COMPARISON OF BRIDGE DESIGN IN MALAYSIA BETWEEN AMERICAN CODES AND BRITISH CODES

WAN IKRAM WAJDEE B. WAN AHMAD KAMAL

A thesis submitted as a fulfillment of requirements for the award of the degree of Master of Engineering (Structure)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

MAC , 2005

For Abah ,Ma ,Adik-adikku,Saudara-mara,Kawan-kawan,Awek2ku,
May God Bless You All...

ACKNOWLEDGEMENTS

First of all, I would like to thank my greatest supervisor, Associate Prof. Dr. Haji Azlan Adnan for his advice and moral support for this research. Also to Structural Earthquake Engineering Research (SEER) group members for giving their support.

I would like to thank Mr. Azizul from Nik Jai Assc. for his cooperation and contribution in my research. Also not forget Hendriawan, Hafifi, Miji, Mat Nan, X-sel,Lobey, and others.

Finally, my thanks are also due to my parent (Abah & Ma), my girlfriend Syikin, and all my friends for understanding and encouragement while doing this research.May god bless you all.

I LOVE U ALL

ABSTRACT

The design of a highway bridge, like most any other civil engineering project, is dependant on certain standards and criteria. Naturally, the critical importance of highway bridges in a modern transportation system would imply a set of rigorous design specifications to ensure the safety and overall quality of the constructed project.

By general specifications, we imply an overall design code covering the majority of structures in a given transportation system.In the United States bridge engineers use AASHTO's standard Specification for Highway Bridges and, in similar fashion or trends, German bridge engineer utilize the DIN standard and British and Malaysia designers the BS 5400 code. In general, countries like German and United Kingdom which have developed and maintained major highway systems for a great many years possess their own national bridge standards. The AASHTO Standard Specification, however, have been accepted by many countries as the general code by which bridges should be designed.

In this research study, investigation and comparisons using codes of practices for bridge design in Malaysia is done . American codes has been choosen as an alternative to British codes in design of bridge, followed by comparison in term of structure component performance due to seismic loading. The purpose is to investigate the performance of existing bridge in Malaysia due to seismic resistant.Thus, the bridge performance over the safety condition and structure integrity while using both codes of practices, American and British Codes is identified.

TABLE OF CONTENTS

CHAPTER II LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

LIST OF SIMBOLS

S	-	Distance Between Flanges
M_{DL}	-	Dead Load Moment
M_{LL}	-	Moment Due to Live Load
M_{LL+I}	-	Moment Due to Live Load + Impact
MB	-	Total Bending Moment
M_{SDL}	-	Moment Super Imposed Dead Load
Es	-	Modulus of Elasticity for Steel
Ec	-	Modulus of Elasticity for Concrete
n	-	modular ratio
r	-	stress ratio
k & j	-	coefficient
b	-	Unit width of slab
d	-	minimum depth required
As	-	Required Area Steel Bar
D	-	Distribution Steel
B_{eff}	-	Effective Width
DF	-	Distribution Factor
I	-	Impact Moment
M_{Max}	-	Maximun Moment
R	-	Reaction of Support
V	-	Shear Force
P_{AE}	-	Active Earth Pressure
K_{AE}	-	Seismic Active Earth Pressure Coefficient
Φ	-	Angle of Friction Soil
A	-	Acceleration Coefficient
δ	-	Angle of Friction Between Soil and Abutment

β	-	Slope of Soil face
Kh	-	Horizontal Acceleration Coefficient
Kv	-	Vertical Acceleration Coefficient
F'_T	-	Equivalent Pressure
W	-	Abutment Load
$\alpha\ \beta\ \gamma$	-	Single Mode Factors
S	-	Site coefficient
V_Y	-	Force Acting on Abutment
P_e	-	Equivalent Static Earthquake Loading
F_A	-	Axial Force
r	-	Radius of Gyration
f_C	-	Concrete Strength
f_S	-	Grade Reinforcement
M_U	-	Ultimate Moment
k	-	Stiffness
v_S	-	Static Displacement

LIST OF APPENDIXES

CHAPTER I

INTRODUCTION

1.1 General

Currently, in Malaysia we have not practice in design of bridge for earthquake situation is not practices. Currently in our code of practice BS 5400, it did not have allocation or rules in earthquake design consideration for bridge structure.Eventhough our country does not have earthquake event occurred very frequently, we must aware that our neighbouring countries such as Indonesia and Philippines is an active earthquake region. Therefore we must take into attention and consideration when we start to design bridge so that the effect of earthquake damage from earthquake event in our neighbouring countries can be minimized to our structures especially bridge.

