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Experimental Investigation of Groin Placement On Minimizing River Bank Erosion

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ABSTRACT

River banks are exposed to bank erosion and destruction. One of the river engineering goals is to provide human life requirements and reduce river danger. So spreading extent of this phenomenon, whose risk and other important factors must be recognized. Using groins is one of the control ways that by accurate design and accurate performance, bank erosion control and field reclamation would be possible. In addition, groin placement has important effect on bank erosion control. The purposes of this research were to survey groin placement on river protection and reduce bank erosion by experimental model. Tests were done by 3 different intervals and 5 discharges. Results showed that in 30 cm with erodible stuff, groin reduced bank erosion, destruction in river bank protection was almost 24-55% and with 15-25 l/s of discharge, bank erosion reduction was about 16.6%. By adding groin at river bank the water surface changes, with increasing discharge water surface first decreases and then increases by adding discharge.

Keywords:

Bank scour; River training; Spur dike; Groin interval; Physical modeling

1. Introduction

Rivers gather and convey downfall as natural flows, so it has been predominant source of water for human beings. Human beings have set up their lives beside river to use it. Living beside rivers has had both advantages and disadvantages. Human beings know that floods have no repairable destruction, so should anchor them by effective contrivance. In some situations by flow diversions many fields would be planted so that they become profitable. One of the important ways to control erosion is keeping river banks against erosion. Destruction not only depends on the type of severity, but also depends on wall characteristics such as shape of structure and mechanical traits of its materials. In the other hand, recognizing sensitive points of rivers and using mechanical or biological methods can reduce erosion (Spandar et al. 1995). Groins are such a structure which are located near the rivers in different angles and run into the bed river cornerwise. Groins might be made by sand. Gabions, the combination of river materials and Gabions, water front and run into the rivers main flow. Design and performance of groins have been done for different goals in chiding: conducting the flow in the favorite position, increasing depth for sailing, preventing river bank erosion and keeping it, conducting flow to inside the arch so restricting river destruction. Drain

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decreases usually after setting groins about 20-30%. Protected wall length by groins is 3-4 times more than their length. (Fayaz Bakhsh, 2003)

Musavi Naeeini et al. (2010), investigated groin location effect on vortices around T-shaped groin in a 90^0 angle arch on a flat surface. They have some tests in 3 locations and 3 angles included 30-45-70 degrees. Results showed maximum vortices at the end of the arch, so there is a correlation between the place of max vortices and max scoured locations. Also they declared that increasing the angle of groin would increase maximum vortices.

Masjedi, at al. (2010) have done many experiments to investigate scour depth around esoteric groins. They set 14 groins in 14 locations with 5 different angles (70-80-90-100 and 110 degrees toward flow direction), 3 discharges (20-24 and 28 l /s) and stable flow 13 cm to investigate scour phenomenon in clear water, for bed flume material steady sandy materials (D_{50}=2mm) and steady coefficient equal to 1.7 used. The results of this research showed that the maximum scour happen in angles between 100-110 degrees (educator groin), minimum depth scour happen in angles between 70-80 degrees (catchy groin). Also in different angles, increasing discharge would increase the scour depth. Aminnezhad, et al. (2010) understood that groin stability in scour is important when encounter to groin especially to headland of the groin flow. By different surveys according to scour by laboratory models 3 continues over handed groin with 3 lengths (10-20 and 30 m) and 3 discharges used to present general pattern for scour around groins and compare them.

Saneie et al. (2010), by laboratory experiments optimized groins with different lengths of first groin in 3 different locations up to second groin, in various values.

Statistical analysis of laboratory data and regression practice showed that respective scour of first headland groin has related to fraud number and also depth flow has related to groin length. The relationship between data has a coefficient equal to 0.939.

Otufi et al. (2010) have located a groin in laboratory to investigate scour around groin in clear water and that groin has been located in these locations, 30 and 180 degrees, different lengths, 8,10 and 12 cm with discharges about 20, 24 and 28 l /s, stability depth 13 cm. In conclusion results showed that increasing groin length due to increasing in scour depth. By increasing in flow discharge and groin location in arches, pit dimension and hill length increase in groin downstream.

