(from STRUCTURAL ANALYSIS SYSTEMS – Vol. 2, A. Niku-Lari, editor, Pergamon, 1986, “BOSOR4 – Program for stress, stability and vibration of complex, branched shells of revolution”, by David Bushnell, pp. 25-54)

BOSOR4 – PROGRAM FOR STRESS, STABILITY AND VIBRATION OF COMPLEX, BRANCHED, SHELLS OF REVOLUTION

David Bushnell, Lockheed Applied Mechanics Laboratory, Department 93-30, Building 255, 3251 Hanover Street, Palo Alto, California, 94304

(This is an abridged version. See the full-length paper for more: bigbosor4.papers/1986.usersmanual.pdf. Also see the following: bigbosor4.abstracts/b4conloads.pdf, bigbosor4.abstracts/b4packet.pdf, bigbosor4.abstracts/bosor.caution.pdf, bigbosor4.abstracts/bosor.caution2.rtf, bigbosor4.abstracts/bosor.caution3.pdf, bigbosor4.abstracts/bigbosor4.scope.txt.)

ABSTRACT

BOSOR4 performs stress, stability, and modal vibration analysis of complex, segmented, branched shells of revolution made of elastic material. It can be used to analyze prismatic shells and panels. It performs moderately large deflection axisymmetirc stress analysis, small deflection non-axisymmetric stress analysis, modal vibration with axisymmetric nonlinear prestress included, and buckling analysis with axisymmetric or non-axisymmetric prestress. Symmetric and non-axisymmetric buckling modes can be found. There is provision for realistic engineering details such as eccentric load paths, internal supports, arbitrary branching conditions, and a library of wall constructions, including layered orthotropic with temperature-dependent material properties. BOSOR4 is divided into three processors. The user provides input data in an interactive mode. Extensive “HELP” prompts and definitions are available, so that looking up variable definitions in a user’s manual is seldom necessary. CALCOMP-type plotting routines are called from a processor that produces plot files. The prebuckling state and buckling or vibration modes are plotted. BOSOR4 runs extremely fast. (2011 NOTE: BOSOR4 is superseded by BIGBOSOR4, which permits many more shell segments. BIGBOSOR4 subroutines produce Postscript files by means of which plots can be shown on a computer screen or hard copies can be obtained.)

THEORETICAL BACKGROUND AND PROGRAM OVERVIEW

The BOSOR4 computer program was developed in response to the need for a tool that would help the engineer to design practical shell structures. An important class of such shell structures includes segmented, branched, ring-stiffened shells of revolution. Even if the actual structure is not a shell of revolution, it is usually beneficial to use BOSOR4 in the preliminary design and analysis phases of a project because one can easily and very rapidly obtain good estimates of the behavior. The engineer is thereby guided to make appropriate models for use with general-purpose programs, for which the investment in labor and computer time is usually far greater than those required to generate models for and obtain results with BOSOR4.

The complex segmented and branched shells of revolution may have various meridional geometry, wall construction, boundary conditions, ring reinforcements, stringer reinforcements, and types of loading, including non-uniform distributed and line loads and non-uniform temperature distributions. etc., etc., see the full paper for more…

