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Momentum Attraction by Flood Plains in Compound Channel

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Article

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TCARTSBA

Most natural rivers have flood plains that extend laterally away from the main river channel at a gentle gradient or in a series of terraces. In certain cases multistage channels are deliberately formed in order to increase conveyance capacity in times of flood and to have recreational land available at other times of the year [1]. Two-stage channels thus consist typically of a main river channel in which there is some discharge all of the time and flood plains, which are dry for most of the time yet perform a vital function in times of flood. Since flood alleviation schemes are the focus of much engineering work, the prediction of the conveyance capacity, velocity distribution and boundary shear stress distribution in such channels is clearly important. The boundary shear stress distribution is a prerequisite for studies on bank protection and sediment transport. The prediction of these parameters in two stage or compound channels is complicated by the lateral exchange of momentum that takes place in the shear layer that forms between the generally faster moving water in the main river channel and the slower moving water on the flood plain. The superposition of high lateral shear on bed-generated turbulence and longitudinal secondary flow structures is an intriguing problem in fluid mechanics. In the context of river channels with flood plains, the problem is usually further complicated even for moderately straight channels by the complex geometry of the cross-section and the heterogeneous nature of the boundary roughness [2].

INTRODUCTION

Compound channels are hydraulic sections that are formed of main channel and floodplain channels. The main channel is part of the lower floor is level and generally have a rectangular or trapezoidal cross-section. This section, pass the typical runoff and base flow in rivers. The floodplain channel, in contrast, is composed of sections of the floor level is higher than the main channel and is located is located one side or both sides of the main channel [5]. This section has normally no role in flow transfer and action is in flood conditions. Generally, its hydraulic roughness is much greater than the main channel. Given the above definitions it is clear that the compound section, hydraulic section is typical of many rivers in alluvial plains. That is where he has long been the cradle of human life and civilization. Certain geometric conditions cause the compound levels are specific hydraulic conditions which require special justification is in these sections. Sections of special geometry combined with a significant difference in roughness of main channel and the flood plain Cause differences between the following sections of this channel is immediately noticeable. This difference in velocity and depth of interaction in turn led to the formation of a boundary area between the sections the energy perspective, the exchange of internal stresses in this area will cause significant energy loss. Also, from another perspective, the striking velocity gradient between the levels of tension between the inner shear flow is in the following section In addition to the bed and wall shear stress is the channel. It is commonly called the apparent shear stress. Regular or irregular channel as to what is considered to be low in energy or longitudinal friction mostly due to the action involved with the channel bed and the solid wall. However, the friction factor and low power portion of the longitudinal the compound channels are included and the corresponding effects on the inner sections cannot be ignored [3].

The main differentiation stages compound with regular and typical sections of the same phenomenon is also hence the use of conventional hydraulic relationships associated with the regular channels, the compound channels, in combination with a significant incidence of errors.

So resulting in a hydraulic study of the sections started decades ago and continues today. review the boundary shear stress not only for discussion is very important in sediment transport and coastal protection it can be keep in check the compound sections in comparison main channels and flood plains to infer the nature of the transverse momentum transfer phenomena and their effects on the distribution of boundary shear stress and the hydraulic properties used [7].

Research background

Topics discussed with momentum transfer near the shear stress and shear force issues range of research on this issue directly and indirectly shaped the more it will be referred to Sellin [14]. He developed a technique for obtaining information on the mechanism and nature of the phenomenon can be used to exchange momentum. He has a high reflecting power of aluminum powder on the surface with a compound channel unraveled and with a camera that was installed just above the water level of the surface pattern was created by the filming and photograph. For more accuracy and velocity under the camera with the same average velocity of the secondary flow at the junction of Main channel and the floodplain channel were moved. Tamai and Kawahara [15] used similar techniques for calculating the momentum transfer in the channel width and length were used. They also calculate the flow rate of hydrogen bubble technique was used in coastal channels.

Zheleznyakov [16] in his research for a compound symmetrical cross section which consists of a Main channels to the part geometry floodplain surrounded by both parties that the same was done.he understood that average velocity and position in Main channel in the shallow floodplain will suffer loss. However, the local velocity at the junction of main channels and floodplain increases at the same time. He also managed to introduce a critical factor in his subsequent articles and compound sections was effective that it Were the Main channels depth to the depth of the channel at the flood plain $n = \frac{y_t}{y_f}$ later called the effective depth [13]. Rapid changes in compound channel of Quadrant First experiments in channels with Main section and two on a broad floodplain In the latter case, their experiments in a channel with Main section and a broad flat floodplain made and results in a logarithmic vertical velocity distribution reached. Myer and Elsawy [10] examined shear stress distribution in symmetric and asymmetric channels. They stated that Transverse momentum transfer greatly reduces shear stress in Main channel and increases shear stress in the flood plains. The momentum transfer between the floodplain and Main section came to the parameter of shear stress. Dimetrio and Knight [7] applying a shear force of shear stress was obtained. Effects of momentum transfer between floodplain and main channel of the transverse momentum Quadrant and achieved remarkable results. They also face two types of vertical and horizontal shear stresses were examined. Posey [11] presented a different approach in calculating the compound sections discharge. The sections were divided into smaller sections after calculating each stated discharge they found the total discharge is obtained from different sections discharge. Finally they found that any error in their results refer to irrespective of momentum transfer between main sections and flood plains. They also found in high transverse momentum transfer mode reduces the bank full discharge and flow rate are compared with the regular channels. They studied apparent shear stress for several hypothetical interaction between main channels and floodplain. They were also introduced an index, so it was considered important indicators of this effect was less than 2.

