Sediment investigation at the 30 degree water intake

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Introduction

Water intakes are used to divert flow from a:

1- main channel in to irrigation system

2- river in to irrigation channels

Introduction

sediment delivery into intakes from rivers causes the following problems:

1- Reduction flow discharge capacity

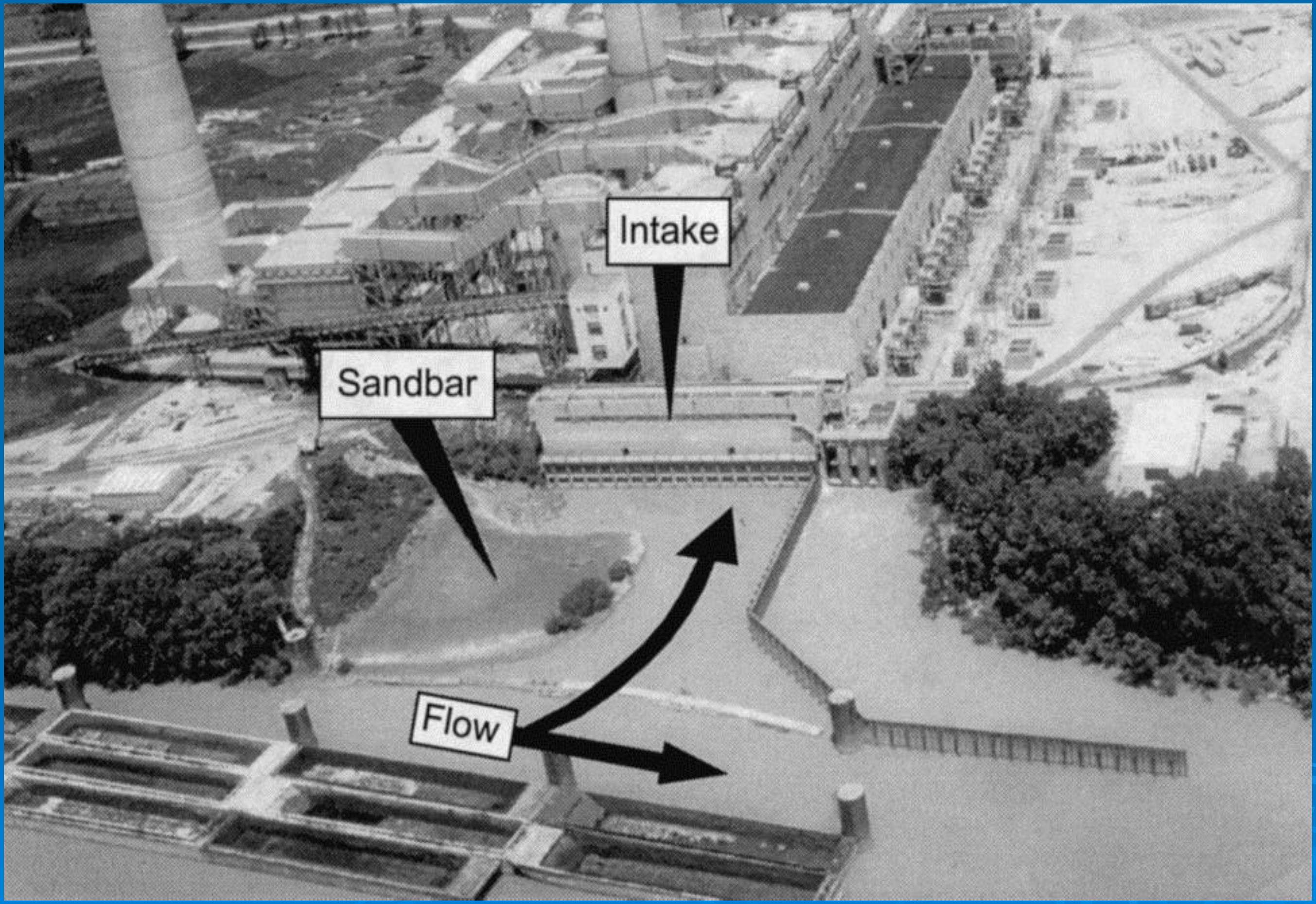
2- Erosion of the channel walls.

3- Interruption of water source for dredging of the channels may cut providing water supplies to the farms.

