# Modeling Structure of Portable River Bridge using Fiber – Reinforced Polymer (FRP)

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**Abstract**. Portable bridge is a device that serve to connect areas near the river to the opposite. The study of portable bridge based on marine buildings (platforms) about ballast system. This utilizes fluid from a constant river flow to meet the bridge ballast pipe with a normal flow control valve. The system was developed by installing a branch and flange on the main pipe as a regulator. A lightweight material chosen as the main material in the portable bridge is Fiber-Reinforced Polymer (FRP) based on ACI 440R-07 standard. Portable river bridge structure modeling is supported by 3D CAD software that focuses on building structures, especially in the main pipe and flange.. This model using main pipe 16"NPS Sch-STD Pipe based on ANSI/ASME B36.10M/19M 2004 standard and flange 16"NPS Weldneck Flange 300# RF Sch-STD based on ASME B16.5 Flanges standard

**Keywords:** Portable Bridge, FRP, CAD Modeling, ANSI/ASME standard

## 1. Introduction

Indonesia is a maritime country whose sea area is wider than the mainland. This happens because the number of rivers that flow from upstream to the sea passes through several long land areas resulting in the separation of land into two different parts. so that it has natural potential that can be exploited to meet the needs of every human life. Every human being needs equipment that is used as a link for both land to be able to carry out economic activities. The study of portable bridges is still limited to the area to be used as its application.

A ballast system is used in a marine building (platform) that utilizes the use of fluid from a constant stream to meet the ballast bridge with a normal flow control valve with the same system [4]. The difference is in the size of the main pipe with branches used in a system that functions as a regulator of the transfer of portable bridges. Portable bridges are interfaces between regions that are used in water, especially rivers with moving fluids, which are expected to be more efficient at an economic point of view. The selection of composite materials such as Fiber Reinforced Polymer (FRP) as a lightweight material, and hence is considered to be used as the main material for portable bridges [6,11]. FRP has a high strength and weight ratio, producing products that are lighter than steel and other alloys [5,13]. Modeling is supported by 3D CAD applications which are considered capable of supporting the planning of bridge construction which focuses on bridge structures, especially on the main beam which functions as an important structure of portable bridges [7]. Conceptually, the proposed portable bridge model is designed with an estimated length of 5 meters and a width of 1 m.

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Medium selection of Fiber-Reinforced Polymer (FRP) materials as the main material for bridges [10]. FRP has several beneficial properties, such as strength to weight ratio, corrosion-free characteristics, and good fatigue resistance, improving making this type of material as material for the construction of portable bridges [9,12]. In advance, previous research showed that several pedestrians and several FRP bridge vehicles had been built and proved the feasibility of this material suitable for light bridges [7,14]. Utilization of original fluid from the river flow supports it, reduces electricity use and reduces the amount of manufacturing costs, by designing a simplified one for pedestrians and facilitating to move from one place to another without the need for heavy equipment [7]. There are various portable bridges that are used by many countries around the world, the process design on the basis of determining the right type of material and the size of structural elements, to include the design of the connection and also to install bridges can meet the requirements safely [15].

## 2. Portable River Bridge

Portable bridges are one of the building innovations that are very beneficial for people in rural areas, especially for those who need transportation support facilities for daily mobility [6]. The main aspects needed are factors of portable river bridge use and safety by considering various safety such as: Wind, river flow velocity, and bridge material strength [4]. Portable bridges can be used to assist the transportation needs of rural communities by using appropriate applied technology. The use of land routes is very helpful to accelerate the mobility of economic growth of the population. Construction of bridges is limited to raw material requirements and access to making the main bridge that can be moved [6]..

## 3. Fiber – Reinforced Polymer (FRP)

Composite Fiber Reinforced Polymer (FRP) is defined as a polymeric (plastic) matrix, either thermoset or thermoplastic, and reinforced (combined) with fiber or other reinforcing materials with an adequate aspect ratio (length to thickness) [8,9].