The prevailing theory

In turbulence due to the turbulent flow due to velocity fluctuations in the three directions of movement also Stresses that occur in otherwise known as the apparent shear stress.

Continuity and momentum equations with respect to x along the flow we have:

$$\frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \qquad (1)$$

$$\rho\left(v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial y}\right) = \rho g S + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} \qquad (2)$$

That ρ is Density of water, g is the acceleration of gravity, s is Channel slope, τ_{yx} τ_{zx} Shear stresses along the x axis, and respectively zx and yx are in the pages. Momentum equation can be written as follows:

$$\frac{\partial(\rho uv)}{\partial y}+\frac{\partial(\rho uw)}{\partial z}=\rho gS+\frac{\partial\tau_{yx}}{\partial y}+\frac{\partial\tau_{zx}}{\partial z} \quad (3)$$

Methods of measuring the shear stress can be divided direct and indirect [12]. Of the various methods of measuring the shear stress, the Preston tube can be named as the most common method of measuring the shear stress. The shear stress is calculated using the following equations to calculate it and get help from the apparent shear stress or the momentum transfer,

$$\frac{\rho g A_{mc} S_f}{2}=\int\tau_0 dp+ASF_V \quad (4)$$

Preston tube is in fact a Pitot tube modified by Preston [12] to measure the shear stress indirectly been developed and placed on the wall or bed.

The main drawback of long computation in one hand and the nature of its high computational errors due to the large errors and is not accountable for the rough beds. Because in rough Beds due to collide in the boundary layer and not in the Preston tube into proper position Extractive numbers of Preston was not reliable. In this study, the stress measured using the drag force and momentum absorption technique has been used. In this method, the fluid drag forces on submerged objects using a variety of power meters, including dynamic load cell is recorded. Fathi Moghaddam and Kowen [6] and Kouwen and Fathi Moghadam [8] used this technique to measure the momentum and the drag of the fluid used by the vegetation elements. Since this method the energy method, the measurement is done in one spot, much less measurement error and precision of vector data is higher than the other methods. In this study, this method for measuring the momentum and friction force taken by the roughness of the channel will be used for floor and wall. In order to excite shear stress in this study used four different types of roughness size, which will be discussed in detail.

Dimensional Analysis: For the direct channel and the water smooth, steady and uniform flow and no surface wave motion and bed load, the parameters affecting the shear stress can be said:

Sensor placement for dynamic load inertia at the start of KEF flume flow, before the experiment is to channel some slight slope, the slope parameter is ignored. Therefore the effective factors in determining the average velocity shear walls and floor can be expressed as follows.

$$f(\bar{u}_{*b},\bar{u}_{*w},\bar{u}_{*},\rho,\upsilon,g,V,h\ ,H,b,K_S,)=0 \quad (5)$$

Using Buckingham theorem above equation can be transformed into relations with several dimensionless parameters. The combination of these three variables, ρ ,V ,Y and repeated with the other parameters and variables Following relationship to estimate the total average shear velocity, average velocity and average bed shear wall shear velocity are obtained:

$$f\left(\frac{\bar{u}_*}{V},\frac{\bar{u}_{*b}}{V},\frac{\bar{u}_{*w}}{V}\frac{\upsilon}{VH},,\frac{gH}{V^2},\frac{b}{h},\frac{k_s}{H},\frac{H-h}{H},\right)=0 \quad (6)$$

$$\beta=\frac{H-h}{H} \quad (7)$$

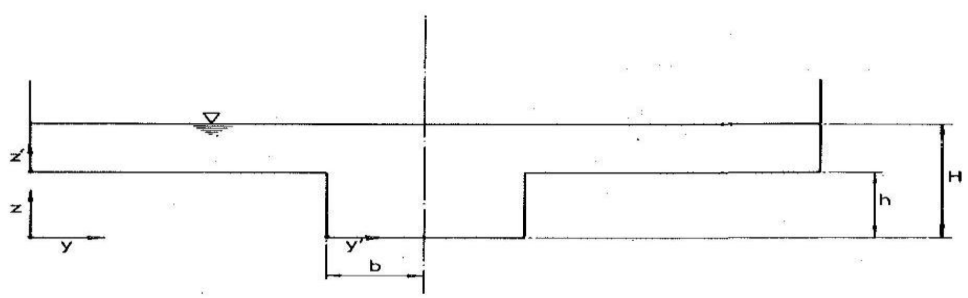

Figure 1: Schematic cross section of the compound channel

Due to the fact that the tests will be performed completely turbulence. The Reynolds number of judgments on the situation will be postponed to later experiments. However, this parameter is omitted due to rough conditions with low bed roughness is permitted in front of viscose.(2)

