

Studies of Effect of Length of the Permeable Spur on Various Hydraulic Parameters

Rahul Kumar Tambe, Deepali Kulkarni

M.Tech Student, Department of Civil Engineering, Bharti Vidyapeeth Deemed University (BVDU), College of Engineering Pune (COEP), India

Assistant Professor, Department of Civil Engineering, Bharti Vidyapeeth Deemed University (BVDU), College of Engineering Pune (COEP), India

ABSTRACT: Dynamic In north territory of India numerous streams include alluvial stores. In the monsoon period the river banks are eroded and changed the river bank. To decrease these kinds of river banks is regularly given by development of stone revetments, impermeable spurs or bed bars so on. The required expenses of these structures are very high. Utilization of permeable structures is a cost effective alternative for the bank protection works. A dampening action on speed of the flow is achieved by permeable structures. In case of sediment present in the rivers, permeable structures help to induce siltation along the bank. The sediment transport limit of a flow is significantly depending on speed. Along these lines, the dampening of speed results in deposition of sediment. The survey of these paper, the effect of length of the permeable spur on various hydraulic parameters such as velocity, discharge, sediment transport capacity extent of scour length of separation etc. is investigated with the help of experiments. Experiments were conducted in a 10 meter long, 0.30 meter wide and 0.45 meter below tilting flume with the acrylic models having various blockages such as 30%, 40%, 50% and solid spur model. The results are analyzed and compared with the existing and field conditions. In this present study, from the result it was concluded that velocity get dampened and due to dampening sedimentation could start. The optimum length of spur is 25% of the total width of the river.

KEYWORDS: River flow, Bank stabilization, Spur, structures, Velocity, Scouring River training, Flow separation, Sediment.

I. INTRODUCTION

Stream preparing is the adjustment of the divert keeping in mind the end goal to keep up the fancied cross segment and arrangement. It means covers all the building works developed on a river to guide and confine the river channel to regulate the flow for effective and safe movement of floods and river sediment. In past history the act of preparing a river dates back to the sixteenth century where the Yellow River in China was prepared by building embankments along its banks so that the flow would be confined to a single deep channel, which would transport the sediment load to the sea. Modern river training practice, however, started in Europe in the nineteenth century, driven by the demands of the industrial revolution for the purpose of maintaining sufficient channel depth and a better course for navigation. In USA the main purpose for river training is to increase the flood carrying capacity of rivers. River training is an age-old practice resulting in incessant development and application of human ingenuity to correct vagaries of the rivers. It requires deep and precise study of river mechanism and behaviour discussed heretofore. River training has assumed considerable significance in India due to huge annual recurring damage caused by the floods; 80 per cent of which accounts for loss of crops. River training, in its broad viewpoints, covers all engineering works developed on a river to manage and confine the flow to the river channel, and to control and regulate the river bed configuration for successful and safe movement of floods and river sediments. Generally, river training envisages training and stabilizing a river within a suitable waterway and along a certain alignment for a variety of purposes. River training works include

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

extensive outlays and it is essential to select the type of the training work and materials of development so as to make optimum use of assets, and effective and economical use of the available development materials.

River training practice driven by the demands of the industrial revolution for the purpose of maintaining sufficient channel depth and a better course for navigation. Groynes are structures constructed at an angle to the flow in order to deflect the flowing water away from critical zones. They are made of stone, gravel, rock, earth, or piles, wooden piles, bamboo porcupines, cribs etc. beginning at the riverbank with a root and ending at the regulation line with a head. They serve to maintain a desirable channel for the purpose of flood control, improved navigation and erosion control.

Objective:

- a. To protect an existing bank line.
- b. The main purpose for river training is to increase the flood carrying capacity of rivers.
- c. Flood Protection.
- d. Maintaining a good and safe navigable channel.
- e. Sediment Control.
- f. Stabilizing the River Channel for Prevention of Bank Erosion.
- g. Classification of River Training Works.
- h. To re-establish some previous flow alignment.
- i. To provide flow constriction.
- j. The use of spur-type structures is that they have been observed to provide an enhancing influence on bank vegetation. The erosive action of currents impinging directly on the bank will often prevent or hinder the natural volunteering of plant materials down the bank. Since spurs shift these main flow currents away from the bank.
- k. Again, spur use is recommended along irregularly shaped banks because excessive bank preparation and shaping is not required to produce a smooth alignment around the bend.
- l. The use of spurs is not adversely affected by irregular bank lines.

A.1 TYPE OF SPURS

Various types of spur can be distinguished according to their construction, action on stream flow and appearance.

- (i) Impermeable spur
- (ii) Permeable spur

Permeable Spur: These spurs permit passage of restricted flow. Because of partial obstruction to flow they promote deposition of sediment as the flow is retarded. They are built of materials like bellies, bamboos, timber, brush, steel or wire discussed hereinafter. They slow down the velocities over apportion of the channel area and thereby induce rapid deposition of sediment. Heavy silt laden river water when so retarded, drops much of its suspended load, bed load to come to rest, thereby building up new bank lines. This side contraction causes a larger proportion of the discharge to flow in the main channel, thus increasing its water and sediment transport capacity.

(a) Tree Spur: Tree spur consists of a 25 mm diameter wire rope firmly anchored at one end to the river bank and tied at the other end to a heavy buoy or a concrete block. The length of stretched wire rope constitutes the length of tree spur. The entire leafy trees with abundant branches such as Babul are employed to increase sedimentation by retarding velocity of flow and intercepting sand and silt. A hole, about 0.3 m up the stem of each tree is drilled through which an iron ring is drawn and attached, either directly or by subsidiary pendant wire ropes, to the main rope. When trees become heavy with detritus they sink. Therefore, they are packed as closely as possible. Initially the spur is laid pointing upstream at an angle between 60° to 70° according to USBR recommendation, so that when it launches and becomes sand bound it assumes a position still facing slightly upstream.

(b) Dip Trees Spur: Dip trees spur consists of entire bamboo trees with branches whose bottom is tied to a heavy concrete block or small crate full of stones by means of a hook. It is then launched in water. It keeps the tree at the launched position and sinks itself in whenever scour occurs. Rows of dip trees form the cross or longitudinal permeable spurs.

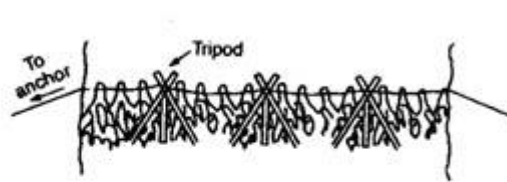


Figure: Typical tree groyne.

Figure:1 Typical tree groyne.

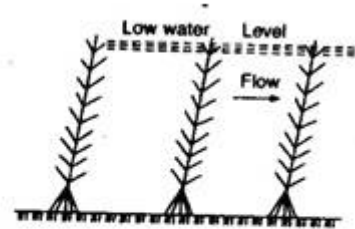


Figure: Dip trees

Figure:2 Dip trees

Tree spurs serve the object if (i) Diverting or deflecting the current directly threatening erosion of a bund, and (ii) To deaden the flow in one by river near the bund in order to open out another by river away from the bund, and (iii) to silt up a channel of the river at its source by checking the flow in it.

