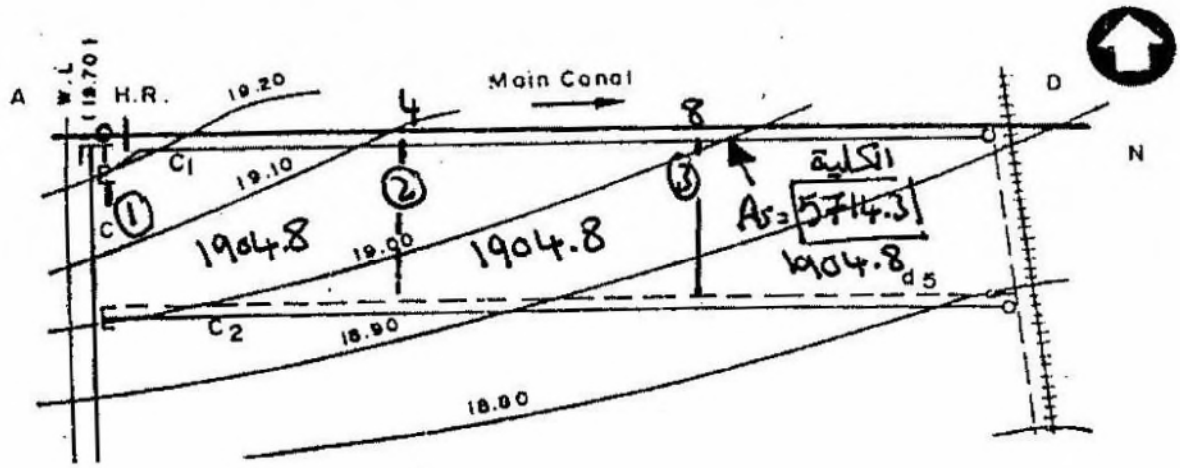
To Calculate Q

Area served المساحة المخدومة (الزمام)



Distribution Canal C1:

As 1 at K.M 0 = 5714.3 f

As 2 at K.M 4= 3809.5+ 0.4*1904.8=4571.5 f

As 3 at K.M 8= 1904.8+ 0.4*3809.5=3428.6 f

$$(Q)_{d.c} = \frac{(W.D)_{d.c} * \text{Area served}}{24*60*60} \quad m^3/sec$$

$$Q1 = \frac{63.44 \times 5714.3}{24 \times 60 \times 60} = 4.2\ m^3/sec$$

$$Q2 = \frac{63.44 \times 4571.5}{24 \times 60 \times 60} = 3.35\ m^3/sec$$

$$Q3 = \frac{63.44 \times 3428.6}{24 \times 60 \times 60} = 2.52\ m^3/sec$$

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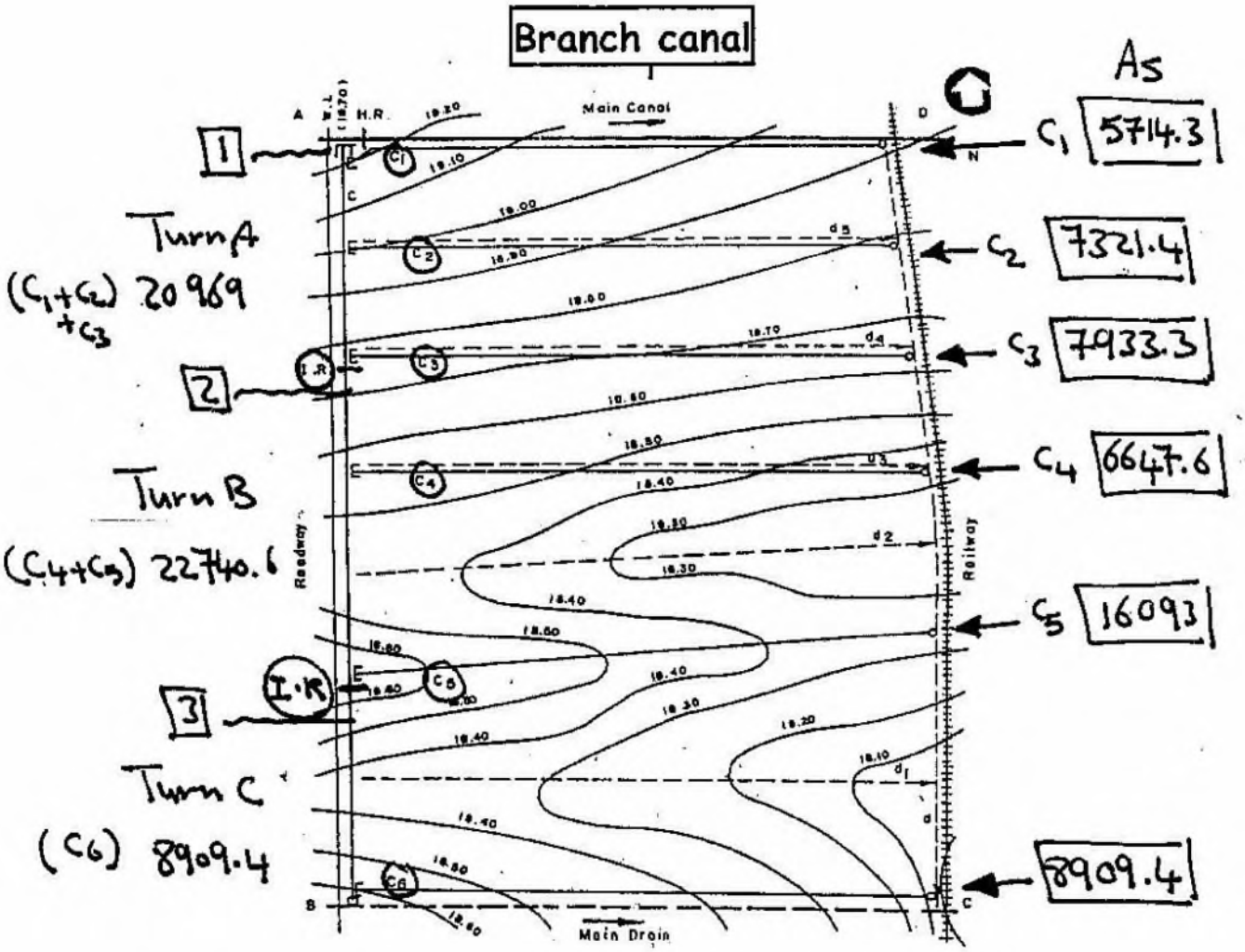
To Calculate Q



compensation factor = 40% from previous turn of rotation

Sec.	Area served			Area served + compansation			Design area served
	A_{turn}	B_{turn}	C_{turn}	A+ 0.4C	B + 0.4A	C + 0.4B	
S_1	20969	22740.6	8909.4	24532.8	31128.2	18005.6	31128.2
S_2	____	22740.6	8909.4	3563.8	22740.6	18005.6	22740.6
S_3	____	____	8909.4	3563.8	____	8909.4	8909.4

