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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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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LIST OF ABBREVIATIONS

Abbreviation	Descrption
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	Descrption
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
α_{cr}	factor to increase the design load to cause elastic instability in a global mode
$\alpha_{cr,s,est}$	estimate of α_{cr} for the sway buckling mode
$\alpha_{cr,r,est}$	estimate of $\alpha_{cr}$for the rafter snap- through buckling mode
α_{LT}	imperfection factor
α_{m}	reduction factor for the number of columns in a row
χ	reduction factor for the relevant buckling curve
χ_{LT}	reduction factor for lateral torsional buckling
ε	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
δ_{NHF}	lateral deflection at the top of the column due to the NHF
φ	global initial sway imperfection
φ_{0}	basic values for global initial sway imperfection
φ_{LT}	values to determine the reduction factor χ_{LT}
ψ	ratio of moments of a segment
γ_{m}	partial factor

Abbreviation	Descrption
γ_{m1}	partial factor for resistance of members to instability(member checks)
γ_{m2}	partial factor for resistance of cross sections in tension to fracture
ν	Poisson's ratio
λ_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