(c) **Pile Spur:** The piles may be wooden balli, sheet pile or R.C.C. pile. They constitute the main verticals driven down 2.5 to 3 m about 6 to 9 m inside the river bed and in at least 2 to 3 similar rows. For ease in driving, the piles are tapered at the base and are fixed with heavy iron shoes. In between the main verticals, there can be two intermediates, embedded at least 1.25 m below the bed. Each row is closely intertwined either with brushwood branches, going in and out around each vertical, or by horizontal railings. Every other main vertical of the rear row is strutted, the struts are embedded a minimum of 2.5 m below bed. Between two rows, the space is filled with brushwood branches in alternate layers of 1.75 m thick brushwood weighted by 0.6 m thick stones or sand bags. Being a permeable spur, the whole space is not filled with stones. The filling is closely packed and tamped. The bed is protected both at upstream and downstream of the spur and around the nose with a fascined mattress or a stone apron 1.0 m thick over a width of 3 m and 6 m along the shank and nose respectively.

(d) **Bamboo Cage Spur:** Figure indicates typical cross section of bamboo cages flat bottomed permeable spurs constructed at NinanNurpur reach of river Hooghly. They were made of full and half split bamboo members, jointed with nails. Each cage consisted of 0.75 × 0.75 m cubical boxes, top and bottom of which were covered with 1.75 × 0.75 m sized lids and contained about 50 bricks. Each cage when dumped in groups covered about 1.70 m³ and remained about 50% permeable ensuring thereby fast construction. The interlocking between the cages increases their resistance to possible drifting and the spur is rendered gradually stable by deposition of silt.

(e) **Porcupines:** Bamboo porcupines have been used in India to induce siltation along the river banks. These are made of 3 to 6 m long bamboos tied together at the centre in the form of a space angle and are weighted by tying some stones to the centre. These add roughness to the channel in the over bank area

A.2 SPUR DESIGN RECOMMENDATION

The following is a summary of the major recommendations given by USBR manual presented in this paper they are organized by design component for easy reference according.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

Permeable spurs

- a. Where it is necessary to provide a significant reduction in flow velocity, a high level of flow control, or where the structure is being used on a sharp bend, the spur's permeability should not exceed 35 percent.
- b. Where it is necessary to provide a moderate reduction in flow velocity, a moderate level of flow control, or where the structure is being used on a mild to moderate channel bend, the spurs with permeability up to 50 percent can be used.
- c. In environments where only a mild reduction in velocity is required, where bank stabilization without a significant amount of flow control is necessary, or on mildly curving to straight channel reaches, spurs having effective permeability up to 80 percent can be used. However, these high degrees of permeability are not recommended unless experience has shown them to be effective in a particular environment.
- d. It is recommended that jack and tetrahedron retardance spurs be used only where it can be reasonably assumed that the structures will trap a sufficient volume of floating debris to produce an effective permeability of 60 percent or less.
- e. It is recommended that Henson-type spurs be designed to have an effective permeability of approximately 50 percent.
- f. The greater the spur permeability, the less severe the scour pattern downstream of the spur tip. As spur permeability increases, the magnitude of scour downstream of the spur decreases slightly in size, but more significantly in depth.
- g. The vertical structural members of permeable spurs should be round or streamlined to minimize local scour effects.
- h. The greater the spur permeability, the lower the magnitude of flow concentration at the spur tip.
- i. If minimizing the magnitude of flow deflection and flow concentration at the spur tip is important to a particular spur design, a spur with a permeability greater than 35 percent should be used.
- j. The more permeable the spur, the shorter the length of channelbank protected downstream of the spur's riverward tip.
- k. Spurs with permeability up to approximately 35 percent protect almost the same length of channelbank as do impermeable spurs; spurs having permeability greater than approximately 35 percent protect shorter lengths of channel bank, and this length decreases with increasing spur permeability.
- l. Because of the increased potential for erosion of the channel bank in the vicinity of the spur root and immediately downstream when the flow stage exceeds the crest of impermeable spurs, it is recommended that impermeable spurs not be used along channel banks composed of highly erodible material unless measures are taken to protect the channel bank in this area.

II. LITERATURE SURVEY

Md.Luftfor et. al. (2011)[40] have studied bamboo bandals are working as a river bank erosion protection & recovery of agricultural land with the aid of sedimentation near the river bank. The bamboo bandalling structures are capable for protecting river banks by flow diversion towards the main channel leading to deep navigational channel formation in

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

the main river. The present paper suggest that for water content less than 0.24, the maximum equilibrium scour depth for both vertical wall and wing wall abutments decreases with an increase in clay content of the clay-sand mixtures. The proposed equations estimate the maximum scour depths for vertical wall abutments obtained from experiments Reasonably well. Standard step method is widely used for the estimation of flow depth or water surface profile at a specific location for a given discharge, channel bed slope, cross-sectional area, hydraulic radius and channel roughness. A sharp-crested V-notch, calibrate Before the experiment, was used for maintaining required discharge.

Mubeen Beg et. al.(2014)[44] carried out the information on different characteristics of scour holes developed around the piers are collected and analyzed. Present study uncovers significant common obstruction impact on scour opening qualities which may prompt to scaffold disappointment, if dock gather impact is disregarded and connect wharfs are composed simply as a disconnected dock.The various effect of porcupines on the speed of flow and their power to capture sediment has been searched experimentally.The present paper distorted hydraulic model studies presented on the existing mobile bed model of Kosi River at CWPRS Pune with horizontal scale 1/500 and vertical scale 1/72.

Mubeen Beg et. al.(2014)[44] have studied Porous asphalt is utilized in Permeable Pavement Systems (PPS) Test techniques based on the utilization of permeable pavement models, manufactured in laboratory and evaluated under various clogging conditions, slope, rain and runoff, have been widely applied to the study of permeable pavements with concrete blocks but not to the study of porous bituminous mixtures.

B.C.Barmana et.al. (2014)[43]have studied to investigate the impact of various porosities of partial blockage at front of bridge pier on local scour profundity conformed scaffold bridge underpins. The permeable blockage with various relative heights was settled on and the mobile bed. The effects of different parameters Including fiber (particle) shape, aspect ratio, orientation, and staggered unit cell angle on the normalized permeability are measured and discussed in detail for the full range of porosities. Topology optimization is used to systematically design periodic materials that are optimized for multiple properties and prescribed symmetries. The goal is to determine the optimal distribution of material phases within this domain.

SanjayA.Burelea et. al. (2012)[46] shows that the considerations of spur permeability were discussed in relation to the selection of an appropriate spur type, However, for both the retardance and retardance/diverter structures, a variety of spur permeability can be and have been designed. Spur permeability as referred to in this report is defined as the percentage of the spur's surface area that is open or unobstructed. In environments where the permeable structure can be reasonably assumed not to clog with floating debris or other material, the determination of a particular spur Is permeability only requires computation of the unobstructed flow area withinthe structure. In most environments, however, the spur's effective permeability will be reduced as floating debris clogs the face of the spur.

