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The Effect of Particle Size on The Migration Rate of Knickpoint Erosion at Different Hydraulic Conditions

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Abstract. Knickpoint, gully or head cut is called the erosion that is formed because of the sudden change in water level or bed level in the river and after concentrating the flow lines the local shear stress increase, bring about the bed erosion rate be intensified in a location where sudden change bed takes place. This erosion causes the riverbed in the location of sudden slope change to migrate to the upstream and makes the width of the river change. This erosion creates irreparable damages. Destruction of upstream structures caused by the bed migration and also roads destruction, residential areas, tourism - recreational areas, farmlands and good vegetation cover can be mentioned. In this paper, we have studied the effect of particle size and various hydraulic conditions to the rate of Knickpoint erosion progression. In this paper to create the relations of migration rate to the upstream according to the hydraulic parameters a laboratory hydraulic flume with dimensions 3 meters in length, width 30cm and height 50 cm was used. The main purpose of the paper is to creating relations for predicting the rate of Knickpoint erosion rates increase in the non-cohesive soil.

Keywords: Knickpoint, migration rate, the average diameter of soil particles, flow rate, hydraulic laboratory flume

1. INTRODUCTION

One of the effective factors in the economy of any country is its resources; soil and water are the most important resource of any country and play a direct role in human life. Today soil erosion and sediment is taken daily increased has become a problem that is increasing every day, and causes the loss of soil, destruction of the land surrounding the rivers, and because of that It reduces the useful volume of the dam`s reservoir and destroying various structures located on the river. This issue causes heavy losses to the economy of country and also reduces the useful sources of water. Therefore, the detailed understanding of the mechanism and the way of creating various erosions is highly important. In this paper the recognition of knickpoint erosion, is topically studied, and the effect of particle size and various hydraulic conditions on the rate of advance of the knickpoint erosion will be study.

Knickpoint migration is the erosion that due to a sudden change of water level or river bed formed and by concentrating of flow lines and intensive increasing in topical shear stress, makes the rate of

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the bed erosion increase in the slope's change location. Due to this phenomenon, sudden changes in the riverbed are created. Due to this phenomenon in addition to the possibility that the riverbed might fall down below in several meters; the banks of the rivers would be unstable, destructed and as a result the width of the river is greatly increased (figure 1). Bed erosion and bank destruction produces a large volume of sediment that is transferred to the downstream. The high sedimentation in rivers, especially on the upstream reservoirs is very dangerous, because it can occupy a useful part of the tank. Besides, this erosion of the riverbed and its widening can also damage the lands surrounding the river and cause the destruction of technical buildings (like pumping stations, bridges, roads and….). Therefore, understanding the factors influencing in knickpoint and knowing the increase rate of this type of erosion is essential.

For example, in the river basin of Guja Qieh with an area of 181.8 square kilometers that has a strong role in agriculture in the north west of Zanjan. The results of some of the evaluating climate indices and the talented rate of the area to knickpoint erosion show the high potential for this type of erosion. The average of deposition is predicted 219.88 tons in hectare and the total deposition of the area is predicted 39874184 tons in year. There are too many areas like this one, which have been fallen in trouble of knickpoint erosion. (1)

Figure 1. A sample of knickpoint erosion

Knickpoints are classically defined in literature as abrupt breaks in slope along channel beds that tend to migrate upstream (Brush and Wolman, 1960). The abrupt break in channel slope induces a sudden increase in flow velocity over the knickpoint causing the impinging flow to plunge and scour the downstream bed. This action induces large amounts of bed erosion and sediment transport that cause the channel to grow wider and deeper over time. These degradation processes cause the channel to become unstable, introducing safety concerns for people and structures surrounding the stream. The degradation of the streambed poses problems such as scour around bridge piers, dams, and pipelines; damage to roads; and loss of valuable farmland that surrounds the stream channel (Papanicolaou, 2008).

Defining the features of a knickpoint is an important first step in developing a thorough and consistent understanding of the behavior of knickpoints. The main features of a knickpoint consist of the knickpoint lip, face, and plunge pool. The lip is the point at which the drop in channel bed elevation occurs. The face extends from the lip to the base of the plunge pool. The plunge pool is a pool that forms at the base of the knickpoint as a result of water plunging over the lip and scouring the downstream bed and knickpoint face (Gardner, 1983).

A knickpoint persists from a mild upstream slope followed by an abrupt change to a steep slope with a return to mild slope immediately downstream. A mild slope will typically convey flows that are subcritical in nature, whereas steep slopes will tend to sustain supercritical flows. These flow regimes are classified by the Froude number, which is a function of the flow velocity and the channel geometry. The abrupt change to steep slope followed by a return to mild (i.e. supercritical flow changing back to subcritical flow) indicates that a hydraulic jump will occur just downstream of the knickpoint, near the base. The sudden dissipation of energy caused by the hydraulic jump is what initiates the bed erosion and the upstream migration of the knickpoint. These flow characteristics are important mechanisms that greatly influence the migration process of knickpoints (Brush and Wolman, 1960).

