CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The research is focusing on the structure behavior of the bridge in term of performance and constructability. In order to evaluate the nonlinear analysis, LUSAS Bridge modeler has been used. LUSAS Bridge is world-leading finite element analysis software for the analysis, design and assessment for all types of bridge structures. LUSAS modeler is for analysis only while for design, the designer need to install the additional installer for design. This software is using coordinate system as an input to build up the model. LUSAS software is easy to understand because it shows a direct preprocessing and post-processing step by step in the tutorial module.

This research is focusing until analysis only, thus only LUSAS modeler is used. The bridge is model as 2- dimensional only. The flow of the process is beginning with data collection which is dead load and live load. All the data need to be calculated based on Euro Code 2 standard. Then, the loading will be assigning to all models with the same value. This precaution is to make sure that all models can go through the same analysis. There are ten models of bridge comprising of three arch, six cable-stayed and one hybrid arch bridge. All the models were made by using LUSAS and analyze using linear static analysis. Linear static analysis is when all loads are applied fixed and remain constant. This analysis only calculates the displacement, stress, strain and reaction. Nonlinear analysis is a case when the loading produce significant changes in the stiffness. Every model is analyzed to obtain the value of bending moment, shear force, normal force and displacement of the bridge structure component.
3.1.1 FLOW CHART

The research flow from the start until end is shown in Figure 3.1 below. The start of project began on September 2014 with literature review on principal component of arch, cable-stayed and hybrid arch bridge. Then follow by analysis of component for cable-stayed bridge and arch bridge. Cable-stayed, arch and hybrid arch bridge are then analyzed by using LUSAS software to obtain and compared their structure performance. Then, the most effective bridge can be obtained.

![Flow Chart](image-url)
3.2 BRIDGE LOADINGS

All data collection needs to be collected before making the model. The collection of data is dead load and live load value only. The effect of wind loading, current loading and earthquake loading were not considered. Dead load and live load values will be use and assign in the model later. All the values are calculated based on the real project to make sure the model is analyzed such a real project model.

3.2.1 DEAD LOAD

Dead load is a permanent load or self-weight of the structure. The dead load of a large span bridge gives the most of the bridge loads. Bridge dead load is calculated from the materials that build it up. In this research, the bridge is made up of concrete deck slab with premix layer, steel I-beam, concrete parapet and railing, concrete column cap and steel pier (Figure 11). The material constants are value as follows. The density of steel \( \rho_s = 78.5 \text{ kN/m}^3 \) and the density of concrete \( \rho_c = 25 \text{ kN/m}^3 \). As refer to Euro Code 1991.2.2003, the calculation for dead load is as below:

![Bridge components](image)

**Figure 3.2**: Bridge components

Structural dead load:

1) Beams
   - Total length = 10 m
   - X-section area = 0.332 m\(^2\)
   - Density of steel = 78.5 kN/m\(^3\)