EXPERIMENTAL DETERMINATION OF LATERAL STIFFNESS CHARACTERISTICS OF SPACE FRAMED THREE DIMENSIONAL STEEL STRUCTURES

by

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SYNOPSIS

The objective of this paper is to discuss the experimentally determined dynamic characteristics and the discrepancies in stiffness contributions of mild steel plane and space framed structures while subjected to lateral forces. The experimental investigations are carried out on two models, they are, single storey and three storey single bay plane and space frames. This preliminary study of force-deflection characteristics shows that lateral stiffness of space framed structure is not a arithmetic summation of plane frames stiffnesses as it is evident from experimental results. An attempt is being made to get a multiplying factor which relates the plane and space frame stiffnesses.

STUDY OF EXPERIMENTAL RESULTS

Two sets of experiments are carried out on three combinations of structures i.e. two plane frames and space frame (combinations of two plane frames by cross beams) (1) static force-deflection curves at various amplitudes of lateral loads, (2) free vibration tests. The experimental models are tested on natural soil through the foundation block so that the effect of yielding of foundation could be studied. A varying lateral load is applied and gradually increasing amplitude of cyclic lateral displacements of the frame are observed.

It is seen from various experimental results that in case of short structures, the lateral stiffness of space frame structures is almost algebraic addition of number of parallel plane frames, but in tall structures, the multiplying factor will be from 1.3 to 1.8 for different stories. There is a good correlation between different frequencies of vibrations and damping characteristics worked out from free-vibration tests. Length of cross members between two parallel plane frames will have greater effect on overall behaviour of the space models. Area affected by yielding in the foundation soil of space framed model structure is also signifant. A refined design approach towards the tall framed structures may be possible if the effect of lateral force distribution on these cross members are considered for the overall structure. The analysis of space framed structures require considerable effort, however, this can be simplified if the use of multiplying factor is made as suggested in this paper.

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DISCUSSION

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The other factors which shall contribute and the studies of which shall be useful are:

1. The relative stiffness of different plane frames which make the space frames.

2. The stiffness of connecting cross beams.

3. Degree of fixity of the joints of cross beams.

4. Height of frame, (for very high frames the behaviour may be different).

5. The total number of plane frames which make the space frame.

6. The ratio of the length and width of the space frame constituted by the plane frames.

Author's Closure

With regard to the question of Mr. Seth, we wish to state that

1. The relative stiffness of different plane frames which make the space frames will definitely contribute towards the total stiffness of the entire frame. In fact the authors have also tried to bring out this fact in the above papers. The main point to emphasis here is that it is not an algebric summation of frame stiffnesses. Therefore, a multiplying factor has been introduced in the theory.

2. The stiffness of the connecting cross beams also effect the over all stiffness of structure. Stiffer the cross beams larger will be the overall stiffness of frame leading to algebric summation of plane frame stiffnesses.

3. Degree of fixity of the joints of cross beams also effect the overall stiffness of the space frame. More rigid joints will give higher stiffness of overall frame.

4. Height of frame will also effect the overall stiffness of the space frame. However, this will require detailed investigations.

5. The total number of plane frames which make the space frame will have very little effect on the multiplying factor. However, larger the number of frames more will be stiffness of space frame.

6. Length and width ratio of the space frame will have little effect on the overall stiffness of space frame. Larger the length, more flexible the frame will be. Hence it may not effect the multiplying factor but stiffness of plane frame themselves will be effected.