The tested parameters:

In order to achieve adequate and reliable data and after consideration of various sources, was appointed to review the following parameters.

Table 1: Tested Parameters

The tested parameters	The tested parameters value
$\beta = \frac{H-h}{H}$	0/1 ، 0/2 ، 0/25 ، 0/3 ، 0/35 ،0/4 ،0/5
$\delta = {}^{b}/_{h}$	0/66 ، 0/83 ، 1/11 ، 1/66
$D50$	1/31 ، 4/6 ، 9/36 ،12/5

As Table 1 show β is the parameter called the relative depth which comes of dividing the depth of shallow floodplain to the depth of main channel. Because of more than 0.5 has been neglected is that higher than it actually in compound channels there is not any, hydraulic mean .and main channel, will operate such as a rectangular hole in the middle of the channel. As noted earlier the floor within the main channel and the floodplain is fixed in all experiments. While the height of the main channel and the floodplain in four different sizes of 6, 9, 12 and 15 cm will change. another test is to measure the roughness Shear stress excite absorption feature in order to show momentum rough ground than other methods that are used almost powerless.

MATERIALS AND METHODS

As was mentioned earlier, this study aims to measure the shear stress and momentum transfer between main channels and floodplain composed of rectangular cross section with momentum absorption technique is used. Momentum measure imposed on the channel bed and walls, changes in the method proposed by Fathi-Moghadam[6] were applied as a table knife edge and a new method was developed under the knife edge of the flume. Experiments was done in a flume with a net width of 80 cm, depth 550 cm and a length of 8.3 meters, including 4.1 meters upstream channel, a knife edge of the flume meter (measuring range) and 3.2 meters downstream channel. Controls of the downstream level and width to depth ratios of the different conditions in the main channel and flood plains of the discharge, a valve at the end of the flume have been pre nose. The total stress of the sensor will use to measure the dynamic load. To measure the dynamic loads of the power converter is used. This tool is used to connect moving part of the channel to the fixed part and the friction force changes recorded on the walls and floor of the mobile channel. Note that for the calibration of these devices are used in different weights.

In this study, the channel was transformed into a rectangular and all the necessary force that causes the longitudinal momentum in the direction of flow in a rectangular channel can be the body of a rough and a rough floor in a state with more than 100 readings was tested. The different modes consist of channels (about 112 cases) were tested. Then, the longitudinal momentum measurements in the compound channel by the readings of a rectangular channel for 7 per share were calculated on the wet and The size of the direct measurement of momentum in the compound channel were compare Subtracting them from the transverse momentum transfer and the nature of the apparent shear stress, respectively.

It is worth noting that the experiments in rectangular channels for four different roughness sizes 1.31, 4.6, 9.36 and 12.5 mm for the roughness of a rough bed mode and a rough wall mode for different depths of the compound channel. Then, compound channel for four different tests that were the height of the main channel sizes 6, 9, 12 and 15 cm for the height of the roughness at different depths was tested in four states were continued. Then, as was mentioned earlier, the comparison of rectangular and compound mode and the momentum transfer between main channel and the floodplain and how the changes were studied.

RESULTS AND DISCUSSION

After various tests and the following assumptions are:

Flume bed and the wall shear stress distribution in the central axis of symmetry of the flume The use and application of research findings in practice, is large enough scale simulation is, Assumed to be fully developed channel flow. The change in longitudinal position measured on the surface does not lead to a change in friction coefficient. As can be seen in Figure 2 to 5 the horizontal axis represents the percentage of apparent shear force % ASF and the vertical axis represents β is the relative depth. In Figure 2 for all four types of wall roughness and the height of 6 cm is shown in the main channel.

$$\frac{\rho g A_{mc} S_f}{2} = \int \tau_0 dp + ASF \quad (8)$$

$$\% \, ASF = \left(\frac{ASF}{\rho g A_{mc} S_f}\right) 100 \quad (9)$$

Figure 3 for the main channel wall height of 9 cm and Figure 4 and 5 respectively for main channel 12 and 15 cm high will be used.