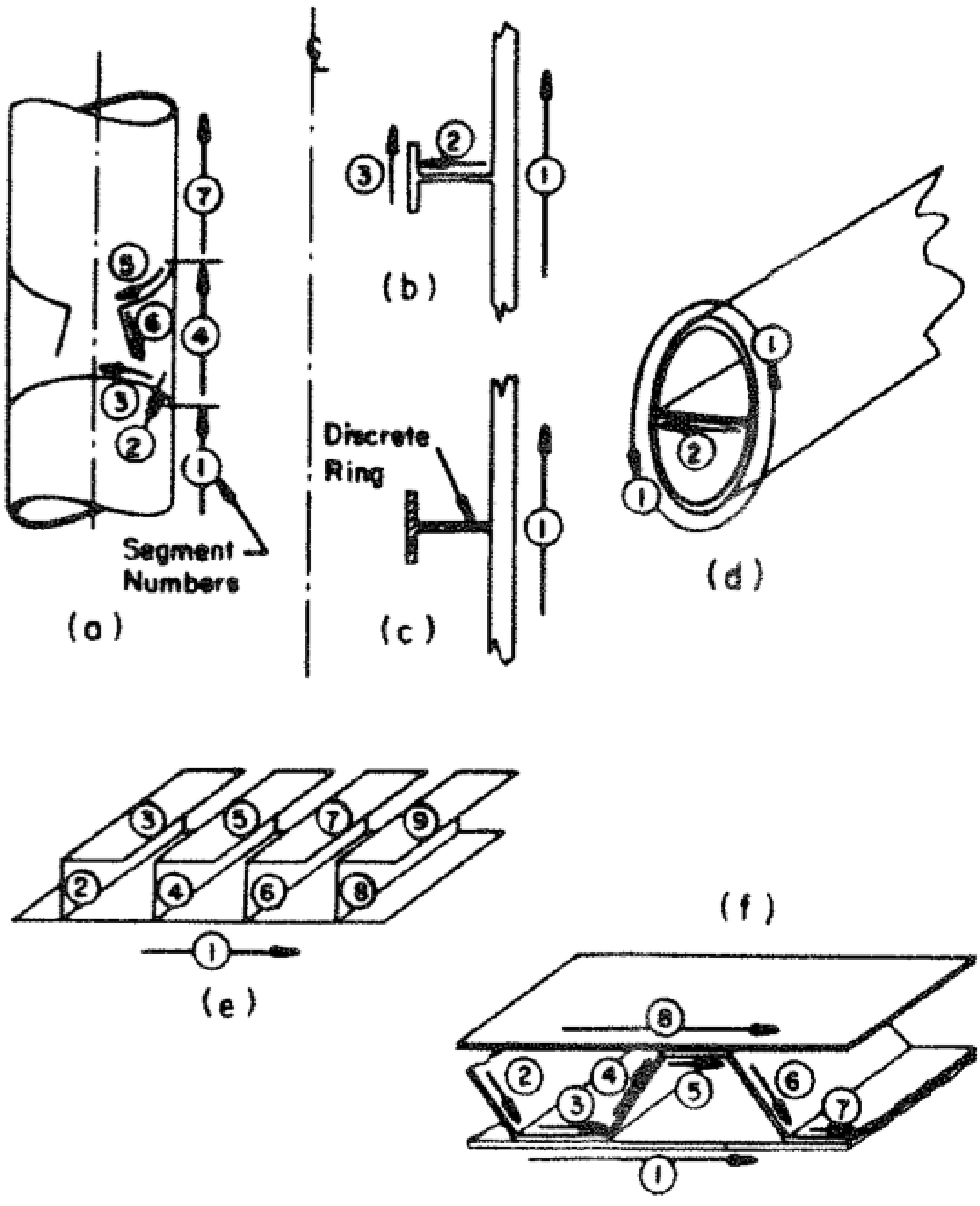
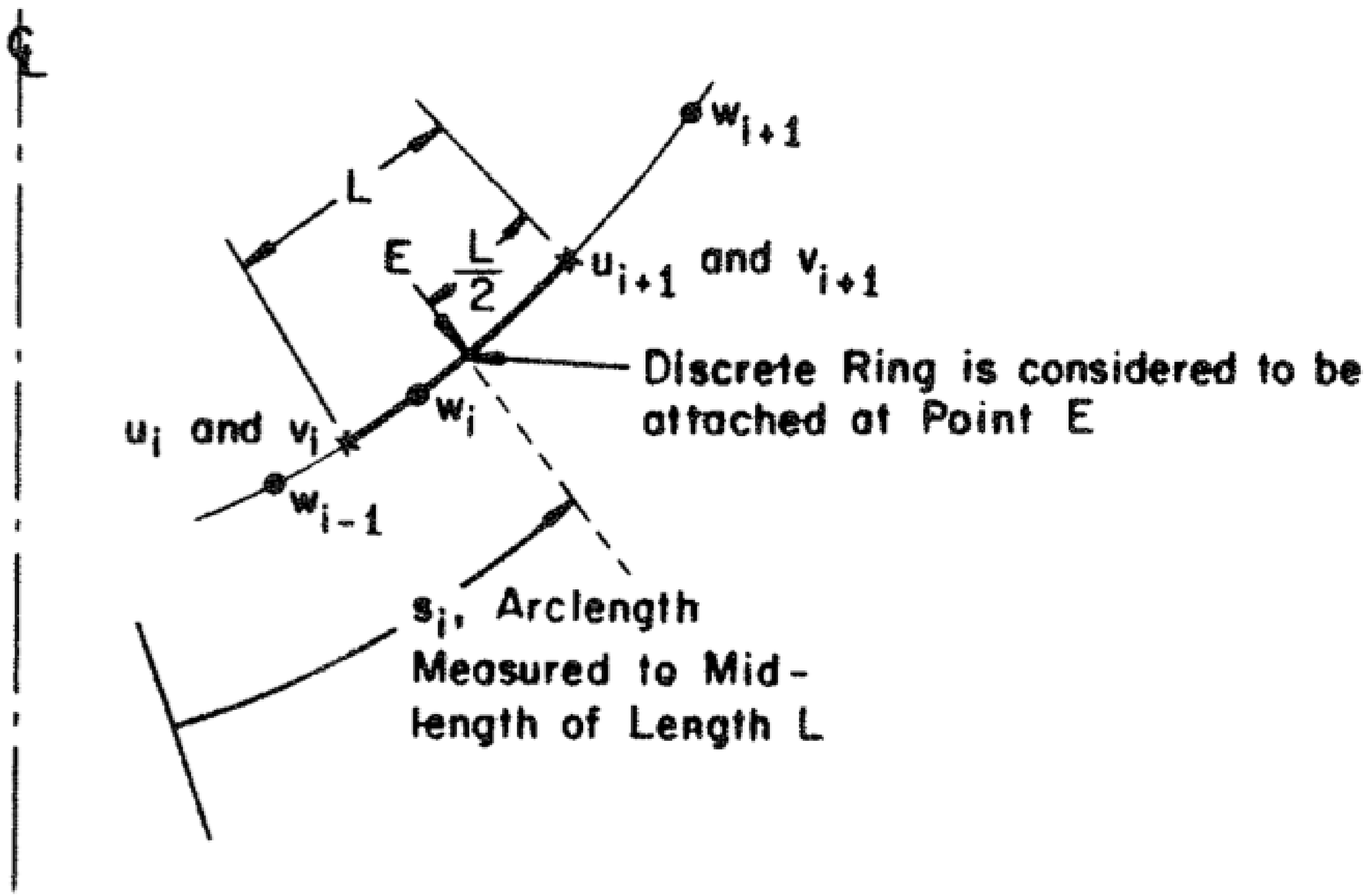
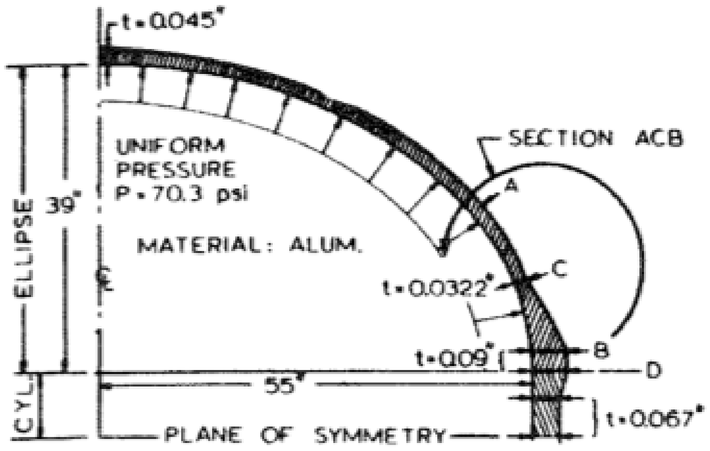


