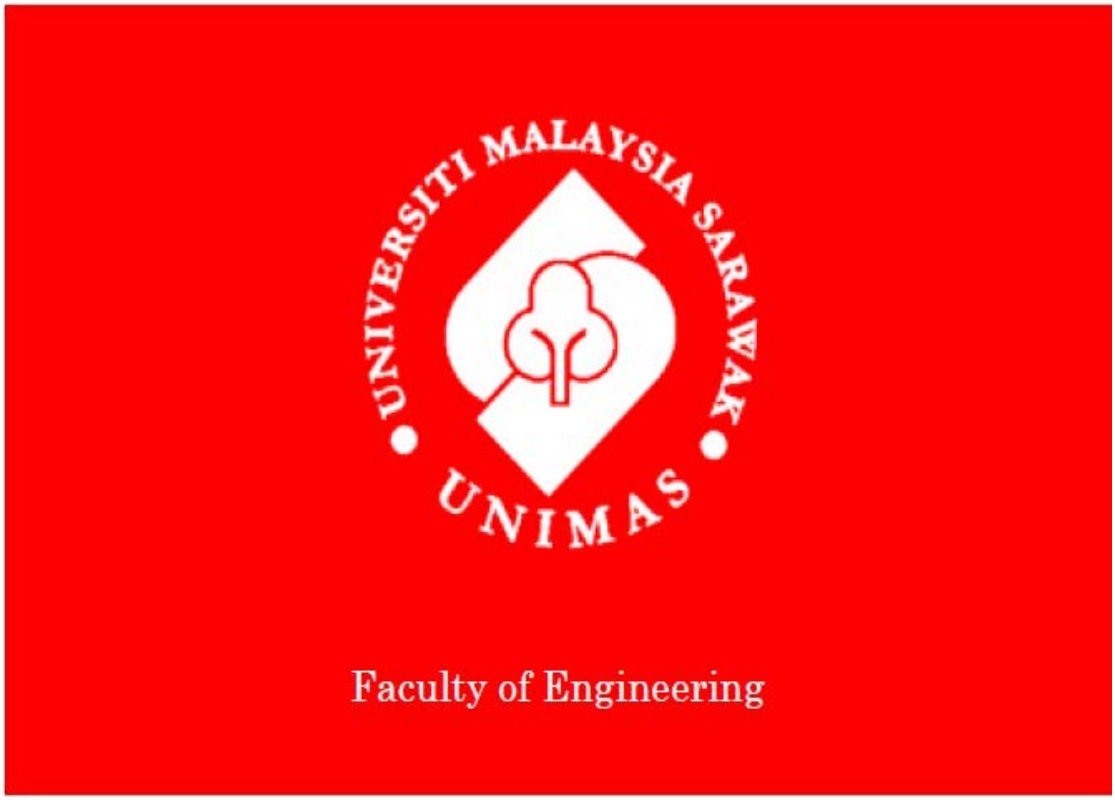

Float and Anchorage System for In-Stream Vertical Micro Hydro Turbine

Bong Chien Chai

Master of Engineering
(Civil Engineering)
2016

UNIVERSITI MALAYSIA SARAWAK

BORANG PENGESAHAN STATUS TESIS

Judul: **FLOAT AND ANCHORAGE SYSTEM FOR IN-STREAM VERTICAL MICRO HYDRO TURBINE**

SESI PENGAJIAN: 2015/2016

Saya **BONG CHIEN CHAI**

mengaku membenarkan tesis * ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sarawak.
2. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Membuat pendigitan untuk membangunkan Pangkalan Data Kandungan Tempatan.
4. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
5. ** Sila tandakan (✔) di kotak yang berkenaan

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan).
☑	TIDAK TERHAD	

Disahkan oleh

(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat tetap: NO. 50, LOT 1417, TMN MUSTAFA
JLN MUARA TUANG, 94300
KOTA SAMARAHAN, SARAWAK