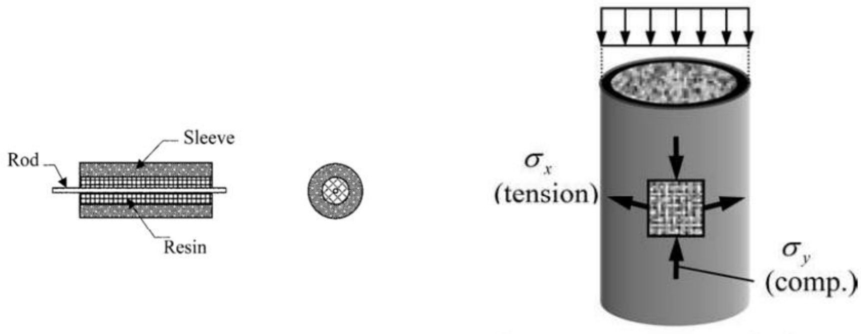


**Figure 1**. FRP composites with both core and tube are loaded

FRP composites have brought many benefits to their selection and use. The choice of material depends on the performance and purpose of using the product. Selection of composites can be adjusted to the needs. It is important for users to understand the environmental aspects, load performance, and product durability requirements and convey this information to the composite professional industry [9,10]. In short, the researchers have previously summarized some of the benefits of FRP composite materials listed as follows ; Lightweight, High strength-to-weight ratio, Directional strength, Corrosion resistance, Weather resistance, Dimensional stability, Radar transparency, Non-magnetic, High impact strength, Low maintenance, Long term durability, Small to large part geometry possible, and Tailored surface finish. and this is all based on FRP material standards listed in ACI 440R-07 about Fiber-Reinforced Polymer (FRP) Reinforcement for Concrete Structures [1].

## 4. Modeling Structure of Portable River Bridge

**Table 1**. Main pipe dimension standard.

| Parameters | Size |
|---|---|
| n (Pipe) | **5** |
| L (wide) | **1 m** |
| Q (debit) | 4,7 $m^3/s$ |
| T (Thickness) | **0,2 m** |
| P (Length) | $5\ m$ |
| ρ (Mass) | 1000 $Kg/m^3$ |
| V (velocity) | $2\ m/s$ |

Based on the parameter in **Table 1**, main pipe structure can be determined using ANSI/ASME B36.10M/19M -2004 standard [3].

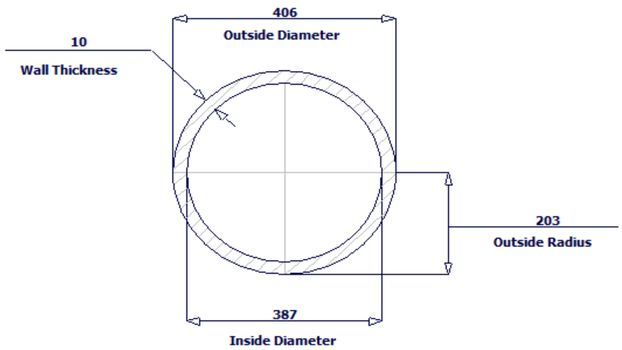


**Figure 2**. Main pipe 16" Sch-STD

Main pipe dimension based on ANSI/ASME B36.10M/19M -2004 standard shows in **Figure 2** has parameter Weight 93 Kg/m, Weight Including Water 211 Kg/m, and Moment of Inertia 23390 $cm^4$.

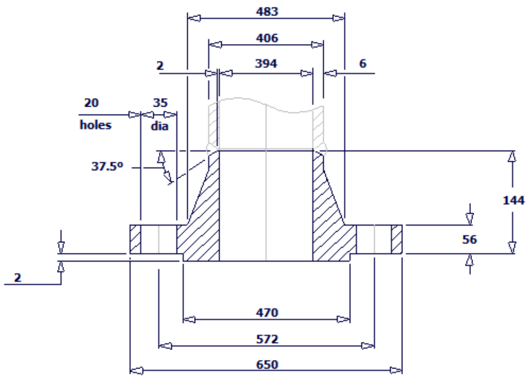


**Figure 3**. Flange design 16"NB WeldNeck Flange 300# RF Sch-10

Flange dimension based on ANSI/ASME B16.5 2003 standard shows in Fig.3 has parameter Weight 107,38 Kg, S/Bolt & nuts Weight 35,2 Kg, and Studbolt Size : 1 + ¼" UNC x 190 Long [2].

The proper schedule of main pipe that suitable for this standard is determined as follows :

$$\sigma A = \sigma B \quad (1)$$

Journal of Physics: Conference Series **1445** (2020) 012029 doi:10.1088/1742-6596/1445/1/012029

$$\frac{n\times m\times g}{A} = \frac{\rho\times Q\times V}{A} \tag{2}$$

$$\frac{5\times 70\times 9{,}8}{p\times l} = \frac{1000\times 4{,}7\times 0{,}783}{\pi\times 0{,}25\times D^2}$$

$$\frac{5\times 70\times 9{,}8}{5\times 1} = \frac{4688{,}02}{6.\pi.0{,}25.D^2}$$

$$D^2 = \frac{4688{,}02}{686} = (2{,}907)^{1/2} = 0{,}435\ m = 16\ Inch = 16”$$

Three-dimensional forms are presented with orthographic projections and this is better than hand drawing. The advantage is that making and modifying images is easier. Three-dimensional frame modeling adds a little extra information. The surface between the edges of the wire frame is not determined and the computer cannot determine what is inside or outside the project being drawn. The wireframe model is often confusing and difficult to interpret because of complicated lines. The pictures below illustrate a portable river bridge frame model by CAD software in each viewpoint.