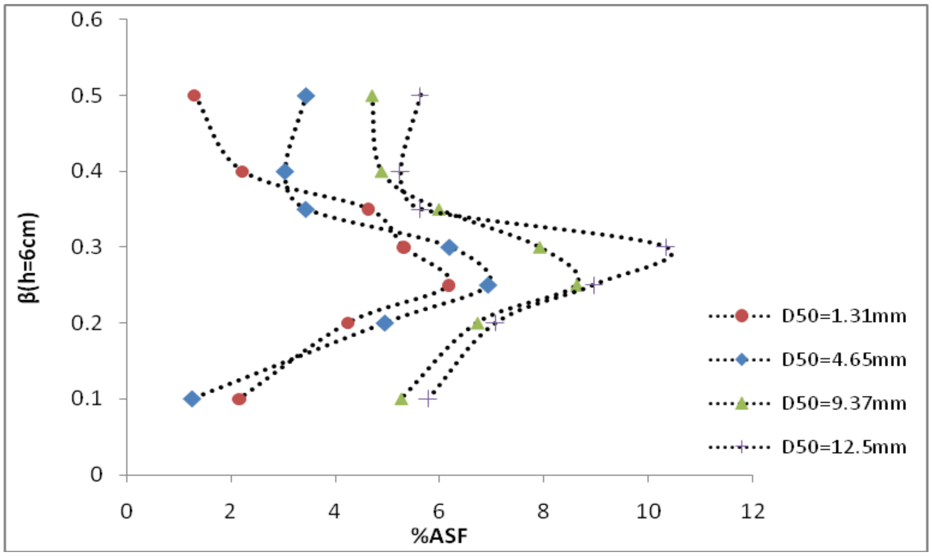

Figure 2: Distribution of shear force (momentum transfer) vs the relative depth h = 6cm

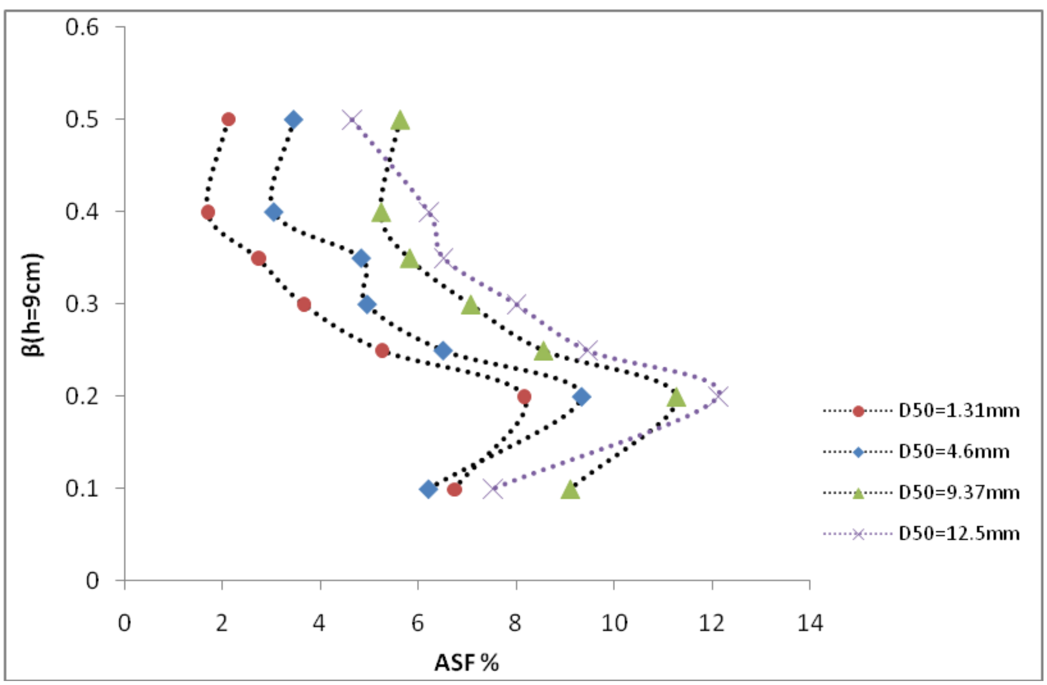

Figure 3: Distribution of shear force (momentum transfer) vs the relative depth h = 9cm

