COMPARATIVE STUDY OF STEEL PLATE GIRDER AND PRESTRESSED CONCRETE GIRDER

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DEDICATION

I would like to dedicate this Master's Degree

To my beloved parents and my siblings.
Thank you very much for your endless support.

To my supervisor, lecturer and classmates.
Thank you very much for your guidance and motivation.

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ABSTRACT

Bridge structure has achieved a worldwide importance because they are key element of any road network. Girder bridges are structurally the simplest and the most commonly used on short to medium span bridges which typically constructed with construction material either steel or concrete. The aim of this project is to compare between steel plate girder and prestressed concrete girder in term of cost, dimension, capacity and environmental impact which include designing and analysis. The work involve in this study is to design bridges that provide light vehicle communication between residential areas using steel plate girder and prestressed concrete girder for five different span length which is 15 meter, 20 meter, 25 meter 30 meter and 35 meter. Comparative between steel plate girder and prestressed concrete girder shows that the estimated cost of prestressed concrete girder is more expensive than steel plate girder for span length 15 meter and 20 meter whereas for span length 25 meter, 30 meter and 35 meter the estimated cost for steel plate girder is more expensive than prestressed concrete girder. In term of impact on environment, the material consumption for steel plate girder is lesser than prestressed concrete girder for all span length meanwhile the amount of embodied energy for prestressed concrete is lesser than steel plate girder for all span length. Thus, steel plate girder is recommended for span length up to 20 meter and for span length beyond 35 meter prestressed concrete girder is more desirable.

ABSTRAK

Struktur jambatan telah mencapai kepentingan di seluruh dunia kerana ianya merupakan elemen yang penting di dalam rangkaian jalan raya. Jambatan struktur *Girder* merupakan jambatan yang paling ringkas dan yang paling umum digunakan bagi panjang rentang yang pendek sehingga ke sederhana panjang dengan menggunakan bahan binaan samada besi ataupun konkrit. Tujuan projek ini adalah untuk membandingkan di antara *Steel Plate Girder* dan *Prestressed Concrete Girder* dari segi kos, dimensi, kapasiti dan kesan ke atas persekitaran yang merangkumi rekabentuk dan analisis. Diantara kerja yang terlibat di dalam projek ini adalah merekebentuk jambatan bagi menampung kenderaan ringan untuk menghubungkan di antara kawasan kediaman dengan menggunakan *Steel Plate Girder* dan *Prestressed Concrete Girder* untuk lima panjang rentang yang berbeza iaitu 15 meter, 20 meter, 25 meter 30 meter dan 35 meter. Perbandingan antara *Steel Plate Girder* dan *Prestressed Concrete Girder* menunjukkan bahawa anggaran kos bagi *Prestressed Concrete Girder* adalah lebih mahal daripada *Steel Plate Girder* untuk panjang rentang 15 meter dan 20 meter manakala untuk panjang rentang 25 meter, 30 meter dan 35 meter anggaran kos untuk *Steel Plate Girder* adalah lebih mahal daripada *Prestressed Concrete Girder*. Dari segi kesan terhadap persekitaran, jumlah penggunaan bahan binaan untuk *Steel Plate Girder* lebih rendah daripada *Prestressed Concrete Girder* bagi semua panjang rentang namun jumlah *Embodied Energy* untuk *Prestressed Concrete Girder* adalah lebih rendah berbanding dengan *Steel Plate Girder* bagi semua panjang rentang. Oleh itu, *Steel Plate Girder* adalah disyorkan untuk panjang rentang hingga 20 meter dan bagi panjang rentang yang melebihi 35 meter *Prestressed Concrete Girder* lebih sesuai.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Bridges are constructed to cross obstacles such as water body or road to provide passage over the obstacle and connecting two inaccessible areas. Bridges are important in the infrastructure of a country because it can reduce distance to travel and enabling the transportation of goods and people. In the early days the bridges were built using stone and wooden.

Bridges have horizontal span between supports to cater vertical loading. Design of bridge is depends on many factors such as the function of the bridge, nature of terrain, construction material, cost of the bridge, safety, aesthetic and many others factors.

The cost for constructing major bridges is expensive and therefore the design of bridge must be efficient, economical and elegant. Efficient is to produce a better performance bridge with minimum usage of material. Economical bridge is when the cost of construction and maintenance can be reduced while the efficiency is maintained. Finally, elegant is the appearances of the bridge without compromising the performance and economy.

1.1.1 Component of bridge

Arrangement of bridge is shown in Figure 1.1 and the basic component parts of bridge structure are as following:

i. Deck - Main part to access from one side to another side

ii. Abutment - The support at the two end of bridge

iii. Pier - Is a compression member to transfer vertical load from superstructure to foundation

iv. Pile - Foundation support to transfer load from structure to soil and it is a fundamental component to bridge with pier

v. Girder - It is a main horizontal beam to support vertical loads.

vi. Bearing - Located in between the girder and pier cap to accommodate movement and displacement.

