

# Effect of Various Bed and Bank Resistances on the Longitudinal and Lateral Velocity Distributions in a Compound Channel

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**ABSTRACT:** A rectangular compound channel with different floodplain on the both sides of the main channel has been considered. Experimental work has been done with different cases with different slope, Velocity at different depth and different section of the floodplains and the main channel has been taken with the help of pitot tube to do the comparison analysis of longitudinal and lateral variation to get the velocity flow distribution in a straight rectangular compound channel in each section with width 0.30 m and 6 m long flume. In the floodplains of the left sides grass carpet has been used and on the other side of the floodplains some artificial plants has been used. In the main channel smooth surface boulders with different size and shape is used. For both the cases Velocity distribution with different depth and velocity has been shown in the figure with each resistance material with. In some cases the flow is confined to the main channel.

**KEYWORDS:** Velocity distribution, Compound channel, Boulders, Grass carpet, Discharge

## I. INTRODUCTION

Due to the presence of free surface and friction along the channel wall and bed, the distribution of velocity in the channel cross-section is not uniform. Also the presence of corner boundaries and bends in the channel cause the velocity vector of flow to have components not only in the longitudinal direction but also in the lateral as well as the normal direction of flow. It has been observed by Chow[1] that in very wide open is in rectangular channel of infinite width, i.e the side of the channel have no influence on velocity distribution in the central zone. A compound channel is studied to know the flood prediction of the area. Shukry [2] found that in short laboratory flume, a small disturbance at the entrance which is usually unavoidable, is sufficient to cause the zone of highest water level to shift to one side, thus, this give rise to a single spiral motion. It has been observed by Chow that in very wide open channel, the velocity distribution in the central zone of the section is essentially the same as it is in rectangular channel of the infinite width i.e the side of the channel have no influence in rectangular channel only when  $B > 5$  to 10 times of depth of flow. It also depends on the rectangular channel whose  $B > 10$  times of the depth of flow.

## II. RELATED WORK

According to Chow (1973) the measured maximum velocity in ordinary channel generally appears to occur below free the velocity characteristics of smooth open-channel flows. surface at a distance of 0.05 to 0.25 of depth. Chow further declared that in a wide, rapid and shallow stream, the maximum velocity may be found at the free surface. Balachandar et al. (2002) indicated that the stream wise mean velocity profiles follow the logarithmic principle for a smooth surface, and the appropriate downward shift, for a rough surface. Tachie et al.(2003) used Laser-Doppler Anemometer (LDA) to measure velocity on a smooth and two geometrically different types of rough surfaces in an

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open channel and showed that roughness effects on the velocity field. Nezu (2005) correlated quality ratio (b/h) with the formation of secondary current indicated the presence of secondary currents generated due to the effect of side wall.

### III. EXPERIMENTAL DETAILS

Experiments are conducted under controlled laboratory conditions in the water resource Laboratory of the Civil Engineering Department at Assam Downtown University, Guwahati, Assam, India. Experiments were carried out by changing the slope of the compound channel having dimension 6 m long, 0.3 m wide and 0.45 m depth flume. A large overhead tank is there for feeding water into the channels. At the downstream end, a volumetric tank is provided as a collecting tank for discharge measurement. For providing a continuous water supply the water from collecting tank comes to the PVC pipe by using a pumps.

Tabulation-1 Different cases of compound channel

Cases	Slope	Discharge in m <sup>3</sup> /sec	Details of the compound channel materials		
			Flood plain (0.06 m)	Main channel (0.19m)	Flood plain (0.05 m)
Case-A	1:150	0.00123	Grass carpet as the bed material	Smooth surface boulder placed above the grass carpet	Artificial plants as the bed material
Case-B	1:300	0.00116	Grass carpet as the bed material	Smooth surface boulder placed above the grass carpet	Artificial plants as the bed material

