CHAPTER I

INTRODUCTION

1.1 General statement of the problem

In the past two decades, a number of reinforced concrete helical stair fixed at both ends has been constructed although their design and construction were not easy. However, owing to the aesthetic appearance and structural advantage, this attractive structure has become popular among structural engineers and architects. Theoretical analysis and experimental research works were also made and published at that time. Nowadays, much is known about the helical stair. Nevertheless, it is found that all the early helical stairs were constructed with the central angle limited to 360 degrees. When the central angle of the helical stair is greater than 360 degrees, the structural behavior of this staircase becomes doubtful. No test records concerning this large angle helical stairs are available at present. It is therefore advantageous to investigate the structural behavior of this staircase.

1.2 Literature review

In 1908, the first reinforced concrete helical stair was constructed in England. It was analysed as an open coiled helical spring and was designed primarily as a torsion member. However this type of staircase was not popular.

Bergman (1956) suggested an approximate analysis by assuming that the helical stair fixed at both ends was represented to a horizontal bow girder. The bending moments, torsional moment and shearing stresses were calculated as in a curve beam loaded normal to its plane. This method failed to take into consi-deration the beneficial structural behavior of a helical beam which was much stronger than a bow girder.

Holmes (1957) published a paper dealing with the theory of helical stair and presented equation for the computation of the two mid span redundants for the usual design case of the uniformly loaded girder. In his analysis the helical stair was simplified as a helical beam. He assumed that the center of gravi-ty of the load lied on the center line of the steps which was assumed to be the longitudinal elastic axis of the beam.

Young and Scordelis (1958) have performed an experiment on the model of a helical girder, fixed at the ends, subtending a horizontal angle of 180 degrees, and having a slope of 30 degrees. Four girders, each having a different uniform rectangular cross-section, were made of plexiglass. The experiment using the large displacement method of the model analysis, was conducted with the aid of the apparatus designed by Gerstle (1955). The influ-ence line for reactions resulting from concentrated loads acting along the center line of the girder have been plotted to compare with an analytical solution. Their experimental results gave very good agreement with the theoretical values.

Scordelis (1960) has presented the tabulated values for the redundants at mid span of a unit uniformly loaded helicoidal girder fixed at its ends. His analysis were based on the same assumption as Holmes' method. However, in the discussion of Scordelis (1960 b) following his paper, he has developed an addi-tional solution by including the eccentricity of the load with respect to the center line of the girder. Tabulated values for the redundant at mid span of a unit uniform torque per lineal foot of horizontal projection have also been published.

Morgan (1960) used the same basic assumptions as Scordelis analysing the helical stair. He also considered the effect of the eccentricity of load with respect to the center line of the steps. However, the method of finding the values of the eccentricity of load were different. Both Scordelis and Morgan's method yielded nearly the same results.

Suphachai Trirojna (1962) has performed the experiment to investigate the structural behavior of a 80-degree helical stair fixed at both ends. Two half scale models were constructed to test under uniform load. The load factor at callapse load of the first and second model were 4.8 and 3.6 respectively.

Saksit Niyomvit (1963) used Scordelis and Morgan method to analyse a 180-degree fixed ended helical stair. The combined equations for uniform load and concentrated load at the central span were also given in his

work. Two half scale models were constructed and then tested. The first model was first tested for a concentrated load and then for uniform load until the staircase failed. The second model was tested for uniform load only. The load factor at collapse load obtained from the two models were 7.5 and 9.8 respectively.

Sakda Santathadaporn (1964) extended the work done by Suphachai and Saksit. In his work, a 360-degree fixed ended helical stair was analysed by the method of Morgan. An experiment was performed by an actual loading test on a full scale helical stair up to 25 percent over the design load. He concluded that the design of a 360 degree helical stair by Morgan's method was satisfactory.

1.3 Purpose and Scope of investigation

The purpose of this thesis is to investigate, both theoretically and experimentally, the structural behavior of a helical stair fixed at both ends with central angle more than 360 degrees.

In this work, the analytical determination of the internal forces and vertical deflections of the helical stair are developed and a prototype of helical stair with central angle 720 degrees is calculated. A half scale reinforced concrete model is constructed for testing. The vertical, horizontal displacement and strain are measured at each increment of load. The model should be tested to failure load.