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Analysis of Shear Lag Effect in Hollow Structure

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Abstract - **In the age of advanced engineering and technology the structures like frame tube systems are widely implemented in high rise structures for its high stiffness in resisting lateral loads. Frame tube system comprises of closely spaced exterior columns tied at each floor level with relatively deep spandrel beam, which creates an effect of 'Hollow Concrete Tube' perforated by openings for windows. A 30 storied structure is analysed to study the "Shear Lag Effect" in Hollow (tubular) Structure using Etabs. The results obtained are in terms of variation of axial forces along height which indicates the occurrence of Shear Lag Effect. The main objective of the present study is to understand the Shear Lag Phenomena in high rise tubular structures.**

Keywords—Flange Section, Web Section, Positive Shear Lag, Negative Shear Lag.

I. INTRODUCTION (*Heading 1*)

Framed Tube structure is an efficient structural system for tall buildings in steel as well as concrete. Such system mainly comprises of closely spaced exterior columns along the periphery, interconnected by deep spandrel beams at each floor level, which creates an effect of 'hollow concrete tube'. The overall bending behavior of tubular building is similar to that of a box girder, through 'shear deformations' which are neglected in box girder, plan a vital role in tubular buildings.

The basic assumption of simple beam theory states that cross sections are assumed to remain plane before and after bending. The assumption results in linear distribution of bending stress in cross sections of beam. This assumption can be true in hollow (tube) sections if shear stiffness of cross section is infinite, i.e. if there is no shear force in hollow section. In hollow sections, the bending stress across the section is non-uniform, resulting in central longitudinal shear strain different from the displacements at the edges of the flange. This state of non-uniformity of normal longitudinal stress is known as 'Shear Lag' (Fig.1)

Shear Lag Effect is generally categorized into 'Positive Shear Lag' and 'Negative Shear Lag'. The stresses that are higher near web section and lesser away from the web section is called 'Positive Shear Lag'. In the region beyond the cantilever length from fixed end, the bending stresses in the tube section at the corners are lower than the stresses at the middle of the flange panel and are termed as 'Negative Shear Lag'.

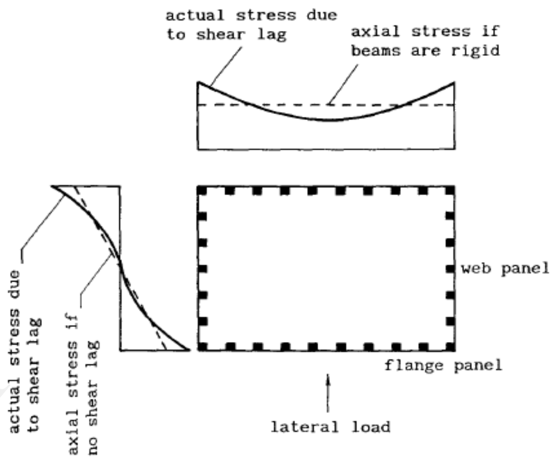

Fig.1 Axial Stress Distribution in Framed Tube.

II. METHODOLOGY

The approach and accuracy of the analytical results depends on the idealization of the geometry and loading of the structure. The exterior frame components or the exterior columns along the periphery of the structure are designed to resist the lateral loads while the internal frame components or the internal columns are designed to carry the other gravitational loads. Simple analysis is carried out on Tubular Frame Structure to determine the shear lag effect using Etabs Platform.

III. PROBLEM STATEMENT

A 30 storied tubular framed building is modeled, having plan dimensions of 45m X 27m. The center-to-center spacing between columns is 3m each, in both flange and web panels and the storey height is 3m. A lateral uniform load of 120 KN/m is applied on the both ends of the flange section.

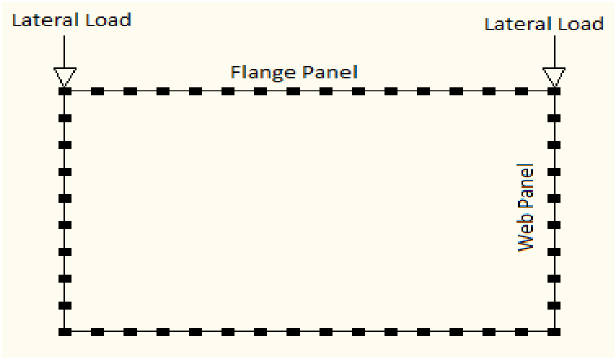

Fig.2 Plan

IV. AXIAL FORCES DISTRIBUTION IN PANELS AND CONCLUSION.

Axial Forces are plotted for every 5th storey so that the effect of shear lag can be easily studied. The shear lag effect in flange panel and web panel is plotted separately.

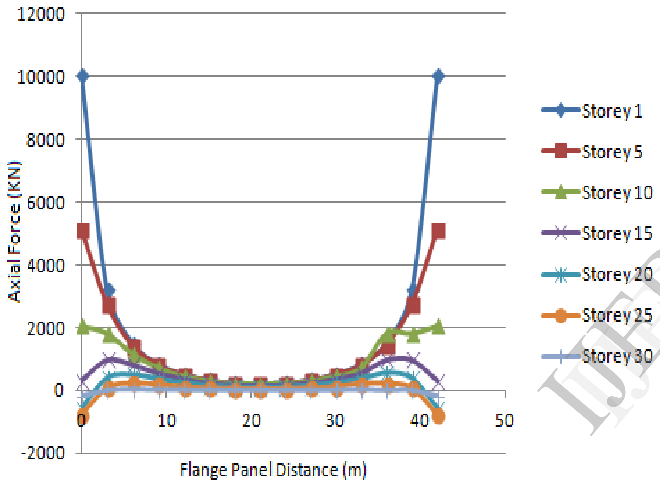

Fig. 3. Axial Forces in Flange Panel Columns

It is observed that axial force in corner columns of storey 1 and storey 5 are maximum and in central columns are minimum, which indicates positive shear lag phenomenon. As corner columns in flange panels experience more axial force than the central column, positive shear lag originates from fixed end.

From the graphs, it is observed that the axial forces in corner columns of storey 15 are lesser than adjacent columns. This indicates occurance of negative shear lag. At storey 30 the central columns start experiencing more axial force than the corner columns.

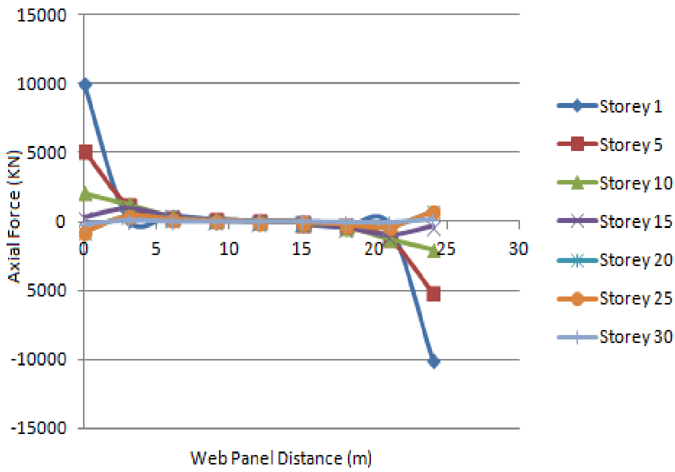

Fig. 4. Axial Forces in Web Panel Columns

In the web panel the axial forces in corner columns decreases with increase in height of the building. It is also observed that negative shear lag is more at the top of the building. From the study of axial force distribution, it is intresting to know that negative shear lag is maximum at top and occurs only after positive shear lag has occurred

ACKNOWLEDGMENT *(Heading 5)*

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