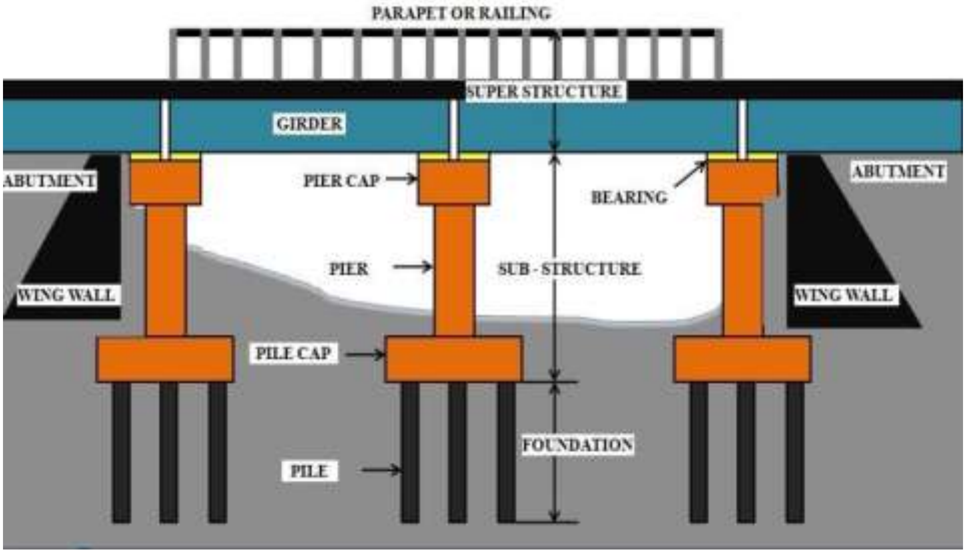

Figure 1.1 Bridges components

1.1.2 Types of Bridges

There are six basic types of bridges as shown in figures below accordingly, which are the girder bridge, arch bridge, truss bridge, cantilever bridge, suspension bridge and cable stayed bridge.

Figure 1.2 Girder Bridge

Figure 1.3 Arch Bridge

Figure 1.4 Truss Bridge

Figure 1.5 Cantilever Bridge

Figure 1.6 Suspension Bridge

Figure 1.7 Cable Stayed Bridge

1.1.3 Girder Bridge

Girder bridge is one of the most important bridge because they are used more frequently than any other type of bridge. Girder bridges have greater stiffness but less subject to vibrations according to (Barker and Puckett, 2013). Girder bridges are consist of deck slabs such as reinforced concrete deck slabs on which vehicles and pedestrian will access through. Decks will be placed on girder and the girder will be supported by pier, abutments and foundations.

1.2 Statement of the Problem

Bridges can be constructed using various type of material including steel, concrete and even timber. Steel plate girder had been used since late 1800s especially in constructions of railroad bridges and steel plate girder is famous because of ease of fabrication.

Since the development of prestressed concrete by Freyssinet in early 1930s, the application of prestressed concrete has evolved in the construction of bridges and gradually replace steel structures bridges which needs costly maintenance due to corrosion (Bhawar et.al, 2015).

In current trend, prestressed concrete bridges have been expanding the applicable and becoming a strong competitor to steel bridges and reinforced concrete bridges (Jagtap and Shahezad, 2016). Therefore, the objective of this proposal is to compare between steel plate girder and prestressed concrete girder in term of cost, environment impact and also the properties of girder in term of depth and weight for various span length.

1.3 Objectives of the Study

The objectives of this study are as follows : -

i. To compare the differences of cost between steel plate girder and prestressed concrete girder for various span length.
ii. To identify the differences of environment impact between steel plate girder and prestressed concrete girder in term of material consumption and embodied energy (EE).

1.4 Scope of the Study

The work involve in this project is designing bridge using steel plate girder and prestressed concrete girder for various span lengths. The bridge is to provide light vehicle communication between residential areas on either side of a carriageway road. The design is based on Eurocode with same loading for each span length ranging from 15 meter to 35 meter for both type of girder. Finally cost analysis, comparison on dimension, capacity and also environmental impact calculation is conducted between the two types of girder.

1.5 Significance of the Study

One of the main criteria of selecting a construction material for particular design is the cost of the material but nowadays construction industries is contributing large part in environmental problems due to extensive resource depletion and energy required for the construction. Therefore, comparative study between steel plate girder and prestressed concrete girder is needed to guide engineers to choose the suitable material of construction according to the requirement of a particular project or design. Through this study, the percentage differences in term of cost and environmental impact between steel plate girder and prestressed concrete girder is obtained for various span length.

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