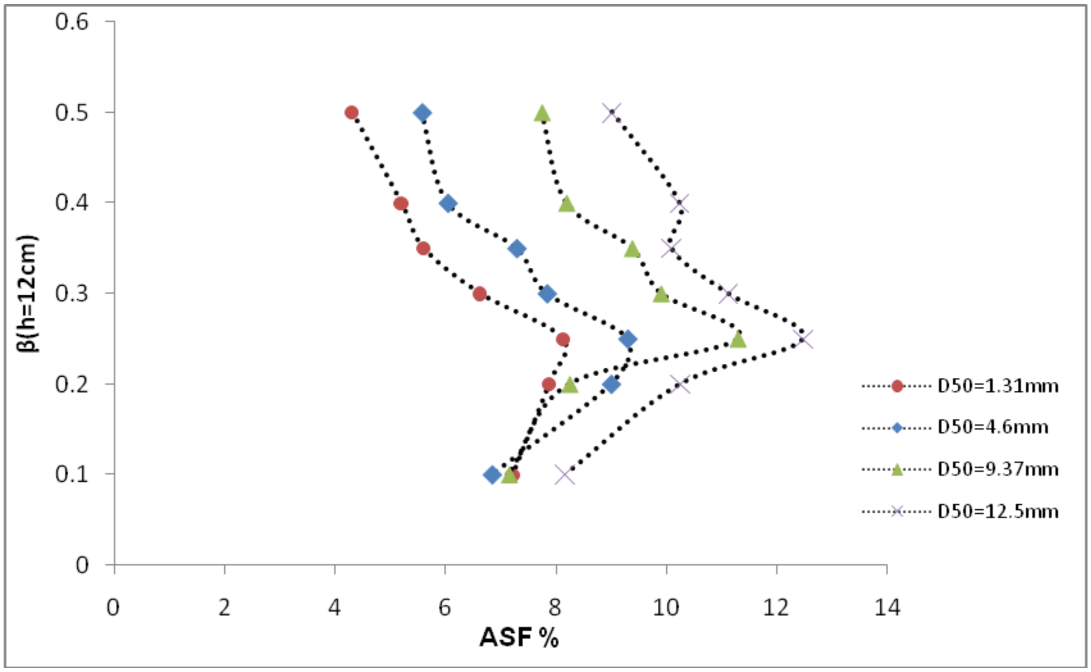

Figure 4: Distribution of shear force (momentum transfer) vs. the relative depth h = 12cm

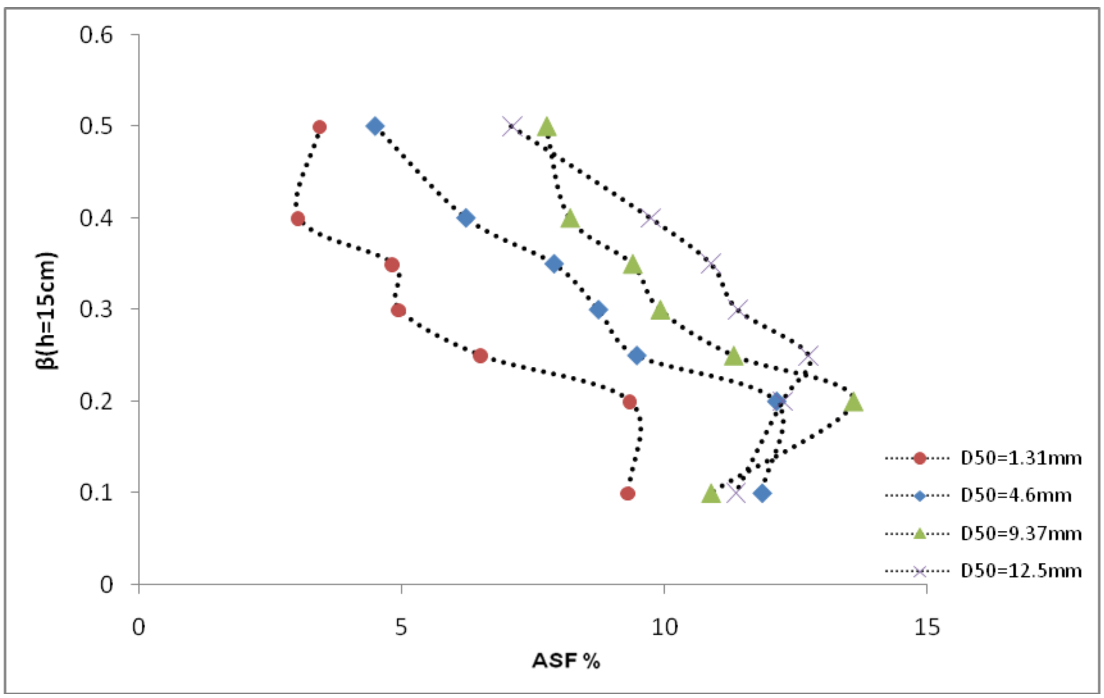

Figure 5: Distribution of shear force (momentum transfer) vs the relative depth h = 15cm

