3. Methodology

3.1. Brief overview of conditions tested

The series of conditions tested are in two stages as follows.

The first stage is the smooth flume alone, the smooth flume with irregularities, the smooth flume with obstructions, the smooth flume with vegetation, the smooth flume with a combination of irregularities and vegetation, the smooth flume with a combination of irregularities and obstructions, the smooth flume with a combination of vegetation and obstructions and lastly the smooth flume with a combination of irregularities, obstructions and vegetation.

The second stage is a repetition of stage one conditions but this time using a rough bed flume achieved by introducing 19mm diameter stones on the bed.

3.2. Description of apparatus

A flume 12.1m in length and 2m wide was used. The flume is connected to a reservoir which serves to provide water for the flume. The flume was demarcated by a metallic wall to narrow the width to a unit width i.e. 1m.

The slope of the flume bed is approximately 0.00058 this value was obtained 3 times with the help of a levelling instrument.

The flume is perforated with 10 holes at 1.1m distances apart along the centre line on the bed of the flume. These holes are connected to tubes leading to 10 stilling pots. Water rises in the stilling pots to heights readable by a digital pointer gauge. The water levels in the stilling pots indicate the levels at the corresponding tapping point location in the flume.

The flume also has a tail gate which can be adjusted to ensure uniform flow in the flume. The discharge is measured by a turbine meter in the supply line which gives the direct reading of the discharge in m^3/hr.

In order to obtain the effects of different components of the elements that contribute to the total friction and hence the value of Manning's n, a reference friction factor of smooth the bed flume was obtain. This was achieved by using a smooth flume with known cross-section and bed slope. The discharge is increased from $15m^3$/hr. to $75m^3$/hr. in successions of $15m^3$/hr. until 5-6 different discharge have been passed through the flume.

3.3 Figure schematic of flume

Figures 3.3.1 to 3.3.8 are schematic representations of the arrangements of the elements in the smooth bed flume while figures 3.4.1 to 3.4.8 are those for the rough bed flume.

