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STUDY OF RIVER TRAINING WORK ON PERMEABLE GROYNES

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

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

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

ABSTRACT

Indian River consists of huge quantity of alluvial deposits. During monsoon season bank of river eroded and changes the direction of river. Damage of bridges and other structure due to the change in river direction is commonly found problem. These rivers are transported large quantity of sediment load during floods. So it is necessary to protect this type of river bank by constructing stone revetment, impermeable spur. Cost of this structure is also very high. The new concept of construction of permeable spur is developed to protect banks of river which is cost effective. Reduction in the velocity is highly achieved by construction of permeable spur. If river consists of huge quantity of sediment then permeable structure acts as a barrier to it.

The sediment transport capacity of a flow is depending on speed of flow. Due to these dampening of speed results in deposition of sediment. Whenever sediments present in the river permeable structures help to induce siltation along the bank. In this paper study was carried out on different permeable groynes on different hydraulics parameter like velocity, discharge, flow separation, sediment transport capacity and depth of scouring with the experiments. These

Experiments are conducted in a 10 meter long, 0.30 meter wide and 0.45 meter deep tilting flume with the acrylic models having various blockages such as 50%, 60%, 70%, 80%, 90% and solid spur (Groynes) model. This result was analyzed and compared with the existing and field conditions.

Key words: Groynes, River Training, Scouring, Discharge, Sediment Transport, Blockage.

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1. INTRODUCTION

Groynes are constructed transverse to the direction of river flow and made up of earthen material. These are extending from some distance from the bank of river channel. Groyens may be constructed perpendicular to bank or at an angle to the bank of river. The location, length and type and number of groynes are required to achive desired objective depend upon river geometry, flow condition, curvature of river, location of permanent structure meandering pattern.

Groynes are made of stone, gravel, rock, earth, or piles, wooden piles, Bamboo porcupines, cribs etc. They serve to maintain a desirable channel for the purpose of flood control and improved navigation and erosion control. Model experimentation can give better idea also effect on certain parameter on the performance of groynes. The number of experiments was conducted in laboratories of Central Water Power Research Station Pune as well as in U.P irrigation institute, Roorkee for the performance of groynes under different hydraulic conditions.

2. LITERATURE SURVEY

Various studies were conducted by many hydraulic, irrigation engineers on bank protection work by using groynes (spur) on various hydraulics parameters. Mushttag Ahamad (Mar-Apr, 1951) carried out number of test on model for series of spur for bank protection work on river Sutlej below the Panjnad headwork. From his study it was concluded that, the optimum ratio α, (α = Spacing of spur / Length of Spur) for maximum length of bank protection, is near about 5. When α> 5, the bank between the spurs may be attacked and eroded. Md.Luftfor et. al. (2011) [40] have studied bamboo bandals for river bank erosion protection & recovery of agricultural land to increase sedimentation near the river bank. The bamboo bandalling structures are capable for protecting river banks by flow diversion towards the main channel. SanjayA.Burelea et. al. (2012) studied that the considerations of spur permeability is depend on selection of an appropriate spur type , However, for both the retardance and diverter structures, a variety of spur permeability have been designed.

The effect of various parameters on local scouring action was systematically carried out at the University of Roorkee, India. In that most of the test was conducting using thin plate as a spur. Mr. Tyagi studied effect the specific gravity of sedimentation around the spur.

3. PROPOSED SYSTEM APPROACH

3.1. Experimental Setup

Flume

The experimentation was carried out in Post Graduate Hydraulic Laboratory of BVDU College of Engineering, Pune. An investigation was done in 10 m long, 0.3 m wide and 0.45m deep re-coursing tilting flume. The flume was operated by a 30 Hp variable-speed centrifugal pump located at the downstream end of the flume. The flume is adjusted with

incline slope of 0.0015 to 0.002. The slope of flume is kept at 0.0015 and 0.002 all through the examination.

Flow Conditions

Two pointer gages with Vernier having accuracy of 0.1 mm were used to measure the water levels at upstream and downstream of the structure. For measuring the point velocity, calibrated propeller type of current meter was used. The V-Notch of 0.45 m width and 0.43 m deep rehbock weir was used at downstream end of the tilting flume for measuring quantity of water. The discharge range is kept 0.0015 m^3/s- 0.005 m^3/s. also velocity range was 0.002 m/s to 0.236 m/s. Froude Number is in between 1.2 to 1.4. Reynolds's number was above the 16000 which is necessary to maintain the turbulent flow in the flume for studies.

