

ASPECTS OF ANALYSIS OF SIMPLY  
SUPPORTED BRIDGE DECKS

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*Specially dedicated to my beloved mom and dad*

*I love you.*

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## ABSTRACT

Bridge analysis is a process in which one determines the responses of structures due to load effects. The responses usually constitute of deflections, torsions, support reactions, bending moments and shear forces. The analysis can be done based on the types of decks and the characteristic behaviours of the bridge structure itself. There are several types of analysis that can be used to analyze the bridge deck structure. However, it is difficult in terms of the suitability to select the method that is most appropriate for a particular problem. This study is conducted in order to evaluate the common methods of bridge deck analysis and to compare the performance between each type of analysis either by using the manual calculation or software analysis. The focus of this study is on the grillage method of analysis and the finite element method of analysis. Subsequently, the method of analysis that can yields suitable and better results is proposed. One structural form of bridge deck in varying skewness and simply supported has been chosen as the case study. This deck is analyzed using the commercially available software called LUSAS. The results show that the finite element method yields lower values than the grillage method. On the other hand, the values of responses whether deflection, bending moment, shear force, support reaction and torsion decrease as the skewness of the bridge deck increases. Based on these findings, it can be concluded that the finite element method can offer better and suitable results especially with the advent of software and computer technology nowadays.

## ABSTRAK

Analisis jambatan adalah satu proses mengenal pasti tindak balas struktur yang berlaku akibat daripada kesan tindakan beban. Tindak balas yang berlaku kebiasaannya terdiri daripada pesongan, kilasan, daya tindak balas, moment lentur dan daya ricih. Analisis boleh dijalankan berpandukan kepada jenis-jenis geladak jambatan dan ciri-ciri struktur jambatan itu sendiri. Terdapat beberapa jenis analisis yang boleh digunakan untuk menganalisa struktur geladak jambatan. Namun begitu, ianya adalah sukar untuk memilih analisis yang sesuai untuk sesuatu masalah berkaitan. Kajian ini adalah bertujuan untuk menilai kaedah yang biasa digunakan untuk menganalisa geladak jambatan dan untuk membuat perbandingan antara setiap kaedah dengan menggunakan samada pengiraan dengan tangan ataupun dengan analisis perisian. Kajian ini lebih tertumpu kepada kaedah jerejak dan kaedah unsur terhingga. Selepas itu, kaedah yang menghasilkan keputusan yang sesuai dan baik akan dipilih. Satu struktur geladak jambatan dengan kecondongan yang berbeza dan disokong mudah telah dipilih dalam kajian ini. Geladak ini telah dianalisa dengan menggunakan perisian yang telah dikomersialkan di pasaran iaitu LUSAS. Keputusan menunjukkan bahawa kaedah unsur terhingga menghasilkan nilai yang lebih rendah daripada kaedah jerejak. Dibalikinya, nilai tindak balas bagi pesongan, kilasan, daya tidak balas, moment lentur dan daya ricih juga menurun dengan kecondongan geladak jambatan meningkat. Berdasarkan kepada dapatan, ianya boleh disimpulkan bahawa kaedah unsur terhingga boleh menawarkan keputusan yang sesuai dan baik khususnya dengan kemajuan perisian and teknologi komputer pada masa kini.

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**LIST OF ABBREVIATION**

2D	=	Two Dimensional
3D	=	Three Dimensional
LUSAS	=	London University Structural Analysis Software
HA	=	Normal Load of Live Load
HB	=	Abnormal Load
UDL	=	Uniform Distributed Load
KEL	=	Knife Edge Load

**LIST OF SYMBOL**

kN	=	kiloNewton
m	=	meter
mm	=	millimeter
BMS3	=	3D Engineering Thick Beam Element
QTS4	=	3D Thick Shell Element
$\delta$	=	deflection
$\gamma_{f1}$	=	Variable Factor