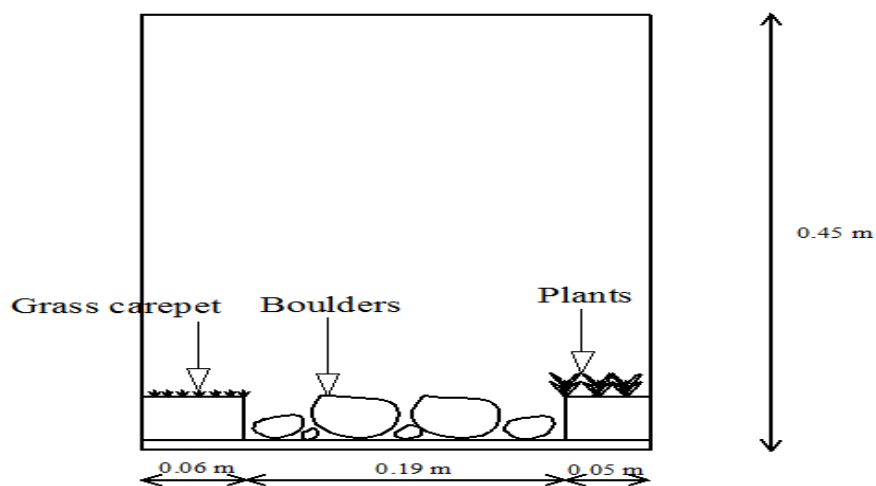


Fig.1 Plan of the cross sectional channel with 0.3 m width and 6 m long Rectangular compound

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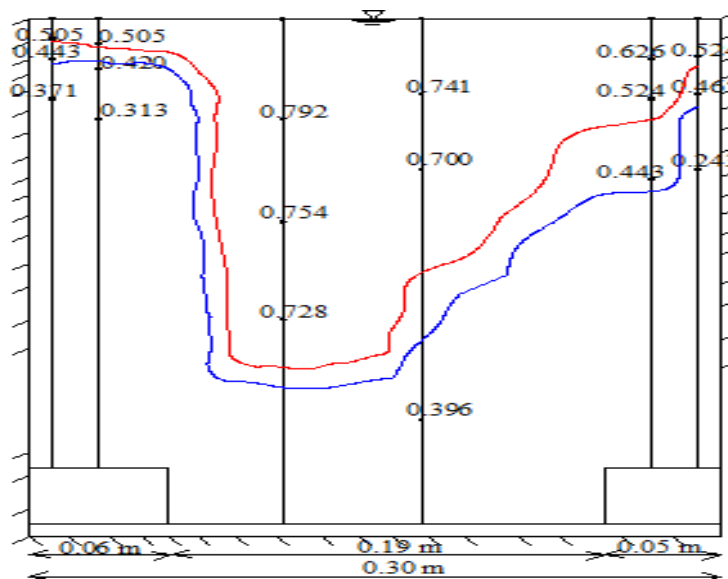


Fig. 2 Cross section of the rectangular compound channel with both sided flood plains.

Cross sectional details of the main channel and flood plains has been represented in figure-1. In the figure-2 it represent the flood plain in the rectangular compound channel. Where the channel width is 0.3m for distance 0.06 m is flood plain, the bed material is Grass carpet, for distance 0.19 m is the main channel ,the bed materials is grass carpet with smooth surface boulders and for distance 0.05 m is flood plain ,the bed resistance is artificial plants.

### Case-A

The velocity distribution of the compound channel with different section with the effect of the material resistance has been shown in the figure from 3-8 along with the depth of water and its velocity with the slope 1:150



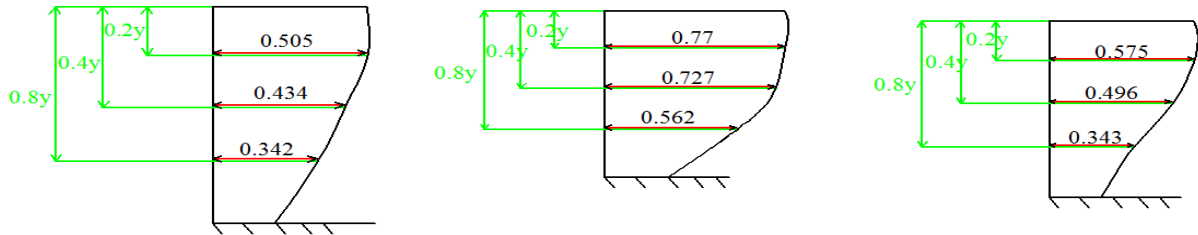
3 (a) Details of Cross section of the flume in 1 m section from the upstream in case-A