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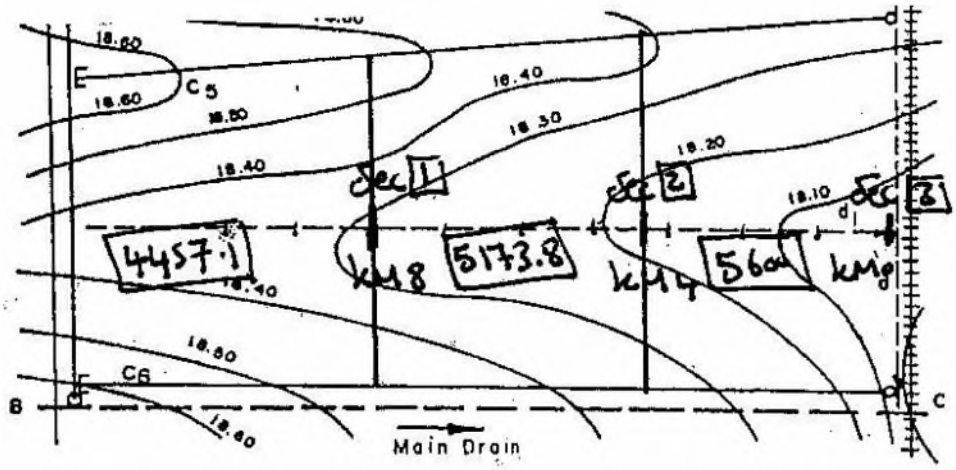
To Calculate Q

$$(Q)_{b.c} = \frac{(W.D)_{b.c} * \text{Design area served}}{24*60*60} \quad m^3/sec$$

$$Q1 = \frac{23.26 \times 31128.2}{24 \times 60 \times 60} = 8.4\ m^3/sec$$

$$Q2 = \frac{23.26 \times 22740.6}{24 \times 60 \times 60} = 6.1\ m^3/sec$$

$$Q3 = \frac{23.26 \times 8909.4}{24 \times 60 \times 60} = 2.4\ m^3/sec$$



For small branch drains Area served = A_s upstream section

بالنسبة للمصارف المساحة المخدومة تساوي المساحة قبل القطاع

Small Branch Drain D1:

As 1 = 4457.1 f

As 2 = 9630.9 f

As 3 = 15230.9 f

3

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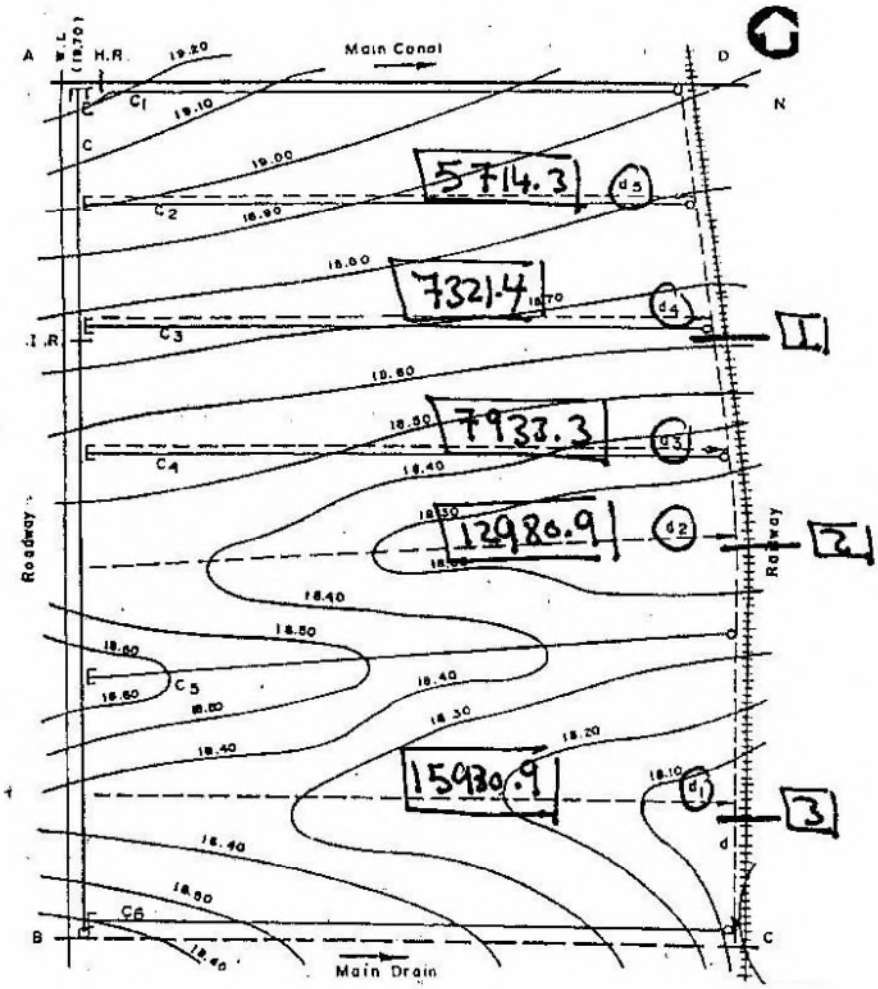
To Calculate Q

For branch drain Area served = $\sum A_s$ of small branch drains upstream section



As 1 =5714.3+7321.4=13035.7 f

As 2 =13035.7+7933.3+12980.9=33949.9 f

As 3 =33949.9+15930.9=49880.8 f

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To Calculate Q

Discharge of drains

$$(Q)_{drain} = \frac{\text{Area served} * \text{Drain water duty}}{24*60*60} \quad m^3/sec$$

Drain water duty ثابت لأي مصرف

Drain water duty = Drainage factor (40%)* F.W.D

Drain water duty = 0.4 * 57.67=23.1 m^3 / fed / day

Small Branch Drain D1:

$$Q1= \frac{23.1\times 4457.1}{24\times 60\times 60} = 1.2\ m^3/sec$$

$$Q2= \frac{23.1\times 9630.9}{24\times 60\times 60} = 2.6\ m^3/sec$$

$$Q3= \frac{23.1\times 15230.9}{24\times 60\times 60} = 4.1\ m^3/sec$$

For Branch drain

$$Q1= \frac{23.1\times 13035.7}{24\times 60\times 60} = 3.5\ m^3/sec$$

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For Distribution canal C1

Sec 1:

Q=4.2 m^3/sec

S=10 cm/km

Z=1:1 (clay)