Naeeni et al (2009) investigated groin's function by studying flow around them. They have experimented in a rectangular direct canal that its width was 60 cm, height 30cm and its length 0.5 m. Tests were done for 15 and 30 centimeter groins that they were single or complement; also their intervals were also equal to1 or 1.5 times more than groins length. Results showed that in binary groins, vortex surrounded by 2 groins disappeared, when its length increased and much flow entered the space between two groins.

Gill (1972) maximum depth erosion happened when upstream bed materials are washed. Edgare et al. (1983), the goals of their tests were designing a system of prevent pages for bank erosion in arches, making rivers direct and changing bed width profile in a direct canal.

Likeda (1991) said that a kind of opengroin by decreasing velocity in coastal area minimize the power of sediment transportation to prevent coastal erosion.

Ettema et al. (2004), investigated groin length effect and scale influence on rotator zone in the back of groin. Alvarez (1990), have used groins to recompose flows in canals and protect river bank erosion. Taminago et al. (2008), used groins to protect river banks around groins so they found out that groin length is much more effective in flow. This paper studied quantitative changes to reduce bank erosion. Talaat et al. (2009), have done their research to introduce no immersed groin for reducing river bank erosion in Naga Hammadi (located in west coastal Nil river). They used two dimensional mathematical models to simulate in many cases. In this method among 18 cases, these factors have selected as effective parameters.

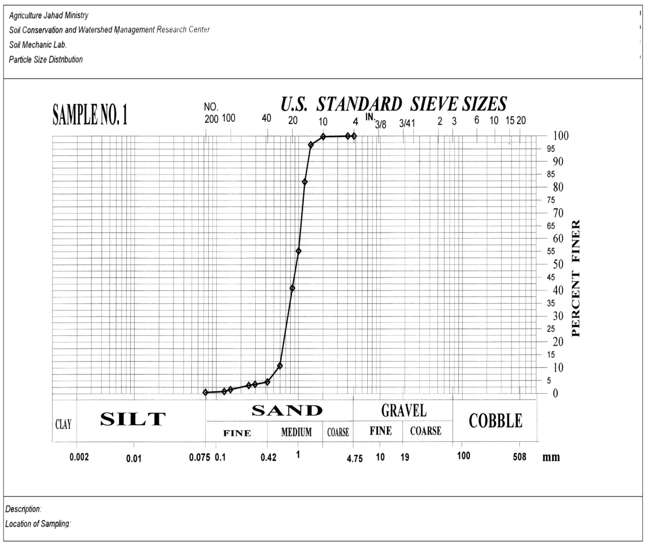
These there parameters include the ratio of canal length to its width or strait ratio, groin angle toward coast and groin intervals. Strait ratio, 0.1-0.2, in angles between 60-90 and 120 degrees, intervals was 2-4 and 7 for groin length. Best function was achieved in Strait ratio equal to 0.2, angle of 120 degrees and the interval was 2-4 meters. Researchers considered that groin work has opposite correlate with groin interval, although groin angle with fix intervals directly correlate with groin length. Maximum and minimum linear velocity happens in 90 degrees and Strait ratio equal to 0.2. Length, interval and angle changes have no effects on incidental velocity. In various tests maximum and minimum incidental velocity happen in one third of median interval of the canal. In fixed length and interval of groin using a group of groins in any angle toward coach or river bank minimize the incidental and linear velocity about 50% and 20%. Linear strait ratio equal to 10% that is more economical than 20%.

It is offered to protect 450 meters of length in 4 groins with an angle equal to 60 degrees (catchy groin), Strait ratio 10% interval should be 4 times more than groin length. on the other hand, in deeper canals educator groin used in 90 and 120 degrees with Strait ratio about 0.2.