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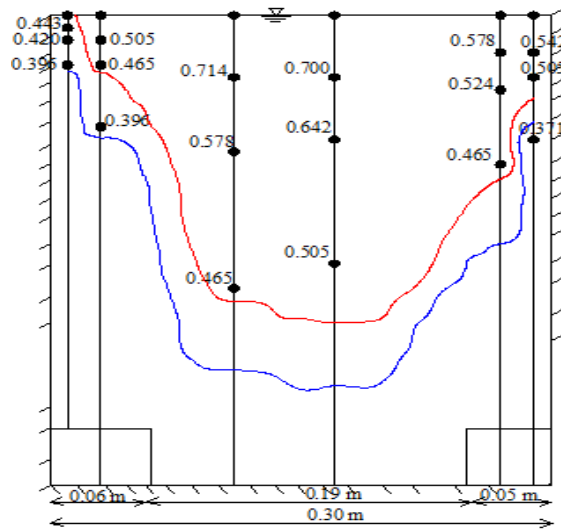
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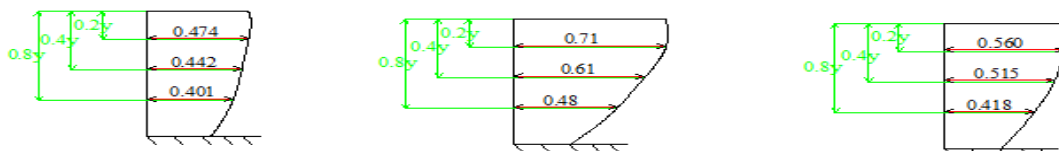


3(b) Effect of Grass carpet      3(c) Effect of boulders with grass carpet      3(d) Effect of plants  
Fig.3 Details of Velocity distributions at section 1m from the upstream of the flume in case-A

The depth of the water of the cross section at 1 m section is shown in fig. 3(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 3(b) and 3(d) in distance of 0.06 m and 0.05 m in x direction. In fig.3(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.



4(a) Details of Cross section of the flume in 2 m section from the upstream in case-A



4(b) Effect of Grass      4(c) Effect of boulders with grass carpet      4(d) Effect of plants  
Fig.4 Details of Velocity distributions at section 2m from the upstream of the flume in case-A

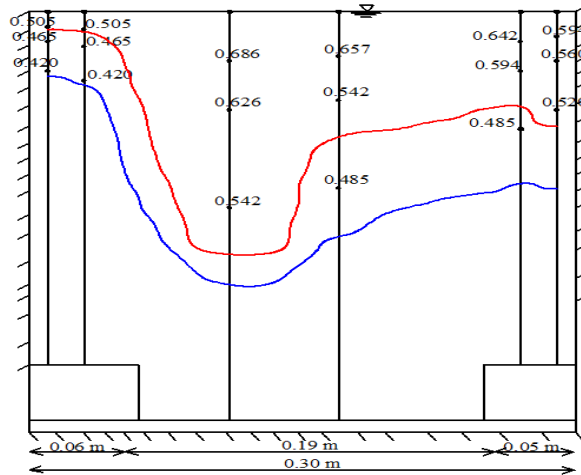
The depth of the water of the cross section at 2 m section is represented in fig. 4(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 4(b) and 4(d) in distance of 0.06 m and 0.05 m. In fig.4(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the compound channel of the cross section of the flume.

