REGULATORS

HYDRAULIC DESIGH

Hydraulic Design

التصميم الهيدروليكى الغرض منه :-

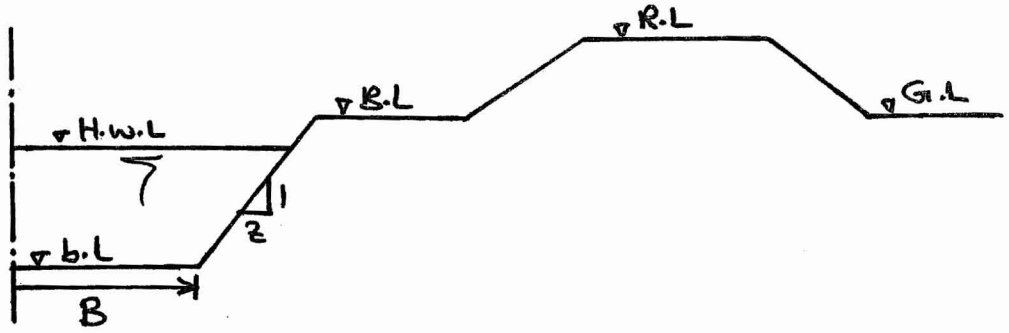
١- إيجاد عدد الفتحات (N) وعرض كل فتحه (b)

٢- التحقق من شرط الضاغط (check of heading up)

Given:-

1- Maximum Canal discharge (Q_{max})

2- Canal cross section:-



3- Maximum allowable heading up (hall)

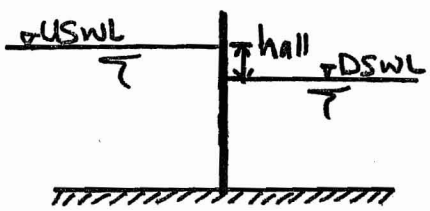
يتم الحصول على (hall) بإحدى الطرق الآتية :-

a- hall = ← (given)

or

b- from longitudinal section

hall = USWL − DSWL



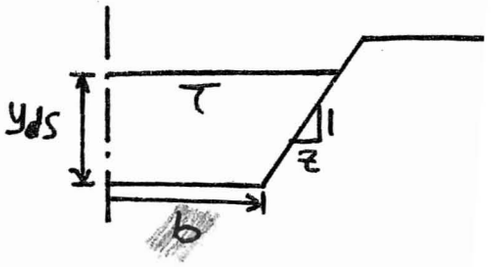
or

c- If not given. take hall = 20 cm

Req:-

1- Dimensions (No of vents (N) and Span (S))
2- Check of heading up (hup)

Sol:-



1- $A_{ds} = y_{ds}(b + z\,y_{ds}) = \_\ m^2$

2- $V_{ds} = \frac{Q_{max}}{A_{ds}} = \_\ m/s$

3- $2\,V_{ds} \leqslant V_r \leqslant 3\,V_{ds}$

$1 \leqslant \quad \leqslant 2$

assume $V_r = \_\ m/sec$

4- $A_{ww} = \frac{Q_{max}}{V_r} = \_\ m^2$

5- $A_{ww} = N * S * y_{ds}$ → N و S = ??

يتم هنا اختيار كل من N و S بحيث يتم فرض أحدهما وإيجاد الآخر ويفضل تقليل عدد الفتحات

assume $N = \_$
find $S = \_$

} أرقام صحيحة

Check of Velocity

- $V_r = \frac{Q_{max}}{A_{ww_{act}}} = \_$ $(1 \rightarrow 2\ m/s)$

δ_o o/c

Check of Contraction factor

- $\alpha = \frac{A_{ds} - A_{ww}}{A_{ds}} = \_ \not> 0.4$

If $\alpha > 0.4$

take $\alpha = 0.4$

$\therefore 0.4 = \frac{A_{ds} - N * S * y_{ds}}{A_{ds}}$

$\therefore S = \_$

Check of heading up:-

$$h_{up} = \frac{V_{us}^2}{2gC^2}\left(\left(\frac{A_{us}}{A_{ww}}\right)^2 - 1\right) \not> h_{all}$$