2. Materials and Methods

To investigate hydraulically and geometrical studies, different tests were done in Watershed Management and Soil Protected Institute of Agriculture Jihad Organization in a flume were whose length was 24 meters, width 150 centimeters, bed incline 0.001 and bank incline was 1:2. For this research 7 meters of the flume used. Fig. 1 shows the flume that was mentioned.

Fig. 1. Diagram of flume, groin location and other in struments



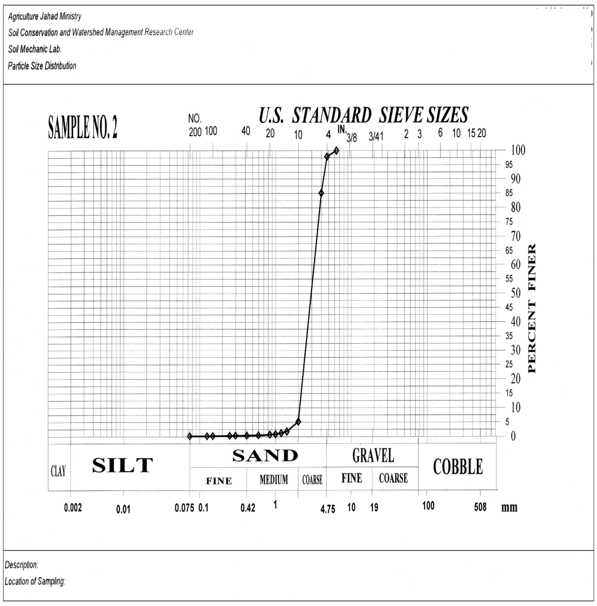


Fig. 2. Diagram of material curve (d_{50}=1 and 3 mm)

First 5 discharges including 15-17.5-20-22.5 and 25 l/s in 1.5 hours without groin selected for doing tests and after preliminary tests, base flow time fixed on 1 hour. To investigate groin effects on bank erosion those tests were redone with groin. The groin that were used in this research was impenetrability, no immersed whose work was surveying all 3 different discharges and in 3 locations distant from erodible materials (P1), 30 centimeters before erodible materials (P2), 30 centimeters after erodible materials (P3) and at last 90 degrees toward the wall. To investigate groin effect to minimize bank erosion 7 meters of flume were selected. Bank material of the outset of flume in 300 centimeters and 200 centimeters in outrace of flume, covered by gravel whose diameter was about 3 millimeter, sandy material or erodible material used between them whose length was 200 centimeter and the diameter of about 1 millimeter. (Fig. 2).

Water flow reservoir was located in upstream and discharge regulation done by cripple in upstream. In the beginning, tests were without groin (instance) in all 5 those discharges. After an hour of test, the valve was closed and the water drained and sucked. Then bank erosion profile changes were measured by point gage, fig (3).

The groin length used in this research was 35 centimeters with 60 degrees angletoward the walls in 3 locations distant from erodible materials (P1), interval before sandy materials (P2), and interval after sandy materials (P3) with 5 discharges 15, 17.5, 20, 22.5 and 25 l/s. After each test bed river and bank inclination were balanced to have a similar situation for each test.

reduce erosion is shown in Fig (6). Tests analysis and results showed that maximum groin headland scour depth happen in 30 centimeters after sandy materials (P3) Fig (5). Diagram (6) analysis represents that discharge increasing due to the increase in erosion, for instance in 25 l/s maximum erosion happens. This diagram (6) shows destruction amount in two cases of using groins and not using them. In conclusion in different discharges before using groin the destruction was about 42-62% but after using groin the destruction decreased.

3. Outcomes

The goals of this research were bank erosion pattern investigation and groin location effect on minimizing the bank erosion, so in each test groin headland scour and erosion profile registered. To analyze patterns laboratory data traced in surfer, fig (4) shows erosion pattern in various tests.
Maximum scour depth of groin headland in different locations and discharges traced in excel, fig (5). Groin location effect to

Variety of destruction percentages in different locations of groin, show that using groin would minimize erosion surface. According to Fig(5), in spite of maximum the scour in (P3) this case is effective to reduce the bank erosion, and its destruction percentage is about 34-55% that shows an impressive role to protect river banks and minimize the river bank erosion about 16.6%.