1/n = 40 (For canal)

Manning equation:

$$\therefore Q = \frac{1}{n} \cdot \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} \cdot S^{\frac{1}{2}} \qquad m^3/sec$$

$$A = y\,(b + zy) = y.(b+1*y)$$

$$p = b + 2y.\sqrt{1+z^2} = b + 2\sqrt{1+1^2} = b + 2.82y$$

$$4.2 = 40 \frac{[y.(b+y)]^{\frac{5}{3}}}{[b+2.82y]^{\frac{2}{3}}} (10*10^{-5})^{0.5}$$

$$\frac{[y.(b+y)]^{\frac{5}{3}}}{[b+2.82y]^{\frac{2}{3}}} = 10.5 \rightarrow 1$$

1

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Buckly equation:

$$\boxed{\textbf{For } y \le 1.62 \text{ m}: \quad y = \frac{b(S+8)^2}{650}}$$

$$y = \frac{b(10+8)^2}{650}$$

$$y = 0.498\ b$$

$$b = 2.01\ y \rightarrow 2$$

From 2 in 1

$$\frac{[y.(2.01y + y)]^{\frac{5}{3}}}{[2.01y + 2.82y]^{\frac{2}{3}}} = 10.5$$

$$\frac{[3.01y^2]^{\frac{5}{3}}}{[4.83y]^{\frac{2}{3}}} = 10.5$$

$$\frac{6.27y^{\frac{10}{3}}}{2.86y^{\frac{2}{3}}} = 10.5$$

$$y^{\frac{8}{3}} = 4.79$$

$$y = (4.79)^{\frac{3}{8}} = 1.79 > 1.62 \quad (X)$$

لذلك الفرض خاطئ أساس أن $y \le 1.62$

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Assume y > 1.62

$$\boxed{y = 0.1\sqrt{b}\,(\frac{S}{2} + 4)}$$

$$y = 0.1\sqrt{b}(\frac{10}{2} + 4)$$

$$y = 0.9\sqrt{b}$$

$$y^2 = 0.81\ b$$

$$\boxed{b = 1.23\ y^2}$$

$$\frac{[y.(1.23y^2 + y)]^{\frac{5}{3}}}{[1.23y^2 + 2.82y]^{\frac{2}{3}}} = 10.5$$

By trials

y	1.7	1.8	1.75
R.H.S	9.34	11.43	10.35

y= 1.75 m (✓)

b= $1.23*1.75^2$ =3.77 m

take y = 1.75 m

b = 4.0 m

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بعد الحصول على أبعاد القطاع يتم تقريب عرض القطاع كالآتي:

1- **b > 1 m**

2- **1<b<2m** يتم التقريب لأقرب 20 سم

1→ 1.2→ 1.4 →1.6→ 1.8→2.0

3- **2<b<5m** يتم التقريب لأقرب 50 سم

2.0→ 2.5→ 3.0 →3.5→ 4.0→4.5

4- **b>5m** يتم التقريب لأقرب 1 م

Sec 2:

Q=3.35 m^3/sec

S=10 cm/km

Z=1:1 (clay)

1/n = 40 (For canal)

Manning equation:

$$\therefore Q = \frac{1}{n} \cdot \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} \cdot S^{\frac{1}{2}} \qquad m^3/sec$$

$A = y\,(b + zy) = y.(b+1*y)$

$p = b + 2y.\sqrt{1+z^2} = b + 2\sqrt{1+1^2} = b + 2.82y$

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y= 1.65 m (✓)

b= 1.23*1.65^2 =3.35 m

take y = 1.65 m

b = 3.5 m

For Small Branch drain D1

Sec 3:

Q=4.1 m^3/sec

S=15 cm/km

Z=3:2 (clay)

1/n = 33 (For drain)

Manning equation:

$$\boxed{\therefore Q = \frac{1}{n} \cdot \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} \cdot S^{\frac{1}{2}}} \qquad m^3/sec$$

$$A = y\,(b + zy) = y.(b+1.5*y)$$

$$p = b + 2y.\sqrt{1+z^2} = b + 2y.\sqrt{1+1.5^2} = b + 3.6y$$

---

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$$4.1 = 33\frac{[y.(b+1.5*y)]^{\frac{5}{3}}}{[b+3.6y]^{\frac{2}{3}}}(15*10^{-5})^{0.5}$$

$$\frac{[y.(b+1.5*y)]^{\frac{5}{3}}}{[b+3.6y]^{\frac{2}{3}}} = 10.14 \rightarrow 1$$

Buckly equation:

Assume b > 2

$$\boxed{y = 1.5\sqrt[3]{b}}$$

$$y^3 = 3.38\ b$$

$$b = 0.3\ y^3 \rightarrow 2$$

From 2 in 1

$$\frac{[y.(0.3y^3+1.5*y)]^{\frac{5}{3}}}{[0.3y^3+3.6y]^{\frac{2}{3}}} = 10.14$$

By trials

y	2.1	2.0	1.9	1.95	1.93
R.H.S	14.09	11.68	9.62	10.61	10.2

y= 1.93 m

b= $0.3*1.93^3$ =2.26 m >2 (✓)

take y = 1.93 m

b = 2.5 m

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Check of velocity:

$$v=\frac{Q}{A} \quad (0.3 \rightarrow 0.9 \ \text{m/sec})$$

Sec 1:

$Q= 4.2 \ m^3/sec$

$A = y\,(b + zy) = 1.75\,(4+1*1.75)=10.1 \ m^2$

$$v=\frac{Q}{A}=\frac{4.2}{10.1} = 0.42 \quad (0.3 \rightarrow 0.9 \ \text{m/sec}) \text{ safe}$$

Canal	Sec 1		Sec 2		Sec 3	
	y	b	y	b	y	b
C1	1.75	4.0	1.65	3.5	✓	✓
C2	✓	✓	✓	✓		
C3						
C4						
C5						

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Example (01)

Zagazig University Faculty of Engineering Civil Engineering Dept	Mid Term Exam April 2004	Irrigation Engineering

N.B: Solve the irrigation and drainage in two separate sheets

Answer the following questions

Question (1): (5-degrees)

Compare between each pair of the following terms:

(a) Field capacity and welting point.
(b) Crop rotation and irrigation rotation.
(c) Water application efficiency and water distribution efficiency.

Question (2): (10-degrees)

A rice zone of area served 12000 feddans irrigated from a main canal in two turns (A) and (B). If the area served of the (A) turn is 40% of the total main canal area served and the crop pattern for the whole area is as follows: 35% cotton, 30% rice and 25% sharaki prepared to be cultivated with maize. If the working period is 4 days, it is required to

(a) Calculate the field water duty?
(b) Calculate the water duty and the discharge of the distributor canals (A) and (B)?
(c) Calculate the water duty and the discharge of the main canal?
(d) What the corresponding values after the turn of sharaki irrigation?