DR. AZHAILI BAHARUN
(Nama Penyelia)

Tarikh: 28 MARCH 2016 Tarikh: 29 MARCH 2016

CATATAN
* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah, Sarjana dan Sarjana Muda.
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

APPROVAL SHEET

The project as follows:

Title:	Float and Anchorage System for In-stream Vertical Micro Hydro Turbine
Author:	Bong Chien Chai
Matrics Number:	10021664

has been read and approved by:

_____ _____

Dr. Azhaili Baharun — Date

Supervisor

FLOAT AND ANCHORAGE SYSTEM FOR IN-STREAM VERTICAL MICRO HYDRO TURBINE

Bong Chien Chai

This thesis is submitted in fulfillment of the requirements for the Degree of Master of Engineering (Civil Engineering)

Faculty of Engineering

UNIVERSITI MALAYSIA SARAWAK

2016

For my beloved family and friends

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to the God for giving me a wonderful life, spirit and wisdom to complete this project and thesis report.

Special appreciation to my supervisor, AP. Dr. Azhaili Baharun, his encouragement and motivation gave me the strength and mettle needed in completing my thesis. The knowledge delivered to me is very sincere as well as his consideration on keeping up with me. Besides, not forgetting my former supervisor, Mr. Abd Azim Abdullah, for his patient and guidance. Thanks to my beloved friends and family for their kindness, care and support during a few years of Master study in UNIMAS.

I would like to thank the Public Works Department (JKR) and Universiti Malaysia Sarawak (UNIMAS), which called as JARIMAS for providing the opportunity and financial support for me to conduct this applied research.

Last but not least, I would like to thank all the lecturers and staffs from Faculty of Engineering for their teachings and technical advices and supports from time to time. Also, a grateful dedication is dedication to anyone who directly or indirectly offer helps in making this project successful.

Pengapung dan Anchorage Sistem untuk Micro Hidro Turbin yang Menegak

ABSTRAK

Pengapung boleh direka dalam pelbagai saiz dan bentuk. Ia boleh dibuat oleh bahan-bahan seperti aluminium, kaca, kayu, konkrit, keluli atau lain-lain. Bahan yang paling sesuai untuk pengapung adalah gentian kaca. Pengapung gentian kaca adalah ringan, kuat, dan mudah untuk dibaiki. Terdapat beberapa kelemahan pada pegapung besar untuk Micro Hidro Turbin, seperti, pegapung besar lebih berat, sukar untuk mengangkut. Penyelesaian masalah ini adalah dibahagikan pengapung besar kepada beberapa pelampung kecil. Terdapat dua konsep Anchorage untuk Micro Hidro Turbin. Iaitu Conceptual Anchorage Sistem 1 (CAS1) dan Conceptual Anchorage Sistem 2 (CAS2). CAS1 boleh berfungsi dalam keadaan air surut dan air pasang, ia adalah sistem yang stabil. CAS2 menunjukkan prestasi yang baik dalam ujian, ia juga berfungsi dengan bagus pada masa air surut, air pasang dan juga mampu bertahan arus yang kuat.

ABSTRACT

Floats can be in many different sizes and styles, all of them are designed to remain suspended within or on the surface of water without sinking. It can be made by a lot of materials, such as aluminum, fiberglass, wood, concrete, steel or etc. The most suitable material of float for the Sustainable In-stream Vertical Micro Hydro Turbine is fiberglass. Fiberglass float is lightweight, strong, and easily to be repaired. There are a few disadvantages of the large float for the Sustainable In-stream Vertical Micro Hydro Turbine, such as weight of the float is consider as heavy, difficult to transport and extra care required during handling. The solution to handle the huge dimension problem is divided the large float into a number of small floats. There are two conceptual anchorage and mooring system for the Sustainable In-stream Vertical Micro Hydro Turbine. There are Conceptual Anchorage System 1 (CAS1) and Conceptual Anchorage System 2 (CAS2). The CAS1 could provide a strong anchoring for the Sustainable In-stream Vertical Micro Hydro Turbine, it can accommodate the rise and fall of tide and it is a stable system. The CAS2 shows good performance during the test, it can hold the floating turbine in a stable manner, it is also able to accommodate the rise and fall of tide and also able to withstand strong current.