Nayan Sharma et.al.(2015)[45] gives additional comments can be made regarding specific spur types identified in Chapter 2 based on their field performance. The permeability of jack and tetrahedron retardance spurs is set by their design. The permeability of these structures is generally greater than 80 percent. However, because of their high level of permeability, they do not provide sufficient flow retardance on their own to be effective as bank-stabilization or flow-control structures. Where they have been effective, it has been because they have trapped a sufficient volume of light floating debris to reduce their effective permeability to an estimated value of approximately 50 to 60 percent. Thus, it is recommended that jack and tetrahedron retardance spurs be used only where it can be reasonably assumed that the structures will trap a sufficient volume of floating debris to produce an effective permeability of 60 percent or less.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

III. PROPOSED SYSTEM APPROACH

A. EXPERIMENTAL SETUP:

Flume

The experiments were carried out in Post Graduate Hydraulic Laboratory of BVDU College of Engineering, Pune. Experiments were arranged in 10 m long, 0.3 m wide and 0.45 m deep re-circulating tilting flume. The re-circulating flow system is served by a 30 hp, variable-speed, centrifugal pump located at the downstream end of the flume. The detailed sketch of experimental setup is given in Figure1. The flume used which is having the minimum slope of 0.0015 and maximum slope of 0.002. The flume slope is adjusted at 0.0015 and 0.002 throughout the experiment



Fig.3: Water Re-circulating Tilting Flumes

Flow Conditions

Two pointer gauges with Vernier, having precision of 0.1 mm were used to measure the water levels at upstream as well as downstream of the structure. To measure the point velocity, calibrated propeller type of current meter was used. The V-Notch of 0.45 m width and 0.43 m depth weir was used at downstream end of the tilting flume for measuring discharge.

The discharge range is $0.0015 \text{ m}^3/\text{s}$ - $0.005 \text{ m}^3/\text{s}$. Corresponding velocity range was 0.002 m/s to 0.236 m/s . Froude Number range is about 1.2 to 1.4. Reynolds's number was above the 16000 which is sufficient to maintain the turbulent flow in the flume for studies. If Reynolds's number was less, it would lead to laminar flow, therefore was avoided.

1. The Study parameters

The following range of hydraulic and other parameters were used for the model studies.

- Range of permeability:** Accordingly in this present study the permeability was kept 70%, 60% ,50% and 0% (Impermeable).
- Angle:** 15° and 30°
- Submergence:** Non submergence
- Length of permeable spurs:** According to the field experience, the length of the spur is restricted to 15% to 20% of total width of channel. Due to the limitations of flume width and the instrumentation available, it was necessary to keep the length of spur to 30%.
- Height of permeable spur:** As per the field data, for non submerged condition, the depth of the permeable spur was assumed as 15 cm in the model.

f. **Location, orientation of permeable spurs:** As per USBR recommendation given in the introduction the spurs are kept perpendicular, as well as the angled towards upstream & downstream 15° & 30° . The primary criterion for establishing an appropriate spur orientation for the spurs within a given spur scheme is to provide a scheme that efficiently and economically guides the flow through the channel bend, while protecting the channel bank and minimizing the adverse impacts to the channel system.

Spur angled downstream produce a less severe constriction of flows than those angled upstream or normal to flow. The greater an individual spur's angle in the downstream direction, the smaller the magnitude of flow concentration and local scour at the spur tip.

Impermeable spurs create a greater change in local scour depth and flow concentration over a given range of spur angles than do permeable spurs. This indicates that impermeable spurs are much more sensitive to these parameters than are permeable spurs.

- g. **The discharge range:** The discharge was kept changing as per the requirement of experiment and corresponding to the water depths. The requirement of the experiment was to get the velocities from lower to higher values. Accordingly the discharge was varied for each run of experiment for each model.
- h. **Depth of flow:** Water level was kept accordingly 8 cm, 10 cm in correspondence with the field experience.
- i. **Velocity:** Velocity was also decided on the basis of the field experience. For permeable structure velocity requirement is 2 to 2.5 m/s in the prototype. In the experiment it was decided to keep the velocity 0.002 m/s to 0.236 m/s.
- j. **Model:** The models of permeable spur were made up of acrylic material. The detailed drawing is given in the figure.
- k. **Froude and Reynolds Number:** To maintain the stable and turbulent flow, corresponding Froude and Reynolds number was maintained. Froude and Reynolds number were adopted for different model runs.

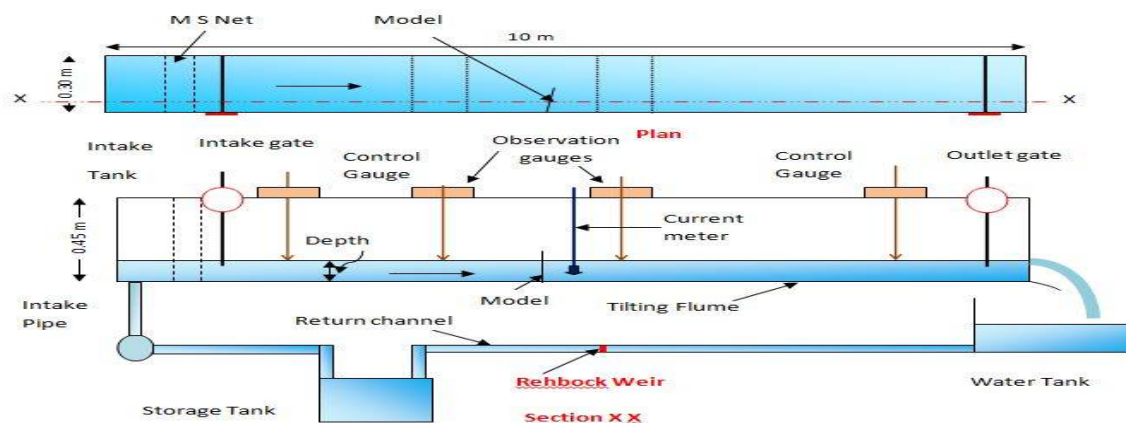


Fig.4: Experimental Setup

Following figures indicate the position of the model and sections where the observations were taken.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

