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Experimental Investigation of the Effect of Reducing the Length and Angle of the Breakwater on Bank Erosion

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Abstract: River banks are exposed to bank erosion and destruction. The undesirable effect of erosion is included muddy water and erosion increasing, river bank destruction and problem of sediment accumulation in shallow. A River utility for human requirements and decreasing the river's dangers are one of the river engineering goals. Expansion and risk of this phenomenon must be recognized by experimental researches. One of the ways to protect of this erosion is Groin with suitable design; not only it can control bank erosion, but also can renew valuable fields. Angles in Groin have an important effect on bank erosion. This research was done by experimental model to nominate Groin's effect on river conservation and reduce river bank erosion. There were 3 lengths (25, 30 and 35cm), 3 angels (45°, 90o and120°) with 5 discharges. Results showed that by increasing Groin's length river banks would reduce in 15-25L/s.

Key words: Bank erosion · River engineering · Groin · Groin's angel · Groin's length

INTRODUCTION

Rivers are a natural path for gathering and carrying rainfall on the ground, it was also noticeable for human being in the past. Otherwise rivers were the place of important cultures birth.

So rivers have had a valuable effect on human lives. Culture formation beside rivers has had positive and negative results. High technology and population growth made people to control river flow. Human being knows that floods would cause destruction, so they researched for solutions.

By changing the flow path to desirable fields, implanting in many fields is possible and it has more portions. One of these ways is conservation river banks against erosion. Not only destruction depends on the type and severity of erosion, but also is depend on the wall's characteristic such as its shape and material. Mechanical and biological methods and recognizing sensitive points can decrease erosion. River bank erosion is due to increasing in sediments and decreasing in dam's age so river bank control can support river environment. The singularity weather situation in Iran is a problematic theme for the river bank control. Landowners are faced with outflow and river bank erosion. In river bank erosion river banks would destroy and it is not returnable processed.

Destruction and many problems happen to fields and structures so watershed managements should prevent such conditions. In Iran, prevention managements should be done by engineers to preserve rivers. Drainage in Clay and adhesive soils is not available because it has low seepage otherwise in the overflow water table may decrease with high speed. Neither adhesive nor fine soils cause surface erosion. Mixture of materials that has been mentioned in above will scour tiny particles and influx coarse particles, [1]. Erosion trend has not yet a numerical method so its process must be done with satellite photographs. River models gather qualitative information but practical methods are coast confirmation and channelize [1].

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Coast Confirmation

Coast Confirmation Is Divided in Two Groups: Direct and indirect.

Direct Method: (length structure) In this method confirmed structure use as cover directly. Body cover may be disposal materials, rusty cars and tires are used in Europe and America, gravels and so on will recommend in Iran.

Wall cover should pass drainage river bank, otherwise structure would be destroyed by soil saturated. Using filters and shrub implanting are some ways of the river bank fixture.

According to the Article Direct Method Is Included:

- The bank makes by Gravel cover
- Stone net cover
- Mixture of sand and cement
- Biological method of implanting

Indirect Method: (Groins) In this method some groins made in a line and staple to the river path. Groins are regimentation based on their materials. Groins move water from the river bank to the middle of the river and decreasing its speed it would be stable and bed load deposit, so the river would turn back and fix. To fulfill sediment among groins trees and plants are needy. Groin use as a deviation. [2]

Groin's Design and Performance Would Be Done by Different Goals Such As: Flow guide, depth increasing, erosion preventing and as a whole preserving river against destruction. Corrected design and performance can control erosion, otherwise it destroys river banks.

In Absolute Designing There Are Some Points

Groin's Angle to the Wall: The angle is between 30-120 degrees. In some situations groins angle would change according to the river bank path. In different angles 90° is more capable of deviation and sediment gathering. Richardson and his colleagues offered to use groins in river curves with less than 90 degrees. Charlton offered staple groins for high slope and gravel bed.

Obviously to design practical groins their condition must be staple or shifted to forward for cave coasts.

In conclusion minimizing in angle would decrease the erosion of depth's effect [3].

Groin's Length: One of the effective factors is groin's distances and its economy. Usually preserving space of groins would change in 2, 3 or 11 times more than its length. In small length intervals, the number of groins and cost will increase. In the other hand length increasing that increase distance, the walls, located between groins, will destroy. Drain's width might decrease about 20-30%. Preserved wall length in every groin is 3-4 times more than groin length. In rivers with old material long length groins is unfavorable because they might destroy.

A groin with short length to fulfill intervals between groin's lengths is favorable. Short groins between long groins to increase sediments are necessary. Models are more practical in these researches [4].