3.2. The Study parameters

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

- **Range of permeability:** According to this present study the permeability was kept 0%, 10%, 20%, 30%, 40%, 50% (Impermeable)
- **Submergence:** Non submergence
- **Length of permeable Groynes:** According to the field experience, the length of the spur is restricted to 15% to 20% of total width of channel but 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:** The depth of the permeable spur was considered to be 15 cm in the model.
- **Location, orientation of permeable spurs:** As per USBR recommendation the spurs are kept perpendicular to the direction of flow.
- **The discharge range:** The discharge was kept according to the requirement of experiment and given water depths. It is necessary for the experiment to get the velocities from lower to higher values so the discharge is also changes for each run of experiment for each model.
- **Depth of flow:** Water level was kept accordingly 8 cm, 10 cm.
- **Velocity:** Velocity was kept on the basis of the field experience. For permeable structure velocity requires 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.
- **Model:** The models of permeable spur were made up of acrylic material. The detailed drawing is given in the figure.
- **Froude and Reynolds Number:** To maintain the stable and turbulent flow Froude no and Reynolds number also maintained for different model runs.

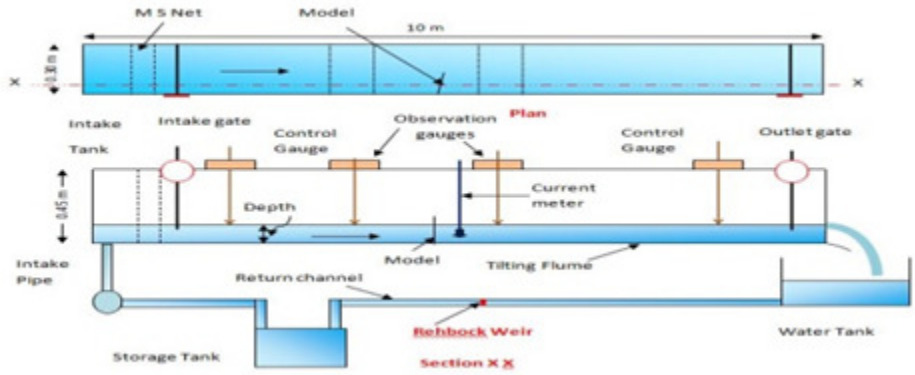

Figure 1 Experimental Setup

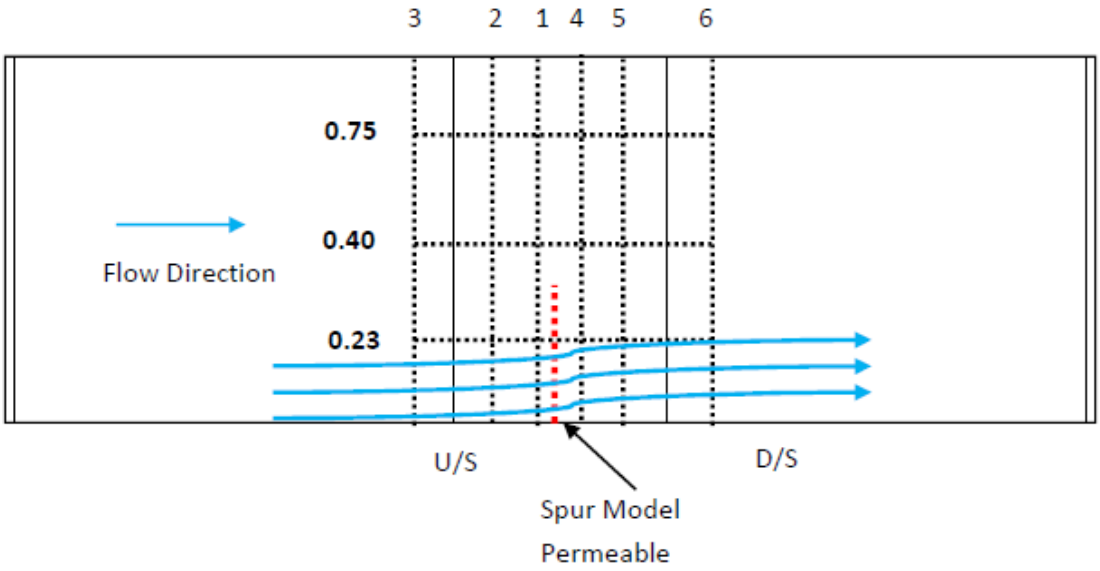

