CANAL ALIGNMENT & DESIGN OF CANAL SECTION

by

J. Gunakar Rao
M.E., MIE, MISTE
E.E., C.D.O., VJA
INTRODUCTION
Harness Water Resources
Irrigate Lands
GDP of Nation / Socio Economic Development
Depending on Water availability, Plan Storage / Diversion Scheme
Identify Ayacut / Command Area (Where? What? How Much?)
Plan Canal System
Design Canal Section
Classification based on discharge

- Main Canal
  - Branch Canal
    - $Q = 14-15$ cumecs and above
- Major Distributary
  - $Q = 0.028$ to 15 cumecs
- Minor Distributary
  - serving more than 40.47 hectares
- Field Channel
  - serving less than 40.47 hectares
Classification of canals based on their alignment

➢ Contour canal
  - Along Contour

➢ Ridge/Watershed canal
  - Along Ridge

➢ Side slope canal
  - Right angles to the contours
Classification of canals based on functionality

Irrigation canal.
Navigation canal.
Power canal.
Carrier canal.
Link canal.
Feeder canal.
Precautions in Canal Alignment:

While aligning a canal following points should be considered in general:

i. The canal should be aligned on the ridge or in such a way as to obtain maximum command.

ii. So far as possible the canal alignment should be kept in the centre of the commanded area.

iii. The canal should be aligned in such a way that the length is minimum possible.

iv. The alignment should avoid inhabited places, roads, railways, properties, places of worship etc.

v. Canal should be taken through the area where subsoil formation is favourable. Water-logged, alkali, saline, rocky soils create troubles.
Precautions in Canal Alignment ......

vi. The alignment should be straight so far as possible. Where alignment is not straight simple circular curves of large radius should be provided.

vii. To ensure economy the alignment of the canal should be such that excessive cuttings and fillings are not required. The alignment should not cross hills or depressions.

viii. While aligning the canal, cost of the land to be acquired should be taken into consideration.

ix. Cost of the alignment should be in proportion to the total cost of the project.

x. The canal should cross minimum number of drainages.
Crop Water Requirement

To know the Discharge required in the canal, crop water requirement is essential.

Crop water requirement may be arrived by adopting:-

1. Duty Method
   Generally - 10,000 acres / 1 TMC for Wet
   15,000 acres / 1 TMC for ID (CWC guidelines)
2. Modified Penman Method
BIS CODES

- IS 5968 : 1987 – Guide for Planning and Layout of Canal System for Irrigation
- IS 7112 : 2002 – Criteria for Design of Cross Section for unlined canals in Alluvial Soils
- IS 10430 : 2000 – Criteria for Design of Lined canals and Guidance for selection of Type of Lining.
- IS 3873 : 1993 – Laying cement concrete/stone slab Lining on canals
- IS 4951 : 1994 – Lining of canals in expansive soils
Planning of Canal System and Alignment

- Head Discharge of Canal

- Land Use Maps in 1:15,000 Scale showing culturable command area, important crops, cropping pattern / proposed cropping pattern

- Canal Alignment Map

- Typical Canal System is: Main canal as Contour Canal and Branches and Distributaries as Watershed / Side slope canals.
Economy in Canal Alignment

- Study Alternative alignments
- Avoid Deep cuts / High Embankments
- Alignment along FSL Contour
- Propose Bed fall nearer to average natural slope of terrain.
- Partial cutting and partial filling recommended
- Alignment in straight lines, avoiding curves
- Radii of curves to be 3 to 7 times water surface width
- Less number of Crossings
- Avoid CM / CD in curves
Economy in Canal Alignment...

➢ Avoid Canal syphons, Flumed sections, inlets, skew crossings

➢ Spacing of Distributaries depending on configuration of area

➢ Reduce Canal section after 10% reduction in canal discharge, followed by cross regulator

➢ Reduce CM/CD works by Diversions / Combining SLB with Regulators / Super passages

➢ Provide Bridges at Designated roads. Distance between two bridges shall not be less than 3 Km

➢ Propose Cross regulator / Drop @ change of section / Bed fall or at maximum interval of 40 Km to take care of Breaching of Embankment
Economy in Canal Alignment...

