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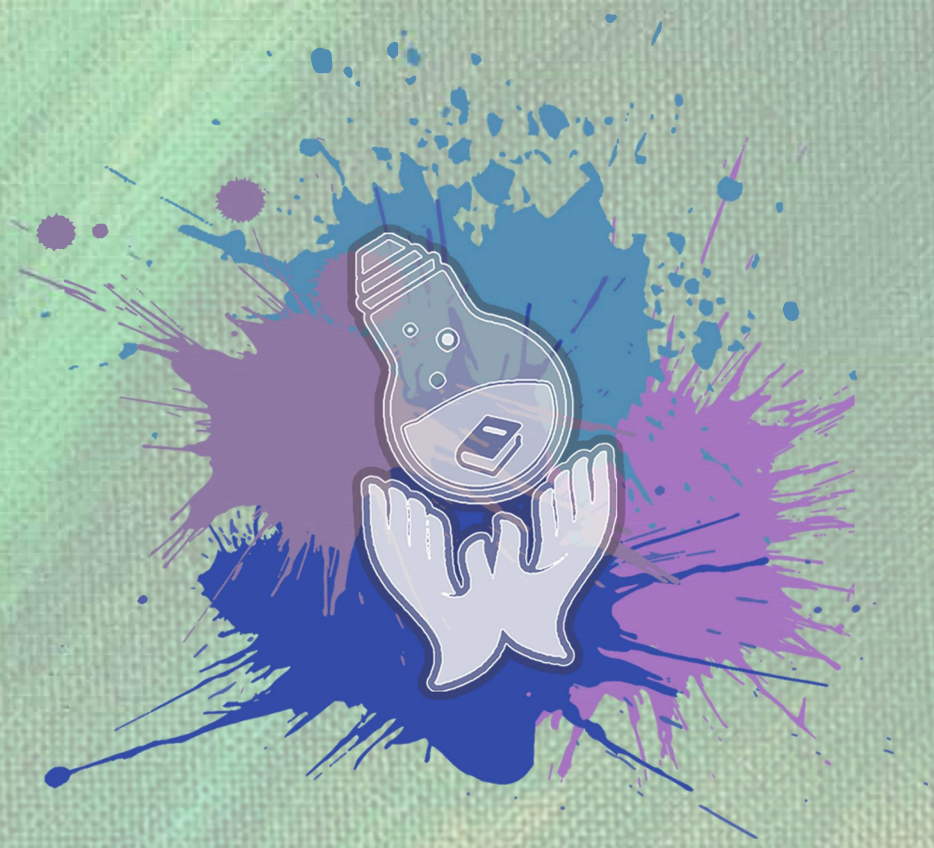

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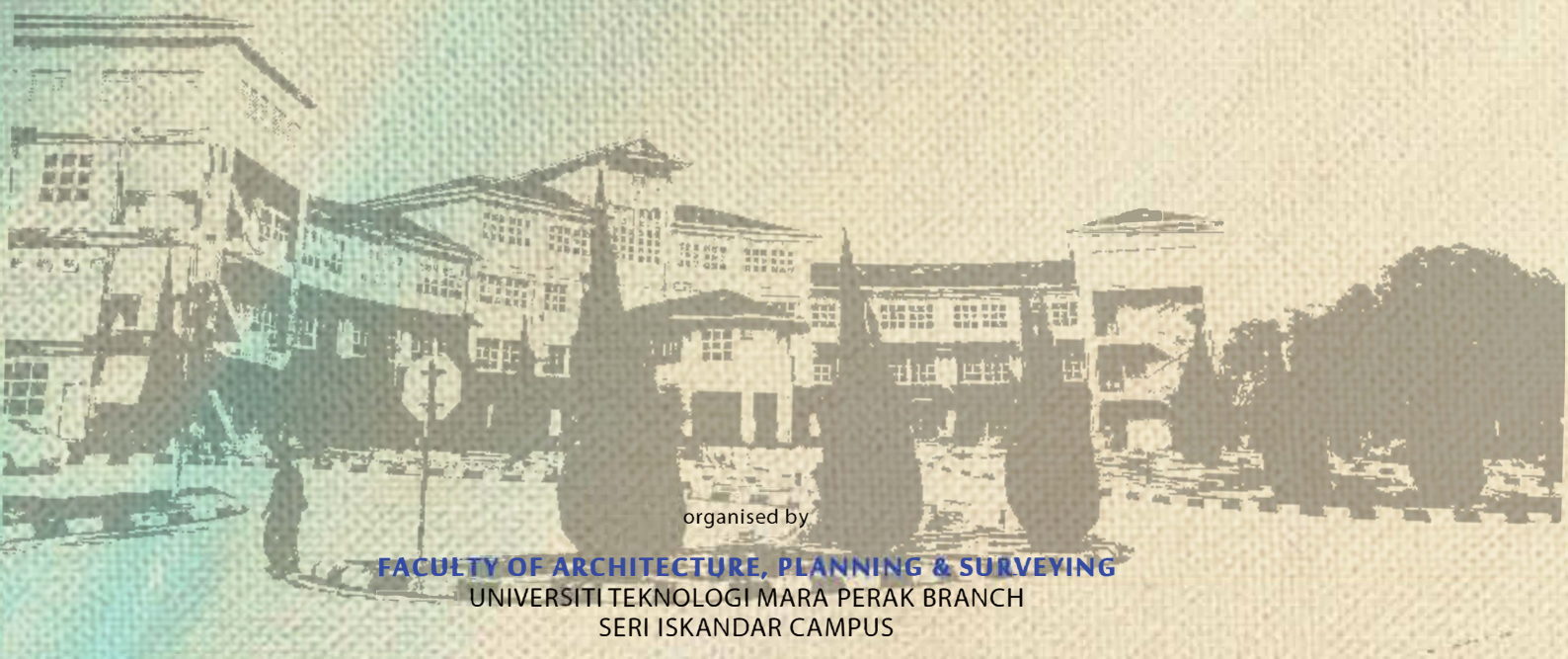