Figure 2 layout of permeable model and flow condition

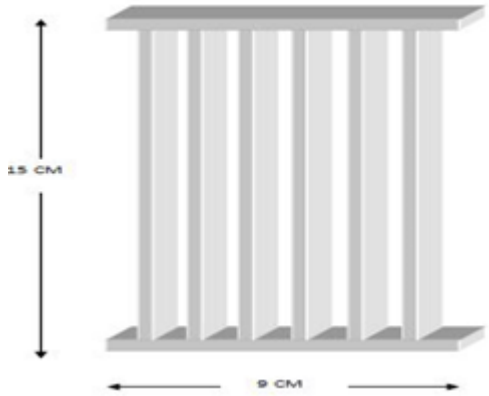

Figure 3 Typical drawing of permeable spur model

4. METHODOLOGY

The following sets of experiments were conducted:

A. Studies under existing conditions: Depth was maintained by using two pointer gauges respectively on upstream and downstream. The discharge is maintained by upstream and downstream gates. The experiments were carried out by adjusting slopes, depth of flows etc. The studies were given the range of velocity of flow, range of F_r and R_e numbers.

B. Studies with spurs with different permeability: The experimental procedure was repeated for the given set of permeability of spur models with as 10%, 20%, 30%, 40%, 50% and observations were taken and then analyzed.

5. RESULT AND DISSCUSSION

1. Effect of Flow Blocking

Steps to analyze the Flow **separation** are as follows

Analysis:

a. From the observation and experimental data, the length of the flow separation at upstream & downstream of the Permeable structure was calculated.

b. Following graph will show blockage verses separation length on u/s and d/s side of spur.

c. Separation length in the stream of upstream and downstream was calculated, by using floating paper to find out the flow pattern separation length.

Observation

It was concluded that as permeability increases from 0% to 50% separation length also increases in upstream or in downstream side or in other words as the blockage increases (50%,60%,70%,80%,90%) separation length also increases.