- Propose Canal Escapes on U/s of Embankment reaches near river / drain course with 50% canal discharge to safeguard against overtopping / breaching during Heavy rainfall / unexpected flood.
- Drops are recommended where canal bed slope is flatter than slope of Ridge.
Design of Canal Section

- Trapezoidal Section for main canals, distributaries / majors
- Cup shaped for Minors, field channels

- Formulae used:-
  - \( Q = AV \) (continuity equation)
  - \( V = \frac{1}{n} R^{1/3} S^{1/2} \) (Manning’s Formula) or
  - \( V = 0.55 m D^{0.64} \) (Kennedy’s Formula)
  - \( m = \frac{V}{V_0} \) (Kennedy’s Critical Velocity Ratio) 0.9 to 1.1 for unlined channels and greater than 1 for lined channels
Design of Canal Section

Trapezoidal Section formula

\[ A = (B+SD) \ D \]
\[ P = B+ 2 \ ((1+n^2)D)^{1/2} \]
\[ R = \frac{A}{P} \]
Design of Canal Section

Design Of Canal (From Chainage 0.000 To 2.215) for Full Discharge (Q)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Required Discharge</td>
<td>52.760 Cusecs</td>
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<tr>
<td>Bed width</td>
<td>3.000 mts.</td>
</tr>
<tr>
<td>Bed fall</td>
<td>1 in 4000</td>
</tr>
<tr>
<td>Manning's rugosity co-efficient (n)</td>
<td>0.02</td>
</tr>
<tr>
<td>Side slopes</td>
<td>1.5 : 1</td>
</tr>
<tr>
<td>Full Supply Depth</td>
<td>0.716 mts.</td>
</tr>
</tbody>
</table>

Area of Cross-section:  
\[ A = (b + n \cdot d) \cdot d \]

Area:  
\[ A = 2.914 \text{ sq.mt.} \]

Perimeter:  
\[ P = b + \sqrt{(1 + n^2) \cdot 2 \cdot d} \]

Perimeter:  
\[ P = 5.580 \text{ mts.} \]

\[ R = \frac{A}{P} \]

\[ R = 0.522 \text{ mts.} \]

\[ R^{2/3} = 0.649 \]

\[ V = \frac{1}{n} \cdot (R^{2/3}) \cdot \left(1 + \frac{1}{S}\right)^{1/2} \]

\[ V = 0.513 \text{ mts/sec} \]

Discharge:  
\[ Q = V \times A \]

\[ Q = 1.494 \text{ cumeecs} \]

\[ Q = 1.494 \text{ cumeecs} \]
# HYDRAULIC PARTICULARS OF A CANAL

## PROPOSED HYDRAULIC PARTICULARS OF DISTRIBUTARY-7 OF HLMC - 4

**SUMMARY FROM CHAINAGE KM 0.000 TO KM 8.172**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>From</th>
<th>To</th>
<th>In Km</th>
<th>Req. Discharge</th>
<th>Design Discharge</th>
<th>Co-efficient of Rugosity</th>
<th>Bed Width</th>
<th>FSD</th>
<th>Surface</th>
<th>Side</th>
<th>Velocity</th>
<th>At Start</th>
<th>At End</th>
<th>Bed Level</th>
<th>Full Supply Level</th>
<th>Loss Of Head Due to</th>
<th>Remarks</th>
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<td>1.570</td>
<td>1.494</td>
<td>1.494</td>
<td>0.020</td>
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<td>4000</td>
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<td>0.513</td>
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<td>0.570</td>
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<td>4000</td>
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<td>0.456</td>
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<td>4000</td>
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</tbody>
</table>

**Notes:**
1. Corewall type drops envisaged.
2. Deep / Change of Section is proposed to combine with other proposed structures (including off-takes) in the nearby location during detailed designing.

