RESEARCH PAPER | Engineering | Volume : 3 | Issue : 8 | Aug 2013 | ISSN - 2249-555X

Varification Studies for Effect of Blockage in Permeable Structurest

KEYWORDS: River Training, Permeable Structure, sediment transport capacity, flow separation

Mrs. Deepali Kulkarni	Prof. R. A. Oak	Prof. P. T. Nimbalkar
Asst.Professor & P.G.Student, BVDU College of Engineering, Pune & Ex. CRO, CW & PRS, Pune	Professor, BVDU College of Engineering, Pune & Ex. CRO, CW & PRS, Pune	Professor, BVDU College of Engineering,Pune

ABSTRACT *:- In northern India most of the rivers comprise alluvial deposits. During the monsoon the river banks are eroded and changed the river bank. Use of permeable structures is a cost effective alternative for the bank protection works.*

A dampening action on velocity of flow is achieved by permeable structures. In case of sediment laden rivers, permeable structures help to induce siltation along the bank. The sediment transport capacity of a flow is majorly depend on velocity. Therefore, the dampening of velocity results in deposition of sediment.

In this present study, the effect of blocking of flow on various flow parameters such as velocity, discharge, sediment transport capacity, depth etc. is investigated with the help of experiments. Experiments were conducted in a 10 meter long, 0.30 meter wide and 0.45 meter deep tilting flume with the acrylic models having different blockage such as 10%, 20%, 30%, 40% 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 permeability should be provided about 40%.

I. INTRODUCTION

River training is an art to protect the bank from erosion, changing the course, flood, and sediment control and navigation etc. Protection to the river banks is normally given by construction of stone revetments, impermeable spur etc. The cost of these traditional methods are very high, due to which the bank protection is generally restricted to the important areas such as urban areas, important roads, railway lines, agricultural lands, etc.

Construction of permeable structure is cheap and simple alternative method which can help not only to protect the bank but also to induce siltation along the bank and help to divert the river channel away.

Only a dampening action on the velocity of flow is achieved by a permeable structure, distinguished from the deflecting or repelling action of an impermeable structure. It is known that the sediment transport capacity of a flow is highly sensitive to the velocity. Therefore, the dampening of velocity could result in deposition of courser particles in the downstream direction. So the permeable structures can be called as sedimenting structure.

Permeable Sructure:

It is a structure made up of small units placed in suitable arrangements. These units are called as elements. Permeable groynes are usually cheaper than the impermeable ones. The basic principle behind the permeable structure is to reduce the velocity by providing partial obstruction to the flow and thereby induce deposition of the sediment.

Permeable groynes may be classified as

1. According to the function served – diverting, damping or sedimenting
2. According to the method and material of construction - i.e. ballies, bamboos, tree branches, R.C.C. poles and M.S. Pipes, etc.
3. According to conditions encountered – submerged, non submerged, etc
4. According to the type of structure provided – spur type, screen type, dampeners' type

Material Used for Permeable Structure: Locally available material like bamboos, ballies, brushwood, willows, bricks etc is mainly used for the construction of permeable structures. GI wire, GI wire mesh, wire ropes, nails etc are the other important but commercially available material used for the structures. Even now a day's RCC poles, M.S. pipes are also used for permeable structure.

Permeable structures commonly used are the screens, spurs and dampeners. The structural elements commonly used are the porcupines, cribs, bally frames, tree branches and willows. A suitable combination of the structure and the elements is made for the design of protection works.

Generally the type of permeable groynes design based on the velocity of flow. Velocity of about 2 m/s to 2.5 m/s is normally acceptable for the porcupine structures made up of bamboos. Porcupines made up of RCC poles can be used for much higher velocities such as 3.5 m/s or above. Refer Fig. No VII and VIII.

In case of shallow water flows and up to a maximum depth of 3m to 4m, porcupines are used for both spurs and screens. For maximum depths of flow between 3 m and 5m to 6m, cribs are preferred. For the depths beyond these limits, bally spurs are preferred. Spurs or dampeners made up of tree branches or willow mattresses are found effective up to a maximum depth of flow of 4 m to 6m, for greater than 6m, wooden pile or bamboo, spurs may be used.

In this present study, effect of blockage was verified on the various flow parameters.

II. LITERATURE REVIEW

Many investigators have studied many parameters with permeable and impermeable spur. Rahman M.L. et.al.(2009, 2011)[13-19] have studied bamboo Bundaling structure as a protection. They have mentioned that bamboo bandalling is a cost effective tool for river training. Oak R.A. et.al. (2009)[12,13] has noted the same thing. Moitaba (2009)[10] has done experiments on the permeable structure having permeability 63% and 70%. It was concluded that scour depth was less with

Volume : 3 | Issue : 8 | Aug 2013 | ISSN - 2249-555X

permeable structure. Cao Yogato (2009)[3] has carried out physical model to access the impacts of permeable groynes on Lower Yellow River. Some other researcher also mentioned the same kind of conclusion that scouring is less with the permeable structure.

