

Physical modeling of water current in Karun River, Shushtar domain

Mehdi Delphi, Hadi Molaei Tavani

Abstract— More than one-third of the earth surface is covered by water of seas and oceans. Also several rivers are originated from them; hence they have applied effect on life of habitants of seaports and coastal towns, also they help to human beings in obviating needs such as fisheries and watery transportation. The studies of water and fluid sciences have significant importance. The Karun river which is the biggest one in Iran passes from Khuzestan province through towns in its pathway. When Karun River comes to Shushtar basin, reaches to a regulative dam, and there is a secondary branch namely Gar-Gar which originated of it and is a artificial watery basin. In this paper parameters of deby sediments and speed of dominated flows in Shushtar basin were determined and flows of Karun River, Shushtar basin are modeled.

Index Terms— Karun River, Current modeling, meander, Shushtar

I. INTRODUCTION

Karun River as the biggest watery river basin after reaching to Shushtar at area of Takht-e-Qeysar and passing of an arc path (meander) passes about one kilometer. The study of flows and sediments debies in this area because of centrifugal force has significant importance. Since in meander of river because of effect of centrifugal force, there are different deby sediments and currents model and have eddy or whirlpool structure so the coastal line destroy in this coastal line and width of river would be extended. Figure 1, is an image of this river in Shushtar Township which has meander in its path. One of recent problems of Karun River especially in overhead and underneath of Ahwaz town, is establishing coastal walls and increasing the height of natural and artificial hill. These actions lead to hydraulic section limiting, depth increasing and water uprising [2]. Massong (2005) has studied the coastal erosion and change which is arises in meander rive ground. In this research, the danger of transmission, extension and change of meander in the river path are warned [3]. In studying Karun River, shushtar which has meander in its path and in this area, arch debies and currents which are affected by centrifugal force in the cycloid path are the parameters which lead to sediments transmission and curvature paths carrying sediment ingredients between two coastal lines and therefore to change in river width in meander of Shotteit. The coastal destruction rate due to centrifugal accelerated currents and coastal sediment in arch meander path cause the coastal erosion, also because of extension of river width existent lands and installations in the

flood plain of river are in danger, this matter cause several social tensions too(increasing of one way lands and covered by water environs of lands). Therefore, the study of current regime in meander and sediment rate, for determining of location and optimum structure of coastal walls is indispensable.

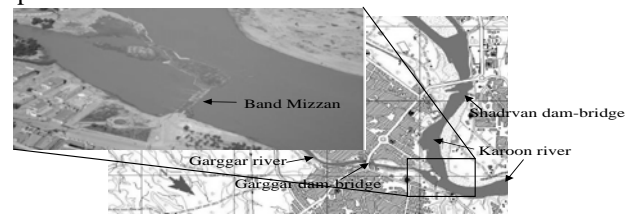


Fig. 1: An image of Karun River, Shushtar basin.

II. TWO FUNDAMENTAL FACTORS

As it was mentioned before in this paper, two main and natural factors around the Gar-Gar which help to decrease sedimentation rate and coastal destruction would be minimized much. First, the direct route of the water canal in Gar-Gar guarantees avoiding any meander for water flowing through it. By this, there wouldn't acceleration for water motion in Gar-Gar. Second, coastal walls in two sides of the gar-Gar river are made by rock and stone. In fact, rocky walls in two sides of it are fasten to resist against water currents [3]. Therefore sedimentation in coastlines would be minimized as much possible. Figure 2 and figure 3 show stone walls around the Gar-Gar in Shushtar domain and direct route of it, respectively. Floodplain zone could be seen when water body flowing in a river basin was more than volume of the basin. In these areas, bank erosion takes place and river supply and path management won't be applicable for long time [8]. Building coastal walls and setting dam on river gates will be useful to preservation of river basin deformation and long time management [4]. Number and position of gates appointed on dam is very important hydraulically and hydro dynamically. Existence of setting dam will lead to water storage and flood prevention. The Karun River, the biggest river in Iran, in Shushtar domain, is divided into two branches, "Gar_Gar" and "The Shotteit" and water bodies in the ratio of 2 to 4 are cleaved between them. The number of gates and their position in a special area called "Band-E-Mizzan" in front of water flowing in The Karun were well appointed at hundreds years ago. As could be seen in Fig. 1, there are nine gates on "Band-E-Mizzan". "Band Mizzan", is a setting and water divider dam. Its position is on top of meander of The Karun, that coast erosion and sedimentation happen so much. Its front wall is set in 90° angle due to river current, so a main part of water body of The Karun would conducted to "Gar_Gar" canal and then erosion and

