Abstract of M.Sc. Engg. (Civil) Thesis on

Improved Design Rationale for Helicoidal Stair Slabs based on Finite Element Analysis

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Attractive appearance of the helicoidal stair slab has drawn the attention of the users and architects. For this reason, the structure is now being increasingly used in many buildings. Due to complex geometric configuration of this structure, the conventional methods of analysis are based on different idealisations and assumptions. All these analytical methods fail to utilise its inherent structural efficiency. With a view to developing a rational design procedure for this structure, finite element approach was introduced to study the actual behaviour of heliocidal stair slabs without any geometric idealisation using eight node curved thick shell element.

The results of finite element analysis were compared with those obtained from the traditional helical girder solution. The comparative investigation revealed that the helical girder solution largely over estimates the vertical moment, lateral moment, lateral shear force and thrust with an under estimation of torsion. Apart from these aspects, the sensitive non-linear response of the structure due to the variation of different geometric parameters including central angle was also distinctly observed from an extensive parametric study.

The investigation on the effect of variation of mesh size on the vertical displacement indicated that a coarse mesh (even 2 x 4) is also capable of performing the analysis satisfactorily. Evidently this confirms the efficiency of the developed software and displays the power of the “Curved Shell Elements”. The deflection pattern and the load deflection response of the structure was also found to be in good agreement with the available results of model studies.

Based on all these findings, a rational design procedure based on finite element analysis has been proposed. A comparative design exercise has illustrated that around 37% overall economy of reinforcement is attainable in the proposed design process.