**Abstract of B.Sc. Engg. (Civil) Thesis on**

**Part II**

# Improved Design Procedue for Helicoidal Stair Slabs based on Finite Element Analysis

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The attractive appearance of 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 method of analysis is based on different idealisations and assumptions. These analytical methods fail to utilise its inherent structural efficiency. A rigorous mathematical analysis which is general enough to include any unsymmetrical case is available. But this approach failed to be popular due to complexity in calculation.

The recent advances at BUET have led to the successful development of a computer software which can tackle this problem in a more rational way. This program is based on the "General Thick Shell Finite Element Program" of Ahmad. This finite element approach can analyse the structure by taking into account its three dimensional characteristics without any geometric idealisation. With this background in view, the present work was aimed to assess the suitability of the developed finite element program over the conventional method of analysis in terms of its economy, reliability and efficiency.

In the present study, two practical cases of helicoidal stair slab were fully analysed by finite element method. The effect of variation in the mesh size on the vertical displacement was also studied. Following this, the cases were analysed by the conventional method (Reynolds & Steedman, 1988) and a comparison with the result of finite element analysis was made. Finally, for an economic assessment, a stair was comparatively designed by using the results of both approaches.

The detail analysis of the stairs by finite element approach indicated that forces and moments are more severe near the inner edge than the outer edge. From comparative observation, a large over estimation of design forces and moments by the conventional method was evident. The study revealed that the conventional method over estimates the bending moment at the support by six times. Within the quarter to mid span this over estimation was limited within two to five times. A similar over estimation of in plane moment was also observed. In case of vertical shear force, conventional method was found to over estimate the force by two to three times. However, both methods predicted a comparable value of in plane shear. The prediction of maximum axial force was also similar in both approaches. But in other than critical sections, conventional approach over estimated the axial force. In contrast to these observations, under estimation of torsional moment by the conventional method was distinctly observed.

The investigation on the effect of variation of mesh size on the vertical displacement indicated that a coarse mesh (even 2 x 4) in finite element approach is also capable of performing the analysis satisfactorily. This evidently confirms the efficiency of the developed software in terms of computation time and displays the power of the "Curved Shell Elements".

The illustrative design indicated that the requirement of flexural and axial reinforcement is significantly less in finite element analysis than that from the conventional method. From the design exercise it also became visible that only about 10% of the traditionally used reinforcement is sufficient to take care of the in plane moment. The possibility of the slab thickness reduction in finite element approach also became evident. The finite element analysis has revealed that in conventional approach torsional moment is under estimated. Hence, the design in conventional method suggests that the concrete section alone is capable of resisting this moment. In contrast to this, the need for minimum torsional reinforcement became evident from the finite element analysis.

These interesting findings clearly demonstrate the potentials of the finite element approach over the conventional one. An indication for further research has therefore been suggested to take this method to the culminating point of developing a design rationale.