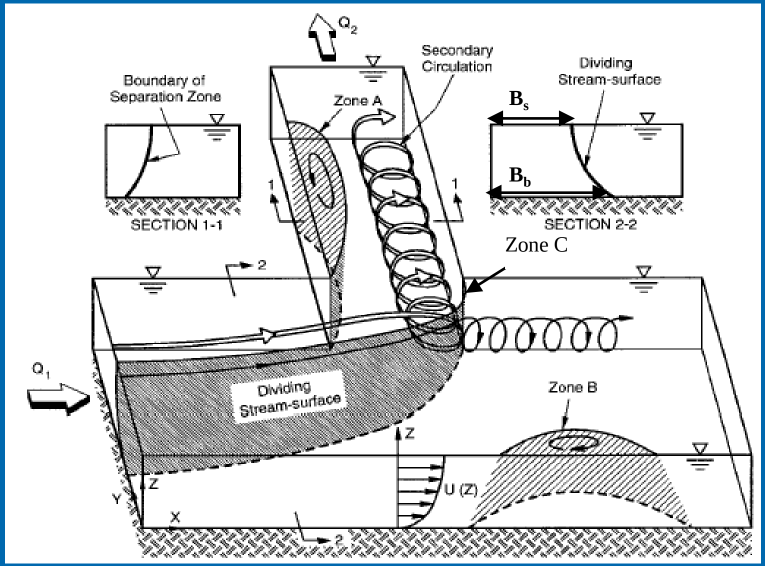
4- Channel dredging costs expensively

5- growing weeds that are harmful to the covers and result in leakage from the channels walls.

Introduction



3D flow patterns in water intake



1- separation zone (Zone A)

2- a contracted flow zone

3- a secondary circulation in the branch and main channels

4- a stagnation point (Zone C)

5- a separation zone in the main channel (Zone B)

6- dividing stream surface (DSS)

7- in the main channels with rectangular section, the diversion flow width at the bed (B_b) is greater than that in the surface (B_s), (section 2-2)

Literature Review

- ✓ Taylor (1944)
- ✓Vanoni (1977) → 30 to 45 degree angle is the best one
- ✓Neary, Odgaard. (1993) →
- ✓Neary et al. (1999)
- ✓ Nazary and Shafai (1999) →
- ✓Karami Moghadam et al. (2010)

