Comments on "Limit Analysis of Elasto-Plastic Archs by Mathematical Programming"

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Reference [1] presented a very valuable contribution towards the application of mathematical programming techniques to the limit analysis of elasto-plastic archs. As an illustrative example a two hinged arch under single concentrated load at mid span was given. My comments are directed towards the physics rather than the mathematics of this problem.

There is, of course, a fundamental difference between archs and ordinary beams in so far as it is not permissable to neglect the effect of the normal forces of the archs which is duly mentioned by the authors. However, the problem is that there are at least six well known cases where the engineering plastic hinge method should not be applied. These cases are mentioned in detail for instance in an article by Prof. Duddeck in the famous German engineering handbook, Beton Kalender [2]. There it is also mentioned explicitly: "Bei druck-beanspruchten Bauteilen kann das einfache Traglastverfahren-selbst wenn der Stabilitatsfall nicht massgebend ist (Beispiel Bild 3.5c)-deshalb nicht brauchbar sein, weil die plastischen Bereiche nicht konzentriert genug auftreten, um sie mit idealen plastischen Gelenken zu erfassen," That means in the case of structures under dominantly compressive loading the plastic zones are too large to be considered a point which is the case with archs and rings in general.

There have been cases reported in the literature where the collapse load of archs and rings was calculated using the simple engineering plastic hinge theory and nevertheless, a fair agreement was found between these results and the experimental ones, as reported for instance by Johnson [3].

It would, therefore, be most interesting from the physical and engineering point of view to know if the authors have compared these results with experiments and what is the order of the error which they expect in their mathematical models. It would also be interesting to know how they could modify their models to account for this error.

Flnally, I would again like to thank the authors on behalf of the editorial board for a most stimulating paper.

References

1. **Abdel Rohman, M.** and **Leipholz, H.**, Limit analysis of elasto-plastic archs by mathematical programming. *Journal of Engineering Sciences*, Vol 5, p. 169 (1979).
2. **Duddeck, H.**, *Traglasttheorie der Stabtragwerke*, Beton Kalender, part II, p. 621 (1972).
3. **Johnson, W.**, *Impact strength of materials*. Arnold-London, p. 182. (1972).

Author's Reply:

By

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The authors agree with the comments given by M.S. El Naschie, concerning that one should be careful in the design of structures subjected to dominant compressive forces, using the plastic theory.

There are still some conditions and restrictions which must be satisfied in the American Code (AISC) if the plastic theory will be used in the design of Multistory frames (1). However, most of the given formulae are based on test results. Recently, researchers predicted how important the effect of plastic zone and strain hardening is on the plastic collapse, Including these effects in the design is being considered.*

In reference (31) mentioned in the paper, Stevens carried out some tests on parabolic archs and agreements in the results have been reported. However, if the arch is subjected to uniform load, the effect of axial force will be predominant so that the collapse will occur either due to instability or plasticity.

The authors acknowledge how important the plastic zone in this case is and emphasized their assumptions in the beginning of the paper. However, some tests are being done at the University of Kuwait, and as soon as the investigation is completed, the results will be studied and published.

References

1. **Driscoll, G.C.** *et al.* "*Plastic Design of Multistory frames*", Lehigh University, August 1965.

*See the work done by **G. Maier**, Technical University (Politecnico), Milan, Italy.