sedimentation in “The Shotteit” will be decreased very much in Shushtar domain. Of course reconstruction of “Band Mizzan” and its gates is necessary to conserving this valuable hydraulic structure in canal of The Karun on mouth of “Gar_Gar”. Sedimentation rate around “Band Mizzan” has been little because it is exactly on top of the The Karun meander; less depth of the river in this area helps to reduce bank erosion too. Material used to building dam is important to fasten it and raise (magnify) dam resistance against water penetration and water destroy. Shape and distance between the gates cross section and area of gate mouth of setting dam is a main factor for efficiency of dam operation. Water body flowing in river route and entering to canal should be enough to decrease water in the first canal and supply necessary water for the second canal after gates mouth in dam face. The shape of gates mouth and windows on the front wall in “Band Mizzan” dam is rectangular. Maybe it would be circle or ellipsoidal or others but after considering all factors about hydro dynamical studies on dam efficiency must be exact and scientific.

Particularly in bending of river route (meander) and on surface of river water, eddies and secondary flows in bank and coastlines of river would be shaped and happen always. Sinusoidal face wall (Fig.5) helps to decrease rate of these currents and then coastal destruction by a main drift [2].



Fig.2 Stone and rocky walls of the Gar-Gar



Fig.3 Route of the Gar-Gar canal straightly

From top of “Band-E-Mizzan” dam a sinusoidal shape with two successive waves in the water surface could be seen. Figure 4 presents the above point. The wave length of this sinusoidal shape should be appointed efficient and exactly to weaken eddies to be swept. In fact, eddies happing on surface of river or secondary flows in banks of river, especially in river meander, will be weaker much more if the wavelength

of sinusoidal shape of the front face of dam comparable with their own. Length scale of surface eddies on “The Shotteit” is about 1 to 5 meters of domain while two wavelengths of “Band Mizzan” wall behind of the river are about 30 and 20 meters from dam top to downstream . We could watch eddies weakening after striking the dam face. Of course intensity of water currents flowing in the river after dam is decreased and enough as a result of number and position of them rather to water currents (with 90° angle). As an applied result gotten using DADISP software, drawing the velocity field with profiling behavior, we got three profile diagrams for the beginning; top meander and the finishing places of the The Shotteit were done as A, B, and C (Fig.6). Regarding to the below diagrams, it could be understood that because of existence of secondary flows in meander rout of a river, the pattern of the flows and currents would be rather complicated and harmful with coastal erosion and destroy on it.

III. LAMINAR CURRENTS AND LITTLE DESTRUCTION FOR GAR_GAR

Due to existence of the setting dam “Band Mizzan” and position of dam gates, Gar_Gar water body after this dam has been deformed to good zone of currents direction. Furthermore enough water body provided to be flowing in the river canal after the setting dam, in existence of bending in river path has been applied and useful to prevent from bank erosion and sedimentation [2]. We don't have any floodplain for “Gar_Gar” but it happens around “The Shotteit” because reconstruction of “The Band-e-Mizzan” that is necessary to optimize the application of the dam hasn't been finished yet. Laminar and calm currents happening in “Gar_Gar” are results of no bending and no much water body flowing in “Gar_Gar” canal (Fig.7). So building of setting dams in correct position with suitable gates and windows in size and number is very applicable to conduct water currents in river that should be performed due to too much consideration. Sometimes known as streamline flow, occurs when a fluid flows in parallel layers, with no disruption between the layers.