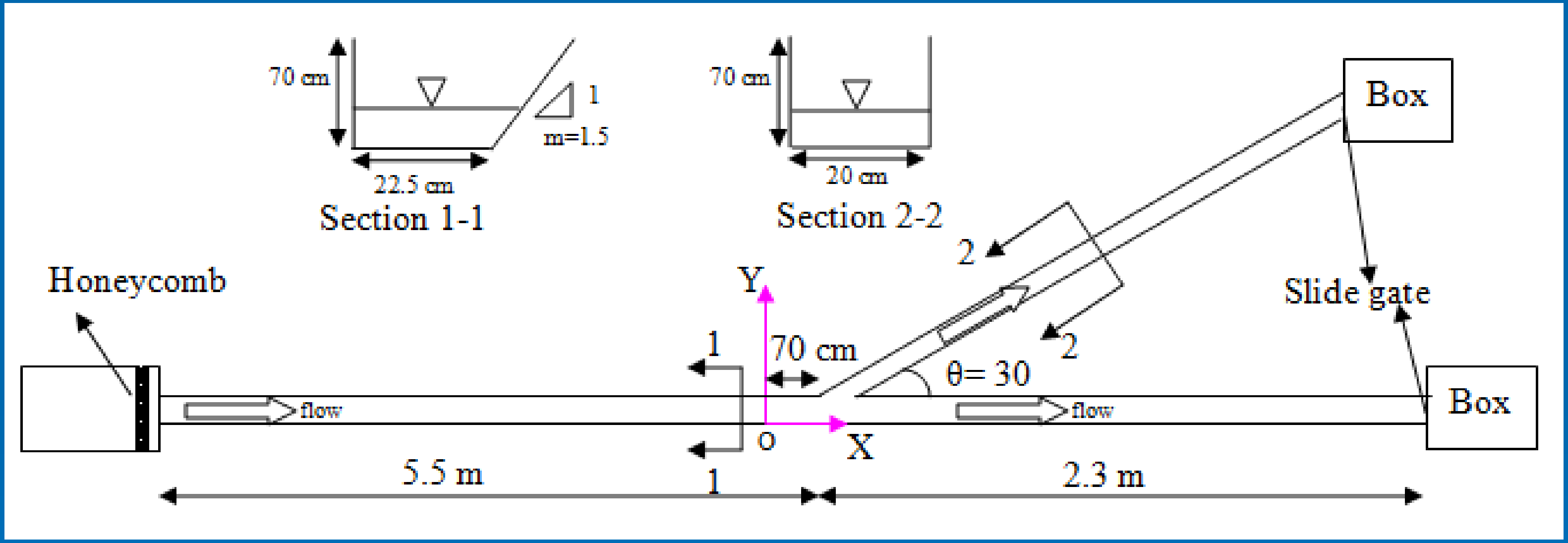
Dimension Analysis

$F(Q_{su}, Q_{si}, Q_u, D_u, t, d_{50}, g, \rho, \rho_s, \upsilon, \theta, k_s, B, T) = 0$

$$\frac{Q_{si}}{Q_{su}} = f\left(\frac{Q_i}{Q_u}, \frac{k_s}{D_u}, Fr, \mathrm{Re}_*\right)$$

$$G_r = \frac{Q_{si}}{Q_{su}} \qquad Q_r = \frac{Q_i}{Q_u}$$

Materials and Methods



Materials and Methods

To perform any case of the experiment:

1- the discharge of the main channel for the corresponding depth and Froud Number was calculated

2- after the flow being steady, the diversion flow ratio was measured using the V-shaped weirs

3- the gates were brought up to the extent that both the diversion flow ratio and the desired depth were safeguarded.