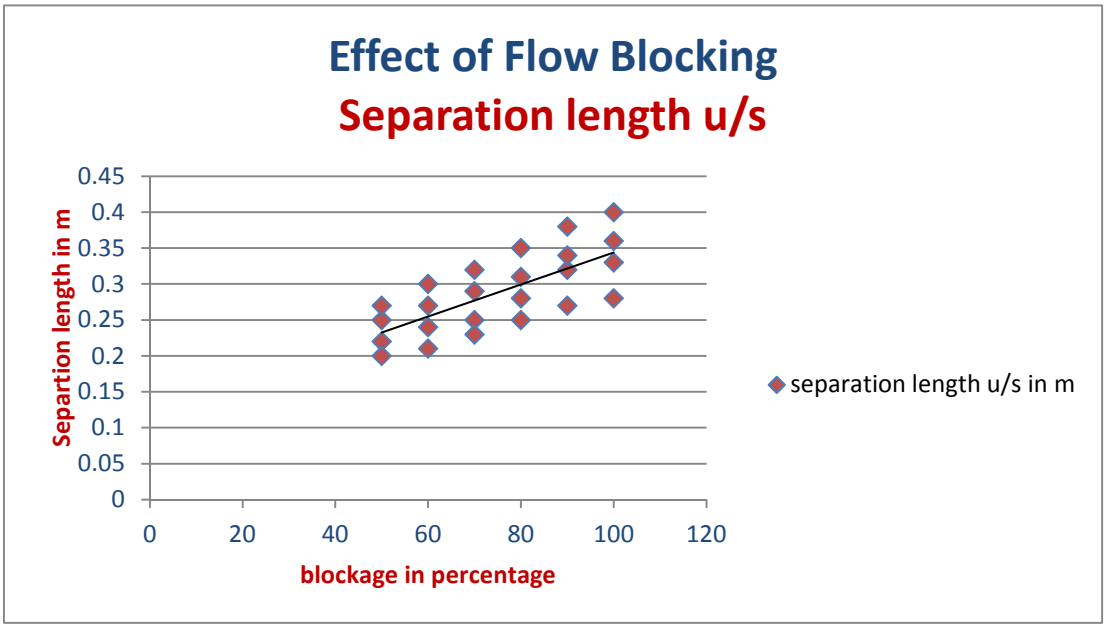

Figure 1 Graph showing separation length on upstream side vs blockage in %

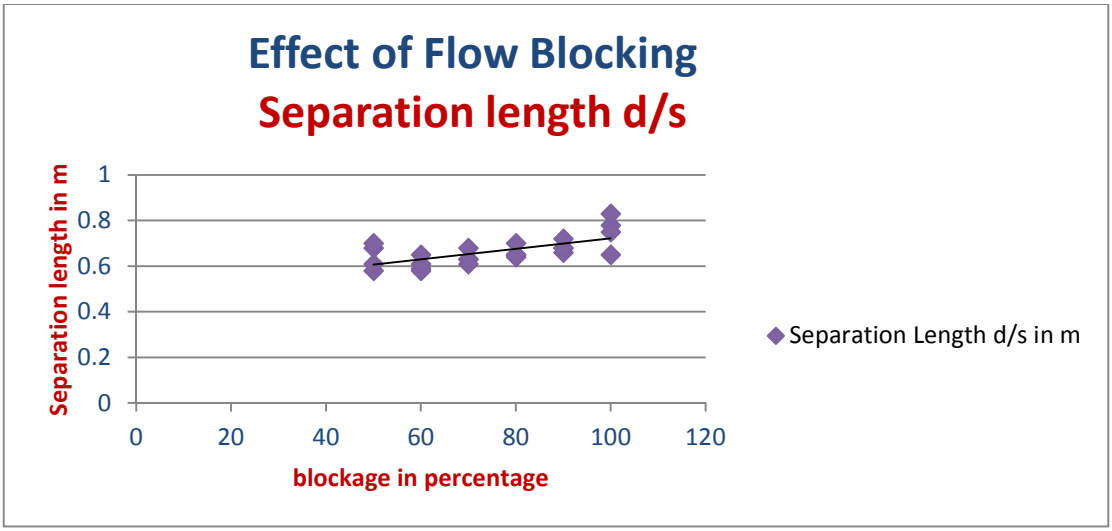

Figure 2 Graph showing separation length on downstream side vs blockage in %

2. Effect of velocity

Steps to analyze Velocity variation are as follows

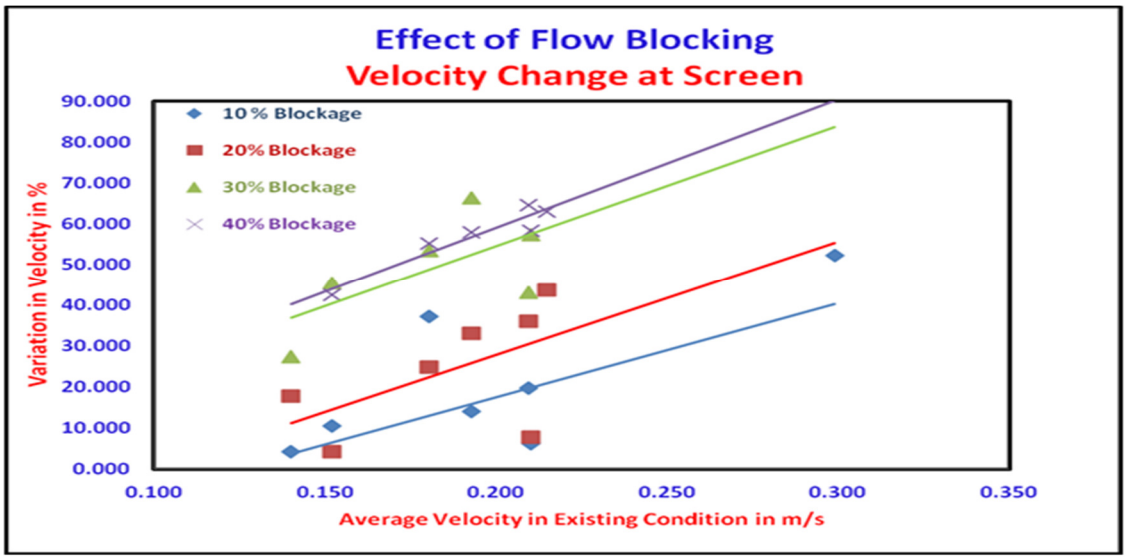

Figure 3 Graph Showing Effect of Flow Blocking due to velocity variation

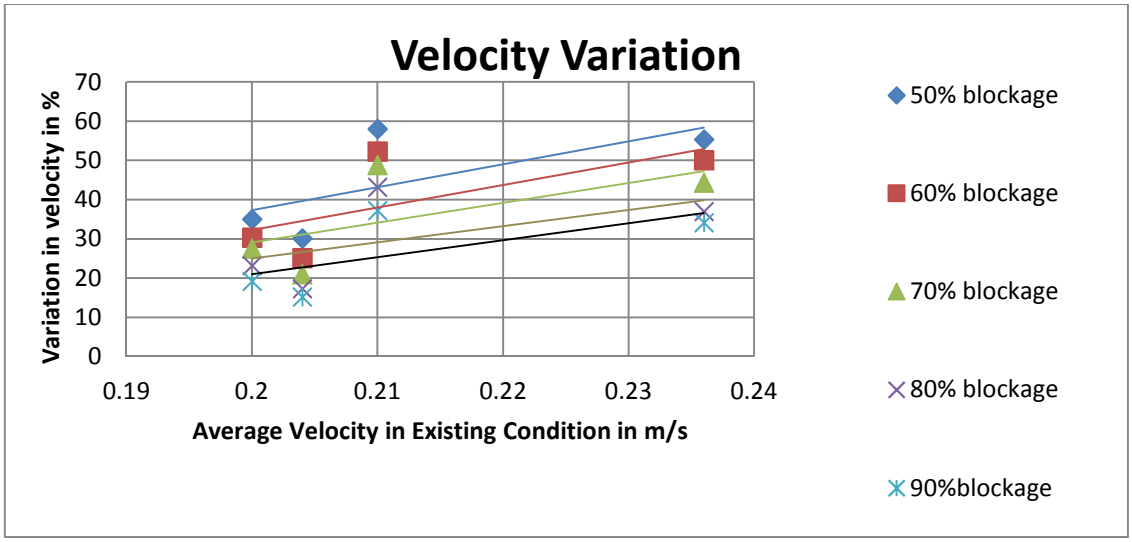

Figure 4 Graph Showing Effect of Flow Blocking due to velocity variation

Analysis

a. Change in velocity between average velocity without structure and average velocity with permeable structure with different permeability were calculated.

b. Variation in velocity with respect to average velocity in existing condition (without structure) was found.

Observations

The above graph shows the relation between the average velocity in existing condition and the change in velocity. As per the previous research done by Prof. (Mrs) D.R.Kulkarni (fig 3) As the average velocity increases the reduction in the velocity also increases. Also from present study the (Fig 4) also suggests that for lower percentage of blockage the variation is less and for higher percentage of blockage there is large reduction in the existing velocity. This is followed by various percentages of blockages from above graph. The trend lines shown in the graph are almost parallel to each other.

6. EFFECT OF FLOW BLOCKING

Steps to analyze Reduction in sediment transport capacity are as follows

Analysis

a. The sediment transport capacity with or without structure by using USBR's consideration is calculated by sediment transport capacity is proportional to the fifth power of average velocity.

b. The difference between the sediment transport capacity after installation of permeable structure and sediment transport capacity in the existing condition was calculated.

c. Plotted the graph between the reduction in the sediment transport capacity due to the permeable structure and the existing average velocity.

