SUMMARY

In a thin sheet containing a central cut-out and subjected to uniaxial tension, there exists, in addition to the usual problem of stress concentration, the possibility of local buckling of the free-edges of cut-out normal to the direction of loading. The buckling phenomenon involves the existence of a non uniform pre-buckle stress state in the vicinity of the cut-out.

In this dissertation, the results of photoelastic stress analysis around square cut-outs of different corner radii, in uniaxially tensioned sheets, are presented. It is observed that the maximum stress concentration factor at corner does not show a monotonic decrease with increasing rounding off corner radius, but exhibits a minimum and then increases with further increase of corner radius. The magnitude of the ratio of rounding off corner radius to half cut-out length corresponding to the minimum value of the maximum stress concentration factor, which in this case happens to be around $r = 0.75$, should be viewed as a significant design parameter that can help the designer select a quantitative value for the so called safe rounded corner of a similar cut-out from strength point of view. The effect of corner radius on the extent of the region of compression, which is

primarily responsible for the local buckling in thin sheets, is also discussed.

An experimental study of the local buckling behaviour of uniaxially tensioned thin sheets with rectangular cut-outs, on the basis of the modified Southwell method is presented. The effects of important parameters like corner radius, cut-out aspect ratio and cut-out length to plate width ratio, on the local buckling stress are discussed.

A study of the frequency response characteristics of uniaxially tensioned sheets with rectangular cut-outs, subjected to transverse vibration, is made with a view to make use of B.L. Clarkson's criterion for the estimation of buckling load. The shape and size of the cut-out and size of sheet specimen are found to influence the sheet-vibration characteristics. It is also noted that for certain combinations of cut-out parameters, the natural frequency versus tensile load plot exhibits a well defined trough corresponding to the local buckling of the free-edges of the cut-out. For other cases, the frequency plots show only points of inflection, corresponding to the local buckling condition. The reasons for this behaviour are discussed.

The tensile loads which cause local buckling of the free-edges of cut-outs, obtained from natural frequency plots and from modified Southwell plots are compared and good agreement is found in almost all cases. The local buckling loads obtained by modified Southwell method are found to be slightly greater than the frequency response plot estimates.

The possible reasons for such behaviour are discussed. The results of this investigation are also compared with those obtained by other investigators, wherever possible, and the agreement is found to be reasonably good in all such cases.

A simple correlation formula, relating the non-dimensional buckling stress and the important cut-out parameters, studied in this dissertation, is presented and the limitations of its applicability are indicated. Finally, the possibility of arriving at an optimum configuration of a rectangular cut-out, in an uniaxially tensioned sheet, which would result in as small a stress concentration factor at corners as possible and, at the same time, as high a local buckling load as possible, is discussed. To a structural designer, dealing with rectangular cut-outs in pressurised cabins, this information is, undoubtedly, of vital importance.

In this thesis, Chapter I gives a fairly exhaustive review of the relevant literatures that are both of general interest and of particular value to the problem studied here. The objectives of this investigation is presented at the end of the Chapter.

Chapter II describes the stress analysis study carried out, using two dimensional photoelasticity. The stress distribution results are presented in graphical form at the end of the Chapter.

Chapter III deals with the estimation of tensile buckling loads in thin sheets with rectangular cut-outs. The modified Southwell method and the dynamic response method, used for the above estimation, are described and the results of the investigation are presented.

In Chapter IV, the results of local buckling study are analysed and the effects of important cut-out parameters on the buckling stress are ascertained. Comparison between the results of the two methods, used for buckling load estimation, is made. A correlation formula, for the estimation of buckling stress, is presented. Discussion on the optimum configuration of rectangular cut-out is presented at the end of the Chapter.

Conclusions based on the results of this investigation are presented in Chapter V. In Chapter VI, suggestions for further research are noted.