4- The sediments were injected in the main channel upstream

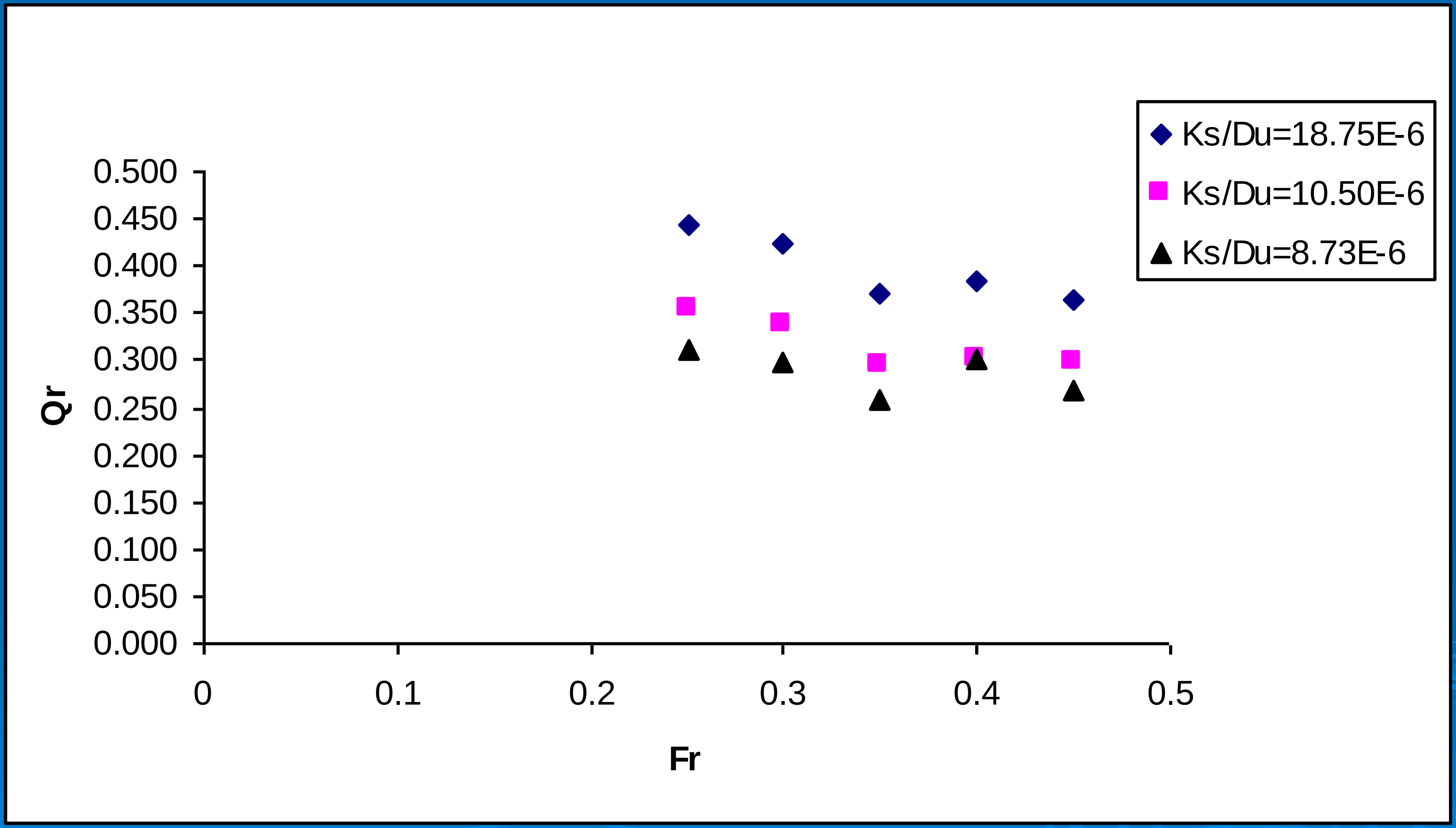
Materials and Methods

Results and Discussion

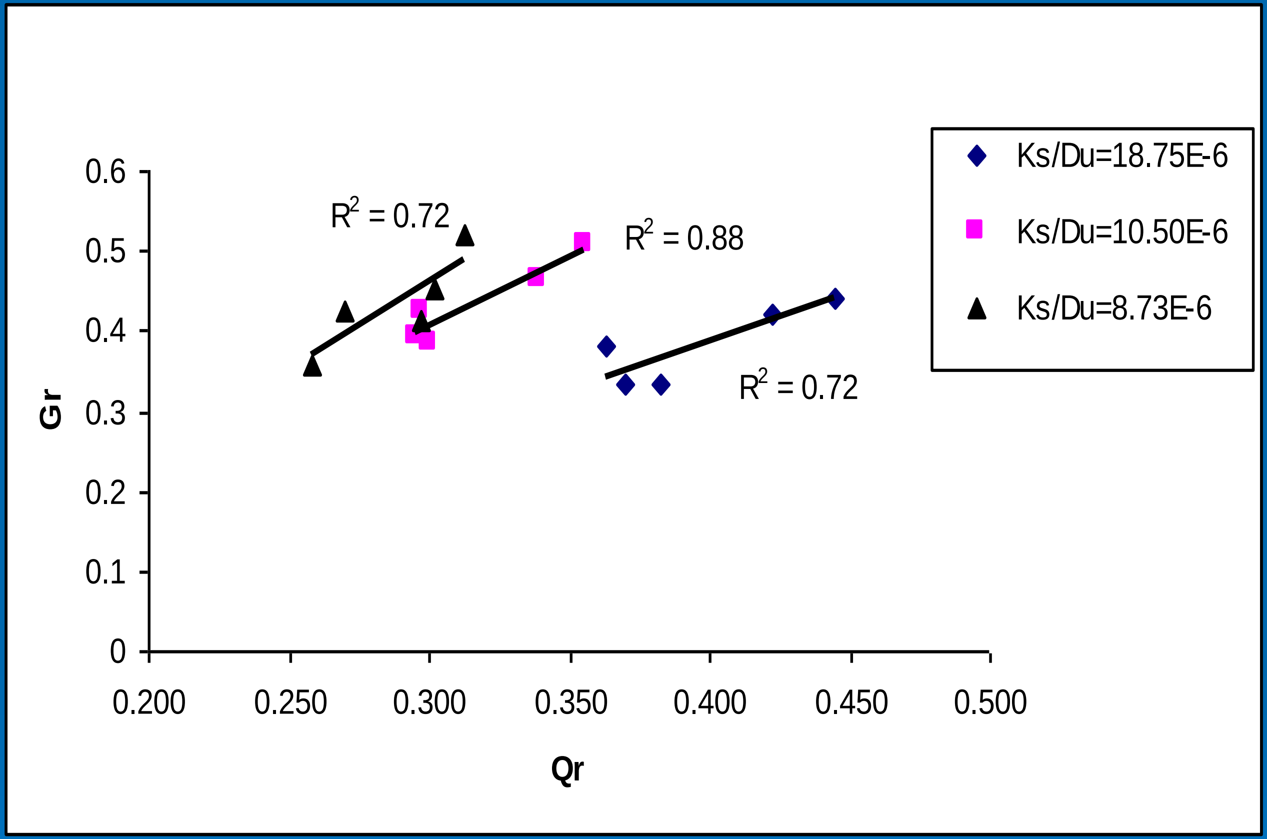
Table 1: The flow condition in this study