With best wishes,

Exam Committee

Eraes

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Example (01)

بسم الله الرحمن الرحيم

ري Mid term 2004

Q(1):

(a) Field capacity

هي نسبه الرطوبه الموجوده بالتربه بعد التخلص من الماء الحر منها وثبوت المحتوى المائي عند مستوى ثابت.

Wilting point

هي شبه الرطوبه داخل التربه التي يجد عندها النبات صعوبه في امتصاص الماء من داخل التربه.

(b) Crop rotation

هي تبادل زراعه المحاصيل المختلفه على نفس الرقعه الزراعيه للحفاظ على خصوبه التربه.

irrigation rotation

هي عمليه تبادل ري المناطق المختلفه.

(c) application eff.

$$E_a = \frac{W_s}{W_f} \times 100$$

هي النسبه بين كميه الماء المخزنه داخل التربه الى كميه الماء الواصله للتربه.

distribution eff.

$$E_d = \left(1 - \frac{y}{d}\right) \times 100$$

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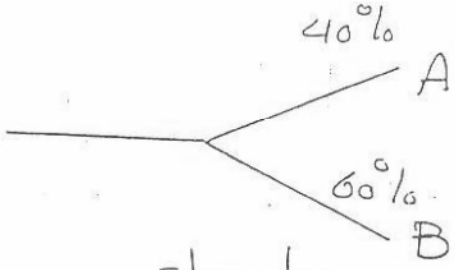
Example (01)

Q(2) :

Given: - area = 12000 f.



	Cotton	Rice	sharaki
	35%	30%	25%
احفظ	350 m3/fld	420	760
	14-18 day	8	28-36

- Working Period = 4 day

Req.:

a - F.W.D = ?

b - (D.C) W.D = ??

(D.C) A = ?? , (D.C) B = ??

c - (M.C) W.D = ?? , M.C = ??

d - after sharaki irrigation.

Sol.:

Area (A) = $\frac{40}{100} \times 12000 = 4800$ f.

Area (B) = $\frac{60}{100} \times 12000 = 7200$ f.

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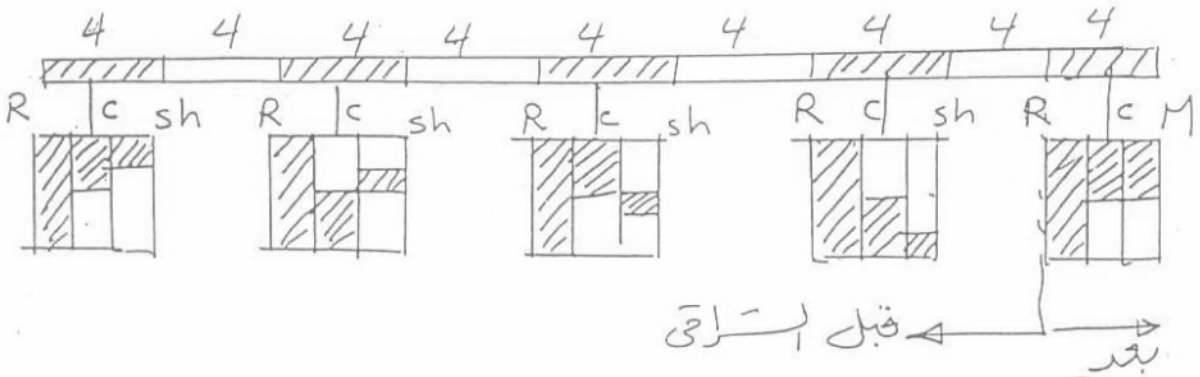
Example (01)



<u>befor sharaki</u>

شراقى قطع

$$- F.W.D = \frac{0.3 \times 420}{4 \times 1} + \frac{0.35 \times 350}{4 \times 2} + \frac{0.25 \times 760}{4 \times 4}$$

$$= 58.7 \ m^3/f/day$$

$$- (D.C)\,W.D = 1.1 \times 58.7 = 64.6 \ m^3/f/d$$

$$- (M.C)\,W.D = \frac{1.2 \times 58.7}{2} = 35.2 \ m^3/f/d$$

$$(Q_{D.C})^{\text{الترعه}}_{A} = \frac{64.6 \times 4800}{24 \times 60 \times 60} = 3.58 \ m^3/s'$$

$$(Q_{D.C})^{\text{الترعه}}_{B} = \frac{64.6 \times 7200}{24 \times 60 \times 60} = 5.38 \ m^3/s'$$

$$Q_{M.C} = \frac{(M.C)_{W.D} \times \text{designed area surfed}}{24 \times 60 \times 60}$$

$$= \frac{35.2 \times (7200 \times 2)}{24 \times 60 \times 60} = 5.9 \ m^3/s'$$

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Example (01)

after sharaki :

$$F.W.D = \frac{0.3 \times 420}{4 \times 1} + \frac{0.35 \times 350}{4 \times 2} + \frac{0.25 \times 350}{4 \times 2}$$

$$= 57.8 \ m^3/f/d$$

$$(D.C)_{W.D} = 1.1 \times 57.8 = 63.6 \ m^3/f/d$$

$$(M.C)_{W.D} = \frac{1.2 \times 57.8}{2} = 34.7 \ m^3/f/d$$

$$(Q_{D.C})_A = \frac{63.6 \times 4800}{24 \times 60 \times 60} = 3.5 \ m^3/s^1$$

$$(Q_{D.C})_B = \frac{63.6 \times 7200}{24 \times 60 \times 60} = 5.3 \ m^3/s^1$$

$$Q_{M.C} = \frac{34.7 \times (7200 \times 2)}{2.4 \times 60 \times 60} = 5.8 \ m^3/s^1$$

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Example (02)

$$D = \frac{\gamma_s}{\gamma_w} * d * ML * [F.C - W]$$

$$D = \frac{1.4}{1} * 50 * 0.8 [0.21 - 0.12]$$

$$D = 5.04 \text{ Cm.}$$

$$F = \frac{5.04}{0.38} = 13.3 \simeq 13 \text{ day}$$

Final (2000)

Question (3): (55% of Irrigation Mark)

A conveyance system for an irrigation project is as shown in Figure (1). The main canal distributes its water for three branches A, B, and C of equal area served of 6000 feddan each. The crop pattern of the whole area is: 40% cotton, 50% sharaki prepared for cultivating maize, and 10% public benefits and the working period is 6 days. Irrigation is allowed only by lift through branch canals. It is required to:

1. Sketch a diagram for the three turns of water application within 36 days.
2. Calculate the field, branch and main canal water duties.
3. Calculate the discharge of branch canal (B) at section (IV).
4. Calculate the area served at section (I), (II), and (III) of the main canal allowing 50% as a compensation factor for previous turn.
5. Calculate the discharge of the main canal at section (I).
6. Draw to a reasonable scale clear sketches showing the different steps of constructing the synoptic diagram of the main canal and its branches.
7. Design the cross section of the main canal (Sec. I), to determine the water depth and bed width for non-silting non-scouring conditions [Z = 1, n = 0.025, and S = 8 cm/km].
8. Draw to a reasonable scale a typical cross section of the main canal (Sec I) showing all levels and dimensions [Bank width = 10 m, land level = 20.00, berm level = 21.00, and the free board = 1.25 m].