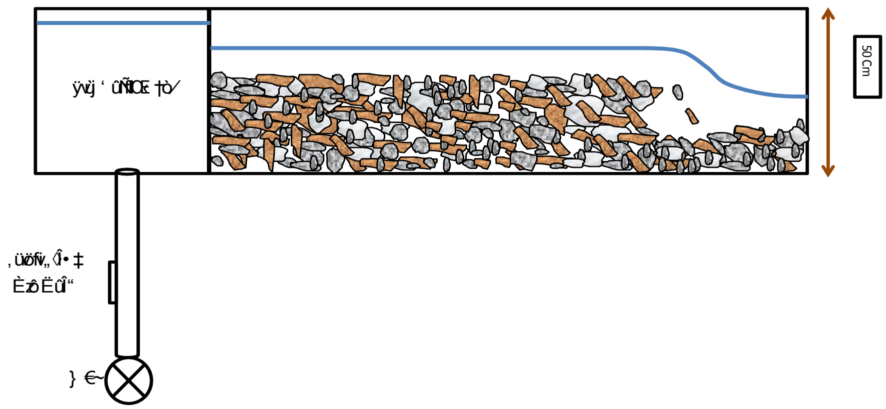
The process of knickpoint migration (in general) is very slow. The migration may continue on for many years until the knickpoint reaches a control structure, until the channel slope is reduced to the point that it cannot displace any sediment, or until the soil structure of the stream bed changes (Brush and Wolman, 1960). The process of knickpoint migration is an area of great interest to engineers and researchers as it affects

the stability of stream channels. As water flows over the lip, erosive stresses are induced at its base; these stresses cause the soil to be displaced and a plunge pool to form. The erosion at the base of the knickpoint undercuts the face, causing a series of mass failures (Papanicolaou, 2008). These actions are the driving mechanisms that cause the knickpoint to migrate upstream and will be discussed in greater detail later in the review

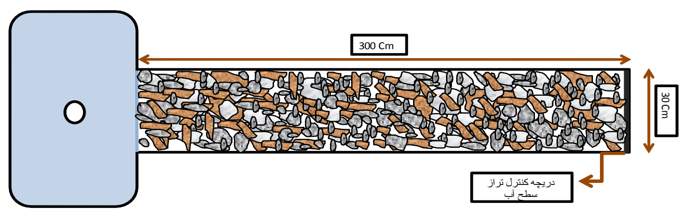
Many researchers to further understand these mechanisms that drive the behavior of knickpoints have conducted much research. Available studies consist of knickpoint formation and classification, migration rate, and velocity field measurements at an overfall. These topics are discussed below.

2. METHODS

As mentioned, the main objectives of the study are to develop a relationship to predict the migration of erosion rate and the impact of various hydraulic conditions on the knickpoint erosion. To achieve the above objectives a laboratory flume with bed material and walls of glass are used. The dimensions of the flume mentioned should be noted that the suitable hydraulic conditions for examining is created, furthermore the width of the flume should be in a shape that migration would be seen in it and the flow be steady along the way. Its sidewalls must be such a way that rising erosion conditions are created. To achieve the above objectives, a flume width of 30 cm, length 3 m and height aspects 50 cm were used. Moreover to achieve the research objectives flow conditions (discharge) are also variable. For this purpose, a pump with the power 2.5-hp with a discharge regulator valve that its threshold shifts is about 1 to 10 liters per second was used. This laboratorial flume is shown in Figure 2 from two plan views and cross-section showing.



(a) cross section



(b) plan view

Figure 2. Cross-section view (a) and plan view (b).

In this paper non-cohesive material with average particle diameters of 16.5 and 22 mm were used in different hydraulic conditions. Hydraulic conditions or discharge should be in such a way that knickpoint erosion is created. Its value should be large enough so destructive shear stress at the desired position formed, it is also should be small enough in order not to cause a general erosion of materials. Therefore, 5 different discharges are used to create the mentioned conditions. Materials at the bottom of the mentioned flume are poured at random, steady. Uniform distribution of the decking is necessary to create conditions in which no other erosion will be created. Moreover, the slope of the bed floor and the flume floor should have been equal to provide the circumstances just for making knickpoint erosion. As it is observed in figure 2, flume contains a tranquilizers flow tank so that the vertical vortex has no impact on the tests. After filling the tank tranquilizers, the flow through a rectangular sharp-edged weir enters into the flume. Since entering the flow into the flume vertical vortex flow conditions occur, at the beginning of the flume channel building rubble with a mean diameter of 100 to 200 mm and the length 90 cm is used to make steady flow conditions for materials testing.