Side slope	Fr	Qr	d_u (m)	Sediment
1.5	0.25	0.445	0.1	√
	0.3	0.423	0.1	√
	0.35	0.37	0.1	√
	0.4	0.383	0.1	√
	0.45	0.363	0.1	√
	0.25	0.312	0.2	√
	0.3	0.297	0.2	√
	0.35	0.258	0.2	√
	0.4	0.3	0.2	√
	0.45	0.27	0.2	√
	0.25	0.312	0.25	√
	0.3	0.297	0.25	√
	0.35	0.258	0.25	√
	0.4	0.3	0.25	√
	0.45	0.27	0.25	√

Results and Discussion

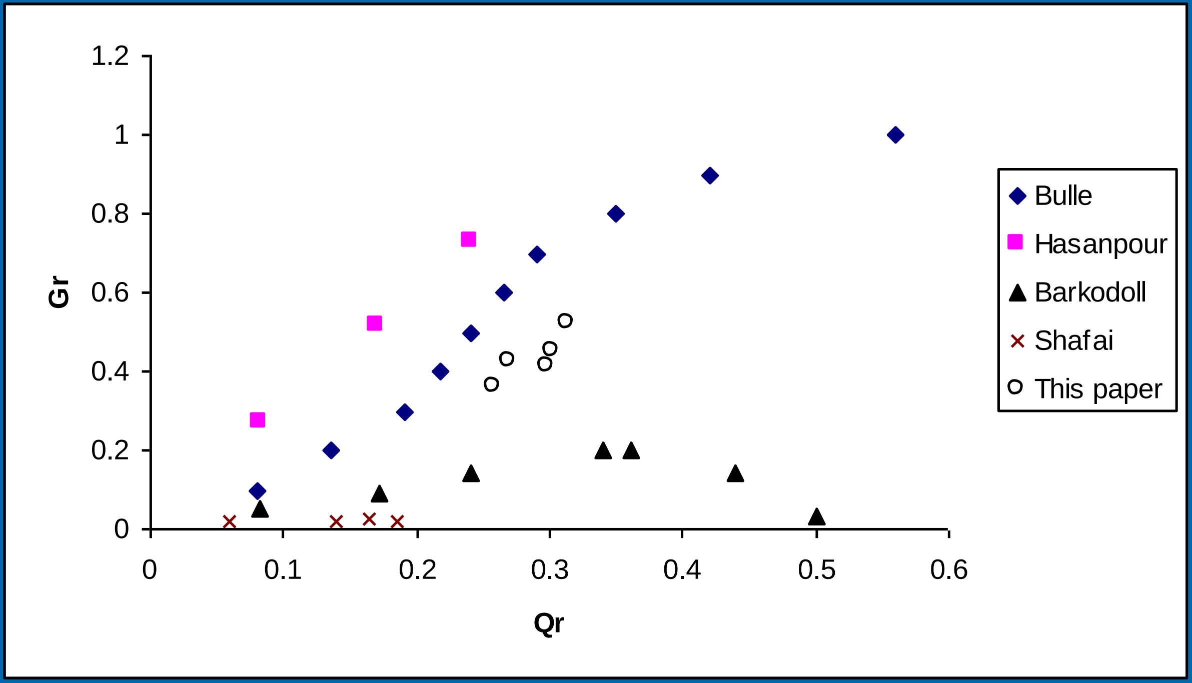


Results and Discussion



the two ratios Qr and Gr are in proportion to each other