According to Figure 2 Can be concluded that in all different roughness, resulting in high relative depth of the shallow floodplain channel is very much on minimum transverse momentum transfer occurs. But in lower relative depth of the transverse momentum transfer more until in β=0.25 Transverse momentum transfer in the highest percentage in the roughness of all falls occur. The reason for this is that, in the depth of the above, the compound channels are actually losing their property and The main channel acts like a hole in the floor of a rectangular channel, It is important to note in Figure 2 that with increasing Roughness size, the amount of transverse momentum transfer of longitudinal momentum towards increased so most transmission of the apparent shear force (momentum transfer) of about 10% and the particle size is 12.5 mm As shown be At shallow depth (h = 6)is not much difference between momentum transfer to the particle size 1.31 and 4.6 mm. In this case given the very broad momentum transfer range of different roughness (from 1% to 10%)

are. according to figure 3, which corresponds to the case (h = 9cm)that is Roughness of all, the high relative depth, which caused high depth on floodplain channel. minimum transverse momentum transfer occurs but in Lower relative depth, the transverse momentum transfer more and more increases until that in β=0.2 Transverse momentum transfer in the highest percentage in the roughness of all falls occur. Most transmission of the apparent shear force (momentum transfer) of about 12.5% and the particle size is 12.5 mm. As can be seen increasing the wall height of the main channel, compared to the previous mode and clear separation between the surface roughness lower shear force values (1.31 and 4.6 mm sizes) will emerge. In this case The momentum transfer range of different roughness (from 3% to 10%) . In Figure 4 can be found in the state, (h = 12cm) high relative depth all the different roughness, which caused high depth floodplain channel is on. Minimum transverse momentum transfer occurs but in Lower relative depth, the transverse momentum transfer more until in β=0.25 Transverse momentum transfer in the highest percentage in the roughness of all falls occur. In this case most transmission of the apparent shear force (momentum transfer) of about 14% and the particle size is 12.5 mm. In Figure 5, which corresponds to the maximum wall height is the main channel Most transverse momentum transfer, the roughness of 9.36 mm in the third place which is about 15% in this case Momentum transfer range can be from 2% to 15% . It should be noted that Maximum momentum transfer for the roughness of 12.5 mm occur in β=0.25 and the other in roughness will occur in β=0.2. Total shear force in all states and all the relative roughness increases with increasing depth that is evident in figures 6 and 7, 8 and 9. It should be noted that maximum shear stress in the range (h = 15) occurs between 1 to 9 of 9 Newton and the maximum roughness of about 12.5 mm. Shear force corresponding to the lowest range (h = 6) is its value between 0.5 to 3.5 is the Newton.

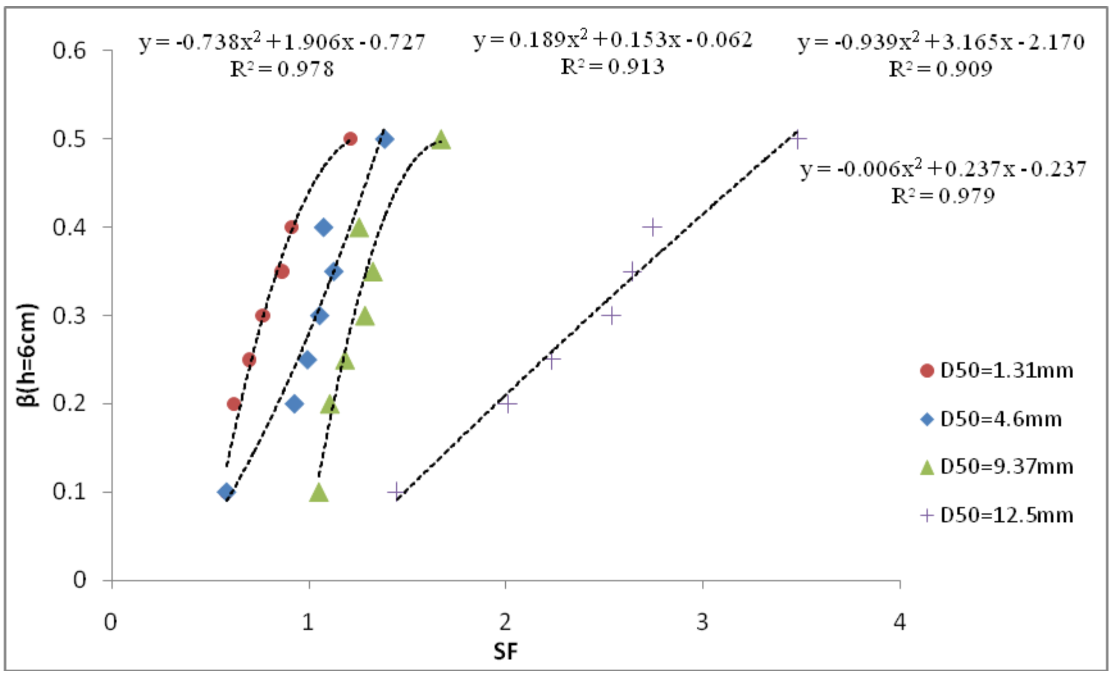

Figure 6: longitudinal shear force at different roughness in (h = 6cm)

As the figures 6 to 9 are show Increase in shear force after β=0.5 with lower slope increases., at the high depth of floodplain the characteristics of compound channel were reduced. Despite the apparent shear force that decreases with increasing relative depth can be found that the shear force will increase with increasing relative depth.