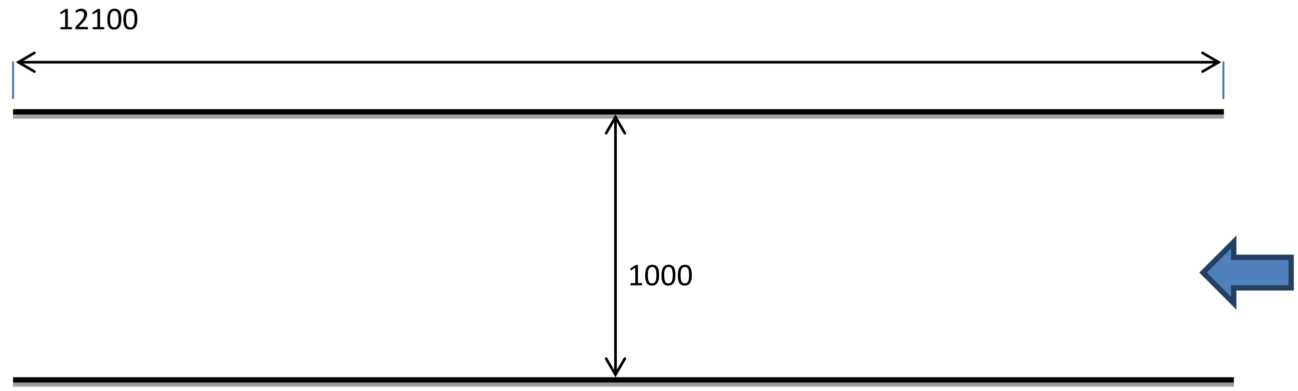

Figure 3.3.1 Smooth bed flume only

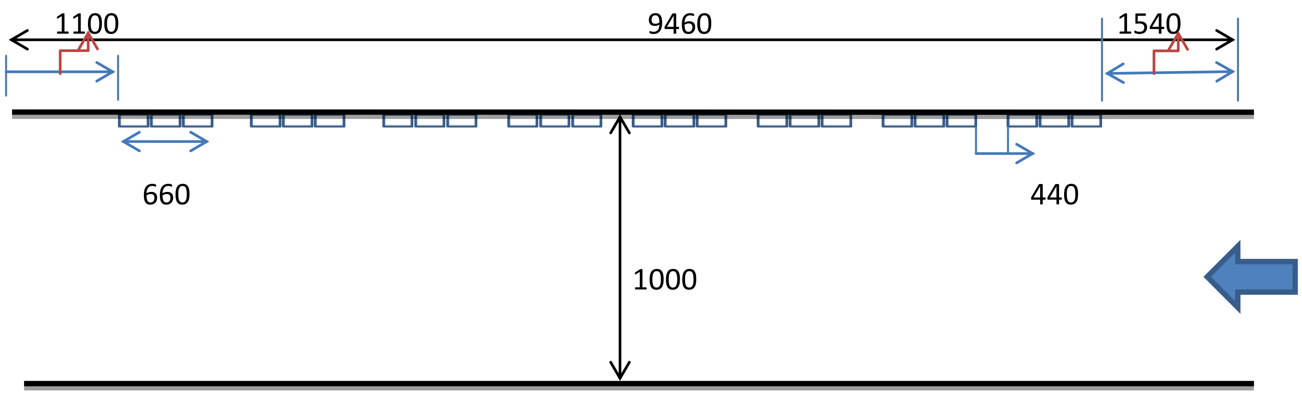

Figure 3.3.2 smooth bed flume with bank irregularities.

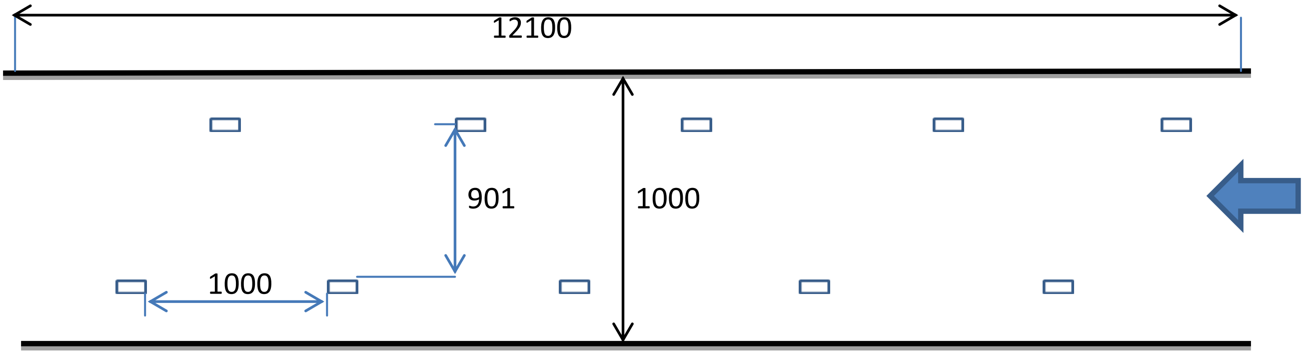

Figure 3.3.3 smooth bed flume with obstructions.

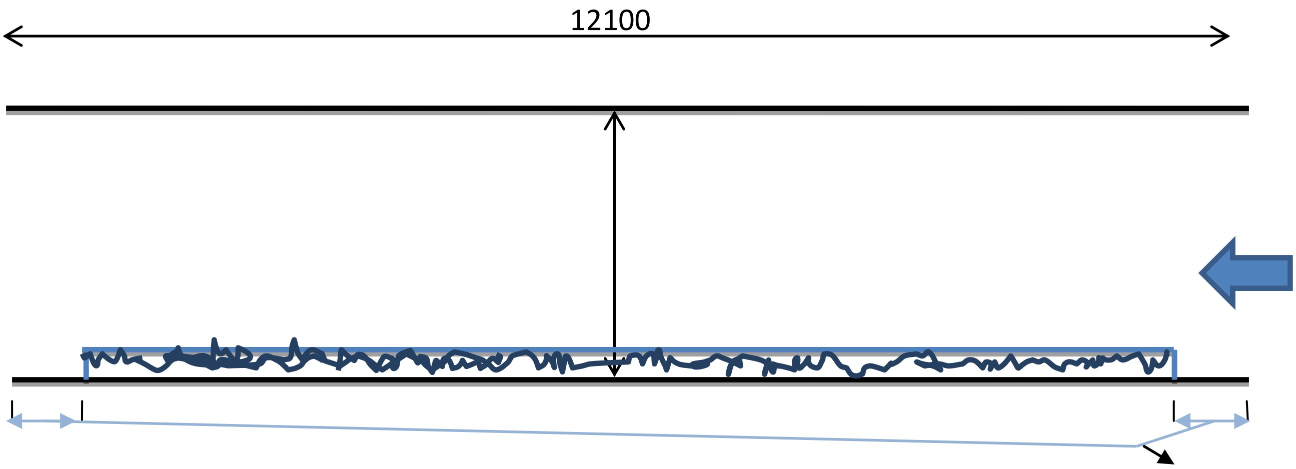

Figure 3.3.4 smooth bed flume with vegetation.