B.C A , B.C B , B.C C $A_s = 6000$ F

40% Cotton No of working day = 6

50% Sharaki Lift irrigation

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Example (02)

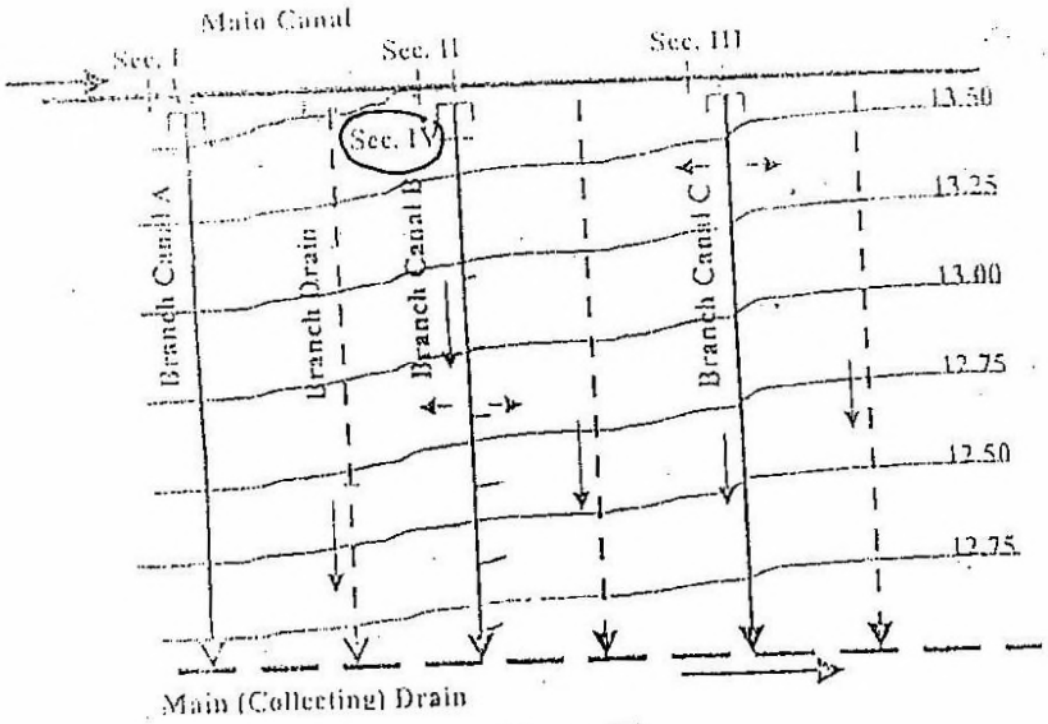
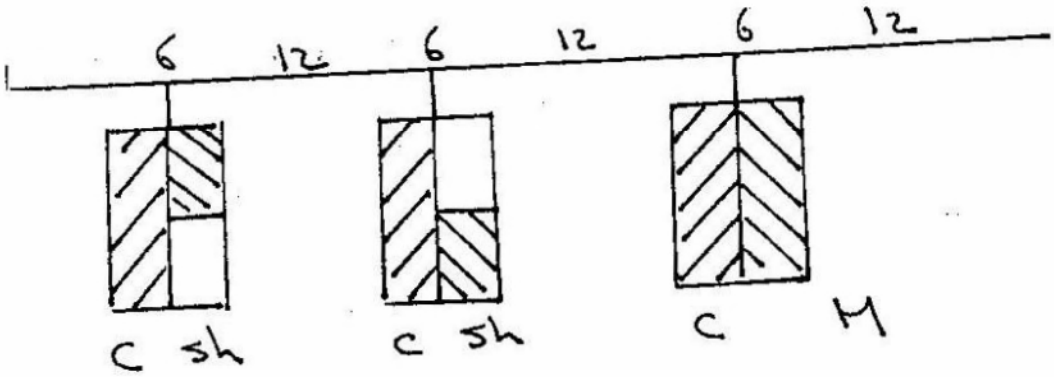


Figure (1)

Cotton	Sharaki
40%	50%
350	760 m^3/Fld
14–18	28–36



(3-turn rotation)

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Example (02)

During sharaki

$$F.W.D = \frac{0.4*350}{1*6} + \frac{0.5*760}{2*6} = 55\ m^3/F/d$$

After sharaki

$$F.W.D = \frac{0.4*350}{1*6} + \frac{0.5*350}{1*6} = 52.5\ m^3/F/d$$

$$(B.C)_{W.D} = 1.1*F.W.D$$
$$= 1.1*55 = 60.5\ m^3/F/d$$

$$(M.C)_{W.D} = \frac{1.2*F.W.D}{3} = \frac{1.2*55}{3} = 22\ m^3/F/d$$

For Branch Canal B

$$Q_{IV} = \frac{A_S*W.D}{24*60*60} = \frac{6000*60.5}{24*60*60} = 4.2\ m^3/s$$

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Example (02)

Sec	As			As + Compensation			Design As
	Turn A	B	C	A+0.5C	B+0.5A	C+0.5B	
I	6000	6000	6000	9000	9000	9000	9000
II	—	6000	6000	3000	6000	9000	9000
III	—	—	6000	3000	—	6000	6000

(3turn)