As stated earlier, materials with bed substance with a suitable and steady condition is distributed over the bottom of the flume and the examinations are done in various hydraulic conditions. Each test method is such a way that the flume bed is covered from sedimentary materials and the flow enters the flume slowly, whereas the downstream valve is completely closed. Since the depth was high enough the outlet valve of the flume is slowly open, meanwhile, Flume inlet valve opens out till the discharge reaches to the desired level. Then the downstream valve opens out till the depth reaches to the desired level. After that by opening the valve suddenly some conditions were created and let the Knickpoint erosion form, and at the same time from the edges of the flume and the longitudinal profile flow in the flume, repeated shots at intervals of 2 seconds were taken. Each experiment continued until the Knickpoint erosion reached the end of the flume and this time depends on the grading and the variable discharge flume. The discharge was constant during the experiments. As a whole10 experiments were done and the table 1 shows the rate of variables in this study. Note that the discharges of the experiment were chosen in such a way that the bed in a normal situation does not live and we have clear water. This means that the sediment is not transferred from upstream erosion and all materials have been transferred solely due to Knickpoint erosion.

Table 1. Rate of variables.

Discharge (lps)	depth (cm)	D50 (mm)	Reynolds no.	Froud No.
1.6 to 9.78	1.2 to 5	16.5 to 22	4900 to 25000	0.47 to 2.11

3. RESULTS AND DISCUSSION

Views

The main objective of this research is to study the process of knickpoint erosion in non-cohesive soil with different grading distribution and under various hydraulic conditions. The experiments were done in a flume with the width of 30 cm, length 3 m, and height of the 50 cm by using the bed materials on average diameters of 16.5 and 22 mm. During the test it was observed that the erosion starts from the location where the bed height changes or Knickpoint and was transferred quickly to the upstream. However, soon after Knickpoint speed depended on the size of materials and discharge. Figure 3 shows an example from the process of regressive erosion development. In this figure, three images including image 1 relates to the zero time or zero hour of the experiment and no erosion has occurred yet. In figure 2, which corresponds to about 16 seconds after the start of the experiment, the Knickpoint erosion has started to move and transferred to the upstream. In figure 3, shows the experiment after a period of 38 seconds from the start that the amount of the migration of bed is done. These observations indicate that, unlike the regressive erosion in non-cohesive soils or a combination of cohesive or non-cohesive materials in which the falling`s posture is almost preserved after erosion refrigeration (referring to figure 1), in non-cohesive materials such as those used in this study, in vertical position the falling is changed to a relatively fast slope approximately equal to the slope static angle of the used materials that is about 30 degrees and the slope remains throughout whole the test. Erosion of sedimentary material placed on the tip of the falling is eroded with a large rage because of the concentration of flow lines and forming fast curvature flow of upstream to downstream and these materials are transferred immediately from the steep falling to downstream. . One part of the eroded sedimentary material is transferred to downstream and another part out of the flume. By continuing erosional process, the upstream bed is formed and actually caused the steep slope created is transported to a relatively mild slope. This process makes a lower rate of sediment transport occurs and its rate will be stopped over the long term.

Figure 3. The way regressive erosion migrate.

Data Collection

For some reason, such as a rapid increase in shear stress at the edge of the steep slope and also creating fast slope in downstream the rate of sediment transport is very high and occurs in a very short period of time. Data collection is not possible to achieve manually. Various methods were examined So that the most appropriate method of providing digital videos and fitting them was diagnosed by application Iphoto. Thus, the walls of the flume were graded and the camera Canon Power Shots S3is was placed in a position with high resolution to have a perfect view from the flume. Before starting each test the camera was prepared for filming and was on from the start of each test. The camera had the characteristics like recording time on film. A digital file was provided for each test and that file was transferred to different frames by application Iphoto. Then the frames that were too numerous, some frames were selected in desired times and by using application Iphoto the desired data specially the following longitude ones, longitudinal side view of water flow and cases like eroded or precipitated areas were collected. However, providing data used with this method was very time-consuming, it had high accuracy. Table 2 shows an example of the raw data obtained in experiment with discharge 4.58, water depth of 0.0175 and the rate of materials 0.22 Y values in this table relate to the flume bed height. Note that a part of the flume length that was tested, divided into 6 sections with the distance of 30 cm and the depth values were collected. X value also shows the edge of the falling from the beginning.

Table 2. An example of extracted data from digital photos related to experiment 7.

