

**INFLUENCE OF FLANGES STIFFNESS ON SHEAR
CAPACITY OF SINUSODAL PROFILED WEB GIRDER
USING FINITE ELEMENT METHOD**

by

HASLINAH BINTI MOHD ALI

Report submitted in partial fulfillment
of the requirements for the degree
of Bachelor of Engineering



JUNE 2014

ACKNOWLEDGEMENT

Alhamdulillah, first and foremost, I would like to express my humble thanks to ALLAH S.W.T. for the strength, inspiration and encouragement given to me throughout the completion of this thesis. I want express my gratitude to my beloved mother, Yasi binti Lasi, my father, Mohd Ali bin Jamili and family members, my sister, Haslinda Mohd Ali and my brother, Hairulanwar Mohd Ali, who were very supportive in my study progress.

I wish to express my profound gratitude to my supervisor, Mr Md Hadli bin Abu Hassan for his influential advice, critics, motivation, friendship, input of ideas, relentless support, guidance and endless encouragement. It was a great pleasure to have an advisor being so helpful and hardworking in his work. Also thanks to my classmate, Zulhelmi bin Zulkeflee for his kindness in helping me for some of the research's part.

Special thanks to my fellow friend who always give a support and encouragement while completing my project research. I also would like to record my appreciation for the invaluable support and operation to all dedicated technician and a few lecturer in School of Environmental Engineering.

Alhamdulillah, this thesis would have not been complete without guidance and assistance from all. To all of them, this thesis is earnestly dedicated. Thank you very much.

APPROVAL AND DECLARATION SHEET

This project report titled Influence of Flange Stiffness on Shear Capacity of Sinusoidal Profiled Web Girder using Finite Element Method was prepared and submitted by Haslinah binti Mohd Ali (Matrix Number: 101200281) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the Bachelor of Engineering (Civil Engineering) in Universiti Malaysia Perlis (UniMAP).

Checked and Approved by

**(EN. MD HADLI BIN ABU HASSAN)
Project Supervisor**

**School of Environmental Engineering
Universiti Malaysia Perlis**

June 2014

**PENGARUH KEKUATAN BEBIBIR TERHADAP KEUPAYAAN SHEAR BAGI
WEB YANG BERKERUT SECARA SINUSOIDAL MENGGUNAKAN KAEDAH
ELEMENT TERHAD**

ABSTRAK

Satu analisis elemen terhad telah dilakukan untuk mengkaji pengaruh kekuatan bebibir terhadap keupayaan shear bagi web yang berkerut secara sinusoidal. Model elemen terhad tiga dimensi dibentuk menggunakan perisian LUSAS (versi 13.6) dan dibandingkan dengan kajian-kajian yang berkaitan dan BS5950 Bahagian 1. Kajian parametric dilakukan terhadap web yang berkerut secara sinusoidal berkenaan dengan dimensi bebibir dan ketebalan dan nisbah segi bagi web. Beberapa model telah diuji untuk membandingkan keupayaan shear bagi web yang berkerut secara sinusoidal dan web konvensional flat. Bebibir dibentuk dalam saiz yang berbeza tetapi web dibentuk dengan saiz yang sama. Hasil kajian menunjukkan web yang dibentuk berkerut secara sinusoidal boleh menampung beban yang lebih tinggi berbanding web konvensional yang rata. Kajian parametric juga menunjukkan ketebalan bebibir tidak mempunyai pengaruh yang banyak terhadap keupayaan menampung beban. Bagi model yang dibentuk dengan nisbah segi kurang daripada satu boleh menampung beban yang lebih tinggi berbanding model yang dibentuk dengan nisbah segi lebih daripada satu.

INFLUENCE OF FLANGES STIFFNESS ON SHEAR CAPACITY OF SINUSOIDAL PROFILED WEB GIRDER USING FINITE ELEMENT METHOD

ABSTRACT

A finite element analysis had been done to study the influence of the flange stiffness on shear capacity of sinusoidal profiled web girder. A three-dimensional finite element model is proposed using LUSAS (version 13.6) software and compare to other related research and BS5950 Part 1. A parametric study was carried out on the sinusoidal web regarding the flange dimensions and the thickness and the aspect ratio of the web. Several models had been tested to compare the shear capacity of sinusoidal profiled web girder with the conventional flat web girder. The flange was designed in different dimension but the web was kept constant. The results show that the sinusoidal profiled web girder could carry higher ultimate shear capacity as compared to the conventional flat web girder. A parametric study showed the difference flange thickness has not great influence in shear capacity of the girder. For the models designed with aspect ratio less than one could support high shear capacity as compared to the aspect ratio more than one.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENT	i
APPROVAL AND DECLARATION SHEET	ii
ABSTRAK	iii
ABSTRACT	iv
TABLE OF CONTENT	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER 1 INTRODUCTION	
1.1 General Background	1
1.2 Problem Statement	6
1.3 Objective of Study	6
1.4 Scope of Study	7
CHAPTER 2 LITERATURE REVIEW	
2.1 Introduction	8
2.2 Shear Capacity of the Girder	8
2.3 Buckling Modes	11
2.4 The Influence of Flange Stiffness	13