نوع المناوبة

$$Q_I = \frac{9000 * 22 * 3}{24 * 60 * 60} = 6.87 \ m^3/sec.$$

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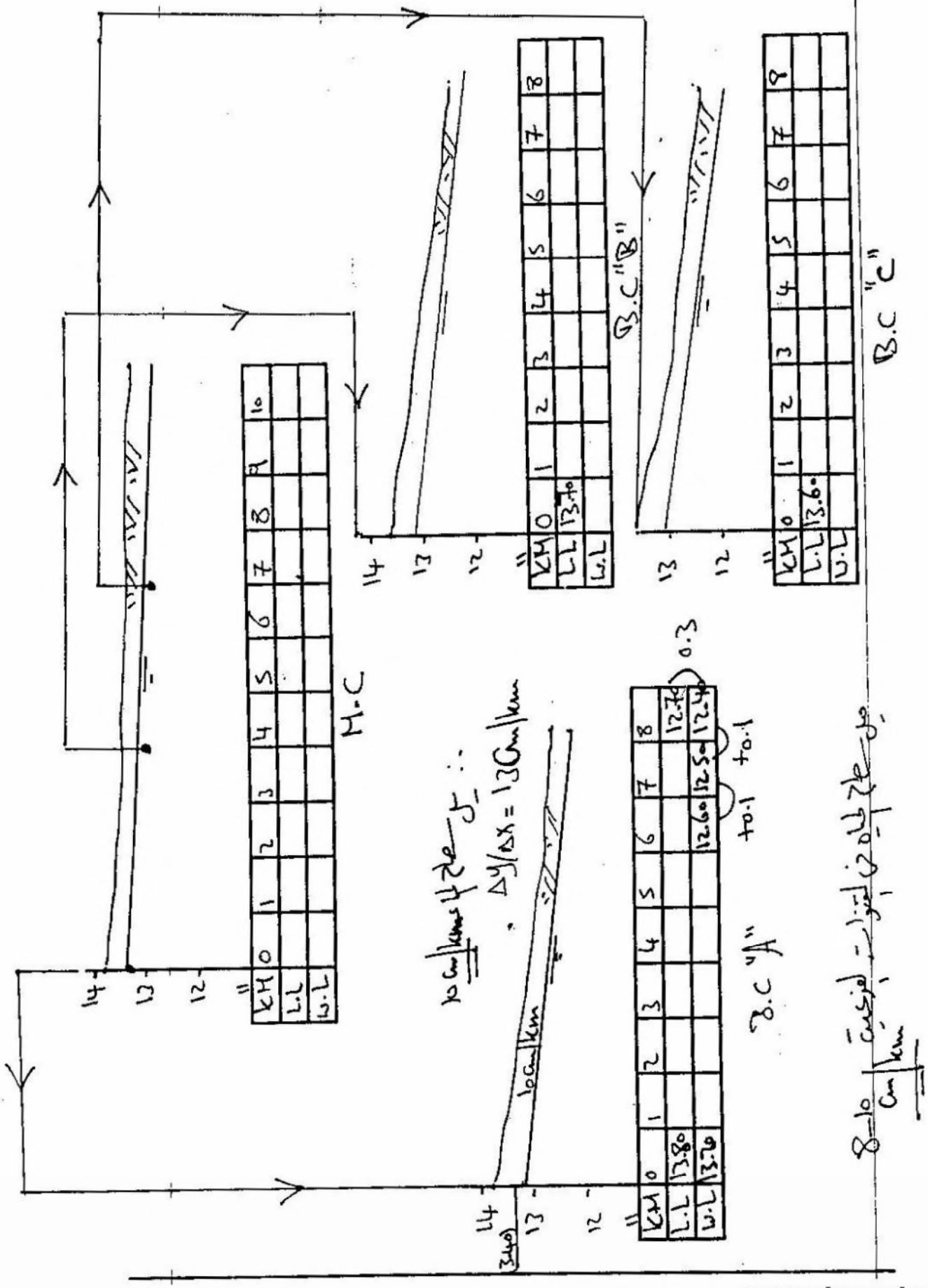
Example (02)



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Example (02)

Sec(I)

$Q = 6.87\ m^3/s$

$Z = 1 \qquad n = 0.025$

$S = 8\ cm/km$

Manning

$$Q = \frac{1}{n} \frac{A^{5/3}}{P^{2/3}} S^{1/2}$$

$$A = y(B + Zy) = y(B + 1 * y) = y(B + y)$$

$$P = B + 2y\sqrt{1 + Z^2} = B + 2.82y$$

$$6.87 = \frac{1}{0.025} \frac{[y(B+y)]^{5/3}}{[B + 2.82y]^{2/3}} * (8 * 10^{-5})^{0.5}$$

$$19.2 = \frac{[y(B+y)]^{5/3}}{[B + 2.82y]^{2/3}} \longrightarrow (1)$$

Buckly

assume $y > 1.62\ m$

$$y = 0.1\sqrt{B}\,(S/2 + 4)$$

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Example (02)

$$y = 0.1\sqrt{B}\,(8/2+4)$$

$$y = 0.8\sqrt{B}$$

$$y^2 = 0.64\,B$$

$$B = 1.56\,y^2 \longrightarrow (2)$$

From (2) in (1)

$$19.2 = \frac{\left[y\,(1.56y^2+y)\right]^{5/3}}{\left[1.56y^2+2.82y\right]^{2/3}}$$

By trials

y	1.7	1.9	2.0
R.H.S	11.48	17.06	20.49

$$Y \simeq 1.97\,m$$

$$B = 6.05 \simeq 6\,m$$

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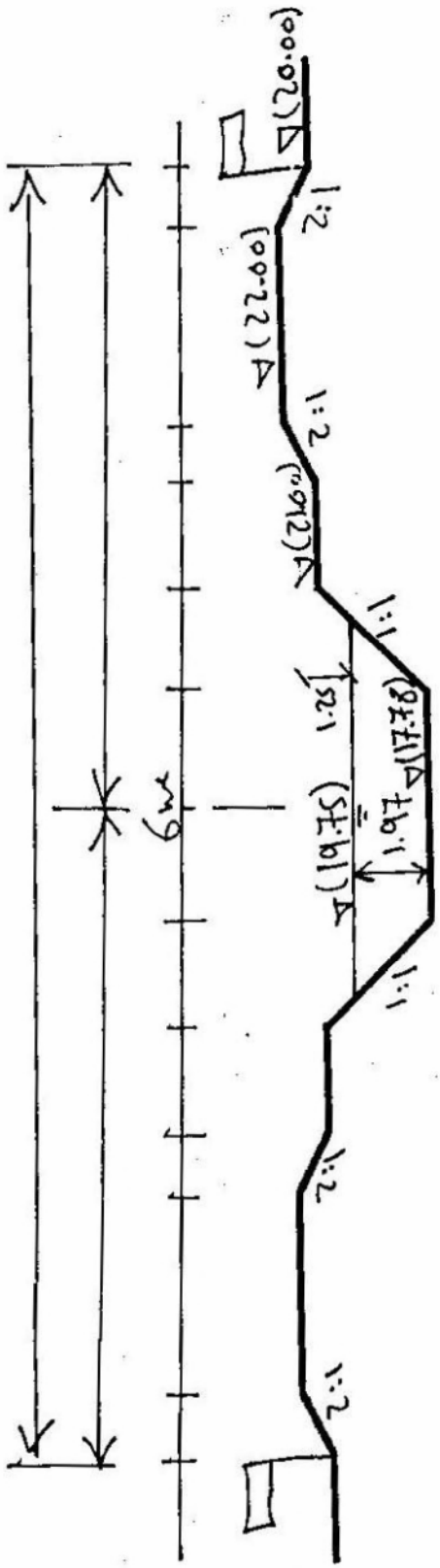
Example (02)