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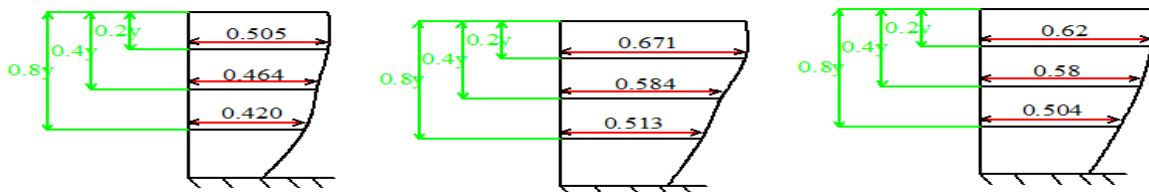
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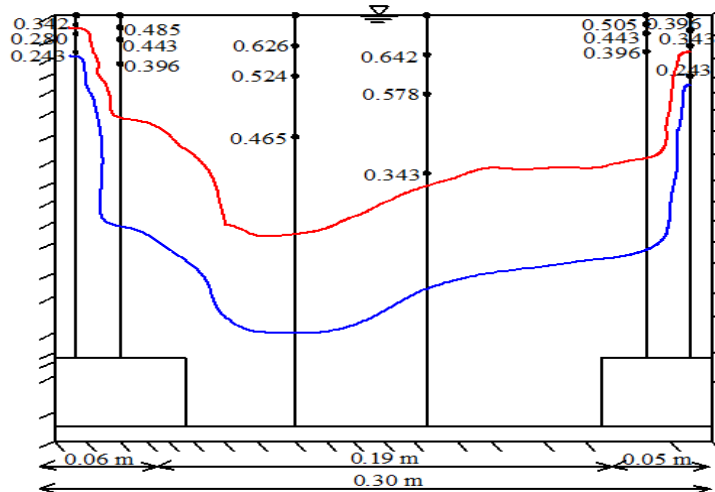
5(a) Details of Cross section of the flume in 3 m section from the upstream in case-A



5(b) Effect of Grass carpet      5(c) Effect of boulders with grass carpet      5(d) Effect of plants

Fig.5 Details of Velocity distributions at section 3 m from the upstream of the flume in case-A

The depth of the water of the cross section at 3 m section is shown in fig. 5(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 5(b) and 5(d) in distance of 0.06 m and 0.05 m in x direction. In fig.5(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.



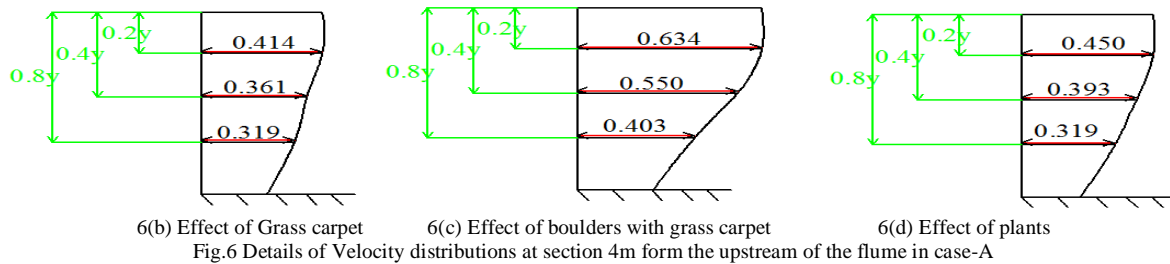
6(a) Details of Cross section of the flume in 4 m section from the upstream in case-A

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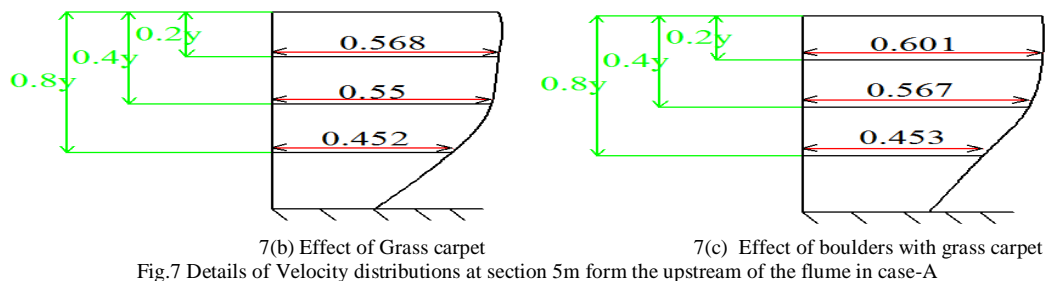
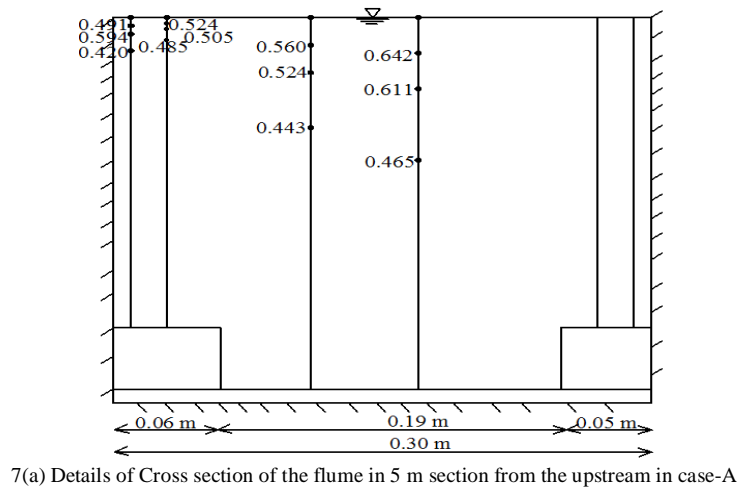
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The depth of the water of the cross section at 4 m section is shown in fig. 6(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 6(b) and 6(d) in distance of 0.06 m and 0.05 m in x direction. In fig.6(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

