



Faculty of Engineering

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

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VERTICAL MICRO HYDRO TURBINE**

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**This thesis is submitted in fulfillment of the requirements for the
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For my beloved family and friends

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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 pengapung besar untuk Micro Hidro Turbin, seperti, pengapung 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

Contents	Page
Acknowledgement	iii
Abstrak	iv
Abstract	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
List of Abbreviations	xiv

CHAPTER 1 INTRODUCTION

1.0 Introduction	1
1.1 In-stream Vertical Micro Hydro Turbine (IVMHT)	2
1.2 Problem Statements	3
1.3 Objectives	4
1.4 Expected Outcome	4
1.5 Outline	5
1.6 Research Methodology	6

Chapter 2 Literature Review

2.0	Introduction	7
2.1	Float Materials & Characteristic	8
2.1.1	Aluminum Float	8
2.1.2	Fiberglass Float	10
2.1.3	Wooden Float	12
2.1.4	Concrete Float	14
2.1.5	Steel Float	15
2.2	Float Shapes	16
2.2.1	Flat-Bottom Model	16
2.2.2	V-Bottom Model	17
2.2.3	Round Bottom Model	18
2.3	Mooring System	19
2.4	Types of Anchorage	24
2.4.1	Admiralty Pattern	24
2.4.2	Stockless Anchor	25
2.4.3	CQR (Clyde Quick Release) Plough Anchor	26
2.4.4	Bruce/ Claw	27
2.4.5	Mushroom	28
2.4.6	Danforth / Fluke Anchor	29
2.4.7	Concrete Block / Deadweight	30
2.4.8	Screw Anchor	31
2.4.9	Grapnel Anchor	32
2.5	Anchoring Gear	33
2.5.1	Twisted Nylon	33

2.5.2 Chain	34
2.6 Summary	36

CHAPTER 3 METHODOLOGY

3.0 Introduction	38
3.1 General Descriptions of Float	39
3.1.1 Platform and Float Connection	42
3.1.2 Buoyancy Force	43
3.1.3 Float System Construction	44
3.2 General Descriptions of Anchorage	49
3.2.1 Holding Conditions	50
3.2.2 Force Exerted	51
3.3 Anchoring and Mooring	54
3.3.1 Catenary Anchor-Leg Mooring Systems	54
3.3.2 Single anchor leg mooring system	55
3.3.3 Column Mooring (Support Frame)	56
3.3.4 Trot Anchor mooring system	57
3.4 Conceptual Anchoring and Mooring of IVMHT	58
3.4.1 General Formation for Conceptual Anchorage System 2	62

CHAPTER 4 RESULTS AND DISCUSSIONS

4.0 Introduction	65
4.1 Discussions of Float	65
4.1.1 Analysis of Floats	68
4.2 Discussions of Anchorage System	70

4.2.1 Conceptual Anchorage System 1 (CAS1)	70
4.2.2 Conceptual Anchorage System 2 (CAS2)	71
4.2.2.1 Calculations of Conceptual Anchorage System 2	72
CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS	
5.0 Introduction	78
5.1 Conclusions	78
5.2 Recommendations and Limitations	79
REFERENCES	80
LIST OF PUBLICATIONS	88
APPENDIXES	

LIST OF TABLES

Table	Page
1.1 Classification of Hydro Power	1
3.1 Buoyancy for Conceptual Pontoon	44
3.2 Formation Formula in Low Tide and High Discharges	64
4.1 Relative Performance – Corrosion and Water Resistance	66
4.2 Thermal Performance	67
4.3 Relative Performance – Maintenance and Repair	67
4.4 Force Resistance and weight in differ theta 3	73
4.5 Force Resistance and Cable Tension when mass is 98.71kg	74
4.6 Force Resistance and Cable Tension when mass is 126.68kg	75
4.7 Force Resistance and Cable Tension when mass is 174.07kg	76
4.8 Force Resistance and Cable Tension when mass is 269.90kg	77