In fluid dynamics, laminar flow is a flow regime characterized by high momentum diffusion, low momentum convection, pressure and velocity independent from time. It is the opposite of turbulent flow. In nonscientific terms laminar flow is "smooth," while turbulent flow is "rough"[7]. The dimensionless Reynolds number is an important parameter in the equations that describe whether flow

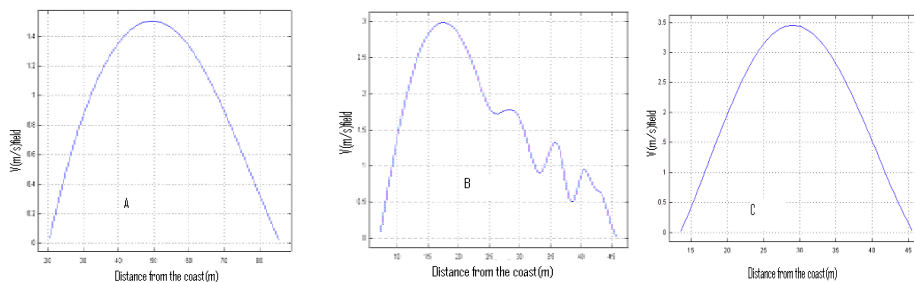


Fig5. Profiles (A) at the beginning (B) top of the meander(C) at the endpoints of the The Shotteit River

conditions lead to laminar or turbulent flow [6]. Reynolds numbers of less than 2100 are generally considered to be of a laminar type. When the Reynolds number is much less than 1, creeping motion or Stokes flow occurs. This is an extreme case of laminar flow where viscous (friction) effects are much greater than inertial forces.



Fig.8 The pattern of laminar currents of water in the Gar-Gar River

IV. DATA ANALYSIS

Measurements in the Gar-Gar river, Shushtar domain, were done in 2002, 1003, 2004 and 2007 for debies of coastal sedimentation. Deby values in coasts of the Gar-Gar has been studied. Water currents flowing through the river canal transport sediment particles to coastlines. Of course sedimentation so coastal destruction is decreased for Gar-Gar due to not existence meander and with rocky walls. Fig.4 (a, b, c & d) shows illustrate sedimentation deby variation during year months in 2002, 2003, 2004 and 2007.

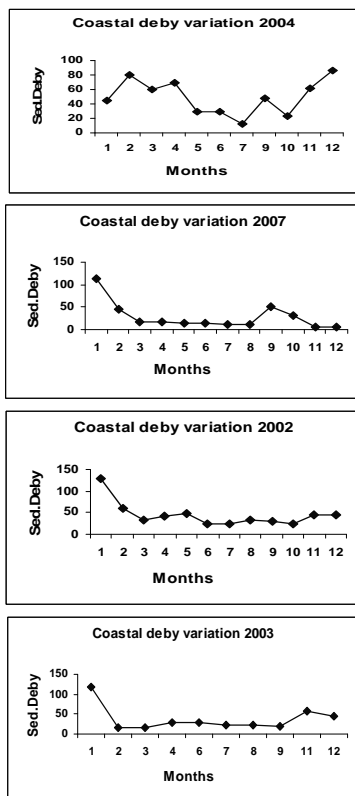


Fig.9 (a, b, c & d) Sedimentation rate in months for 2002, 2003, 2004 and 2007



Fig6. Sinusoidal shape of the Band Mizzan



Fig7. The meander of the The Shoteit River

Concentrating on the diagrams we could get applied results. Using the applied results mentioned a below, hydraulic and hydrological principles important in water structures have been got in civil engineering. Shore protection and coast management is a basic and useful in ports and coastal cities. However we should be able to apply basins of surface water in life in optimum and efficient ways [4]. Surface water on the earth and atmosphere are two components of the double system important for weather change [5].

V. SAMPLINGS AND MEASURES

In different months of year in two season of winter and summer of deby in Karun River, in the two places before and after balance band, Shushtar basin by Flow meter contain the variant diagrams of this physical parameter of river that include the reviver hydraulics, are formed as fig. 2.

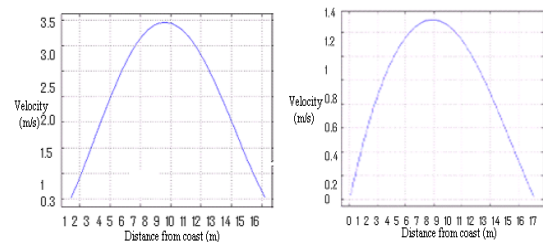
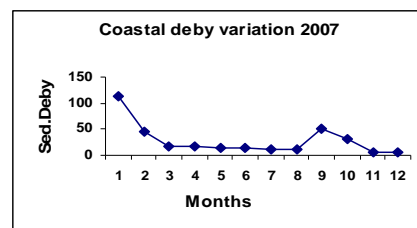


Fig.10. Diagram of mean variant of currents speed.