Generally these are the results of the study can be summarized as follows:

Changes of the apparent shear force (transverse momentum transfer) is to increase the depth relative to the high ratio of β=0.25 Reduced relative to depth ratio of β=0.2 in the following sections, the compound of the apparent shear force (transverse momentum transfer) is reduced.

In β=0.25 and β=0.2 usually most of the apparent shear force (momentum transfer cross) occurs. This means that flow in floodplain, slowing the movement of flow in the main channel or in other words flow in main channel takes the flow in floodplain that is very important In river and coastal engineering and organization. Will be considered in β=0.5 When exactly is the water depth in the floodplain, equal to the main channel wall height so in compound sections in rivers and natural watercourse about conditions that may be due to dehydration of water depth in the channel is very little more attention be paid to floodplain because This may increase the apparent shear force and consequently the secondary vortex and consequently will lead to coastal erosion and degradation.

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The compound sections, the relative depth greater than β= 0.5 are losing their property be the compound and the rules governing the flow of hydraulic fluid channel does not comply with the compound sections. More shear force in the apparent roughness belongs to larger average particle size. Also, the height of the wall of the main channel is more, and the amount of apparent shear force will be more. Maximum frame rate of change of shear force occurs at the lowest height of the wall of the main channel. That in River and coastal projects in the economic arguments, it is important to discuss the importance of dredging the river makes it clear.

The steep increase in the total shear force at h = 12cm were much worse than other states that Is illustrated that at the height of the main channel wall shear rate increases force overall trend of the relative depth to be faster.

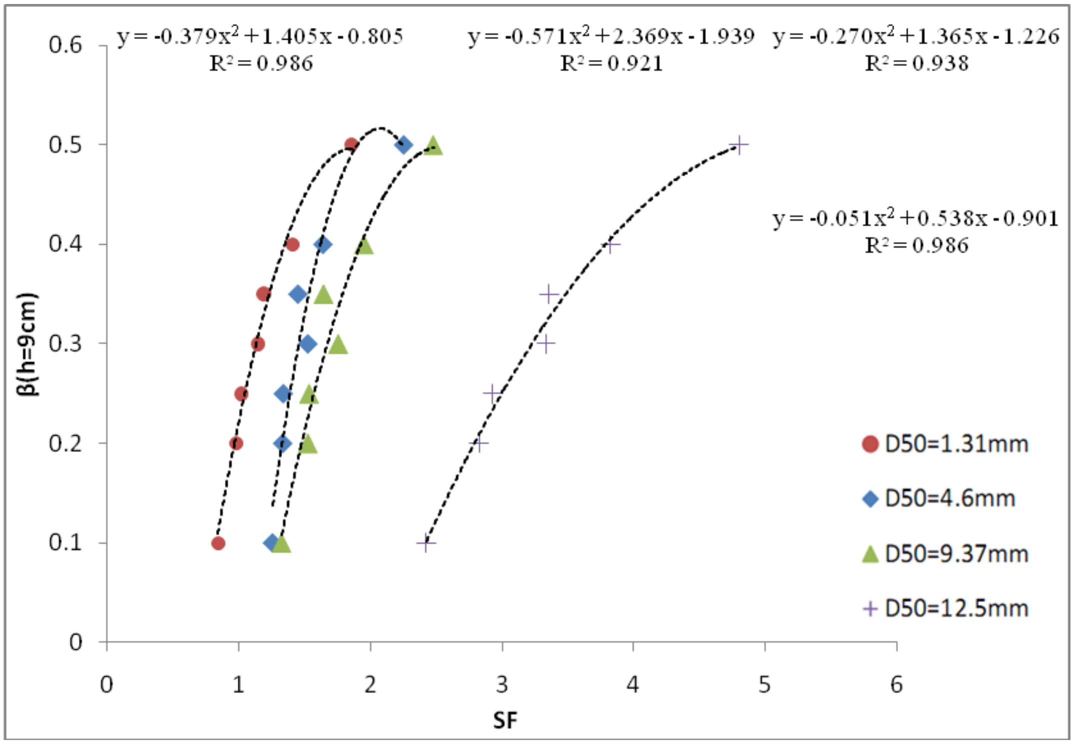

Figure 7: longitudinal shear force at different roughness in (h = 9cm)

