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Study to Improve the Discharge Capacityof the River Jehlum

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ABSTRACT
Sustainability may be defined as the process of maintaining the various changes in order to make the human survival and also the survival of the flora and fauna possible with ease on the Planet Earth.This sustainability is applied to the naturally existing water bodies such that the threat of the floods and then the devastation they lead to gets minimized . In this study sustainability is adopted to improve the discharge capacity of the River Jehlum.This water body has become a threat for the survival of the human population , animals and also acts as a barrier in the economic development of the Kashmir Valley as it is prone to the floods . The main reason due to which the River Jehlum is more liable to the floods is the presence of the weak banks which are made of traditional sand bags, that result in the reduction of the discharge capacity of the channel up to a great extent . In order to minimize the threat of the floods new banks are being constructed and strengthened by providing the reinforcement to the banks by making use of the various types of the geo-synthetics ,which also act as a separator between the water and the soil ,thus decreasing the deposition of the sludge on the banks preventing the banks from getting raised . As the banks get strengthened and clogging gets decreased the discharging capacity of the River Jehlum gets increased from 900 cumec to 1200 cumec in the Srinagar city.
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I. INTRODUCTION

River Jehlum is one of the largest water bodies of the Kashmir Valley. All the hydro-water projects in the Valley are based on this water body. This water body has become a threat to the human life , animal life and property as it is prone to flood. The main cause of the floods is the presence of low lying banks , swampy and the marshy area which has been occupied over the time by the population for the urbanisation thus reducing the area for detention basin. During the peak floods due to excessive rainfall as there is reduction in flood channels and also the spill way that has been used as a regulator has also been clogged along with the time the water is not able to pass through the banks and hence overflows the banks due to which the entire city gets submerged. In September 2014, Srinagar city faced very devastating floods which resulted in the excessive devastation to the human life, property, cattle .The main aim of this study, is to provide the strong banks such that they are able to retain water in peak condition. The construction of a regulatory work such as a dam is avoided to reduce the pollution and such that there is no deterioting effect on the flora and the fauna. There has been a rapid growth of 70% in the population in the past fourty years within the Jehlum basin. Due to this urbanization and the tremendous increase in the population density , the demand for the land for the settlement of the people increases considerably .This excessive demand has led to the urbanization of the low lying areas along the left bank of the River Jehlum ; which actually before the urbanization were acting as the flood detentions.These urbanized areas are highly vulnerable to the damage of both the life and the property.Keeping under consideration the devastation caused by the floods in the past ,the discharge that was reduced along with the time due to the narrow banks due to the accumulation of the slit and the soil and also due to the excessive erosion of the banks due to the exposure to the running water.The main reason of the reduced discharged capacity of the River Jehlum is the presence of weak banks along the sides of the River Jehlum as the banks are made up of simple sand bags and due to the continuous dredging of the sand along the banks of the river.In this study by construction the new banks and strengthening the old ones by making use of the geo-synthetics to provide reinforcement to the banks and to act as a separator between the soil and the water such that the soil does not get deposited on the banks rather than by using the traditional sand bags . The various types of the geo-synthetics such as the geo-textiles , geo-grids , have been used as they act as the separator and as they are able to provide the stability (Zornberg.J.G 2003). When sand comes in contact with the water the bulking of sand takes place due to

which its volume gets increased up to ten times due to which the quantity of the sand that gets deposited on the banks also gets increased proportionally leading to clogging of banks thus reducing the discharge capacity of the River Jehlum.

1. Geo-Synthetics :

According to the ASTMD 4439 a Geo-Synthetic may be defined as under :

It is a planar product which is manufactured from the polymeric material which can be used with the soil , rock , earth or any other geo-technical engineering related material as an integral part of a man-made project , structure or system . The term Geo -Synthetics is made up of two words ie. Geo and Synthetics.Geo means earth and synthetics refers to the materials that are made by the humans. Geo-synthetics have emerged as an excellent material in the engineering field which find numerous application in the various fields of the transportation , hydraulics , geo-technical and environmental science.These synthetic liners have been used since 1930's. The geo-synthetic materials have become a well established construction material for the environmental applications all over the world as they act as a barrier between the soil and the water (Milkas Scholz , 2013). The geo-synthetics are evaluated as the most economical and providing most of the environmental benefits (Werner.W.Muller & Fokke Saathoff 2015). The Geo-synthetics have become a well established construction material for the environmental applications all over the world Palmeria.E.M ,Tatsouka , .F.Bathrust et al (2008).

2. Types of Geo-Synthetics

The various types of the geo-synthetics used are as under:

1) Geo-Textiles.
2) Geo-Grids.
3) Geo-Nets.
4) Geo-Membranes.
5) Geo-Synthetic Clay Liners.
6) Geo-Pipes.
7) Geo-Foam
8) Geo-Composites.
9) Geo Bag.
10) Geo Mat.

II. OBJECTIVES OF THE STUDY

The aim of this experimental work is to make use of the geo-synthetics in the construction of the banks such that the interaction between the soil and the water is minimum.The following objectives are proposed in the present investigation:

1) To increase the strength of the existing banks and form the new strong banks by making use of these sustainable materials , thus reducing the intensity of the floods.