No. of photo	TIME	ΔTime	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	X
1888	11:23:06	0	15	15	15	15	15	15	0
1889	11:23:07	0:00:01	9	15	15	15	15	15	18.5
1890	11:23:09	0:00:03	8.8	14	15	15	15	15	23
1891	11:23:11	0:00:05	8.5	14	15	15	15	15	23
1892	11:23:13	0:00:07	8.3	14	15	15	15	15	23
1893	11:23:15	0:00:09	8.3	14	15	15	15	15	23
1894	11:23:18	0:00:12	8.3	14	15	15	15	15	23
1895	11:23:20	0:00:14	8.3	14	15	15	15	15	23
1896	11:23:22	0:00:16	8.3	14	15	15	15	15	23
1897	11:23:24	0:00:18	8.3	14	15	15	15	15	23
1898	11:23:26	0:00:20	8.3	13.2	15	15	15	15	23.5
1899	11:23:28	0:00:22	8.3	13.2	15	15	15	15	23.8
1900	11:23:31	0:00:25	8.3	13	15	15	15	15	25
1901	11:23:33	0:00:27	8.3	13	15	15	15	15	33
1902	11:23:36	0:00:30	8.3	13	14.5	15	15	15	45
1903	11:23:38	0:00:32	8.3	12.8	14.3	15	15	15	55
1904	11:23:40	0:00:34	8.3	12.8	14.3	15	15	15	55
1905	11:23:42	0:00:36	8.3	12.6	14.3	15	15	15	55
1906	11:23:44	0:00:38	8.3	12.6	14.3	15	15	15	55
1912	11:24:23	0:01:17	5.3	9.6	12.3	15	15	15	55
1913	11:24:25	0:01:19	5.2	9.5	11.3	15	15	15	60
1914	11:24:28	0:01:22	5.2	9.5	11	15	15	15	60
1915	11:24:30	0:01:24	5.2	9.5	11	15	15	15	60
1916	11:24:33	0:01:27	5.2	9.5	11	15	15	15	60
1917	11:24:35	0:01:29	5.2	9.5	11	15	15	15	60
1918	11:24:37	0:01:31	5.2	9.5	11	15	15	15	60
1919	11:24:40	0:01:34	5.2	9.5	11	15	15	15	60

Raw table above was obtained for 10 examinations; these tables are the main basis of this research, as stated tables above were collected form of formed photos, then the bed height rate at different times and long distances of migration at different times were collected from the forms. The above data were used to complete the table 3. In this table 10 different discharges were calculated for different flow parameters such as the average particle diameter of D_{50} in meters, Y_n normal depth of flow in the flume in meters, Y_e depth of flow on the location of sudden slope change bed in meters, Q discharge rate in liters per second, U mean flow velocity in the flume in meters per second, Fr Froude number was calculated in the flume.

Table 3. Different parameters of flow and materials for 10 examinations.

NO. of Experiment	D50	Yn	Ye	Q	U	Fr
1	0.0165	0.012	0.002	1.6	0.44	1.30
2	0.0165	0.0175	0.01	2.65	0.50	1.22
3	0.0165	0.045	0.012	4.26	0.32	0.47
4	0.0165	0.05	0.017	6.5	0.43	0.62
5	0.0165	0.05	0.021	8.04	0.54	0.77
6	0.022	0.01	0.00	2.39	0.66	1.93
7	0.022	0.0175	0.01	4.58	0.87	2.11
8	0.022	0.045	0.012	6.57	0.49	0.73
9	0.022	0.05	0.017	8.76	0.58	0.83
10	0.022	0.05	0.021	9.78	0.65	0.93

Displacement rates

Falling edge displacement was determined using data collected at different times. Views and data show that the migration rate at the edge of early times is very high and decreases gradually. Therefore, the final migration rate cannot show the actual mechanism or Knickpoint erosion. Hence it was decided to collect the migration rate in a shorter timeframe and the timeframe was chosen with three seconds of trial and error to show the process of migration rate changes. For example table 4 was collected from the rate of displacement of the slope sudden change of the Knickpoint bed X in meters in 5 different discharges against various times in seconds (0 , 3 , 5 , 6 , 8 , 10 , 15 , 25 and 40 seconds).

Table 4. Migration regressive erosion in meters at different times in 10 different flow discharges.

NO. of Experiment	X								
	0	3	5	6	8	10	15	25	40
1	0.00	0.64	0.65	0.89	0.90	0.90	0.90	0.90	0.90
2	0.00	0.25	0.38	0.44	0.60	0.63	0.80	0.90	0.90
3	0.00	0.32	0.40	0.45	0.51	0.59	0.75	0.90	0.90
4	0.00	0.34	0.58	0.65	0.70	0.75	0.90	0.90	0.90
5	0.00	0.49	0.59	0.69	0.80	0.90	0.90	0.90	0.90
6	0.00	0.64	0.65	0.89	0.90	0.90	0.90	0.90	0.90
7	0.00	0.25	0.38	0.44	0.60	0.63	0.80	0.90	0.90
8	0.00	0.32	0.40	0.45	0.51	0.59	0.75	0.90	0.90
9	0.00	0.34	0.58	0.65	0.70	0.75	0.90	0.90	0.90
10	0.00	0.49	0.59	0.69	0.80	0.90	0.90	0.90	0.90