Beside this many researchers mainly focused on the local scour and velocity distribution of flow at a conventional impermeable groyne. Most of the research has been done with the impermeable groyne and less permeable groyne or slotted spur.

Review of literature shows that in spite of the importance of conventional structures as impermeable groynes, less attention have been paid to study other types of structures such as permeable groyne to minimize the occurrence of erosion around the structure due to the passage of flow through the structure due to passage and to reduce the flow velocity near the river bank.

In this present study, the permeable structures with variable permeability were discussed.

III. EXPERIMENTAL SETUP AND METHODOLOGY

The experiments were carried out at B.V.D.U. College of Engineering, Hydraulics Laboratory, Pune in 10 m long, 0.30 m wide and 0.45 deep tilting flume. The detailed sketch of experimental setup in Fig. No. IX. The channel slope was adjusted 0.002 and 0.004 throughout the experiment. The Rehbock weir was fitted at the downstream end, used to measure the discharge. The water depth in the flume was adjusted by a steel gates located at upstream and downstream of the flume. A vernier pointer gauge with an accuracy of ±0.5 mm was used to measure the water levels. Permeable groyne model was made up of an acrylic material having the height of 15 cm, width of 9 cm and thickness of 1.5 cm and designed to maintain the desired permeability. The model was kept perpendicular to the flume wall. Refer Fig. No.III

The hydraulic conditions adopted for the experiments are given in Table no.I

TABLE I
Details of Experimental Conditions

Types of groynes	Permeable
Permeability	90%. 80%, 70%, 60% and solid groyne
Submergence	Non – submerged
Slope	0.002 and 0.004
Discharge	0.0015 m^3/s - 0.0060 m^3/s.
Avg. Velocity	0.005 m/s to 0.826 m/s
Flow Depth	5, 8, 10 and 12 cm
Reynolds Number	Above 16000
Froude Number	0.06 to 0.455

Initially the experiments were conducted for getting the velocity distribution of the flow without structure. The discharge and velocity in the vicinity, upstream and downstream of the permeable spur model was measured. Model observations were conducted for different depths, slopes and permeabilities as indicated above. Overall 48 runs were taken to complete the set of experiments.

IV. RESULT ANALYSIS AND DISCUSSIONS

The effect of blocking due to permeable spur was found out. The observations were analyzed and interpreted through following graphs.

I. Effect of flow Blocking : Reduction in discharge

The below graph shows the variation of discharge with respect to Froud Number. As the graph shows, for 10% blockage reduction in discharge is slightly increasing with respect to the Froude Number. Further increase in blockage causes decrease in discharge carrying capacity. Graph also suggests that increase in Froude number causes decrease in discharge. This graph indicates that blockage causes the reduction of discharge in blockage area compared with the initial discharge carrying capacity. All the lines are following same trend. The reduction in the discharge 0.0001 to 0.0012 in fractions for permeability range from 10% to 40%

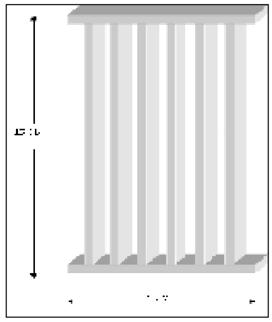

Fig. No. I Permeable spur model

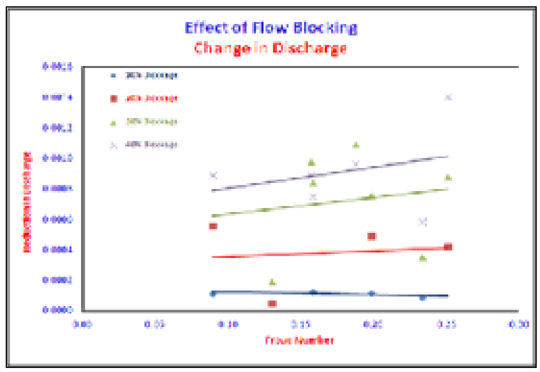

Fig. No. II Graph showing the effect of blocking on reduction in discharge

Effect of Blockage: Reduction in Velocity

· The above graph shows the relation between the average velocity in existion condition and the variation 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 was found in various percentages of blockages. for the range of existing velocity from 0.13 to 0.30, the reduction in velocity range is 4 to 66%. 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.

