ON LIMIT ANALYSIS OF CYLINDER-CYLINDER INTERSECTIONS SUBJECTED TO INTERNAL PRESSURE

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SUMMARY

According to the present ASME Boiler and Pressure Vessel Code, limit analysis can be used as a criterion for the structural integrity of pressure vessel components, instead of the computation of some stress intensities, under certain conditions of operation. In the present state of the art, it can be safely assumed that any problem with rotational symmetry of loading and geometry, no matter how complex, can be solved from a practical point of view, i.e. sufficiently close lower and upper bounds can be obtained for a significant evaluation of the collapse load.

Non-symmetric problems, however, are far more difficult. In recent years, a considerable effort has been invested into numerical methods to analyze shell intersections, in particular right cylinder-cylinder intersections subjected to internal pressure, end loads and end couples. Upper bounds have been obtained and at least three papers have been published between 1971 and 1973 on lower bounds for this configuration.

It is the authors' contention that the validity of the published lower bound papers has not been demonstrated. While it is not clear as to whether the bounds presented are too high or too low, it is felt that many serious difficulties encountered in the method of analysis have been ignored and that it would be inappropriate for code users to take results into consideration.

The purpose of this paper is to discuss a new method for the numerical estimation of lower bounds to the collapse pressure of a right cylinder-cylinder intersection. The technique consists in subdividing the domain of interest (i.e. a quarter of the small cylinder and one half of the large cylinder) into three zones and to use stress functions for the generalized stresses such that continuity between zones and symmetry are satisfied. The stress functions contain arbitrary parameters, and the lower bound problem is reduced to that of maximizing the pressure such that yield inequalities are satisfied everywhere, and such that, at the junction between the two cylinders, the continuity of stresses is satisfied.

The major limitation of the method is the capacity of the minimization technique to satisfy the function continuity constraints. In fact, strict satisfaction has not been possible, and the values of the collapse pressure has been obtained by extrapolation for a few arbitrary small values of discrepancy at that junction.

The lower bound "estimations" obtained have been somewhat low. This is due in part to the fact that only three zones have been considered for the stress distribution. It is expected that use of four or more zones with the same general approach would provide good values of lower bounds for a significant range of intersection parameters.