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A CONCEPT DESIGN STAGE OF MODULAR BUOY

Muhammad Umarul Asyraf bin Ibrahim[1] and Rohaizad Hafidz bin Rozali[2]
[1 2] Maritime Engineering Technology Section, Universiti Kuala Lumpur MIMET, 32200, Perak
Email: umarulasyraf1993@gmail.com[1], rohaizad@unikl.edu.my[2]

Abstract:
The objective of this project is to present the concept design stage of a buoy. The buoy is the structure which is floating on the sea surface has been used for several applications measuring oceanographic, meteorically, chemical and biological parameters. The buoy is also used to show the direction of the sea route to ship during sailing. Generally, the conventional material of buoy is steel. Steel buoy has many advantages such as high strength and easy manufacturing using cutting and welding process to take shape. However, it can lead to marine pollution due to steel corrosion and maintenance cost due to its heavy weight. To overcome this problem, Wave scan buoy using polyethylene which is light and environmentally friendly are developed. The design and application of Wave scan buoy for a deep-water tsunami detection system for Malaysia are discussed. The Wave scan superstructure shape was chosen for reference. In this study, the researchers will design the buoy from existing design body to the modular type concept design. The concept design includes the principal dimensions and identifies all major design trade-offs. Concept design process example was carried out using Computer Aided Design (CAD) software to speed up the design process. The concept design determines whether the modular buoy can be a feasible design to continue development in the preliminary design stage. The intent of the concept design is to provide the designer to resolve all design trade-offs. The sooner you resolve the major design trade-offs, the less work you will have to do to complete the design and the more successful it will be.

Keywords:
Buoy; modular buoy; concept design stage; design spiral; design process

1.0 INTRODUCTION

Over the years there have been numerous types and styles of marine buoys designed to serve various functions. A lot of research has been carried out in focusing on the design that brings out the stability, which is challenging due to the geometric shapes of the product and the complexity of the phenomena. Generally, the conventional material of buoy is steel. Steel buoy has many advantages such as high strength and easy manufacturing using cutting and welding process to take shape. However, it can lead to marine pollution due to steel corrosion and maintenance cost due to its heavy weight. To support the potential of buoy development, new design buoy that introduces modular concept will be shown. The advantages of modular design have completely reduced the weight of the existing buoy makes a slightly better for an operation to install or uninstall the buoy make it friendlier user plus does not need much cost during operation. This paper presents the concept design stage of modular buoy. In addition, the material used for modular buoy will be suggested.

2.0 LITERATURE REVIEW

2.1 Malaysian Tsunami Buoy

The buoy was designed by review of the existing design and which are still actively used. One of the buoy designs in Malaysia name as Wave scan has been deployed Malaysian open water. As mention by the Aasen, Mustapha, Schjolberg, & Elliott (2007), the main function of this buoy is to continuously measure the ocean water pressure. Its pressure sensors have a pulse output where can measure sea pressure every 15 seconds. The selected design in Figure 1 for this project is the buoy designed by a company named Furgo. The Wave scan has a discus-shaped hull. It has been designed to provide less drag and large buoyancy suitable for deep offshore and remote locations or areas with strong current forces. Fugro Company had designed a buoy that used a base material that controlling earth ecosystem by using a polyethylene. The idea of wave scan buoy is significantly good but, it is lack of modularity. With the total weight of 924kg and diameter 2.8m, it cannot be considered as a modular.