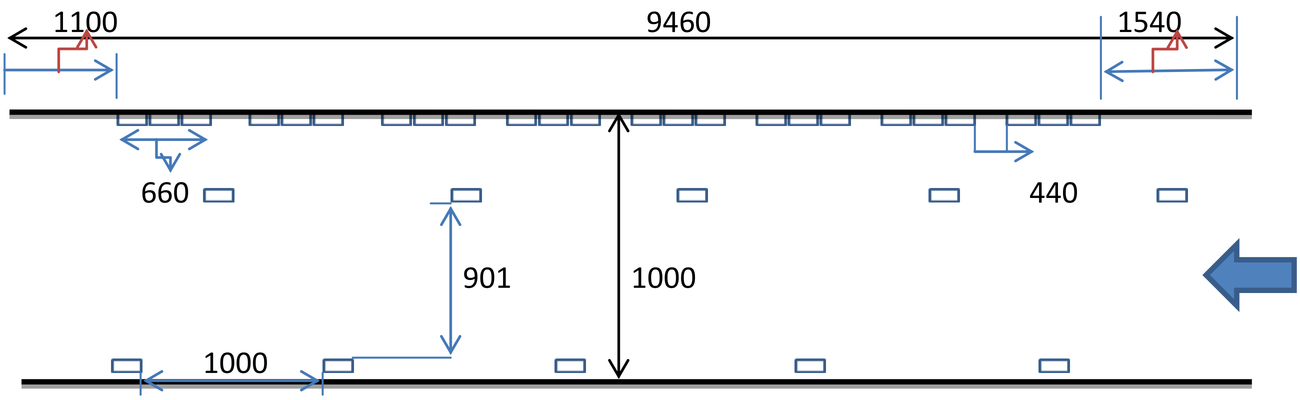

Figure 3.3.5 Smooth bed flume with irregularities and obstructions

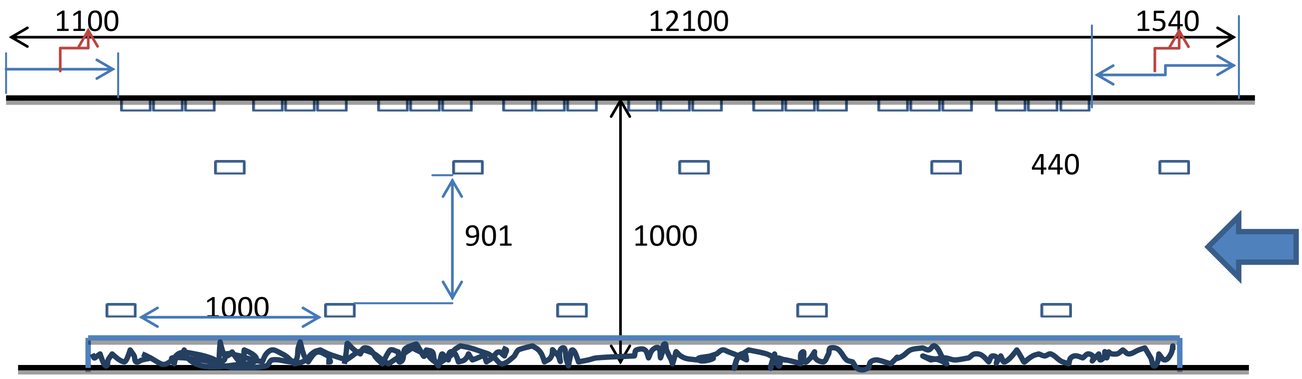

Figure 3.3.6 Smooth bed flume with irregularities, obstructions and vegetation

