UNIVERSITI TEKNOLOGI MARA

STRUCTURAL PERFORMANCE OF GLULAM MENGKULANG TIMBER BEAM WITH SLOTTED-IN STEEL PLATE BOLTED CONNECTION

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy
(Civil Engineering)

College of Engineering

January 2022

ABSTRACT

The connection plays a vital role in assembling the timber members to maintain stability and strength in the timber structure. The large deformation concept is adopted in the timber connection design to allow ductility failure instead of timber brittle failure, thus providing a higher lateral load-carrying capacity and structural stability. Since timber is a combustible material, the design of timber connections becomes more crucial to prevent premature failure due to fire loading. Additional designs for fire requirements are specified. Currently, European Yield Model (EYM) design theory is widely adopted to design timber connections at normal temperature and for fire requirements. However, the Malaysian Design Code for Timber (MS544) still lacks extensive specifications for determining the performance of tropical timber connections in a fire event. Therefore, this research aims to provide insight into the structural timber connections after exposure to a fire event for further study and reference. It specifically studies the structural performance of the slotted-in steel plate bolted connection in the engineered wood product (EWP) glued-laminated (glulam) timber beam after exposure to a standard fire. A modification to the extensive EYM theoretical model specified in Eurocode (EC) 5 for the fire is proposed to suit Malaysian tropical timber. It involved experimental tests under four-point bending and tensile loads for eighteen (18) glulam Mengkulang timber beams samples in 130mm x 150mm x 1400mm geometry specifications connected with slotted-in steel plate and bolts 12mm, 16mm, and 20mm diameters. The Mengkulang glulam timber beams samples were divided into groups 1 and 2. Group 1 consisted of eleven (11) samples tested in tensile, with nine (9) were performed at normal temperature, and two (2) were performed in a standard fire. The tensile test at normal temperature was performed until rupture to determine the samples ultimate load-carrying capacity. The tensile test in the standard fire was performed in a fire furnace by positioning the samples vertically, supported at the top end, and the bottom end was subjected to a static tensile load of 40% ultimate load-carrying capacity at normal temperature. The samples were exposed to fire, and the temperature was controlled to follow the standard fire curve specified in BS476-22. Group 2 consisted of seven (7) glulam timber beams tested in bending at normal temperature, with three (3) were tested after exposure to a 30-minute standard fire and cooled down to normal temperature. The results were further used to validate the computer simulation using the finite element method (FEM) for parametric study. After exposure to the standard fire, the experimental results showed the load-carrying capacity of the Mengkulang glulam timber beams under the four-point bending test reduced by 71.8%, 26.1%, and 47.6% for bolt diameters of 12mm, 16mm, and 20mm, respectively. Further investigations show that the glulam timber beams samples before exposure to the standard fire reached ductility failures. However, after exposure to the standard fire, the experimental results show the brittle failure in timber. A linear fitting was established to modify the EYM specified in Eurocode 5 to determine the load-carrying capacity of glulam Mengkulang timber bolted connection after exposure to the standard fire, thus proposing the equation for decay constant.

ACKNOWLEDGEMENTS

Firstly, I wish to thank God for allowing me to embark on my PhD and complete this long and challenging journey. My gratitude and thanks go to my supervisor, Assoc. Prof. Dr Rohana Hassan and co-supervisor, Prof. Dr Zakiah Ahmad and Prof. Dr Azmi Ibrahim. Thank you for the support, patience, and ideas in assisting me with this project. I also would like to express my gratitude to the Heavy Structure Lab Uitm and Concrete Lab IUKL staff, especially Mr Muhammad Tarmizi Ismail and Mr Muhamad Zuhair Abd Rasid, for providing the facilities, knowledge, and assistance.

My appreciation goes to the staff of the Fire Testing lab UTM and SIRIM, who provided the facilities and assistance during the fire test. Special thanks to my colleagues and friends for their supports and invaluable views that helped me with this project.

Finally, this thesis is dedicated to the loving memory of my very dear late father, Haji Shakimon Samad and my mother, Hajah Siah Sarmin, for the vision and determination to educate me. A special acknowledgement to my wife, Dr Nor Fadhilah Mohamad, for her persistent prayer throughout these challenging years. This piece of victory is dedicated to the three of you. Alhamdulilah.

TABLE OF CONTENT

	Page
CONFIRMATION BY PANEL OF EXAMINERS	**ii**
AUTHOR'S DECLARATION	**iii**
ABSTRACT	**iv**
ACKNOWLEDGEMENTS	**v**
TABLE OF CONTENT	**vi**
LIST OF TABLES	**xi**
LIST OF FIGURES	**xiii**
LIST OF PLATES	**xvii**
LIST OF SYMBOLS	**xviii**
LIST OF ABBREVIATIONS	**xx**
LIST OF NOMENCLATURES	**xxii**
CHAPTER ONE: INTRODUCTION	**1**
1.1 Research Background	1
1.2 Statement of Problem	2
1.3 Objectives of Research	3
1.4 Scope of Research	4
1.5 Structure of the Thesis	7
CHAPTER TWO: LITERATURE REVIEW	**9**
2.1 Introduction	9
2.2 Glued-laminated Timber	10
2.2.1 Production Stages	10
2.2.2 Timber Grading	11
2.2.3 Finger Joints	14
2.2.4 Laminations	16
2.2.5 Adhesive	18
2.2.6 Fire Performance of Timber Component	18

2.3 Timber Connections 23
2.3.1 Introduction 23
2.3.2 Mechanical Timber Connections 25
2.3.3 Bolted Timber Connections 29
2.4 Key Parameters Influencing Timber Connection Capacity and 31
Behaviour 2.4.1 Material Properties 31
2.4.2 Moisture Content 31
2.4.3 Load Duration 31
2.4.4 Dimensions of the Fasteners and Timber Members 32
2.4.5 Arrangement of Fasteners 32
2.4.6 Direction of Loading to Timber Grain's Direction 32
2.5 Load-Carrying Capacity of Bolted Timber Connection at Normal
Temperature 32
2.5.2 European Yield Model (EYM) 34
2.5.3 EYM Adoption in EC5 38
2.6 Load-Carrying Capacity of Bolted Timber Connection in Fire 2.6.1 48
Experimental Research 48
2.6.2 Numerical Simulations 51
2.6.3 Design of Bolted Connections in Fire According to EC5 55
2.7 Design of Timber Connection Using Malaysian Standard 56
2.7.1 Strength Group and Grade Identification 57
2.7.2 Mengkulang Timber 58
2.8 Conclusion 59

CHAPTER THREE: METHODOLOGY 61
3.1 Introductions 61
3.2 Bending Strength Properties of Bolt 64
3.2.1 Sample Preparations 64
3.2.2 Test Method 64
3.2.3 Evaluation of Dowel Bending Yield Strength Properties 65
3.2.4 Evaluation of Bolt Ductility 67
3.2.5 Evaluation of Resilience and Toughness Properties of Bolts 68