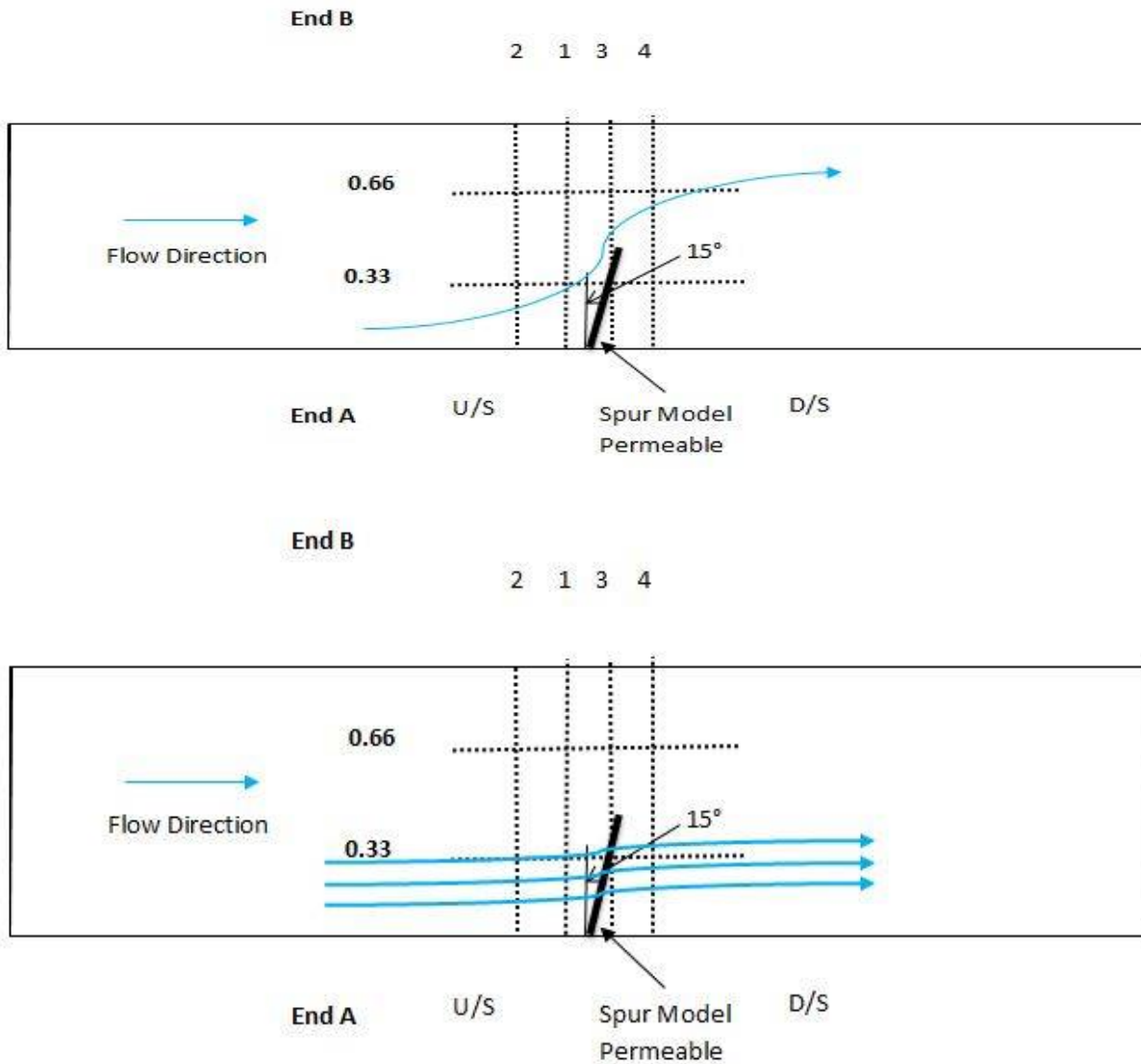


Fig.5: Figure showing layout of permeable model and flow condition

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

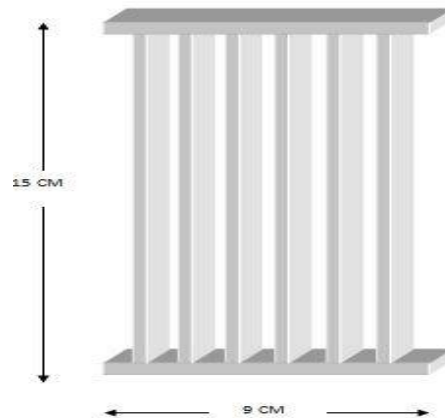


Fig. 6: Typical drawing of permeable spur model

B. METHODOLOGY:

The following sets of experiments were conducted:

a. Studies under existing conditions: Initially experiments were carried out without any obstruction to get a confirmation of steady and uniform flow and normal velocity distribution along the flow. A point velocity was measured at the three sections along the flow, at five sections such as End A, 0.33, 0.66 and End B across the flow and along the depth such as at the bottom, centre and top of the flow. It is clearly indicated in figure given above in Figure. These studies would clearly indicate the velocity distribution in the open channel flow. Depth was maintained by using two pointer gauges respectively at upstream and downstream. The discharge is maintained by upstream and downstream gates.

The experiments were carried out for different discharge stages, longitudinal slopes, depth of flows, etc. The studies were given the range of velocity of flow, range of Fr and Re numbers. The ranges for discharge, velocity and depth were already mentioned in the experimental setup.

b. Studies with spurs with different permeability: The above sets of experiments were repeated for the range of permeability. The same procedure was repeated with the permeable spur models with variable permeability such as 70%, 60% 50% and 0%. A point velocity was measured along the flow at six different sections as shown in figure. The observations were taken and then analyzed.

IV. RESULT AND DISCUSSION

1. Effect of flow blocking :

Steps for analysis of Change in **Scouring pattern** are as follows:

Analysis:

- Plotted this permeability versus scouring depth of flow in existing condition .
- For a given permeability, scour depth was found with the help of pointer gauge between u/s & d/s.
- From pointer gauge the depth of bed level were calculated & the depth of scouring pattern were measured.
- The difference of bed level and depth of scouring pattern gives scouring depth.
- Graph indicate that there is reduction in scouring on permeability increases.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

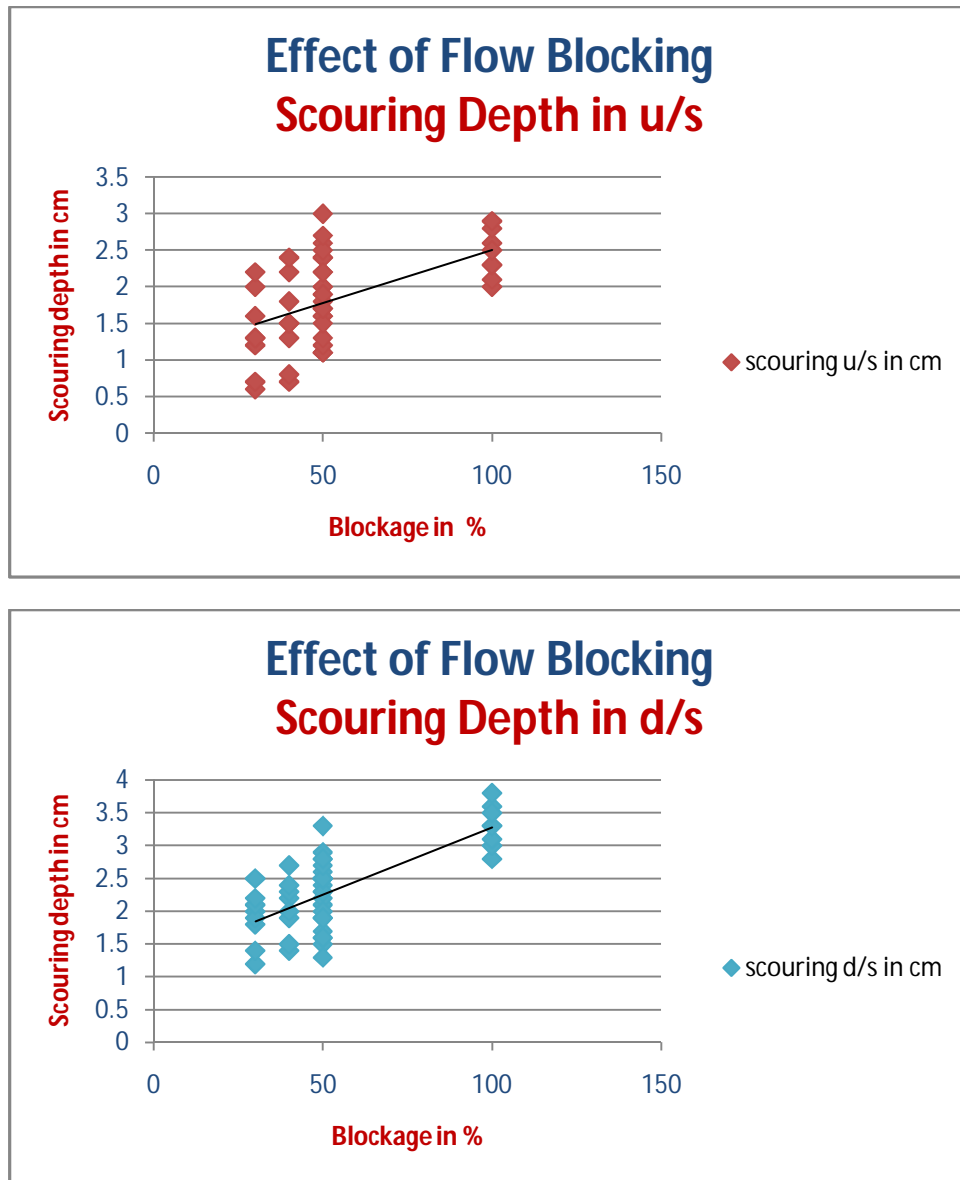


Fig.7: Graph Showing Effect Of scouring depth vs Blockage

Observations:

Graph indicate that there is reduction in scouring on Blockage decreases.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

2. Effect of velocity:

Steps to analyze Velocity change at screen are as follows

Analysis:

- Change in velocity between average velocity without structure and average velocity with permeable structure having different permeability were calculated.
- Variation in velocity with respect to average velocity in existing condition (without structure) were found.
- Plotted graph between the change in velocity and average velocity in existing condition. It would give better pictorial view to understand the percentage reduction in the velocity due to the permeable structure.

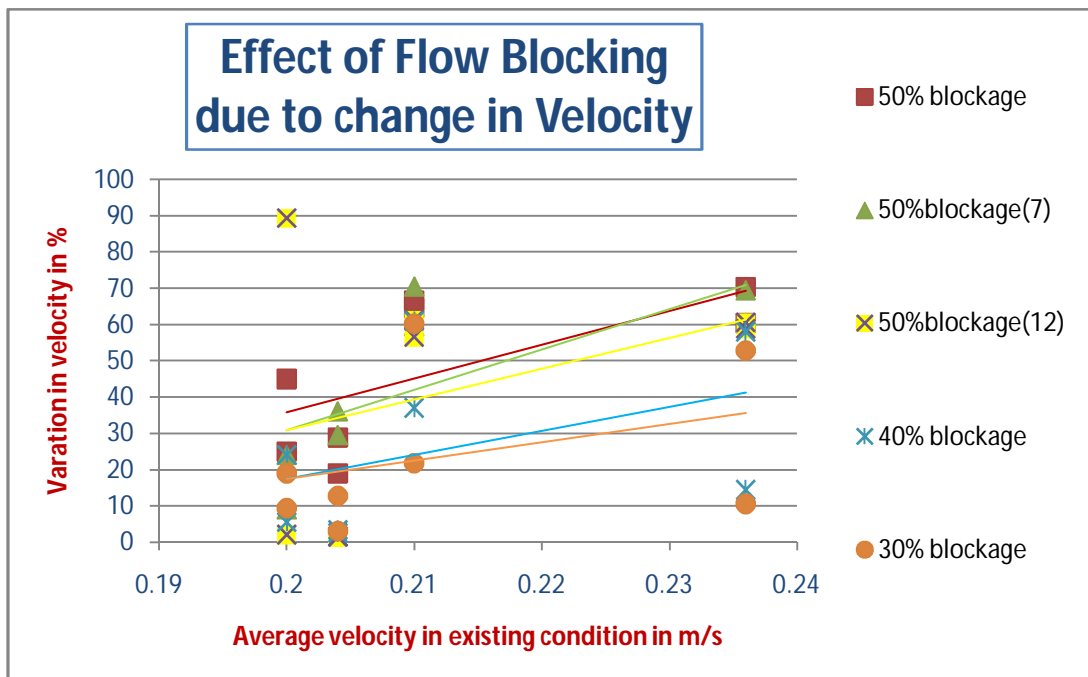


Fig.8: Graph Showing Effect Of Flow Blocking On Velocity

Observations:

The above graph shows the relation between the average velocity in existence condition and the change in velocity. As shown in graph, as the blockage increases the variation in the velocity also increases. All the points refers the reduction in velocity due to blockage. As the average velocity increases the reduction in the velocity also increases. This trend is followed by various percentages of blockages. The graph also suggests that the for lower percentage of blockage the variation is less and for higher percentage of blockage there is large reduction in the existing velocity. The trendlines shown in the graph are almost parallel to each other.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

3. Effect of Flow Blocking:

Steps to analyze **Reduction in sediment transport capacity** are as follows:

Analysis:

- The sediment transport capacity with or without structure by using USBR's consideration that sediment transport capacity is proportional to the fifth power of velocity were calculated.
- The difference between the sediment transport capacity after installation of permeable structure and sediment transport capacity in the existing condition were calculated.
- Plotted the graph between the reduction in the sediment transport capacity due to the permeable structure and the existing average velocity.

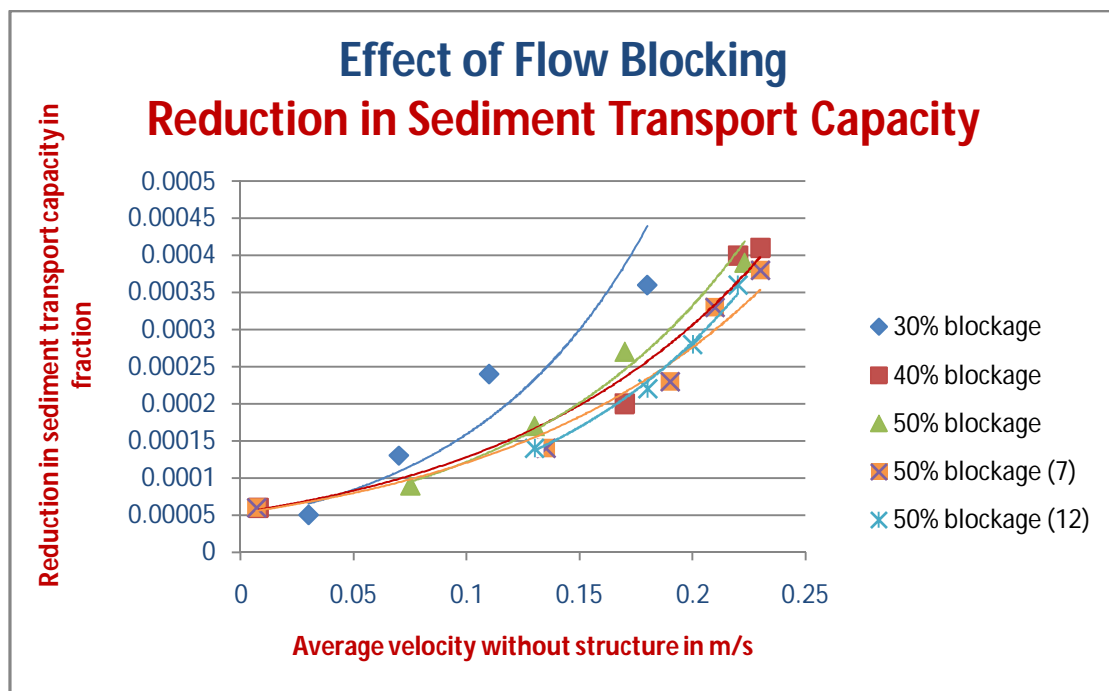


Fig.9: Effect Of Blocking On Sediment Transport Capacity

Observations:

The above curve gives the relation between the average velocity in existing condition and the sediment transport capacity. The graph follows the exponential relation. The graph shows that, increase in the average velocity in the existing condition there is decrease in sediment transport capacity. If sediment transport capacity decreases then there will be increase in the deposition. Ultimately that reduces the erosion which is the aim of the transverse structure i.e. spur.