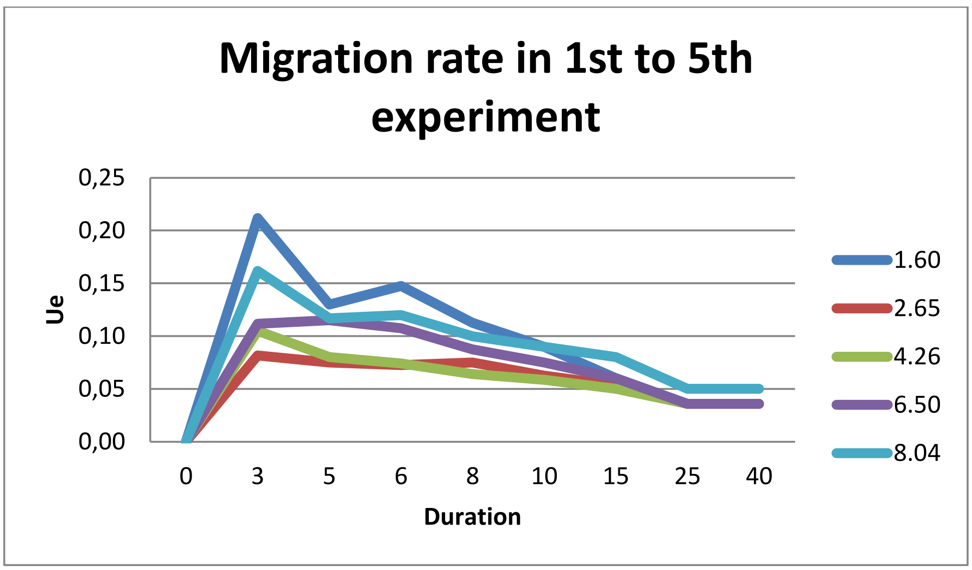
Then, by using the data of the table 4, instantaneous migration rate were calculated by dividing the distance in timeframe. The minimum and maximum instantaneous rate was also determined. The average rate was also calculated from the final time trial. Table 5 was shown as an example of instantaneous velocity of migration erosion to upstream in meters per second at different times and also, the average, and its minimum and maximum absolute for 10 different tests.

Table 5. The rate of regressive erosion migration.

NO. of Experiment	Ue									U	Umin	Umax
	0	3	5	6	8	10	15	25	40			
1	0.00	0.21	0.13	0.15	0.11	0.09	0.06	0.04	0.04	0.09	0.04	0.21
2	0.00	0.08	0.08	0.07	0.08	0.06	0.05	0.04	0.04	0.05	0.04	0.08
3	0.00	0.11	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.06	0.04	0.11
4	0.00	0.11	0.12	0.11	0.09	0.08	0.06	0.04	0.04	0.07	0.04	0.12
5	0.00	0.16	0.12	0.12	0.10	0.09	0.08	0.05	0.05	0.09	0.05	0.16
6	0.00	0.21	0.13	0.15	0.11	0.09	0.06	0.04	0.04	0.09	0.04	0.21
7	0.00	0.08	0.08	0.07	0.08	0.06	0.05	0.04	0.04	0.05	0.04	0.08
8	0.00	0.11	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.06	0.04	0.11
9	0.00	0.11	0.12	0.11	0.09	0.08	0.06	0.04	0.04	0.07	0.04	0.12
10	0.00	0.16	0.12	0.11	0.10	0.09	0.06	0.04	0.04	0.08	0.04	0.16

Figure 4 shows a rate of Knickpoint erosion migration to upstream in meters according to the discharge in liters per second at different times in seconds in different discharges.

Knickpoint erosion migration rate to upstream is expected to have a direct relationship with the discharge, but because in the relatively low discharges and because of being low, the flow discharge is formed in a part of the width in flow and is not established in overall width of the section, therefore the erosion is established in one of the banks of the channel, and the rate of Knickpoint erosion migration rate to upstream in discharges that are relatively low expected to be in higher value, because the focus of shear stresses and erosion is in a smaller range, despite the discharge rate is low but, the rate of shear stress is higher due to low width and concentrating in the smaller range, this rate is seen in maximum rate in relatively higher discharges because, flow is established in total width of the section and in the relatively high discharges which corresponded to expectations .