# **CHAPTER 1**

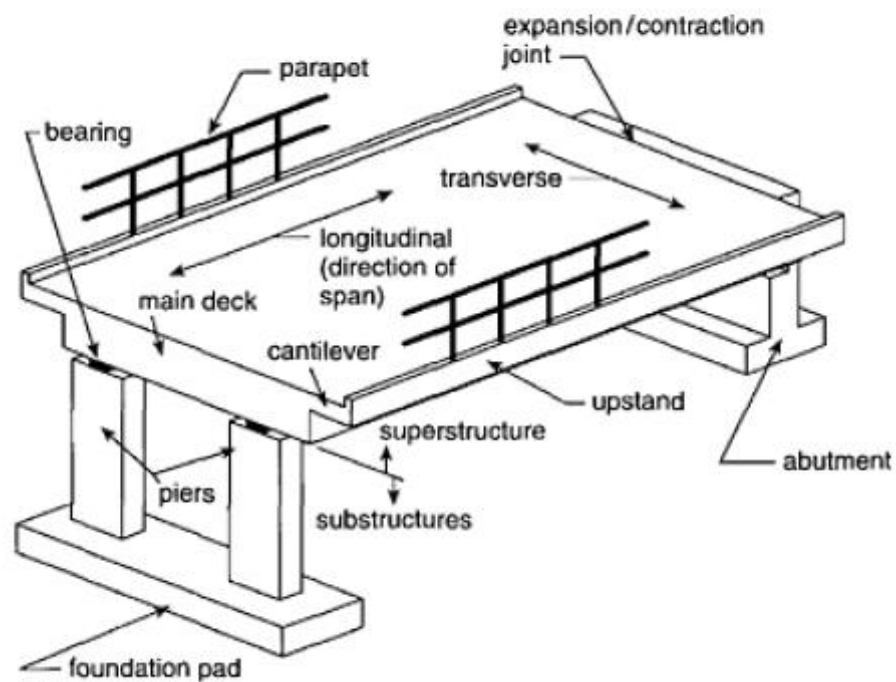
## **INTRODUCTION**

### **1.1 General Review**

A bridge is a structure built to span physical obstacles such as a body of water, valley, or road for the purpose of providing passage over the obstacle. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed, the material used to make it and the funds available to build it. A bridge is designed for trains, pedestrian or road traffic, a pipeline or waterway for water transport or barge traffic.

Bridges may be classified by how the forces of tension, compression, bending, torsion and shear are distributed through their structure. The analysis have been developed in the last thirty years by using hand methods and recently the application of digital computers have enabled engineers to analyze decks with complex and complicated structure.

There are several types of deck construction divided into beam, slab, beam and slab and cellular slab. Each type of deck has their different geometric and behavioural characteristics. The method of analysis can be determined based on deck behaviors characteristics. Figure 1.1 shows the component that is usually found on a typical bridge.



**Figure 1.1** Portion of Bridge Illustrating Bridge Engineering Terms  
(O'Brien and Keogh, *Bridge Deck Analysis*, 1999)

## **1.2 Problem Statement**

Recently most of the engineer was using finite element method as their method of analysis. Although for the simple structure, it will become costly because the finite element method is quite difficult and it may take time-consuming process compare to the grillage method of analysis. Moreover, some of the methods of analysis of are not suitable for certain types of bridge deck because of their geometric and their behavior characteristics. As such there is a need to conduct a thorough comparison between each type of analysis method in order to know and understand which analysis method is more suitable for a particular type of decks.

## **1.3 Objective of Study**

The objectives of this study are as follows:

1. To evaluate the available methods of bridge deck analysis
2. To compare the performance between each type of analysis methods for analyzing bridge deck
3. To conduct the analysis of bridge deck using grillage method and finite element method
4. To propose which method of analysis that can provide better and suitable results

## **1.4 Scope of Study**

There are several types of bridges commonly constructed and this study is focused on a Highway Bridge. Among the structural forms of bridge deck, simply supported beam and slab deck is selected to be studied. This study is conducted in order to evaluate the common methods of bridge deck analysis and to compare the performance between each type of analysis either by using the manual calculation or software analysis. The focus of this study is on the grillage method of analysis and the finite element method of analysis. Subsequently, the method of analysis that can yields suitable and better results is proposed. One structural form of bridge deck in varying skewness and simply supported has been chosen as the case study. This deck is analyzed using the commercially available software called LUSAS. Besides that, only vertical loadings are considered which are dead load, superimposed dead load and HA and HB loading.

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[www.LUSAS.com](http://www.LUSAS.com)