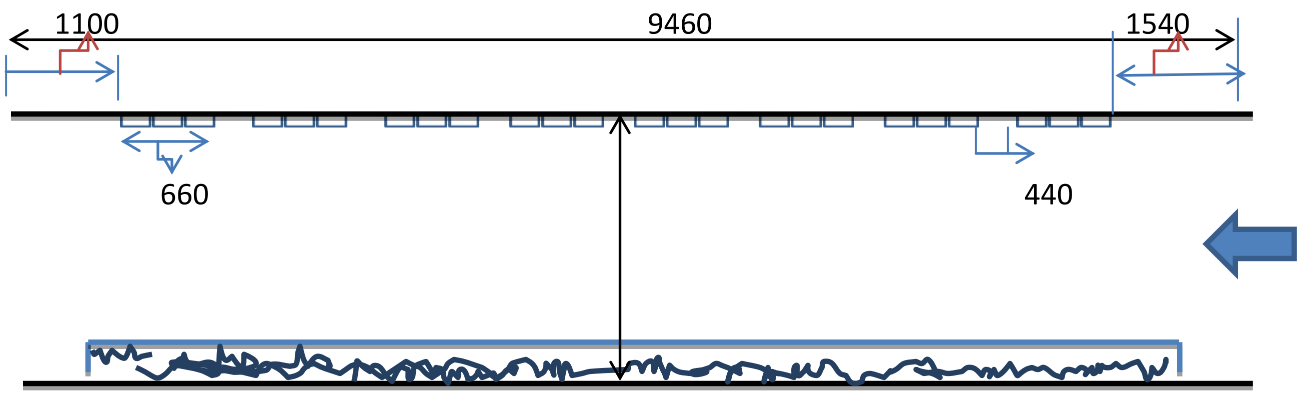

Figure 3.3.7 Smooth c bed flume with irregularities and vegetation

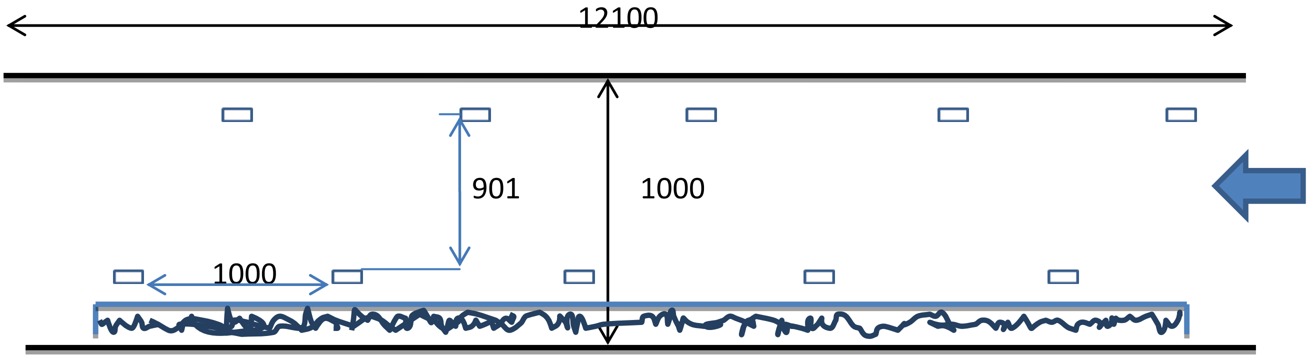

Figure 3.3.8 Smooth bed flume with obstructions and vegetation

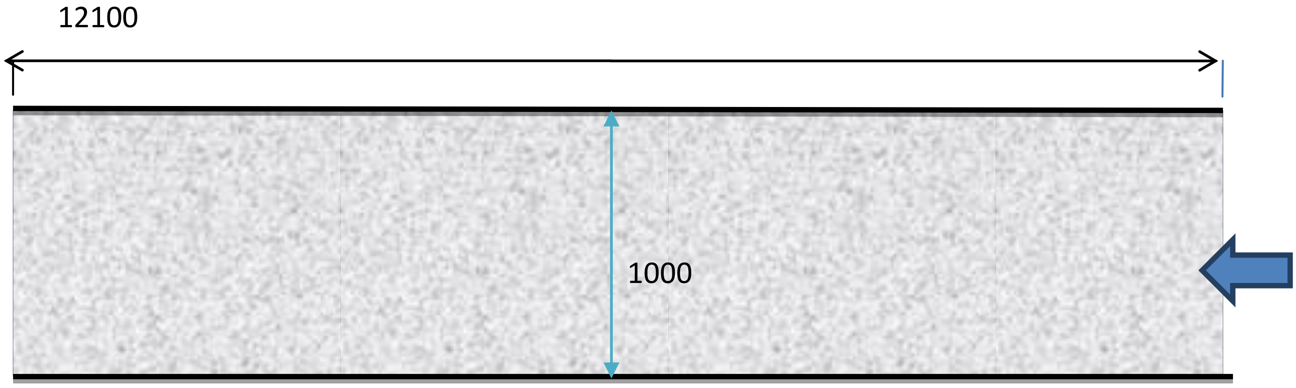