Chupani *et al.* (2005) investigation on the effective factors of groins showed groins in 100-120 degree and gabion is more practical for deviation. Chupani *et al.* (2001) investigation of models to prevent erosion and sediment showed that 20 degrees have better situation against the flow for erosion.

Masjedi *et al.* [2] research was about scour phenomenon with clear water and it showed that increasing in groin's length due to scour depth increasing. Also the dimension of a hill and hole in shallow might be increased. Liked [5], declared that one kind of open groins with speed decreasing decrease sediments and erosion. Othama and Mast [6] research was about the groin' length effect in rotator area. Alvarez [7] used groins as a leader flow into the channels and preserving of bank erosion. Tamingoa and jaung [8], used groins as a preservative for river banks and understood that its length effect on groin flow is noticeable.

MATERIAL AND METHOD

To investigate hydraulic and geometry pattern this survey accomplished in SCWMRI laboratory. A flume that was chosen for this test was as below:

L: 10m, width: 150cm, bed slope: 0.001 and bank slope: 1/ 2. Figure (1).

For this purpose different discharges (15, 17.5, 20, 22.5 and 25 l/s) without groin and in one hour were done. This research was repeated with groin to know its influence. The groin was inscrutable and adrift, flume material is about 300cm and 200 cm in its band and the end were gravel (D: 3mm) and in the intervals (L: 200cm) was sandy soil (D: 1mm). Water store was on top of the flume and different discharges were controlled by a cripple. Gauge was closed every one hour drainage was performed.

Fig. 1: Flume, Groins place in flume and instruments

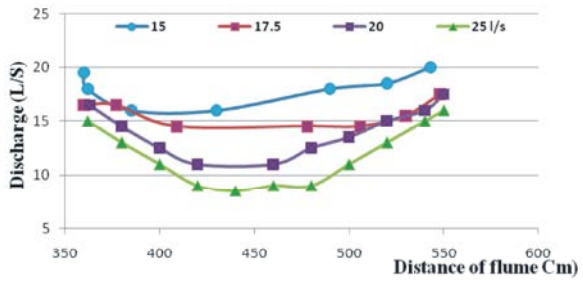

Fig. 2: Bank erosion without groin

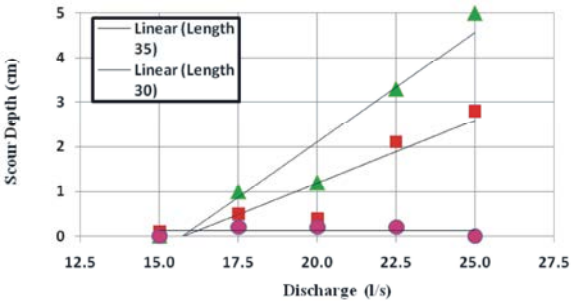

Fig. 3: Scour depth with all lengths and discharges in 120°

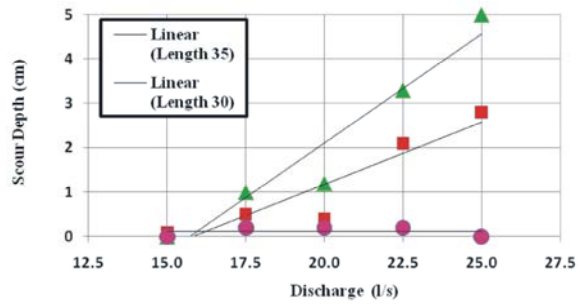

Fig. 4: Scour depth with all lengths and discharges in 90°

Bank erosion variation measured by point gage. Surveys were repeated for 3 lengths (25, 30 and 35 cm), 3 angles (45°, 90° and 120°) and 5 amounts of discharges. After each test flume bed and groin's angle was returned to its first station. Recognizing the groin's influence of minimizing erosion was the purpose.

RESULTS

Different profiles in each erosion and scour were gathered. The figures below show each profile in their characteristic in excel.

Figures 4 and 5 show that maximum scour have happen in longer length (35cm) that has lower discharge (15 l/s) and much erosion happen in higher discharges and lengths. Figures 6, 7 and 8 show the percent of erosion in different amount of lengths, discharges (as mentioned above).

