# STRESS ANALYSIS OF A PRESTRESSED CONCRETE NUCLEAR PRESSURE VESSEL BY THE FINITE ELEMENT METHOD USING VARIABLE STRAIN ELEMENTS

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A number of finite element methods for Prestressed Concrete Pressure Vessel (PCPV) stress analysis problems, which are based on constant strain elements, have been introduced in the past. In this report, a summary is given of the development of a digital computer program by the finite element method using variable strain elements.

The program is aimed at analysing the elastic behavior of prestressed concrete pressure vessels as an axi-symmetric composite structure under any combination of the following axi-symmetric and non-symmetric loading conditions: body force, prestressing loads, thermal loads, surface loads, locked-in residual stresses, and seismic loads.

The PCPV is idealized by systems of the variable strain elements; i.e., six-point triangular elements and eight-point rectangular elements. Integration over the area of the element is carried out by analytical method to enhance the accuracy of the element stiffness matrix. The Conjugate Gradient iterative procedure (CG Method) is adopted to solve the total stiffness simultaneous equations.

Example analyses are given of cylinders subjected to axi-symmetric and non-symmetric loadings to illustrate the validity and practicability of the program.

The method is then applied to PCPV. The analysis results are compared with those obtained from the finite element method based on the constant strain elements, and it is shown that the results are more accurate with the same machine time and less input data.

In conclusion, the method can be used satisfactorily for the elastic analysis of PCPV and similar structures such as a prestressed concrete containment for a nuclear reactor.

Stress and deformation under any combination of loadings can be plotted automatically through another computer program which is also developed for this study.

All works were carried out on the IBM 360/75J computer operated by the IBM Japan Ltd., Tokyo, Japan.