Results and Discussion



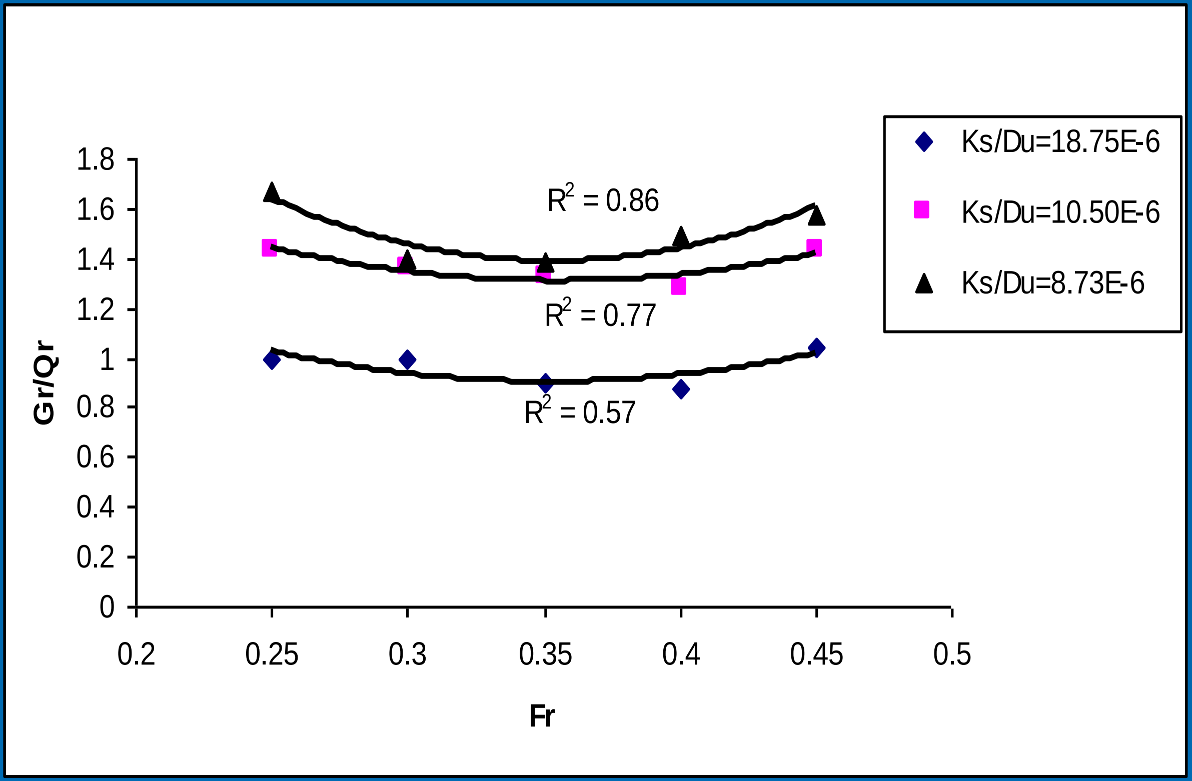
Hasanpour's work → linear relation

Barkdoll's results → There exists a turning point

Shafai and Nazari → much less sediment entry

Bulle → 30 degree → our results are in harmony with Bulle's

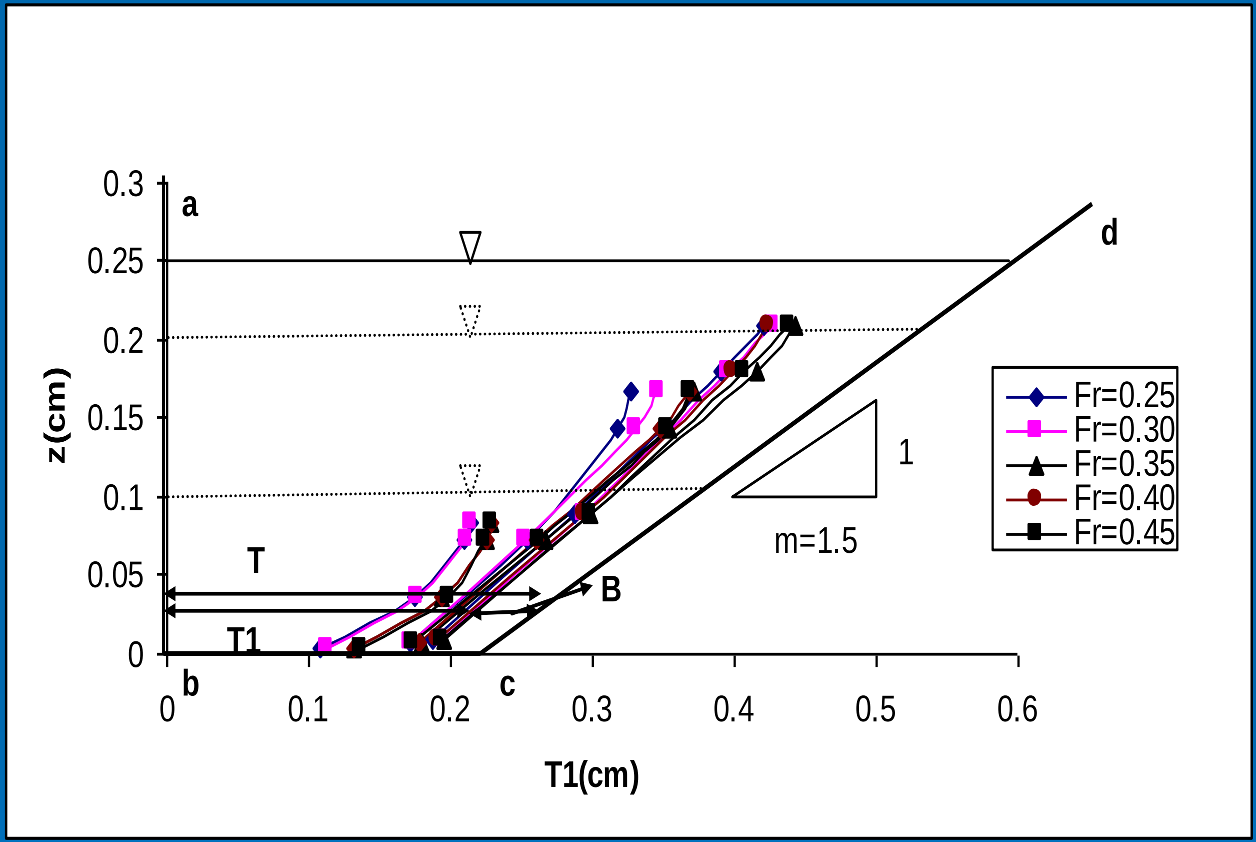
Results and Discussion



in the bounded interval of Froude number 0.35-0.40

G_r/Q_r rate reaches it's minimum

Results and Discussion