Fig. 1 Examples of branched structures that can be analyzed with BOSOR4. (from STRUCTURAL ANALYSIS SYSTEMS – Vol. 2, A. Niku-Lari, editor, Pergamon, 1986, “BOSOR4 – Program for stress, stability and vibration of complex, branched shells of revolution”, by David Bushnell, pp. 25-54)



$$\lfloor q_i \rfloor = \lfloor w_{i-1}, u_i, v_i, w_i, u_{i+1}, v_{i+1}, w_{i+1} \rfloor$$

Fig. 2 Finite difference discretization: the “finite difference element”. The meridional length of the element is L; the single integration point is at the element mid-length E; the nodal degrees of freedom involved in the local stiffness, mass, and load-geometric matrices for the ith finite element are identified in the vector q_i. (from STRUCTURAL ANALYSIS SYSTEMS – Vol. 2, A. Niku-Lari, editor, Pergamon, 1986, “BOSOR4 – Program for stress, stability and vibration of complex, branched shells of revolution”, by David Bushnell, pp. 25-54)



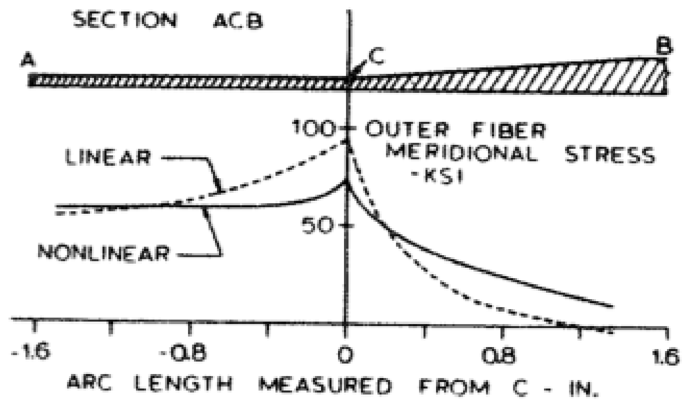


Fig. 6 Linear and nonlinear axisymmetric analyses of an internally pressurized ellipsoidal tank with variable thickness. The stress concentration at Point C is due to load path eccentricity, and the predicted stresses decrease if nonlinear geometric effects are accounted for. (from STRUCTURAL ANALYSIS SYSTEMS – Vol. 2, A. Niku-Lari, editor, Pergamon, 1986, "BOSOR4 – Program for stress, stability and vibration of complex, branched shells of revolution", by David Bushnell, pp. 25-54)

