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A Critical Review of Turbulence Characteristics in Open Channel Flow

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***Abstract:** This study subject encompasses a comprehensive evaluation of the available literature on turbulence in open channel flows. Open channel flows are characterized by intricate fluid dynamics, including the production of turbulent eddies and vortices that can profoundly alter transport processes and mixing of diverse fluids. The paper addresses the numerous forms of turbulence that can occur in open channels, such as coherent structures, secondary currents, and bed-generated turbulence. We investigate the elements that determine the intensity and features of these turbulent flows, including channel geometry, flow velocity, fluid properties, and roughness of the channel substrate. The paper also assesses the current theoretical models used to characterise open channel turbulence and the experimental techniques used to quantify and demonstrate turbulent flows in open channels. By critically scrutinising the strengths and limits of the current literature, this review outlines the essential research gaps that need to be addressed to expand our understanding of turbulent open channel flows. This study contributes to the development of enhanced models and techniques for managing and modulating open channel flows in diverse applications.*
***Keywords:** Turbulent, Eddies, Open Channel Flow, Fluid Dynamics, Secondary Currents Turbulance.*

I. INTRODUCTION

The complicated phenomenon known as open-channel flow turbulence has been intensively explored for many years. In open channels like rivers, canals, and streams, the fluid interacts with the free surface and the bed to generate this form of flow. There are still a lot of unresolved problems and challenges that need to be addressed despite significant inquiry. The study of open-channel flow turbulence has entered a new phase in the twenty-first century owing to the swift improvement of computational and experimental approaches. The objective of this study is to explore the most recent developments in our knowledge of the science of open channel flow turbulence and the applications of it in Hot-wire anemometers that have been employed in airflow experiments since the 1950s to study turbulent boundary layers and duct flow. In 1980s the laser anemometry has substantially lowered the difficulties of undertaking the research in open channel turbulence, permitting in-depth analyses of unstable and channel flows as well as more basic two-dimensional uniform flows. It is crucial to grasp open-channel flow turbulence for managing water resources, controlling floods, and conserving the environment**.**

A. Importance of Shear Stress and Eddy Vorticity

One of basic term in the study of fluid mechanics is shear stress which is the force per unit area that the fluid exerts on the boundary surface. In the flow of an open channel, the fluid's momentum is transmitted to the bed and the free surface by the shear stress. The degree of bed erosion, sediment movement, and the formation of bedforms like ripples and dunes are all impacted by the intensity of the shear force. Shear stress is another key aspect in the design of hydraulic structures like weirs, spillways, and energy dissipators, particularly when it comes to their stability and size. Using the depth-integrated Navier-Stokes equation, they provided an analytical solution that took into account the effects of bed friction, lateral turbulence, and secondary currents. Tang and Knight (2008) have devised a technique for evaluating average depth velocity and distribution of shear stress for overbank flows in compound channels using depth integrated Navier Stokes equation. They propose an analytical solution that addresses the effects of bed friction, lateral turbulence, and secondary currents. The existence of secondary current close to the interface area has been hypothesised by Carter and Williams (2008). They demonstrated the presence of a persistent secondary flow at the internal corner that exacerbates bed stress on the floodplain. In order to anticipate the stage-discharge correlations in compound channels with greater width ratios. Khatua and Patra (2012a and 2012b) developed an innovative method called MDCM and reported apparent shear stress in terms of interaction length. Rouse, H. (1937) proposed that turbulence is a random, chaotic motion that arises in fluids when the flow is disrupted. He argued that turbulence is characterised by the occurrence of eddies, which are zones of spinning fluid that mix the fluid and carry momentum and energy throughout the flow.