Figure 3.4.1 Rough bed flume only

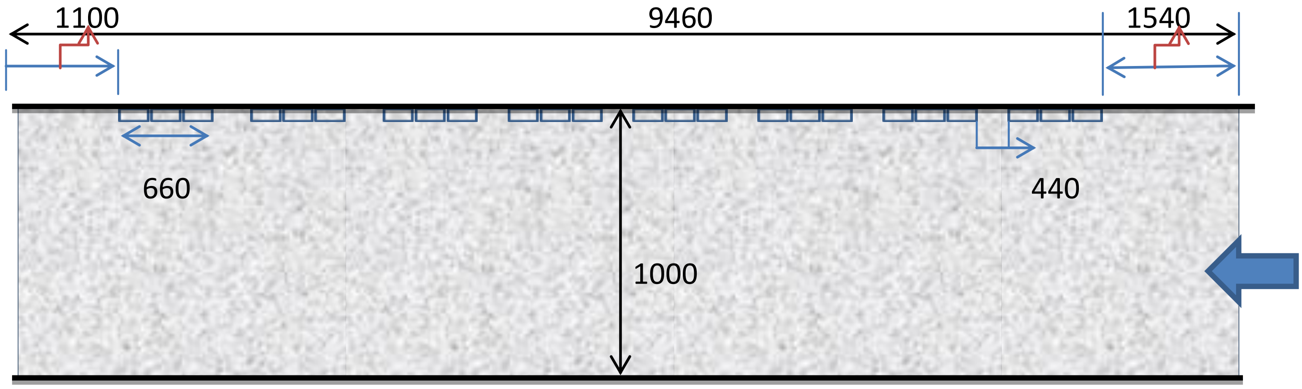

Figure 3.4.2 Rough bed flume with bank irregularities.

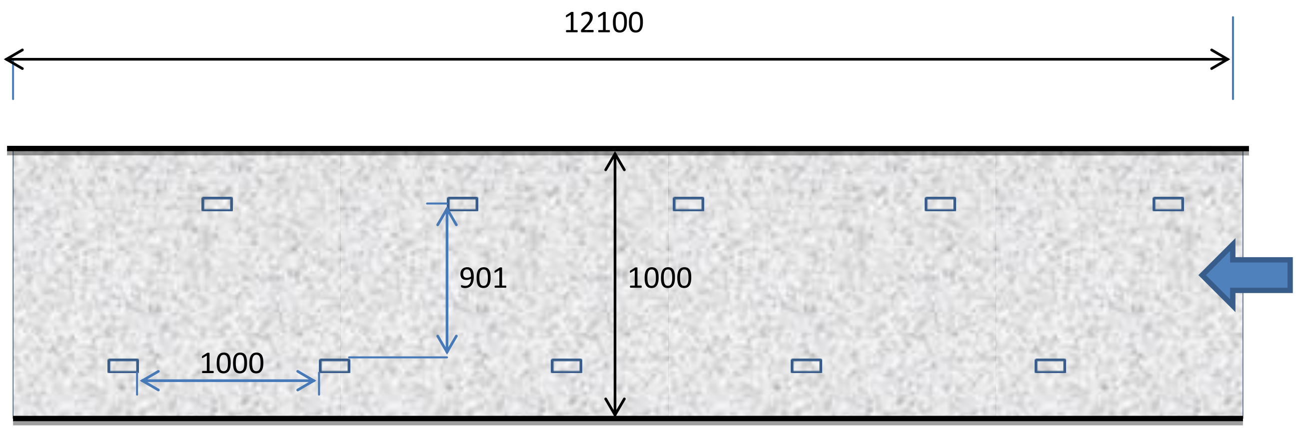

Figure 3.4.3 Rough bed flume with obstructions.

