COMPARISON OF PORTAL FRAMES OF UB SECTIONS WITH THE LATTICE GIRDER PORTAL FRAMES.

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B.Sc. Eng (Hons)

This thesis is submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfillment of the requirement of the Degree of Master of Engineering in Structural Engineering Designs.

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Sri Lanka.
September 2009

DECLARATION

This work included in this thesis in part or in whole has not been submitted for any other academic qualification at any other institution

ABSTRACT

Portal frame structures are very popular in industrial buildings due to their pleasing appearance and shorter construction period. In Sri Lanka too, steel construction is increasingly being used for single storey buildings. Basically there are two types of steel portal frames adopted in Sri Lanka; these are called Prefabricated and pre-Engineered portal frames.

Although the portal frame is inherently pleasing to the eye, given a well proportioned and detailed design, and less in cost for providing controlled environments, industrial connotation, together with increased service requirements has encouraged the use of lattice trusses for the roof structures. The structural forms both in the simple form fixed column bases and as portal frames with moment resisting connections between the tops of columns are used for long span structures.

Although it is widely used, portal frame may not be the best solution for large span single story buildings. Lattice girders are successfully used for medium size spans. However it is not widely used for large span buildings in Sri Lanka.

The construction industry here has many years of experience and necessary skills on fabricating truss or lattice type structures. Even though skilled and unskilled labour involvement is high, it will not reflect crucially on ultimate cost of the structure as the labour cost is less here in Sri Lanka, compared to European countries. Therefore in Sri Lanka lattice girder construction for large span buildings may be more cost effective.

The main objective of this research is to compare the portal frames formed with lattice girders with the conventional portal frames with Universal Beam sections for different span ranges and compare them in same spans, in the context of optimum cost and space requirements.

The space requirement for the lattice girder column is not critical compared to the space requirement for the column in UB portal for all spans.

The governing criteria for selecting the section sizes of the frame members of the both structural forms depends on the wind condition prevailing in the location selected for building the structure.

The study is concluded as, for wind zone -1; the portals for selected geometry with angle sections are less economical when it is compared over the portal with universal beam sections for similar spans when the elastic analysis is performed for both structural forms.

For wind zone-3, weight of the 30m and 40m portals with angle sections are less when it is compared with the portals with universal beam sections. The percentage reduction in weight ranges from 10-20 for 30m and 40m frames. For spans 20m and 50m, weight of the portals with angle sections are higher when it is compared with the portals with universal beam sections.

A uniform pattern of weight variation cannot be observed in Wind Zone-3 structures as in Wind-Zone-1.

Hence for Wind Zone-3, for selecting economical structural forms, a detailed cost analysis should be carried out for both structural forms inclusive of the fabrication cost.

Further, since this study has been limited to lattice girder portals of a specific geometry, it is recommended that if the geometry of a particular structure to be designed is very different, the cost effectiveness needs to be determined.

ACKNOWLEDGEMENT

My research is **"COMPARISON OF PORTAL FRAMES OF UB SECTIONS WITH THE LATTICE GIRDER PORTAL".** This research is done for the partial fulfillment of the requirements for the Masters of Engineering Degree in Structural Engineering Designs at the Department of Civil Engineering at the University of Moratuwa.

I acknowledge my deepest sense of gratitude to my mentor Dr. Mrs. M.T.P. Hettiaracchchi for the excellent guidance provided to me throughout, the study period, especially at the initial stage and preparation of the thesis.

Further I would like to take this opportunity to express my appreciation to the persons who have contributed their time, energy, ideas, experience, help and encouragement to complete this study.

I sincerely appreciate the National Water Supply & Drainage Board of Sri Lanka for financing my Master's study and for granting me study leave.

I would like to thank all the staff members of Planning and Designs Section and Research & Development Section of the Board for their kindness and support. Special thanks should go to Ms. Vinitha Kuruppu(Draughts Person) and Ms. Chandra Shanthi (Typist) of the Planning and Designs Section

Further, I would like to thank Mr. D.S.D. Jayasiriwardene (Deputy General Manager Planning & Designs Section of National Water Supply & Drainage Board) for helping me to obtain the duty leave for my research study without which I will not be able to complete this study in time and for the encouragement given to me to continue the study as a senior engineer in the field.

My appreciation specially goes to all the academic and non academic staff members at the Department who helped me directly and indirectly during my study period at the university.