Eventhough our bridge structure might just get small vibration due to earthquake from our near region country, it may also contribute to some side effect in long term period if it happened for many times. This situation might cause cracking and collapse to our bridge. So ,in solving this problem we need a code of practice that considered earthquake loading in design process. In this research , we try to compare two codes of practice AASHTO-ACI and BS 5400 for bridge design resist of seismic loading. The design of a highway bridge, like most other civil engineering project, is dependent on certain standards and criteria. Naturally, the critical importance of highway bridges in a modern transportation system would imply a set of rigorous design specification to ensure the safety and overall quality of the constructed project.

1.2 General Specifications

In general specifications, we imply an overall design code covering the majority of structures in a given transportation system. In the United States bridge engineers use Ashton's standard Specification for Highway Bridges and, in similar fashion or trends, German bridge engineer utilize the DIN standard and British and Malaysia designers the BS 5400 code. In general, countries like German and United Kingdom which have developed and maintained major highway systems for a great many years possess their own national bridge standards. The AASHTO Standard Specification, however, have been accepted by many countries as the general code by which bridges should be designed.

This does not mean that the AASHTO code is accepted in its entirety by all transportation agencies. Indeed, even within the United States itself, state transportation departments regularly issue amendments to the AASHTO code. These amendments can offer additional requirements to certain design criteria or even outright exceptions.

1.3 Problem Statement

According to the latest information we get, most bridge engineers in Malaysia are using BS 5400 code for guideline in design bridge project. This is because our bridge engineer got their basic knowledge or tertiary education from European countries like United Kingdom , New Zealand , and others countries that practices BS 5400 as a code of practice. That is they use BS 5400 code as a common practice in our country.Eventhough they already knew that BS 5400 does not have seismic consideration in their practice calculation design, they just ignored this case because in their opinion our country is outside seismic activity area.They forgot our country is near to our country neighbour such as Sumatera (Indonesia) and Philiphinnes that still have an active earthquake location center.However, we received vibration due to earthquake measuring 4.3 Richter scale in Penang Island , Kelantan , Perak and Kedah.This event was occurred caused by earthquake in Acheh (Indonesia).Some of our building structure like column , wall and slab are cracking due to this vibration from Acheh earthquake.Based on Malaysia Meteorological Services statement and other source, a reading value of earthquake for peninsular Malaysia as 0.075 g (75 gal) and for Sabah is 0.15 g (150 gal).These value is considered low vibration by some engineer and is not concern for a safety of bridge structure but for others person that concern of it this value can caused collapsed to our building or bridge if it happened frequently.

Therefore , a need to review our practice design code and also our construction method especially in design of bridge is much needed so as to protect bridge structure from the undesired damaging effect due to this natural disaster.The aim of this research is to compare our currently code of practice (BS 5400) with AASHTO-Seismic Design Code in term of efficiency in design a bridge in Malaysia.It also investigate which two code much applicable is to be applied in our country.The way to compare these two codes are by trying to redesign our existing bridge structure by using the different code of practices.In our case , we use American code of practice in redesigning our bridge structure.After that, we analyze and determine which code is much better for our country in design.

1.4 Objectives

The aims of this research are as follow :

a) To investigate codes of practices suitable for our bridge structure design.
b) To determine whether current codes of practice in Malaysia (BS 5400) is still practical for now or instead.
c) To determine the existing capacity of bridges in resisting low intensity seismic loading due to near earthquake source.
d) To compute the cost of using the different codes of practices.
e) To determine the Time History Analysis Response(Time-acceleration) due to earthquake event using both codes of practices.