In this present study, the graph shows the typical similar trend for the various percentages of blockages. The trendline of 40% blockage shows the declination at the higher values of the average velocity at existing condition. The trendline of 30% blockage shows that the reduction in the sediment transport capacity is more at the lower velocities. For other blockages, more reduction in the sediment transport capacity is possible for higher velocities.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

4 Effect of Flow Blocking:

Steps to analyze the Flow separation are as follows:

Analysis:

- From the observation and experimental data, the length of the flow separation at upstream & downstream of the permeable structure were calculated.
- Following graph will show blockage verses separation length.
- Separation length in the stream of upstream and downstream were calculated , used floating paper to find out the flow pattern separation length.
- It was concluded that as permeability increases separation length decreases.

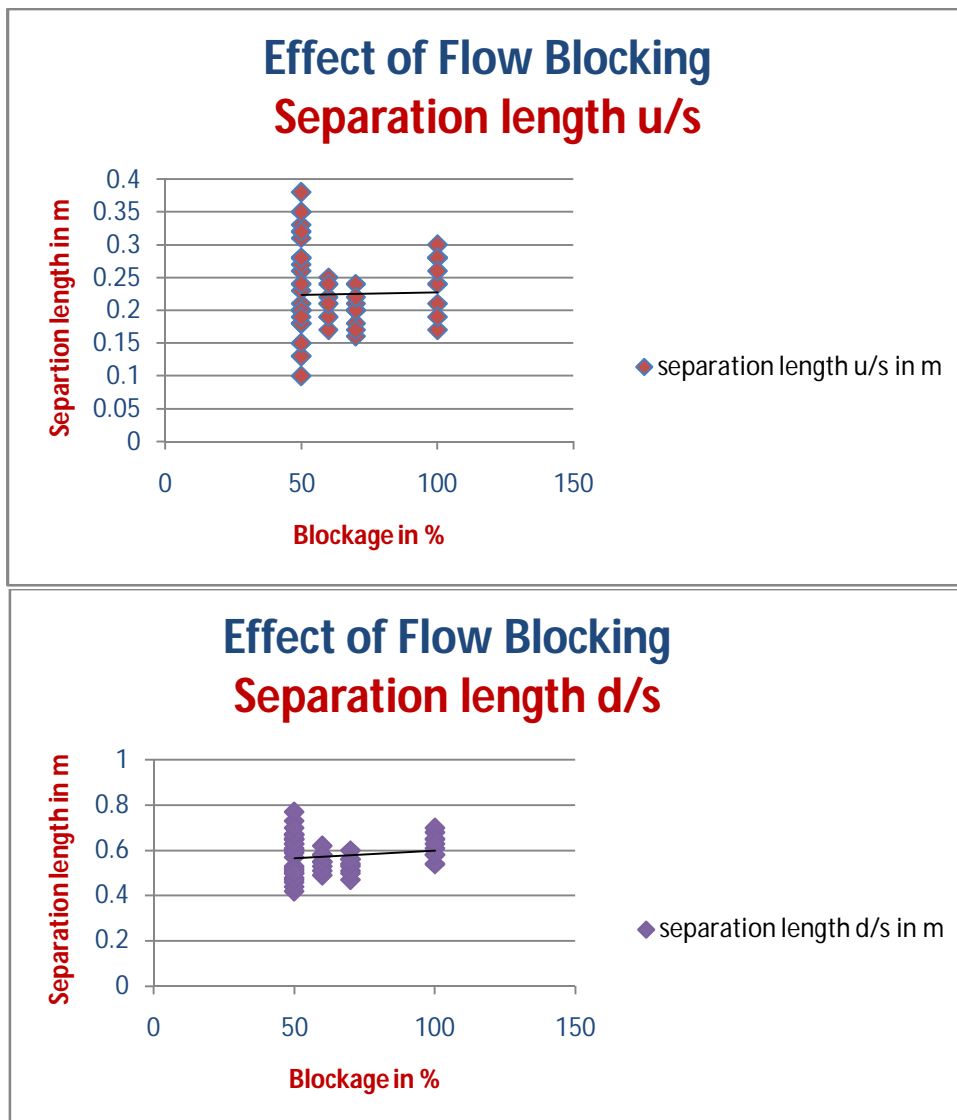


Fig.10: Graph Showing Effect Of Blocking On Flow Separation

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

Observations:

The above graph shows that as permeability increases separation length decreases. And as blockage increases the flow separation also increases. It is very obvious if block the flow it will pass from somewhere else but here the blockage is permeable. There is very less blockage to the flow that's why the flow velocity gets dampened but the separation is very less for lesser percentage of the blockage. For the higher blockages separation increases. For solid spur where the permeability is zero the flow separates from the bank and affects the other bank.

Observations:



Fig.11: Flow Separation Due To Impermeable Spur

In the above photograph it is clear that the flow is totally separated from the main flow. The flow is almost stagnant near the structure and eddies are formed at downstream of the permeable structure.

In the below photographs the flow separation due to solid spur and permeable spur was shown. In solid spur, flow is totally separated from the side of the flume. Even the eddies formation due to reversal of flow due to blockage was observed. But in case of the permeable spur flow is almost passing through the spur so there are no chance of formation of eddies and separation of flow.

Effect of solid spur

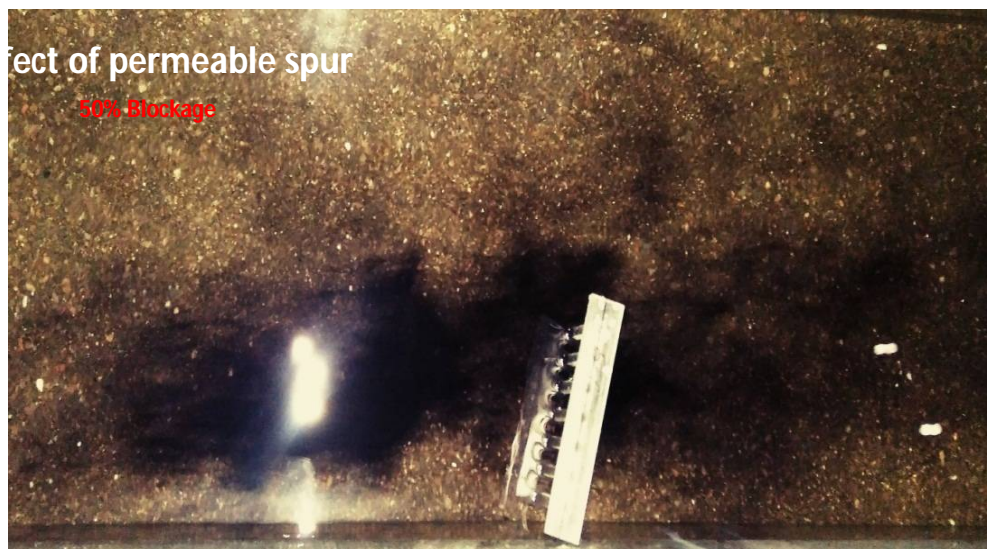


Fig.12: Photographs showing solid and permeable spur (50% blockage)

