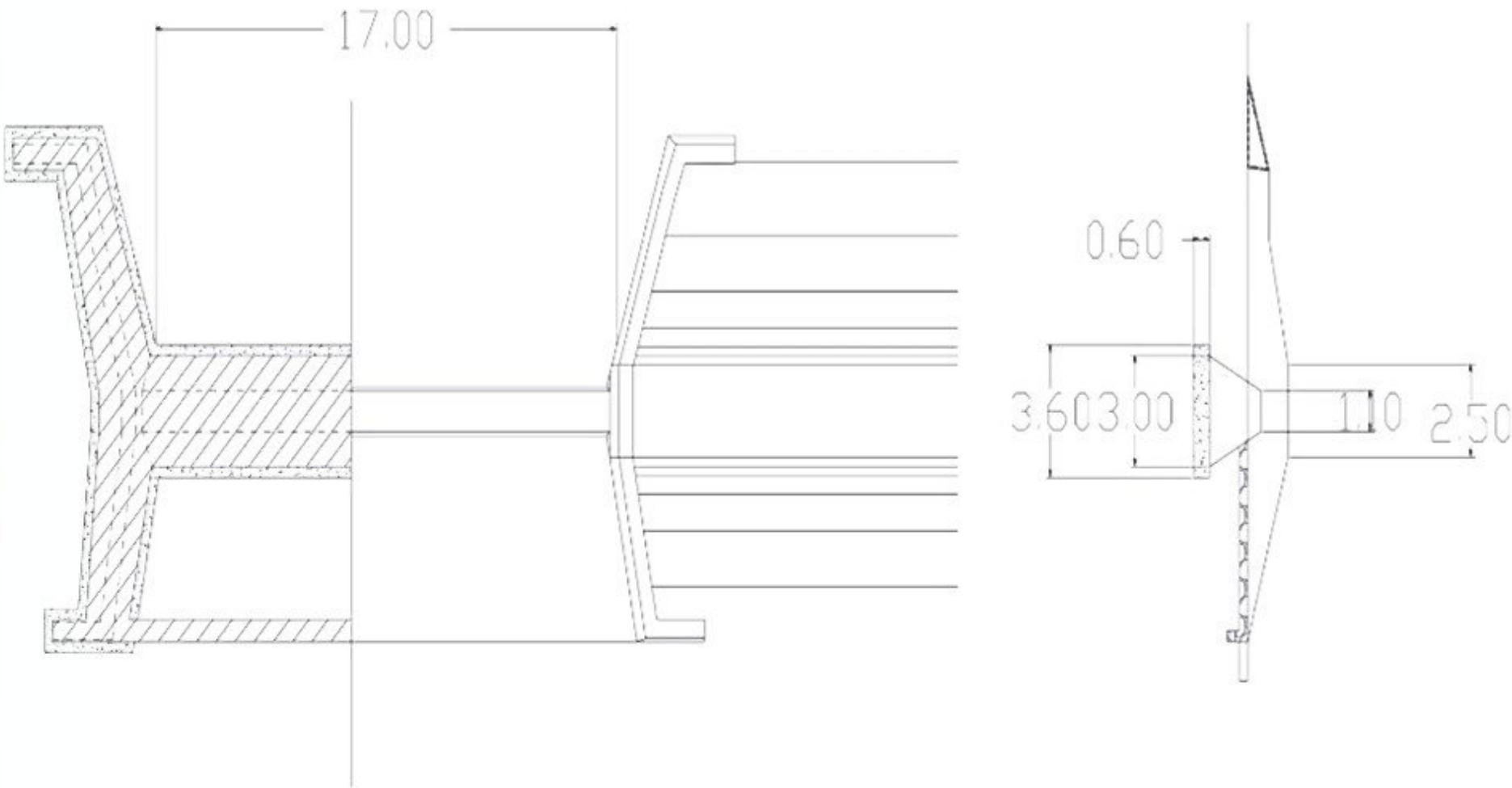
- **BASE WIDTH**
- Mo = $((H+S)^3)/6$
- Mo = $((1.9)^3)/+$
- Mo = 1.14 .....(1)
- Base width is given by
-
- $M= (1/12) [\{ (p + 1(1/2))*H + 2(1/2)*S\}(b^2) + a(pH - H – S)b – (1/2) (a^2) (H+3S)]$ .....(2)
-
- Where H = 1.9, S =0 & p= 2.25
- Equating (1) & (2)
- $1.14 = (1/12) [\{(2.25 +1.5)*1.9 + 2.5 *0\} b+ 1.1 \{2.25*1.9 -1.9- 0\} b – (1/2) (1.1)^2 (1.9)]$
- 13.68 = 5.1b + 2.6125b – 1.1495
- 14.8295 = 7.725b
- Therefore b = 1.92m
-
- Say Base width = 2m
- But for stability reasons consider base width of **3m**