In some cases of flow it represent that the water is confined due to the resistance i.e fig-7 and fig-8



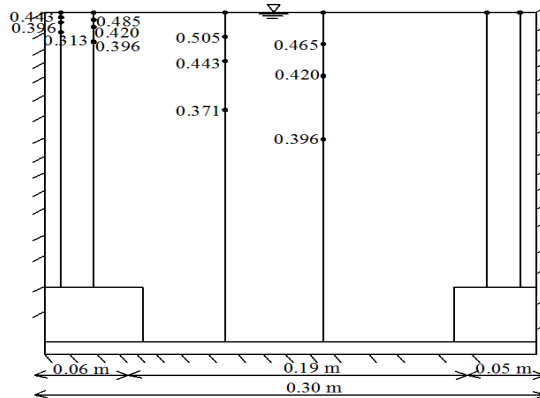
The depth of the water of the cross section at 5 m section is shown in fig. 7(a). The velocity distribution of the flood plains with the bed material grass carpet is represented in fig. 7(b) in distance of 0.06 m in x direction. In fig.7(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

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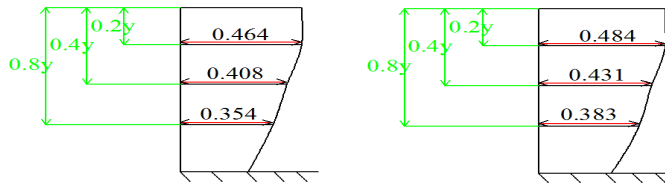
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8(a) Details of Cross section of the flume in 6 m section from the upstream in case-A

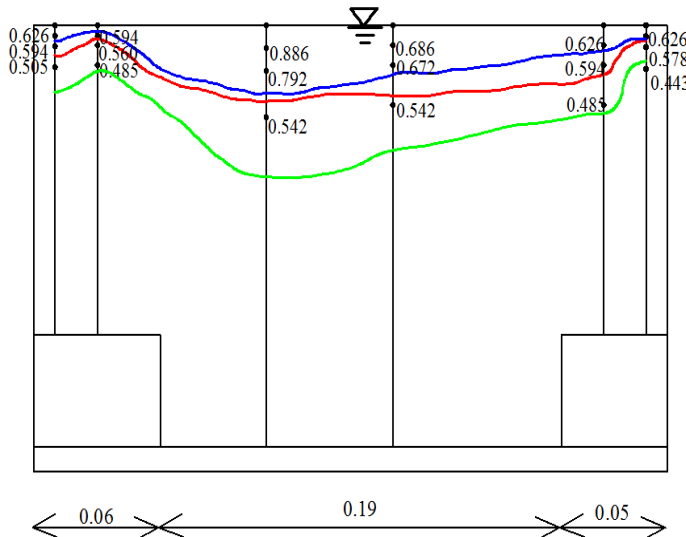


8(b) Effect of Grass carpet      8(c) Effect of boulders with grass carpet  
Fig.8 Details of Velocity distributions at section 6m form the upstream of the flume in case-A