TABLE OF CONTENTS

Chapter 2 Literature Review

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CAS1	Conceptual Anchorage System 1
CAS2	Conceptual Anchorage System 2
CQR	Clyde Quick Release
DPS	Dynamic Positioning System
FB	Buoyant Force
IVMHT	In-stream Vertical Micro Hydro Turbine
MBM	Multi-buoy moorings
SPH2O	Specific gravity of water
SPM	Single point mooring

CHAPTER 1

INTRODUCTION

1.0 Introduction

Sarawak is the state of Malaysia that full of hydroelectric resources. In Sarawak, there are a lot of mountains, rivers, and rainfall to give large opportunities for hydroelectricity development. Hydro represents non-consumptive, non-radioactive, and non-polluting use of water resources towards energy development with most mature technology characterized by highest prime moving efficiency and excellent operational flexibility [1]. It contributes to a significant percentage of world electric supply today. The scale of hydro power can be classified according to table 1.1. Different types of hydro will accommodate for different types of applications or end users. The micro hydro power may provide electricity to a village or small number populations.

Table 1.1: Classification of Hydro Power

Output (Kw)	Classification
Up to 300	Micro Hydro Power
101 to 2000	Mini Hydro Power
2001 to 25000	Small Hydro Power

The definition of micro hydropower varies in different countries and can even include system with a capacity of a few kilowatts [2-6]. One of the many definitions for micro hydropower is hydro systems up till a rated capacity of approximately 300kW capacity [7]. The limit is set to 300kW because this is about the maximum size for most stand-alone hydro systems not connected to grid.

Commonly there are two type of turbine for micro hydro, vertical axis turbine and horizontal axis turbine [8]. For this research will more focus on the float and the anchorage system of the vertical turbine micro hydro. In this chapter will cover the statement of problems for this project. Besides, the clear objectives of this project will be stated in order to overcome the problems. The benefits and expected outcomes at the end of anchorage and float system of micro turbine will be briefly explained. In addition, the expected outcomes are discussed based on the objectives. The brief explanation of the content for each chapter for the anchorage for micro hydro will be covered in the project report outline.

1.1 In-stream Vertical Micro Hydro Turbine (IVMHT)

The micro hydro project is part of Unimas' community based project in collaboration with the Ministry of Rural and Regional Development where Unimas will become the first university to develop a sustainable in-stream vertical micro hydro turbine generator prototype that would provide electricity in rural areas in the Sarawak. The turbine will rotate to generate electricity by a motor system as shown in Figure 1.1.