2) To discard the use of the soil and sand bags to in the construction of the banks which have failed to provide strength to the banks.

3) To restore and to enhance the discharging capacity of the River Jehlum.

4) To reduce the erosion of the banks at various spots.

III. CURRENT DISCHARGE CAPACITY OF RIVER JEHLUM

As the Srinagar City is situated above 2m to 3m below the designed flood levels of the River Jehlum corresponding to a design discharge of 900 Cumec in the city reaches.Any flood discharge above 900 Cumec will increase the threat of floods and will lead to encroaching. A flood spillway had been constructed in the past , to by-pass the excess water from the river Jehlum . But the channel capacity of this spill-way got reduced by 4000 Cumec ; due to the accumulation of the load from the various tributaries due to which the bed got raised . Since the last three decades the water holding capacity of the banks has reduced to one fifth , due to the presence of the extensive marshes. The velocities in the river Jehlum during low discharge varies from 0.75 feet/sec to 1.2 feet/sec while during the floods the velocity varies from 4.5 feet/sec to 5.00 feet/sec.In Srinagar City , during the floods the velocity varies from 6 ft/sec to 6.5 ft/sec , which causes a thrust on both the banks of the river which result in the formation of the breach of bank.A provision has to be made to divert a discharge of 1302.75 cumec from the main river to the upstream of the Srinagar City in order to prevent the floods as the River Jehlum passing through the city has not the capability to hold a flood discharge of more than 991.21 cumec.

IV. TESTS CONDUCTED ON THE SOIL SAMPLE

The various tests that have been conducted in the present study are as under:

1) Optimum Moisture Content.
2) Maximum Dry Density.
3) Shear Parameters.
4) Sieve Analysis.
5) Consistency Limits.

In order to conduct all the above mentioned tests three soil samples were collected from the Pampore area.

1) Optimum Moisture Content

The value of the optimum moisture content obtained for the soil samples conducted are specified below in the Table 1.1 respectively.

Table 1.1 Value of Optimum Moisture Content

Sample	Optimum Moisture Content
Sample 1	10
Sample 2	9
Sample 3	9.5

2) Maximum Dry Density

The value of the maximum dry density obtained for the soil samples are specified below in the Table 1.2 respectively.

Table 1.2 Value of Dry Density (g/cc)

Sample	Max. Dry Density
Sample 1	1.88
Sample 2	1.81
Sample 3	1.85

3) Shear Parameters

The shear parameters of the soil sample include two separate components , which are as under:

3.1) The Angle Of Friction : The value of the angle of friction obtained for the soil samples is specified below in Table 1.3 (a) respectively.

Table 1.3 (a) Value of Angle of Friction

Sample	Angle of Friction
Sample 1	20
Sample 2	22
Sample 3	23

3.2) Cohesion : The value of the cohesion obtained for the soil samples are specified below in Table 1.3 (b) respectively.

Table 1.3 (b) Value of Cohesion (kg/sqm)

Sample	Cohesion
Sample 1	0.52
Sample 2	0.52
Sample 3	0.48

4) Sieve Analysis

After conducting the sieve analysis of the collected soil sample it was concluded that the that IS Classification of the soil sample is CL ie the soil sample collected are 99% composed of the clay as shown below in the Table 1.4.

Table 1.4 Value of Sieve Analysis

Sample	Sieve Analysis
Sample 1	99 % CL
Sample 2	99 % CL
Sample 3	99 % CL

5) Consistency Limits

The value of the various consistency limits obtained for the collected soil samples are as under:

5.1) Liquid Limit (LL)

The value of the liquid limit obtained for the collected soil samples are specified below in the Table 1.5 respectively.

Table 1.5 Value of Liquid Limit

Sample	Liquid Limit
Sample 1	34.6 %
Sample 2	34.2 %
Sample 3	31.6 %

5.2) Plasticity Limit (PL)

The value of the plasticity limit obtained for the collected soil samples are specified below in the Table 1.6 respectively.

Table 1.6 Value of Plasticity Limit

Sample	Plasticity Limit
Sample 1	22.69 %
Sample 2	23.94 %
Sample 3	23.04 %

5.3) Plasticity Index (PI)

The value of the plasticity index obtained for the collected samples are specified below in the Table 1.7 respectively.

Sample	Plasticity Index
Sample 1	11.91 %
Sample 2	10.26 %
Sample 3	8.56 %

V. DISCUSSION

In this section we discuss the various important features of the geo-synthetics used in our study which include geo –textiles , geo-grids and the geo- bags.