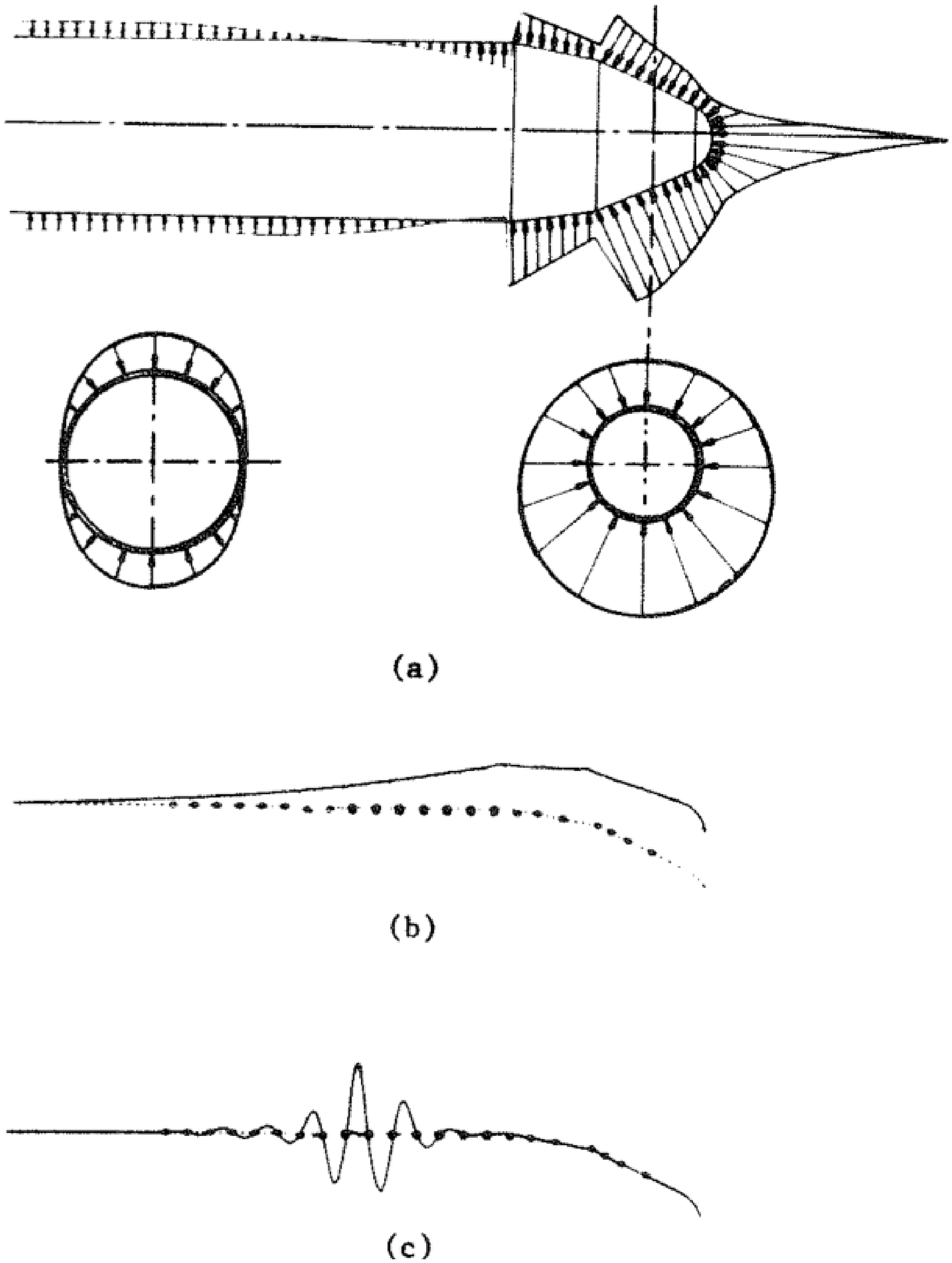


Fig. 9 Buckling mode of a non-axisymmetrically loaded rocket payload shroud shown in Fig. 9(a): (a) Pressure distribution measured in a wind tunnel test; (b) Prebuckling beam-type deflection; (c) Non-axisymmetric buckling mode. Buckling is between the discrete rings and occurs with 13 circumferential waves. (from STRUCTURAL ANALYSIS SYSTEMS – Vol. 2, A. Niku-Lari, editor, Pergamon, 1986, "BOSOR4 – Program for stress, stability and vibration of complex, branched shells of revolution", by David Bushnell, pp. 25-54)