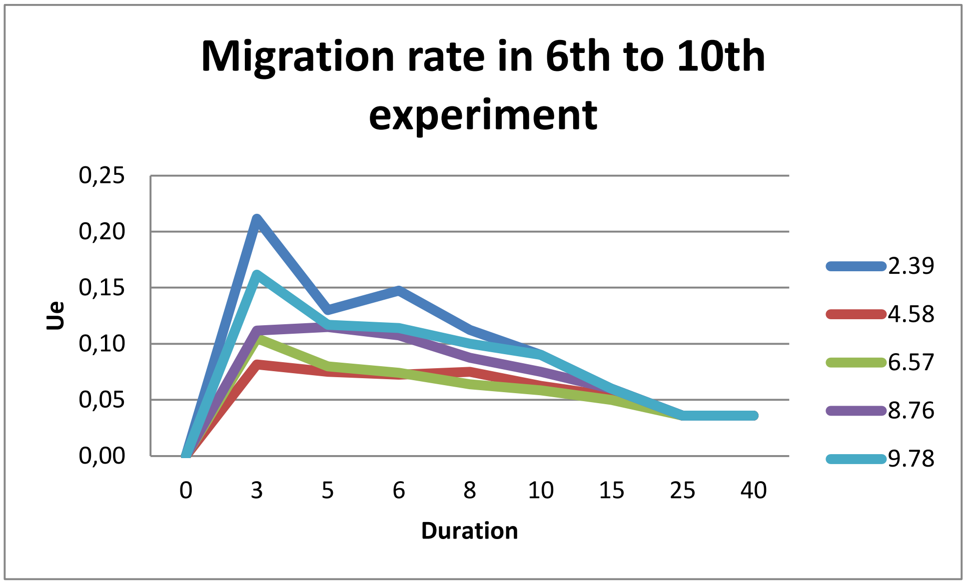
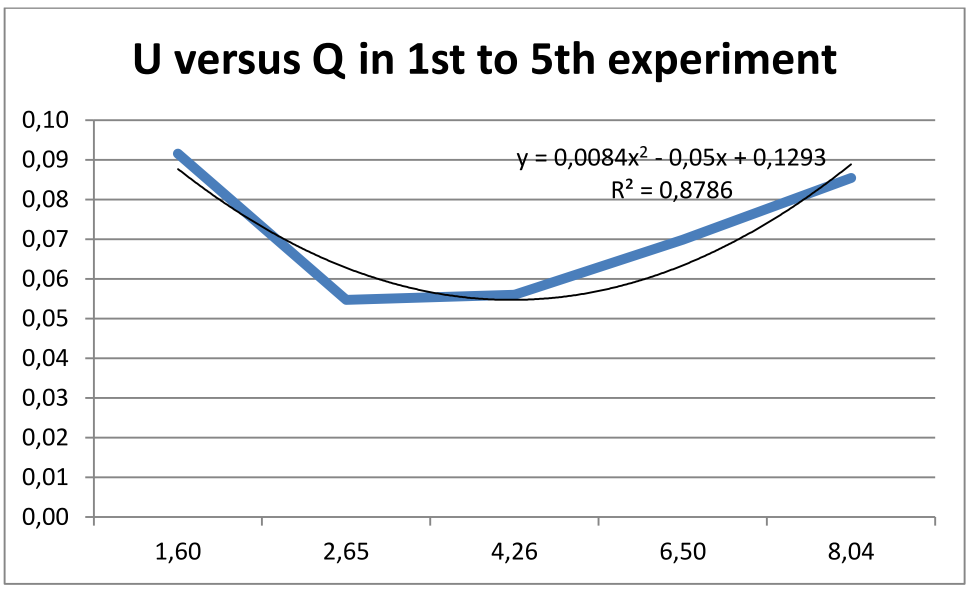


Figure 4. The migration rate of erosion over time, in 10 discharges and 2 soils with average diameters of 0.016 (examinations 1 to 5) and 0.022 (examinations 6 to 10) in meters.



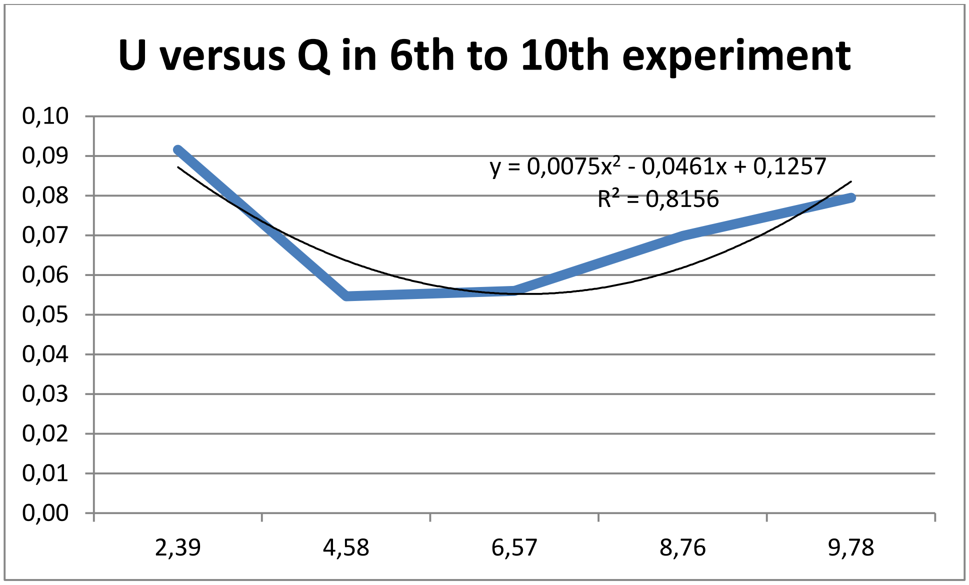


Figure 5. Shows the speed of to upstream in meters per second according to the discharge rate in liters per second at different times in seconds.