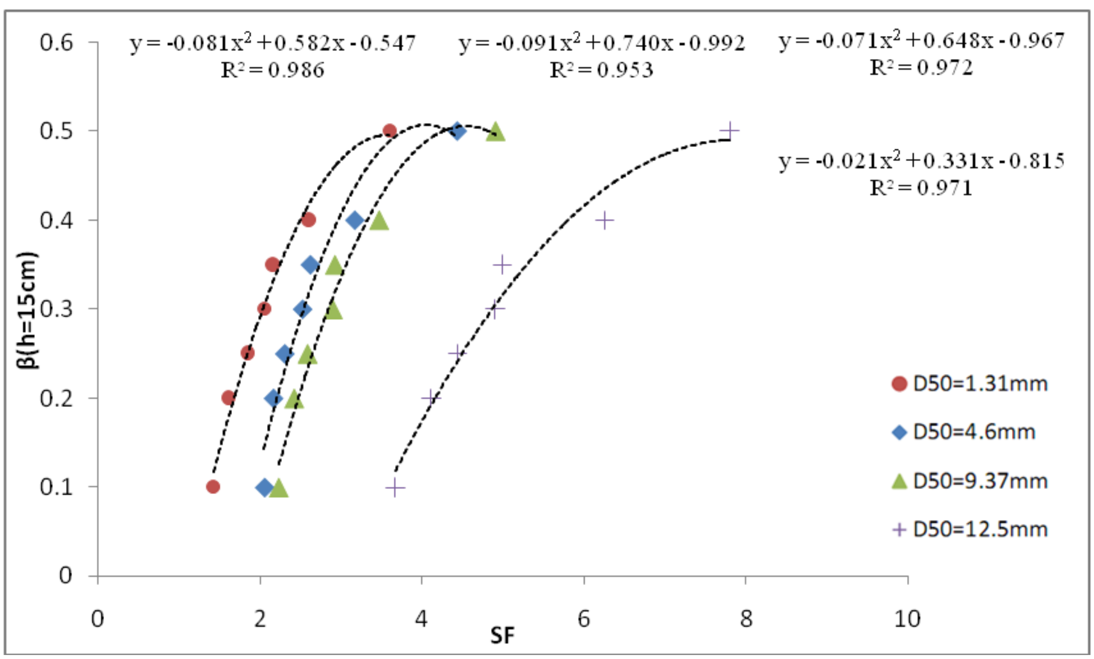

Figure 8: longitudinal shear force at different roughness in (h = 12cm)

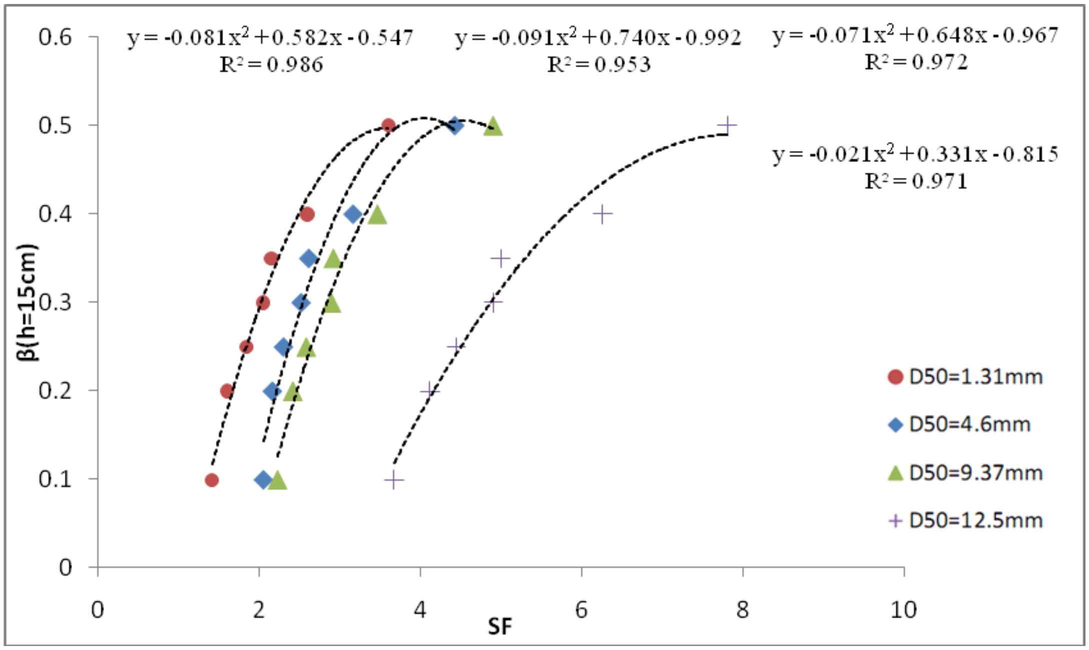

Figure 9: longitudinal shear force at different roughness in (h = 15cm)

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