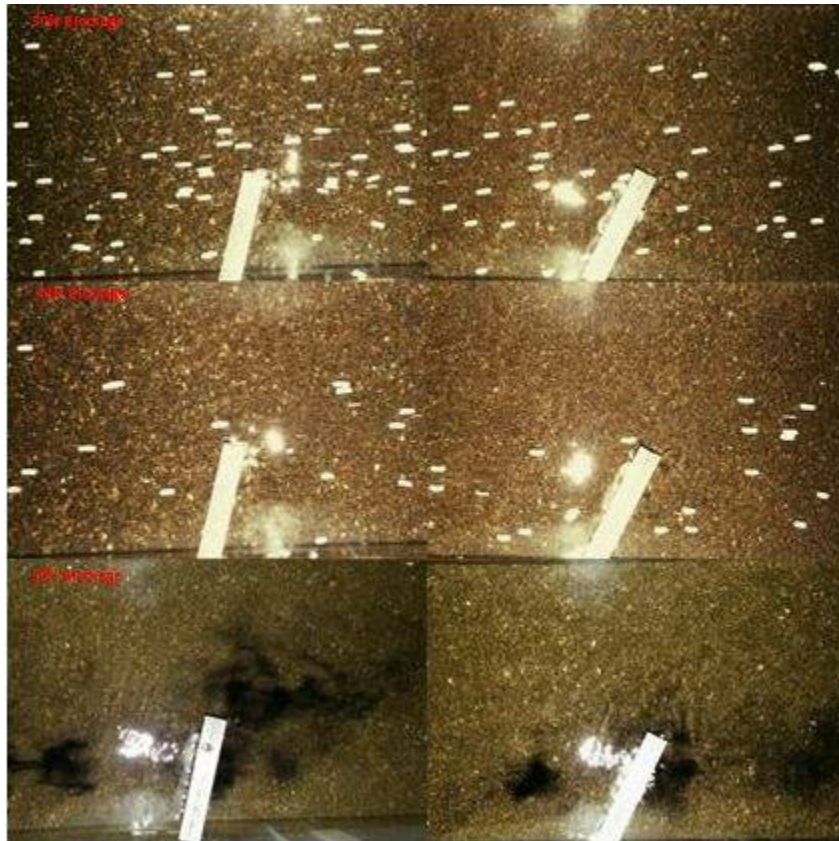


Fig.13: Photographs Showing Comparison Between Flow Separation Due To Various Blockages

The above pictures are taken while performing the experimentation. Above picture indicates that the flow separation is less for the less blockage and increases with increase in the percentage of blockage. No eddy formation is observed in the permeable structure at the down stream end. For solid spur maximum flow separation is observed.



Fig.14: Photographs showing Comparison between flow separation for (50% blockage)

5 Conclusion

- a. Generally for given value of average velocity in existing condition, velocity variation increases as increase in blockage. In this present study, for the range of existing velocity from 0.002 to 0.24.
- b. For more blockages there will be major reduction in the velocity.
- c. For given value of blockage as average velocity in existing condition increases reduction in velocity also increases.
- d. From the results of sediment transport capacity, it is observed that for given value of average velocity without structure, reduction in sediment transport capacity increases as the blockage increases. In this present study, the range varies from 0.00001 to 0.00045 for reduction in sediment transport capacity for the range of velocity from 0.002 to 0.24 m/s.
- e. For the given value of blockages, the reduction in sediment transport capacity increase as average velocity without structure increases except 40% blockage.
- f. For 40% blockage for higher velocity there is slight decrease in reduction in sediment transport capacity. The reason for the same could not be analyzed.
- g. For higher velocity without structure, more blockages required for reducing the sediment transport capacity.
- h. Generally for given percentage of blockage, the scouring depth increases as blockage increases. The range of scouring depth varies from 6mm to 38 mm for the range of existing velocity.
- i. For given percentage of blockage variation in depth increases as average velocity in existing condition increases.
- j. From the result of flow separation it is observed that flow separation increases as percentage blockage increases. As an extreme case, solid structure flow is totally diverted to the other bank. Naturally all intermediate stages would be in between this.
- k. From the above conclusions it is clear that 40% blockage will be optimum blockage in erosion control.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

- I. The projected length of permeable spurs should be held to less than 24 percent of the channel width. However, this criterion depends on the magnitude of the spur's permeability. Between these two limits, a linear relationship between the spur permeability and spur length should be used.