Sec (I)

مقطع متماثل رسم 1:200

Final (1999)

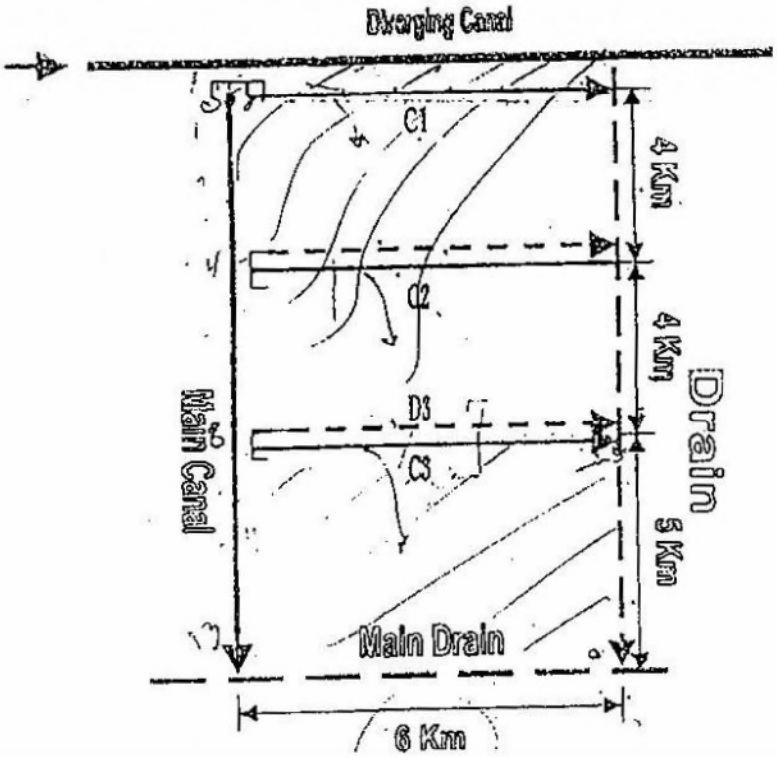
(2) A main canal serves the area shown below. A two turn rotation system is used (7 days working period) to irrigate 40% of the area served with cotton crop and 55% of the area served is sharaki. Allow 20% as wash factor and 10% as conveyance losses. It is required to:

A. Calculate the field, distributary and main canal water duties.

B. Draw neat sketch for the synoptic diagram of canals.
Design the cross section of canal C3 and drain D3 to determine the water depth and bed slope. Mean velocity in the canal v = 0.50 m/sec. while in the drain is v = 0.4 m/sec, bed width b = 3.0 m in the canal and b = 2.0 m in the drain, side slope 1: 1 in the canal and 3:2 in the drain, and Manning n = 0.025 for both canal and drain.

C. Draw the typical combined cross section at the middle of both the canal C3 and the drain D3 showing all details and dimensions. Take all bank widths 8 m., external land slope 2:1 and land level (10.00). Check seepage.

D. Draw typical longitudinal section of canal C3.



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Example (02)

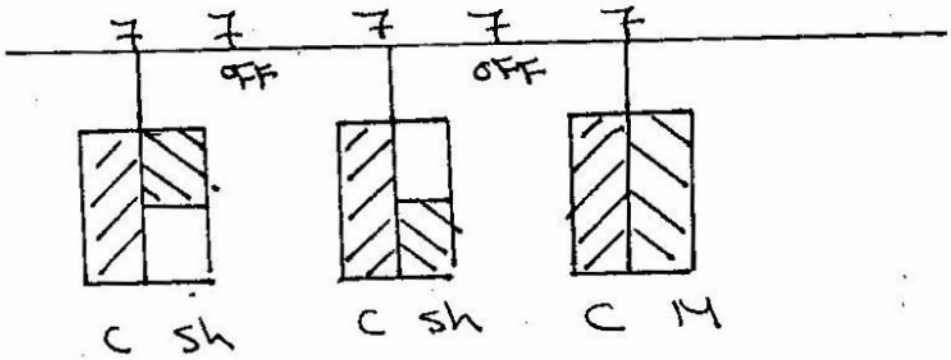
(2-turn rotation)