Destruction is about 27-65% in 30 centimeter before sandy material (P2) and in the being of sandy materials (P1) destruction percentage is about 36-46%.

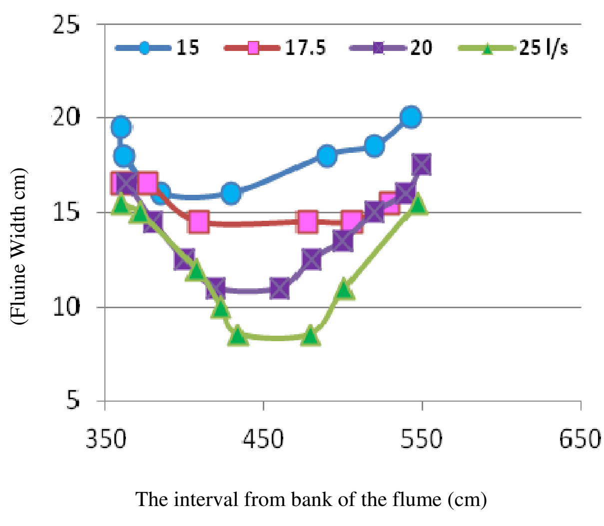


Fig. 3. Bank erosion without groin (incident dicharges)

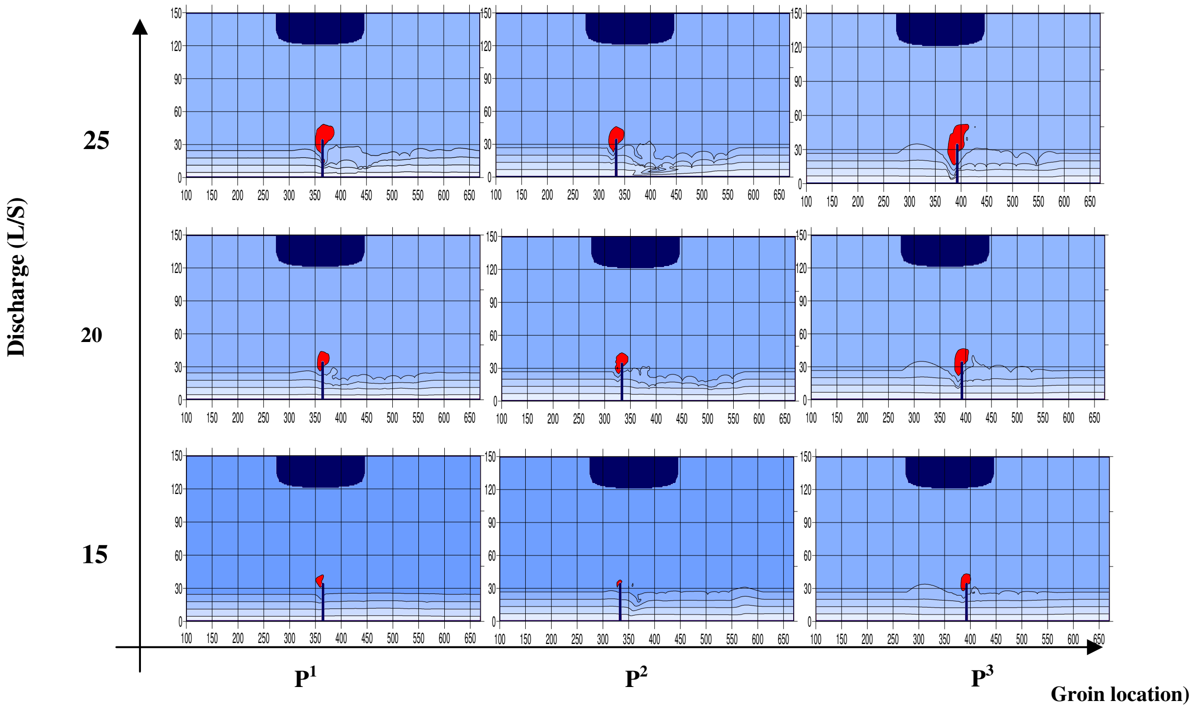


Fig. 4. river bank erosion pattern by changing in groin

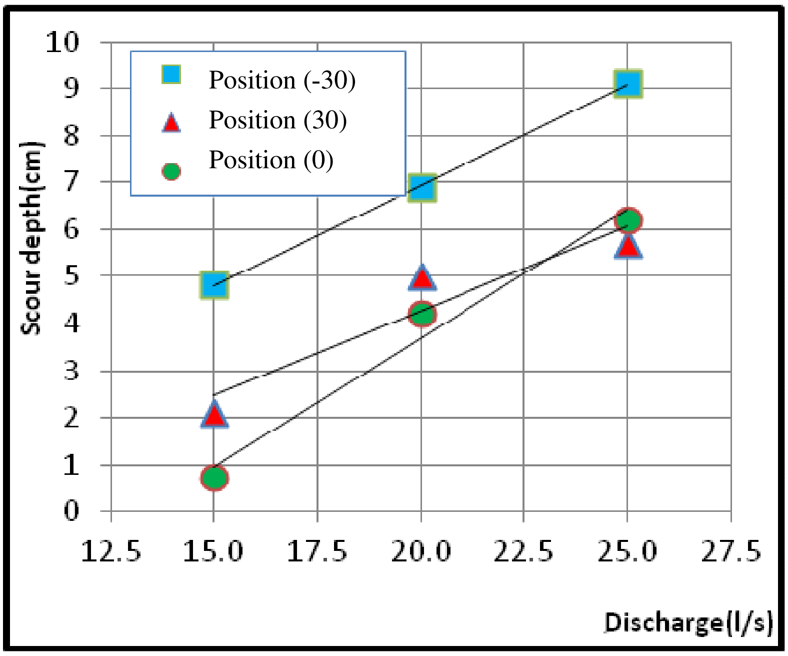