The Diversion Stream Surface (DSS) for different Froude numbers

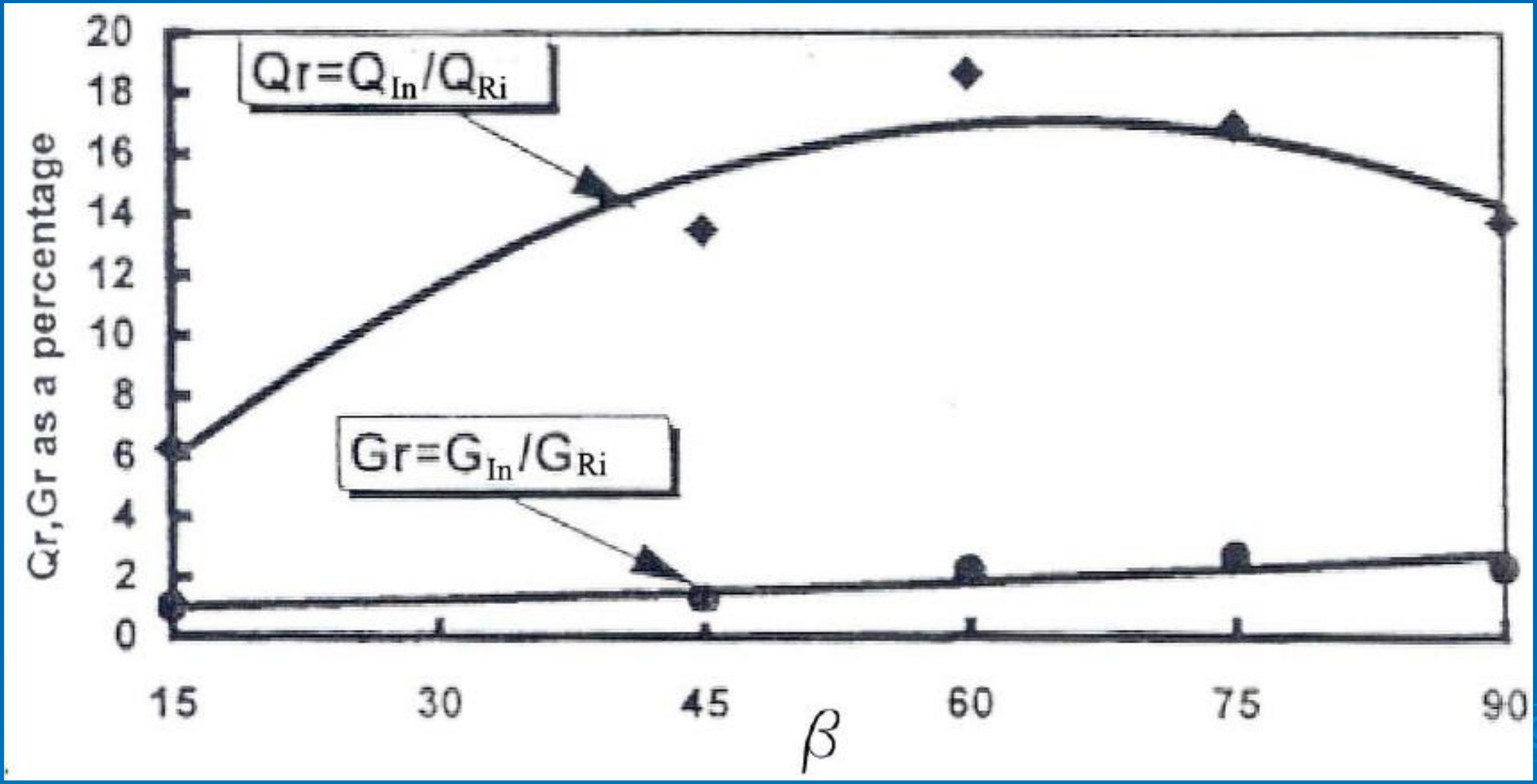
Conclusions

1- The sediment ratio when the approaching Froude Number is between 0.35 and 0.45 (in the upstream of the main channel) is minimal

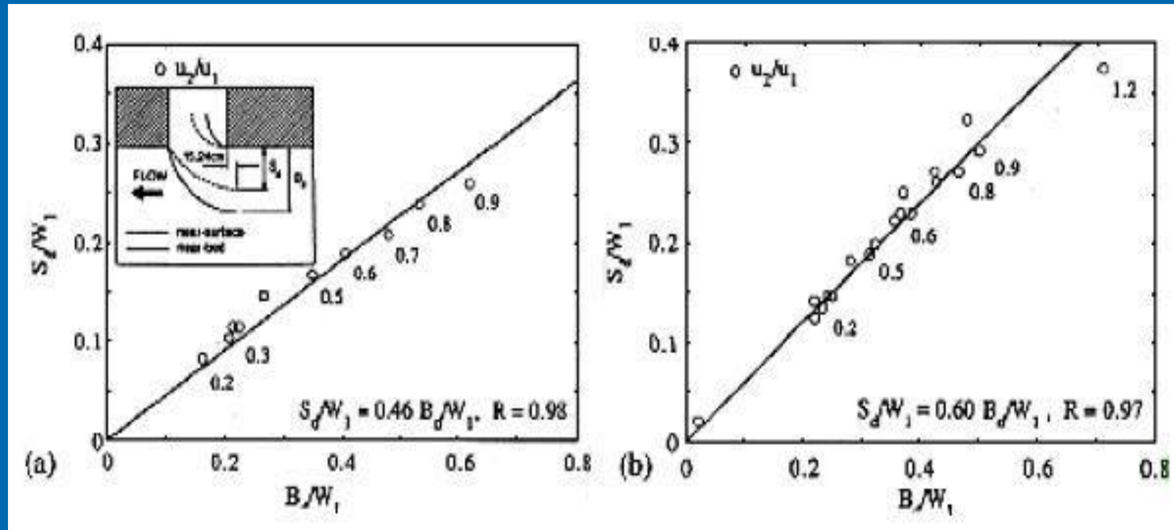
So, it is recommended that with the purpose of decrease in the suspended loads, the water depth in the irrigation channels be so adjusted that the Froud Number falls into this interval.

2- In a high roughness ratio, when the dividing flow ratio increases, the rate of increasing the sediments entry decreases.


Thanks



$Qr=Q_{In}/Q_{Ri}$
$Gr=G_{In}/G_{Ri}$
Qr,Gr as a percentage
0
2
4
6
8
10
12
14
16
18
20
15
30
45
60
75
90
β



$$\frac{S_d}{W} = 0.46\frac{B_d}{W}$$

$$\frac{S_d}{W} = 0.6\frac{B_d}{W}$$

S_d Distance to near-surface dividing streamline

B_d Distance to near-bed dividing streamline

W Width of main channel