LIST OF FIGURES

Figure	Page
1.1 In-stream Vertical Micro Hydro Turbine (IVMHT)	3
1.2 Flow Chart of Research Methodology	6
2.1 Catamaran Float	8
2.2 Flat Bottom Model	17
2.3 V-bottom Model	17
2.4 Round Bottom Model	18
2.5 Pre-stressed Mooring Systems with Normal Condition and No Load	20
2.6 Pre-stressed Mooring System with Loaded Condition	20
2.7 Slack Mooring System	20
2.8 The Dolphin- Frame guide system	21
2.9 Admiralty Pattern Anchor	25
2.10 Stockless Anchor	26
2.11 CQR (Clyde Quick Release) Plough Anchor	27
2.12 Claw Shaped Anchor	28
2.13 Mushroom Anchor	29
2.14 Danforth Anchor	30
2.15 Deadweight Anchor	31
2.16 Screw Anchor	31
2.17 Grapnel Anchor	32

2.18	Twisted Nylon	34
2.19	Stud-link chain	35
2.20	Short-link open chain	35
3.1	Large Float	40
3.2	Composed Small Floats 1	40
3.3	Composed Small Floats 2	41
3.4	Replaceable Float	41
3.5	Front View Connection	42
3.6	Side View Connection	42
3.7	Plan View of Conceptual float of IHMHT	43
3.8	Formwork with Grease	45
3.9	Fiberglass Mat	45
3.10	Mixing of Resin with Hardener	46
3.11	Applying Resin to the First Layering Fiberglass	46
3.12	Painting the Fiberglass Float	47
3.13	Measuring the Weight of Fiberglass Float	47
3.14	Getting ready for Float Experiment	48
3.15	Sentinel and Kellet	52
3.16	Multiple anchor-leg mooring	54
3.17	Single anchor leg mooring	55
3.18	Column Mooring	56
3.19	Trot Mooring	57
3.20	Conceptual Anchorage System 1 (CAS1)	58
3.21	Submerged Buoy Used in CAS1	58
3.22	Conceptual Anchorage System 2 (CAS2)	60

3.23	Laboratory emulation of CAS2	60
3.24	Laboratory emulation of 2nd generation of CAS2	61
3.25	Analysis of Laboratory emulation of 2nd generation of CAS2	62
4.1	Conceptual Pontoon	68
4.2	Combination of two pontoons	69
4.3	Combinations of four pontoons	69
4.4	Elevation view of CAS2	72

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.

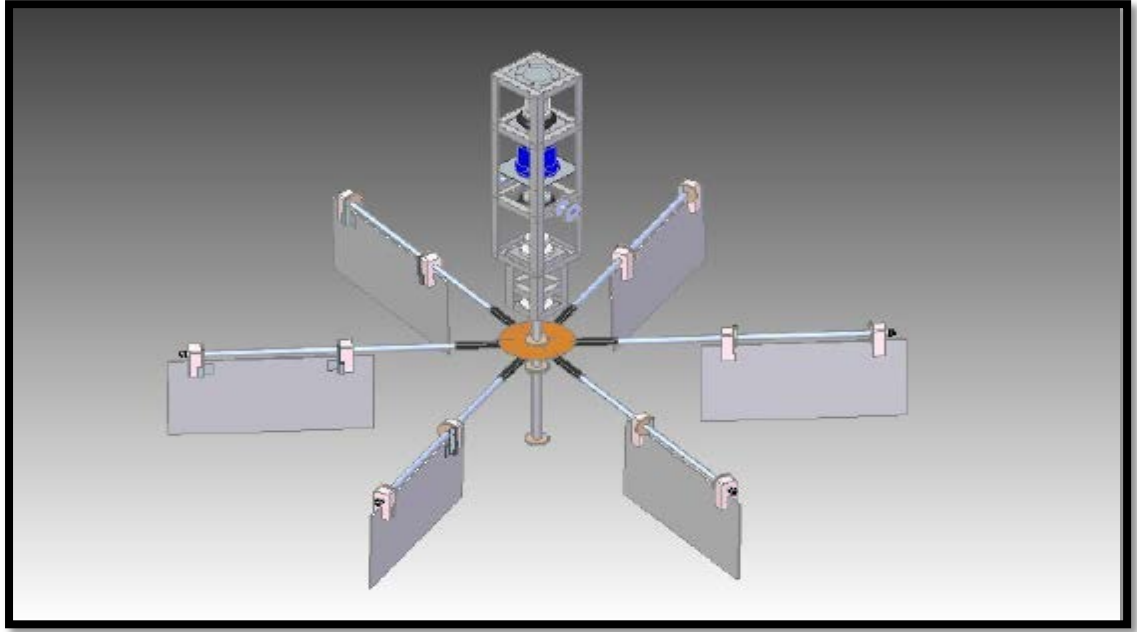


Figure 1.1: In-stream Vertical Micro Hydro Turbine (IVMHT)

