

**IMPLICATIONS OF EUROCODE FOR STEEL PORTAL  
FRAMES IN SRI LANKA**

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Master of Science Degree in Structural Engineering Design

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Thesis submitted in partial fulfillment of the requirements for the degree of Master of  
Science in Structural Engineering Design

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## **Abstract**

Portal frame structures are widely used all over the world and in Sri Lanka for warehouses and factory buildings as they allow a large column free area with a maximum open space. They are basically made out of steel. Speedy construction, flexibility in use and easy maintenance are the main advantages in steel portal frames. Up until now in Sri Lanka, steel portal frames were designed mainly according to the British standards. But Eurocode is a more updated set of guidelines formed through research and experience.

This paper investigates the implications of Eurocode for steel portal frames in Sri Lanka. A field survey was carried out via questionnaires and responses in interviews to get a firsthand understanding of portal frame structures prevalent in Sri Lanka. With this experience, 48 different portal frames were selected for the parametric study to suit the Sri Lankan conditions varying the span range from 20m to 50m, eaves height from 4.5m to 6.0m and frame spacing from 4.5m to 9.0m. They were analysed to find the implications of Eurocode based on the methods proposed by the Steel Construction Institute. Results of parametric study were compared with each other and with available literature and publications.

Identified implications are discussed in this paper concerning forces, moments and weight variations. A table was developed to obtain optimum column and rafter sections for selected ranges of parameters. No significant advantages were found in designing portal frames to elastic theory based on Eurocode compared to British standards in terms of weight. Main frame weight as a percentage of ULS axial force of a column (excluding the self weight of frame) was found to be in the range of 10% to 45% for 4.5m eaves height frames and 18% to 45% for 6.0m eaves height frames.

Specially dedicated to my beloved family and friends...

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# CONTENTS

Declaration of the candidate and supervisor.....	i
Abstract.....	ii
Dedication.....	iii
Acknowledgement.....	iv
Table of contents.....	v
List of figures.....	vii
List of tables.....	ix
List of abbreviations.....	xi
List of appendices.....	xiv
1. Introduction.....	1
1.1 Background.....	1
1.2 Research Objective.....	2
1.3 Scope of the work.....	2
1.4 Methodology.....	2
2. Literature review.....	5
2.1 Portal frame structures in Sri Lanka.....	5
2.2 Eurocodevs. BS 5950.....	5
2.3 Second order effects.....	9
2.4 Optimisation of steel portal frames.....	12
2.5 Deflection limits.....	12
3. Field survey.....	14
3.1 Questionnaire.....	14
3.2 Analysis and results.....	14
3.3 Selected building parameters for the parametric study.....	18

4. Design of Portal frames .....	20
4.1 Design considerations.....	20
5. Analysis, results and discussion.....	22
5.1 General.....	22
5.2 Results.....	23
5.2.1 Result –Tables.....	25
5.2.2 Axial forces on columns and rafters.....	35
5.2.3 Bending moment of columns.....	39
5.2.4 Weight comparison- Parametric study.....	42
5.2.5 Comparison of load effects- Eurocode and British Standards.....	51
5.2.6 Comparison of steel grades – Parametric study.....	53
5.2.7 Comparison of portal frame weights– Parametric study with available literature.....	55
5.2.7.1 Research works done by Perera, et al.....	55
5.2.7.2 Data available in publications of the Steel Construction Institute .....	60
5.2.7.3 Field survey data.....	62
5.3 Discussion.....	64
6. Conclusion and recommendations.....	70
References.....	74
Appendix A           Questionnaire.....	76
Appendix B           Design of portal frames.....	83
Appendix C           Specimen design calculation of a portal frame.....	99
Appendix D           Steel universal beams - property table.....	155
Appendix E           Initial design table.....	161