**CHECK**
- **A.E.** 10.618
- **A.E.** 2.043
- **A.E.** 8.560
- **A.E.** 0.075
- **A.E.** 10.618

**Page 1 of 1**
# Statement Showing C.M. Works

**Proposed Hydraulic Particulars of Distributary - 7 (HLMC Package No. 4)**

*From Chainage KM 0.000 to KM 8.172*

**Statement Showing the Cross Masonry Works**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Description</th>
<th>Name of Cross Masonry Work</th>
<th>Chainage (Km)</th>
<th>Existing Road Level / Road Width (m)</th>
<th>Bed Width (m)</th>
<th>F.S.D</th>
<th>Hydraulic Particulars of Canal</th>
<th>Loss of Head (m)</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>ROAD BRIDGE</td>
<td>Single Lane Bridge</td>
<td>5.00</td>
<td>0.930</td>
<td>0.577</td>
<td></td>
<td>446.556</td>
<td>446.556</td>
<td>447.133</td>
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<td>ROAD BRIDGE</td>
<td>Single Lane Bridge</td>
<td>7.350</td>
<td>0.930</td>
<td>0.577</td>
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<td>443.790</td>
<td>444.195</td>
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<tr>
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<td>PIPE CULVERT</td>
<td>Single Lane Bridge</td>
<td>7.566</td>
<td>Will be submitted along with structure design</td>
<td>0.930</td>
<td>0.577</td>
<td>443.236</td>
<td>443.236</td>
<td>443.641</td>
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<td>CTC</td>
<td>Single Lane Bridge</td>
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<td>0.930</td>
<td>0.577</td>
<td>442.696</td>
<td>442.696</td>
<td>443.041</td>
</tr>
</tbody>
</table>

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For Ratna Saisudhir (J.V)  
DEE  
A.E. / A.E.E.  
EE  
S.E.
# STATEMENT SHOWING C.D. WORKS

PROPOSED HYDRAULIC PARTICULARS OF DISTRIBUTARY - 7 (HLMC PACKAGE NO. 4)  
FROM CHAINAGE KM 0.000 TO KM 8.172  
STATEMENT SHOWING THE CROSS DRAINAGE WORKS

<table>
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<tr>
<th>SL. NO.</th>
<th>NAME OF CD WORK</th>
<th>CHAINAGE IN KM.</th>
<th>BED LEVEL IN MTS</th>
<th>C. A. SQ. KMS.</th>
<th>M.F.D CUMEC'S</th>
<th>O.M.F.L MTS.</th>
<th>BED WIDTH IN MTS</th>
<th>F.S.D IN MTS.</th>
<th>C.B.L IN MTS.</th>
<th>F.S.L IN MTS.</th>
<th>T.B.L IN MTS.</th>
<th>LOSS OF HEAD IN MTS.</th>
<th>REMARKS</th>
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<tr>
<td>1</td>
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<td></td>
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<td>3.000</td>
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for Ratna Saisudhir (JV) DEE A.E. / A.E.E. EE S.E.
# STATEMENT SHOWING REGULATORS

## PROPOSED HYDRAULIC PARTICULARS OF DISTRIBUTARY - 7 (HLMC PACKAGE NO. 4)

**FROM CHAINAGE KM 0.000 TO KM 8.172**

**STATEMENT SHOWING THE DETAILS OF CROSS REGULATORS**

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<tr>
<th>SL. NO.</th>
<th>STRUCTURE</th>
<th>CHAINAGE IN KM</th>
<th>EXISTING ROAD LEVEL / AVG. GL. IN MTS.</th>
<th>HYDRAULIC PARTICULARS OF CANAL</th>
<th>LOSS OF HEAD IN MTS.</th>
<th>REMARKS</th>
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<td>F.S.D</td>
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<tr>
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<td></td>
<td>T.B.L.</td>
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<tr>
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<td>449.447</td>
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For: Ratna Sainadhur (J.V)  
DEE  
A.E./A.E.E.  
EE  
S.E.
## PROPOSED HYDRAULIC PARTICULARS OF DISTRIBUTARY - 7 (HLMC PACKAGE NO. 4)
### FROM CHAINAGE KM 0.000 TO KM 8.172
#### STATEMENT SHOWING THE DROP WORKS

<table>
<thead>
<tr>
<th>S.N.</th>
<th>CHAINAGE Km</th>
<th>DESCRIPTION OF DROP</th>
<th>B.WIDTH</th>
<th>FSD</th>
<th>B.L.</th>
<th>F.S.L.</th>
<th>T.B.L.</th>
<th>LOSS OF HEAD</th>
<th>SOILS AT FOUNDATION LEVEL</th>
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<tbody>
<tr>
<td></td>
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<td>U/S D/S</td>
<td>U/S D/S</td>
<td>U/S D/S</td>
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<tr>
<td>1</td>
<td>1.570</td>
<td>Core Wall Type</td>
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<td>3.000</td>
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<td>0.716</td>
<td>452.500</td>
<td>452.300</td>
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<td>452.217</td>
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<td>3</td>
<td>2.288</td>
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<td>0.601</td>
<td>0.601</td>
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<td>452.461</td>
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<td>7</td>
<td>5.145</td>
<td>Core Wall Type</td>
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<td>0.600</td>
<td>0.577</td>
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<td>443.172</td>
<td>442.732</td>
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</table>