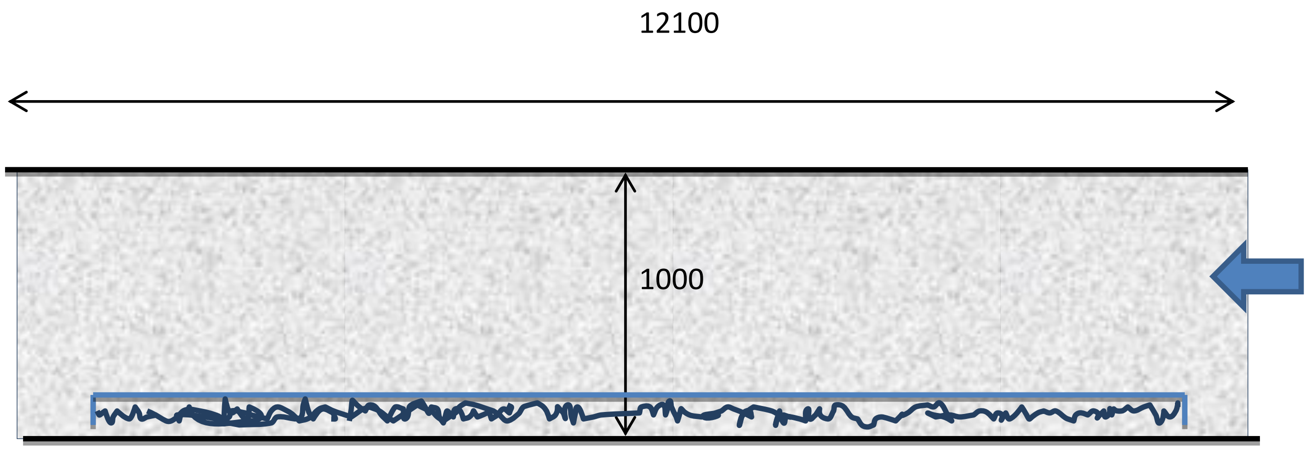

Figure 3.4.4 Rough bed flume with vegetation.