Fig. 5. Groin headland scours depth

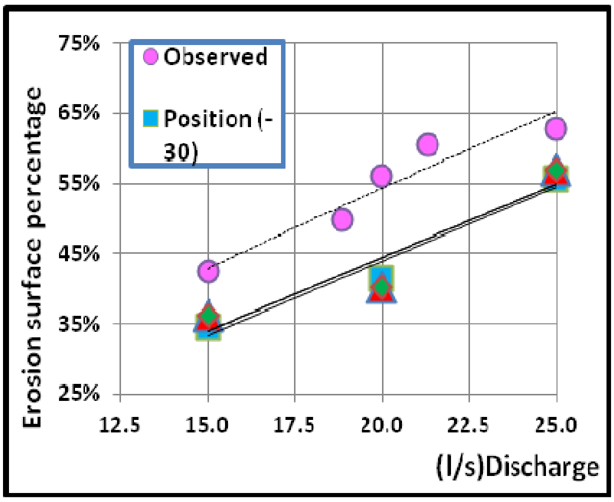


Fig. 6. Erosion percentages in changing groin location

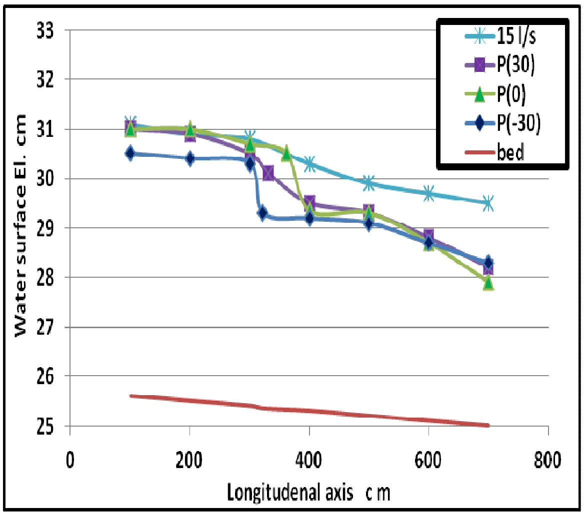


Fig. 8. Breakwater position and water surface profiles Q: 15 l/s

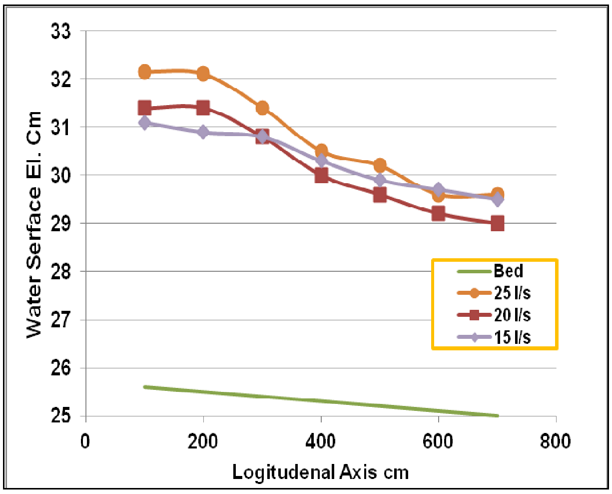


Fig. 7. Water surface profiles at different discharge (Without breakwater)

