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AN EXAMPLE OF SEVERE NON-CONVEXITY IN TRUSS OPTIMISATION

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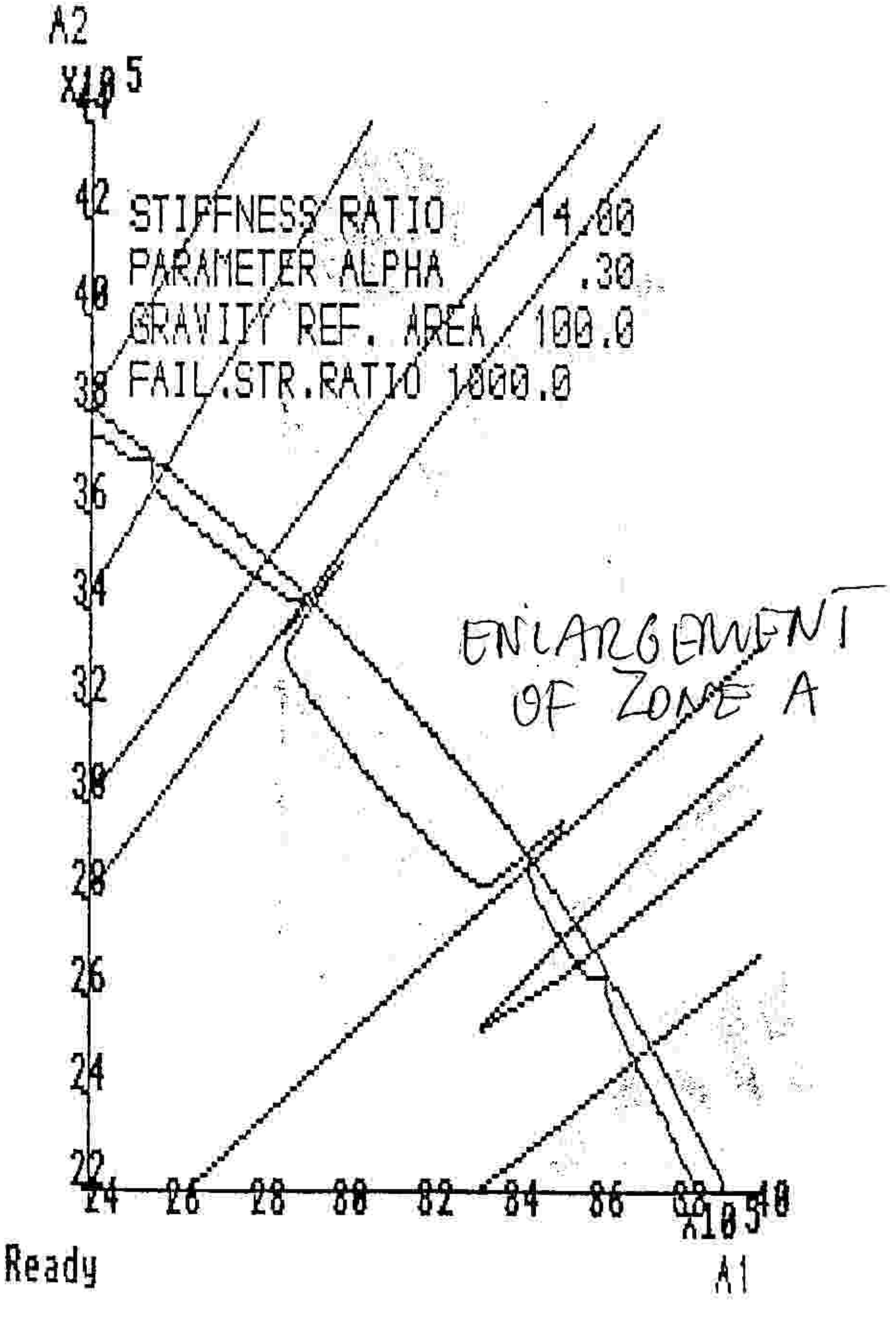
ABSTRACT