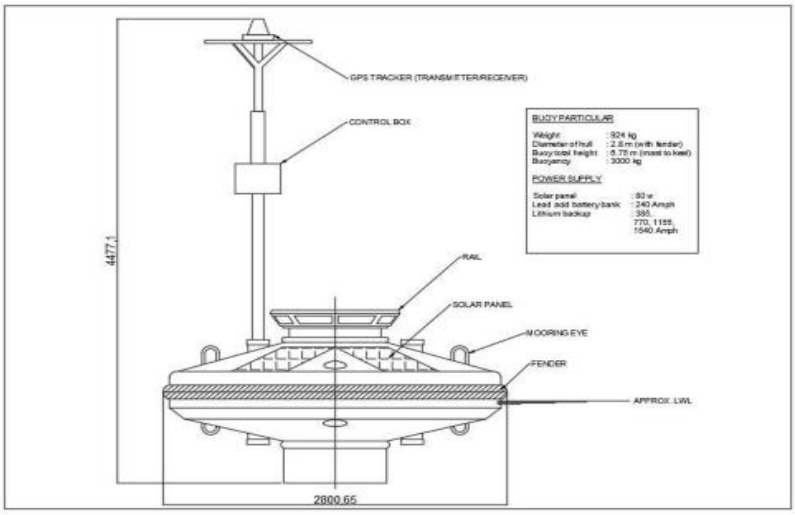

Figure 1: Wave scan buoy

2.2 Design Spiral

Traditionally, the process of the new design is based on a brainstorming idea among the designers. The client will specify buoy features according to their requirements. A design spiral concept is an approach that can be used for the development of the new product. Evans (1959) and Mistree, Smith, Bras, Allen , & Muster (1990) visualize the ship design process start with concept design, preliminary design, and details design. The key to a successful of the design is the resolution of all major design trade-offs. If we discover a problem in the detail design phase, then we might have to completely rework the design. The early we resolve the major design trade-offs (weight vs cost, weight, hull shape, vertical center of gravity vs stability), the less work we will have to do to complete the design and the more successful it will be.

2.3 Modular Concept

According to Lacey, Chen, Hao, & Bi (2019), "Modular" is a method of construction involving the construction of sections away from the building site and then delivery to the intended site. Installation is completed on site of the prefabricated sections. The modules can be placed side-by-side, end-to-end, or stacked to allow a variety of settings and styles. Using inter-module connections, also known as interconnections, the modules are joined together after placement. The interconnections tie together the individual modules to form the overall structure of the product. Doerry and Koenig (2017) discuss that the modular construction of ship technology provides an option for inserting different parallel ship modules. This concept can be used to be exercised in new construction.

3.0 METHODOLOGY

To achieve a feasible design, the researchers need to make sure that everything fits, the buoy floats, and it performs as expected. The interaction of the many interrelated variables must be identified before a design trade-off can be identified. The critical criteria need to design the buoy is the shape according to the dimension and estimate buoy weight. To speed the design process AutoCAD software is used as design software. For weight estimation, manual calculations using the basic mathematical formula (Density (kg/m^3) = Mass (kg) / Volume (m^3) are needed as for determining the area, the total volume of the model and many more. The total volume needed in this research in determining the approximate weight of the model using the fiberglass material

4.0 ANALYSIS AND FINDINGS

The concept design of the modular buoy was developed in accordance with the design spiral method. The diamond shape has been chosen as a hull body design. The V-shaped bottom will make it more stable same as the ship hull design. The modular buoy has very simple hull form, being defined by its diameter and length. The diameter of the hull body is 2m and the length from the keel to the antenna with maximum 4.55m height. Figure 2 shows the structural topology of this buoy consists of 3 modules

which are buoy body, component box, and a tower section. These sections can be plug in and out to show the modular type concept. Weight is a characteristic of a product that gives a big impact, especially to a new design. The estimated buoy body in lightweight conditions is 256.45kg

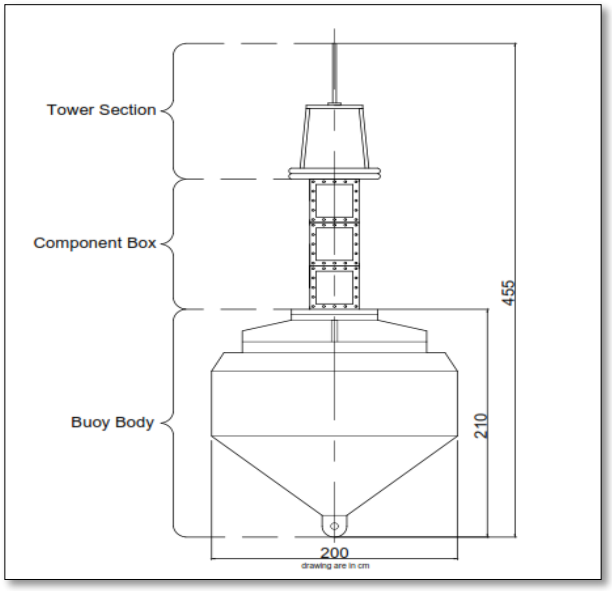

Figure 2: Modular buoy structure

5.0 CONCLUSION

In this study, the concept design of the V-shaped modular buoy is created by using AutoCAD software. We also changed the existing buoy material to fiberglass and estimate the hull weight body. The shape, materials, and weight are important criteria in concept design in order to produce a good design. The existing Wave scan buoy weight is 924kg whereas the new design buoy weight is 256.45kg. This shows 72% of weight reduction and proves that the new design is more lightweight than the existing design. Notice that the weights of the buoy play a key role in the design trade-offs. Defining an accurate weight estimate for the early in the design phase is the best tool in minimizing the design iteration time. This research has achieved its objectives with the propose new modular buoy concept design and weight estimation. Next, further analysis and technical development are required for the modular buoy design. It can be identified through the assessment at the next preliminary design phase.

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