CHAPTER 3 METHODOLOGY

3.1 Introduction	15
3.2 Design to BS5950: Part 1	15
3.2.1 Design Strength	15
3.2.2 Classification of Girder Cross-section	16
3.2.3 Moment Capacity	16
3.2.4 Shear Capacity	18
3.2.5 Recommended Proportions for Web	18
3.2.6 Recommended Proportions for Flange	19
3.2.7 Shear Buckling Resistance and Web Design	19
3.3 Designs to Lusas Finite Element	20
3.3.1 Lusas Finite Element Model	20
3.3.2 Geometry and Materials	21
3.3.3 Global Distributed Load	23

CHAPTER 4 RESULTS AND DISCUSSIONS

4.1 Introduction	25
4.2 The Local and Global Buckling of the Girder	25
4.3 Shear Capacity of Sinusoidal Profiled Web Girder and Conventional Web Girders	27
4.4 Influence of Flange Contribution of the Girder.	30

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction	42
5.2 Conclusion	42
5.3 Recommendation	43
5.4 Commercialization	44

REFERENCES

45

APPENDICES

APPENDIX A

47

APPENDIX B

51

© This item is protected by original copyright

LIST OF TABLES

Tables No.		Page
4.1	Comparison of the load capacity between sinusoidal web and conventional web girder	28
4.2	Results of the difference classes of limiting value for conventional web girder with $a/d > 1$	31
4.3	Results of the difference classes of limiting value for conventional web girder with $a/d < 1$	31
4.4	Results of the difference classes of limiting value for sinusoidal web girder with $a/d > 1$	34
4.5	Results of the difference classes of limiting value for sinusoidal web girder with $a/d < 1$	34

LIST OF FIGURES

Figures No.		Page
1.1	The structure of several types of connection of the plate girder	1
1.2	Types of girder	2
1.3	Sinusoidal profiled web girder	3
1.4	The construction of Putrajaya Auditorium Complex using plate girder	4
1.5	Sample project of corrugated web by Zeman and Co.	5
2.1	Phase in girder behavior until collapse	9
2.2	Load-deflection Curves for Corrugated Web Girder Investigated by R. Lou and Edlund under Shear with Different Corrugation Depths	11
2.3	Buckling Modes of corrugated Web by Lou and Edlund	13
3.1	Limiting value for rolled section and welded section (table 11, BS5950)	16
3.2	Shear buckling strength based on Annex H (BS5950)	19
3.3	Critical shear buckling resistance based on Annex H (BS5950)	20
3.4	Finite element model	21
3.5	The element type and shape for the plate girder components	21
3.6	Total lagrangian of non linear geometry in finite element	23
3.7	The load position in finite element model	24
4.1	Unsymmetrical deformed mesh of sinusoidal profiled web girder	26
4.2	The local buckling mode of the conventional flat web girder	26

4.3	The global buckling mode of the sinusoidal profiled web girder	27
4.4	Shear capacity - displacement graph for the shear capacity between sinusoidal web girder and the conventional web girder	28
4.5	Evolution of deformation contours in x direction of global failure mode of sinusoidal profiled web girder (sinusoidal-T9)	29
4.6	Shear capacity – displacement curves for conventional web girder with $a/d > 1$	32
4.7	Shear capacity – displacement curves for conventional web girder with $a/d < 1$	32
4.8	Shear capacity – displacement curves for sinusoidal web girder with $a/d > 1$	35
4.9	Shear capacity – displacement curves for sinusoidal web girder with $a/d < 1$	35
4.10	Shear capacity – displacement curve of fc1m1-t6 model	37
4.11	Displacement-length graph of the conventional web girder	37
4.12	Buckling Modes of the conventional web girder	38
4.13	Plastic hinge at the top flange of the conventional web girder	38
4.14	Shear capacity – displacement curve of sc1m1-t12 model	39
4.15	Displacement-length graph of the sinusoidal web girder	39
4.16	Buckling Modes of the sinusoidal web girder	40
4.17	Plastic hinge at the top flange of the sinusoidal web girder	40