Working days = 7

Wash Factor
20%

10% Conveyance losses

Cotton	Sharaki
40%	55%
350	760
14-18	28-36



During sharaki

20% wash Factor

$$F.W.D = \left(\frac{0.4*350}{1*7} + \frac{0.55*760}{2*7}\right)*1.2$$

$$= 59.8\ m^3/F/d$$

After Sharaki

$$F.W.D = \left(\frac{0.4*350}{1*7} + \frac{0.55*350}{1*7}\right)*1.2$$

$$= 57\ m^3/F/d$$

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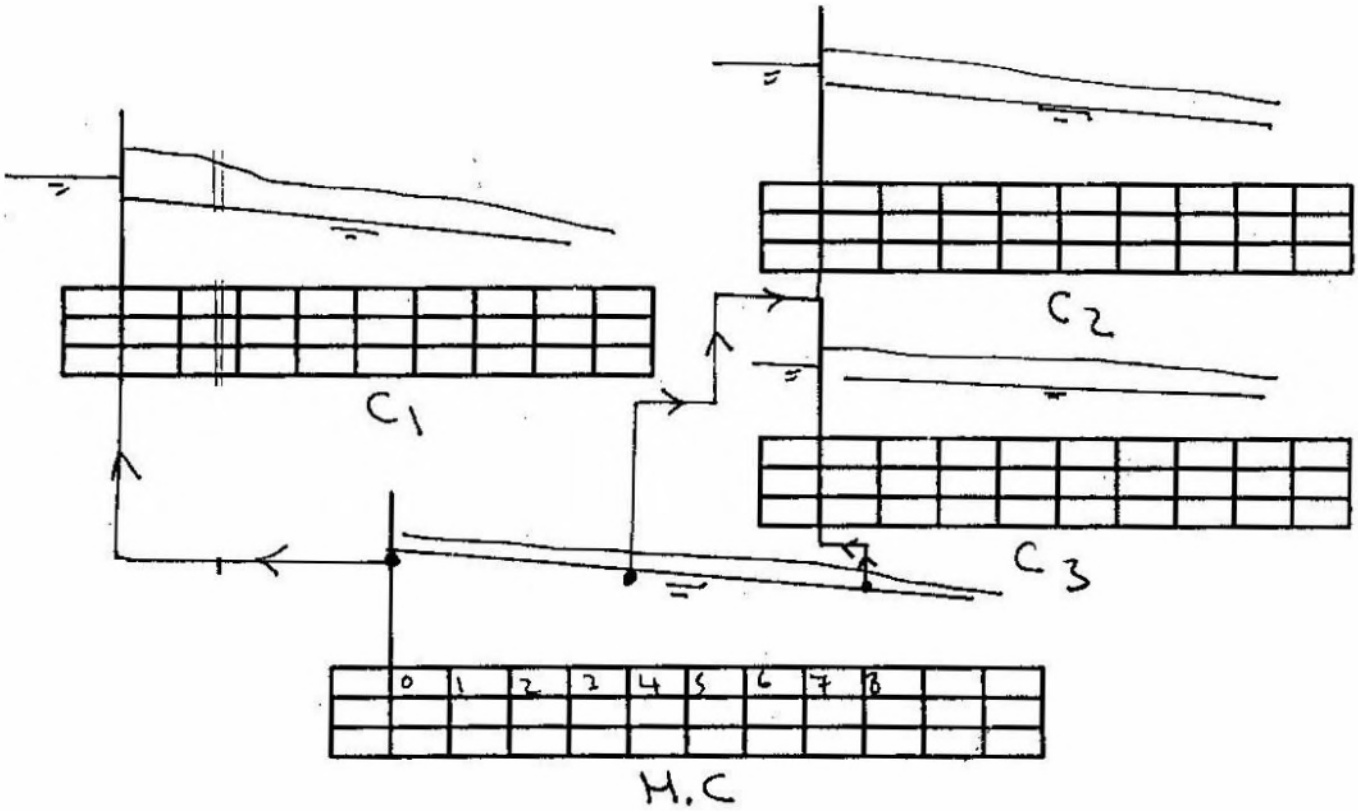
$$(B.C)_{W.D} = 1.1 * F.W.D$$
$$= 1.1 * 59.8 = 65.8 \ m^3/F/d$$

$$(M.C)_{W.D} = \frac{1.1 * (B.C)_{W.D}}{(2) \ \text{نوع المناوبة}}$$

$$= \frac{1.1 * 65.8}{2} = 35.9 \ m^3/F/d$$



Synoptic diagram for Canals (sketch only)

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For Canal

C_3

$V = 0.5\ m/sec$

$b = 3m$

$Z = 1 \quad , \quad n = 0.025$

Req: y, S

Manning

$$V = \frac{1}{n} \frac{A^{2/3}}{P^{2/3}} S^{1/2}$$

$$A = y(b+Zy) = y(3+y)$$

$$P = b + 2y\sqrt{1+Z^2} = 3 + 2.82y$$

$$0.5 = \frac{1}{0.025} \frac{[y(3+y)]^{2/3}}{[3+2.82y]^{2/3}} S^{1/2} \longrightarrow (1)$$

مبدأ سم

$$A_s = \frac{5000 * 6000}{4200} = 7142.8\ F$$

$$Q = \frac{A_s * W.D}{24 * 60 * 60}$$

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Example (02)

$$Q = \frac{7142.8 * 65.8}{24 * 60 * 60} = 5.44 \ m^3/s$$

$$Q = A.V$$

$$5.44 = A * 0.5 \Rightarrow A = 10.88 \ m^2$$

$$A = y(3+y)$$

$$10.88 = 3y + y^2$$

$$y^2 + 3y - 10.88 = 0$$

$$y = \frac{-3 \pm \sqrt{3^2 + 4 * 1 * 10.88}}{2 * 1}$$

$$\boxed{y = 2.12 \ m} \rightarrow (2)$$

From (2) in (1)

$$0.5 = \frac{1}{0.025} \frac{[2.12(3+2.12)]^{2/3}}{[3+2.82*2.12]^{2/3}} S^{1/2}$$

$$\boxed{S = 1.21 * 10^{-4}}$$

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Example (02)

For Drain D_3

$V = 0.4\ m/s$
$b = 2\ m$
$Z = 1.5$ $n = 0.025$

$$A_s = \frac{4000 * 6000}{4200} = 5714.3\ F$$

$$D.W.D = F.W.D * \text{drainage factor}$$

$$= 59.8 * 0.4 = 23.9\ m^3/F/d$$

assume

$$Q = \frac{A_s * WD}{24 * 60 * 60} = \frac{5714.3 * 23.9}{24 * 60 * 60} = 1.58\ m^3/s$$

$$Q = A.V$$

$$1.58 = A * 0.4 \Rightarrow A = 3.95\ m^2$$

$$3.95 = y(b + Zy)$$
$$= y(2 + 1.5y)$$

$\downarrow$ get y

Manning $\rightarrow$ get S

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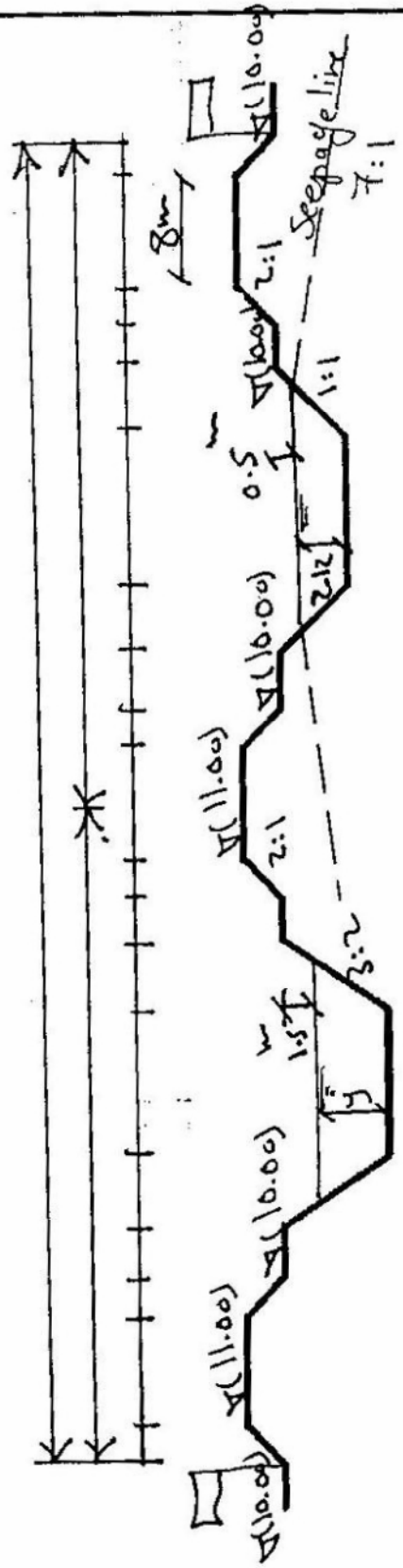
Example (02)



Combined Cross Section
of C_3 & D_3

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