

THEORETICAL AND EXPERIMENTAL INVESTIGATION
OF
NONPRISMATIC FOLDED PLATES

Thesis submitted

by

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for the Degree of
DOCTOR OF PHILOSOPHY
in
CIVIL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING
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OCTOBER, 1980

CERTIFICATE

Certified that this work "Theoretical and Experimental Investigation of Nonprismatic Folded Plates" by Mr. Hasmukh Vithalbhai Trivedi has been carried out under our supervision and it has not been submitted elsewhere for a degree.

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ACKNOWLEDGEMENT

It gives me immense pleasure to express my deep sense of gratitude to Prof. K. Seetharamulu and Dr. S.N.Sinha for their constant help, encouragement and guidance during the progress of this study. Indeed, but for their keen interest in the progress of the work, this project could not have been completed in time.

The author is also grateful to the Ministry of Education, Government of India for providing him the research fellowship and to Prof. S.B. Kumta, Director of Technical Education, Gujarat State for sponsoring him under Q.I.P.

The author is thankful to the staff of the structures laboratory and workshop of Civil Engineering Department for the help extended during the experimental investigation, particularly to Mr. G.S. Giani and Mr. Badleram for the assistance rendered in fabrication of the models.

He is also thankful to the staff of Computer Centre for the help extended during the theoretical investigation.

The assistance rendered by Mr. N.L. Arora in preparation of the drawings and Miss Neelam in typing the manuscript is gratefully acknowledged.

Last but not the least, I thank all my colleagues and friends for their all round help all these years.



(H.V. TRIVEDI)

ABSTRACT

Although extensive literature is available on theoretical and experimental investigation of prismatic folded plates, the study concerning nonprismatic folded plates is extremely limited. Main objective of the present investigation is to develop suitable methods for the analysis of nonprismatic folded plates. The methods proposed are (a) force method and (b) energy method. A shape of nonprismatic folded plate has been proposed and its suitability is investigated herein. The shape is obtained by varying the depth of folded plate parabolically along span with maximum depth at midspan. Theoretical analysis, experimental investigation, parametric study and preparation of analysis curves are attempted for the proposed shape of the folded plate structure. The contents of the study are summarised as follows.

Energy method originally proposed for the analysis of single span prismatic folded plates is extended herein to nonprismatic folded plates in Chapter 3. The sine series is chosen as displacement function for each plate. The amplitudes of the harmonics are treated as the unknowns while minimizing the total potential energy. The structure is divided into a number of transverse sections for numerical integration. Three examples are illustrated to establish suitability of the method. Effect of number of sections

considered for integration and number of terms of harmonics for the deflected shape on accuracy of solution is examined. The results of energy method are compared with those of available experimental and theoretical investigations and have been found to be in good agreement.

Matrix force method for the analysis of nonprismatic folded plates is developed in Chapter 4. The structure is made statically determinate by introducing rotational hinges and longitudinal rollers at nodes. Three basic steps of analysis - equilibrium, deformation force relation and compatibility are described for the solution of nonprismatic folded plates. Numerical method is used to obtain plate flexibility matrix. The effect of number of sections on the accuracy of results is examined. The applicability of the method is examined by comparing the results of analysis predicted by force method with those reported earlier. The results of the proposed method compare well.

Experimental investigation carried out on two sand araldite models of the proposed shape is described in Chapter 5. Araldite and sand were mixed in the proportion 1:7 by weight. The two models have approximately same cross section at midspan and cover same plan area. The ratio of depth at support to depth at midspan is 0.5 for model 1 and 0.25 for the second model. The experiments were conducted

under three load conditions. Strains and deflections are measured at midspan and quarter span sections. Longitudinal stresses, transverse moments and deflections are compared with those obtained from the force method. The comparison shows that the method is more suitable for the analysis of such structures and is chosen for the parametric study and preparation of 'Analysis Curves'.

Parametric study and analysis curves for the proposed shape are presented in Chapter 6. The geometrical parameters considered for parametric study are span L , width of top plate B_t , inclination of side plate θ , thickness of plate T and depth at support Y_s . The analysis curves for geometrical parameters are prepared in terms of nondimensional parameters L/B , T/B , θ and Y_s/Y_m . The force parameters are longitudinal stresses and transverse moments which are also expressed as nondimensional parameters. The curves facilitate quick design and eliminate the use of a computer.

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