STARS - A COMPUTER CODE FOR STRUCTURAL (DYNAMIC) ANALYSIS OF REACTOR SYSTEM

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This paper describes a procedure for determining the response of various reactor structures (including the core and the reactor internals) to applied dynamic loads, such as earthquake or forces due to loss of coolant accident. The calculational procedure is contained in the computer code STARS (Structural Analysis of Reactor Systems). The code calculates the transient response of a discrete mass, planar model, idealized by an assemblage of one-dimensional finite elements (i.e., elastic beams with bending and shear stiffness and linear and non-linear spring elements which may be gapped). A unique feature of the code is its capability to evaluate the transient response of two or more subsystems during impact as well as non-impact conditions. The code is written in Fortran IV and is operational on CDC 6600 computer having a capacity of 65,000 words.

The method of analysis is based on the displacement method and uses two numerical integration techniques, viz., fourth-order Runge-Kutta and the fourth-order Adam-Bashforth Predictor-Corrector methods. The dynamic equations of motion of the discrete mass system are formed and the response of each lumped mass is calculated at specific instants of time. At a given time the motions are held fixed. Based on the motion and internal forces at previous times, the responses at the time in question are predicted. With these predicted values of the motion, the internal forces are calculated. Using these forces, a new response motion is obtained. Therefore, at each time step, the relationship between the response motion and the internal forces is satisfied. The process is continued step-by-step throughout the time interval of interest.

In addition to the step-by-step solution of the nonlinear equations of motion, the STARS Code provides for the solution of the natural frequencies and mode shapes of the elastic system.

The loadings may be comprised of 5 random motions at 5 different nodal points and as many as 5 different force time histories at 20 nodal points. Viscous as well as non-viscous damping values may be specified. Output from the STARS Code consists of printed and plotted time histories of the response motions, internal distortions and internal forces, and internal bending moments. The paper also discusses the modeling techniques, test cases used to check out the accuracy of the code, and the results obtained. Possible applications of the code to analyze nuclear reactor systems during various loading conditions are discussed.