The depth of the water of the cross section at 6 m section is shown in fig. 8(a). The velocity distribution of the flood plains with the bed material grass carpet is represented in fig.8(b) in distance of 0.06 m in x direction. In fig.8(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

## Case-B

The velocity distribution of the compound channel with different section with the effect of the material resistance has been shown in the figure from 9-13 along with the depth of water and its velocity with the slope 1:300



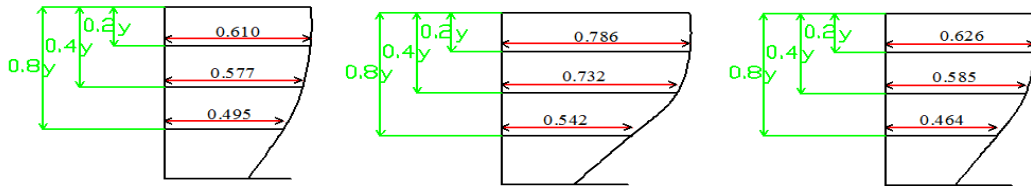
9(a) Details of Cross section of the flume in 1 m section from the upstream in case-B

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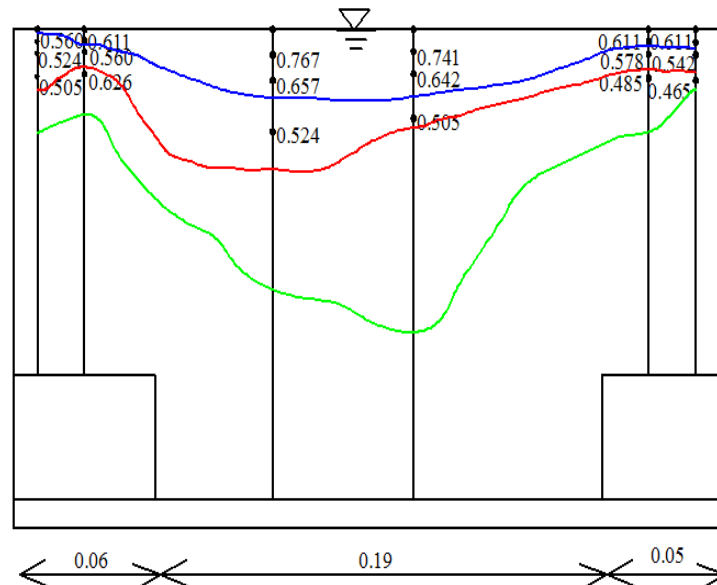
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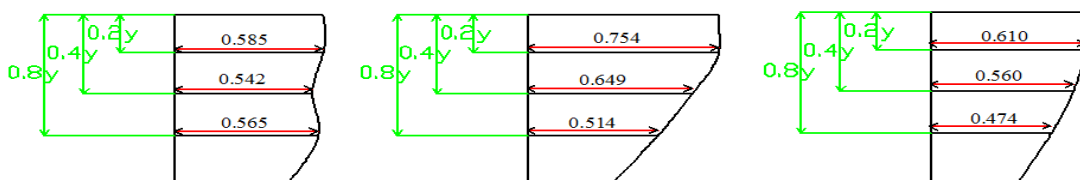


9(b) Effect of Grass carpet      9(c) Effect of boulders with grass carpet      9(d) Effect of plants  
Fig.9 Details of Velocity distributions at section 1m from the upstream of the flume in case-B

The depth of the water of the cross section at 1 m section is shown in fig. 9(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 9(b) and 9(d) in distance of 0.06 m and 0.05 m in x direction. In fig.9(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.



10(a) Details of Cross section of the flume in 2 m section from the upstream in case-B



10(b) Effect of Grass carpet      10(c) Effect of boulders with grass carpet      10(d) Effect of plants  
Fig.10 Details of Velocity distributions at section 2m from the upstream of the flume in case-B

The depth of the water of the cross section at 2 m section is shown in fig.10 (a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 10(b) and 10(d) in distance of 0.06 m and 0.05 m in x direction. In fig.10(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.



