CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Bridge is a common structure to connect a point to another point via a lake, sea, or another circumstance that block people from across it. Before bridge create it history, human use stepping-stones to cross streams and other natural obstacles. Later, human become more advance, they use felled tree trunks as a bridge. Here, a simple beam bridge was created (Ryall et al., 2000). The function of bridge can be divided into two that are highway bridge and pedestrian bridge. Highway bridge is a bridge that been designed to carry over vehicles (large load) while pedestrian bridge is designed to carry people only (small load). Bridge have many types. Every type of bridge has different strength to support loading. The type of bridge depends on function of the bridge, the nature of the terrain where the bridge is going to be constructed and anchored, the material used and the funds available to build it.

Arch bridge is a very common bridge with it famous aesthetical value. Arch bridge history start during 4000 B.C when the community of Sumerians that lived in the Tigris-Euphrates Valley discovers the arch shape advantages in construction. They use sunbake brick to form an arch shape and began to construct small arch bridge (Wai and Lian, 1999). Arch is define as a curved structural member spanning and opening and acts as a support for the loads above the opening. The true perfect arch is which only a compressive force acts at the centroid of each element of the arch. The shape of the true arch can be thought of as the inverse of a hanging chain between abutments. For practice, it is impossible to have a true arch except for one loading condition. The arch bridge is subjected to multiple loading which will produce bending moment stresses in the arch rib that are generally small compared with the axial compressive stress. Arch
bridge components are arch, deck and floor beam. Arch bridge advantages are the arch can be built on larger scales, the structure is much lighter because the arch itself can support the loading, the deformations under traffic loads are limited, the malfunction can be detect early and have aesthetical value (Weber, 1999).

However, cable-stayed bridge is famous with its long span that is around 1000m. Cable-stayed bridge span is longer because the cable can support the deck effectively rather than arch bridge. Cable-stayed bridge start its history during year 1883. During that time, the Roebling design a bridge according to suspension bridge design but he assigned additional inclined cables to provide stability against wind and to stiffen the bridge. Thus, the bridge become the first hybrid type of cable bridge name as Brooklyn bridge with total length of 1059.9m and main span of 486.5m (Elsa, 2007). The modern cable-stayed bridge developed on the second half of the twentieth century. It was discover by Dischinger, who realized that stability and stiffness could be achieved with high strength prestressed cables. The first modern cable-stayed bridge is Stromsund Bridge in Sweden, 1956 with total length of 332m and main span of 182.6m.

Bridge construction have been developed in Malaysia since 1960. Malaysia have constructed many cable-stayed bridge type such as the most popular bridge in Malaysia, Penang Bridge. Cable-stayed type bridge is chosen because of its performance and constructability. The main advantage of this type of bridge is the reducing of stress due to the support from the stayed cable. The history of cable-stayed bridge in Malaysia began on 1972. It was constructed in Kota Kinabalu, Sabah (Wahid et al., 2002). Cable-stayed bridge components are tower, cables and deck. To expand span length further, the cable-stayed bridge deck-supporting system is the cable-tower system. The deck system required to be stiffer than those used on beam, truss, and arch bridges. The bridge performance and constructability for the cable-stayed bridge is mainly depend on the structure performance of the cable itself.

Arch bridge has a very limit of increasing length which its rise-to-span ratio would become smaller and arch may become unstable under loads when arch span become longer. The common length of arch bridge is around 500m. Meanwhile, according to Hongwei and Amjad (2015), as the span length increase, the stay cable become ineffective due to several factors that are firstly, as the cable length increase, the cable become heavier which result in cable sag effect becomes more dominant and result in significant reduction of cable stiffness, secondly when the cable length
increases, the cable’s frequency increase throughout the entire bridge which result in internal resonance problems, and thirdly corrosion problem due to environmental effect on the cable.

Combination of cable-stayed arch bridge is purposely to overcome the disadvantages of above arch and cable-stayed bridge. Cable-stayed arch bridge is a combination of two different engineering techniques which is arch and cable-stayed that produces a hybrid. The first cable-stayed arch bridge structure is Seri Saujana Bridge in Putrajaya, Malaysia with length of 300m. The capability to support load is come from the components that made up the bridge. The bridge component such as arch for arch bridge is designed to support load from the deck to the tower. While the stayed cable for cable-stayed arch bridge is also design to carry load from the deck to the pylon. But there is different in term of total loading that can be support by these bridge components and to know the different, a research must be conducted to study the principle components of the bridge.

The principle components study that is focusing in this research is only for arch bridge and cable-stayed bridge. This result will be analyze and compare with combine cable-stayed arch bridge. The bridge performance will be analyzed by using Ansys or LUSAS 14 software. The scope of this research only focuses on Highway Bridge. The result or outcome predicted is to obtain the most effective highway bridge in term of structure performance and constructability.

1.2 PROBLEM STATEMENT

Based on the comparison of length span, the cable-stayed bridge is longer than the arch bridge. This is why cable-stayed bridge is commonly constructed compared to arch bridge nowadays. In the construction bridge over the sea, the arch bridge has the disadvantage because the tie girder has to be constructed before the arch ribs can function. While for the cable-stayed bridge, the deck elements and cables are erected simultaneously during the construction process.

In term of structural performance, cable-stayed bridge disadvantage is 1; when the cable length increase, the cable become heavier which result in cable sag effect becomes more dominant and result in significant reduction of cable stiffness and, 2; when the cable length increases, the cable’s frequency increase throughout the entire