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MECHANICS OF MATERIALS MODEL

Jeffrey P. Meister
Institute for Computational Mechanics in Propulsion
Lewis Research Center
Cleveland, Ohio

The Mechanics of Materials Model (MOMM) is a three-dimensional inelastic structural analysis code for use as an early design stage tool for hot-section components. MOMM is a stiffness method finite-element code that uses a network of beams to characterize component behavior.

The Mechanics of Materials Model contains three material models to account for inelastic material behavior. These include the simplified material model, which assumes a bilinear stress-strain response; the state-of-the-art model, which utilizes the classical elastic-plastic-creep strain decomposition; and Walker's viscoplastic model, which accounts for the interaction between creep and plasticity that occurs under cyclic-loading conditions.

Static and transient analyses can be performed utilizing the MOMM code for applied loads, thermal loads, and enforced displacements. The transient analysis is performed using Newmark's integration scheme. Frequency and buckling problems are solved for by using conventional eigenvalue extraction techniques. Frequency and buckling analyses may be performed by using the initial or tangent stiffness.

Input parameters for the computer code consist of information defining the analysis model (geometry, material, boundary conditions, and loads) and information describing the method of solution to be selected. The model is defined by four-node rectangular elements called framework cells. The framework cells are transformed internally into a network of six beams (four edge beams and two diagonal beams). The initial material properties to be input include the modulus of elasticity, Poisson's ratio, mass density, coefficient of thermal expansion, and yield stress. A hardening slope must also be input for use with the simplified material model. The initial temperature is input and the time at initial conditions is set to zero. Boundary conditions are specified at each node by indicating a constrained or non-constrained condition for the six degrees of freedom. The number and type of load increments must also be specified. The user may specify various types of loads including concentrated loads, line loads, surface pressures, centrifugal loads, enforced displacements, and thermal loads.

Input associated with the method of solution includes (1) choice of constitutive model, (2) choice of static or transient analyses, (3) choice of buckling and/or frequency analyses, and (4) choice of initial or tangent stiffness for buckling or frequency analyses. A convergence value, defining the allowable relative difference in energy between two consecutive iterations to satisfy convergence, must also be input by the user. Figures 1 to 3 illustrate results obtained using the MOMM code for three sample problems.