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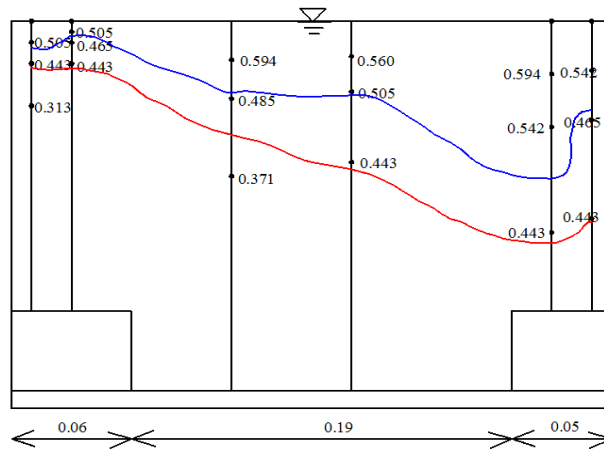
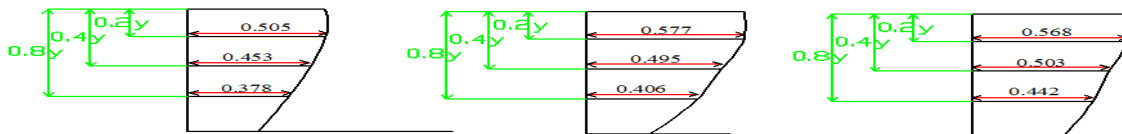


Fig.11 (a) Details of Cross section of the flume in 3 m section from the upstream in case-B



11(b) Effect of Grass carpet      11(c) Effect of boulders with grass carpet      11(d) Effect of plants

Fig.11 Details of Velocity distributions at section 3m from the upstream of the flume in case-B

The depth of the water of the cross section at 3 m section is shown in fig. 11(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 11(b) and 11(d) in distance of 0.06 m and 0.05 m in x direction. In fig.11(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

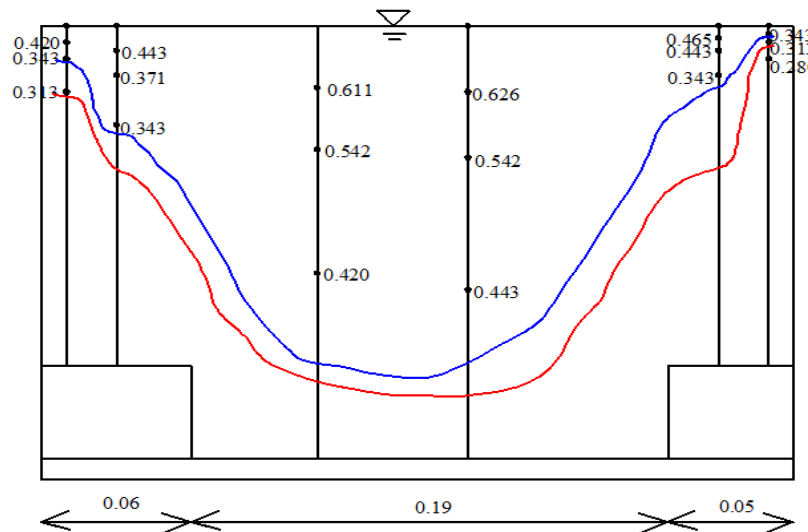


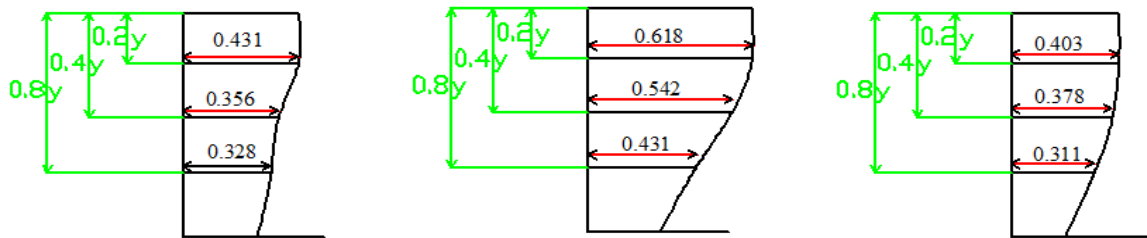
Fig. 12(a) Details of Cross section of the flume in 4 m section from the upstream in case-B