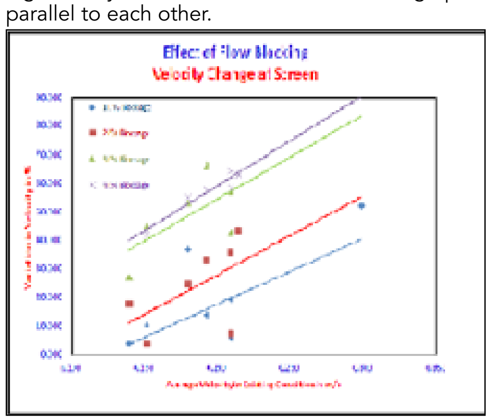

Fig. No. III Graph showing the effect of blocking on reduction in velocity

Volume : 3 | Issue : 8 | Aug 2013 | ISSN - 2249-555X

II. Effect of flow Blocking : Reduction in Sediment Transport Capacity

The above curve gives the relation between the average velocity in existing condition and the sediment transport capacity. The graph follows the logarithmic 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 20% blockage shows the declination at the higher values of the average velocity at existing condition. The trendline of 10% 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.

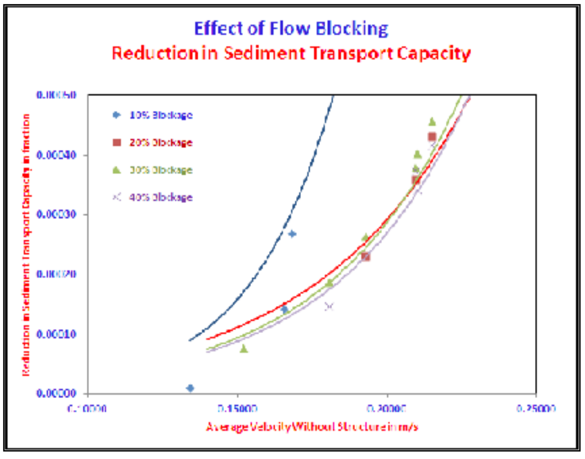

Fig. No. IV Graph showing the effect of blocking on reduction of sediment transport capacity

For better visualisation of the phenomena, photographs the flow separation due to solid spur and permeable spur was shown in Fig. No. VI. 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.

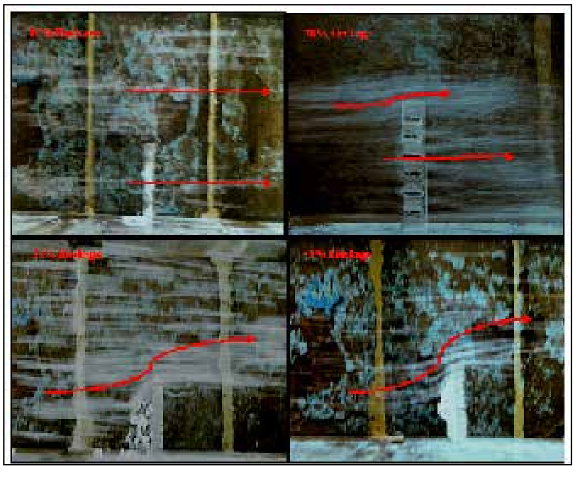

Fig. No. V Photograph Showing Comparison of the flow separation between the various permeable spur

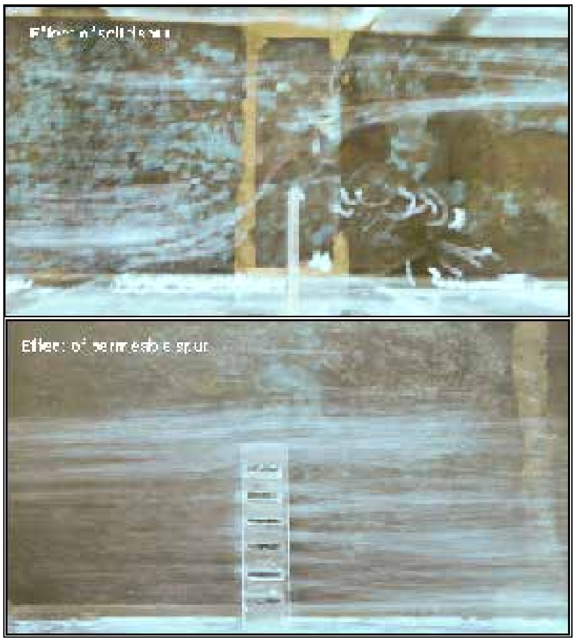

Fig. No. VI Photograph Showing Comparison of flow separation between permeable and impermeable spur