1.5 Scope of study

The scope of the research are limited to certain things as follow :

a) Bridge component of structure ; Deck , Girder , Pier and Abutment.
b) In Malaysia high risk seismic location.(e.g : Sabah and Penang Island)
c) Compare in term of size of components and cost .(e.g : Volume of concrete and amount of steel that will be required)

1.6 Organization of Thesis

Extensive literature reviews are available in Chapter 2.Background theory and Principal of bridge engineering are described in Chapter 3.

1.7 Unit Conversion

Both SI Metric and Imperial Units are use throughout this thesis.

can determine the high performance of a material. In the area of materials for repair and rehabilitation development of coatings, epoxy grouts, fiber reinforcement, and other materials enables the repairs to be very specific adapting to the problem.

5.3 Conclusion

With the prospects and possibilities presented above one can say that the future of bridges has just begun. The three main areas of future development that were pointed out in the previous sections show that the range of ideas to be explored is very wide. Some of these ideas may prove impractical within the technical environment, while others will become feasible once the existing technologies have been developed further. The approaches mentioned will contribute to the development of amazing new structures. Only the fascination that is characteristic for bridge engineering field will remain the same that it has always been, during the many centuries that have passed since the first bridges were erected.

REFERENCES

Standard Specifications for Highway Bridges, 15th ed, American Association of State highway and Transportation Officials, Washington, D.C, 1993.

Standard Plans for Highway Bridges, vol. I,Concrete Superstructures, U.S department of Transportation ,Federal Highway Administration,Washington, D.C,1990.

Winter,George and Nolson,Arthur H., *Design of Concrete Structures,* 9th ed.,McGraw-Hill,New York,1979.

Gutkowski,Richard M. and Williamson,Thomas G., "Timber Bridges:State of Art," *Journal of Structural Engineering,*American Society of Civil Engineers,pp.2175-2191,vol.109,No.9,September,1983.
Standard details for Highway Bridges,New york State Deparment of Transportation,Albany,1989.

Elliot,Arthur L.,"Steel and Concrete Bridges*,"Structural Engineering Handbook*,Edited by Gaylord,Edwin H., Jr., and Gaylord,Charles N., McGraw-Hill,New York,1990.

AASHTO Manual for Bridge Maintenance,American Association of State Highway and Transportation Officials,pp.77-104,Washington,D.C.,1987.
*Bridge Design Practice Manual,*CaliforniaDepartment of Transportation,p.1-11,Sacramento,1983.

Robert A.et al., *Goals,Opportunities, and Priorities for the USGSEartquake Hazard Reduction Program,*U.S. geological Survey,p.366,Wahington, D.C.,1992.*Bridge Design Practice Manual,* 3rd ed., California Department of Transportation, Sacramento.,1971.

Steinman ,D.B., and Watson , S.R., Bridges and Their Builders,2nd ed., Dover Publications Inc., New York,1957.

Starzewski,K., "Earth Reatining Structures and Culverts."*The Design and Construction of Engineering Foundation,*Edited by Hendry, F.D.C., Chapman and Hall, New York, 1986.

Bowles,Joseph E., Foundation Analysis and Design, 2 nd ed., McGraw-Hill,New York,1977.

Standard Specification for Highway Bridges, 15th ed., American Association of State Highway and Transportation Officials, p. 646, Washington, D.C., 1993.

Walley,W.J., and Purkiss, J.A., "Bridge Abutment and Piers," pp. 821 – 884*,The Design and Construction of Engineering Foundations,*Edited by

Henry, F.D.C., Chapman and Hall, New York, 1986.

Standard Specifications for Highway Bridges, 15th ed, American Association of State highway and Transportation Officials, Washington, D.C, 1993.

Standard Specifications for Highway Bridges, 15th ed, American Association of State highway and Transportation Officials, Washington,pp. 646 D.C, 1993.

Winter , George, and Nilson, Arthur H., *Design of Concrete Structures,*9th ed.,McGraw-Hill,New York,1979.