I am grateful to all my colleagues in the M.Eng Batch 2005/2006. Special thanks should go to my friends Shavin Femando and Keerthi Rathnayake for extending their corporation for completing this study.

I like to express my deep, heart felt gratitude and love to my mother and late father for spending their means with great kindness for giving me this precious education and their devotion to my education, with out which I would not able to fulfill my dreams in education. Further I would like to be grateful to my brother and sister in - law for shouldering all the responsibilities of taking care of my mother. Their devotion laid the path for me to spend my time on higher studies.

Also I would like to give my thanks to , my husband and son for their patience and moral support extended throughout my studies. Very special thanks should go to my husband for encouraging me to continue the study every time I lose energy to do so.

Finally I would like to thank my domestic helpers at home for their kind support without which I would not be able to find time to complete this work.

ABBREVIATIONS

A = Area or Surface area of the structural element of which the wind surf

Ae = Effective area

A_g = Gross area

Ao = Area of the rectilinear element of the section which has the largest dimension in the direction parallel to the load

Ap = Apex

As = Shear area of a bolt

Av = Shear area

b = Outstand or width of panel

Cpe = External wind pressure coefficient

Cpi = Internal wind pressure coefficient

D = Depth of section

d = Depth of web or Nominal diameter of a bolt

E = Eaves point

F = Wind force or Applied force (compressive or tensile)

FS = Frame spacing

Fv = Shear force

h = Height to eaves of the building

I = Intermediate point

K = Constant found in design of building of high winds in Sri Lanka

L = Length of Building

Lxx, Lyy = Effective length in x-x and y-y direction.

l = Greater horizontal dimension of the building

M = Mass of roof covering or Applied moment at the section considered

m = Equivalent uniform moment factor

Mb = Buckling resistance moment (lateral torsional l capacity) about major axis

Mc = Moment capacity

Mx = Applied moment about the major axis

My = Applied moment about the minor axis

Mcx, Mcy = Reduced moment capacity of the section about the major and minor axis in the presence of axial load

M_2 = Moment about local axis (2) with respect to the local axes of frame element in SAP 2000.8

M3 = Moment about local axis (3) with respect to the local axes of frame element in SAP 2000.8

NE_1 = Next to eaves point - 1

NE_2 = Next to eaves point – 2

P = Axial force (Tension or compression) in local axis (1) with respect to local axes of frame element in SAP 2000.8

Pb = bearing capacity of a bolt

Pbb = Bearing strength of a bolt

Pc = Compressive capacity

p_c = Compressive strength

Pcs = Compressive strength for slender section

p_s = Shear strength of a bolt

Ps = Shear capacity of a bolt

Pv = Shear capacity

Py = Design strength of steel

q = Dynamic wind pressure

R1 = Rotation of a joint about the joint local axis (1) with respect to the joint local axes of frame element in SAP 2000.8

R2 = Rotation of a joint about the joint local axis (2) with respect to the joint local axes of frame element in SAP 2000.8

R3 = Rotation of a joint about the joint local axis (3) with respect to the joint local axes of frame element in SAP 2000.8

rx, ry, rxx, ryy = Radius of gyration about xx and yy axes.

S = Span of the frames in plan

Sx,Sy = Plastic modulus about major and minor axis

S/2 = Half space length of the roof in plan

S1 = Topography factor

S2 = Ground roughness

S3 = Statistical factor

T = Torque about local axis (1) with respect to the local axes of frame element in SAP 2000.8

T = Thickness of flange

t = Thickness of web or thickness of the connected ply of a connection

U1 = Displacement of a joint in the direction of joint local axis (1) with respect to the joint local axes of frame element in SAP 2000.8

U2 = Displacement of a joint in the direction of joint local axis (2) with respect to the joint local axes of frame element in SAP 2000.8

U3 = Displacement of a joint in the direction of joint local axis (3) with respect to the joint local axes of frame element in SAP 2000.8

V = Basic wind speed

Vs = Design wind speed

V2 = Shear force in local axis (2) with respect to local axes of frame elements in SAP 2000.8

V3 = Shear force in local axis (3) with respect to local axes of frame element in SAP 2000.8

w = Lesser horizontal dimension of the building

Z = Smallest modules of elasticity about the appropriate axis or lever Arm

Zx, Zy = Elastic modulus about major and minor axis

α^{o} = Wind direction

θ^{0} = Roof angle in degrees

λ_{TB} = Equivalent slenderness

λ = Slenderness, that is effective length divided by the radius of gyration

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