VI. CURRENT COUNTERS

Considering the stream speed in river coasts equal to zero and applying primary conditions and the characteristics of component of dominant stream, the speed equal to 0.1 and 0.15, the counter of figure 4 is obtained by software Fluent.



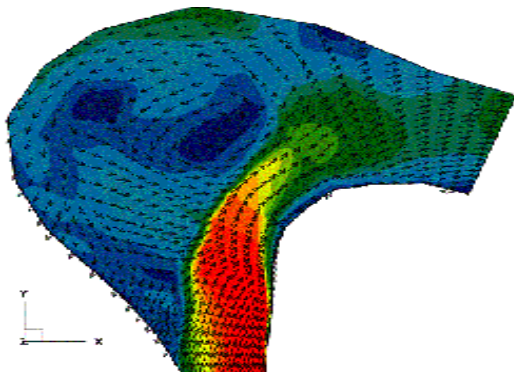


Fig12. The streams counter of Shotteit River in Shushtar basin.

VII. RESULT AND DISCUSSION

In meander of river whirlpool or eddies are seen on the water surface, because of centrifugal forces effects from center of path curvature as an arch from a circular path. As a result rotator or secondary streams between two coastal lines in meander lead to transferring of sediments ingredients and increasing of sediment rate, destroying and internal erosion. So establishing resistant and waterproof coastal or rock or stone walls (sheet pile and...) along to coastal line in meander of river in indispensable. Also continues monitoring of streams profile model, reciprocal effect of river streams and coastal lines should studied, evaluated and managed. Other interesting point is that in the meander of river because of centrifugal and accelerative force, the acceleration of sediment particles and dominant stream would increase, finally vortex secondary streams in river lead to coastal sediment and therefore destroying of coast. In the location under study of this research, establishing the regulative dam Band-E-Mizan and existing water control valves and directing it from that (0,1 of the total stream) to secondary channel and artificial lead to decreasing the amount of sediment rate and coastal destroying. River basins as secondary water bodies canal are among lands. If lands around rivers would be stable without slip and river direction is straight, sedimentation rate in coasts of river will be the most little. River basin under conditions that there wouldn't be floodplain, flood so sedimentation wont be considerable. According to the deby profiles, we could see maximum sedimentation deby in March. It is resulted from maximum fall so more water body in canal then. The most important factors for decreasing sedimentation rate in river basin are as below. We could get useful and applied results from researches like this article such followed notes:

- 1) Direction of setting dam should be straight in ratio to water currents of river for entrance after dam to optimize the efficiency that related to their structure.
- 2) Numbers of windows and gates on setting dam must be appointed correctly to apply exact control water body flowing in river or canal after setting dam.
- 3) Building of setting dam and establishing of the second canal in place of maximum curvature of river is an applied task to decrease the rate of sedimentation and bank erosion.
- 4) Fastening bank lines of river, building of river coastal walls and deepening of the river basin would be useful to

avoid happening of flood around river.

- 5) Materials for building of coastal structures must be appointed resistant rather than water.
- 6) Flood currents and sedimentation in the river with high current velocity could be controlled by setting dam creation.
- 7) Superposition of surface waves and secondary flows with dam structure mouths can lead to decrease erosion and make a calm river.

REFERENCES

- [1] Alleyassin A. 1995. Application of river engineering, Iran.
- [2] [Mosaddad S.M. and Akhyani M. 2007. Coastal destroy due to river bending and drift of sedimentation due to piers. In: Proc of the Hydropower2007 International conference, Kandy, Sri Lanka, 2007, pp121-126.
- [3] Mosaddad S.M., Akbari Bidokhti A.A. and Ezam 2008. Current modeling considering civil engineering problems building coastal walls. In: Proc of the Fluid Mechanics Asian congress, Daejeon, South Korea, 2008, pp 234-241.
- [4] Blishev, M., (1997), WAVE MOTION, New York, pp: 85-107.
- [5] Massong M.,(2005), Bernalillo River Maintenance priority Site Bend Migration Monitoring USA, 7p.1