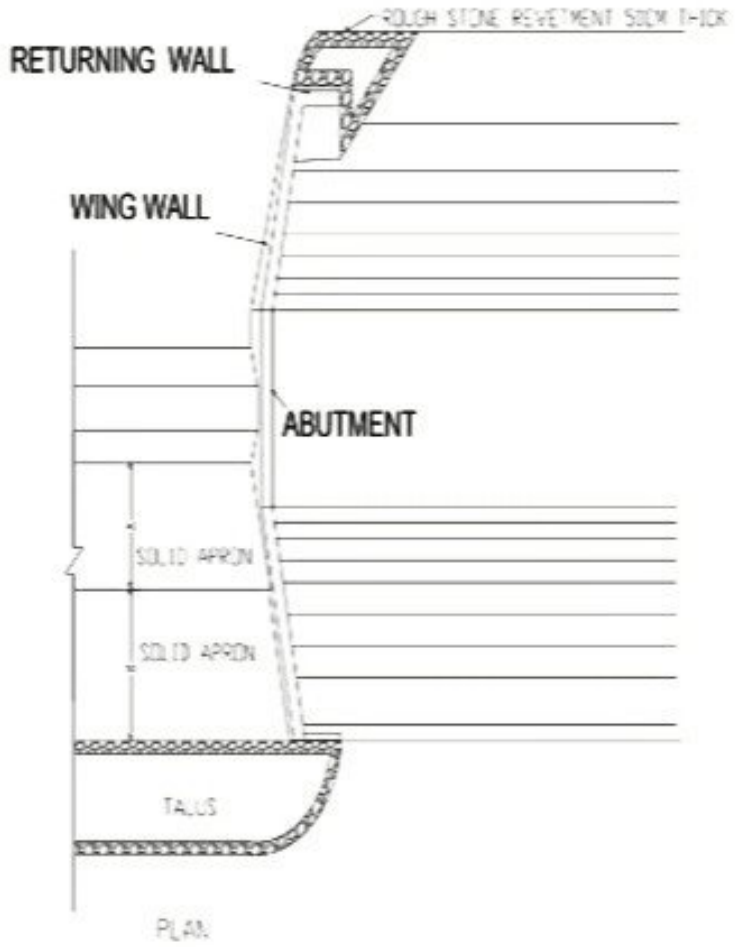
- **Abutments , Wings & Return Wall**
- Top width of Abutments = 0.50m
- Front Batter = 1 in 8
- Length of it must be enough to completely encase the tank bond.
-
- Abutments:
- Height of Abutments = 3.9m
- Therefore bottom width is required is about 3.9 * 0.4 = 1.56m
- Therefore provide 1.60m
-
- The wing wall must be sloping down from 'B' till it reaches 30cm above F.R.L.
- I.e. +98.30m at 'C'
- So the portion BC will have sloping down from +100.00m to +98.30m
- Section of wing wall at 'C'
- Height of foundation = +98.30-96.10
- = +2.2m
- Base width = 0.88 or 0.90m
- Top width is same i.e. 0.50m & the bottom width slowly reduces from 1.60 to 0.90m at section 'C'.

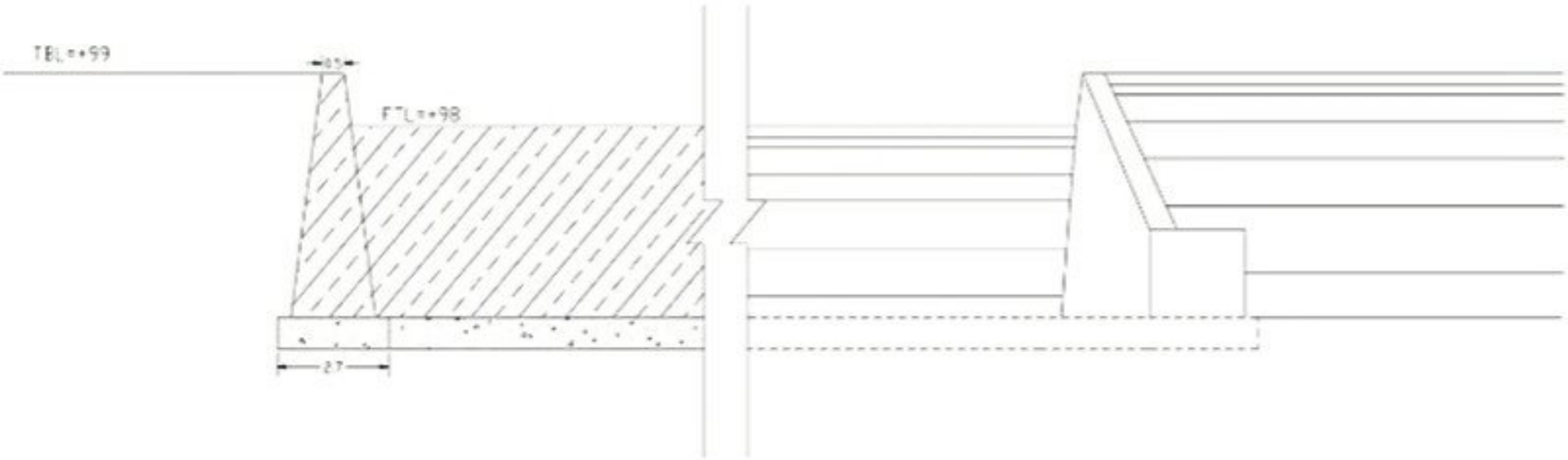
- **LEVEL WING & RETURN**
- Portion CD & CE have throughout 30cm above F.R.L.
- The same section of wall is adopted
-
- C/s side transition
- Generally splay of line is provided for easy approach of water
-
- D/s side Wings & returns
- The top of wing wall at 'F' above foundation = 97.50-96.10
- = 1.40m
- Therefore Base Width = 1.40 * 0.4 = 0.56
- Therefore provide 0.60m & the same section is continued for return also.
-
- D/s side transition
- Splay of line 3 may be provided.

- **PITCHING**
- Ground level at site = +97.50m
-
- Therefore no Apron is required.
- In order to check the soil erosion stone pitching may be provided on the D/s side of 15 to 30cm thick for the length of 2 to 3m.

SURPLUS WEIR




ROUGH STONE REVETMENT 500M T=1CM
RETURNING WALL
WING WALL
ABUTMENT
SOLID APRON
SOLID APRON
TALUS
PLAN



LONGITUDINAL SECTION

LONGITUDINAL ELEVATION