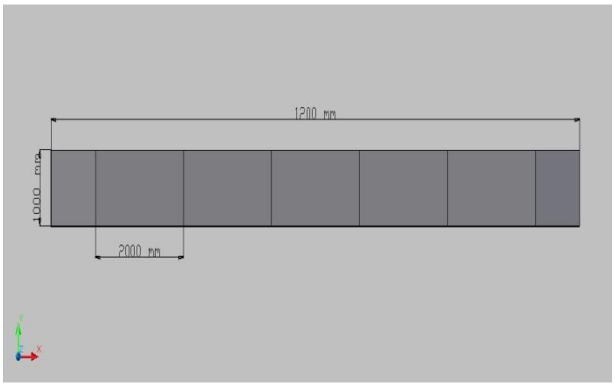


**Figure 4**. Top view

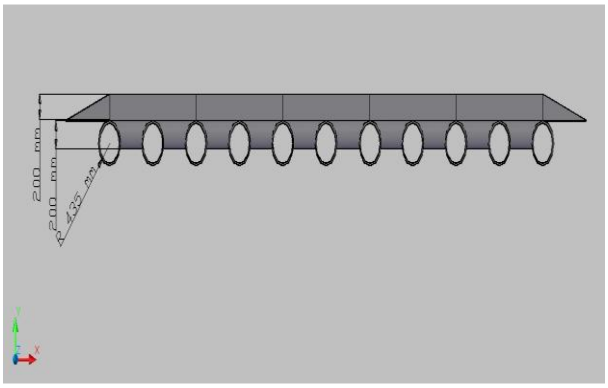

**Figure 5**. Front view

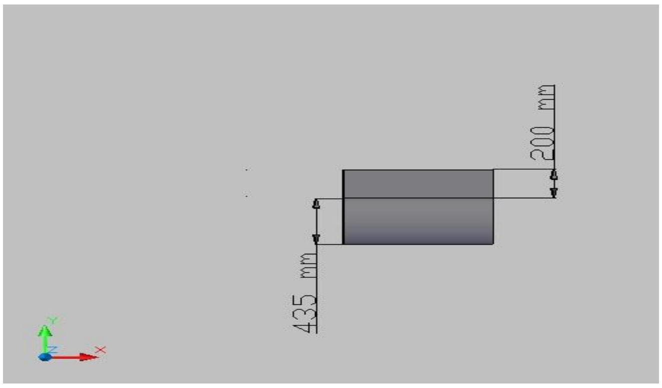


**Figure 6**. Right – side view

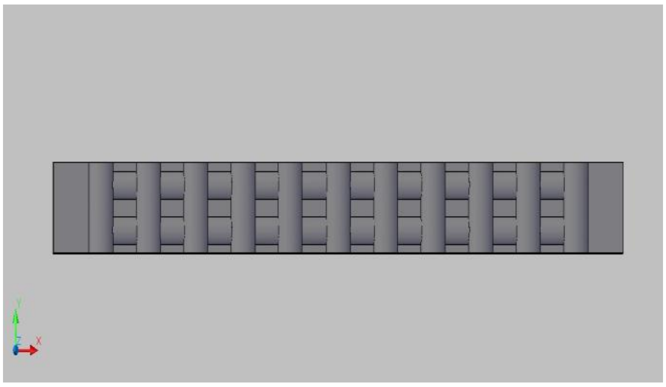

**Figure 7**. Bottom view

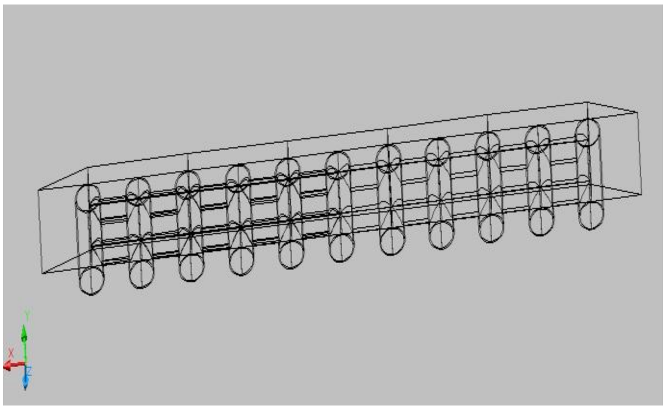

**Figure 8**. Wireframe

## 5. Conclusion

The main purpose of the bridge design is to support mobility between rural areas by utilizing portable river bridge technology. Of course by prioritizing safety for users to support their daily activities. Constant river flow can be considered an important factor in the application of this technology. The selection of building structures uses a ballast system commonly used on ships to balance air buildings. the material used is FRP composite pipe, chosen because it is considered as an alternative standard suitable material to be applied in the waters based on ACI 440R-07 standard. Modeling is done by using 3D CAD to determine the dimensions of the structure of portable river bridges based on ANSI / ASME 3.16 and ASME B.36-10M standards with geometric results of the main pipe diameter 16 ", with a width of 1 m, and a length of 5 m.

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