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12(b) Effect of Grass carpet      12(c) Effect of boulders with grass carpet      12(d) Effect of plants  
Fig.12 Details of Velocity distributions at section 4m from the upstream of the flume in case-B

The depth of the water of the cross section at 4 m section is shown in fig. 12(a). The velocity distribution of the flood plains with the bed material grass carpet and bed material artificial plants is represented in fig. 12(b) and 12(d) in distance of 0.06 m and 0.05 m in x direction. In fig.12(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

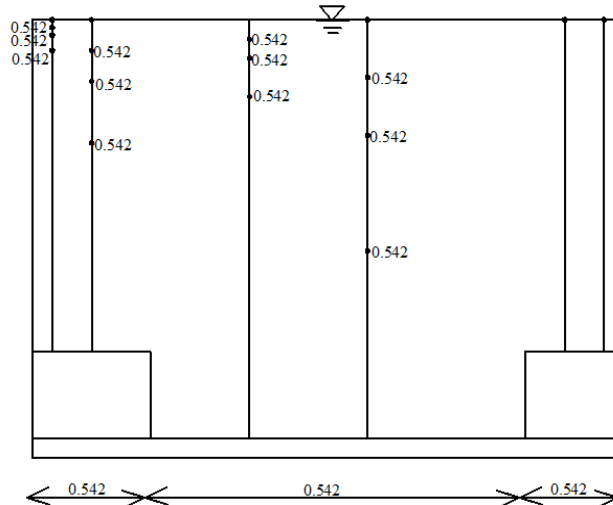
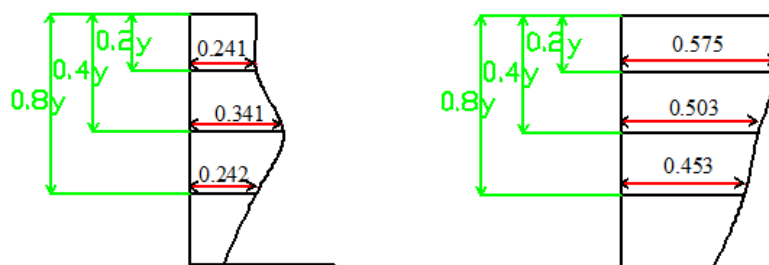


Fig. 13(a) Details of Cross section of the flume in 5 m section from the upstream in case-B



13(b) Effect of Grass carpet      13(c) Effect of boulders with grass carpet  
Fig.13 Details of Velocity distributions at section 5m from the upstream of the flume in case-B

The depth of the water of the cross section at 5 m section is shown in fig. 13(a). The velocity distribution of the flood plains with the bed material grass carpet is represented in fig. 13(b) in distance of 0.06 m in x direction. In

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fig.13(c) is the velocity distribution of the main channel with the bed material smooth surface boulder in distance of 0.19 m in x direction of the cross section of the flume.

## IV. OBSERVATION AND DISCUSSION

Velocity distributions mainly depend on the flow of discharge and bed material. If the discharge is more flood plains are getting more effected. Here it is observed when the depth of water is less the velocity is more as the depth of water is increased the velocity is reduced. In this experimental work for both the cases, in case-A section 5m and 6 m of the compound channel the artificial plants section is not flooded. In case-B section 6 m both sides flood plain is not flooded as the flow is confined in the main channel due to the main channel resistance. The laboratory studies shows that for case -B the depth of water is more in every section of the flume which reduce the velocity and in section 3 m of the artificial plant section the depth is more than the main channel and another flood plain.

## V. CONCLUSION

From the experimental work done for both the cases with the different size of smooth surface boulders and different bed resistance in each lateral section it shows the bed material as rough bed. In case-A for slope 1:150 the depth of water, discharge, velocity are almost constant with the flow of water in the compound channel in section 1m to 5m but in case-B for changing the slope in to 1:300 the depth of water and velocity are not same and there is large variation throughout the channel and the main channel is confined in the downstream 6 m section.

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