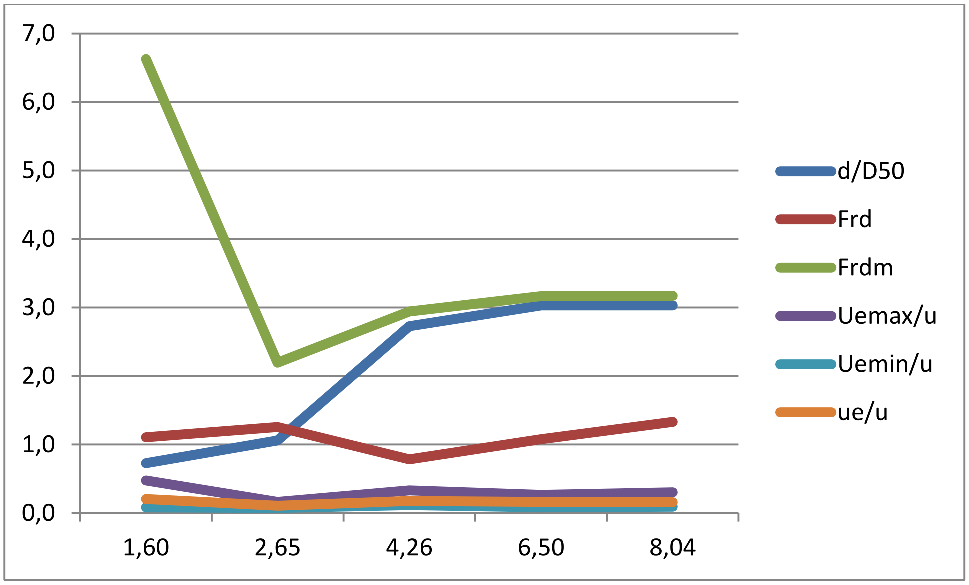
As mentioned above the Knickpoint erosion migration rate to the upstream is linked directly to the discharge; however because of the relatively low discharge, due to the low discharge, the flow is formed in a section width of the flow and is not established in overall width of the segment. Therefore the erosion rate will be established in one of the banks of the channel, and so the rate of Knickpoint erosion migration to upstream in relatively low discharges is expected to be in a higher rate in comparison with the expectations, because the focus of shear stresses and erosion is in a smaller range. Although the flow discharge is low, however, due to low width and focus in shear stress is higher in smaller rate. This rate is established in the whole width of the section in relatively high discharges due to the flow concentrating to that place and in the relatively high discharges the maximum rate of migration is seen that which corresponded to expectations.

Table 6 shows dimensionless parameters, depth compared with the average diameter of the particles, Froude number, Froude number of particles, the absolute maximum speed of migration to the mean flow velocity, the mean speed of migration to the mean flow velocity, the mean speed of migration to the mean flow velocity respectively. Furthermore, the relations listed below for 2 types of soil are established to estimate the erosion rate to the discharge.

For soil with an average diameter of 0.0165
$U = 0.0084Q^2 - 0.05Q + 0.1293$
And for soil with an average diameter of 0.022:
U = 0.0075Q2 - 0.0461Q + 0.1257

Table 6. Dimensionless parameters of flow and materials.

NO. of Experiment	d/D50	Frd	Frdm	Uemax/u	Uemin/u	ue/u
1	0.70	1.10	6.60	0.50	0.10	0.20
2	1.10	1.30	2.20	0.20	0.10	0.10
3	2.70	0.80	2.90	0.30	0.10	0.20
4	3.00	1.10	3.20	0.30	0.10	0.20
5	3.00	1.30	3.20	0.30	0.10	0.10
6	0.55	1.93	8.57	0.32	0.05	0.14
7	0.80	2.11	3.29	0.09	0.04	0.06
8	2.05	0.73	3.93	0.22	0.07	0.11
9	2.27	0.83	3.70	0.20	0.06	0.12
10	2.27	0.93	3.34	0.25	0.06	0.12