REFERENCES

1. Agarwal, S.K.: Protection of Majuli Island Against Flood and Erosion – A Case Study
2. Arun Lila, MahendraChaudhari, Minimal Korulla: "River Training Structures" in Proceedings of the Workshop on Recent Trends in River and Coastal Protection Works, June 11-12, 2009, PP 126 – 141
3. Azad, S., Oak ,R.A.: Use of Permeable Structures for Anti Erosion Work – A Case Study in National Conference " National Conference " Hydraulics, Water Resource, Coastal and Environmental Engineering", Hydro 2009
4. Babbar, Richa, Sethia, Baldev,: River Training for Navigation: A Case Study
5. Burule, S.A., Gupta, I.D., Singh,M.N., Sharma,Nayan, Zulfikar Ahmad, : "Experimental Study on Performance of Spur" in ISH Journal of Hydraulic Engineering, Vol. 18, NO. 3, September 2012, PP 152 – 161
6. Cao, Yogatao: The Impacts Of Applying Permeable Groynes in the Lower Yellow River; Yellow River Institute of Hydraulic Research (YRIHR)
7. CBIP, Manual on River Behaviour, Control and Training, Publication No.60, 1956, PP 240 – 243 p. 190.
8. Federal Highway Administration – Bridge Scour and Stream in Stability Counter measures : Experience, Selection and Design Guidance (Third Edition) (2011)
9. Gao, Xiang- Gang, Liu HuanFang, HauGen Fu: " Research on Scouring and Silting Character around Permeable Spur" in Journal of CN China Rural Water and Hydropower 2010-11
10. Gao, Xiang- Gang, Liu HuanFang, HauGen Fu: Experimental Study on Local Scour and Silting around Permeable Spur, in International Journal of Port and Waterways Engineering, 2007 – 12
11. Garde, R.J., RangaRaju, K.G.: Mechanics of Sediment Transportation and Alluvial Stream Problems, New Age International Publication.
12. Hong, Koo, Yeo : "Nature- Friendly River-training Structure Using Groynes" in 4th Joint Seminar Between IWHR and Korea Institute of Construction Technology, Beijing, PP 29 – 51
13. Kothyari, U.C., RangaRaju, K.G.: "Scour Around Spur Dikes and Bridge Abutments", in Journal of Hydraulic Research, Vol. 39, 2001, No. 4, PP 367 – 374
14. Kulkarni, S.B., Prayag, J.D.: "State of Art on Spurs", Central Water and Power Research Station – Technical Memorandum 1991-92
15. Mike Feduk, : Erosion Protection of a Clay Bank of Keogh River Using Spurs (Debris Groynes) in *Sreamline*, BC's Watershed Restoration Technical Bulletin, PP 12 – 19
16. Mioduszewski, Tomasz, Maeno, Shiro, Uema,Yatsugi : "Influence of the spur dike permeability on flow and scouring during a surge pass" in International Conference on Estuaries and Coasts, PP 380 – 388
17. Moitaba, G.K., Abbas, B.G.: Effect Of Groyne Opening Percentage On River Outer Bank Protection, Journal Of Applied Sciences (2009)
18. Muzumdar, S.K. : "Protection of Flood Embankments By Spurs with Reference to Kosi River", presented in National Conference on Hydraulics and water Resource Engineering, Hydro 2011 PP 336 – 343
19. Nasrollahi,A., Ghodsian, M., SaheliNeyshabouri, S.A.A., : Local Scour Around Permeable Spur, Journal of Applied Sciences Vol. 8 No. 19, 2008, PP 3398 – 3406
20. O'Donnell,J P, Henson Spur Jetty in Oil and Gas Journal, Volume 71 Issue no. 2, PP 100 – 103
21. Oak, R.A., Kulkarni, S.B, V.K. Appukkuttan: Use Of Permeable Structures For Bank Protection Measures: Field Experience With Different Rivers, In National Conference On Hydraulics, Hydro 1999, March 6-7
22. Oak, R.A., Permeable Structures In Alluvial Rivers – Short Note
23. Oak, R.A.: "Use of Permeable Structures for River Training and Bank Protection Works" in Proceedings of the Workshop on Recent Trends in River and Coastal Protection Works, June 11-12, 2009, PP 86 – 97
24. Rahman, M.L., Basak, B.C., Osman, M.S., AltafHossain. : Interaction of Low Cost Bandle Structures For Sediment Management in National Conference " Hydraulics, Water Resource, Coastal and Environmental Engineering", Hydro 2009
25. Rahman, M.L., Basak, B.C., Osman, M.S.: "Velocity Distribution Around the Low Structures named Bandalling for River Bank Protection" in Proceedings of River,Coastal, and Estuarine Morpho dynamics (RCEM 2009) PP 497 – 502
26. Rahman, M.L., Basak, B.C., Osman, M.S.: Low Cost Techniques to Recover Agricultural Land Through River Bank Erosion Protection in ICID 21st International Congress on Irrigation and Drainage 15 - 23 Oct. 2011
27. Rahman, M.L., Basak, B.C., Osman, M.S.: Recovery of Agricultural Land Through River Bank Erosion Protection, National Conference of Hydraulics and water Resource Engineering, Hydro 2011
28. Rahman, M.L., Basak, B.C., Osman, M.S.: River Bank Stabilization with the Application of Bamboo Bandalling Structure – A Case Study in 4th Annual Paper Meet and 1st Civil Engineering Congress Dec 22-24, 2011, Dhaka, Bangladesh
29. Rahman, M.M., Nakagawa, Ishikagi, A.T.M., : Channel Stabilization using Bandalling in Annuals of Disaster Prevention Research Institute, Kyoto University, No. 46 B, PP 613- 618 , 2003
30. Report from JIP, CBIP on Floods, Flood Control, and River Training
31. Report of Workshop Holding at NINI, Patna by Inland Waterways Authority of India on River Training Issues
32. Revised Chapter VIII (River Training and Protection Works), Indian Railways Bridge Manual 2011
33. Roger A. Kuhnle, Carlos V.Alonso, F.Douglas Shield Jr.: "Local Scour Associated with Angled Spur Dikes", in Journal of Hydraulic Engineering, Technical Notes, PP 1087 – 1093

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

34. Ronald R. Copeland, "Bank Protection Techniques Using Spur Dikes" Miscellaneous Paper, Hydraulic Laboratory U.S.Army Engineer Waterways Experiment Station, Final Report, January 1983.
35. Shiyekar, S.S., Shitole, M.S. : Planning Designing and Layout of Permeable structures in alluvial rivers, in National Conference of Hydraulics and water Resource Engineering, Hydro 2005 PP
36. Teraguchi, H., Nakagawa, H., Kawaki, K., Baba, Y., and Zang, H.: Morphological Changes Induced by River Training Structures : Bundle like structures and Groynes in Annuals Of Disaster Prevention Research Institute, Kyoto University, No. 53 B, 2010
37. Uijtewaal, W.S.J. : Effects of Groyne Layout on the Flow in Groyne Fields; Laboratory Experimental, Journal Hydraulic Engineering, ASCE, Vol. 131, No. 9, 2009 PP 782 – 791.
38. Zhang, H., Nakagawa, H.: Characteristics of Local Flow and Bed Deformation at Impermeable and Permeable Spur Dykes, in Annual Journal of Hydraulic Engineering, JSCE, Vol. 53, 2009, Feb., PP 145 – 150
39. Zhang, H., Nakagawa, H.: "Scour around spur dyke: Recent Advances and Future Researches in Annuals of Disaster Prevention Institute, Kyoto University, No. 51 B, 2008 PP 633- 652
40. LOW COST TECHNIQUES TO RECOVER AGRICULTURAL LAND THROUGH RIVER BANK EROSION PROTECTION, Md. LutforRahman, B.C. Basak and Md. Showkat Osman, International Congress on Irrigation and Drainage, 15-23 October 2011, Tehran, Iran.
41. KoustuvDebnath, SusantaChaudhurib and Mrinal K. Manik, "Local scour around abutment in clay/sand-mixed cohesive sediment bed", ISH Journal of Hydraulic Engineering, 2014 Vol. 20, No. 1, 46–64
42. Backwater profile during barrage gate operation for variable pond levels B.C. Barmana, R.B. Sahu and G. Bhandar, ISH Journal of Hydraulic Engineering, 2014 Vol. 20, No. 3, 239–249
43. Mubeen Beg and Salman Beg, "Scour hole characteristics of two unequal size bridge piers in tandem arrangement" ,ISH Journal of Hydraulic Engineering, 2014.
44. Riverbank protection with Porcupine systems: development of rational design methodology.
45. Mohammad Aamir and Nayan Sharma, ISH Journal of Hydraulic Engineering, 2015.
46. Experimental study on performance of spurs Sanjay A. Burelea*, Ishwer D. Gupta, ISH Journal of Hydraulic Engineering Vol. 18, No. 3, September 2012, 152–161
47. Jorge Rodriguez-Hernandez; Daniel Castro-Fresno , "Characterization of the infiltration capacity of permeable pavements with porous asphalt surface using the CF Infiltrometer", Journal of Hydrologic Engineering. Submitted July 17, 2010; accepted July 25, 2011 posted ahead of print July 27, 2011. doi:10.1061/(ASCE)HE.1943-5584.0000480
48. Nasr-Allah T. Hemdan 1, Mohamed Y. Abdallah, " EXPERIMENTAL STUDY ON THE EFFECT OF PERMEABLE BLOCKAGE AT FRONT OF ONE PIER ON SCOUR DEPTH AT MULT-VENTS BRIDGE SUPPORTS" , Journal of Engineering Sciences Assiut University Faculty of Engineering Vol. 44 No. 1 January 2016 PP. 27 – 39.
49. K. Yazdchi , S. Srivastava, S. Luding, "Microstructural effects on the permeability of periodic fibrous porous media" ,International Journal of Multiphase Flow 37 (2011) 956–966
50. James K. Guest , Jean H. Pre´vost, "Optimizing multifunctional materials: Design of microstructures for maximized stiffness and fluid permeability" ,International Journal of Solids and Structures 43 (2006) 7028–7047.
51. Verification studies for the effect of blockage in permeable structure," Deepalikulkarni, R.A oak, P.t nimbalkar", indian journal of applied research, 2013 vol.3 issue.8.
52. www.google.com