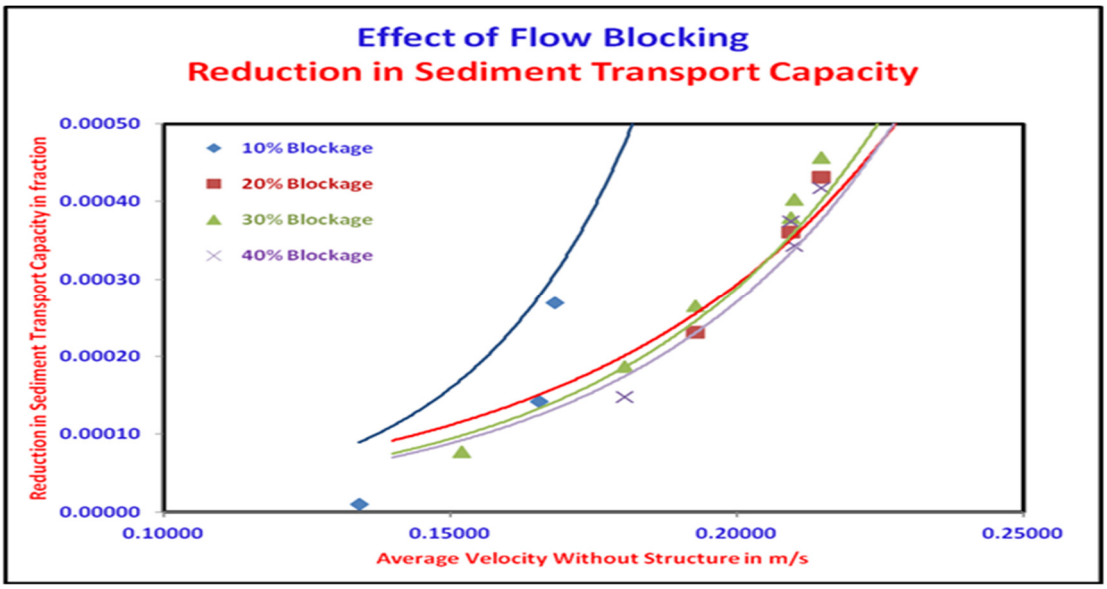

Figure 5 Graph shows effect reduction in sediment transport capacity

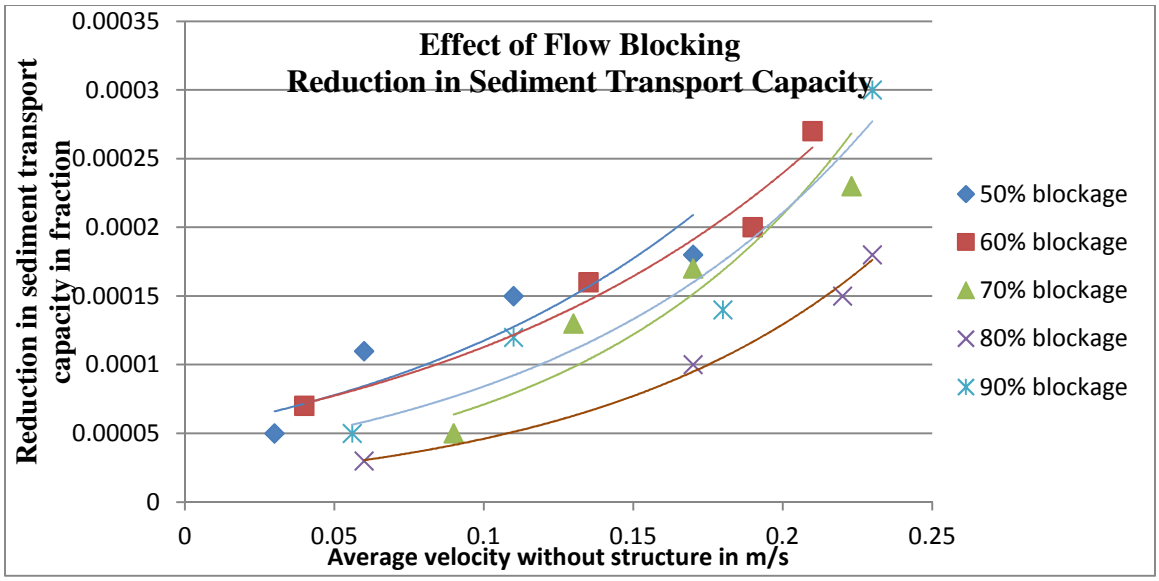

Figure 6 Graph shows effect reduction in sediment transport capacity

Observations

As per the previous research done by Prof.(Mrs) D.R. Kulkarni (graph 5) the above curve gives the relation between the average velocity in existing condition and the sediment transport capacity for various blockages. The graph follows the logarithmic relation. Similarly, from present study (Graph6) increase in the average velocity in the existing condition there is decrease in sediment transport capacity. It is clear from above two graph sediment transport capacity decreases then there will be increase in the deposition. As the blockages of 50% blockage shows that the reduction in the sediment transport capacity is more at the lower velocities

7. CONCLUSION

1. It was concluded that the as percentages in blockage increases separation length also increases.

2. For given value of average velocity in existing condition, velocity variation increases as increase in blockage.
3. For given value of blockage as average velocity in existing condition increases reduction in velocity also increases.
4. For more the blockages, there will be major reduction in the velocity.
5. From the result of velocity variation of the flow it is concluded that velocity variation increases as percentage blockage increases
6. From the results of sediment transport capacity graph, it is observed that for given value of average velocity without structure, reduction in sediment transport capacity also increases as the blockage increases.
7. From present and past studies may conclude that higher the velocity without structure, more will be the blockages required for reducing the sediment transport capacity.
8. For erosion control in flood situation permeable groynes may provide immediate and effective solution.

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