V. CONCLUSIONS

- Generally for given value of Froude Number, reduction in discharge increases as blockage of flow increases. In this present study for the range of Froude No. 0.10 to 0.25, the range of decrease in the discharge 0.0001 to 0.0012 in fractions for the 1o% to 40% blockage range.
- Generally for given blockage if Froude Number increases reduction in discharge also increases except 10% blockage. Due instrumental limits, the reduction in discharge is not measured.
- 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 0.13 to 0.30, the reduction in velocity range is 4 to 66%.
- For given value of blockage as average velocity in existing condition increases reduction in velocity also increases.
- For more blockages there will be major reduction in the velocity.
- From the result of velocity variation across the flow, it is observed that, velocity variation increases as percentage blockage increases.

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 0.2148 for reduction in sediment transport capacity for the range of velocity from 0.13 to 0.20 m/s.

- For the given value of blockages, the reduction in sediment transport capacity increase as average velocity without structure increases except 20% blockage.
- For 20% blockage for higher velocity there is slight decrease in reduction in sediment transport capacity. The reason for the same could not be analyzed.
- For higher velocity without structure, more blockages required for reducing the sediment transport capacity.
- As the blockage increase, velocity decreases at the structure so it starts sedimenting.
- Finally it is concluded that, permeable structures are effective tool for erosion control.

Volume : 3 | Issue : 8 | Aug 2013 | ISSN - 2249-555X

Fig. No. VII Photograph Showing Effectiveness of permeable spur

Fig. No. VIII Photograph Showing Effectiveness of permeable spur

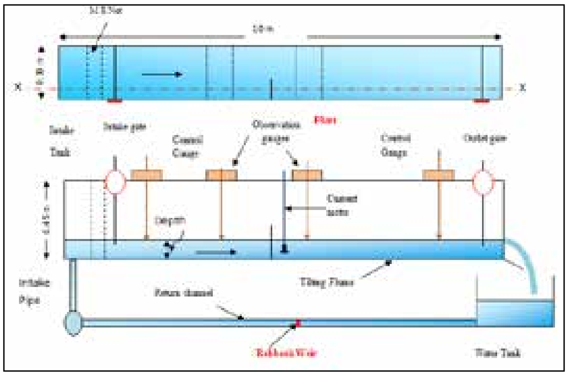

Fig. No. IX Experimental Setup

REFERENCE [I] Arun Lila, Mahendra Chaudhari, 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 | [II] Azad, S., Oak ,R.A.: Use of Permeable Structures for Anti Erosion Work – A Case Study in National Conference on National Conference " Hydraulics, Water Resource, Coastal and Environmental Engineering", Hydro 2009 | [III] Cao, Yogatao: The Impacts Of Applying Permeable Groynes in the Lower Yellow River; Yellow River Institute of Hydraulic Research (YRIHR) | [IV] CBIP, Manual on River Behaviour, Control and Training, Publication No.60, 1956, PP 240 – 243 p. 190. | [V] Federal Highway Administration – Bridge Scour and Stream in Stability Counter measuers : Experience, Selection and Design Guidance (Third Edition) (2011) | [VI] 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 | [VII] Garde, R.J., Ranga Raju, K.G.: Mechanics of Sediment Transportation and Alluvial Steam Problems, New Age International Publication. | [VIII] 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 | [IX] 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 | [X] Moitaba, G.K., Abbas, B.G.: Effect Of Groyne Opening Percentage On River Outer Bank Protection, Journal Of Applied Sciences (2009) | [XI] Nasrollahi,A., Ghodsian, M., Saheli Neyshabouri, S.A.A., : Local Scour Around Permeable Spur, Journal of Applied Sciences Vol. 8 No. 19, 2008, PP 3398 – 3406 | [XII] Oak, R.A., Kulkarni, S.B, V.K. Appukuttan: Use Of Permeable Structures For Bank Protection Measures: Field Experience With Different Rivers, In National Conference On Hydraulics, Hydro 1999, March 6-7 | [XIII] 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 | [XIV] Rahman, M.L., Basak, B.C., Osman, M.S., Altaf Hossain. : Interaction of Low Cost Bandle Structures For Sediment Management in National Conference " Hydraulics, Water Resource, Coastal and Environmental Engineering", Hydro 2009 | [XV] Rahman, M.L., Basak, B.C., Osman, M.S.: "Velocity Distribution Around the Low Sructures named Bandalling for River Bank Protection" in Proceedings of River,Coastal, and Estuarine Morpho dynamics (RCEM 2009) PP 497 – 502 | [XVI] 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 | [XVII] 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 | [XVIII] 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 | [XIX] 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 | |