1. Introduction

Manning's equation

$$V = \frac{R^{\frac{2}{3}} S^{\frac{1}{2}}}{n} \qquad 1.1$$

is the most widely used formula for open channel flow. Engineers use it to estimate flow velocity and discharge for a wide range of hydraulic designs and practices in the determination of the resistance to flow.

However the accuracy of the resistance coefficient for predicting flow characteristics in a particular reach, with vegetation, obstructions and irregularities remains questionable.
In this work effort is made to reinvestigate the actual contribution of vegetation, irregularities and obstructions in an open channel.

1.1 Specific Research Objectives/Problem statement

Many calculations of resistance to flow in open channels have been based on the available values of Manning's n available. However the empirical formulae used to obtain these n values are questionable hence this work investigates the following

1. To verify the actual contribution of vegetation, obstructions and irregularities to the composite roughness in Low River flow.
2. To provide a method for combining the effects of the different contributions of composites to the overall resistance.

These objectives have been addressed by undertaking a literature survey, experimental investigation and data analysis.

1.2 Justification for research

Without an accurate estimate of resistance to flow, very little confidence can be placed on subsequent design calculations or predictions. At present, the accuracy of the friction factor f for predicting flow characteristics in a particular reach, with vegetation, obstructions and irregularities remains questionable. Many studies of flow resistance have been carried out to

provide accurate estimates of resistance coefficient in given circumstances especially under overbank conditions. However, none as yet has lead to a generally applicable method. In addition, as most of this work is based on laboratory experiments, these results may not reflect the real situations in natural rivers with highly irregular shape and variations in surface roughness. An attempt was made to focus on the estimation of flow resistance in natural rivers under low flow conditions and to verify Manning's n.

1.3 Scope of the study

The research work will consider the existing methods used to predict the total resistance to flow in channels with either and or combination of vegetation, irregularities and obstructions. This research work will be limited to sparse arrangement of these different elements in the channel.

1.4 Layout/structure of the research.

This research is organised around the following six chapters.

1. **Introduction**. This chapter provides an overview of the problem dealt with in this research.
2. **Background**. This chapter provides reviewed approaches for predicting resistance to flow in open channels with different elements.
3. **Methodology and description of apparatus.** The method/approach used to carry out the experiments including the apparatus used for the experiments are discussed in this chapter.
4. **Experimental investigation of total resistance to flow under different conditions.** The permutation of the three different elements (vegetation, irregularities and obstructions) in both rough and smooth beds. This experimental work shows how total resistance to flow in a channel is affected by different elements in the channel. Also the testing of existing methods of predicting total resistance in a channel was carried out.

5. **Analysis of the experimental data and prediction methods for total resistance under all the conditions tested.**. The data from the experiments are analysed here and tested against existing methods of prediction. Also an attempt to provide new methods of predicting the total resistance in channels with the conditions tested and how good the new methods work for all conditions tested are presented in this chapter.
6. **Conclusion and recommendations.** This chapter presents conclusion of the project and recommendations regarding further research.