## LIST OF FIGURES

	Page
Figure 1.1	Structural elements of a steel portal frame ..... 02
Figure2.1	Second order effects of axially loaded beams ..... 10
Figure 2.2	Second order effects on portal frames ..... 11
Figure 2.3	Recommended deflection limits for Eurocode ..... 13
Figure 5.1	Column axial force variations of 4.5m eaves height portal frames designed to Eurocode- Parametric study ..... 36
Figure 5.2	Column axial force variations of 6.0m eaves height portal frames designed to Eurocode 3- Parametric study ..... 36
Figure 5.3	Rafter axial force variations of 4.5m eaves height portal frames designed to Eurocode 3- Parametric study ..... 38
Figure 5.4	Rafter axial force variations of 6.0m eaves height portal frames designed to Eurocode 3- Parametric study ..... 38
Figure 5.5	Column bending moment variations of 4.5m eavesheight portal frames designed to Eurocode- Parametric study ..... 40
Figure 5.6	Column bending moment variations of 6.0m eaves height portal frames designed to Eurocode- Parametric study ..... 40
Figure 5.7	Horizontal force variations at the bottom of the column of 4.5m eaves height portal frames designed to Eurocode- Parametric study ..... 41
Figure 5.8	Horizontal force variations at the bottom of the column of 6.0m eaves height portal frames designed to Eurocode – Parametric study ..... 41
Figure 5.9	Weight of a single main frame designed to Eurocode – Parametric study ..... 43
Figure5.10	Main frame self-weight as a percentage of ULS axial force on a single column of 4.5m eaves height portal frames designed to Eurocode- Parametric study ..... 44

Figure 5.11	Main frame self-weight as a percentage of ULS axial force on a single column of 4.5m eaves height portal frames designed to Eurocode- Parametric study .....	44
Figure 5.12	Percentage variation of rafter weight to the weight of a single main frame 4.5m eaves height designed to Eurocode- Parametric study.....	45
Figure 5.13	Percentage variation of rafter weight to the weight of a single main frame (6.0m eaves height) designed to Eurocode- Parametric study.....	46
Figure 5.14	Comparison of total weight of the main steel frames designed to Eurocode (90m building length) – Parametric study.....	47
Figure 5.15	Comparison of weight of the structures designed to Eurocode (90m building length) –Parametric study.....	49
Figure 5.16	Percentage of purlin weight to total weight of structure (4.5m eaves height) designed to Eurocode- Parametric study.....	50
Figure 5.17	Percentage of purlin weight to total weight of structure (6.0 m eaves height) designed to Eurocode- Parametric study.....	50
Figure 5.18	Comparison of single frame weight- Parametric study (Eurocode) and research works by Perera, et al.....	58
Figure 5.19	Percentage variation of a main frame weight (4.5m eaves height) -Parametric study (Eurocode) to research works by Perera, et al.....	59
Figure 5.20	Percentage variation of a main frame weight (6.0m eaves height) –Parametric study (Eurocode) to research works by Perera, et al.....	59

## LIST OF TABLES

Page		
Table 2.1	Factors for design combinations at ULS for BS5950-1:2000.....	06
Table 2.2	Factors for design combinations at ULS forEurocode.....	07
Table 2.3	Partial factors given in Eurocode and British standards.....	08
Table 2.4	Criteria to be considered in structural beam design .....	09
Table 2.5	Criteria to be considered in structural column design .....	09
Table 3.1	Summary of general details of the portal frames.....	14
Table 3.2	Summary of design standards and analysis method of portal frames .....	15
Table 3.3	Summary of dimensions of portal frames.....	17
Table 3.4	Variable parameters selected for the parametric study.....	18
Table 3.5	Fixed parameters selected for the parametric study.....	18
Table 5.1	Selected variable parameters and their range used for the parametric study.....	22
Table 5.2	Fixed parameters used for the parametric study.....	23
Table 5.3	Purlin details.....	23
Table 5.4	Section sizes of portal frames designed to Eurocode– Parametric study.....	25
Table 5.5	Analysis results of portal frames designed to Eurocode– Parametric study.....	26
Table 5.6	Comparison of column analysis results (Eurocode) -1- Parametric study.....	27
Table 5.7	Comparison of Rafter analysis results (Eurocode)-1 – Parametric study.....	28
Table 5.8	Comparison of column analysis results (Eurocode)-2– Parametric study.....	29
Table 5.9	Comparison of rafter analysis results (Eurocode)-2– Parametric study.....	30