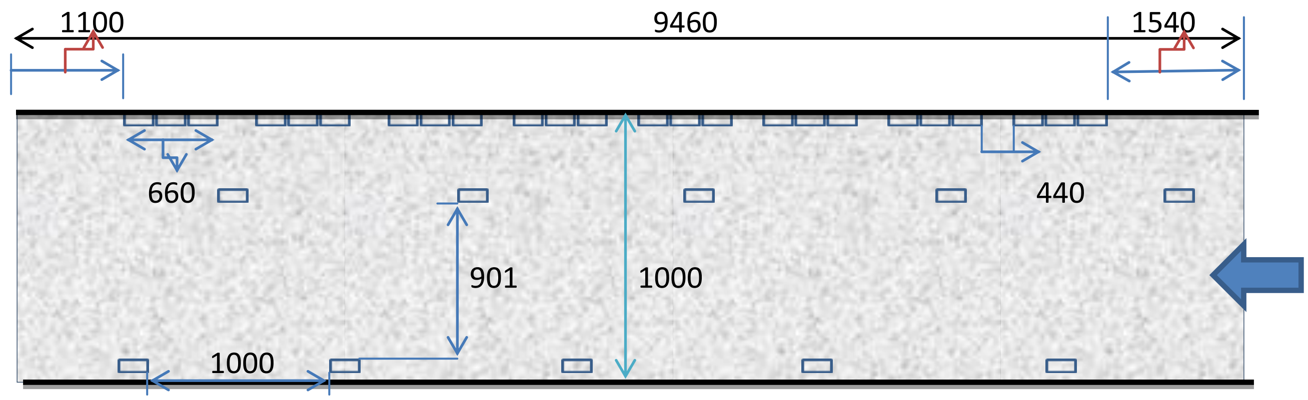

Figure 3.4.5 Rough bed flume with irregularities and obstructions

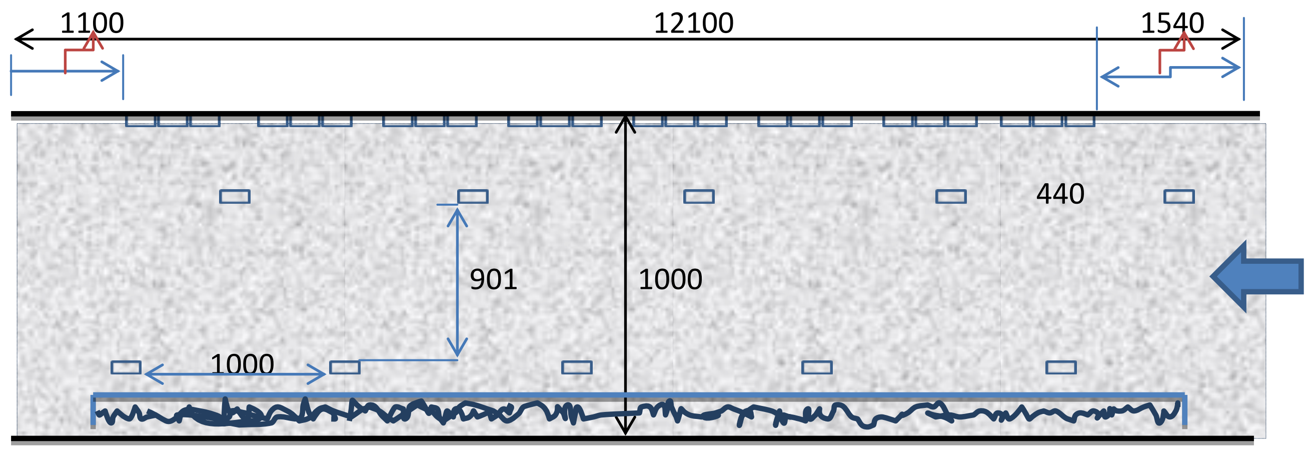

Figure 3.4.6 Rough bed flume with irregularities, obstructions and vegetation

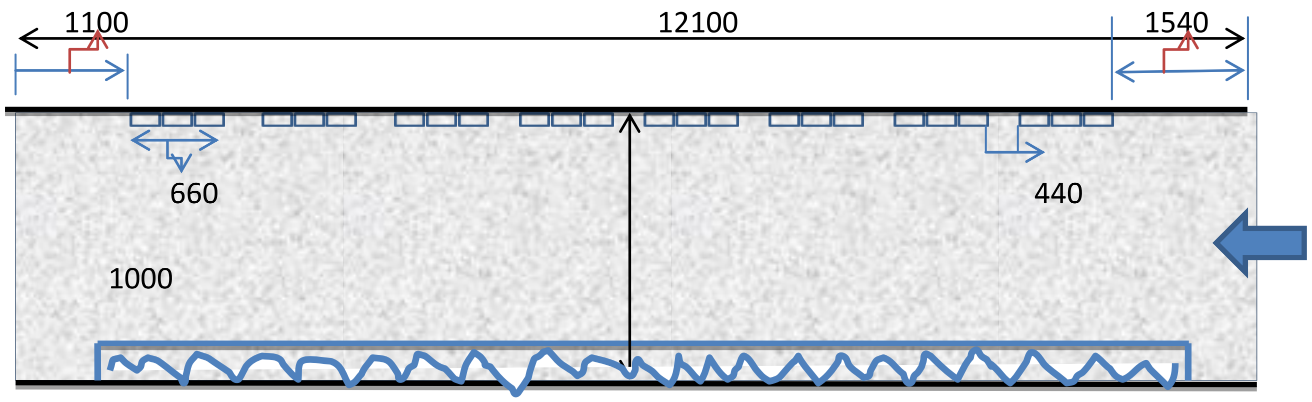

Figure 3.4.7 Rough bed flume with irregularities and vegetation

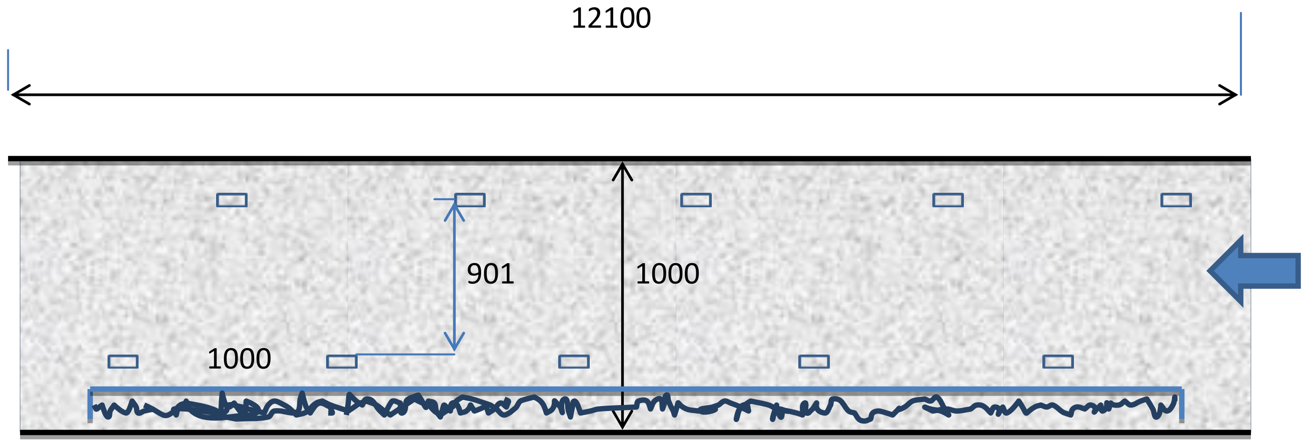

Figure 3.4.8 Rough bed flume with obstructions and vegetation

3.4 Depth of flow

The accurate uniform depth of flow corresponding to each discharge was obtained by adjusting the tailgate of the flume until the water surface slope was the same as the bed slope of the flume. Then the depth was measured to provide the corresponding accurate depth at such discharge.

The depths read from the 10 stilling pots were then plotted against the distance of the drilled holes from the beginning of the flume. The slope of this graph gives the slope of the water surface. The tailgate was adjusted while keeping the discharge constant until a slope equal to the bed slope was read from the stilling pots at this point the flow in the flume is uniform and the corresponding average depth at that discharge is the depth of flow.

3.5 Stage one

The experiments on the smooth bed flume where conducted with the bed of the flume being free of any roughness thus it was considered a smooth bed flume.

1. Experiments on the smooth flume began by first running five different discharges with the flume with no obstructions, irregularities and vegetation strands flume and the corresponding depth of flow were obtained and recorded as shown in figure 3.3.1 above. The friction factors and Manning's roughness coefficient (n) for the empty flume was then calculated and documented.
2. Secondly irregularities were introduced into the smooth flume and again five different discharges were passed through the flume as shown in figure 3.3.2 and also photographically in figure A1 of the appendix. The discharges and their corresponding depths of flow were obtained and documented.
3. Obstructions were arranged in the smooth flume and five discharges were run to obtain the five corresponding depths of flow as shown in figure 3.3.3 above and also photographically in figure A3 of the appendix.