CANTILEVERED PLATE RESULTS

LENGTH, 4 IN.; WIDTH, 1.0 IN.; THICKNESS, 0.05 IN.; ELASTIC MODULUS, 1.0×10^7 PSI;
POISSON'S RATIO, 0.25

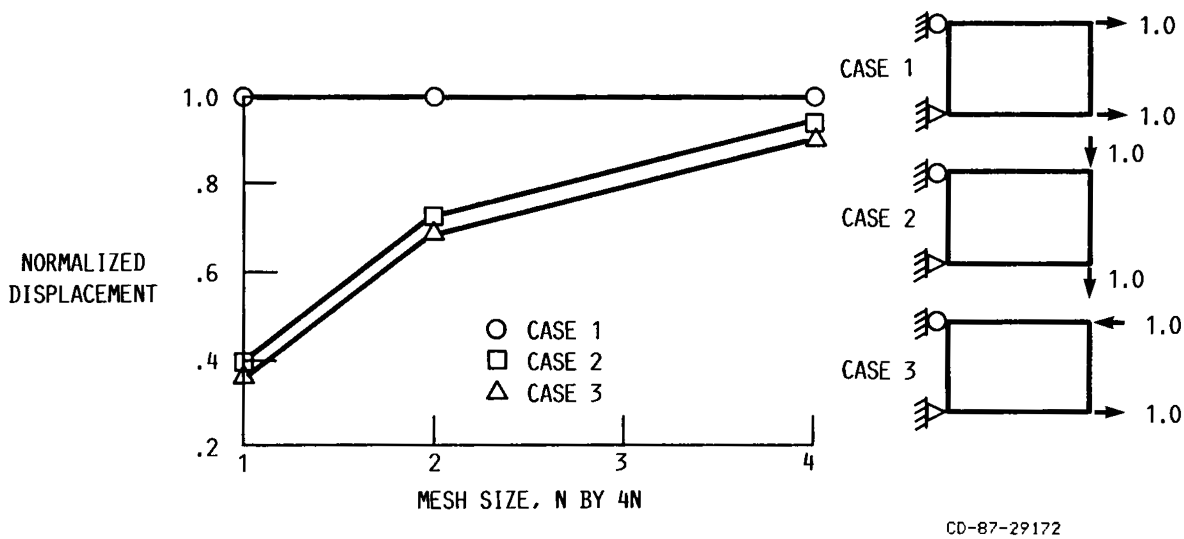


Figure 1

CLAMPED PLATE RESULTS

LENGTH, 20 IN.; WIDTH, 20 IN.; THICKNESS, 0.5 IN.;
ELASTIC MODULUS, 3.0×10^7 PSI; POISSON'S RATIO, 0.316; LOAD, 1.0 LB

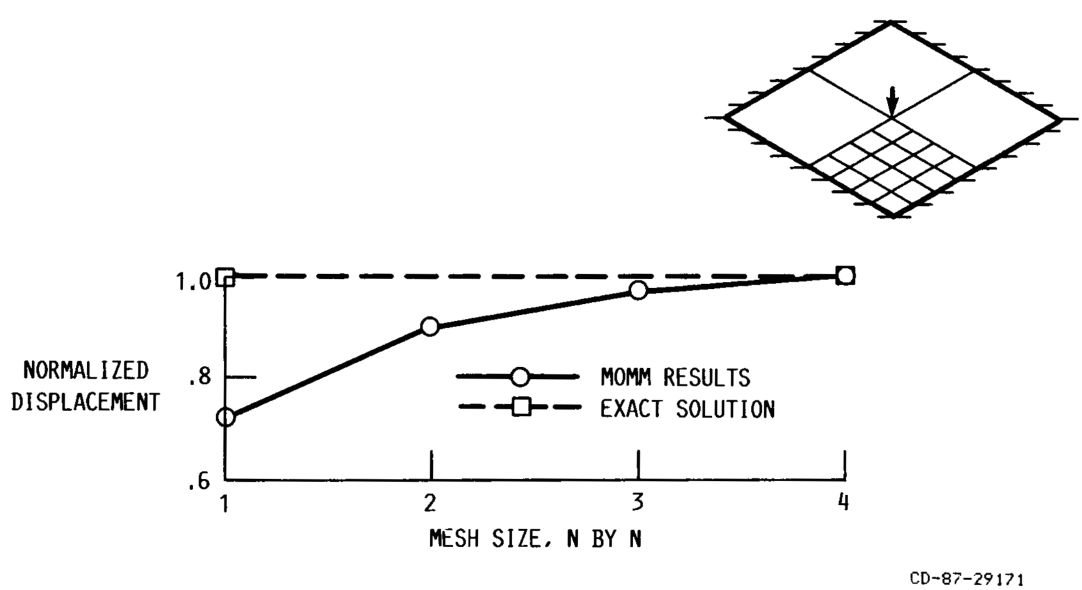
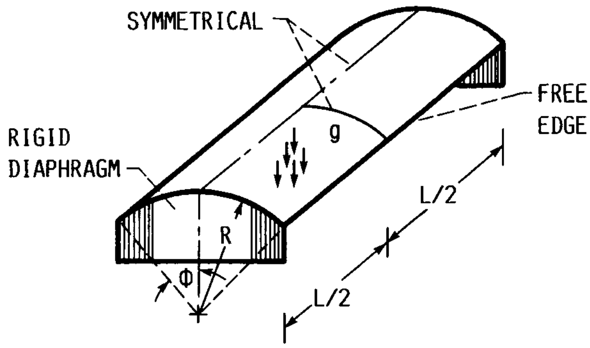


Figure 2

SHELL ROOF RESULTS

LENGTH, L, 50 FT; RADIUS, R, 25 FT; THICKNESS, 3 IN.; ELASTIC MODULUS, 3.0×10^6 PSI; POISSON'S RATIO, 0.0; SHELL WEIGHT, 360 PCF ($LB-FT^3$); $\Phi = 40^0$



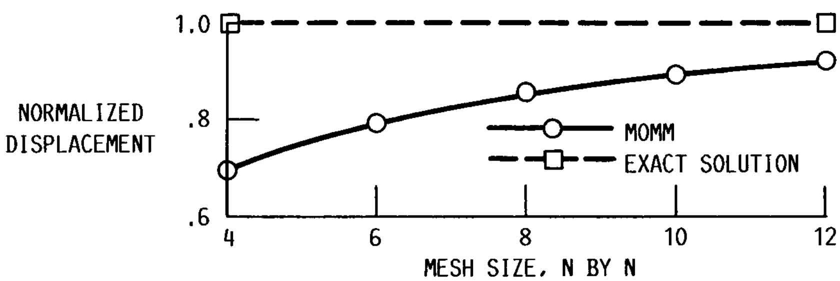


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Figure 3