Table 5.10	Comparison of weight of portal frames of 4.5m eaves height designed to Eurocode –Parametric study .....	31
Table 5.11	Comparison of weight of portal frames of 6.0m eaves height designed to Eurocode- Parametric study .....	33
Table 5.12	Comparison of load effects – Parametric study (Eurocode and British Standards).....	52
Table 5.13	Comparison of steel grade effects – Parametric study (S355 and S275).....	54
Table 5.14	Comparison of sections of 4.5m eaves height portal frames designed to Eurocode (parametric study) and research works by Perera,et al. ....	56
Table 5.15	Comparison of sections of 6.0m eaves height portal frames designed to Eurocode (parametric study) and research works by Perera,et al.....	57
Table 5.16	Comparison of the sections obtained from parametric study (Eurocode) with preliminary sizes given by the Steel Construction Institute (P399).....	61
Table 5.17	Comparison of the section obtained from parametric study (Eurocode) with preliminary sizes given by the Steel Construction Institute (P252).....	61
Table 5.18	Comparison of sections obtained from parametric study (Eurocode) and field survey data .....	63
Table 5.19	Critical design criteria and the sequences, when using the sections proposed by Perera, et al.for parametric study–1.....	66
Table 5.20	Critical design criteria and the sequences, when using the sections proposed by Perera, et al. for parametric study–2.....	68

## LIST OF ABBREVIATIONS

Abbreviation	Description
A	cross sectional area of the member
$A_v$	shear area
E	modulus of elasticity
$f_y$	yield strength
$f_u$	ultimate strength
G	shear modulus
$G_k$	nominal value of the permanent actions
$Q_k$	nominal value of the imposed actions
h	column height
$H_{Ed}$	design value of horizontal reaction at the bottom of the column due to the horizontal loads and the equivalent horizontal force
I	second moment of area of rafter
$I_T$	torsional constant of the member
i	radius of gyration about the relevant axis
$L_{cr}$	developed length of the rafter pair between columns
$M_{cr}$	elastic critical moment for lateral torsional buckling
$M_{y,Ed}$	design bending moment, y-y axis
$M_{z,Ed}$	design bending moment, z-z axis
$M_{y,Rd}$	design values of the resistance of bending moment, y-y axis
$M_{z,Rd}$	design values of the resistance of bending moment, z-z axis
$M_{b,Rd}$	lateral torsional buckling resistance
$N_{Ed}$	design compression force in rafter
$N_{c,Rd}$	design resistance to normal forces of the cross section for uniform compression
$N_{b,y,Rd}$	flexural buckling resistance in the major axis
$N_{b,z,Rd}$	flexural buckling resistance in the minor axis

Abbreviation	Description
$N_{cr}$	elastic critical buckling load for the complete span of the rafter
$V_{Ed}$	design shear force
$V_{c,Rd}$	design shear resistance
$V_{pl,Rd}$	Plastic design shear resistance
$W_{pl,y}$	plastic section modulus of the member
$W_{el,min}$	minimum elastic section modulus
$W_{eff,min}$	minimum effective section modulus
x-x	axis along a member
y-y	axis of a cross section
z-z	axis of a cross section
$\alpha_{cr}$	factor to increase the design load to cause elastic instability in a global mode
$\alpha_{cr,s,est}$	estimate of $\alpha_{cr}$ for the sway buckling mode
$\alpha_{cr,r,est}$	estimate of $\alpha_{cr}$ for the rafter snap-through buckling mode
$\alpha_{LT}$	imperfection factor
$\alpha_m$	reduction factor for the number of columns in a row
$\chi$	reduction factor for the relevant buckling curve
$\chi_{LT}$	reduction factor for lateral torsional buckling
$\varepsilon$	strain
$\delta_{H,Ed}$	maximum horizontal deflection at the top of either column, relative to the base, when the frame is loaded with horizontal loads
$\delta_{NHF}$	lateral deflection at the top of the column due to the NHF
$\varphi$	global initial sway imperfection
$\varphi_0$	basic values for global initial sway imperfection
$\varphi_{LT}$	values to determine the reduction factor $\chi_{LT}$
$\psi$	ratio of moments of a segment
$\gamma_m$	partial factor

Abbreviation	Description
$\gamma_{m1}$	partial factor for resistance of members to instability(member checks)
$\gamma_{m2}$	partial factor for resistance of cross sections in tension to fracture
$\nu$	Poisson's ratio
$\lambda_1$	slenderness value to determine the relative slenderness
$\bar{\lambda}$	non dimensional slenderness
$\bar{\lambda}_{LT}$	non dimensional slenderness for lateral torsional buckling

## LIST OF APPENDICES

Appendix	Description	Page
Appendix A	Questionnaire.....	76
Appendix B	Design of portal frames.....	83
Appendix C	Specimen design calculation of a portal frame .....	99
Appendix D	Steel universal beams - property table.....	155
Appendix E	Initial design table .....	161