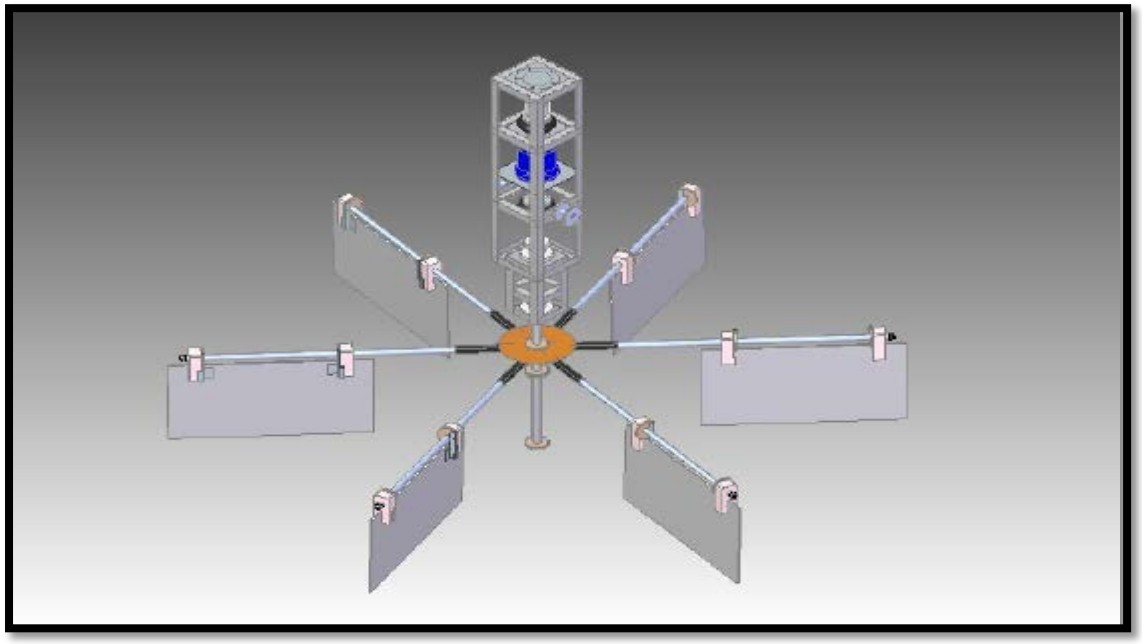

Figure 1.1: In-stream Vertical Micro Hydro Turbine (IVMHT)

The turbine has to cater at the speed of river between 1.3m/s to 2.72m/s, which had been measured by the technician of Civil Engineering, Faculty Engineering, Universiti Malaysia Sarawak (APPENDIX A). The floating and anchorage design has to suit for the current speed and fluctuation of water level of the river.

1.2 Statement of Problems

There are two types of Micro Hydro, which is supported by fixed structure or anchorage and float system to support the instream micro hydro system. For instream micro hydro system, the adequacy of the anchorage and float system design is important because it will affect the stability and functional of the micro hydro turbine to produce electricity. Besides, the huge dimension of float is considered heavy, difficult to transport and extra care required during handling.

1.3 Objectives

The purpose of this project is to design a suitable turbine floating system and anchorage for In-stream Vertical Micro Hydro Turbine. There are three objectives must be achieved:

- To investigate the suitable material for float.
- To design the floating system for the Sustainable In-stream Vertical Micro Hydro Turbine.
- To design the anchorage to sustain for different water levels.

1.4 Expected Outcome

The floating system and anchorage are very important part for the overall project because it will affect the functional of the micro hydro turbine to produce electricity and achieved the goal of the project.

There are several outcomes expected from this research:

- Identification of suitable design options of float and anchorage system for In-stream Vertical Micro Hydro Turbine.
- Proposal of a float system that can support the In-stream Vertical Micro Hydro Turbine.

1.5 Outline

Chapter 1 provides a brief introduction and overview of float and anchorage system for in-stream vertical micro hydro turbine, this chapter also covers the statement of problems which describes the real time problems faced, objectives, and expected outcomes from this study.

Chapter 2 reviews some literature, which discusses the shape, material, and characteristic of floats and anchorage system. This chapter also present the summary and results of the recent studies relating to the float and anchorage system for micro hydro turbine.

Chapter 3 explains the design methodology used to construct a float and anchorage system. Some of the material chosen for float and anchorage will be discussed in this section.

Chapter 4 presents results and discussions of the basic configuration and operation of the conceptual float and anchorage system for IVMHT.

Chapter 5 the concluding remarks and suggestions of further research are presented in this section.