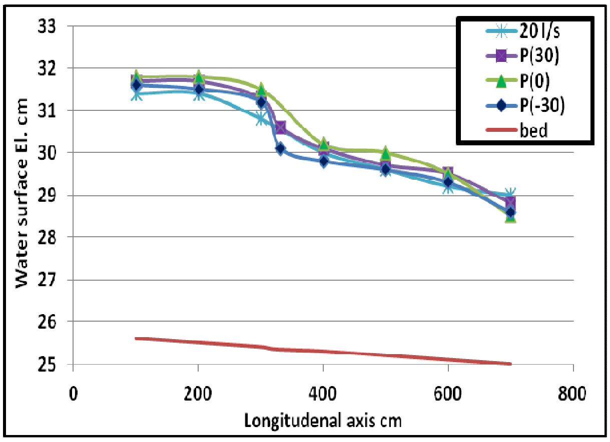


Fig. 9. Breakwater position and water surface profiles Q: 20 l/s

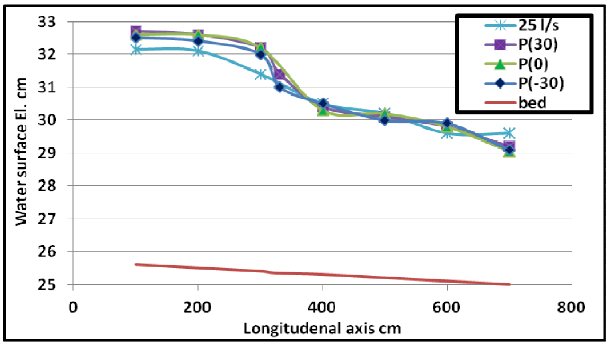


Fig. 10. Breakwater position and water surface profiles Q: 25 l/s

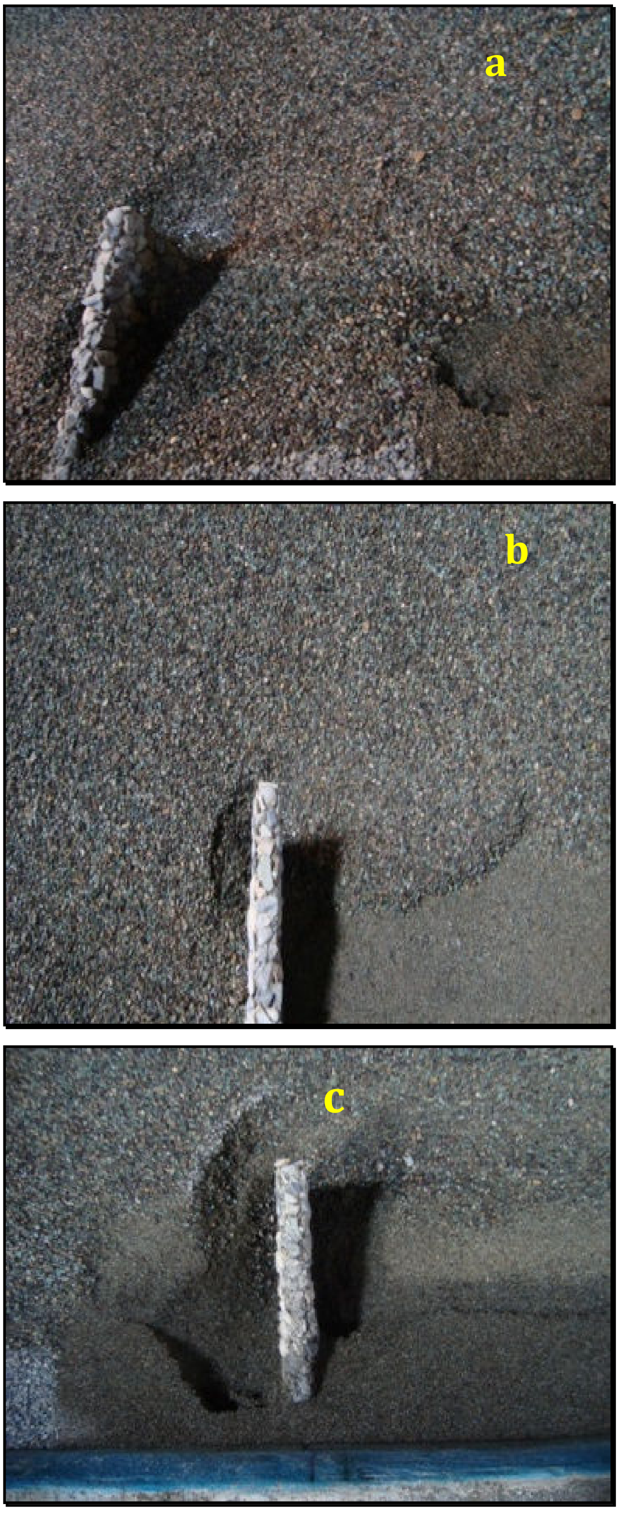


Fig. 11. Groin placements in some locations (a: 30 cm before erodible material (P_1). B: at the beginning of erodible material (P_2). C: 30 cm after erodible material.)

4. Structural Changes of Position Deviation of the Breakwater in Water Surface Profiles

The results of the experiments in form are shown as breakwater in all three situations, the lowest flow tested, resulting in low profile surface and reduced the depth of flow and increased flow, the discharge 20 and 25 liters per second flow depth increased. Fig (7) indicated water surface profile without breakwater and fig (8) – (10) show the effect of groin on water surface adjust it at different discharge.

Fig. (11) shows groin (length: 35 cm, angle: 900 and discharge is 25l/s) effect to protect and reduce bank erosion.

5. Conclusions

Results of graphs showed that groin in the initial of strait path produce width waves that move off the erosion coach. This factor shows reducing in erosion percentage when the discharge is about 15 l/s. the graphic results show that wall destruction is about 42-62% before using groin in different discharges and destruction reduced after using groins. Different amounts of destruction in various groin length represent the groin effect to reduce erosion. Among the selected intervals for groins, According to diagram (6), the groin that was located after the sandy materials (P_3) has a effective fig to the protect river bank, despite maximum scour in groin headland, decreased bank erosion and its destruction was about 34-55% and bank erosion 16.6%. In spite of the fact that groin with 35 cm length could decrease the erosion amount in comparison with the other lengths and there is no difference between graphs in fig. 6 because they overlap on one another, but it is better to use a groin with lower scour depth. Much scour happen in 30cm after sandy materials, so using the other intervals of after sandy materials or 30 cm before the sandy materials is suitable. (Fig. 5).

By adding groin at river bank the water surface changes, with increasing discharge water surface first decreases and then increases by adding discharge.

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