Will be submitted along with structure design.
### Curve Statement

**CURVE STATEMENT**

<table>
<thead>
<tr>
<th>SL</th>
<th>I.P. NO</th>
<th>I.P. CHAINAGE</th>
<th>DEFLECTION</th>
<th>RADIUS OF TANGENT</th>
<th>CURVE</th>
<th>APEX</th>
<th>T P1</th>
<th>T P2</th>
<th>REMARKS</th>
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<tr>
<td>1</td>
<td>IP1</td>
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<td>28.44</td>
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<td>2</td>
<td>IP2</td>
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<td>85.0</td>
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<td>IP3</td>
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<td>24.37</td>
<td>47.47</td>
<td>3.425</td>
<td>1.006</td>
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Typical Canal Sections

NOTES:

1. FREE BOARD

<table>
<thead>
<tr>
<th>CANAL DISCHARGE</th>
<th>FREE BOARD</th>
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</thead>
<tbody>
<tr>
<td>1 TO 3 CUBIEMS</td>
<td>0.20M</td>
</tr>
<tr>
<td>LESS THAN 1 CUBIEM</td>
<td>0.15M</td>
</tr>
<tr>
<td>LESS THAN 0.1 CUBIEM</td>
<td>0.15M</td>
</tr>
</tbody>
</table>

2. RETAIN TO MAKE 1 IN 100 SLOPE TOWARDS DRAIN.

3. DOWEL (Dowel-Drain-Bank):

- WIDTH OF COPING
  - 225 MM UPTO 3 CUBIEMS DISCHARGE
  - 350 MM FOR DISCHARGE MORE THAN 3 CUBIEMS
  - 500 MM FOR DISCHARGE MORE THAN 10 CUBIEMS

4. FULL SIMPLY DEPTH:

- CHAINAGE IN KM
- PER (M)
- BED WIDTH (W) (M)
- FREE BOARD (D) (M)

<table>
<thead>
<tr>
<th>CHAINAGE IN KM</th>
<th>PER (M)</th>
<th>MIN. (W) (M)</th>
<th>MAX. (D) (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 KM TO 2.205 KM</td>
<td>0.77M</td>
<td>3.00M</td>
<td>0.500</td>
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<tr>
<td>2.215 KM TO 3.200 KM</td>
<td>0.615</td>
<td>3.00M</td>
<td>0.500</td>
</tr>
<tr>
<td>3.200 KM TO 5.145 KM</td>
<td>0.560</td>
<td>2.50M</td>
<td>0.700</td>
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<tr>
<td>5.145 KM TO 8.172 KM</td>
<td>0.577</td>
<td>0.93M</td>
<td>0.300</td>
</tr>
</tbody>
</table>

5. REFERENCE CODE:
- IS: 10450 = 2000
- IS: 945 = 1954

6. LINING DETAILS

- DRAINAGE: 1404-07/12/39 TO BE REFERRED.

7. FOR DOWEL BANK REFER DETAIL A

8. ALL DIMENSIONS ARE IN MILLIMETERS AND THE LEVELS ARE IN M METERS.

9. IN REGARDS TO THE SELECTION OF SOILS, OR THE NATURAL SOILS AVAILABLE (IF AVAILABLE) MAY BE MODIFIED AS PER IS 4543 OR CONTRACT AGREEMENT TO BE PROCEEDED.

10. ONLY APPROVED SOILS ARE TO BE USED FOR BANK FORMATION / BED FILLING.

NOTE:
1. HYDRAULIC GRAVITY LINE SHOULD HAVE SLOPES OF 3% AS FOR GRADE 400 OF 50% SIDE AND CONTINUOUS SLOPING OF 5% IS SUGGESTED, AND CONTINUOUS SLOPING OF 5% IS RECOMMENDED IF NECESSARY.

ADVISORY OF INCONSPICUOUS - ORANGE A CONSPICUOUS - ORANGE A CONSPICUOUS - ORANGE A
DOWEL (Dowel-Drain-Bank)

REMARKS:

PATNA ASHOKBAPUR-3111
CUTTED DRAIN (P/I 11)

Date

Recheck

APPROVED

Supervising Engineer
Flow Diagrams

FLOW DIAGRAM OF DISTRIBUTOR-7, ON TBP HLMC
Typical L/S of Canal