Although considerable advances have been made in numerical optimisation strategies for structural design, the possibility of multiple optima, and the risk of achieving a sub-optimal (locally optimum) solution still remain. Currently only combinatorial optimisation methods can be expected to overcome this problem, and they are computationally very expensive. Not all instances of structural optimisation are associated with nonconvexity, and the convex problems can be solved quite inexpensively; unfortunately there does not exist a simple rule for classifying structures as convex or nonconvex with respect to optimisation: they may be of either type depending on the numerical constants involved. An understanding of the shape and connectivity of the feasible domain would help toward finding such a classification rule. The boundaries of the feasible domain are formed by the stress and displacement constraints. In statically determinate structures these would be hyperplanes in an appropriately chosen set of coordinates. In indeterminate problems the boundaries become slightly curved, and the curvature may sometimes be of the nonconvex type. This has been found in transversely loaded beam grillage problems, for example. If some member areas are allowed to vanish, then the corresponding stress limits will no longer apply: also, there are now several possible structural configurations of various degrees of indeterminacy. Usually this leads to a feasible set consisting of disjoint subsets, and the overall nonconvexity of the problem is compounded. It is tempting to believe that this situation can be prevented by imposing finite lower limits on the areas. However recent numerical studies by the authors indicate that this conjecture is false. An example will be presented wherein the feasible domain is made of disjoint lobes even when all members are constrained to remain present in the structure. As far as the development of optimisation software packages is concerned, this result suggests that the method used should be closely matched to the class of structures for which the package is destined.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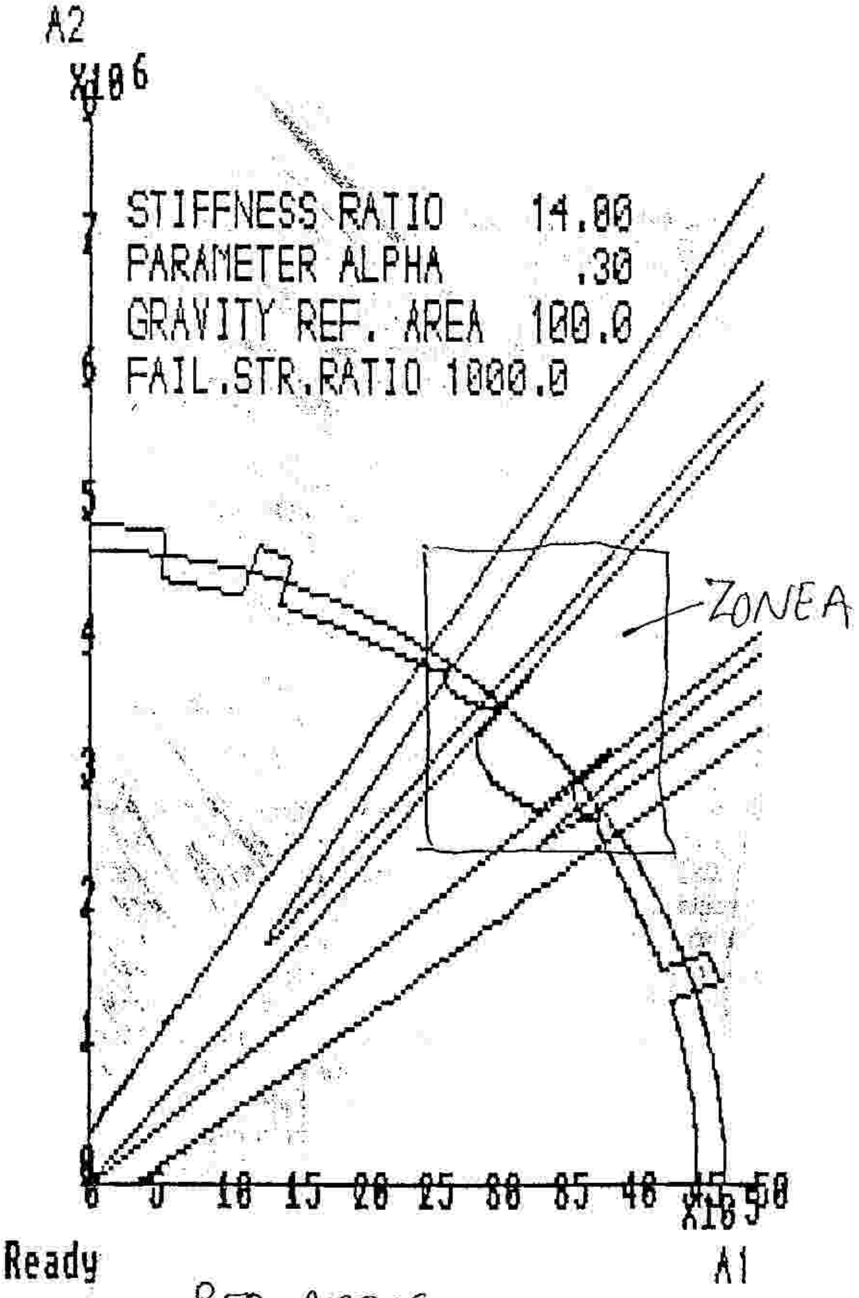

RED AREAS:
FEASIBLE DOMAIN