In [1] the structural strength of a brittle material, alucoceramics, was assessed on the example of the operation of spherical monolithic shells subjected to high external hydrostatic pressure. Tests of ceramic shells to destruction and with limited repeated static loads indicate that the use of brittle nonmetallic materials of the type of ceramics, pyroceram, and technical glass is promising in highly stressed monolithic shells of rotation subjected to external hydrostatic pressure.

However, in practice sectional designs of strong shells composed of separate elements are needed; this is due to the production technology of such shells and considerations of the practical use of such structures. However, the possibility of using brittle nonmetallic materials in sectional strong structures for special purposes with different types of joints depends on the solution of a number of design and technological problems. These problems have so far not appeared in Soviet and non-Soviet literature.

A promising method of obtaining strong and durable permanent joints in highly stressed shells made of pyroceram of technical glass is gluing with epoxy compounds made on the basis of epoxy resin ED-6. This new technological kind of joint requires thorough study.

Exploratory experiments conducted previously by the present authors and other researchers to determine the load-bearing capacity of sectional spherical glass shells showed that a glued joint, its thickness and properties substantially change the load-bearing capacity of such structures. In addition to that, it was noted that axial alignment of the end faces of the mating parts must be ensured.

The present work contains the results of the theoretical and experimental investigation of the state of stress and strain and of the load-bearing capacity of a sectional spherical shell in dependence on the specified parameter of the glued joint of the two halves. It was noted that there is a stress concentration in the zone of the joint causing premature loss of load-bearing capacity of shells subjected to external hydrostatic pressure. Particular attention was given to the theoretical investigation of the stress—strain state of the structure in the zone of the joint with different parameters of the glued joint and technological imperfection, i.e., noncoincidence of the mating elements in the cross section of the joint because, in the authors' opinion, it is precisely these factors which are responsible for the premature failure of the structure. Solutions as to design and technology are suggested which make it possible to lower local stress concentration in the glass elements of the sectional shell. Limits are imposed on the thickness of the glued joints and on the noncoincidence of the geometric shapes of the joined elements.

Since the main principle of designing joints in strong structures of brittle materials is to ensure strength in local zones, the present investigation of the stress—strain state of a sectional shell with permanent glued joint was made on the basis of the assumptions of the axisymmetric mixed problem of the linear theory of elasticity. The numerical investigation of the structure was carried out by the finite-element method (FEM) which was thoroughly explained in [2–5]. The application of the numerical method of solving the problem aims at revealing zones of compressive stress concentration, and also of tensile stresses, i.e., at obtaining a qualitative and quantitative picture of the stress—strain state in the zone of the permanent glued joint.
The calculation was carried out by a method worked out at the Institute of Strength Problems, Academy of Sciences of the Ukrainian SSR, and explained in [5], which was realized on a digital computer ES-1020 in the form of a complex of programs written in FORTRAN IV.

The solving equations of the FEM are derived from Lagrange's variational principle on the assumption of the linear distribution of displacements over a triangular element into which the meridional section of the shell was broken up. The system of linear algebraic equations was solved by Gauss' elimination method.

The numerical solution was accepted as accurate when doubling the density of the grid did not change the results of the previous solution by more than 3%. The accuracy of the numerical results obtained was evaluated by comparing them with the results of the calculations carried out according to a program described in [4], and experimentally by the method of small-base strain-gauge measurements of the axial and circumferential stresses.