1) Geo-Textiles :

The geo-textiles used in our study are non-woven fabrics.They are manufactured by needle punching process.They are composed of polyethylene , polyester , polyamide and polypropylene.They provide high rate of flow of water through them and have small openings.They perform the functions of separation , stabilization and filtration.The various characteristics of the geo-textiles used are specified as under:

1.1) Mass Per Unit Area : The mass per unit area of the woven geo-textile used is 350 gsm.
1.2) Size Of The Opening : The apparent size of the opening of the geo-textile used is 0.15 mm.
1.3) Tensile Strength : The tensile strength of the geo-textile used is 17.5 kN/m.
1.4) Elongation : The elongation of the geo-textiles used is 50 %.
1.5) Rate Of Flow Of Water : The rate at which the water is flowing through the fabric is 2500 L min per sq metre.
1.6)) Cost : The cost of the geo-textile used is 171 per sqm .
1.7) Width Of The Entire Roll : The width of the entire roll of the geo-textile used is 4 mts.
1.8) Length Of The Entire Roll : The length of the entire roll of the geo-textile used is 100 mts.
1.9) Weight Of The Entire Roll: The weight of the entire roll of the geo-textile used is 140 Kg.
1.10) Thickness : The thickness of the geo-textiles used is 2.5 mm
1.11) Trapezoidal Tear Strength : The trapezoidal shear strength provided by the geo-textile used is 0.49 KN.
1.12) CBR Puncture Strength : The CBR puncture strength provided by the geo-textiles used is 3 KN.
1.13) UV Resistance : The UV resistance provide by the geo-textile used is 70%.
The type of the woven geo-textile used in our study is shown if the Fig 1.1 as under :

Fig 1.1 Non-woven 350 gsm Geo-Textile

2) Geo-Grid

In order to provide the reinforcement at the steep slopes , deep foundations high polymer materials which were prepared by the tensile drawing were required .Thus geo-grids were manufactured to provide reinforcement in such critical areas .The main benefit of using the geo-grids is that there are openings between the longitudinal and the transverse which provide enough space for the soil to travel from one grid to the other.A geo-grid may be defined as a geo-synthetic material consisting of connected parallel sets of tensile ribs with apertures of sufficient size to allow strike-through of the surrounding soil, stone, or any other geotechnical material. Geo-girds used are composed of , polyester or polypropylene.The main function of the geo-grids is to provide the reinforcement . The geo-grid used in our study are woven black polyester bi-axial geo-grids 40 KN.The various characteristics of the geo-grids used are as under :
2.1) Thickness : The geo-grids used have a thickness of 2-5mm.
2.2) Material Grade : The grade of the materials of the geo-grids used is 40 KN.
2.3) Coating : The geo-grids used have a coating of PVC.
2.4) Cost : The cost of the geo-grid used is 838 per sqm.
The geo-grids used in our study are shown below in the Fig 1.2 :

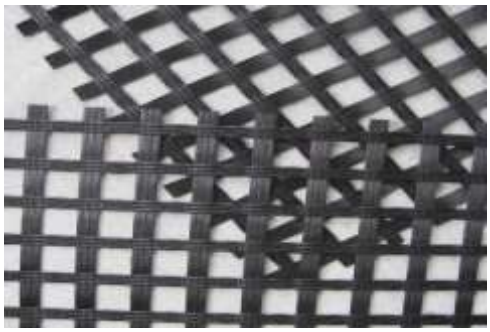

Fig 1.2 Bi-axial 40 KN Geo-Grids

3) Geo-Bag

The bags manufactured from the geo-textiles are known as the geo-bags These bags are manufactured with the UV stabilized anti-oxidants such that they can control the erosion at the site up to a great extent. These bags are filled with the soil and are used to form stable banks.In our study we are making use of the 350 gsm geo-textiles which are then filled with the locally available soil.They are used to form the new embankments and provide reinforcement to the soil beneath.The cost of the geo-bags used is Rs.313 per bag.The geo-bags used in our study is shown below in the Fig 1.3
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Fig 1.3 Geo-Bag 350 gsm

VI. RESULTS :

The results that are obtained at the end of our study are summarised as under:

i) Over Topping

By making use of the various types of the geo-synthetics the over-topping of the banks is eliminated.

ii) Discharge Capacity

The discharge capacity of the River Jehlum gets increased from 900 cumec in the Srinagar city to 1200 cumec . By using this study the discharge capacity of the River Jehlum and its various tributaries get increased thus reducing the threat of the floods and prevents over topping of the channel.The discharge capacity of the Jehlum and its important tributaries before our study and results achieved after our study are summarised as under in Table 1.8.

Table 1.8 Increase in the Discharge Capacity.

Channel	Previous Discharge	Increased Discharge
River Jehlum	900 cumec	1200 cumec
River Jehlum at Naidkhai Bridge	800 cumec	1115 cumec
Kutkhul	200 cumec	280 cumec
Surnikhul	100 cumec	200 cumec

VII. CONCLUSION

The conclusion of our study is summarised as under :

i) Reduction In The Interaction

The geo-synthetics reduce the interaction between the soil and water in the banks of the River Jehlum ,thus resulting in reduction in the deposition of the soil on the banks and improving the drainage function.

ii) Stability Of The Banks

As the banks of the River Jehlum become stable the discharging capacity of the channel and its various tributaries gets increased in the Srinagar City and also at the various other important locations.

iii) Increase In The Discharging Capacity

As the discharging capacity of the water body increases and also by stabilizing the banks of the River Jehlum the chances of the overflowing of the channel gets reduced thus minimising the occurance of the floods and also reducing its intensity ,thus saving the Srinagar City from the devastation.

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