Where:-

- **C:** معامل يتوقف على عرض الفتحه

$C = 0.72 \longrightarrow S < 2$

$= 0.82 \longrightarrow 2 \leq S \leq 4$

$= 0.92 \longrightarrow S > 4$

- $A_{ww} = S * N * y_{ds} = \cdots$

- $A_{us} = y_{us}(b + z y_{ws}) = \cdots$

  - $y_{ws} = y_{ds} + h_{all}$

- $V_{ws} = \frac{Q_{max}}{A_{us}} = \cdots$

* If $h_{up} < h_{all}$ ..... $\rightarrow$:- ok

* If $h_{up} > h_{all}$ ..... $\rightarrow$:- Not ok

ويتم زيادة عرض الفتحه (S)

Alexandria University
Faculty of Engineering
Irrigation Eng. and Hydraulics Dept.

Sheet (3)
Regulators

1- Figure (1) shows the D.S cross section of a main canal in which a reinforced concrete regulator is to be constructed. The regulator consists of 4 vents each 3.0 m width. The maximum discharge through the regulator is Q = 50 m^3/sec and the maximum heading up is 10 cm. The following data are also considered in the design: (i) The bridge width = 10.0 m and it has 2 sidewalks of 1.0 m each, (ii) The pier width =1.0 m,(iii) Box and sloping wing walls are used for upstream and downstream sides, respectively, and (iv)Vertical sliding steel gates with *four* Main girders are used

It is required to:

a) Check the value of heading up for fully open gates.

b) Give a complete structure design of the gate, and find the required lifting force.

c) Draw neat sketch showing each of the following views:

i. Plan (H.E.R.)

ii. Longitudinal section through a vent centerline.

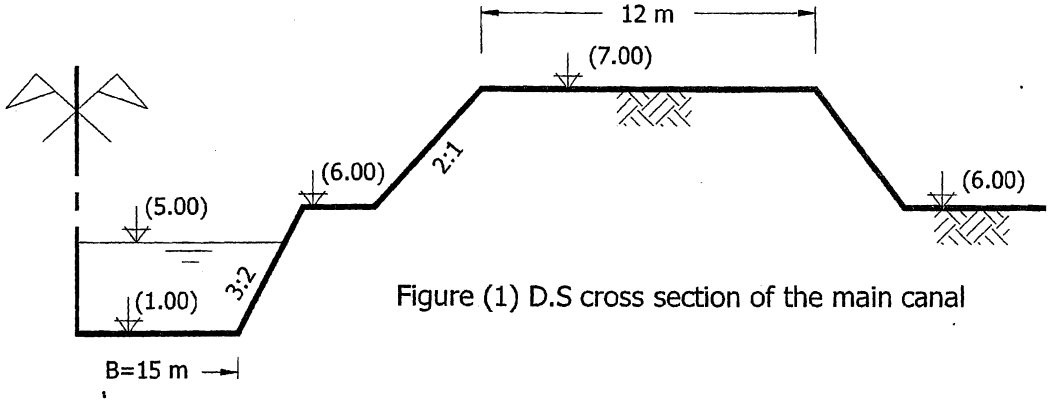


Figure (1) D.S cross section of the main canal

2- A reinforced concrete head regulator with 200.0 m approach channel is to be constructed to feed a main canal from a Rayah. The cross sections data for the canal and Rayah at the crossing site are given in the following table. The available data for the regulator are:

- **Maximum allowable discharge through the canal is 6.8*10^6 m^3/day**
- **The span of vents is 5.0 m,**
- **The bridge width over the regulator is 10.0 m and it has two sidewalks of 1.0 m width for each,**
- **U.S and D.S box wing walls are used,**
- **The width of the intermediate piers is 1.0 m.**

It is required to:

1- **Carry out the hydraulic design of the regulator (calculate the number of vents, and check of heading up).**
2- **Find the position of the main girders analytically (use 3 M.G).**
3- **Give a complete structure design of the gate (skin plate –M.G – X.G – Roller).**
4- **Find the required lifting force.**

	Bed width (m)	Berm width (m)	Road width (m)	Side slopes	Bed Level	Water Level	Berm Level	Road Level
Canal cross sec.	25.0	4.0	10.0	2:1	(2.00)	(5.60)	(6.20)	(8.00)
Rayah cross sec.	40.0	5.0	12.0	3:2	(1.00)	(5.70)	(6.20)	(8.00)

