THE DEVELOPMENT OF AN OPTIMIZED LONG-SPAN CANTILEVER TRUSS SYSTEM FOR ROOFING APPLICATION

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Degree of Master of Science

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June, 2024

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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…… Date: June 12, 2024

Prof. (Mrs.) J. C. P. H. Gamage

ABSTRACT

The Development of an Optimized Long-Span Cantilever Truss System for Roofing Application

The structural efficiency of long-span cantilever trusses significantly relies on the vertical stiffness of the cantilever and its capacity of resistance against the vertical loads. When the cantilever span increases, the deflection of the end tip of the cantilevered truss under vertical loads becomes more pivotal as it reduces the vertical stiffness of the cantilever structure. Therefore, alternative member arrangements and geometry were altered innovatively to develop an optimum configuration of cantilever truss systems with a high capacity-to-weight ratio. This thesis illustrates the development approaches, numerical and analytical calculations of the decision-making process, and a detailed discussion of selected configurations and their performance.

Key Words:

Cantilever Roof Truss, efficiency, High Capacity, Optimization

ACKNOWLEDGEMENT

I extend my heartfelt gratitude to my supervisor, Prof. (Mrs.) J. C. P. H. Gamage, for her continuous guidance, encouragement, and invaluable advice throughout the course of this research study. Her unwavering and generous support, along with her valuable suggestions, have been instrumental in the completion of this study.

Additionally, I acknowledge Prof. (Mrs.) Chintha Jayasinghe, Head of the Department of Civil Engineering at the University of Moratuwa, Prof. S. A. S. Kulathilaka (former Head of the Department), Dr. H. M. Y. C. Mallikarachchi (Head of Building & Structural Engineering Division), and Prof. I. R. A. Weerasekera (former Head of Building & Structural Engineering Division) for their pivotal roles in organizing the postgraduate program.

I express my sincere thanks to the Course Coordinators, Dr. H. M. Y. C. Mallikarachchi, Dr. H. D. Hidallana Gamage, and Dr. Pasindu Weerasinghe, for their assistance and support during my postgraduate studies. I am grateful to all other academic staff members of the Civil Engineering department for imparting their knowledge and advice throughout this period.

I would like to thank my former employers, Mr. Ashoka Bandara and Mr. Mahesh Jayanthipura of A.M.A Water Engineering, for giving me the opportunity to pursue this MSc program. Special thanks go to Miss Nalini Pathirana, my current boss at Sanken Overseas, for encouraging me to complete my research study. I also extend my thanks to all my colleagues from both workplaces for their support during my studies.

I would like to express my deepest gratitude to my parents for their unwavering support and encouragement throughout my academic journey. Their belief in my abilities and constant motivation have been the driving force behind my achievements. I am forever indebted to them for their sacrifices and unconditional love.

I am also profoundly grateful to my wife, whose patience, understanding, and steadfast support have been invaluable. Her encouragement has provided me with the strength to persevere through the challenges of this research. Her love and companionship have been a source of great comfort and inspiration.

Lastly, I want to acknowledge my beloved daughter, Vihana, whose presence has filled my life with immense joy and purpose. The thought of being a role model for you has kept me focused and dedicated to completing this thesis. You are my greatest motivation, and I hope to make you proud.

Thank you all for your endless support and love. This accomplishment would not have been possible without you.

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LIST OF ABBREVIATIONS

Abbreviation	Description
FRP	Fiberglass reinforced polymer
Zn/Al	Zinc Aluminium
thk.	Thickness
SDL	Superimposed dead load
LL	Live load
UDL	Uniform distributed load
CHS	Circular hollow section
BM	Bending moment
SF	Shear force
FEM	Finite element modelling
w.r.t	with respect to

LIST OF SYMBOLS

Symbol	Description	
ρ	Density	kg/m³
γ	Unit weight	kN/m³
E	Modulus of elasticity	MPa
G	Shear Modulus	MPa
f_y	Yield strength of steel	N/mm²
f_u	The ultimate strength of steel	N/mm²
ν	Poisson's ratio	[unitless]
α	Coefficient of linear thermal expansion	K^{-1}
W	Total UDL load	kN
l	The span of the cantilever truss	m
D	Top and bottom chord depth	m
M	Cantilever moment at support	kNm
F_{chord}	Maximum axial force on chord member	kN
F_{web}	Maximum axial force on the web member	kN
$A_{min,chord}$	Minimum steel area required for chord member	cm²
$A_{min,web}$	Minimum steel area required for web member	cm²
A	The area of the steel section	cm²
D	Outer diameter of CHS section	mm
t	Thickness	mm
P_{cr}	Euler's buckling load	kN
I	The second moment of the area	mm⁴
L_e	Effective length	m
K	Effective length factor	[unitless]
σ_{cr}	Critical stress	N/mm²
$(L_e/r)_{cr}$	Critical slenderness ratio	[unitless]
P	Member forces	N
L	Member length	m
$\|P\|$	The absolute value of member forces	N
$\|P\|_{max}$	Maximum absolute value of member forces	N
A_{req}	Required area of steel section	cm²
A_a	Area of initial proposed steel section	cm²
A_b	Area of final selected steel section	cm²
$(L_e)_{cr,a}$	Critical length for initially proposed section	m