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It is further certified that the student has fulfilled all the requirements of Comprehensive, Candidacy and SOTA.

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ACKNOWLEDGEMENT

I would like to express my profound appreciation to my supervisor Dr. Rajesh Kumar and Dr. S. Mandal, for their continuous assistance and valuable advice throughout this research work. They made me comprehend, by means of his day-to-day invaluable input to this research, guidance, and inspiration. Also, their simplicity and attitude of "Helping to all" always encouraged me to learn the different aspects of life.

I willfully thanks to Prof. V. Kumar, Department of Civil Engineering, for being my internal expert of the subject of the thesis. He assisted me in all area of the thesis and clarifies technical doubt, and encourages me by means of support, advice and inspiration.

I am thankful to Prof. Devendra Mohan, Head of the Department of Civil Engineering, Banaras Hindu University for his support and providing pleasant working atmosphere in the Department.

I am grateful to Prof. P. K. S. Dikshit, Department Civil Engineering Department for their reminders to complete research work in time and encouragement.

I am grateful Dr. S. Mukhopadhyay, Department of Mathematical Sciences, for her continuous help, valuable suggestion, guidance and inspiration.

I thanks to Dr. K. K. Pandey; Dr. P. R. Maiti; Dr. Anurag Ohri and Dr. B. N. Singh, Department of Civil Engineering, for their kind assessment and suggestions.

I also wish to thank all the teaching and non-teaching staff of the Department of Civil Engineering, for their cooperation and help. I also wish to thank to staff of Work Shop in Department of Mechanical Engineering as they help me a lot when model construction

I would also like to thank to my seniors, Dr. Ajay Kumar; Dr. K. Narayan, Mr. Sanjay Srivastav, Mr. Manvendra Singh Chauhan and Mr. Atul; colleague, Mr. H. S. Birajdar; friends, Mr. Amit, Mr. Rahul, Mr. Ravi, Mr. Sujeet, Mr. Chayan, Mr. Shashi and Mr. Alok for their helpful and needy suggestions for better quality of work. Special thanks go to my friend Mr. Ghanshyam and Mr. Chandrashekhar, research scholar in Department of Mathematical Sciences, for their help in mathematical formulation and solutions involve in the thesis.

I wish to extend the deepest sense of respect to my parent for instilling in me confidence and a drive for pursuing my education and for the support that they have provided me through my entire life.

Heartiest thanks to my brother and sisters: Krishna Pratap Singh; Kanchan Singh and Sadhana Singh whose consistent encouragement enabled me to complete this work.

In particular, I would like to thank Pooja, my wife, for her patience, attention, understanding and support during development of this study. Additional gratitude is extended to my son: Atharva; nephew and nieces: Shivam, Ashta and Ashu for their love and affection.

Lastly and above all, deeply grateful to the invisible yet present helping hands of Lord Shiva, with which He has made my life complete and full of meaning.

Gyani Jail Singh

Dedicated

To

Grand Parent

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PREFACE

Tubular structures are the most popular structural form used for construction of multi storey buildings. Construction of high-rise buildings used to be driven by the demand for vertically managed additional floor area in densely populated lands. Advancements in structural engineering and technology have greatly enhanced the height of the superstructures. Combined improvements in analysis and design, fabrications as well as construction techniques, made the skyscrapers more relevant and feasible. Despite these developments, the present study is conducted to investigate following points: (i) to conduct parametric study of shear lag in box beams for developing formulation of shear lag factor considering different type of loading, viz., (a) uniform loading (b) loading with cosine law, for three varying support conditions such as simply supported beam, cantilever beam and fixed end beam; (ii) to study the effect of elastic parameters, such as Young's modulus and Poisson's ratio; (iii) to study the effect of corner modification on shear lag phenomenon in the plan of the tubular structures, such additional corner column and different type of modification was considered by H. Kawai to study the wind load effect; (iv) to find the point of contraflexure in tubular structures, viz., high rise and low rise structures such that to identify the critical column for the design along with study of the effect of the relative stiffness of the structural elements; (v) to study the soil structure interactions of a tubular model and comparing the result based on support conditions (a) with fixed base and (b) with base fixed in soil and the relative difference in responses of the corner column and central columns.