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Prob(1)

[a]- Check the value of heading up

$$h_{up} = \frac{V_{us}^2}{2g C^2}\left(\left(\frac{A_{us}}{A_{ww}}\right)^2 - 1\right)$$

$\therefore S = 3^m \longrightarrow \therefore C = 0.82$

- $A_{ww} = N_* S_* y_{ds} = 4*3*4 = 48\ m^2$
- $A_{us} = y_{us}(B + z y_{ws})$

take $y_{ws} = y_{ds} + h_{all} = 4 + 0.1 = 4.1^m$

$\therefore A_{ws} = 4.1(15 + 1.5 * 4.1) = 86.715\ m^2$

$\therefore V_{ws} = \frac{Q_{max}}{A_{ws}} = \frac{50}{86.715} = 0.577\ m/s$

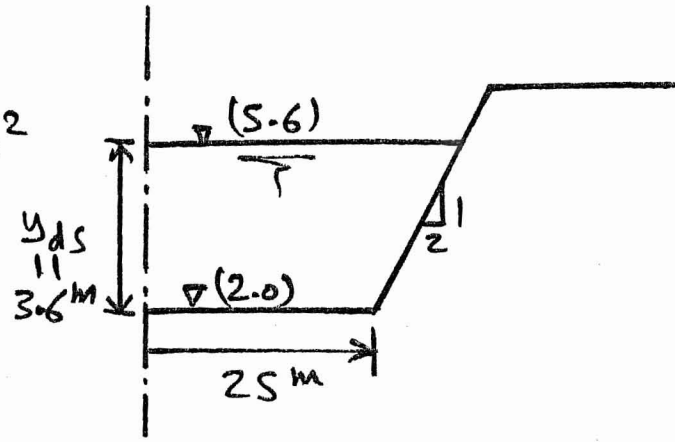
$\therefore h_{up} = \frac{(0.577)^2}{19.62*(0.82)^2}\left(\left(\frac{86.715}{48}\right)^2 - 1\right)$

$= 0.057^m = 5.7^{cm} < h_{all} = 10^{cm}$

$\therefore$ OK

Prob (2)

1- Carry out the hydraulic design



- $A_{ds} = 3.6(25 + 2*3.6) = 115.92\ m^2$

$$Q_{max} = \frac{6.8 * 10^6}{24 * 60 * 60} = 78.7\ m^3/s$$

- $$V_{ds} = \frac{Q_{max}}{A_{ds}} = 0.68\ m/s$$

$$2V_{ds} = 1.36 \leqslant V_r \leqslant 2.04$$

$$1 \leqslant \quad \leqslant 2$$

assume $V_r = 1.5\ m/sec$

$$\therefore A_{ww} = \frac{Q_{max}}{V_r} = 52.47\ m^2$$

$$A_{ww} = N * S * y_{ds}$$

$$52.47 = N * 5 * 3.6$$

$$N = 2.91\ s$$

take $N = 3.0$ vents

* Check of velocity

$$V_r = \frac{Q_{max}}{A_{WW}} = \frac{78.7}{3*5*3.6} = 1.46 \text{ m/s} \quad (1 \rightarrow 2 \text{ m/s})$$

∴ OK

* Check of α

$$\alpha = \frac{A_{DS} - A_{WW}}{A_{DS}} = \frac{115.92 - 3*5*3.6}{115.92} = 0.53 > 0.4$$

∴ Not OK

take $\alpha = 0.4$

$$0.4 = \frac{115.92 - N*5*3.6}{115.92}$$

$$\therefore N = 3.86$$

∴ take **N = 4.0 vents**

* check of heading up

$$h_{up} = \frac{V_m^2}{2gC^2}\left(\left(\frac{A_m}{A_{WW}}\right)^2 - 1\right)$$

- $C = 0.92$ & $A_{WW} = 4*5*3.6 = 72 \text{ m}^2$
- $y_m = y_{DS} + 0.1 = 3.7 \text{ m}$ & $A_m = 3.7(25 + (2)*3.7) = 119.$
- $V_m = \frac{78.7}{119.88} = 0.66 \text{ m/s}$

$$\therefore h_{up} = 0.046 \text{ m} = 4.6 \text{ cm} < h_{all} = 10 \text{ cm}$$

∴ OK