



Sand particle size distribution and Discharge at the Ganga Flood Plain

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Particle Size Distribution

The sand collected from the river bed at different survey sites was subjected to Sieve Analysis to determine the particle size distribution. 1200 grams of sand from each site were sieved thrice on 16 sieves whose sizes gradually decreased from 1 mm to 0.075 mm.

Using MATLAB, Semi-Log graphs were plotted for % finer by mass vs. Particle size in mm for each 39 sand samples. The median grain size (d_{50}) and the Geometric Standard deviation (σ_g) were hence calculated.

The d_{50} size, called the median grain size, is the grain diameter for which half the sample (by weight) is smaller and half is larger.

If the σ_g is found out to be less than 1.5, the river sediment is said to be uniform. On the other hand σ_g greater than 1.5 will classify the sediment as non-uniform.

Introduction

The discharge of a river and the varying sizes of sand particles found in its basin is an important element in the hydrological modelling of the river basin. A detailed survey was carried out by the WRM group (GRBMP), at 39 sites along the Ganga River in its flood plain. The survey sites stretched from Kannauj, via Kanpur, Allahabad till Mirzapur, covering a distance of 450 Km. The survey commenced on 31st May, 2011 and ended on 7th July, 2011.

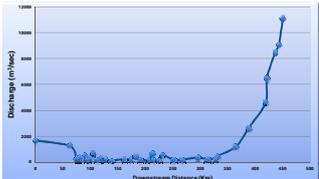
Calculating Discharge

Various practical methods of calculating the Discharge of an Open Channel flow are mentioned in IS-1192: Velocity Area Methods for Measurement of Flow of Water in Open Channels. The methods are applicable to rivers and natural drainage channels in which there can be no control on either the velocity or the sectional area through which the water is flowing. The Ganga River belongs to the aforementioned category and hence the methods mentioned in IS-1192 are used.

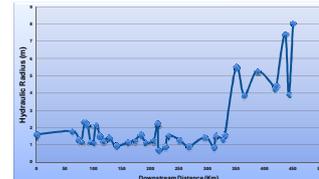
Determination of Depth – Due to the erratic nature of the river bed, measurement of depth was made at intervals close enough to define cross sectional profile accurately. 15-20 verticals were used for accurate reading irrespective of the size of the river. EchoSounder, an instrument that uses SONAR technique was used in calculating the depth of the river bed.

Measurement of Velocity – Due to unstable beds, velocity observations are normally made at the same time and in the same verticals as the measurements of the depth. The velocity at each vertical was measured by exposing the current meter at 0.6 of the depth below the surface. The value observed was taken as the mean velocity in the vertical.

Graph's plotted for the Change in Discharge, Hydraulic Radius, σ_g and d_{50} downstream.



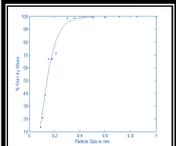
The discharge decreased substantially (from 1200 to 300 m³/sec) after the Ganga Barrage at Magzin Ghat. It remained nearly constant (200-500 m³/sec) till Sangam, Allahabad where after the convergence of Yamuna river, it started increasing at a rapid rate. The rate was further increased by the convergence of Tamsa River just before Dubeypur.



The Hydraulic radius for each survey site was calculated by dividing the wetted perimeter from the cross sectional area. The Hydraulic radius upstream lied between 0.7 to 2.2 m. After the convergence of Yamuna at Sangam, it increased immediately and was found to lie between 3.8 to 8.1 m.

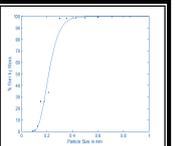
Particle Size Distribution Graphs for 4 Survey Sites are shown below :-

Kannauj



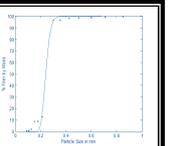
$\sigma_g = 1.5728$
 $d_{50} = 0.1429$ mm

Naubasta



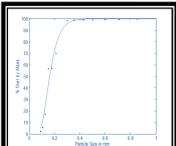
$\sigma_g = 1.3472$
 $d_{50} = 0.2153$ mm

Kalakankar Ghat

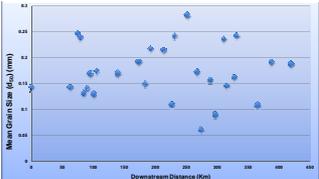


$\sigma_g = 1.1335$
 $d_{50} = 0.2422$ mm

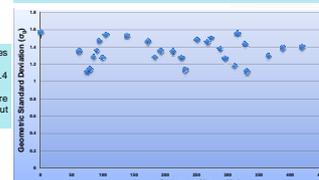
Sangam (Allahabad)



$\sigma_g = 1.4263$
 $d_{50} = 0.1629$ mm



- The Mean Grain Size of the sand samples were found to lie in between 0.05 mm to 0.3 mm.
- 90% of samples were found to lie in between 0.1 to 0.25 m.
- The mean of the median diameter was found out to be 0.1735.
- No particular trend was observed in the mean Grain Size as we moved along the downstream from Kannauj to Mirzapur.



- The Geometric Standard Deviation of the Sand Particles ranged from 1.1 to 1.6.
- 46.4% samples were found to lie in between 1.2 to 1.4 and 35.7% samples between 1.4 to 1.6.
- 82.14 % of samples had σ_g less than 1.5 and were classified uniform. The remaining samples were found out to be mildly non-uniform.

Acknowledgement

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Appendix

IS 1192: 2001, Velocity Area methods for measurement of flow of water in open channels.