4. Vegetation was arranged in the smooth flume by help of short 0.5mm diameter wooden rods joined together by a wooden bar of about 0.5mm thickness and the five discharges were run to obtain the corresponding depths of flow as shown in figure 3.3.4 above also please see figure A5 of the appendix for better understanding.

5. Irregularities and obstructions were also arranged inside the flume as shown on the diagram and again five discharges were run through the flume and five corresponding depths of flow documented as shown in figure 3.3.5 and also figure A7 of the appendix.
6. Irregularities and vegetation were also arranged inside the smooth flume and the five discharges were run to obtain the corresponding five depths of flow as shown in figure 3.3.7 and also figure A9 of the appendix.
7. Vegetation and obstructions were again arranged in the smooth flume and the five different discharges were run to obtain the five corresponding depths as shown in figure 3.3.8 and also figure A11 of the appendix.
8. Lastly irregularities, obstructions and vegetation were arranged inside the flume; again 5 discharges were run to obtain five different depths of flow as shown in figure 3.3.6 and also figure A13 of the appendix.

For these experiments approximate intervals of 10 minutes was given after adjustment of the tail gate for the level of water in the stilling pot to stabilize.

Detailed procedures for the calculation and generation of the tables will be stated in chapter five for ease of understanding as the tables differ in procedure of generation and cannot be generalised here.

3.6 Stage 2

The flume was emptied and lined with stone of about 19mm nominal size and five discharges were run in the rough bed flume to obtain the five corresponding depths of flow in the flume as shown in figure 3.4. 1.

The arrangements of figure 3.3.1-3.3.8 in stage one were repeated in the rough flume and the 5 discharges and corresponding five depths of flow were then obtained as shown in figures 3.4.1-3.4.8 above and also figures A15, A17, A19, A21, A23, A25, A27 and A29 of the appendix.

Using the slope of the water surface obtained from the depth vs. discharge graphs plotted as the S_f, the depths, the discharges the Darcy-Weisbach friction factors (f) as well as the Manning's roughness coefficients (n) were then evaluated using equations 2.1 and 2.14 discussed in chapter 2.

Finally the analysis of the different contributions of the different elements to the composite roughness was carried out in chapter five.