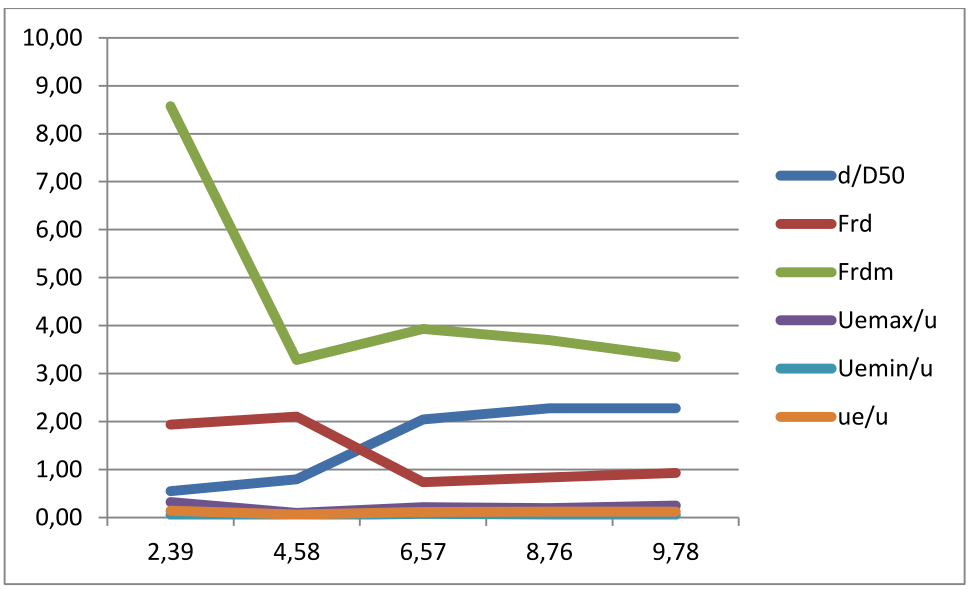


Figure 6. Shows the number rate of the various dimensionless parameters.

Diagram in green shows the changes rate of the, changes show that particle Froude number in the relatively low discharges due to flow is not established in the whole width of the section, therefore erosion is established in one the banks channel and the vertical section level on the flow decreases, therefore flow speed is very high in the location of sudden change slope bed and slope bed is very high also in the location of sudden change slope which causes the particle Froude number be too high, but in the relatively higher discharges, because the flow covers the total width of the bed, the speed rate has a more responsible process in the location of sudden change in the slope with the low process, but in the relatively high discharges because of further erosion to time, the slope of floor changes bed is more steady, therefore the amount of particle Froude has a slight decrease.

Diagram in red is the rate of and due to the relatively low discharges, the flow is established in one side of the channel and the speed of flow is almost higher, Froude number flow should be more than relatively high discharges. Then, the process of changes should be upward in above discharges that this could be seen in the diagram.

Diagram in blue is the ratio of flow depth to the average diameter of the particles, and should be upward because of its increase with discharge.

Next diagrams all three are the speed erosion rate (maximum, minimum and average) to the flow speed, and because in the relatively low discharges, the flow is established in one side of the channel and the flow speed is almost higher, these ratios are relatively higher in these discharges.

4. CONCLUSION

The results of diagrams and tables show that the rate of erosion to the hydraulic conditions and different times has significant changes. As time increases the erosion rate and the migration rate decreases. Because in early times the rate of shear stress and particle Froude number is remarkably high in the location of sudden slope change and when time passes, the reduction of fallen slope is reduced from the erosion rate, while in some discharges the erosion will be completely destroyed. But the rate of erosion to different hydraulic conditions itself does not show a permanent change, while in the discharge 2.39 and 1.6 liters per second the rate of erosion has not been the lowest, because in this discharge is established in a part of the channel width. Therefore, the effective width of the flow will not be the total channel width and the speed flow and naturally, the shear stress and particle Froude number will significantly increase in erosion section, which causes a significant increase erosion rate. And also according to the Figure 6 in normal depth conditions are less than 2; therefore the general erosion is zero. But particle Froude number in depth conditions over Knickpoint erosion of local section is higher than 2 and erosion is also seen in this section.

It is expected that the rate of migration Knickpoint erosion to upstream to have a direct relation with the discharge, but because of the relatively low discharges that the discharge flow is formed in a part of the flow width and is not established in the whole section of the width, therefore erosion is established in one of the channel banks, therefore the rate of Knickpoint erosion migration to upstream in the rather low discharges is much higher than expectations, because the focus of shear stresses and erosion are in the smaller range. Although the discharge flow is low, the rate of shear stress is higher due to the lack of width and focus on a smaller range, this rate in relatively high discharges because the flow is established in the whole width of the section and in the relatively high discharges the rate of migration is seen that corresponded to expectations.

In the end it seems necessary that hydraulically, there have been limited studies about Knickpoint erosion and the main studies are limited to study of Knickpoint erosion in water shed and had general studies about Knickpoint erosion. Topical studies of a Knickpoint erosion is very limited, it is recommended to conduct further researches in the field of erosion in order to avoid hazards and damage of it.

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