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

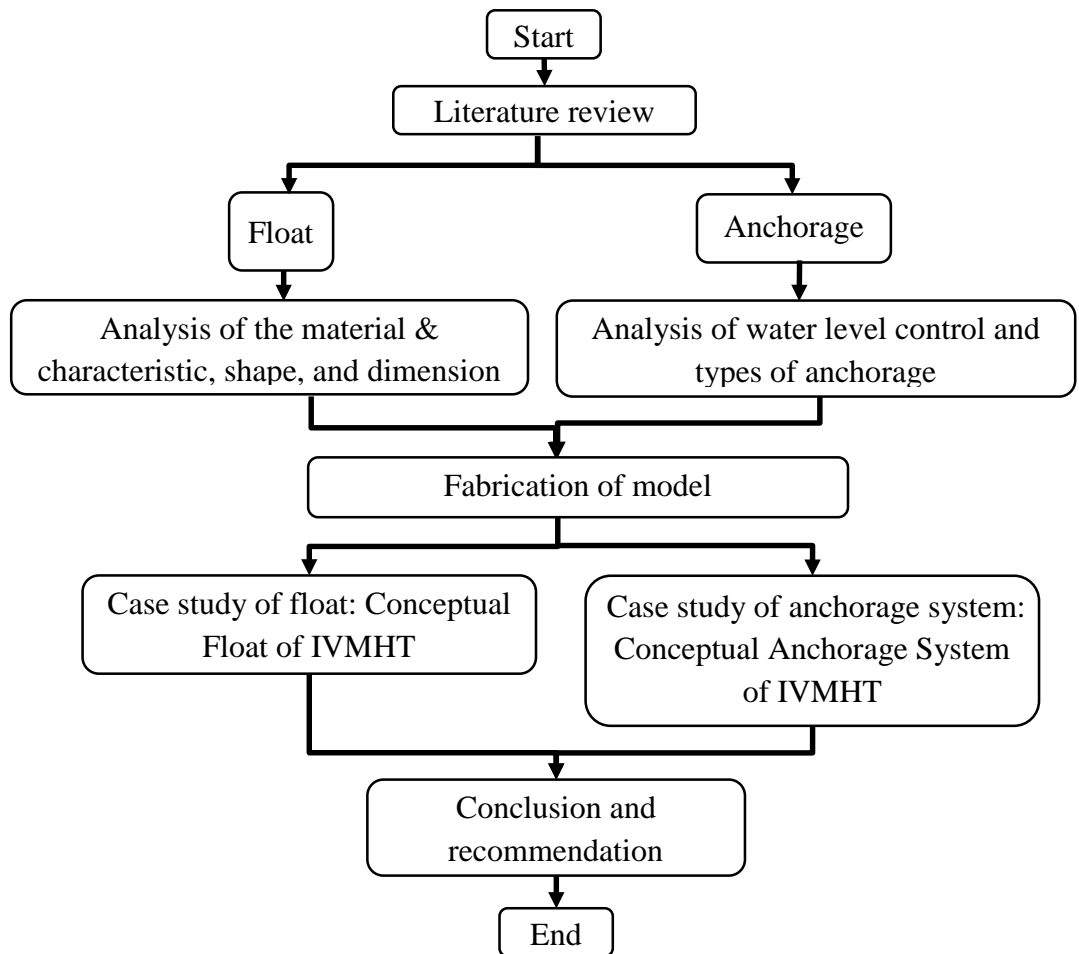


Figure 1.2: Flow Chart of Research Methodology

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].