1.6 Research Methodology

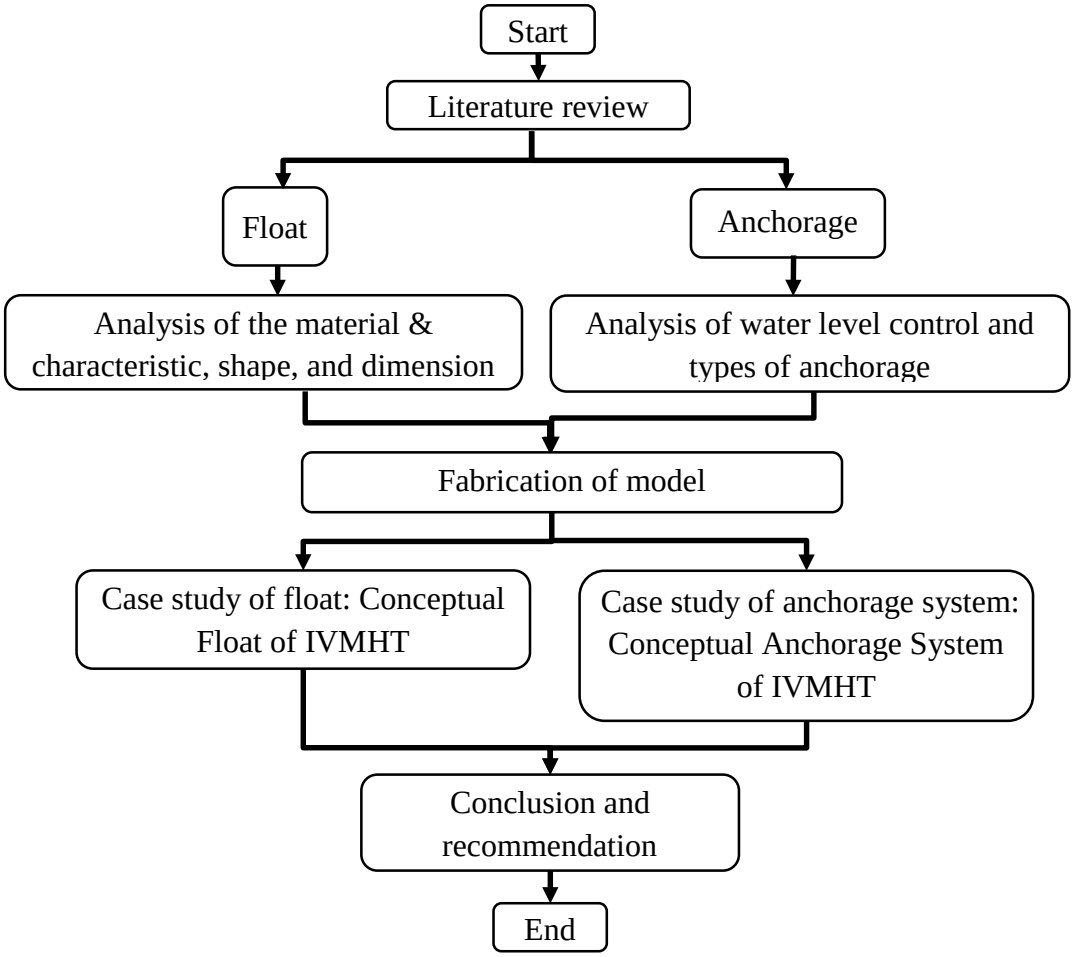

Figure 1.2: Flow Chart of Research Methodology

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

To achieve the objectives as described in chapter 1, this section will discuss on the research that previously done on float material, characteristic, shapes, types of anchorage. The float is used to support a vertical turbine on water. It may be simply constructed from sealed cylinders such as pipes or barrels and even fabricated boxes from metal. These may be used to support a simple platform, creating a raft. The basic design is usually implemented as a simple catamaran (Figure 2.1) or, with three rows of floats. A fixed platform can be used as a dock. An anchor is a device that made by metal, which is used to connect a raft to the bed of a body of water to prevent the raft from drifting due to wind or current [9]. Anchors can either be temporary or permanent [10]. A permanent anchor is used in the creation of a mooring, and is seldom moved; a specialist service is normally needed to move or maintain it. Raft carries one or more temporary anchors which may be of different designs and weights [11-12].