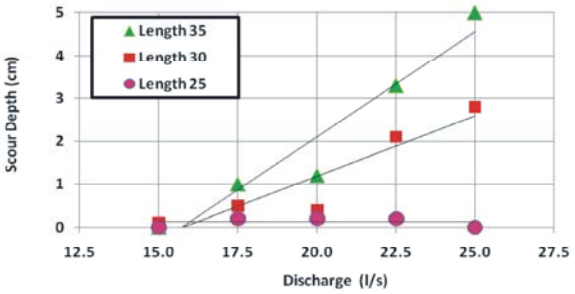

Fig. 5: Scour depth with all lengths and discharges in 45°

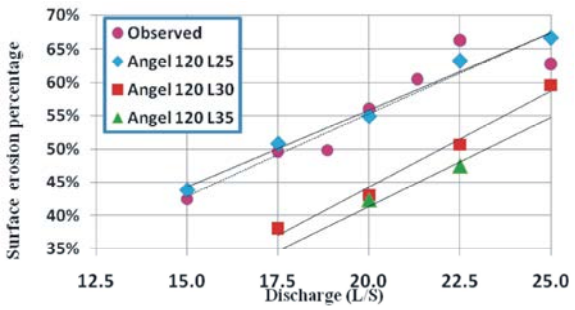

Fig. 6: Erosion percentages with different lengths in 120°

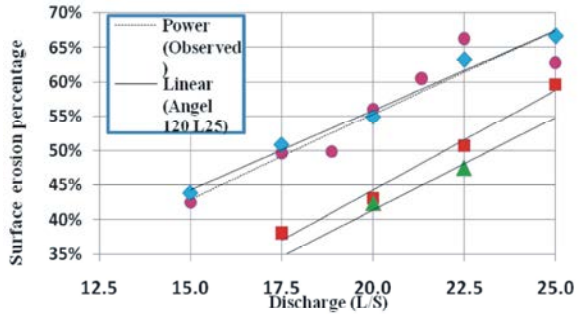

Fig. 7: Erosion percentages with different lengths in 90°

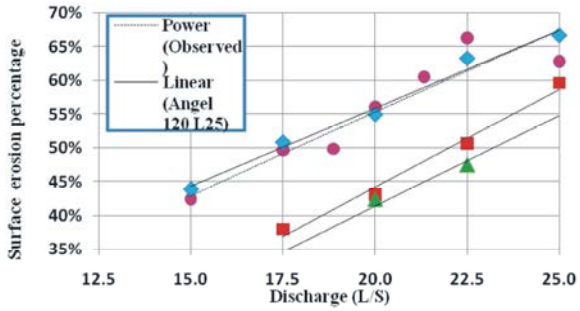

Fig. 8: Erosion percentages with different lengths in 45°

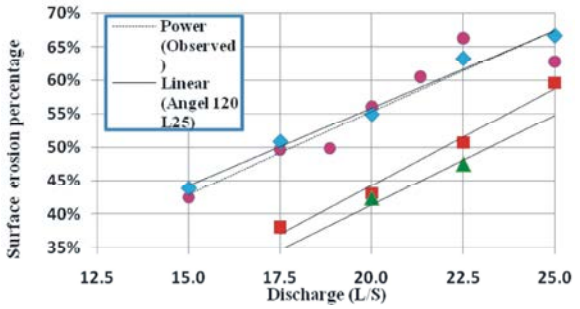

Fig. 9: Erosion percentages with different lengths in 25°

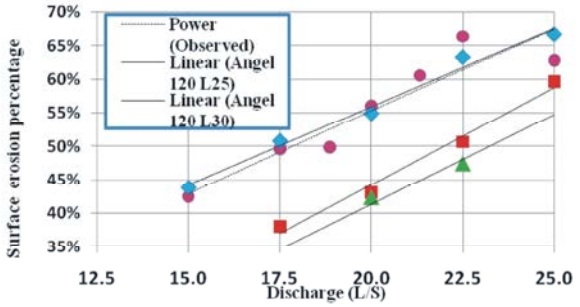

Fig. 10: Erosion percentage and different angles in 30cm length

CONCLUSION

According to survey destruction without groin in different discharges was about 42-62% and it was decreased by using groins. Results show that groins can decrease erosion. Table (1) shows changes and their results. According to this table in 25cm in length there is no preserving against erosion.

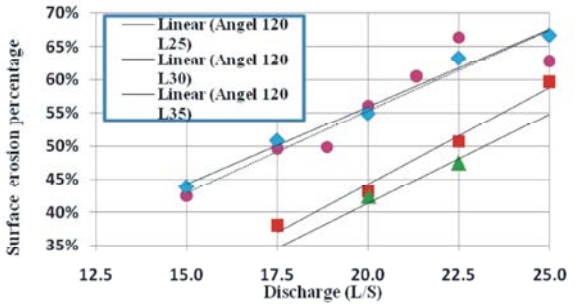

Fig. 11: Erosion percentage and different angles in 35cm length

Table 1: percentage of destruction in different situations

Angle (degree)	Length (cm)	Destruction (%)
120	35	27-55
	30	37-60
	25	44-66
90	35	36-46
	30	42-53
	25	41-63
45	35	29-50
	30	33-53
	25	41-59

In addition, length increasing decreases erosion area, when the length increase about 16% preserved area increase 40%.

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