Based on the present study the following facts are observed:

(i) A clear understanding of the effects of variation of parameters is essential to effectively control the shear lag phenomenon. Shear lag is more pronounce as the relative stiffness of cover sheet increases. In simply supported case the relative stiffness (I_s/I) and the parameter *l/w* in case of built-up beam, which have great impact on shear lag. The parameters I_s/I, *l/w* and *G/E* are the main features in design of tubular structures. The effect of variation of all parameters, i.e., I_s/I, *l/w* and *G/E* estimated precisely and accurately. The monographs are applicable to the both tubular framed buildings and box girder bridges as well. Ductility of a composite tubular structure is difficult to assess, however, the effect of material properties on shear lag phenomenon can be assessed.

(ii) The structural efficiency against lateral loads increases significantly with additional corner columns when provided in the manner proposed in the present study which results into reduction of shear lag effect. The technique proposed is very efficient to neutralize the negative shear lag and it also makes reduction in positive shear lag without changing much in the plan of tubular structure since dimension of the tube is preserved throughout. The variations of the axial force are normalized and the value of normalization factors ranges from 1.4 - 2.

The variation of axial force in the columns is quite regular through the height of the building. The negative shear lag does not appear in model 6. The optimum length of the overhanging can be estimated for other tubular building plan of different width/depth.

The corner modification of type second also has great impact on axial forces and lateral displacement of the buildings. The corner cut, corner roundness and corner recessions are more suitable for reduction in shear lag effect under lateral loading. Among these three basic modifications, it is concluded that the corner roundness has greater resistance against shear lag effect as the axial forces in the corner column reduces and the lateral displacement is nearly equal to other two basic modifications. In the upper storey, the reversal of the deflection in central column of the modified model (Type Second) is less as compared to the basic example model. The reversal of lateral deflections in the central column of the upper story of the building is a reason of negative shear lag produces at this level. Since the reversal of the deflection in the corner column is less as compared with central column in the upper storey of the tube, it may produces warping in the cross-sections of tube.

(iii) The positive shear lag occurs at the support and changes to negative at the top of structure. The effect of negative shear lag near the top is so pronounced that column near the corners may develop axial forces opposite to those in the other column. Along with the height, axial force in column adjacent to corner column increase and with further increase in height it shifts towards the central column.

Inflection point for framed tube structure does not fall for all columns within 1/4th of the span from the support as applicable for box girders.

Variation of axial forces in columns is altered by the variation of stiffness of beam as well as of column. In the flange columns, axial force increases with increasing relative stiffness of beams and columns.

Base bending moment reduces consistently as the relative stiffness of beam increases. Increase in column stiffness has increased base bending moment in both flange & web columns. Lateral deflection of the tubular building decreases with increasing stiffness of both beams and columns. However, compared to beams, increased stiffness of columns has more effectiveness in reducing lateral deflection.

Some column of compression flange may also develop tension right from the support depending upon height of the structure and loadings. Columns in upper storeys are critical columns for the designer as they may develop tension.

It is observed that the support conditions may have a profound effect on the global dynamic response of the shear beam. In particular, it is found that the influence of the soil-structure interaction may increase the maximum overall displacement of the shear beam significantly.

(iv) It is concluded that (i) The peak model displacement (PMD), increases significantly as the stiffness of the base decreases (ii) The peak model velocity (PMV) of shear beam decreases along with decrease in base stiffness (iii) The spectral acceleration response of the model (PMA) changes drastically as stiffness of base decreases.

The study expected to give new impetus towards the understanding of shear lag phenomenon for different earthquake zones and wind sensitive areas in the Indian subcontinents.